Adaptive Management Framework for the Central and North Coast of British Columbia

Knowledge Summary:

Information Used for Estimating Probability of Success and Uncertainty for EBM Strategies

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Final Report
Prepared for the Ecosystem Based Management Working Group

Karen Price*, Stephen Tyler, Dave Daust and Cristina Soto
Contact: adaptive@telus.net
*pricedau@telus.net

Adaptive Resource Management Ltd.

Disclaimer

This report was commissioned by the Ecosystem-Based Management Working Group (EBM WG) to provide information to support full implementation of EBM. The conclusions and recommendations in this report are exclusively the authors', and may not reflect the values and opinions of EBM WG members.

Preface

This document is divided into two parts. Part I includes objectives related to the broad goal of maintaining ecological integrity. Part II includes objectives related to the broad goal of improving human well-being. Both parts are partially complete, addressing only some of the objectives that influence the broader goals. These gaps in the Knowledge Summary should be filled over the next few years as part of the adaptive management process.

Part I. Ecological Integrity

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1 Introduction

This document summarises current knowledge about the goals, objectives and management strategies in land-use plans applying to the North Coast and Central Coast of BC[1]. It can be used to support ecosystem-based management decisions and to prioritise studies that help improve management.

The knowledge summary is based on graphs that explicitly link objectives and management strategies[2]. These graphs are essentially hypotheses about the relationship between a strategy—represented by an implementation indicator—and the best-estimated probability of success at achieving an objective[3]. For example, a graph can be drawn to relate equivalent clearcut area (an implementation indicator) to the probability of achieving the objective of maintaining water quantity. This graph can be used to determine the probability of achieving the objectives associated with any indicator value (e.g. 20% equivalent clearcut area). The graph provides a simple visual tool to show the estimated probability of success of planned management strategies (target levels of indicators) in comparison with the probability of success based on the current situation. Assuming agreement on the importance of objectives, strategies with low probabilities of success are candidates for further planning and for effectiveness monitoring to determine actual negative consequences on ecological integrity.

All best-estimated relationships have associated uncertainty. The knowledge summary includes this uncertainty either graphically or in text description (the same information is presented in tabular form for human wellbeing). Areas of high uncertainty have high priority for study to increase confidence in the model. The knowledge summary discusses briefly how various uncertainties can be resolved.

Additional text provides further information useful for prioritising projects, including recovery time, influence of an objective on a goal and influence of a strategy on an objective.

The knowledge summary and associated prioritisation procedure can facilitate decisions about priorities for planning, implementation monitoring, effectiveness monitoring and validation monitoring and research based on the current and future state, the probability of success and uncertainty (

Table 1 below provides a generalised summary).

[1] The objectives and management strategies included are those listed in Price K and Daust D. 2007. Land-use plan summary for the North and Central Coast Regions of British Columbia. Report to the EBMWG.
[2] For definitions, *ibid*
[3] "Risk" as used in North and Central Coast documents is equivalent to {1 – [best-estimated probability of success]}. This document uses probability terminology as more intuitive to non-technical readers.

Table 1. High priority planning, monitoring and research activities as determined by information on objective/strategy pairs in knowledge summary. (See accompanying document; “Guide to the Knowledge Summary”)

Current state known	Target exists	Probability of success	Uncertainty	High Priority AM Activity
Yes or no	No	Not estimable	Not estimable	Planning
No	Yes or no	Not estimable	Not estimable	Implementation monitoring
Yes	Yes	Low	Low to medium	Planning; effectiveness monitoring
Yes	Yes	Low to high	High	Validation monitoring and research
Yes	Yes	High	Low to medium	None necessary; monitor implementation

The target audience for the knowledge summary includes planners, managers, researchers, and anyone involved in adaptive management or monitoring. The text requires some level of technical expertise and familiarity with the issues involved for any particular objective or goal.

The Knowledge Summary is intended to be a living document, to be refined and updated as information and desire warrants. In this way, communities, licensees or other groups can take the information included in the document and add their own knowledge, or create their own entries for an objective and strategies that are not included in this draft. For example, information on localised strategies and current indicator value may be included in Forest Stewardship Plans. Additionally, objectives and strategies taken from other sources (e.g. Fisheries Act) can be included. Essentially, the summary provides a formalised way of integrating and considering large quantities of information, seeded with existing knowledge relevant to the coastal ecosystem-based management process.

The companion document, a Guide to Using the Adaptive Management Knowledge Summary, provides a description of the knowledge summary and a prioritisation procedure for identifying AM projects, and includes guidance for updating or expanding this document.

2 Goal: Maintain Hydroriparian Ecological Integrity

Information Sources and Updates

Drafted: Karen Price, September 2008, based on an expert panel on coastal hydrology and sedimentology[4], an expert panel on coastal hydroriparian ecosystems, and review papers[5] completed as background for the Hydroriparian Planning Guide.

Reviewed:

Updated:

Overview of Current Knowledge Relating to Goal

Objectives associated with maintaining hydroriparian ecological integrity include maintaining streamflow levels, channel characteristics and water quality (sediment levels, temperature, chemical composition) within their natural range (Figure 1). Changes in flow and/or sedimentation can affect channel morphology and substrate. All changes can affect the organisms that rely on hydroriparian ecosystems. Biological objectives include maintaining the natural ecological function of hydroriparian ecosystems, and protecting and sustaining high-value fish habitat.

Uncertainty About Achieving Goal if Objectives are Achieved

Low.

Rationale: Taken together, the broad objectives to maintain water flow and quality and to maintain hydroriparian ecology cover the relevant factors influencing hydroriparian ecological integrity (Table 2). Maintaining stream morphology is the most influential physical objective; water quantity is less influential. Fish habitat is a subset of hydroriparian biodiversity.

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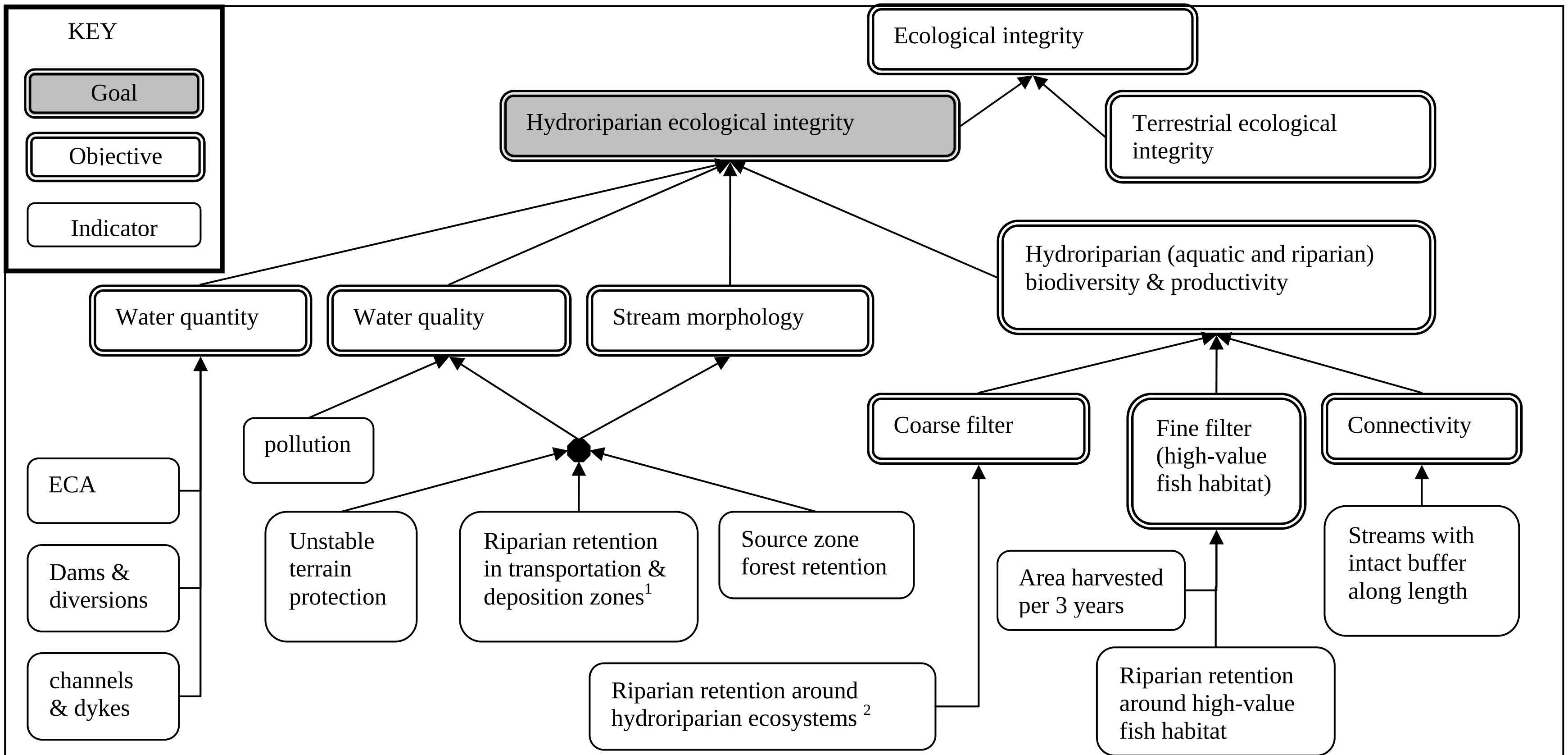
[4] Price, K. and Church, M. 2002. Risk to ecosystem functions. Summary of expert workshops. Hydroriparian Planning Guide Background Information. Participants: Gordon Butt (Madrone Consultants); Dan Hogan (Ministry of Forests); Peter Lewis (Ministry of Sustainable Resource Development); Michael Miles (M.A. Miles and Assoc.); Kyle Young (Simon Fraser University); Kristie Trainor (UBC); Nick Winfield (Department of Fisheries and Oceans), Michael Church (UBC), Jim Pojar (Ministry of Forests), Allen Banner (Ministry of Forests), Laurie Kremsater (UBC), Doug Steventon (Ministry of Forests), Rachel Holt (Veridian Ecological Consulting), Karen Price (consultant)

[5] Church, M and B. Eaton. 2001. Hydrological effects of forest harvest in the Pacific Northwest. Technical Paper #3 for Hydroriparian Planning Guide. Price, K and McLennan, D. 2002. Impacts of Forest Harvesting on Terrestrial Riparian Ecosystems of the Pacific Northwest. Technical Paper # 7 for Hydroriparian Planning Guide.

Figure 1. Objectives and strategies influencing hydroriparian ecological integrity goal[6]



[1] Applies to riparian forest around active fluvial units, wetlands, streams in transportation & deposition zones and small steep streams capable of debris transport.

[2] Applies to estuaries, karst, floodplains, fans, streams > 1.5m with fish, small steep streams susceptible to debris flow, small steep streams with distinct microclimate, all other streams, ocean spray forest, lakes, wetlands, forested swamps, bogs and fens.

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[6] Some objectives are divided into separate parts in this concept map (e.g., water quality is separated from stream morphology here).

Table 2. Summary of objectives and relative importance of each objective. MO = Ministerial Order; HPG = Hydroriparian Planning Guide; FRPA = Forest and Range Practices Act.

Objective Class	Influence on Goal	Objective Status
Water quantity: maintain streamflow within range of natural variability.	Medium	MO/FRPA
Water quality and stream morphology: maintain channel characteristics and water quality within range of natural variability.	High	MO/FRPA
Coarse filter hydroriparian biodiversity: maintain the natural ecological function of hydroriparian (i.e. aquatic and terrestrial riparian) ecosystems.	High	MO
Fine filter hydroriparian biodiversity: fish and high-value fish habitat	Low	MO/FRPA
Coarse filter hydroriparian biodiversity: connectivity	Low	HPG

If the goal is not achieved, recovery potential is variable: while some impacts can be remedied through restoration activities, catastrophic events and persistent small changes can have lasting impacts. Changed sediment loads can lead to loss of spawning habitat. Loss of species and genes is irreversible; loss of populations is difficult to reverse.

Influence of Goal on Other Goals

High.

Rationale: Loss of water quality carries a probability of a serious consequence for many other goals, including terrestrial ecological integrity, rare and focal species, grizzly bears, harvesting fish and wildlife, and tourism and outdoor recreation.

2.1 Objective: Maintain Water Quantity

Influence of Objective on Goal

Moderate. (Table 2 above).

Rationale: Although major impacts often follow high flows, sediment plays a larger role in changing system morphology. Most stream systems were developed during higher than current flows.

Recovery Period for Objective

Moderate.

Rationale: Hydrological recovery occurs in plantations after about 30 years—although full recovery takes longer. Roads do not recover until deactivation.

Relationships between Objective and Strategies

The objective is intended to be applied at a watershed scale. Because trees intercept and use water, flow responses (amount and timing of peak flows, mean flows, low flows) are related primarily to the amount and location, rather than type, of harvesting. Equivalent clearcut area indicates the amount of area cleared within a watershed.

Table 3. Summary of indicators and relative importance of each to the water quantity objective. MO = Ministerial Order.

Indicator	Influence on objective	Strategy status
equivalent clearcut area (ECA) per watershed	High	MO
dams, diversions, channels and dykes	High	CC LRMP

Dams, Diversions, Channels and Dykes

Uncertainty about achieving the water quantity objective arises because this indicator does not apply outside of the CC LRMP and because targets in the CC LRMP are open to interpretation.

Equivalent Clearcut Area (ECA)

In an extensive review of scientific literature for coastal ecosystems, significant changes occurred to hydrology with rates of forest harvest higher than 1% of the forested area of a watershed per year averaged over 20 years[7]. Studies have been unable to detect effects below this threshold, but these findings are likely due to statistical ambiguity or precision of equipment (e.g. weirs and climate measures). An expert panel convened to develop risk curves for BC's north and central coast drew two curves (one with, one without, roads) relating hydrologic risk to forest clearance. Figure 2 shows the curve associated with roads along with related uncertainty; without roads, the inflexion point moves from 20% to 30%.

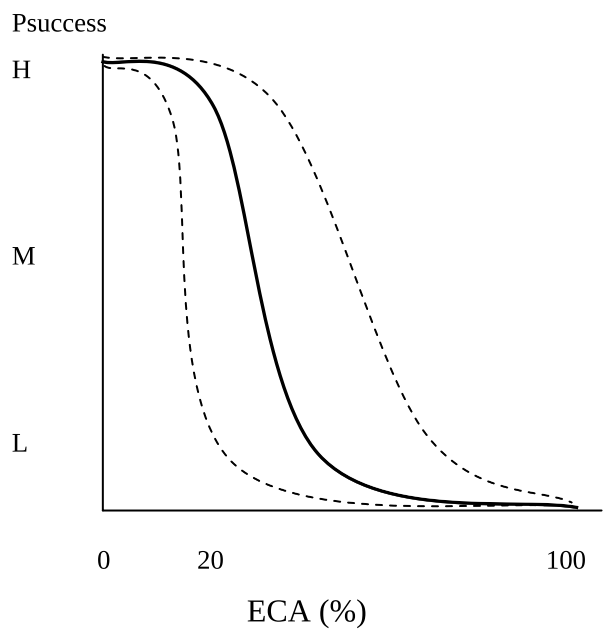


Figure 2. Probability of success at achieving water quantity objective as a function of forest clearance. Solid line represents best estimate; dotted lines represent extent of uncertainty.

[7] Church, M and B. Eaton. 2001. Hydrological effects of forest harvest in the Pacific Northwest. Technical Paper #3 for Hydroriparian Planning Guide.

The 20% clearance threshold (at which probability of success begins to decrease) defined by the expert panel matches the 1%/year rate-of-cut threshold averaged over 20 years concluded from the literature review; hence this curve is consistent with both local expert opinion and published literature.

In general, below 20% ECA, uncertainty is relatively low. Uncertainty in the middle of the curve is high (Table 4).

Table 4. Factors leading to uncertainty in the relationship between the ECA and water quantity.

Factor	Degree of influence	Ease of resolving
Variation among watershed features	High	Difficult—requires large-scale study for further resolution; coastal watershed assessment procedure can reduce uncertainty for a particular watershed
Location of harvest	Moderate	Resolvable by improving information on snowline and stratifying ECA by sensitivity of location
Roads	Moderate	Resolvable by including road density and location
Watershed size	Moderate	Resolvable by stratifying by watershed size
Lack of target for "non-sensitive" watersheds	High for those watersheds	Resolvable by defining a target for all watersheds

ECA (or, similarly, annual rate-of-cut) has a history of being an easy-to-measure planning indicator of changes in water flow. Unfortunately, it is a blunt instrument and cannot represent the complexity of hydrologic responses to harvesting. The variation among watershed features makes it difficult to generalise. Even within watersheds, natural annual flood size and low flow varies tremendously, making detection of changes in flow difficult without measurements of precipitation. Resolving uncertainty about the relationship between ECA and flow regimes requires a large-scale study stratifying watersheds by type. A coastal watershed assessment procedure has been developed that is able to assess the sensitivity of a particular watershed. Application of the complete procedure reduces uncertainty, particularly if calculations are based on percent of forested area in a watershed rather than total area[8].

Uncertainty arises because the indicator does not include location of harvest, roads or watershed size. Location of harvest is important because harvesting in riparian areas, variable source areas (e.g. wet sites linked to streams, alluvial fans) and peak-flow-generating zones (above the snow zone) will have higher impacts than harvesting elsewhere. Information on the elevation of the snowline would help to calibrate and refine the ECA indicator by determining peak-flow and low-flow generating areas. Roads also impact hydrology—again, location as well as overall density is important. Watershed size is a critical factor. Land-use is more likely to affect water flows in small watersheds; effects in large watersheds may be undetectable because they are swamped by natural variability. The uncertainty associated with this indicator could be reduced by stratifying watersheds by size, looking at small watersheds (e.g. down to 500 ha), examining ECA in sensitive and less sensitive locations, and including a measure of road density and

[8] Coastal Watershed Assessment Procedures have been modified at various times. The most thorough version best reduces uncertainty.

location (on wet sites and slopes). The requirement to complete overview watershed assessments when targets are exceeded in sensitive watersheds decreases uncertainty for these watersheds.

The lack of a target for watersheds other than those designated as “sensitive” greatly increases the uncertainty in these watersheds unless watershed assessments are completed. A target for % of source zone with forest at hydrological recovery age (see below under Maintaining Channel Characteristics) reduces this uncertainty somewhat. The definition of ECA as % of watershed area in the South Central Coast objectives adds high uncertainty. The natural variation in water flow in any watershed is linked to the amount of the area forested. By calculating the cleared area as a % of the watershed, it would be possible to remove all of the forest in a watershed with a small portion forested. This change could have a significant impact.

Available Implementation Data and Targets

Targets exists for “important fisheries watersheds” only. Data for current values have not been summarised (Table 5). **High priority** for data collection. **High priority** for setting targets for non-sensitive watersheds.

Table 5. Current and future indicator values (when known) for ECA.

	Current Indicator Value	Future Indicator Value
Central and North Coast important fisheries watersheds	Unknown	20%, or higher based on assessment
Central and North Coast other watersheds	Unknown	No target
South Central Coast important fisheries watersheds	Unknown	20%, or higher based on assessment
South Central Coast other watersheds	Unknown	No target

Probability of Achieving Objective and Uncertainty

The estimates in Table 6 are based on the indictor data and the current knowledge described above.

Table 6. Current and future probability of success and uncertainty for ECA.

	Current		Future	
	P(success)	Uncertainty	P(success)	Uncertainty
Central and North Coast important fisheries watersheds	Unknown	Unknown	High	Low
Central and North Coast other watersheds	Unknown	Unknown	Low*	High
South Central Coast important fisheries watersheds	Unknown	Unknown	High	Low
South Central Coast other watersheds	Unknown	Unknown	Low	High

*Due to lack of a target and knowledge that it is an issues.

The probability of maintaining water quantity is high in important fisheries watershed and low in other watersheds due to lack of a target. There is a particular need to investigate small watershed as noted under the objective to maintain high value fish habitat.

2.2 Objective: Maintain Channel Characteristics (Including Stream Morphology, Bank Stability and Downed Wood) and Water Quality Within Range of Natural Variability

Influence of Objective on Goal

High. (Table 3 above.)

Rationale: Changes patterns of sedimentation, bank stability and downed wood are the primary cause of long-term changes to channel morphology.

Recovery Period for Objective

Moderate.

Rationale: Watershed restoration activities are designed to aid recovery. While many strategies (e.g. road deactivation) can be effective, funding for restoration is not guaranteed, and neither is success. Large wedges of sediment deposited in streams take about 30 – 50 years to recover; small volumes are flushed out within a year. Active roads continue to deliver sediment until a few years following deactivation; inactive roads recover after 20 – 30 years.

Relationship between Objective and Strategies

This objective is designed to encompass stream morphology, bank stability, downed wood and sediment. Strategies to retain riparian vegetation around water features are the chief means of achieving success. The extent of the influence of riparian buffer on aquatic function varies with terrain and ecosystem. Physical functions of streams are influenced by at least one tree height; biological functions are influenced over greater distances[9]. On the coast, default buffer width is usually 1.5 site-potential tree heights; this distance can be modified (by half a tree height) to meet site-specifics.

Incremental sediment delivered to streams derives from roads, from activities in unstable terrain, and from destabilisation of stream banks and loss of downed wood. The indicators included do not deal with sediment introduced at road crossings, and hence the indicators are insufficient to measure success at achieving the objective. One indicator deals with unstable terrestrial terrain; another with unstable in-stream terrain. Most of the remainder are designed to consider bank stability and downed wood input around different types of hydroriparian ecosystems. Wetlands are less influential as they do not introduce sediment downstream. Buffers around transportation and deposition zones are a subset of active fluvial units. A final indicator looks at water pollutants.

Table 7. Summary of indicators and relative importance of each to the channel characteristics objective. MO = Ministerial Order; EBMH = Ecosystem-based Management Handbook; HPG = Hydroriparian Planning Guide; LRMP = Land and Resource Management Plan.

Indicator	Function of indicator	Influence on objective	Strategy status
% active fluvial units reserved including buffer	Bank stability	High	MO
% wetlands reserved including buffer	Bank stability	Low	MO
% of natural riparian forest buffer in transportation and deposition zones	Bank stability and downed wood	Medium	MO/FRPA[10]
% of potentially unstable terrain harvested	Unstable terrain	High	EBMH
% of natural riparian forest around small steep streams with high potential for debris transport	Unstable terrain	Medium	HPG

[9] See Hydroriparian Planning Guide and associated Technical Reports.
[10] For the South Central Coast, FRPA definitions of buffer width are an alternative option to those in the MO

% of source zone with functional riparian forest	Downed wood, ECA	Medium	MO
level of water pollutants	Water quality	High	LRMP

Impacts of Roads

Uncertainty about achieving objectives in relation to channel characteristics arises because there is no listed indicator relating to sediment derived from road crossings. The impact of road crossings is highly variable. If soil is not erodible, risk is minimal. Fine sediments may cloud the water, but will flush through quickly. Roads through erodible soils, however, have the potential to introduce larger sediment that remains within the system for longer.

Activities on Unstable Terrain

An expert panel convened to develop risk curves for BC's north and central coast[11] drew a single curve relating risk to stream morphology to an index of activities on unstable terrain. They based the curve on an index provided in the Coastal Watershed Assessment Procedure Guidebook (1995) that combines the length of road on Class IV or V terrain (km/km^2) and the ha of Class IV or V logged (%), where both values are rescaled to a score between 0 and 1[12]. The panel noted that probability of success is high for index values of less than 0.8, and low for values above 1.2 (Figure 3). This curve is consistent with coastal experience as documented in the Coastal Watershed Assessment Procedures, but insufficient published literature exists for comparison.

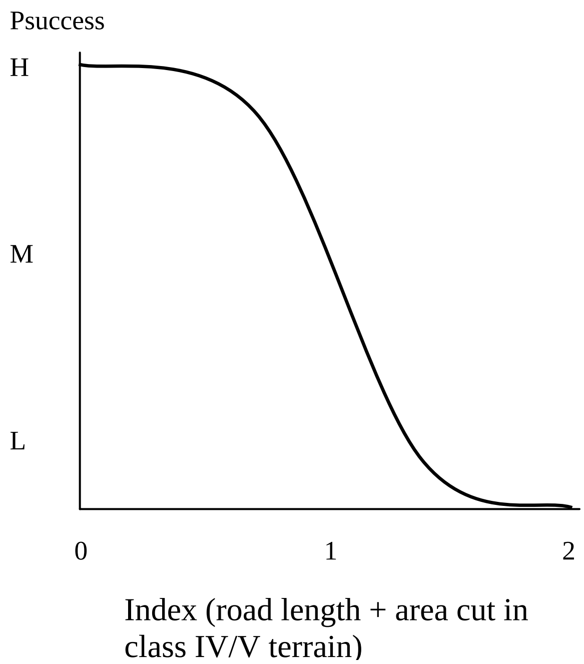


Figure 3. Probability of maintaining water quality as a function of activities in unstable terrain.

[11] Price, K. and Church, M. 2002. Risk to ecosystem functions. Summary of expert workshops. Hydroriparian Planning Guide Background Information. Participants: Gordon Butt; Dan Hogan; Peter Lewis; Michael Miles; Kyle Young; Kristie Trainor; Nick Winfield and Michael Church.

[12] See Hydroriparian Planning Guide for methodology.

There are several sources of uncertainty around this curve summarised in Table 8 and described in more detail below.

Table 8. Factors leading to uncertainty in the relationship between activities on unstable slopes and channel characteristics.

Factor	Degree of influence	Ease of resolving
Variation among watershed features	High	Sediment source mapping and erosion mapping could be used to stratify watersheds by sensitivity
Harvest and road-building and maintenance practices	High if best practices are not followed	Resolvable by stratifying by practice; difficult to tease apart effects of roads and harvest without large-scale study
Extent of coupling between hillslopes and stream systems	Moderate	Resolvable by including extent of coupling in monitoring

Uncertainty arises in the middle of the curve because some watersheds are more sensitive than others. An index of drainage basin sensitivity would usefully refine this general curve. If available tools for reducing risk are not used (i.e. best harvesting and road-building practices), uncertainty at the top portion of the curve would increase. The legacy of roads can last many decades, depending upon the quality of design and maintenance. Studies of fine sediment often confound the effects of roads and harvest, making it difficult to detect the cause. Basic information about the sources of sediment within a watershed before and after harvest would identify the sources particular to each watershed and determine if the size and natural amount of sediment sources changes with management. It would allow development of more refined stream quality indicators. Sediment source mapping, erosion mapping and terrain stability mapping have well-established methodologies. The location of Class IV and V terrain determines delivery potential: lack of consideration of whether hillslopes are coupled or uncoupled to stream systems increases uncertainty.

Streambank Stability

For streambank stability, the same expert group drew a suite of curves based on the % of riparian forest cleared (Figure 4). Ideally, this indicator considers all riparian forest that influences, and is influenced by, the stream: i.e. the buffer is defined by ecological criteria. Practically, it is based on the mean 1.5 tree-height default riparian zone.

In the source zone, where many streams flow through non-erodible material, the probability of success remains high until a high level of clearance. This curve shifts depending on the proportion of erodible material (i.e. streams with higher proportion of erodible materials are more sensitive). Some small streams in the source zone have a high potential for debris transport and follow a much steeper curve (described below under Hydroriparian Biodiversity).

In the transport process zone, where banks are largely alluvial, probability of success decreases rapidly with the proportion of riparian forest harvested. There is high sensitivity at small levels of forest removal because bank erosion yields additional sediment to the stream channel, which then forms deposits around which the stream must flow, resulting in additional current attack and erosion of banks. The expert group hypothesised that the deposition process zone may be even more sensitive because streambanks there are entirely composed of recent alluvium, but noted that documentation is insufficient to quantify any distinction. The unconfined nature of channels on floodplains and fans, and subsequent movement of the channel itself, means that the entire floodplain and fan must be buffered (i.e. buffering the stream channel alone is insufficient).

This curve is based on expert opinion, but the steep slope for streams in the transport and deposition zones is consistent with published literature.

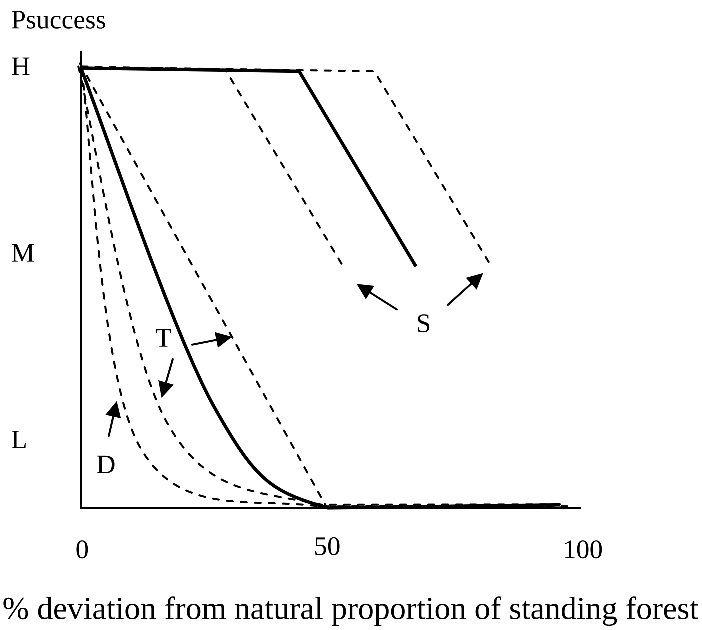


Figure 4. Probability of achieving bank stability, and hence water quality, as a function of natural riparian forest. D, T and S indicate deposition, transport and source zones, respectively, in the drainage basin. Solid lines represent best estimate; dotted lines represent extent of uncertainty (deposition zone has uncertainty only on one side of the solid line).

The uncertainty explicitly drawn in the figure around the transportation zone curve arises from lack of knowledge (Table 9). The uncertainty drawn around the source zone curve arises primarily from differences in the sensitivity to erosion of streambanks. There is additional (not explicitly drawn) uncertainty around both curves due to the possibility of windthrow in riparian buffers.

Table 9. Factors leading to uncertainty in the relationship between proportion of riparian forest and bank stability.

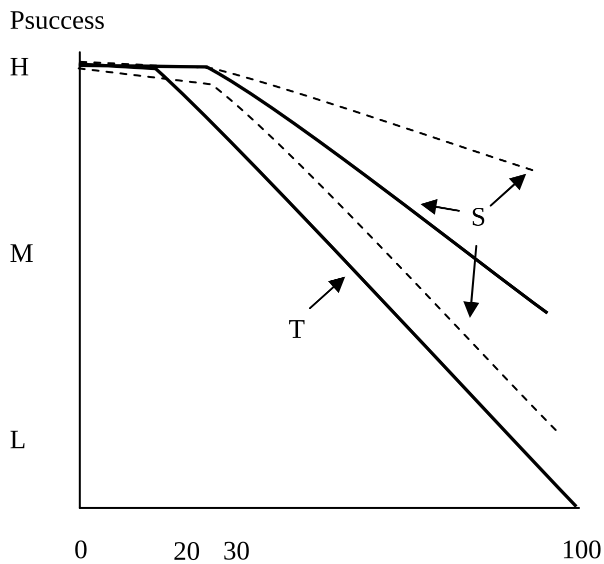
Factor	Degree of influence	Ease of resolving
Lack of knowledge	Moderate	Difficult—requires large-scale study
Variation in sensitivity to erosion	Moderate	Resolvable by stratifying by sensitivity
Windthrow	High	Resolvable by surveying windthrow over time

Downed Wood

Hydrological and terrestrial expert groups considered downed wood independently. Their models were fully consistent, with the exception that the terrestrial group did not explicitly draw curves for different process zones. The model below is based on the results of the hydrological group.

Process zones receive wood from different sources. In the source zone, most wood travels downslope during mass wasting events. In the transportation and deposition zones, most wood comes from adjacent riparian forest (though wood can still be delivered downslope to streams with a narrow valley flat). Old forest is a necessary part of the downed wood indicator in transportation and deposition zones. In the source zone, however, smaller pieces of wood may be effective. In the transportation and deposition zones, the probability of maintaining sufficient downed wood to maintain stream morphology and water quality is insensitive to removal of natural riparian forest up to 20% and subsequently increases linearly (Figure 5). In the source zone, the risk to downed wood is insensitive to forest clearance across the entire source zone of the watershed up to 30% and subsequently increases at an uncertain rate. Although the distinction between coniferous and deciduous cover is important, published information is insufficient to distinguish between forest types.

These curves are consistent with those for equivalent clearcut area and streambank stability above.



T: % deviation from natural riparian forest
S: % forest < 30 years

Figure 5. Probability of achieving objectives relating to channel characteristics in relation to downed wood, and hence water quality, as a function of standing natural riparian forest for the transportation and deposition zones; and of % of forest under 30 years for the source zone. Solid lines represent best estimate; dotted lines represent extent of uncertainty around the source curve.

The explicit uncertainty drawn around the source curve arises because of the lack of knowledge about the importance of large wood in small streams and because of variation among stream systems in the source zone (Table 10). There is uncertainty around both curves due to windthrow.

Table 10. Factors leading to uncertainty in the relationship between proportion of riparian forest and bank stability.

Factor	Degree of	Ease of resolving

	influence	
Lack of knowledge about importance of large wood	Moderate	Difficult—requires large-scale study
Variation in stream sensitivity to downed wood in source zone	Moderate	Resolvable by stratifying by sensitivity
Windthrow	High	Resolvable by surveying windthrow over time

Available Implementation Data and Targets

Targets exist for fluvial terrain units, for buffers around streams and wetlands in the transportation and depositions zones and for forest over 30 years old in the source zone. There are no targets for the indicators of activities on unstable terrain, for % of natural riparian forest around small steep streams with high potential for debris transport or for water pollutants. Data have not been compiled for any of the indicators (Table 11). There is a **high priority** for data collection and compilation. In particular, Forest Stewardship Plans might include specific strategies to minimise risk of landslides (a FRPA objective)—these strategies could be used to look at unstable terrain.

Table 11. Current and future indicator values for indicators relating to channel characteristics

Indicator	Current Indicator Value	Future Indicator Value
% of active fluvial terrain units reserved including adjacent natural riparian forest buffer: Central and North Coast	Unknown	100% of fluvial units; 90% of buffer
% of active fluvial terrain units reserved including adjacent natural riparian forest buffer: South Central Coast	Unknown	90% of fluvial units; 0% of buffer
% of wetlands reserved including buffer (for specified size wetlands)	Unknown	90% of forest in buffer
% of natural riparian forest buffer around streams in transportation and deposition zones	Unknown	90% of forest in buffer
% of potentially unstable terrain harvested (Class IV and V)	Unknown	No target
% of natural riparian forest around small steep streams with high potential for debris transport	Unknown	No target
% of source zone with functional riparian forest	Unknown	70% > 30 years old
level of water pollutants.	Unknown	No target

Probability of Achieving the Objective and Uncertainty

The estimates in Table 12 are based on the indicator data and the information described above.

Table 12. Current and future probability of success and uncertainty for indicators relating to channel characteristics.

	Current		Future	
	Psuccess	Uncertainty	Psuccess	Uncertainty
% of active fluvial terrain units reserved including adjacent natural riparian forest buffer: Central and North Coast	Unknown	Unknown	High	Low
% of active fluvial terrain units reserved including adjacent natural riparian forest buffer: South Central Coast	Unknown	Unknown	Low	Low

% of wetlands reserved including buffer (for specified size wetlands)	Unknown	Unknown	High	Low
% of natural riparian forest buffer around streams in transportation and deposition zones	Unknown	Unknown	High	Low
% of potentially unstable terrain harvested (Class IV and V)	Unknown	Unknown	Low*	Low
% of natural riparian forest around small steep streams with high potential for debris transport	Unknown	Unknown	Low*	Low
% of source zone with functional riparian forest	Unknown	Unknown	High	Low
Level of water pollutants.	Unknown	Unknown	Unknown**	Unknown

*Due to lack of target and knowledge that this indicator is an issue.
**Knowledge about whether this indicator is an issue is lacking.

The indicators with targets generally have a high probability of achieving the objective of maintaining water quality and stream morphology. The exception is due to the lack of a buffer around fluvial units in the South Central Coast. If water courses move to the edge of the unit, the lack of forest could lead to bank failure. The probability of overall success at achieving the objective is decreased due to the lack of targets for activities on unstable terrain and around small steep streams with high potential for debris transport.

2.3 Objective: Maintain Hydroriparian Biodiversity and Productivity: Coarse Filter

The probability of achieving hydroriparian ecological integrity may differ from that described above for terrestrial ecological integrity. Biogeoclimatic ecosystem classification was designed for classifying forested ecosystems. It does not consider hydrological features, provide landscape context, or combine sites into ecosystem complexes—all important aspects of hydroriparian ecosystems. Some hydroriparian ecosystems are particularly sensitive to disturbance; others influence ecosystems downstream. Considering hydroriparian ecosystems specifically facilitates assessing risk for these elements.

Influence of Objective on Goal

High. (Table 3 above.)

Rationale: This objective covers the biological elements of hydroriparian ecological integrity and hence complements the physical elements covered by the above objective.

Recovery Period for Objective

Variable; long for some functions.

Rationale: Some elements of hydroriparian function recover relatively quickly (e.g. shrub cover); some take over 100 years (e.g. downed wood, old riparian ecosystems); others may not return to the same state after disturbance (e.g. changes in ecosystem productivity following hillslope failures).

Relationships between Objective and Strategies

Hydroriparian exist at the interface of terrestrial and aquatic ecosystems. The presence of water moderates the microclimate and often increases the productivity and structural diversity of the adjacent forest. Forests adjacent to streams provide a source of litterfall and downed wood to the aquatic ecosystem. Some hydroriparian ecosystems are more sensitive to harvesting disturbance than others (Table 13).

Table 13. Sensitivity to disturbance and relative influence on hydroriparian ecological integrity of different hydroriparian ecosystems. MO = Ministerial Order; EBMH = Ecosystem-based Management Handbook; HPG = Hydroriparian Planning Guide.

% reduction in natural riparian forest in buffer around each hydroriparian ecosystem	Sensitivity	Strategy status
• estuaries,	High	MO
• floodplains,	Moderate	MO
• fans,	Moderate	MO
• karst,	High	EBMH
• streams > 1.5 m with fish,	Low	MO
• small (1 - 3 m) steep (>20%) streams/gullies with high susceptibility to debris flow,	High	HPG
• small steep streams/gullies with distinct microclimate,	Moderate	EBMH
• other streams,	Low	EBMH
• ocean spray forest,	Low	EBMH
• lakes,	Low	MO
• wetlands,	Low	MO
• forested swamps,	Moderate	MO
• bogs,	Low	EBMH
• fens	Low	EBMH

The probability of maintaining hydroriparian ecological function increases sigmoidally as the percent of natural riparian forest increases relative to amounts estimated under natural disturbance conditions (Figure 6). The shape of this curve is similar to that for terrestrial ecological integrity. Local experts in coastal ecosystems considered that different ecosystems have different sensitivity, and created a suite of three curves for highly sensitive, moderately sensitive and less sensitive hydroriparian ecosystems (they felt that uncertainty was too high for increased precision, and judged that information was not sufficient to draw different curves for different regions of the coast).

The expert group felt that estuaries, karst ecosystems and small, very steep streams/gullies with high susceptibility to debris flow follow the highly sensitive curve, where probability of success drops rapidly with any disturbance. The small, steep streams in this class are often gullied, incised in deep till, with accumulation of large organic debris, and may be glacier-headed. They are usually infrequent in a watershed, but may be concentrated in headwater scarps. They generate energy and materials that impact entire stream systems.

The experts defined moderately sensitive ecosystems as floodplains, fans, forested swamps and small steep streams/gullies with distinct microclimate. These small steep streams are located in more resistant bedrock, usually not gullied, and often bouldery with a tumbling step-pool structure. They provide a distinctive microclimate of high humidity within an envelope of trees, and house specially adapted organisms with low adaptive capability. Consistent with their discussions, the probability of success for these ecosystems follows a curve with inflexion points at 50% and 90% of natural (i.e. probability of success is high when intact ecosystems are more than 90% of natural; probability is low when intact ecosystems are less than 50% of natural; risk is intermediate between; Figure 6). Less sensitive fluvial ecosystems (remaining small streams, shoreline forests, lakes and wetlands) follow a similarly-shaped, but shallower curve, with inflexion points at 30% and 70% (Figure 6). In all cases, streams on unstable terrain follow the sensitive curve.

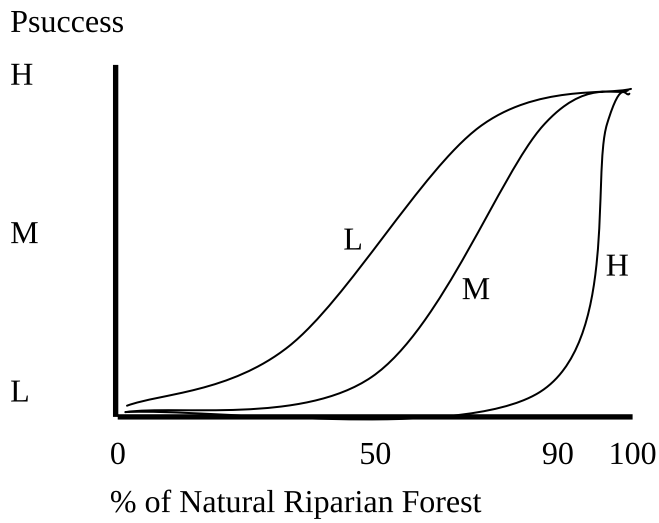


Figure 6. Probability of maintaining hydroriparian ecological integrity as a function of natural riparian forest. Highly sensitive ecosystems follow curve "H"; moderately sensitive ecosystems follow curve "M"; less sensitive ecosystems follow cure "L".

Table 28 above provides estimates of the natural proportion of old forest in the upland source zone (i.e. small steep upland streams and some wetlands) and around fluvial systems in the transportation zone of each region of the coast.

Uncertainty around the curves is low when the probability of success is low. Uncertainty is fairly high in the middle of the curves and moderate when probability of success is high. The uncertainty around the less sensitive curve is broader than around the sensitive curves because it covers a wider range of conditions (Table 14).

Table 14. Factors leading to uncertainty in the relationship between proportion of riparian forest and hydrological ecological integrity.

Factor	Degree of influence	Ease of resolving
Definition of riparian forest as fixed width	Moderate	Difficult to resolve as a generality. Requires assessment in the field and updates of map.
Blowdown in buffers	High in some areas	Resolvable by monitoring blowdown and improving estimates of potential to blow down.
Lack of indicator for interior forest	Moderate	Resolvable by analysing amount of interior riparian forest as well as amount influenced by edge
Management practices in buffer	Moderate	Irresolvable without a large-scale experiment.

Uncertainty arises primarily because the natural riparian forests are defined within target-width reserves (1.5 ± 0.5 tree heights). Hydrologically- and ecologically-defined riparian zones are sometimes wider, and sometimes narrower, than fixed-width targets. This uncertainty can only be resolved as stand-level mapping documents hydrologically and ecologically-defined widths. Even when appropriate width buffers are left, uncertainty is associated with blowdown. This uncertainty can be reduced by monitoring standing buffers over time and modifying practices accordingly.

Edge effects add further uncertainty. Ideally the indicator would examine three forest conditions: interior old growth, old growth equivalent and deciduous. Interior old growth gives the best indication of undisturbed riparian forest. Old growth equivalent could include edge or interior forest and can include recovery from variable retention. Deciduous ecosystems provide diversity in floodplains. This uncertainty could be reduced by analysing all three types of forest conditions. Looking at old growth equivalent requires further work on recovery, collecting through an adaptive management strategy.

Additional uncertainty arises because the activities within riparian management zones can vary considerably. The curves shown are based on the assumption of conventional harvesting.

Available Implementation Data and Targets

Information has not been compiled for these indicators (Table 15). There is a high priority for data collection and compilation. There are no targets for several indicators.

Table 15. Current and future indicator values for indicators relating to hydroriparian biodiversity.

Indicator	Current Indicator Value	Future Indicator Value*
% reduction in natural riparian forest in buffer around the following hydroriparian ecosystems:		
• estuaries: North and Central Coast	Unknown	0%
• estuaries: South Central Coast	Unknown	0 – 10%**
• karst ecosystems	Unknown	No target
• floodplains	Unknown	10%
• fans	Unknown	10%
• streams > 1.5 m with fish	Unknown	10%
• small (1 – 3 m), steep (>20%) streams/gullies with high susceptibility to debris flow	Unknown	No target
• small (1 – 3 m), steep (>20%) streams/gullies with distinct microclimate	Unknown	No target
• other streams	Unknown	No target
• ocean spray forest	Unknown	No target
• lakes	Unknown	10%
• wetlands	Unknown	10%
• forested swamps	Unknown	30%
• bogs	Unknown	No target
• fens	Unknown	No target

* Note that these targets are the low-risk/default targets; an additional 5 – 10% can be harvested with specifications
** Depending upon whether included as high-value fish habitat or not

Probability of Achieving the Objective and Uncertainty

The estimates in Table 16 are based on the indicator data and the information described above.

Table 16. Current and future probability of success and uncertainty for indicators relating to hydroriparian biodiversity.

Indicator	Current Psuccess	Current Uncertainty	Future Psuccess	Future Uncertainty
% reduction in natural riparian forest in buffer around the following hydroriparian ecosystems:				
• estuaries: North and Central Coast	Unknown	Unknown	High	Moderate
• estuaries: South Central Coast	Unknown	Unknown	Moderate to High	Moderate
• karst ecosystems	Unknown	Unknown	Low*	Low
• floodplains	Unknown	Unknown	High	Moderate
• fans	Unknown	Unknown	High	Moderate
• streams > 1.5 m with fish	Unknown	Unknown	High	Moderate
• small (1 – 3 m), steep (>20%) streams/gullies with high susceptibility to debris flow	Unknown	Unknown	Low*	Low
• small (1 – 3 m), steep (>20%) streams/gullies with distinct microclimate	Unknown	Unknown	Low*	Low
• other streams	Unknown	Unknown	Low*	Low
• ocean spray forest	Unknown	Unknown	Low*	Low
• lakes	Unknown	Unknown	High	Low
• wetlands	Unknown	Unknown	High	Low
• forested swamps	Unknown	Unknown	High	Moderate
• bogs	Unknown	Unknown	Low*	Low
• fens	Unknown	Unknown	Low*	Low

*Due to lack of target and knowledge that this indicator is an issue.

The probability of maintaining hydroriparian biodiversity is high for ecosystems with a target and low for those without.

2.4 Objective: Protect and Sustain High-value Fish Habitat: Fine Filter

Relative Influence of Objective on Goal

Low. (Table 2 above.)

Rationale: Fish habitat is a subset of hydroriparian biodiversity.

Recovery Period for Objective

Long.

Rationale: Although some elements of fish habitat (e.g. shade, invertebrate food sources) recover quickly; other elements, particularly structural complexity, flow stability and spawning substrate can take more than 100 years. Destruction of critical spawning or rearing habitat can result in loss of a fish stock.

Relationships between Objective and Strategies

Protection of fish habitat requires that all hydroriparian functions be maintained. Habitat depends on riparian structure as well as water flow, quality and temperature. Large pieces of downed wood increase channel complexity, form pools and provide shelter. Riparian vegetation moderates water temperature, filters sediment, stabilises channel banks and provides nutrients to the aquatic system. Considerable research exists on ecologically-appropriate riparian zones. A riparian buffer of at least one tree height is necessary to maintain function of the aquatic system[13].

Some fish habitat has particularly high value because it is used for spawning and rearing. These areas include all estuaries, floodplains (including off-channel habitat) and marine interfaces that are used by herring and marine invertebrates for reproduction. Changes to high-value fish habitat can have large detrimental effects to fish populations (Table 17).

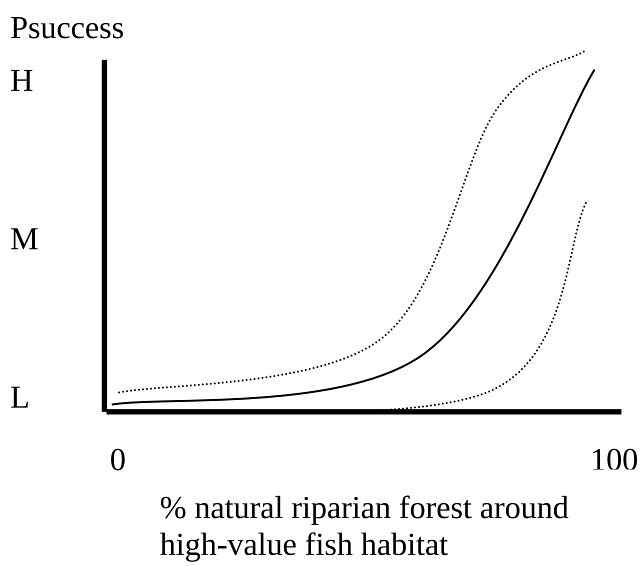
Process characteristics differ between small and large watershed systems. Watersheds smaller than 1,000 hectares are headwater-driven systems where hillslope disturbances directly affect adjacent channels. Hence, high-value fish habitat in these small watersheds is particularly sensitive to upslope activities, and a second indicator has been developed accordingly (Table 17).

Table 17. Summary of indicators and relative importance of each to the high value fish habitat objective. MO = Ministerial Order; EBMH = Ecosystem-based Management Handbook.

Indicator	Influence on objective	Strategy status
% natural riparian forest within 1.5 tree heights around high-value fish habitat;	High	MO
% of watershed harvested in 3 years in small watersheds.	Moderate	EBMH

Buffer around high-value fish habitat

Because of the sensitivity and critical nature of high-value fish habitat, the probability of maintaining high-value fish habitat drops rapidly as the amount of riparian forest deviates from natural (Figure 7). This curve integrates the various functions of riparian structure in providing fish habitat.



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[13] Young, K. 2001. A review and meta-analysis of the effects of riparian zone logging on stream ecosystems in the Pacific Northwest. Technical Paper #4 for Hydroriparian Planning Guide.

Figure 7. Probability of maintaining fish habitat versus retention of natural riparian forest around high-value fish habitat. Solid line represents best estimate; dotted lines represent extent of uncertainty.

There is moderate uncertainty at high probability of success because the strategies for some hydroriparian functions are not precautionary (see water quality section above). In particular, upstream impacts (e.g. debris flows originating in unbuffered small steep streams with high potential for sediment transport) can affect high-value fish habitat (Table 18). In addition, windthrow often removes some of the reserved buffer.

Additional uncertainty arises because the definition of high-value fish habitat may exclude important habitat types beyond those listed (e.g. small streams can be critical for coho).

Table 18. Factors leading to uncertainty in high-value fish habitat and existing indicators.

Factor	Degree of influence	Ease of resolving
Sediment transport from upstream	High	Difficult to resolve: requires large-scale experiment
Blowdown in buffers	Moderate (high in some areas)	Resolvable by monitoring blowdown and improving estimates of potential to blow down.
Definition of high-value fish habitat	Moderate	

Activities in Small Watersheds

Fisheries experts concluded that precautionary guidelines included in the Hydroriparian Planning Guide were sufficient to maintain high-value fish habitat in watersheds larger than 1,000 hectares, but that additional strategies were necessary in small watersheds. Processes in these watersheds are driven by headwaters; hillslope disturbances directly affect downstream channels.

They did not draw a curve relating the strategy to the objective, but estimated that probability of success would decrease if more than 10% of the forested area of a small watershed was removed over 3 years.

Available Implementation Data and Targets

There is a target for the first, but not the second, indicator. Data have not been compiled for either indicator (Table 19). There is a high priority for data collection and compilation.

Table 19. Current and future indicator values for indicators relating to high-value fish habitat

Indicator	Current Indicator Value	Future Indicator Value
% natural riparian forest within 1.5 tree heights around high-value fish habitat	Unknown	100%
% of watershed harvested in 3 years in small watersheds	Unknown	No target

Probability of Achieving the Objective and Uncertainty

The estimates in Table 20 are based on the indicator data and the information described above.

Table 20. Current and future probability of success and uncertainty for indicators relating to high-value fish habitat.

	Current		Future	
Indicator	Psuccess	Uncertainty	Psuccess	Uncertainty
% natural riparian forest within 1.5 tree heights around high-	Unknown	Unknown	High	Moderate

value fish habitat				
% of watershed harvested in 3 years in small watersheds	Unknown	Unknown	Low*	High

*Due to lack of target and knowledge that this indicator is an issue.

The probability of maintaining high value fish habitat is high based on activities around mapped habitat areas. However there is moderate uncertainty because of a lack of targets for some upstream hydroriparian ecosystems and because of windthrow. The probability of success in small watersheds is low with high uncertainty because of the high influence of upstream ecosystems on the high value fish habitat in these watersheds.

2.5 Objective: Hydroriparian Biodiversity—Connectivity

Influence of Objective on Goal

Low. (Table 2 above.)

Rationale: In general, published consensus is that amount of habitat reserved is more important than pattern.

Recovery Period for Objective

Moderate and variable

Rationale: Some elements of connectivity recover quickly (e.g. shade, cover for small organisms); others can take decades (e.g. heterogeneity).

Relationships between Objective and Strategies

There is general consensus that connectivity is important for maintenance of biodiversity. The role of corridors in providing connectivity is less well accepted, although support for the use of corridors for movement as well as for habitat is increasing for a variety of taxa. Riparian areas are natural candidates for corridors due to their lineal nature and use as travel corridors in natural systems (Table 21).

Table 21. Summary of indicators and relative importance of each to the High Value Fish Habitat objective. HPG = Hydroriparian Planning Guide.

Indicator	Influence on objective	Strategy status
• % of streams with natural cover along their entire length within process zones	High	HPG

Due to high uncertainty in the published literature about the use of riparian corridors, probability of success at achieving connectivity is estimated to decrease linearly as the proportion of streams with natural levels of cover increases (Figure 8). Although natural levels of connected cover vary across the coast (e.g., some areas have naturally connected forest from head to mouth; whereas in other areas streams usually cross avalanche tracks, bogs, and other non-forested ecosystems), a local expert group considered that a single curve for all regions reflects the current state of knowledge.

The curve does not apply at the level of individual streams, but to the population of streams within a watershed. Calculating the corridor indicator involves counting streams within a process zone.

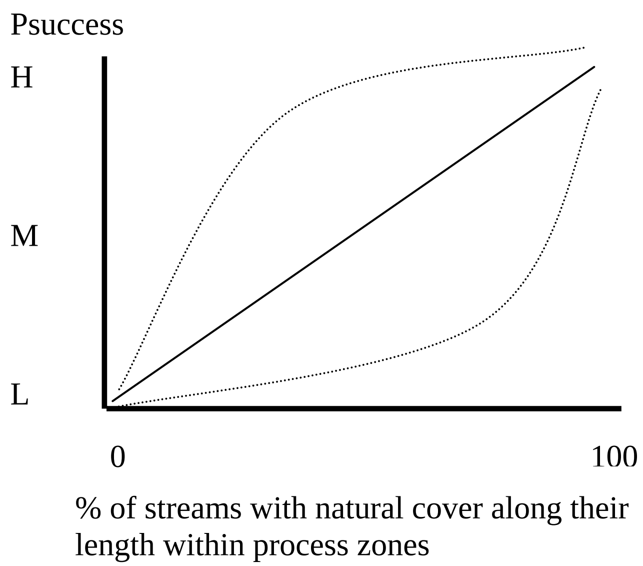

Figure 8. Probability of maintaining hydroriparian biodiversity versus natural cover along streams. Solid line represents best estimate; dotted lines represent extent of uncertainty.

Uncertainty is high, particularly in the middle of the curve, because organisms respond differently and because research on the effectiveness of corridors is difficult to conduct (Table 22).

Table 22. Factors leading to uncertainty in the relationship between percent riparian forest and high value fish habitat.

Factor	Degree of influence	Ease of resolving
Variable organism response	High	Very difficult: requires large-scale experiment

Available Implementation Data and Targets

There is no current legal target for this indicator. Data have not been compiled (Table 23). There is a high priority for data collection and compilation.

Table 23. Current and future indicator values for indicators relating to high-value fish habitat

Indicator	Current Indicator Value	Future Indicator Value
% streams with natural cover along length with process zones	Unknown	No target

Probability of Achieving Objective and Uncertainty

The estimates in Table 24 are based on the indicator data and the information described above.

Table 24. Current and future probability of success and uncertainty for indicators relating to high-value fish habitat.

	Current		Future	
Indicator	Psuccess	Uncertainty	Psuccess	Uncertainty
% streams with natural cover along length within process zones	Unknown	Unknown	Low*	High

*Due to lack of target and knowledge that this indicator is an issue.

Due to the lack of a target, the probability of success at achieving connectivity is low. Uncertainty is high, however, due to lack of knowledge about the effectiveness of riparian corridors in providing connectivity.

3 Goal: Maintain Terrestrial Ecological Integrity

Information Sources and Updates

Drafted: Karen Price, September 2008, based on a comprehensive literature review of threshold amounts of habitat where impacts are detected[14], estimates of natural disturbance in coastal ecosystems[15] and background papers on uncertainties[16].

Reviewed:

Updated:

Overview of Current Knowledge Relating to Goal

Maintaining terrestrial ecological integrity and maintaining hydroriparian ecological integrity are the two broad categories within the goal of maintaining ecological integrity. Objectives supporting the goal of terrestrial ecological integrity address ecosystem representation, stand structure, ecosystem productivity (soil and terrain impacts), rare species and exotic species (Figure 9).

Terrestrial ecological integrity and biodiversity are used interchangeably throughout most coastal documents. In the context of land-use management, terrestrial ecological integrity is primarily a function of the diversity and amount of ecosystems (which serve as habitats for species) and secondarily of their spatial pattern over landscapes. Ecosystem-based management hypothesises that maintaining a composition, amount and spatial distribution of ecosystems that reflects natural patterns will maintain biodiversity and ecological processes.

Ecosystem diversity reflects variation in the physical environment (e.g., climate, physiography), and in disturbance frequency and intensity. The biogeoclimatic ecosystem classification system (BEC) captures variation in the physical environment; seral stage and measurements of remnant structure capture disturbance frequency and intensity, respectively. Significant ecological variation occurs among BEC subzones and among site series within subzones. Similarly, seral stages differ ecologically and stands of a given age differ because of remnant structure.

Some ecosystems merit special attention because they are particularly important or because they are susceptible to damage. Riparian ecosystems, particularly floodplains and fans, are special because they are rich and productive—important to biodiversity[17]. Rare ecosystems can be lost from landscapes due to random disturbances. Deciduous and mixed deciduous-coniferous seral

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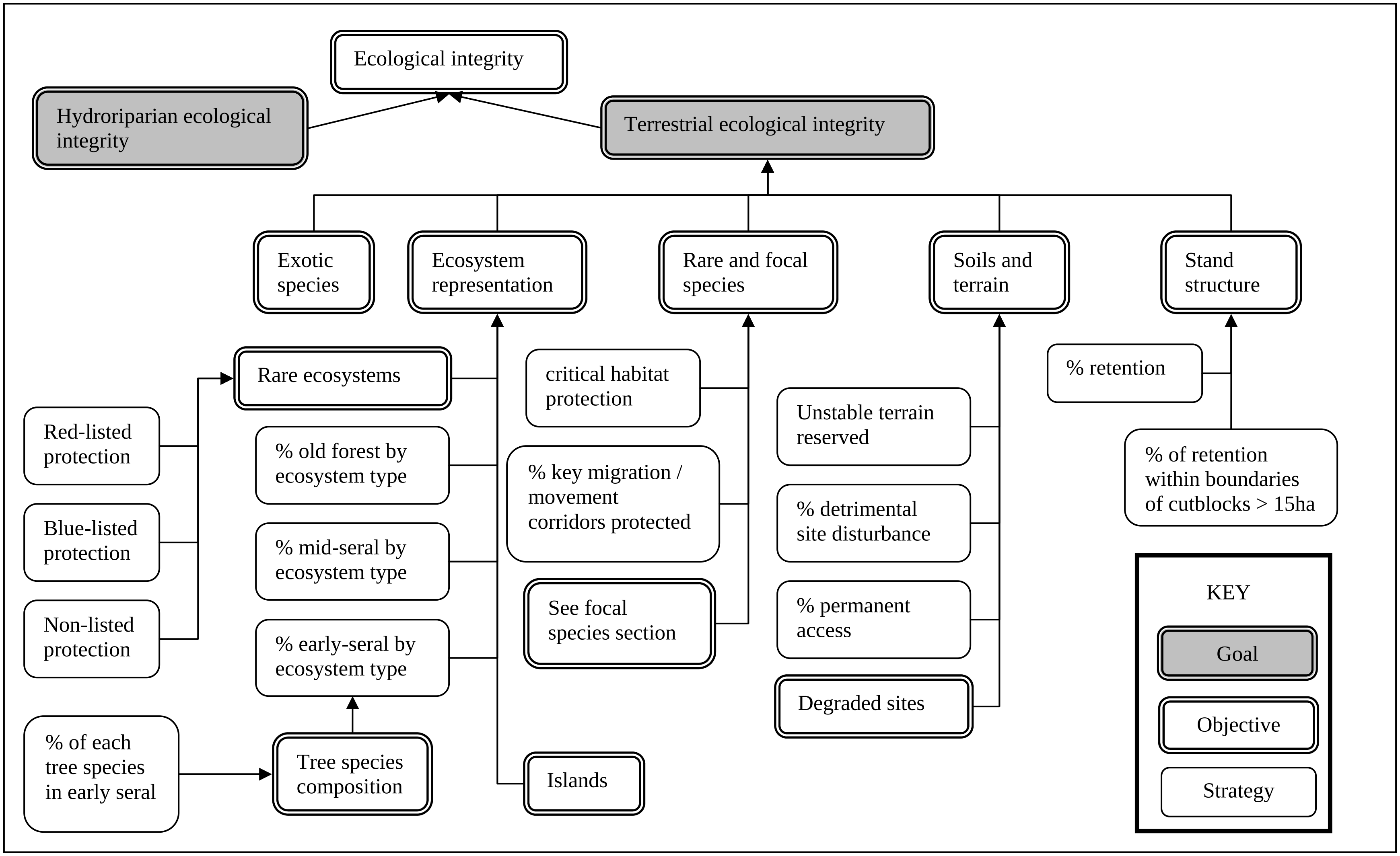
[14] Price, K., Holt, R. and Kremsater, L. 2007. Representative Forest Targets: Informing Threshold Refinement with Science. Report for RSP and CFCI.
[15] Price, K. and Daust, D. 2003. The Frequency of Stand-replacing Natural Disturbance in the CIT Area. Report for CIT.
[16] Holt, R., Price, K., Kremsater, L., MacKinnon, A. and Lertzman, K. 2008. Defining old growth and recovering old growth on the coast: discussion of options. Report for EBMWG; Price, K. 2008. Using site series surrogates to calculate ecosystem representation. Report for EBMWG. Kremsater, L., Price, K. and Holt, R. 2008. Accounting for stand-level retention. Report for EBMWG. Price, K. 2008. Deciduous ecosystem representation. Report for EBMWG.
[17] Terrestrial riparian ecosystems are considered under Hydroriparian Ecological Integrity.

Figure 9. Objectives and strategies influencing the terrestrial ecological integrity goal.



stages are vulnerable in landscapes managed for coniferous timber production. Similarly, some species or populations require special attention.

The spatial pattern of ecosystems determines the density of resources within a habitat and influences the ability of organisms to move among their habitats. Spatial pattern also determines the amount of interior and edge habitat. Some species prefer interior habitats; others prefer edge. Interior old forest habitats are most vulnerable to impacts of forestry.

Uncertainty About Achieving Goal if Objectives are Achieved

Moderate.

Rationale: Taken together, the objectives listed in coastal land-use plans[18] cover most relevant factors influencing terrestrial ecological integrity (Table 25). Objectives address both the diversity and seral stage of ecosystems on the landscape and within the stand. They highlight ecosystems that merit special attention. The objectives addressing ecological representation influence the goal most. Remaining objectives, applying to special ecosystems and species are of secondary influence. Several objectives—islands, exotic species and degraded sites—do not have strategies or readily available knowledge are not discussed in subsequent sections at this time.

Uncertainty about achieving the goal despite achieving all objectives arises because global warming is altering disturbance regimes and the moisture and nutrient regimes of sites, and because objectives for stand structure are poorly linked to natural disturbance.

Table 25. Summary of objectives and relative importance of each objective. MO = Ministerial Order; EBMH = Ecosystem-based Management Handbook; FRPA = Forest and Range Practices Act; LRMP = Land and Resource Management Plan.

Objective Class	Influence on Goal	Objective Status
Ecosystem representation: maintain the natural diversity of species, ecosystems and seral stages.	High	MO/FRPA
Rare ecosystems: protect known red- and blue-listed and regionally rare ecosystems.	Medium	MO
Habitat for rare and focal species: maintain adequate and sufficiently distributed habitat to maintain healthy populations and individuals of red- and blue-listed and focal species.	Medium	EBMH
Stand structure: retain forest structure and diversity at the stand level.	Medium	MO/FRPA
Tree species composition: maintain site productivity and a natural species mix.	Low	EBMH
Islands (missing strategies)	Medium	LRMP
Exotic species (missing strategies)	Medium	LRMP
Soils and terrain: conserve soil productivity and protect unstable slopes.*	Medium	EBMH/FRPA
Degraded sites (missing strategies)	Low	LRMP

* Covered under Maintain Hydroriparian Ecological Integrity

[18] Objectives are taken from Price, K. and Daust, D. 2007. Land-use plan summary for the North and Central Coast regions of British Columbia, updated where necessary to reflect changes in legal Land Use Objectives since the report was completed.

If the goal is not achieved, and species or genotypes are lost within the plan area, recovery potential is very low: loss of species and genes is irreversible; loss of populations is difficult to reverse. In highly dissected landscapes, like much of the coast, some organisms may be genetically distinct among sub-watersheds.

Influence of Goal on Other Goals

High.

Rationale: Loss of terrestrial ecological integrity carries a probability of a serious consequence for all other goals.

3.1 Objective: Maintain the Natural Diversity of Species, Ecosystems and Seral Stages

Influence of Objective on Goal

High (Table 25 above).

Rationale: This objective is essentially equivalent to the goal of maintaining terrestrial ecological integrity. Other objectives are subsets of special species or ecosystems.

Recovery Period for Objective

Long.

Rationale: Old forest takes centuries or even millennia to recover. It is possible to mitigate some of the impacts to old forest by creating structurally-variable mature stands (e.g. leaving snags, creating gaps), but such efforts are expensive and unlikely to be broadly applied. In addition, some elements of biodiversity, because of poor dispersal and/or particular requirements, depend on old trees.

Relationships between Objective and Strategies

Table 26 lists indicators, based on strategies included in land-use plans, that are related to the natural diversity of species, ecosystems and seral stages.

Table 26. Summary of indicators and relative importance of each to the natural diversity objective. MO = Ministerial Order.

Indicator	Influence on objective	Strategy status
% of natural abundance of old forest per ecosystem type	High	MO
% of mid-seral forest in each ecosystem type	Low*	MO
% of early-seral forest in each ecosystem type	Low*	MO

*current forestry practices do not reduce the abundance of these seral stages

The probability of maintaining terrestrial ecological integrity decreases sigmoidally as the amount of any ecosystem (seral stage and type) decreases (Figure 10). Conceptually, this curve applies to any seral stage. However, because old forest is the most prevalent seral stage naturally on the coast, and because it is also the seral stage most at risk, the curve is applied primarily to old forest. The probability of maintaining terrestrial ecological integrity is high when above 60% of the total area of an ecosystem is old, low when 30% is old, and intermediate between.

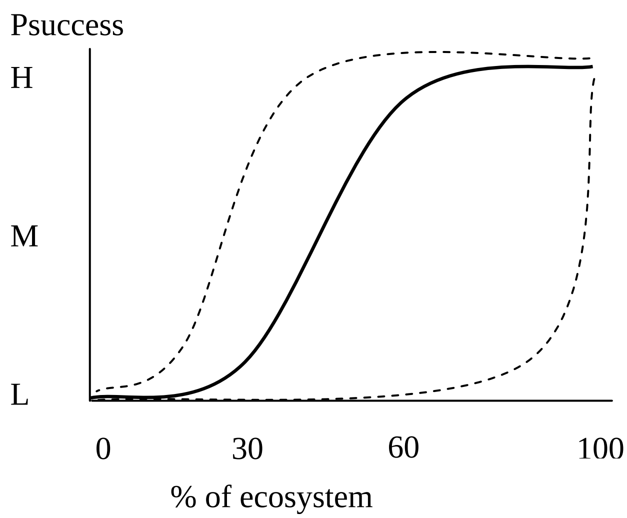


Figure 10. Probability of success at achieving ecological integrity versus percentage of each ecosystem. Solid line represents best estimate; dotted lines represent extent of uncertainty.

Different ecosystems experience different natural disturbance regimes, and the organisms within them are likely adapted to these regimes. Hence organisms (and communities and processes) may be more flexible in more-frequently disturbed ecosystems. Lower amounts of old forest, then, are required achieve a similar probability of success in more-frequently disturbed ecosystems. One way to account for this difference is to express the probability of success based on the amount of old forest *relative to* the amount occurring naturally (Figure 11).

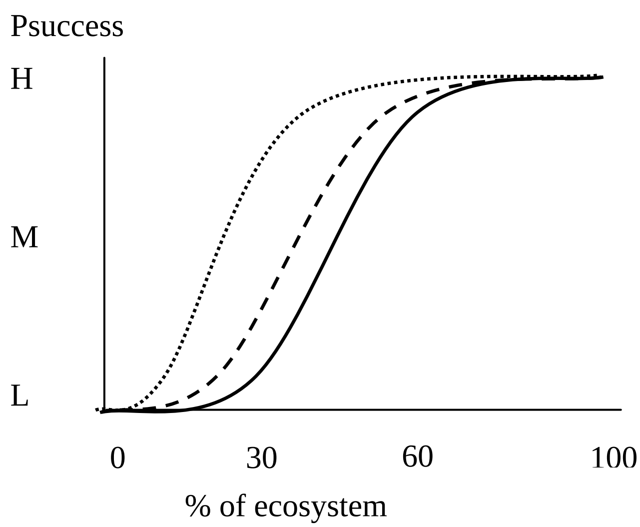


Figure 11. Probability of success at achieving ecological integrity for two ecosystems with different disturbance regimes. Solid line as in Figure 10; dashed line CWHvm1; dotted line CWHdm.

Uncertainty around the curve is low when the amount of an ecosystem drops below 30% (i.e. when probability of success is low). Uncertainty is high elsewhere due to several factors summarised in Table 27 and described in more detail below.

Table 27. Factors leading to uncertainty in the relationship between the % of ecosystem in old forest and ecological integrity.

Factor	Degree of influence	Ease of resolving
Ecosystem definition: site series surrogate	High for productive ecosystems, lower for less productive ecosystems	Resolvable by using site series
Ecosystem definition: old forest 250 or 180 years	High when used in timber supply analysis to determine cut	Resolvable by dividing "old" forest into classes
Variable organism response	High in middle of curve	Irresolvable
Negative exponential assumption	Low if ecosystems are classified correctly for natural disturbance estimates	Potentially resolvable by trying other models or dividing sample
Ongoing natural disturbances	Medium (potentially high due to climate change)	Irresolvable

Using timber analysis units as site series surrogates to define ecosystem type increases uncertainty when moderate to high levels of old forest remain. Analysis units are a very poor surrogate for site series because each unit includes a variety of site series. Within each analysis unit, productive site series will generally be at higher risk because they are targeted by harvesting; hence it is possible to retain a high proportion of each analysis unit and lose a high proportion of some site series. This uncertainty can be resolved by defining ecosystems by site series (or groups of site series that reflect ecology better than timber analysis units). Such TEM mapping is costly. Using a combination of ssPEM for planning and TEM collected during harvest planning could reduce uncertainty somewhat. Comparing analysis units and TEM in a spatial planning model would also reduce uncertainty as it is possible that strategies to maintain other values (e.g. hydroriparian ecosystems) also offer protection to productive site series.

Defining old forest by age, with a cut-off of 250 years in the North Coast and 180 years in the South Coast also increases uncertainty when high levels of old forest remain, because it does not capture the ancient forest ecosystems that dominate coastal landscapes. The vast majority of coastal forest is considerably older than 250 years under natural disturbance regimes; much of it is thousands of years old. Replacing these undisturbed forests with 250-year-old stands initiated by harvesting could result in the loss of attributes associated with ancient forests. Uncertainty also exists about the difference in attributes and processes between old and ancient forests. Practically, no harvested forest will cross these age thresholds for decades. However, because the age definitions are used in timber supply modeling, allowing forest to grow to 180 or 250 years and hence increasing allowable cut of undisturbed forest in the short term, this uncertainty is high. This uncertainty is resolvable by considering all age classes (e.g. 120 – 180, 180 – 250, 250 – 1,000, 1,000 +), or by separating ancient, or unmanaged, forests as a class.

Even with ecosystems defined by site series and considering all ages, uncertainty remains relatively high in the middle of the curve, because response varies among organisms (e.g.

sensitive or specialist species respond at higher habitat abundance than generalists). This uncertainty is not easily resolvable even with long-term experiments because the diversity of species' needs and the complexities of interactions among species means that risk will vary among ecosystems and species. It is possible, however, to reduce the uncertainty at relevant points on the curve by monitoring the most sensitive species naturally occurring in an area.

Some uncertainty is associated with natural disturbance estimates. These estimates are subject to the assumptions of the negative exponential model and the necessity of picking a time frame and spatial scale. The negative exponential model likely overestimates disturbance frequency. This uncertainty is somewhat resolvable by trying models other than the negative exponential and by ensuring that ecosystems are clustered appropriately for estimation of natural disturbance regime (e.g. separating north-facing terraces from south-facing slopes). In addition, climate change will influence natural disturbance regimes and add uncertainty to the current estimates.

An additional type of uncertainty is associated with achieving indicator targets (i.e. location on the X-axis rather than the shape of the curve). Large natural disturbances, added to harvesting disturbance, can move seral stage composition away from planned targets. This uncertainty decreases as scale increases.

It is not complex to detect when the percent retained of any seral stage of any ecosystem is putting ecological integrity at high risk based on theory. It is, however, very difficult to detect actual impacts to ecological integrity, because seral-stage distribution of ecosystems is the best coarse-filter surrogate for detecting impacts. Monitoring of particularly sensitive organisms is possible, but expensive, and hindered by low statistical power.

Available Implementation Data and Targets

Targets exist within Ministerial Orders for the amount of natural old forest in "site series surrogates" (analysis units within BEC variant). Data are available for current indicator values, but have not been compiled in a format appropriate for analysis yet[19]. There is low priority for further indicator data collection based on site series surrogates.

Natural disturbance frequency, and hence amount of naturally-old forest, has been estimated for most terrestrial and fluvial ecosystems on the coast (with the exception of some deciduous ecosystems; Table 28).

Table 28. Range of natural variability in proportion of old forest.

Region	Ecosystem[1]	Disturbance Return Interval[2]	% over 250 years	% over 180 years
Hypermaritime	Upland	4,500 – not since glaciation	95 – 98	96 – 99
	Fluvial	2,200 – not since glaciation	89 – 98	92 – 99
	Ocean spray	1,000 – 5,600	78 – 96	84 – 97
Outer Coast North	Upland	1,800 – not since glaciation	87 – 98	90 – 99
	Fluvial	500 – 2,100	61 – 89	70 – 92
Outer Coast South	Upland	900 – 2,500	76 – 90	82 – 93
	Fluvial	400 – 1,400	54 – 84	64 – 88
Inner Coast	Upland	500 – 5,600	61 – 96	70 – 97
	Fluvial	300 – 900	43 – 76	55 – 82

[1] Based on groups of site series listed in small-scale predictive ecosystem mapping
[2] To nearest 100 years (Price and Daust 2003)

[19] Holt, R. 2008. Base case analysis. Report to EBM WG.

Probability of Achieving Objective and Uncertainty

The estimates in Table 29 are based on the indicator data and the current knowledge about probability of success and uncertainty described above. Because the data are not yet available for analysis, Table 29 presents a general example only.

Table 29. Current and future probability of success and uncertainty for old forest.

	Current		Future	
Ecosystem	**P(success)**	**Uncertainty**	**P(success)**	**Uncertainty**
Rare ecosystems	Variable	High	High	High
Productive modal and common ecosystems	Variable	High	Low	Low
Unproductive modal and common ecosystems	High	Low	High	High

There is a high probability of success for maintaining rare ecosystems (analysis units within biogeoclimatic subzones) based on current targets. Existing targets pose a high risk to other ecosystems (that cover 94% of the landbase) and analysis shows that some ecosystems are already at high risk. High priority for planning and effectiveness monitoring.

3.2 Objective: Protect known red- and blue-listed and regionally rare ecosystems.

Influence of Objective on Goal

Medium (Table 25 above).

Rationale: Rare ecosystems are a sub-set of all ecosystems as addressed above. They require additional consideration, however, due to rarity: they have a higher probability of being lost due to stochastic events.

Recovery Period for Objective

Long.

Rationale: Most ecosystems listed as rare by the Conservation Data Centre[20] on the coast are old, and take centuries to recover. Potential of recovery is lower for rare than for common ecosystems as sources for locally extirpated organisms are further away, and low density of rare ecosystems limits colonisation and dispersal. Full recovery may not be possible.

Relationships between Objective and Strategies

Objectives call for specific attention to rare ecosystems because these ecosystems are at higher risk from stochastic events (i.e. it is easier for a disturbance to affect all of a rare ecosystem than all of a common ecosystem). Rare ecosystems listed by the Conservation Data Centre are based on the plant associations used in the Biogeoclimatic Ecosystem Classification System: i.e. they are specific structural stages of a site series.

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[20] Rare ecosystems in British Columbia are tracked by the Conservation Data Centre. Red-listed ecosystems typically have 20 or fewer good examples in all of British Columbia; blue-listed ecosystems have fewer than 100.

Ecosystems may be rare naturally, or may be rare because of historic alteration (e.g., logging). Ideally, only naturally rare ecosystems would be addressed here, and rarity due to alteration could be addressed under maintaining a natural seral-stage distribution.

Table 30 lists the indicators, based on strategies in the land-use plans, that are related to rare ecosystems.

Table 30. Summary of indicators and relative importance of each to the rare ecosystem objective. MO = Ministerial Order; EBMH = Ecosystem-based Management Handbook.

Indicator	Influence on objective	Strategy status
% of known red-listed plant communities protected	High	MO
% of known blue-listed plant communities protected	Moderate	MO
% of known non-listed, naturally rare ecosystems protected	Moderate to High	EBMH

As discussed in section 3.1 above, the probability of maintaining terrestrial ecological integrity decreases sigmoidally as the amount of any ecosystem (seral stage and type) decreases (Figure 10 above). Because of the lower probability of re-establishing organisms in rare ecosystems due to their dispersion over the landscape, this curve is shifted for very rare ecosystems, so that the probability of achieving the objective declines as soon as any red-listed ecosystem is harvested (Figure 12). Blue-listed ecosystems, with 20 – 100 examples in the province, follow a similar curve to the ecosystems shown in Figure 10. Rare ecosystems not listed by the Conservation Data Centre follow either curve depending upon their rarity.

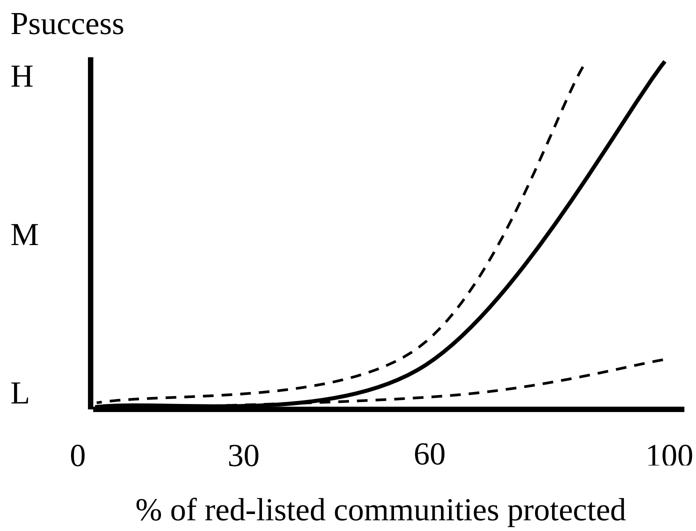

Figure 12. Probability of success at achieving ecological integrity versus percentage known red-listed plant communities protected. Solid line represents best estimate; dotted lines represent extent of uncertainty.

Uncertainty around the curve is low when the amount of an ecosystem drops below 60% (i.e. when probability of success is low). Uncertainty is high elsewhere due to factors summarised in (Table 27) and (Table 31) and described in more detail below.

Table 31. Factors leading to uncertainty in the relationship between the % of rare ecosystem protected and ecological integrity.

Factor	Degree of influence	Ease of resolving
CDC definition	High	Resolvable by classifying rare ecosystems as those site series with the potential to develop a rare plant community
Ecosystem definition: site series surrogate	High for deciduous analysis units	Resolvable by defining ecosystems by site series
Unlisted ecosystems	High for these ecosystems	Identifiable through local knowledge; uncertainty about risk is difficult to resolve

Beyond the uncertainties associated with all ecosystems listed in Table 27, an additional uncertainty in relation to listed rare ecosystems is that most are listed by the Conservation Data Centre as rare only in specific (usually old) seral stage. Hence, site series *with the potential to become* rare ecosystems over time, are not covered within the “rare ecosystem” objective. This issue reduces the certainty about probability of success because some productive rare ecosystems have been harvested to the extent that very few old stands remain. While these remnant old stands are protected, younger stands that would have become old, and developed the rare plant association, are not. This uncertainty can be easily resolved by including site series with the potential to become rare as they age in the criterion. Basing ecosystem definition of analysis units rather than site series adds to this uncertainty as ecosystems with the potential to develop rare plant associations may not be recognised as a different seral stage of a particularly site series under the surrogate system.

The uncertainty related to ecosystem definition by site series surrogates also poses additional uncertainty for rare ecosystems. Some cottonwood ecosystems are rare site series. Analysis units do not distinguish rare site series with large and long-lasting cottonwood components from more common site series with a shorter cottonwood stage. This uncertainty is resolvable by describing these easily-identified ecosystems by site series.

Uncertainty is high for indicators that only consider listed ecosystems. Truly rare ecosystems likely have not been described and listed. These unlisted rare ecosystems may be at particular risk because of lack of awareness. Conversely, some listed ecosystems are not truly rare and could be at less risk than suggested by the curve. Local knowledge is useful to reduce these uncertainties. Actual risk varies somewhat by ecosystem, but this uncertainty is difficult to resolve: some ecosystems may be more sensitive than others.

It is easy to detect when the percent alteration of rare ecosystems puts ecological integrity at high risk based on the hypothetical curve. It is also easy to detect negative consequences because loss of any rare ecosystem has, by definition, a consequence for ecological integrity. Field work actually examining species loss or community shifts is much more difficult.

Available Implementation Data and Targets

Targets exist in Ministerial Orders for listed, but not other, rare ecosystems (Table 32). No data are available to assess current indicator levels). There is a high priority to synthesise data to look at rare ecosystems. There is also a high priority to collect data comparing existing rare ecosystems to their historical extent.

Table 32. Current and future indicator values for rare ecosystems.

Ecosystem	Current Indicator Value (%)	Future Indicator Value (% of each occurrence)
Red-listed plant community	Unknown	100
Blue-listed plant community	Unknown	70[21]
Non-listed rare ecosystems	Unknown	0

Probability of Achieving the Objective and Uncertainty

The estimates in Table 33 are based on the indicator data and the current knowledge about probability of success and uncertainty described above.

Table 33. Current and future probability of success and uncertainty for old forest.

Ecosystem	Current		Future	
	P(success)	Uncertainty	P(success)	Uncertainty
Red-listed ecosystems	Unknown	Unknown	High	High
Blue-listed ecosystems	Unknown	Unknown	High	High
Non-listed rare ecosystems	Unknown	Unknown	Low	Low

The probability of success at maintaining CDC-listed ecosystems is high, although uncertainty is high due to lack of a target for recruitment of site series that have been heavily harvested. Other rare ecosystems are at high risk as there is not strategy in place to maintain them.

3.3 Objective: Maintain Adequate Habitat to Maintain Healthy Populations of Red- and Blue-listed and Focal Species[22]

Influence of Objective on Goal

Medium (Table 25 above).

Rationale: If all ecosystem types are adequately represented, habitat for most organisms will also be maintained. However, some species may have additional requirements (either because they range widely or are particularly sensitive to habitat availability).

Recovery Period for Objective

Variable; long for some.

Rationale: Habitat requirements vary among species; some may recover relatively quickly, but some habitat requirements may take over 100 years to recover. Mitigative actions are possible, but their success is questionable. Loss of species or genes is not recoverable. Loss of populations is difficult to reverse.

Relationships between Objective and Strategies

Table 34 lists the indicators, based on strategies in the land-use plans, that are related to rare and focal species.

Table 34. Summary of indicators and relative importance of each to the rare ecosystem objective. EBMH = Ecosystem-based Management Handbook.

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[21] There is an alternative option to protect at least 70% of each type of blue-listed community within a landscape unit.

[22] See sections on individual species for specific objectives

Indicator	Influence on objective	Strategy status
% of critical habitat of red- and blue-listed and focal wildlife species protected	High	EBMH
% of key wildlife migration/movement corridors protected	Moderate	EBMH

The probability of maintaining a given species decreases sigmoidally as the amount of critical habitat decreases (similar shape to Figure 10). Impacts on biodiversity are clear. Impacts on ecological integrity are less obvious due to the potential for species substitution. The function describing key migration corridors is likely similar.

Uncertainty around the habitat curve is low when the amount of a critical habitat drops below 30% (i.e. when probability of success is low) and when the amount of a critical habitat is high (above 60%). Uncertainty is high between 30 and 60% due to variability in response and because climate change will change ecosystem distribution and disturbance regime (Table 35). Neither of these uncertainties is easily amenable to general resolution. Further work on individual species can decrease uncertainty for these specific organisms.

Uncertainty is moderate to high at all points on the migration corridor curve because so little is known about the importance of corridors.

Table 35. Factors leading to uncertainty in the relationship between the % of critical habitat and ecological integrity.

Factor	Degree of influence	Ease of resolving
Variable organism response	High in middle of curve	Irresolvable
Climate change	Potentially high	Irresolvable
Lack of knowledge about corridors	Moderate	Very difficult

Available Implementation Data and Targets

There are no targets within Ministerial Orders for these indicators (Table 36). Information has not been compiled for current condition.

Table 36. Current and future indicator values for critical habitat.

Indicator	Current Indicator Value (%)	Future Indicator Value (%); (% total)
% critical habitat protected	Unknown	No target
% key migration corridors protected	Unknown	No target

Probability of Achieving Objective and Uncertainty

The estimates in Table 37 are based on the indicator data and the current knowledge about probability of success and uncertainty described above.

Table 37. Current and future probability of success and uncertainty for old forest.

	Current		Future	
Indicator	P(success)	Uncertainty	P(success)	Uncertainty
% critical habitat protected	Unknown	Unknown	Low*	Low
% key migration corridors protected	Unknown	Unknown	Low	Moderate

*Due to lack of a target and knowledge that this indicator is important; note that strategies designed for individual species could increase the chance of success for these species.

If strategies described for individual species are not sufficient, the probably of achieving this general goal is low due to lack of targets.

3.4 Objective: Retain Forest Structure and Diversity at the Stand Level

Influence of Objective on Goal

Medium. (Table 25 above).

Rationale: Stand-level and landscape-level retention serve different ecological purposes. However, if there is sufficient representation of each ecosystem over the landscape to ensure a high probability of success at maintaining ecological integrity, stand-level retention is less important[23]. As ecosystem representation decreases, stand-level retention becomes more influential to the success of maintaining ecological integrity.

Recovery Period for Objective

Long.

Rationale: Stand heterogeneity and large structures take more than a century to develop. Some mitigation is possible (e.g., creating snags), but potential is limited (e.g., tree size limits snag size) and activities are unlikely to be cost effective.

Relationships between Objective and Strategies

Natural disturbance leaves behind structural remnants of the pre-disturbance stand, including live trees, snags and downed wood (scattered and in patches). These structures play important ecological roles in the young, post-disturbance stand.

Table 38 lists the indicators, based on strategies in the land-use plans, that are related to stand structure.

Table 38. Summary of indicators and relative importance of each to stand structure. MO = Ministerial Order.

Indicator	Influence on objective	Strategy status
% of cutblock retained as standing trees, within and adjacent to clearcuts or within partial cuts	High	MO
% of retained standing trees that occur within cutblock boundaries in cutblocks larger than 15 ha	Medium	MO

At the stand scale, retention serves three primary functions: 1) maintaining species and processes that would otherwise be absent from early seral stands, 2) enriching re-established forest stands with structural legacies, so that they develop complex structures and begin to function as older stands sooner than they otherwise would; and; 3) enhancing landscape connectivity by providing a habitat mosaic in which organisms can move over small scales. Stand level retention starts to

[23] Based on conservation design principles.

provide benefits in the form of structural legacies at above 15 – 20%, and to provide benefits for maintaining species in stands at above 30%. Even at high levels of retention, harvested blocks are not equivalent to undisturbed forest. The probability of success at achieving the stand-level components of ecological integrity increases sigmoidally as a larger proportion of the block is retained as standing trees (Figure 13).

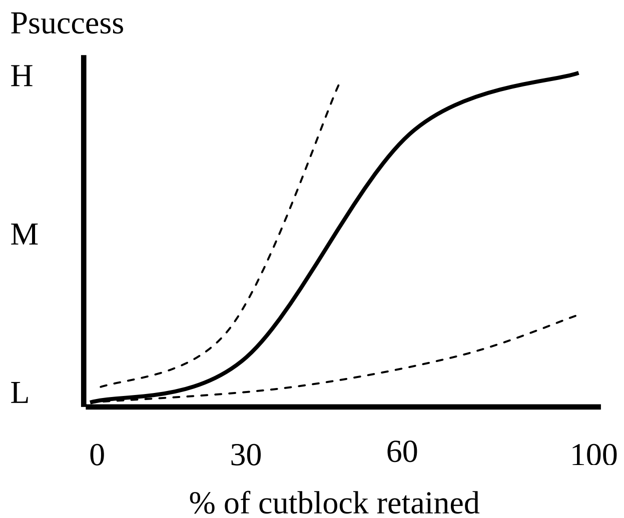


Figure 13. Probability of achieving stand-level ecological integrity as a function of the percent of cutblock retained. Solid line represents best estimate; dotted lines represent extent of uncertainty.

Uncertainty is low at low levels of retention and high at higher levels for several reasons (Table 39).

Table 39. Factors leading to uncertainty in the relationship between the % retention and ecological integrity.

Factor	**Degree of influence**	**Ease of resolving**
Allowance of retention to be outside stand	High	Resolvable by monitoring the portion of retention within the stand
Variable structure in patches	Moderate	Resolvable by defining retention based on the stand profile
Snags and downed wood	Low	Resolvable by monitoring types of structure
Windthrow	Moderate	Resolvable by surveying windthrow
Landscape context	High	Very difficult to resolve—requires large-scale experiment

Allowing some or all of the retention to be outside the harvested cutblock means that there could be nothing left within the stand: hence uncertainty is high that any of the three functions would be served, even at high levels of retention. This uncertainty could be resolved by only considering retention within a stand (i.e. set the second indicator at 100% for all block sizes).

Moderate uncertainty arises because retention can vary considerably in content. Larger structures are more valuable to a wider array of organisms than small trees: 15% retention of small trees in an unproductive microsite will not serve the same function as a similar patch of large trees in a productive area. This uncertainty could be resolved in part by considering only the retention that follows the profile of the harvested stand or biased towards larger structures. Further reduction of this uncertainty would involve field studies to investigate the relative value of different types of structures—a difficult and costly process.

Minor uncertainty is associated with the lack of any stipulation for snags or downed wood. This uncertainty is not large because standing trees (particularly if well chosen) will, over time, die and fall.

Moderate uncertainty is associated with the effects of windthrow on retention. In coastal forests with few stand-replacing disturbances, small remnant patches would be unlikely to result from natural disturbances. This uncertainty could be resolved by a field survey of windthrow.

The value of stand-level retention varies with landscape context. Unfortunately, literature examining the trade-off between landscape-level and stand-level retention is very sparse. Resolving this uncertainty would require a large-scale experiment examining different levels of stand-level retention in areas with different landscape-level retention.

Available Implementation Data and Targets

Data about current in-stand retention levels have not been compiled. Estimates of long-term remnant structure are not available. **High priority** for data collection. There are interim legal targets specifying a minimum of 15% retention, but no legal targets for higher retention in some blocks. Because retention is not required to be within the block (except for 50% for blocks over 15ha), the actual target for within-stand retention is uncertain (Table 40).

Table 40.Current and future indicator values for stand-level retention.

	Current Indicator Value (%)	Future Indicator Value (%)
% of cutblock retained within or outside block	Unknown	15%
% retained within blocks > 15ha	Unknown	50%

Probability of Achieving Objective and Uncertainty

Estimated levels of probability of success and uncertainty (Table 41) are based on indicator values and the relationships described above.

Table 41. Current and future probability of success and uncertainty for stand-level retention.

	Current		Future	
	P(success)	Uncertainty	P(success)	Uncertainty
% of cutblock retained within or outside block	Unknown	Unknown	Low	Low
% retained within blocks > 15ha	Unknown	Unknown	Low	Moderate

Targets put stand-level ecological integrity at high risk. However, because management practices may leave more structure—due to retention for other purposes—actual retention may be higher than targets, and the probability of success might be higher. Hence, there is a high priority for collecting information on current values.

3.5 Objective: Maintain a Natural Tree Species Mix

Influence of Objective on Goal

Low. Table 25 above.

Rationale: This objective is essentially a sub-set of the objective to "maintain a natural distribution of species, ecosystems and seral stages" above. It is noted separately because some tree species, especially western redcedar and cottonwood, form ecosystems characteristic of the coast.

Recovery Period for Objective

Medium.

Rationale: Tree species diversity can recover in less than 100 yr, given some minor mitigation. Deciduous trees generally occur in early seral stages (< 100 yr), but returning to natural abundance may take more than 100 yr, without mitigative practices that favour deciduous species. Similarly, coniferous trees can return to their original diversity in early seral stages, given mitigation. In later seral stages, succession will increase diversity in monocultures over time.

Relationships between Objective and Strategies

Table 34 lists the indicators, based on strategies in the land-use plans, that are related to tree species composition.

Table 42. Summary of indicators and relative importance of each to the natural tree species objective. FRPA = Forest and Range Practices Act.

Indicator	Influence on objective	Strategy status
% of natural occurrence of each tree species in managed early seral forest protected	High	FRPA

The probability of success at achieving the objective of maintaining a natural species mix increases proportionally as amount of each tree species increases up to the natural amount (Figure 14). Medium probability of success falls between 33% and 67% of natural.

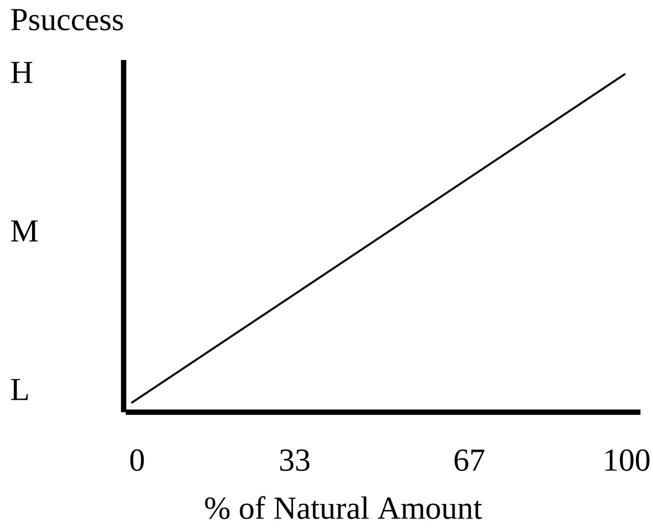


Figure 14. Probability of success of achieving a natural tree species mix versus percent component of each tree species in early seral stands.

Uncertainty around this curve is generally low. Uncertainty arises if tree species composition in old forest is affected by highgrading. For example, if western redcedar is harvested preferentially from some old site series, but the amount of the stand harvested is low, these sites could still be used to represent western redcedar ecosystems, but would not include any of the defining tree species.

Detecting negative consequences would be difficult, requiring study of organisms' response to tree species diversity.

Available Implementation Data and Targets

No targets exist within Ministerial Orders (Table 43); there are silvicultural requirements within FRPA. No data describe current indicator levels. **High priority** for data collection.

Table 43.Current and future indicator values for tree species component in managed stands.

	Current Indicator Value (%)	**Future Indicator Value (%)**
% of each tree species	Unknown	Unknown

Probability of Achieving Objective and Uncertainty

Estimated levels of probability of success and uncertainty (Table 44) are based on indicator values and the relationships described above.

Table 44. Current and future probability of success and uncertainty for tree species component in managed forests.

	Current		**Future**	
	P(success)	**Uncertainty**	**P(success)**	**Uncertainty**
% of each tree species	Unknown	Unknown	Unknown	Unknown

*Due to lack of a target and lack of knowledge about the extent of the issue.

The probability of achieving a natural tree species mix is unknown, There is not target, but many species will regenerate naturally. Species for special consideration may include cottonwood and western redcedar.

4 Goal: Maintain Specific Rare and Focal Species

This section can be completed when knowledge is compiled. A current EBM WG project is considering species-specific knowledge.

5 Goal: Maintain Grizzly Bears

This section can be completed when knowledge is compiled. Grizzly bear knowledge is being considered along with other focal and rare species in a current EBM WG project.

Part II. Human Well-Being

Table of Contents

1 Introduction

This document is a companion to the Knowledge Summary for Ecological Integrity. The EI Knowledge Summary is based mostly on research and the judgement of panels of experts convened over the previous years of study for the Coast Information Team to provide the best scientific evidence on coastal ecosystems. The KS for EI uses **graphs** to represent the probability of achieving the objective based on different levels of implementation of the proposed strategy, and related uncertainty.

The contents of this document, by comparison, **do not represent a comprehensive summary of scientific evidence about the relationships between Human Well Being goals, objectives and strategies.** This is partly because the HWB goals and objectives identified in Land Use Objectives are not matched by strategies, so it is impossible to link agreed objectives and strategies in the same way. It is also because there is no synthesis of evidence and information related to HWB in the same way that CIT studies synthesized ecological information for the Coast. The purpose of this document is to *illustrate* and test the application of a Knowledge Summary for Human Well Being. Because the users and contributors of HWB knowledge will frequently be community members or managers, the presentation format has been adjusted for readability: we use **tables** to represent nominal probabilities for achieving the objective given different implementation levels of the strategy. While the values used for specific indicators and probabilities are intended here to be *plausible*, and are sometimes backed by reference materials, they do not reflect a major research exercise and so are **not claimed to be accurate**. Accuracy can be improved, and utility of this tool increased, through collaborative updates of this material involving knowledge holders and managers.

This document explores two HWB goals taken from among the broad objectives referred in Schedules C and G of Land and Resource agreements between First Nations and the Province[24], and elaborates five specific objectives related to these. The goals are: Economic Diversification and Sustaining Cultural and Traditional Resources. A total of 21 strategies are proposed here to demonstrate how the Knowledge Summary can be structured. These are *illustrative strategies only* and are not based on documented management commitments.

To modify the strategies or values presented in these illustrative examples, managers could add information available to them from experience; or commission a research study by a suitable expert; or convene a workshop of diverse knowledge holders (local elders, experienced practitioners, professionals in the field, researchers); or consult broadly with community members who hold relevant knowledge. Different questions could be addressed by different knowledge holders. For example, it may be desirable to define specific quantitative target survival rates for juvenile scallops in grow-out: those would depend on the scale of the operation; seed and operating costs; and on feasible levels assessed by experts. This data could be assembled by managers with little difficulty. Updating the values of indicators or probabilities

[24] Schedule C in Land and Resource Protocol Agreement between Gitga'at First Nation, Haisla First Nation, Heiltsuk Nation, Kitasoo / Xaixais First Nation, Metlakatla First Nation, Wuikinuxv First Nation and Her Majesty the Queen in Right of the Province of British Columbia, March 23, 2006; and Schedule G in Land Use Planning Agreement-in-Principle between Mamalilikulia-Qwe'Awa'Sot'Em First Nation, 'Namgis First Nation, Tlowitsis First Nation, Da'nxda'xw Awaetlatla First Nation, Gwa'sala-'Nakwaxda'xw First Nation, We Wai Kai First Nation, We Wai Kum First Nation and Kwiakah First Nation and the Province of British Columbia, March 27, 2006.

in this draft on the basis of the knowledge of communities, resource managers, and relevant experts can be undertaken in a focused manner for those values that are particularly important for management decision-making (e.g. where experience is limited, influence on results is high, and uncertainty is resolvable).

In the following text where illustrative strategies are presented, implementation indicators are suggested for those strategies along with qualitative targets. In most cases, quantitative data for these indicators are not currently collected in a systematic fashion. However, the indicators are self-explanatory, and qualitative levels (e.g. Low / medium / high) could be obtained through local leaders or knowledgeable practitioners through interview or proxy surveys. If quantitative measures are needed, these would require investment in data collection.

How to use this Knowledge Summary: One benefit of the Knowledge Summary is that developing the KS focuses managers' attention on objectives and strategies (that is, what they should DO) rather than on problems. It provides a simple structure for thinking about management actions to achieve an agreed objective.

Readers can use the content of the KS, as updated, to identify priority AM actions. By referring to the summary tables at the end of each section dealing with a specific objective, and using the guidelines in Table 1 in the introduction to Part 1 of the Knowledge Summary, users can identify relevant opportunities for investment in monitoring or research.

2 Concept Maps

This section presents schematic "concept maps" that represent the goals, objectives and strategies addressed in this Knowledge Summary, showing key conceptual links. Each of the objectives and strategies is described in more detail in the text. Readers can refer back to these diagrams for an overview for each goal.

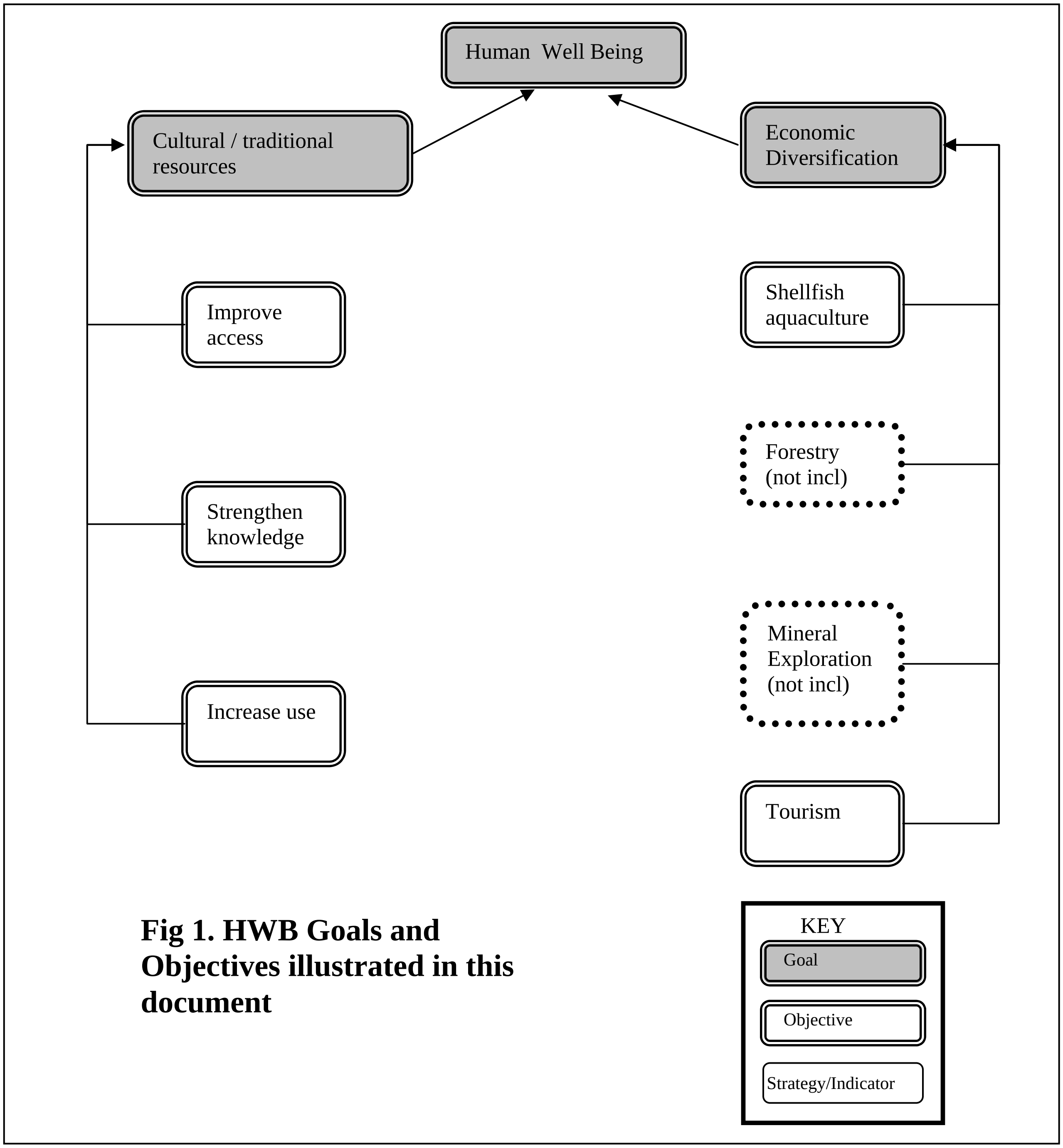


Fig 1. HWB Goals and Objectives illustrated in this document

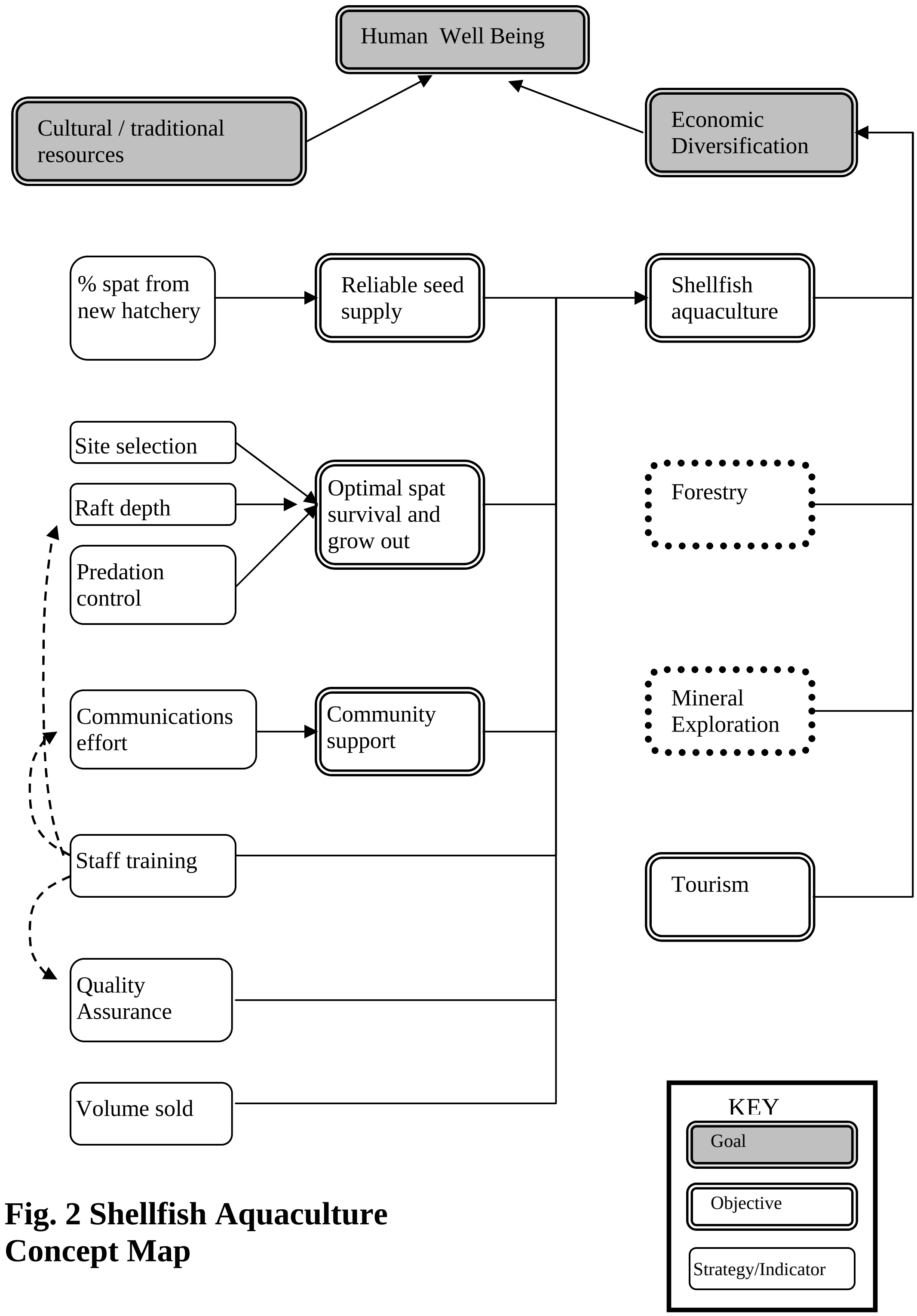


Fig. 2 Shellfish Aquaculture Concept Map

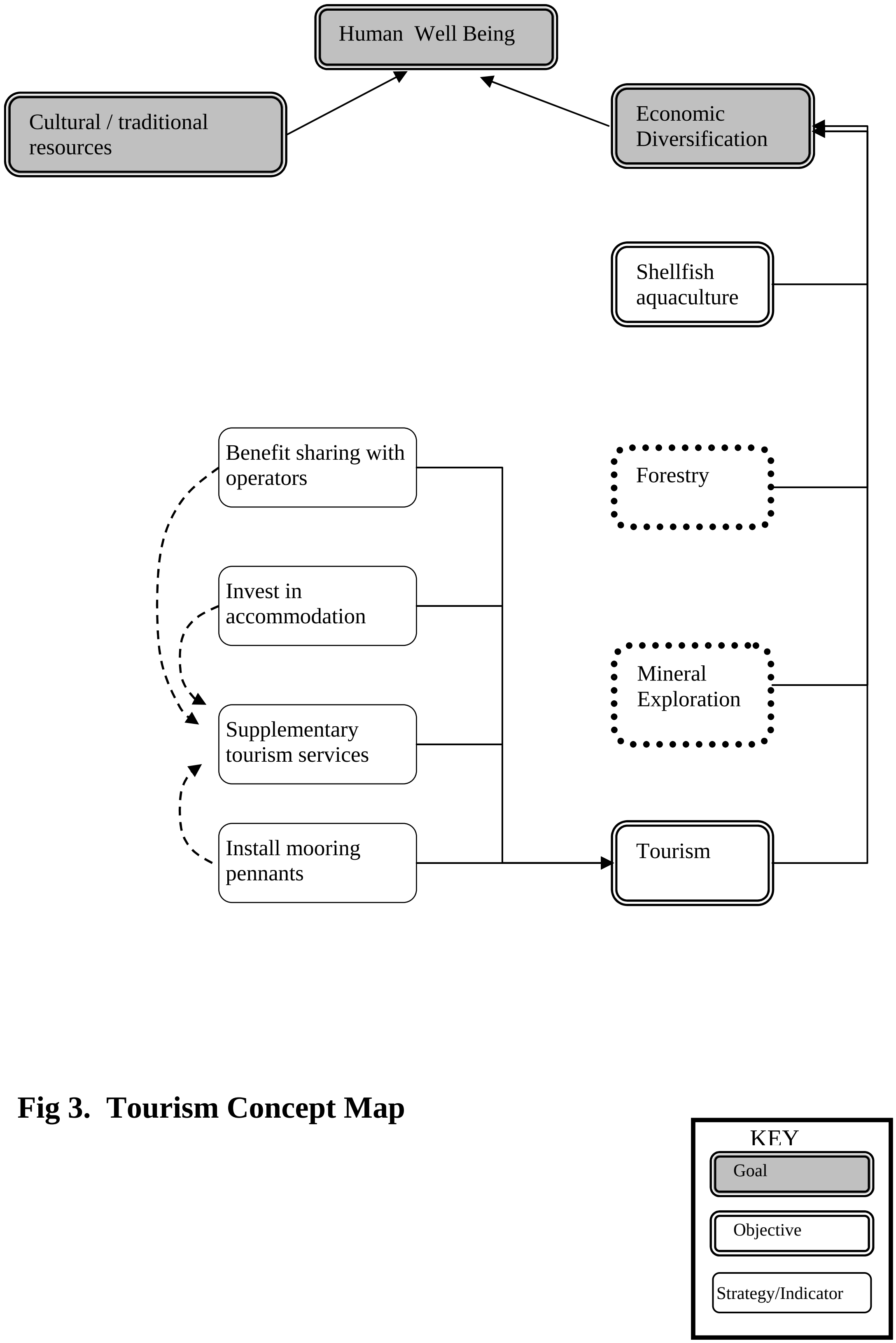


Fig 3. Tourism Concept Map

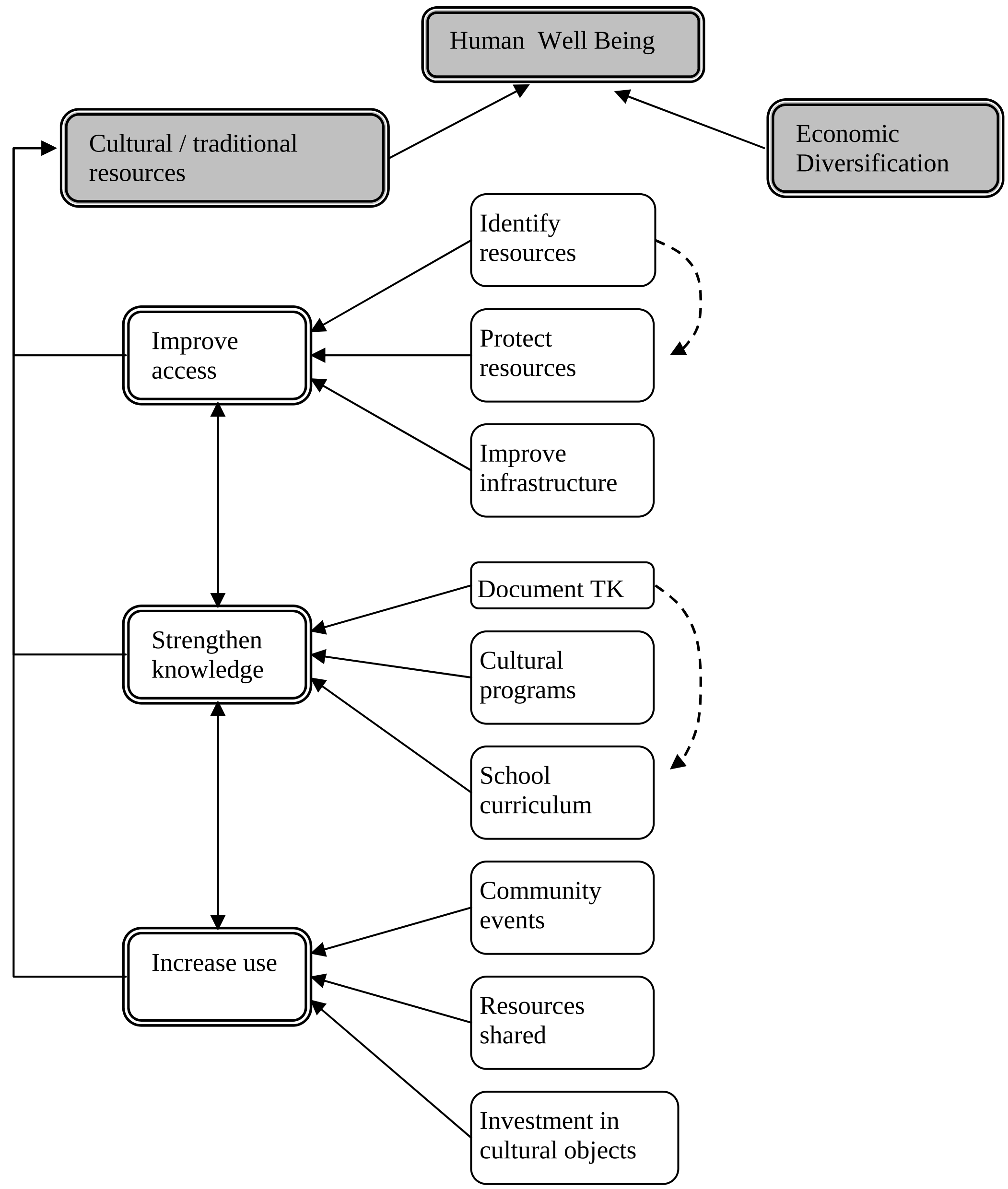
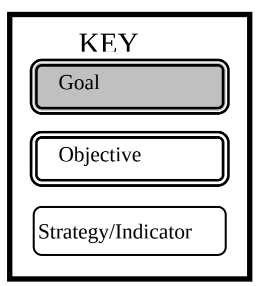


Fig. 4 Cultural and traditional resources concept map



3 Goal: Economic Diversification

Information Sources and Updates

Authors: Stephen Tyler and Cristina Soto

Sources: cited within text

Original Draft: November 2008

Revision Dates:

Information from Land-use Plan Summary

The full text of the goal addressed in this section is:

"Diversify the economies of First Nations' and other communities in the Plan Area(s)".

This statement is an Objective in Schedule C / G, but given its breadth is considered a goal here, with accompanying Objectives.

This goal contributes to achievement of the even broader goal of "providing adequate opportunities for individuals and households to meet their needs" (EBMH), which in turn addresses the ultimate social goal of "achieve high levels of human well-being" (EBMH).

This goal is related to the goal to "promote Plan Area(s) resource development by local individuals and communities" (also from G2G agreements) and the goal to "improve prospects for employment in the Plan Area" (from G2G agreements). Economic diversification introduces new economic activities that can take advantage of the region's natural resource assets, and creates new local employment opportunities.

A variety of specific objectives and strategies have been identified at the community level to address this goal. Forestry, tourism, and shellfish aquaculture are all strategies adopted by coastal communities to diversify their economies and increase employment. Details vary between communities, but the information below can be modified to reflect local specifics.

Overview of Current Knowledge Relating to Goal

The plan area contains abundant natural resources: terrestrial, aquatic and marine. Objectives aim to develop different resource sectors. Traditionally, local people have used fish and shellfish for sustenance. Historically rich commercial fisheries have been depleted, and the likelihood of stock recovery is low. Practical alternatives for commercial employment include forestry, tourism, and shellfish aquaculture. Mineral exploration offers lower potential as the region is not known for terrestrial mineral deposits, exploration is difficult and costly in comparison with more accessible regions of the province, mineral exploration offers only a limited number of jobs, and those require high levels of technical expertise. All three of the main economic options for diversification require development of new skills and assurance of high-value markets to ensure long-term commercial success and sustainability. Marketing strategies for these sectors focus mainly on quality of the product, requiring greater emphasis on management, staff training, consistency and quality control.

The different diversification options impose different demands for community labour and marketing skills. Tourism training is comparatively low-cost and can be undertaken seasonally as required for entry level and low-skill positions. However, specialized positions (chef, guide, management) require experience, certification, and / or training outside the community. Because of the high cost of travel to the region, the tourism market is limited and expensive. Customers demand a high value, high quality experience, requiring special efforts by staff. Marketing must be carefully targeted and built on reputation and personal referrals by discriminating guests.

Logging is a high cost activity in relatively inaccessible coastal areas. Labour skill requirements are variable, but many positions demand high technical skills and costly training. Vulnerability to commodity market cycles can be reduced through specialization in niche products or markets, but this requires reliable access to quality logs and greater attention to performance (e.g. delivery of product to timing and quality specs).

Shellfish aquaculture requires a range of skills – a typical shellfish farm requires basic technical skills for most operating staff, and builds on existing community skills (fishing, marine livelihoods, navigation, outdoor work). The industry requires high capital investment in production and processing, frequent and predictable transportation services and knowledge of markets.

Uncertainty About Achieving Goal if Objectives are Achieved

If all objectives are achieved there is low uncertainty that the goal will be met, because multiple resource based businesses would diversify the economy by definition (Table 1). Again, by definition, no single objective can have a dominant influence on the goal.

Table 45. Summary of objectives and relative influence of each objective on the goal.

Objective	Influence on Goal
Develop a viable shellfish aquaculture sector that contributes to the local economy	Moderate
Develop a viable forest sector that contributes to the local economy	Moderate
Develop a viable tourism sector that contributes to the local economy.	Moderate
Develop a viable mining exploration sector that contributes to the local economy	Low

Influence of Goal on Other Goals

High

Rationale: Economic diversification relying on resource-based activities would contribute substantially to a resource development goal, as well as to income and employment goals. All of these goals are closely interlinked and mutually supportive, although not identical. They are fundamental to addressing other human well being issues in communities.

3.1 Objective: Increase Community Revenues and Employment from Shellfish Aquaculture

Influence of Objective on Goal

Moderate (Table 1 above).

Rationale: Shellfish aquaculture is a new economic venture that has potential to employ 6 - 10 full-time staff in each community over the medium term. In smaller communities this would be a significant contribution to the goal of economic diversification, while in larger communities the impact would be modest.

Relationships between Objective and Strategies

Strategies encompass a range of management tasks essential to developing a viable SA industry. All strategies are important for success of the industry; however, in terms of *relative* importance site selection, grow-out, processing and marketing are key. Market prices are an important factor in profitability, but because they are beyond the control of managers, they do not figure in this summary.

Table 46. Summary of strategies / indicators and relative importance of each to shellfish aquaculture.

Strategy / Indicator	Influence on Objective
Proportion of seed sourced from regional hatchery	Moderate
Survival and growth rate of juvenile scallops	High
Community awareness and support of aquaculture	Moderate
Percent of workforce trained	Moderate
Investment in quality assurance of product	High
Volume of product sold	High

Hatchery Seed Supply

Strategy: In order to ensure effective seed supply to community shellfish aquaculture operations once they are fully operational, managers should source most spat from a new regional hatchery.

Scallop culture in British Columbia is dominated by a Japanese species, *Patinopecten yessoensis.* Therefore, seed production is hatchery based. Access to quality seed stock needs to be timely and affordable; furthermore, survival rates of seed can vary widely depending on the supplier (Ecotrust et al. 2004). Although spat production in hatcheries is well established, there is only one supplier in British Columbia and limited experience with this source. Reliance only on this source introduces a high degree of uncertainty. Vertical integration is common in aquaculture businesses, and to reduce uncertainty operators could collaborate regionally to construct a dedicated hatchery. First Nations have found an investment partner for a proposed hatchery operation (B. Watkinson pers. comm.).

Table 47. Probability of achieving objective and uncertainty related to hatchery seed supply

Proportion of spat sourced from new hatchery	Probability of success	Uncertainty
Low	Low to moderate	High
Medium	Low to moderate	High
High	High	Moderate

Once built, disease, water quality and other problems affecting survival rates of seed are all sources of uncertainty in hatchery operation. Siting of the hatchery can be an effective way to control for water quality. Although disease outbreaks are reduced by the use of antibiotics or other chemicals, they can nevertheless occur unpredictably. Careful professional management of the hatchery will be important to ensure consistent quality of product. While mechanisms to reduce uncertainty from water quality and from management are easily identified, they may be difficult to implement.

Table 48. Factors leading to uncertainty in the relationship between new hatchery seed supply and shellfish aquaculture

Factor	Degree of Influence	Ease of resolving
Water quality	High	Resolvable through siting and quality monitoring
Disease	High	Difficult
Hatchery management	High	Resolvable through recruitment, training and oversight

Growth and mortality in grow-out

Strategy: Managers should take measures to maximize survival rate and growth rate for juveniles.

This strategy is more like a sub-objective of the aquaculture objective. Survival and growth rates cannot be obtained directly, but only through the indirect efforts of managers controlling other factors. Key factors affecting grow-out are water quality, water depth, and storm exposure. Scallops have relatively low tolerances for temperature and salinity fluctuations. Juvenile scallops are particularly prone to mortality during the early post-set stage (BC Shellfish Growers Association). Storm exposure and water quality can be managed through site selection (see strategy above). Raft depth can be controlled by raft construction and anchoring. Uncertainty is relatively high since scallop culture is still new in Northwest coast environments. Additional potential hazards include predation and poaching. Although their effects may be serious, studies can reveal rates and prevention methods. Rates of grow-out, and losses to disease or predation, will be crucial factors in profitability. A key factor in maximizing productivity is appropriate labour inputs to sort and bag scallops by size in order to reduce competition and improve food access for individual organisms as they mature (cf Training strategy below). The current knowledge about these grow-out strategies is summarized in Table 6 below.

Table 49. Management strategies to optimize grow-out and related risks and uncertainty

	Indicator level	Probability of success	Uncertainty
Site selection (# of site tenures meeting optimal criteria)	Low	Low	Low
	Medium	Low	Low
	High	High	Moderate
Raft depth – variance from optimal	Low	High	Moderate
	Medium	Moderate	Low
	High	Low	Low
Predation control measures implemented	Low	Low	High*
	Medium	Moderate	High*
	High	High	High*
Variance of scallop size in net bag	Low	High	Low
	Medium	Moderate	High
	High	Low	Low

* High uncertainty partly because need for strategy (extent of problem) is unknown

For those sub-strategies where uncertainty is significant, this is largely due to lack of local knowledge and experience. Monitoring of mortality, predation, and grow-out is the appropriate initial step. If this reveals unexpected outcomes, that would suggest uncertainties to be addressed. Uncertainty around juvenile mortality and grow-out can be reduced by 1) consulting with existing scallop aquaculture operations, 2) consulting expert advisors to commercial mollusc culture, and 3) adaptive management experiments. Each step becomes more expensive. Documentation and sharing of experiences between community operators should be encouraged to better identify good practices.

Table 50. Factors leading to uncertainty in the relationship between grow-out and aquaculture.

Factor	Degree of Influence	Ease of resolving
Water quality (salinity and temperature)	High	Largely resolvable through siting
Disease	High	Difficult
Predation	Moderate	Resolvable through studies
Effective sorting of immature scallops	Moderate	Resolvable through training and supervision

Table 51. Grow out strategies summary

	Current state	Target state	Prob of success	Uncertainty
Site selection (# of site tenures meeting optimal criteria)	High	High	High	Low
Raft depth – variance from optimal	Unknown	Low	High	Moderate
Predation control measures implemented	Unknown	High	High	High*
Variance of scallop size in net bag	Low	Low	High	Low

* High uncertainty partly because need for strategy (extent of problem) is unknown
Values identified are illustrative only and have not been confirmed by local observation or knowledge holders.

Communications effort

Managers should implement awareness building and communications about shellfish aquaculture operations in the local community, in order to manage expectations, encourage worker recruitment, and political support.

Shellfish aquaculture is new to First Nation communities of the North and Central coast although wild shellfish are harvested traditionally. Successful implementation will require community support and commitment to training, staff recruitment and management responsibilities. Communities should have realistic expectations of employment and of commercial benefits as the industry develops, in order to avoid disappointment and reduce the risks of political disputes. Community partnerships in regional marketing enterprises will require transparency of financial information over time.

In small communities, improved awareness of the benefits from shellfish aquaculture can strengthen local interest, worker recruitment, motivation and support. For example, a sense of collective involvement and benefit will improve security of aquaculture rafts and production sites by having community members voluntarily monitor activities as they are passing.

The effect of communications in contributing to successful aquaculture enterprises is uncertain, as community support depends not only on information and managing expectations, but also upon factors that are independent of aquaculture, such as social cohesiveness and community leadership. However, at low levels of communications effort it will be difficult to recruit local staff, ensure site security and gain political support. Uncertainty can be reduced through more effective communications efforts and responsiveness to community concerns. Management structure of aquaculture operations can also help to reduce vulnerability to community political disputes: businesses such as aquaculture should be under the direct control of a development corporation at arm's length from political decision-makers (B. Watkinson pers. comm.).[25]

Table 52. Risk and uncertainty related to awareness and communications effort

Communications effort	Probability of success	Uncertainty
Low	Low	Low
Medium	Moderate	Moderate
High	High	Moderate to High

Table 53. Factors leading to uncertainty in the relationship between communications effort and aquaculture

Factor	Degree of Influence	Ease of resolving
Unrealistic expectations about employment or benefits	High	Mostly resolvable through communications efforts
Low awareness of aquaculture operations	Moderate	Mostly resolvable through communications efforts
Communty social cohesiveness	Moderate	Difficult
Stability and confidence in leadership	High	Difficult
Aquaculture operations influenced by local politics	High	Partially resolvable through corporate structure of operating entity

Training

Managers should ensure that a high percentage of the workforce is well trained for their positions.

The intent of training is to develop sufficient skills among staff to ensure that management strategies can be effectively carried out. Shellfish farms are expected to employ a general manager, site manager, crew supervisor, two technicians and 5 - 7 production workers (Ecotrust et al. 2004). Raft construction and maintenance, and regular sorting of growing scallops are essential for cost-effective grow-out (see Growth and mortality in grow-out, above). Commercial diver qualifications are required for some aspects of maintenance. Skilled processors are needed to consistently select and prepare a high quality product that meets health standards. Skilled managers are needed to establish appropriate standards and practices related to grow-out and processing, to hire and train staff, to develop a supportive workplace environment, and to track and adjust costs in order to maintain profitability.

[25]This is the same message strongly made by Clarence Louie, Osoyoos Band Chief in his address to Together on the Coast, November 2008, Prince Rupert.

Table 54. Risk and uncertainty related to training

Proportion of workforce trained	Probability of success	Uncertainty
Low	Low	Low
Medium	Low	Moderate
High	High	Moderate to High

Although a labour force is available in the communities, matching suitable trainees for the required tasks, appropriate training partners and sufficient funding can be problematic. This creates uncertainty not only in arranging the required training, but in assuring its effectiveness. The quality and cost of current training programs may not match the requirements and resources of coastal community aquaculture operations, or the qualifications of applicants. Resolving this issue is expected to be of moderate difficulty (a First Nations-run learning centre is being initiated with partners[26]). Mentoring trainees for various positions through collaboration with experienced businesses is a potential supplement to formal training (Ecotrust et al. 2004).

Even with adequate training, retention of trained staff may be a challenge. Sites are relatively isolated and only accessible by boat. Work must be performed regularly and diligently in a range of weather conditions, and with limited supervision, and will not appeal to everybody. Community awareness and support can help to create interest and mobilize individual commitment to new jobs in this field (see Community support, above). Attrition rate will be easy to determine as time passes, but difficult to estimate accurately ahead of time. While there are few alternative employment opportunities for unskilled labour, skilled and trained staff may well become more mobile as the industry develops.

Table 55. Factors leading to uncertainty in the relationship between training and shellfish aquaculture

Factor	Degree of Influence	Ease of resolving
Training program relevance and cost	Moderate	Resolvable through special training programs or mentoring
Availability of suitable trainees	High	Resolvable through local recruitment efforts
Attrition rate	Moderate	Resolvable through community support and experience

Quality assurance investments

Managers must invest in quality assurance for product processing.

[26] A. Sterritt, Coastal Guardian Network Workshop, August 2008, Prince Rupert

There are two levels of quality assurance. In the first instance, processing plant facilities, procedures and product must meet all government health standards for shellfish processing at a level of 100%. This is a minimum requirement for operation and commercial sales. Beyond that, specific market requirements will impose additional quality requirements.

Table 56. Risk and uncertainty related to product quality

Investment in quality assurance	Probability of success	Uncertainty
Low	Low	Low
Medium	Low	Low
High	High	Moderate

Shucked meats could be sold either fresh or frozen. The production of a fresh whole scallop product in addition to the shucked product remains an option (tied to Marketing strategies, see below). A high quality product is essential to ensure consistent sales and premium prices. This is partially dependent on a good site for a processing facility (Ecotrust et al. 2004). Currently, existing facilities are being examined for their processing potential; however, the most likely options would require modification since they are not certified from Canadian Food Inspection Agency for shellfish (B. Watkinson, pers. comm.).

Quality of the product is largely dependent on water quality during grow-out, particularly as it pertains to the presence of biotoxins, harmful chemicals or bacteria. This is primarily assured by site selection (see Growth and mortality strategy, above). Ongoing biotoxin monitoring and sanitary surveys as well as water quality testing can reduce uncertainties here, along with monitoring of any nearby developments, and currents that may bring toxins to the culture sites.

Processing quality assurance also depends on staff training (see Training strategy above). A quality assurance and testing program will be required. Its effectiveness will be determined by its design and the diligence of staff.

A final uncertainty relates to equipment failure in the processing or storage areas (particularly for refrigeration equipment). This uncertainty can be reduced by capital investment and effective maintenance efforts. While all the uncertainty factors can be resolved through investment in quality assurance, their interaction and the potential for accidents create moderate uncertainty in any event.

Table 57. Factors leading to uncertainty in the relationship between quality assurance and aquaculture

Factor	Degree of Influence	Ease of resolving
Processing plant site and configuration	High	Resolvable through capital investment
Variable water quality at culture sites	Moderate	Resolvable through monitoring
Quality assurance procedures in plant	High	Resolvable through design and staff training
Equipment failure in plant or storage	High	Resolvable through maintenance and investment

Volume of product sold

Managers must ensure high volume of product is sold.

A “high volume” marketing strategy is preferred given the production volumes projected for the initiative. Value added products can be developed as profitable opportunities are identified (Ecotrust et al. 2004). Highest value markets are international (principally in Asia). Fresh product attracts the highest prices, but also requires reliable and timely transport, which is somewhat uncertain. Special shipping arrangements are essential to the success of this strategy, and will also require investment.

Table 58. Risk and uncertainty related to volume sold

Volume sold	Probability of success	Uncertainty
Low	Low	Low
Medium	Low	Low
High	High	Moderate

On of the main uncertainties in returns from sales is the cost of transportation from the North and Central Coast, which cuts into producer margins.[27] This uncertainty can be managed by pooling transportation costs through cooperative relationships between First Nations producers in joint processing, transportation, and marketing.

To secure access to high-value markets, a partnership has been established with a private investor from Asia. This partner brings expertise in markets, product and quality standards, and offers equity investment in exchange for assured supply. The persistence of the marketing agreement depends on both supply side factors (reliable production and delivery of high quality product, competition from other suppliers) as well as demand side factors (incomes and consumption patterns in high value markets). In addition, the marketing agreement may be affected by failure of the partner’s related business units. While attentive and successful management of local operations can contribute to maintaining marketing operations, and an economic downturn in key Asian markets increases risk, many of these factors are essentially unpredictable or uncontrollable by producers.

[27] Ecotrust et al. (2004) notes the following:“The cost of moving freight from processing centers to final markets will depend on whether product is transported by air, land or sea. Bulk frozen products transported by full truck or container (sea or rail) have the lowest freight rates. Air freight will be the highest, and is expected to be restricted to fresh products only. Strategies for freight will be dependant on marketing and final customers….Processing in Prince Rupert offers truck transport east or south to major markets, and rail service to North American destinations as well as shipping access to Asian markets through the Port… Product landed in Port Hardy will probably have to be transhipped to Vancouver for cold storage or transhipping to container, truck or air freight.”

Table 59. Factors leading to uncertainty in the relationship between volume sold and aquaculture success

Factor	Degree of Influence	Ease of resolving
Fuel costs	high	Difficult to irresolvable
Regional collaboration among producers	moderate	Easy
Marketing agreement persistence	high	Moderate to irresolvable

Overall Summary – Aquaculture Objective

Table 60. Summary of key strategies for successful aquaculture

Strategy	Current state	Target state	P (success)	Uncertainty
% of spat from new hatchery	Nil	High	High	Moderate
Site selection (# of site tenures meeting optimal criteria)	High	High	High	Low
Raft depth – variance from optimal	Unknown	Low	High	Moderate
Predation control measures implemented	Unknown	High	High	High*
Variance of scallop size	Low	Low	High	Low
Communications effort	Low	High	High	High
Training	Moderate	High	High	High
Quality assurance	NA	High	High	Moderate
Volume sold	NA	High	High	Moderate

* High uncertainty partly because need for strategy (extent of problem) is unknown

Values identified are illustrative only and have not been confirmed by local observation or knowledge holders.

Ease of collecting indicator data

Once quantitative targets for strategies have been determined, where relevant, most indicators would be easily collected in the normal course of operations. Special surveys would be needed to provide quantitative measures of community support, but depending how crucial this strategy was deemed to be in any particular case, these surveys could be relatively simple.

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Watkinson, B. pers. comm. Executive Director, North Coast Skeena First Nations, Prince Rupert, B.C.

3.2 Objective: Increase Revenues and Employment from Tourism[28]

Influence of Objective on Goal

Moderate (Table 25 above)

Rationale: This is one of several objectives that can contribute to economic diversification.

Relationship between Objective and Strategies

Creating community economic benefits from tourism can be approached in several ways. One strategy is to negotiate benefit-sharing agreements with existing tourism operators in the area. These could be of several types depending on the nature of the operation: lodges may offer opportunities for seasonal employment in housekeeping, maintenance, guiding or other positions; while various small-scale cruising enterprises offer potential for service provision, guiding, or cultural tourism. The benefits may involve employment as wage labour for an external commercial enterprise, or they may involve contract or sales opportunities for small local businesses in furnishing services or supplies. Another strategy would be to develop, maintain and market accommodation to serve as a base for local adventure travel, either as a community economic venture or in partnership with experienced tourism operators. A third approach, which could supplement either of the other two but is less likely to be successful on its own, would be to develop and provide tour services for local attractions (bear watching, cultural sites, kayaking, hiking, fishing) to supplement other tourism experiences for visitors who are already in the area. Another low-cost option would be to construct and place mooring pennants near townsite services or at popular scenic sites to encourage use of local services, help manage yacht access, and potentially link to onshore (semi-wilderness) facilities, for which small fees could be charged.

Except for the strategy of providing supplementary tour services, these strategies are largely independent: depending on their financial and human resource capacity and their relationship with potential business partners, communities could choose to pursue only one, or several of these strategies. An important consideration in all tourism development options is for the level of activity to be consistent with the ecological and social carrying capacity of the community and First Nations territory involved. Tourists pay for the privilege of certain kinds of experiences, and in order to generate business communities must be able to provide the quality of experience that tourists expect. A key strategic decision will be whether to promote tourist access to First Nations communities, thereby creating potential opportunities for small local service businesses, or encourage instead that tourists use remote sites, thereby preserving community privacy and flexibility during peak tourism periods.

In order to generate meaningful employment and revenues from tourism, several strategies will probably need to be pursued. The greatest influence on achieving the goal will be from participation in tourism ventures that are already well established and successful. Starting up new ventures will require investment in facilities and staff training, and has much higher risks. While employment can be created fairly quickly, commercial profitability may take several seasons to

[28] This section draws on insights from Freeze, D. and R. Cloutier. 2000. Klemtu Tourism Strategy.

establish. Unconventional, adventure- and ecologically-oriented travel is an expanding market, but a relatively small market appealing to a modest economic and demographic niche.

Table 61. Summary of strategies and relative influence in achieving tourism employment and revenues

Strategy	Influence on Objective
Establish benefit-sharing agreements with existing tourism operators	High
Invest in tourist accommodation	Moderate
Provide supplementary tourism services	Low
Install yacht mooring pennants	Low

Benefit-sharing agreements with existing tourism operators

A number of communities have already established benefit-sharing agreements with tourist lodges or with pocket cruising operators who use important areas of their marine territory. The benefits from these agreements depend on the details of each agreement, but typically include such features as: priority employment of local community members, subject to meeting job qualifications; joint training programs; provision of services (at competitive rates); and may include basic per client fees. In exchange for these provisions, the First Nations community offers access and use of customary marine and land territories under specified conditions. The types of benefits available from tourism operators would obviously vary depending on the type of operation: a large and well-known adventure tourism lodge would have more opportunities than a small pocket cruising operator who only ran one or two groups through the territory each year. The benefits from such agreements will increase with the number of agreements and scale of each operation.

Table 62. Probability of achieving tourism employment and revenue objective and uncertainty related to benefit-sharing agreements

Number / scale of agreements	**Probability of success**	**Uncertainty**
Low / small	Low	Low
Medium	Moderate	Moderate
High / large	High	Low to Moderate

The uncertainties surrounding success from this strategy decline if a large number of agreements can be negotiated, or if agreements can be negotiated with large operators (if any) in the community's territory. However, even under favourable circumstances, uncertainty remains about whether sufficient number of suitable staff could be found in the community to take advantage of the potential employment opportunities. This uncertainty can be reduced by community-based training programs for tourism services, and by positive relationships between the community and tourism operators. Still, some positions such as guides require both experience and client relations skills, and the candidate pool in any community may be limited. Similarly, in order for community small business owners to profit from providing services to tourism operators, their services need to meet the standards of the operators and the expectations of their clients. There are inherent commercial risks that contribute to the uncertainty of achieving the objective, compounded by the relative lack of commercial tourism experience in most communities. For some types of service business, such as providing stopover services to passing pocket cruise tours, a complicating factor may be the quality and accessibility of services to boat passengers (dock facilities, proximity to dock, scenic quality of site).

Table 63. Factors leading to uncertainty in the relationship between number of agreements and tourism benefits

Factor	Relative importance	Ease of resolving
Availability of suitable candidates for seasonal employment	High	Moderate – partly resolvable through training
Lack of tourism service experience among businesses	High	Moderate – will decline with experience
Commercial risks for expanding service businesses	Moderate	Difficult
Harbour / waterfront quality for tourist access	Moderate	Can be difficult if competing industrial uses

Tourist accommodation

The potential for tourism is limited in many places by the lack of suitable accommodation. However, building and maintaining accommodation that is only used for a short summer season is costly, and with limited options for visitor access to most communities (typically air, although some also have limited ferry service), the investment is risky. There are a range of strategies for providing accommodation, from luxury tow-in barge lodges to primitive wilderness shelters such as canvas tent-roofed platforms or half-wall cabins. The accommodation may be built in communities, perhaps taking advantage of existing under-utilized structures, to encourage visitors to use local services and businesses. Or it may be built in appealing wilderness sites, to manage user impact and generate revenues from visitors.

Different kinds of accommodation are suitable for different tourist markets. If additional accommodation is provided, it should match the market demand, or be accompanied by a substantial marketing effort to introduce a new market segment. For example, while there are already fly-in wilderness lodges (with varying levels of amenity) all along the coast, there might be a market for a different kind of accommodation experience, such as kayak camps or lake fishing camps, or community-based tour operations. Determining an appropriate match between accommodation and tourist demand is a challenging task.

More accommodation is not necessarily better: if accommodation spaces go unused, the investment is not profitable and the enterprise becomes an economic drain rather than a benefit. Occupancy rates provide a useful indicator for managers. If occupancy rates are consistently high, this is usually an indicator that expansion of accommodation of that type would be profitable. If they are consistently low, that type of accommodation is already over-supplied relative to market demand. A desirable range for seasonal occupancy rates is around 75 – 80%.

The problem is that this indicator is not very helpful for new accommodation that potential clients are not yet aware of.

Table 64. Probability of increasing tourism benefits and uncertainty related to accommodation occupancy rates

Seasonal occupancy rates	Probability of success	Uncertainty
Low	Low	Moderate
Medium (75-80%)	High	Low
High	Moderate	Moderate

A key uncertainty in achieving tourism benefits from accommodation is therefore the associated marketing effort that would accompany expansion of accommodation, or introduction of a new accommodation market category unlike other available options. There is also uncertainty associated with the success of high occupancy accommodation, because of unrealized expansion potential that could further increase benefits.

Table 65. Factors leading to uncertainty in the relationship between accommodation occupancy and tourism benefits

Factor	Relative importance	Ease of resolving
Marketing effort to accompany new accommodation	High	Resolvable by investing in marketing
Unrealized potential for further benefits under high occupancy	Low	Difficult

Provide supplementary tourism services

If agreements are in place with existing tourism operators, or if accommodation is sufficient to meet demand for a variety of accommodation types in the area, then there is good potential to build additional tourism revenue and employment through supplementary services. These could include local services such as guiding, cultural interpretation, catering or food services, specialized transportation services such as water taxis, etc. These would be marketed to tourism operators or clients already in the area, including pass-through pocket cruise operators.

The level of benefits available from such supplementary service provision will depend on the volume of tourists who have access to them and the relevance of the services to their needs. Marketing of available services to this target audience will be an important factor in ensuring a higher probability of success from expansion of supplementary services. The other main uncertainty about the effect of this strategy is the linkage to other benefit sharing or accommodation arrangements: without good links to existing primary tourism attractors in the nearby area, supplementary services will not attract clients.

Table 66. Probability of increasing tourism benefits and uncertainty related to supplementary services

Range of supplementary tourism services	Probability of success	Uncertainty
Low	Low	Low
Medium	Medium	High
High	High	High

Table 67. Factors leading to uncertainty in the relationship between supplementary services and tourism benefits

Factor	Relative importance	Ease of resolving
Marketing effort for supplementary services	High	Resolvable by investing in marketing
Linkages to primary tourism attractors bringing visitors to the area	High	Resolvable through benefit-sharing agreements or investment

Install yacht mooring pennants

Mooring pennants include a concrete anchor and heavy chain, which sit on the ocean floor, together with mooring line and a mooring buoy on the surface to provide a stable anchor point for yachts. Mooring configuration is designed to accommodate boats in a specified size range. This is a relatively inexpensive and low-maintenance strategy to encourage yachts that are passing through the area to stop in specific places. While it is possible to collect a small fee for use of the secure mooring site, a greater benefit may be that the pennants are located so as to encourage boaters to purchase additional services (e.g. food or fuel from the nearby community, or guiding services for nearby sites). This strategy assumes that suitable tourism services are available at the sites where the mooring pennants are located.

Uncertainties associated with the contribution of mooring pennants to achieving the objective are high because revenues from mooring itself are low, levels of use are unknown and the potential demand for other services is highly uncertain. Many boaters value the independence of their travel experience and are low consumers of services.

Table 68. Probability of increasing tourism benefits and uncertainty related to mooring pennants

Number of mooring pennants close to services	Probability of success	Uncertainty
Low	Low	Low
Medium	Medium	High
High	High	High

Table 69. Factors leading to uncertainty in the relationship between mooring sites and tourism benefits

Factor	Relative importance	Ease of resolving
Level of use of mooring sites	High	Resolvable through monitoring
Low direct revenues	Moderate	Difficult
Uncertain demand for supplementary services	High	Moderate to difficult: will require marketing

Overall summary: Tourism employment and revenue

Table 70. Summary of key strategies for tourism employment and revenue

Strategy	Current state	Target state	P (success)	Uncertainty
Number of benefit-sharing agreements	Low	High	High	Low to Moderate
Tourist accommodation – occupancy rates	Unknown	Moderate	High??	Low??
Range of Supplementary tourism services	Low	High	High	High
Number of mooring sites	Low	High	High	High

Values identified are illustrative only and have not been confirmed by local observation or knowledge holders.

4 Goal: First Nations' cultural/traditional resources

Information Sources and Updates

Authors: Cristina Soto and Stephen Tyler

Sources: cited within the text

Original Draft: November 2008

Revised:

Information from Land-use Plan Summary

The full text of the goal addressed in this section is:

"Sustain cultural/traditional resources for First Nations' domestic use". This statement is an Objective in Schedule C / G, but given its breadth is considered a goal here, with accompanying Objectives.

This goal contributes to achievement of the even broader goal of "enhancing community viability and human wellbeing" (from EBM Handbook and G2G agreements) as well as "providing adequate opportunities for individuals and households to meet their needs" (EBMH).

Overview of Current Knowledge Relating to Goal

The plan area contains an abundance of natural resources that have been harvested and managed by First Nations for millenia: terrestrial, aquatic and marine. Historically and to the present, the seasonal rounds of coastal First Nations include practices closely tied to traditional and cultural uses of key resources; fishing for and processing oolichans into "grease" (or trading for it) in early spring; harvesting berries and fruit in late summer; fishing for salmon in the fall; collecting seaweeds, shellfish, cedar bark, mushrooms, herring roe, and many others. Plant medicines are gathered at various times of the year, depending on the species. Trade between interior and coastal peoples historically included many of these items. This trade still occurs although in considerably reduced form.

Colonization brought huge changes to traditional lifestyles that disrupted the ceremonial, educational, and livelihood practices through which management and use of these resources were taught, shared and regulated. Changes such as missionization, disease and population loss, potlatch bans, residential schools, and a shift to an economy based on commodities all undermined the cultural basis for traditional resource use. The loss of lands associated with the reserve system as well as impacts of developments such as industrial fishing and forest harvesting, road and rail development, etc., have imposed huge losses in quality and access to cultural/traditional resources. [29]

In the context of forest harvest practices, loss of access has occurred through logging of, for example, monumental cedar trees used for totem poles and canoes. Logging practices also affect understory growth and damage habitat for important food and cultural species. EBM recognizes the need for protecting not only the key ecological functions of forest plant and wildlife communities, but also, through this Goal, the cultural and traditional values of such plant and

[29] Halpin and Seguin (1990); McDonald (2003); Daly (2005), U'mista Cultural Society (2008)

wildlife communities. Some of the necessary changes to forest planning and operating practices are addressed by agreements to set aside Conservation Areas on the coast. Other aspects are addressed in the ecological Land Use Objectives (cf. Knowledge Summary for EI). But further planning and consultation measures will probably be required to ensure this Goal can be achieved outside Conservation Areas.[30]

So, while this Goal is closely tied to ecological integrity, the focus in this part of the Knowledge Summary will be on the social and cultural aspects of the Goal. The ability to "sustain" traditional/cultural resources for First Nations' use has three closely interlinked components in this context:

1. First Nations ability/opportunity to access these resources, including high quality harvesting sites;
2. First Nations knowledge of the resources and how to use them; and the transmission of this knowledge in the context of their culture;
3. Levels of First Nations use of the resources.

These have been restated as Objectives in Table 71 and elaborated upon below and in Fig. 4[31]. Note that these objectives are closely related and mutually reinforcing.

Error! Not a valid bookmark self-reference.**Table 71. Summary of objectives and relative influence of each objective on the goal**

Objective	Influence on Goal
Improve access to cultural and traditional resource harvesting sites	High
Strengthen First Nations' knowledge of the resources in cultural context	High
Increase use of cultural and traditional resources	Moderate

<u>Uncertainty About Achieving Goal if Objectives are Achieved</u>

Moderate

Improved access, use and greater knowledge of the resources are necessary, but not sufficient conditions for success in sustaining First Nations' cultural and traditional resources. As discussed above, the quality and abundance of the resource is also threatened by ecosystem degradation and disturbance. While many aspects of ecological integrity are addressed in the

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[30] A recent Forest and Range Evaluation Program (FREP) report analyzing cultural resource strategies used in Forest Stewardship Plans will provide an important piece to build on, with additional information from First Nations' current planning processes (B.C. Ministry of Forests & Range 2008).

[31] Two indicators are listed in Schedule C and G for the goal considered here: "Identification of First Nations' cultural/traditional resources" and "First Nations' harvest levels". Rubus (2007) and Sheltair (2008) reports suggest not using the former and replacing the latter with "Number of community members…" In the end, the Sheltair report suggests two broad indicators of cultural well-being: number of people speaking the language and the number of salmon returning. The Sheltair report notes that other suggested indicators would require considerable effort to collect data.

Land Use Objectives, some issues (e.g. climate change) are beyond the influence of managers and it may prove impossible to prevent the loss of significant cultural and traditional resources.

Influence of Goal on Other Goals

High

Sustaining traditional and cultural resources is important to preserving First Nations cultures on the coast. The loss of First Nations cultures, including their access to traditional foods, has been a major contributing factor identified by researchers in the deterioration of health and social conditions among First Nations communities (Turner et. al. 2000; Daly 2005; Catherine Coldwell, Nak'azdli Elder in UNBC (2008). Cultural disintegration has direct impacts on Human Well Being by weakening healthy social relationships, undermining personal identity, eroding the social knowledge base, and fostering conflict.

"Use" is a broad term that includes harvest, consumption, and production of goods and art. Depending on the resource in question, actual amounts harvested may be less important to long-term use than sharing the knowledge and the language associated with the harvest and processing (see Strengthening Knowledge objective). Physical health may be a factor in the participation of middle aged people and elders. North Americans are increasingly sedentary and the percentage of obesity and diabetes has increased along with carbohydrates and fat in the diet. Aboriginal communities have been particularly susceptible. Unfortunately, there has been a negative spiral of loss of access to territories affecting lifestyle, diet (shift from seafood and wild meat to simple carbohydrates), and health which then reduces physical activity and ability to access traditional resources.

The use of the resources is important not only for their own sake, but for the associated cultural and social values transferred.[32] These factors indirectly link to such crucial Human Well Being goals as educational achievement, personal health, and economic capacity. For these reasons, sustaining traditional and cultural resources is closely linked to all other Human Well Being goals.

4.1 Objective: Improve access to traditional harvesting sites and resources

Influence of Objective on Goal

High (Table 71 above).

Rationale: Access to traditional and cultural resources has been constrained by a variety of factors, yet it is a pre-requisite to First Nations' ability to manage, sustain, harvest and use these resources.

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[32] For example, in a recent survey, a high proportion of Inuit respondents indicated the importance of hunting caribou, not merely for its food value but because key skills such as travel and outdoor survival were transferred through shared hunting experiences (InterGroup 2008).

Relationships between Objective and Strategies

Access to the resource refers to two dimensions of the problem: 1) securing and exercising rights to use the resource; and 2) the physical possibility of getting to the habitats or sites where resources are gathered. The rights issue is an important one that underlies all of the other objectives and strategies for this goal. This issue is widely recognized and a range of strategies from interim measures to treaty negotiation or legal procedures are already being employed. We don't address such measures further here, because they are mostly pursued at a political, rather than a management, level.

Physical access has become problematic for a variety of reasons: loss of resources or habitats near communities; lower seasonal mobility of First Nations peoples due to a shift to wage-based livelihoods; losses due to industrial activity or road construction. In some cases, trails have grown over or been destroyed or blocked by a development activity, e.g. cut block or log dump. Improving access requires identifying traditional use sites through interviews and groundtruthing as well as identifying any additional areas that may currently have suitable habitats for particular species (acknowledging that, for example, forest harvesting and ecological succession have altered the landscape; thus, some traditional areas may no longer be productive and different areas may now be productive).

To improve access to cultural and traditional resources, three strategies are suggested: identify productive sites for valuable resources through Traditional Use Studies and habitat assessments; protect and manage resources that have been identified; and provide seasonal shelters, where these do not exist, to facilitate access and use of high value cultural resources.

Table 72. Summary of strategies and relative influence of each in improving access

Strategy	Influence on Objective
Identify resource sites through TUS and habitat assessments	Moderate
Protect and manage resources to ensure sustained use	Moderate
Improve access infrastructure in important user areas	Moderate

Note that none of these strategies has a very high influence on achieving the objective of improved access. While they will help to improve access to cultural resources, successful achievement of the objective depends also on the success of the other two objectives (increased knowledge and use). These three objectives are closely linked and mutually reinforcing.

Identify valuable cultural resource sites

Valuable cultural resource sites have been known and used for generations by First Nations communities. But in the past decades, important traditional sites have been extensively altered by industrial activity, knowledge of other sites has been lost as seasonal resource use patterns have changed, and lack of use has led to loss of access and memory. Yet many sites continue to be used regularly. In order to improve access and to ensure stewardship of these resources in the face of competing land uses, valuable sites should be identified. There are hundreds of different plants and other resources used by First Nations, distributed across many different ecosystems.

This is a large task, and should start with resources that First Nations communities themselves feel are most valuable.

Because of the number of different resources of interest, we would expect that over time the number of valuable sites identified would increase if access is improving and the resources are being used. The increased probability of successfully improving access as identified sites grow is not so much due to a causal relationship as to the correlation of a series of related factors (knowledge, use, interest and physical access).

Table 73. Probability of achieving objective and uncertainty related to site identification

Number of valuable cultural resource sites identified	Probability of success	Uncertainty
Low	Low	Moderate
Medium	Moderate	Moderate
High	High	Moderate

Uncertainty about the relationship between number of sites and improved access arises from a variety of sources. Traditional use surveys are difficult and validation costly: sites identified through interviews are often hard to find on the ground. Ecological assessments of potential habitat are frequently inaccurate. Significant disturbance to natural ecosystems will alter traditional plant communities that served as field markers of important species. In addition, many valuable resources have naturally variable distributions in space and time: the knowledge to be able to assess promising sites as conditions change may be more valuable than specific site identification.

The relationship between number of sites and access may not be that important. Other factors may be more relevant to access than numbers: e.g. proximity or quality of sites, or popularity of the resource in current lifestyles. Determining "value" of the cultural resource is not self-evident and may vary from one community to another. This can be resolved by each community, but it means results may not be readily shared (if that would be desirable).

There are also uncertainties related to the mechanism chosen for documentation. If conclusions from use studies or knowledge collection from elders are documented for sharing with community members, there are risks of security and protection of the knowledge, as well as over exploitation (see Protection strategy below). On the other hand, if this information is collected but poorly documented, there are risks that it will not be effectively transmitted either through oral and shared practice traditions that are disappearing or through easily accessible local information. Whatever documentation practices are chosen by communities, these should be carefully explained and their effectiveness evaluated.

Table 74. Factors leading to uncertainty in the relationship between number of valuable sites and increased access

Factor	Relative importance	Ease of resolving
Resource constraints lead to inaccurate site identification	High	Moderate to Difficult
Site suitability changes with conditions	Low	Difficult
Number of sites may be less important than subjective value factors	Moderate	Resolvable by community preference
Quality, utility and accessibility of documentation	High	Resolvable by community

Protect and manage the resources to ensure sustained use

Broad protection for cultural resources is a strategy being pursued through Conservation Management Areas that permit aboriginal use for traditional purposes. Individual specific sites outside CMA's can be protected from industrial activity through identification in referral processes and subsequent planning. However, in addition to these measures, the strategy could also include traditional or contemporary resource management practices to ensure habitat protection, propagation, and control of exploitation rates. This might also include measures to restrict access if necessary (note the apparent contradiction with the objective: to ensure long-term access may require short-term limitations on access to sensitive or over-exploited resources). Note that before they can be protected, valuable sites must first be identified (see above strategy).

One way to measure the implementation of this strategy is the area under protection or active management. As this area increases, managers can have more confidence that access to valuable cultural resources is being improved. Uncertainty related to protection and management is low, and related mainly to the overall effectiveness of familiar protection and management practices.

Table 75. Probability of achieving objective and uncertainty related to protection and management

Area of cultural resources protected or actively managed for cultural resources	Probability of success	Uncertainty
Low	Low	Low
Medium	Moderate	Low
High	High	Low

Table 76. Factors leading to uncertainty in the relationship between area of protected sites and increased access

Factor	Relative importance	Ease of resolving
Effectiveness of management practices	High	Easy – resolvable through the adoption of proven practices

Improve access infrastructure

Another strategy for improving access is to improve the infrastructure to facilitate travel and harvesting activities. Terrestrial sites in particular may be difficult to access or remote from communities. Trails and shelters (e.g. simple cabins) can make it simpler for family groups of different ages to access and use particular cultural resource sites. Note there is a contradiction here between facilitating access and controlling access (see Protect and manage resources, above), which has to be resolved in the case of each relevant site.

Uncertainty in relation to the effect of this strategy on the objective relates mainly to the interaction between the different objectives. While there is little uncertainty that infrastructure investments will improve potential access, it is not evident that knowledge of harvesting, management or use practices, and levels of interest, will be sufficient to motivate users to take advantage of this potential. Other barriers may also exist: even with improved trails and shelters, for example, the cost of fuel to reach remote sites may still be prohibitive for many families.

Table 77. Probability of achieving objective and uncertainty related to infrastructure

Investment in access infrastructure	Probability of success	Uncertainty
Low	Low	Low
Medium	Moderate	Moderate
High	Moderate	High

Table 78. Factors leading to uncertainty in the relationship between area of protected sites and increased access

Factor	Relative importance	Ease of resolving
Motivation and interest of users	High	Moderate to difficult to resolve without experience
Barriers to travel (e.g. fuel costs)	High	Difficult

Overall Summary: Improve Access

Table 79. Summary of strategies to improve access to valuable cultural and traditional resources

Strategy	Current state	Target state	P (success)	Uncertainty
Number of sites identified	Low	High	High	Moderate
Area protected or managed	Low	High	High	Low
Investment in infrastructure	Low	High	Moderate	High

Values identified are illustrative only and have not been confirmed by local observation or knowledge holders.

4.2 Objective: Strengthen First Nations' knowledge of the resources in cultural context

Influence of Objective on Goal

High. (Table 71 above).

Rationale: Knowledge of the resources (in its cultural, social and ecological dimensions) is an integral part of the use and long term sustaining of resources by First Nations.

Relationships between Objective and Strategies

Three strategies are proposed for this objective, to address the decay in traditional knowledge about cultural resources, their identification, management, collection and use. The first strategy is to improve documentation of traditional knowledge in culturally relevant contexts (e.g. local language, customs, social structures). The second is to invest time and resources in community-level programs to engage children and youth in learning and practicing traditional customs related to resource use. The third strategy is to incorporate language and cultural content in the formal school curriculum. All three have a potential positive influence on the objective of strengthenening First Nations' traditional knowledge, but the influence of any of them alone will depend on a wide range of other factors such as the support of the community and the extent to which the knowledge can be applied in practice.

Table 80. Summary of indicators and relative importance of each in strengthening First Nations' knowledge of cultural resources

Strategy / indicator	Influence on Objective
Extent of documentation of traditional knowledge	High
Investment in community cultural programs	Moderate
Classroom hours devoted to FN cultural knowledge in schools	Moderate

Documentation of Traditional Knowledge

Documentation of Traditional Knowledge (TK) is crucial and urgent because of the rate at which this knowledge is being lost. Loss of knowledge jeopardizes the ability to achieve the overall goal of sustaining cultural and traditional resources. Traditional Knowledge (TK) is understood here to potentially include the names of the species, their habitats, aspects of their management and processing, spiritual and medicinal knowledge, oral history and customary law regarding resource access and use. TK can be obtained through interviews with elders, or through participatory research in the field, and recorded with various technologies. Traditional Use studies discussed above (cf. strategies for improving access) may overlap with TK studies and include the identification of sites. If elders speak an aboriginal language, ideally TK would be conveyed and recorded in that language and translated.[33] This recognizes that world view is a form of "knowledge" that is embedded in language and is a key aspect of cultural/traditional life ways (Berkes 1999).

Table 81. Probability of strengthening knowledge and uncertainty related to documenting TK

Extent of community TK documentation	Probability of success	Uncertainty
Low	Low	Low
Medium	Low	Moderate
High	Low to Moderate	High

Traditional mechanisms for transferring this knowledge involved oral traditions and practices: stories, ceremonies, feasts, and a wide range of shared harvesting and management practices. These are still important contributing factors to maintaining and strengthening knowledge, which cannot be replaced solely by documentation. But as memory and experience of the old ways fade and practices are not maintained, documentation is a crucial measure to prevent further losses. The likelihood that documentation alone will lead to successful accomplishment of the objective, even if it is extensive, is moderate at best. Factors contributing to the uncertainty of this outcome include the success of other related objectives and the format / accessibility of documentation to potential users (including teachers, parents, youth).

Table 82. Factors leading to uncertainty in the relationship between TK documentation and strengthened knowledge

Factor	Relative importance	Ease of resolving
Success of other related objectives	High	Difficult
Format / accessibility of documentation	High	Resolvable by ensuring format matches user needs

Investment in community cultural programs

Cultural programs that involve direct interaction between elders and practitioners and the younger generation have been occurring for years in aboriginal communities in BC and the North

[33] Rubus and Sheltair reports identified "number or percent of community members speaking tribal languages", respectively, as an Indicator for this Schedule C&G Objective (the Goal considered here). The loss of fluent language speakers certainly is an indicator of loss of TK on a large scale. However, some aspects of knowledge of cultural/traditional resources can be passed on without fluency of language in the recipient and younger people may be learning aspects of the language (for example in school) that do not pertain to traditional uses. We assume that First Nations consider it important to pass on language and cultural/traditional resource use knowledge together where possible. We have not included may want to do here is label the first two above as "Community indicators" and then the Number of language speakers as an overview indicator?

(and many other parts of Canada). For example, Rediscovery camps for youth were initiated in Haida Gwaii in the 1970s and have spread to other areas of BC and Canada (Donald 1999). The intent of these programs is to provide opportunities for young people to interact with elders and engage in familiarization, harvesting and processing of cultural and traditional resources for use in ceremonies and other cultural activities. Because households are often oriented more to wage labour and employment, traditional family mechanisms for this kind of cultural learning have declined.

Increased investment in cultural programs does not guarantee their success, however. Forces of social and cultural change are very powerful and the likelihood that these programs by themselves will be successful in strengthening knowledge of cultural and traditional resources is only moderate. Because they involve community members and young people in cultural activities that otherwise would probably not be shared in the same way, they already represent a positive contribution to achieving the objective, but uncertainties related to rate of participation and community support remain high and have an important effect on the likelihood of success.

Table 83. Probability of strengthening knowledge and uncertainty related to cultural programs

Investment in cultural programs	Probability of success	Uncertainty
Low	Low	Low
Medium	Moderate	High
High	Moderate	High

Table 84. Factors leading to uncertainty in the relationship between cultural programs and strengthened knowledge

Factor	Relative importance	Ease of resolving
Rate of participation	High	Moderate to Difficult – activities need to be appealing to youth
Community support	High	Resolvable but requires strong leadership, vision and commitment

School curriculum content

Schools on reserves as well as public schools that have high populations of aboriginal students are increasingly incorporating cultural learning, including the local First Nations language and culture in the curriculum.[34] Innovative curricula is increasingly available, for example, a Grade 6-8 study of the Kwakwa̱ka̱'wakw potlatch that contains information on oolichans, their harvesting, and the role of grease in the culture (National Museum of the American Indian 2008).

[34] Kispiox School is a private, independent school located on a Gitxsan reserve, and offers "training feasts" for each of three clans; Elders' visits in which cedar basket weaving, drum making or other skills are taught; and has included hunting and meat processing. Cultural traditions are also taught at the local Rediscovery Camp (Reinhold Steinbeisser, pers. comm.)

The greater the number of instruction hours devoted to cultural knowledge, the more likely this will lead to strengthening First Nations knowledge.

Public schools have required content that must be covered and in higher grades, provincial exams with specific knowledge that must be mastered by students to pass. Variation from the curriculum can influence a school's ranking and performance. Individual Education Plans are used by the Province of BC for variation in an aboriginal K-12 student's program, but the constraints are evident in policy documents.[35] On-reserve schools may have more leeway to incorporate additional cultural content (R. Steinbeisser pers. comm.).

Even given constraints of the content of curriculum, innovative, knowledgeable and enthusiastic teachers can make a difference in teaching culturally relevant curriculum. However, teacher qualities are highly variable. Hiring practices of First Nations' schools can attempt to introduce these requirements but given the availability of teachers and the rate of loss of language and culture related to sustenance practices, this uncertainty is expected to be difficult to resolve. Another uncertainty relates to the degree of documentation of traditional cultural knowledge, to facilitate incorporation in the curriculum.

Table 85. Probability of strengthening knowledge and uncertainty related to school curriculum

Hours of cultural instruction	Probability of success	Uncertainty
Low	Low	Low
Medium	Moderate	High
High	Moderate	High

Table 86. Factors leading to uncertainty in the relationship between cultural programs and strengthened knowledge

Factor	Relative importance	Ease of resolving
Competition with other curriculum content	High	Moderate to Difficult due to provincial standards
Staff skills and commitment	High	Moderate to difficult
TK documented and assessed for use	Moderate	Resolvable by documenting TK

[35] See http://www.bced.gov.bc.ca/policy/glossary.htm#aboriginal_education_programs_and_services

Overall Summary: Strengthening First Nations Knowledge about Resources in Cultural Context

Table 87. Summary of strategies to strengthen knowledge

Strategies	Current state	Target state	P (success)	Uncertainty
Documentation of TK	Low	High	Low to moderate	High
Investment in community cultural programs	Low	High	Moderate	High
School curriculum content	Low	High	Moderate	High

Values identified are illustrative only and have not been confirmed by local observation or knowledge holders.

4.3 Objective: Increase use of cultural and traditional resources

Influence of objective on goal:

High (Table 71 above).

Rationale: First Nations cultural and traditional resources can only be sustained over the long term through continued use in some form.

Relationships between Objective and Strategies

Traditional use of cultural resources has declined for many reasons. In some cases modern substitutes are more convenient or accessible, and in other cases traditional high value resources (e.g. salmon) have become locally scarce or costly to collect. Sometimes declining use of traditional resources, especially foodstuffs, also reflects changing tastes and preferences of the younger generation. Ultimately, to increase the use of cultural and traditional resources will require a re-emphasis of these values in individual, family and community life. Many communities on the coast are encouraging such a value shift already through many individual and collective decisions. An important part of encouraging such changes is to recognize and celebrate these efforts.

Another strategy, also being applied already in some communities, is to organize community fishing or harvesting efforts, particularly for nutritional foods, and share the catch with households who cannot afford the fuel and equipment costs for such collection themselves. This will increase the use of traditional foods.

For non-food resources (such as fibers or cedar bark), because more convenient and lower cost modern substitutes exist, continued use will be tied to investment in cultural resources (carvings, ceremonial and ritual objects) by local communities, tourists or outside interests.

Table 88. Summary of indicators and relative importance of each in increasing use of traditional resources

Strategy / Indicator	Influence on objective
Number of community events / celebrations featuring traditional foods	Moderate
Amount of resources harvested for sharing	Moderate
Investment in cultural objects	Moderate

Even taken together, these strategies may have only a moderate influence on the objective. Because the reasons for the decline in use are diverse and not easily addressed by community leaders or resource managers, strategies to change the situation are fragmentary and partial.

Encouraging use of traditional foods in community celebrations

This strategy is widely employed as a matter of course, but could be made more effective through explicit promotion, modeling and support to engage multiple generations in all aspects of food harvest, preparation and presentation. The effectiveness of the strategy is uncertain, and at best likely to be only moderate. Food preferences of coastal communities have changed and while efforts can be made to re-introduce forgotten or unusual traditional foods along with continuing favourites (such as fish and berries), the likelihood of their success in encouraging use is not high.

Table 89. Probability of increasing use and uncertainty related to use of traditional foods in community celebrations

Number of community events featuring traditional foods	**Probability of success**	**Uncertainty**
Low	Low	High
Medium	Low	High
High	Moderate	High

Uncertainty about the likelihood of success from this strategy is high because it depends crucially on the degree of social reinforcement for changes in preferences and tastes, as well as success in achieving the other linked objectives.

Table 90. Factors leading to uncertainty in the relationship between featuring traditional foods at community celebrations and overall use of traditional foods

Factor	Relative importance	Ease of resolving
Tastes and preferences	High	Resolvable through simple surveys
Preserving knowledge and access to the resources	High	Difficult – see other objectives

Organized collection and sharing of traditional resources

This strategy relies on community organizational efforts to collect or harvest traditional resources for wider use. It responds to a situation where there is high interest and demand for the resource in the community, but significant barriers to its harvesting. These may be related to the costs of travel or equipment to collect the resource, or to distance or inaccessibility. The strategy will work best in conditions where the resource can be found in high concentrations and large amounts harvested with relatively limited effort by a small group to take back to the community. For those circumstances where this strategy is appropriate, it is likely to be highly effective in increasing use above levels that would otherwise occur. However, these appropriate circumstances are fairly limited (e.g. fish, oolichan, berries, wild game, and perhaps monumental cedar as a non-food resource).

Table 91. Probability of increasing use and uncertainty related to amount of traditional resource harvested for sharing

Amount of resource harvested for sharing	Probability of success	Uncertainty
Low	Low	Low
Medium	Moderate	Low
High	High	Low

Investment in cultural objects

Community and external investment in cultural objects such as ceremonial wood carvings and baskets made from traditional materials will contribute to maintaining knowledge and use of these resources. But because the time involved in collecting, preparing and creating these works is substantial, they are costly and the amount of traditional resources used will always be small. This strategy is more a mechanism to raise the social profile of cultural resources than to have a direct effect on the quantities used. Its main influences are indirect, by reinforcing the symbolic and practical connections between traditional life and culture and the resources found in traditional territories. On its own, this strategy has low probability of success of increasing use of cultural resources at most practical levels of implementation. But it may be important for its symbolic value in any case, and has been adopted by many communities on the coast already. Uncertainties surrounding the effectiveness of this strategy are low.

Table 92. Probability of increasing use and uncertainty related to investement in cultural objects

Investment in cultural objects	Probability of success	Uncertainty
Low	Low	Low
Medium	Low	Low
High	Low	Low

Overall Summary: Increase use of cultural and traditional resources

Table 93. Summary of strategies to increase use of cultural and traditional resources

Strategy	Current state	Target state	P (success)	Uncertainty
Number of community ceremonies	Medium	High	Moderate	High
Amount harvested for community sharing	Low	High	High	Low
Investment in cultural objects	Low to Medium	High	Low	Low

Values identified are illustrative only and have not been confirmed by local observation or knowledge holders.

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