MARBLED MURRELET MANAGEMENT STRATEGY FOR CLAYOQUOT SOUND

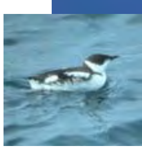

PHOTO: Sydney/Pretty Girl Watershed Planning Unit (Photo by S. Leigh-Spencer)

by

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DISCLAIMER

The views expressed herein are those of the authors and do not necessarily reflect those of the Ministry of Environment

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PHOTO: ***Marbled Murrelet incubating an egg at a Hemmingsen Creek nest near Port Renfrew, BC. Photo: Nicholas Hatch, USFS PNW Research Station.***

EXECUTIVE SUMMARY

We used an ecosystem-based management approach to develop a management strategy for Marbled Murrelets in Clayoquot Sound, BC. Our goal was to ensure that nesting reserves of sufficient quality and quantity, in addition to ecosystem-based forestry practices, would sustain the present and future populations of Marbled Murrelets. A combination of audiovisual and vegetation surveys defined nesting habitat attributes for Marbled Murrelets, which were then used to construct a Habitat Suitability Model applied to Vegetation Resource Inventory maps at a 1:20 000 scale. Potential reserves were chosen through examination of the Habitat Suitability maps and air photo interpretation. Final reserves were delineated after habitat quality was verified through low-level aerial surveys. Including habitat that is protected in other reserves, 44 576 ha of “Important” habitat (62% of all Important habitat) was protected, including 15 626 ha of Important habitat in 76 new Marbled Murrelet reserves.

The ultimate goal of our management strategy was not to protect every nest, but to ensure that a large part of the nesting habitat was protected at any given time. Population and density estimates from radar counts were used to predict that 57 ± 38% of the Important habitat required by the population would be protected by reserves. In addition, ecosystem-based forestry practices ensure that the rate of habitat loss outside of reserves is reduced, effectively increasing the size of the reserve network. Furthermore, some habitat outside of reserves will remain inaccessible to logging, and some marginal habitat protected in reserves will provide nesting opportunities. Therefore, it is likely that significantly more than 62% of nests will be protected at any given time. To monitor the effectiveness of this management strategy, we present a radar monitoring approach that has a high power to detect population change due to forest harvest and other environmental disturbances. Reserve design based on multi-scale science-based research and inventory techniques can be applied to ecosystem management of nesting habitat throughout the Marbled Murrelet’s range.

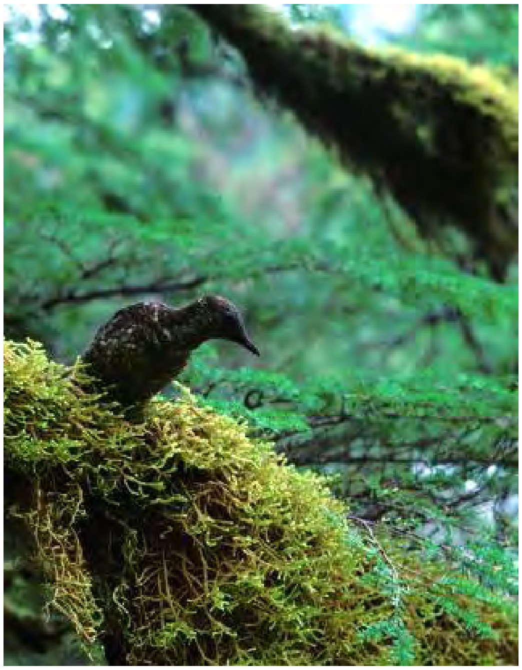

PHOTO: *Photo: Mark Hobson*

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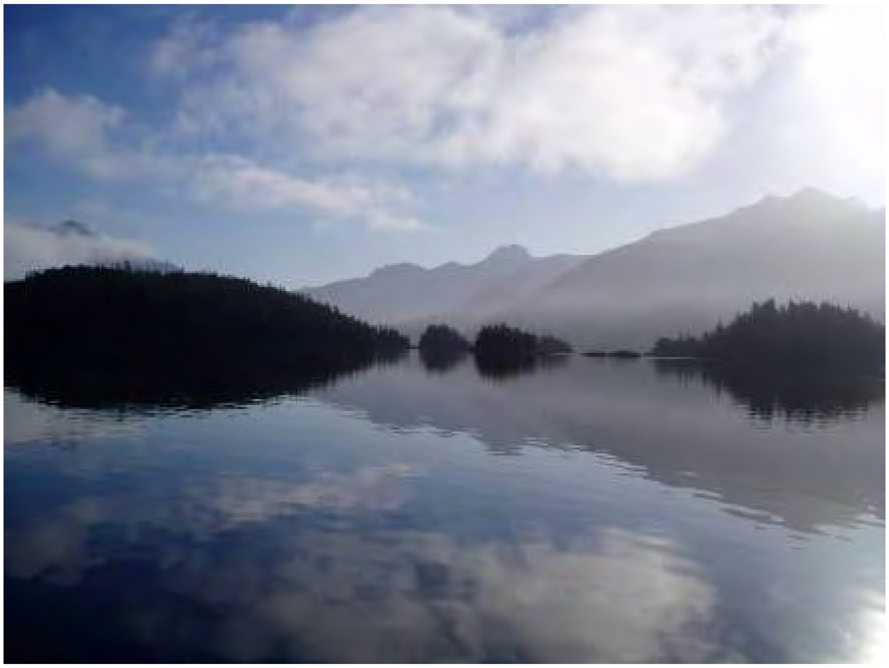


PHOTO: Tofino-Tranquil Planning Unit

INTRODUCTION

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small diving seabird that ranges along the west coast of North America from the Aleutian Islands to California (Ralph et al. 1995). This is the only alcid that nests in trees, mostly on mossy platforms of old growth conifers. During the breeding season, from March to September, breeding birds commute to and from the nest at dusk and dawn, often silently. This makes it extremely difficult to locate nests and make predictions about habitat requirements and populations.

Marbled Murrelet populations are in decline primarily due to loss of old growth forests that provide nesting habitat (Ralph et al. 1995). Additional factors contributing to the decline include mortality from gillnet fisheries, oil spills, and changes in the marine food web (Canadian Marbled Murrelet Recovery Team [CMMRT] 2003). In British Columbia the Marbled Murrelet is red-listed (CDC 2000), and nationally it is designated as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). A national strategy for the recovery of Marbled Murrelets was produced in 1994 (Kaiser et al. 1994) and a revised recovery strategy (Environment Canada 2007) is under review at this time.

A key concept in the recovery strategy is the protection of core habitat areas where source populations could offset declines in other parts of the province (CMMRT 2003). In the West and North Vancouver Island Conservation Region, substantial losses in old growth forest raised concerns about Marbled Murrelet populations (CMMRT 2003), and sea-censuses from 1982 to 1993 showed evidence of decline (Kelson et al. 1995). The population in Clayoquot Sound was identified as being of provincial and global importance (Burger 2002). This population represents about one-third of the west and north Vancouver Island regional population (6000–8000 birds of approximately 19 000–25 000; Burger 2002; CMMRT 2003), making it one of the highest concentrations of breeding Marbled Murrelets south of Alaska (Sealy and Carter 1984; Rodway et al. 1992; Burger 1995, 2002). These high numbers reflect the large remaining areas of old growth nesting habitat adjacent to productive nearshore marine feeding areas (Burger and Chatwin 2002). Because of the importance of the Clayoquot Sound Marbled Murrelet population, these tracts of forest must be managed to maintain the integrity of this core area and source population.

In 1995, the BC government decided to support the ecosystem-based planning recommendations of the Scientific Panel on Sustainable Forest Practices in Clayoquot Sound (Clayoquot Sound Scientific Panel 1995). As a result, wildlife studies were initiated to assess the habitat requirements for sensitive and forest-dependent species. The Scientific Panel recommendations involve an ecosystem-based approach to watershed-level planning that includes rate-of-cut restrictions, variable retention targets, and the creation of reserves to protect unstable slopes, sensitive soils, rare ecosystems, important wildlife habitat, and hydroriparian resources. Forestry operations are planned after non-timber values are protected. This paradigm shift in forestry practices is seen as a key concept for sustainable development in Clayoquot Sound. The creation of reserves for focal species is described in Section 7.16 of the Scientific Panel report: "at the watershed level, map and designate reserves in which no harvesting will occur to protect ... red- and blue-listed species" (Clayoquot Sound Scientific Panel 1995).

Beginning in 1996, the Ministry of Environment began to coordinate inventories for wildlife species at risk, including songbirds, bats, Roosevelt Elk (*Cervus canadensis roosevelti*), amphibians, Vancouver Island Watershrews (*Sorix palustris vancouverensis*), White-tailed Ptarmigan (Vancouver Island subspecies: *Lagopus leucura saxatilis*), Black Bear (*Ursus americanus*), and Marbled Murrelets. Marbled Murrelets became the focus of watershed reserve planning because of their dependence on old growth nesting habitat and the global importance of Clayoquot Sound to Marbled Murrelet population recovery. Our goal was to design a management strategy that included nesting habitat reserves of sufficient quality, quantity, and distribution to meet the goal of sustaining Marbled Murrelets in Clayoquot Sound as a core population.

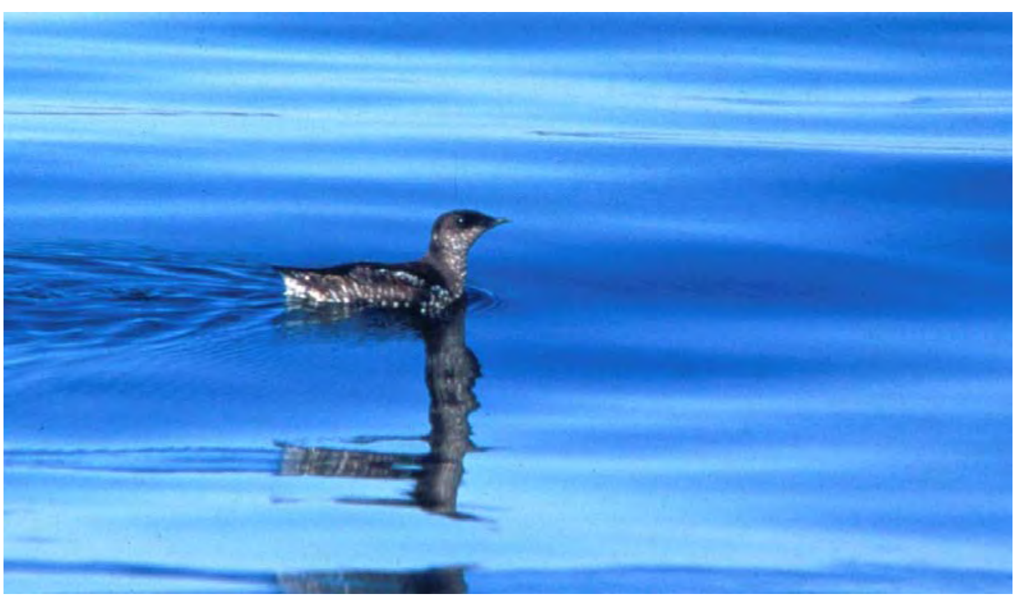
This management strategy was completed after a complex process of research and inventory was conducted. We began by undertaking habitat and audiovisual inventory from 1996 to 1998 throughout Clayoquot Sound to determine habitat relationships (Rodway and Regehr 2002). From this work, Bahn and Newsom (2002a, 2002b) created a habitat suitability index (HSI) model based on several key habitat elements: height and age of leading tree or second leading tree species, basal area of canopy and emergent trees, vertical canopy complexity (to differentiate between even-age and uneven-age stands), canopy closure, average distance from the ocean, and average elevation. Radar surveys for population inventory (Burger 2002b) and tree-climbing surveys were conducted and used to determine nesting density and area requirements of Marbled Murrelets.

The Bahn-Newsom HSI (Bahn and Newsom 2002b) was applied to forest polygons from Vegetation Resource Inventory (VRI) maps. HSI scores divided habitat into four classes: Important-Excellent, Important-Good, Suboptimal, and Unsuitable. The main strength of this model was in eliminating low-quality habitat (Suboptimal and Unsuitable) from further consideration and in identifying concentrations of high-quality habitat. However, the model was less capable of differentiating between Good and Excellent habitat, which is why these categories are both considered "Important." Although the HSI model was constructed before nests were found, subsequent comparisons to new models that used information from nest locations and modern statistical methods showed that the HSI was equally capable of predicting nesting habitat (Bahn and Lank in press). The HSI model was evaluated using actual nest locations, with the conclusion that selecting habitat from the top two habitat classes (Important-Excellent and Important-Good) would maintain twice as many nests as would randomly selected habitat (Bahn and Lank in press). Bahn and Lank suspect that the limiting factor in performance of the HSI model is the underlying variability in murrelet ecology—the low density of nests and wide range of habitats occupied by murrelets makes them a difficult species for habitat modelling. We are confident that the Bahn-Newsom model is the best tool for identifying Marbled Murrelet habitat in Clayoquot Sound when it is used in combination with other methods to verify reserve selection.

The use of the Bahn-Newsom HSI model was pioneered by Chatwin (2002) in creating the first Marbled Murrelet management strategy for four planning units (Flores, Bedingfield, Cypre, Tofino/Tranquil). In the current study, nine more planning units were assessed to complete a management strategy for the entire Sound: Clayoquot River, Kennedy Lake, Upper Kennedy, Fortune Channel, and the Bedwell/Ursus/Bulson; the planning units within Strathcona Park: Moyeha and Megin; and the Hesquiaht and Sydney/Pretty Girl planning units that were assessed in 2002 and 2003 through contracts issued by International Forest Products Ltd. We did not inventory the Long Beach Planning Unit because it has The only watershed planning unit not inventoried was Long Beach, due to the a relatively small amount of nesting habitat available and because much of this unit is designated as provincial or national park or lies within the district of Tofino. This report presents proposed reserves and recommendations for the entire Clayoquot Sound Land Use Decision Area (Figure 1). This exercise was conducted to provide direction to the Clayoquot Sound Technical Planning Committee.

STUDY AREA

Clayoquot Sound is located on the west coast of Vancouver Island (lat 49°00'N to 49°30'N, long 125°20'W to 126°35'W), within the Windward Island Mountains Ecosection (Demarchi et al. 1990) and the Coast and Mountains Ecoprovince (Figure 1). This is the rainiest zone in British Columbia, with cool summers and mild winters, and ever-present mist (Meidinger and Pojar 1991). These conditions support a rich temperate rainforest characterized by dense epiphyte growth of mosses, lichens, and liverworts on trees that often reach dimensions of more than 50 m in height and 2 m in diameter. This rainforest borders a productive coastline where upwellings from along the continental shelf support a rich marine food web. The roiling, shallow waters on the rugged outer coast make the most accessible feeding grounds for Marbled Murrelets.



All polygons that were rated for suitability in this study are located within three variants of the Coastal Western Hemlock (CWH) biogeoclimatic zone. The Southern Very Wet Hypermaritime (CWHvh1) subzone occurs on the outer coast up to 150 m in elevation and is dominated by mixtures of western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis*), with some yellow-cedar (*Chamaecyparis nootkatensis*; Green and Klinka 2004). The Submontane Very Wet Maritime (CWHvm1) subzone is the most extensive subzone variant in Clayoquot Sound, occurring from 150 to 600 m on the outer coast and from sea level to 600 m on inland watersheds (Green and Klinka 1994). The dominant tree species in this subzone, depending on slope and drainage, are western hemlock, amabilis fir (*Abies amabilis*), western redcedar, yellow-cedar, mountain hemlock (*Tsuga mertensiana*), and Sitka spruce. The Montane Very Wet Maritime (CWHvm2) subzone occurs from 600 to 900 m in coastal watersheds (Green and Klinka 1994). Dominant tree species range from western hemlock and amabilis fir at lower elevation to western redcedar, yellow-cedar, and mountain hemlock at higher elevation.

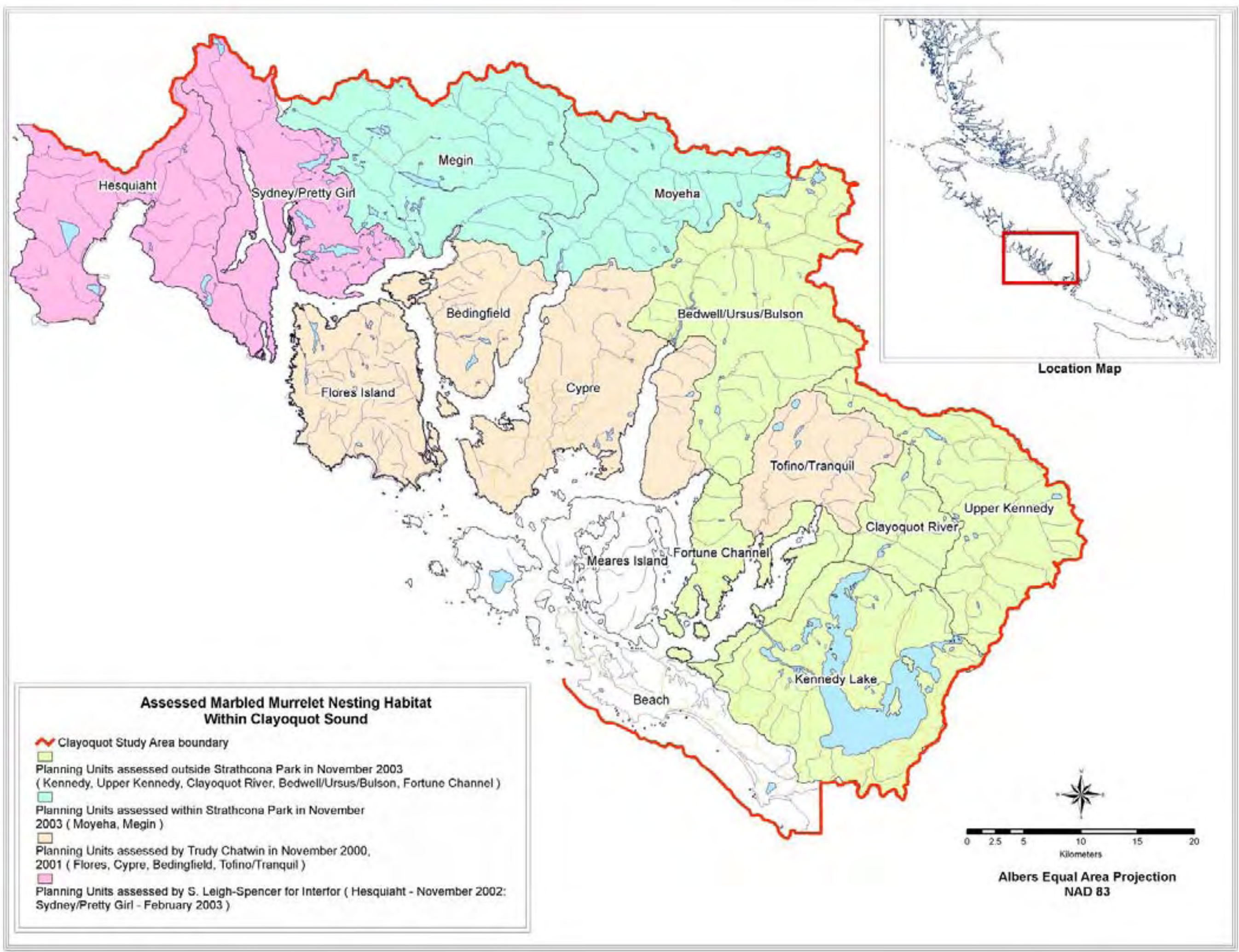


Figure 1. Study Area - Watershed groups assessed for Marbled Murrelet nesting habitat suitability in Clayoquot Sound.

METHODS

Potential Marbled Murrelet nesting habitat within nine planning units (Clayoquot River, Kennedy Lake, Upper Kennedy, Fortune Channel, Bedwell/Ursus/Bulson, Moyeha, Megin, Hesquiaht, and Sydney/Pretty Girl) with the Bahn-Newsom HSI model (Bahn and Newsom 2002b) and the standard methods for air photo interpretation and low-level aerial surveys outlined by Burger (2004). We used a combination of the habitat rankings from these methods to delineate potential Marbled Murrelet reserves in a five-step process: (1) The Bahn-Newsom HSI model was applied to the nine planning units to identify "Important" (Important-Excellent and Important-Good) habitat. Concentrations of Important habitat were identified, and potential reserves were sketched on 1:20 000 maps. (2) The potential reserves of Important habitat identified in Step 1 were refined by using air photo interpretation (Burger 2004). (3) Low-level aerial assessments by helicopter (Burger 2004) were used to evaluate and confirm the suitability of potential reserves. (4) The final outlines of reserves were chosen to provide the greatest overlap with existing reserves and to distribute the reserves relatively evenly throughout each planning unit and throughout all of Clayoquot Sound. (5) Licensees operating within Clayoquot Sound were asked to review potential reserves before they were delineated on 1:20 000 maps and digitized for calculation of total area.

Step 1: Mapped Habitat Analysis

The Bahn-Newsom model (Bahn and Newsom 2002b) for nesting habitat suitability was used to assign potential habitat to one of four classes: Important-Excellent, Important-Good, Suboptimal, and Not Suitable. Potential reserves were sketched by identifying concentrations of Important habitat (Important-Good and Important-Excellent; Figure 2) and placing them relatively evenly throughout the planning unit.

Figure 2. Aerial surveys by helicopter are an important tool for identifying suitable habitat because they provide a good view of potential nesting platforms (large limbs covered with a thick layer of epiphyte).

Step 2: Air Photo Interpretation

The potential reserves identified in Step 1 were further refined by S. Leigh-Spencer using air photo interpretation based on methods outlined by Donaldson (2004). Air photo interpretation provides a more refined analysis of the structure and complexity of the forest canopy, tree size, microtopography, and other features (Donaldson 2004). This method uses a six-level ranking system based on age class, height class, canopy structure and gaps, vertical complexity, topographic complexity, and tree species composition (Table 1). Stands with low scores could be eliminated from further consideration. The remaining suitable habitat within the potential reserves was outlined and numbered to be assessed by low-level aerial surveys in Step 3 (Figure 3).

Step 3: Low-level Aerial Assessment

Aerial surveys are important for correcting and confirming assessments by air photo interpretation and for determining the presence of microhabitat features that cannot be detected in air photos. In particular, aerial surveys can check for the presence and abundance of nest platforms, the cover and thickness of epiphytes, and canopy structure and complexity that allow access to nest sites (Burger 2004). In addition, aerial surveys can assess tree species and size, stand age class, availability of gaps in the forest, topographical microstructures, and recent changes in forests not captured in maps or air photos (Burger 2004). Potential reserves were rated according to the same six-level ranking used in air photo interpretation (Table 1).

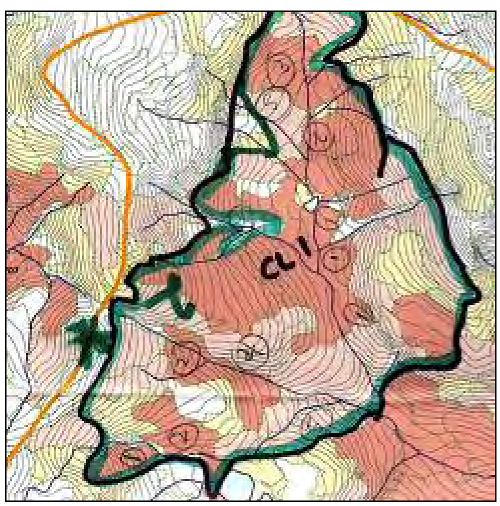


Figure 3. Example of a numbered potential reserve polygon. The green outline is the refined area of suitable habitat after air photo interpretation. The circled numbers are ranks assigned during low-level aerial assessment.

Table 1. Ranking system used in the protocols for air photo interpretation and aerial surveys of Marbled Murrelet habitat (Burger 2004)

Rank	(Score)	Habitat value	General description of habitat quality and availability of key habitat features	Percentage of polygon area with habitat feature present
6	(0)	Nil	All key habitat features absent; nesting impossible (e.g., bogs, bare rock).	0%
5	(1)	Very low	Key habitat features sparse and might not all be present; nesting highly unlikely.	about 1%
4	(2)	Low	Key habitat features all evident but patchy and sparse; nesting possible but unlikely, or at very low density.	2–5%
3	(3)	Moderate	Key habitat features present but uncommon and patchy; nesting likely but at moderate to low densities.	6–25%
2	(4)	High	Key habitat features common and widespread; nesting likely.	25–50%
1	(5)	Very high	Key habitat features present in abundance; nesting highly likely.	50–100%

Helicopter flights (Figures 4 and 5) to rank the suitability of potential nesting reserves were conducted in November 2002 by S. Leigh-Spencer and D. Drake; in November 2003 by S. Leigh-Spencer, T. Chatwin, and B. Retzer; and in February 2003 by S. Leigh-Spencer, T. Tripp, and D. Preikshot. Following the protocol (Burger 2004), these surveys were conducted with an experienced pilot and a navigator/observer in the front seat beside the pilot, a primary observer in the back seat behind the navigator, and a recorder behind the pilot. All crew were in direct communication with the pilot and each other.

At each assessment site, data were recorded for each habitat attribute by hovering just above treetops at each sample point and visually estimating each of the attributes within an approximate 100-metre radius of the point. A field ranking of Marbled Murrelet nesting suitability was then assigned and marked on the map for individual sections of the potential reserve (Figure 3). A data sheet (Figure 6) was then filled out for the overall potential reserve. See appendices 1 to 4 for evaluations of potential reserves.

Figure 4. Helicopter used in aerial surveys of Clayoquot Sound.

Figure 5. View of Bedwell River estuary and Bedwell Sound from helicopter.

Step 4: Data Assessment and Delineation of Potential Reserves

Following aerial assessment of the potential reserves, polygons with low suitability ranks (4, 5, and 6, as determined from aerial assessment) within the reserves were removed from the final delineation, except where they were necessary to provide continuity between high-rank areas. One of the main criteria for final placement of potential reserves within each planning unit was the overlap with existing reserves (these include hydroriparian, sensitive soils and unstable terrain, forest interior and late successional forests, rare ecosystems, and areas of high cultural, recreational, and scenic value; Clayoquot Sound Scientific Panel 1995). Another priority was to achieve a relatively even distribution of reserves within each planning unit and throughout all of Clayoquot Sound. The potential reserves were then digitized and used for the final calculation of overall proposed retention within each planning unit.

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Observers				Date		
Polygon or site name/number				Video taken Yes / No		
Air Photo No.				Still Photo Nos.		
Description		UTM zone	Easting			
			Northing			
	Rank (shaded parameters are most important)					
	6	**5**	**4**	**3**	**2**	**1**
	Nil	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Large trees (% of canopy trees)	**0**	**~1%**	**1-5%**	**6-25%**	**26-50%**	**51-100%**
% canopy & emergent trees with platforms	**0**	**~1%**	**1-5%**	**6-25%**	**26-50%**	**51-100%**
Moss development (% canopy trees with obvious mossy pads)	0	~1%	1-5%	6-25%	26-50%	51-100%
Canopy cover (circle nearest 10%)	-	<20% or >80%	20% or 80%	30% or 70%	40%, 50%, or 60%	
Vertical canopy complexity	**Nil**	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Topographic complexity	Nil	Very low	Low	Moderate	High	Very High
Age class	**<8 (<140 y)**		**8 (140-250 y)**		**9 (>250 y)**	

Leading tree species							
a) slopes	W. hemlock **Hw**	Amabilis fir **Ba**	W. redcedar **Cw**	Yellow cedar **Yc**	Sitka spruce **Ss**	Douglas-fir **Fd**	Other:
b) valley bottom							

Overall field ranking (give % of polygon area in each class)	**6** **% Nil**	**5** **% Very low**	**4** **% Low**	**3** **%Moderate**	**2** **%High**	**1** **%Very High**
Slope position	Valley bottom	Lower slope	Mid slope	Upper slope	Ridge top	Not included in ranking
Slope grade	Flat	Gentle	Moderate	Steep		
Notes:						

Figure 6. Data sheet used to rank Marbled Murrelet nesting habitat polygons.

Step 5: Licensee Consultation

Copies of the proposed Marbled Murrelet nesting habitat polygons were provided for review to the licensees operating within the planning units assessed (Interfor, Iisaak, and BC Timber Sales). Where possible, changes were made to incorporate the Licensees' concerns

Evaluation of Reserves

After the five-step process was complete, the quantity and quality of potential reserves were evaluated to assess the effectiveness of our management strategy. To evaluate the quantity of reserves, we compared the area of Important habitat that would be protected with the area of habitat required to sustain the current population (calculated from radar estimates of population and density) and with the target of the Draft Marbled Murrelet Recovery Strategy (to protect 70% of the nesting habitat; Environment Canada 2007).

We used the radar density estimate for west Vancouver Island of 0.090 ± 0.060 birds/ha (CMMRT-ALL algorithm). (Appendix 5 compares habitat ranks from the Bahn-Newsom HSI model, aerial survey and air photo interpretation from Burger 2004, and habitat categories defined by the CMMRT 2003.) We also calculated habitat requirements from nest density estimates (Conroy et al. 2002), but we hesitate to use this measure to evaluate the reserve network because of the limited applicability of this density to a broad range of habitats.

We evaluated reserve habitat quality by analyzing the size and shape of reserves and their ability to maintain interior forest habitat free from edge effects (mainly predation from corvids).

RESULTS

Potential nesting habitat in nine planning units (Bedwell/Ursus/Bulson, Clayoquot River, Fortune Channel, Kennedy Lake, Upper Kennedy, Sydney/Pretty Girl, Hesquiaht, Megin, and Moyeha) was evaluated in 2002-2003. As a result, new Marbled Murrelet reserves were proposed in seven of the planning units, where they made up 5.2% of the total area (Table 2). The remaining two planning units (Megin and Moyeha) had no proposed reserves because much of the habitat existed within Strathcona Provincial Park (Table 3). The four planning units (Flores, Bedingfield, Cypre, Tofino/Tranquil) assessed by Chatwin (2002) in 2001–2002 are summarized in Table 4. In all, 251 250 ha were assessed in 13 planning units. Including habitat protected in other reserves, the total Important habitat protected within Clayoquot Sound amounts to 44 576 ha, or 61.8% of all Important habitat. Of this, 15 626 ha of habitat were included in 76 new proposed Marbled Murrelet reserves, accounting for 6.2% of the total area (Table 5, Figure 6). Descriptions of potential reserves in individual planning units are provided after the overall summaries of Marbled Murrelet habitat.

Table 2. Important Marbled Murrelet habitat protected within proposed and existing reserves in seven planning units surveyed in Clayoquot Sound, 2002–2003

	Bedwell/ Ursus/ Bulson		Clayoquot River		Fortune Channel		Kennedy Lake		Upper Kennedy		Sydney/Pretty Girl		Hesquiaht		Total	
Habitat measure	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Total area	29 402	100	7738	100	9158	100	29 604	100	20 591	100	20 276	100	23 960	100	140 729	100
Important habitat	10 087	34.3	3828	49.5	1872	20.4	3885	13.1	6537	31.7	6703	33.1	4457	18.6	37 368	26.6
Total area of proposed MaMu reserves	1520	5.2	1083	14.0	125	1.4	772	2.6	1170	5.7	1327	6.5	1298	5.4	7 294	5.2
Important habitat within existing reserves	5148	51.0	1861	48.6	506	27.0	1776	45.7	2653	40.6	2054	30.6	1836	41.2	15 832	42.4
Important habitat within existing & proposed MaMu reserves	5704	56.5	2305	60.2	793	42.3	2129	54.8	3065	46.9	2679	40.0	2391	53.6	19 065	51.0

NOTE:

"Important habitat" and "Total area of proposed MaMu reserves" are percentages of the total area of the planning unit.

"Important habitat within reserves" and "Important habitat within existing and proposed MaMu reserves" are percentages of all Important habitat in the planning unit.

Table 3. Important Marbled Murrelet habitat protected within the existing reserve of Strathcona Park for the Megin and Moyeha Planning Units, 2004

	Megin		Moyeha		Total	
Habitat Measure	ha	%	ha	%	ha	%
Total area	30 093	100	18 381	100	48 474	100
Important habitat	10 866	36.1	4013	21.8	14 879	30.7
Total area of proposed MaMu reserves	2278	7.6	1364	7.4	3642	7.5
Important habitat within existing reserves	10 843	99.8	4013	100	14 855	99.8
Important habitat within existing and proposed MaMu reserves	10 843	99.8	4013	100	14 855	99.8

Table 4. Important Marbled Murrelet habitat protected within proposed and existing reserves in four planning units assessed by Chatwin (2002) in Clayoquot Sound, 2000–2001

	Bedingfield		Cypre		Flores		Tofino/Tranquil		Total	
Habitat Measure	ha	%	ha	%	ha	%	ha	%	ha	%
Total area	10 601	100	24 508	100	15 307	100	11 630	100	62 046	100
Important habitat	3714	35.0	7540	30.8	5084	33.2	3886	33.4	20 224	32.6
Total area of MaMu reserves	636	6.0	1907	7.5	1329	8.6	818	7	4690	7.4
Important habitat within existing reserves	1663	44.8	2986	39.6	1879	37.0	1680	43.2	8208	40.6
Important habitat in existing and proposed MaMu reserves	1927	51.9	3913	51.9	2707	53.2	2108	54.2	10 655	52.7

Table 5. Important Marbled Murrelet habitat protected within proposed and existing reserves in all 3 planning units assessed in Clayoquot Sound, 2000–2004

	All Planning Units	
Habitat Measure	ha	%
Total area	251 250	100
Important habitat	72 172	28.7
Total area of MaMu reserves	15 626	6.2
Important habitat within existing reserves	38 896	53.9
Important habitat in existing and proposed MaMu reserves	44 576	61.8

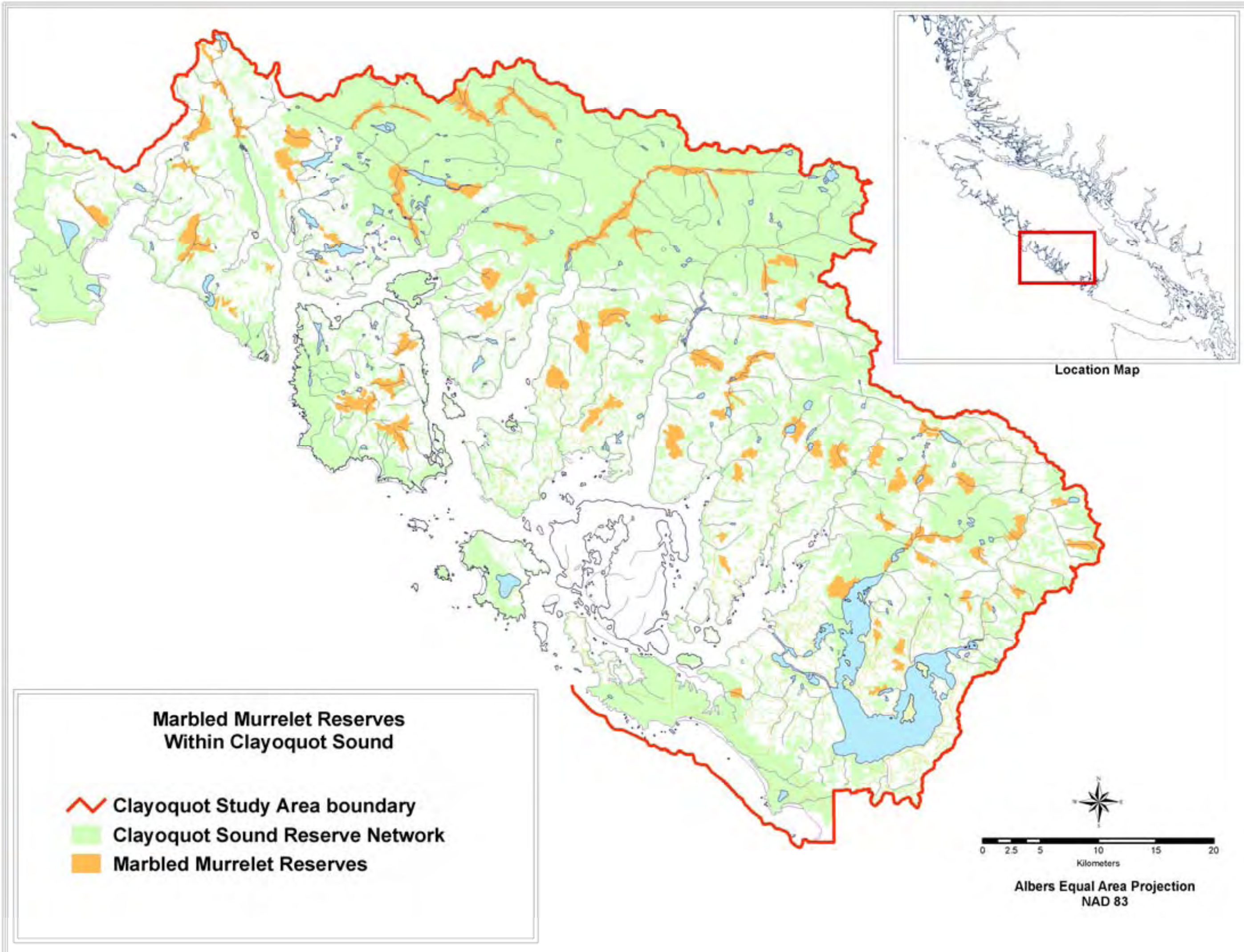

Figure 7. Overview of the proposed Marbled Murrelet nesting habitat reserves in all the planning units in Clayoquot Sound.

Table 6. Area (ha) of Marbled Murrelet nesting reserves proposed and polygons assessed within the Bedwell/Ursus/Bulson Planning Unit. An additional four polygons labeled "1-4 (park)" contained within the boundaries of Strathcona Park were not broken down by habitat type.

Polygon Number	Area Assessed	Area Important within Assessed	Area of Proposed Reserve	Important Habitat within Proposed Reserve	Overlap with Existing Reserve	Area of proposed reserve outside existing
1	724.2	314.7	–	–	–	–
1A	143.8	133.4	–	–	–	–
2*	886.2	509.4	303.3	224.7	265	38.3
2A*	13.7	13.4	84.1	68.8	28.5	55.6
3*	522.4	448.3	482.3	417.2	374.3	108.0
3A	195.7	156.3	–	–	–	–
4	392.5	199.8	–	–	–	–
5*	327.7	206.3	70.7	68.9	40.4	30.3
6	195.3	113.5	–	–	–	–
6A	147.5	69.3	–	–	–	–
7*	210.5	149.3	104.2	87.2	53.6	50.6
8*	127.5	92.1	93.8	82.3	73.3	20.5
9*	164.7	157	119.6	117.6	55	64.6
10	185.1	119.8	–	–	–	–
11*	–	–	261.7	222.3	169	92.7
Total	4236.8	2682.7	1519.7	1289	1059.1	460.6

***Polygons containing proposed reserves.**

Bedwell/Ursus/Bulson Planning Unit

The Bedwell/Ursus/Bulson Planning Unit contains 29 402 ha. Of the 4237 ha of suitable habitat assessed (derived from the Bahn-Newsom HSI; Figure 8), 1520 ha, or 5.2% of the watershed, was included in eight proposed reserves (Figure 9). The area of proposed reserves outside of existing reserves totals 461 ha, or 1.6% of the total planning unit (Table 6).

Reserve 7 is within the Bedwell watershed, reserves 5 and 11 are within the Ursus watershed, and reserves 2, 8, and 9 are within the Bulson watershed. Reserve 2 (park) is within the Blaney Creek watershed, and Reserve 3 is within Ashwood Creek; both are tributaries of the Bedwell and within Strathcona Park (therefore not included in the 461 ha of additional proposed reserves).