



Cumulative Effects Framework

Assessing and Managing Cumulative Effects in British Columbia

Howe Sound Cumulative Effects Project

Marbled Murrelet – Current Condition Report



South Coast Natural Resource Region

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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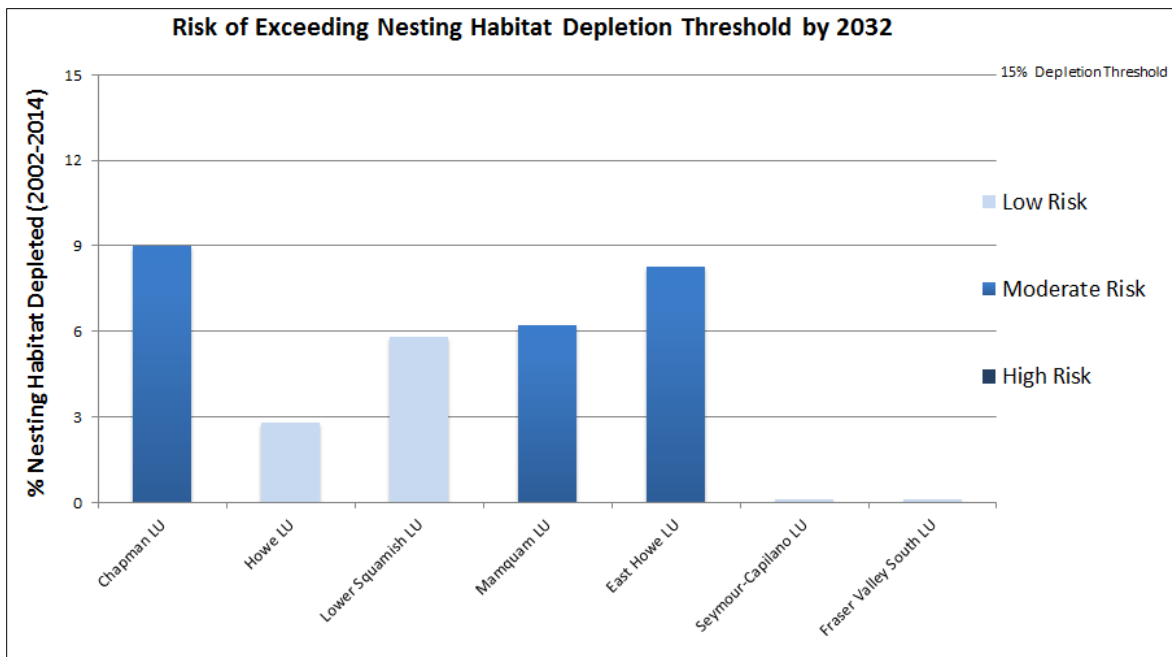
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Executive Summary

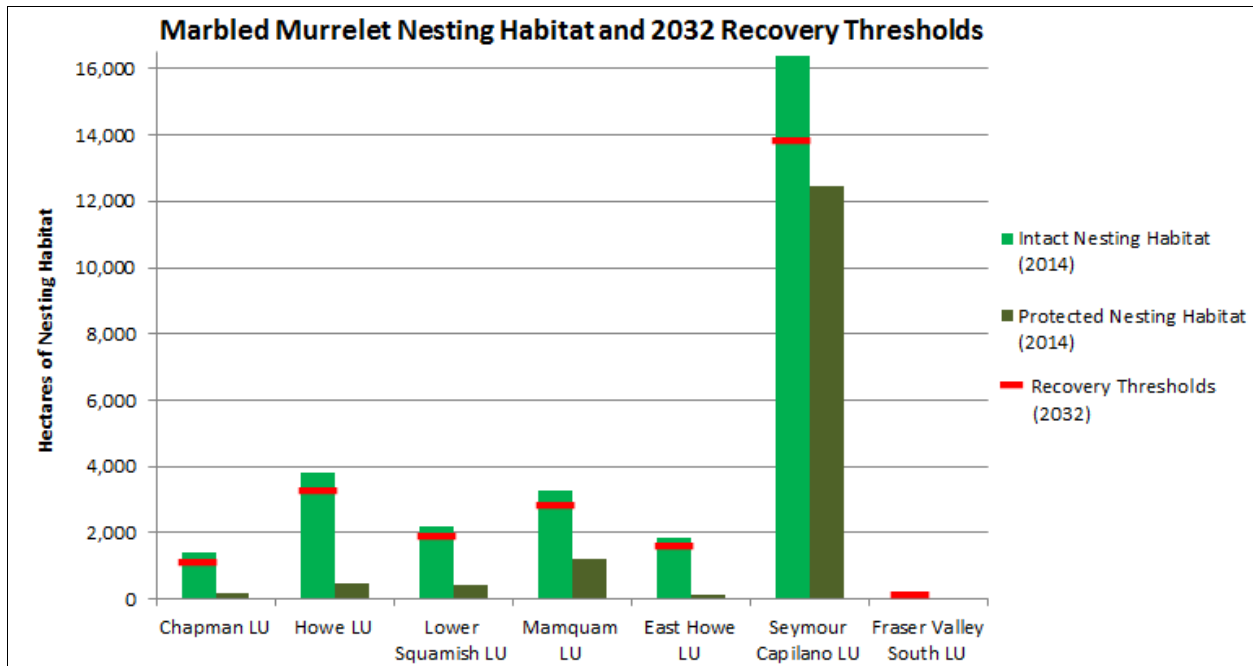
The Howe Sound Cumulative Effects Project represents the Province’s initial application of the Cumulative Effects Framework in the South Coast Natural Resource Region of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD). This report presents a current condition assessment of Marbled Murrelet in the Howe Sound area.

Two key nesting habitat indicators from the Marbled Murrelet CE assessment protocol have been used to estimate the population sustainability risk for Marbled Murrelet in each landscape unit (LU) in the Coast Area. The indicators are suitable nesting habitat (classes 1-3) and suitable nesting habitat protected. These indicators help to estimate the risk to Marbled Murrelet population sustainability (by LU) as it relates to the federal recovery strategy management objectives for this Threatened species and British Columbia’s implementation plan for the recovery of Marbled Murrelet. The critical habitat objective being assessed by this report is to retain 85% of 2002 modeled nesting habitat in the Southern Mainland Coast Conservation Region by 2032. This report focuses on the assessment results for seven LUs that fully, or partially, overlap the Howe Sound CE Project area. These LUs range in size from 22,645 ha (Chapman LU) to 324,745 ha (Fraser Valley South LU) and offer general assessment results that should not be used to confirm the specific impacts from individual developments.

Overall, the current condition assessment results indicate that four landscapes Units (Howe, Lower Squamish, Seymour-Capilano and Fraser Valley South) have a “Low Risk” of exceeding nesting habitat depletion thresholds by 2032 and three landscape units (Chapman, Mamquam and East Howe) have a “Moderate Risk” of exceeding those same thresholds.



The assessment results also indicate that about 62% (2,548 ha) of current Marbled Murrelet nesting habitat within the project area is protected and that most of the LUs contain intact Marbled Murrelet nesting habitat that is still above the minimum 2032 recovery thresholds. However, no aerial nesting habitat surveys were conducted in the Seymour and Capilano watersheds for this assessment. As a result, the actual amount of suitable nesting habitat (Class 1-3) in the Seymour-Capilano LU is likely over-estimated in comparison to the other LUs.



Historical forest harvesting practices and other land developments in the Howe Sound area have shaped the current forest seral stage distribution and limited the amount of old growth forest needed by Marbled Murrelet for suitable nesting habitat. As a result, the actual amount of suitable nesting habitat in the project area is quite limited (4,110 ha) and most of it occurs at higher elevations.

Approximately 5% (656 ha) of the modelled nesting habitat within the Howe Sound CE Project area has been deleted between 2002 and 2014. At this rate, it is likely that most, if not all, the LUs in the Howe Sound area are projected to satisfy the Marbled Murrelet nesting habitat conservation objectives set out for 2032.

FLNRORD is currently exploring a number of actions in response to these results such as comparing these predictions to available site-specific habitat and population survey information and applying these risk assessments to land and resource planning and management decisions where possible. Comparing the assessment results to available on-the-ground habitat surveys will more accurately confirm or reject the accuracy of the results and

predictions. However, on their own, these initial assessment results do offer some general insights that can be considered immediately in certain statutory authorization decisions (i.e. major projects, urban land development, forest management) and more proactive legal designations (e.g. Wildlife Habitat Areas and Old Growth Management Areas).

FLNRORD is currently in the process of looking to spatially protect an additional 10,931 ha of suitable Marbled Murrelet nesting habitat in the Southern Mainland Coast conservation region (includes the Howe Sound area) primarily through the legal designation of some new Wildlife Habitat Areas. In some circumstances, additional Old Growth Management Areas may also be established to protect suitable nesting habitat.

Overall, the results from this assessment indicate that long-term forest management should consider a more balanced forest seral stage distribution within priority LUs to help improve Marbled Murrelet nesting habitat conditions and reduce population sustainability risk. This could involve further old-growth recruitment and/or protection at lower elevations near key marine forage areas. It could also involve forest managers considering habitat fragmentation, stand patch size and shape when protecting suitable nesting habitat in old forest stands.

Forest management for Marbled Murrelet nesting habitat will need to be considered in the broader context of integrated resource management direction for other values. Integrated resource management within the broader Southern Mainland Coast conservation region may consider prioritizing certain areas for nesting habitat protection and making trade-offs in other less important/effective areas while still achieving the overall recovery objective for the region.

The results of this assessment will also be incorporated into some new decision-support tools and processes that FLNRORD is developing. These tools and processes will: integrate and communicate resource value objectives, assess how well these objectives are being achieved, and provide the basis for the development of integrated resource management responses.

The habitat model, indicators and data used in this assessment can only provide an initial coarse filter estimate of nesting habitat current condition and sustainability risk. The assessment is only based upon two indicators and would benefit from using additional habitat and population factors in the future. Therefore, this assessment does not tell the whole story and more investigation is required to better inform land and resource management.

1. Introduction

The Howe Sound Cumulative Effects Project represents the province's initial application of the Cumulative Effects Framework in FLNRORD's South Coast Natural Resource Region. This report presents an initial current condition assessment of Marbled Murrelet in the Howe Sound CE Project area (Appendix I). Other values being assessed for current condition in the Howe Sound area include: Aquatic Ecosystems, Old Growth Forests, Forest Biodiversity, Visual Quality, Grizzly Bear and Roosevelt Elk.

The Province of British Columbia views the assessment and management of cumulative effects as a vital part of sustainable and integrated resource management, and an important foundational piece for addressing First Nations rights and interests. As population and resource demands grow, we must be able to measure the effect of all natural resource activities, large and small, on values that are important to the people of British Columbia. In January 2014, cabinet provided direction for the development and phased-implementation of the BC *Cumulative Effects Framework* (CEF). The intent of the CEF is to incorporate the combined effects of all activities and natural processes into decision-making to help avoid unintended impacts to key economic, social and environmental values. For more, see the CEF website: <http://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/cumulative-effects-framework>.

The Howe Sound Cumulative Effects Project will help with the implementation of a coordinated, multi-sector approach to assessing and managing cumulative effects. This will be achieved by providing transparent decision-support information to the province, First Nations, other levels of government and non-government stakeholders.

FLNRORD's South Coast Natural Resource Region has identified Marbled Murrelet as one of its initial regional values for CE assessment. Marbled Murrelet is listed as a 'Threatened' species in Canada and a 'Blue-Listed' species in British Columbia and is considered a species at risk in BC. Marbled Murrelet have a very specialised nesting habitat strategy that is particularly sensitive, or vulnerable, to human activities and natural events. Along the British Columbia coastline, Marbled Murrelets nest primarily in mossy platforms high up in the canopy of large old growth conifer trees located generally within 50km of marine foraging areas. While Population Growth Rate and Nesting Habitat are key components for assessing population sustainability risk, this initial assessment focuses only on nesting habitat because of its data availability. More information on Marbled Murrelet and management objectives can be found in Appendices II and III.

The intent of this report is to provide an initial indication of the current condition of the Marbled Murrelet value by assessing two key habitat indicators in seven LUs that overlap the Howe Sound CE Project area, while also providing some additional supplemental information and environmental context (Appendix IV). The current condition results provide some important information on the amount of suitable nesting habitat in the Howe Sound area and the risk of exceeding nesting habitat depletion thresholds by 2032 (based upon Federal nesting habitat conservation objectives). This initial assessment acts as a coarse filter to help direct further current condition assessment and monitoring work.

This report is largely made up of a nesting habitat sustainability risk map, a nesting habitat depletion trend map, two indicator maps and some supplemental information. The results from this assessment will be considered by FLNRORD to inform future assessments, planning projects, management decisions and resource objectives. However, further validation, analysis and contextual examination is required before assessing the actual hazard to Marbled Murrelet nesting habitat and broader population sustainability. Therefore, the results in this assessment (relative to a high or low assessment rating) do not necessarily tell the whole story and more investigation is required to determine if special management actions are warranted.

2. Assessment Approach for Marbled Murrelet

The conceptual assessment model used for this current condition report is derived from the conceptual influence diagram (Figure 1) found in *Cumulative Effects Framework- West Coast Region: Knowledge Summary for Marbled Murrelet*, 2015. This diagram depicts the factors affecting population sustainability for Marbled Murrelet. Three main habitat risk factor groups were identified as: Amount (area) of Suitable Nesting Habitat; Edge Effects and Fragmentation of Nesting Habitat; and Marine Habitat Conditions. Of these three risk factor groups, the indicators relating to suitable nesting habitat were used in the conceptual assessment model used in for this report (Figure 2) as this risk factor group was viewed as the most immediate limitation to Marbled Murrelet population sustainability and had available data. This conceptual assessment model provides an initial foundation for a consistent approach in assessing the risk of achieving short-term conservation objectives for Marbled Murrelet in the Coast Area by 2032. Over time, other habitat or population risk factors may also be used as indicators for a more fulsome assessment of current condition.

Two nesting habitat factors were used as indicators in this current condition assessment: the Amount (area) of Suitable Nesting Habitat and the Amount (area) of Suitable Nesting Habitat in Protected Status. These two indicators were used to estimate the risk of not meeting the conservation objective of retaining at least 85% of 2002 Marbled Murrelet populations in the Southern Mainland Coast Conservation Region by 2032 through the retention of proportionate amounts of 2002 modeling nesting habitat. These two indicators use data from both Algorithmic Nesting Habitat Suitability Mapping (2002 BC Nesting Habitat Suitability Model) and Empirical Attribute-based Nesting Habitat Suitability Mapping (Low Level Aerial Surveys) to collectively provide a spatial habitat risk assessment at a broad scale in Howe Sound and the South Coast area.

Biological Rationale for Indicator: Amount of Suitable Nesting Habitat

The loss of nesting habitat in old-growth forests has been identified as the principal threat to Marbled Murrelet in B.C. Marbled Murrelet population changes tend to show a strong linear relationship with changes in available areas of nesting habitat. Consequently, populations are expected to decline in proportion to the loss of suitable nesting habitat. Therefore, stabilizing the loss of suitable nesting habitat is expected to go a long way towards stabilizing Marbled Murrelet populations.

The baseline amount of suitable nesting habitat in 2002 was estimated using the BC Marbled Murrelet Nesting Habitat Suitability Model which used forest inventory information (Vegetation Resources Inventory) and other variables like elevation and distance to coastal waters to evaluate habitat suitability.

A complementary and more accurate method of estimating suitable nesting habitat is the use of low level aerial surveys for habitat classification. This empirical method of data collection was used in the Howe Sound area to develop a more refined estimate for the Suitable Nesting Habitat indicator map.

Biological Rationale for Indicator: Amount of Suitable Nesting Habitat in Protected Status

The amounts of suitable habitats in and outside protected areas can be used to evaluate how close we are to minimum thresholds for Marbled Murrelet sustainability and recovery. In the Southern Mainland Coast the threshold is to retain 85% or greater of the baseline 2002 suitable nesting habitat (BC modelled habitat) by 2032. By knowing the amount of suitable habitat (BC Modelled habitat) in protected areas, it can be calculated how much habitat is needed outside protected areas to meet or exceed minimum retention thresholds to stabilize Marbled Murrelet populations.

For more information, please see references: *Knowledge Summary for Marbled Murrelet, 2015* and *Methodology for Modelling MAMU Habitat Supply in British Columbia, 2015*.

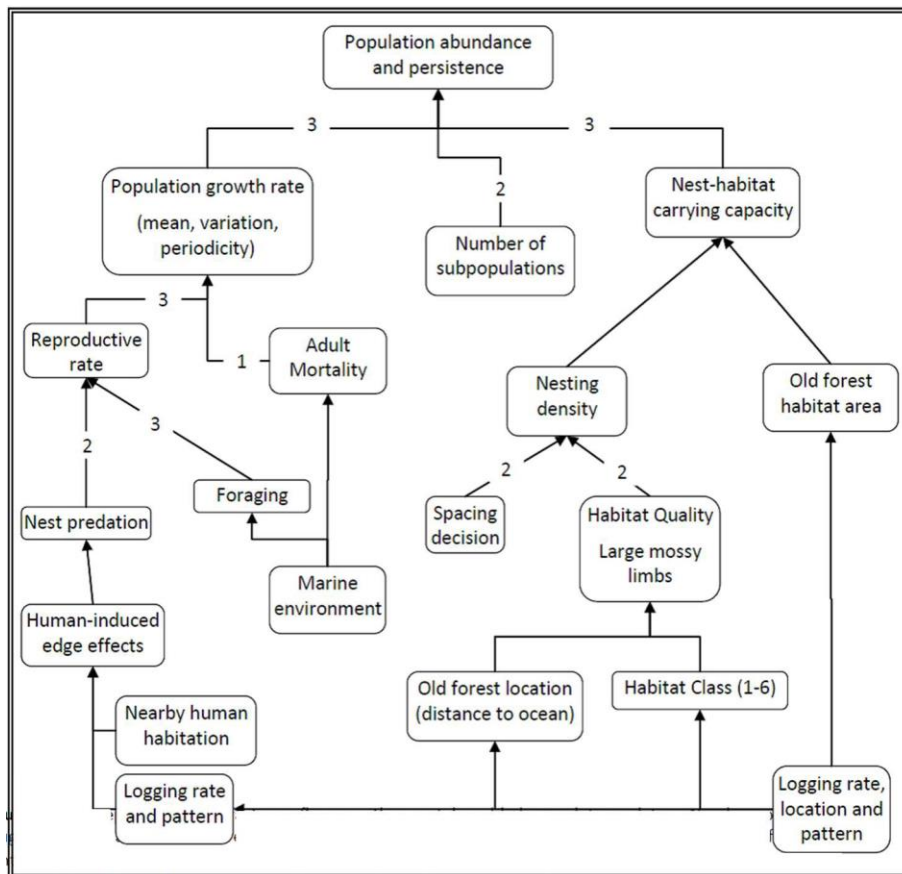


Figure 1: Conceptual Influence Diagram for Marbled Murrelet Population Sustainability (from Cragg, 2015)

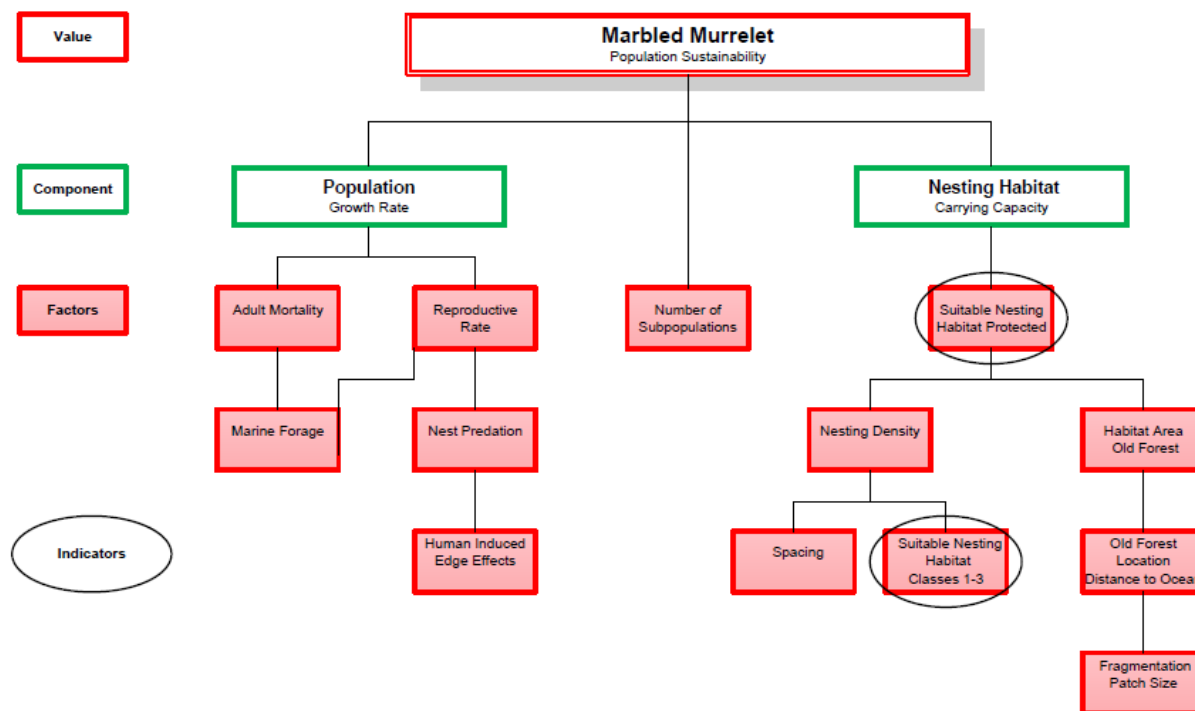


Figure 2: Cumulative Effects Framework Conceptual Model for Marbled Murrelet

Conceptual Models for values describe how components and indicators influence or interact to affect the condition of a value.

Components (green) are features and attributes of a value that should be measured and managed to meet objectives associated with values.

Factors (red) are influential processes or states that act on a component and include both positive and negative effects. They may be used as indicators.

Indicators (black circles) are the metrics used to directly or indirectly measure and report on the condition of a component (state indicators) or the processes that act upon or influence the condition of a component (pressure indicators).

Limitations of the CEF Assessment Protocol for Marbled Murrelet

The key limitations of this initial Marbled Murrelet CE assessment protocol are:

- This assessment is only based upon two indicators (both terrestrial) that relate to the assessment of Marbled Murrelet population sustainability. A more fulsome assessment in the future could consider other population sustainability factors like: indicators for edge effects and fragmentation of nesting habitat; indicators for marine forage conditions (e.g. forage fish surveys, boat traffic surveys); indicators for climate change impacts; indicators for old growth forest patch size and shape; indicators for linkages between marine and terrestrial habitats; and indicators for subpopulations;
- The BC habitat model used in this habitat risk assessment exercise is suited for the broad-scale estimation of Marbled Murrelet nesting habitat area (provincial, regional or landscape level) but not for the identification precise habitat locations. The accuracy of the BC habitat model used in this risk assessment is limited by the quality of the forest cover data/Vegetation Resources Inventory used in the model. Habitat classification through low level aerial surveys can improve confidence levels in the BC habitat model estimates;
- The accuracy of the BC habitat model in identifying suitable nesting habitat as a 2002 baseline is also limited by the use of bivariate ranking system (the habitat is suitable or not) as opposed to using a multivariate nesting habitat classification system used in low level aerial surveys;
- The BC Habitat Model tends to overestimate the amount of suitable nesting habitat compared to the low level aerial survey classifications (1-3);
- The 2014 suitable nesting habitat low level aerial survey data was available only for those landscape units within the Howe Sound CE Project area. There is less confidence estimating the location and area of suitable nesting habitat within the other landscape units that are further removed from Howe Sound but still within 50 km (e.g. Seymour-Capilano LU); and
- The risk assessment outputs have some degree of uncertainty associated with them due to the uncertainties associated with some of the data inputs.

3. Current Condition Assessment Results

The current condition assessment results for Marbled Murrelet provide general coarse filter information about meeting the recovery strategy management objective of retaining at least 85% of 2002 nesting habitat levels by the year 2032 in the Southern Mainland Coast. The results are averaged for each LU (some go beyond the Howe Sound CE Project area). Table 1 below provides an overview of the general nesting habitat sustainability risk by LU.

Table 1. Marbled Murrelet Nesting Habitat Sustainability Risk by LU (2002-14)

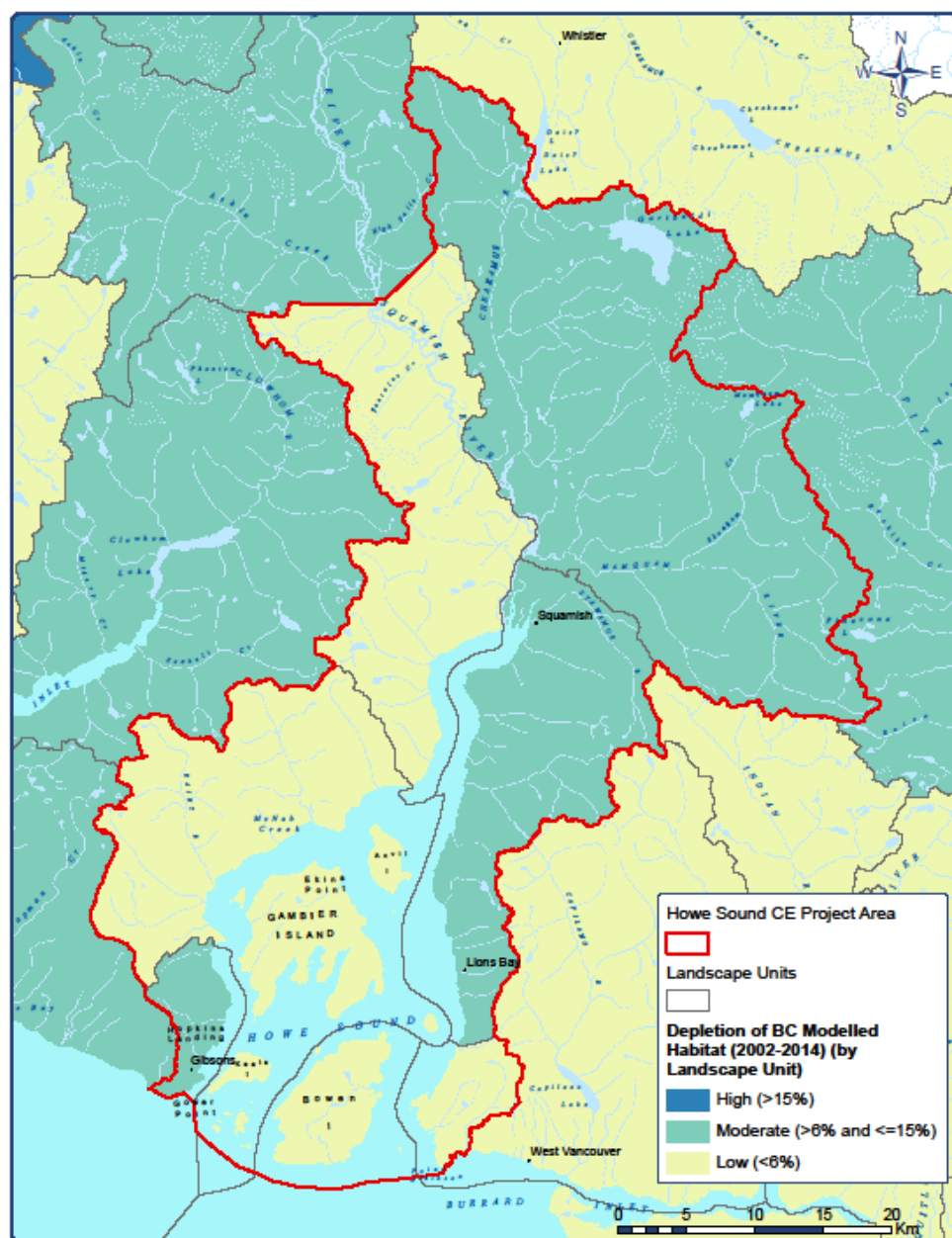
Landscape Units	Low Risk <6% Depletion	Moderate Risk >6%-15% Depletion	High Risk >15% Depletion
Chapman LU (22,645 ha)			
Modeled Nesting Habitat Depleted (2002-2014)		(9%)	
Indicator: Area of Intact Nesting Habitat (2014)		1,429.22 ha	
Indicator: Nesting Habitat Protected (2014)		(14%) 200.09 ha	
Nesting Habitat Threshold (2032)		1,334.69 ha	
Howe LU (34,622 ha)			
Modeled Nesting Habitat Depleted (2002-2014)	(2.8%)		
Indicator: Area of Intact Nesting Habitat (2014)	3,834.9 ha		
Indicator: Nesting Habitat Protected (2014)	(12%) 460.19 ha		
Nesting Habitat Threshold (2032)	3,352.87 ha		
Lower Squamish LU (34,923 ha)			
Modeled Nesting Habitat Depleted (2002-2014)	(5.8%)		
Indicator: Area of Intact Nesting Habitat (2014)	2,185.93 ha		
Indicator: Nesting Habitat Protected (2014)	(20%) 437.19 ha		
Nesting Habitat Threshold (2032)	1,972.23 ha		
Mamquam LU (75,853 ha)			
Modeled Nesting Habitat Depleted (2002-2014)		(6.2%)	
Indicator: Area of Intact Nesting Habitat (2014)		3,264.76 ha	
Indicator: Nesting Habitat Protected (2014)		(37%) 1207.96 ha	
Nesting Habitat Threshold (2032)		2,959.73 ha	
East Howe LU (31,892 ha)			
Modeled Nesting Habitat Depleted (2002-2014)		(8.3%)	
Indicator: Area of Intact Nesting Habitat (2014)		1,854.36 ha	
Indicator: Nesting Habitat Protected (2014)		(8%) 148.35 ha	
Nesting Habitat Threshold (2032)		1,718.12 ha	
Seymour-Capilano LU (67,736 ha)			
Modeled Nesting Habitat Depleted (2002-2014)	(0%)		
Indicator: Area of Intact Nesting Habitat (2014)	16,362.92 ha		
Indicator: Nesting Habitat Protected (2014)	(76%) 12,435.82 ha		
Nesting Habitat Threshold (2032)	13,908.48 ha		
Fraser Valley South LU (324,743 ha)			
Modeled Nesting Habitat Depleted (2002-2014)	(0%)		
Indicator: Area of Intact Nesting Habitat (2014)	69.14 ha		
Indicator: Nesting Habitat Protected (2014)	(79%) 54.62 ha		
Nesting Habitat Threshold (2032)	58.77 ha		

Initial Interpretation of the Current Condition Results

Some initial observations and possible key drivers affecting the CE results include:

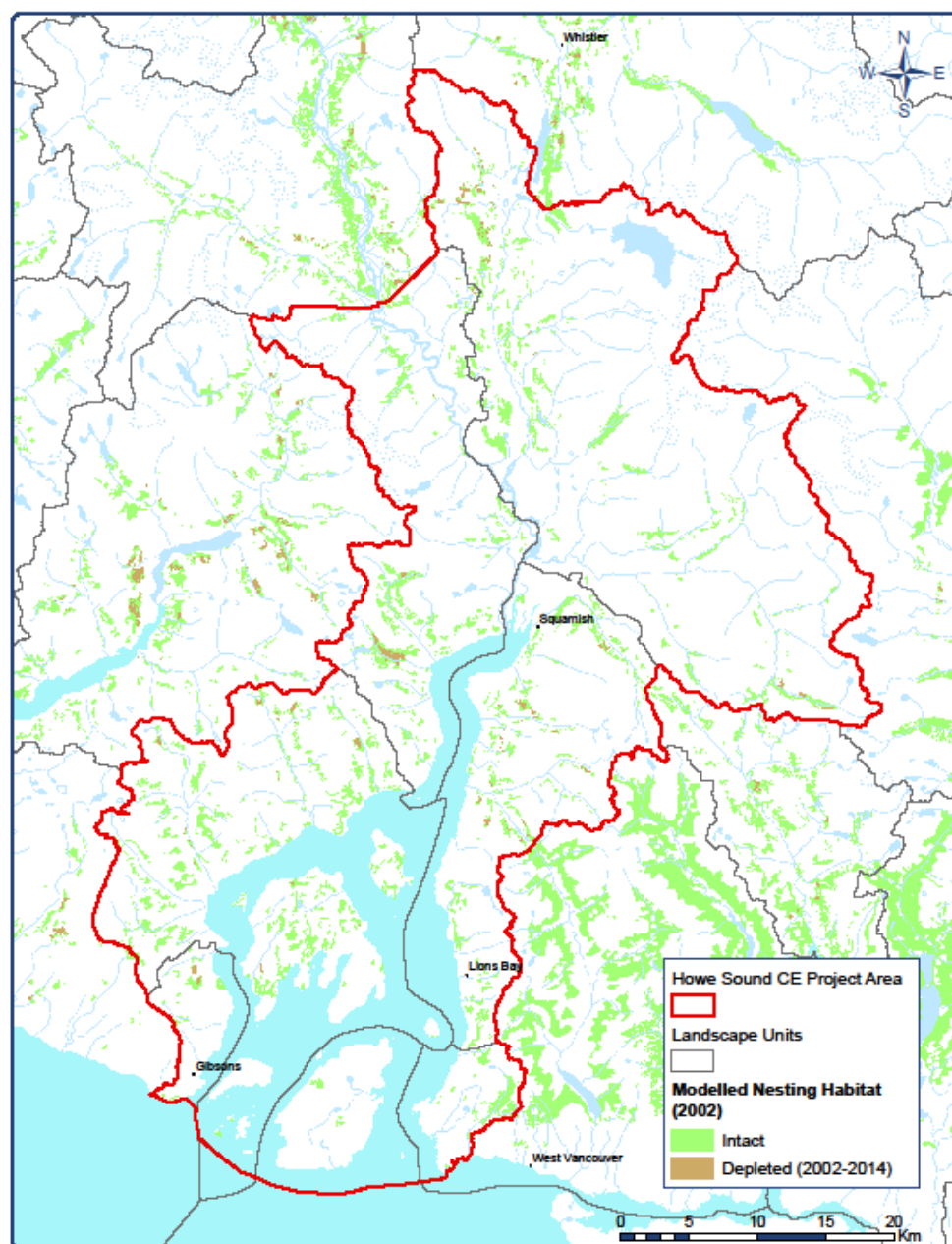
- A total of 5% (656 ha) of the modelled nesting habitat within Howe Sound CE Project area has been depleted between 2002 and 2014;
- No more than 10% (1,229 ha) of the 2014 modelled nesting habitat within in the project area can be depleted from 2014-2032 to stay within conservation thresholds;
- Three out of the 7 LUs in the project area (Chapman, Mamquam and East Howe LUs) are expressing a moderate level of risk for exceeding habitat depletion thresholds by 2032;
- Low level aerial surveys of Howe Sound indicate that there is actually a very limited amount of suitable Marbled Murrelet nesting habitat (4,110 ha) in the actual project area itself;
- About 62% (2,548 ha) of the identified suitable nesting habitat in the Howe Sound project area is under some form of protection;
- The Seymour-Capilano LU has the most amount of intact and protected modelled nesting habitat (16,362.92 ha) due to old growth stands in Cypress Provincial Park and the Capilano and Seymour watersheds;
- The actual amount of 2014 intact nesting habitat and protected nesting habitat in the Seymour-Capilano LU is overestimated because it has not yet undergone low level aerial survey classification for suitable nesting habitat (classes 1-3). However, the LU likely has the greatest area of suitable nesting habitat near Howe Sound;
- While the Seymour-Capilano LU might have the greatest amount of nesting habitat near Howe Sound, it is uncertain whether Marbled Murrelet use this nesting habitat due to busy nearby marine waters and the increased presence of predators (e.g. Corvids)
- The large Fraser Valley South LU has very little intact nesting habitat left due to being highly developed and urbanized. The small amount of nesting habitat left in the LU is mainly found in small patches on Bowen Island;
- Historical forest harvesting practices (scale, pattern and stand selection) and other land developments have shaped the current forest seral stage distribution in the Howe Sound area and limited the amount of old growth forest used by Marbled Murrelet for suitable nesting habitat;
- Most of the lower elevation forest stands in the project area (<900m) are second growth stands that are less than 140yrs old and thus do not exhibit the old growth forest characteristics suitable for Marbled Murrelet nesting habitat;
- There is a significant amount of old forest in the project area but much of it occurs at higher elevations where the trees do not possess the same old growth forest characteristics suitable for Marbled Murrelet nesting habitat; and
- Where suitable nesting habitat has been identified in the project area, it exists in higher elevation old growth patches (mainly Howe, Lower Squamish and Mamquam LUs).

Risk of Exceeding Nesting Habitat Depletion Thresholds by 2032



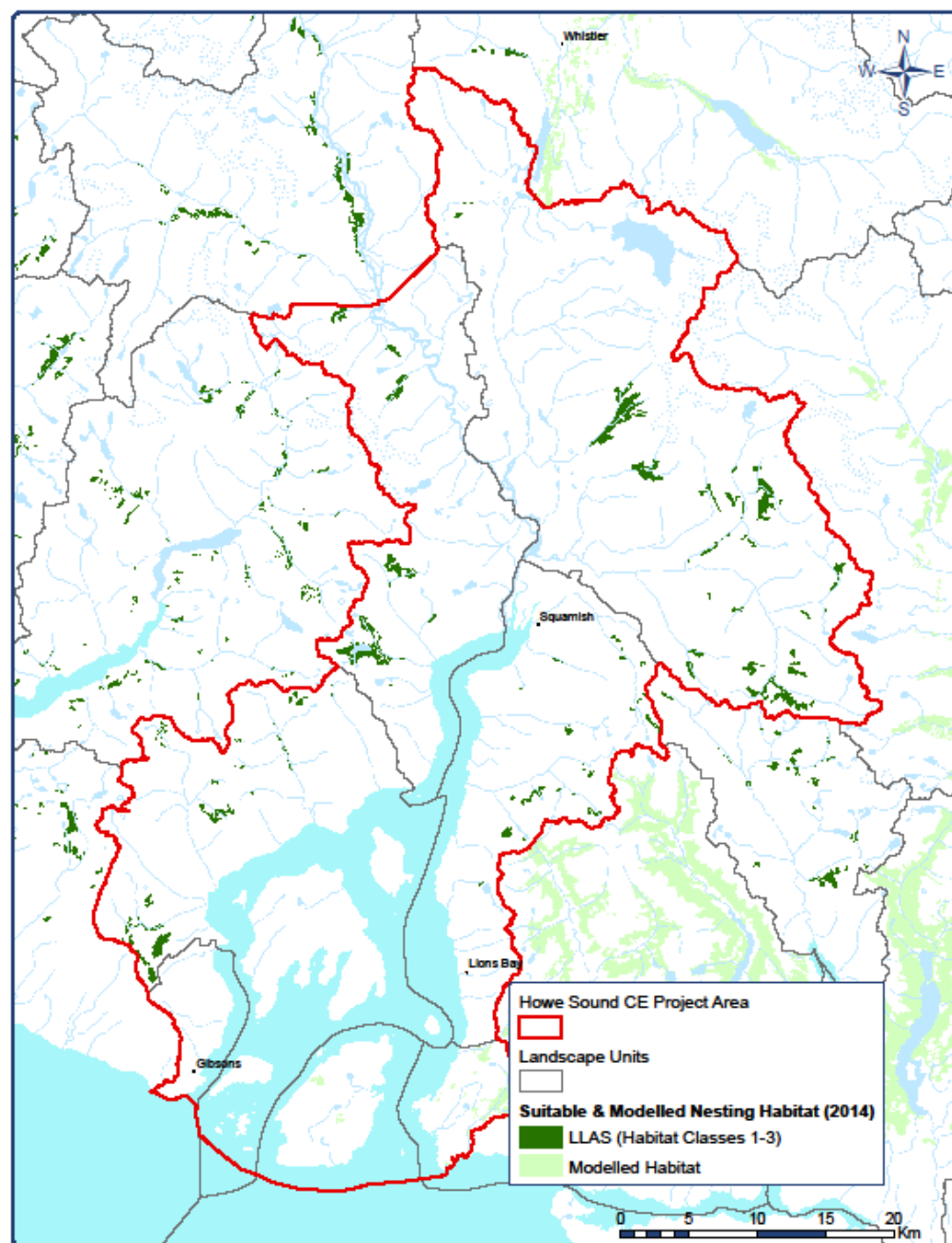
This map provides an estimate of risk by LU for meeting the Marbled Murrelet critical nesting habitat short-term objective by 2032 (85% retention of 2002 modeled nesting habitat levels). High Risk=Low chance of meeting objective; Moderate Risk= Moderate chance of meeting objective; Low Risk =High chance of meeting objective. Darker colours indicate LUs at a higher risk to Marbled Murrelet sustainability where further assessment and management may be warranted.

BC Modelled Nesting Habitat with Depletions



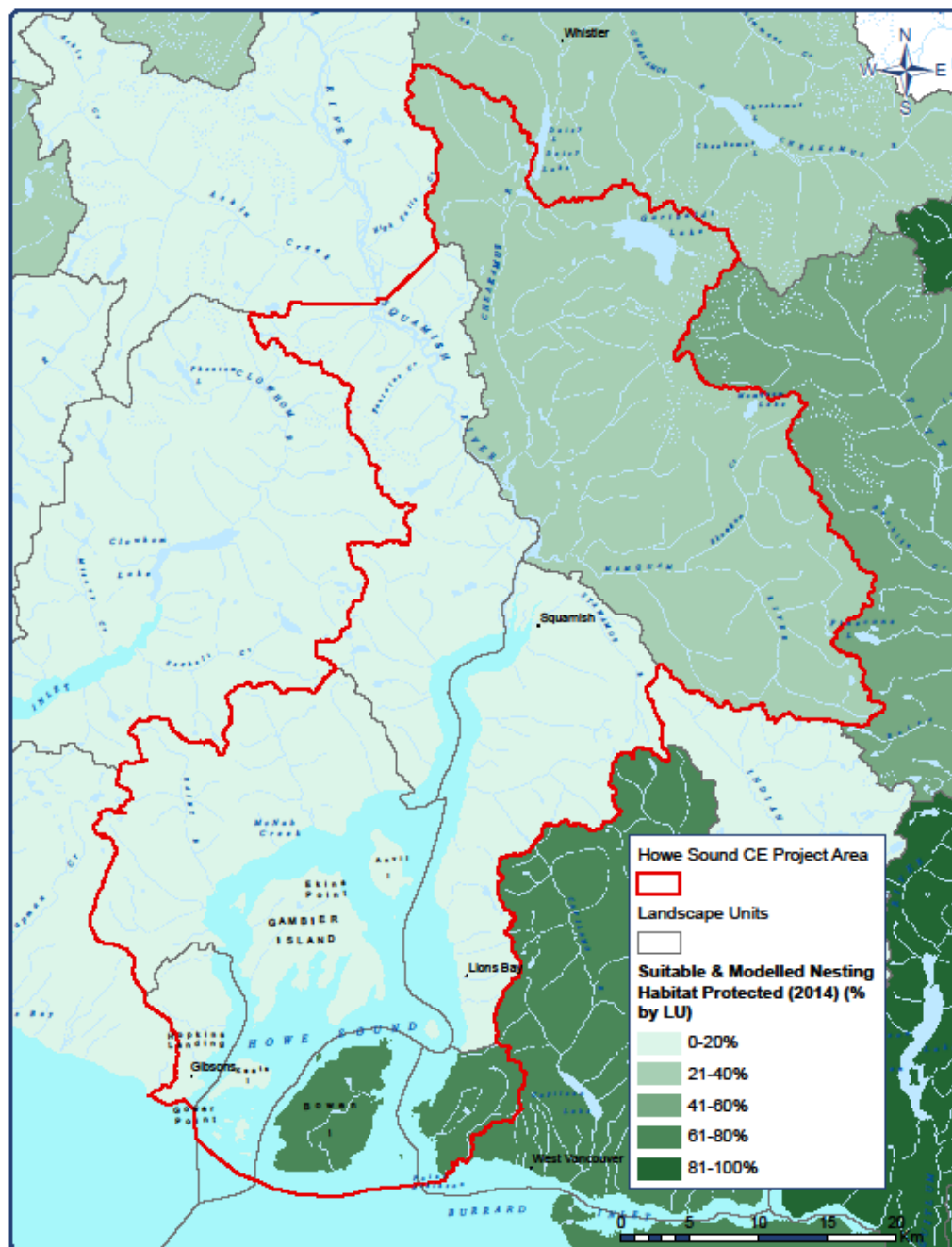
This map shows the Marbled Murrelet nesting habitat depletion trend by LU from 2002-2014. It shows the depletions of modelled nesting habitat up until 2014. Five percent of the modelled nesting habitat in the Howe Sound CE Project area has been depleted between 2002-2014. Note: The conservation threshold for the whole Southern Mainland Coast is no more than 15% nesting habitat depletion by 2032.

Indicator - Suitable and Modelled Nesting Habitat



This map shows the nesting habitat for Marbled Murrelet in the Howe Sound area using the best available information: suitable habitat identified through low level aerial survey (LLAS) classifications conducted up until 2014 and BC modelled habitat. LLAS Habitat Classes 1-3 are shown as just one colour (dark green) on this map as all three of these habitat classes (the top 3 of 6 habitat classes) are all viewed by the province as representing suitable Marbled Murrelet nesting habitat in BC.

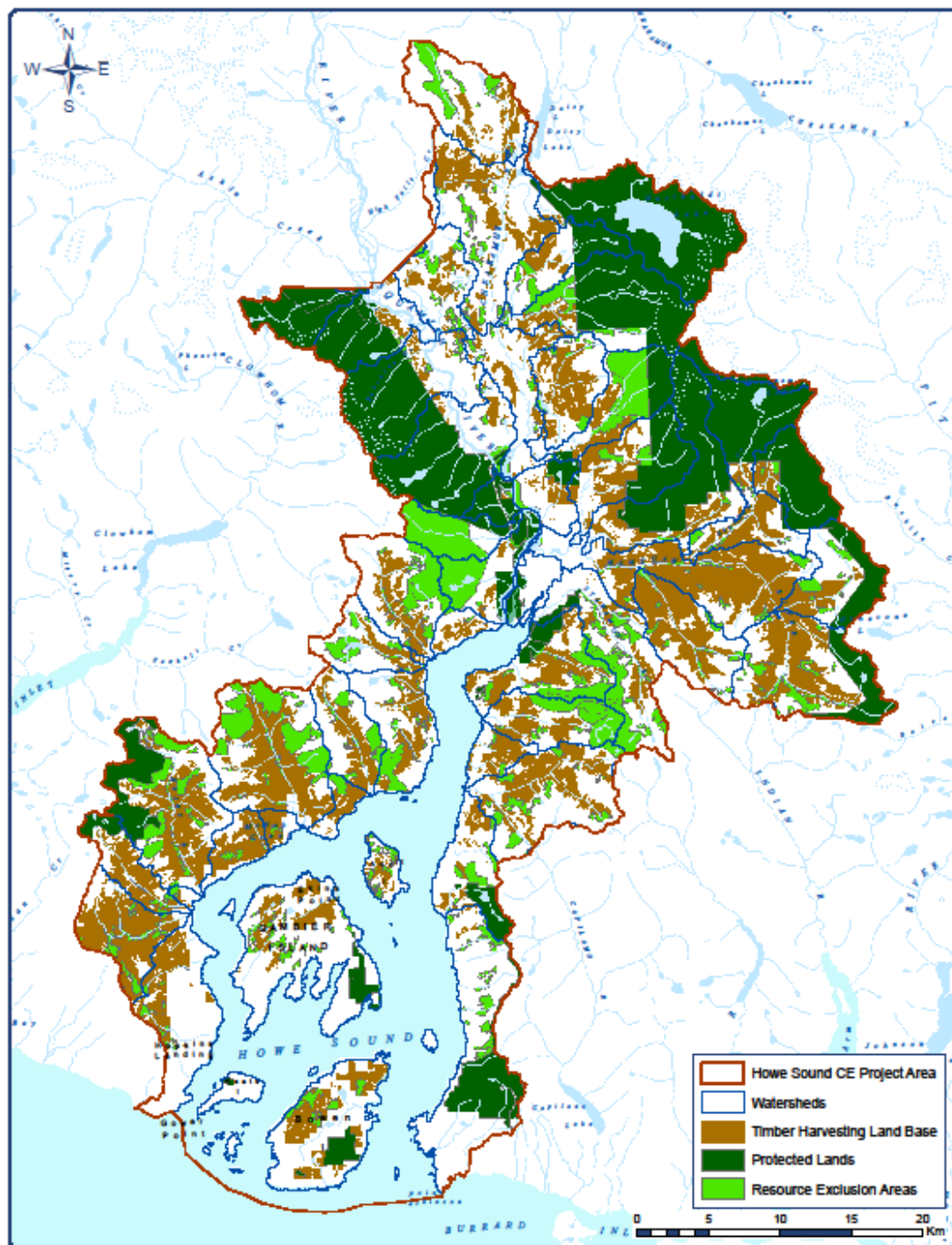
Indicator - Suitable and Modelled Nesting Habitat Protected



This map shows the percentage of suitable and modelled Marbled Murrelet nesting habitat protected within each landscape unit in the Howe Sound area. The lighter green colours give an indication of those landscape units where there is currently less protection for Marbled Murrelet nesting habitat and where retention measures may be needed.

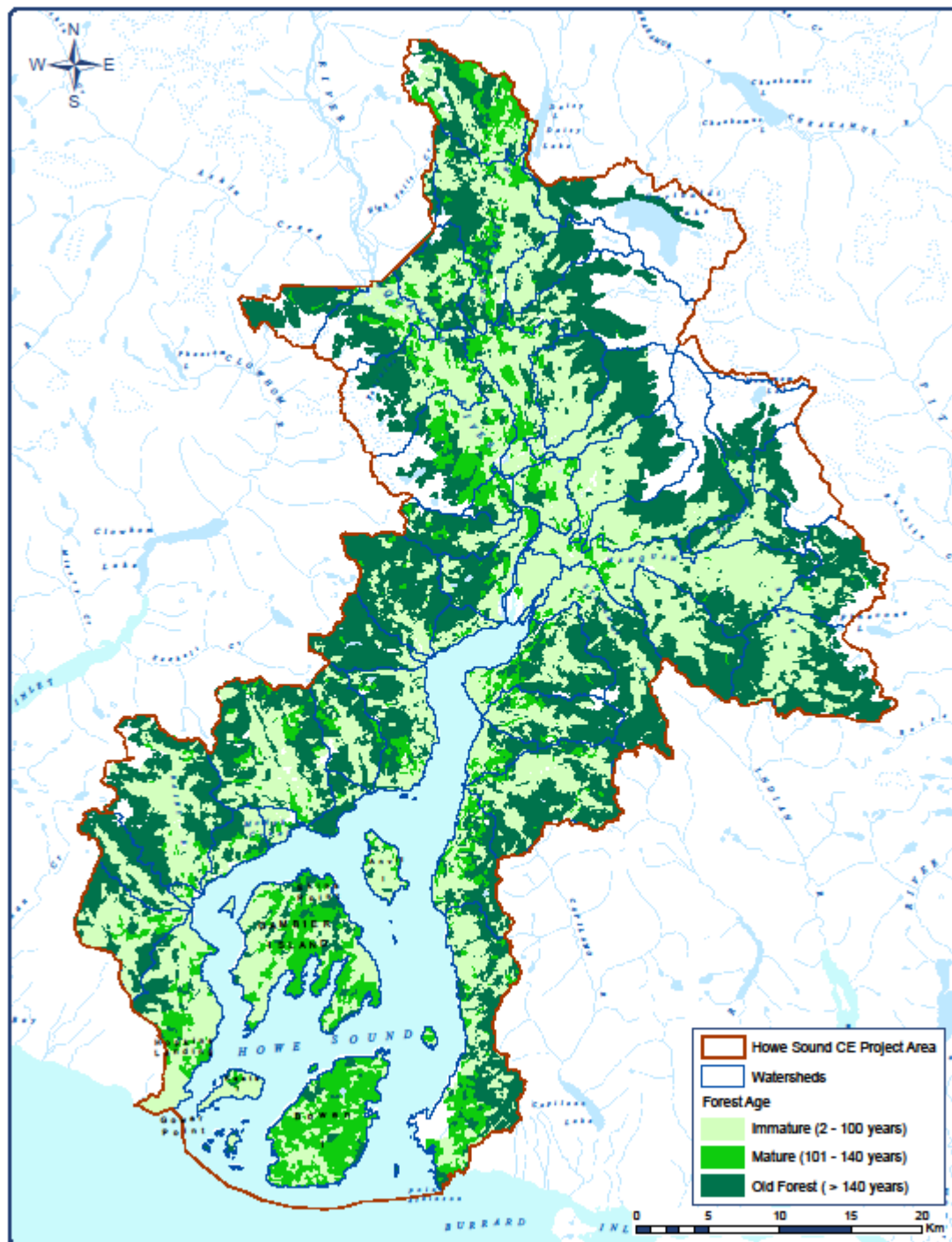
4. Supplemental Information

Protected Lands and Timber Harvesting Land Base

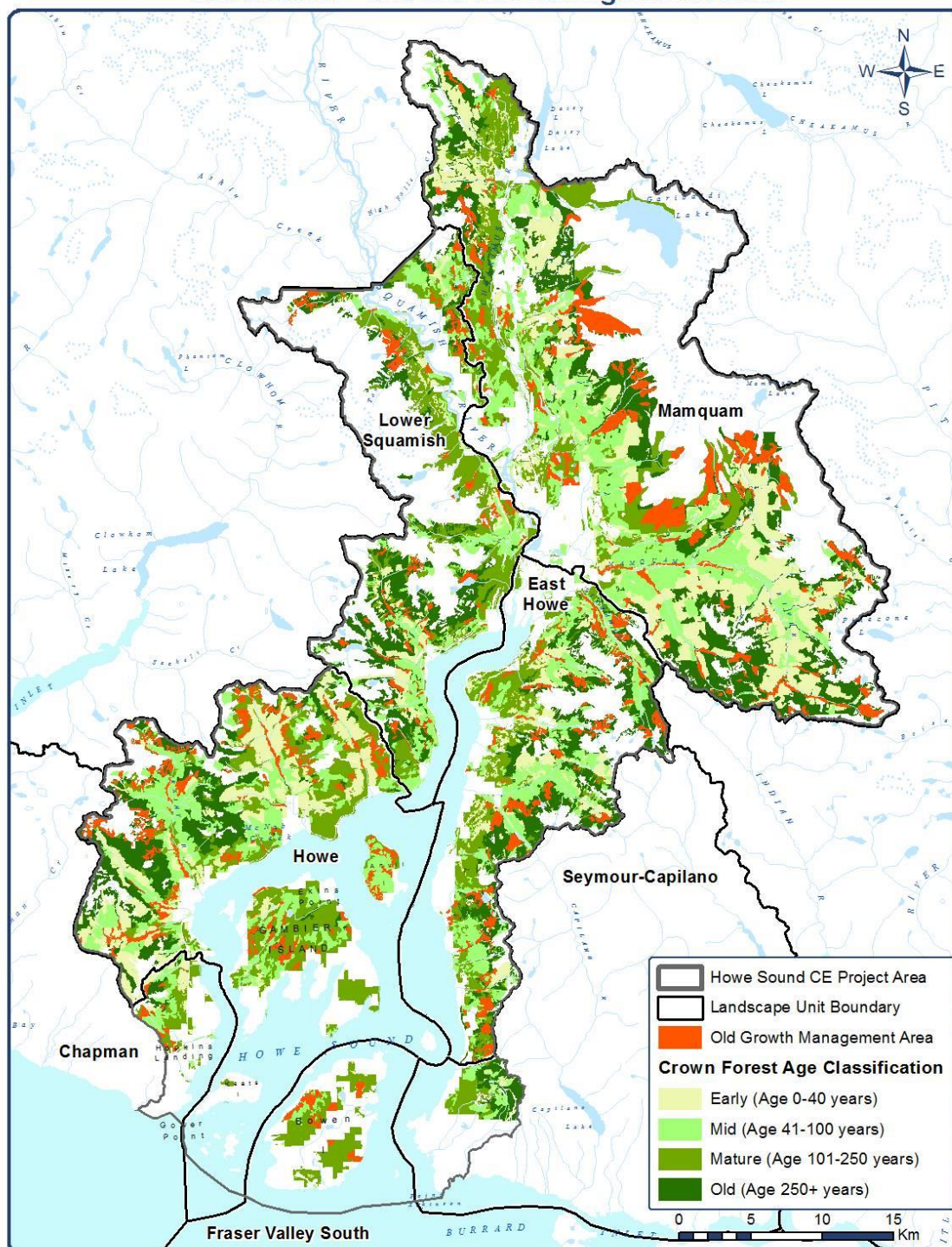


Note: For a description of *Protected Lands* and *Resource Exclusion Areas*, please go to:
<http://wwwd.env.gov.bc.ca/soe/indicators/land/land-designations.html>

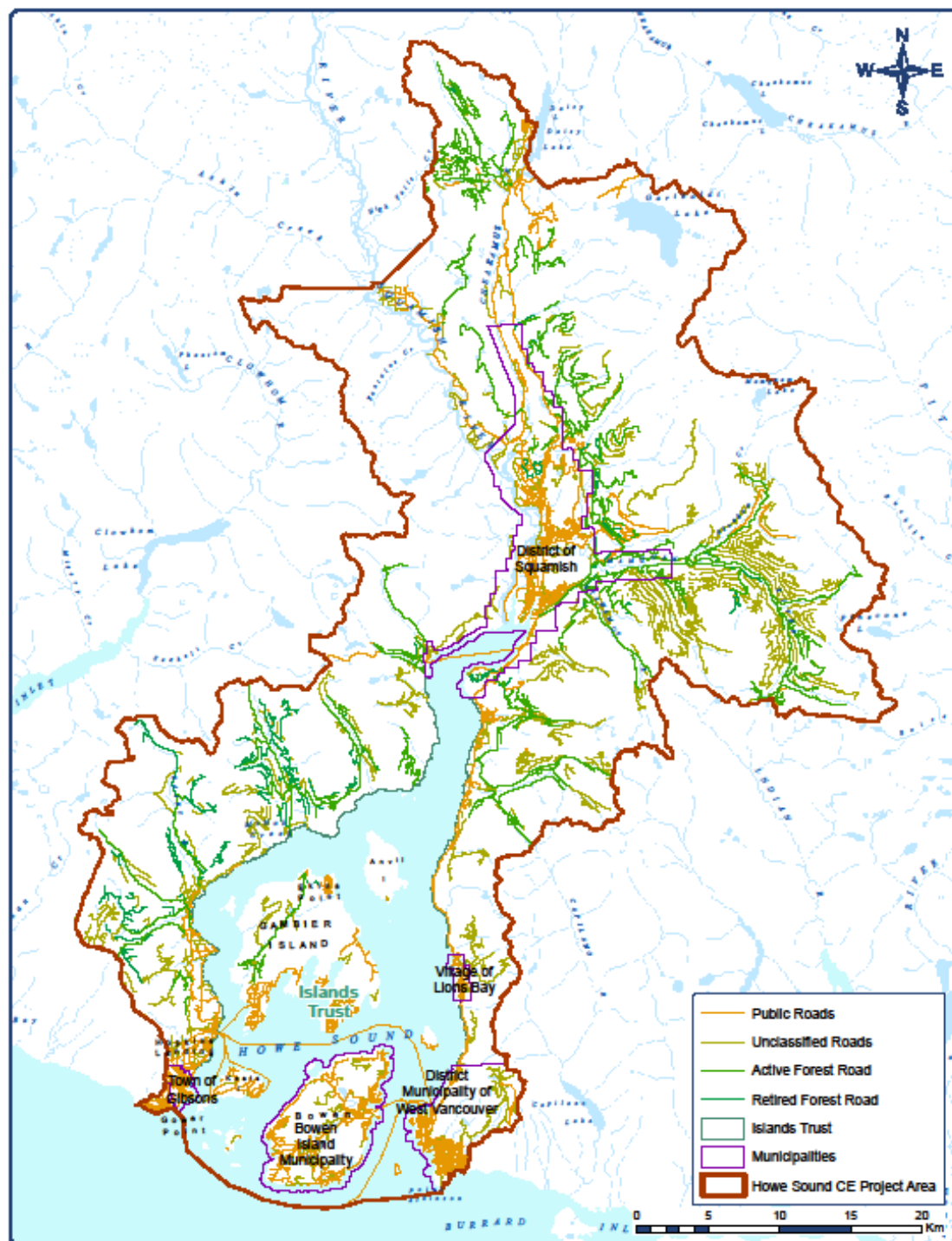
Forest Age and Watersheds



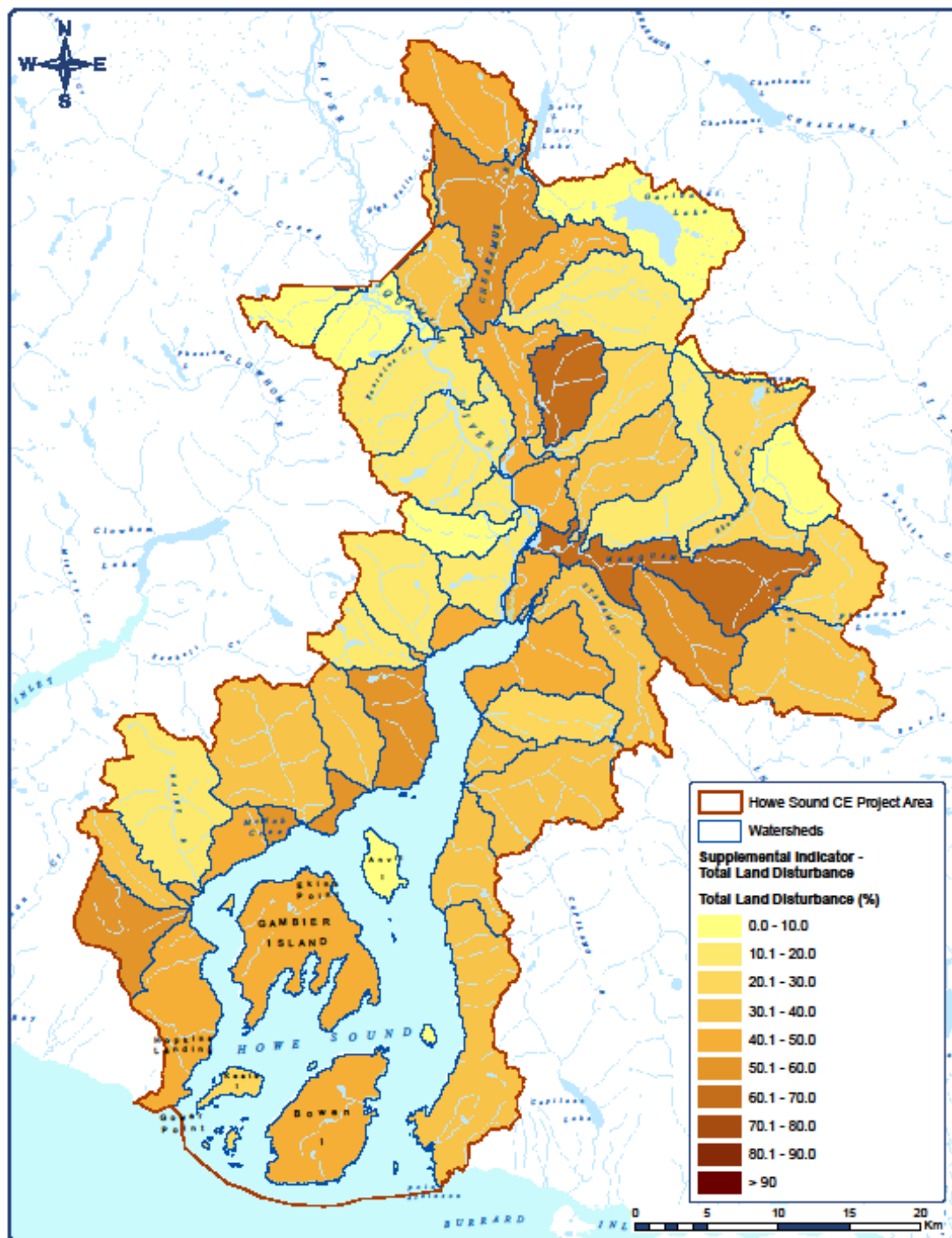
Old Growth - Old Growth Management Areas



Roads and Land Jurisdiction



Total Land Disturbance



5. Discussion of Assessment Results

The current condition assessment results expressed in this report should be viewed as initial coarse filter information for consideration in strategic, tactical and operational decision-making at all levels of governance. Nevertheless, it is recognized that this initial current condition assessment has its limitations and could benefit from further validation monitoring work. These assessment results should also be considered in the context of: First Nations' interests; economic development, recreational values, ecological function, additional wildlife values; climate change; public safety; the location of marine forage species, and other important contextual information before determining if, and what kind of, a management response is warranted.

The assessment results in this report provide some general insight into where Marbled Murrelet population sustainability is potentially at higher and lower risk due to nesting habitat sustainability. From this assessment, it appears that historical logging and land development practices have had some long-term effects on forest seral stage distribution and Marbled Murrelet nesting habitat in the Howe Sound area. Suitable nesting habitat is currently somewhat limited in the Howe Sound area and is primarily found at higher elevations. The LUs with the lowest risk to nesting habitat sustainability include the Howe and Seymour-Capilano LUs (Fraser Valley South LU excluded due to low level of intact nesting habitat). The Chapman, East Howe and Mamquam LUs all show a moderate level of habitat sustainability risk.

At the individual LU scale, the ministry is exploring a number of actions in response to these assessment results such as looking at recent trends, comparing these predictions to available habitat and population survey information and applying these risk assessments, where possible, to land and resource management decisions. Some possible management responses could be to implement a more balanced forest seral stage distribution within some priority LUs. This could involve further old growth recruitment or protection (through WHAs and OGMAs) at lower elevations that are near known marine forage areas. Some examples of potential management responses are offered in Table 2. The table provides some hypothetical management responses for two LUs that were selected for their differing levels of assessed risk, to demonstrate how this information could be applied in different circumstances. The table also provides some potential interpretations of the assessment results, some types of further assessment that could be undertaken and some potential management responses to the observed risks.

Table 2. Examples of Potential Interpretation, Further Assessment & Management Responses

Landscape Unit & Interpretation	Nesting Habitat Sustainability Risk (H,M,L) & Indicators		
	Nesting Habitat Sustainability Risk	Area of Intact Nesting Habitat	Area of Nesting Habitat Protected
<i>Seymour-Capilano LU</i> 244,480 ha (e.g. High level of nesting habitat and protected habitat)	Low (0% Depletion 2002-14)	16,362.92 ha	76%
Initial Interpretation	<ul style="list-style-type: none"> ➤ Much of the LU falls within Cypress Provincial Park or protected Metro-Vancouver watersheds that have some protected old growth (especially at higher elevations). ➤ Low level aerial surveys have not been flown in the LU yet so the modelled nesting habitat area is higher than the actual suitable habitat. The LU still has a lot of potential suitable nesting habitat that is protected and could be an important nesting area. ➤ There is a general perception that these habitats are not actively used by Murrelet due to a lack of available forage fish in nearby Burrard Inlet 		
Recommended Further Assessment	<ul style="list-style-type: none"> ➤ Low level aerial surveys to validate suitable nesting habitat model. ➤ Assess key marine forage areas for Marbled Murrelet within 50km flight distance of the suitable nesting habitat in the LU (includes Howe Sound) 		
Potential Management Responses	<ul style="list-style-type: none"> ➤ Provincial land authorization decisions in the LU to consider the preservation of existing suitable nesting habitat in close proximity to marine forage areas; and ➤ Provincial coastal authorization decisions related to key marine forage areas within 50 km of suitable nesting habitat to consider Marbled Murrelet ecological needs and disturbance factors. 		
<i>Chapman LU</i> 22,645 ha (e.g. Low level of nesting habitat and protected habitat)	Moderate (9% Depletion 2002-14)	1,429.22 ha	14%
Initial Interpretation	<ul style="list-style-type: none"> ➤ The Chapman LU has a low level of intact nesting habitat largely due to historic forest harvesting . ➤ Old-growth recruitment efforts in the LU (WHA or OGMA establishment etc.) will eventually result in improved nesting habitat suitability. ➤ The LU supports valuable forestry operations in the Sunshine Coast District and has a moderate risk of exceeding the nesting habitat depletion threshold by 2032 if current nesting habitat depletion rates continue. 		
Recommended Further Assessment	<ul style="list-style-type: none"> ➤ Low level aerial surveys to validate suitable nesting habitat model. ➤ Assess key marine forage areas for Marbled Murrelet within 50km flight distance of the suitable nesting habitat in the LU. 		
Potential Management Responses	<ul style="list-style-type: none"> ➤ Any new old growth protection or recruitment through legal designations (e.g. OGMAs and WHAs) should consider potential Marbled Murrelet nesting habitat. 		

The assessment results and insights contained in this report can be considered immediately in certain statutory decisions (i.e. legal designations, major projects, urban land development, forest management) and pro-active initiatives (i.e. road deactivation, silviculture practices, habitat restoration). FLNRORD is currently looking to protect an additional 10,931 ha of suitable Marbled Murrelet nesting habitat in the Southern Mainland Coast conservation region (includes Howe Sound) to meet its 80% spatial protection target (77,132 ha). The majority of the spatial nesting habitat protection will be through the establishment of Wildlife Habitat Areas (WHAs) but in some circumstances additional Old Growth Management Areas may also be used.

FLNRORD staff are developing tools and processes designed to integrate and communicate resource value objectives, assess how well these objectives are being achieved (including results from this report) and respond with integrated resource management approaches to help achieve these objectives. In the spirit of the United Nations Declaration on the Rights of Indigenous Peoples, FLNRORD will share these assessments with key local First Nations in the Howe Sound CE Project area and collaborate on the development of any warranted management responses.

Possible Management Considerations

The following information is to be considered in future Marbled Murrelet habitat management and related authorization decisions:

- The protection of Marbled Murrelet nesting habitat should be considered in the broader context of Natural Resource Sector (NRS) integrated management so as to consider other values in the Howe Sound area and explore possible synergies with other complementary management tools (Old Growth Management Areas, Ungulate Winter Ranges, Wildlife Habitat Areas, Wildlife Management Areas, Wildlands, General Wildlife Measures, Parks, Conservancies etc);
- NRS integrated resource management within the broader Southern Mainland Coast conservation region may consider prioritizing certain areas for nesting habitat protection and making trade-offs in other less important/effective areas while still achieving the overall recovery objective for the conservation region of 85% nesting habitat retention by 2032;
- NRS integrated resource management within the broader Southern Mainland Coast conservation region will need to consider any additional management direction that may be set by the province of British Columbia for the management of Marbled Murrelet nesting habitat in 2018/2019 (e.g. WHAs or OGMA's to protect Marbled Murrelet nesting habitat and *Land Act* section 93.4 Orders re: nesting habitat retention targets);

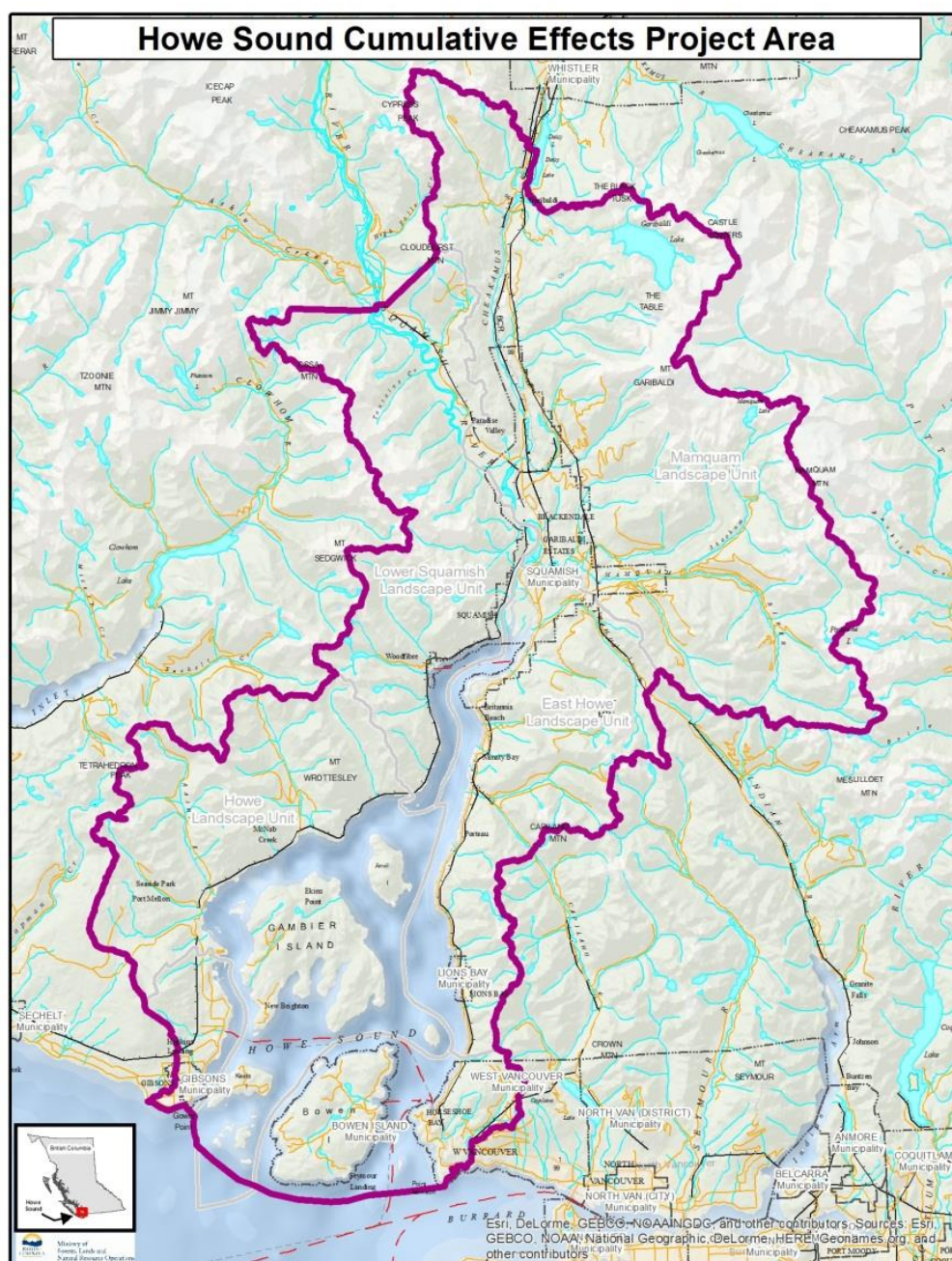
- In the long-term, the selection of suitable Marbled Murrelet nesting habitat for protection should consider the linkages between terrestrial and marine habitats. For example, suitable nesting sites located within 0-50 km of known marine forage areas should be given strong consideration in habitat protection measures;
- Where portions of Landscape Units are located within 0-50km of coastal waters that possess quality marine forage areas, future forest management should consider a more balanced forest seral stage distribution in those areas;
- Suitable nesting sites identified near primarily busy marine waterways with lesser marine forage opportunities may be seen as a lesser priority for future protection;
- Forest management should consider habitat fragmentation, stand patch size and shape when protecting suitable Marbled Murrelet nesting habitat in old forest stands;
- This Marbled Murrelet CE current condition assessment can inform NRS strategic area based planning discussions, Environmental Assessment processes and any Land and water authorizations in the Howe Sound area;
- The assessment results can be used to improve the identification of priority Landscape Units for more detailed monitoring, assessment and research;
- Over the long-term, an opportunity exists for recruitment of additional suitable nesting habitat (old growth forest stands) in the Howe Sound area if some lower elevation (<900m) second growth stands (<140yrs) are protected; and
- Without more detailed validation/interpretation of the current condition results, the results are to be used only as an initial coarse filter before appropriate management direction can be determined through consultation and NRS management discussions.

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Appendix I

Map of Howe Sound Cumulative Effects Project Area



The Project area was tailored to the Howe Sound area to meet the expressed interests of local stakeholders. Local communities expressed a shared interest in CE value assessments that were focussed on a more natural boundary like the Howe Sound watershed instead of the three separate provincial administrative districts that straddle the Howe Sound area. The project area essentially follows the height of land around Howe Sound and aligns with Provincial Landscape Unit boundaries except at the entrance to Howe Sound where the boundary was extended to capture the area from West Vancouver around Bowen Island to Gibsons considering bathymetry lines.

Appendix II

Marbled Murrelet Value Description

Marbled Murrelet Value Description

Description

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small diving seabird found along the coastlines of the North Pacific Ocean. Marbled Murrelet populations in North America occur from the Aleutian islands in Alaska down the Pacific Coast all the way to central California (within 30-80km of the coastline). This small but plump seabird grows up to 25cm in length, weighs about 190-270g and lives to about 12 years of age. It has short strong wings that are well adapted for forage diving in shallow coastal waters. Marbled Murrelets fly very fast (generally more than 60km/hr) but are not very maneuverable in flight due their small wings and plump bodies. Unlike most other seabirds that nest in colonies, Marbled Murrelets nest at very low densities near good marine foraging areas. They produce one egg per year during the spring and summer months and have developed a specialized nesting strategy to improve the chances of their eggs becoming fledglings. Along the British Columbia coastline, Marbled Murrelets nest primarily in mossy platforms high up in the canopy of large old growth conifer trees located generally within 50km of coastal foraging areas.

Habitat

Marbled Murrelets, like most seabirds, spend most of their time on coastal waters foraging and moulting and only come to land to breed. However, the habitat requirements in both the terrestrial and marine habitat types are critical to their life support needs and should be considered in species recovery and integrated resource management. Mitigating the risk to their habitat requirements in both these habitat types is important to the long-term population sustainability of the species along B.C.'s coastline.

Marbled Murrelet forage and moult in nearshore and sheltered coastal waters. They forage primarily on small schooling fish (Pacific Herring, Pacific Sand Lance, Surf Perch and juvenile salmon) and shrimp-like crustaceans in coastal waters where prey aggregations are most likely to occur. Important foraging sites include: tidal channels, shelves at the mouths of inlets, shallow coastal banks and sometimes coastal lakes. Marbled Murrelets dive for their food in shallow waters, including channels, fjords, bays and inlets that are usually less than 30m deep and within 500m of shore. In the more sheltered waters, they may use areas within 2km of shore.

Marbled Murrelets only come to shore during the breeding season to nest. The breeding season runs from late-April to early September. Mating pairs have one egg and take turns nesting and then rearing the nestling until it can become a fledgling and fly back to the ocean by itself.

In coastal BC, Marbled Murrelets primarily nest on mossy platforms often associated with old growth tree canopies found in lower elevation coastal temperate rainforests. These older seral stage coniferous forests stands (Age Class 9 >250 years is preferred and but Age Class 8 140-250 years is possible) can provide the characteristics most suitable for Marbled Murrelet nests. In general, suitable nesting sites consist of a combination of tall trees with strong mossy limb platforms and a variable canopy structure to support shelter and flight access, landing and take-off needs. Nest trees in British Columbia are typically greater than 40m tall and nest site heights greater than 30m. While not a sole criterion for habitat suitability, Marbled Murrelets nesting sites in British Columbia are also most likely to be found at elevations under 900m. Research has indicated that there is a strong correlation between the size of Marbled Murrelet populations and the area of suitable nesting habitat. As a result, the availability and protection of suitable nesting habitat is seen as one of the most important factors affecting the sustainability of Marbled Murrelet populations in coastal BC.

Population Distribution and Threats

The total population of Marbled Murrelets in British Columbia is not well known but according to the *Recovery Strategy for the Marbled Murrelet (Brachyramphus marmoratus) in Canada* it is estimated in 2014 to be about 99,000 which equates to almost 30% of the world's total population for the species (Table 1). While Marbled Murrelet populations are generally widespread within 50km of B.C.'s coastline (Figure 1), they are not evenly distributed. Their distribution pattern is more clumped and is likely influenced by both the availability of suitable nesting sites and the proximity of marine forage areas. While there is very little long-term monitoring data to assess population trends, the available anecdotal information and data indicate that that some populations in British Columbia are in decline, like those on Vancouver Island and the Southern Mainland. Bertram et al. in 2015 estimated the Southern Mainland Coast conservation region was experiencing a -3% per year population decline.

Table 1. Estimates of Marbled Murrelet populations in each conservation region in BC (Environment Canada 2014)

Conservation Region	Estimated # of Birds (range)	Estimated # (mid-point)
Northern Mainland Coast	18,400-26,000	22,200
Haida Gwaii	8,500-25,000	16,750
Central Mainland Coast	20,000-42,000	31,000
Southern Mainland Coast	6,000-7,000	6,500
West & North Vancouver Island	18,700-23,600	21,150
East Vancouver Island	1,000-2,000	1,500
Total for B.C.		
All birds	72,600-125,600	99,100
Mature adults (rounded)	54,500-94,200	74,300



Figure 1: Range of Marbled Murrelet in British Columbia. Includes all islands and mainland within 50 km of BC coastline.

The greatest threat to Marbled Murrelet population sustainability along B.C.'s coastline is the loss or degradation of nesting habitat. The historical and continued loss of suitable nesting habitat is primarily the result of conventional forestry operations in coastal old growth forests. There is a strong correlation between the number of Marbled Murrelets and the availability of suitable nesting habitat. Populations with a loss of suitable nesting habitat in coastal old growth forests have experienced a significant decline in Marbled Murrelet recruitment. As a result, Marbled Murrelet breeding populations are expected to decline in coastal forest areas where suitable old growth forest characteristics have been, or are expected to be, significantly altered by conventional forest harvesting practices and other human development activities that remove old growth trees and cause significant habitat fragmentation. Second growth coastal forests are also not likely to see the return of breeding populations unless the new forest stands are allowed to develop old growth forest characteristics suitable for nesting (e.g. >140yr old conifer forest stands with mossy limb platforms and variable canopy structure).

A number of other threats can also have significant individual or cumulative impacts on Marbled Murrelet populations. These threats include: increased predation risk from growing avian predator populations; risk of collisions with rural powerlines or windturbines; entanglement in fishing gear; oiling from minor and major coastal oil spills; contamination from marine bioaccumulation of toxins; forage area disturbance from coastal development and boat traffic; prey depletion from commercial fisheries; and marine ecosystem changes due to ocean warming and acidification. While these threats have the potential to have significant impacts on Marbled Murrelets, the most significant and current threat to all Marbled Murrelet populations is the loss of suitable nesting habitat. Nevertheless, management for Marbled Murrelet in B.C. should still give consideration to all these threats in the development of integrated management approaches for the species. As a result, both Canada and British Columbia have very important management roles within their respective jurisdictions as it relates to the sustainability of Marbled Murrelet populations along Canada's Pacific coast.

Conservation Status

In 1990, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the species as Threatened in Canada and this was reaffirmed in 2000 and 2012. In accordance with the federal *Species at Risk Act*, Environment Canada published a Marbled Murrelet recovery strategy in 2014: http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/plans/rs_guillemot_marbre_marbled_murrelet_0614_e.pdf

The BC Conservation Data Center has Marbled Murrelet ranked as S3B/S3N (Special Concern; Vulnerable to Extirpation or Extinction –for both breeding and non-breeding) and identified it as a Blue-listed species (of Special Concern). The species is considered at risk in BC and is particularly sensitive, or vulnerable, to human activities and natural events.

Appendix III

Management Objectives for Marbled Murrelet

Management Objectives for Marbled Murrelet

Both the federal strategy and provincial implementation plan for Marbled Murrelet recovery lay out short-term and long-term conservation objectives for Marbled Murrelet populations and distribution. They also provide associated critical habitat targets within six separate Marbled Murrelet Conservation Regions (Figure 2):

Short-term Population and Distribution Objective

- Halt the overall decline of Marbled Murrelets in Canada. Specifically, halt the overall decline of the provincial population and its nesting habitat area over a 30yr period (from 2002-2032) so that it will have stabilized above 70% of 2002 levels;
 - The Critical Habitat Objective for the Southern Mainland Coast Conservation Region: Retain at least 85% of 2002 populations through retention of proportionate amounts of 2002 nesting habitat. The minimum suitable habitat retention level for the Southern Mainland Coast to attain this objective is estimated to be 103,358ha.

Long-term Population and Distribution Objective

- Ensure the species will have a high probability of persistence beyond 2032 across its home range. This will be attained by maintaining or restoring sufficient suitable nesting and marine habitat, and by reducing other threats within each conservation region to stabilize the Canadian population of Marbled Murrelets within the accepted range of natural variation;

The *Implementation Plan for the Recovery of Marbled Murrelet (Brachyramphus marmoratus) in British Columbia (2018)* provides some additional implementation objectives that address terrestrial nesting habitat on provincial Crown Lands. The BC implementation plan provides objectives that maximize the conservation efforts to benefit the recovery of Marbled Murrelet while also considering other socio-economic and environmental values. The implementation plan objectives are:

1. By October 2018, issue a land use objectives regulation order under the provincial Land Act to maintain minimum habitat thresholds for provincial Crown land in the southern conservation regions (not yet initiated)
2. By December 2020, spatially protect a minimum of 80% of the minimum habitat threshold in the West and North Vancouver Island and Southern Mainland Coast conservation regions.

3. By December 2020, establish priority old growth management areas containing Marbled Murrelet nesting habitat in the southern conservation regions.
4. Continue to improve the identification of suitable nesting habitat in priority areas where uncertainties in habitat mapping exist and where habitat availability is approaching the minimum habitat thresholds, as new tools and information becomes available.
5. As new habitat mapping and protection occurs, update nesting habitat availability , estimates of existing protection, and minimum habitat thresholds in all conservation regions at least every 2 years.
6. By June 2018, develop a population monitoring plan and implement this plan in 2019.
7. Return to Senior Government in 2020 with a project update.

The province is currently working with First Nations and key stakeholders to develop a spatial habitat management approach in the South Mainland Coast conservation region to ensure functional nesting habitat is protected/maintained and socio-economic impacts are minimized. To meet the conservation region's 80% spatial nesting habitat protection target of 77,132 ha, FLNRORD is working towards the protection of an additional 10,931 ha of suitable Marbled Murrelet nesting habitat in the region primarily through the establishment of new Wildlife Habitat Areas under the provincial *Forest and Range Practices Act* (FRPA). In some circumstances, new Old Growth Management Areas may also be established to protect additional suitable nesting habitat. A land use objectives regulation order under the *Land Act* will be developed to address the remaining 20% or so needed to meet the overall nesting habitat retention target.

The federal and provincial management objectives outlined above provide the basis from which to develop an initial cumulative effects assessment protocol for Marbled Murrelet in British Columbia.

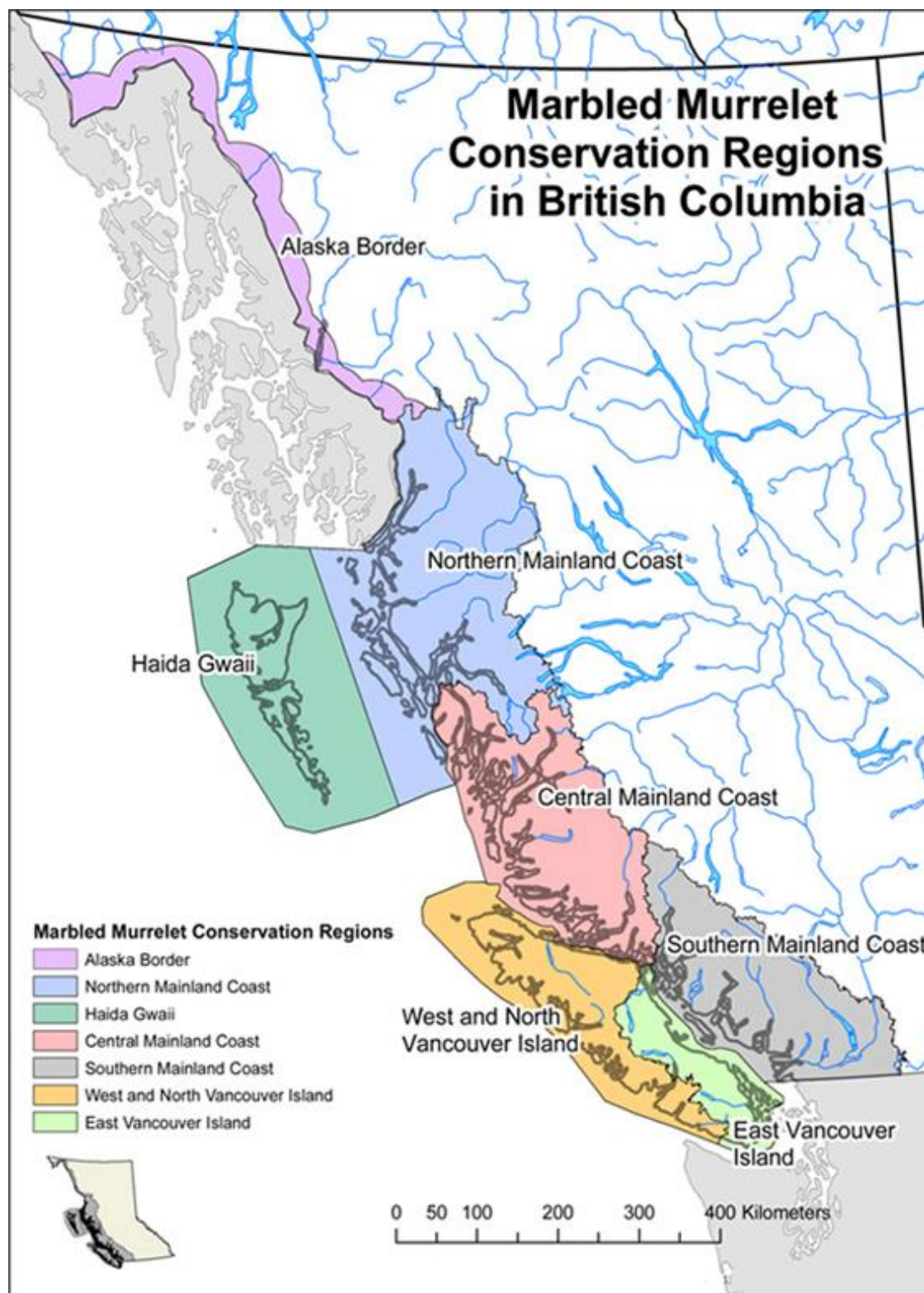


Figure 2: Marbled Murrelet Conservation Regions in British Columbia for purposes of federal recovery strategy (Environment Canada, 2014).

Appendix IV

Howe Sound Context for Marbled Murrelet

Howe Sound Context for Marbled Murrelet

Location and Topography

Howe Sound contains one of the most southern fiords on British Columbia's coast. The entrance to Howe Sound is located about 10 km northwest of the city of Vancouver and stretches from the Strait of Georgia heading north for about 43 km up to the Squamish River Estuary. The sound itself is a triangular shaped inlet bounded by steep coastal mountains ranging from 1,200 m in the south up to about 2,700 m in the north. The southern portion of the sound contains four major islands (Bowen, Keats, Gambier and Anvil) and numerous smaller islands while the northern portion of the sound narrows to a 3 km wide channel becoming a fiord for 15 km before reaching the Squamish estuary. The estuary is fed by the Squamish River and the associated Cheakamus and Mamquam river drainages.

Precipitation and Climate Change

In general, the Howe Sound area is warm and dry during the summer months and cool and very wet (snow at higher elevations) during the winter months. In the coming years, warming from climate change is expected to affect weather conditions and seasonal precipitation in the Howe Sound area. Climate change in the South Coast will likely shift the current rain/snow-driven hydrological regime to a more rain-driven regime over the next 35 years. More winter precipitation will likely fall as rain rather than snow and result in: lower snowpacks, earlier/more rapid snowmelt and longer fire seasons. Forest fire seasons and risk are expected to increase as periods of relative summer drought become more common. In addition, more severe winter storms are projected which can lead to an increased risk of flooding, landslides and windthrow of larger trees. Some of these anticipated changes, like increased winter storms and summer fire risk, are seen as minor threats to Marbled Murrelet suitable nesting habitat in the general Howe Sound area.

Old Growth Forests and Climate Change

There is currently not a lot of large patches of age class 9 old growth forest (>250yrs) below 900m in the Howe Sound Project area. Most of the lower elevation forests in the area are second growth forests that are in the process of maturing. The mature and old forest stands that do exist tend to occur at the higher elevations or have been fragmented by forest harvesting and other human developments. The limited amount of old growth forest characteristics suitable for Marble Murrelet nesting habitat in the Howe Sound area is expected to improve over time as mature stands age and some of them are protected for wildlife, biodiversity and other values. Marbled Murrelets in southern Howe Sound during the summer months may also use suitable nesting habitat in old growth forest patches in nearby watersheds along Vancouver's North Shore Mountains and/or the Sunshine Coast.

The ecosystems in the Howe Sound watersheds and broader South Coast region are currently experiencing the cumulative impacts of natural disturbances (i.e. fire, landslides, floods), anthropogenic disturbances (i.e. energy development, resource extraction, recreation, housing development) and climate change. Climate change alone is projected to change ecosystems over the next 30 years by altering temperature, hydrological, fire and natural disturbance regimes in the South Coast. Current climate change projections suggest Biogeoclimatic Zones in BC will shift upslope and northward. The main Biogeoclimatic zones found in the Howe Sound area include: Coastal Western Hemlock (CWH) -found at lower forest elevations; Mountain Hemlock (MH) - found at higher forest elevations; and Coastal Mountain Heather Alpine (CMA) -found just above the treeline. By the 2050s, the CWH and MH zones are predicted to shift about 200 – 300 m upward in elevation. Conversely, the CWH zone is projected to expand inland and upslope. This could increase the potential for suitable Marbled Murrelet nesting habitat in Howe Sound over time. This highlights the importance of long-term monitoring and adaptive management in the area.

Human Settlement

The Howe Sound area falls within the traditional homelands of the Coast Salish people. The Squamish Nation has numerous reserves and cultural sites within the Howe Sound area and Squamish river watersheds. The Squamish Nation along with the neighbouring Tsleil-Waututh and Musqueam Nations have utilized the environments and resources in the Howe Sound area for thousands of years.

Overall, about 40-50,000 people live in the Howe Sound area with the majority of people residing in the communities of Squamish, Britannia Beach, Lions Bay, Horseshoe Bay, Gibsons, and Bowen Island. To date, the topography in the area has restricted most of the settlement to the coastline, valley bottoms and lower lying islands. It is estimated that the population in the Sea-to-Sky corridor could increase by almost 30% over the next 25 years. It is anticipated that associated commercial services, tourism and recreational use will also continue to grow in the area during this period. Approximately 13,000 new dwelling units are currently being planned in the broader Howe Sound area through resort and housing development proposals. Consequently, the human ecological footprint in the Howe Sound area is expected to increase placing Marbled Murrelet marine and terrestrial habitats under greater use and development pressures.

Land Use

The Howe Sound area, with its close proximity to Vancouver, has long been an interface area between wilderness and increasing human settlement, development and recreational activity. The area has multiple competing economic, social, cultural and environmental values and is now being exposed to a new era of development interests and potential cumulative impacts on

terrestrial and marine ecosystems. The area's economy is diversifying and becoming less reliant on natural resource extraction as improved highway access and tourism infrastructure spur new resort, housing, recreation, commercial and industrial development interests. This increase in development and recreational use is expected to have cumulative impacts on Marbled Murrelet terrestrial and marine habitats.

While the forestry sector has historically had the largest impact on Marbled Murrelet nesting habitat in the Howe Sound area and broader South Coast region through road development, timber harvesting and associated logging practices, forest management can also help with the recovery and sustainability of Marbled Murrelet populations by ensuring that some key mature forest stands are allowed to develop and retain old growth forest characteristics over time. About 79% of the land in the Howe Sound CE Project area is forested and timber harvesting is allowed in roughly 29% of these forested lands. By contrast, 24% of the land in the project area falls within parks and protected areas and about 37% of the land area has some form of forest protection. Much of the lower elevation forest in the CWH biogeoclimatic zone is second growth forest. About 5% of the timber harvesting land base (THLB) is currently made up of old forest stands (> 140yrs) and 44% of these old forest stands have some form of long-term protection status.

Recovering Marine Environment and Use

The marine environment in Howe Sound is currently recovering from nearly a century of heavy industrial use while also facing new impacts from climate change, foreshore development, increased recreational use and fishing pressure. Some mitigation and remediation efforts over the past 20 years in Howe Sound have helped to improve the health of some coastal foreshore habitats in the Howe Sound area. Recent sightings of cetaceans and other large marine mammals in the area suggest the marine food web is becoming more productive at the lower trophic levels and once again supporting forage fish. The main forage fish for Marbled Murrelet in Howe Sound include: Pacific Herring, Surf Smelt and Pacific Sand Lance. Northern Anchovy occasionally come into Howe Sound and also provide forage opportunities. In recent years, forage fish like Pacific Herring and Northern Anchovy are starting to return in the Howe Sound area in greater numbers.

The marine environments of Howe Sound experience a great deal of human activity that has the potential to individually, or cumulatively, impact upon Marbled Murrelet marine habitats. Some of these key marine uses in Howe Sound include: foreshore developments, industrial shipping, ferry services, recreational boating; recreational fishing, commercial fisheries and waste effluent discharge. Use of the marine environments and resources in the Howe Sound area are expected to increase in the coming years due to increasing housing and tourism in the Sea-to-Sky corridor and the greater Vancouver area. This expected increase in human marine

use could result in direct, or indirect, impacts to Marbled Murrelets utilizing the marine environments of Southern Howe Sound. In particular, the physical disturbance of these seabirds from boating/shipping traffic or the reduction of forage fish spawning habitat/population numbers could have a significant impact on the sustainability of Marbled Murrelet in the Howe Sound area. The cumulative effects on coastal Marbled Murrelet marine habitats will need to be carefully considered by respective government decision-makers/managers in this time of increasing development, recreational use and climate change, in order to sustain a Marbled Murrelet population in the area and overall ecosystem integrity in the Howe Sound area.

Marbled Murrelet in Howe Sound

It is not entirely clear how many Marbled Murrelets are currently utilizing the marine and/or terrestrial environments in the Howe Sound CE project area but local bird counts and checklists indicate that Marbled Murrelets do breed, forage and winter in the Howe Sound area but are much more likely to use the southern portion of Howe Sound than the northern portion (north of Porteau Cove). The Audubon Society's Christmas Day Bird Count in 2015/16 counted 30 Marbled Murrelets in the lower portion of the Howe Sound area which has some shallower and more sheltered coastal waters near Gambier, Bowen and Keats Islands that may provide suitable marine forage areas for seabirds. These more sheltered waters are also within 50 km of suitable nesting habitat inside and adjacent to the Howe Sound area. It has also been confirmed that Marbled Murrelet do use the northern portion of Howe Sound as well during the summer nesting season but their presence there is not common. Historical inventory work has found nesting locations in the Squamish River, Ashlu River and Furry Creek watersheds. The identification of key Marbled Murrelet marine and terrestrial habitats in the Howe Sound area and managing key threats to them will be important to the recovery of species in the area.