Managing For Goshawks on the North Coast:

1. Field verification of the overlaps in goshawk and Marbled Murrelet habitat suitability ranking.

2. Predicted location and number of goshawk territories in relation to areas of high ranked Marbled Murrelet habitat in Protected and Non-protected Management Units.

Prepared For:

Anne Hetherington,
Ministry of Water, Land and Air Protection,
Smithers, B.C.

(Aaltanhash Valley, North Coast)

(Juvenile Goshawk)

Prepared By: Frank Doyle

Wildlife Dynamics Consulting
P.O. Box 129
Telkwa, B.C. V0J 2X0
Tel: 250-846-5100
doyle@bulkley.net

January 2006

Executive Summary

When managing for Species at Risk in forested landscapes there is often conflicting pressure on the forested habitat that they require, brought about by the harvesting of our forests. As only so much forested area can be given specific protection, either through specific regional management areas, or through individual Wildlife Habitat Areas (WHA's), it is beneficial to overall species management if we can get the greatest benefit from the placement of these areas, by identifying areas that potentially protect more than one species.

On the North Coast, the Northern (*laingi*) Goshawk is a red-listed species that requires mature-old growth forested habitat for nesting and foraging, and yet no WHA protection can be given to this required habitat unless its nests are located. However, in such an environment locating nests of this secretive forest raptor is impractical without considerable investment of both time and money. This project examines the possibility of managing for the goshawk and Marbled Murrelet nesting requirements within the same protected forested habitats. Considerable overlap in the nesting habitat suitability for both species has been identified during the development for standards in aerial habitat interpretation for both species. This project uses this overlap to predict the number and location of goshawk territories in relation to large areas of high ranked Marbled Murrelet habitat throughout the North Coast. In addition, it field tests the accuracy of these predictions, and compares the habitat suitability ranking for goshawks and murrelets at 28 randomly selected forest sites, to determine the degree of overlap in suitability ranking between the two species.

At these 28 sites, there was considerable overlap in the ranking of nesting habitat attributes assigned to both goshawks and murrelets. High ranked murrelet sites typically represented high ranked goshawk habitat and low ranked habitat was typically low ranked for both species. In contrast, topographically, slope grade showed a high degree of divergence with the flatter and steeper sites being contrastingly ranked high or low for both species. However, the overall weighting of this variable in the field verified patch, and the modeled Marbled Murrelet ranking predictions, did not change the observed overall overlap in habitat rankings.

Overall it is estimated that 19 - 43 goshawk territories may be within the existing protected areas, and that 9 - 29 territories may be outside of these protected areas. The great range in uncertainty in the number of territories being driven by our lack of knowledge in certainty as to the abundance and availability of prey within the North Coast landscapes (interior, inner islands and outer islands). The habitat assessment from these survey flights suggests that the estimates for the number of potential goshawk territories, from the earlier LUP habitat suitability model, may be too high. Only a stratified habitat assessment of prey species composition and relative abundance will help to refine our ability to predict how many, and the likely location of goshawk territories in this landscape.

While further work is required, the observed overlap in goshawk and Marbled Murrelet habitat suitability now provides the opportunity to protect core potential nesting areas for both species using Wildlife Habitat Areas, strategically located within the Timber Harvested Land Base. For goshawks, designation of these WHA's now will also ensure that core potential nest areas exist, around which future landscape-forestry management can be developed that will ensure for a long-term viable goshawk population.

Although the WHA allocation may protect potential core nest areas of the highest probability territories, it will not protect the other essential requirement: the goshawks foraging

area. To successfully manage for goshawks across the land base, or on a territory by territory basis, harvesting has to be both spatially and temporally designed at the landscape level to ensure that existing foraging area requirements are maintained. Proactive harvesting and silviculture planning at the stand level will significantly lessen the time required for the habitat to recover by retaining or hastening desirable stand structure. It is also important, that once restored, the foraging habitat remains to be used by goshawks and other wildlife for a considerable time. The length of time restored habitat needs to be maintained will in turn be dependent on the spatial and temporal habitat-replacement plan, which needs to be developed as part of the Forest Stewardship Plan to meet results-based goals for maintaining red-listed species.

Contents:

Acknowledgements

This project is indebted to the help and experience of my colleagues on the murrelet-goshawk habitat suitability flight, Alan Burger, Anne Hetherington, Jared Hobbs and to our Canadian Helicopters pilot Tony Walker for his excellent and accurate piloting during our surveys. The project was funded by the Ministry of Water, Land and Air Protection Victoria and Region Forest Investment Account.

Project Rationale

1. Field Verification of the overlaps in goshawk and Marbled Murrelet habitat suitability ranking.

In addition to the Northern *laingi* Goshawk (*Accipiter gentilis laingi*), Marbled Murrelets (*Brachyramphus marmoratus*) are a focal forest nesting SAR, for which habitat suitability mapping and habitat verification flights will be taking place to determine the location, and subsequent level of habitat protection required to maintain this species as per the guidelines of the Marbled Murrelet Recovery Team. Analysis of the habitat around known murrelet nest sites and around known goshawk nests, suggests there may be considerable overlap in their habitat requirements (Doyle 2004). This overlap provides for the opportunity that habitat protection for murrelet nesting can also be used strategically to maintain goshawk habitat.

Habitat suitability verification flights will be taking place in September/October throughout the North Coast, and I propose that we use this opportunity to verify the suitability and overlap of Marbled Murrelet and goshawk nesting and foraging habitat at the same time. In addition, these flights will provide a further opportunity to verify the assumptions in habitat suitability as determined from Forest Cover and topography, used to predict the number of potential goshawk territories within each Management Unit.

2. Predicting the number of territories in areas of high ranked Marbled Murrelet habitat per Management Unit.

Goshawks breeding in the valleys and on the islands of the North Coast are probably the Northern Goshawk *laingi* subspecies, a species that is recognized as a Species at Risk, and listed as threatened by COSEWIC. To determine if an opportunity exists to successfully manage for this species and another SAR, and Marbled Murrelets at the same time, we need to determine the number of predicted goshawk territories that potentially will be protected if we maintain only the larger areas (>200ha) of Marbled Murrelet habitat.

This proposal will use the experience from the goshawk habitat requirements in similar habitat on Vancouver Island, Haida Gwaii and from the one known nest site and predicted territory on the North Coast, at Alder Creek, to predict the number of territories within each Management Unit. Primarily, this assessment will use the Alder Creek goshawk nesting habitat, and the area of suitable foraging habitat found within this watershed, as a benchmark to determine the likely presence and number of goshawk territories within the watersheds that make up the present management units in the region (protected and non-protected).

Estimating the Habitat overlap between Marbled Murrelets and goshawks and estimating the number of Goshawk Territories

Goshawk habitat suitability overlaps with Marbled Murrelet nesting habitat.

Method

On the 7th October 2004, I joined the Marbled Murrelet aerial habitat verification suitability team (Alan Burger and Anne Hetherington) and conducted goshawk nesting and overall landscape suitability ranking of 28 sites that were randomly sampled as part of the Marbled Murrelet Model habitat verification (Based on the Draft report by Burger et al. 2004 "Testing models of habitat suitability for nesting Marbled Murrelets, using low-level aerial surveys on the North Coast, British Columbia").

At each of the sites sampled I conducted an independent habitat assessment for goshawk nesting suitability based on Tree Height, Canopy Closure, Tree Species and Vertical Canopy Complexity and Slope (see Doyle March 2004: Standard Methods for Identifying and Ranking Nesting Habitat of Northern Goshawks in British Columbia, using air photo interpretation and Low Level aerial surveys).

The overall habitat ranking system used for each species and for the individual habitat features used to determine suitability for each species, varied from a four to a six ranked system, therefore when necessary the data was transformed to allow for a consistent comparison between the two species.

Finally, the habitat suitability ranking of the individual sample sites for goshawk nesting was independent of their topographic location, and is purely focused on the structural attributes of the habitat.

Results

Overall, the habitat suitability ranking of the random Marbled Murrelet sample sites, for both goshawks and murrelets showed strong parallels, with high ranked murrelet nesting habitat consistently representing high ranked goshawk nesting habitat (Figure 1 and 2). This was also consistent with lower ranked habitats; however, few samples were available for sites with low suitability.

Typically, high overall goshawk nesting suitability (Rank 1 and 2) was associated with a greater range in murrelet habitat suitability (Rank 1 to 3). Using this broader range in requirements we see nearly a 100% overlap in the overall ranking for each of the 28 sites sampled if we also include the number of sites with an adjacent ranked habitat (Table 2). The only exception was seen when using the habitat suitability 6 ranking system for murrelets (Figure 1), when habitat ranked as Very High (1) for goshawks was ranked 3 for murrelets. Overall therefore habitat seen as having high suitability for murrelets is also suitable for goshawks.

Figure 1. Overall Goshawk Habitat Suitability compared to Marbled Murrelet Patch Suitability, using the Six Ranking System. Low number = higher ranking, (Number) = Number of Sites with this ranking.

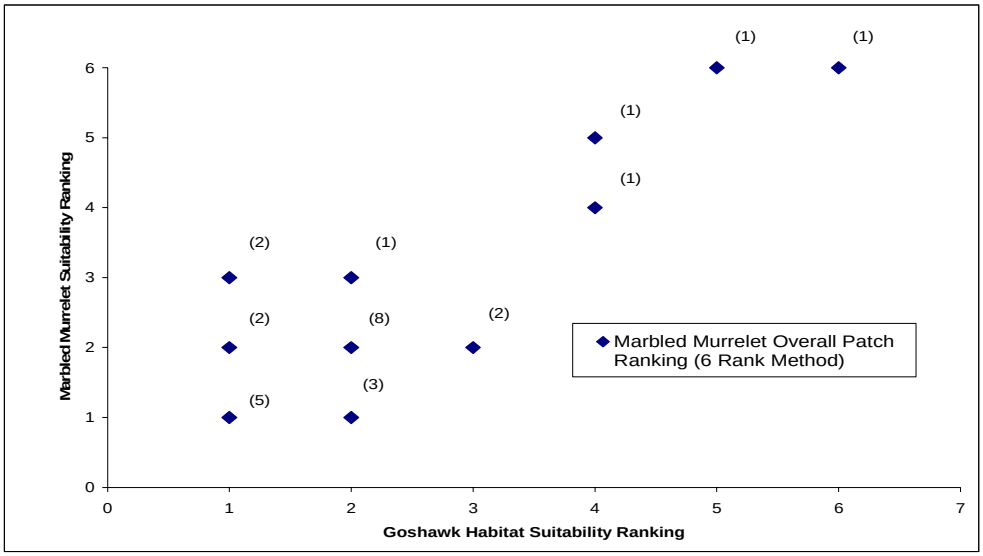


Figure 2. Overall Goshawk Habitat Suitability compared to Marbled Murrelet Patch suitability, using the Four Ranking System. Low number = higher ranking, (Number) = Number of Sites with this ranking.

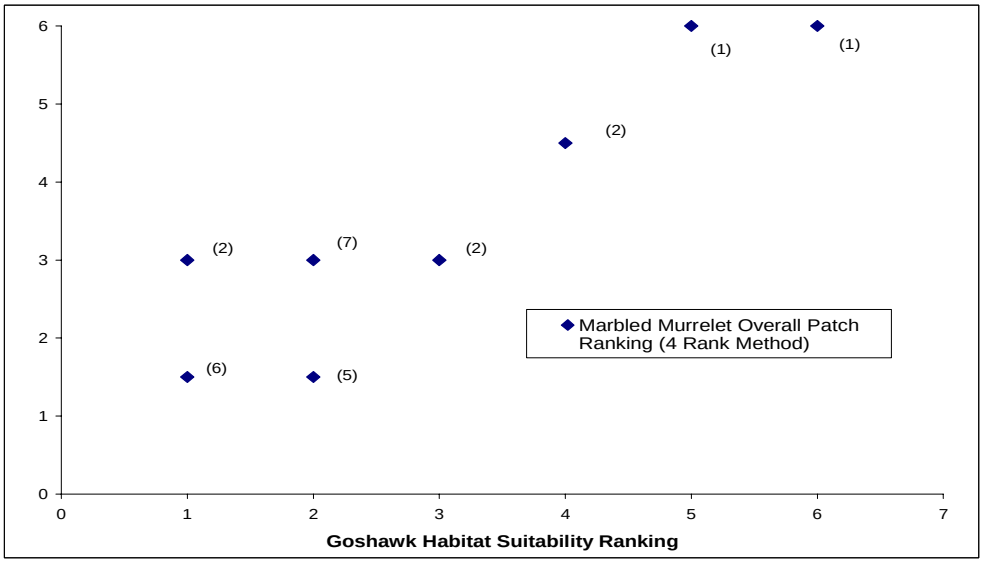
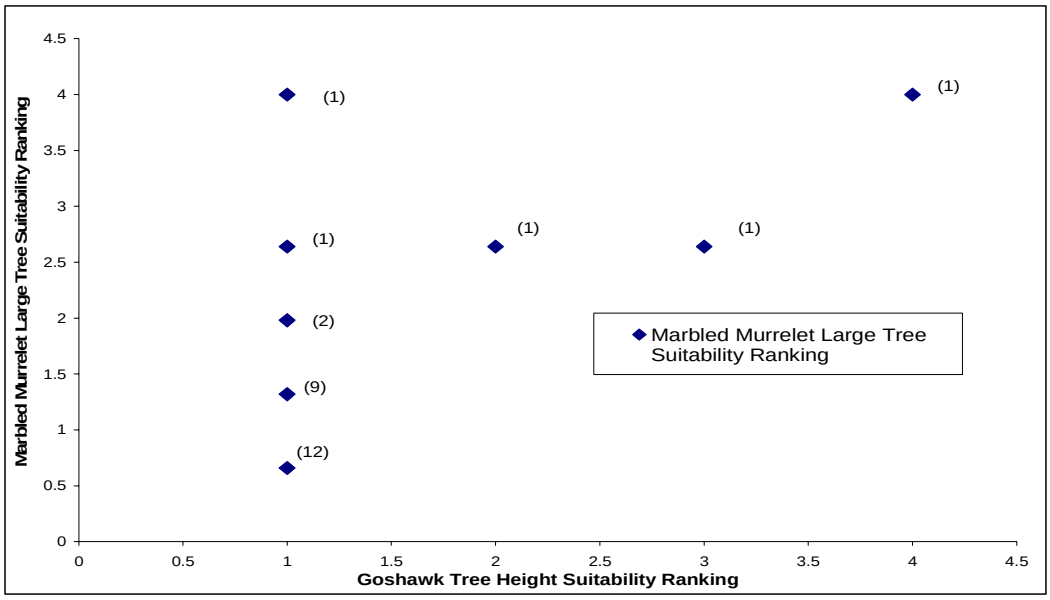


Table 2. Overlap between the suitability ranking for murrelets and goshawks. (Number) = Sample size).

	Percentage overlap in Goshawk Habitat Suitability Ranking compared to Murrelet Ranking					
Murrelet Suitabily Ranking Type	NoGo 1 = MaMu 1 or 2	NoGo 2 = MaMu 1, 2 or 3	NoGo 3 = MaMu 2, 3 or 4	NoGo 4 = MaMu 3, 4 or 5	NoGo 5 = MaMu 4, 5 or 6	NoGo 6 = MaMu 5 or 6
4 Ranks	100 (9)	100 (13)	100 (2)	100 (2)	100 (1)	100 (1)
6 Ranks	78 (9)	100 (13)	100 (2)	100 (2)	100 (1)	100 (1)

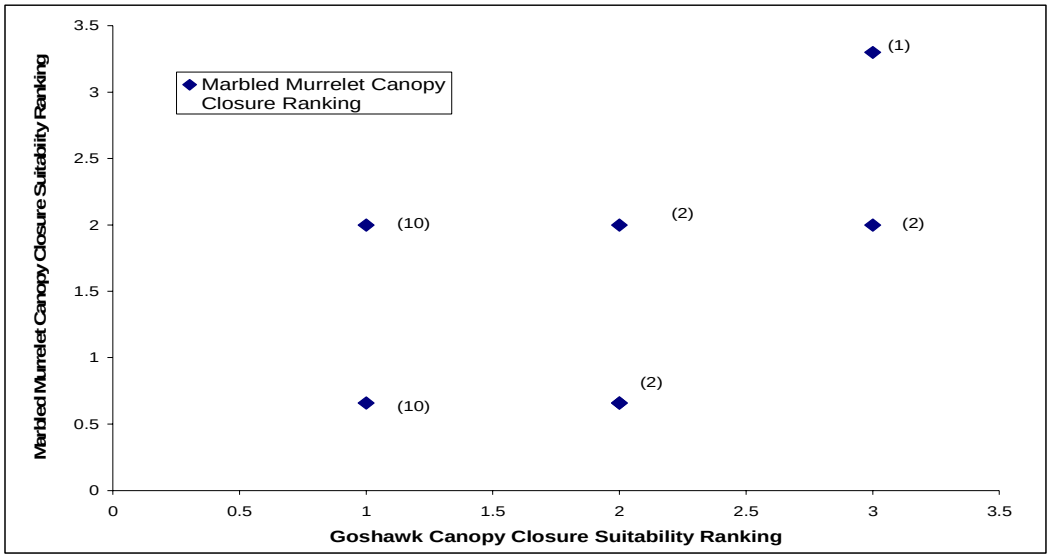
When we compared the ranking of the individual structural attributes selected by both species there is a similar pattern in overlap. For tree height selection there was an 84% overlap in high ranked goshawk suitability of sites, with sites ranked 1 or 2 for murrelet suitability. However, a few sites (11%, n =3) also showed there was potentially a wide range (1-4) of murrelet suitability rankings that was still high (1) suitability goshawk habitat (Figure 3).

Figure 3. Marbled Murrelet Large Tree suitability compared to the goshawk tree height suitability ranking. Low number = higher ranking, (Number) = Number of Sites with this ranking.



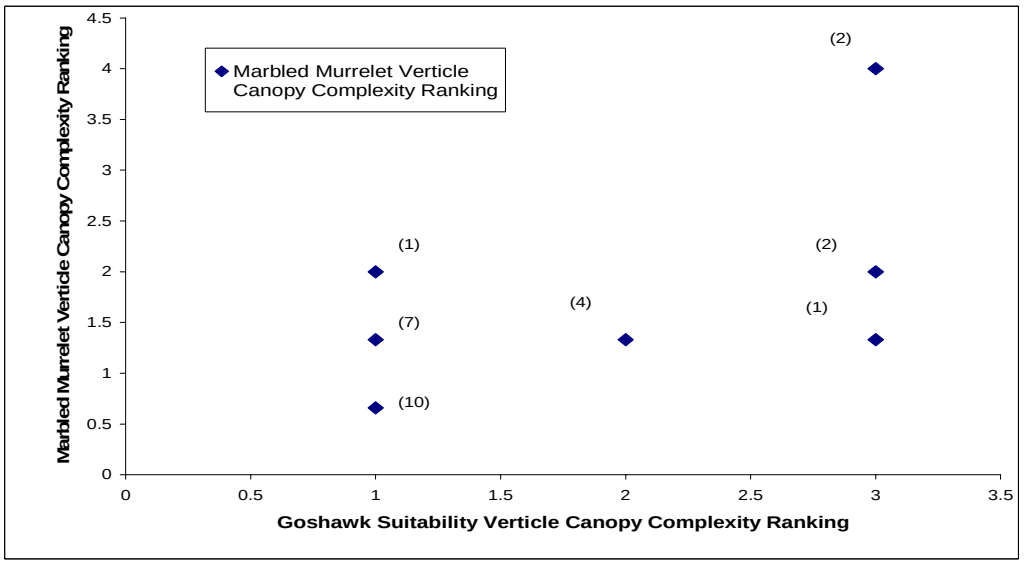
Canopy closure requirements for both species do differ slightly, with a more closed canopy being selected for by goshawks. This wider range in requirements consequently resulted in many sites ranked moderate (2) for murrelets ranking high for goshawks (Figure 4).

Figure 4. Comparison between murrelet and goshawk Canopy Closure habitat suitability ranking. Low number = higher ranking, (Number) = Number of Sites with this ranking.



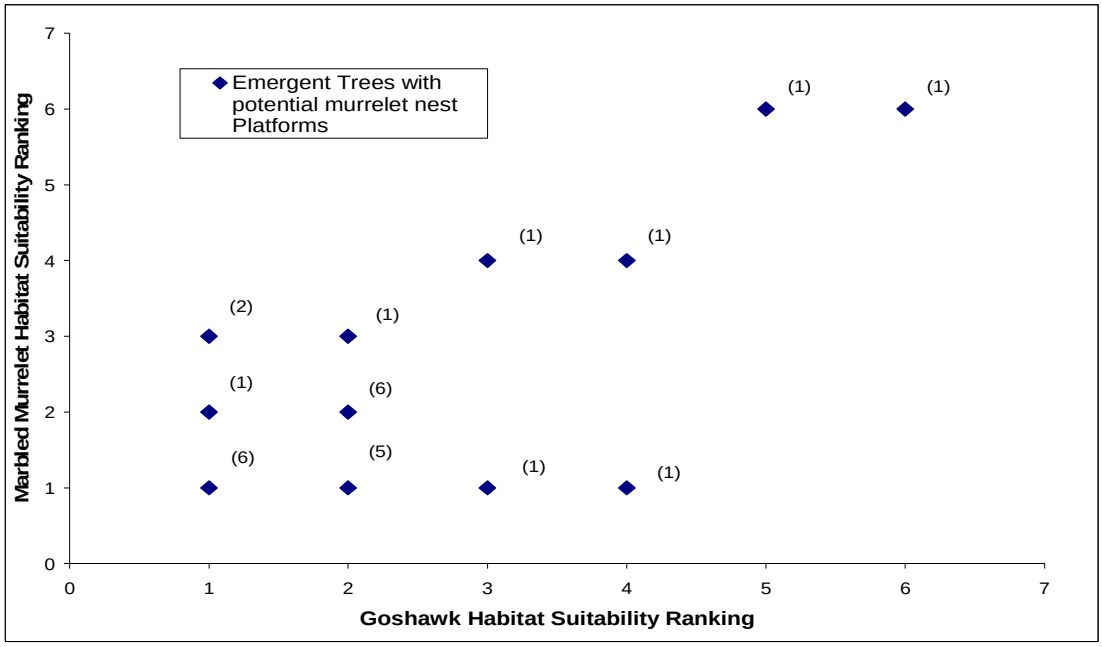
In contrast, parallels between the species in vertical canopy complexity habitat suitability ranking, were less clear in this small sample, however high ranked murrelet sites were typically (61%) also higher ranked for goshawks. In general there was a more rapid decrease in ranking for goshawks with increased canopy complexity than for murrelets (Figure 5), and a greater range of goshawk ranking was observed in relation to the highest murrelet ranked sites.

Figure 5. Comparison between murrelet and goshawk Vertical Canopy Complexity habitat suitability ranking. Low number = higher ranking, (Number) = Number of Sites with this ranking.



A final comparison of structural attributes compared overall goshawk habitat suitability with the murrelet suitability ranking based on platform counts and availability on emergent trees. This showed a general trend such that lower ranked murrelet sites were also lower ranked goshawk sites (Figure 6), but in this case goshawk suitability ranking also decreased in some stands (7%, n = 2), that were ranked as high for murrelets.

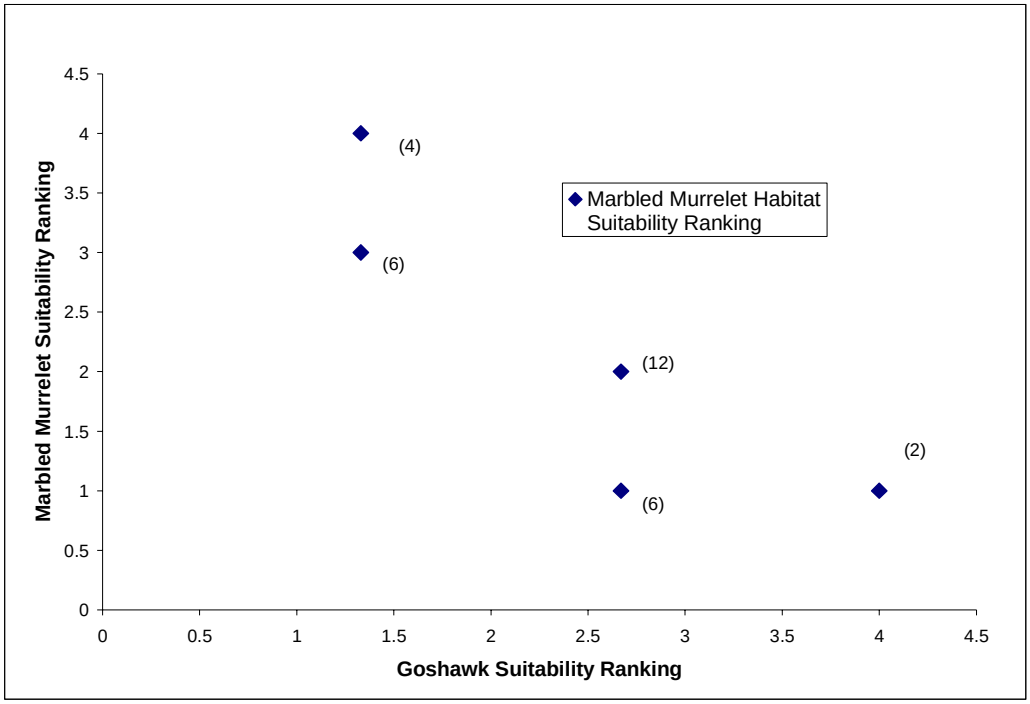
Figure 6. Overall Goshawk Habitat Suitability compared to emergent trees with Marbled Murrelet Platforms. Low number = higher ranking, (Number) = Number of Sites with this ranking.



Topographically, a distinct difference in habitat selection is predicted for the steeper and flatter slope grades, with a steep grade corresponding to a high ranking for murrelets and a low ranking for goshawks. At mid-slope grades, there is however considerable overlap, and of the sites sampled 57% (N = 28) has a similar ranking.

The largest potential divergence in ranking, based on this small sample, were the 36% (n = 10) of sites that ranked high for goshawk habitat suitability, but ranked low for murrelets. These are the sites on flat or more gentle slopes with <29% slope grade, which provide both high ranked goshawk nesting and foraging habitat. This difference may however be inaccurate, as old-growth stands is sites with little topographic relief, may still have a complex canopy structure that may provide adequate marbled murrelet access to potential nest platforms.

Figure 7. Comparison between murrelet and goshawk Slope Grade habitat suitability ranking. Low number = higher ranking, (Number) = Number of Sites with this ranking.



In addition, to the comparison between structural attribute rankings for the two species, an assessment of the comparisons between stand and patch attribute rankings for goshawks and with the predicted habitat of that site using the Murrelet suitability models was also conducted (Table 3). For each model, overall site goshawk suitability ranking shows a wide range in the corresponding predicted murrelet suitability at that location. However, the results are consistent with the attribute ranking comparisons, with sites ranked high for goshawk suitability VH (1) - M (3) typically ranking (82%, n = 22) Superior (1) to Fair (3) for murrelets using the Regional Murrelet Model. Similarly, higher ranked goshawk habitat (High – Medium) overlapped 96% (n = 24) with High ranked habitat in the MMRT model. At the lower end of the ranking scale, there is also some consistence with areas that were identified as low in the models typically ranking low for goshawk suitability in the field. The one obvious exception was one site that ranked high for goshawk nesting but ranked low in all three models, however, the predicted mapped habitat of this random site was inconsistent with the habitat actually found during the survey.

Table 3. A comparison between habitat suitability ranking for goshawks with the predicted murrelet habitat suitability models.

Goshawk Suitability Ranking		VH	VH	VH	VH
	#	2	4	2	1
	%	**22**	**44**	**22**	**10**
Marbled	Regional Model Rank	1S	2G	3F	4N
Murrelet	Corrected Regional Rank	1S	2G	3F	
Models	MMRT Model Rank	1H	1H	1H	1H

Goshawk Suitability Ranking		H	H	H	H	H
	#	4	2	4	2	1
	%	**31**	**15**	**31**	**15**	**8**
Marbled	Regional Model Rank	1S	2G	3F	4N	4N
Murrelet	Corrected Regional Rank	1S	2G	3F		4N
Models	MMRT Model Rank	1H	1H	1H	1H	4N

Goshawk Suitability Ranking		M	M	L	L	VL	N
	#	1	1	1	1	1	1
	%	**50**	**50**	**50**	**50**	**100**	**100**
Marbled	Regional Model Rank	1S	2G	3F	4N	4N	4N
Murrelet	Corrected Regional Rank	1S	2G	3F		4N	4N
Models	MMRT Model Rank	1H	1H	1H	1H	4N	4N

Goshawk Suitability ranking: VH = Very High, H = High, M = Medium, L = Low, VL = Very Low, N = Nil. **Marbled Murrelet Predicted Habitat Suitability Rankings:** 1S = Superior, 1H = suitable Habitat, G = Good, 3F = Fair, 4N = Not suitable (Nil).

Accuracy of the pre flight prediction of the number of goshawk territories

Based on the observed goshawk habitat suitability I compared the predicted estimate of the number of goshawk territories that may be within each landscape unit (Table 4). This took into account not only the suitability of the nesting habitat, but also the likelihood that the observed surrounding area in that landscape unit was also suitable foraging habitat, based on tree species and habitat type composition (Bloxton 2002, Doyle 2004b).

This assessment was consistent for three of six areas sampled. In one other case (Goat Creek) field verification indicate the landscape may support a goshawk territory when the mapped prediction was that there was insufficient habitat to support a territory. For a further two areas (Upper and Lower Kowesas), the habitat encountered was so very different from the benchmark site or other known goshawk nest areas in BC, that it was difficult to determine if the area potentially supported breeding. Here the ~1 km broad valley floor supported a predicted high quality foraging and nesting habitat, and yet this suitability was terminated

abruptly by sheer rock valley sides and mountains, with predictably poor foraging suitability. Based on the extent of the suitable linear habitat in the valley floor there may be enough habitat for 2 territories, however, birds may have to carry prey a long distance, and any nest site would have to be relatively (<300m) close to a large river which is inconsistent with typical nest site selection (Doyle 2003).

The final area surveyed, Princess Royal Island, was outside of the preliminary predicted territory estimate mapping. This area was lower in elevation than much of the adjacent inland coast, and lacked the relatively large areas of low ranked goshawk habitat (steep sided cliff and mountain habitat) typical of that area. Overall the landscape here appeared to provide suitable territory components (nesting and foraging habitat), with the area around Cornwall Inlet providing for the possibility of at least one goshawk territory on the island.

Table 4. Predicted and actual estimate of the number of goshawk territories within each survey area.

Land Use Zones	Location	Predicted Overall # Goshawk Territories Pre Flight	Predicted Overall # Goshawk Territories Post Flight
Shearwater Hotspings	Upper Kowesas	1	1 ?
	Lower Kowesas	1	1 ?
	Berrie Creek	1	1
	Europa West	1	1
Bishop Bay	Paril Creek	2	2
	Goat Creek	0	1
Princess Royal Is.	Cornwall Inlet	N/A	≥1

Predicting the number of goshawk territories in areas of high ranked Marbled Murrelet habitat.

Methods

This exercise simply compared the characteristics (forest type and area, and topographic location) of the one known North Coast goshawk nest site at Alder Creek, and estimated the likelihood and number of goshawk territories in each management unit based on this "benchmark site". The topography and vegetation at this one site is characteristic of the North Coast: steep sided U shaped valley, heavily forested on the lower slopes, bog-fen areas at its base, and low vegetation/shrub interspersed with sheer rock walls from 1/3rd of the way up the sides of the valley. As a further consideration, we used the observed spacing between goshawk nest areas on Vancouver Island (7-8km) (McClaren 2003), as an estimate of the likely spacing between pairs on the North Coast. This method did not try to replace the location and estimates from a model of suitable goshawk habitat and territory suitability developed for the North Coast LUP (Mahon et al, 2002), as it focused on large areas (>200ha) of high ranked Marbled Murrelet habitat for each specific Management Unit, and considered only the habitat within the boundary area of that Unit. In addition, it also used a more conservative estimate for spacing distance between territory centers, based on the low spacing seen between nests areas on Haida Gwaii (Doyle 2003) and Vancouver Island (McClaren 2003), rather than the 4-5km spacing, that is more representative of the ICH and SBS that was used in the NC goshawk model.

The estimated number of territories was then ranked on a probability scale of High, Medium and Low. Where High represents the estimated number of territories based the forest type and topographic similarity to the "benchmark" territory, which can be placed within each management unit. Medium = slightly less suitable forest habitat as seen at the benchmark site (~10-20% less), Low = some suitable habitat present but ~ $\geq$20-30% less than seen at the "benchmark site". If the area had <30% of suitable habitat as seen at the "benchmark site" then the area was considered unsuitable for goshawks.

Finally, a further Marbled Murrelet habitat suitability flight in October 2005 was conducted along the outer coast and islands within the Coastal Western Hemlock-very wet hypermaritime biogeoclimatic ecosystem classification. This flight was focused on assessing overall Marbled Murrelet habitat suitability, but it also used the information from the earlier goshawk habitat assessment flight, to determine if the required goshawk forest attributes observed on this earlier flight, were also present within this very wet outer coastal habitat.

Results

The results are summarized in Table 1a and b. This indicates that within the existing no harvest management units, if we exclude the wet hypermaritime as being suitable for goshawks, there could be as few as 19 territories and a reduced likelihood that there may be up to 43 territories. Within the harvested management units, there is estimated to be as few as 9 territories and a reduced likelihood of up to 29 territories.

Based on the mapped habitat attributes and the flight along the outer coast and islands the area within the very wet hypermaritime biogeoclimatic zone was considered to have insufficient suitable habitat to support a goshawk territory, based both on nesting habitat

requirements, and the size of the foraging area required as indicated by the spacing of pairs on Vancouver Island. In addition, many of the areas along the coast are swamp/bog habitat which is poor quality foraging habitat for goshawks (Squires and Reynolds 1997, Doyle 2003).

Table 1a. Estimated potential number of goshawk territories in protected North Coast Management Units (Areas in **BOLD *ITALIC*** are in the wet hypermaritime forest which is probably unsuitable for goshawks).

Area Type	Area Name	Potential number of Goshawk Territories		
		High	Medium	Low
Provincial Park	Khutzmaten	4	5	6
	Klewnuggit Marine Park	0	0	0
	Union Passage Marine Park	0	0	0
Biodiversity Area	Porcher Island	0	0	0
	Kshwan	1	2	2
	Kitsault/Stagoo	3	4	4
	Sparkling East	3	5	6
	Pa_aat West	0	0	0
	Alwyn Lake	0	0	0
	Kingknown Inlet	0	0	0
No Logging (Section 13)	Stagoo South	1	1	1
	Kwinamass	2	3	3
	Union West	0	1	1
	Dundas	0	0	0
	Khyex	2	3	4
	Tuck-Woodworth Lakes	0	0	1
	Stephens	0	0	0
	N, Kumealon/Kildale Lakes	0	0	0
	Khtada West	1	2	2
	Ecstall River	0	0	1
	Brown South/Sparkling	2	3	3
	Porcher-Kitkatla Inlet	0	0	0
	Goschen Is.	0	0	0
	Banilla Is.	0	0	0
	Banks North	0	0	0
	Gamble Lake	0	0	1
	Monkton North	***1***	***1***	***1***
	Campania	0	0	0
	Fin Is.	0	0	0
	Gil Is.	0	0	0
	Union Passage	0	0	0
	Monkey Beach	0	0	0
	Europa	0	0	0
	Aristezabal North	0	0	0
	Ashdown Is.	0	0	0
	Aristezabal West	0	0	0
	Aristezabal East	0	0	0
EBM and Outstanding Areas	Gribble	0	1	1
	Tsimtalk Lake	0	1	1
	Kennedy Is.	0	0	1
	Union South	0	0	1
	Somerville	0	2	2
	Somerville Is.	0	0	1
	Big Falls West	0	0	1
Total (Exluding very wet forest type)		**20 (19)**	**34 (33)**	**44 (43)**

Table 1b. Estimated Potential number of goshawk territories within harvested management Units on the North Coast. (Areas in **BOLD *ITALIC*** are in the wet hypermaritime forest which is probably unsuitable for goshawks).

Area Type	Area Name	Potential number of Goshawk Territories		
		High	Medium	Low
Timber Harvest Management Zone	Och Creek	0	1	1
	Kshwan North	0	0	0
	Kitsawlt	0	1	1
	Larcom Lagoon	0	0	0
	Maple Bay	0	1	3
	Pearse North	0	0	0
	Pearse - Lizard Cove	0	0	0
	Pearse - Winter	0	0	0
	Wales Is.	0	0	0
	Chambers West	0	0	0
	Chambers East	***0***	***1***	***1***
	Union West	0	0	0
	Quottoon Narrows	1	2	2
	Skeena River Estury Sites	1	2	3
	Marmot Bay/Georgie River	1	2	2
	Kitson Is.	***0***	***1***	***1***
	Kwintsa	0	0	0
	Khtada East (Alder Creek)	1	1	1
	Scotia	0	1	1
	Scotia West	0	0	0
	Scotia East	0	0	1
	Brown North	0	0	0
	Big Falls	0	0	0
	Johnson North	1	1	2
	North Kumealon-Baker Inlet	0	1	2
	Porcher East	0	0	0
	Captin Cove/Pitt Island	***2***	***3***	***3***
	Hevenor	0	1	1
	devon Lake	0	0	0
	Batchallor Lake	0	1	1
	Wears Lake	0	1	1
	Lowe Gamble	0	0	0
	Red Lake Bluff South	0	1	1
	Union Passage	0	0	0
	Tuwartz West	0	0	0
	Hawksbury Is.	***0***	***1***	***2***
	Gill Is.	***0***	***1***	***2***
	McCauley Is.	0	0	0
	Banks Northeast	0	0	0
	Banks-Walker Lakes	0	0	1
	Banks Keeck Lakes	0	0	0
	Banks South	0	0	0
	Trutch Is.	0	0	0
	Aristezabal Is.	0	0	0
	Bishop Bay Hotsprings/Triumph	3	3	4
	Europa West	1	1	1
	Digby Is.	0	0	0
Total (Excluding very wet forest type)		**11 (9)**	**28 (21)**	**38 (29)**

Discussion

The two components of this project, establishing the degree of habitat suitability overlap between goshawks and murrelets, and estimating the number of goshawk territories within areas of high ranked murrelet habitat, both suffered from relatively low field verification sample sizes and a non-stratified habitat assessment approach focused on forested habitats. However, the results from this small sample size are consistent with a much larger sample of stratified assessments, in similar habitat on Haida Gwaii (Doyle 2004). Similarly any biases in habitat suitability based on sampling only forested habitats, is also considered unlikely, as research in rainforest habitats has consistently shown that goshawk nesting and foraging is focused within forest stands (Iverson et al. 1996, Bloxton 2002, McClaren 2003).

Another potential weakness of this study, is that the actual habitat suitability assessments for goshawks at each murrelet sample site did not take into account the proximity of each site to shoreline, or the spatial arrangement of potential suitable nesting and foraging habitat within the landscape, all of which we know can influence the actual use of individual areas for nesting by goshawks. The potential of such individual sites should again be verified using North Coast goshawk habitat suitability modeling approach (Mahon et al. 2002).

Overall, however, the high overlap in individual forest structural attribute ranking and the overall patch habitat suitability ranking between goshawks and murrelets, suggest that strategically managing for murrelets can retain suitable goshawk nesting habitat. The main possibility for divergence in suitability ranking between these two species was seen in slope grade selection. This divergence was however, not weighted strongly enough in relation to the forest structural variables included in the overall patch, and predicted murrelet habitat models, to change the overall pattern, i.e. high ranked murrelet habitat was typically also high ranked goshawk habitat.

Goshawk foraging habitat typically encompasses similar forest attributes as selected for nesting (Doyle 2004), and therefore retention of murrelet habitat will also help to maintain foraging habitat depending on the amount, patch size, prey availability and distance to nest. However, the overall area or goshawk foraging habitat retention needs to be far greater (several thousand ha), than the minimum goshawk nesting (patches >200 ha), if the retention of murrelet habitat is to directly result in the maintenance of a goshawk territory.

The most critical weakness in the goshawk territory suitability assessment is that we do not have any information on actual prey abundance and species composition for any locations on the North Coast. We do not know if the prey populations are as abundant as seen in the Interior Kispiox and Lakes Forest Districts where goshawk pairs nest 4-5 km apart (Doyle and Mahon 2001, Mahon and Doyle 2003), or indeed if they are lower than seen on Vancouver Island where nests are ~ 7km apart (McClaren 2003). This flight, certainly did not clarify this lack of knowledge, although the weight of evidence suggests the prey base may be lower than earlier predictions, as the large areas forested bog habitat may be expected to be very unproductive foraging habitats, based on the work in comparable habitats on Haida Gwaii (Doyle 2004b). Finally, the forested habitat on the valley floor in the steep sided U shaped valleys that are characteristic of the North Coast, in addition to being inundated by heavy snowfall (that may restrict access to ground vegetation for hares) is also impacted by persistent cold outflow winds, which may impact the productivity and vegetation types (sub alpine fir) of these low elevation sites (Wilford pers. comm.). We do not know what, or if, these combined impacts may be having on prey populations, but again it is probable that the

foraging suitability may be lower than seen in the interior or on Vancouver Island. If this is the case then the number of predicted territories may be considerably lower than the highest probability estimates.

Using the Alder Creek site as a benchmark, and the flight verification of the overall habitat suitability model, it is considered probable that the earlier habitat modeling (Mahon et al, 2002), over estimated the potential number of suitable goshawk territories in the North Coast. From this research the number of territories is estimated to be 71-58% lower than the earlier prediction. Even though practically we cannot verify any of these figures, and considering we potentially underestimated the number of territories by constraining our estimate to within management units, this low estimate of the potential number of territories still suggests that this red-listed species may be less abundant (28-72 territories) than previously thought (97- 172). Using these estimates, between 60-67% of the predicted territories are within existing protected areas, with the remaining potential territories being inside the Timber Harvested Land Base (THLB).

As a potential mechanism to protect Identified Wildlife Species outside of the existing protected areas, the IWMS allows a 1% allocation of the THLB for Wildlife Habitat Area protection. As we saw both Marbled Murrelets and goshawks select for similar forest attributes and it is therefore suggested that the WHA's should be selected such that they provide habitat for both species. This is essential for goshawk as the present legislation does not allow the allocation of WHA's for goshawks without a known, occupied nest area being identified first. As this is not practical (funding and time), then the only protection for the red listed goshawk will come from identifying WHA's for murrelets that also have a high potential of being used by goshawks. In addition, the proposed areas of protection for Marbled Murrelets (ideally >200ha), are also the same as the observed requirements for goshawk nest area suitability (encompasses the area in which alternate nests are located, and the post fledging area of the young). However, for this approach to be successful the selected WHA's, also need to be far enough apart to provide nesting opportunities for adjacent pairs. Goshawk nest areas are regularly spaced within forested landscapes depending on the abundance and availability of prey in that landscape (Doyle 2006). Within the North Coast the spacing between nest areas is unknown, but based on the habitat observations from the verification flights it is probably closer to ~ 7km apart as observed on Vancouver Island (McClaren 2003), rather than the 4-5km observed in interior BC (Mahon et al. 2002). In addition, these nest areas will only support breeding by goshawks if they retain connectivity to the surrounding mature forested landscape, and if the surrounding territory continues to provide for the goshawks foraging requirements.

As nest area connectivity and foraging habitat requirements are essential to ensure a viable goshawk territory, and as we are unsure of the spacing requirements, it is suggested that where appropriate nesting and foraging habitat (predominantly contiguous mature-old growth forested habitat) still exists on a landscape scale, WHA nest areas should be placed in potential territories which are adjacent to existing protected areas, in which goshawks are predicted to be breeding. This has the benefit of:

- Providing a larger overall protected foraging and nesting area, thus increasing the possibility that any existing goshawk territories in the area remain viable.
- Providing for the opportunity to more readily ensure that the nest area does not become an isolated mature forest patch surrounded by young seral forest.
- Reducing the possibility of the patch being isolated and therefore more susceptible to blowdown.

- Ensuring a larger overall protected area that may also benefit other species.
- Possibly facilitate dispersing young and reoccupation of vacant nests and in-filling of additional territories in high-prey years.

If no suitable habitat is present adjacent to existing protected areas, then goshawk WHA's with the THLB should be chosen based on the suitability ranking as to which areas have the highest potential to support nesting. Ideally this would again focus on areas in which the forest is predicted to support more than one territory, thus (given our uncertainty of the overall habitat suitability for foraging, and thus our uncertainty of the actual territory spacing) increasing the likelihood of protecting sufficient habitat to maintain at least one viable territory.

Goshawks primarily depend on mature forest environment to provide for their foraging and nesting requirements; within the harvested land base harvesting will therefore be expected to reduce the suitability of the landscape for goshawks (Squires and Reynolds 1997). Successful stewardship planning for goshawks within the harvested land base will therefore require planners to manage for goshawk habitat needs first, and then to determine the fiber supply once this management framework is in place. To successfully manage for goshawks in such an environment, we therefore need to know when, and under what conditions, young forests start to provide habitat that meets the goshawks requirements. Ongoing work on Haida Gwaii (Doyle 2006b), in a similar wet hypermaritime environment as on the North Coast, is looking at when harvested areas attain suitable goshawk foraging and nesting attributes. This research indicates that both required foraging and nesting attributes are not attained, even on the richest growing sites, until the forest is at least 80 years of age. This therefore suggests that few harvested areas on the North Coast are likely to be old enough to be contributing to goshawk nesting and foraging requirements. In addition, it also suggests that within the harvested land base that the harvesting age needs to be considerably longer than 80 years if the intent is to once again provide forest attributes that will result in a secure viable population of this red listed species. Large scale clear-cut harvesting of the young forest prior to, or as it reaches the stage when it starts to attain suitability for goshawks, will presumably result in a reduction or permanent loss of goshawks from the timber harvesting land base. As there is such a long period of time post harvest before the habitat once again provides suitable conditions for goshawks, and as there are relatively few High-Medium suitability territories likely to support goshawks on the North Coast, then rather than post harvest trying to once again provide suitable goshawk habitat, it is suggested that prior to harvest forest manager's work with the biologists to ensure the best opportunity that all potential high-medium ranked goshawk territories will remain viable. This collaboration will require the retention of key habitat requirements (nest areas, connectivity, high quality foraging habitats) across the land base, with both the spatial and temporal management of harvest patches such that the required goshawk attributes (abundant prey that is available to a foraging goshawk, and suitable nest areas) continue to be provided.

Based on this research, and the "predicted" low density on goshawks within the North Coast, the BC Provincial Goshawk Recovery Team encourages the approach discussed above, such that where the opportunity exists, WHA's should be selected that will provide for both Marbled Murrelet and Goshawk nesting habitat requirements.

Future goshawk information requirements to effectively manage for goshawks on the North Coast.

1. Nesting: Ground verification of the goshawk nesting habitat suitability as interpreted using the low level aerial survey in this report. Including verification of beneath canopy habitat attributes, and locating a sample of goshawk nests to verify use of predicted habitat attributes used in the North Coast goshawk population models and estimates.

2. Foraging: An assessment of prey species composition and relative abundance stratified across habitat types, as defined by Forest Cover and/or Site Series habitat polygons. This assessment needs to be conducted across the landscape such that comparable sampling of habitats takes place in interior, inner coastal and outer island landscapes.

- Does prey population abundance and diversity change between forest types and topographic location?
- How does the relative abundance of prey compare to the relative abundance of prey on Vancouver Island, Interior BC and on Haida Gwaii?
- And subsequently how many pairs of goshawks are likely to be supported by the prey population available within the North Coast Landscape?
- Within the THLB the development of landscape scale management guidelines that will ensure goshawks are not permanently lost from this landscape

Literature Cited:

Bloxton, T. D. 2002. Prey abundance, Space use, demography, and foraging habitat of Northern Goshawks in Western Washington. MSc. Thesis University of Washington.

Burger A. E. 2003. Standard methods for identifying and ranking nesting habitat of Marbled Murrelets in British Columbia using air photo interpretation and low-level aerial surveys. MWALP, Victoria, BC.

Doyle, F. I. 2003. Biological Review and Recommended Interim Strategy Direction for Northern Goshawks on Haida Gwaii/Queen Charlotte Islands. MWLAP, Smithers, BC.

Doyle, F. I. 2004. Standard methods for identifying and ranking nesting habitat of Northern Goshawks in British Columbia using air photo interpretation and low-level aerial surveys. MWALP, Queen Charlotte Islands. 1-34.

Doyle, F. I. 2004b. Managing for Goshawks in TFL39 on Haida Gwaii/Queen Charlotte Islands. Goshawk and Marbled Murrelet Habitat Suitability. FIA Weyerhaeuser Ltd, QCI.

Doyle, F. I. 2006. Goshawks in Canada: Population responses to harvesting and appropriateness of using standard bird monitoring techniques to assess their status. In Studies in Avian Biology. In Press.

Doyle, F. I. 2006b. When do naturally regenerating, and pre-commercially thinned second growth forests, attain attributes that will support Northern laingi Goshawks and Marbled Murrelets on Haida Gwaii. Cascadia, 2005 FIA. In Prep.

Doyle, F. I. and T. Mahon. 2001. Inventory of the northern goshawk in the Kispiox Forest District "Annual Report 2000". B.C. Ministry of Environment, Lands and Parks. Smithers.

Iverson, C.G., Hayward, G.D, Titus, K., DeGayner, E., Lowell, R.E., Crocker-Bedford, D., Scheimpf, F.P., and J. Lindell. 1996. Conservation Assessment for the Northern Goshawk in Southeast Alaska. USDA Forest Service Gen. Tech. Rep. PNW-GTR-387.

McClaren, E. L. 2003. Northern goshawk (Accipiter gentilis laingi) population inventory summary for Vancouver Island, British Columbia (1994-2002). Ministry of Environment, Lands and Parks, Nanaimo, B.C.

Mahon, T. and F.I. Doyle. 2003. Northern goshawk in the Lakes and Morice Forest Districts – 5-year project summary and management recommendations. Project: IFPA No. 431.02. Babine Forest Products Ltd., Burns Lakes, BC and Houston Forest Products Ltd., Houston, BC.

Mahon T., F. I, Doyle, D. Morgan, A. Waterhouse, and J. Warren. 2002. Northern Goshawk (Accipiter gentilis ??) Habitat in the North Coast Forest District. Foraging and Nesting Habitat Suitability Models. MSRM, Smithers, BC.

Squires, J.R. and R.T. Reynolds. 1997. Northern Goshawk. In: A. Poole and F. Gill (Eds.). The Birds of North America. No 298. Academy of Natural Sciences and The American Ornithologists Union, Washington, D.C.