LOW-LEVEL AERIAL ASSESSMENT OF POTENTIAL MARBLED MURRELET NESTING HABITAT IN TFL 37 AND FLA19233, NORTHERN VANCOUVER ISLAND

Prepared By:

John A. Deal, RPBio, RPF
Canadian Forest Products Ltd.
Coastal Operations
Woss, B.C.
V0N 3P0

Brian R. Smart, RPF, RPBio
Smart Forest Planning
8131 Frances Avenue
Halfmoon Bay, B.C.
V0N 1Y1

March 2004

EXECUTIVE SUMMARY

During October 2002, the first phase of a Marbled Murrelet (MAMU) nesting habitat identification project was initiated by Canfor within its' Englewood Operations on northern Vancouver Island. This phase focused on low-level aerial (helicopter) surveys to classify potential nesting habitat within (i) potential old growth management areas; (ii) Provincial Parks and Ecological Reserves within the Lower Nimpkish, Upper Nimpkish, Tsitika (land that was originally part of TFL 37), Artlish, and Tahsish Landscape Units; and (iii) areas of interest as defined by aerial photograph interpretation and forest cover algorithm. Phase 2 of the project is proposed for 2003/2004 and involves classification of MAMU habitat potential on all unclassified mature and old growth stands within Canfor's Englewood Operations.

Phase 2 of the project began in May 2003 and assessed the remaining forested landbase in TFL 37, FLA19233 (within the draft Artlish and Tahsish Landscape Units), and TO716 (within the draft Tahsish landscape unit) for Marbled Murrelet nesting habitat potential.

A total of 231,995 ha were classified through a combination of low-level aerial reconnaissance and air photograph interpretation ("Very High" (class 1) to "Unsuitable" (class 5)) and GIS analysis ("Nil" (Class 6)). A total of 66,886 ha (29%) of potential nesting habitat ("Low" to "Very High") were identified across the study area. There were 46,110 ha of potential nesting habitat in TFL 37 and adjacent Protected Areas. There were 20,776 ha potential nesting habitat in FLA19233, TO716 and adjacent Protected Areas.

Classification of Protected Areas within the study area identified 15,404 ha of potential nesting habitat, but this figure does not include Artlish Caves Park, Tahsish River Ecological Reserve, Claude Elliot Ecological Reserve, and the portion of Schoen that is not within the Upper Nimpkish LU. Over 90% of the surveyed area in Tahsish-Kwois Park was determined to be potential nesting habitat. Sixty-four percent of the forested area surveyed area in Schoen Lake Provincial Park (Upper Nimpkish Landscape Unit only) was classified as potential nesting habitat, compared to 55% of forested area in Woss Lake Provincial Park.

Nearly 40% of the deer winter range area in TFL 37 had potential for Marbled Murrelet nesting habitat, compared to 80% in FLA19233. In TFL 37, differences were observed depending on location with respect to the main Nimpkish Valley. The deer winter ranges along the Nimpkish River generally did not possess suitable Marbled Murrelet habitat structure. The canopies tended to be more even (low canopy complexity) and very few nesting platforms were observed. This may be explained by the natural disturbance history (more frequent wildfire), exposure to wind, high exposure to solar radiation, and/or lack of topographic shading.

Elk winter ranges generally provided very good nesting habitat for Marbled Murrelets. They are commonly on gentle slopes where shading from adjacent crowns may influence mossy platform development. In addition, elk winter ranges are often found in moist riparian areas, which could influence the microclimate.

The upper elevation limit of mossy platforms was generally between 800 m and 850 m elevation, but mossy platforms were observed up to 1000 m in a few gullies. Increased snow loading may be one factor limiting development of mossy pads at these elevations. Near the upper elevation limit, mossy platforms were generally observed in yellow-cedar trees, while adjacent hemlock or amabilis fir did not have mossy platforms.

Seventy-five percent of the old growth in the low elevation CWHxm2 is unsuitable nesting habitat for Marbled Murrelets. CWHxm2 is a dry ecosystem with more frequent fire return intervals than the CWHvm1. At higher elevations, 31% of the old growth CWHvm2 and 68% of the old growth MHmm1 did not provide suitable nesting attributes.

It was observed that drainages with abrupt changes in direction, i.e. North-South to East-West (90^o turn) generally have better Marbled Murrelet nesting habitat attributes than a drainage with gradual changes in direction. This may be related to wind strength since there is less distance available to build up wind speed or there is a greater degree of shelter from the prevailing winds.

Topographic diversity along a mountain appears to influence Marbled Murrelet nesting habitat quality and may also provide a visual queue to help the Marbled Murrelet locate the nest tree. Slopes with a high density of gullies seem to provide good quality potential nesting habitat. Gullies can provide areas of topographic shading on otherwise exposed slopes, easy access for Marbled Murrelets into the canopy, and shelter from hot summer winds that may desiccate arboreal moss. Streams associated with gullies may influence the microclimate by increasing the relative humidity.

ACKNOWLEDGEMENTS

The authors would like to thank Ian McDougall, MSRM, for his advice, the aerial photograph review, help to organize 2002 flight plans, and navigation. We would also like to thank (i) Stewart Guy, MWLAP, for his support and input, (ii) WRM Resource Consulting for digitizing the data.

The project was funded by: (i) Canadian Forest Products Ltd and (ii) the B.C. Forest Investment Account delivered through both Canadian Forest Products Ltd and MWLAP.

JAD BRS

.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

FEDERAL AND PROVINCIAL LISTINGS

Marbled Murrelets (*Brachyramphus marmoratus*) are listed by the Committee on Status of Endangered Wildlife in Canada (COSEWIC) as *Threatened* (Hull 1999), and are on British Columbia's provincial red list (Fraser *et al*. 1999). The species has been designated an identified wildlife species and was incorporated into the province's Identified Wildlife Management Strategy (IWMS) established under the Forest Practices Code Act (BC Ministry of Environment, Land and Parks and BC Ministry of Forests 1999). IWMS mandates the creation of Wildlife Habitat Areas (WHAs) to preserve elements of biodiversity not otherwise addressed by the Forest Practices Code.

MARBLED MURRELET NESTING HABITAT

Much of the conservation concern related to Marbled Murrelets is due to their unique nesting requirements: limbs in large conifers that support thick mats of moss and other epiphytes, or other soft substrates (Nelson 1997, Manley 1999). Within Tree Farm Licence (TFL) 37, this habitat is generally found in old growth forests below 900 m elevation. Younger, managed forests lack some preferred stand characteristics such as vertically complex canopies with many gaps and potential nest platforms (Bahn and Newsom 2002, Waterhouse et al. 2002). For a detailed review of Marbled Murrelet (MAMU) nesting ecology, see Burger (2002) and Canadian Marbled Murrelet Recovery Team (2003).

SUSTAINABLE FOREST MANAGEMENT PLAN

In 2000, Canfor's Englewood Operations received sustainable forest management certification through an independent audit to the CAN/CSA-Z809-96 (Canadian Standards Association 1996) standard. The standard required a sustainable forest management plan (SFMP) to be developed through the input of a public advisory group. The Nimpkish Woodlands Advisory Committee (NWAC), Canfor's public advisory group for TFL 37, identified Marbled Murrelet nesting habitat as an indicator of sustainable forest management. The following objective was developed:

Maintain $\geq$10% of the original suitable marbled murrelet habitat by LU. Develop strategy by December 2004. (Deal and Manning 2002).

TFL 37 MARBLED MURRELET CONSERVATION STRATEGY

In 2002, Canfor initiated the development of a Marbled Murrelet nesting habitat management strategy to meet the Sustainable Forest Management Plan objective. The strategy will be comprised of 2 main components: (i) conservation areas (potential WHAs) and core areas, and (ii) a monitoring strategy. In order to determine the best location of conservation areas, a number of factors need to be considered: habitat plots and transects, aerial photograph interpretation, low-level helicopter reconnaissance surveys; dawn audio-visual data; radar data, topographic complexity, tree canopy complexity, patch size, edge effects, and impact on forest asset. This project is designed to provide low-level helicopter reconnaissance data to complement data that has been collected on TFL 37 since 1991 to ensure best placement of conservation areas.

OBJECTIVES

Due to multiple species at risk funding priorities, the project was split into 2 phases. Phase 1 surveyed Canfor's high priority sites that included potential Old Growth Management Areas, Provincial Parks, Ecological Reserves, and areas of interested within the timber harvesting land base (Deal and Smart 2003). Phase 2 surveyed the remaining old growth within Canfor's TFL 37, FLA19233 and TO716 to identify all potential Marbled Murrelet nesting habitat for long-term planning purposes. This report summarizes the complete assessment.

The objectives of this project were to:

i. Identify and rank the quality of suitable MAMU habitat within TFL 37, FLA19233 and TL T0716.

ii. Identify and rank the quality of suitable MAMU habitat within the Provincial Parks and Ecological Reserves that are within and adjacent to Canfor's Operations,

STUDY AREA

The nesting habitat inventory was conducted in selected areas throughout TFL 37, Forest Licence (FL) A19233, and Timber Licence T0716. These licences are managed by Canadian Forest Products Limited (Canfor), Coastal Operations - Englewood (**Figure 1**). The 189,000 ha TFL is located on northern Vancouver Island, near Woss, British Columbia at 50°13'N, 126°36'W. The 25,000 ha Atluck Licences (FLA19233 and T0716) are located west of TFL 37 in the Artlish and Tahsish Landscape Units. Forest harvesting has occurred in the valley since 1908 and Canfor presently harvests approximately 1.068 million m^3/year on the TFL (approximately 0.8% of the productive forest land base/year) and 107,000 m^3/year on FLA19233.

The Nimpkish Valley is within the Coast and Mountains Ecoprovince, Western Vancouver Ecoregion and the Northern Island Mountain ecosection of B.C. Wide valleys and mountains in the northern portion of Vancouver Island characterize the area. Forest harvesting over large portions of the Ecoprovince has resulted in changes to natural habitat conditions (Campbell *et al*. 1990). Topography and landforms of the valley are typical of the insular mountains physiographic system and elevations range from sea level to approximately 1,800 m. The terrain is characterized by dense coniferous forests on rolling uplands and

steep and rugged mountain slopes, often with exposed bedrock (Pojar et al. 1991a). The Nimpkish Valley is found within Coastal Western Hemlock (CWH) and Mountain Hemlock (MH) biogeoclimatic ecosystem classification (BEC) zones. The CWH occurs at low to middle elevations along the entire British Columbia coast (Pojar et al. 1991a). Low elevations are dominated by coniferous forests composed of western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*), especially in the drier variants (Campbell et al. 1990). Other trees include western redcedar (*Thuja plicata*) shore pine (*Pinus contorta* var. *contorta*), western white pine (*Pinus monticola*), yellow-cedar (*Chamaecyparis nootkatensis*) and red alder (*Alnus rubra*). Woody shrubs that include blueberries and huckleberries (*Vaccinium* spp.), and salal (*Gaultheria shallon*) dominate the understory. Subzones and variants found along an elevational gradient in the Nimpkish Valley includes (i) very dry maritime coastal western hemlock subzone (CWHxm) at lower elevations, (ii) submontane very wet maritime coastal western hemlock variant subzone (CWHvm1) above the CWHxm to approximately 600 m, and (iii) the montane very wet maritime coastal western hemlock variant (CWHvm2) from approximately 450 to 800 m elevation. The windward moist maritime mountain hemlock variant (MHmm1) occurs between 800–1000 m (Green and Klinka 1994).

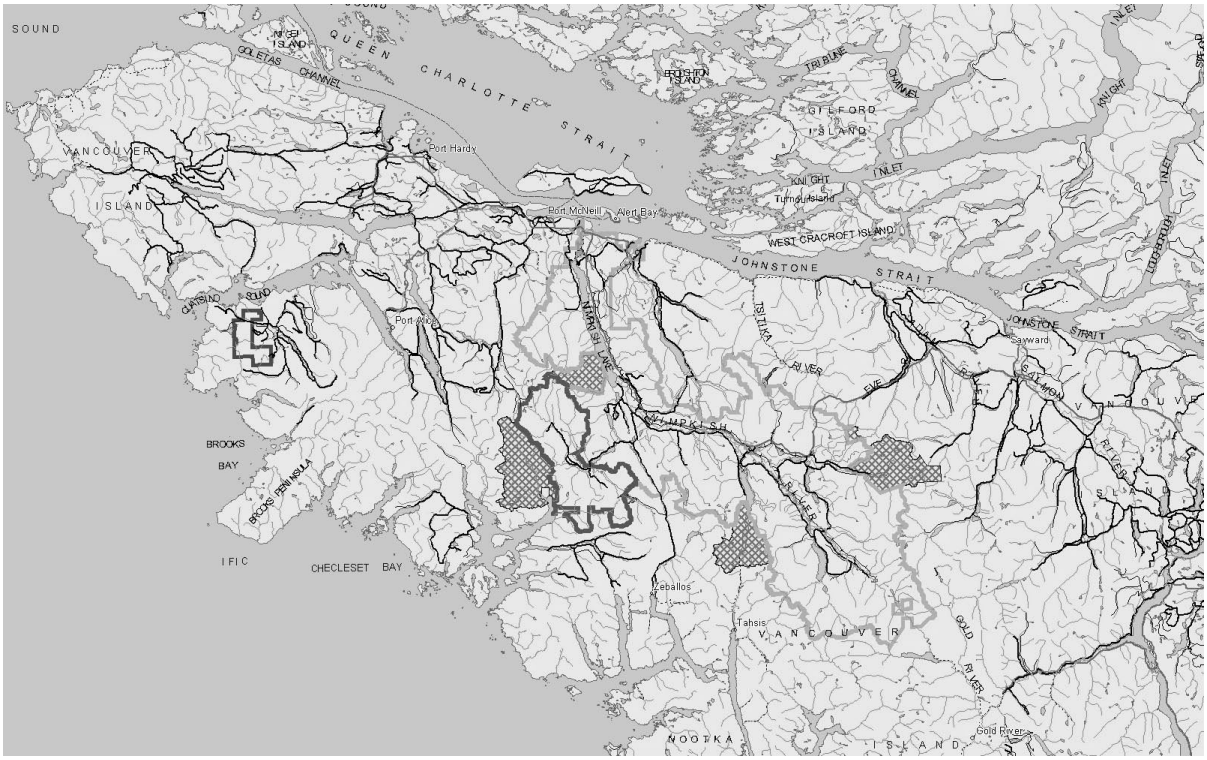

Figure 1. Marbled Murrelet nesting habitat study area (FL: pink; TFL: orange).

The Mountain Hemlock zone represents the subalpine of the coastal mountains. The winter snowpack is slow to melt resulting in a short growing season (Pojar *et al*. 1991b). Mountain hemlock (*Tsuga mertensiana*), amabilis fir (*Abies amabilis*) and yellow-cedar (*Chamaecyparis nootkatensis*) are predominant trees, while ericaceous shrubs dominate the understory (Pojar *et al*. 1991b).

Old growth forests of the Nimpkish Valley are typically uneven-aged or multiple-aged forests. They experience rare to infrequent stand-initiating events that generally occur at 250-year intervals in the CWH and 350 years in the MH zones (BC Ministry of Environment and BC Forest Service 1995). Natural regeneration usually occurs in gaps created by the death of individual or small patches of trees. The infrequent disturbance pattern has left a landscape of irregular edges with small openings created by high winds, fire, avalanches and landslides. A large natural opening in this forest type can exceed 250 ha (BC Ministry of Environment and BC Forest Service 1995).

METHODS

AERIAL ASSESSMENT

In preparation for the assessment, 1:10,000 orthophotographs were printed on 34" X 44" map paper covering the entire assessment area. Priority areas were assessed in October 2002 (potential old growth management areas, Protected Areas and areas of interest.

The surveyor in the front seat navigated, identified candidate stands and surveyed stands for attributes while the person in the rear seat surveyed stand attributes and mapped results onto the orthophotographs. During flights with one person, the navigating, stand identification, surveying and mapping was done from the front seat.

Assessment areas were surveyed to verify presence of suitable mossy platforms for nesting (other substrates were not recorded), suitable age class and stand structure. Marbled Murrelet nesting habitat quality was delineated, on a scale of 1-5, within each of the polygons (**Table 1**, **Figures 2-6**). These maps were later digitized using ArcView 3.2. Only the portion of Schoen Park that is within the draft Upper Nimpkish LU was surveyed.

Tahsish-Kwois Park, adjacent to Englewood's Timber Licence T0716 and FLA19233, was surveyed differently than other parks and potential MAMU areas. The park is very large (10,915 ha) and most of the area is potentially suitable MAMU habitat. To make the habitat identification process more cost effective a number of stands, representative of the park's aspects, elevation, stand types as well as complete spatial distribution, were selected for the confirmation flight. The results of the confirmation flight were then extrapolated to qualify other stands using aerial photograph analysis.

Table 1. Marbled Murrelet nesting habitat quality class description.

Nesting Habitat Class	Description
1, very high	All favourable MAMU habitat attributes present in abundance.
2, high	All favourable attributes present to varying degrees. Many suitable mossy platforms easily visible, good stand structure.
3, moderate	Most favourable attributes present, in varying degrees. Moderate number of suitable mossy platforms, numerous mossy platforms still fairly easy to spot.
4, low	Some favourable attributes present. Suitable mossy platforms sparse, occasional mossy platforms visible.
5, unsuitable	Few favourable attributes present, no suitable mossy platforms observed. Although attributes may be present, there are not enough to be selected as suitable for MAMU habitat conservation.
6, nil	Previously harvested areas, and non-forested areas

Figure 2. Photograph of Class 1 (Very High Potential) Marbled Murrelet nesting habitat.

Figure 3. Photograph of Class 2 (High Potential) Marbled Murrelet nesting habitat.

Figure 4. Photograph of Class 3 (Moderate Potential) Marbled Murrelet nesting habitat.

Figure 5. Photograph of Class 4 (Low Potential) Marbled Murrelet nesting habitat.

Figure 6. Photograph of Class 5 (Unsuitable Potential) Marbled Murrelet nesting habitat.

RESULTS AND DISCUSSION

A total of 231,995 ha were classified through a combination of low-level aerial reconnaissance and air photograph interpretation ("Very High" (class 1) to "Unsuitable" (class 5)) and GIS analysis ("Nil" (Class 6)). A total of 66,886 ha (29%) of potential nesting habitat ("Low" to "Very High") were identified across the study area (**Table 2**). There were 46,110 ha of potential nesting habitat in TFL 37 and adjacent Protected Areas. There were 20,776 ha potential nesting habitat in FLA19233, TO716 and adjacent Protected Areas.

"Unsuitable" habitat totalled 45,344 ha and "Nil" totalled 119,764. The "Nil" category represented areas previously harvested and non-forest types, i.e. large rock outcrops, glacier, and lakes (**Table 2**).

Figure 7 illustrates the spatial distribution of the MAMU nesting habitat classes across the study area.

Table 2. Area classified for potential MAMU nesting habitat, by habitat class.

MAMU Habitat Class	TFL (ha)*	FL (ha)**	*Total (ha)*
Very High	2,332	1,302	*3,634*
High	12,009	5,898	*17,907*
Moderate	19,260	9,533	*28,793*
Low	12,509	4,043	*16,552*
Unsuitable	40,686	4,658	*45,344*
Nil	110,241	9,524	*119,765*
Total	*197,037*	*34,957*	*231,995*

* Includes all protected Areas except Claude Elliot ER portion of draft Tsitika LU
** Includes FLA19233, TO716 and Tahsish-Kwois Provincial Park

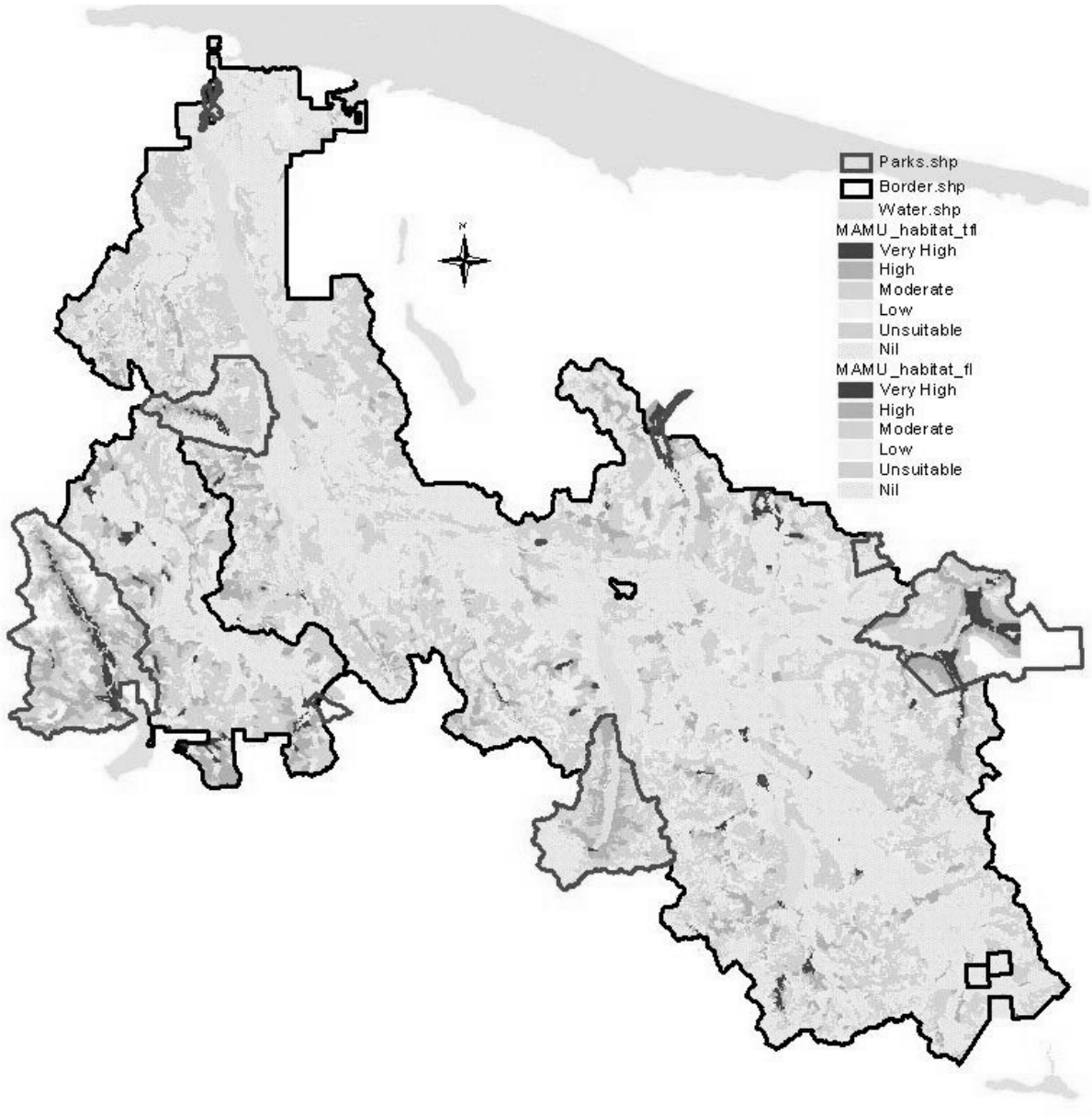

Figure 7. Spatial distribution of potential Marbled Murrelet nesting habitat, by class, within the study area.

PROTECTED AREAS

Classification of Protected Areas within the study area identified 15,404 ha of potential nesting habitat (**Table 3**), but this figure does not include Artlish Caves Park, Tahsish River Ecological Reserve, Claude Elliot Ecological Reserve, and the portion of Schoen that is not within the Upper Nimpkish LU. Over 90% of the surveyed area in Tahsish-Kwois Park was determined to be potential nesting habitat. Sixty-four percent of the forested area surveyed area in Schoen Lake Provincial Park (Upper Nimpkish Landscape Unit only) was classified as potential nesting habitat, compared to 55% of forested area in Woss Lake Provincial Park (**Table 3**).

Table 3. Potential Marbled Murrelet nesting habitat within Protected Areas adjacent to TFL 37 and FLA19233.

	Nesting Habitat Class						
Protected Area	Very High	High	Moderate	Low	Unsuitable	Nil	*Total*
Claude Elliot Lake Park	88	0	0	0	8	109	*205*
Highway Rest Area	0	0	0	0	4	7	*11*
Lower Nimpkish Park	0	8	31	0	26	137	*202*
Mt.Cain Reg. Park	0	0	0	0	150	346	*496*
Nimpkish Lake Park	135	276	303	228	1,302	1,676	*3,920*
Nimpkish River ER	11	0	0	0	0	4	*15*
Schoen Lake Park	918	1,492	856	421	2,042	889	*6,617*
Woss Lake Park	17	1,279	660	45	1,659	2,809	*6,468*
Tahsish-Kwois Park	622.1	2611	3486.2	1918.1	711.5	0	*9,349*
Total	*1,791*	*5,665*	*5,336*	*2,612*	*5,903*	*5,977*	*27,284*

UNGULATE WINTER RANGE

Over 6,200 ha of ungulate winter range (UWR) have been identified in TFL 37 (Deal 2001). There are 79 ranges varying in size from 17.4 ha to 284.1 ha. They are considered fully constrained since harvest opportunities are unlikely. UWR's were assessed for MAMU nesting habitat quality since they comprise the majority of the moderate size (50-200 ha) old growth patches in TFL 37. Deer winter ranges are found on steep southerly slopes while elk winter ranges are found on the valley bottoms.

Nearly 40% of the deer winter range area in TFL 37 had potential for Marbled Murrelet nesting habitat, compared to 80% in FLA19233 (**Table 4**). In TFL 37, differences were observed depending on location with respect to the main Nimpkish Valley. The deer winter ranges along the Nimpkish River generally did not possess suitable MAMU habitat structure. The canopies tended to be more even (low canopy complexity) and very few nesting platforms were observed. This may be explained by the natural disturbance history (more frequent wildfire), exposure to wind, high exposure to solar radiation, and/or lack of topographic shading. In general, deer winter ranges within subdrainages of the Nimpkish had low to moderate nesting potential on the lower slopes. This may be a factor of wind disturbance. The majority of the old growth deer winter range area in FLA19233 provided suitable potential nesting habitat for marbled murrelets. This is likely due to the increased moisture associated with the West Coast of Vancouver Island.

Elk winter ranges generally provided very good nesting habitat (**Table 4**). Seventy-eight percent of elk winter ranges in TFL 37 provided potential nesting habitat for marbled murrelets, compared to 97% in FLA19233. Elk winter ranges are commonly on gentle, valley-bottom slopes, where shading from adjacent crowns may influence mossy platform development.

Table 4. Summary of Marbled Murrelet nesting habitat potential in ungulate (deer and elk) winter ranges in TFL 37 and FLA19233.

Nesting Habitat Class	TFL 37 Deer Winter Range (ha)	TFL 37 Elk Winter Range (ha)	FLA19233 Deer Winter Range (ha)	FLA19233 Elk Winter Range (ha)
Very High (1)	2.8	242.6	11.6	69.6
High (2)	439.7	315.6	190.4	0.1
Moderate (3)	913.4	73.6	388.1	0.0
Low (4)	459.6	0.0	204.5	0.0
Unsuitable (5)	2,998.1	180.2	143.8	2.1
Total	*4813.6*	*811.9*	*938.4*	*71.7*

ELEVATION LIMITS

The upper elevation limit of mossy platforms was generally between 800 m and 850 m elevation, but mossy platforms were observed up to 1000 m in a few gullies. Increased snow loading may be one factor limiting development of mossy pads at these elevations. Near the upper elevation limit, mossy platforms were generally observed in yellow-cedar trees, while adjacent hemlock or amabilis fir did not have mossy platforms.

Table 5 illustrates a high proportion of "Nil" habitat in the CWHxm2 (80%) and CWHmm1 (90%) (low elevation) in TFL 37. This is due to large non-forested areas such as waterbodies and second-growth forests. If the "Nil" category is removed, 75% of the remaining CWHxm2 old growth forest is unsuitable. CWHxm2 is a dry ecosystem with more frequent fire return intervals than the CWHvm1. At higher elevations, 31% of the old growth CWHvm2 and 68% of the old growth MHmm1 did not provide suitable nesting attributes.

There was no "Very High" habitat identified in the CWHvm2 or MHmm1 in TFL 37 and only minor amounts in FLA19233 (CWHvm2 only) (**Tables 5 and 6**). Thirty-one percent (not including "Nil") of the potential nesting habitat in the MHmm1 is either "Moderate" (10%) or "Low" (21%) suitability in TFL 37. In the CWHvm2 (TFL 37), 13% of the old growth is rated as "High" suitability, 32% is "Moderate" suitability and 18% is "Low" suitability.

Table 5. Area surveyed for potential MAMU nesting habitat by biogeoclimatic ecosystem classification (BEC) unit in TFL 37 and adjacent protected areas (not including pre-1995 Schoen Park portion).

	Nesting Habitat Class						
BEC	Very High (ha)	High (ha)	Moderate (ha)	Low (ha)	Unsuitable (ha)	Nil (ha)	Total (ha)
CWHxm2	3	259	386	515	3,477	18,974	*23,614*
CWHmm1	115	735	293	44	782	17,400	*19,369*
CWHvm1	1,048	5,486	4,518	1,346	7,061	35,753	*55,211*
CWHvm2	132	3,788	10,746	5,110	8,885	16,894	*45,554*
MHmm1	0	330	2,568	5,122	16,694	11,272	*35,985*
Total	*1,297*	*10,599*	*18,510*	*12,138*	*36,898*	*100,292*	*179,733*

Table 6. Area surveyed for potential MAMU nesting habitat by biogeoclimatic ecosystem classification (BEC) unit in FLA19233/TO716 and adjacent protected areas (not including Artlish Caves Park and Tahsish River Ecological Reserve).

	Nesting Habitat Class						
BEC	Very High (ha)	High (ha)	Moderate (ha)	Low (ha)	Unsuitable (ha)	Nil (ha)	Total (ha)
CWHvm1	1,253	4,037	3,323	936	658	7,775	*17,981*
CWHvm2	49	1,764	5,055	2,033	1,930	1,438	*12,268*
MHmm1	0	96	678	949	1,631	148	*3,501*
Total	*1,302*	*5,897*	*9,055*	*3,918*	*4,218*	*9,362*	*33,750*

GENERAL OBSERVATIONS

Topographic Diversity

It was observed that drainages with abrupt changes in direction, i.e. North-South to East-West (90^{o} turn) generally have better MAMU nesting habitat attributes than a drainage with gradual changes in direction. This may be related to wind strength since there is less distance available to build up wind speed or there is a greater degree of shelter from the prevailing winds.

Topographic diversity along a mountain appears to influence MAMU nesting habitat quality and may also provide a visual queue to help the MAMU locate the nest tree. Slopes with a high density of gullies seem to provide good quality potential nesting habitat. Gullies can provide areas of topographic shading on otherwise exposed slopes, easy access for MAMUs into the canopy, and shelter from hot summer winds that may desiccate arboreal moss. Streams associated with gullies may influence the microclimate by increasing the relative humidity. A gully is an area containing a stream where the overall stream gradient is > 25% and a reach of that stream, >100m long, has: (i) a sidewall >3m, (ii) a side slope >50% and (iii) a stream channel gradient >20% (BC Operational and Site Planning Regulation, Section 1).

Topographic Shading

Areas that are shaded by adjacent mountains during the summer months tend to provide better quality habitat than areas exposed to the sun. For example, a northerly slope tends to be higher quality than a southerly slope on the TFL. As mentioned above, topographic shading also occurs on a smaller scale within gullies. Topographic shading may be an important factor in moss development in order to prevent or minimize desiccation from hot summer temperatures.

CONCLUSIONS

Based on the results, the following conclusions can be drawn:

(i) A total of 46,110 ha of potential nesting habitat were identified in TFL 37 and adjacent Protected Areas;
(ii) A total of 20,766 ha of potential nesting habitat were identified in FLA19233, TO716 and adjacent Protected Areas;
(iii) Deer Winter ranges in TFL 37 tend to be drier and provide a lower proportion of suitable nesting habitat when compared to the deer winter ranges in FLA19233;
(iv) Potential Marbled Murrelet nesting habitat is more sporadic at higher elevations (CWHvm2 and MHmm1); and
(v) Provincial Parks and Ecological Reserves within and adjacent to Canfor's Englewood Operations provide a high proportion of potential high quality Marbled Murrelet nesting habitat.

RECOMMENDATIONS

Based on the results the following is recommended:

(i) When classifying Marbled Murrelet at an operational scale, maximize the use of aerial photograph interpretation to reduce the overall flying time required, thereby reducing the cost.

(ii) When classifying Marbled Murrelet at an operational scale, use a combination of aerial photograph interpretation and low-level aerial reconnaissance rather than forest cover algorithms since the combination appears to be a better spatial predictor of suitable habitat.

LITERATURE CITED

Bahn, V., and D. Newsom. 2002. Habitat suitability mapping for Marbled Murrelets in Clayoquot Sound. Pages 101-119, *In*: A. E. Burger and T. A. Chatwin [editors]. Multi-scale studies of populations, distribution and habitat associations of Marbled Murrelets in Clayoquot Sound, British Columbia. BC Ministry of Water, Land and Air Protection, Victoria.

BC Ministry of Environment and BC Ministry of Forests. 1995. Forest Practices Code of British Columbia: Biodiversity Guidebook. September 1995.

BC Ministry of Environment, Lands and Parks and BC Ministry of Forests. 1999. Managing identified wildlife: procedures and measures, volume 1. Victoria.

Burger, A. E. 2002. Conservation assessment of Marbled Murrelets in British Columbia: a review of the biology, populations, habitat associations, and conservation. Prepared for: Canadian Wildlife Service, Delta, BC, BC Ministry of Forests and BC Ministry of Water, Land and Air Protection, Victoria.

Canadian Marbled Murrelet Recovery Team 2003. Marbled Murrelet Conservation Assessment 2003, Part B: Marbled Murrelet Recovery Team Advisory Document on Conservation and Management. CMMRT Working Document No. 1.

Canadian Standards Association. 1996. CAN/CAS-Z809-96. A sustainable forest management system: specifications document. Etobicoke, Ontario; Canadian Standards Association. 12 pp.

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser and C. E. McNall eds. 1990. The Birds of British Columbia. Vol. I. Nonpasserines; Introduction, Loons through Waterfowl. Royal British Columbia Museum. Victoria, B.C. 514 pp.

Deal, J.A. 2001. TFL 37 ungulate winter range plan. Prepared for Canadian Forest Products Ltd. Woss, BC. 437 pp.

Deal, J.A. and B.R. Smart 2003. Low-level Aerial Assessment of potential marbled murrelet nesting habitat in TFL 37 and FLA19233, Northern Vancouver Island: phase 1. Prepared for Canadian Forest Products Ltd. Woss, BC 18 pages

Deal, J.A. and E.T. Manning. 2002. Sustainable Forest Management Plan: Canadian Forest Products Ltd. – Englewood DFA. Prepared for Canadian Forest Products Ltd. Woss, BC. 176 pp.

Green, R. N. and K. Klinka. 1994. A field guide to site identification and interpretation for the Vancouver forest region. Ministry of Forests, Research Program, Victoria. 285 pp.

Fraser, D. F., W. L. Harper, S. G. Cannings, and J. M. Cooper. 1999. Rare birds of British Columbia. BC Ministry of Environment, Lands and Parks, Victoria.

Hull, C. L. 1999. COSEWIC Status Report Update on Marbled Murrelet *Brachyramphus marmoratus* (Gmelin). Report to Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Centre for Wildlife Ecology, Department Biological Sciences, Simon Fraser University, Burnaby, BC.

Manley, I. A. 1999. Behaviour and habitat selection of Marbled Murrelets nesting on the Sunshine Coast. M.Sc. Thesis, Simon Fraser University, Burnaby, BC.

Nelson, S. K. 1997. Marbled Murrelet *Brachyramphus marmoratus*. *In*: A. Poole and F. Gill [editors]. The Birds of North America, No. 276. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC.

Pojar, J., K. Klinka and D. A. Demarchi. 1991a. Chapter 6: Coastal Western Hemlock Zone. Pp. 113–124. *In* Meidinger, D. and J. Pojar eds. Ecosystems of British Columbia. Research Branch, Ministry of Forests, Victoria.

Pojar, J., K. Klinka and D. A. Demarchi. 1991b. Chapter 7: Mountain Hemlock Zone. Pp. 113–124. *In* Meidinger, D. and J. Pojar eds. Ecosystems of British Columbia. Research Branch, Ministry of Forests, Victoria.

Rodway, M. S. 1990. Status report on the Marbled Murrelet in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Waterhouse, F. L., R. Bradley, J. Markila, F. Cooke, and L. Lougheed. 2002. Use of airphotos to identify, describe and manage forest structure of Marbled Murrelet nesting habitat at a coastal British Columbia site. BC Ministry of Forests Technical Report TR-016, Nanaimo.