EBMWG DS04a

Co-Location Project Final Report:

Prepared for the Ecosystem Based Management Working Group.

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Chuck Rumsey
Hannah Horn

EBMWG DS04

Co Location Project
Final Report

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1 INTRODUCTION

1.1 Purpose of DS04 Co-Location project

Careful design of old growth reserves can help to satisfy multiple ecological conservation and forestry economic objectives simultaneously. The purpose of this project is to explore how this can most effectively be achieved in the Central and North Coast LRMP planning areas and to use the results to forward implementation of Ecosystem Based Management (EBM) land use objectives. Results will be used to identify potential areas for old growth management reserves that meet conservation objectives while avoiding timber supply impacts. It is important to note, that the results presented here are experimental and strategic in nature, and as clearly stated in the project terms of reference, are in no way intended to be construed as ready-to-implement defacto reserve maps.

EBM in the Coastal Context

A key outcome of strategic planning exercises on the mainland coast of BC has been the adoption of EBM as the approach to planning and management of terrestrial resources. With regard to Ecological Integrity, full implementation of EBM is defined in Government-to-Government (G2G) Agreements between First Nations and the Province of B.C. as:

"Conservation measures…that seek to achieve a low level of ecological risk overall…over time, including:

a) Strategic land use zones (conservancies, biodiversity etc) and, as appropriate, related management plans

b) Landscape reserves (First Nations cultural areas, old growth management areas, ungulate winter range, and general wildlife measures); and

c) *Land use objectives (cultural, biodiversity, hydroriparian, wildlife, etc.)"*

Legal direction: Coastal Land Use Orders

Co-location of focal species habitats within old growth retention areas is enabled under Section 14 of the Central & North and South Central Coastal Orders[1]. 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,

[1] Full description of Central & North and South Central Coastal Orders can be found at http://www.ilmb.gov.bc.ca/slrp/lrmp/nanaimo/cencoast/plan/objectives/index.html

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 Coastal Orders contain objectives that specifically address grizzly bear habitats and black bears within Kermode Stewardship Areas but other wildlife species are addressed through co-location under section 14.

1.2 Project Implementation

1.2.1 Links to the EI02c Focal Species Project

The DS04 Co-Location Focal Species Project is closely linked to the EI02c Focal Species Project which was initiated, in part, to develop and refine habitat mapping and models to be used as inputs to co-location exercise.

Figure 1 summarizes the relationship between the Focal Species and Co-Location Projects. In the Focal Species Project, domain experts used best available base information and ecological knowledge to recommend map inputs and scenarios to be tested by the co-location project. The outputs of co-location were evaluated by the domain experts and the feedback from this evaluation informed the next round of scenarios (Horn and Rumsey 2009a). The eventual outcome of this iterative effort is intended to provide an automated approach for strategically locating potential areas for old growth retention in a manner that meets conservation objectives while minimizing impacts to timber supply. The Focal Species Project also assessed how much habitat is not captured within OGRAs and made strategic recommendations for managing focal species habitats outside of reserves (Horn and Rumsey 2009b).

The interaction between DS04 and EI02 was undertaken in three distinct phases as follows:

Phase 1: Preparation for strategic co-location scenarios
In Phase 1, focal species 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. This input was summarized in *Knowledge Base for Focal Species and their Habitats in Coastal B.C.* (Part 3 of the Focal Species Project report series) (Horn 2009a).
The inputs from Phase 1 were used to prepare a proof of concept of a 'Co-location Tool' using MARXAN conservation planning software (see section 2.2) 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 assessed the sensitivity of the scenarios to changes in targets for old growth retention. Scenarios were run for the South Coast planning sub-region (see section 2.1). Domain experts met in December to review the scenarios and develop recommendations for improving habitat mapping and to refine inputs into MARXAN. These inputs informed scenario runs in Phase 3.

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. The review and recommendations are summarized in *Management recommendations for focal and fine filter species under Ecosystem-Based Management* (Part 1 of the Focal Species Project report series) (Horn and Rumsey 2009b).

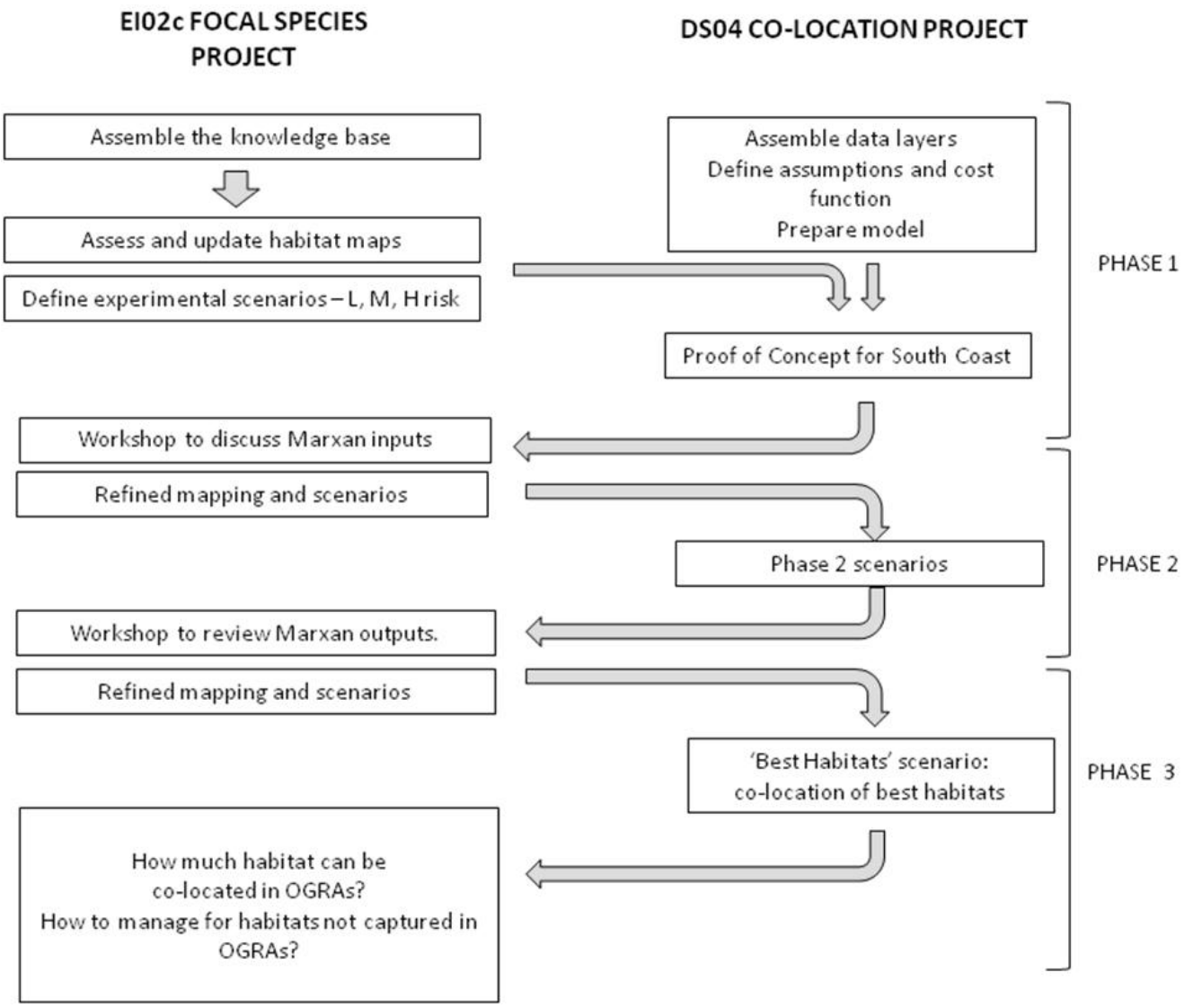


Figure 1. Relationship between the EI02c focal species and DS04 co-location projects

1.2.2 Links to the Landscape Level Reserve Project

A parallel Landscape Level Reserve Project compared the strategic DS04 co-location outputs to reserves designed by planners at the landscape scale using a more hands-on approach (Lewis and Kremsater 2009). The 'landscape unit design' process uses the output of scenarios based on different levels of habitat retention to guide the more detailed co-location of habitats within OGRAs.

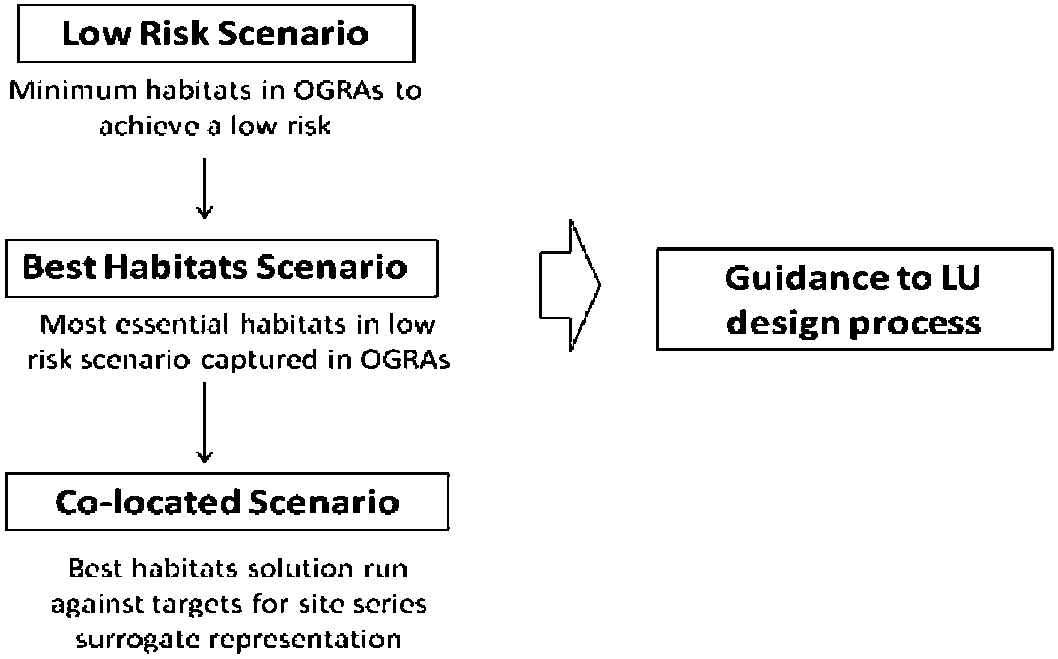


Figure 2. Link between the focal species, co-location and landscape level reserve projects and focal species project reports.

1.3 Document Purpose

This report is focused on describing the methods and results arising from the final set of co-location scenarios run for the South Central Coast, Mid Coast and North Coast Study Areas (see section 2.1). As such, it ties directly into EI02c reports, most specifically, to *Methods for Strategic Co-Location of Habitats in Coastal B.C.* (Part 3 of the Focal Species Project report series, Horn and Rumsey 2009c) which details the methods recommended by domain experts to strategically co-locate focal species habitats within old growth retention areas, including data inputs.

The DS04 report is also accompanied by a suite of GIS and database products that provide a more interactive opportunity to explore results and which will hopefully serve as starting point for future co-location efforts and to guide the application of strategic co-location outputs during detailed landscape unit design.

2 METHODS

2.1 Study Area

The coastal planning region comprises the boundaries of the North and Central Coast Land and Resource Management Plans (LRMPs). For the purposes of the DS04 project, the region is divided into three sub-regions that are referred to in this report: North Coast, Mid Coast and South Coast (Figure 2). The boundaries of each study area are defined by the collective landscape units that are located in the sub-region.

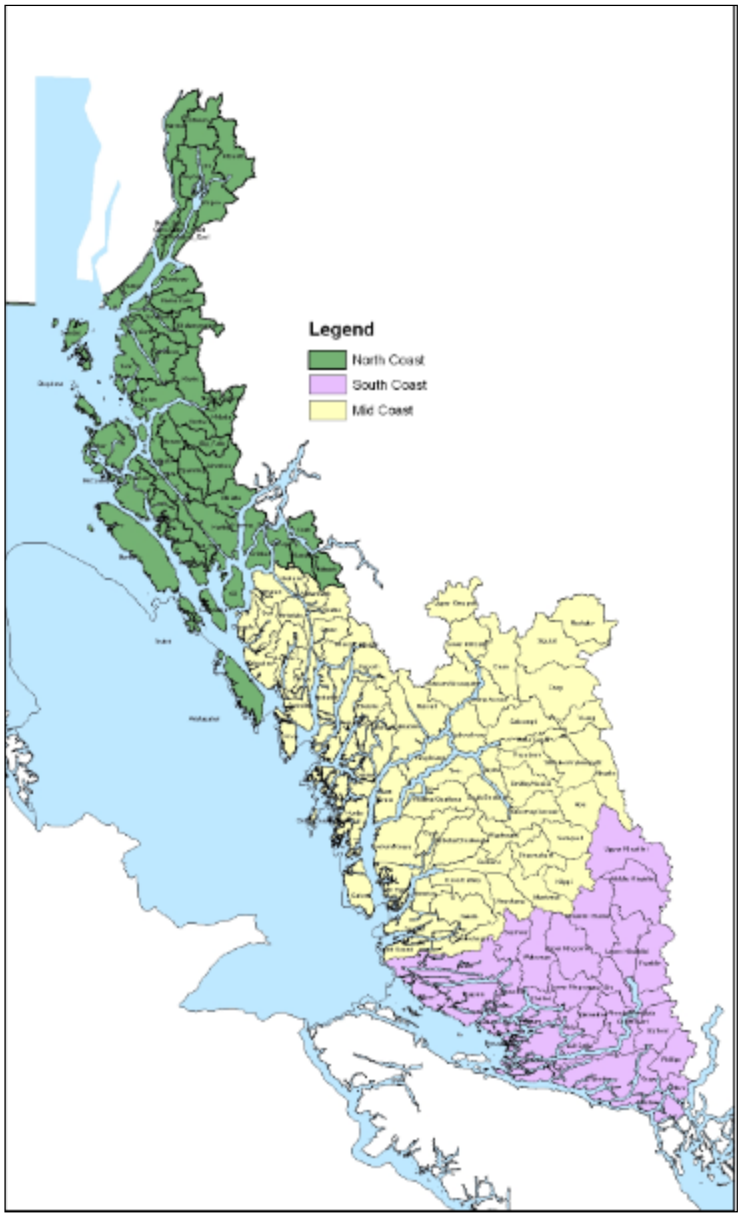
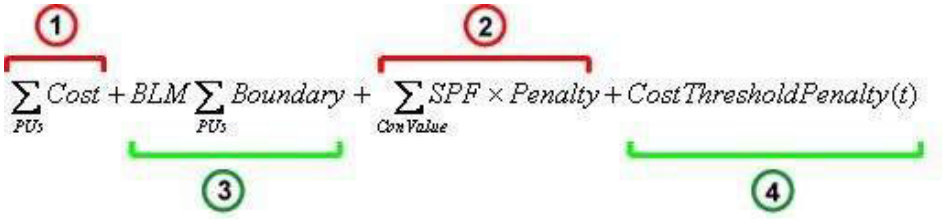


Figure 2. Sub-regions for coastal planning under EBM

2.2 Marxan

For the purposes of co-location we used the site selection software Marxan, applying an algorithm called "simulated annealing with iterative improvement" as a method for efficiently selecting sets of areas to meet conservation goals (Ball et al, 2009). The algorithm attempts to minimize reserve or portfolio "cost" while maximizing attainment of conservation goals. In the case of DS04, cost was assessed based on a combination of total area and timber value (see section 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)
4. The penalty for exceeding a preset cost threshold (optional)

The specific settings for these parameters are further discussed below.

2.3 Existing 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. In the final suite of scenarios, existing reserves were "locked" into the solution, meaning that the amount of habitat and forests that were found in each area were counted directly toward meeting conservation goals.

To be included as an existing reserve, an area needed to have a clear spatial boundary with a high degree of certainty that existing legislation and/or policy would reserve the area from timber harvest activities. In many cases these criterion were easy to evaluate, such as in the case of provincially mapped parks and conservancies, while other administrative areas presented interpretive challenges that varied by sub-region. In general, the following reserve areas were:

- **Conservation Areas** – Existing parks, conservancies, and biodiversity areas,

- **Riparian** – combination of buffered 'High Value Fish Habitat' and 'Floodplain' layers. (note: this layer was not available for analysis in the North Coast study Area).
- **Wildlife Habitat Areas** –identified for tailed frog, Marbelled Murrelet, and Grizzly Bear.
- **Grizzly Critical Habitat** – As identified by recently established legal orders for the South, Mid, and North Coast sub-region.
- **Ungulate Winter Range --** As identified by recently established legal orders.

A full explanation of the rationale behind the inclusion or exclusion of species specific reserves is found in Appendix 1 and the specific source of GIS data sets used to demark these areas is provided in Appendix 2.

2.4 Planning Units

In order to better represent the land base around which decisions regarding old growth reserves were to be made, forest polygons from available forest cover were used for the analysis. These polygons were provided by the provincial government's Integrated Land Management Bureau (ILMB) and were mapped at the 1:20,000 scale using a combination of data provided by licensees and the provincial government. Existing reserves and Landscape Unit boundaries were intersected with these forest polygons to create a final planning unit layer for each sub-region.

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 project, we incorporated both an area-based cost as well as a surrogate for timber values (see Section 2.5.1). Where choices existed for co-locating forest and habitat values for reserve, a preference for selecting reserves away from areas with high potential timber value was established.

2.5.1 SELES and the creation of a cost layer

Using SELES, the initial cost function was derived based on total volume harvested per 1-ha analysis cell over a 400 year analysis window. For these purpose, 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 (Fall 2003). 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 4 times as far).

The SELES derived cost surface applied only to the Timber Harvesting Land Base (THLB), since areas outside of the THLB, by definition, contained no harvestable timber values over the long term (see Box 2.5.1 for further notes on THLB). However, in addition to the timber-based values, all planning units had the area cost (in hectares) added to the unit. In this way even non-THLB units had a cost associated for inclusion into a solution, such that if two non-THLB planning units had equal amounts of conservation gain, the smaller of the two would be chosen for the solution.

Box 2.5.1 The Timber Harvesting Land Base (THLB)

The extent to which an area is said to be part of either the THLB or non-THLB has important implications for reserve design. In the past, timber supply models used by the BC Ministry of Forests have treated non-THLB areas as *defacto* reserved, i.e. assuming no timber harvest will occur there.

In reality however, data from existing and proposed cut blocks indicate that significant amount of harvest is taking place in what the latest Ministry of Forests TSR identifies as non-THLB. Efforts are underway to update the "line of operability" and presumably such updates will help create more certainty on the issue.

For the purposes of DS04, as per the project terms of reference, we have used the data that is available despite its apparent shortcomings. Indeed, it seems likely that areas within the currently identified THLB have a higher probability of being subject to harvest than non-THLB. Nonetheless, future co-location efforts should be undertaken with updated information on operability.

2.6 Boundary Length

By adjusting thresholds for overall boundary length, Marxan can be programmed to produce more or less compact or 'clumped' reserve systems. A more compact solution will mean that targets are likely to be met in a smaller number of large reserves. This has the effect of reducing fragmentation, something that is desired when designing habitat reserves at a landscape scale. However, creating a more compacted solution also increases the over all cost of the solution, since planning units, regardless of their conservation value, will be swept into a solution strictly to satisfy the limit of boundary length.

While using boundary length (as applied in Marxan though the Boundary Length Modifier--BLM) would create more connected solutions, trying to decipher the source of additional costs for a scenario would hamper interpretation of solution results. As DS04 is intended as a strategic level assessment it was decided that the larger benefit lay with creating easily comparable solutions where assigned cost and representation targets were not subject to other constraints. As such, for the primary scenarios developed for DS04 (see Section 2.10.1), boundary length has not been used. However, boundary length has been calculated for all planning units and a BLM can be applied, as was done in one secondary scenario for demonstration purposes.

2.7 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 through 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 (Appendix 3). The seral class for each SSS was broken into seral classes as follows:

- Old -- >250 years (except in the South Central Coast where it is >180 years)
- Mature -- 120 to 250 years (or 120 to 180 in the south)
- Mid -- 40 to 120 years
- Young -- 0 to 40 years

2.7.1 Recruitment

In addition to identifying 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 2.7.1).

Box 2.7.1 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

2.8 Focal Species Marxan Inputs

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

A full accounting of the habitat layers used as inputs is found in Appendix 1, while the specific GIS sources for each of the following focal species is described in Appendix 2. 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 2009b). Black bear habitat suitability mapping was reviewed by domain experts and rejected for use as an input to the co-location exercise.

2.8.1 Coastal Black-tailed Deer Winter Range

Based on recommendations from the Phase 1 EI02c Workshop, a habitat suitability layer was created for subsequent phases of DS04. This information added 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 et al 2009b) and goals applied as described in section 2.2.8.

At the time of analysis, deer habitat mapping was not completed for the North Coast and was not included.

2.8.2 Grizzly Bear

Grizzly Bear habitat classes 1 – 6 were provided by ILMB for most of the study area as well as the scheduled map layer of critical Grizzly Bear habitat under the appropriate Coastal Orders. Representation goals were applied to Classes 1 and 2. For the most part, polygons labeled Class 1 also constitute Critical Habitat under legal order and as such, were fixed into the planning unit layer and assumed part of any conservation solution in 'locked' scenarios (see section 2.3). For the purposes of goal setting and reporting, habitat classes were stratified by Biogeoclimatic Ecosystem Classification (BEC) zone, subzone and variant.

It is important to note that for Mid Coast Landscape Units that were fully protected, grizzly bear habitat was not identified. While this does not hamper the co-location of reserves per say, since goals were set landscape by landscape (see section 2.9), it does prevent an exact sub-regional gap assessment concerning how much grizzly bear habitat is being reserved.

2.8.3 Marbled Murrelet

Modeled and mapped information for Marbled Murrelet is in varying states of completion between the 3 sub-regions of the project. Fortunately, for the South Central Coast, all landscape units had either air photo interpretation or low level aerial assessment mapping completed. In the case of the Mid Coast, this was also true except for 4 landscape units where the Hobbes model is used and 7 more where only the Marbled Murrelet Recovery Team (MMRT) model is available (see Appendix 2). For the North Coast, only the Hobbes model was used.

As reserve analysis was being done within and not among LUs, the difference in data sets was not considered an obstacle. 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.

2.8.4 Mountain Goat

Based on recommendations from the Phase 2 EI02c Workshop, a habitat suitability layer describing class 1 and 2 female goat habitat was used for the South Coast while for the mid and north coast a single goat suitability model was provided. These models supplement the Ungulate Winter Range designation which is an important element of existing reserves, but does not capture all existing habitat.

2.8.5 Northern Goshawk

Through discussions with the Northern Goshawk Recovery Team, it was decided that the existing Northern Goshawk foraging and nesting 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. For the study area, known nest sites were also buffered by 200 meters and incorporated into the analysis.

2.8.6 Tailed Frog

New tailed frog habitat layers were created in 2008 to support the the EI02c and DS04 projects. These consist of two classes of buffered stream and 2 classes of tailed frog basins differentiated by ruggedness class (30 – 70% and 71 – 120%). Two further classes were established based on the watersheds containing the buffered stream segments.

2.9 Representation Goals

2.9.1 Site Series Surrogates

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. As the project came near to completion, a new set of Landscape Unit objectives were established for old growth retention. These objectives assign a percentage target, ranging between 30 and 100% to the SSS's of each Landscape Unit, based on the expected Range of Natural Variation (RONV) for the SSS (see Appendix 3). Those SSS classified as Very Rare, Rare or Modal also received at least 70% RONV retention goals, while an additional suite of SSS identified as vulnerable also had incremental hectare goals added to percentage goals to ensure better than "High Risk" management.

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).

2.9.2 Focal Species Habitat Representation

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)'.

In its final phase, EI02c made recommendations that called for three different representation scenarios which used variations on the "Low Risk" representation goals. These goals and their rationale for each species are described in Appendix 1.

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

2.10 Scenarios

2.10.1 Primary Scenarios

In the final phase of the DS04 project three primary scenarios became the focus of co-location experiments. All three scenarios used the same landscape unit objectives to define old growth retention goals for site series surrogates. For focal species representation goals, each scenario was based on, or involved a variation of, the "Low Risk" goal definition (see Table 2.10.1.1)

- Scenario 1: *Low Risk* -- In this scenario, focal species goals were applied as described in table 2.10.1.1

- Scenario 2: *Best Habitats* -- For the "Best Habitats" scenario, Domain Experts were asked to define a subset of habitat attributes within the available species model that they considered "best." For example, instead of collocating with both "High" and "Moderate" probability habitats, the representation target might only apply to "High." The hope was to create a more focused co-location scenario that pushed co-location into optimum areas for species overlap and for overlap to be centered on the most valuable of habitats.

- Scenario 3: *Co-Located Landscape Unit Objectives (LUO)* – This scenario was created for the purpose of modeling how successful co-location might be given the limitations of the existing legal orders. In this case, "Best Habitat"[2] goals were still applied to focal species target, but a cost threshold was set within Marxan. That threshold was based on the total cost associated with meeting only the LUO goals for SSS old growth retention and Grizzly Bear critical habitat—a number calculated in a separate Marxan run with only those LUO features included. The resulting threshold or "budget" then acted as a cap in a second Marxan run that included both SSS and Focal Species habitat. Using the Species Penalty Factor, Marxan was programmed to meet all of the SSS goals, but only represent focal species habitat up to the point that the cost budget would not be exceeded.

A detailed description of these representation goals as applied to each focal species, including rationale for their use, is presented in Appendix 1.

[2] In the case of South Coast "Low Risk" Goals were used for the Budgeted LUO scenario, but based on subsequent domain expert input, "Best Habitat" Goals made more intuitive sense and were thus used in Mid Coast and North Coast scenarios

Table 2.10.1.1 Final representation goals for "Low Risk" and "Best Habitat" Scenarios[3]

Species	Locked in	Low Risk scenario	Best Habitat Scenario (targets are a % of outcomes of the Low Risk scenario)
Deer	Approved UWRs	90% of H habitat but could achieve with a minimum of 70% H and twice the M	100% of LR solution
Grizzly bear	Approved whas	100% of Class 1, 100% of Class 2 in order of priority: early/late spring; vh1; floodplains outside of riparian buffers x BEC x LU	100% of LR solution
Marbled murrelet	Approved whas	100% of Class 1, 100% of Class 2, make up to 62% with Class 3 x distance to ocean class x LU	100% of Class 1 and 100% of Class 2; 100% of proposed WHAs in MC and NC;
Mountain goat	Approved uwrs	South Coast: 90% of Type 1, but could achieve with a minimum 70% Type 1 and twice the Type 2 Mid Coast: 90% Suitable North Coast: 100% suitable	100% of LR solution; 100% of proposed UWR in NC and SC
Northern goshawk	Approved whas	100% of buffered nest areas (all age classes) 60% of M or H foraging habitat, at least half to be H; 60% of M or H nesting habitat, at least half to be H	100% of known nest areas; 100% of nesting habitat; 33% if foraging habitat
Tailed frog	Approved whas	50% of Class 1 streams, 45% of Class2 streams, 30% of Class 3 basins, 40% of Class 4 basins 100% of Class1 and 2 streams that overlap known tailed frog occurrences	100% of LR solution for buffered streams (Class 1 + Class 2); 100% of Tier 1 TF habitats in MC

[3] In the case of the South Central Coast the following key exceptions existed: No goals for Northern Goshawk, Deer type 2 and Goat type 2 were set. The changes between South Central Coast and Mid/North Coast were the consequence the sequential sequencing of the sub-regional analysis and the evolving discussion and debate among experts during the course of the analytical process.

3 RESULTS

3.1 Packaging of Results

Results from the DS04 package are described both spatially, in the form of GIS layers, and quantitatively, largely through tables and figures. In the latter case, results can also be described for the sub-regional study areas as a whole, as well as for individual Landscape Units. For this document, focus will be placed on describing overall sub-regional results since display of landscape by landscape outputs would overwhelm the document. However, a full breakdown of both sub-regional and landscape results is made available in the DS04 'Results Package' through the use of pivot tables which allow the user to select combinations of species, landscape units, and other data to survey results in closer detail and at finer scales.

3.1.1 Spatial Ouputs

One of the most important products that emerge from the Marxan driven co-location exercise are the spatial outputs that can be created in a GIS environment using what are called Marxan 'Best' and 'Summed' solutions.

Best Solutions – These outputs can be used to create a spatial layer that describes the 'optimum' co-location scenario for any particular set of inputs and goals. Best solutions are a binary output in which each planning unit in the study area is either "in" or "out" of the solution (see Figure 3.1.1.1). This format allows for concise quantitative summaries of what each scenario costs and how well targets are met. However, it should be noted that Best solutions are only theoretically "optimum" and there may indeed be alternative solutions that yield very similar benefits to resolving the conservation challenge at hand. In many ways the absolute binary results masks or hides what may be considerable variability in meeting any particular scenario.

In the spatial outputs delivered in the DS04 results package, the Best solution will be described for each scenario by a "1" in the field labeled for the scenario name. A zero indicates that the planning unit is not part of the solution for the scenario.

Summed Solutions – These outputs are based on the number of times Marxan selects a particular planning unit in resolving any particular scenario. In the DS04 project, each scenario is run 100 times, and as such each planning unit could have a summed solution score between zero and 100. A zero means the unit was never selected for the solution, while 100 means it was always selected. For example, an existing reserve would always be scored a 100 since it was "locked" into the solution. On inspection, one sees that there is in fact a wide range of variation between these extremes[4] (Figure 3.1.1.2). For the sake of this report, we describe planning units that are selected more frequently as having a higher conservation "utility" than those less frequently selected.

[4] Note that in the solution shapefiles of the DS04 data package these scores have been simplified to a whole integer score between 0 and 10.

It is impossible to do many of the necessary summary quantitative assessments that Best solutions provide, since a unit must be either in or out of a solution when calculating metrics such as the size of the solution. However, it is these summed solutions that may provide the most spatial insight for planners, since the inherent variability allows for greater flexibility when accommodating multiple objectives, including those not being actively supported or modeled by Marxan (see section 4.0).

Figure 3.1.1.1 Example of "Best" Solution for Low Risk Scenario in Stafford LU. Pink area is "in" and white areas are "out".

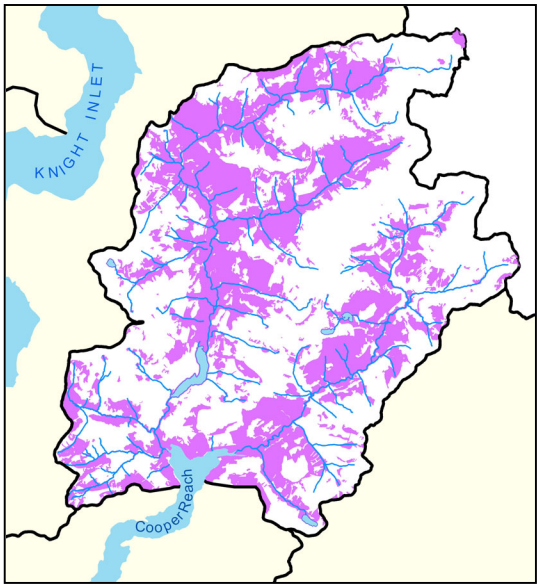
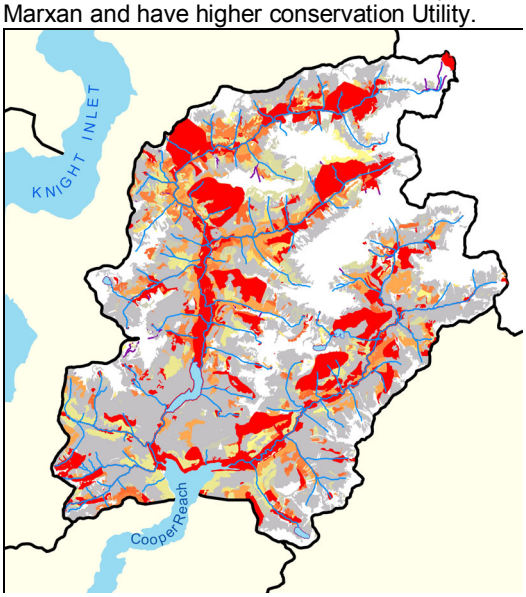


Figure 3.1.1.2 Example of "Summed" Solution for Low Risk Scenario in Stafford LU. Hotter colours have been selected more often by Marxan and have higher conservation Utility.



A note on mapping: Because of the complexity of spatial results and the scale at which they are rendered, it is very difficult to display resultant maps in a report. Occasionally this report will take examples from individual Landscape Units in order to demonstrate key concepts, but it is advised that all spatial results (which are provided in the DS04 results package as shapefiles in the BC Albers projection) be pulled into an appropriate GIS for complete viewing and comparisons.

3.1.2 Quantitative Results

The remainder of this report will focus on three main types of quantitative assessments of the co-location scenarios.

1. Existing Protection –An assessment of the extent of current protection for species habitat. An analysis which does not involve Marxan directly, but rather a GIS driven product developed as a pre-cursor to Marxan runs. The existing protection does not vary between scenarios, but what is characterized as 'existing' does vary by sub-region.

2. Scenario Footprint – A description of the overall size of a scenario solution in terms of forested area, THLB area, and overall cost.

3. Habitat Results – An assessment of how much of each habitat type is captured by each scenario solution.

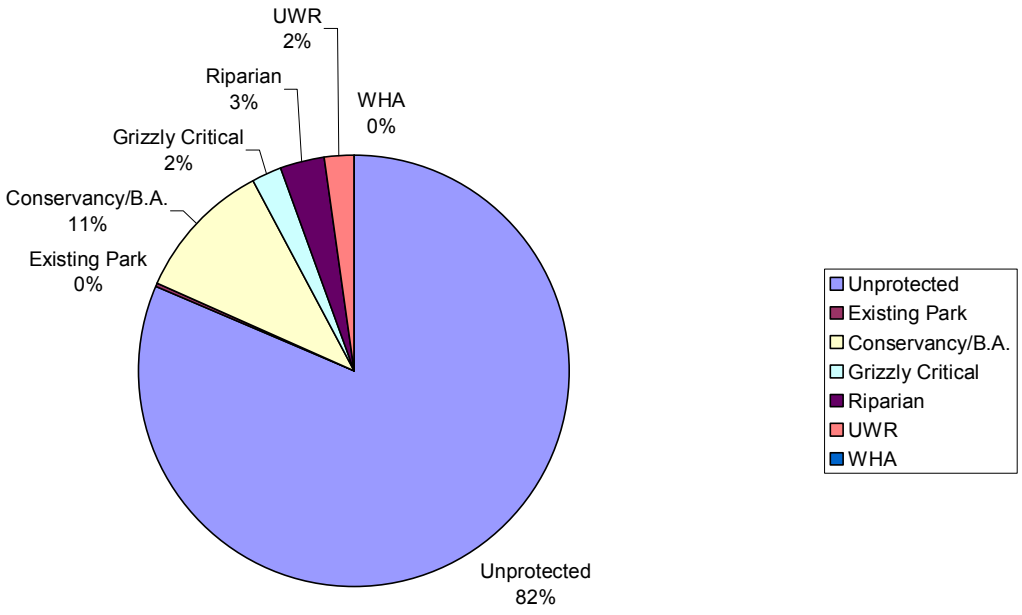
3.2 Existing Protection

For a full list of species habitats and their levels of protection by sub-region, and by Landscape Unit, please refer to the DS04 data package and associated pivot tables.

3.2.1 South Central Coast

Taken as a whole, the various existing reserves of the South Central Coast are sporadic covering almost 180,000 hectares or 18.7% of the forested area[5] of the sub-region (Figure 3.2.1).

Figure 3.2.1.1 Current protection of forested landbase in the South Central Coast sub-region

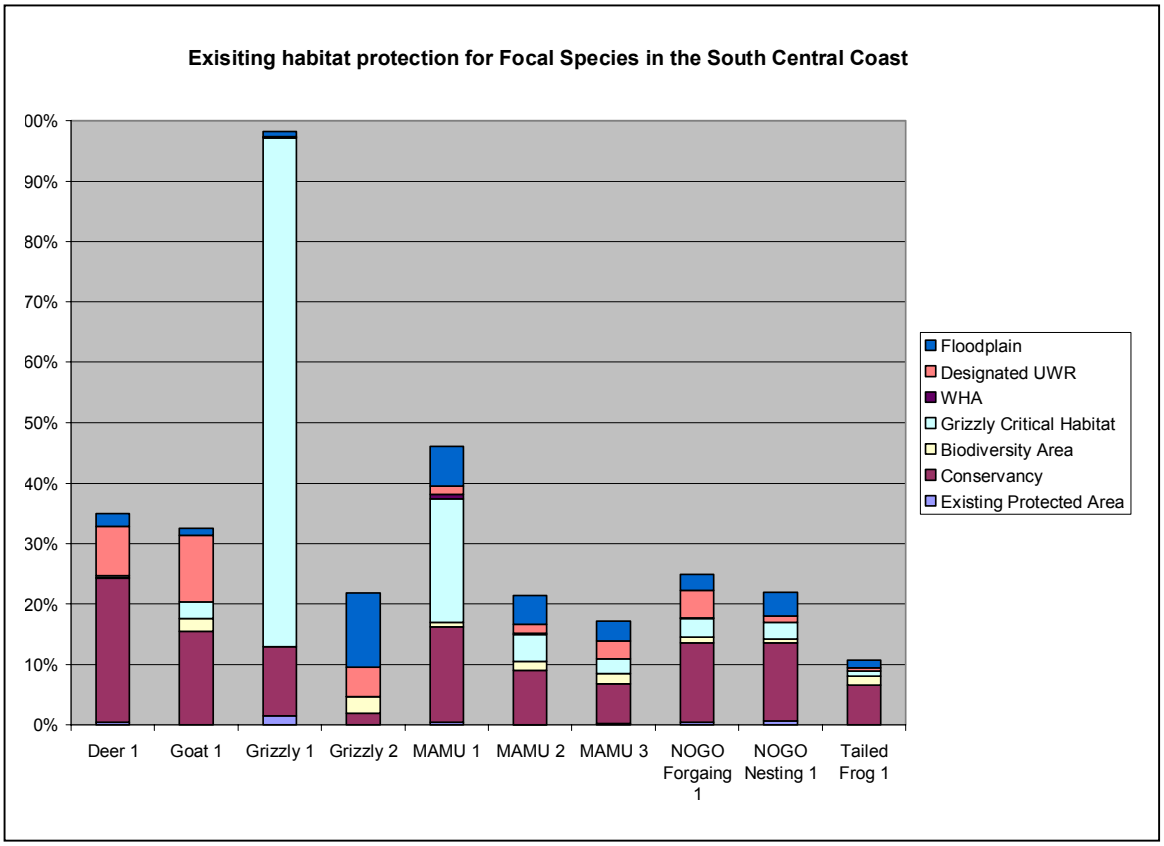


The benefit of existing protection to species habitats varies, representing some better than others (Figure 3.2.1.2). The largest contribution to habitat protection comes from designated conservancies, though for grizzly bear Critical Habitat (class 1) is clearly crucial. Other overlaps of note include the degree to which Marbled Murrelet class1 habitat is picked up by grizzly Critical Habitat and to a lesser extent, the important role of Floodplain reserves in capturing grizzly bear class 2 habitats. It is also notable that existing UWR captures only about 10% of identified high value goat habitat in the sub-

[5] "Forested" for this analysis includes any forest cover polygon for which a full Site Series Surrogate has been defined.

region. Finally, with the exception of grizzly bear 1 habitat, existing protection falls short of the low risk scenario recommended by domain Experts in the EI02 project. This assessment does not include the additional protection provided through implementation of all of the LUOs, for example old growth representation which will provide additional habitat. Again, these are sub-regional summaries and it is important to remember that we can expect protection to vary considerably between Landscape Units-- it is quite possible for habitat to be completely conserved by an existing park in one landscape while entirely left out in another.

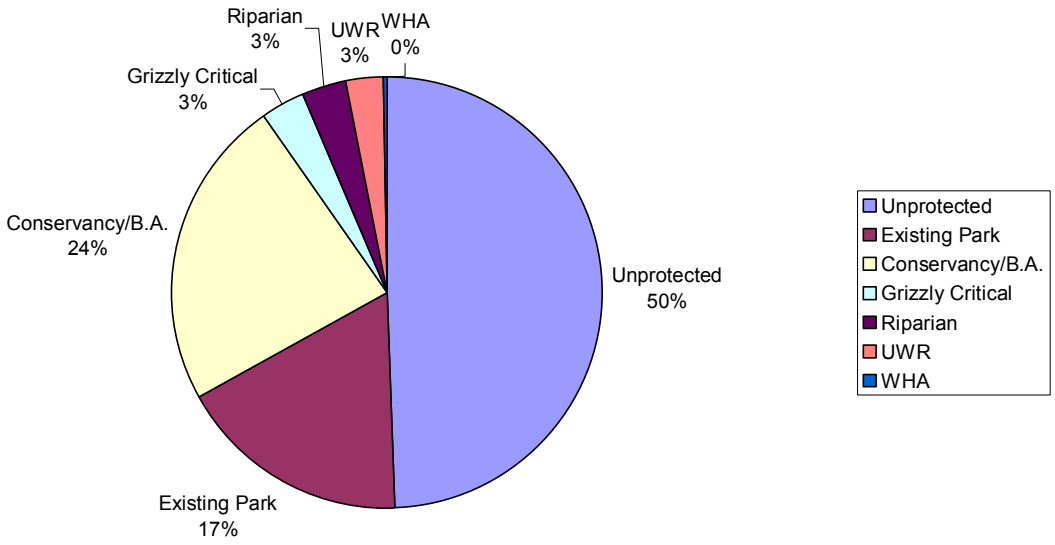
Figure 3.2.1.2



3.2.2 Mid Coast

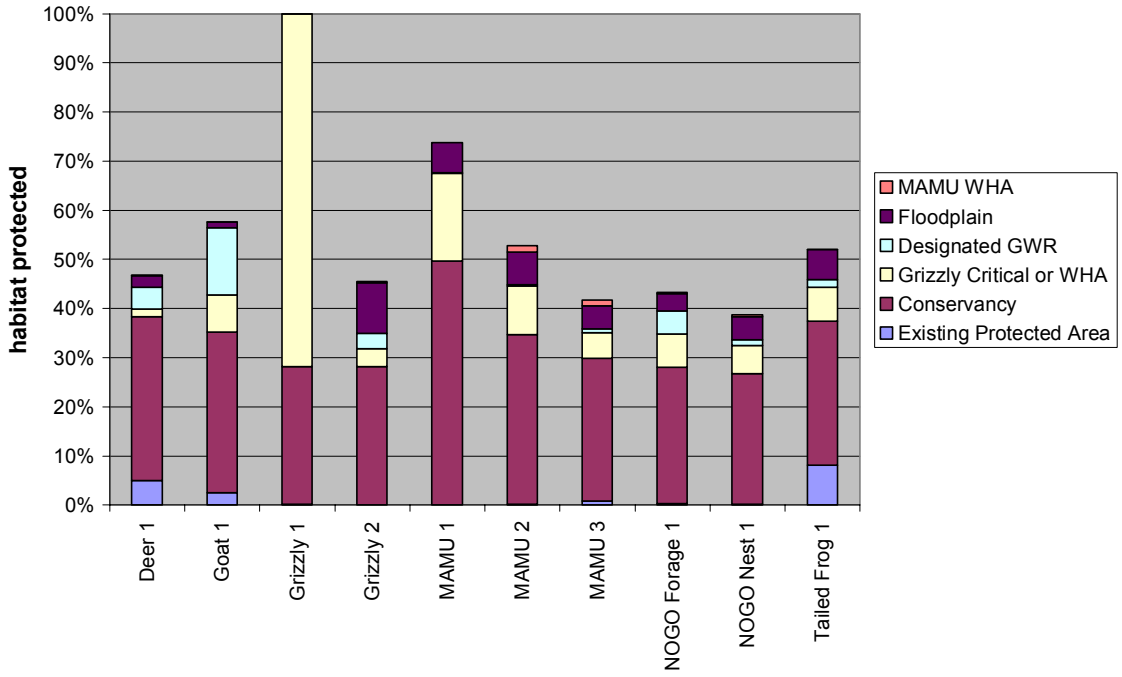
Just over 50% of the forested landbase for the Mid Coast lies within current protected areas including sizeable new Conservancies in addition to previously established provincial parks such as Tweedsmuir (Figure 3.2.2.1).

Figure 3.2.2.1 Current protection of forested Land base in Mid Coast sub-region



The extent to which these current protected areas and reserves overlap with focal species habitat is described in Figure 3.2.2.2. Compared to the South Coast, considerably more protection is afforded to focal species in the Mid Coast.

Figure 3.2.2.2 **Exisiting and proposed habitat protection for Focal Species in the Mid Coast**



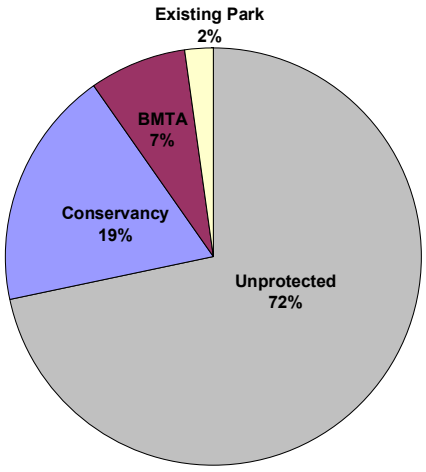
As was the case with the South Central Coast, there is a notable overlap between Marbled Murrelet class 1 habitat and grizzly bear Critical Habitat. In the Mid Coast there is also a substantial contribution made by newly designated Conservancies and Biodiversity Areas towards habitat protection. Despite a relatively large footprint overall, previously existing protected areas do not contribute much habitat protection for the focal species shown here. As with the South Central Coast, designated Ungulate Winter Range captures only around 10% of suitable goat habitat.

3.2.3 North Coast

For the North Coast, evaluating current reserve status was simplified to an assessment of existing parks, Conservancies, and Biodiversity, Mining and Tourism Areas (BMTA's). At the time of writing, most other reserve types—ungulate winter ranges, critical habitat, and wilderness habitat areas—were in the process of being finalized. While the co-location exercise for Low Risk and Best Habitat scenarios did account for these proposed areas in their solutions (100% inclusion of proposed areas), they have not been characterized as "existing" reserve for this study. Further, no floodplain/riparian data layer was available for the North Coast, and as such the reserve that will eventually be established along those areas could not be accounted for in the North as it was in South Central and Mid Coast study Areas.

With the above limitations noted, there is still ~28% of the North Coast in park, Conservancy or BMTA status (Figure 3.2.3.1)

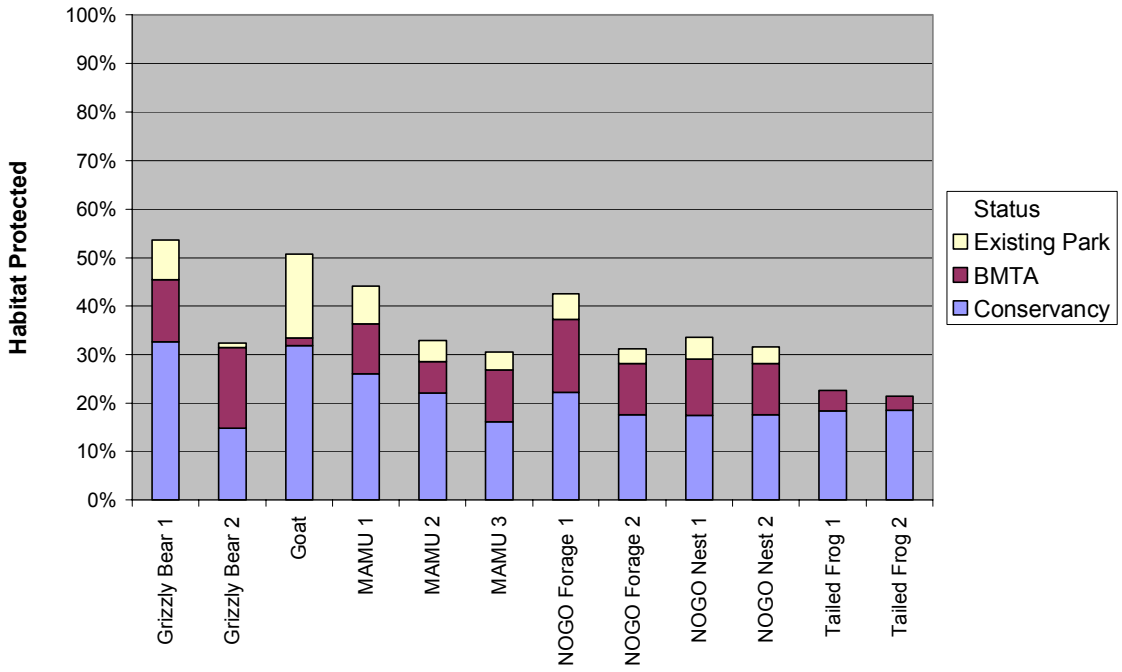
Figure 3.2.3.1 Forested area of the North Coast in existing protection



Within the 28% of protected forested area, there is at least 30% of each focal species habitat type with the exception of tailed frog (Figure 3.2.3.2). The latter short-coming may well be attributable to the limited extent of the tailed frog range in the North Coast, which makes coincident inclusion in a few large protected areas less likely than for a more evenly distributed habitat time. If riparian reserves were accounted for, tailed frog habitat representation in existing or defacto reserve would likely also have been

increased. Grizzly bear class 1, goat, Marbled Murrelet class 1, and Northern Goshawk foraging class 1 habitats are particularly well represented (>40% representation) by the existing reserve system.

Figure 3.2.3.2 Habitat representation in existing reserves for the North Coast



3.3 Scenario Footprint

One of the most basic measures for a co-location scenario involves assessing the total area and cost which any particular solution requires to meet representation targets. In the context of this study we also provide (below) a simplified look at cost by also assessing the distribution of any particular solution relative to THLB. Results will also vary significantly between Landscape Units and as such, please refer to the DS04 results package for a more detailed accounting of scenario footprint results.

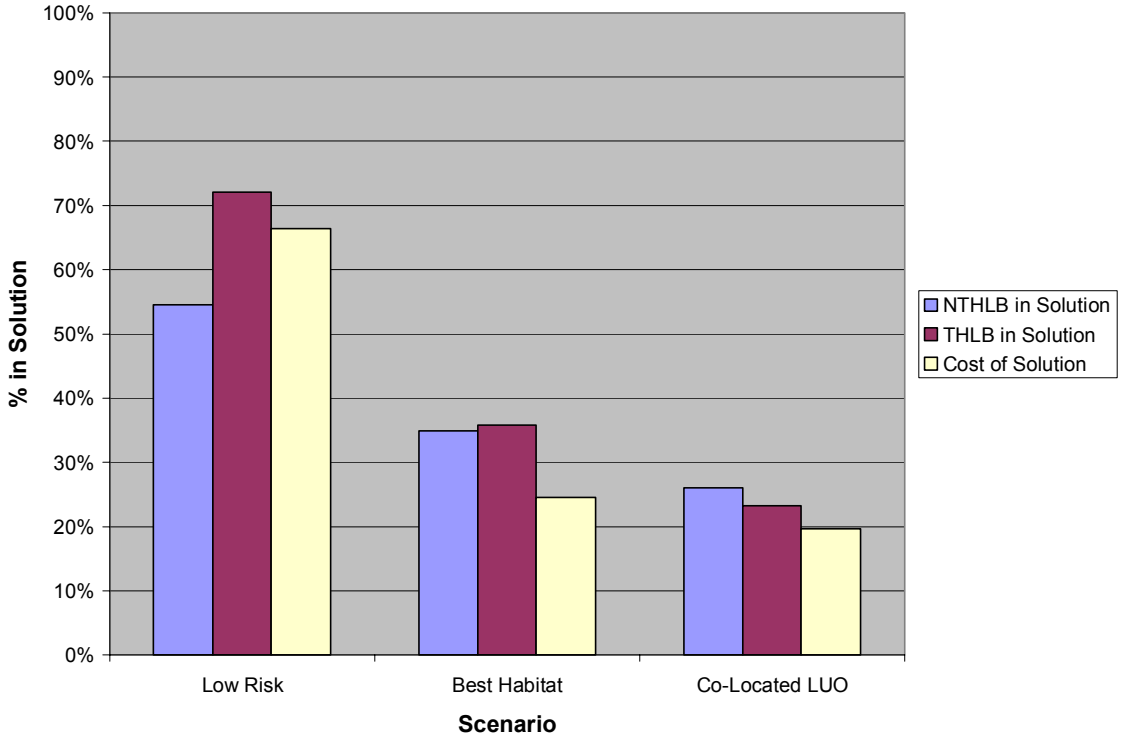
3.3.1 South Central Coast

The Low Risk scenario occupied well over half of the South Central Coasts THLB, NTHLB and total available cost (Figure 3.2.1.1). This comes as no surprise given the very high representation targets established in Low Risk scenario. However, the Best Habitat scenario yielded significant reductions in these measures, more than halving the THLB required to meet goals, and reducing costs by over 60%. These footprint 'savings' reflected several modifications to the Best Habitat scenario, including elimination of

representation goals for Northern Goshawk[6], Goat and deer moderate habitat, Marbled Murrelet class 3 habitat, and tailed frog class 3 and 4 habitats. Subsequent to South Coast analysis, the Best Habitat solution was altered to reflect table 2.10.1.1.

As expected, the Co-Located LUO scenario has the smallest footprint overall, since the cost budget was calibrated to a Marxan run that included representation goals only for old growth (and grizzly bear class 1), with no targets for other focal species habitats. There was approximately a 20% savings in cost moving from the Best Habitat to Co-Located scenario, a much more modest decrease than was seen in the shift from Low Risk to Best Habitat amount. Overall, there was a very large difference in NTHLB, THLB and overall cost between the Low Risk scenario and what current reserve policy would provide in the sub-region (as represented by the Co-Located LUO scenario). How this difference translated into gaps in habitat protection is explored further in section 3.4.

Figure 3.3.1.1 Scenario Footprint for the South Central Coast



3.3.2 Mid Coast

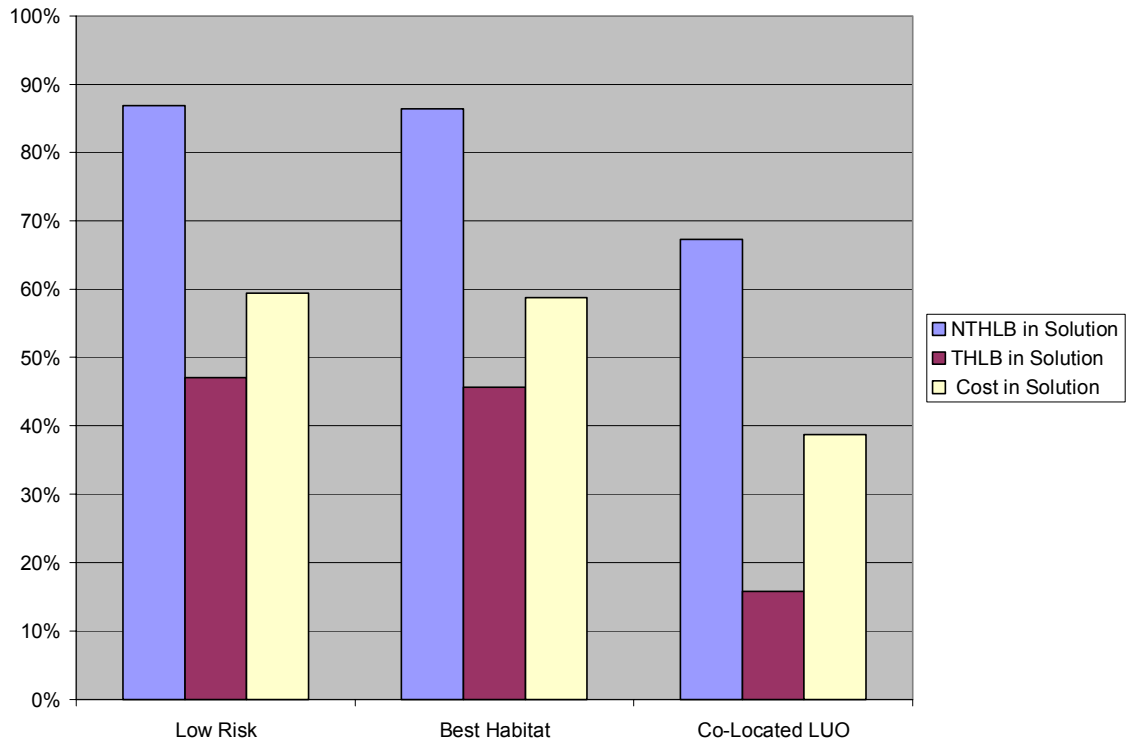
There was a very small difference in footprint and cost between the "Best Habitat" and "Low Risk" scenarios for the Mid Coast (Figure 3.3.2.1). This may be a consequence of a key modification undertaken to the Best Habitat scenario goals for Northern Goshawk, Deer and Goat that was applied to Mid (and North) Coast analysis. A review of table

[6] Subsequently,

2.10.1.1 shows that the key difference between Low Risk and Best Habitat scenarios was a reduction in Northern Goshawk foraging habitat, and the removal of targets for Marbled Murrelet class 3 and tailed frog classes 3 and 4. These alterations however appear to have had little effect on the overall size and cost of the reserve solution. If the Best Habitat scenario was intended to narrow down co-location to more important or critical habitats, it may not be sufficiently limited in its scope.

As with the South Central Coast (and as expected based on the cost threshold or budget applied), the Co-Located LUO scenario had a smaller aerial footprint than the other scenarios, particularly with regard to THLB where there was ~66% reduction in area of THLB between Low Risk and Co-location scenarios. The difference between total cost for those same scenarios was less dramatic when compared to the South Coast results, with only a ~35% reduction in cost as one moves from Low Risk to Co-Location LUO scenarios. However, it would be inappropriate to conclude that co-location is more costly in the Mid Coast compared to south since a number of other factors are at play making comparison between sub-regions difficult—not the least of which being that cost was developed and normalized independently within each sub-region.

Figure 3.3.2.1 Scenario Footprint for the Mid Coast

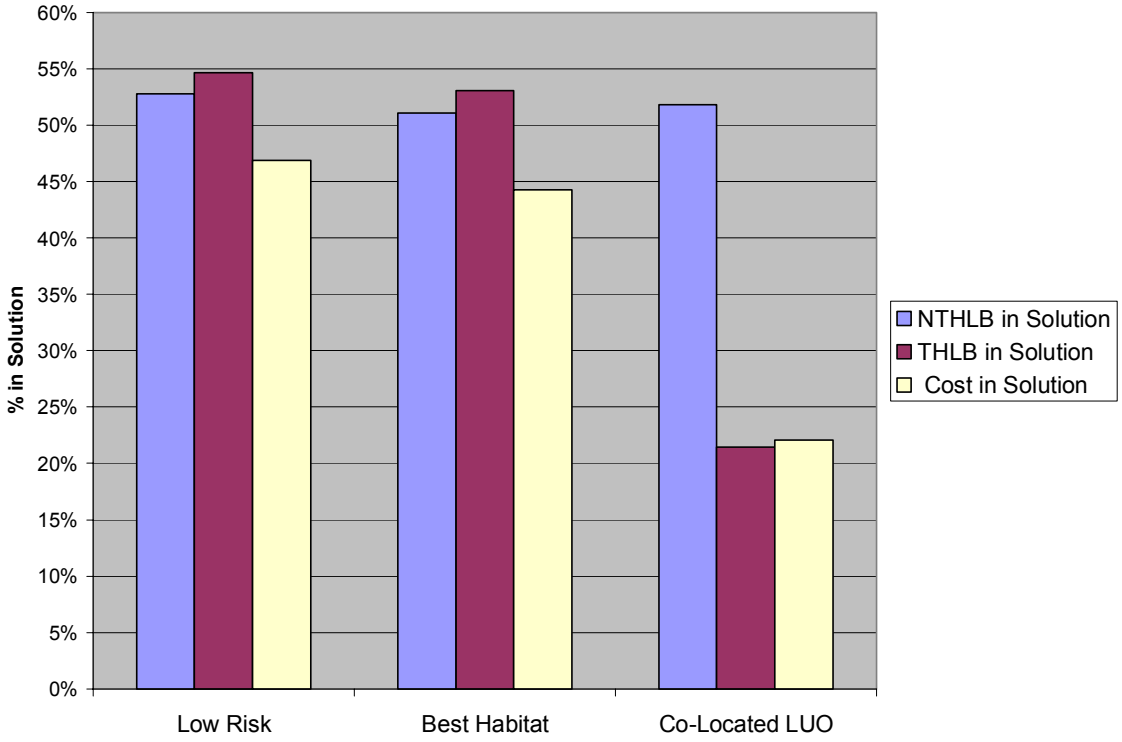


3.3.3 North Coast

Similar to Mid Coast results, there was little difference in aerial extent and cost footprint between Low Risk and Best Habitat scenarios—despite notable reductions in the goals for Goshawk foraging, Marbled Murrelet class 3, and tailed frog habitats (Figure 3.3.3.1).

Just over half of the sub-region's non-THLB and THLB, and just under half of the available cost were required to meet the Low Risk and Best Habitat requirements. The Co-Located LUO scenario filled out approximately the same non-THLB area, but reduced the THLB and cost to that of just over 20% of that found in the North Coast. This THLB impact was consistent with Mid and South Central results.

Figure 3.3.3.1 Scenario Footprint for the Mid Coast



3.4 Habitat Results

Assessing the amount of habitat each DS04 scenario captures allowed Domain Experts to evaluate the degree to which a scenario met, exceeded, or fell short of various habitat representation benchmarks as proposed in the EI02 project. These results focus on habitats as opposed to Site Series Surrogates since in all DS04 scenarios, current Land Use Objectives are being met by the scenarios.

The figures below define for each species habitat type, how much habitat is found in existing reserves (always constant across scenarios), how much more was added by Marxan for a particular scenario, and also, the distribution of the remaining species habitat outside of the reserve solution with regard to THLB and non-THLB. These latter elements are meant to provide some insight as to how vulnerable, unprotected habitat may be if representation thresholds are not met in the scenario.

Domain experts were asked to evaluate the degree to which the Co-Located LUO scenario (which represents the extent of current policy/legislation for the coast), captured habitat relative to the expert definitions of low risk as described in table 2.10.1.1 The difference between Low Risk and the cost limited Co-Located LUO scenario also provides insight on how readily a particular habitat can be co-located with LUO objectives in the subregion or landscape of interest.

A full account of the focal species models, representation goals and expert recommendations that have been informed by these results is found in EI02c reports, including *Recommendations for the Management of Focal Species Habitats under Ecosystem-Based Management*.(Horn and Rumsey, 2009b), and *Methods for Strategic Co-Location of Habitats in Coastal B.C* (Horn and Rumsey, 2009c)

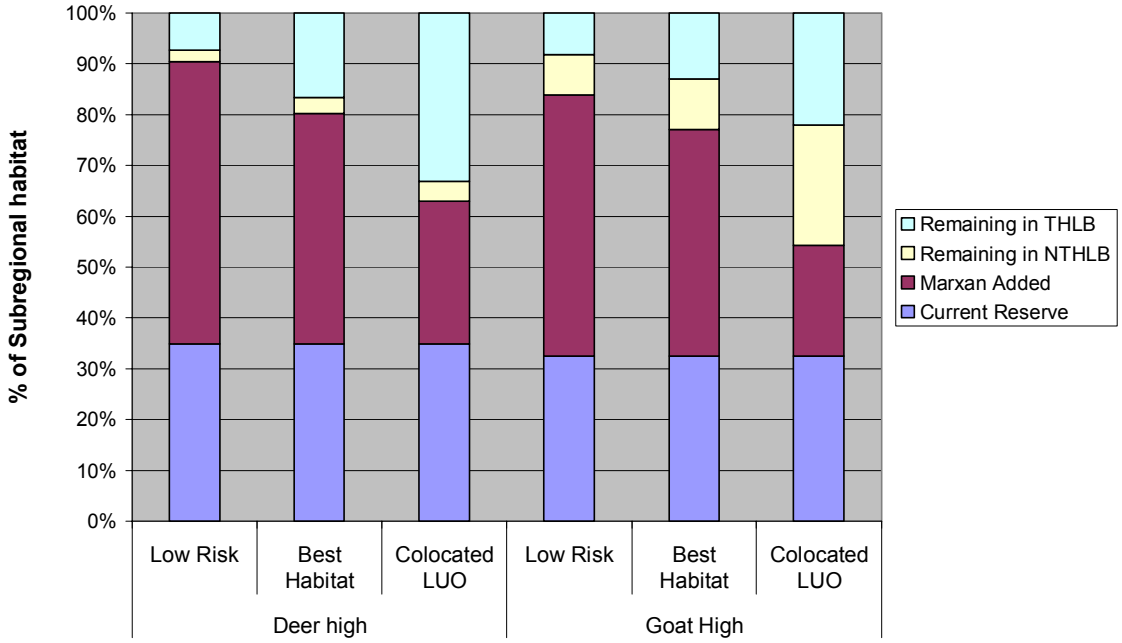
3.4.1 South Central Coast

South Central Coast scenarios were undertaken early on in project development and there are variations in how representation targets were applied when compared to the Mid and North coast analysis. Most notably, the Best Habitat scenario varied from the stated goals in table 2.10.1.1 (see section 3.3.1). This variation led to a notable difference in both overall footprint of solutions, as well as representation of habitat, between the Low Risk and Best Habitat Scenarios—a difference which is largely erased in the results for Mid and North Coast. Consequently, a clear pattern of diminishing habitat representation (matching a diminishing aerial footprint and cost) is seen as we move from Low Risk to Best Habitat to Co-Located LUO scenario.

Probably the most apparent pattern to be observed for the South Central Coast is the relatively low degree of existing protection for species habitat and the high degree of overlap between habitat and THLB. These conditions make cost limited co-location a challenging prospect and indeed, large differences between proposed low risk goals and Co-Located LUO scenario results are the norm as opposed to the exception.

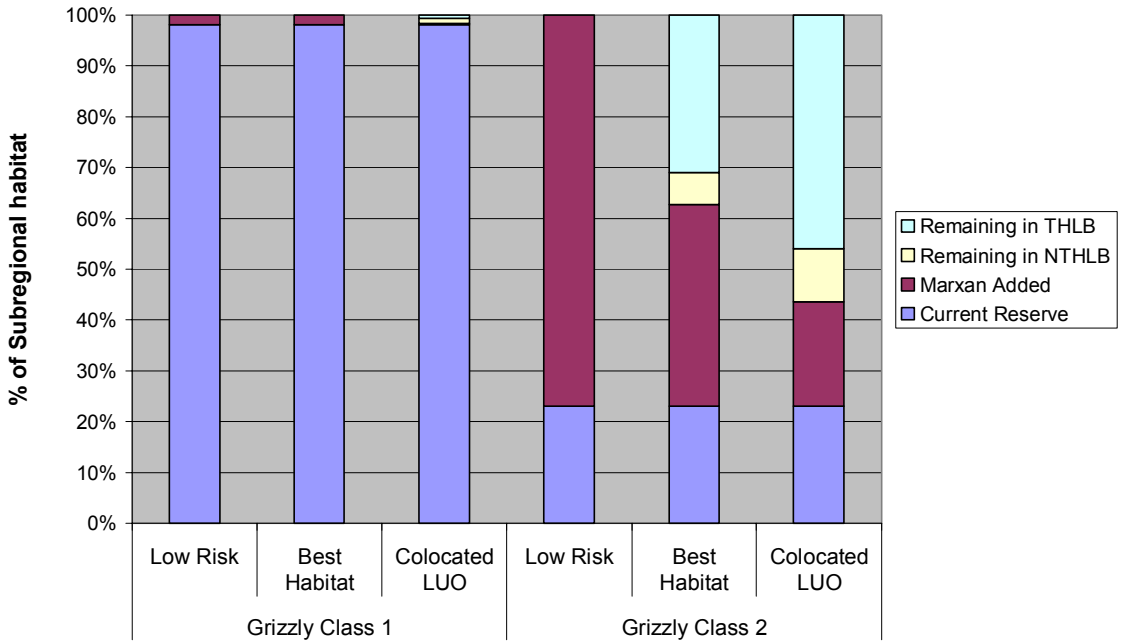
Ungulates: While falling short of the low risk goal of 70%, the fact that the Co-Located LUO scenario still retains over 60% of high value deer (type 1) habitat (Figure 3.4.1.1)—attributable to the fact that much of this can be found in non-THLB and that the habitat overlaps well with forests required to meet existing Landscape Unit Objectives. Goat 'high' (type 2) habitat was more difficult to co-locate, but still over half of all available high value habitat was retained in the Co-Located LUO scenario.

Figure 3.4.1.1 South Central Coast Habitat protection and reserve status compared among DS04 Scenarios: Deer High and Goat High



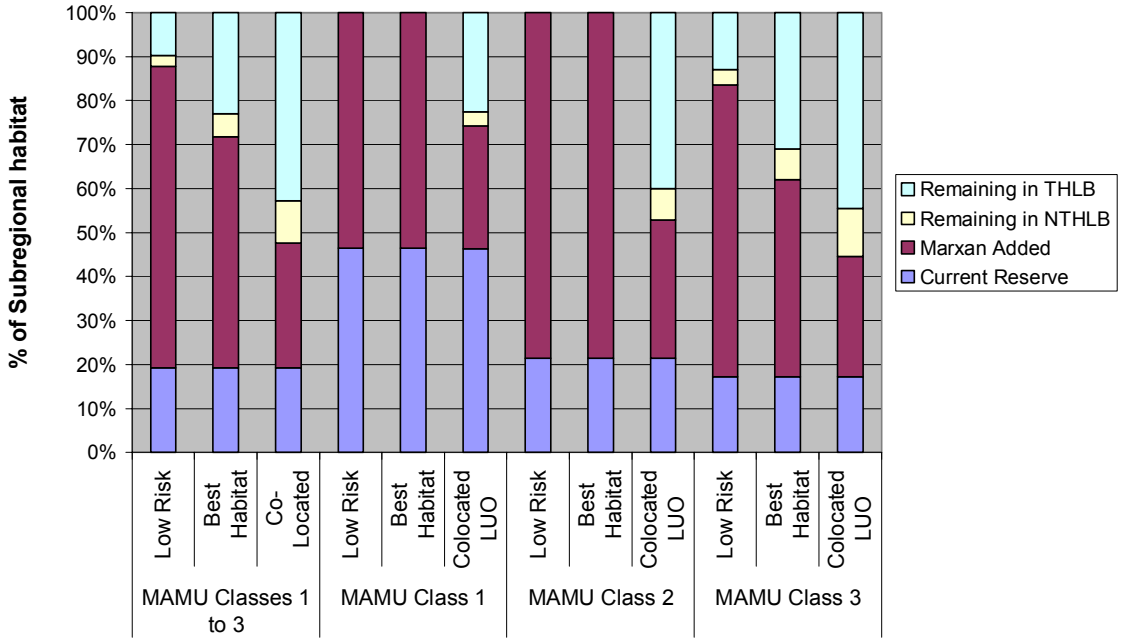
Grizzly Bear: Grizzly bear class 1 habitat was almost entirely protected by the identified Critical Habitat polygons (Figure 3.4.1.2). Class 2 habitats proved somewhat more difficult to represent in the Co-Located LUO scenario (43% representation), likely due to the large overlap between these habitats and THLB in the South Coast. However, there is enough non-THLB class 2 habitat available that if defacto left undisturbed by harvest, would allow for greater than 50% representation of the habitat type—consistent with the Best Habitat goal (and land use orders for the Mid and North Coast.)

Figure 3.4.1.2 South Central Coast Habitat protection and reserve status compared among DS04 Scenarios: Grizzly Bear



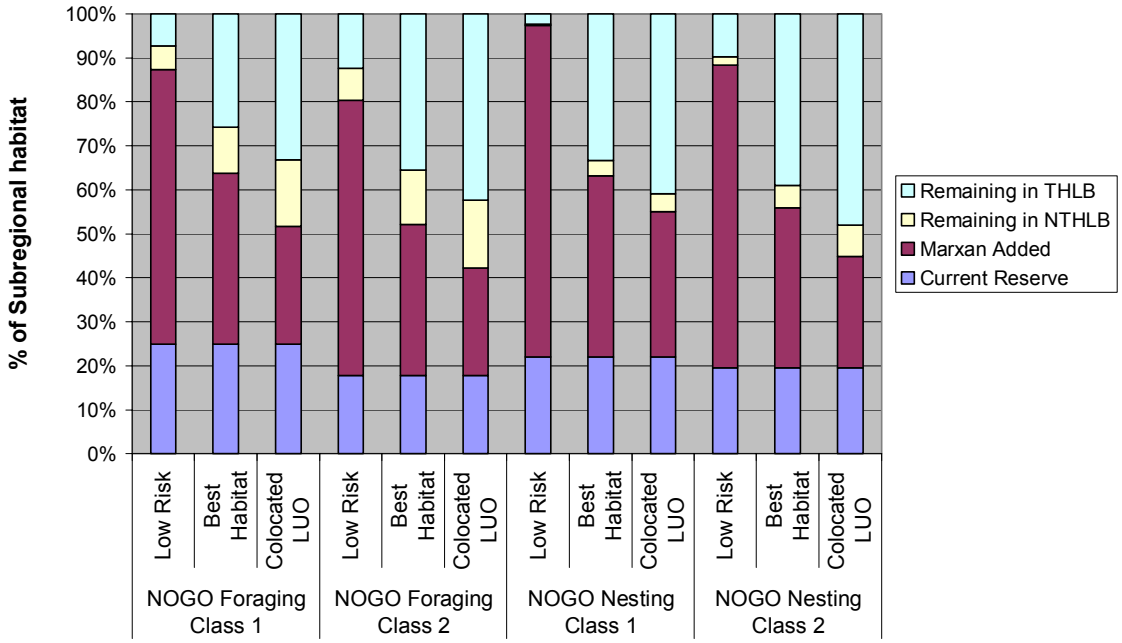
Marbled Murrelet: Achieving Low Risk goals under the constraints of the Co-Located LUO scenario is hampered to some degree by the amount of overlap between Murrelet habitat and THLB (Figure 3.4.1.3). For classes 1 and 2 there was roughly a 20% and 40% difference respectively to meeting the proposed low risk benchmark of full protection of these habitat classes. Overall, there was almost a 15% gap to meeting the 62% representation threshold for all of classes 1 through 3 combined.

Figure 3.4.1.3 South Central Coast Habitat protection and reserve status compared among DS04 Scenarios: Marbled Murrelet (MAMU)



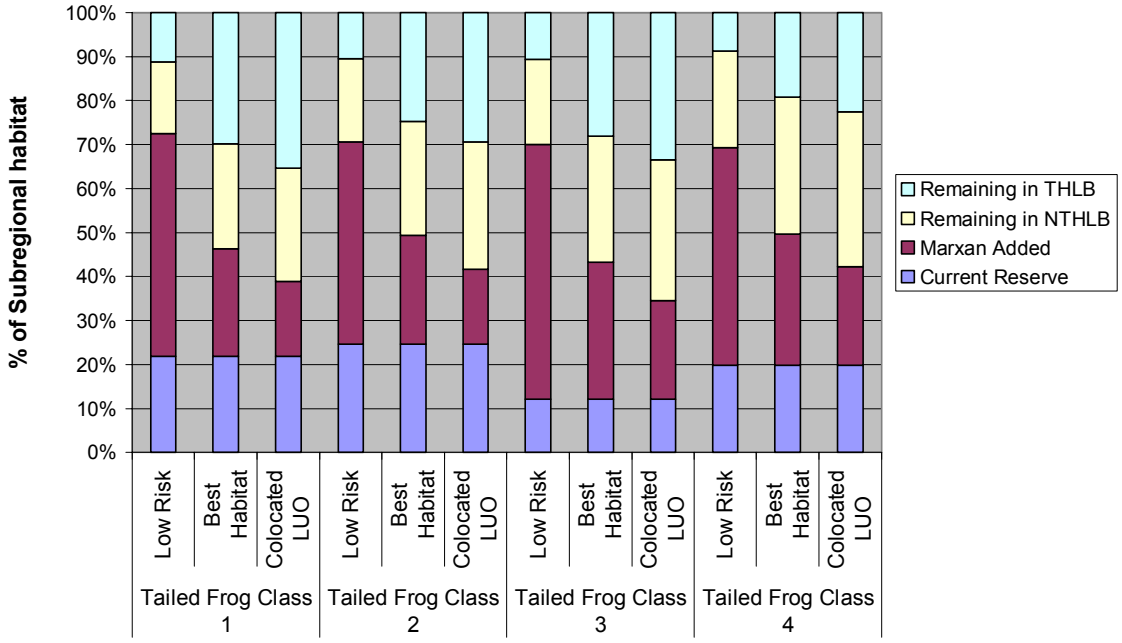
Northern Goshawk: Goshawk results were very similar in pattern to those of Marbled Murrelet, with differences between proposed low risk goals and Co-Located LUO results emerging as a consequence of limited existing protection in reserves, and the high degree of overlap between habitat and THLB (Figure 3.4.1.4).

Figure 3.4.1.4 South Central Coast Habitat protection and reserve status compared among DS04 Scenarios: Northern Goshawk (NOGO)



Tailed Frog: Compared to other species habitats, the difference between proposed low risk thresholds and Co-Located LUO scenarios were minimal (Figure 3.4.1.5). In fact low risk representation goals were slightly exceeded for classes 3 and 4 and nearly reached for class 2, while there was approximately a 10% shortfall for class 1. This relative success could be attributed in part to the lower retention goals that were established for these habitats, as well as the availability of the habitat types in non-THLB.

Figure 3.4.1.5 South Central Coast Habitat protection and reserve status compared among DS04 Scenarios: Tailed Frog

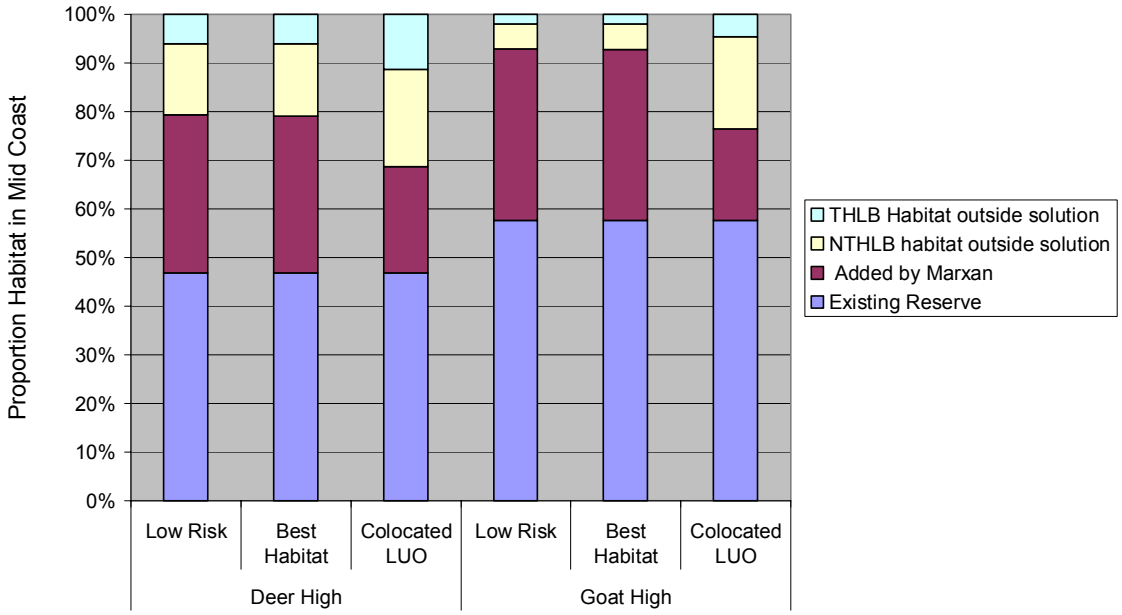


3.4.2 Mid Coast

For the Mid Coast, the Low Risk and Co-Located scenarios still constituted the proposed high and low representation thresholds respectively. However, in the Mid Coast, the Best Habitat result was barely distinguishable from the Low Risk scenario. In general, the Mid Coast results reflected a much higher degree of existing protection for habitat as compared to the South Central Coast and suggested that more opportunities existed for co-locating habitat with old growth objectives—particularly within the non-THLB.

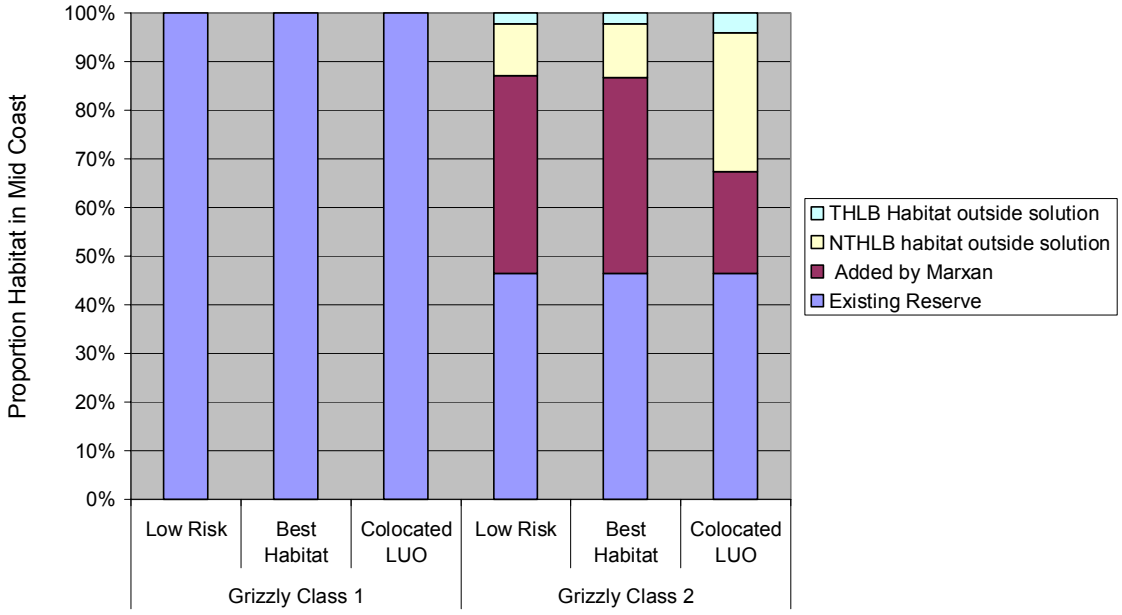
Ungulates: The Co-Located LUO scenario retained about 68% of high value (type 1) deer habitat, almost meeting the low risk target (70%). Meanwhile 76% of mountain goat 'suitable' habitat was retained in the same scenario-a 14% shortfall to its low risk target. There may be additional security offered to ungulates by the large proportion of habitat that is outside of the scenario solutions, but which is still found in the non-THLB.

Figure 3.4.2.1 Mid Coast habitat protection and reserve status compared among DS04 scenarios: Deer and Goat High Suitability



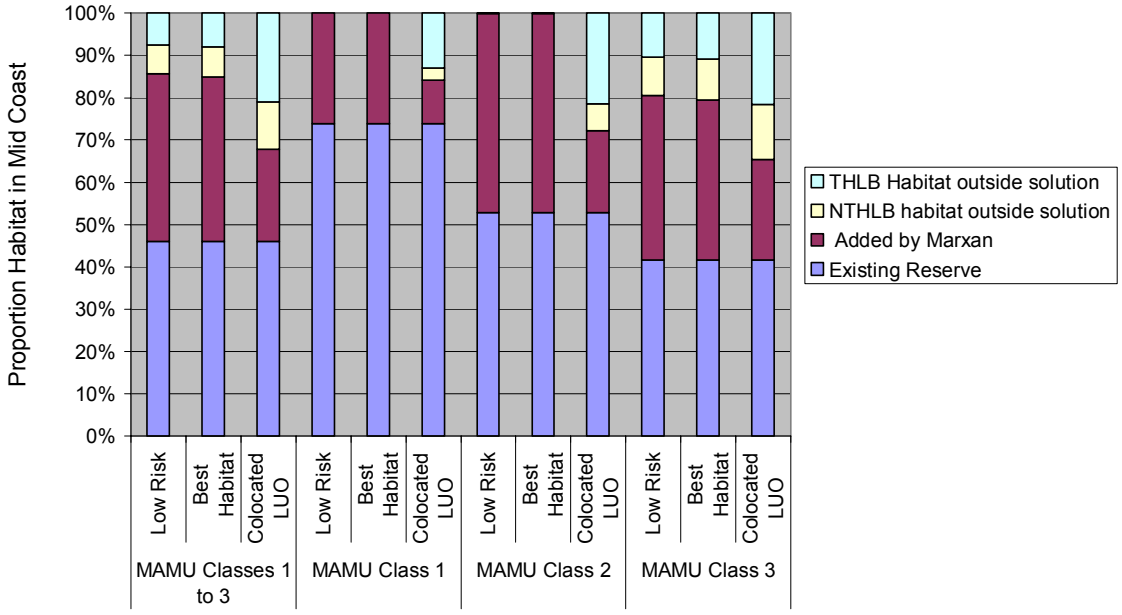
Grizzly Bear: All Grizzly Bear class 1 habitat was defacto reserved by Critical Habitat designation, while grizzly bear class 2 habitat representation approached 70% in the Co-Located LUO scenario. It is interesting to note, that much of the remaining habitat outside of the reserve solutions was located in the non-THLB—possibly a consequence of taking preferred habitat types first (see Horn and Rumsey 2009c), which in effect locked in many habitat polygons that were part of the THLB.

Figure 3.4.2.2 Mid Coast habitat protection and reserve status compared among DS04 scenarios:
Grizzly Bear Class 1 and 2



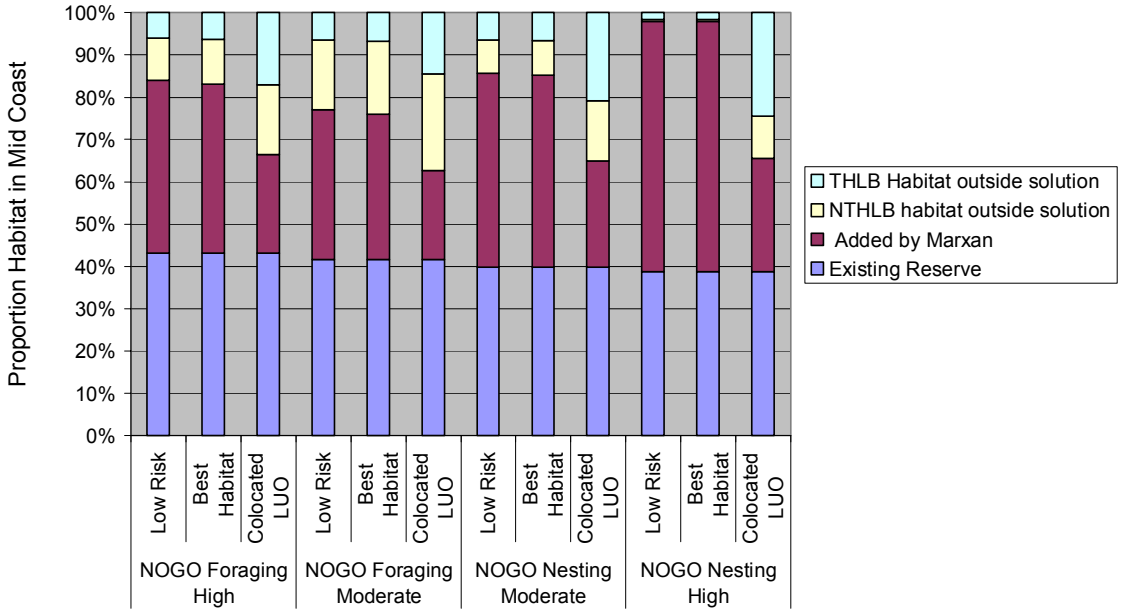
Marbled Murrelet: The Co-Located LUO reserve solution exceeded the low risk representation goal (62%) for combined Marbled Murrelet classes 1 through 3 (Figure 3.4.2.3). However, there were shortfalls with regards to achieving the low risk goal of reserving 100% of class 1 and class2 habitat. The majority of the class 1 and 2 habitat left out of the Co-Located LUO solution was located in the THLB, the inclusion of which would surpass that scenario's mandated cost budget.

Figure 3.4.2.3 Mid Coast habitat protection and reserve status compared among DS04 scenarios:
Marbled Murrelet (MAMU), 0 to 30km from Ocean



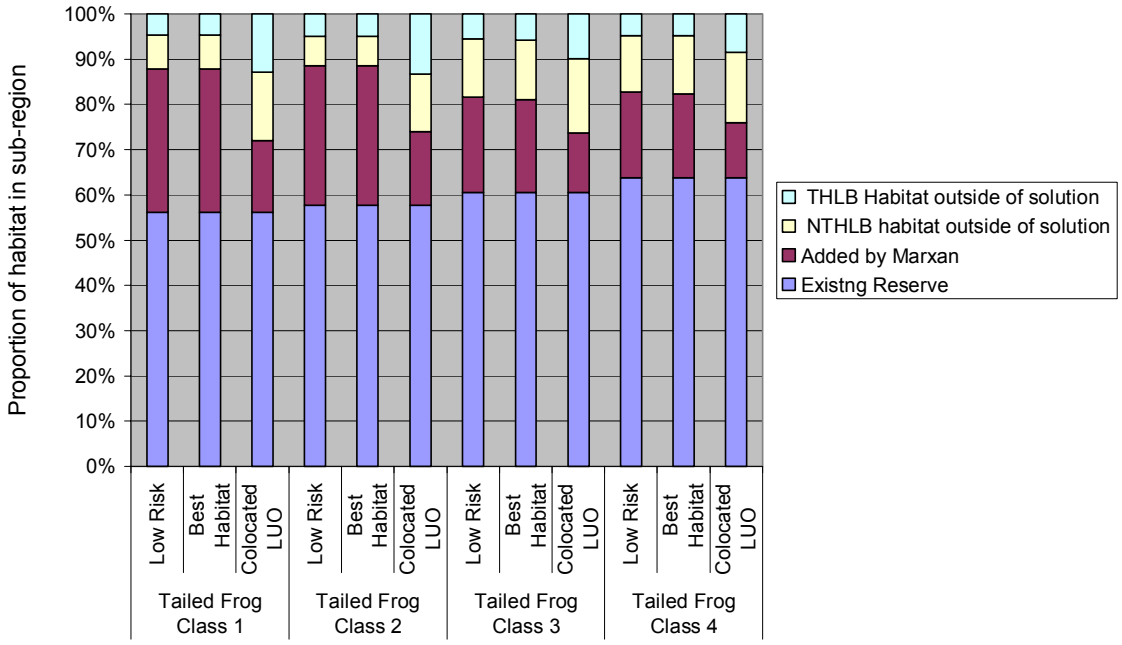
Northern Goshawk: Despite being cost-limited the Co-Located LUO scenario still allowed for representation of over 60% of Northern Goshawk foraging and nesting habitat. Despite these habitats making covering a very large proportion of the region, there was significant overlap with existing protection, other species habitats, and non-THLB.

Figure 3.4.2.4 Mid Coast habitat protection and reserve status compared among DS04 scenarios: Northern Goshawk (NOGO)



Tailed Frog: In the Mid Coast, existing protected areas and defacto reserves already included enough tailed frog habitat to meet low risk representation goals (Figure 3.4.2.5). Additional representation was also picked up through the co-location exercise across all scenarios, including the Co-Located LUO which added enough habitat to exceed 70% representation for classes 1 through 4.

Figure 3.4.2.5 Mid Coast habitat protection and reserve status compared among DS04 scenarios: Tailed Frog



3.4.3 North Coast

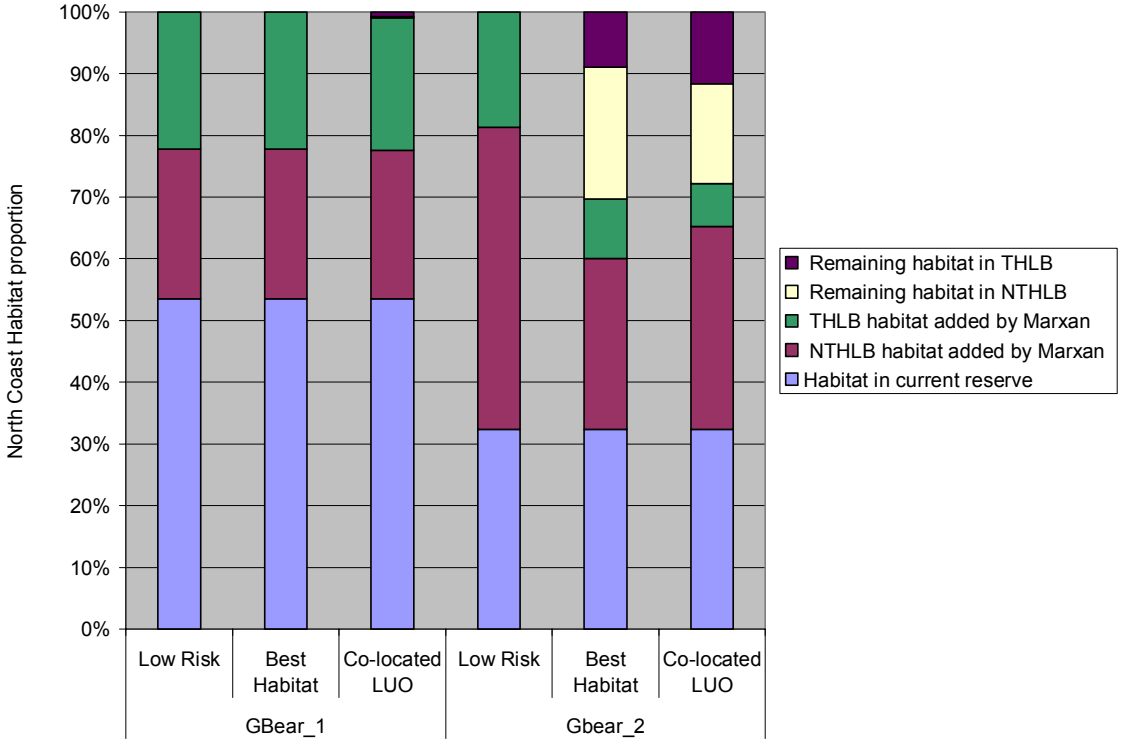
In the North Coast, a much reduced logging history, and higher proportion of non-THLB allowed for greater co-location opportunities than those found in the South Coast. In many cases the gap between low risk representation targets and Co-Located LUO scenario results were bridged with habitat found in the non-THLB. Further, despite the lack of a riparian/floodplain reserve layer, there still was a high degree of overlap between habitat and existing/defacto reserves in the North Coast.

Unfortunately, a deer model was not available for analysis for the North Coast.

Also, please note that for North Coast results, an additional data segment has been added to the representation figures that describes the THLB/non-THLB breakdown both outside of, and within the any particular scenario result.

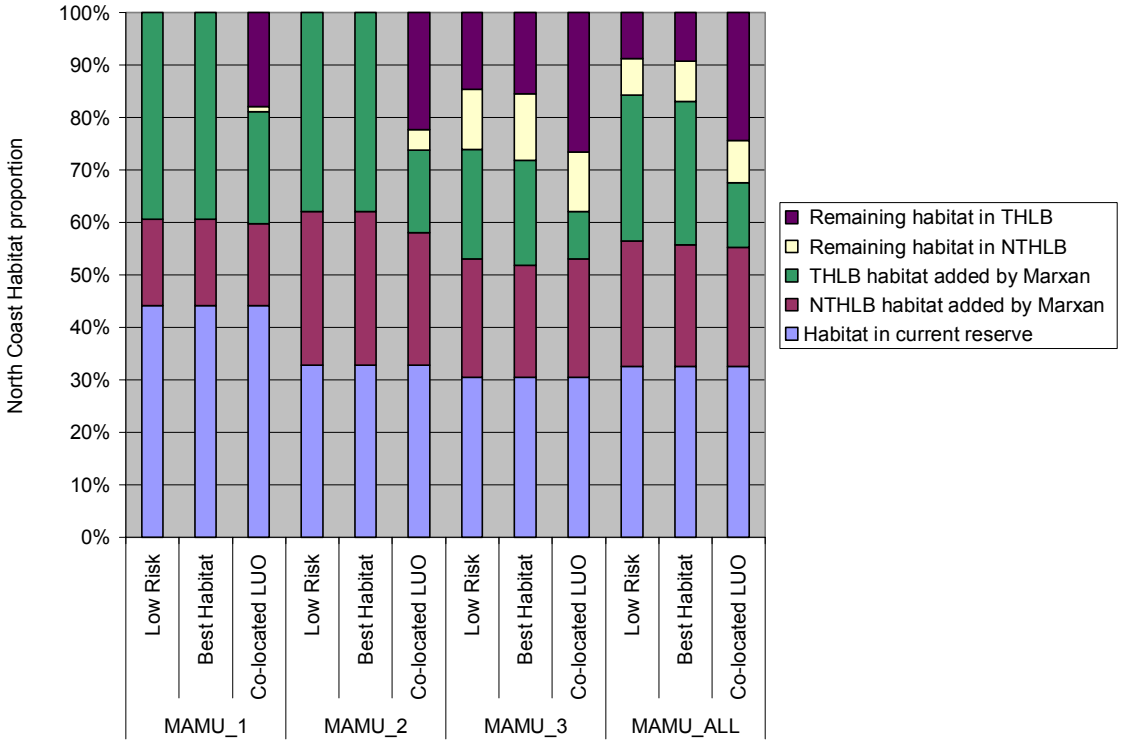
Grizzly Bear: North Coast LUO's required 100% of class 1 habitats to be reserved (Figure 3.4.3.1) across all scenarios. Similarly, the Low Risk scenario required 100% of class 2, while the Best Habitat scenario dropped this requirement to 50%, As it turned out, for both the Best Habitat and cost limited Co-Located LUO scenario, grizzly bear 2 habitat was over 70% was represented. While results by individual landscape will vary, as a whole, it would appear that co-locating the current Grizzly Bear class 2 objective for the North Coast need not add additional area or cost to any reserve design based around current old growth objectives.

Figure 3.4.3.1. North Coast habitat protection and reserve status compared among DS04 scenarios: Grizzly Bear



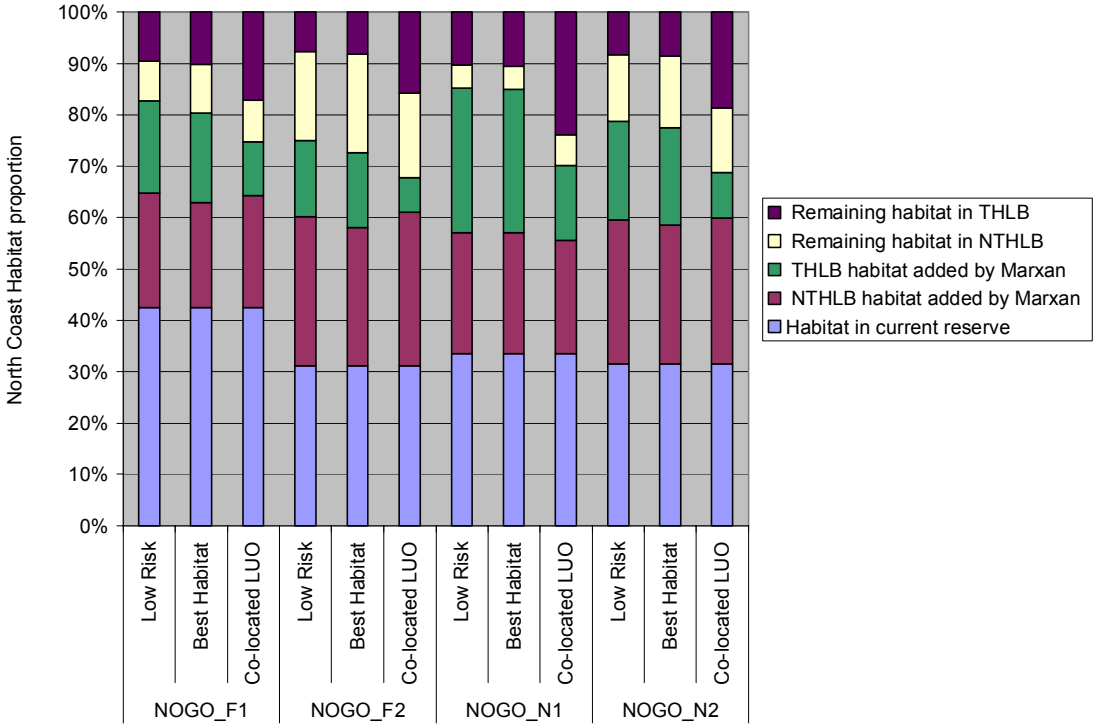
Marbled Murrelet: Low Risk and Best Habitat scenarios required 100% of Marbled Murrelet class 1 and class 2, but in the cost limited Co-located LUO scenario representation dropped to ~81% and ~75% respectively (Figure 3.4.3.2). Most of that difference was made up of habitat located in the THLB. The overall stated low risk goal of capturing 62% of the total of habitats 1,2, and 3 is met and exceeded in all scenarios including the Co-Located LUO.

Figure 3.4.3.2 North Coast habitat protection and reserve status compared among DS04 scenarios: Marbled Murrelet



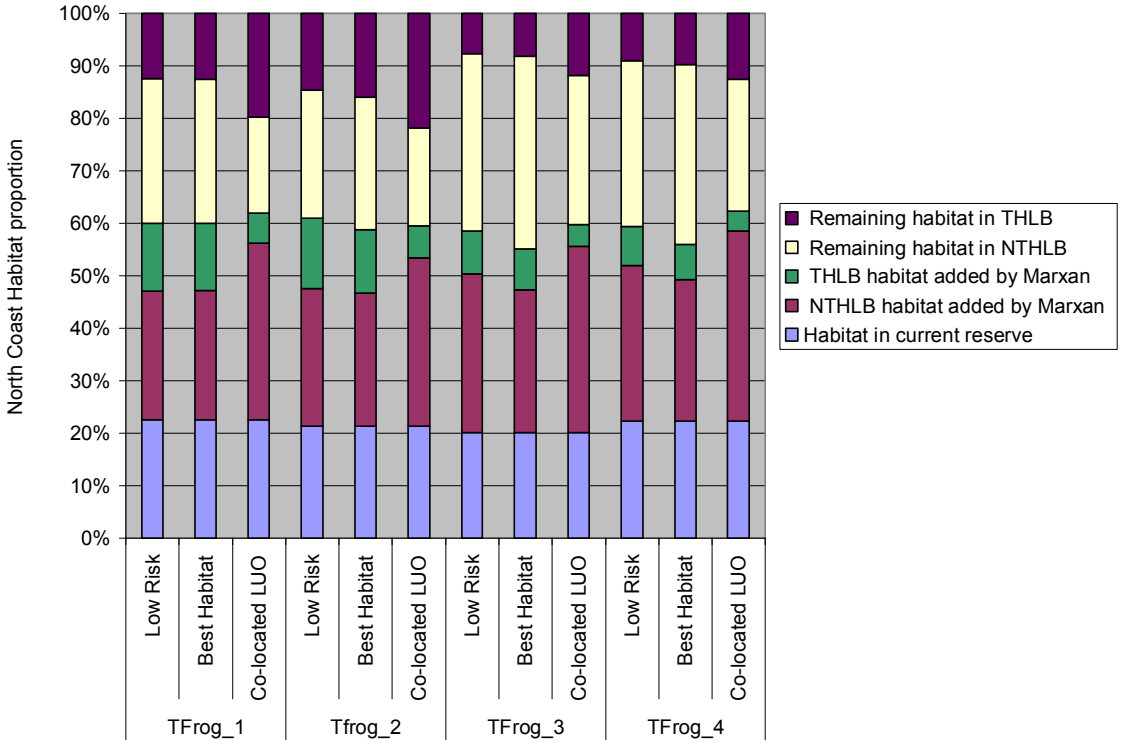
Northern Goshawk: For Goshawk nesting habitat Low Risk and Best Habitat scenarios were met through the inclusion of existing reserves, THLB and non-THLB in almost equal measure. The cost limited Co-Located LUO scenario subsequently reduced THLB included by about 50%, but overall, approximately 70% of nesting classes 1 and 2 were represented (Figure 3.4.3.3). Foraging habitat representation reached almost 60% with just existing reserves and non-THLB, even for the Co-Located scenario. As was the case for nesting habitat, the Co-Located LUO scenario reduced the amount of THLB foraging habitat included in reserve. For Best Habitat and Co-Located LUO scenarios, foraging 2 habitat is over-represented (compared to the proposed goal), indicating that the habitat type is highly coincident with other habitat types, non-THLB and forest already required to meet the old growth LUO's.

Figure 3.4.3.3 North Coast habitat protection and reserve status compared among DS04 scenarios: Northern Goshawk



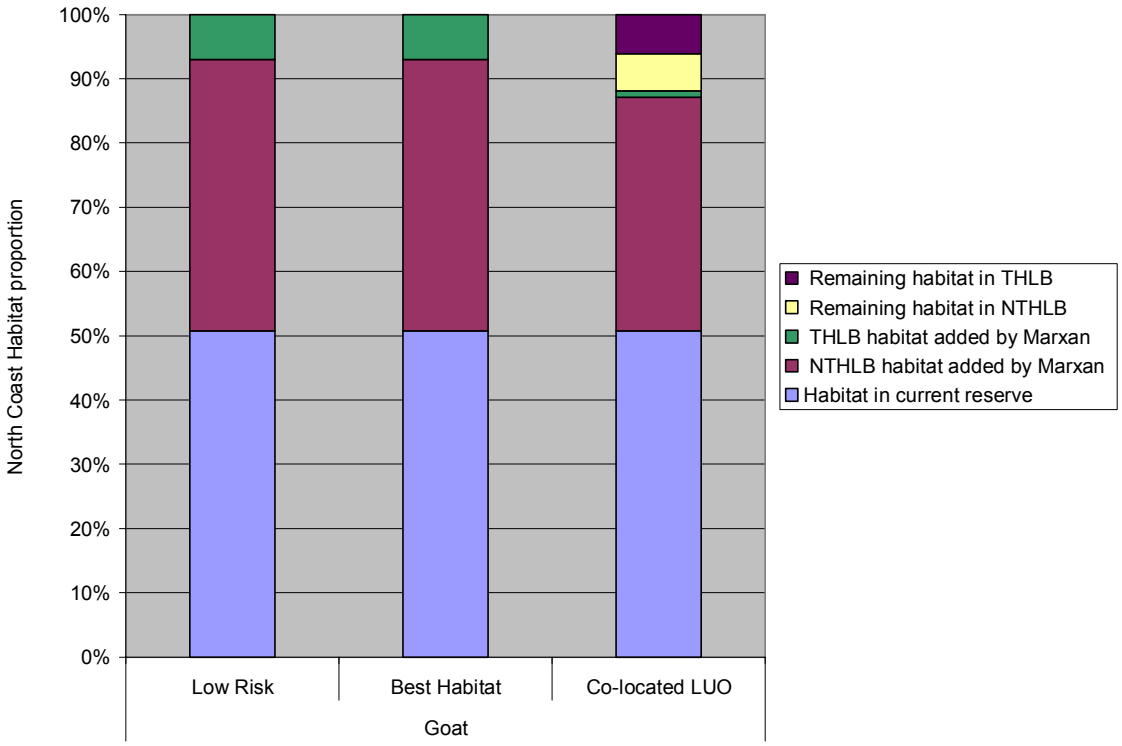
Tailed Frog: In all scenarios, including the cost limited Co-Located LUO scenarios, proposed representation goals for tailed frog habitat classes 1 through 4 were met (Figure 3.4.3.4). While representation of these habitats in existing reserves might be limited, there appears to be good opportunities for meeting the remaining gap to low risk goals in non-THLB and THLB that is already required for meeting old growth objectives.

Figure 3.4.4 North Coast habitat protection and reserve status compared among DS04 scenarios: Tailed Frog habitat



Mountain Goat: Low Risk and Best Habitat scenarios for mountain goat both required 100% of 'suitable' habitat, but even the cost limited Co-Located LUO scenario manages to capture almost 90% of available habitat (Figure 3.4.5). It should be noted that the suitability layer for the North Coast had a much smaller overall extent as compared to Mid and South Central Coast, and further that over half of it is located in existing reserves. The success of the Co-Located LUO scenario in picking up this habitat type is also consistent with the fact that an additional 30-40% can be found in non-THLB, much of which may have been coincident with non-THLB required to meet LUO old growth objectives.

Figure 3.4.5 North Coast habitat protection and reserve status compared among DS04 scenarios: Mountain Goat



4 LIMITATIONS

4.1 Interpreting Results

The outputs known as "Best solutions" emerging from any Marxan scenario in DS04 should not be interpreted or taken as de facto reserves. Instead, these areas should be used for ongoing strategic analysis with regard to how multiple land use objectives can be accommodated.

On the other hand, summed solutions emerging from DS04 Marxan scenario should provide useful guidance for identifying areas with a high probability of meeting multiple land use objectives. This guidance is best used by reserve design experts, and people knowledgeable about the landscape unit in question. A proposed process for using Marxan outputs in conjunction with expert driven 'rational' design is discussed in Project No. DS04 (b) report *Design concepts for Landscape-Level Reserves: a comparison of Methods*, (Lewis and Kremsater, 2009) under Section 4.0 *A recommended landscape-level planning methodology.*

4.2 Issues with Data and Focal Species Models

A full accounting of the limitations of habitat models used for this project can be found in *Methods for Strategic Co-Location of Habitats in Coastal B*.C (Horn and Rumsey, 2009c). However, it is important to note that ungulate models, grizzly bear polygons, and the Northern Goshawk model are all under review and/or have been modified since these analyses have been conducted. In particular, the ungulate models used in this study have since been deemed, inappropriate for further planning efforts until such time that necessary improvement can be made.

5 RECOMMENDATIONS

5.1 Data and Modeling improvements

As noted above in section 4, several important modifications to data should be undertaken before further landscape design work proceeds, including:

- An improved cost value modeling is required, preferably in the form of a detailed operability assessment as has recently been completed for much of the Mid Coast sub-region. At the very least a simplified timber value and new 'operability' line would greatly enhance the reserve selection process.

- Improvements applied to existing Site Series Surrogate mapping in accordance with recommendations made by EBMWG project EI03a, Ecological Condition-Current Baseline and most up-to-date logging information.

- Community Forests should be made part of the Site Series Surrogate database, and a clear methodology for accounting for community forests, private lands, reserve lands etc. should be established

- Habitat mapping needs to be completed for Mid Coast protected areas.

- Domain Expert recommendations on habitat mapping need to be incorporated and where necessary, revised models produced and made available for subsequent reserve design/planning exercises.

5.2 Reserve Design Methodology

The process of spatializing reserves in the study area is well underway, but several key methodological issues remain outstanding, including the following:

- Based on Domain Expert feedback, a hierarchy of habitat types is required in order to better fine tune the goals used for species habitats in the Co-location scenario.

- Allowable impacts to THLB and non-THLB should be clearly articulated. i.e. how much THLB can be included in a reserve design to satisfy co-location requirements that may go above and beyond area required to meet old growth objectives.

- A high risk threshold for focal species habitat representation should be defined.

- A new Co-Located scenario for all sub-regions should be run based on the above mentioned updates and clarifications.

5.3 Proposed Landscape Design and Planning Process

Recommendations for applying DSO4 and EI02 results have been incorporated into the Project No. DS04 (b) report *Design concepts for Landscape-Level Reserves: a comparison of Methods*, (Lewis and Kremsater, 2009) under Section 4.0 *A recommended landscape-level planning methodology*.

6 LITERATURE CITED

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