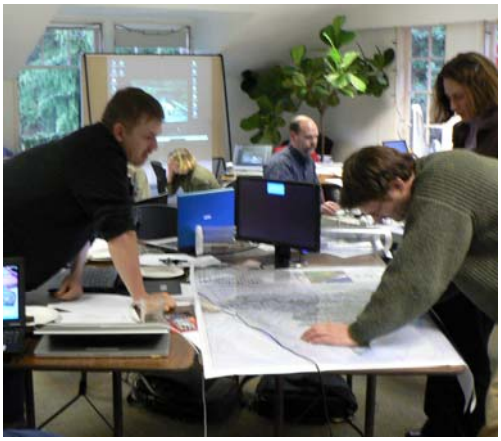
EBM Working Group Focal Species Project

Part 5:

Review of Phase 2
Co-Location Scenario Outputs



Prepared for the EBM Working Group

by
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Disclaimer

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

Executive Summary

Domain experts met in Vancouver in December 2008 to review products created as part of Phase 2 of a project to develop a tool to strategically co-locate habitats within old growth retention areas using the MARXAN conservation planning software. Co-location scenarios were assessed for their effectiveness in capturing habitats for seven focal species: black bear, black-tailed deer, grizzly bear, marbled murrelet, mountain goat, northern goshawk, and tailed frog.

The results of this review were used to further refine the MARXAN co-location tool, suggest improvements to habitat mapping, and assess, overall, the effectiveness of MARXAN in co-locating habitats within old growth reserves.

Technical limitations

As this was the first complete run of MARXAN using habitat layers for six of the seven focal species, some technical issues were identified that were resolved in subsequent analyses:

- The new habitat layer for black-tailed deer over-estimated the area of high value habitats
- The new habitat layer for mountain goat underestimated the highest value habitats.
- Domain experts consider the tailed frog habitat layer to be satisfactory, but identified problems with the method of capturing tailed frog habitats of different classes in MARXAN.

Habitat mapping for black bears was not available for use as an input to MARXAN and, therefore, the scenario outputs could not be assessed in a quantitative manner. A model of denning habitat could be used as an input to future analysis.

General conclusions

Of the four species for which quantitative analysis was completed (grizzly bears, marbled murrelet, mountain goats, and northern goshawk), the following general conclusions were identified:

- The 70% site series surrogate (SSS) target tends to meet the targets for low risk across species, even when the old forest is randomly selected (not driven by targets for habitat). The exception is outcome for grizzly bears, which meets the mid-risk target for habitats but not the low risk.
- The 30% SSS target tends to equate to a high risk for species when the old forest is randomly selected.
- Driving solutions to co-locate habitats within old growth retention areas directs solutions to the best habitats for each species, contributing to an outcome that is closer to the low risk

scenario than through random capture of SSS. However, a habitat driven solution this is more costly for timber supply.

- The cost layer is driving solutions to the upper elevations and steeper slopes. The timber cost model is modeled over 400 years while the focal species habitats are based on suitability, or current condition. The result is that the cost stays constant and focal species habitats get pushed into areas of currently suitability, regardless of how the quality of habitat changes over time. For species such as northern goshawks, which require large areas of habitat over time, it is important to factor in second growth coming on-line.
- While no one species greatly overlapped another, multi-species scenarios provide large amounts of co-location but over a large area.

Species specific conclusions

Grizzly bear

- Where the target for capture of Class 2 habitats is less than 100%, the solution should be driven to the rarest and most important of these habitats. Stratification of Class 2 into seasonal habitats, as well as by BEC variant, will better direct outcomes to the most important Class 2 habitats.
- MARXAN does well where Class 2 habitats are comprised of old growth (i.e., the model selects old forest) however Class 2 habitats are often non-forested or may be earlier seral forest. The inputs into MARXAN need to be such that the range of Class 2 habitats are captured (including entire grizzly bear habitat complexes).
- Setting targets by BEC variant helps to provide a distribution of habitats across elevations with the priority being lower elevation habitats and Class 2 polygons in hypermaritime areas.

Marbled murrelet

1. Incidentally capturing marbled murrelet habitat as a result of meeting a target for old growth will not necessarily drive a solution to the best habitats. A shortfall of Class 1 and 2 habitats is of most concern as there is the greatest certainty that these habitats provide nesting habitat.
2. Class 1 and 2 habitats are unevenly distributed across landscape units. One-third of landscape units contain most of the high value habitat.
3. Targets for marbled murrelet habitat should be achieved according to distance-to-ocean class to ensure a distribution of habitats into high use areas less than 30 km from the ocean. Habitats greater than 50 km from the ocean should be excluded from the analysis.

4. Conserving existing high quality habitats is the priority; existing habitat should not be traded off against recruitment of future potential habitats.

Northern goshawk

- SSS representation contributes to a good solution for goshawk because the results are distributed across numerous ecosystems. However, scenarios that do not explicitly include goshawk nesting and foraging habitats inadequately provide for a distribution of high and moderate value habitats across landscape units.
- Because MARXAN focused on capturing old forests (>250 yrs.) first to meet site series surrogate targets, forests between 80-250 yrs were likely selected less frequently in OGRAs. Therefore, important habitat types for goshawks between 80-250 yrs. were not part of the MARXAN solution in some landscape units.
- Recruitment: Younger stands in valley bottoms provide potential high quality habitat in the future. For goshawk, the whole landbase needs to be considered, including forests growing into older second and third growth stands. The current timber cost model drives outcomes away from potential recruitment areas.
- There is strong overlap between goshawk and marbled murrelet habitat; however, the area of overlap only represents a small proportion of goshawk habitat.

Tailed frogs

There was relatively little overlap between tailed frogs and other species because:

- Tailed frogs are lotic and other focal species are terrestrial; and
- Habitats for other focal species tend to be at lower elevations.

Table of Contents

1.0 Purpose of the Focal Species Workshop

This document summarizes the outcomes of the Phase 2 review of scenarios at a workshop in Vancouver on December 9 and 10 2008.

This report is Part 5 of six reports prepared as part of the EBM Working Focal Species Project. The suite of reports includes:

Part 1: Management recommendations for focal and fine filter species under Ecosystem-Based Management

Part 2: Methods for Strategic Co-Location of Habitats within Old Growth Retention Areas

Part 3: Knowledge Base for Focal Species and their Habitats in Coastal B.C.

Part 4: Summary of Habitat Mapping to Support EBM Implementation

Part 5: Review of Phase 2 Co-Location Scenario Outputs

Part 6: Summary of Peer Review Comments and Responses

1.1 Background

The purpose of the EBM Working Group Focal Species Project is to develop recommendations for addressing the habitat requirements for focal species as part of the implementation of ecosystem-based management (EBM) in coastal BC. The specific focus of the project is to

- define the habitat requirements for each species, in terms of quality of habitat and sufficiency of habitat supply with the EBM definition of "seeking to achieve a low risk to ecological integrity";
- seek to co-locate habitats within reserves identified for old growth representation (called 'old growth retention areas' or OGRAs), to the extent possible, and assess gaps in what can be achieved through co-location; and
- update and improve the quality of existing habitat models.

Co-location of habitats within old growth retention areas is enabled under Section 14 of the Coastal Orders. Section 14 (objectives for landscape level biodiversity) requires the retention of a specified amount of old forest within each site series. Subsection (7) states:

"To the extent practicable, include within old forest retention areas, stands of monumental cedar for future cultural cedar use, rare and at risk old forest ecosystems, habitat elements important for species at risk, ungulate winter range, and regionally important wildlife, including:

(a) mountain goats;

(b) grizzly bears;

(c) northern goshawks;

(d) tailed frogs; and

(e) marbled murrelets".

The co-location aspect of the project was completed in three phases in close conjunction with the DS04 Co-Location Project to design a strategic co-location planning tool using MARXAN conservation planning software. Each phase of the Focal Species Project informed the Co-location Project, which in turn, informed the next phase of the Focal Species Project (Figure 1).

Phase 1: Preparation for strategic co-location scenarios

In Phase 1, domain experts provided information and literature references on focal species in the coastal planning area, reviewed and recommended improvements to mapping, and made preliminary recommendations into co-location scenarios.

The inputs from Phase 1 were used to prepare a proof of concept of a 'Co-location Tool' using MARXAN conservation planning software to strategically co-locate areas of old growth retention with habitats for focal species. The proof of concept was tested for the South Coast planning sub-region.

Phase 2: Testing of strategic co-location scenarios

In Phase 2, domain experts reviewed outputs of various scenarios using MARXAN to test and assess the sensitivity of the scenarios to changes in targets for old growth retention. Scenarios were run for the South Coast planning sub-region.

Domain experts met in December to review the scenarios and develop recommendations for improving habitat mapping and to refine inputs into MARXAN.

Phase 3: Synthesizing results

In Phase 3, domain experts reviewed a final set of scenarios that represented low risk, best habitats and co-located solutions. Scenarios were run for the Mid and South Coast sub-regions. They used this review to develop strategic recommendations for management of focal species within and outside of old growth retention areas under Ecosystem-Based Management.

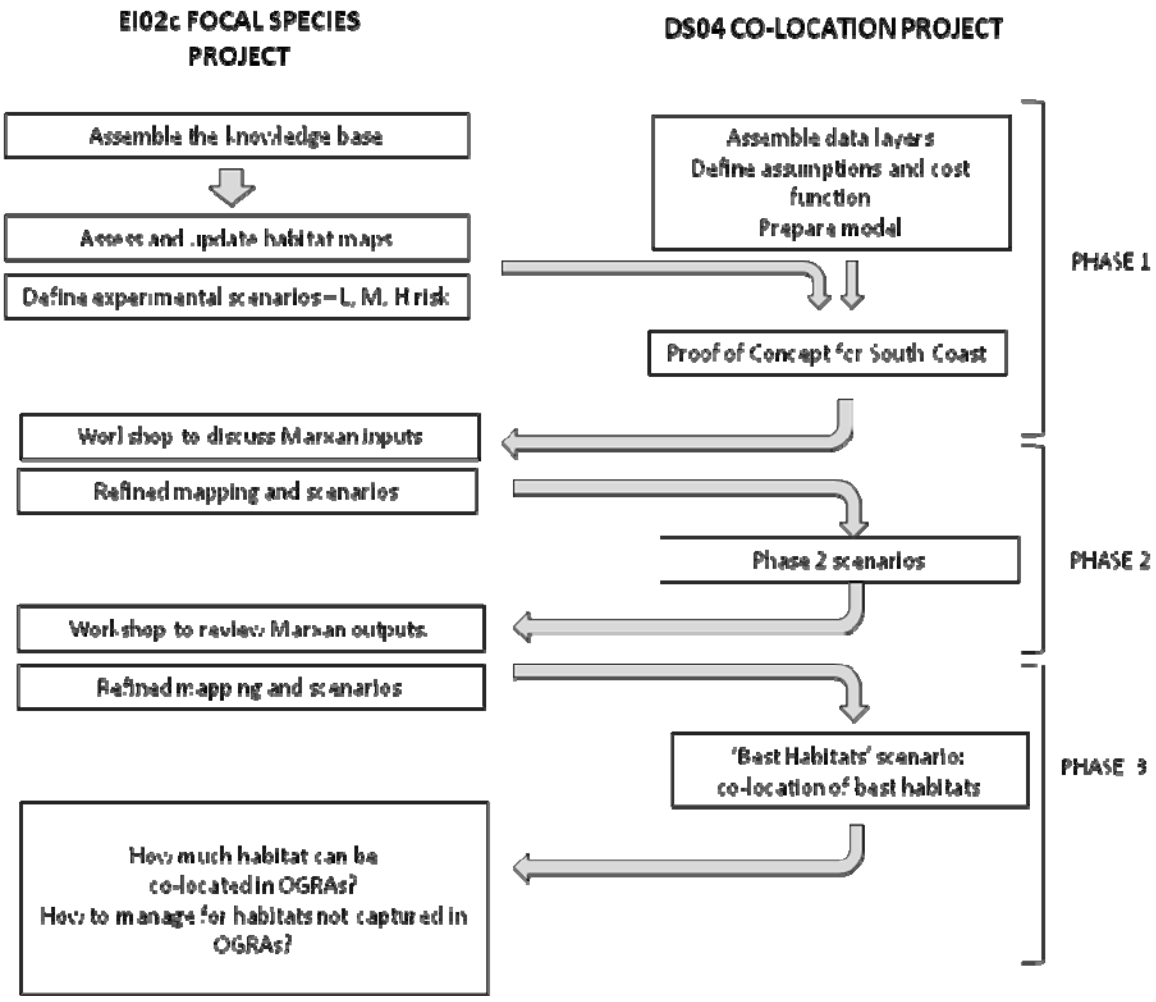


Figure 1. Interaction between the Focal Species Project (EI02c) and Co-Location Project (DS04)

1.2 Workshop overview

1.2.1 Purpose of the December workshop

- Review of co-location scenario outputs for the South Coast for individual focal species and for all species combined.
- A set of recommendations for:
    - Implementation of old growth retention areas in the South Coast
    - Adjustments to future scenario runs for the Mid and North Coasts
- Identification of outstanding gaps re mapping and research

1.2.2 Workshop Participants

Name	Affiliation	Topic area
Volker Michelfelder	Ministry of Environment	Tailed frog
Pierre Friele	Cordilleran Geoscience	Tailed frog
Helen Davis	Artemis Wildlife Consultants	Bears
Grant MacHutchon	A Grant MacHutchon Consulting	Bears
Tony Hamilton	Ministry of Environment	Bears
Shawn Taylor	Goat Mountain Resources	Ungulates
Kim Brunt	Ministry of Environment	Ungulates
Ken Dunsworth	Ministry of Environment	Ungulates
Sally Leigh-Spencer	International Forest Products	Ungulates
Erica McClaren	Ministry of Environment	Northern goshawk
Todd Mahon	Wildfor Consultants	Northern goshawk
Frank Doyle	Wildlife Dynamics Consulting	Northern goshawk
Alan Burger	Alan Burger Consulting	Marbled murrelet
Louise Waterhouse	Ministry of Forests and Range	Marbled murrelet
Stephanie Hazlitt	University of British Columbia	Marbled murrelet

Workshop delivery:

Chuck Rumsey	Co-location project manager
Hannah Horn	Focal species project manager

2.0 Overview of Co-Location Methods

This section describes the methods for using MARXAN software to co-locate focal species habitats while meeting targets for old growth retention in the South Coast planning sub-region. Further technical details regarding co-location methods can be found in Rumsey (2009).

The purpose of the DS04 Co-location Project is "to use a spatially explicit conservation site selection algorithm and a spatial timber supply model to identify potential areas for old growth management reserves that meet conservation objectives while avoiding timber supply impacts".

2.1 South Coast Pilot

The South Coast pilot of the DS04 Co-Location Project was designed to test methods and explore results with regard to a set of co-location experiments conducted in the southern part of the Central Coast of British Columbia (Figure 1). The pilot provided an opportunity to pull together and evaluate the quality and consistency of existing data sets available for analysis, and to engage domain experts in a process of review of those inputs and their appropriate use in a co-location exercise. Equally important was the opportunity created to experiment with various modeling parameters and to share results with domain experts and decision-makers alike in order to evaluate the efficacy and utility of project products.

In June of 2008, focal species domain experts gathered to workshop as part of Phase 1 of the Focal Species Project. Central to their purpose was to evaluate initial data, models and approaches to co-location. A number of important recommendations were put forth by workshop participants, particularly with regard to habitat model inputs. As a result, in the summer of 2008, the EI02 team worked with various domain experts to revise a series of habitat layers for inclusion in the assessment. In addition, domain experts recommended changes to the targets used to drive the co-location.

The revised map products and co-location targets, as described in this section, were applied and the outputs reviewed at a subsequent workshop of domain experts in December 2008.

The DS04 Co-Location Project was expanded in Phase 3 to include the Mid Coast and will ultimately include all three planning sub-regions (North Coast, Mid Coast and South Coast). A parallel EBM Working Group project (Landscape Level Reserve Design) experimented with 'hands on' landscape design and assessed the use of strategic level MARXAN outputs in guiding more detailed reserve design (Lewis and Kremsater 2009).

2.2 Methods

2.2.1 Study Area

The initial pilot for the South Central Coast was undertaken in 29 Landscape Units (LUs) in the southern portion of BC's central Coast (Figure 1), and referred hereafter as the 'South Coast'. This area was selected for piloting based on the immediate relevance of the question of reserve planning to ongoing Detailed Strategic Planning (DSP) processes.

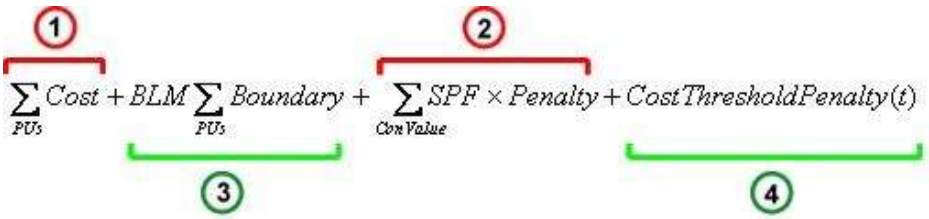
Figure 1. Landscape Units of South Coast sub-region

The pilot phase of this project assessed co-location using representation targets applied at both the Landscape Unit (LU) scale and the study area or 'sub regional' scale (see section 2.2.9)

2.2.2 MARXAN Conservation Planning Software

For the purposes of this pilot we used the site selection software MARXAN which applies an algorithm called "simulated annealing with iterative improvement" as a method for efficiently selecting sets of areas to meet conservation goals. The algorithm attempts to minimize reserve

or portfolio "cost" while maximizing attainment of conservation goals. For this project, cost is assessed based on a combination of total area and timber value (see section 2.2.5), and conservation goals are expressed as a proportion of area for forest site series surrogate seral stages and focal species habitat types. This set of objectives constitutes the "Objective Cost function:"



Where,

1. The total cost of the reserve network (required);
2. The penalty for not adequately representing conservation features (required);
3. The total reserve boundary length, multiplied by a modifier (optional); and
4. The penalty for exceeding a preset cost threshold.

The specific settings for these parameters are further discussed below.

2.2.3 Existing or Pending Conservation Areas and Reserves

An important comparative assessment for co-location of conservation values involves evaluating the contribution of already identified and delineated conservation areas and reserves.

1. **Conservation Areas**
    - Existing or proposed parks, conservancies, and biodiversity areas,
2. **Riparian** –
    - Combination of buffered 'High Value Fish Habitat' and 'Floodplain' layers
3. **Wildlife Habitat Areas**
    - WHAs approved under the Government Actions Regulation.
    - Identified for tailed frog and in the case of the Phillips LU, Grizzly Bear.
4. **Grizzly Critical Habitat**
    - As identified by the December 2008 version of the South Central Coastal Order.
5. **Ungulate Winter Range**
    - UWRs approved under the Government Actions Regulation.

2.2.4 Planning Units

In order to better represent the land base around which decisions regarding old growth reserves were to be made, the pilot used forest polygons themselves for the analysis. In the study area, there were 91,250 of these units, each representing a distinct combination of site series surrogate, seral class, and land status (see section 2.2.3).

2.2.4.1 Locked and Unlocked Scenarios

In the initial set of experiments leading up to the June 08 workshop, scenarios were run with existing reserves both 'locked in', and 'unlocked'. An unlocked scenario is one in which no areas, even if currently protected, are assumed to be part of a potential solution. Based on recommendations from domain experts, the decision was made to lock in all existing reserves, and thus automatically count habitat and forest values found within those reserves toward representation goals.

2.2.5 Cost Surface

The cost input for MARXAN is an important determinant of the ultimate size, efficiency and spatial configuration of a solution set. For this pilot, we incorporated both an area-based cost as well as a surrogate for timber values. This latter element was proposed to account for the idea that where choices exist for co-locating forest and habitat values for reserve, there is a preference for selecting reserves away from areas with high potential timber value.

An important note about cost: In this pilot exercise, representation targets and associated species penalty factors (section 2.2.2) were set such that MARXAN will always select enough sites to achieve conservation goals, regardless of the costs associated. The cost layer affects the placement of those sites, and potentially the overall size of the solution portfolio, but in no case does the cost input impede meeting *full* representation targets.

2.2.5.1 SELES and the creation of a cost layer

Using SELES (Spatially Explicit Events Simulator), the initial cost function was derived based on total volume harvested per 1-ha analysis cell over a 400 year analysis window. For the purposes of this project, SELES modeled a spatial baseline timber supply scenario (i.e. spatialized version of last Timber Supply Review or management plan plus new WHAs and UWRs). This particular scenario provided a more complete picture of harvest potential, and was not confounded by the timber supply model's choice of flexible netdowns (e.g. locations of EBM netdowns that target less than 100% of an element, such as blue-listed ecosystems).

The initial cost results from this model were then divided by the square root of the normalized distance to existing access (road or ocean). This modification reflects that higher distance to

existing access reflects a lower economic cost of conservation. Modifying again the distance factor by taking a square root emphasizes that distance itself is likely to be less influential than volume overall in evaluating ultimate timber values (e.g. for double the volume, one would be willing to go four times as far).

2.2.6 Forest Representation

Old growth representation is a key driver for the co-location purposes in this project. A 1:20,000 forest cover polygon layer was provided thorough ILMB by CFCI to facilitate evaluation of Site Series Surrogates (SSS) by seral stage. These surrogates were derived by combining BEC variant, leading species and site index class. The seral class for each SSS was broken down into Old, Mature, Mid and Young seral classes using a classification under development by the EBMWG. Old for the study area was classed as any forest over 180 years. A description of site series surrogates and their classification is provided in Rumsey (2009).

2.2.6.1 Recruitment

In addition to identify areas for reserving existing old, this project assessed areas for recruitment to meet representation goals in those cases were there was insufficient old to meet targets. To facilitate this recruitment process, an 'oldest first' step-down of representation targets was employed. For example, if existing old was insufficient to meet a target, the remaining gap between existing old and the target was recruited from mature stands of the SSS. If not enough mature was available, the remaining gap in target was transferred to mid, and finally down to young if required (see Box 2.2.6).

Box 2.2.6 An example of DS04 recruitment

SSS1 Representation goal = 30%

Total SSS1 = 200ha

- **Old 40 ha,**
- **Mature 10 ha,**
- **Mid 5 ha,**
- **young 145 ha**

Goal Total ha = (30% x 200ha) = 60ha

- **Goal Old 40 ha (all)**
- **Goal Mature 10 ha (all)**
- **Goal Mid 5 ha (all)**
- **Goal Young 5 ha**

2.2.7 Focal Species MARXAN Inputs

The EI02c Focal Species Project was tasked with directing the incorporation of appropriate models into the co-location. Through the input of that project and its associated domain experts, a data set was supplied to the DS04 Co-Location Project through ILMB for use in setting representation targets.

A full description of habitat models and their derivation is provided in the Focal Species Project document Part 4: *Summary of Habitat Mapping to Support EBM Implementation* (Horn 2009). Black bear habitat suitability mapping was reviewed by domain experts and rejected for use as

an input to the co-location exercise. Bear experts therefore undertook a *post hoc* assessment of scenario outputs for their contribution to black bear habitat.

2.2.7.1 Coastal Black-tailed Deer Winter Range

Based on recommendations from the Phase 1 EI02c Workshop, a habitat suitability layer was created for the next phase of DS04. This information adds an important supplement to the Ungulate Winter Range designation which is an important element of existing reserves, but does not capture all existing habitat.

Habitat was filtered for High and Medium based on Coast or Mountain ecosections (see Horn 2009) and goals applied as described in section 2.2.8.

2.2.7.2 Grizzly Bear

Grizzly Bear habitat classes 1 – 6 were provided by ILMB for the entire study area as well as the scheduled map layer of critical grizzly bear habitat under the South Central Coastal Order. Representation goals were applied to Classes 1 and 2. For the most part, polygons labelled Class 1 also constitute critical habitat under the South Central Coast legal order and as such, were fixed into the planning unit layer and assumed part of any conservation solution in 'locked' scenarios (see sections 2.2.3 and 2.2.4.1).

For the purposes of goal setting and reporting, habitat classes were stratified by Biogeoclimatic Ecosystem Classification (BEC) zone, subzone and variant.

2.2.7.3 Marbled Murrelet

As of December 2008, a comprehensive and detailed assessment of marbled murrelet habitat had been completed for all Landscape Units in the South Coast sub-region using air photo interpretation or low level aerial assessment. At the time of these analyses, air photo interpretation was available for 22 of 28 LUs, with another six LUs having had low level aerial assessments completed.

As reserve analysis was being done within and not among LUs, the difference in data sets was not considered an obstacle, since, in all cases, representation goals could be applied to habitat classes 1, 2 and 3. However, domain experts for marbled murrelets recommend that, unless there are gaps in the air photo-based layer, it is preferable to not combine air photo interpretive mapping with low level aerial assessment; only use the one layer (Horn 2009).

Marbled murrelet habitats were stratified by distance to ocean class (0 – 30km; 30 – 50km; >50km) and BEC zone, subzone and variant to assist with reporting.

2.2.7.4 Mountain Goat

Based on recommendations from the Phase 1 EI02c Workshop, a habitat suitability layer describing both male and female goat habitat was created for Phase 2. This information supplements the Ungulate Winter Range designation which is an important element of existing reserves, but does not capture all existing habitat.

2.2.7.5 Northern Goshawk

Through discussions with the Northern Goshawk Recovery Team, it was decided that the existing Northern Goshawk foraging model would be incorporated into the goal setting process for co-location. The model was filtered for high and medium habitat and goals set according to those rankings (see section 2.2.8). For the study area, buffered data was also provided for four known nest sites.

2.2.7.6 Tailed Frog

New tailed frog habitat layers were created in 2008 to support the Phase 2 analyses. These consist of two classes of buffered stream and 2 classes of tailed frog basins differentiated by ruggedness class (30 – 70% and 71 – 120%).

2.2.8 Goals

Old growth representation targets have been the focus of ongoing negotiations and analysis on the B.C. Coast throughout the life of the EBM Working Group. Emerging from these discussions, goals for site series surrogates were based on the following four commonly discussed old growth representation thresholds:

30% of total SSS retained as old

30% of the Range of Natural variation (RONV) retained as old

50% of the RONV within each SSS retained as old

70% of the RONV within each SSS retained as old

A more complete discussion of appropriate representation thresholds as they apply to ecological risk can be found in the EI03 Ecological Baseline report (Holt and Rumsey 2009).

An important investment in time and effort was made by the EI02c domain experts to find appropriate representation goals for focal species. While not directly comparable to the notion of ecological risk as it applied to forest targets, three increments of goals were established: 'Low Risk', 'Higher Risk A (Experimental Mid Risk)' and 'Higher Risk B (Experimental High Risk)'.

Goal Stratification: Goals for all forest types and species were stratified by Landscape Unit.

Table 1. Representation goals for focal species

Note: these goals are experimental and were adjusted in subsequent analyses based on review by domain experts.

Focal species	Low risk goal	Higher risk Goal <a> (Experimental Mid Risk)	Higher risk goal <b> (Experimental High Risk)
Black-tailed Deer (Approved UWRs locked in)	100% of H habitats; could achieve with a mix of H and M habitats if have a minimum 70% H and 2x the M to make up to H equivalent area.	90% of H habitats; could achieve with a mix of H and M habitats if have a minimum 70% H and 2x the M to make up to H equivalent area.	80% of H habitat; could achieve with a mix of H and M habitats if have a minimum 70% H and 2x the M to make up to H equivalent area.
Grizzly Bear (Schedule 2 habitats and approved WHAs locked in)	100% Class 1 and 2 x BEC variant x LU	100 % Class 1; 50% of Class 2 habitats x CWH & MH BEC variants x LU	100% Class 1 x BEC variant x LU
Marbled Murrelet	62% of [Classes 1 + 2 + 3]: 100% of Class 1 and 2 and achieve the remainder with Class 3 where necessary	62% of [Classes 1 + 2 + 3]: Class 1 = Class 2 = Class 3	100% of Class 1 and Class 2
Mountain Goat (Approved UWRs locked in)	100% of Type 1; could achieve with a mix of Type 1 and Type 2 habitats if have a minimum 70% Type 1 and 2x the Type 2 to make up to Type 1 equivalent area.	80% of Type 1. Target for MARXAN = midpoint of 70%; could achieve with a mix of Type 1 and Type 2 habitats if have a minimum 70% Type 1 and 2x the Type 2 to make up to Type 1 equivalent area.	60% of Type 1; could achieve with a mix of Type 1 and Type 2 habitats if have a minimum 70% Type 1 and 2x the Type 2 to make up to Type 1 equivalent area.
Northern Goshawk	60% of M or H foraging habitat [= 0.5 - 1.0]; at least half of this to be H [= 0.75 - 1.0]	40% of M or H foraging habitat [= 0.5 - 1.0]; at least half of this to be H [= 0.75 - 1.0]	20% of M or H foraging habitat [= 0.5 - 1.0]; at least half of this to be H [= 0.75 - 1.0]
Northern Goshawk	1) 100% of nest sites (from the point file) to be included in OGRAs, 2) 100% of mature and old forest within 800m-buffered nest area polygons	1) 100% of nest sites (from the point file) to be included in OGRAs, 2) 100% of mature and old forest within 800m-buffered nest area polygons	1) 100% of nest sites (from the point file) to be included in OGRAs, 2) 100% of mature and old forest within 800m-buffered nest area polygons

Focal species	Low risk goal	Higher risk Goal <a> (Experimental Mid Risk)	Higher risk goal <b> (Experimental High Risk)
Tailed Frog (Approved WHAs locked in)	Class 1: 50%; Class 2: 45%; Class 3: 30%; Class 4: 40%; fragmentation: low	Class 1: 35%; Class 2: 30%; Class 3: 25%; Class 4: 30%; fragmentation: low	Class 1: 20%; Class 2: 20%; Class 3: 20%; Class 4: 20%; fragmentation: moderate

2.2.9 Scenarios

The number of suggested goal settings created numerous potential combinations – presenting both a challenge and an opportunity. In addition to varying goals, the option to create different pairings or groupings of habitat and forest types presented itself as a means for better understanding which habitats and /or forest types might be driving potential reserve solutions. Table 2 describes the scenarios run in Phase 2, reviewed by domain experts and reported on in subsequent chapters of this document.

Table 2. MARXAN scenario reviewed as part of the Phase 2 Focal Species Project.

Scenario	Description
SSS_30	30% of each Site Series Surrogate as Old
SSS_30R	30% RONV of each Site Series Surrogate as Old
SSS_50R	50% RONV of each Site Series Surrogate as Old
SSS_70R	70% RONV of each Site Series Surrogate as Old
HR_FocSPP_all	Focal Species Highest Risk Targets
MR_FocSPP_all	Focal Species Mid Risk Targets
LR_FocSPP_all	Focal Species Lowest Risk Targets
HR_30	Focal Species Highest Risk Targets and 30% SSS
HR_30R	Focal Species Highest Risk Targets and 30% RONV SSS
MR_30	Focal Species Mid Risk Targets and 30% SSS
MR_30R	Focal Species Mid Risk Targets and 30% RONV SSS
LR_30	Focal Species Lowest Risk Targets and 30% SSS
LR_30R	Focal Species Lowest Risk Targets and 30% RONV SSS
LR_70R	Focal Species Lowest Risk Targets and 70% RONV SSS
MM_LR_30R	MAMU only, Lowest Risk Targets and 30% RONV SSS
DR_LR_30r	Deer only, Lowest Risk Targets and 30% RONV SSS
NG_LR_30R	NOHO only, Lowest Risk Targets and 30% RONV SSS
TF_LR_30R	Tailed Frog only, Lowest Risk Targets and 30% RONV SSS
GB_LR_30R	Grizzly only, Lowest Risk Targets and 30% RONV SSS
GT_LR_30R	Goat only, Lowest Risk Targets and 30% RONV SSS
GBMM_LR_30R	Grizzly and MAMU, Lowest Risk Targets and 30% RONV SSS
half_fslr_30r	50% Focal Species Lowest Risk Targets and 30% RONV SSS
fslr_seed	Focal Species (all) Low Risk run first, solution is used to seed a follow-up run using SSS 30% RONV
FS_NO_NG_LR	All Focal Species except NOGO, Lowest Risk goal
FS_NONG_LR_30R	All Focal Species except NOGO, Lowest Risk goal, plus SSS 30% RONV

2.3 References

Holt, R.F. and C. Rumsey. 2009. *EI03 Ecological Baseline Assessment*. Prepared for the Ecosystem-based Management Working Group.

Horn, H.L. 2009. *Part 4: Summary of Habitat Mapping to Support EBM Implementation.* Prepared for the Ecosystem-based Management Working Group.

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Rumsey, C. 2009. *Co-location Modelling to Inform Old Growth Reserve Selection: EBMWG Project DS04a, Final Report.* Prepared for the Ecosystem-based Management Working Group.

3.0 Results for Black Bears (*Ursus americanus*)

Domain experts:

Helen Davis, Artemis Wildlife Consultants

Tony Hamilton, B.C. Ministry of Environment

Grant MacHutchon, A. Grant MacHutchon Consulting

3.1 Description of experimental scenarios

A black bear habitat layer was not used as an input to MARXAN for two reasons:

- An acceptable habitat suitability layer for black bears was not available and there was no existing habitat model for black bears.
- Because no suitable model existed for black bears, the habitat requirements for black bears will only be addressed by the suite of EBM objectives, including co-location of habitats for other focal species within old growth retention areas. This includes an overlap of grizzly and black bears in requisite habitats.

3.2 Findings from review of scenario outputs

1. The domain experts had originally assumed that the needs of black bears would be addressed in the Class 2 habitats on the east side of the occupied grizzly bear area. This was not the case because the habitats that are currently identified as Class 2 are concentrated in two landscape units (that have TEM), they are not spread out across the landscape units enough, and habitats that are good for grizzly bears may be too risky for black bears to use due to predation risk.
2. Black bears require large, old forest structures for denning. Habitat mapping does not necessarily pick up the large structural elements required by black bears for denning, although a model of denning habitat could be used as an input to future analysis.
3. Black bear habitat requirements were not well-captured by those of other focal species. There is some overlap with the needs of grizzly bears. There is also some overlap between habitat requirements of black bears and marbled murrelets in the hypermaritime, but this needs to be investigated further once the marbled murrelet model has been finalized. There may be some capture of the needs of black bear denning habitat if there is a stand age filter associated with deer and goshawk OGRAs. There is little overlap of habitat requirements between black bears and tailed frogs, although changes to the model that include more of the basins around occupied streams could capture some denning habitat.

4.0 Results for Coastal Black-tailed Deer (*Odocoileus hemionus*)

Domain experts:

Kim Brunt, Ministry of Environment, Nanaimo

Ken Dunsworth, Ministry of Environment, Hagensborg

Steve Gordon, Ministry of Environment

Sally Leigh-Spencer, International Forest Products

Shawn Taylor, Goat Mountain Resources

4.1 Description of experimental scenarios

4.1.1 Map inputs

MARXAN used the coast-wide deer winter range mapping, prepared in 2008 – 9, as an input.

4.1.2 Habitat definition

The definitions of high and moderate value habitat differ between sub-regions. During their review of co-location experiments resulting from application of the results of the first iteration of the deer winter habitat suitability model, domain experts determined that the habitat cut-offs for the South Coasts were overestimating the amount of high value habitat, particularly in the Mountain ecosections.

4.1.3 Co-location scenarios

Targets for habitat retention are based on a Target Retention Value (TRV) approach, which was used for both deer and goats. The objective is to achieve the overall TRV – which may be made up of all H habitats or a combination of H and M habitats. The target is a minimum retention of 70% H in any solution. The remainder is to be made up of twice as much M habitat to achieve the total % retention as outlined in the following examples.

Scenario	TRV
Low risk scenario	100% H
Mid risk scenario	90% H
Higher risk scenario	80% H

Example of the TRV approach:

In the low risk scenario for a landscape unit with 1000 ha of H value habitats, MARXAN could either

a. Capture 1000 ha of H, or
b. Capture a minimum of 700 ha H value habitat + a minimum of 600 ha M habitat for an equivalent solution.

In the mid risk scenario for a landscape with 1000 ha of H value habitats, MARXAN could either

a. Capture a minimum of 900 ha of H, or
b. Capture a minimum of 630 ha in H (0.7 x 900 ha) + a minimum of 540 ha of M habitat [(900-630) x 2] for an equivalent solution.

Rationale for habitat targets:

Domain experts estimate that up to 50% or more of H value winter habitat may have already been harvested, based on amount and distribution of early seral stands with favourable topographic characteristics. They have estimated risks associated with deer based on % retention targets of the remaining habitat. The low risk scenario is therefore may be up to 50% of H value habitats that once occurred on the landbase; the higher risk scenario represents 0.8 x 0.5 = 40% of what may have once occurred on the landbase.

Where the availability of H is drawn down, twice as much M must be captured to achieve the TRV because habitats in the M category are relatively poorer quality habitat with a lower probability of supporting deer.

Analysis units:

Landscape unit

4.1.4 Reporting outputs

1. Area of H and M habitat by LU and ecosection
   i. in OGRAs;
   ii. in total
2. Area of each OGRA polygon by LU
3. Area of M and H habitats (combined) within each OG polygon by LU

4.2 Findings from review of scenario outputs

4.2.1 Comparison of scenarios

When the Ungulate Team reviewed the scenario outputs they determined that the habitat cut-offs applied to the deer model overestimated the amount of high value habitat. For this reason, the team was unable to draw any meaningful conclusions. Habitat cut-offs will be adjusted and tested during the next round of co-location experiments.

4.2.2 Overlap with other species

Northern goshawk nesting / foraging habitat and mountain goat winter range represents most of the overlap that occurs between deer winter habitat and other species. This would be expected as these species have some general similarities in habitat requirements related to forest age, structure, and, in the case of mountain goats, topographic characteristics.

5.0 Results for Grizzly Bears (*Ursus arctos*)

Domain experts:

Helen Davis, Artemis Wildlife Consultants

Tony Hamilton, B.C. Ministry of Environment

Grant MacHutchon, A. Grant MacHutchon Consulting

5.1 Description of experimental scenarios

5.1.1 Map inputs

MARXAN used various map products that ranked suitability of habitats for grizzly bears according to the provincially accepted 6-class system[1]. These scenarios only addressed vegetative habitat; they did not include

- Salmon availability or abundance
- Non-forested habitats that are not mapped as Class 1 or 2
- Winter denning habitat; suitability was only ranked for the four active seasons of early spring, late spring, summer, and fall

5.1.2 Co-location scenarios

Low risk scenario:	100% Class 1 and 2 x BEC variant x LU
Mid risk scenario:	100 % Class 1; 50% of Class 2 habitats x CWH & MH BEC variants x LU
Higher risk scenario:	100% Class 1 x BEC variant x LU

Analysis units:

Landscape Unit (LU) and BEC variant

5.1.3 Reporting outputs

1. Area of habitat classes 1 and 2 captured in OGRAs
2. Area of each seral stage (ha) x BEC variant x LU:

[1] RIC, Resources Inventory Committee. 1999. *British Columbia wildlife habitat rating standards. Version 2.0*. Terrestrial Ecosystems Task Force, Resources Inventory Committee, Victoria, B.C.

- Within and outside of OGRAs
- Within and outside of the THLB

3. Total area of Class 1 and 2 habitats by LU

5.2 Findings from review of scenario outputs

See Section 2.2.9, Table 2 for a listing of MARXAN scenario runs.

When reviewing the MARXAN outputs, the Bear Team focussed their review on Class 2 habitats in the CWHvm1, vm2 and vh1 in the South Coast study area because:

- The target for Class 1 habitats in all three scenarios is 100% retention. Additionally, Class 1 habitats are designated in the schedule to South Central Coastal Order and, so, are locked in as part of the reserve layer.
- Scenario results show that the aerial extent of Class 2 is low in the CWHws2, CWHdm and MHmm. Domain experts assume that targets for SSS representation will capture all of the Class 2 habitats in these BEC variants.

The Bear Team compared all MARXAN scenario outputs against the mid risk 30R (MR_30R) scenario. This scenario consists of:

- experimental mid risk targets for all focal species combined; and
- a target for old seral retention of 30% of the range of natural variability (RONV) by site series surrogate (SSS).

While the preferred (lowest risk) scenario is to capture 100% of Class 1 and 100% of Class 2 habitats they felt it would be more useful to see what would happen, experimentally, if only 50% of the Class 2 habitats were captured e.g., Where would they be located? How would they be distributed?

5.2.1 Comparison of mid risk scenario to site series surrogate targets

Domain experts compared the MR_30R scenario with scenarios driven by targets for old growth retention by SSS. The purpose of this comparison was to see how much grizzly bear habitat is captured incidentally while seeking to meet different targets for old seral retention.

Results:

BEC variant	% Class 2 habitat captured		
	30% of RONV (SSS_30R)	50% of RONV (SSS_50R)	70% of RONV (SSS_70R)
CWHvh1	41%	42%	98%
CWHvm1	35%	41%	48%
CWHvm2	30%	42%	54%

At best just over half of the Class 2 habitats in the vm1 and vm2 are captured incidentally by meeting targets for SSS representation, even when the 70% target is applied.

The incremental gains in habitat captured in the vm1 and vm2 are relatively small as one targets for OG increase, particularly in the increase from 30% to 50% representation.

Almost 100% of the CWHvh1 is captured in the SSS_70R scenario.

Conclusions:

The SSS_70R scenario most closely reflects the mid risk scenario.

The SSS_30R scenario falls well short of the mid risk scenario, only capturing two-thirds of the targets.

Where solutions are not driven by targets for focal species habitats, less habitat for grizzly bears is captured since the cost surface pushes solutions outside the low elevation habitats that coincide with areas of high habitat value. Even when the target for OG representation is as high as 70% of RONV, only half of the class 2 habitats are captured. This suggests that efforts to meet old growth targets without accompanying targets for specific focal species habitat will not achieve an optimal solution for grizzly bears.

There is no indication from this scale of review what type of Class 2 habitat was captured. In the future, reporting by seasonal habitat, as well as by BEC variant, will allow domain experts to assess the extent to which the most important seasonal habitats are captured in OGRAs.

5.2.2 Comparison of scenarios with and without site series surrogates

Domain experts compared multi-species scenarios with and without accompanying targets for old growth retention by site series. The purpose of this comparison is to assess how well MARXAN captures Class 2 habitats when solutions are driven by targets for focal species rather than SSS.

Results:

BEC variant	% Class 2 habitat captured				
	Mid risk all species – without SSS (MR_FocSPP-all)	Mid risk all species – with SSS (MR_30R)	30% of RONV – no focal species targets (SSS_30R)	50% of RONV – no focal species targets (SSS_50R)	70% of RONV – no focal species targets (SSS_70R)
CWHvm1	53%	53%	35%	41%	48%
CWHvm2	58%	56%	30%	52%	54%

BEC variant	% Class 2 habitat captured				
	High risk all species – without SSS (HR_FocSPP-all)	High risk all species – with SSS (HR_30R)	30% of RONV – no focal species targets (SSS_30R)	50% of RONV – no focal species targets (SSS_50R)	70% of RONV – no focal species targets (SSS_70R)
CWHvm1	41%	45%	35%	41%	48%
CWHvm2	42%	41%	30%	52%	54%

In both the vm1 and vm2, the mid risk scenarios capture more Class 2 habitat than the SSS_70R scenario.

The high risk scenarios capture the same amount of habitat as the SSS_50R in the vm1 but less than the SSS_50R in the vm2.

More habitats are captured in the mid risk scenarios compared to the high risk scenarios. The difference in between the mid and high risk scenarios is greater in the vm2 than the vm1, particularly in the vm1.

There is little difference in the amount of habitat captured when the focal species targets are combined with the SSS_30R targets, although there is a slight increase in Class 2 captured in the vm1 when the SSS targets were included.

Conclusion:

Not surprisingly, the scenarios that are driven to meet focal species goals capture more habitat than the old growth retention targets on their own. MARXAN is driven to meet the habitat target so the result should be at least that outcome. Targets were exceeded in both mid risk scenarios, suggesting that the targets for some other focal species are influencing the outcome.

The high risk scenario does not have a target for Class 2 and yet over 40% of the habitat is captured. This suggests that the targets for other focal species are contributing to the result. This is supported by the high risk scenario providing a better result for bears than the 50% of RONV.

The lack of difference between the habitat-driven outcomes with and without the 30RSSS target suggests that the targets for habitat capture exceed most targets for SSS representation.

Summary:

Overall at the regional scale, the descending order of the scenarios above in their ability to capture grizzly bear Class 2 habitats within the CWH vm1 & vm2 was (in order of best to worst):

1. Multi-species mid risk scenarios (with and without SSS)
2. 70% of RONV by SSS_70R
3. Multi-species high risk scenarios (with and without SSS)
4. 50% of RONV by SSS_70R
5. 30% of RONV by SSS_70R

5.2.3 Overlap with other species

Class 1 grizzly bear habitats are locked in as part of the reserve layer in the Land Use Orders therefore are captured in all other focal species scenarios. Consequently, the comparison of grizzly bears with other species continued to focus on Class 2 habitats only.

Overlap with grizzly bear habitats in the CHWvm1:

Low risk scenarios for individual species (marbled murrelet (MM_LR_30R), tailed frog (TF_LR_30R), northern goshawk (NG_LR_30R), black-tailed deer (DR_LR_30R), and mountain goat (GT_LR_30R)) were slightly better or equivalent to the SSS_30R scenario at capturing Class 2 CWHvm1 grizzly bear habitat, but worse than all other scenarios evaluated in sections 5.2.1 and 5.2.2.

Overlap with grizzly bear habitats in the CHWvm2:

Only the northern goshawk and blacktailed deer were better than the high risk scenario (HR_30R) at capturing vm2 habitat, but were as effective as the mid-risk scenarios and SSS_70R scenario.

Conclusions:

In the vm1, individual focal species contribute to the capture of grizzly bear class 2 habitats but not to a large extent.

In the vm2, northern goshawk and black-tailed deer contribute more than other species to co-location with grizzly bear habitats. It should be noted, however, that the deer mapping used in the co-location was thought to over-estimate the amount of high value deer habitat.

It would be useful to use the multi-species runs to assess the contribution of individual species and the combined species to assess the overall opportunities for co-location.

5.2.4 Other observations

- In the moderate risk scenario, about a third to a half of the Class 2 targets are met by locked in/reserve areas and half is acquired randomly. A large amount of Class 2 habitat is therefore selected randomly. Where the target for capture of Class 2 habitats is less than 100%, the solution should be driven to the rarest and most important of these habitats. Stratification of Class 2 into seasonal habitats, as well as by BEC variant, will better direct outcomes to the most important Class 2 habitats.
- The model does well where Class 2 habitats are comprised of old growth (i.e., the model selects old forest) however Class 2 habitats are often non-forested or may be earlier seral forest. The inputs into MARXAN need to be such that the range of Class 2 habitats are captured (including entire grizzly bear habitat complexes).
- Setting targets by BEC variant helps to provide a distribution of habitats across elevations with the priority being lower elevation habitats and Class 2 polygons in hypermaritime areas.

6.0 Results for Marbled Murrelets (*Brachyramphus marmoratus*)

Domain experts:

Alan Burger, Alan Burger Consulting and University of Victoria

Stephanie Hazlitt, University of British Columbia

Louise Waterhouse, B.C. Ministry of Forests and Range

6.1 Description of experimental scenarios

6.1.1 Map inputs

MARXAN used air photo interpreted and low-level aerial survey mapping–that ranks habitats according to 6 classes. The ranking gives 1 to the highest rank (key habitat features area present in abundance; nesting is highly likely), 2 – 5 for lower ranked habitats and 6 for nil habitats (all key habitat features are absent and nesting is impossible).

6.1.2 Habitat definition

Domain experts defined 'suitable habitat' as Classes 1 to 3. The low use of Class 4 and 5 habitats precluded their direct inclusion as suitable nesting habitat.

6.1.3 Scenarios

Low risk scenario:	62% of the area of Class 1 to 3 habitats where Class 1 and 2 habitats are captured first and made up to 62% with Class 3
Mid risk scenario:	62% of Class 1 to 3 habitats where Class 1 = Class 2 = Class 3
Higher risk scenario:	100% of Class 1 and 2 habitats (see below for why this is high risk)

Analysis unit:

Landscape unit

Note: the Marbled Murrelet Team was interested in running scenarios by landscape unit and sub-region, however, the analysis was only completed by landscape unit.

Rationale for scenarios:

These scenarios were based on the CMMRT goal of conserving 69% of suitable habitat in Northern and Central Mainland conservation regions in the long term. Risk in these scenarios is an adjustment of representation of habitat among the three upper habitat quality classes: Very High (Class 1), High (Class 2), and Moderate (Class 3). The 62% target is an adjustment of the

69% to account for those 10% of nests that occur outside of Class 1 – 3 habitats. The risk is the risk of not achieving the Recovery Team goals (CCMRT 2003) of 69% retention of 2002 habitat area (adjusted in this project to 62% to account for the 10% of nests thought to occur in lower quality habitat).

The scenarios did not include any marine foraging mapping as conservation features or considerations of marine elements relative to terrestrial habitat quality in the MARXAN analyses.

6.1.4 Reporting outputs

1. Area of habitat classes 1 - 3 captured in OGRAs
    - by landscape unit and sub-region;
    - by BEC variant; and
    - by distance to ocean class.

2. Area of each habitat class (1 - 3) captured in other reserves (parks, conservancies, schedule 2 grizzly bear critical/ sensitive habitats, wildlife habitat areas, ungulate winter ranges, hydroriparian reserve);

3. Total area of each habitat class (1 - 3) by LU

6.2 Findings from a review of scenario outputs'

See Section 2.2.9, Table 2 for a listing of MARXAN scenario runs.

The Marbled Murrelet Team focussed on the marbled murrelet low risk–30R scenario (MM_LR_30R) and compared it to the other scenarios. This scenario consists of:

- experimental low risk targets for marbled murrelet habitat (100% of Class 1 and 2 habitats and the remainder in Class 3 to achieve an overall target of 62% marbled murrelet habitat); and
- a target for old seral retention of 30% of the range of natural variability (RONV) by site series surrogate (SSS).

6.2.1 Comparison of low risk scenario to site series surrogate targets

Domain experts compared the MM_LR_30R scenario with scenarios driven by targets for old growth retention by SSS. The purpose of this comparison was to see how much marbled murrelet habitat is captured incidentally while seeking to meet different targets for old seral retention.

Results:

- The SSS_30R scenario (target = 30% of RONV by SSS) does not achieve the minimum amount of habitat for marbled murrelet. There is a substantial deficit of the higher value habitats in particular, with only one-third of the Class 1 and one-quarter of the Class 2 habitats captured.
- The SSS_50R scenario (target = 50% of RONV by SSS) captures more marbled murrelet habitat than the SSS_30R scenario. It captures approximately 72% of combined Class 1 and 2 habitats with a 9% deficit in the amount of overall suitable habitat captured compared to the lower risk MM_LR_30R scenario. With the exception of the following scenario (SSS_70R) and those that combined low risk options for all species, this scenario seems to provide the most secure option for marbled murrelet habitat.
- The SSS_70R scenario (target = 70% of RONV by SSS) captures large amounts of habitat, with almost all Class 1 and Class 2 habitats captured and 32% more Class 3 habitats than in the lower risk MM_LR_30R scenario. The SSS70R scenario would work well for marbled murrelets.

6.2.2 Comparison of low risk scenario to mid and higher risk scenarios

Domain experts compared the MM_LR_30R scenario with the two higher risk scenarios, where solutions were driven by mid and high risk targets for all seven focal species:

Results:

- The mid risk scenario (MR_30R) weighs Class 1 – 3 habitats equally, which allows MARXAN to select lower quality habitat if the cost is lower. The outcome is that this scenario captures more hectares of Class 1-3 habitats in total but captures 8362 ha less of the Class 1 and 2 habitats and over-represents Class 3. Domain experts are of the opinion that the gain in overall hectares from this scenario does not outweigh the reduction in area of the highest quality (Class 1 and 2) habitats.

  Relying on Class 3 habitat to achieve the overall 62% habitat target provides less certainty about the value of the habitat captured. There is less certainty that Class 3 contains suitable nesting platforms and there are also uncertainties associated with habitats captured in the hypermaritime i.e., if Class 3 habitats are identified in the hypermaritime preliminary work indicates they may, in fact be Class 4 or 5.
- The higher risk scenario (HR_30R) only has targets for the capture of Class 1 and 2 habitats (target = 100%) but no targets for Class 3 habitats. As, directed, in this scenario MARXAN captures all of Classes 1 and 2 but does not capture adequate amounts of Class 3 and has 14, 992 ha less habitat overall (18% less habitat than the lower risk scenario). If MARXAN

has open choice of where to capture habitat it will go to even lower quality (Class 4 – 6) habitats to minimize cost. This scenario falls well short of meeting the long term goal of the CCMRT for habitat conservation.

6.2.3 Other observations

- The amount of marbled murrelet habitat captured in the timber harvesting landbase (THLB) is approximately doubled between the SSS_30R scenario (14% of the THLB) and the SSS_50R scenario (31% of the THLB). This outcome demonstrates the large amount of marbled murrelet habitat in the THLB. The amount of THLB overlapping marbled murrelet habitat in the MM_LR_30R scenario is 28%, approximately the same as in the SSS_50R scenario.
- As the targets for SSS increase from 30% to 50% to 70% there is only a small increase observed in the amount of Class 1 and 2 habitats captured, with most of the increase occurring in Class 3 habitat. This is because Class 1 and 2 habitats mainly occur in the THLB and are costly, so if MARXAN has a choice, it will pick up less costly Class 3 habitats in the non-timber harvesting landbase (NTHLB). The conclusion is that, unless targets for marbled murrelet habitat specifically drive solutions to the costlier Class 1 and 2 habitats, the class 3 will be picked up preferentially.
- The spatial distribution of available suitable habitat is very patchy and uneven across landscape units: 8 to 10 of the 29 landscape units in the South Coast contain most of the Class 1 and 2 habitats. Class 3 tends to be more evenly distributed.
- Recruitment: many of the historic Class 1 and 2 habitats have been logged, which may explain the uneven distribution of high quality habitats. However, domain experts have stated that achieving an even distribution of habitats is not as important as picking up the best remaining habitat. Because murrelet habitat requires about 200 years post-logging to be suitable, the recovery team[2] has not put emphasis on recruitment of habitat in the Central and North coast regions.

6.2.4 Overlap with other species

- There is about a 20 – 40% overlap of marbled murrelet habitat with other focal species. The overlap appeared to mostly occur for Class 3 habitats.

[2] CMMRT (Canadian Marbled Murrelet Recovery Team). 2003. *Marbled Murrelet Conservation Assessment 2003, Part B – Marbled Murrelet Recovery Team Advisory Document on Conservation and Management*. Canadian Wildlife Service, Delta, B.C.. URL: http://www.sfu.ca/biology/wildberg/bertram/mamurt/links.htm

- Northern goshawk (NoGo) foraging habitat only overlaps well with marbled murrelet Class 3 habitat (but not Class 1 and 2, 44% and 31% respectively). The overlap between marbled murrelet and northern goshawk habitat is predictable since the generalized habitat requirements in the goshawk foraging layer get pushed to marbled murrelet habitats under co-location. Domain experts suspect that, if northern goshawk nesting habitat rather than foraging habitats were compared, co-location would improve for marbled murrelet (Class 1 and 2). Both marbled murrelet and northern goshawk require large areas of low elevation forest to achieve the lower risk targets.
- There is a fairly strong overlap between deer habitat and marbled murrelet Class 3 habitat (although the current deer mapping overestimates the amount of high value deer habitat).
- A strong overlap was predicted to occur with grizzly bear habitat however, only 66% of the marbled murrelet Class 1 and 39% of marbled murrelet Class 2 habitat overlapped grizzly habitat. This can be explained by the way that grizzly bear habitats were addressed in the analysis. 100% of Class 1 grizzly bear habitats are protected under the Coastal Orders and, so, were 'locked in' to the reserve layer as a solution. Therefore the only grizzly bear habitats reported were Class 2 habitats. Also, like marbled murrelets, grizzly bears have high value habitats in the hydroriparian, which was also 'locked into' the reserve layer.
- Other focal species were not good surrogates for marbled murrelets, mainly because their habitat requirements differed, in terms of kinds of attributes required and the location of habitats on the landbase. In addition, some species may not require as much old growth as the marbled murrelets, resulting in a smaller, actual area of overlap.

6.3 Conclusions

5. With regard to the targets for old seral retention:
    - The 70% RONV scenario (SSS_70R) will adequately achieve the targets in the low risk marbled murrelet scenario.
    - The 50% RONV scenario (SSS_50R) almost provides sufficient habitat to meet the targets for the marbled murrelet mid risk scenario objectives, but an additional driver for selection of Class 1 & 2 habitats would be required to achieve the Low Risk objectives for marbled murrelets.
    - The 30% RONV scenario (SSS_30R) does not provide adequate habitat for marbled murrelets; there is a substantial deficit of suitable habitats across all three habitat classes (1 – 3).

6. Incidentally capturing marbled murrelet habitat as a result of meeting a target for old growth will not necessarily drive a solution to the best habitats. A shortfall of Class 1 and 2 habitats is of most concern as there is the greatest certainty that these habitats provide nesting habitat.
7. Future MARXAN runs should test ways to address the uneven distribution of high quality (Class 1 and 2) marbled murrelet habitats across landscape units. Suggested approaches:
    - locking in Class 1 and 2 habitats, thereby *de facto* capturing these habitats where they occur; or
    - seeking to meet targets by sub-region rather LU, to provide flexibility in the locations of habitat captured. This would need to be tested in future MARXAN runs.
8. Targets for marbled murrelet habitat should be achieved according to distance-to-ocean class to ensure a distribution of habitats into high use areas less than 30 km from the ocean. Habitats greater than 50 km from the ocean should be excluded from the analysis.
9. Conserving existing high quality habitats is the priority; existing habitat should not be traded off against recruitment of future potential habitats.
10. Other focal species' habitats, as currently tested, are not good surrogates for marbled murrelet habitat.

7.0 Results for Mountain Goat (*Oreamnos americanus*)

Domain experts:

Kim Brunt, Ministry of Environment, Nanaimo

Ken Dunsworth, Ministry of Environment, Hagensborg

Steve Gordon, Ministry of Environment

Sally Leigh-Spencer, International Forest Products

Shawn Taylor, Goat Mountain Resources

7.1 Description of experimental scenarios

7.1.1 Map inputs

- Biological ungulate winter range map: MARXAN used the recently completed mountain goat model for the South Coast. The model is described in section 8.3.1.
- Legal ungulate winter range map approved under the Government Actions Regulation.

7.1.2 Habitat definition

For the co-location experiments, highest value habitats were defined as

Type 1 (VH): RSF values 0.185 – 1

Type 2 (H): RSF values 0.024 – 0.185

7.1.3 Co-location scenarios

Targets for habitat retention in the South Coast were based on a Target Retention Value (TRV) approach, which was used for deer and goats. The objective is to achieve the overall TRV – which may be made up of all Type 1 habitats or a combination of Type 1 and 2 habitats. The target is a minimum retention of 70% Type 1 in any solution. The remainder is to be made up of twice as much Type 2 habitat to achieve the total % retention.

Low risk scenario 100% Type 1

Mid risk 80% Type 1

Higher risk 60% Type 1

Example of the TRV approach:

In the above low risk scenario for a landscape unit with 1000 ha of Type 1 value habitats, MARXAN could either

c. Capture 1000 ha of Type 1, or

d. Capture a minimum of 700 ha Type 1 value habitat + a minimum of 600 ha Type 2 habitat for an equivalent solution.

Legal UWRs were locked in at 100% retention.

Analysis unit

Landscape unit

7.1.4 Reporting outputs

1. Map of outputs;
2. Reporting area of Type 1 and Type 2 habitat by landscape unit:
   i. in OGRAs;
   ii. in total

7.2 Findings from a review of scenario outputs

See Section 2.2.9, Table 2 for a listing of MARXAN scenario runs.

The ungulates team focused on the goat low risk–30R scenario (GT_LR_30R) and compared other scenarios to this. The GT_LR_30R scenario seeks to concurrently achieve low risk targets for goat habitat while retaining 30% of RONV (range of natural variability) within old growth stands by site series surrogate (SSS).

7.2.1 Comparison of low risk scenario to site series surrogate targets

Domain experts compared the GT_LR_30R scenario with scenarios driven by targets for old growth retention by SSS. The purpose of this comparison was to see how much goat habitat is captured incidentally while seeking to meet different targets for old seral retention.

- the SSS_70R scenario (target = 70% of RONV) captures the amount of habitat in the low risk goat scenario
- the SSS_50R scenario (target = 50% of RONV) captures the amount of habitat in the mid risk goat scenario
- the SSS_30R scenario (target = 30% of RONV) captures the amount of habitat in the higher risk goat scenario

7.2.2 Comparison of low risk scenario to mid and higher risk scenarios

Comparison of the low risk multispecies scenario (LR_FocSPP_all) with the mid and higher risk multispecies scenarios, where the solutions are driven by different amounts of focal species habitat:

- The LR_FocSPP_all scenario captures more habitat than the scenario just driven by mountain goat habitat, which is as expected.
- The multispecies mid risk scenario meets the target for Type 2 habitats but captures less Type 1 habitats than the LR_FocSPP_all scenario.
- The multispecies higher risk scenario only poorly captures Type 1 and Type 2 habitats.

7.2.3 Other observations

A visual assessment of the outputs from the GT_LR_30R scenario indicated a shortfall in the capture of snow interception cover (i.e., forested cover) in upper elevations. This is likely because habitat definitions for the South Coast model underestimate the highest value habitats. These habitat definitions will be revisited before the next round of co-location.

8.0 Results for Northern Goshawk (*Accipiter gentilis laingi*)

Domain experts:

Frank Doyle, Wildlife Dynamics Consulting

Todd Mahon, Wildfor Constants

Erica McClaren, Ministry of Environment

8.1 Description of experimental scenarios

8.1.1 Map inputs

Two map layers were used as inputs to MARXAN:

- The Northern Goshawk *A. g. laingi* Recovery Team/Habitat RIG habitat suitability model nesting and foraging outputs
- Known nest sites, buffered by 800 m to approximate a 200 ha nest area/PFA.

8.1.2 Habitat definitions

Mapped nest areas:	All forest within the 800 m buffer around known nest areas/PFAs
Modelled nesting layer:	Nesting 1 (N1) (high value habitat) = [0.75 - 1.0]; Nesting 2 (N2) (moderate and high value habitat) = [0.5 - 1.0] To ensure that a proportion of high quality nesting habitat was selected in the solution, we had to include a combination of moderate and high in N2.
Modelled foraging layer:	Forage 1 (F1) (high value habitat) = [0.75 - 1.0]; Forage 2 (F2) (moderate and high value habitat) = [0.5 - 1.0] To ensure that a proportion of high quality foraging habitat was selected in the solution, we had to include a combination of moderate and high in N2.

8.1.3 Co-location scenarios

The Northern Goshawk Recovery Team has insufficient information at this time to set measurable habitat and population goals for recovery (Northern Goshawk *A. g. laingi* Recovery Team 2008). However, for the purpose of this co-location work, domain experts identified low, moderate and high risk scenarios associated with amounts of nesting and foraging habitat protected in co-location scenarios.

These scenarios were developed based on the assumption that foraging habitat will not be met entirely within OGRAs and other reserves. Foraging areas are far too large for a fine-filter management approach and need to be managed using a dynamic coarse-filter landscape approach.

i. Nest areas + PFAs

Recommended low risk scenario: 100% of known nest areas/PFAs (all forested habitat within a 200 ha buffer centered on nest areas);

ii. Modelled nesting habitat

Recommended low risk scenario: 60% [N1 + N2] with at least half (30%) of this target comprised of N1

Analysis unit: Landscape unit

iii. Modelled foraging areas

Recommended low risk scenariot: 60% [F1 + F2] with at least half (30%) of this target comprised of F1

Analysis unit: Landscape unit

8.1.4 Reporting outputs

Foraging habitat: % F1 and F2 habitat within and outside of OGRAs x subregion and LU

Nesting habitat:
1) % N1 and N2 habitat within and outside of OGRAs x subregion and LU; and
2) Amount of mature and old forest within each 800 m-buffered nest area/PFA polygon.

For both nesting and foraging we were interested to know the amount of moderate and high value habitat within the timber-harvesting land base (THLB) and non-contributing land base (NCLB). As well, we wanted to know the results with and without the cost layer to assess the influence this layer had on the distribution of goshawk habitat captured.

8.2 Overview of Findings from a review of scenario outputs

See Section 2.2.9, Table 2 for a listing of MARXAN scenario runs.

It is important to highlight that the evaluation of the co-location scenarios has been done under extreme time and resource limitations imposed by the EBMWG. It is with serious reluctance that we offer these comments and they should be considered preliminary conclusions.

Some of our major concerns include:

- We have not had adequate time to discuss the implications of scenario outputs as a focal species group. Information presented here are observations by individual species experts based on a couple of hours of evaluating the final outputs (spatially and tabularly) for co-location between site series surrogate targets and goshawk scenarios only.
- We have not had time, nor been provided documentation, to enable us to effectively understand the assumptions behind the habitat models and scenarios for the other focal species. We have not been able to accurately assess overlap among goshawk and other focal species habitat scenarios. In addition, we do not know whether problems identified with other focal species models at the December 2008 workshop have been addressed and, if so, how.
- We have not had an opportunity to discuss assessment approaches, findings, and interpretations with other focal species experts.

Based on these limitations and shortcomings, we have not been able to evaluate the co-location scenarios to the level that would normally be considered appropriate, professional, and defendable. We strongly recommend that the EBMWG consider extending the time and resources for this co-location exercise to facilitate a more thorough assessment to be conducted.

8.2.1 Comparison of low risk scenario to site series surrogate targets

Domain experts compared the NG_LR_30R scenario with scenarios driven by targets for old growth retention by site series surrogates (SSS). The purpose of this comparison was to see how much goshawk habitat is captured incidentally while seeking to meet different targets for old seral retention.

Results:

- The SSS 30R scenario achieved less that half of the low risk target for goshawk nesting (Figure 1) and just over half for foraging. On a Landscape Unit basis, SSS_30R only met the low risk scenario for nesting habitat in 3 of the 29 landscape units.

  Amount of N1 captured in NoGo_LR compared to SSS_30R = + 49.45%

  Amount of N2 captured in NoGo_LR compared to SSS_30R = + 47.57%

  Amount of F1 captured in NoGo_LR compared to SSS_30R = + 54.72%

  Amount of F2 captured in NoGo_LR compared to SSS_30R = + 50.81%

(see section 8.1.2 for definitions)

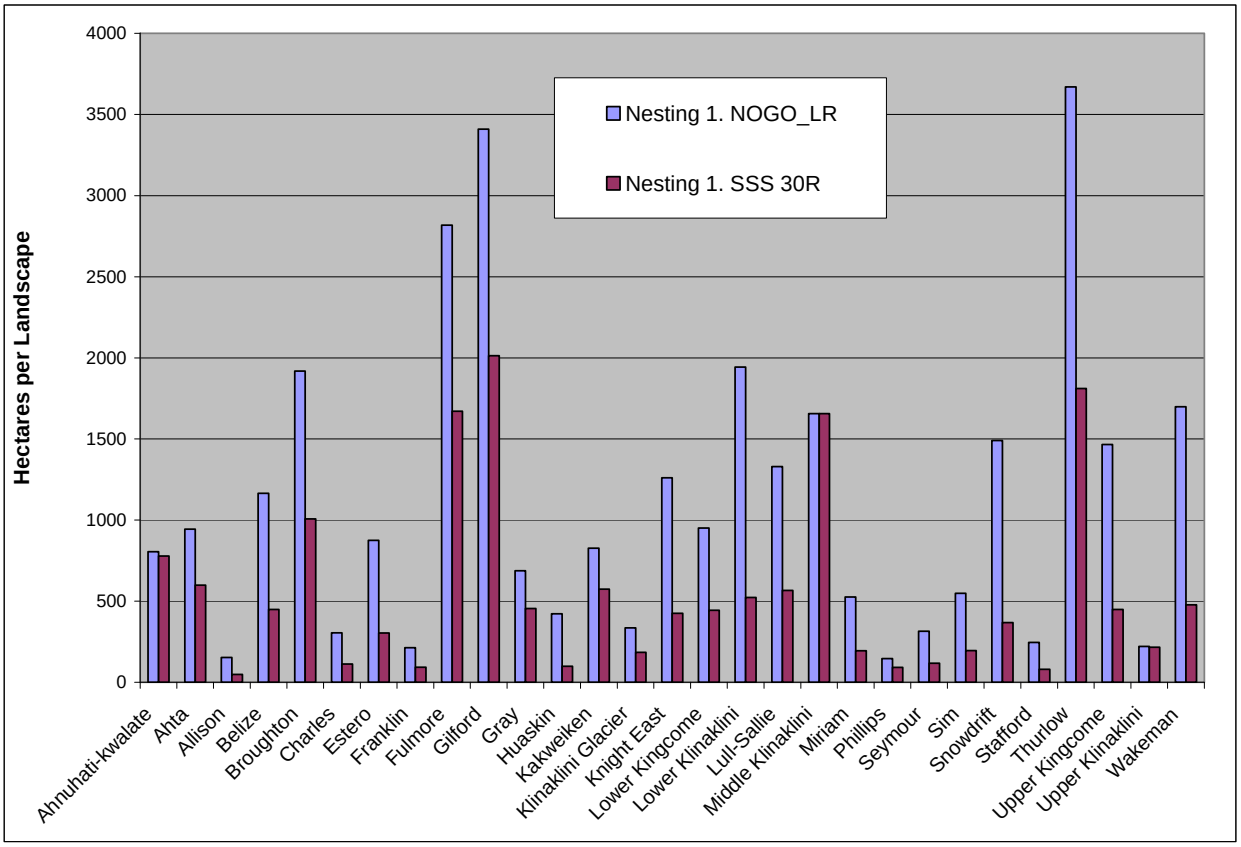

Figure 1. Comparison between the habitat captured per Landscape Unit (hectares) for solutions for Nesting 1. NoGo_LR and SSS30R.

8.2.2 Comparison of low risk scenario to mid and high risk scenarios

Domain experts did not have time to make this comparison, but it may be informative. They anticipate that the majority of foraging habitat will continue to be in the working forest THLB. Mid and high risk scenarios may therefore be viable scenarios.

8.2.3 Comparison of low risk multi-species scenario to scenarios with and without goshawk habitat as an input

Results:

- The lower risk multi-species scenario (LR_FocSPP_all) captures more than the NG_LR_SSS30R scenario.

  Conclusion: This outcome is expected and shows that scenarios for goshawk habitat do not address all focal species.

- The LR_FocSPP_all scenario run without scenarios for goshawk habitat captures less than the NG_LR_SSS30R scenario.

Conclusion: This outcome indicates that the combined scenarios for other focal species do not fully address goshawk; there is incremental habitat that is captured by using goshawk scenarios as a driver of MARXAN.

8.2.4 Other observations

- Foraging habitat appears to be well distributed in OGRAs in SSS scenarios and focal species scenarios where goshawk scenarios are explicit. In scenarios where goshawk is not included as a driver, some landscape units have very little foraging habitat.
- Existing no-harvest areas (protected areas and other areas removed from the timber harvesting land base) account for approximately one-third of area required to meet lower risk target for goshawk.
- In the solution for the low risk scenario, NG_LR_SSS30R, 3.37% of the total area of forest captured in the solution is high quality nesting habitat (N1; Figure 2) and of this amount 6.32% was in the THLB.
- High quality nesting habitat is less than the area of available THLB in all Landscape Units for which there is THLB available for harvest (Figure 3).

Conclusions:

- MARXAN will provide a better outcome for northern goshawk habitat when scenarios for goshawk are used to drive solutions toward suitable goshawk habitats.
- Existing reserve areas will not adequately meet scenarios for goshawk habitat.
- High quality nesting habitat (Nesting 1) does not take up a large area of forested landbase in the South Coast sub-region (less than 4% of total forest and less than 7% of the THLB for the sub-region a whole). The proportion of nesting habitat relative to the THLB varies considerably from landscape unit to landscape unit, which suggests a Landscape Unit - specific approach to co-location may be required to optimize solutions for goshawk.

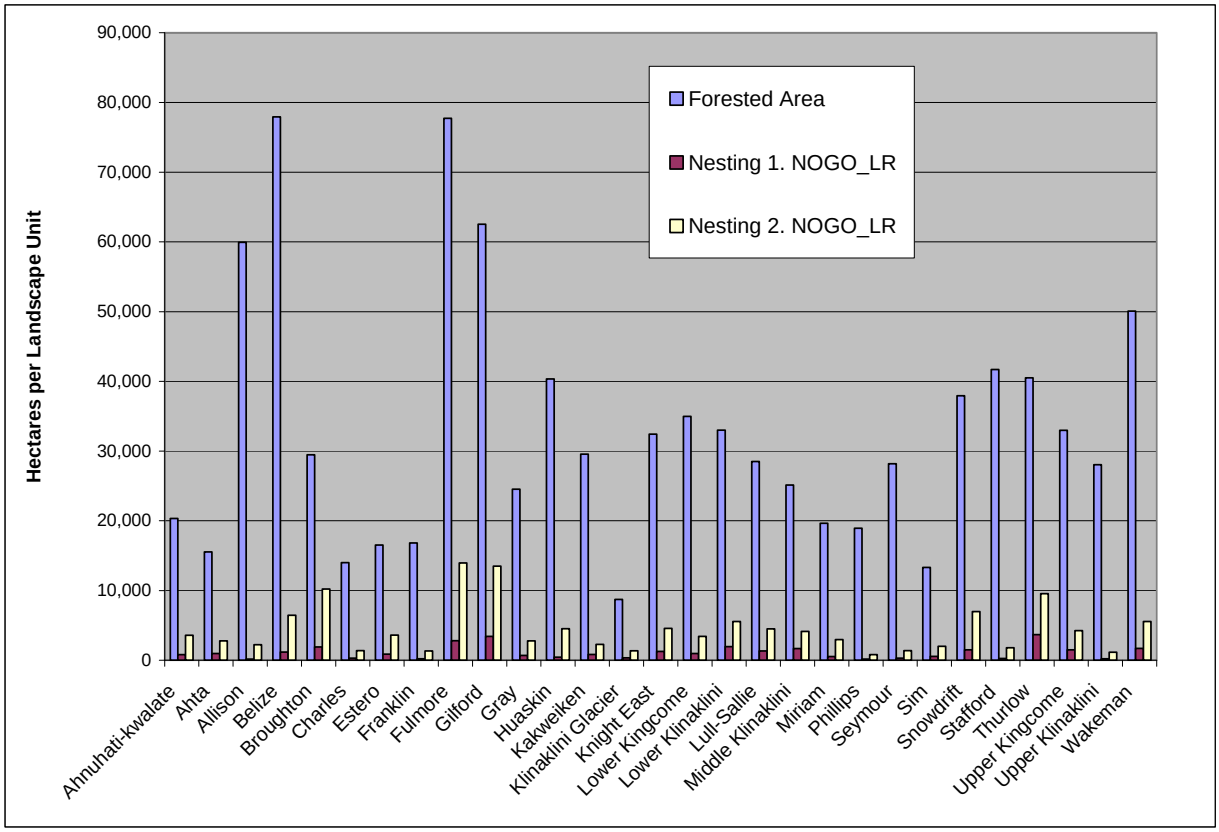

Figure 2. Hectares of nesting habitat with the Forested Landbase by Landscape Unit.

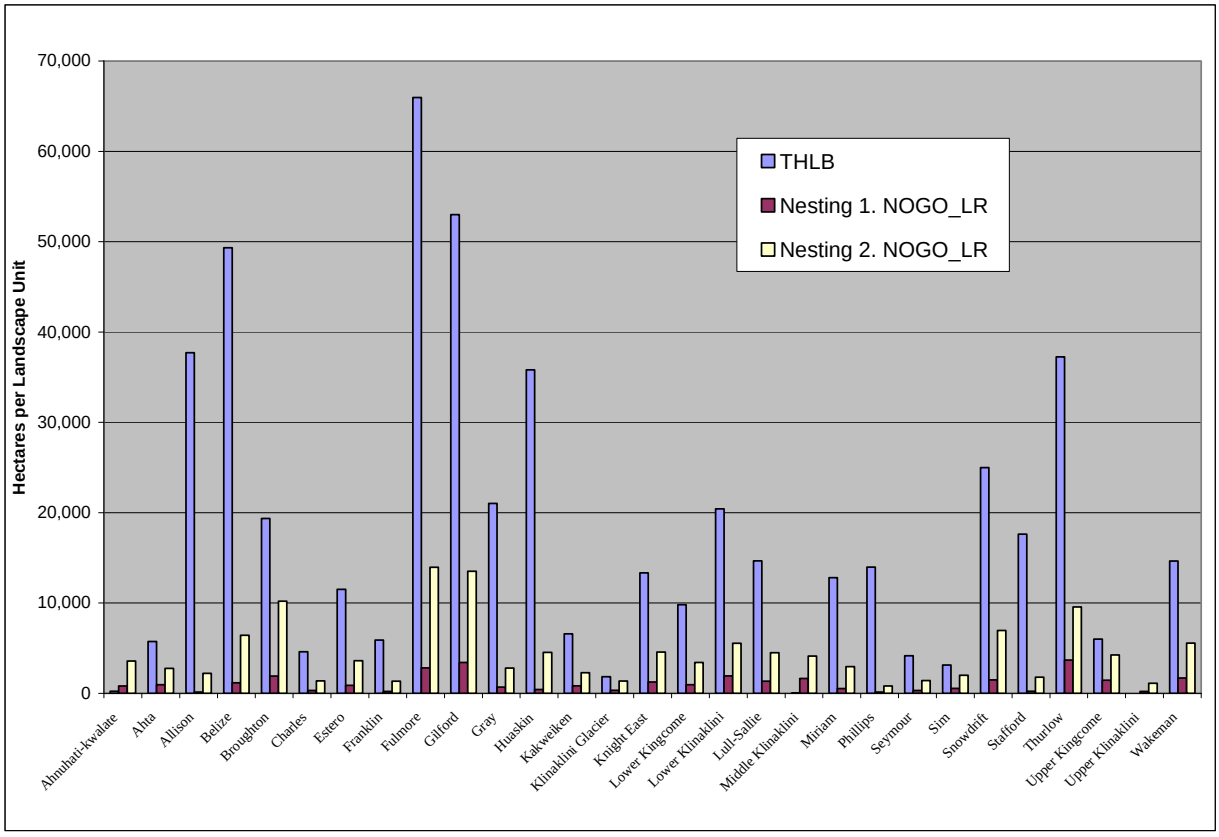

Figure 3. Hectares of nesting habitat with the THLB Landbase by Landscape Unit.

8.2.5 Overlap with other species

There is no one species that significantly overlaps with goshawk habitat. However, a large proportion (85%) of goshawk habitat is captured by all six focal species combined. While the amount of habitat is well captured, the key issue is the distribution and quality of habitats captured in OGRAs.

- There is a large amount of overlap with Marbled Murrelet Class 1 habitat but there is ten times the amount of goshawk habitat so, while Marbled Murrelet habitat may be addressed by goshawk habitat, the reverse is not true.
- There is some overlap with tailed frog and mountain goat at higher elevations. Is unexpected to see so much habitat captured at higher elevations
- There is also a high overlap with deer, which one would intuitively expect as deer require mature forest cover at lower elevations.
- Grizzly Bear capture valley bottom habitats. Reported amounts of overlap are skewed by the large amounts of Class 2 habitats in the Fulmore and Stafford (a technical issue discussed in the Grizzly Bear section).

8.3 Technical Issues with the MARXAN runs

- Because MARXAN focused on capturing old forests (>250 yrs.) first to meet site series surrogate targets, forests between 80-250 yrs were likely selected less frequently in OGRAs. Therefore, important habitat types for goshawks between 80-250 yrs. were not part of the MARXAN solution in some landscape units.
- The cost layer is driving solutions to the upper elevations and steeper slopes. The timber cost model is modeled over 400 years while the focal species habitats are based on suitability, or current condition. The result is that the cost stays constant and focal species habitats get pushed into areas of currently suitability, regardless of how the quality of habitat changes over time. For goshawk, which require large areas of habitat over time, it is important to factor in second growth coming on-line.
- Anomalies with the cost layer also seem to result in more moderate than high habitat in the solution.

8.4 Future considerations

1. Assess the degree to which inherent biases in goshawk models and MARXAN design are resulting in under-representation of certain ages, elevations and slopes e.g., under-representation of older second growth forest (> 60 years).
2. Develop a method to design MARXAN to seek a solution that maximizes overlap with other focal species habitat needs and site series or site series surrogates, while minimizing cost but also represents suitable nesting habitat patch sizes that are distributed at estimated territorial spacing distances.
3. Run goshawk capability models for nesting and foraging to examine the amount and distribution of goshawk habitat over time within and outside OGRAs.

8.5 Conclusions

- The combination of multi-species scenarios and targets for old growth retention captures adequate amounts of goshawk habitat overall (in addition to nest areas/PFAs). SSS representation contributes to a good solution for goshawk because the results are distributed across numerous ecosystems. However, scenarios that do not explicitly include goshawk nesting and foraging habitats inadequately provide for a distribution of high and moderate value habitats across landscape units.
- Recruitment: Younger stands in valley bottoms provide potential high quality habitat in the future. For goshawk, the whole landbase needs to be considered, including forests growing

into older second and third growth stands. The current timber cost model drives outcomes away from potential recruitment areas.

- There is strong overlap between goshawk and marbled murrelet habitat; however, the area of overlap only represents a small proportion of goshawk habitat.

9.0 Results for Coastal Tailed Frog (*Ascaphus truei*)

Domain experts:

Pierre Friele, Cordilleran Geoscience

Volker Michelfelder, Ministry of Environment

9.1 Description of experimental scenarios

9.1.1 Map inputs

MARXAN used the updated tailed frog model that was developed based on basin size and ruggedness class.

- Tailed frog streams were buffered by 50m each side. Areas of overlap between the stream buffer and the basin were dissolved to separate the buffered streams from the remaining basin area.
- Non-forested polygons were removed from the dataset (age class = 0).

There are nine approved WHAs in the South Coast, each consisting of a core area (100% netdown) and buffer area (80% netdown).

9.1.2 Habitat definition

Class 1 habitat = buffered streams, ruggedness 30 - 70%;

Class 2 habitat = buffered streams, ruggedness 71 - 120%;

Class 3 habitat = remaining basin area, ruggedness 30 - 70%;

Class 4 habitat = remaining basin area, ruggedness 71-120%

(see assumptions in section 7.5.2.1 re ruggedness and habitat value for basins)

9.1.3 Scenarios

Low risk scenario:	Class 1: 50%; Class 2: 45%; Class 3: 30%; Class 4: 40%; Fragmentation: low
Mid risk scenario:	Class 1: 35%; Class 2: 30%; Class 3: 25%; Class 4: 30%; Fragmentation: low
Higher risk scenario:	Class 1: 20%; Class 2: 20%; Class 3: 20%; Class 4: 20%; Fragmentation: moderate

Domain experts also identified a 'lowest risk' scenario of 100% of Classes 1 – 4 habitats i.e., entire sub-basins captured. This scenario was not run in MARXAN but was acknowledged to have the least risk to *A. truei.*

Established WHAs: the entire WHA (core+ buffer area) was locked in as part of the designated 'reserve' layer.

Analysis units:

Landscape unit

9.1.4 Reporting outputs

1. Area of total habitat in OGRAs x habitat class x basin size x LU
2. % mature and old forest in OGRAs x habitat class x basin x LU
3. Total length (km) of buffered stream per basin
4. Total area of basin
5. Measure of fragmentation per basin (not sub-basin), calculated from basic summary stats

9.2 Findings from review of scenario outputs

9.2.1 Review of scenarios

There were two problems with the MARXAN outputs:

- resultant polygons fragmented stream segments; and
- solutions for stream buffers and their contributing basins were not linked. They need to be together for a functional solution i.e., want the ecological benefit (hydrologic) of the watershed as a whole linked to buffered streams.

Because of these issues, domain experts were unable to assess the effectiveness of co-location solutions in addressing habitat requirements for tailed frogs.

9.2.2 Overlap with other species

There is not a lot of overlap between species. This is not surprising because:

- Tailed frogs are lotic and other focal species are terrestrial.
- Habitats for other focal species tend to be at lower elevations. For example, high value hydroriparian habitat for grizzly bears and marbled murrelets occurs in low elevation areas and not in higher elevation fishless headwater streams.
- High elevation habitats, e.g., for mountain goats, are not focussed around streams.

This lack of overlap is precisely why tailed frog were chosen as a focal species. By including tailed frog in the analysis it was hoped that some protection could be focussed on upland streams.

9.2.3 Conclusions

1. MARXAN methods need to be adjusted to
   a. prevent fragmentation of stream segments in the solutions; and
   b. link buffered streams to their contributing basins in the solutions.

   One approach to address (b) would be to capture entire basins in the MARXAN analysis, but that would create a higher timber cost than is strictly needed for the ecological benefit sought.
2. The priority focus should be on capturing stream buffers by habitat class then on capturing basins.
3. The reliability of the MARXAN solutions is affected by limitations of the input data. While domain experts have confidence in the habitat model used, there are uncertainties associated with the lack of tailed frog inventory and the patchiness of habitats.