Xsu gwin lik’l’inswx:
West Babine
Sustainable Resource
Management Plan

Technical Report

March 2004

This document describes the technical and modelling information used as a basis for Xsu gwin lik'l'inswx: West Babine Sustainable Resource Management Plan. At the time of plan writing, the following information was the best available information.

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1.0 BACKGROUND INFORMATION

1.1 Babine Local Resource Use Plan

The original Treatment Unit boundaries for the Babine LRUP area were based on an unpublished report from the Wildlife Branch, of B.C. Environment by E.C. Lea and R.C. Kowall titled *Biophysical habitat units of the Babine River Study Area.* Keith Simpson interpreted this report into mapped polygons in 1991-92 in two reports (*Grizzly bear habitats and biodiversity guidelines in the Babine River Drainage* and *Seasonal habitat use by grizzly bears in the Babine River Drainage*) completed for the Ministry of Forests and Ministry of Environment in Smithers, BC.

The original LRUP mapping included only the southern portions of the West Babine SRMP area, and in 2001 Todd Mahon and Maggie Marsland expanded this coverage to cover the northern area (See unpublished report completed for Ministry of Forests, Kispiox District and the Ministry of Environment, Lands and Parks, Skeena Region titled *Babine LRUP Treatment Unit Mapping Extension, Kispiox Forest District*). The methodology for the original treatment unit mapping was used as the basis for this expanded coverage.

Following is a summary table that identifies the objectives of the treatment units and additional considerations used in the mapping of the treatment units.

Treatment Unit Objectives

Treatment Unit	Management Objectives	Additional considerations and comments
1	• Maintain the riparian ecosystem intact in terms of structure, composition and function • Maintain 70 percent of all habitat types structurally and functionally intact in the upland buffer/movement corridor • Provide linkages with other habitats • Maintain the integrity of the movement corridor through providing thermal and security cover, snow interception and visual screening • Maintain the productivity of fish streams	• Generally follow major rivers and streams • Boundary located to provide ≥100m beyond break of incised stream gullies/valleys
2	• Maintain unmanaged stands representative of all habitats, including old growth forest types • Maintain linkage with other units	• Most restrictive TU – no harvest or roads allowed • Reserved for very highest habitat concentrations in the study area • 2 areas identified: Sperry avalanche tracks+wetlands and the Shelagyote headwater wetland complex • Damsumlo wetlands also considered, currently TU 4
3	• Minimize habitat fragmentation across the landscape • Provide linkages among FEN, riparian systems, and high value bear habitat • Contribute to biodiversity objectives • Maintain grizzly bear movement corridors	• Considered to be almost equivalent to TU 1 • Mostly placed along major tributary systems, however, occasional upland linkages with no riparian association • Frequently used as elevational link between valley bottoms and higher elevation polygons

Treatment Unit	Management Objectives	Additional considerations and comments
4	• Preserve high value grizzly bear habitat • Minimize opportunities for human-bear conflict	• Based on concentrations of high value habitats • Boundaries generally located to include ≥100m of mature coniferous forest around high value non-forested and seral habitats such as alder seeps, wetlands and deciduous south aspect slopes
5	• Minimize opportunities for human-bear conflict and disturbance within berry producing areas	• Poor confidence any available maps accurately depict the highest concentration of huckleberry sites
6	• Balanced management objectives for timber extraction, grizzly bears, biodiversity, recreation, etc.	• Integrated resource management zone.

1.2 Biogeoclimatic Zones

This coverage was clipped from Version 5.0 of the provincial coverage, which was created on April 17, 2003. This coverage includes new biogeoclimatic mapping using digital elevation models and bases derived from the 1:20 000 TRIM or TRIM2 mapping. Therefore, this version has a scale of 1:20 000.

Information on this coverage was obtained at the following website:
http://www.for.gov.bc.ca/hre/becweb/subsite-map/provdigital-01.htm

1.3 Forest Cover

The current Forest Cover Inventory used was the coverage on which the *Kispiox Timber Supply Area Analysis Report* (May 2002) was based. This information was complied by the Ministry of Forests in 2000, based on inventory initially completed in 1992, with stand characteristics such as tree height, stocking and age projected to 1999. The inventory was updated to account for timber harvesting up to 1997.

1.4 Special Management Zone Boundaries

The plan contains two special management zones (SMZ), the Babine River Valley SMZ and the Atna/Shelagyote SMZ. These zones were established by the Kispiox Land and Resource Management Plan (April 1996).

The Atna/Shelagyote SMZ was designated to maintain provincially significant scenic resources, backcountry recreation opportunities, grizzly bear denning habitat, mountain goat habitat and extensive wetlands in the upper Sicintine and Shelagyote valleys. Commercial timber harvesting was deferred so that additional information about scenic, recreation and wildlife resources could be collected. After assessment of the ecological values of the SMZ and the timber values of the SMZ, the West Babine SRMP has recommended increasing the size of this zone to more fully maintain important grizzly bear habitat and extensive wetland and bull trout habitat in the upper Shelagyote valley. The West Babine SRMP has also recommended that this zone become a no logging zone and be removed from the Timber Supply Area.

The Babine River Valley SMZ was designated to protect and buffer river-based resource values within the Babine River wilderness corridor (i.e. the protected area). Forestry activities within the Babine SMZ were to be consistent with the Babine River LRUP. The West Babine SRMP does not alter the objective of the zone and is consistent with the timber harvesting strategies, however, the boundary has been expanded in the eastern portion of the plan area to more effectively protect and buffer the wilderness values associated with the river.

The boundary expansion was based on air photo interpretation work and a ground check completed by Steve Webb, RPF of Silvicon Services Inc. in April 2003 and summarized in *Access and Timber Development Strategy Evaluation for Shenismike/Shelagyote Triangle and Gunanoot Lake North as part of the West Babine Sustainable Resource Management Plan.*

1.5 Timber Harvesting Landbase

The current Timber Harvesting Landbase used for all analysis in the SRMP was the coverage produced by the Ministry of Forests for the *Kispiox Timber Supply Area Analysis Report* (May 2002).

1.6 Watershed Boundaries

Watershed boundaries are based on the British Columbia Watershed Atlas that is maintained by the Aquatic information Branch of the Ministry of Sustainable Resource Management. Watershed boundaries are based on 1:50,000 NTS aquatic-related linework (streams, lakes and wetlands), and contain boundaries for all third order and greater systems. The coverage used was release on March 31, 1998.

Information on this coverage was obtained at the following website:
http://srmwww.gov.bc.ca:8000/pls/dr_pub_prod/drwp_info_source_dtls.display?forInfoSrceID=9

2.0 ECOLOGICAL INFORMATION

2.1 Core Ecosystems

Core ecosystems are based on the Treatment Unit 2 boundaries from the Babine Local Resource Use Plan. They represent old growth management areas (OGMAs) and detailed methodology for OGMA calculation and identification is described below.

Budget Calculation

The database for calculating the OGMA budget was determined as per the Landscape Unit Planning Guidebook (LUPG). The budget, however, deviated from that recommended by this guidebook and took direction from the Kispiox LRMP. The Kispiox LRMP recommends that 12% of old growth be conserved for each mid-sized watershed. As such OGMAs areas are allocated for at 12% for the Babine, Gail, Hannawald, Nichyeskwa, Shedin, and Shelagyote watersheds.

Management from the Forest Practices Code and the Babine LRUP treatment unit mapping is considered as it contributes to the budget of old forest from riparian reserve zones, Park and Treatment Units 2 and 3 respectively. This information is found in tables 2.8 and 3.1.

OGMA Identification

Non-contributing and partially contributing polygons that were either old or near old were identified. Polygons sharing common boundaries were merged together to create larger polygons that may contribute to old growth management. To ensure the polygons would offer some interior forest conditions, those polygons that provided an interior core greater than 2 hectares where identified and labeled as available OGMAs. Interior core was identified as the interior area with an edge buffered by 80 meters. 80 meters is used to define interior forested condition (in contrast to the biodiversity guidebook's 600 meters) based on recent work within British Columbia's interior forests (Burton, 1999).

OGMAs were selected from the available OGMAs based on a number of criteria including:

- size, with larger OGMAs preferred;
- known habitat information, particularly bull trout staging areas and high value grizzly bear habitat suitability;
- possible road locations; and,
- Babine LRUP treatment unit mapping

The result is a series of OGMAs that have mature and old forested characteristics, meet LRMP targets, protect some habitat values and have a minimal impact on timber supply.

Table 2.8. Old Growth Retention Report

a	b	c	d	dd	ee	e2	e3	e	f	g	h
Watershed	**BEC (variant)**	**Old growth age**	**Old growth target %**	**Forested Area (ha)**	**% Old in Parks**	**% Old in TU2**	**% Old in TU3**	**% Old NC**	**% Old within X years NC**	**% Old THLB**	**% Old within X years THLB**
Babine River	ESSFmc	250	12	2194				12	10	52	18
	ESSFwv	250	12	13987		0	0	14	37	4	9
	ICH mc 1	250	12	10964		0	0	1	14	3	17
	ICH mc 2	250	12	1082			0		3	2	2
	SBS mc 2	140	12	16923	7	0	1	12	1	28	2
Gail-Thomlinson	ESSFmc	250	12	7461		0		31	8	36	5
	ESSFwv	250	12	2070				50	32	1	1
	SBS mc 2	140	12	6030	3	0	1	27	0	26	0
Hanawald	ESSFmc	250	12	11454			0	13	17	36	15
	SBS mc 2	140	12	6979	0	0	0	13	1	44	4
Nichyeskwa	ESSFmc	250	12	7872		4		35	28	6	1
	ESSFwv	250	12	11				21		30	
	SBS mc 2	140	12	1374		4		28	0	1	
Shedin	ESSFwv	250	12	10301		0	1	41	28	13	5
	ICH mc 1	250	12	18202		2	4	19	11	39	10
	ICH mc 2	250	12	420				2	6	14	4
Shelagyote	ESSFmc	250	12	1817			8	4	14	29	23
	ESSFwv	250	12	18784		4	3	28	22	18	9
	SBS mc 2	140	12	8733	0		3	26	1	31	0

- column a: lists all the landscape units in the TSA/TFL.
- column b: lists the BEC variants for each LU.
- column c: old growth age from the tables in appendix 2.
- column d: old growth target from the tables in appendix 2 based on biodiversity emphasis from the RLUPS.
- column dd: total forested area in hectares including P, C, N from THLB.
- column ee: percentage of old forest found in the non-contributing land base and in a park.
- column e2: percentage of old forest found in Treatment Unit 2.
- column e3: percentage of old forest found in Treatment Unit 3.
- column e: percentage of old forest found in the non-contributing land base.
- column f : percentage of forest that will be old within X years (e.g., >120 and <140 if old = 140+ ; or > 200 and <250 if old = 250+), found in the non-contributing land base.
- column g & h: % old and almost old found in the THLB.

Table 3.1. OGMA Targets Report

a	b	c	d	e	e2	e3	f	g	h	i	j	k	
Watershed	**BEC (variant)**	**Forested Area (ha)**	**Old growth target (ha)**	**Old growth in Parks (ha)**	**Old growth in TU2 (ha)**	**Old growth in TU3 (ha)**	**Old growth in NC (ha)**	**Old growth in THLB (ha)**	**Old Growth in RRZ**	**Remaining Old Growth Target**	**Available OGMAs**	**Proposed OGMAs**	**Comment**
Babine River	ESSFmc	2194	263				260	1142	28	235	201	201	small, dispersed zone
	ESSFwv	13987	1678		23	53	1900	619	19	1583	7846	2510	incl. Shegisic
	ICH mc 1	10964	1316		0	16	161	285	5	1295	1573	1146	park
	ICH mc 2	1082	130			0		20		130	28	180	recruit - shedin/Babine Conf.
	SBS mc 2	16923	2031	1203	2	173	2047	4726	65	588	2631	1726	Park
Gail-Thomlinson	ESSFmc	7461	895		0		2321	2669	76	819	2290	937	
	ESSFwv	2070	248				1041	19		248	1640	324	
	SBS mc 2	6030	724	158	14	63	1627	1562	21	468	1568	500	
Hanawald	ESSFmc	11454	1375			11	1456	4174	83	1281	2155	1409	
	SBS mc 2	6979	837	4	9	21	895	3083	123	680	241	618	
Nichyeskwa	ESSFmc	7872	945		314		2717	488		631	5461	1011	THLB wrong
	SBS mc 2	1374	165		61		388	19		104	774	160	THLB wrong
Shedin	ESSFwv	10301	1236		36	79	4271	1290	17	1104	7261	1085	
	ICH mc 1	18202	2184		284	725	3418	7141	83	1092	4974	1941	
	ICH mc 2	420	50				8	60		50	60	105	recruit - shedin/Babine Conf.
Shelagyote	ESSFmc	1817	218			150	77	518	11	57	169	76	
	ESSFwv	18784	2254		689	524	5272	3314	205	836	8184	1752	
	SBS mc 2	8733	1048	17		238	2238	2726	90	703	1438	1320	

* NC means the non-contributing land base (includes partially contributing).
column **c** = total crown forested area, expressed in ha.
column **d** = based on target of 12% for the BEC variant, expressed in ha.
column **e** = amount of existing old growth within parks.
column **e2** = amount of existing old growth within Treatment Unit 2 areas.
column **e3** = amount of existing old growth within Treatment Unit 3 areas.
column **f** = amount of existing old growth in the NC land base available to meet the OGMA target.
column **g** = amount of existing old growth in the THLB available to meet required OGMA hectares defined in column d.
column **h** = amount of existing old growth in the RRZ available to meet required OGMA hectares defined in column d.
column **i =** difference between target and old growth found in TU2, TU3 and Park.
column **j** = amount of existing old growth and near old in the non-contributing and partially contributing landbase available in polygons with a minimum of 80 meters buffer
Proposed OGMAs delineated to meet target in i.
Note: calculations in h, i, j, k are approximations only. Proposed OGMAs include area within TU2, TU3 and Parks. Ideally, these areas would be excluded from the proposed OGMA calculation.

2.2 Landscape Corridors

Landscape corridors provide connectivity across the landscape, between riparian areas and between riparian and upland areas. Corridors are based on Treatment Unit 1 and 3 mapping from the Babine Local Resource Use Plan.

Table 2 in the West Babine SRMP is a Decision Matrix for timber harvesting within Landscape Riparian Corridors, and this table comes from the Bulkley Timber Supply Area Landscape Unit Plans.

2.3 Grizzly Bear Habitat and Population Estimates

a. Grizzly Bear Population Estimates

Under the Grizzly Bear Conservation Strategy (1995), the Wildlife Branch of the Ministry of Water, Land and Air Protection has estimated grizzly bear populations for each Wildlife Management Unit of the province. This estimate is based on habitat capability (because of the impracticality of census), stepped down for the existing levels of habitat loss, habitat alteration, displacement, fragmentation and mortality in each Management Unit. The West Babine SRMP area contains portions of two much larger Management Units (6-7 and 6-8).

These management units are large areas and the step-down is applied as an average of conditions across the area. Management Unit 6-8 has a much higher step-down because it includes settled areas of the Bulkley River Valley and large areas that have been developed for forestry. The step-down for Management Unit 6-7 is much less, reflecting its larger undeveloped area. The numbers shown for the plan area reflect the resent population estimate (factored by area) and the step down used for Management Unit 6-7, since the plan area and Management Unit 6-7 have similar habitats and degree of development. These numbers should not be interpreted as precise, but as an illustration of approximate numbers and step-down.

b. High Value Grizzly Bear Habitat

High value grizzly bear habitat has been identified based on the Treatment Unit 4 and 4a mapping from the Babine Local Resource Use Plan.

c. Core Security Areas

A core security area is any patch of ground that does not contain an open road (any existing roads must be in an *inaccessible condition*) or the influence of a road and where the impact of roads on grizzly bear mortality is minimized. To be effective grizzly bear habitat, a core security area must be of sufficient size. In this plan, the minimum size an area must be in order to be considered an effective core security area is 1000 hectares. The Risk Assessment Tool documentation describes the process of modeling core security area, including the Arc Macro Language and Structured Query Language scripts used in this plan.

In short, core security area is achieved in areas without open roads. To model full build-out condition for each BMU it was assumed that all roads are either in an *accessible* or *partially accessible* condition. To begin, all roads within 500 meters of the selected study area are highlighted. Every road within this area then has a 500 meter buffer applied to it. Beyond 500 meters, the impact of the road is assumed to not affect grizzly bear mortality and is thus, a core security area. After overlaying the buffered road area with an outline of the study area, excluding alpine, water and other areas that do not contribute to bear habitat, the core security areas are identified.

d. Habitat Displacement

Habitat displacement is a concern when addressing grizzly bears in this plan because as the density of roads in an area increases, so to does the impact to grizzly bears. The modeling aspect of habitat displacement is discussed in the Risk Assessment Tool documentation section along with the technical AML and SQL scripts used in developing the tool.

To be brief, habitat displacement was addressed by dividing the landscape into a four-class Road Density Index (RDI). The RDI classes are:

- zero kilometres of road per square kilometre;
- greater than zero and less than 0.6 kilometres of road per square kilometre;
- greater than 0.6 and less than 1.2 kilometres of road per square kilometre; and,
- greater than 1.2 kilometres of road per square kilometre.

Using the potential road network developed for this plan, the road density was calculated using ESRI GRID software. However, not every road in the plan area was included in the index. Only roads with an operation class of one, two or three were analyzed, as the potential impact of human-grizzly bear interactions decrease as roads are less frequently used.

After the plan area has a Road Density Index applied to it, an analysis of those impacts can be performed. For the purposes of this plan, only areas where the RDI is greater than 0.6 kilometres of road per square kilometre were considered. There is more discussion of the Road Density Index under the Risk Assessment Tool, including the AML code that uses GRID commands to classify the landscape.

e. Risk Assessment Tool

What follows is the documentation of the risk assessment tool created for the initial draft of the West Babine SRMP. Many of the management objectives in Draft 2.0 are based on the results of the outcome of this assessment.

Two goals of the West Babine Sustainable Resource Management Plan are grizzly bear conservation and providing access for timber harvesting operations. The Risk Assessment Tool addresses these two goals, or resource management issues, in an environmental risk assessment framework. The purpose of the tool is to provide a measure of risk to grizzly bears and potential harvest value for a set of development scenarios in the plan area.

The Risk Assessment Tool provides information about development scenarios across Bear Management Units (BMUs) for the entire plan area. It is the culmination of two sets of analyses. The first set addresses direct mortality risk from human bear interaction and habitat displacement risk from vehicle traffic for grizzly bears, and the second set calculates value of timber available through various development scenarios. A predictive risk model is developed using the grizzly bear habitat statistics and risk-level thresholds. Similarly, a timber value model is developed using the volumes, timber values and operational costs. The risk assessment and timber values identified in the tool will be used to guide forest development in a manner that minimizes the risk to grizzly bears while providing access for timber harvesting.

Risk Assessment Tool

The Risk Assessment Tool is a complex spreadsheet reporting grizzly bear habitat conditions and timber volume statistics for each scenario within the West Babine SRMP plan area. The statistics are reported for each scenario, summarized to the BMU level.

A BMU is defined as the approximate home range of a cub-less female grizzly bear; 12 approximate home ranges, or BMUs, are identified in the plan area. Within each BMU there are a number of Mainline Units (MLU). An MLU is analogous to a road shed; it is a logical timber chance where all roads in an MLU must flow through one outlet.

Scenarios

In generating the Risk Assessment Tool, every potential development pattern (based on MLUs as the operational unit) was identified as a scenario A total of 303 access scenarios or options were identified. Each record in the list contains the BMU and "open" MLUs for each scenario. The following rules were used in developing the list of MLU options:

- any MLU accessed must be supported "downstream" by an open MLU;
- all MLUs within each BMU must be accessed in at least one scenario; and,
- adjacent BMU conditions are not considered in developing the list of access scenarios.

Spreadsheet Categories

The Risk Assessment Tool is comprised of a number of categories, each addressing one timber indicator or grizzly bear conservation factor. The categories are:

- area statistics;
- core security area statistics;
- habitat displacement statistics;
- grizzly bear mortality risk;
- grizzly bear habitat displacement risk
- timber volume;
- operational value and net stand value; and,.
- timber access indicator.

All scenarios are represented by a record in the tool. All modelling and calculations are performed on the assumption that every MLU listed in the scenario is open for harvesting.

The area statistics category include details on:

- gross and functional area of the BMU;
- high value grizzly bear habitat (classes 1 and 2 from the grizzly bear habitat suitability mapping);
- accessible contributing and partially contributing land from the THLB at that scenario and total THLB area in the BMU.

This section of the tool also contains the probability of entry values and the status of the scenario. The status column reports on whether a scenario is at a current, interim or build-out stage.

The core security area (CSA) statistics provides information on the availability of CSA for a given scenario. These statistics are divided into two classes: core security areas of 1000 to 10000 hectares and core security areas of greater than 10000 hectares. The columns report on the number of CSAs, total hectares in core security, the amount of high value habitat in core security and the percentages of the CSA that is actually high value grizzly bear habitat. The section also summarizes the two classes of CSA and reports the percentage of high value habitat across the BMU that is within a CSA and the percentage of the BMU that is a CSA.

The habitat displacement statistics use a road density index (RDI) to quantify and qualify the landscape. Using the first, second and third operational classes of the road network, the landscape is classified into four RDI classes. They are:

- 0 kilometres of road per square kilometre;
- greater than 0 and less than 0.6 kilometres of road per square kilometre;
- greater than 0.6 and less than 1.2 kilometres of road per square kilometre; and,
- greater than 1.2 kilometres of road per square kilometre.

These four classes then report the following statistics for each scenario:

- area of this RDI class in hectares;
- percentage of the BMU that is in this RDI class;
- high value grizzly bear habitat area in hectares in this RDI class;
- percentage of the RDI class that is high value grizzly bear habitat; and,
- percentage of the high value habitat in entire BMU that is within this RDI class.

The grizzly bear risk section uses the statistics generated by analysis of core security areas and habitat displacement to assign risk categories to each scenario. There are four risk categories: two each for core security areas and habitat displacement. The following tables define the risk category thresholds for core security area and habitat displacement: there is a measure of both the quantity and quality of habitat affected in each scenario.

Core Security Area (% area)

Risk	Cutoff
High	Less than 55 % of BMU in CSA
Medium	Greater than or equal to 55 % and less than 67 % of BMU in CSA
Low	Greater than or equal to 67 % of BMU in CSA

Core Security Area (habitat quality)

Risk	Cutoff
High	Less than 60 % of high value habitat in CSA
Medium	Greater than or equal to 60 % and less than 80 % of high value habitat in CSA
Low	Greater than or equal to 80 % of high value habitat in CSA

Habitat Displacement (area)

Risk	Cutoff
High	Greater than 12 % of BMU with a High RDI class
Medium	Greater than or equal to 8 % and less than 12 % of BMU with a High* RDI class
Low	Less than 8 % of BMU with a High* RDI class

Habitat Displacement (quality)

Risk	Cutoff
High	Greater than or equal to 10 % of high value habitat in High* RDI class
Medium	Greater than 8 % and less than 10 % of high value habitat in High* RDI class
Low	Less than 8 % of high value habitat in High*

* The area of High RDI class is calculated by summing 100% of the area with RDI> 1.2 km/km^2 and 50% of the area with RDI 0.6 > 1.2 km/km^2

Timber Volume

The timber volume section lists the cubic meters of timber available for each scenario; this is divided into stand quality and harvest method classes. The three stand quality classes are sawlog, marginal sawlog and pulplog (see Timber Suitability Documentation). Cedar sawlog is a fourth class identified in the Timber Suitability Documentation, but the model results show the plan area does not contain any cedar sawlog. Each class reports the volume of timber harvestable by ground-based rubber equipment (slopes < 35 degrees), ground-based tracked equipment (slopes >= 35 degrees and less than 50 degrees) and cable equipment (slopes greater than or equal to 50 degrees). The net volume in each category is further reduced by 15 percent for sawlog and marginal sawlog timber and by 20 percent for pulplog timber to account for discrepancies between net standing volume projected by the forest cover inventory and scaled volume. This section also reports the volume adjusted cycle time of each scenario. Cycle time was initially calculated for each MLU, which equated to the cost to transport a cubic meter of wood, by the shortest route, from the MLU to Hazelton. Using the weighted mean of cycle times and total timber volume, the volume adjusted cycle time was calculated for every scenario.

Timber Values and Costs

The operational values and costs section reports the gross stand value, harvest cost and haul costs. The following tables outline the calculations for the values of sawlog, marginal sawlog and pulplog, the cost for each harvest method and the hauling costs. The figures for timber value and harvest system cost are in dollars per cubic meter and the hauling cost is in cubic meters per hour, based on $2.52 tonne per hour and 1.2 cubic meters per tonne.

Timber Value	$/m3
Cedar Sawlog (none exist)	80
Sawlog	63
Marginal Sawlog	56
Pulplog	50.75

Harvest System Cost	$/m3
Ground – rubber	18
Ground – tracked	22
Cable	30

Hauling cost	m3/hr
Trucking cost	3.024

Net value is also reported for each scenario, where the harvesting and haul costs are subtracted from the gross value. The timber indicator is based on net value and is reported for each scenario as a percentage of the total value accessible for the given scenario.

For details on the computer program used for the Risk Assessment Model, please see Appendix 1.

2.4 Seral Stage Retention Targets

Seral stage retention targets were supplied by the Ministry of Water, Land and Air Protection, and were based on work completed by Doug Steventon, Ministry of Forests (2002) and the Forest Practices Code Biodiversity Guidebook (1996). Steventon's report *Historic Disturbance Regimes of the Morice and Lakes Timber Supply Areas: Draft Discussion Paper* addressed disturbance regimes and resulting seral stage distributions in the Sub-boreal Spruce subzone (SBSmc) and in the Engelmann Subalpine Fir subzones (ESSFwv and ESSFmc), while target for the Interior Cedar Hemlock subzone (ICHmc) was taken from the older Biodiversity Guidebook.

2.5 Equivalent Clearcut Area (ECA) Triggers

The Kispiox LRMP identified an average ECA trigger of no more than 22% of the forested land in a watershed to be in a hydrological condition equivalent to clearcut (ECA). This guideline was to be refined at the landscape planning level. For the West Babine plan area, Dave Wilford, Research Officer and Hydrologist with the Ministry of Forests, Regional Service Centre located in Smithers BC completed an assessment in 2002 for the watersheds in the area and refined them based on the GIS area summary in the following table, ECA triggers from adjacent landscape unit plans and on his expert knowledge.

Table 1. Forested area in West Babine watersheds

Watershed	Area (Ha)	Forested Area (Ha)	THLB (Ha)	%THLB/ Total Forested	% THLB/ Watershed
Babine River	55790	43453	15669	36%	28%
Gail	25279	17724	7558	43%	30%
Hanawald	23092	18666	12237	66%	53%
Shedin	61070	29402	12866	44%	21%
Shelagyote	57437	29168	11577	40%	20%

2.6 Wildlife Tree Patch Retention Targets

Wildlife tree patch retention targets for cutblocks less than 80 ha in size were based on figures supplied by the Kispiox Forest District (Maggie Marsland) and are in accordance with the district's operation policy. For cutblocks greater than 80 ha in size, retention targets were increased by 50 - 100% based on:

- the Forest Practices Code Biodiversity Guidebook (1996) which notes the need for structural retention within cutblocks increase with cutblock size and that additional structural retention within large cutblocks helps to minimize fragmentation and provide habitat for species such as bears and furbearers; and
- Gitxsan First Nations house chiefs who indicated a desire to see increased retention within larger cutblocks.

2.7 Shenismike Corridor

The Shenismike Corridor was created by the West Babine SRMP Draft 2.0 to more effectively protect wildlife movement corridors in the vicinity of Grizzly Drop. The boundaries were delineated not to the heights of land, but rather based on the location of previously identified landscape corridors and core ecosystems.

2.8 Access Management Zones

The four access management zones (Sperry/Rosenthal, Big Slide, Shenismike West and Shenismike-Shelagyote) were created by the West Babine SRMP Draft 2.0 to manage for important grizzly bear habitat. Zonation was based on consultation with the Ministry of Water, Land and Air Protection and information from the Grizzly Bear Technical Workshops that preceded Draft 1.0 of the SRMP. Additional information around wilderness and tourism values associated with the Babine River, supported the creation of the Shenismike-Shelagyote access management zone.

The access control points were based on managing high value grizzly bear habitat within the access management zones, and meeting the intent of the Babine LRUP and the Kispiox LRMP by not permitting permanent roads within the Special Management zone.

Other information used in consideration of the Shenismike-Shelagyote access management zone was the report *Access and Timber Development Strategy Evaluation for Shenismike/Shelagyote Triangle and Gunanoot Lake North as part of the West Babine Sustainable Resource Management Plan* completed by Steve Webb, RPF of Silvicon Services Inc. on April 24, 2003 for MSRM provides an indication of timber value and access considerations based on non-statistical field sampling and air photo and resource mapping interpretations.

2.9 Patch Size Objective

Rationale for Interim Patch Size Guidelines, West Babine River Management Area
March 19, 2004
Phil Burton, Canadian Forest Service, Prince George, B.C.

Maintaining the patterns and biological legacies of natural disturbance provide a rough "coarse filter" approach to conserving biodiversity, protecting ecosystem integrity, and respecting aesthetic considerations. Along with determining the rate and focus of timber harvesting (which then sculpt the forest age class distribution), managing the forest patch size distribution may offset some of the negative impacts of industrial forestry. With this goal in mind, a set of interim guidelines for patch sizes is offered for each sub-basin of the Kispiox TSA portion of the Babine River watershed.

First it should be noted that there has not been a local study documenting the size or frequency of natural disturbances in the study area. Nor (to my knowledge) have forest cover polygons denoting pre-logging patch structure in the West Babine drainage been reconstructed for a GIS-based analysis of patch sizes. Consequently, inferences about the West Babine drainage disturbance regime are based on the behaviour of the same or similar BEC units elsewhere. This approach has obvious limitations, including a suspected over-estimation of the prevalence of landscape-level wildfires, and underestimation of the prevalence of old growth forest maintained by gap dynamics. There are ways to adjust the tabulated values accordingly, but this has not been done in the worksheets attached, as the modest levels recommended for very small and very large patches would already be a marked departure from business as usual.

Emphasis was placed on trying to estimate the prevalence of gap dynamic processes (single-tree and small-group mortalities), and the prevalence of very large (>1000 ha or at least >250 ha) wildfires in the natural disturbance regime of these forest types. Since traditional forest operations to date have concentrated on the creation of cutblocks in the 20 to 200 ha size classes, a more naturalized landscape probably requires more small openings and a few very large openings.

Following DeLong (2002), it is expected that the natural disturbance regime is more meaningfully described on the basis of a landscape unit or watershed, not just on the basis of BEC units (as implied in the natural disturbance types employed in the Biodiversity Guidebook). Therefore patch size guidelines have been proposed for each of six sub-basins within the West Babine River management area, with the percentage area occupied by each BEC unit making an area-weighted contribution to estimates of sub-basin level averages for the abundance of patches of a given size class. Feedback from Doug Steventon and Craig DeLong suggests that these sub-basins may be too small to serve as equilibrial landscapes or *de facto* natural disturbance units. This concern is justified, because the sub-basins measure only 9,246 to 45,150 ha each, so guidelines have also been offered for the entire study area (146,647 ha). But if the objective of special management is to protect water quality, grizzly bear habitat, and visual quality, then I would still recommend applying (any given set of) patch size guidelines within each sub-basin. Though highly flexible (+/- 10%) because of the uncertainty in the underlying data, these values should not provide the sole guidance in setting patch size objectives. For example, meeting special management objectives in the Babine River sub-basin may require more than 10% of patches to be in gap-sized openings, even though this is what the data suggest to have naturally prevailed in the BEC units comprising the sub-basin.

Data, their sources, and calculations for deriving sub-basin targets are detailed in Table 1 (attached Excel spreadsheet), based on available information for the prevalence of very small (<1 ha) or "gap-based" openings, those <80 ha in size, those >250 ha in size, and those >1000 ha in size; targets for openings 80-250 ha were subsequently derived by subtraction (Table 2, attached). Estimates were based on:

- Bartemucci et al.'s (2002) field survey of canopy gaps (particularly those classified as "developmental gaps") in the SBSmc2, ESSFmc, and ICHmc2 subzones of northwestern B.C.;
- DeLong's (2002) description (expert-based) of the prevalence of gap dynamics in natural disturbance units containing the same or similar BEC units in the Prince George Forest Region;
- Steventon's (2002) statistical modelling of patch size distributions in the SBSmc, ESSFmc and ESSFwv subzones within the Morice and Lakes Timber Supply Areas; and
- Wong et al.'s (2003) review of natural patch sizes (particularly the proportion >1000 ha) throughout the province, usually drawing on BEC units similar to those in the Babine drainage.

In order to make the targeted distribution of size classes more even, to offset a likely over-estimation of the extent of very large fires, and to avoid a perceived need for very large forest openings in this mountainous terrain, the >1000 ha patch size category has been amalgamated with the >250 ha patch size category (see below, and Table 3, attached). Further adjustments based on local empirical research (into the history and pattern of wildfires, windthrow, insect outbreaks, root rot pockets and other natural disturbances) would obviously be desirable. But the values given here represent a good start at providing an objective, defensible basis for a forest patch size structure designed to emulate the pattern of natural disturbances in the West Babine management area.

References Cited:

Bartemucci, P., K.D. Coates, K.A. Harper, and E.F. Wright. 2002. Gap disturbances in northern old-growth forests of British Columbia, Canada. Journal of Vegetation Science 13: 685-696.

DeLong, S.C. 2002. Natural Disturbance Units in the Prince George Forest Region: Guidance for Sustainable Forest Management. Internal Report, B.C. Ministry of Forests, Prince George Forest Region, Prince George, B.C. 36 p.

Steventon, J.D. 2002. Historic Disturbance Regimes of the Morice and Lakes Timber Supply Areas. Draft Discussion Paper, B.C. Ministry of Forests, Prince Rupert Forest Region, Smithers, B.C. 22 p.

Wong, C., B. Dorner, and H. Sandmann. 2003. Estimating Historical Variability of Natural Disturbances in British Columbia. Land Management Handbook 53. B.C. Ministry of Forests, Forest Science Program and B.C. Ministry of Sustainable Resource Management, Resource Planning Branch. Victoria, B.C. 140 p.

Recommended patch size targets for sub-basins of the Babine River watershed.

	Percent of Forested Area to be Logged				
Sub-Basin	**<1ha**	**1-80ha**	**80-250 ha**	**>250 ha***	**TOTAL**
Babine River	**10**	10	35	45	100
Gail-Thomlinson	25	0	20	**55**	100
Hanawald	20	5	20	**55**	100
Nichyeskwa	25	0	20	**55**	100
Shedin	20	10	45	25	100
Shelagyote	25	0	25	50	100
If defined over the Entire study area**	15	10	30	45	100

* the two largest size classes used in Tables 1 and 2 have been amalgamated, because the natural extent of giant openings (>1000 ha) is thought to have been over-estimated (being based on data from plateaus further south and drier mountains further east), and are not a necessary target in this mountainous landscape, where hydrological and visual impacts are of concern.
** based on amalgamated data, not the average of individual subbasins
All values can be considered +/- 10%, given the uncertainties in transferring the data used.
Note that these guidelines do not consider the existing age or patch structure found in the areas referenced.
Values in **bold** are the same as those estimated in the revised guidelines of Feb 2, 2004.

Table 1. Data and calculations in support of objectively defined patch size targets for sub-basins of the Babine River watershed.

a	b	c	d		e	f	g	h	I	j	k	l	m	n	o	p	q	r	s
						Calculations for Smallest Openings, < 1ha					Calculations for Openings <80 ha		Calculations for Giant Openings, >1000 ha					Calculations for Large Openings, >250 ha	
Sub-Basin	BEC variant	NDT*	Forested Area**(ha)		% by BEC variant	Prevalence*** of gap dynamics, %	Prevalence+ of gap dynamics, %	% in Old Growth++	Mean of Columns f, g	BEC-Weighted Target+++	Small Patch Estimates, %#	BEC-Weighted Target+++	Giant Patch Estimates, %##	Giant Patch Estimates, %#	Giant Patch Estimates, %***	Mean of Columns m, n	BEC-Weighted Target+++	Large Patch Estimates, %###	BEC-Weighted Target+++
Babine River	ESSFmc	2	2,194		4.86	30.0	42.24	63.90	36.12		20		61	20	40	40.3		52.0	
	ESSFwv	1	13,987		30.98	35.0	11.90	18.01	23.45		19		23	7	35	21.7		46.0	
	ICH mc 1	2	10,964		24.28	10.0	3.78	11.86	6.89		34		1	-	70	35.5		2.5	
	ICH mc 2	2	1,082		2.40	10.0	3.83	12.01	6.92		34		1	-	70	35.5		2.5	
	SBS mc 2	3	16,923	45,150	37.48	2.0	18.05	40.02	10.02	14.62	21	23.80	74	35	70	59.7	40.51	57.0	38.81
Gail-Thomlinson	ESSFmc	2	7,461		47.95	30.0	44.21	66.88	37.10		20		61	20	40	40.3		52.0	
	ESSFwv	1	2,070		13.30	35.0	33.85	51.21	34.42		19		23	7	35	21.7		46.0	
	SBS mc 2	3	6,030	15,561	38.75	2.0	23.85	52.89	12.93	27.38	21	20.25	74	35	70	59.7	45.34	57.0	53.14
Hanawald	ESSFmc	2	11,454		62.14	30.0	32.49	49.15	31.24		20		61	20	40	40.3		52.0	
	SBS mc 2	3	6,979	18,433	37.86	2.0	25.71	57.00	13.85	24.66	21	20.38	74	35	70	59.7	47.65	57.0	53.89
Nichyeskwa	ESSFmc	2	7,872		85.14	30.0	26.91	40.71	28.45		20		61	20	40	40.3		52.0	
	SBS mc 2	3	1,374	9,246	14.86	2.0	13.36	29.62	7.68	25.37	21	20.15	74	35	70		57.0		
Shedin	ESSFwv	1	10,301		35.62	35.0	35.69	53.99	35.34		19		23	7	35		46.0		
	ICH mc 1	2	18,202		62.93	10.0	18.51	58.01	14.25		34		1	-	70		2.5		
	ICH mc 2	2	420	28,923	1.45	10.0	5.16	16.19	7.58	21.67	34	28.66	1	-	70		2.5		
Shelagyote	ESSFmc	2	1,817		6.19	30.0	21.65	32.75	25.82		20		61	20	40		52.0		
	ESSFwv	1	18,784		64.03	35.0	30.21	45.71	32.61		19		23	7	35		46.0		
	SBS mc 2	3	8,733	29,334	29.77	2.0	25.63	56.84	13.82	26.59	21	19.66	74	35	70		57.0		

* NDT = natural disturbance type, as defined in B.C. Forest Practices Code Biodiversity Guidebook (1995). 146,647 146,647

** Forested Areas by BEC variant are for provincial crown land only, provided by James Cuell, B.C. Ministry of Sustainable Resource Management

*** Prevalence of gap dynamics and very large disturbances based on expert opinion reported by DeLong (2002) for same or similar BEC variants in Prince George Forest Region

\+ Prevalence of gap dynamics from Bartemucci et al. (2002), where local old growth abundance is multiplied by the zonal abundance of developmental gaps in old growth.

++ Dominated by gap dynamics (by definition); based on thresholds defined in Biodiversity Guidebook; existing areas or targets of ca. 12% as provided by James Cuell (MSRM).

+++ All BEC-weighted targets weight the available BEC-specific estimates by the prevalence of the variant in the sub-basin to come up with an overall mean for the sub-basin, adjusted for smaller or larger size classes as appropriate; values <0 indicate quotas already utilized in smaller or larger size classes.

\# Derived for these same ESSF and SBS variants from Fig.4 of Steventon 2002 (statistical fits to patch size distributions in the Morice and Lakes TSAs), and for the ICHmc from the lower limit of <10 ha patches for ICHwk by Rogeau 2000 as reported in LMH-53 (Wong et al. 2003).

\## Disturbances or patches >1000ha in size for closest BEC variant analogs reported in LMH 53 (Wong et al. 2003): Andison 1996, DeLong & Tanner 1996, Hawkes et al. 1997, DeLong 1998, Rogeau 2000.

\### Derived for these same ESSF and SBS variants from Fig.4 of Steventon 2002 (statistical fits to patch size distributions in the Morice and Lakes TSAs), and for the ICHmc from the upper limit of >1000 ha patches for ICHwk by Rogeau 2000 as reported in LMH-53 (Wong et al. 2003).

Table 2. Objectively defined patch size targets for sub-basins of the Babine River watershed.

Sub-Basin	<1ha	1-80ha	80-249 ha*	250-1000 ha	>1000 ha	TOTAL
Babine River	10	15	30	5	40	100
Gail-Thomlinson	15	10	20	10	45	100
Hanawald	15	10	20	10	45	100
Nichyeskwa	25	0	20	15	40	100
Shedin	10	20	40	0	30	100
Shelagyote	15	5	30	15	35	100

Raw calculations in Table 1 adjusted to sum to 100%, maintaining ratios and rounding down for the smallest and largest size classes, rounding up for intermediate size classes.

* by subtraction from smaller and larger size classes.

Table 3. Rationalized patch size targets for sub-basins of the Babine River watershed, and rationale.

Percent of Forested Area to be Logged					
Sub-Basin	**<1ha**	**1-80ha**	**80-250 ha**	**>250 ha***	**TOTAL**
Babine River	**10**	15	**30**	45	100
Gail-Thomlinson	15	**10**	20	**55**	100
Hanawald	15	**10**	20	**55**	100
Nichyeskwa	25	0	20	**55**	100
Shedin	10	20	40	**30**	100
Shelagyote	15	5	**30**	50	100

* the two largest size classes used in Tables 1 and 2 have been amalgamated, because the natural extent of giant openings (>1000 ha) is thought to have been over-estimated (because based on data from plateaus further south and drier mountains further east), and are not a necessary target in this mountainous landscape, where hydrological and visual impacts are of concern.

All values can be considered +/- 10%, given the uncertainties in transferring the data used.

Note that these guidelines do not consider the existing age or patch structure found in the areas referenced.

Values in **bold** are the only ones which agree with revised interim guidelines as per Feb 2, 2004.

2.10 Bull trout

a. Spawning surveys

Tributaries suspected of containing spawning habitat for fluvial bull trout shall be assessed for the presence of spawning bull trout prior to the selection of a crossing location. Bull trout spawning surveys will consist of trained professional fisheries biologists or, technicians experienced in the identification and location of adult bull trout spawning pairs and redds. At a minimum, surveys will consist of:

- ground based stream walks of all stream reaches accessible to bull trout from the mainstem Shelagyote River;
- using polarized glasses, and beginning at the confluence of the tributary with the mainstem river, crews will survey the channel for bull trout redds and spawning pairs;
- redds and/or spawning adult locations will be geo-referenced where possible; and,
- a minimum of two surveys will be conducted the first + 3 days of Sept. 15, and the second + 3 days of Sept 23 (Giroux 2001). Sample dates should be selected to optimize clear and low water conditions.

b. Operating windows

Bull trout spawning activity coincides with the initiation of descending water temperatures following summer highs. Therefore, to avoid conflicts with spawning or migrating bull trout, in-stream activities shall not commence or continue past August 15. Emergence of bull trout fry remains uncertain for the Shelagyote watershed; however, late-June remains as the estimated period of emergence *(Fraley & Shepard 989)*. Bull trout fry remain in the substrate after emergence for cover and will remain proximal to emerging habitat for up to one year. Care must be taken not to introduce fine inorganic material to reaches downstream of in or about-stream works to avoid substrate compaction and fry displacement. In-stream works between the last week of July and first week of August would provide the period of least impacts to bull trout. Development proponents are advised to refer to WLAP R6, in-stream works and measures document published by the former Habitat Protection Section of BC Environment.

3.0 SOCIAL/CULTURAL HERITAGE INFORMATION

3.1 Atna Pass and Shelf Ridge Trails

The West Babine SRMP area is important to the Gitxsan First Nation, and known trails of importance to the Gitxsan, and providing potential tourism opportunities were included in the plan. The information on the location of these trails came from two sources:

- Strategic Watershed Analysis Team's 1999 unpublished, draft report prepared for Ministry of Environment, Lands and Parks, *General biodiversity project, Taking Stock II: Sam Green and Shedin Watersheds Wildlife Inventory and Habitat Assessment*.
- A report completed for SCI, Carnaby Lumber Operations by Kenny Rabnett in Feb. 2001, *Gitxsan Cultural heritage within portions of the Shelagyote Chart*

3.2 Visual Quality Objectives

The Visual Quality Objective polygons used in the West Babine SRMP came from the Ministry of Forests, Kispiox Forest District Visual Landscape Inventory. The inventory was completed between August 1997 and March 2000. (Babine River, Gunanoot Lake and Sicintine inventories completed Aug 11, 97; Skeena River Feb. 28, 1999, and the Lower Skeena portion completed March 6, 2000.)

The definitions and percent modification associated with each objective type (modification, partial-retention, and retention) come from the Bulkley TSA landscape unit plans.

4.0 ECONOMIC INFORMATION

4.1 Berry Gathering Areas

Traditional Gitxsan berry-harvesting areas identified in the SRMP have been taken from two sources. The first source was an extensive field-based survey and traditional ecological knowledge review conducted by the Strategic Watershed Analysis Team I 1999. This unpublished draft report, prepared for Forest Renewal BC and Ministry of Environment, Lands and Parks is titled *General biodiversity Project Taking Stock II: Sam Green and Shedin Watersheds Wildlife Inventory and Habitat Assessment*. The other source was a map produced by the Gitxsan Watershed Authority GIS department (July 4, 2002), the *Selected Gitxsan Ecology, Cosmology and History in the Babine Watershed*.

4.2 Pine Mushroom Areas

Highly productive pine mushroom habitat is frequently found in mature forest stands (80 - 200 years old) with a submesic soil moisture regime and poor-medium soil nutrient regime. In the West Babine, high value habitat occurs in the 01b phase of the ICHmc1 and ICHmc2 subzones. Pine mushroom areas identified in the plan are based on unpublished report completed by Jodi Friesen (2002) for MSRM titled, *Pine Mushroom Habitat Mapping in the Babine Watershed*.

This project used airphoto interpretation (black and white photos, average scale of 1:18,000) to identify the 01b site series of the ICHmc1 and mc2 subzones, and then transferred these polygons to forest cover inventory maps. Based on ground-truthing, an estimate of approximately 85% accuracy is given for the 01b site series delineation.

4.3 Shelagyote Tourism Node

The Shelagyote Tourism Node zone was created by the SRMP, Draft 2.0 in recognition of the importance of maintaining the wilderness nature of the Babine River Corridor Park and protecting the value of the existing tourism operation in the vicinity. The boundary was based on the partial retention VQO boundaries that were identified from the Visual Landscape Inventory.

Other information used in consideration Shelagyote Tourism Node was the report *Access and Timber Development Strategy Evaluation for Shenismike/Shelagyote Triangle and Gunanoot Lake North as part of the West Babine Sustainable Resource Management Plan* completed by Steve Webb, RPF of Silvicon Services Inc. on April 24, 2003 for MSRM. This report provides an indication of timber value and access considerations based on non-statistical field sampling and air photo and resource mapping interpretations.

4.4 Stand Quality

In support of the draft *Babine Access Management Plan*, from which the SRMP evolved, a project to develop timber suitability based on stand quality and slope classes of the landscape was completed. Details of that project are described below.

Data

Inputs to the process include the Timber Harvesting Landbase (THLB), Digital Elevation Model (DEM), Special Management Zones (SMZ) around the Babine River corridor and Mainline Units (MLU) used in the project.

Output

The desired outputs for this project include a map indicating timber stand quality and a table or matrix break down of each MLU by stand quality and slope class. Stand quality is broken into cedar saw log, saw log, marginal saw log, pulp log, young forest and areas with no timber value. Slope class is divided according to harvesting technique. These categories are described in detail later in Appendix C.

Criteria – Stand Quality

The following table details the class breakdown for stand quality used in this project. The class breaks and definitions are based on the Bulkley TSR2 and local knowledge, assembled by MSRM staff.

Class	Inventory type groups	Age class	Height class	SI
Cw Sawlog				
Cedar – All	9–11	All	All	All
Sawlog				
Spruce – All	21, 23–26	All	All	All
Pine – All	28, 30, 31	All	All	All
Balsam – G	18 – 20	All	All	≥ 17
Hemlock	14, 16	All	All	All
Hemlock	12, 15, 17	≤ 7	All	All
Marginal sawlog				
Hemlock	12, 15, 17	8	≥ 4	All
Balsam – M	18–20	All	All	≤ 12 < 17
Pulplog				
Balsam – P	18–20	All	All	< 12
Hemlock	12, 15, 17	8	< 4	All
Hemlock	12, 15, 17	9	All	All

Note: Pulp > 50% pulp
Marginal sawlog 50–70 % sawlog
Sawlog >70 % sawlog

Minimum harvestable age is 80 (age class 5+) with the exception of the Babine SMZ, which is 140 yrs (age class 8+).

Lower SI is defined by THLB

Harvest Method (Slope Class)

The following table details the breakdown for slope class and harvest method.

Slope Class	Harvest Class	Description	Slope criteria
1	GR	ground-based, rubber tire	0–35 %
2	GT	ground based, tracked	35>50 %
3	CA	Cable	≥ 50 %

For details on the modeling program, please see appendix 2.

4.5 Timber Harvest Season

Harvest season is important to this analysis in that licensees require access to timber during both the winter and the summer to maintain a supply of logs to sawmills. Where ground water is high, summer access for harvesting may not be possible. In these cases a winter only harvesting approach may be the only solution. To derive summer / winter wood, the grizzly bear habitat suitability model was analyzed for site series values. Using professional knowledge of ground conditions, a table of site series and corresponding seasonal harvesting restrictions was developed. Table 1 illustrates the modelled site series in the Kispiox grizzly bear habitat suitability model and the seasonal harvesting classification each site series is assigned. The classifications are: A – all season, W – winter, X – inoperable.

Table 1 – Site series in Kispiox grizzly bear model and associated seasonal harvest classification

Ssval	Ss Name	Ss Desc	Harvtime
0			X
1	WA	Water	X
2	RO	Rock	X
3	UR	Human Settlement	X
6	AW	Alder/Willow	X
8	AW	Alder/Willow	X
9	AW	Alder/Willow	X
11	SA-c	Avalanche Chute-cool	X
13	SA-c	Avalanche Chute-cool	X
14	SA-c	Avalanche Chute-cool	X
17	SA-w	Avalanche Chute-warm	X
19	SA-w	Avalanche Chute-warm	X
20	SA-w	Avalanche Chute-warm	X
22	WL	Wetland	X
33	WL/M	Wetland/Meadow	X
35	WL/M	Wetland/Meadow	X
35	WM	Wetland/Meadow	X
37	WL/M	Wetland/Meadow	X
43	BU-d	Burn-dry	A
53	BU-m	Burn-mesic	A

Ssval	Ss Name	Ss Desc	Harvtime
73	HS-d	Herb/Shrub-dry	A
75	HS-d	Herb/Shrub-dry	A
76	HS-d	Herb/Shrub-dry	A
83	HS-m	Herb/Shrub-mesic	A
85	HS-m	Herb/Shrub-mesic	A
86	HS-m	Herb/Shrub-mesic	A
93	HS-w	Herb/Shrub-wet	W
95	HS-w	Herb/Shrub-wet	W
96	HS-w	Herb/Shrub-wet	W
103	YF-d	Young Forest-dry	A
105	YF-d	Young Forest-dry	A
106	YF-d	Young Forest-dry	A
113	YF-m	Young Forest-mesic	A
115	YF-m	Young Forest-mesic	A
116	YF-m	Young Forest-mesic	A
121	PF/Kr-w	Subalpine Krumholtz-wet	X
123	YF-w	Young Forest-wet	W
125	YF-w	Young Forest-wet	W
126	YF-w	Young Forest-wet	W
133	NP-d	Non-productive Forest-dry	X
135	NP-d	Non-productive Forest-dry	X
135	NP-m	Non-productive Forest-mesic	X
135	NP-w	Non-productive forest-wet	X
136	NP-d	Non-productive Forest-dry	X
136	NP-m	Non-productive Forest-mesic	X
136	NP-w	Non-productive Forest-wet	X
143	DE	Deciduous	X
146	DE	Deciduous	X
150	52 / 53 / 54	52/53/54 ICH	W
150	52/53/54	52/53/54 ICH	W
151	PF/Kr-d	Subalpine Krumholtz-dry	X
153	PF/Kr-d	Subalpine Krumholtz-dry	X
156	PF/Kr-m	Subalpine Krumholtz-mesic	X
158	PF/Kr-m	Subalpine Krumholtz-mesic	X
163	PF/Kr-w	Subalpine Krumholtz-wet	X
166	DL	Dry Alpine Tundra	X
168	02/03 (wv & mc)-w	02/03 ESSF-w	A
169	02/03 (wv & mc)	02/03 ESSF	A
171	02/01b-w	02/01b ICH-w	A
172	02/01b	02/01b ICH	A
173	02/01c	02/01c SBS	A
174	02/01c-w	02/01c SBS-w	A
180	HG	Heath/Grass	X
182	01/04/05 (wv mc) 06(mc)-w	01/04/05(wv mc)/06(mc) ESSF-w	W

Ssval	Ss Name	Ss Desc	Harvtime
183	01/04/05 (wv mc) 06(mc)	01/04/05(wv mc)/06(mc) ESSF	W
185	01/03-w	01/03 ICH-w	W
186	01-Mar	01/03 ICH	W
187	01/05/06 SBS	01/05/06 SBS	W
188	01/05/06 SBS-w	01/05/06 SBS-w	W
200	HM	Herbaceous Meadow	X
202	08 09(wv) 09 10(mc)	08 09(wv)/09 10(mc) ESSF	W
203	06 (wv) 07 (mc)	06(wv)/07(mc) ESSF	W
208	04 (mc1/mc2)	04 ICH	W
209	06 (mc1) 07 (mc2)	06(mc1)07(mc2) ICH	W
210	05 (mc2)	05(mc2) ICH	W
211	9	09 SBS	W
212	10	10 SBS	W
213	12-Jul	12/07 SBS	W
222	05 (mc1) 06 (mc2)	05(mc1)06(mc2) ICH	W
233	NP-m	Non-productive Forest-mesic	X
243	NP-w	Non-productive Forest-wet	X
999	N999	Unclassified	X

For details on the modeling program, please see appendix 3.

4.6 Forest Health

Analysis for forest health in the Babine Access Management Plan study area was initiated in January 2002 with the help of the regional forest entomologist with the Ministry of Forests in Smithers. Three beetle species were focused on for the analysis, including the mountain pine beetle (*Dendroctonus ponderosae*), spruce bark beetle (*Dendroctonus rufipennis*) and balsam bark beetle (*Pryocetes confusus*). The algorithms to model hazard ratings for the pine and spruce beetles were developed based on the Bark Beetle Management Guidebook (1995) in concert with the regional entomologist, and the balsam bark beetle hazard rating algorithm was developed by the regional entomologist.

a. Mountain Pine Beetle

HAZARD = P * A * L where
P = % pine
A = age factor
L = location factor

Values for each factor are:

Percent pine
percent value of pine in each forest cover polygon

Age factor

Age	Factor
<= 60 years	0.1
61 – 80 years	0.6
>= 81 years	1.0

Location factor

Location	Factor
>= 800 m elevation	0.7
< 800 m elevation	1.0

The class breaks (low, medium, high and very high) for pine beetle hazard were defined as follows:

Class	Values
No value	0
Low	0 to <= 0.25
Medium	> 0.25 to <= 0.5
High	> 0.5 to <= 0.75
Very High	> 0.75

b. Spruce Bark Beetle

HAZARD = SUM(BGC zone + site quality + % spruce + stand age)

Values for each factor are as follows:

Parameter	Value
BGC Zone	
SBS, BWBS	1.50
ESSF, ICH, MS	1.10
SWB	0.50
Site Quality	
Good	1.66
Medium	0.88
Low, Poor	0.36
% spruce	
80 – 100	1.33
20 – 79	1.21
0 – 19	0.59
Stand Age	
> 121	1.78
101 – 120	1.10
40 – 100	0.12
< 40	0.00

As an addendum to the spruce hazard rating, where stand age of a polygon that contains spruce is less than or equal to 40 years, the spruce hazard value is set to 0.

The class breaks (low, medium, high and very high) for spruce beetle hazard were defined as follows:

Class	Values
No value	0
Low	0 to <= 2.66
Medium	> 2.66 to <= 3.86
High	> 3.86 to <= 5.065
Very High	> 5.065

c. Balsam Bark Beetle

Only two hazard classes are identified for balsam beetle. Class one is all balsam leading polygons with 60 percent or greater balsam make-up and in age classes 8 or 9. Class two are all balsam leading polygons (60 percent balsam or greater) in age classes 6 or 7.

For details on the modeling program, please see appendix 4.

4.7 Mineral Values

a. Reported Mineral Exploration

The Geological Survey Branch, Ministry of Energy and Mines maintain a provincial Assessment Report Index System (ARIS) database that records exploration work. The ARIS database is only a partial record of mineral exploration work in BC since it is incomplete for work prior to 1947; since reports are confidential for one year after filing; and because significant amounts of current exploration work and expenditures are not submitted as assessment work because the work was conducted on a regional scale and could not be applied to a specific mineral property, or has not been filed in order to maintain confidentiality of valuable data.

It has been estimated that on a provincial basis, ARIS only captures 40% of all exploration work done. In a study of the Ft. St. James district, ARIS was estimated to capture only 31% of mineral exploration work in the area.

For more information on ARIS, check out http://www.em.gov.bc.ca/mining/Geolsurv/Aris/default.htm

b. Known Mineral Occurrences

The Geological Survey Branch, Ministry of Energy and Mines, maintains ‘MINFILE’ a relational database containing information on metallic, industrial mineral and coal occurrences within the Province of British Columbia. A mineral occurrence is defined as in-situ bedrock or placer mineralization, on surface, in drill holes, or in underground workings; generally, it does not include float, geochemical or geophysical anomalies. The MINFILE database is a record of known mineral occurrences in BC, compiled from government sources (i.e. geological survey crews, regional geologists and assessment reports). The data is reliable, but incomplete, as it does not include information from private company files. Site locations are generally accurate within 500 metres.

Mineral occurrences are recorded in the MINFILE database and are divided into categories based on their level of exploration or development work. In the West Babine plan area, the following three occurrences occur:

- Showings: Occurrences hosting minor in-situ mineralization and lacking exploration work beyond prospecting.
- Prospects: Documented occurrences (this may include geochemical and geophysical surveys, trenching and limited drilling) containing mineralization that warrants further exploration.
- Developed Prospects: Occurrences on which exploration and development have progressed to a stage that allows a reasonable estimate of the amount(s) of one or more of the potentially mineable commodities.

For Draft 2.0 of the SRMP, the MINFILE database was accessed in April 2003. Updates to MINFILE are occurring on an ongoing basis. For more information on MINFILE, check out http://www.em.gov.bc.ca/mining/Geolsurv/minfile/default.htm

c. Oil and Natural Gas Potential

This information is from a provincial coverage, mapped at 1:1,000,000 scale and is based on the Geological Survey of Canada's Institute of Sedimentary and Petroleum Geology studies, both published and unpublished reports. The mapping was completed in September 1994. This inventory evaluates potential oil and gas terrestrial reserves only.

APPENDIX 1: RISK ASSESSMENT TOOL AML

Grizzly Bear Matrix

Using the Arc Macro Language (AML), the program GB_MATRIX.AML was written to perform the analysis needed for populating the grizzly bear portions of the Risk Assessment Tool.

Routines

This technical description of GB_MATRIX.AML provides extensive detail of the script, summarizing the actions taken in each routine. In addition, the script in Appendix F1 provides some documentation. The AML contains the following routines: INI, SETUP_BAMP_GB_MATRIX, PICK_OPTION, BUFFER_ROADS, RUN_DENSITY, SET_CORE, SET_RDI, JOIN_SUIT_TU, UPDATE_MATRIX and FINAL_UPDATE_MATRIX. Throughout the AML, an ORACLE table named BAMP_GB_MATRIX is populated with statistics. This ORACLE table can then be inserted into the Risk Assessment Tool at the end of the program, creating the predictive risk model for grizzly bear habitat impacts.

Routine INI

This routine sets the Arc environment to a start-up condition. The program ensures the user has run the script from the ARC prompt. The workspace is set to a working directory. The session is connect ORACLE and the various internal variables are set. These include coverages, directories, internal variables and the OPTIONS.CSV text file. OPTIONS.CSV is the text file that contains the list of scenarios. Each line in OPTIONS.CSV contains the BMU and a list of the MLUs that are open for that scenario.

Routine SETUP_BAMP_GB_MATRIX.AML

This routine calls the Structured Query Language (SQL) script named CK_BAMP_GB_MATRIX.SQL (Appendix F2). This script then deletes the table BAMP_GB_MATRIX from the ORACLE schema which the user logged on to. The script also creates the table BAMP_GB_MATRIX that will be populated during this AML.

The next steps do not occur in a routine, but set the loop that will cycle through all of the scenarios in OPTIONS.CSV. The first record is read and set to a variable. The BMU and list of MLUs are also set to variables. The loop is created and every record in OPTIONS.CSV goes through the routines listed above expect for FINAL_UPDATE_MATRIX which occurs at the end of the AML, outside of the loop. A watch file and ECHO are also set inside the loop.

Routine PICK_OPTION

This routine creates a number of coverages and grids used throughout the loop within the AML. The first function is to kill any of the grids or coverages that are created in the routine. Second, an ARCEDIT session is started and the coverage BMU_COV is created from the master BMU coverage. It must be kept in mind that all of these commands inside the loop relate to only one record from OPTIONS.CSV at a time. Therefore, the coverage BMU_COV is the extent of whichever Bear Management Unit is listed in the record currently selected. This coverage also contains the linework and codes for Mainline Units. The next step is to set an item equal to “ON” for every MLU listed in the scenario option. These “ON” MLUs are then selected and put to another coverage, named MLU_COV. Another coverage named MLU_OFF is created based on the MLUs in BMU_COV that are “OFF.’ If the record includes every MLU in the BMU, the coverage MLU_OFF is still created, but has no attributes. The next steps in this routine kill a set of grids whenever the BMU is changed in the OPTIONS.CSV. This saves processing time as the following grids only need to be created once as long as the BMU does not change: ALP_CL6, GB_BAMP_G, TU_GRD, THLB_G, BMU_GRD. The first grid to be created is BMU_GRD, using the polygon coverage BMU_COV. The &DESCRIBE command is used on this grid to gather information on its extents and row and column definitions. This data is used to create the next set of grids, ensuring that all grids used for analysis in this AML begin in the same location, contain the same number of cells and do not overlap cells in any locations. A short description of each grid follows:

- ALP_CL6 is a grid created from the coverage GB_ALPINE that includes just the Heath/Grass, Herbaceous Meadow and Dry Alpine Tundra polygons;
- GB_BAMP_G is a grid of grizzly bear habitat suitability (the highest value of three seasons is used to create the grid);
- TU_GRD is a grid of Treatment Unit mapping; and
- THLB_G is a grid of the contributing classes in the THLB, which are contributing, partially contributing, non-contributing and excluded.

The next step is to buffer the "ON" MLUs coverage MLU_COV by 500 meters. Using the buffered coverage, the road network is clipped to the coverage RDS_1. RDS_1 is then erased by the "OFF" MLUs to create the line coverage RDS_DISP. The purpose for buffering the "ON" MLUs is to capture any roads outside of the BMU that may influence the impact of roads on grizzly bears. RDS_DISP is then converted to the grid RDS_MORT. The final steps of this routine are to remove the operational class four and five roads from the RDS_DISP coverage. The item density is added to the arc attribute table and set to the internal value of each arc.

Routine BUFFER_ROADS

The routine begins by killing the two grids that are created subsequently created. In GRID, the grid RDS1 is created by applying a EUCDISTANCE command to the grid RDS_MORT to a distance of 500 meters. The CON and ISNULL functions are then applied to the grid RDS1 which results in the grid RDS_MORT5. In this grid, cells within 500 meters of a road have a cell value of 999 and cells greater than 500 meters from a road have a cell value equal to one.

Routine RUN_DENSITY

This routine uses an AML developed by Kristin Karr that takes the line coverage RDS_DISP (operational class one, two and three roads within 500 meters of the "ON" MLUs) and creates the road density index (RDI) grid RDI_G. The routine coverts RDS_DISP to a grid. The functions THIN and CON are used to prepare the grid. A FOCALSUM function is performed on the grid using a rectangular shape of 33 cells by 33 cells. This equates to a roaming window of one square kilometre. The grid values are then converted from floating points to integers and combined with two factors generated in the AML by Kristin Karr. Using a remap table, this grid is reclassified and four RDI classes are identified. The classes are:

- 0 kilometres of road per square kilometre;
- Greater than 0 and less than 0.6 kilometres of road per square kilometre;
- Greater than 0.6 and less than 1.2 kilometres of road per square kilometre; and
- Greater than 1.2 kilometres of road per square kilometre.

The final steps of this routine are to attach density labels to the RDI_G value attribute table.

Routine SET_CORE

This routine creates a grid that identifies core security areas (CSAs), named CORE, and also the GB_MATRIX.DAT. These first steps are to kill any grids and INFO files that will be made in this routine. Then, in GRID, the ALP_CL6, RDS_MORT5 and BMU_GRD are added together in a grid called C1. A CON function is used to calculate all C1 cells whose value is three to one. In this case, the cells that will make up a core security area all have a value of one in the input grids. Thus, when the three grids are added together, all cells with a value of three must be a CSA. The function REGIONGROUP is used to group all adjacent cells from the grid C2 and assign a common cell value to each group. The next two CON statements (creating grids C4 and C5) select only those regions whose areas are between 1000 and 10000 hectares (C4) and greater than 10000 hectares. The final grid statement adds C4 and C5 with BMU_GRD to create CORE. The final steps in this routine are in tables and creates the GB_MATRIX.DAT which will begin the record population in BAMP_GB_MATRIX. The data attribute table is defined and the BMU_CODE, MLU list, number of small CSAs (1000 to 10000 ha) and number of large CSAs (greater than 10000 ha) are added to the table.

Routine SET_RDI

This routine creates the road density index grid that will be used to determine final classification. The first step is to kill R1 and RDI from the workspace, in preparation for the GRID commands. The first GRID command adds the RDI_G, ALP_CL6 and BMU_GRD grids together to create the grid R1. Note that the values in RDI_G are one, two, three and four, each relating to an RDI class. In the ALP_CL6 grid, values are one (non-alpine) and 999 (alpine). BMU_GRD has only one as a value, equal to the Bear Management Unit. The second GRID command is a conditional statement. Where R1 less than or equal to six, the value of RDI is set to R1 minus two. By this command, any cell within the BMU (value one) plus any cell that is not alpine (value one) plus any cell in the RDI_G grid (values one to four) will be equal to six or less and consequently, set equal to the original road density index value. Cells whose value is greater than six are set to a value of five. Cells in RDI with a value of five are equal to alpine from ALP_CL6.

Routine JOIN_SUIT_TU

This routine contains the final GRID commands and the result is the grid, MATRIX, with which the ORACLE table BAMP_GB_MATRIX is updated. The first steps in this routine are to kill MATRIX and TU_GRD1. Then, in GRID, a CON function is used to take TU_GRD and calculate the null values equal to zero. The final command in this routine is to use COMBINE and join the value attribute tables of THLB_G, GB_BAMP_G, TU_GRD1, RDI and CORE to MATRIX.VAT. The value attribute table for MATRIX now appears as follows:

VALUE
COUNT
THLB_G
GB_BAMP_G
TU_GRD1
RDI
CORE

For each item in MATRIX.VAT, the following table describes each item and the possible values of each cell:

THLB_G	1	Contributing (THLB)
	2	Partially Contributing (THLB)
	3	Non-contributing (THLB)
	4	Excluded (THLB)
GB_BAMP_G	1	High (grizzly bear suitability)
	2	Moderately High
	3	Moderate
	4	Low
	5	Very Low
	6	Nil
	999	Unknown
TU_GRD1	0	Outside Plan Area
	1	Treatment Units 1, 2 and 3
	2	Treatment Units 4 and 4a
	3	Treatment Units 5 and 6
	4	Alpine and Park
RDI	1	RDI > 1.2 km / km2
	2	RDI <= 1.2 and > 0.6 km / km2
	3	RDI <= 0.6 and > 0 km / km2
	4	RDI = 0 km / km2
	5	Alpine from ALP_CL6
CORE	1	Non-Core Security Area
	2	Core Security Area (1000 – 10000 ha)
	3	Core Security Area (>= 10000 ha)

The INFO file for MATRIX is now ready for moving to ORACLE.

Routine UPDATE_MATRIX

This routine populates the columns in the ORACLE table BAMP_GB_MATRIX for the current record in OPTIONS.CSV. Prior to the Oracle update commands, the SQL script CK_MATRIX.SQL (Appendix F3) is called and run. The purpose of this SQL script is to remove any ORACLE tables that may exist and need to be created during this routine. The next two commands create the tables MATRIX_DATA based on the INFO file MATRIX.VAT and MATRIX_OPTION based on GB_MATRIX.DAT. These two ORACLE tables are used to populate the records in BAMP_GB_MATRIX upon which the preceding analysis was performed. The DBMSEXECUTE commands are run to perform an ALTER, an INSERT and a number of UPDATE commands. To begin, an AREA_HA column is added to the table MATRIX_DATA and is populated by multiplying the count of cells by 0.09. As each cell is 30 meters by 30 meters (or 900 square meters in area), multiplying the number of cells by 0.09 calculates the total hectares of those cells. Using the sum of AREA_HA, the columns in BAMP_GB_MATRIX are updated based on criteria specific to each column. For example:

- column S3 is populated by the sum of AREA_HA if the value of RDI does not equal five (alpine, rock and ice). Column S3 is the total functional area of the BMU; and

- column C3 is populated by the sum of AREA_HA if the value of CORE equals two (core security area greater than or equal to 1000 hectares and less than 10000 hectares) and the value of GB_BAMP_G equals one or two (high value grizzly bear habitat). Column C3 is the number of hectares in core security areas less than 10000 hectares but greater or equal to 1000 hectares and in high value grizzly bear habitat.

The column names used in the ORACLE table BAMP_GB_MATRIX are the equivalent of the excel spreadsheet column names used for the Risk Assessment Tool. The Oracle table has cryptic column names simply for coding purposes. The final command in this routine is to commit the data. This is also the last command within the loop. At the end of this routine the next record in OPTIONS.CSV is read and the loop is run through again. This continues until all records in OPTIONS.CSV have been read.

Routine FINAL_UPDATE_MATRIX

The last routine in this AML updates the ORACLE table BAMP_GB_MATRIX a final time, performing calculations and preparing the table for its export to a Microsoft Excel spreadsheet. These ORACLE commands calculate percentages for different columns in the table.

Timber Matrix

The next step in creating the Risk Assessment Tool is to create the columns and statistics surrounding the timber aspect of the Babine Resource Management Plan. As stated earlier, for each Mainline Unit, the stand value, harvesting costs and hauling costs must be attained. To do this, an AML script titled TREE_MATRIX.AML (Appendix F4) is run. The script is similar to GB_MATRIX.AML in that it cycles through a text file that contains all of the possible scenarios or options and populates an ORACLE table with relevant statistics. For each access scenario, the timber value, harvest cost and hauling cost are calculated, using the cubic meters of timber within the Mainline Unit.

Routines

The TREE_MATRIX.AML begins by setting initial variables, connecting to the ORACLE database and establishing the proper workspace in the routine INI. A second routine, SETUP_BAMP_TREE_MATRIX, is then called to perform commands to ensure the data is in its proper format within ORACLE.

Routine SETUP_BAMP_TREE_MATRIX

This routine begins by calling the SQL script SETUP_BAMP_TREE_MATRIX.SQL (Appendix F5). The script drops the ORACLE table BAMP_TREE_MATRIX, if it exists and then creates it, allowing the program to be run using the most current information available in the data warehouse. The SQL script also drops the table BAMP_TREE_DATA, if it exists. The next set of commands in this routine recreates the INFO table BAMP_TREES.DAT using the following items from the coverage LOGSLP (LOGSLP was created using the TIMBER_EFFECTIVENESS AML script, documented earlier): MLU_CODE, VOL1TOT, AREA, CYCLE_VALUE, STAND_QUALITY, SLOPE_CLASS and CONTCLAS. The INFO table is then pushed to ORACLE and named BAMP_TREE_DATA.
The next set of commands is begun by reading OPTIONS.CSV. For each record in the text file, the following routines are performed: MK_ORA_TREE_DATA, SET_CYCLE_TIME_VAR and UPDATE_BAMP_TREE_MATRIX. After every record in OPTIONS.CSV has been read, the AML is complete.

Routine MK_ORA_TREE_DATA

This routine begins with an SQL script named CK_TREE_DATA.SQL (Appendix F6). The script simple recreates the ORACLE table BAMP_TREE_DATA_S to ensure there is a clean, empty table to begin working with. A DO VAR loop is run using the MLUs for each record from OPTIONS.CSV and the table BAMP_TREE_DATA_S is populated for each MLU within the particular option. At this point, the two tables BAMP_TREE_DATA and BAMP_TREE_DATA_S have identical descriptions. This routine ends with five DBMSEXECUTE statements that calculate the area of each record to hectares and the volume of each record from cubic meters per hectare to total cubic meters.

Routine SET_CYCLE_TIME_VAR

This routine is used to calculate the volume adjusted cycle time for each Mainline Unit and the minimum probability of entry value for the selected option. In tables, the table containing cycle times and total volume for every MLU is selected and then each record is unselected. The options list is run through to select those records in the INFO table for which the MLU is accessed. A statistics calculation is performed, to calculate the weighted mean of cycle hour and total volume. This value is set to a variable, CYCLE_TIME_SUM. A different statistical operation is performed to obtain the minimum probability of entry value for the scenario option at each of the three time frames, 0 – 30 years, 30 – 60 years and 60 – 90 years. These statistics are also set to variables, ENTRY_ONE, ENTRY_TWO and ENTRY_THREE.

Routine UPDATE_BAMP_TREE_MATRIX

This is the final routine, and it populates the ORACLE table BAMP_TREE_MATRIX, at which point it can be inserted to the Risk Assessment Tool. The first commands in this routine include recreating the INFO table BAMP_TREE_OPTION.DAT and adding the Bear Management Unit code and list of MLUs to it. A SQL script, CK_TREE_MATRIX.SQL (Appendix F7) is then called. This script simply deletes the table BAMP_TREE_OPTION, if it exists. The next command creates that same table from the INFO table BAMP_TREE_OPTION.DAT. This ORACLE table provides the relate keys to ensure only those records in BAMP_TREE_MATRIX that contain the BMU and MLU options are updated. At this point, a number of DBMSEXECUTE commands are performed to update BAMP_TREE_MATRIX using the summary of volumes and areas in BAMP_TREE_DATA_S. The probability of entry values and cycle time values are also populated to BAMP_TREE_MATRIX at this point. It should be noted that the total volumes are scaled back, based on the stand quality for each scenario. For cedar saw logs, saw logs and marginal saw logs, the volume of the stand is reduced by 15 percent to more accurately reflect reality. In pulp log stands, the volume is reduced by 20 percent. The final command in this routine is to commit the data to ORACLE.

At this point, the next record in OPTIONS.CSV is read and the routines are performed again until the time at which every record in OPTIONS.CSV has been processed. At this point, the ORACLE table BAMP_TREE_MATRIX is ready to be included with the core security area statistics in the Risk Assessment Tool.

Conclusion

At the end of running GB_MATRIX.AML and TREE_MATRIX.AML, two Oracle tables exist with a full suite of grizzly bear and timber statistics, pertaining to every potential access scenario. These two Oracle tables are then used to populate the Risk Assessment Tool template. The grizzly bear risk thresholds and timber value and cost factors are stored in a separate spreadsheet and are applied to the statistics, resulting in a quantitative and qualitative risk rating to grizzly bears and a timber harvesting value for every option. The final Risk Assessment Tool spreadsheet provides an estimation of the grizzly bear habitat and timber conditions across the plan area at every possible access scenario.

(1): GB_MATRIX.AML

```
/*---------------------------------------------------------------------
/*              BC Ministry of Sustainable Resource Management
/* Program:  gb_matrix.aml
/*---------------------------------------------------------------------
/*
/* Purpose:
/*         AML to populate table for gbear risk statistics.
/* Arguments:
/*     None.
/* Assumptions:
/*     This AML assumes the following:
/*      -user starts AML from Arc prompt;
/*      -the following export command from UNIX has been run to
/*       establish the shortcut $BAMP:
/*          export BAMP=/whse/smt/arclib/babine_amp;
/*      -the workspace bears exists in $BAMP/working;
/*      -options.csv exists in bears workspace. This is a file
/*       containing the options for MLU access;
/*      -the following coverages exist in $BAMP:
/*          /admin/qmlu_bamp
/*          /roads/trds_bamp
/*          /gbear/gb_alpine
/*          /gbear/gb_hival
/*          /habitat/qtu_bamp
/*          /forest/thlb_bamp
/*      -sql directory exists with $BAMP and contains following sql
/*       scripts:
/*          ck_bamp_gb_matrix.sql
/*          ck_matrix.sql
/*      -text file akesqkm_4class.rmt exists in $BAMP/working/bears
/*       to classify roaded density index; and
/*      -user has read write privileges to workspace $BAMP/working/bears
/*       and user's own oracle schema.
/*
/* Outputs:
/*         This AML creates output for each record in options.csv. For each
/*     record, the following coverages are created:
/*      BMU_COV, BMU_COV5, MLU_COV, MLU_COV5, MLU_OFF, RDS_1 and RDS_DISP
/*     The following grids are also created for each record in options.csv:
/*      ALP_CL6, BMU_GRD, C1, C2, C3, C4, C5, C6, CORE, GB_BAMP_G, MATRIX
/*      R1, RDI, RDI_G, RDS1, RDS_DISP1, RDS_DISP2, RDS_DISP3, RDS_DISP4
/*      RDS_DISP5, RDS_DISP6, RDS_MORT, RDS_MORT5, THLB_G, TU_GRD, TU_GRD1
/*     The following INFO files are created:
/*      gb_matrix.dat
/*     Oracle tables in the user's schema:
/*      BAMP_GB_MATRIX, MATRIX_OPTION, MATRIX_DATA
/*
/* Notes:
/*     This script must be watched as it is run. There is a problem when
/*     the memory of Arc exceeds some limit. The AML bails at this point
/*     and the program must be restarted. To maintain a unique list of
/*     options in the BAMP_GB_MATRIX oracle table, the options.csv file
/*     must be updated by removing all records that have already been
/*     processed.
```

```
/*
/* Future:
/*     Fix problem in AML that causes the program to bail as memory gets
/*     too full. One fix may be to quit out of Arc after every 50th
/*     record or so, thereby freeing up Arc's memory or reserved space.
/*
/*--------------------------------------------------------------------
/*  History:
/*  18-Mar-2002  jawarren  v1.0 Creation date.
/*
/*=====================================================================
/*
&severity &error &routine bailout
&severity &warning &routine bailout
/*


&type
&type Starting BC MELP %AML$FILE% v1.0 on [date -vmsfull] ...
&type
/*
&call ini
/*&call setup_bamp_gb_matrix

&s opentext [open %options_text_file% openstatus -r]
&s record_val [read %opentext% readstatus]

&do &while %readstatus% eq 0
 reset
 &s bmu_code [before %record_val% , ]
 &s mlu_option_list [after %record_val% , ]
 &watch watch%bmu_code%.wat
 &echo &on
 &call pick_option
 &call buffer_roads
 &call run_density
 &call set_core
 &call set_rdi
 &call join_suit_tu
 &call update_matrix
 &watch &off
 &r kill_xyxy_grids.aml
 &s record_val [read %opentext% readstatus]
&end

&if [close %opentext%] = 0 &then
 &ty %options_text_file% closed successfully

&call final_update_matrix
```

```
&return

/*=====================================================================
/*
/*   ini - set gb_matrix to startup state.
/*
&routine ini

/* ensure startup program is ARC
&if [show program] ne ARC &then
 &return &error AML ERROR: GB_MATRIX must start from ARC prompt

&s ws $BAMP/working/bears
workspace %ws%

&sv orauserpass = [response ‘Enter username’]/[response ‘Enter oracle password’ -noecho]
&r ora_connect %orauserpass%

&s options_text_file %ws%/options.csv
&s bmu $BAMP/admin/qmlu_bamp
&s roads $BAMP/roads/trds_bamp
&s alpine $BAMP/gbear/gb_alpine
&s gbears $BAMP/gbear/gb_hival
&s tu $BAMP/habitat/qtu_bamp
&s thlb $BAMP/forest/thlb_bamp
&s sqldir $BAMP/sql
&s prev_bmu_code = 0

&return

/*=====================================================================
/*
/*   setup_bamp_gb_matrix
/*
&routine setup_bamp_gb_matrix

&system sqlplus %orauserpass% @%sqldir%/ck_bamp_gb_matrix.sql

&return

/*=====================================================================
/*
/*   pick_option
/*
&routine pick_option

&do var &list bmu_cov mlu_cov rds_disp mlu_cov5 rds_1 mlu_off
 &if [exists %var% -cover] &then
  kill %var% all
&end

&do var &list rds_mort
 &if [exists %var% -grid] &then
  kill %var% all
&end
```

```
ae
 ec %bmu% poly
 select bmu_code = [quote %bmu_code%]
 put bmu_cov
 arc build bmu_cov
 ec bmu_cov poly
 additem bmu 4 5 b
 additem mlu_open 3 3 c
 sel all
 calc bmu = 1
 calc mlu_open = 'OFF'
 &do mlu &list [unquote %mlu_option_list%]
  sel mlu_code = [quote %mlu%] and area > 0
  calc mlu_open = 'ON'
 &end
 sel mlu_open = 'ON'
 put mlu_cov
 arc build mlu_cov
 ec bmu_cov poly
 sel mlu_open = 'OFF'
 &if [show number selected] = 0 &then
  arc create mlu_off bmu_cov
 &else put mlu_off
 arc build mlu_off
 save
quit

&if %bmu_code% ne %prev_bmu_code% &then &do
 &do var &list alp_cl6 gb_bamp_g tu_grd thlb_g bmu_grd
  &if [exists %var% -grid] &then
   kill %var% all
 &end

 polygrid bmu_cov bmu_grd bmu
  30
  y

 &describe bmu_grd
  &s cellsize %grd$dx%
  &s minx %grd$xmin%
  &s miny %grd$ymin%
  &s rows %grd$nrows%
  &s cols %grd$ncols%

 polygrid %alpine% alp_cl6 alpine_code
  %cellsize%
  n
  %minx% %miny%
  %rows% %cols%

 polygrid %gbears% gb_bamp_g hival
  %cellsize%
  n
  %minx% %miny%
  %rows% %cols%
```

```
 polygrid %tu% tu_grd tu_grd_code
  %cellsize%
  n
  %minx% %miny%
  %rows% %cols%

 polygrid %thlb% thlb_g contclas_cd
  %cellsize%
  n
  %minx% %miny%
  %rows% %cols%
&end

&s prev_bmu_code = %bmu_code%

buffer mlu_cov mlu_cov5 # # 500 0.0000000000000001 poly

/* clip roads for displacement roads for rdi
clip %roads% mlu_cov5 rds_1 line
erase rds_1 mlu_off rds_disp line

/* convert
linegrid  rds_disp rds_mort
 %cellsize%
 n
 %minx% %miny%
 %rows% %cols%
 nodata

ae
 ec rds_disp arc
 select op_class in {4,5}
 &if [show number selected] > 0 &then
  delete
 additem density 4 5 b
 sel all
 calc density = rds_disp#
 save
quit

&return

/*=====================================================================
/*
/*   buffer_roads
/*
&routine buffer_roads

&ty Routine BUFFER_ROADS ************

&do var &list rds_mort5 rds1
 &if [exists %var% -grid] &then
  kill %var% all
&end

grid
```

```
 rds1 = eucdistance ( rds_mort, # , #, 500 )
 rds_mort5 = con ( isnull ( rds1 ) , 1 , 999 )
quit

&return

/*=====================================================================
/*
/*   run_density
/*
&routine run_density

&ty Routine RUN_DENSITY ************

&do var &list density.cellvalue
 &if [exists %var% -info] &then
  killinfo %var%
&end

/* prep rds_disp for density algorithm
pullitems rds_disp.aat density.cellvalue density
tables
 additem density.cellvalue code 4 5 b
 sel density.cellvalue
 calc code = 1
quit

/* programming pulled from Kristin Karr's AML ASQKM_CLASS_WEEDED.AML
&s in_cover rds_disp
&s item density

&s input = %in_cover%

&do var &list %input%1 %input%2 %input%3 %input%4 %input%5 %input%6 rdi_g
 &if [exists %var% -grid] &then
  kill %var% all
&end

linegrid %input% %input%1 %item% %item%.cellvalue
 30
 n
 %minx% %miny%
 %rows% %cols%
 nodata

grid
mape %input%1
setwindow %input%1
status

&type THINNING %input%
%input%2 = thin(%input%1,positive,nofilter,sharp,3)
%input%3 = con(isnull(%input%2),0,%input%2)
list %input%1.sta
list %input%2.sta
list %input%2.vat
```

```
list %input%3.vat

&type MOVING WINDOW ON %input%
%input%4 = focalsum(%input%3,rectangle,33,33,data)

&type REGRESSGION ON %input%
%input%5 = int(( 0.847785 + ( 1.148698 * %input%4 )))

&type RECODE TO DENSITY CLASSES ON %input%
%input%6 = reclass(%input%5,akesqkm_4class.rmt,data)
list %input%6.vat
quit

rename %input%6 rdi_g

tables
 additem rdi_g.vat dens_label 35 35 c
 sel rdi_g.vat
 res value = 1
 move '> 1.2424 km/sqkm' to dens_label
 asel
 res value = 2
 move '> 0.6060 and <= 1.2424 km/sqkm' to dens_label
 asel
 res value = 3
 move '> 0 and <= 0.6060 km/sqkm' to dens_label
 asel
 res value = 4
 move '0 km/sqkm' to dens_label
 asel
quit

&return

/*=================================================================
/*
/*   set_core
/*
&routine set_core

&ty Routine SET_CORE **************
&do var &list c1 c2 c3 c4 c5 core
 &if [exists %var% -grid] &then
  kill %var% all
&end

&do var &list gb_matrix.dat
 &if [exists %var% -info] &then
  killinfo %var%
&end

grid
 c1 = bmu_grd + rds_mort5 + alp_cl6
 c2 = con ( c1 == 3 , 1 )
 c3 = regiongroup ( c2 , # , eight )
 c4 = con ( isnull (select ( c3 , [quote count >= 11111 and count < 111111]) ) , 0 , 1 )
```

```
 c5 = con ( isnull (select ( c3 , [quote count >= 111111]) ) , 0 , 2)
 core = c4 + c5 + bmu_grd
quit

tables
 select c3.vat
 resel count >= 11111 and count < 111111
 &s sm_core_freq [show number select]
 aselect
 resel count >= 111111
 &s lg_core_freq [show number select]

 define gb_matrix.dat
bmu_code 2 2 c
mlu_options 254 254 c
sm_core_freq 4 5 b
lg_core_freq 4 5 b
 ~
 ~

 select gb_matrix.dat
 add
  [quote %bmu_code%]
  [quote [unquote %mlu_option_list%]]
  [unquote %sm_core_freq%]
  [unquote %lg_core_freq%]
  ~
quit

&return

/*=====================================================================
/*
/*   set_rdi
/*
&routine set_rdi

&ty Routine SET_RDI ************
&do var &list rdi r1
 &if [exists %var% -grid] &then
  kill %var% all
&end

grid
 r1 = rdi_g + alp_cl6 + bmu_grd
 rdi = con ( r1 <= 6 , r1 - 2 , 5 )
quit

&return

/*=====================================================================
/*
/*   join_suit_tu
/*
&routine join_suit_tu
```

```
&ty Routine JOIN_SUIT_TU *****************
&do var &list matrix tu_grd1
 &if [exists %var% -grid] &then
  kill %var% all
&end

grid
 tu_grd1 = con( isnull (tu_grd) , 0, tu_grd )
 matrix = combine ( thlb_g, gb_bamp_g , tu_grd1, rdi, core)
quit

&return

/*=====================================================================
/*
/*   update_matrix
/*
&routine update_matrix

&ty Routine UPDATE_MATRIX ***************

&system sqlplus %orauserpass% @%sqldir%/ck_matrix.sql
infodbms oracle matrix.vat matrix_data
infodbms oracle gb_matrix.dat matrix_option

/* perform updates here -- not from SQL script
dbmsexecute oracle alter table MATRIX_DATA add (AREA_HA number(38,5));
dbmsexecute oracle update MATRIX_DATA set AREA_HA = COUNT * 0.09;
dbmsexecute oracle insert into bamp_gb_matrix (s1,s5,c1,c4) ~
  select * from matrix_option;
dbmsex oracle update BAMP_GB_MATRIX set S2 = ~
 (select sum(AREA_HA) from MATRIX_DATA) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set S3 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI <> 5) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set S4 = ~
 (select sum(AREA_HA) from MATRIX_DATA where GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C2 = 0 ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C2 = ~
 (select sum(AREA_HA) from MATRIX_DATA where CORE = 2) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C3 = 0 ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C3 = ~
 (select sum(AREA_HA) from MATRIX_DATA where CORE = 2 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C5 = 0 ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C5 = ~
 (select sum(AREA_HA) from MATRIX_DATA where CORE = 3) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set C6 = 0 ~
 where S5 = [quote [unquote %mlu_option_list%]];
```

```
dbmsex oracle update BAMP_GB_MATRIX set C6 = ~
 (select sum(AREA_HA) from MATRIX_DATA where CORE = 3 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D11 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 1 and GB_BAMP_G in (1,2,3,4,5)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D13 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 1 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D21 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 2 and GB_BAMP_G in (1,2,3,4,5)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D23 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 2 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D31 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 3 and GB_BAMP_G in (1,2,3,4,5)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D33 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 3 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D41 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 4 and GB_BAMP_G in (1,2,3,4,5)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set D43 = ~
 (select sum(AREA_HA) from MATRIX_DATA where RDI = 4 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set H11 = ~
 (select sum(AREA_HA) from MATRIX_DATA where TU_GRD1 = 1 and THLB_G in (1,2) ~
 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set H12 = ~
 (select sum(AREA_HA) from MATRIX_DATA where TU_GRD1 = 1 and THLB_G in (3,4) ~
 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set H21 = ~
 (select sum(AREA_HA) from MATRIX_DATA where TU_GRD1 = 2 and THLB_G in (1,2) ~
 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set H22 = ~
 (select sum(AREA_HA) from MATRIX_DATA where TU_GRD1 = 2 and THLB_G in (3,4) ~
 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set H31 = ~
 (select sum(AREA_HA) from MATRIX_DATA where TU_GRD1 = 3 and THLB_G in (1,2) ~
 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsex oracle update BAMP_GB_MATRIX set H32 = ~
 (select sum(AREA_HA) from MATRIX_DATA where TU_GRD1 = 3 and THLB_G in (3,4) ~
 and GB_BAMP_G in (1,2)) ~
 where S5 = [quote [unquote %mlu_option_list%]];
dbmsexec oracle commit;
```

```
&return

/*=====================================================================
/*
/*   final_update_matrix
/*
&routine final_update_matrix

&ty Routine FINAL_UPDATE_MATRIX ************

dbmsex oracle update BAMP_GB_MATRIX set C3 = C3 / C2 * 100;
dbmsex oracle update BAMP_GB_MATRIX set C6 = C6 / C5 * 100;
dbmsex oracle update BAMP_GB_MATRIX set C7 = ( C2 + C5 ) / S3 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D12 = D11 / S3 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D14 = D13 / D11 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D15 = D13 / S4 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D22 = D21 / S3 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D24 = D23 / D21 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D25 = D23 / S4 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D32 = D31 / S3 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D34 = D33 / D31 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D35 = D33 / S4 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D42 = D41 / S3 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D44 = D43 / D41 * 100;
dbmsex oracle update BAMP_GB_MATRIX set D45 = D43 / S4 * 100;
dbmsex oracle update BAMP_GB_MATRIX set H13 = ( H11 + H12 ) / S4 * 100;
dbmsex oracle update BAMP_GB_MATRIX set H23 = ( H21 + H22 ) / S4 * 100;
dbmsex oracle update BAMP_GB_MATRIX set H33 = ( H31 + H32 ) / S4 * 100;
dbmsex oracle commit;

&return

/*=====================================================================
/*
/*   Usage - print out usage message.
/*
&routine usage

&return USAGE: gb_matrix

/*=====================================================================
/*
/*   Bailout - Respond to an error somewhere in this file.
/*
&routine bailout

&return &error Internal error in gb_matrix.aml
/*=================================================================
```

(2): CK_BAMP_GB_MATRIX.SQL

```
/* script run at start of AML gb_matrix to remove oracle table
 and create table for populating during AML */

execute drop_table_exist ( 'BAMP_GB_MATRIX' );

create table BAMP_GB_MATRIX
 (
  S1  varchar2(5),
  S2  number(38,5),
  S3  number(38,5),
  S4  number(38,5),
  S5  varchar2(255),
  C1  number(14,3),
  C2  number(38,5),
  C3  number(14,3),
  C4  number(14,3),
  C5  number(38,5),
  C6  number(14,3),
  C7  number(14,3),
  D11  number(38,5),
  D12  number(14,3),
  D13  number(38,5),
  D14  number(14,3),
  D15  number(14,3),
  D21  number(38,5),
  D22  number(14,3),
  D23  number(38,5),
  D24  number(14,3),
  D25  number(14,3),
  D31  number(38,5),
  D32  number(14,3),
  D33  number(38,5),
  D34  number(14,3),
  D35  number(14,3),
  D41  number(38,5),
  D42  number(14,3),
  D43  number(38,5),
  D44  number(14,3),
  D45  number(14,3),
  H11  number(38,5),
  H12  number(38,5),
  H13  number(14,3),
  H21  number(38,5),
  H22  number(38,5),
  H23  number(14,3),
  H31  number(38,5),
  H32  number(38,5),
  H33  number(14,3));

exit;
```

(3): CK_MATRIX.SQL

```
/* script run during AML gb_matrix to remove oracle tables that
 are created during the AML */

execute drop_table_exist ( 'MATRIX_DATA' );
execute drop_table_exist ( 'MATRIX_OPTION' );

exit;
```

(4): TREE_MATRIX.AML

```
/*---------------------------------------------------------------------
/*              BC Ministry of Sustainable Resource Management
/* Program:  tree_matrix.aml
/*---------------------------------------------------------------------
/*
/* Purpose:
/*      This AML reads the options.csv list of access scenarios and
/*      populates BAMP_TREE_MATRIX with timber volume, stand value, haul
/*      cost, harvest cost and cycle time data.
/* Arguments:
/*      Fill this out later.
/* Assumptions:
/*          Fill this out later.
/*
/* Outputs:
/*          Fill this out later.
/*
/* Internal variables :
/*
/*
/*---------------------------------------------------------------------
/*  History:
/*  04-Apr-2002  jawarren  v1.0 Creation date.
/*
/*=====================================================================
/*
&severity &error &routine bailout
&severity &warning &ignore
/*


&type
&type Starting BC MELP %AML$FILE% v1.0 on [date -vmsfull] ...
&type
/*
&call ini
&call setup_bamp_tree_matrix

&s opentext [open %options_text_file% openstatus -r]
&s record_val [read %opentext% readstatus]

&do &while %readstatus% eq 0
 &s bmu_code_val [before %record_val% , ]
 &s mlu_option_list [after %record_val% , ]
 &call mk_ora_tree_data
 &call set_cycle_time_var
```

```
 &call update_bamp_tree_matrix

 &s record_val [read %opentext% readstatus]
&end

&if [close %opentext%] = 0 &then
 &ty %options_text_file% closed successfully

&return

/*===================================================================
/*
/*   ini - set tree_matrix to startup state.
/*
&routine ini

/*  ensure startup program is ARC
&if [show program] ne ARC &then
 &return &error AML ERROR: TREE_MATRIX must start from ARC prompt

&s ws $BAMP/working/trees
workspace %ws%

&sv orauserpass = jawarren/Marchin8
/*&sv orauserpass = [response 'Enter username']/[response 'Enter oracle password' -noecho]
&r ora_connect %orauserpass%

&s options_text_file %ws%/options.csv
&s sqldir $BAMP/sql
&s cycle_dat bamp_tree_cycle
&s tree_cov $BAMP/working/timber/logslp
&s tree_dat bamp_trees.dat

&return

/*===================================================================
/*
/*   setup_bamp_tree_matrix
/*
&routine setup_bamp_tree_matrix

&sys sqlplus %orauserpass% @%sqldir%/setup_bamp_tree_matrix.sql

&if [exists %tree_dat% -info] &then
 killinfo %tree_dat%

pullitems %tree_cov%.pat %tree_dat% mlu_code vol1tot area cycle_value stand_quality slope_class contclas
infodbms oracle %tree_dat% bamp_tree_data

&return

/*===================================================================
/*
/*   setup_bamp_tree_matrix
/*
&routine mk_ora_tree_data
```

```
&sys sqlplus %orauserpass% @%sqldir%/ck_tree_data.sql

&do var &list [unquote %mlu_option_list%]
 dbmsexecute oracle insert into BAMP_TREE_DATA_S ~
  select * from BAMP_TREE_DATA where ~
  MLU_CODE = [quote %var%];
 dbmsexecute oracle commit;
&end

dbmsexecute oracle alter table BAMP_TREE_DATA_S add ( ~
 AREA_HA number(14,1));
dbmsexecute oracle update BAMP_TREE_DATA_S set AREA_HA = ~
 AREA / 10000;
dbmsexecute oracle alter table BAMP_TREE_DATA_S add ( ~
 ACT_VOL number(14,1));
dbmsexecute oracle update BAMP_TREE_DATA_S set ACT_VOL = ~
 AREA / 10000 * VOL1TOT;
dbmsexecute oracle commit;

&return

/*=====================================================================
/*
/*   set_cycle_time_var
/*
&routine set_cycle_time_var

 tables
  select %cycle_dat%
  nselect
  &do var &list [unquote %mlu_option_list%]
   asel mlu_code = [quote %var%]
  &end
  statistics # cycle.dat
  mean cycle_hour total_volume
  end
  select cycle.dat
  &s cycle_time_sum [show record 1 mean-w-cycle_hou]
  kill cycle.dat
  select %cycle_dat%
  nselect
  &do var &list [unquote %mlu_option_list%]
   asel mlu_code = [quote %var%]
  &end
  statistics # prob_ent.dat
  min one
  min two
  min three
  end
  select prob_ent.dat
  &s entry_one [show record 1 min-one]
  &s entry_two [show record 1 min-two]
  &s entry_three [show record 1 min-three]
  kill prob_ent.dat
 quit
```

```
&return

/*==================================================================
/*
/*   update_bamp_tree_matrix
/*
&routine update_bamp_tree_matrix

/* make BAMP_TREE_OPTION.DAT table
&if [exists bamp_tree_option.dat -info] &then
 killinfo bamp_tree_option.dat

tables
 define bamp_tree_option.dat
  bmu_code 2 2 c
  mlu_options 254 254 c
  ~

 select bamp_tree_option.dat
 add
  [quote %bmu_code_val%]
  [quote [unquote %mlu_option_list%]]
  ~
quit

&system sqlplus %orauserpass% @%sqldir%/ck_tree_matrix.sql
infodbms oracle bamp_tree_option.dat bamp_tree_option

/* updates to BAMP_TREE_MATRIX
dbmsexecute oracle insert into bamp_tree_matrix (b1,b2) ~
 select * from bamp_tree_option;
dbmsexecute oracle update BAMP_TREE_MATRIX set A1 = ~
 (select sum(AREA_HA) from BAMP_TREE_DATA_S where CONTCLAS in (‘C,’’P’)) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set E1 = %entry_one% ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set E2 = %entry_two% ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set E3 = %entry_three% ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set S1 = ~
 (select sum(ACT_VOL*0.85) from BAMP_TREE_DATA_S where STAND_QUALITY = ‘S’ and ~
  slope_class = 1) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set S2 = ~
 (select sum(ACT_VOL*0.85) from BAMP_TREE_DATA_S where STAND_QUALITY = ‘S’ and ~
  slope_class = 2) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set S3 = ~
 (select sum(ACT_VOL*0.85) from BAMP_TREE_DATA_S where STAND_QUALITY = ‘S’ and ~
  slope_class = 3) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set M1 = ~
 (select sum(ACT_VOL*0.85) from BAMP_TREE_DATA_S where STAND_QUALITY = ‘MS’ and ~
  slope_class = 1) ~
```

```
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set M2 = ~
 (select sum(ACT_VOL*0.85) from BAMP_TREE_DATA_S where STAND_QUALITY = 'MS' and ~
  slope_class = 2) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set M3 = ~
 (select sum(ACT_VOL*0.85) from BAMP_TREE_DATA_S where STAND_QUALITY = 'MS' and ~
  slope_class = 3) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set P1 = ~
 (select sum(ACT_VOL*0.8) from BAMP_TREE_DATA_S where STAND_QUALITY = 'P' and ~
  slope_class = 1) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set P2 = ~
 (select sum(ACT_VOL*0.8) from BAMP_TREE_DATA_S where STAND_QUALITY = 'P' and ~
  slope_class = 2) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set P3 = ~
 (select sum(ACT_VOL*0.8) from BAMP_TREE_DATA_S where STAND_QUALITY = 'P' and ~
  slope_class = 3) ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle update BAMP_TREE_MATRIX set T1 = %cycle_time_sum% ~
 where B2 = [quote [unquote %mlu_option_list%]];
dbmsexecute oracle commit;

&return

/*=====================================================================
/*
/*   Usage - print out usage message.
/*
&routine usage

&return USAGE: tree_matrix

/*=====================================================================
/*
/*   Bailout - Respond to an error somewhere in this file.
/*
&routine bailout

&return &error Internal error in tree_matrix.aml
/*=====================================================================
```

(5): SETUP_BAMP_TREE_MATRIX.SQL

```
/* script run at start of AML tree_matrix to remove oracle table
 and create table for populating during AML */

execute drop_table_exist ( 'BAMP_TREE_MATRIX' );

create table BAMP_TREE_MATRIX
 (
  B1  number(14,0),
  B2  varchar2(255),
  A1  number(38,3),
```

```
 E1  number(38,3),
 E2  number(38,3),
 E3  number(38,3),
 S1  number(38,3),
 S2  number(38,3),
 S3  number(38,3),
 M1  number(38,3),
 M2  number(38,3),
 M3  number(38,3),
 P1  number(38,3),
 P2  number(38,3),
 P3  number(38,3),
 T1  number(14,3),
 V1  number(14,3),
 C1  number(14,3),
 H1  number(14,3));

execute drop_table_exist ( 'BAMP_TREE_DATA' );

exit;
```

(6): CK_TREE_DATA.SQL

```
/* script run at start of AML tree_matrix to remove oracle table
 and create table for populating during AML */

execute drop_table_exist ( 'BAMP_TREE_DATA_S' );

create table BAMP_TREE_DATA_S
 (
 MLU_CODE                   VARCHAR2(9),
 VOL1TOT                    NUMBER(14,1),
 AREA                       FLOAT(126),
 CYCLE_VALUE                FLOAT(126),
 STAND_QUALITY              VARCHAR2(2),
 SLOPE_CLASS                NUMBER(38),
 CONTCLAS                   VARCHAR2(2));

commit;

exit;
```

(7): CK_TREE_MATRIX.SQL

```
/* script run during AML tree_matrix to remove oracle tables that
 are created during the AML */

execute drop_table_exist ( 'BAMP_TREE_OPTION' );

exit;
```

APPENDIX 2: STAND QUALITY AML MODEL

Modelling Process

Using Arc/INFO Arc Macro Language (AML) a model was developed to use the input data and class criteria to form output tables and spatial products. The AML (in Appendix C1) provides some documentation. In this report, a detail of each routine in the AML is provided for clarity of the modelling process. There are five routines in the model: INI, SETUP_COVER, DATA2ORA, UPDATE_COVER and MK_HAB_SLOPE.

Routine INI

After starting the AML, routine INI is called and the required environment is established in order to run the program. Actions include ensuring the program is begun at the ARC prompt, the user is in the proper workspace, a connection to Oracle RDBMS is established with a username and password, internal variables are set and a Structured Query Language (SQL) script is called that drops any tables that must be created during the course of this model. That SQL script is named CK_TIMBER_EFFECTIVENESS.SQL and is in Appendix C2.

Routine SETUP_COVER

This routine ensures the working coverage is in the workspace and adds necessary columns in order to proceed. The first task is to UNION the THLB with the SMZ, allowing the model to differentiate those areas inside the Babine Corridor SMZ and those areas outside, with respect to minimum harvestable age. The coverage that is created, named QLGHB, is used for analysis in this model. Two items are added to the polygon attribute table (PAT) of QLGHB. The items are stand_quality and gistag. The item stand_quality will be populated based on criteria identified earlier whereas gistag is used to link the Arc/INFO files with the Oracle files later on. Gistag is calculated to an internal coverage item, resulting a unique value for each polygon in QLGHB.

Routine DATA2ORA

This routine calculates stand quality using Oracle and the dataset for QLGHB. Initially, a check is performed to ensure the subset of QLGHB.PAT does not exist. The following items are then pushed into the INFO file QLGHB.DAT: gistag, spc1, itg, site_idx, proj_agecl, lrmp_rmz, stand_quality and contclas. This INFO table is then copied into Oracle as BAMP_TIMBER. The SQL script CALC_TIMBER_EFFECTIVENESS.SQL is then called. This script is in Appendix C3 and performs the following functions.

SQL script CALC_TIMBER_EFFECTIVENESS.SQL.

This script creates a procedure to step through each record in the table BAMP_TIMBER and identify stand quality, using the criteria outlined above. This is done using the following logic:

To identify a polygon as saw log,
lead species = S, SB or SW and inventory type group (ITG) = 21 or 23 – 36

OR
lead species = PL and inventory type group = 28, 30 or 31

OR
Lead species = B or BL and inventory type group = 18, 19 or 20 and site index >= 17.

To identify a polygon as marginal saw log,
Lead species = B or BL and inventory type group = 18, 19 or 20 and site index < 17.

To identify a polygon as pulp log,
Lead species = H, HW or HM and inventory type group = 12, 14, 15, 16 or 17.
If a polygon within the Babine Corridor SMZ is <= projected age class 7, it is classified as young. Outside of the Babine Corridor SMZ, a polygon that is <= projected age class 4 is classified as young. In order to receive any of the above classifications, a polygon must have a THLB contributing class of 'partially' or 'contributing.' Polygons that have a THLB contributing class of 'non-contributing' or 'excluded' are classified as No Value. The SQL script ends by executing the procedure that populates the item STAND_QUALITY in the Oracle table and committing the actions.

Routine UPDATE_COVER

This routine populates the coverage QLGHB with the stand quality ratings established in the previous routine. A relate is established between the Oracle table BAMP_TIMBER and the PAT for QLGHB and all of the polygons, except for the universe polygon, are updated to reflect stand quality. The final action of this routine is to dissolve QLGHB based on stand quality. All adjacent polygons in QLGHB with the same stand quality value are dissolved to form one polygon. The result of this is QLGHB, with 79,645 polygons, is dissolved to the coverage QLGHB_BAMP, with 2,717 polygons. This coverage is to be used for cartographic purposes.

Routine MK_HAB_SLOPE

This is the final routine for this model, and performs a number of essential tasks, including incorporating MLUs and slope classes into the mix, as well as producing the reporting table. Initially a list of coverages is provided and deleted if they exist. A UNION is performed on QLGHB and the already-generated slope cover to create a temporary coverage. The slope coverage was created at an earlier point using criteria provided above. The slope coverage is based on the 25 meter Gridded DEM and consequently has minimum polygon sizes of 625 square meters. This resultant temporary coverage is then combined with the MLU coverage to create LOGSLP. The INFO table BAMP_LGHB_ANALYSIS is checked for existence and removed if necessary. At this point the INFO table BAMP_LGHB_ANALYSIS is created by pulling the items ROAD_SHED, MLU_CODE, STAND_QUALITY, SLOPE_CLASS, AREA AND VOL1TOT from LOGSLP.PAT. As a measure of volume is required in the reporting matrix / table, the item VOL1TOT, measured in cubic meters per hectare, provides a good representation of volume in the THLB polygons. The next steps in MK_HAB_SLOPE are to remove the universe record from BAMP_LGHB_ANALYSIS and add an item to report area by hectares. This is done by dividing area, which is reported in square meters, by 10000. The final two steps in this routine are to copy the INFO table BAMP_LGHB_ANALYSIS to an Oracle table by the same name. Another SQL script (TIMBER_SUMMARY.SQL – Appendix C4) is then called, which creates a table for reporting Timber Suitability in a suitable fashion.

SQL Script TIMBER_SUITABILITY.SQL

The first steps in the SQL script are to set up the reporting variables, as an ASCII text file is generated from this process. Column widths and formats are established here. Then the table BAMP_SUMMARY is dropped, if it exists, in preparation for the creation of that table, ensuring all reporting is done using the most up-to-date data. After the table BAMP_SUMMARY is created, a unique set of combinations is pulled from the table BAMP_LGHB_ANALYSIS, identifying for each MLU the unique cases of each slope class. For example, in MLU shele-e-2, only slope classes 1 and 2 are present and therefore, records for those slope classes in that MLU are inserted to the table BAMP_SUMMARY. The next five commands update the BAMP_SUMMARY table by inserting the sum of the volume per area (in m3/ha) multiplied with the area (in hectares) resulting in total volume, reported for each record for saw logs, marginal saw logs, pulp logs, young forest and no value land. The last commands set the output to an ASCII file (to be loaded to Excel for reporting purposes) and select all records in the BAMP_SUMMARY table.

Table Explanation

The following is an excerpt from the table generated by this model.

ROAD_SHED	MLU_CODE	SLOPE CLASS	SAWLOG	MARGINAL SAWLOG	PULP LOG	YOUNG	NO VALUE
Babine South	gailw-a-1	1	3701	203162			455090
		2	1302	2482			161117
		3	2325	909			203910
	gailw-a-2	1	582061	534386	17058	9377	257575
		2	27471	17209	6171		68710
		3	8875	11538	12915		87169

(1): TIMBER_EFFECTIVENESS.AML

```
/*----------------------------------------------------------------------
/*                BC Ministry of Sustainable Resource Management
/* Program:  timber_effectiveness.aml
/*----------------------------------------------------------------------
/*
/* Purpose:
/*          AML to identify timber effectiveness using species, ITG and
/*      site index. Combines with slope classes to create a matrix for
/*      interpretation.
/*      For the Babine Access Management Plan.
/* Arguments:
/*
/* Assumptions:
/*          Files, AML or environment variables, etc. needed by this script.
/*
/* Outputs:
/*          List of files or output data produced.
/*
/* Internal variables :
/*
/*
/*----------------------------------------------------------------------
/*  History:
/*  18-Jan-2002  jawarren  v1.0 Creation date.
/*
/*======================================================================
/*
&severity &error &routine bailout
&severity &warning &ignore
/*
```

```
&type
&type Starting BC MELP %AML$FILE% v1.0 on [date -vmsfull] ...
&type
/*
&call ini
&call setup_cover
&call data2ora
&call update_cover
&call mk_hab_slope

&return

/*=====================================================================
/*
/*   ini - set timber_effectiveness to startup state
/*
&routine ini

&if [show program] ne ARC &then
 &return &error TIMBER_EFFECTIVENESS.AML must start from the ARC prompt.

workspace $AL/babine_amp/working/timber

/* connect to oracle
&s orauserpass = [response 'Enter username']/[response 'Enter oracle password' -noecho]
&r ~jawarren/aml/ora_connect %orauserpass%

/* initial variable setup
&s fordir $AL/babine_amp/forest
&s thlb %fordir%/thlb_bamp
&s smz $AL/babine_amp/admin/qsmz_bamp
&s dem $MOF/fcfd/dki/dem/tdem
&s sqldir $AL/babine_amp/sql
&s oratable bamp_timber
&s logcov qlghb
&s slpcov $AL/babine_amp/dem/tslp_c
&s mlu $AL/babine_amp/admin/qmlu_bamp

&system sqlplus %orauserpass% @%sqldir%/ck_timber_effectiveness.sql

/*
&return

/*=====================================================================
/*
/*   setup_cover - gets coverage %logcov% in right spot, adds items,
/*               creates gistag and unions with SMZ if necessary
/*
&routine setup_cover

&if ^ [exists %logcov% -cover] &then
 union %thlb% %smz% %logcov%

tables
```

```
 select %logcov%.pat
 &do var &list gistag
  &if [iteminfo %logcov%.pat -info %var% -exists] &then
   calc %var% = 0
  &else
   additem %logcov%.pat %var% 5 5 n 2
 &end

 &do var &list stand_quality
  &if [iteminfo %logcov%.pat -info %var% -exists] &then
   calc %var% = ‘‘
  &else
   additem %logcov%.pat %var% 2 2 c
 &end

 sel %logcov%.pat
 calc gistag = %logcov%-id

quit

&return /* end of routine setup_cover

/*==================================================================
/*
/*   data2ora - prepares data for trip to oracle, including pulling items
/*              to own data attribute table, calling sql script to drop
/*              oracle table if it already exists, push dat to oracle and
/*              run SQL script to calculate stand quality.
/*
&routine data2ora

&if [exists %logcov%.dat -info] &then
 killinfo %logcov%.dat

pullitems %logcov%.pat %logcov%.dat gistag spc1 itg site_idx proj_agecl lrmp_rmz stand_quality contclas htcl_pr

infodbms oracle %logcov%.dat %oratable%

&system sqlplus %orauserpass% @%sqldir%/calc_timber_effectiveness.sql

&return /* end of routine data2ora

/*==================================================================
/*
/*   update_cover - takes hazard values in oracle and updates coverage
/*
&routine update_cover

tables
 relate add log_rel %oratable% oracle gistag gistag linear rw
 select %logcov%.pat
 resel area > 0
 calculate stand_quality = log_rel//stand_quality
quit

&if [exists qlghb_bamp -cover] &then
```

```
 kill qlghb_bamp all

&return

/*==========================================================================
/*
/*   mk_hab_slope - unions timber_effectiveness coverage with already created
/*       slope coverage
/*
&routine mk_hab_slope

&do var &list logslp temp
 &if [exists %var% -cover] &then
  kill %var% all
&end

union %logcov% %slpcov% temp

/* add MLU boundaries to mix
union temp %mlu% logslp

&if [exists bamp_lghb_analysis -info] &then
 killinfo bamp_lghb_analysis

pullitems logslp.pat bamp_lghb_analysis road_shed mlu_code stand_quality slope_class area vol1tot

tables
 select bamp_lghb_analysis
 resel area < 0
 purge
 y

 additem bamp_lghb_analysis area_ha 8 18 f 5
 asel
 calc area_ha = area / 10000
quit

infodbms oracle bamp_lghb_analysis bamp_lghb_analysis

&system sqlplus %orauserpass% @%sqldir%/timber_summary.sql

&return

/*==========================================================================
/*
/*   Usage - print out usage message.
/*
&routine usage

&return USAGE: timber_effectiveness

/*==========================================================================
/*
/*   Bailout - Respond to an error somewhere in this file.
/*
&routine bailout
```

```
&return &error Internal error in timber_effectiveness.aml
/*==============================================================
```

(2): CK_TIMBER_EFFECTIVENESS.SQL

```
/* script run at start of AML logger_habitat to remove oracle tables that
 are created during the AML */

execute drop_table_exist ( ‘BAMP_TIMBER’ );
execute drop_table_exist ( ‘BAMP_LGHB_ANALYSIS’ );

exit;
```

(3): CALC_TIMBER_EFFECTIVENESS.SQL

```
/* SQL script is run from AML TIMBER_EFFECTIVENESS for Babine Access Management Plan
   to identify timber effectiveness */

create index BAMP_TIMBER_IDX on
 BAMP_TIMBER (
  GISTAG );

create or replace procedure BAMP_TIMBER_PROC
is
 V_SQ varchar2(2);
 V_SPC varchar2(2);
 V_ITG number(5,2);
 V_SI number(5,2);

 cursor SQ_CURS is
  select * from BAMP_TIMBER for update;

 begin
 for SQ in SQ_CURS
 loop
  V_SQ := ‘NV’;
  /* cedar sawlog classification */
  if SQ.SPC1 in (‘CW’)
     then
   V_SQ := ‘CS’;
  end if;
  /* sawlog classification */
  if ( SQ.SPC1 in (‘S,’’SB,’’SW’) and SQ.ITG in (21,23,24,25,26) ) or
     ( SQ.SPC1 = ‘PL’ and SQ.ITG in (28,30,31) ) or
     ( SQ.SPC1 in (‘B,’’BL’) and SQ.ITG in (18,19,20) and SQ.SITE_IDX >= 17 ) or
     ( SQ.SPC1 in (‘H,’’HW,’’HM’) and SQ.ITG in (14,16) ) or
     ( SQ.SPC1 in (‘H,’’HW,’’HM’) and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL <= 7 )
     then
   V_SQ := ‘S’;
  end if;
  if ( SQ.SPC1 in (‘B,’’BL’) and SQ.ITG in (18,19,20) and SQ.SITE_IDX >= 12 and SQ.SITE_IDX < 17 ) or
     ( SQ.SPC1 in (‘H,’’HW,’’HM’) and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL = 8 and SQ.HTCL_PR >= 4 )
     then
```

```
   V_SQ := 'MS';
  end if;
  if ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL = 8 and SQ.HTCL_PR < 4 )
or
     ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL = 9 ) or
     ( SQ.SPC1 in ('B,''BL') and SQ.ITG in (18,19,20) and SQ.SITE_IDX < 12 )
     then
   V_SQ := 'P';
  end if;
  if SQ.PROJ_AGECL <= 4 and SQ.PROJ_AGECL > 0 and SQ.LRMP_RMZ is null
     then
   V_SQ := 'Y';
  end if;
  if SQ.PROJ_AGECL <= 7 and SQ.PROJ_AGECL > 0 and SQ.LRMP_RMZ = 'BABINE'
     then
   V_SQ := 'Y';
  end if;
  if SQ.CONTCLAS in ('N,''X') then
   V_SQ := 'NV';
  end if;
  update BAMP_TIMBER
  set STAND_QUALITY = V_SQ where current of SQ_CURS;
 end loop;
end BAMP_TIMBER_PROC;
/

/* execute procedure */
execute BAMP_TIMBER_PROC;
commit;

quit;
```

(4): TIMBER_SUMMARY.SQL

```
/* Babine Access Management Plan
   Timber Suitability / Timber Effectiveness Table Generator
   SQL script to create spreadsheet ready output for Timber Suitability Analysis

   HISTORY: create January 21, 2002 - jawarren
*/

set pause off
column road_shed format a15
column mlu_code format a9
column slpc format 99
column sq_s format 999999
column sq_ms format 999999
column sq_p format 999999
column sq_y format 999999
column sq_nv format 999999
set linesize 120
set pagesize 50

execute drop_table_exist ( 'BAMP_SUMMARY' );

create table bamp_summary (
```

```
 road_shed varchar2(16),
 mlu_code varchar2(9),
 slpc number(38),
 sq_s number(14,1),
 sq_ms number(14,1),
 sq_p number(14,1),
 sq_y number(14,1),
 sq_nv number(14,1));

insert into bamp_summary
( road_shed, mlu_code, slpc )
  select road_shed, mlu_code, slope_class
  from bamp_lghb_analysis
  group by road_shed, mlu_code, slope_class;

update bamp_summary set sq_s =
 ( select sum ( vol1tot * area_ha )
 from bamp_lghb_analysis
 where stand_quality = 'S' and
  bamp_lghb_analysis.road_shed = bamp_summary.road_shed and
  bamp_lghb_analysis.mlu_code = bamp_summary.mlu_code and
  bamp_lghb_analysis.slope_class = bamp_summary.slpc );

update bamp_summary set sq_ms =
 ( select sum ( vol1tot * area_ha )
 from bamp_lghb_analysis
 where stand_quality = 'MS' and
  bamp_lghb_analysis.road_shed = bamp_summary.road_shed and
  bamp_lghb_analysis.mlu_code = bamp_summary.mlu_code and
  bamp_lghb_analysis.slope_class = bamp_summary.slpc );

update bamp_summary set sq_p =
 ( select sum ( vol1tot * area_ha )
 from bamp_lghb_analysis
 where stand_quality = 'P' and
  bamp_lghb_analysis.road_shed = bamp_summary.road_shed and
  bamp_lghb_analysis.mlu_code = bamp_summary.mlu_code and
  bamp_lghb_analysis.slope_class = bamp_summary.slpc );

update bamp_summary set sq_y =
 ( select sum ( vol1tot * area_ha )
 from bamp_lghb_analysis
 where stand_quality = 'Y' and
  bamp_lghb_analysis.road_shed = bamp_summary.road_shed and
  bamp_lghb_analysis.mlu_code = bamp_summary.mlu_code and
  bamp_lghb_analysis.slope_class = bamp_summary.slpc );

update bamp_summary set sq_nv =
 ( select sum ( vol1tot * area_ha )
 from bamp_lghb_analysis
 where stand_quality = 'NV' and
  bamp_lghb_analysis.road_shed = bamp_summary.road_shed and
  bamp_lghb_analysis.mlu_code = bamp_summary.mlu_code and
  bamp_lghb_analysis.slope_class = bamp_summary.slpc );

set pagesize 500
```

```
spool $BAMP/working/timber/timber_value.txt

select * from bamp_summary
where slpc > 0
order by road_shed, mlu_code, slpc;

spool off

quit
```

APPENDIX 3: TIMBER HARVESTING SEASON AML

Model

The model for assigning seasonal harvesting classifications is embedded in a separate model that is run to set the grizzly bear suitability model to its initialization state. The code to set the item HARVTIME to the seasonal harvest classification is as follows:

```
resel ssval in {0,1,2,3,6,8,9,11,13,14,17,19,20,22,33,35,37,121,133,135,136,143,146,151,153,156} or
ssval in {158,163,166,180,200,233,243,999} and area > 0
calc harvtime = ‘X’
asel
resel ssval in {43,53,73,75,76,83,85,86,103,105,106,113,115,116,168,169,171,172,173,174} and
area > 0
calc harvtime = ‘A’
asel
resel ssval in
{93,95,96,123,125,126,150,182,183,185,186,187,188,202,203,208,209,210,211,212,213,222} and
area > 0
calc harvtime = ‘W’
```

The result of this code is a polygon coverage that can be colour-themed or analyzed based on the ‘harvtime’ item, which then can indicate the most appropriate seasons of harvest for areas in the plan.

APPENDIX 4: FOREST HEALTH AML MODEL

Model

Using Arc Macro Language, a script was developed to calculate forest health for the plan area. The AML can be found in Appendix D1 and is entitled: FOREST_HEALTH.AML
This AML is straightforward, with only four routines: INI, SETUP_COVER, DATA2ORA and UPDATE_COVER.

Routine INI

The initial routine sets the working environment and local variables to a start up condition. The workspace is set, along with coverages and grids, other directories and Oracle database parameters. The user is also connected to the Oracle instance SMTPROD1.

Routine SETU_COVER

This routine ensures the coverage THLB_BAMP is in the proper location with the correct attributes including the GISTAG and elevation. To begin, the source Timber Harvesting Landbase (THLB) coverage is copied to the working directory. The GISTAG and hazard value items are added to the polygon attribute table (PAT) and reset to zero. The hazard ranks are also added to the PAT and set to null. The GISTAG is assigned a unique value for each record, enabling relates and tracking. Finally, elevation is assigned for each polygon using the GET_ELEV.AML. This AML takes the mean elevation across a polygon and assigns that value to the polygon. The Gridded DEM is used in this script as a base.

Routine DATA2ORA

This routine prepares the dataset for Oracle and runs the Structured Query Language (SQL) script that calculates forest health ratings. To begin, a list of items used in the SQL script are pulled from the PAT and inserted to a data attribute table (DAT). This DAT is then loaded to the user's schema after ensuring that table does not already exist. At this point, the SQL script mentioned earlier is run to calculate forest health rankings. The script is in Appendix D2 and is named CALC_FOREST_HEALTH_HAZARD.SQL. This script runs three procedures, one each for pine, balsam and spruce hazard ratings. The script uses the criteria listed above to determine health hazard. The result of the Oracle script is a table with a risk value for each polygon for pine, balsam and spruce forest health.

Routine UPDATE_COVER

The final routine in FOREST_HEALTH.AML populates the items created in THLB_BAMP.PAT with forest hazard value and rankings. To begin, a relate is established between the THLB_BAMP.PAT and the Oracle forest health table using GISTAG. The next and final steps are to calculate the PAT hazard value equal to the Oracle table hazard value and then using the criteria provided above, ranks are assigned to each polygon. The ranks are from one to five, with one posing the highest risk to forest health.
The AML finishes running at this point, and it is up to the user to load THLB_BAMP back to the Babine AMP warehouse.

(1): FOREST_HEALTH.AML

```
/*---------------------------------------------------------------------
/*              BC Ministry of Sustainable Resource Management
/* Program:  forest_health.aml
/*---------------------------------------------------------------------
/*
/* Purpose:
/*          AML to identify forest health hazards with respect to Pine, Spruce
/*      and Balsam beetles.
/*      For the Babine Access Management Plan.
/* Arguments:
/*
/* Assumptions:
/*          Files, AML or environment variables, etc. needed by this script.
/*
/* Outputs:
/*          List of files or output data produced.
/*
/* Internal variables :
/*
/*
/*---------------------------------------------------------------------
/*  History:
/*  14-Jan-2002  jawarren  v1.0 Creation date.
/*
/*=====================================================================
/*
&severity &error &routine bailout
&severity &warning &ignore
/*

&type
&type Starting BC MELP %AML$FILE% v1.0 on [date -vmsfull] ...
&type
/*
&call ini
&call setup_cover
&call data2ora
&call update_cover

&return

/*=====================================================================
/*
/*   ini - set forest_health to startup state.
/*
&routine ini

&if [show program] ne ARC &then
 &return &error FOREST_HEALTH.AML must start from the ARC prompt.

workspace $AL/babine_amp/working/health

/* connect to oracle
```

```
&s orauserpass = [response ‘Enter username’]/[response ‘Enter oracle password’ -noecho]
&r ~jawarren/aml/ora_connect %orauserpass%

/* initial variable setup
&s fordir $AL/babine_amp/forest
&s forcov thlb_bamp
&s dem $MOF/fcfd/dki/dem/tdem
&s sqldir $AL/babine_amp/sql
&s oratable bamp_hazard
/*
&return

/*=================================================================
/*
/*   setup_cover - gets coverage thlb_bamp in right spot, adds items,
/*               creates gistag and adds elevation
/*
&routine setup_cover

&if ^ [exists %forcov% -cover] &then
 copy %fordir%/%forcov%

tables

 select %forcov%.pat
 &do var &list gistag pl_haz_val s_haz_val bl_haz_val
  &if [iteminfo %forcov%.pat -info %var% -exists] &then
   calc %var% = 0
  &else
   additem %forcov%.pat %var% 5 5 n 2
 &end

 &do var &list pl_haz s_haz bl_haz
  &if [iteminfo %forcov%.pat -info %var% -exists] &then
   calc %var% = ‘‘
  &else
   additem %forcov%.pat %var% 2 2 c
 &end

 sel %forcov%.pat
 calc gistag = %forcov%-id

quit

&if ^ [iteminfo %forcov%.pat -info elevation -exists] &then
 &r ~jawarren/aml/get_elev.aml %forcov% poly %dem% elevation

&return /* end of routine setup_cover

/*=================================================================
/*
/*   data2ora - prepares data for trip to oracle, including pulling items
/*             to own data attribute table, calling sql script to drop
/*             oracle table if it already exists, push dat to oracle and
/*             run SQL script to calculate forest health hazard.
/*
```

```
&routine data2ora

&if [exists %forcov%.dat -info] &then
 killinfo %forcov%.dat

pullitems %forcov%.pat %forcov%.dat gistag pl_haz_val s_haz_val bl_haz_val spc1 pct1 spc2 pct2 spc3 pct3 spc4
pct4 spc5 pct5 spc6 pct6 proj_agecl zone site elevation

&system sqlplus %orauserpass% @%sqldir%/ck_forest_health.sql

infodbms oracle %forcov%.dat %oratable%

&system sqlplus %orauserpass% @%sqldir%/calc_forest_health_hazard.sql

&return /* end of routine data2ora

/*=====================================================================
/*
/*   update_cover - takes hazard values in oracle and updates coverage
/*
&routine update_cover

tables
 relate add haz_rel bamp_hazard oracle gistag gistag linear rw
 select %forcov%.pat
 calculate pl_haz_val = haz_rel//pl_haz_val
 calculate s_haz_val = haz_rel//s_haz_val
 calculate bl_haz_val = haz_rel//bl_haz_val
 /* rank pine
 resel pl_haz_val = 0
 calc pl_haz = '5'
 asel
 resel pl_haz_val > 0 and pl_haz_val <= 0.25
 calc pl_haz = '4'
 asel
 resel pl_haz_val > 0.25 and pl_haz_val <= 0.50
 calc pl_haz = '3'
 asel
 resel pl_haz_val > 0.50 and pl_haz_val <= 0.75
 calc pl_haz = '2'
 asel
 resel pl_haz_val > 0.75
 calc pl_haz = '1'
 asel
 /* rank spruce
 resel s_haz_val = 0
 calc s_haz = '5'
 asel
 resel s_haz_val > 0 and s_haz_val <= 2.66
 calc s_haz = '4'
 asel
 resel s_haz_val > 2.66 and s_haz_val <= 3.86
 calc s_haz = '3'
 asel
 resel s_haz_val > 3.86 and s_haz_val <= 5.065
 calc s_haz = '2'
```

```
 asel
 resel s_haz_val > 5.065
 calc s_haz = '1'
 asel
 /* rank balsam (fir)
 resel bl_haz_val = 0
 calc bl_haz = '5'
 asel
 resel bl_haz_val > 0 and bl_haz_val <= 5
 calc bl_haz = '2'
 asel
 resel bl_haz_val > 5
 calc bl_haz = '1'
 asel
quit

&return

/*=========================================================================
/*
/*   Usage - print out usage message.
/*
&routine usage

&return USAGE: forest_health

/*=========================================================================
/*
/*   Bailout - Respond to an error somewhere in this file.
/*
&routine bailout

&return &error Internal error in forest_health.aml
/*====================================================================
```

(2): CALC_FOREST_HEALTH_HAZARD.SQL

```
/* SQL script is run from AML TIMBER_EFFECTIVENESS for Babine Access Management Plan
   to identify timber effectiveness */

create index BAMP_TIMBER_IDX on
 BAMP_TIMBER (
  GISTAG );

create or replace procedure BAMP_TIMBER_PROC
is
 V_SQ varchar2(2);
 V_SPC varchar2(2);
 V_ITG number(5,2);
 V_SI number(5,2);

 cursor SQ_CURS is
  select * from BAMP_TIMBER for update;

 begin
```

```
 for SQ in SQ_CURS
 loop
  V_SQ := 'NV';
  /* cedar sawlog classification */
  if SQ.SPC1 in ('CW')
     then
   V_SQ := 'CS';
  end if;
  /* sawlog classification */
  if ( SQ.SPC1 in ('S,''SB,''SW') and SQ.ITG in (21,23,24,25,26) ) or
     ( SQ.SPC1 = 'PL' and SQ.ITG in (28,30,31) ) or
     ( SQ.SPC1 in ('B,''BL') and SQ.ITG in (18,19,20) and SQ.SITE_IDX >= 17 ) or
     ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (14,16) ) or
     ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL <= 7 )
     then
   V_SQ := 'S';
  end if;
  if ( SQ.SPC1 in ('B,''BL') and SQ.ITG in (18,19,20) and SQ.SITE_IDX >= 12 and SQ.SITE_IDX < 17 ) or
     ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL = 8 and SQ.HTCL_PR >= 4 )
     then
   V_SQ := 'MS';
  end if;
  if ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL = 8 and SQ.HTCL_PR < 4 )
or
     ( SQ.SPC1 in ('H,''HW,''HM') and SQ.ITG in (12,15,17) and SQ.PROJ_AGECL = 9 ) or
     ( SQ.SPC1 in ('B,''BL') and SQ.ITG in (18,19,20) and SQ.SITE_IDX < 12 )
     then
   V_SQ := 'P';
  end if;
  if SQ.PROJ_AGECL <= 4 and SQ.PROJ_AGECL > 0 and SQ.LRMP_RMZ is null
     then
   V_SQ := 'Y';
  end if;
  if SQ.PROJ_AGECL <= 7 and SQ.PROJ_AGECL > 0 and SQ.LRMP_RMZ = 'BABINE'
     then
   V_SQ := 'Y';
  end if;
  if SQ.CONTCLAS in ('N,''X') then
   V_SQ := 'NV';
  end if;
  update BAMP_TIMBER
  set STAND_QUALITY = V_SQ where current of SQ_CURS;
 end loop;
end BAMP_TIMBER_PROC;
/

/* execute procedure */
execute BAMP_TIMBER_PROC;
commit;

quit;
```