GEOGRAPHIC DISTRIBUTION OF THE MARBLED MURRELET ON VANCOUVER ISLAND AT INLAND SITES DURING THE 1991 BREEDING SEASON

Jean-Pierre L. Savard
Moira J. Lemon

TECHNICAL REPORT SERIES NO. 189
Pacific and Yukon Region 1994
Canadian Wildlife Service

Environment Canada
Canadian Wildlife Service

Environnement Canada
Service Canadien de la faune

Canada

TECHNICAL REPORT SERIES
CANADIAN WILDLIFE SERVICE

This series of reports, established in 1986, contains technical and scientific information from projects of the Canadian Wildlife Service. The reports are intended to make available material that either is of interest to a limited audience or is too extensive to be accommodated in scientific journals or in existing CWS series.

Demand for these Technical Reports is usually confined to specialists in the fields concerned. Consequently, they are produced regionally and in small quantities; they can be obtained only from the address given on the back of the title page. However, they are numbered nationally. The recommended citation appears on the title page.

Technical Reports are available in CWS libraries and are listed with the DOBIS system in major scientific libraries across Canada. They are printed in the official language chosen by the author to meet the language preference of the likely audience. **To determine whether there is significant demand for making the reports available in the second official language, CWS invites users to specify their official language preference. Requests for Technical Reports in the second official language should be sent to the address on the back of the title page.**

SÉRIE DE RAPPORTS TECHNIQUES
DU SERVICE CANADIEN DE LA FAUNE

Cette série de rapports donnant des informations scientifiques et techniques sur les projets du Service canadien de la faune (SCF) a démarré en 1986. L'objet de ces rapports est de promouvoir la diffusion d'études s'adressant à un public restreint ou trop volumineuses pour paraître dans une revue scientifique ou l'une des séries du SCF.

Ordinairement, seuls les spécialistes des sujets traités demandent ces rapports techniques. Ces documents ne sont donc produits qu'à l'échelon régional et en quantités limitées; ils ne peuvent être obtenus qu'à l'adresse figurant au dos de la page titre. Cependant, leur numérotage est effectué à l'échelle nationale. La citation recommandée apparaît à la page titre.

Ces rapports se trouvent dans les bibliothèques du SCF et figurent aussi dans les listes du système de référence DOBIS utilisé dans les principales bibliothèques scientifiques du Canada. Ils sont publiés dans la langue officielle choisie par l'auteur en fonction du public visé. **En vue de déterminer si la demande est suffisamment importante pour produire ces rapports dans la deuxième langue officielle, le SCF invite les usagers à lui indiquer leur langue officielle préférée. Il faut envoyer les demandes de rapports techniques dans la deuxième langue officielle à l'adresse indiquée au verso de la page titre.**

GEOGRAPHIC DISTRIBUTION OF THE MARBLED MURRELET ON VANCOUVER ISLAND AT INLAND SITES DURING THE 1991 BREEDING SEASON

Jean-Pierre L. Savard [1,2]
Moira J. Lemon [1]

Technical Report Series No. 189
Pacific and Yukon Region 1994
Canadian Wildlife Service

This series may be cited as:

Technical Report Series No. 189. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia. J-P.L. Savard, Lemon, M.J. Geographic Distribution of the Marbled Murrelet on Vancouver Island at inland sites during the 1991 breeding season.

[1] Canadian Wildlife Service
P.O. Box 340
Delta, British Columbia
V4K 3Y3

[2] Current address:
Canadian Wildlife Service
1141, route de l'Église
P.O. BOX 10,100, 9th Floor
Ste-Foy (Québec)
G1V 4H5

Printed on recycled paper

Issued under the Authority of the
Minister of Environment
Canadian Wildlife Service

Ministry of Supply and Services Canada 1994
Catalogue No. CW69-5/189E
ISBN 0-662-21351-3
ISSN 0831-6481

Copies may be obtained from:
Canadian Wildlife Service
Pacific and Yukon Region
P.O. Box 340,
Delta, British Columbia
Canada V4K 3Y3

ABSTRACT

Marbled Murrelets were surveyed in the coastal waters and in 82 watershed systems of Vancouver Island during May, June and July 1991. We used road transects consisting of 8 to 10, 10 min. stops located 0.5 to 1 km apart and fixed stations surveyed from one hour before sunrise to one hour after sunrise to survey watersheds. Marbled Murrelets were widely distributed on Vancouver Island. The number of Marbled Murrelet detections varied during the three months of the study being lowest in May and highest in July. There was no consistent pattern between the number of detections at a fixed station and the distance of the station from the coast. Watersheds emptying on the west coast yielded on average higher levels of murrelet activity than those emptying on the east coast. Road transects located in the center of the watershed yielded more detections than those at the mouth or the top end. The Georgia Depression Ecoprovince which covers the south eastern portion of Vancouver Island had the lowest number of murrelet detections. Watersheds with less than 50% of their forested area in old growth yielded lower number of murrelet detections than watersheds with more old growth. Also, stations located within 500 m of old growth stands had significantly more detections than those further away. We obtained a broad view of inland murrelet activity on Vancouver Island, however, our survey efforts were too low to properly assess the use of a given watershed by murrelets.

RÉSUMÉ

On a effectué un dénombrement de l'alque marbrée dans les eaux côtières et dans 82 bassins hydrographiques de l'île de Vancouver au cours des mois de mai, juin et juillet 1991. Nous avons utilisé des transects routiers, soit de huit à dix arrêts de dix minutes à des intervalles de 0,5 à 1 km et des stations fixes où l'observation commençait une heure avant le lever du soleil pour se terminer une heure après. L'alque marbrée était largement répartie sur l'île de Vancouver. Le nombre d'alques marbrées observées a varié au cours des trois mois qu'a duré l'étude, le plus faible ayant été enregistré en mai et le plus élevé, en juillet. Il n'y avait pas de constance entre le nombre d'oiseaux détectés et la distance de la station à la côte. Les bassins hydrographiques qui se déversent sur la côte ouest connaissaient généralement en moyenne une activité plus intense que ceux qui débouchent sur la côte est. Les transects routiers situés au centre des bassins hydrographiques ont donné lieu à un plus grand nombre d'observations que ceux situés à l'embouchure ou à la source. C'est dans l'écoprovince de la dépression de Géorgie, qui couvre la partie sud-est de l'île, que l'on a enregistré le moins d'observations. Dans les bassins hydrographiques dont moins de 50% de la zone forestière se compose de peuplements mûrs, on a dêtecté moins d'alques que dans les bassins où ces peuplements sont plus nombreux. En outre, les stations situées à moins de 500 m des peuplements mûrs ont donné lieu à un nombre beaucoup plus grand d'observations que celles qui en étaient plus éloignées. Notre objectif était d'avoir une vue d'ensemble de l'activité de l'alque marbrée à l'intérieur de l'île de Vancouver. Nous l'avons atteint. Cependant, nos efforts n'ont pas permis d'évaluer convenablement l'utilisation d'un bassin hydrographique donné par les alques marbrées.

ACKNOWLEDGEMENTS

The large number of surveys was made possible by the cooperation of several government departments and forest companies. Funding for the study was provided by the Canadian Wildlife Service, Canadian Parks Service, B.C. Ministry of Forests, B.C. Ministry of Lands and Parks, Canadian Forest Products Ltd., Canadian Pacific Forest Products Ltd., Fletcher Challenge Canada Ltd., MacMillan Bloedel Ltd., Western Forest Products Ltd. and the World Wildlife Fund. The B.C. Conservation Foundation administered the funds for the project. We thank them all for their commitment and support. We would also like to thank Ron McLaughlin, Wildlife Biologist with MacMillan Bloedel, and Dave Lindsay, Fish and Wildlife Biologist with Fletcher Challenge Canada, for coordinating the involvement of the forest companies. Thanks to Anne Harfenist, Alan Burger, Ron McLaughlin, Dave Lindsay, Gary Kaiser and Bob Elner for their constructive comments on the manuscript.

Surveys were carried out by the following individuals, and we thank them for their enthusiasm and diligence.

CANADIAN WILDLIFE SERVICE
Mauricio Alvarez, Andrew Bryant, Pascal Dehoux, Rod French, Steve Hamel, Ivan Jimenez, Kristina Johnston, Paul Jones, Moira Lemon, Chris McNeill, Klaus Schuetze, Rick Toochin.

CANADIAN PARKS SERVICE
Karel Allard, Bob Ammerman, Barb Aylard, Cathie Block, Pitt Brooks, Barry Campbell, Doug Clark, Bob Hansen, Holmes, L. Ivanisko, Laurenson, Michel Léger, Marla Oliver, Morgan Reid.

B.C. MINISTRY OF ENVIRONMENT
Knut Atkinson, Trudy Chatwin, L. Friis, Jevis, Joanne McGauchi, Charles Mamo, Todd Manning, Karen Morrison.

B.C. MINISTRY OF FORESTS
Jim Butcher, Fuchs, Henigman, Sandy McRuer, Kevin MacPherson, Danny Tyson.

B.C. MINISTRY OF LANDS AND PARKS
Larry Bendreau, Sue Bushell, Gordon Crawford, Denis Fraser, Joanne McLeod, R. Quitter, Rick Simmons, Leslie Smith

CANADIAN FOREST PRODUCTS LTD.
H. Bomford, B. Drobe, J.F., Kent Holmquist, Alan McLeod, G. Payne, P. Wooding, Rob Woodside.

CANADIAN PACIFIC FOREST PRODUCTS LTD.
Colin Buss, Roger Tailleur

FLETCHER CHALLENGE CANADA LTD.
C. Carter, G.D. Farenholtz, L. Giguère, P. Kay, G. Lawson, Dave Lindsay, T. Molfenter, M. Perdue, B. Sinclair, S. Voller, W.B. Wall.

MACMILLAN BLOEDEL LTD.

Ron Bennett, Kris Bjarnason, B. Chapman, M.D., Joe Duckworth, J. Eden, Doug Flegel, Ed. G., Doug Greenwood, Kevin Hunter, Gary Johnsen, R.J. Lavis, B. Leicester, Pete Lenihan, Warren Littlejohn, J. McDonald, L. Martin, Moraet, C.N., T. Norris, D.V.O., D.P., Steve Page, Pat Phillips, L. Pinter, Marian Porter, Ed Proteau, M.W.R., Marcel Rivard, R.S.R., W.L. Schuckel, Tom Shepherd, S. Stupich, G. Szamosi, T.T., M. Wall.

WESTERN FOREST PRODUCTS LTD.

Jack Broekhuizen, Doug Cassidy, Mike Dietsch, Bob Hay, G. Lemieux, Tahl Lunock, K. McGourlick, Lee Mitchell, D. Morgensen, Jim Muress, Ray Robazzo, V.V., Murray Watkinson, Greg Yeomans.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Concern for Marbled Murrelets has increased considerably within the last decade in view of studies suggesting a close association of breeding murrelets with old growth forests (Nelson *et al.* 1992, Carter and Erikson 1992, Marshall 1988 a, b, Paton and Ralph 1988, Nelson 1989, Varoujean *et al.* 1989, Eisenhower and Reimchen 1990, Hamer and Cummins 1990, 1991, Reimchen 1991, Rodway *et al.* 1991, Singer *et al.* 1991, Paton *et al.* 1992). Marbled Murrelets were assigned the status of threatened species in Canada in 1990 because of the vulnerability of the species to breeding habitat depletion, oil spills, and gill nets.

Little is known of the geographical distribution of Marbled Murrelets in British Columbia at inland sites. To help palliate this lack of information, a large scale survey of Vancouver Island was initiated in the spring of 1991. The main objectives of the study were 1) to assess the presence or absence of Marbled Murrelet activity in several watersheds of Vancouver Island and 2) to quantify the relative abundance of murrelets in selected coastal waters along the Island. (Results of this objective have been presented in Savard and Lemon 1992, and will not be repeated here). The results of incidental surveys conducted in 1991 and 1992 by teams in the Queen Charlotte Islands and on Vancouver Island are presented in appendices 16 and 17.

METHODS

INLAND SURVEYS

The survey methods were based extensively on the methods used in Oregon, California and Washington (Paton *et al.* 1990, Nelson 1989, Anonymous 1991) but incorporated recent findings in British Columbia (Rodway *et al.* 1991). We used two survey techniques in watersheds: road transects and fixed stations (appendix 2). The techniques provide data at different scales, with fixed stations being more efficient at a local scale.

ROAD TRANSECTS

Road transects are used to determine the geographic distribution of Marbled Murrelets over a wide area of the species range at inland forested sites and to determine relative murrelet activity levels over a broad area of the species range (Paton *et al.* 1990). Each

transect consisted of 10 fixed stations located 0.5 to 1 km apart along a road. Each station was surveyed for a 10 minute period during which all murrelet detections were recorded. A detection is defined as a bird or a group of birds behaving in a similar manner at the same time. Surveys usually began 60 minutes before official sunrise and continued up to 60 minutes after sunrise. Stations were located, whenever possible, where the view of the sky was unobstructed in order to maximize visual detections. Each station was characterized in terms of % of open sky, forest type and other location features (See appendix 2). The exact location of each road transect, the survey dates and survey conditions are presented in appendices 3,4,5 and 6 whereas data on detections and behaviours are presented in appendices 7 and 8.

FIXED STATIONS

Fixed stations are used to quantify relative levels of Marbled Murrelet activities at specific sites, to detect low levels of murrelet activity or confirm the presence or absence of murrelets at a given site. They are also used to assess whether murrelets appear to be using a site or merely flying over it on route towards other areas.

Fixed stations were located in selected habitats at a location where the view of the sky was unobstructed to maximize visual detections. Only one fixed station was done each morning by a given observer. The survey at the station started 60 minutes prior to official sunrise and continued at least 60 minutes after sunrise. If detections were recorded 60 minutes after sunrise, the survey continued until 15 minutes had elapsed since the last detection. All murrelet detections were recorded during the survey.

We attempted to survey most watersheds three times. The first two surveys were road transects; if no Marbled Murrelets were detected during those two surveys, then a third replicate of the road transect was carried out. However, if Marbled Murrelets had been detected, the third survey was a fixed station, located at the station on the road transect which had the highest level of detections. Several other watersheds were surveyed by the training team using fixed stations. The location, characteristics, survey dates and survey conditions of fixed stations are given in detail in appendices 9 to 13, whereas the survey results and behaviour data are presented in appendices 14 and 15.

DATA COLLECTED

A detection is defined as a bird or a group of birds behaving in a similar manner at the same time. A detection can be visual and/or auditory. We also recorded the number of calls heard during a detection. For road transects we used two measures of murrelet abundance: the number of detections per station for a given transect and the proportion (%) of stations with at least one detection. Full details of the data collection protocol are given in Appendix 2.

OBSERVERS

In order to survey a large number of watersheds, it was necessary to use many observers. The study was done in cooperation with several forest companies, government agencies and non-governmental groups (see Acknowledgements). Training sessions were held for all groups using tape recordings and videos of birds in flight and when possible, training in

the field. The training team surveyed several fixed stations including replicate surveys at selected stations to assess seasonal differences in detections and also to verify the reliability of the volunteers' surveys.

This large number of participants made possible the coverage of a large proportion of Vancouver Island's watersheds but also increased the variability of the data.

STATISTICAL ANALYSIS

We used non-parametric statistics for our statistical comparisons, mostly Kruskal-Wallis (KW) and Mann-Whitney (MW) tests (Zar 1974).

When observers could not count the number of calls in a detection, they recorded "M" (multiple) to indicate >10 calls. To compile the total number of Keer calls in a survey we substituted the value of 25 for any "M"s recorded. This value is taken from Rodway *et al* (1991) where 25 was calculated to be the mean number of calls in detections where calls were counted and found to be >10.

HABITAT MEASUREMENTS

For the purpose of this report, a primary watershed stream is defined as a water course, and all its tributary streams, which drains directly into salt water. A secondary watershed is a stream and its associated tributaries, that empties directly into the main body of a primary stream. A tertiary stream system is one that flows directly into a secondary system.

Watershed boundaries were traced along heights of land depicted on 1:500,000 scale National topographic series (N.T.S.) map sheets 92 S.W., 92 S.E., and 92 N.W. of Vancouver Island with 500 and 1000 foot contour intervals, published by the Department of Energy, Mines and Resources. These were overlaid on a 1:500,000 scale Satellite Image Mosaic of Vancouver Island, produced by the Landsat-5 Thematic mapper in 1989 and published by B.C. Ministry of Forests. Features of the terrain on this mosaic are divided into seven categories, and colour enhanced for recognition. The categories are as follows: 1. Forest land-predominately mature coniferous, 2. Forest land-predominately immature coniferous, 3. Wetland/Barren land, 4. Snow or ice/tundra, 5. Forest land/ Barren land cutblocks, 6. Predominately agricultural land, and 7. Predominately urban.

For each watershed surveyed for Marbled Murrelets, we calculated the total area as well as the total forested area (this measurement excluded all nonforested areas such as lakes, alpine, snowfield, and wetlands). The portion of the watershed covered by the category "mature coniferous forest" (no history of logging) was then traced and its area measured and presented as a percentage of the total forested area. These areas were digitized and measured using a CAD program.

STUDY AREA

Vancouver Island is divided into two ecoprovinces (Fig. 1) defined as areas with consistent climate or oceanography, relief and plate tectonics (Demarchi *et al.* 1990):

The Coast and Mountains Ecoprovince includes the windward side of Vancouver Island. The lowest vegetation zone is dominated by Western Hemlock whereas Sitka Spruce forms a narrow belt adjacent to the ocean. This ecoprovince contains the Western Vancouver Island ecoregion which is divided in three ecosections:

1) The Northern Island Mountains ecosection is a partial rainshadow area of wide valleys and mountains located in the northern portion of Vancouver Island. Eight watersheds were surveyed with 16 fixed stations and 16 road stations (Fig. 1).

2) The Nahwitti Lowland ecosection receives high precipitation but has a relatively flat topography being located at the north end of Vancouver Island. Twelve watersheds were surveyed with 14 fixed stations and 6 road transects (Fig. 1).

3) The Windward Island Mountains ecosection covers most of the west coast of Vancouver Island including lowlands, islands and mountains. Most fixed stations, a total of 75 and 41 road transects, were located within this ecosection (Fig. 1). We subdivided this ecosection into six smaller areas:

   A) The Brooks Peninsula area where 12 watersheds were surveyed with 3 road transects and 14 fixed stations.

   B) The Kyuquot area where 8 watersheds were surveyed with 7 road transects and 12 fixed stations.

   C) The Nootka Sound area where 10 watersheds were surveyed with 4 road transects and 12 fixed stations.

   D) The Clayoquot Sound and Tofino area where 16 watersheds were surveyed with 11 road transects and 17 fixed stations.

   E) The Bamfield area where 6 watersheds were surveyed with 8 road transects and 14 fixed stations.

   F) The Port Renfrew area where 3 watersheds were surveyed with 8 road transects and 6 fixed stations.

The Georgia Depression Ecoprovince lies between the Vancouver Island mountains and the Southern Coast Mountains. It is located in the rainshadow of the Vancouver Island Range. The Eastern Vancouver Island Ecoregion, located in this ecoprovince, is an area of limited rainfall comprising two ecosections, the Leeward Island Mountains and the Nanaimo Lowlands. Because only three murrelet stations were located in the Nanaimo Lowlands we included these stations within the Leeward Island Mountains ecosection for a total of 13 watersheds surveyed with 17 fixed stations and 17 road transects.

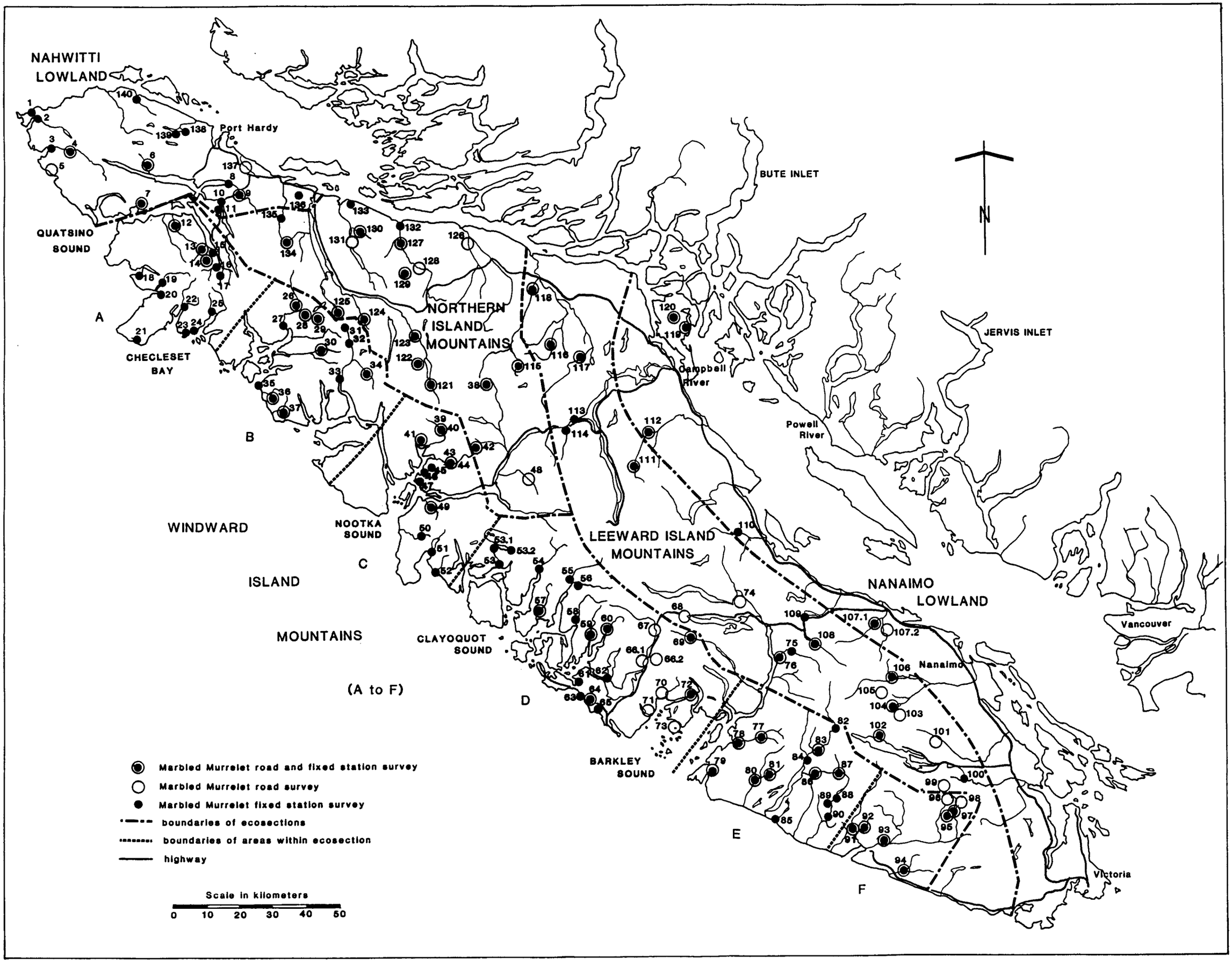


Fig. 1. Location of road transects and fixed stations on Vancouver Island.

RESULTS

FACTORS AFFECTING MARBLED MURRELET INLAND ACTIVITY

1) **Month**

Marbled Murrelet activity as quantified by the number of detections was lowest in May and highest in July (Fig. 2). The mean length of the activity period (duration) followed a similar pattern. Therefore, the following analysis were done for each month seperately.

2) **Distance from salt water**

For each station, we measured both the straight line distance between the station and the closest salt water, (usually the head of an inlet) and also the distance following the watershed itself. In the case of the fixed stations, there was no significant differences in the number of Marbled Murrelet detections in relation to the location of the station from salt water in May (KW = 2.100, P = 0.350) and July (KW = 0.257, P = 0.879) (Fig. 3). However there were significantly more detections closer to salt water for the month of June (KW=6.736, P=0.034). For road transects neither the mean number of detections per station or the proportion (%) of stations with detections were significantly related to distance of the transect from salt water (KW <2.700 P>0.2). However, results from fixed stations suggest that there might be a tendency for fewer detections further away from the coast, but larger sample sizes would be needed to confirm this trend. Patterns were similar with distances measured following the watershed.

3) **Distance from ocean**

We also measured for each station and transect the straight line distance to open ocean (*i.e.* mouth of inlets). There was no consistent patterns either for fixed or road stations across months (KW, P<0.1, Fig. 4). Only in June for the fixed stations was the pattern nearly significant (KW=4.5, P=0.104) at the 0.1 level. However, the trend between months was inconsistent.

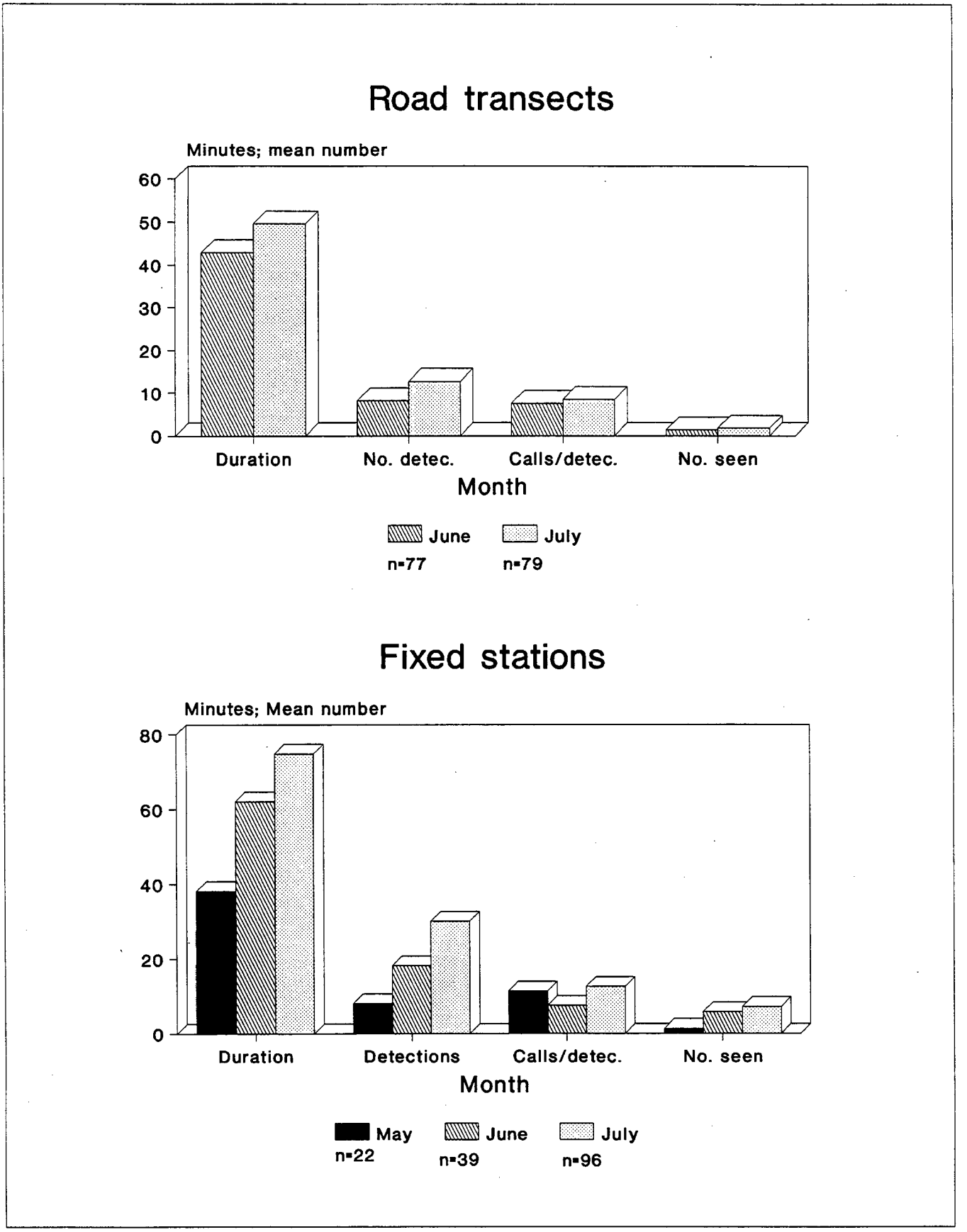


Fig.2 Number of Marbled Murrelet detections in relation to month.

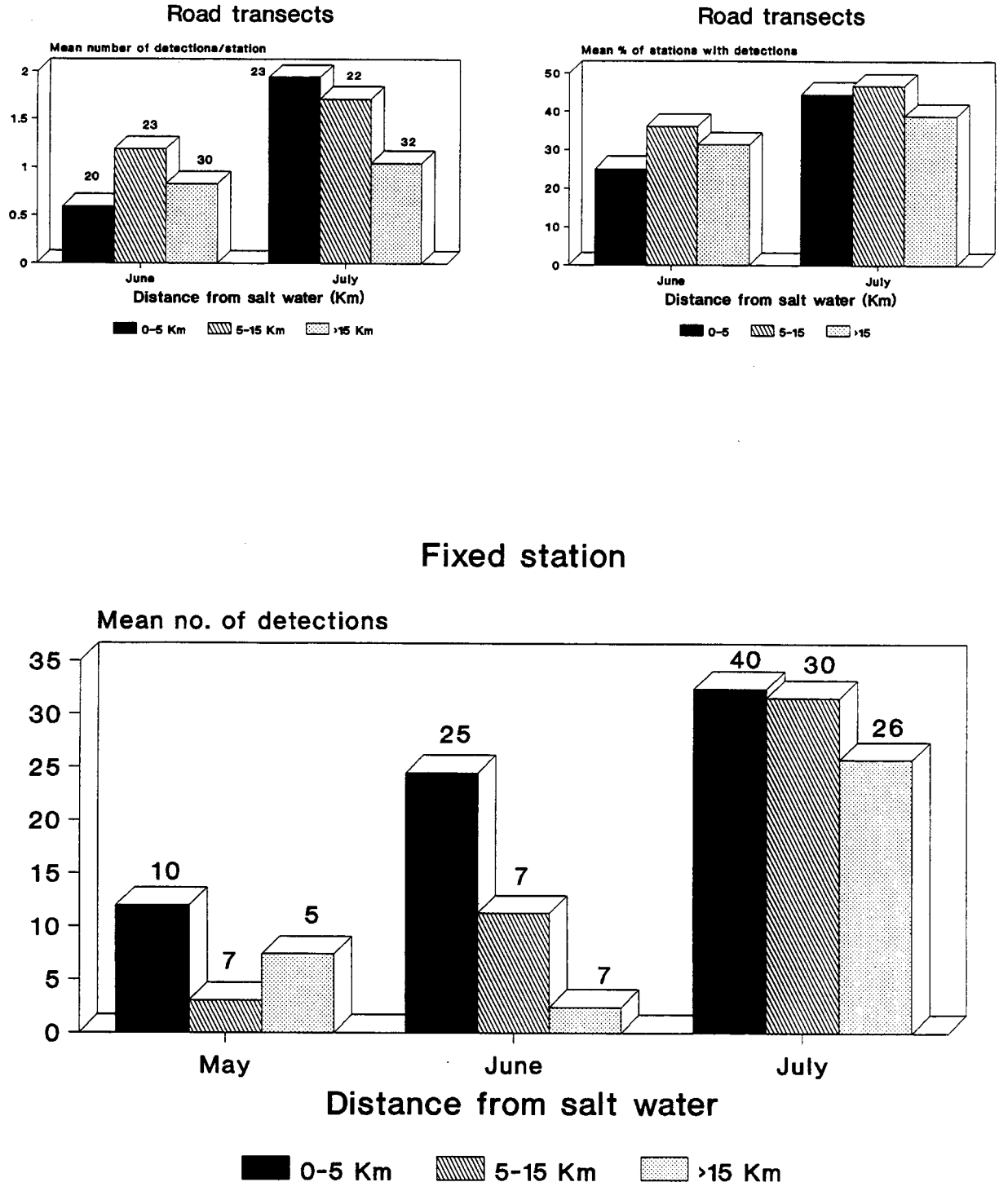
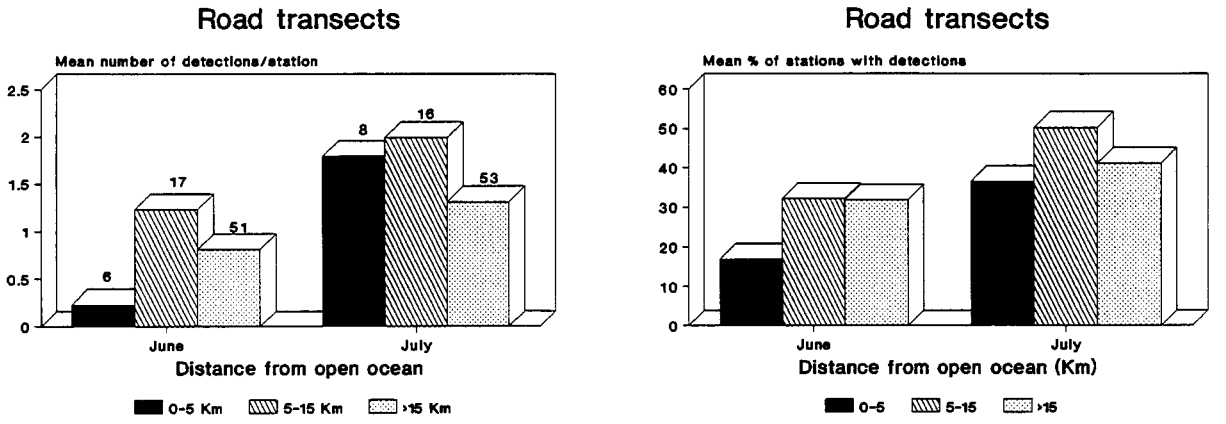


Fig. 3 Number of Marbled Murrelet detections in relation to straight line distance from salt water (number above histogram indicates the number of stations and transects)



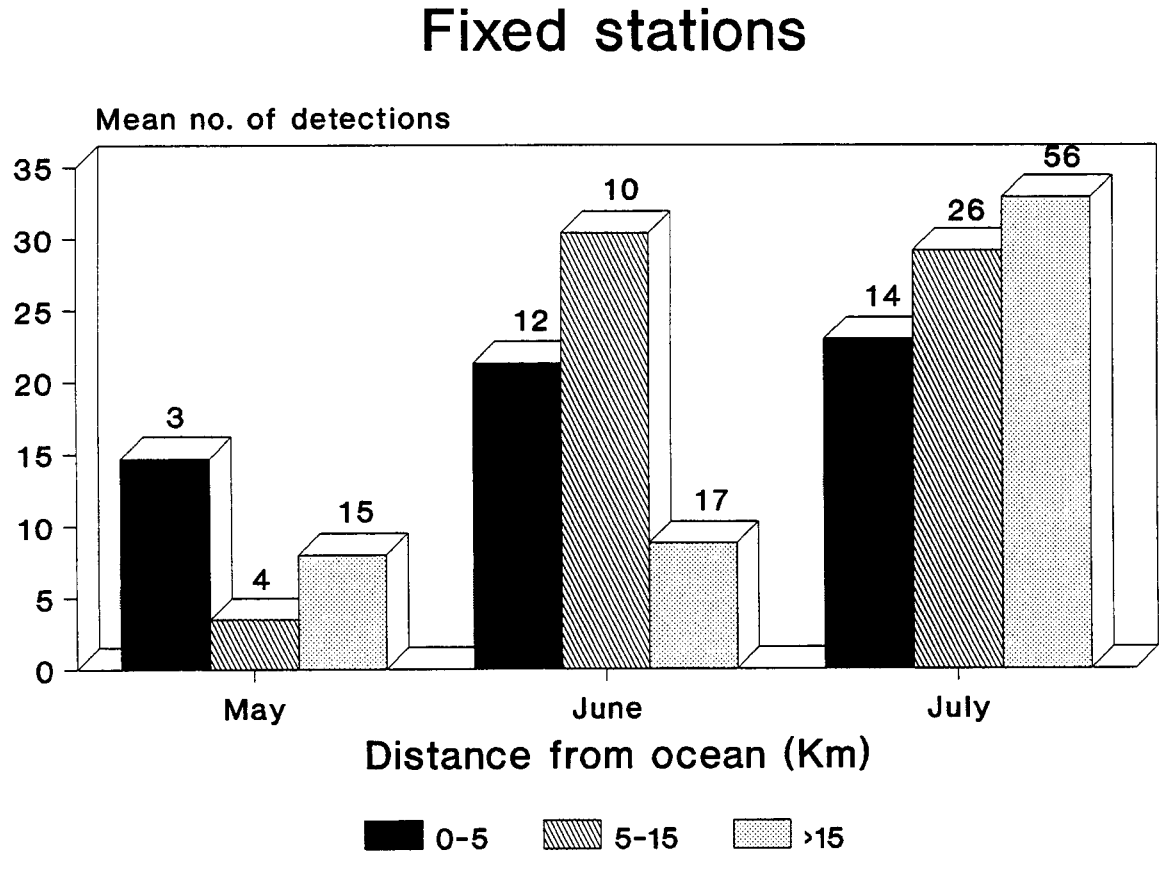


Fig. 4 Number of Marbled Murrelet detections in relation to straight line distance from open ocean (numbers above histograms are the sample sizes)

4) **East and west coast of Vancouver Island**

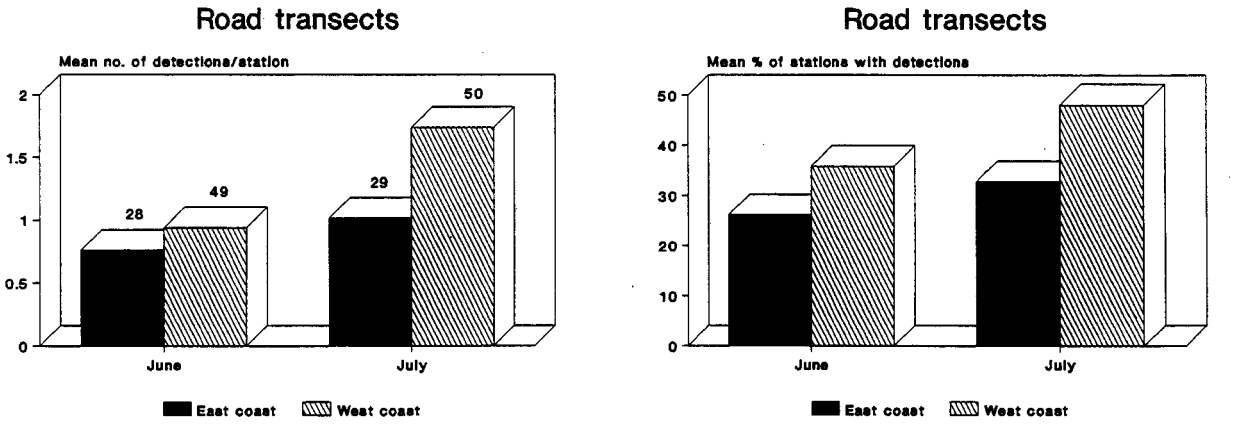
We compared the level of Marbled Murrelet activity for watersheds emptying on the east and west coasts of Vancouver Island. There was a strong tendency for higher activity levels on watersheds associated with the west coast of the Island especially in July (Fig. 5). The pattern was statistically significant in the month of July for both fixed (MW = 1,315, P = 0.005) and road stations (MW = 564, P = 0.10 for detection/stations and MW = 514.5, P = 0.032 for % of station with detection).

5) **Location within the watershed**

We also examined whether the location of the station within the watershed affected the number of Marbled Murrelet detections. There were no significant differences in the mean number of murrelet detections in relation to the location in the watershed for the fixed stations (Fig. 6; July: KW = 0.795, P = 0.851; June: KW = 3.758, P = 0.289; May: KW = 0.189, P = 0.979). The lack of significance for June is likely due to low sample sizes in some of the categories. Sample sizes, however, were adequate for road transects and there were significant differences in June (KW = 7.297, P = 0.063) and July (KW = 10.652, P = 0.014) with the highest level of detections per station occurring in the center of the watershed (Fig. 6).

6) **Ecosections**

The level of Marbled Murrelet activity varied geographically (Figs. 7 and 8). Differences were statistically significant for both fixed stations and road transects in June (KW, P<0.10) and July (KW, P<0.05). The Georgia Depression Ecoprovince covering the south eastern portion of Vancouver Island had the lowest average level of Marbled Murrelet activity for both fixed and road stations. The Nahwitti Lowland ecosection also had low levels of murrelet activity as indicated by the results of the fixed stations. Road transect results suggested a possibly higher level of activity but sample sizes were lower (five road transects vs 14 fixed stations). These fixed stations probably provide



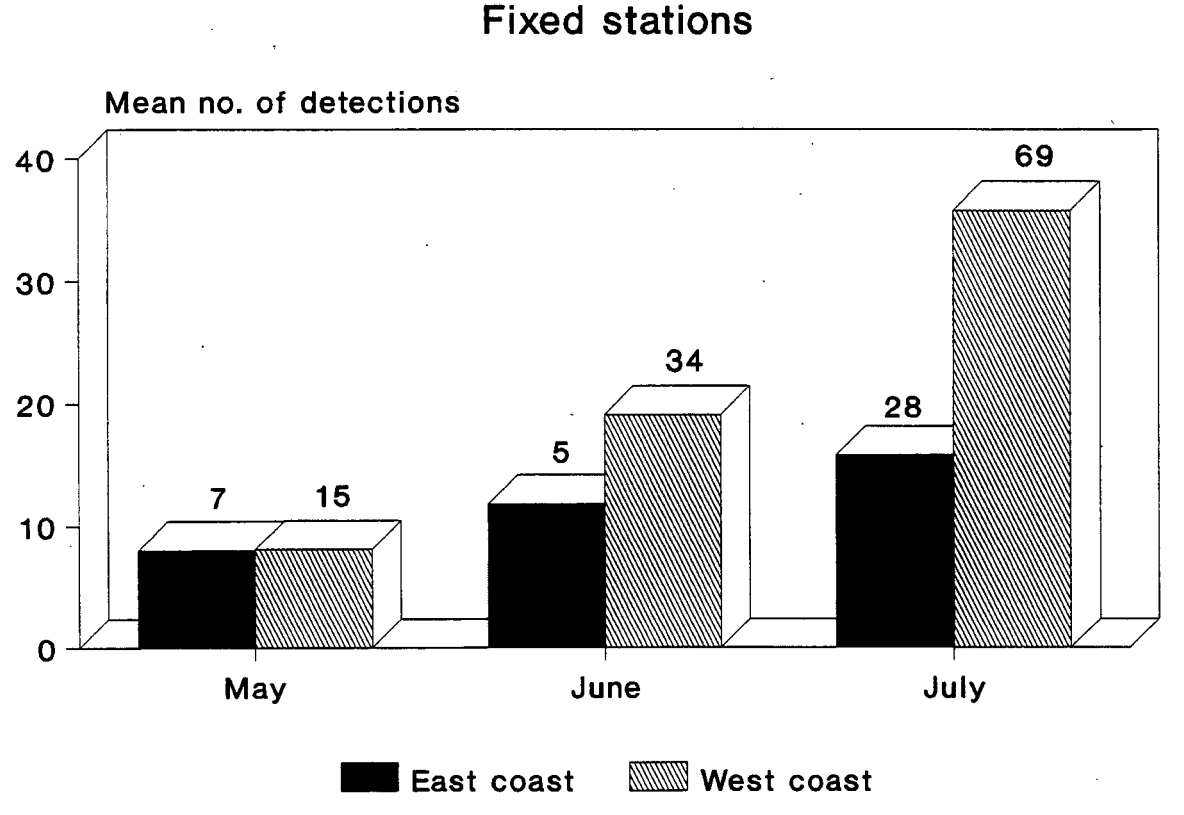
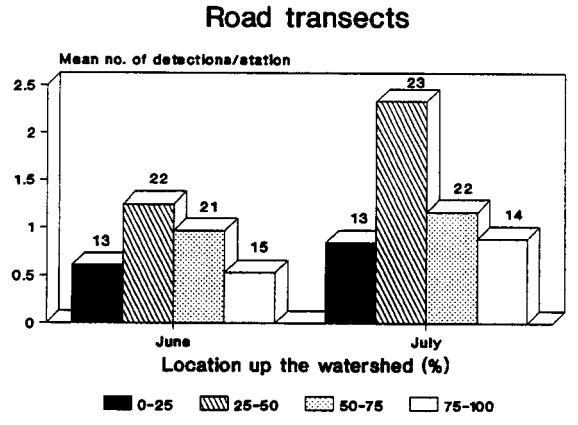
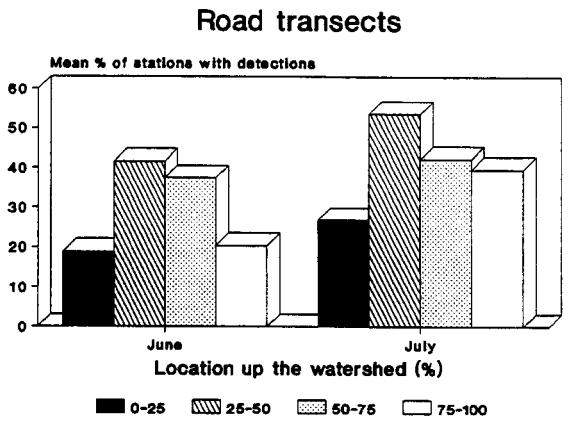


Fig.5 Number of Marbled Murrelet detections in the watersheds of the east and west coasts of Vancouver Island (Numbers above the histograms are the sample sizes)





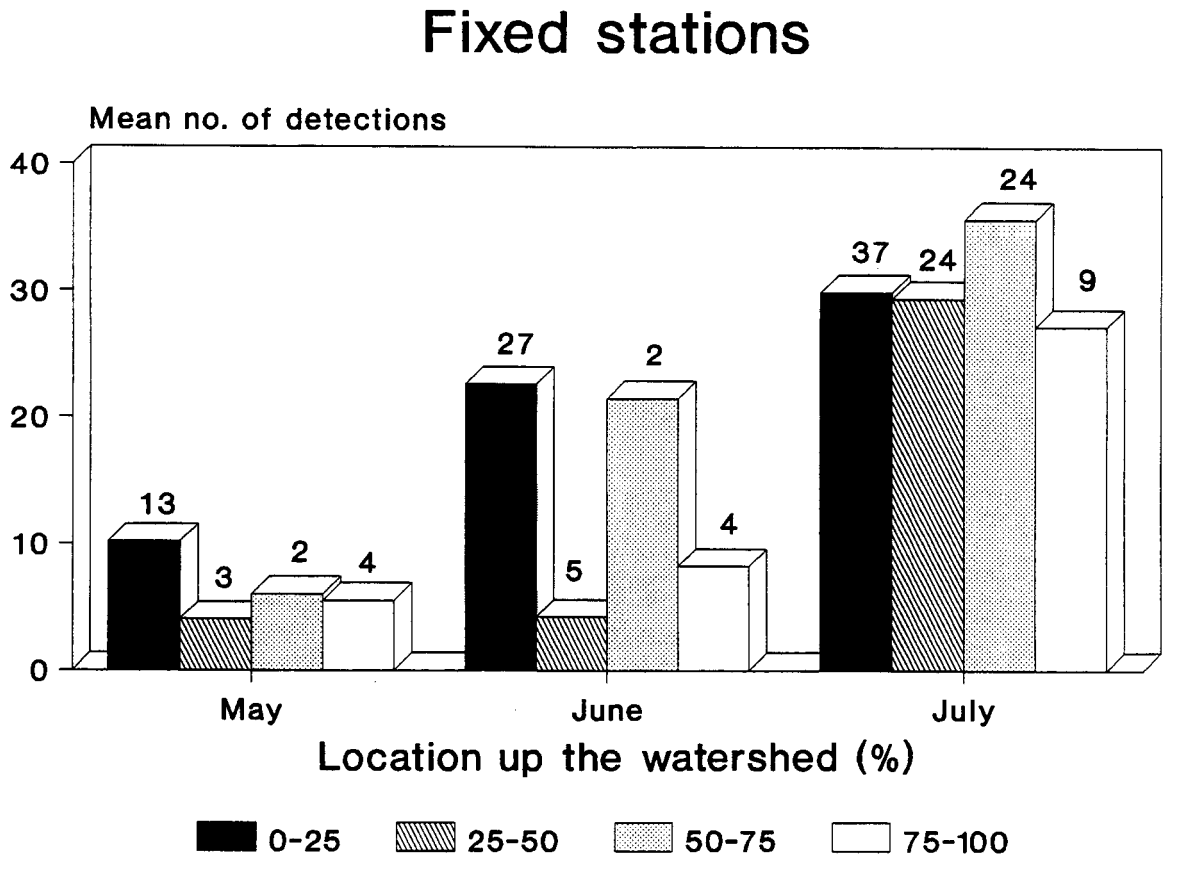
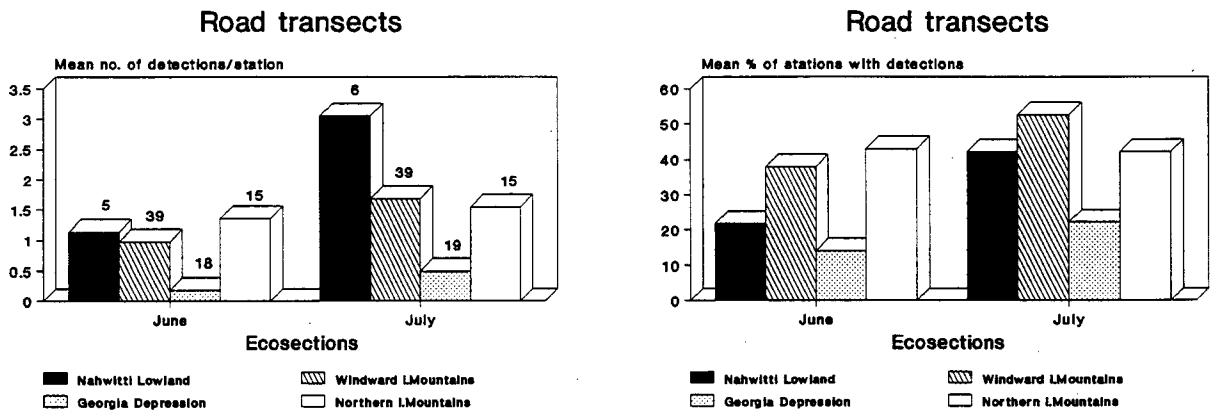


Fig. 6 Number of Marbled Murrelet detections in relation to the location of the survey station in the watershed. (Numbers above the histograms are the sample sizes).



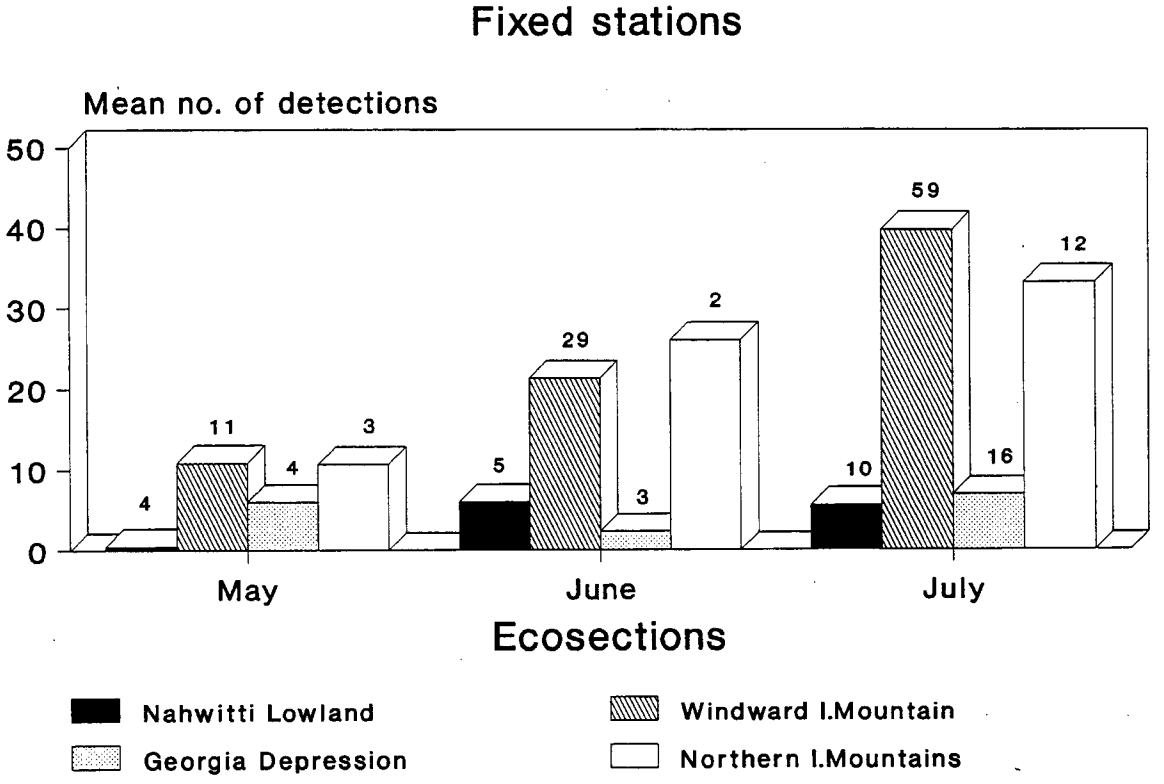


Fig. 7 Number of Marbled Murrelet detections in relation to the ecosection classification. (Numbers above the histograms are the sample sizes).

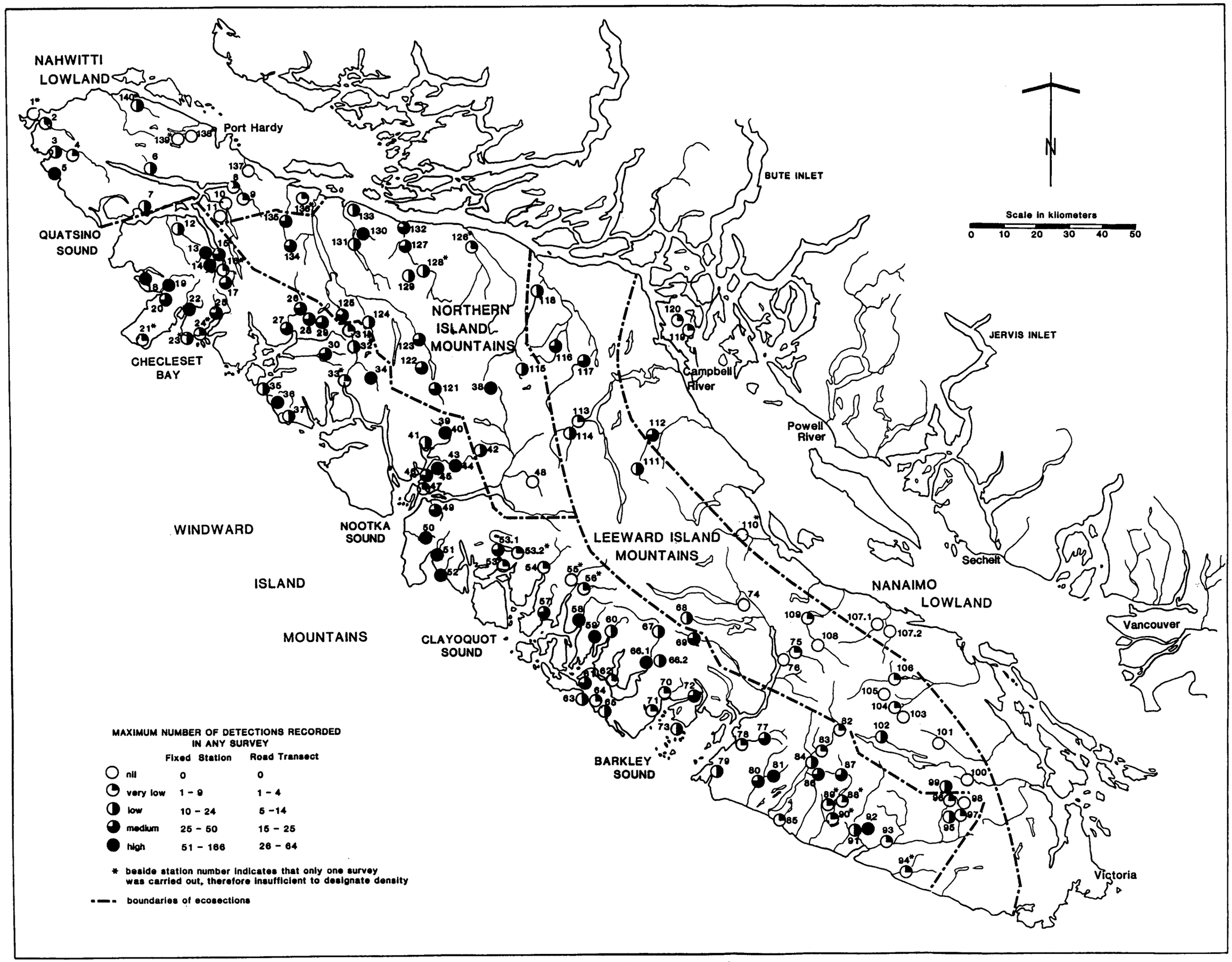


Fig. 8. Comparison of the number of Marbled Murrelet detections in various watersheds of Vancouver Island.

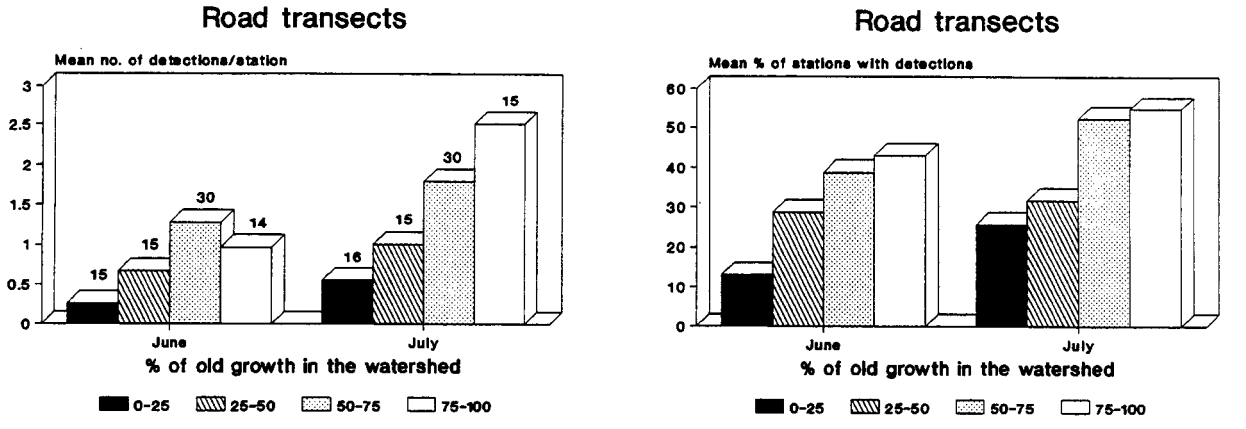
a better picture of the level of activity of Marbled Murrelets in this ecosection. Highest detections for fixed stations occurred in the Windward Island Mountain ecosection covering the west coast of Vancouver Island. A detailed discussion of the results for individual watersheds is presented in appendix 18.

7) **Proportion of old growth in the watershed**

There was a significant tendency for watersheds with less than 50% of their forested area still in old growth forest to have lower levels of Marbled Murrelet activity (Fig. 9). For fixed stations there were significantly more Marbled Murrelet detections in watersheds with >75% old growth in May (KW = 7.385, P = 0.061) and with >50% old growth in July (KW = 12.046, P=0.007). The lack of a significant pattern in June (KW = 4.145, P = 0.246) may be due to low sample sizes in some categories. Road stations supported the pattern observed with the fixed stations in July. The number of murrelet detections per station at road transects was significantly affected by the proportion of old growth present in the watershed both in June (KW = 12.894, P=0.005) and July (KW = 17.452, P=0.001) as was the percentage of stations with detections (June: KW = 13.634, P = 0.003; July: KW = 11.331, P = 0.010).

8) **Distance from old growth**

Stations and transects located within 500 m of old growth stands had significantly more detections than those further away (Fig. 10). For fixed stations, stations located within 200 m of old growth had significantly more detections than those at greater distance in June (KW = 11.58, P = 0.009) and July (KW = 26.877, P = 0.000) but not in May (KW = 5.405, P=0.144). For road transects, transects with more than 50% of their stations within 500 m of old growth had significantly more Marbled Murrelet detections per station in June (KW = 11.437, P<0.01) and July (KW = 19.689, P<0.001), and also had a greater percentage of stations with detections (June: KW = 12.838, P = 0.005; July: KW = 16.304, P = 0.001).



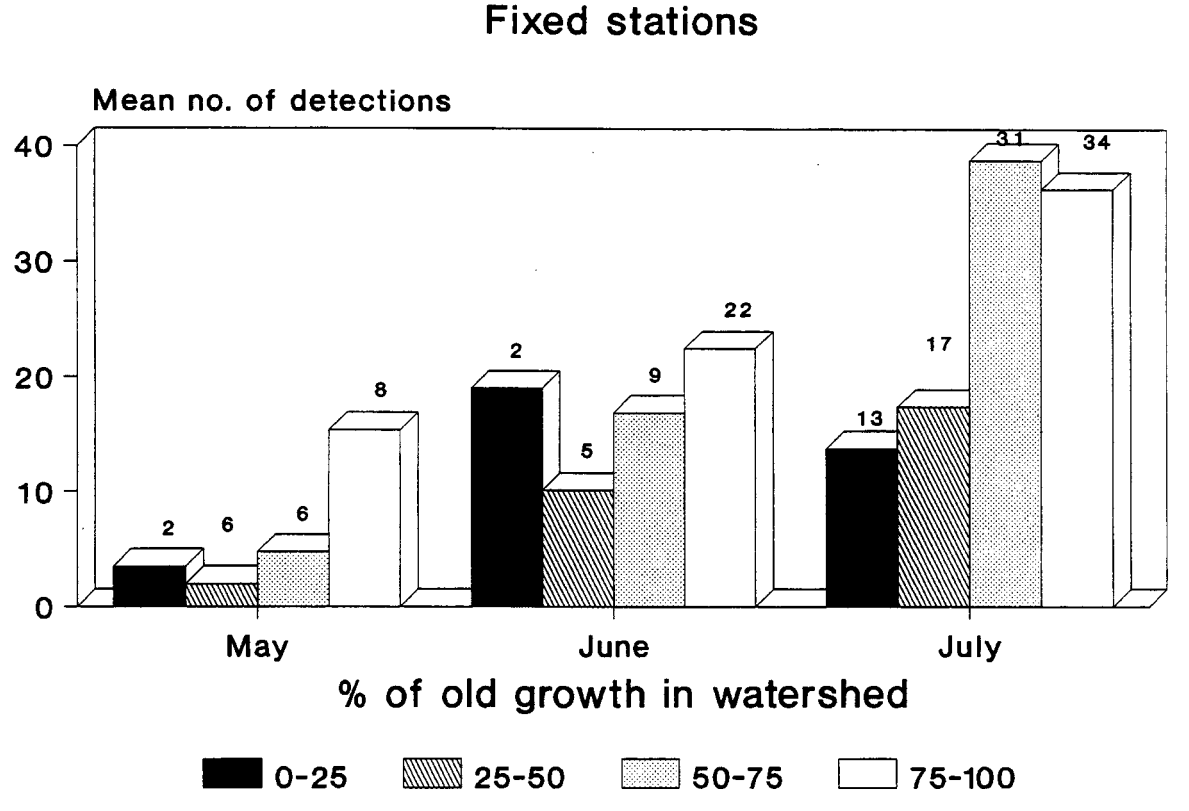
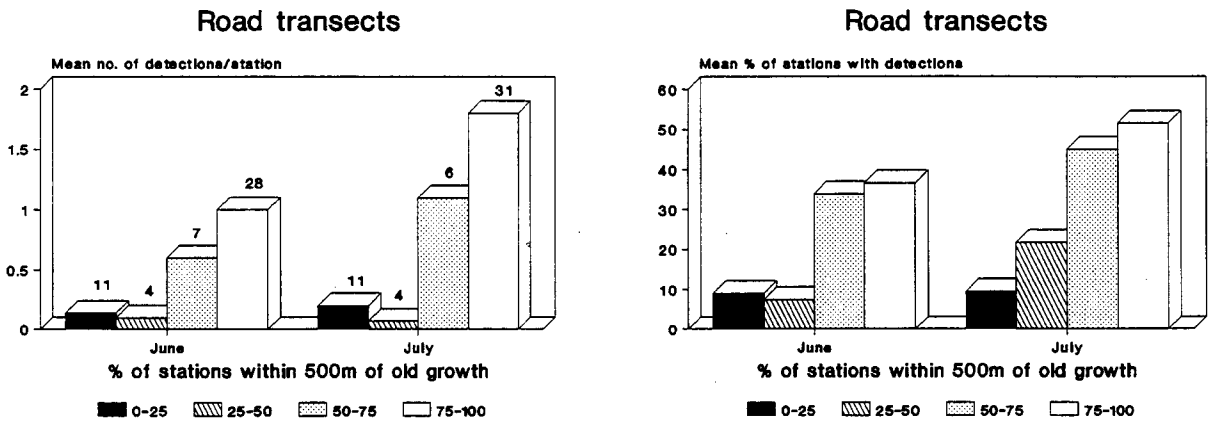


Fig. 9 Number of Marbled Murrelet detections in relation to the proportion of the watershed still in old growth forest. (Numbers above the histograms are the sample sizes).



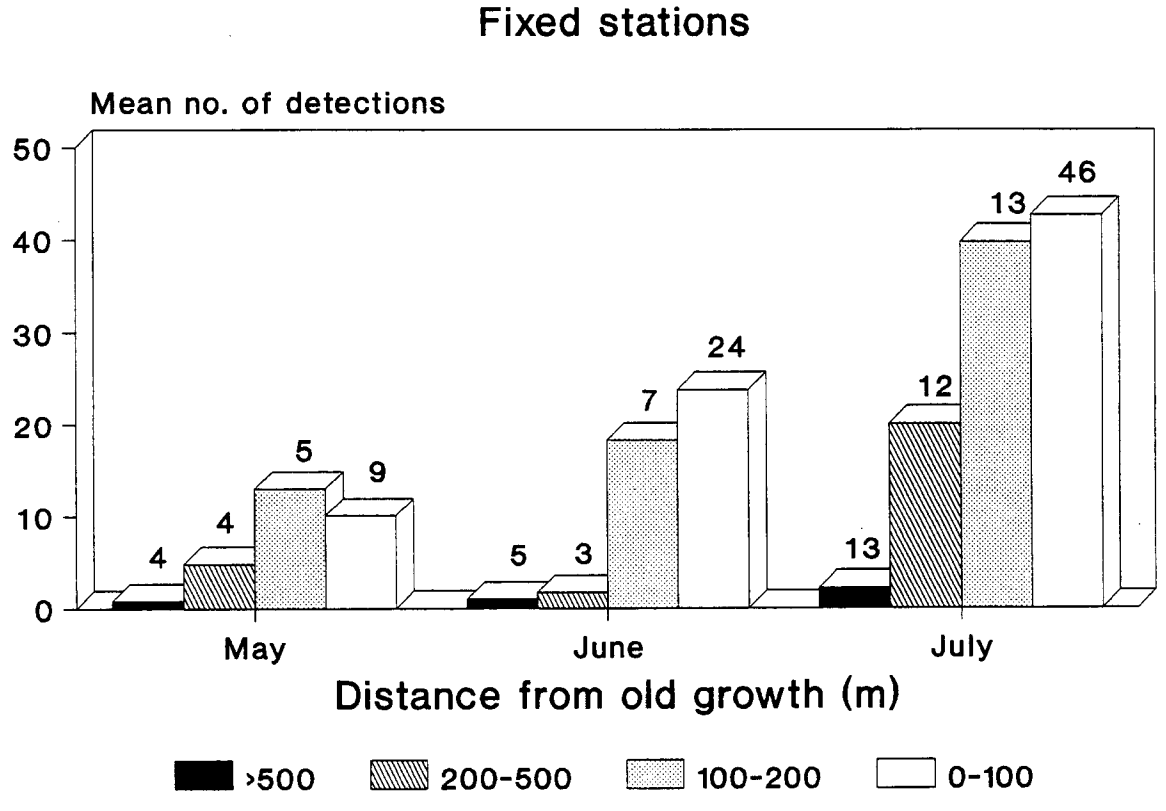


Fig. 10 Number of Marbled Murrelet detections in relation to the distance of the sampling station from old growth forest. (Numbers above the histograms are the sample sizes).

DISCUSSION

SURVEY LIMITATIONS

A study of such large geographical scale, relying on several participants, yields a great amount of heterogeneity in the results. Marbled Murrelet detections are influenced by observer skills, visibility at the station and weather. Also, in order to survey several watersheds, the coverage of any single watershed was necessarily limited. Finally, the coverage of each watershed was not standardized in terms of station numbers and location. Thus, interpretation of the survey results should be done with caution.

We do not fully understand the implications of the intensity of murrelet activity measured. Whether it can be directly translated into breeding densities is unresolved but unlikely due to the high variability in activity level at any station. However, certain behaviours have been associated with breeding activities *i.e.* silent flight below or near the canopy. The detection of these behaviours is difficult to standardize as it is greatly affected by the characteristics of the sampling station and the skill of the observer.

A low intensity of Marbled Murrelet activity in a given watershed does not necessarily indicate low useage of the area by murrelets. The utilisation of stands may vary between years in relation to conditions at sea (i.e. low productivity years) and varies most certainly from month to month. The interim management guidelines for Marbled Murrelet habitat conservation in Washington, Oregon and California recommend that each site should be surveyed a minimum of four times in each breeding season for a minimum of 2 years to adequately assess the use of a given area or stand by murrelets (Paton *et al.* 1990, Anonymous 1991).

VARIATION IN MARBLED MURRELET ACTIVITY

The intensity of Marbled Murrelet activity was lowest in May and highest in July. This is now a well documented and quantified pattern that has been common to Marbled Murrelet studies (Carter and Erikson 1992, Ralph *et al.* 1989, Paton *et al.* 1990, Hamer and Cummins 1990, 1991, Rodway *et al.* 1991, 1993a,b). Hamer and Cummins (1990,1991) suggest that the higher intensity of activity in July corresponds to the period when food demands of young are highest and multiple foraging trips are made to and from nest sites. Rodway *et al.* (1991,1993b) suggest that the increase is also likely due to an influx of non-breeding birds in the breeding areas. Such a phenomenon is well known in colonial alcids where non breeding birds frequent breeding colonies late in the breeding season to prospect for nest sites and interact behaviorally (Manuwal 1974a, Sealy 1976, Gaston 1990). Also, the increase in intensity of activity in July is accompanied by an increase in the number of Marbled Murrelets in coastal waters (Carter 1984, Kaiser *et al.* 1991, Rodway *et al.* 1991). This supports the idea that at least part of the increase in intensity of activity may be due to an influx of non breeders.

MARBLED MURRELET ACTIVITY IN RELATION TO WATERSHED LOCATION

There was no consistent pattern between the number of Marbled Murrelet detections and the distance of the sampling station from the coast, either from the closest sea water or from the open ocean. This suggests that most Vancouver Island watersheds may be used by Marbled Murrelets, which have been detected up to 60 km from the coast in other studies (Nelson *et al.* 1992, Ralph *et al.* 1989, Rodway 1990, Rodway *et al.* 1992). Our selection of a grouping of 15 km and over may have masked any relationship. Hamer *et al.* (1990, 1991) found in the Puget Sound area that inland murrelet detections occurred only between 30 and 70 km from the Sound. The absence of murrelet detections closer to the Sound was attributed to the absence of mature forests in Washington's more agricultural landscape. Although Marbled Murrelets can nest close to the coast there is no evidence of higher nesting

densities at any particular distance from the coast. However, this is not surprising in view of the small number of nests found to date. The recording of Marbled Murrelet activity several kilometers inland in areas with coastal old growth suggest some kind of spacing behaviour in that species. If this occurred it would greatly limit the use of small old growth patches by murrelets.

Recent observations (Prestash, pers. comm. and Varoujean *et al.* 1989) indicate that Marbled Murrelets can travel great distances (10 - 60 km) from their nesting to feeding areas. Therefore murrelet concentrations on the water may not always be related to Marbled Murrelet inland activity in adjacent areas. For example, boat surveys in Checleset Bay (Savard and Lemon 1992) did not reveal high Marbled Murrelet concentrations, yet the adjacent Nasparti River valley had one of the highest intensities of inland murrelet activity of this study.

Watersheds emptying on the west coast of Vancouver Island tended to have higher Marbled Murrelet activity than those emptying on the east coast. This is possibly related to the lower intensity of exploitation of the west coast forests which translates into a greater proportion of the sampling stations close to old growth. However, several other factors could account for this pattern; for example, the highly indented nature of the west coast, the greater productivity of the coastal waters and climate.

Finally, there was no observable pattern in intensity of Marbled Murrelet activity that could be related to the location of the transects or stations within the watershed itself. However, our sampling effort was not designed to address this issue, which would be best addressed by sampling a given watershed at different locations. Manley *et al.* (1992) found a negative correlation between Marbled Murrelet activity levels and distance from ocean in the Carmanah watershed.

GEOGRAPHICAL VARIATION IN MARBLED MURRELET ACTIVITY

Our results show the wide distribution of Marbled Murrelets on Vancouver Island. Marbled Murrelets were detected in most of the watersheds surveyed. However, there were differences in the intensity of activity between landscape types. Vancouver Island harbours two ecoprovinces which are defined as an area with major physiographic and minor macroclimatic variations (Demarchi *et al.* 1990). The intensity of Marbled Murrelet activity was higher in the Coast and Mountains than in the Georgia Depression Ecoprovince, possibly because of the drier climate (which may impede the development of mossy platforms on tree branches for nesting) and the longer logging history of the latter.

MARBLED MURRELET ACTIVITY IN RELATION TO OLD GROWTH

There was a positive relationship between the intensity of Marbled Murrelet activity and the percentage of old growth forest in the watershed. Marbled Murrelet activity levels were highest in watersheds with over 50% old growth remaining and lower in watersheds with less than 25% remaining. Unfortunately, our sampling effort was too low to refine this pattern in more detail. Several factors may mask any relationships. First, because of limited access, the ability of the observer to detect Marbled Murrelets may be somewhat reduced in pristine watersheds. Second, several of the heavily logged watersheds were larger than pristine ones which may reduce the likelihood of murrelet detections because a funneling effect of the murrelets in larger valleys is less likely. Third, in logged watersheds, the only Marbled Murrelet activity may be in the remnant old growth thus making murrelet detections highly influenced by the location of the station within those watersheds.

The distance of the sampling station from old growth forest affected murrelet detections with stations nearest to old growth having the highest number of detections. Unfortunately, stations located in heavily logged watersheds tended to be also further away from old growth forest so that it is not clear which of the two factors may be most important. The difficulty in positioning stations near remnant old growth in logged watersheds may account to some degree for the low detection levels in some watersheds. The use of remnant old growth by murrelets in heavily logged watersheds needs to be better quantified. The positive association of Marbled Murrelet activity with old growth has been a common feature of several studies of murrelets to date (Sealy and Carter 1984, Paton *et al.* 1992, Marshall 1988,a,b, Varoujean *et al.* 1989, Eisenhower and Reimchen 1990, Rodway 1990, Hamer and Cummins 1990, 1991, Rodway *et al.* 1991, 1993 a,b).

WATERSHED COVERAGE

The present study provides only a general picture of Marbled Murrelet activity in the watersheds surveyed. More intensive effort will be required to quantify murrelet activity in a given watershed. However, we found Marbled Murrelets in coastal stands as well as in stands in the center of the Island. We also found a significant association between Marbled Murrelet inland activity and old growth forests.

The low intensity of murrelet activity recorded in some watersheds, especially those in the Georgia Depression Ecoregion on the east coast of the Island, is associated with extensively logged watersheds but also coincides with a drier microclimate. Most survey transects and stations within the watersheds of this region were located away from old growth forest. In these watersheds, we should expect, given the association of Marbled Murrelet inland activity with old growth as reported in most studies, that any Marbled Murrelet activity will be centered around the remnant old growth within these watersheds. Thus we may have underestimated murrelet activity

in some of these watersheds. We have one indication that this may be the case in the San Juan River watershed. This 64,500 ha watershed had only 24% of its old growth remaining. The upper portion of the watershed was covered by 4 road transects and 2 fixed stations. All stations but one, the one located in old growth forest, had very few or no Marbled Murrelet detections. The station in old growth had a high number of detections (74 detections, 1458 calls). Unfortunately, no other stations in heavily logged watersheds could be positioned near old growth.

Marbled Murrelets may be affected by patch size and patch distribution when forests are fragmented. Some Marbled Murrelet nests found in California in the remaining old growth were characterized by their location in a tree taller than others, near the edge of an opening or on a steep slope, providing an easy flight path to and from the nest (Singer *et al.* 1991). However, it remains to be quantified whether access to trees in B.C. is a limiting factor in old growth forests, which naturally contain openings and a varied crown structure. In Alaska, nests were found in trees larger but often 5-10 m shorter than the surrounding canopy on generally gradual to moderate, but occassionally steep slopes (N. Naslund pers. comm.). The high level of predation observed on the nests found to date (Singer *et al.* 1991) especially by corvids, is a source of concern as fragmentation may increase nest vulnerability to these species.

Several questions still need to be addressed in relation to exploited watersheds: What is the best size and distribution of old growth fragments for Marbled Murrelets? Are many small fragments better than a single one? Are high and low elevation fragments similarly used? Are Marbled Murrelets territorial, semi-colonial or both? Are predation levels related to fragment size? Can Marbled Murrelet use artificial nesting structures? Answers to these questions will provide knowledge needed to help maintain or enhance Marbled Murrelet use of exploited watersheds and contribute to the sustainable use of our resources.

CONCLUSIONS

1) Marbled Murrelet detections were more numerous in July than in June or May.
2) Marbled Murrelets were detected in nearly all watersheds adequately surveyed.
3) The intensity of Marbled Murrelet inland activity, as measured by the number of detections, was higher in watersheds on the west coast than on the east coast of Vancouver Island.
4) Marbled Murrelet detections were more numerous in watersheds with more than 50% of their forested area in old growth.
5) Marbled Murrelet detections were highest in stations located in or near old growth.
6) Marbled Murrelets were detected inland at all distances from the coast.
7) The Georgia Depression Ecoprovince (Leeward Island Mountains Ecosection and Nanaimo Lowlands Ecosection) had the most heavily logged watersheds and the lowest level of Marbled Murrelet activity.
8) The Windward Island Mountain ecosection had the highest level of Marbled Murrelet activity.

LITERATURE CITED

Anonymous 1991. Interim management guidelines for Marbled Murrelet habitat conservation in Washington, Oregon and California. Pacific Seabird Group.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser and M.C.E. McNall 1990. The Birds of British Columbia. Royal British Columbia Museum, Victoria, B.C. 514 p.

Carter, H.R. 1984. At-sea biology of the Marbled Murrelet (*Brachyramphus marmoratus*) in Barkley Sound, British Columbia. M.Sc. thesis, Univ. Manitoba, Winnipeg. 143pp.

Carter, H.R. and Erickson, R.A. 1992. Status and conservation of the Marbled Murrelet in California, 1892 - 1987. Pp 92-108 In H.R. Carter and M.L. Morrison (eds.) Status and Conservation of the Marbled Murrelet in North America, Proc. Western Found. Vert. Zool. Vol. 5, No. 1. 134p.

Day, R.H., K.L. Oakley and D.R. Barnard. 1983. Nest sites and eggs of Kittlitz's and Marbled Murrelets. Condor 85:265-273.

Demarchi, D.A., R.D. Marsh, A.P. Harcombe and E.C. Lea. 1990. The environment. pp. 55-144 in Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser and M.C.E. McNall. The Birds of British Columbia. Royal British Columbia Museum, Victoria, B.C. 514p.

Eisenhower, A.E. and Reimchen, T.E. 1990. Inland flight patterns of Marbled Murrelets (*Brachyramphus marmoratus*) on the Queen Charlotte Islands, British Columbia. Can. Field Nat. 104:439-444.

Gaston, A.J. 1990. Population parameters of the Ancient Murrelet. Condor 92:998-1011.

Hamer, T.E. and E.B. Cummins 1990. Forest habitat relationships of Marbled Murrelets in Northwestern Washington. Washington Dept. of Wildl., Olympia, WA.

Hamer, T.E. and E.B. Cummins 1991. Relationships between forest characteristics and use of Inland sites by Marbled Murrelets in Northwestern Washington. Washington Dept. of Wildl., Olympia, WA.

Kaiser, G.W., T.W. Mahon, and M.D. Fawcett. 1991. Studies of Marbled Murrelets in marine habitats during 1990. Technical Report Series No. 131, Can. Wildl. Serv. Pacific and Yukon Region.

Manley, I., R. Shortt, and A.E. Burger. 1992. Marbled Murrelet activity patterns in the Carmanah Valley on the southwest coast of Vancouver Island. Pp. 71-75 in Vermeer, K., R.W. Butler and K.H. Morgan (eds.) The ecology, status, and conservation of marine and shoreline birds on the west coast of Vancouver Island. Can. Wildl. Serv., Occ. Pap. No. 75. Ottawa.

Manuwal, D.A. 1974a. The natural history of Cassin's Auklet (*Ptychoramphus aleuticus*). Condor 76:421-431.

Marshall, D.B. 1988a. A status of the Marbled Murrelet in North America: with special emphasis on California, Oregon, and Washington. U.S. Fish Wildl. Serv. Biol. Rep. 88. 19pp.

Marshall, D.B. 1988b. The Marbled Murrelet joins the old-growth forest conflict. Amer. Birds. 42: 202-212.

Nelson, S.K. 1989. Development of inventory techniques for surveying Marbled Murrelets (*Brachyramphus marmoratus*) in coniferous forests of the Oregon coast range. Nongame Wildlife Program, Portland, Oregon, Dept. Fish Wildl., Publ. No. 88-6-01. 104p.

Nelson, S.W., M.L.C. McAllister, M.A. Stern, D.H. Varoujean, and J.M. Scott. 1992. The Marbled Murrelet in Oregon, 1899-1987. Pp. 61-91 In H.R. Carter and M.L. Morrison (eds). Status and conservation of the Marbled Murrelet in North America. Proc. Western Found. Vert. Zool. Vol. 5, No. 1. 134p.

Paton, P.W.C. and C.J. Ralph. 1988. Geographic distribution of the Marbled Murrelet in California at inland sites during the 1988 breeding season. Unpubl. report. California Dept. Fish and Game, Sacramento, California. 35p.

Paton, P.W.C., C.J. Ralph, H.R. Carter and S.K. Nelson. 1990. Surveying Marbled Murrelets at inland forested sites: a guide. Gen. Tech. Rep. PSW-120. Berkley, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 9p.

Paton, P.W.C., C.J. Ralph and R.A. Erickson. 1992. Use of an inland site in northwestern California by Marbled Murrelets. Pp 109-116 In H.R. Carter and M.L. Morrison (eds). Status and conservation of the Marbled Murrelet in North America. Proc. Western Found. Vert. Zool. Vol. 5, No. 1. 134p.

Quinlan, S.E. and J.H. Hughes. 1990. Location and description of a Marbled Murrelet tree nest site in Alaska. Condor 92:1068-1073.

Ralph, C.J., S.L. Miller, N.L. Naslund, B. O'Donnell, P.W.C. Paton and J. Sealy 1989. Marbled Murrelet research during 1989 in northern and central California. An interim report. U.S.D.A. Forest Service, Pacific Southwest Forest and Range Experimental Station. 50pp.

Reimchen, T.E. 1991. Marbled Murrelet habitat use in the Queen Charlotte Islands. *In*: Rodway, M.S., J-P.L. Savard and H.M. Regehr. Habitat use and activity patterns of Marbled Murrelets at inland and at-sea sites in the Queen Charlotte Islands, British Columbia. Can. Wildl. Serv., Pacific and Yukon Region. Technical Report Series No. 122.

Rodway, M.S. 1990. Status report on the Marbled Murrelet (*Brachyramphus marmoratus*) in Canada 1990. Committee on the Status of Endangered Wildlife In Canada, Ottawa, Ontario. 58p.

Rodway, M.S., J-P.L. Savard and H.M. Regehr. 1991. Habitat use and activity patterns of Marbled Murrelets at inland and at-sea sites in the Queen Charlotte Islands, British Columbia. Can. Wildl. Serv. Pacific and Yukon Region, British Columbia. Technical Report Series No. 122.

Rodway, M.S., H.R. Carter, S.G. Sealy and R.W. Campbell. 1992. Status of Marbled Murrelet in British Columbia. Pp 17-41 In H.R. Carter and M.L. Morrison (eds). Status and conservation of the Marbled Murrelet in North America. Proc. Western Found. Vert. Zool. Vol. 5, No. 1. 134pp.

Rodway, M.S., H.M. Regehr, and J-P.L. Savard. 1993a. Activity levels of Marbled Murrelets in different inland habitats in the Queen Charlotte Islands, British Columbia. Can. J. Zool. 71:977-984.

Rodway, M.S., H.M. Regehr, and J-P.L. Savard. 1993b. Activity patterns of Marbled Murrelets in old-growth forest in the Queen Charlotte Islands, British Columbia. Condor 95:831-848.

Savard, J-P.L. and M.J.F. Lemon. 1992. Summer distribution and abundance of Marbled Murrelets on the west and east coasts of Vancouver Island, Pp. 114-118 in Vermeer, K., R.W. Butler and K.H. Morgan (eds.). The ecology, status, and conservation of marine and shoreline birds on the west coast of Vancouver Island. Can. Wildl. Serv., Ottawa. Occ. Pap. No. 75.

Sealy, S.G. 1976. Biology of nesting Ancient Murrelets. Condor 78:294-306.

Sealy, S.G., and H.R. Carter. 1984. At-sea distribution and nesting habitat of the Marbled Murrelet in British Columbia: problems in the conservation of a solitarily nesting seabird. Pp. 737-756 *In* Croxall, J.P., P.G.H. Evans and R.W. Schreiber (eds.). ICBP Technical Publication No. 2. Cambridge, England.

Simons, T.R. 1980. Discovery of a ground-nesting Marbled Murrelet. Condor 82:1-9.

Singer, S.W., N.L. Nasland, S.A. Singer and C.J. Ralph. 1991. Discovery of two nests of the Marbled Murrelet. Condor 93:330-339.

Varoujean, D.H., W.A. Williams and D.R. Warrick 1989. Nest locations and nesting habitat of the Marbled Murrelet (*Brachyramphus marmoratus*) in coastal Oregon. Nongame Wildl. Program, Oregon Dept. Fish Wildl., Publ. No. 88-6-02.

Zar. 1974. Biostatistical Analysis. Prentice-Hall, Englewood Cliff, New Jersey.

APPENDIX 1

NUMBER OF MARBLED MURRELET DETECTIONS IN

RELATION TO VARIOUS FACTORS.

This appendix presents the actual data of figures 3-4-5-6-7-9 and 10 with the sample sizes and the standard error associated with the measures. It also provides the results of the statistical analysis for each comparison. The data should help a better interpretation of the figures.

Appendix 1a. Number of Marbled Murrelet detections in relation to straight line distance from salt water (Fig. 3).

Month (sample size)[1]	Distance to salt water (km) 0-5	5-15	>15	Kruskal Wallis	P value
Fixed stations (Mean number of detections ± standard error)					
May (10-7-5)	12.0 ± 4.4	3.0 ± 1.0	7.4 ± 3.2	2.100	0.350
June (25-7-7)	24.4 ± 6.7	11.3 ± 5.8	2.4 ± 0.9	6.736	0.034*
July (40-30-26)	32.4 ± 5.6	31.6 ± 6.7	25.8 ± 5.2	0.257	0.879
Road transects (Mean number of detections per station ± standard error)					
June (20-23-30)	0.6 ± 0.3	1.2 ± 0.3	0.8 ± 0.2	2.638	0.267
July (23-22-32)	1.9 ± 1.9	1.7 ± 0.4	1.0 ± 0.2	2.334	0.311
Road transects (Mean percentage of stations with detections ± standard error)					
June (20-23-30)	25.0 ± 5.9	36.0 ± 5.8	31.3 ± 5.0	1.617	0.446
July (23-22-32)	44.3 ± 7.0	46.5 ± 6.5	38.7 ± 5.4	0.793	0.673

[1] Sample size (A-B-C): A for 0-5 km; B for 5-15km; C for >15km
* Statistically significant at $p<0.1$

Appendix 1b. Number of Marbled Murrelet detections in relation to straight line distance from open ocean (Fig. 4).

Month (sample size)[1]	Distance to salt water (km) 0-5	5-15	>15	Kruskal Wallis	P value
Fixed stations (Mean number of detections ± standard error)					
May (3-4-15)	14.7 ± 7.9	3.5 ± 1.6	8.0 ± 2.8	1.091	0.580
June (12-10-17)	21.3 ± 8.3	30.4 ± 13.3	8.8 ± 3.5	4.522	0.104*
July (14-26-56)	24.6 ± 8.5	28.0 ± 7.6	32.9 ± 4.2	2.833	0.243
Road transects (Mean number of detections per station ± standard error)					
June (6-17-51)	0.2 ± 0.1	1.2 ± 0.5	0.8 ± 0.1	1.721	0.423
July (8-16-53)	1.8 ± 1.3	2.0 ± 0.5	1.3 ± 0.2	1.946	0.378
Road transects (Mean percentage of stations with detections ± standard error)					
June (6-17-51)	16.9 ± 9.2	32.2 ± 7.8	31.9 ± 3.6	1.463	0.481
July (8-16-53)	36.6 ± 13.0	50.3 ± 8.8	41.2 ± 4.0	1.313	0.519

[1] Sample size (A-B-C): A for 0-5 km; B for 5-15km; C for >15km
* Statistically significant at $p<0.1$

Appendix 1c. Number of Marbled Murrelet detections in the watersheds of the east and west coasts of Vancouver Island (Fig. 5)

Month (sample size)[1]	East Coast	West Coast	Mann Whitney	P value
Fixed stations (Mean number of detections ± standard error)				
May (7-15)	8.0 ± 3.9	8.1 ± 2.8	50	0.859
June (5-34)	11.8 ± 7.2	19.1 ± 5.2	77	0.736
July (28-69)	15.8 ± 3.3	35.8 ± 4.4	1321	0.005*
Road transects (Mean number of detections per station ± standard error)				
June (28-49)	0.8 ± 0.2	0.9 ± 0.2	596	0.333
July (29-50)	1.0 ± 0.2	1.7 ± 0.3	568	0.108*
Road transects (Mean percentage of stations with detections ± standard error)				
June (28-49)	26.1 ± 4.7	35.8 ± 4.1	556	0.163
July (29-50)	32.8 ± 5.7	48.1 ± 4.2	515	0.032*

[1] Sample size (A-B): A for East Coast: B for West Coast
* Statistically significant at $p<0.1$

Appendix 1d. Number of Marbled Murrelet detections in relation to the location of the survey station in the watershed (Fig. 6)

Month (sample size)[1]	Location up the watershed (%) 0-25	25-50	50-75	75-100	Kruskal Wallis	P value
Fixed stations (Mean number of detections ± standard error)						
May (13-3-2-4)	10.2 ± 3.7	4.0 ± 1.0	6.0 ± 1.0	5.5 ± 2.5	0.189	0.979
June (27-5-2-4)	22.6 ± 6.3	4.2 ± 2.0	21.5 ± 17.5	8.3 ± 5.9	3.758	0.289
July (37-24-24-9)	29.9 ± 5.7	29.4 ± 6.5	35.7 ± 7.4	27.2 ± 9.2	0.795	0.851
Road transects (Mean number of detections per station ± standard error)						
June (13-22-21-15)	0.6 ± 0.4	1.2 ± 0.4	1.0 ± 0.2	0.5 ± 0.2	7.541	0.057*
July (13-23-22-14)	0.8 ± 0.4	2.3 ± 0.4	1.2 ± 0.3	0.9 ± 0.3	9.329	0.925
Road transects (Mean percentage of stations with detections ± standard error)						
June (13-22-21-15)	18.8 ± 7.1	41.5 ± 5.9	37.4 ± 5.9	20.3 ± 5.7	8.972	0.030*
July (13-23-22-14)	26.8 ± 8.3	53.5 ± 6.1	42.1 ± 5.4	39.5 ± 10.3	6.045	0.109

[1] Sample size (A-B-C-D): A for 0-25%, B for 25-50%, C for 50-75%, D for 75-100%
* Statistically significant at $p<0.1$

Appendix 1e. Number of Marbled Murrelet detections in relation to the ecosection classification (Fig. 7)

Month (sample size)[1]	Nahwitti Lowland	Windward I. Mountains	Georgia Depression	Northern I. Mountains	Kruskal Wallis	P value
Fixed stations (Mean number of detections ± standard error)						
May (4-11-4-3)	0.5 ± 0.5	10.9 ± 3.5	6.0 ± 3.8	10.7 ± 8.3	7.109	0.069*
June (5-29-3-2)	6.0 ± 4.5	21.3 ± 5.9	2.3 ± 1.9	26.0 ± 13.0	7.051	0.070*
July (10-59-16-12)	5.6 ± 2.4	39.8 ± 4.8	6.9 ± 3.1	33.2 ± 5.0	30.442	0.000*
Road transects (Mean number of detections per station ± standard error)						
June (5-39-18-15)	1.1 ± 1.0	1.0 ± 0.2	0.2 ± 0.1	1.4 ± 0.3	14.454	0.002*
July (6-39-19-15)	3.1 ± 1.8	1.7 ± 0.3	0.5 ± 0.2	1.5 ± 0.4	11.799	0.008*
Road transects (Mean percentage of stations with detections ± standard error)						
June (5-39-18-15)	21.7 ± 14.8	38.0 ± 4.6	14.0 ± 4.1	42.9 ± 6.0	13.527	0.004*
July (6-36-19-15)	42.2 ± 15.3	52.6 ± 4.5	22.1 ± 6.4	42.2 ± 7.4	12.942	0.005*

[1] Sample size (A-B-C-D): A for Nahwitti Lowland, B for Windward Island Mountains, C for Georgia Depression, D for Northern Island Mountains

* Statistically significant at $p<0.1$

Appendix 1f. Number of Marbled Murrelet detections in relation to the proportion of the watershed still in old growth forest (Fig. 9)

Month (sample size)[1]	% of old growth in watershed 0-25	25-50	50-75	75-100	Kruskal Wallis	P value
Fixed stations (Mean number of detections ± standard error)						
May (2-6-6-8)	3.5 ± 1.5	2.0 ± 1.0	6.0 ± 2.9	15.4 ± 4.9	7.385	0.061*
June (2-5-9-22)	19.0 ± 19.0	8.6 ± 7.6	17.2 ± 5.1	21.5 ± 7.6	4.145	0.246
July (13-17-31-34)	13.8 ± 6.1	17.4 ± 5.1	38.8 ± 6.3	36.3 ± 6.3	12.046	0.007*
Road transects (Mean number of detections per station ± standard error)						
June (15-15-30-14)	0.3 ± 0.1	0.7 ± 0.2	1.3 ± 0.3	1.0 ± 0.3	12.894	0.005*
July (16-15-30-15)	0.6 ± 0.3	1.0 ± 0.3	1.8 ± 0.3	2.5 ± 0.7	17.452	0.001*
Road transects (Mean percentage of stations with detections ± standard error)						
June (15-15-30-14)	13.0 ± 5.2	28.7 ± 7.6	38.7 ± 4.8	42.9 ± 6.6	13.634	0.003*
July (16-15-30-15)	25.7 ± 8.4	31.7 ± 8.1	52.2 ± 4.6	54.7 ± 7.7	11.331	0.010*

[1] Sample size (A-B-C-D): A for 0-25%, B for 25-50%, C for 50-75%, D for 75-100%
* statistically significant at $p<0.1$

Appendix 1g. Number of Marbled Murrelet detections in relation to the distance of the sampling station from old growth forest (Fig. 10)

Fixed stations (Mean number of detections ± standard error)

	Distance from old growth (m)					
Month (sample size)[1]	>500	200-500	100-200	0-100	Kruskal Wallis	P value
May (4-4-5-9)	0.8 ± 0.5	4.8 ± 2.3	13.0 ± 7.5	10.1 ± 3.1	5.405	0.144
June (5-3-7-24)	1.0 ± 0.8	1.7 ± 1.2	18.3 ± 7.3	23.8 ± 6.9	11.580	0.009*
July (13-12-13-46)	2.2 ± 1.1	20.1 ± 4.3	39.8 ± 9.3	42.7 ± 5.5	26.877	0.000*

Road transects (Mean number of detections per station ± standard error)

	% of stations within 500m of old growth					
	0-25	25-50	50-75	75-100		
June (11-4-7-28)	0.14 ± 0.06	0.1 ± 0.1	0.6 ± 0.3	1.0 ± 0.3	11.437	0.010*
July (11-4-6-31)	0.2 ± 0.1	0.07 ± 0.05	1.1 ± 0.3	1.8 ± 0.3	19.689	0.000*

Road transects (Mean percentage of stations with detections ± standard error)

	% of stations within 500m of old growth					
	0-25	25-50	50-75	75-100		
June (11-4-7-28)	9.1 ± 3.9	7.5 ± 7.5	33.9 ± 11.5	36.7 ± 15.9	12.838	0.005*
July (11-4-6-31)	9.5 ± 4.6	21.7 ± 18.5	45.0 ± 29.7	51.5 ± 5.0	16.304	0.001*

[1] Sample size (A-B-C-D): A for >500m; 0-25%, B for 200-500m; 25-50%, C for 100-200m, 50-75%, D for 0-100m; 75-100%

* statistically significant at $p<0.1$

Appendix 2.

MARBLED MURRELET INVENTORY PROTOCOL
Canadian Wildlife Service 1991
Compiled by
Jean-Pierre L. Savard
Research Scientist

In 1990, the Marbled Murrelet was classified as a threatened species in Canada because of the threats posed by logging, fishing nets and oil spills (Rodway 1990). Less than 20 nests of the species have been found worldwide and only 1 in British Columbia. Recent studies have pointed to old growth forest as an important nesting habitat (Marshall 1988, Paton and Ralph 1988, Nelson 1989, Varoujean *et al.* 1989).

The breeding distribution and ecology of Marbled Murrelet in British Columbia is poorly known. Increased efforts and cooperation between agencies are needed to improve our understanding of the ecology of the species.

This protocol will help standardize data acquisition on Marbled Murrelet activity at inland sites. It is based extensively on the methods used in Oregon, California and Washington (Paton *et al.* 1990, Anonymous 1991) but incorporates recent findings in British Columbia (Rodway *et al.* 1991).

Two survey methods are presented: a) road transects, and b) fixed stations.

The interim management guidelines for Marbled Murrelet habitat conservation in Washington, Oregon and California recommend that each site should be surveyed a minimum of 4 times in each breeding season in a minimum of 2 years to adequately assess the use of a given area or stand by murrelets.

However, the goal of our large scale survey is not to document specific stand use but rather to obtain a general idea of the inland distribution of Marbled Murrelets. The sample design for 1991 will be the following:

1. Each road transect should be surveyed twice between mid-May and mid-July on Vancouver Island, reversing the order of stations in the second survey. In the Queen Charlotte Islands, activity is intense until late July.

2. If no murrelets are detected after two surveys at any station, a third survey should be done.

3. If murrelets are detected at several stations, the most heavily used station should be selected and a fixed station observation should be carried out there instead of a third road survey.

At least three surveys will be conducted, two of which will be road transects, where appropriate.

The third survey will be a fixed station survey if murrelets have been detected, or a road survey if they have not.

If Marbled Murrelets are detected at more than 1/2 the stations surveyed on the first road transect, observers could have the option of skipping the 2nd road survey, if they want to cover more watersheds. The fixed station survey at the road station with the highest activity level must still be done.

In areas where road surveys are impossible (i.e. areas without roads), the fixed station method should be used. Each fixed station should be surveyed at least twice between June and late July.

Completed data sheets should be sent to:

Marbled Murrelet Surveys
Canadian Wildlife Service
P.O. Box 340
Delta, British Columbia
V4K 3Y3

A) Road Transect Surveys

The main objectives of the road transect survey are: a) to determine the geographic distribution of Marbled Murrelets over a wide area of the species' range at inland forested sites, and b) to determine relative murrelet activity levels over a broad area of the species' range (Paton *et al.* 1990).

Survey protocol (adapted from Paton *et al.* 1990 and Anonymous 1991)

1. Locate transect within 75 km of salt water.

2. Begin 60 minutes before official sunrise and continue 60 minutes after official sunrise. If the day is going to be clear, begin 75 minutes before official sunrise.

3. Census 8-10 stations each morning during the 120 minute period.

4. Survey each station for 10 minutes.

5. Stations should be spaced a minimum of 0.5 km apart (0.5 to 1 km) and located near suitable habitat (old forest).

6. If possible, locate stations where the view of the sky is unobstructed in order to maximize visual detections.

7. Reverse the sequence of the stations on subsequent surveys.

8. Fill out survey form clearly.

9. Keep your eyes on the sky to maximize visual detections.

10. Tape recorders are recommended.

11. Locate transects and the stations on detailed map.

12. Roughly characterize habitat near each station:
    a) % of open sky (without obstruction)
    b) type of forest: (i.e. old growth, x years old, clearcut, etc.)
    c) general features: (i.e. near a stream, on a bridge, etc.)

B) Fixed Survey Stations

The main objectives of the fixed survey stations are:

1. Determine murrelet activity levels at a specific site.

2. Detect low density populations of murrelets or confirm the absence of murrelets at a given site.

3. Determine if the birds appear to be using the site or are merely flying over the site to and from other sites.

C) Survey Protocol

1. Locate fixed station in desired habitat where the view of the sky is unobstructed in order to maximize visual detections.

2. Begin 60 minutes before official sunrise and continue 60 minutes after official sunrise. If detections occur after the 120 minute survey, continue until 15 minutes have elapsed since the last detection. Begin the survey 75 minutes before official sunrise if the day is going to be clear.

3. Survey only 1 station per morning.

4. Keep your eyes on the sky to maximize visual detections.

5. Tape recorders are recommended.

6. For evening surveys, start 30 minutes before official sunset and continue until 45 minutes after official sunset.

7. Observers should arrive 5-10 minutes before the official start time.

Instructions for data form: (Paton *et al.* 1990, Rodway *et al.* 1991, Anonymous 1991).

1. **Watershed**: name of watershed where survey is located.

2. **Site**: location of transect or fixed station within the watershed.

3. **Date**: year, month, day.

4. **Observer**: full name.

5. **Transect**: location of transect within the watershed starting and ending point.

6. **Fixed station**: location of the fixed station.

7. **Time start**: time at which the survey started.
   end: time at which the survey ended.

8. **Official sunrise**: from Nautical Almanac obtainable from Atmospheric Environment Canada or newspaper.

9. **% cloud**: % of cloud in the sky at the beginning and end of the survey (approximate).

10. **Precipitation**: N = none, F = fog, D = drizzle, R = rain. To be recorded at the beginning and end of the survey.

11. **Wind**: give direction and speed. Use Beaufort Scale:
    (To be recorded at beginning and end of the survey.)
    0. *Calm:* Movement of the air is less than 1 mile (1.6 km) an hour. Smoke rises vertically; the sea is mirror-smooth.
    1. *Light air:* 1-3 miles (1.6-4.8 km) an hour. The drift of smoke indicates the direction of the breeze.
    2. *Light breeze:* 4-7 miles (6.4-11.3 km) an hour. Leaves begin to rustle.
    3. *Gentle breeze:* 8-12 miles (12.9-19.3 km) an hour. Leaves and twigs in motion; crests on waves begin to break.
    4. *Moderate breeze:* 13-18 miles (20.9-29.0 km) an hour. Small branches move; dust rises; many whitecaps on waves at sea.
    5. *Fresh breeze:* 19-24 miles (30.6-38.6 km) an hour. Small trees in leaf begin to sway.
    6. *Strong breeze:* 25-31 (40.2-49.9 km) an hour. Large branches begin moving.

7. *Moderate gale:* 32-38 miles (51.5-61.1 km) an hour. Whole trees in motion:
8. *Fresh gale:* 39-46 miles (62.8-74.0 km) an hour. Twigs break off.
9. *Strong gale:* 47-54 miles (75.6-86.9 km) an hour. Foam blows in dense streaks across the water at sea.
10. *Whole gale:* 55-63 miles (88.5-101.4 km) an hour. Trees uprooted; huge waves build up with overhanging crests.
11. *Storm:* 64-75 miles (103.0-120.7 km) an hour.
12. *Hurricane:* Wind velocities above 75 miles (120.7 km) an hour.

12. **Station number:** to fill when doing a transect.

13. **Detection number**: a detection is defined as a bird or a group of birds behaving in a similar manner at the same time. Record groups as they are first seen; eg. if a group of birds is initially detected together but then splits into smaller groups, record them as a single detection and note the behaviour of the separated groups; if separate flocks merge, record them as separate detections, noting their behaviour. More than one line can be used for a single detection to record the behaviour of separate groups. Notes made at the bottom of the form should be referenced to the detection number. The detection number is a sequential numbering on the form.

14. **Time**: Record the time birds are first detected. Use Pacific Standard Time as that is the time used on official sunrise tables. Subtract one hour from Daylight Saving Time to get Standard Time.

15. **Direction from**: direction from which the birds are first detected (N, NE, E, SE, S, SW, W, NW)
to: direction of murrelet flights, where they are going (N, NE, E, SE, S, SW, W, NW).

16. **Calls No**: number of calls: Total number of keer calls heard from the bird or groups of birds involved in the detection. For more than 10 calls that become difficult to count, use "M" (multiple) or > number counted (e.g. >26). Record "0" if no keer calls are heard (always fill in this column).
Type:
K = typical 'keer' call
A = 'alternate', 'quack' type of call
S = single isolated 'keer' (emphatic and sometimes cut short)
W = wingbeats
J = jet sound
When more than one type is heard during a detection, use 2 or 3 lines. When the detection is both visual and auditory, add a V in front of the type: VK, VA, etc.

17. **Number of birds seen**: record actual number seen.

18. **Estimated birds**: number of birds estimated at time of first detection. This is difficult to tell with audio detections; 3 birds can sound like 10. Record 3 if you are sure there are at least 3 birds. If you don't know, put a "U" for unknown.

19. **Behaviour**:
D = direct flight
C = circle
L = land
S = call from stationary point (from a bird perched in a tree)
A = aerial dive
U = unknown

20. **Closest distance**: Closest horizontal distance (in meters) from the observer to the bird(s). A bird flying overhead would have a horizontal distance of zero.

21. **Height**: lowest height (in meters) above the ground the bird(s) are observed, or use the following code:
A = >1 tree height above canopy,
B = < 1 tree height above canopy,
C = below canopy,
E = enter canopy,
X = exit canopy,
U = unknown.
If using the codes, give approximate height of trees at the station.

Suggestions:

- Do not be too hasty to begin recording data. Listen and watch until you are certain the detection is completed. This is particularly important with a tape recorder because your voice will drown out the sound and 1 detection could get recorded as 2.

- Predetermine the directions (N, E, W, etc.) with some feature of your station, then you don't have to use the compass for each detection.

- Pace out some trees or other features at set distances so that distance estimates are easier to make. (This is not always possible in road transects - not enough time).

- The most important data to be recorded is the number of detections and the number of birds seen.

- It is important to record if birds seen were calling or silent.

Common problems encountered in data recording.

Whenever a large number of observers are involved in a study such as this, there is the potential for variability in observations. While every effort was made to ensure uniformity of data recording during Marbled Murrelet surveys, a few recurring errors showed up on subsequent review of the data. We list these here to assist in improving future surveys.

1. On road transect surveys, each station visited should be listed and the time that the 10 minute observation period begins, recorded.

2. There was some confusion about the definition of a detection - a detection can be more than one bird (see definition).

3. The number of call notes (keer or alternative) that the bird(s) gives should be counted or if >10, recorded as M for multiple.

4. If the detection is of a silent bird or birds, ensure that this is clear on the form (put 0 in the call column).

5. Although the suggested length of time for a Fixed Station survey is two hours, there must be a minimum of 15 minutes after the last detection is recorded, to ensure that all activity has ceased at the site. In July, activity of Marbled Murrelets increases and the survey can last up to 3 1/2 or 4 hours.

6. The stationary behaviour type is meant to be used where the observer is certain that the calls are coming from a bird perched in a tree. Two or three call notes heard in the distance may sound as if the bird is not flying, but could easily come from birds that are circling, or flying direct, where movement would be hard to discern from a distance. Caution is advised before recording this behaviour type. When uncertain always use 'U' for unknown behaviour.

MARBLED MURRELET DETECTION FORM Page____ of____

Watershed: _____ Year/Month/Day

Site: _____ Date_____ Observer_____

Transect _____ Fixed station_____

Time start_____ End_____ Official sunrise_____

% cloud: begin: _____ Precipitation: begin:_____ Wind: begin:_____

end: _____ end:_____ end:_____

12 Stat #	13 Detect #	14 Time	15 Direction From	15 Direction To	16 Calls #	16 Calls Type	17 # bird seen	18 Total est.# birds	19 Behavior	20 Closest Dist. (m)	21 Height (m)	Comments

Height:
A=>1 tree height above canopy;
B=<1 tree height above canopy;
C=below canopy;
E=enter canopy;
X=exit canopy;
U=unknown.

Behaviour:
D=direct flight;
C=circle;
L=land;
S=call from stationary point;
A=areal dive;
U=unknown.

Precip. **N**=none;
F=fog;
D=drizzle;
R=rain.

Wind: see over.

Call type:
K=typical keer call;
A=alternate quack-type call;
S=single isolated keer (emphatic and sometimes cut short);
W=wingbeats;
J=jet sound;
when more than 1 type is heard in a detection, use 2 or 3 lines; when detection is also visual use **V** in front of type letter (VK,VA,etc.)

12 Stat #	13 Detect #	14 Time	15 Direction		16 Calls		17 # bird seen	18 Total est.# birds	19 Behavior	20 Closest Dist. (m)	21 Height (m)	Comments
			From	To	#	type						

Wind: Beaufort Scale: **0**=Calm (<2 km/h); **1**=Light air (2-5 km/h); **2**=leaves begin to rustle (6-12 km/h); **3**=leaves and twigs in motion, crests on waves begin to break (13-19 km/h); **4**=small branches move, dust rises, many whitecaps on waves (21-29 km/h); **5**=small trees in leave begin to sway (30-39 km/h); **6**=large branches begin moving (40-50 km/h); **7**=whole trees in motion (51-61 km/h).

Comments: ____

____

____

____

____

APPENDIX 3. LOCATION OF MARBLED MURRELET ROAD TRANSECTS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
4.0	SAN JOSEF R. (LOWER)	S.MAIN–END SJM	WFP GY	910628
4.1	SAN JOSEF R. (LOWER)	SJ ,ASHBY MAIN	WFP GY	910705
5.0	RONNING CREEK	RONNING MAIN	WFP GY	910712
6.0	HUSHAMU CK.	HUSHAMU M/L	WFP JB	910614
6.0	HUSHAMU CK.	HUSHAMU M/L	WFP JB	910628
7.0	SIMPSON CREEK	LOWER CREEK	WFP JM	910621
7.0	SIMPSON CREEK	LOWER CREEK	WFP JM	910704
9.0	WAUKWAAS CREEK	251–O'CONNOR LK	WFP KM	910626
9.0	WAUKWAAS CREEK	251–O'CONNOR LK	WFP KM	910708
12.1	INGERSOLL R.	EAST ML	WFP TL	910614
12.1	INGERSOLL R.	EAST ML	WFP TL	910627
12.2	INGERSOLL R.	K MAIN LINE	WFP TL	910612
12.2	INGERSOLL R.	K MAIN LINE	WFP TL	910628
13.1	TEETA CREEK	TEETA VALLEY	WFP MD	910612
13.1	TEETA CREEK	TEETA VALLEY	WFP MD	910628
13.2	TEETA CREEK	UPPER SLOPE	WFP MD	910614
13.2	TEETA CREEK	UPPER SLOPE	WFP MD	910627
14.0	CAYUSE CREEK	CAYUSE M/L	WFP MD,RR	910613
14.0	CAYUSE CREEK	CAYUSE M/L	WFP LM,RR	910628
26.0	TAHSISH R. (UPSTREAM)	AR–63–I60	CANFOR AM	910630
26.0	TAHSISH R. (UPSTREAM)	AR–63–I60	CANFOR AM	910708
28.0	ARTLISH R. (UPPER)	SALLY ROAD	CANFOR AM	910701
28.0	ARTLISH R. (UPPER)	SALLY ROAD	CANFOR JF	910705
29.0	ARTLISH R.–TURBINE CK.	TURBINE CK. ML	CANFOR AM	910628
29.0	ARTLISH R.–TURBINE CK.	TURBINE CK. ML	CANFOR AM	910705
30.0	KAOUK RIVER	UPPER KAOUK M/L	CPF CB	910705
30.0	KAOUK RIVER	UPPER KAOUK M/L	CPF CB	910716
34.0	NOMASH R. (ZEBALLOS R.)	RUGGED CK–NOM.6	CPF CB	910704
34.0	NOMASH R. (ZEBALLOS R.)	RUGGED CK–NOM.6	CPF CB	910715
36.0	KAPOOSE–PORRITT CK	UPPER ENDS	CPF CB	910724
37.0	TARA CK.–TATCHU CK	LOWER ENDS	CPF CB	910709
37.0	TARA CK.–TATCHU CK	LOWER ENDS	CPF CB	910710
38.0	GOLD RIVER(UPPER)	TWADDLE LK(WEST)	CPF RT	910628
38.0	GOLD RIVER(UPPER)	TWADDLE LK(WEST)	CPF RT	910710
39.0	CONUMA RIVER	MID CONUMA ML	CPF RT	910621
39.0	CONUMA RIVER	MID CONUMA ML	CPF RT	910704
41.0	CANTON CREEK	E. CANTON M/L	CPF RT	910627
41.0	CANTON CREEK	E. CANTON M/L	CPF RT	910709
42.0	UPANA RIVER	HEADWATERS	CPF RT	910620
42.0	UPANA RIVER	HEADWATERS	CPF RT	910708
43.0	NESOOK RIVER	LOWER NES.M/L	CPF RT	910619
43.0	NESOOK RIVER	LOWER NES.M/L	CPF RT	910703
48.0	PAMELA CK.(UCONA R.)	TO PARK BOUNDRY	CPF RT	910626
48.0	PAMELA CK.(UCONA R.)	TO PARK BOUNDRY	CPF RT	910705
48.0	PAMELA CK.(UCONA R.)	TO PARK BOUNDRY	CPF RT	910715
49.0	MOOYAH RIVER	REHAB ROAD	FCC MP,SV	910628
49.0	MOOYAH RIVER	REHAB ROAD	FCC MP	910710
57.0	CYPRE RIVER	CYPRE M/L	MACBLO LM	910612
57.0	CYPRE RIVER	CYPRE M/L	MACBLO LM	910627
59.0	TRANQUIL CREEK	LOW TRANQUIL ML	MACBLO JM	910626
59.0	TRANQUIL CREEK	LOW TRANQUIL ML	MACBLO JM	910709
60.0	TOFINO CREEK	TOFINO M/L	MACBLO JM	910618
60.0	TOFINO CREEK	TOFINO M/L	MACBLO JM	910704
64.0	SANDHILL CREEK (INLAND)	HWAY #4	NPARK CB,BC	910620
64.0	SANDHILL CREEK (INLAND)	HWAY #4	NPARK BC,MR	910705

APPENDIX 3. LOCATION OF MARBLED MURRELET ROAD TRANSECTS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
66.1	KENNEDY R.(LOWER)	ABOVE LAKE	MOE KM,A	910620
66.1	KENNEDY R.(LOWER)	ABOVE LAKE	MOE KM,A	910703
66.2	CANOE CK.(KENNEDY R.)	CANOE CREEK	MOE KM,	910719
67.0	KENNEDY R.(MID)	SUTTON PASS	MOE KM,A	910621
67.0	KENNEDY R.(MID)	SUTTON PASS	MOE KM	910704
67.0	KENNEDY R.(MID)	SUTTON PASS	MOE KM,LF	910718
68.0	SPROAT LAKE	SP4	MACBLO RT	910622
68.0	SPROAT LAKE	SP4	MACBLO AB	910714
69.0	NAHMINT R. (UPPER)	SP5	MACBLO AB	910622
70.0	TOQUART-LUCKY CREEK	ACROSS VALLEYS	MFOR JH,F	910618
70.0	TOQUART-LUCKY CREEK	ACROSS VALLEYS	MFOR JH,F	910627
70.0	TOQUART-LUCKY CREEK	ACROSS VALLEYS	MFOR JH,F	910718
71.0	MAGGIE LK(TOQUART BAY)	TOQUART RD	MACBLO GJ	910618
71.0	MAGGIE LK(TOQUART BAY)	TOQUART RD	MACBLO GJ	910707
72.0	SKULL LK(PIPESTEM-EF.HAM)	SKULL LAKE	MFOR SM,JB	910618
72.0	SKULL LK(PIPESTEM-EF.HAM)	SKULL LAKE	MFOR SM,JB	910703
73.0	BROKEN ISLANDS	WATER TRANS	NPARK L,H	910606
73.0	BROKEN ISLANDS	WATER TRANS	NPARK L	910704
73.0	BROKEN ISLANDS	WATER TRANS	NPARK L	910719
74.0	STAMP RIVER	TURTLE LK. RD	MACBLO MR	910624
74.0	STAMP RIVER	TURTLE LK. RD	MACBLO MR	910708
76.0	CHINA CREEK (LOWER)	LOWER CHINA CK	MACBLO BL	910614
76.0	CHINA CREEK (LOWER)	LOWER CHINA CK	MACBLO BL	910628
77.0	SARITA RIVER(UPPER)	LAKE,CENTRAL ML	MACBLO KH.MD	910703
77.0	SARITA RIVER(UPPER)	LAKE,CENTRAL ML	MACBLO KH.MD	910711
78.0	SARITA RIVER (LOWER)	M/L TO BLEINHAM	MACBLO DP,DF	910613
78.0	SARITA RIVER (LOWER)	M/L TO BLEINHAM	MACBLO DP,DF	910628
79.0	PACHENA R. (LOWER)	PACHENA M/L	MACBLO PL,KH	910613
79.0	PACHENA R. (LOWER)	PACHENA M/L	MACBLO MD,KH	910628
80.0	KLANAWA RIVER (LOWER)	NEWSTEAD/DARLING	MACBLO EP,DF	910703
80.0	KLANAWA RIVER (LOWER)	NEWSTEAD/DARLING	MACBLO EP,DF	910711
81.0	KLANAWA R.-EAST(UPPER)	UPPER KLA.M/L	MACBLO DO,CN	910613
81.0	KLANAWA R.-EAST(UPPER)	UPPER KLA.M/L	MACBLO DO,CN	910628
83.0	NITINAT RIVER	GRANITE ONEWAY	MACBLO CN,EG	910703
83.0	NITINAT RIVER	GRANITE ONEWAY	MACBLO CN,EG	910711
86.0	CAYCUSE RIVER	LOWER R.-CAR.ML	FCC DL,SV	910618
86.0	CAYCUSE RIVER	LOWER R.-CAR.ML	FCC SV	910703
87.0	CAYCUSE RIVER	UPPER R.HATT ML	FCC WW,GF	910618
87.0	CAYCUSE RIVER	UPPER R.HATT ML	FCC WW	910703
91.0	GORDON RIVER	GORD. R. ML	FCC SV	910620
91.0	GORDON RIVER	GORD. R. ML	FCC SV	910704
92.0	BRADEN CK.(GORDON R.)	BRADEN CK ML	FCC WW	910620
92.0	BRADEN CK.(GORDON R.)	BRADEN CK ML	FCC WW	910704
93.0	SAN JUAN-RENFREW-HARRIS	FAIRY-LIZARD LK	FCC GF	910620
93.0	SAN JUAN-RENFREW-HARRIS	FAIRY-LIZARD LK	FCC MP	910704
94.0	LOSS CREEK	LOSS CK. ML	WFP MW	910603
94.0	LOSS CREEK	LOSS CK. ML	WFP MW	910608
95.0	SAN JUAN RIVER(UPPER)	Y1400	MACBLO BC	910619
95.0	SAN JUAN RIVER(UPPER)	Y1400	MACBLO BC	910703
96.0	SAN JUAN RIVER (UPPER)	XLINE-X25	MACBLO GS	910619
96.0	SAN JUAN RIVER (UPPER)	XLINE-X25	MACBLO GS	910703
96.0	SAN JUAN RIVER (UPPER)	XLINE-X25	MACBLO GS	910717
97.0	SAN JUAN RIVER(UPPER)	X45.5	MACBLO TN	910619
97.0	SAN JUAN RIVER(UPPER)	X45.5	MACBLO TN	910703
98.0	SAN JUAN RIVER(UPPER)	PETE LAKE X44	MACBLO MW	910619

APPENDIX 3. LOCATION OF MARBLED MURRELET ROAD TRANSECTS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
98.0	SAN JUAN RIVER(UPPER)	PETE LAKE X44	MACBLO MW	910703
99.1	ROBERTSON RIVER	HEAD E.FORK	MACBLO WS	910619
99.1	ROBERTSON RIVER	HEAD E.FORK	MACBLO WS	910703
99.2	ROBERTSON RIVER	R3000-3411	MACBLO WS	910717
101.0	CHEMAINUS R. (UPPER)	BRANCH F	MACBLO TS	910619
101.0	CHEMAINUS R. (UPPER)	BRANCH F	MACBLO TS	910703
102.0	COWICHAN LAKE	NORTH SHORE LK	FCC DL	910704
103.0	JUMP CK.SOUTH (NANAIMO R)	LK-HEAD(L,C LINE)	MACBLO SS	910619
103.0	JUMP CK.SOUTH (NANAIMO R)	LK-HEAD(L,C LINE)	MACBLO SS	910703
104.0	NANAIMO R. JUMP CK.	LANDALT RD.	FCC SV,PK	910621
104.0	NANAIMO R. JUMP CK.	LANDALT RD.	FCC SV,MP	910705
105.0	DUNSMUIR CK (NANAIMO R)	HEAD(D11-D12)	MACBLO JL	910619
105.0	DUNSMUIR CK (NANAIMO R)	HEAD(D11-D12)	MACBLO JL	910703
106.0	NANAIMO R. NANAIMO LAKES	FCC ML	FCC WW,TM	910621
106.0	NANAIMO R. NANAIMO LAKES	FCC ML	FCC WW,BS	910705
107.1	ENGLISHMAN R. (LOWER)	S. ENGLISHMAN R	MACBLO PP	910613
107.1	ENGLISHMAN R. (LOWER)	S. ENGLISHMAN R	MACBLO PP	910626
107.2	ENGLISHMAN R.(UPPER)	143A JNCT	MACBLO JE	910613
107.2	ENGLISHMAN R.(UPPER)	143A JNCT	MACBLO LP	910626
108.0	CAMERON RIVER (UPPER)	UPPER VALLEY	MACBLO DP,TT	910614
108.0	CAMERON RIVER (UPPER)	UPPER VALLEY	MACBLO DP,TT	910628
111.0	OYSTER R.	UPPER-NORM LK	FCC WW	910625
111.0	OYSTER R.	UPPER-NORM LK	FCC WW	910710
112.0	OYSTER R.	LOWER ML	FCC GF	910625
112.0	OYSTER R.	LOWER ML	FCC GF	910710
115.0	WHITE R. (UPPER)	STEWART LAKE	MACBLO MR,SR	910618
115.0	WHITE R. (UPPER)	STEWART LAKE	MACBLO MR,SR	910709
116.0	MEMEKAY R. (EAST)	EAST MAIN	MACBLO KB,SP	910617
116.0	MEMEKAY R. (EAST)	EAST MAIN	MACBLO KB,SP	910705
117.0	SALMON RIVER(UPPER)	SALMON R. M/L	MACBLO SP,KB	910614
117.0	SALMON RIVER(UPPER)	SALMON R. M/L	MACBLO SP,KB	910705
118.0	WHITE R.(LOWER)	A-BRANCH	MACBLO MR,SR	910617
118.0	WHITE R.(LOWER)	A-BRANCH	MACBLO MR,SR	910708
119.0	QUADRA I. VILLAGE BAY ML	VILL. BAY RD.	FCC GF	910626
119.0	QUADRA I. VILLAGE BAY ML	VILL. BAY RD.	FCC GF	910711
120.0	QUADRA I. GRANITE BAY	GRAN.BAY RD.	FCC WW	910626
120.0	QUADRA I. GRANITE BAY	GRAN.BAY RD.	FCC WW	910711
121.0	SEBALHALL CK.(NIMPKISH R)	SEBALHALL RD	CANFOR AM	910626
121.0	SEBALHALL CK.(NIMPKISH R)	SEBALHALL RD	CANFOR AM	910709
122.0	YOOKWA CK.(NIMPKISH R.)	YOOKWA ML	CANFOR AM	910618
122.0	YOOKWA CK.(NIMPKISH R.)	YOOKWA ML	CANFOR AM	910703
123.0	NIMPKISH R. (UPPER)	DUNCAN RD.	CANFOR RW	910628
123.0	NIMPKISH R. (UPPER)	DUNCAN RD.	CANFOR BD	910705
124.0	KAIPIT CK(NIMPKISH R)	KAIPIT ML	CANFOR AM	910625
124.0	KAIPIT CK(NIMPKISH R)	KAIPIT ML	CANFOR JF	910704
125.0	PINDER CK.(NIMPKISH R)	PINDER RD-WOLFE LK	CANFOR KH,BD	910626
125.0	PINDER CK.(NIMPKISH R)	PINDER RD-WOLFE LK	CANFOR BD	910704
126.0	EVE RIVER	TATLOS N.-ML	MACBLO CE	910627
127.0	TSITIKA R.(LOWER)	TS ML(M590-480)	MACBLO GR,KO	910614
127.0	TSITIKA R.(LOWER)	TS ML(M590-480)	MACBLO MMP	910703
127.0	TSITIKA R.(LOWER)	TS ML(M590-480)	MACBLO MMP	910711
128.0	TSITIKA R.(MID-LOW)	TATLOS151-M452	MACBLO MMP	910723
129.0	CLAUDE-ELLIOT (TSITIKA R)	C.E.17-32	CANFOR AM	910617
129.0	CLAUDE-ELLIOT (TSITIKA R)	C.E.17-32	CANFOR AM	910704
130.0	KOKISH R. EAST FORK	EAST KOK. ML	FCC GF	910627

APPENDIX 3. LOCATION OF MARBLED MURRELET ROAD TRANSECTS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
130.0	KOKISH R. EAST FORK	EAST KOK. ML	FCC GF	910712
131.0	BONANZA R.(KOKISH R)	SOUTH ML	FCC WW	910626
131.0	BONANZA R.(KOKISH R)	SOUTH ML	FCC WW	910712
134.0	KILPALA R.(NIMPKISH)	KILPALA ML	CANFOR AM	910627
134.0	KILPALA R.(NIMPKISH)	KILPALA ML	CANFOR AM	910706
137.0	KEOGH RIVER	RUP.200-400	WFP DC	910608
137.0	KEOGH RIVER	RUP.200-400	WFP DC	910728

OBSERVERS

NPARK: CANADIAN PARKS SERVICE
MOE: B.C. MINISTRY OF ENVIRONMENT
MFOR: B.C. MINISTRY OF FORESTS
CPF: CANADIAN PACIFIC FOREST PRODUCTS LTD.
CANFOR: CANADIAN FOREST PRODUCTS LTD.
FCC: FLETCHER CHALLENGE CANADA LTD.
MACBLO: MACMILLAN BLOEDEL LTD.
WFP: WESTERN FOREST PRODUCTS LTD.
For the second set of initials in the observer column see acknowledgements.

Abbreviations, numbers and letters in site column are road names and designations used on the forestry maps of those areas. M/L = Mainline.

APPENDIX 4. CHARACTERISTICS OF THE 1991 MARBLED MURRELET ROAD TRANSECTS.

NO	TR. L. (km)	C	DIST. S.W1. (km)	DIST. S.W2. (km)	DIST. V.S.W. (km)	DIST OCEAN (km)	% UP W.	DIST. OF STAT. TO OLD GROWTH (NO.) IN O.G.	< 500m	> 500m	W.	FORESTED AREA HA	% OLD GROWTH
4.0	2.4	W	2.0		3.2	9.2	15				1	12521	58
4.1	2.4	W	2.0		3.2	9.2	15				1	12521	58
5.0		W	1.6			1.6					2	2552	75
6.0	6.0	W	3.0		5.5	27.0	55				1	1848	70
7.0	3.5	W	4.0		4.0	16.0	44				2	1565	66
9.0	10.0	W	8.0	12.0	8.0	45.0	50				1	14726	39
12.1	9.0	W	4.0		4.0	20.8	25	3	5	2	1	7690	60
12.2	10.0	W	5.5		5.5	20.8	34	2	2	6	1	7690	60
13.1	8.0	W	4.0		4.0	24.5	44	1	5	4	1	2824	80
13.2	5.0	W	3.0		3.0	25.6	33	5	3	2	1	2824	80
14.0	6.5	W	4.5		4.5	25.0	45	6	4	0	1	3075	95
26.0	5.0	W	9.0		11.0	31.0	42	2	6	2	1	26673	79
28.0	4.0	W	9.0		16.0	31.0	89	0	9	1	1	11932	82
29.0	4.0	W	11.0		13.0	32.0	72	1	5	3	1	11932	82
30.0	6.5	W	11.0		11.0	26.0	61	3	3	4	1	11042	55
34.0	5.5	W	9.0		14.0	30.0	43	2	5	2	2	3466	69
36.0	5.0	W	4.0		6.0	4.4		0	7	1	1	4023	50
37.0	6.0	W	3.0		3.0	3.0		1	3	3	1	4952	67
38.0	6.0	W	31.0	46.0	36.0	56.5	40	3	5	1	3	2651	55
39.0	6.5	W	8.0		12.0	34.5	55	2	7	1	1	9831	74
41.0	4.0	W	5.5		6.0	30.0	60	0	9	0	1	2936	80
42.0	4.5	W	12.0		27.0	36.0	100	2	8	0	2	5378	70
43.0	6.5	W	5.0		5.5	26.5	29	2	7	1	2	5766	92
48.0	4.5	W	11.0		15.0	44.0	36	1	5	4	3	3235	69
49.0	5.5	W	3.5		4.5	13.0	45				1	3960	58
57.0	8.0	W	2.5		2.5	12.0	15				1	5442	64
59.0	5.5	W	3.5		4.0	21.0	30	0	6	1	1	5305	75
60.0	5.5	W	2.5		2.5	24.6	25	2	5	1	1	5670	90
64.0	5.5	W	2.0		3.0	2.0	50	7	0	3	1	2118	60
66.1	3.5	W	15.0		25.0	20.0	45				1	45103	67
66.2	3.5	W	15.0		25.0	20.0	45				1	45103	67
67.0	3.5	W	17.0		37.0	30.0	66				1	45103	67
68.0											2	33618	47
69.0											1	18833	80
70.0	8.0	W	3.0		3.0	11.0	19				1	13417	88
71.0	6.0	W	2.0		2.0	2.0	13				1	5100	27
72.0	3.0	W	1.0		2.0	13.0	100	0	8	0	1	3143	60
73.0													
74.0	6.0	W	14.0	19.0	14.0	49.0	22	0	0	8	1	113177	45
76.0	6.0	W	2.5	28.0	3.0	40.0	15	0	0	10	1	11418	27
77.0	5.0	W	8.0		10.0	25.0	50	0	7	3	1	18369	30
78.0	4	W	3.5		3.5	20.5	18	0	3	7	1	18369	30
79.0	4.5	W	2.4		2.4	6.0	20	1	7	2	1	5073	23
80.0	4	W	7.0		7.0	7.0	26	3	6	1	1	23955	66
81.0	5	W	16.0		17.0	16.0	63	6	4	0	1	23955	66
83.0	4.5	W	24.0		29.0	30.0	46	0	4	6	1	76645	32
86.0	6.5	W	24.0		27.0	24.0	26				2	19525	28
87.0	7.0	W	27.0		32.0	27.0	50				2	19525	28
91.0	6.5	W	7.0		7.0	11.4	18				1	30972	21
92.0	8.0	W	8.0		10.0	14.4	45				2	5099	50

APPENDIX 4. CHARACTERISTICS OF THE 1991 MARBLED MURRELET ROAD TRANSECTS.

NO	TR. L. (km)	C	DIST. S.W1. (km)	DIST. S.W2. (km)	DIST. V.S.W. (km)	DIST OCEAN (km)	% UP W.	DIST. OF STAT. TO OLD GROWTH (NO.) IN O.G.	< 500m	> 500m	W.	FORESTED AREA HA	% OLD GROWTH
93.0	10.0	W	9.0		9.0	11.0	20				1	64485	24
94.0	24.0	W	7.5		17.0	7.5	89	1	5	2	1	7531	61
95.0	4.0	W	25.0	30.0	34.0	25.0	30	2	7	0	2	6106	22
96.0	7.0	W	33.0	30.0	46.0	33.0	100	0	6	7	2	6106	22
97.0	4.5	W	32.0	32.0	44.0	32.0	87	0	8	2	2	6106	22
98.0	4.5	W	33.0	30.0	45.0	33.0	93	6	3	1	2	6106	22
99.1	5.0	E	29.0	35.0	55.0	35.0	93	0	8	1	2	10645	7
99.2	5.0	E	29.0	35.0	55.0	35.0	93	3	0	0	2	10645	7
101.0	6.5	E	34.0		45.0	34.0	96	0	0	10	1	35483	5
102.0	11.0	E	36.4		50.0	42.0	70	0	0	9	1	116024	6
103.0	7.5	E	31.0		40.0	31.0	81	0	0	9	2	20998	22
104.0	10.0	E	28.3		35.0	30.7	83				2	20998	22
105.0	9.5	E	28.0		36.0	28.0	76	0	3	5	2	20998	22
106.0	10.5	E	19.0		32.5	24.3	58				1	84724	13
107.1	5.0	E	7.0		11.0	8.0	38	0	0	10	1	30944	12
107.2	5.0	E	8.0		15.0	12.0	52	0	0	10	1	30944	12
108.0	5.0	E	19.0	13.0	29.0	19.0	62	0	2	8	1	24507	19
111.0	10.0	E	26.5		32.0	26.5	78				1	32860	37
112.0	9.0	E	19.0		22.0	19.0	54				1	32860	37
115.0	5.0	E	40.1		41.0	40.1	64	4	6	0	3	4855	80
116.0	7.0	E	30.0		34.0	30.0	56				2	22628	60
117.0	5.5	E	26.0		45.0	28.0	66	7	2	1	1	130970	48
118.0	6.5	E	11.0		12.0	13.0	13	2	0	8	2	32542	72
119.0	8.0	E	1.0			2.0		0	0	9			
120.0	9.0	E	4.0			4.0		0	0	10			
121.0	8.0	E	58.0	17.0	88.0	58.0	44	1	8	1	3	5368	70
122.0	4.5	E	49.0	17.0	77.0	49.0	66	2	8	0	3	3259	64
123.0	9.0	E	38.7	26.0	65.0	38.7	54	2	0	8	2	41338	56
124.0	6.0	E	37.0	23.0	48.0	37.0	77	1	7	1	2	7619	72
125.0	7.5	E	38.0	17.0	43.0	38.0	79	4	5	0	2	12569	56
126.0		E						0	0	10	2	24079	69
127.0	9.0	E	6.0		6.0	7.0	16				1	36260	87
128.0	7.5	E	15.0		18.0	15.0	49	4	6	0	1	36260	87
129.0	4.5	E	19.0		21.0	21.0	41	4	5	0	2	4958	87
130.0	10.0	E	10.0		14.0	10.0	64				1	34700	46
131.0	8.0	E	11.4		11.4	11.7	34				2	14675	54
134.0	8.0	E	19.0		24.0	19.0	56	1	8	1	2	9083	74
137.0	9.0	E	3.0	8.0	5.5	3.0	18				1	12978	26

TR.L.= Transect length in km
C= Coast where the watershed empties
DIST.S.W.1= Straight distance to salt water where watershed empties
DIST.S.W.2= Straight distance to salt water on opposite coast
W.=Primary,secondary or tertiary watershed
DIST.V.S.W.= Distance to salt water along the watershed
DIST.OCEAN= Straight distance to open ocean on coast where watershed empties
%UP W.= Location of transect in the watershed

Dist of Stat. to Old growth (No.) – the number of stations on the transect located at 3 different distances to old growth forest

a) in O.G. – in old growth
b) <500m – less than 500m to old growth forest
c) >500m – greater than 500m to old growth forest

APPENDIX 5. WEATHER PARAMETERS ASSOCIATED WITH EACH ROAD TRANSECT SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
4.0	SAN JOSEF R. (LOWER)	910628	100	100	N	N	1	1
4.1	SAN JOSEF R. (LOWER)	910705	100	100	N	N	1	1
5.0	RONNING CREEK	910712	100	100	R	N	5	1
6.0	HUSHAMU CK.	910614	100	100	F	F	0	0
6.0	HUSHAMU CK.	910628	50	70	F	F	0	0
7.0	SIMPSON CREEK	910621	20	40	N	N	0	1
7.0	SIMPSON CREEK	910704	40	10	N	N	4	2
9.0	WAUKWAAS CREEK	910626	100	100	D	N	0	0
9.0	WAUKWAAS CREEK	910708	100	100	N	N	0	0
12.1	INGERSOLL R.	910614	100	100	N	N	0	0
12.1	INGERSOLL R.	910627	100	100	N	F	0	0
12.2	INGERSOLL R.	910612	100	100	N	R	1	1
12.2	INGERSOLL R.	910628	100	100	N	F	0	0
13.1	TEETA CREEK	910612	100	100	N	D	0	0
13.1	TEETA CREEK	910628	0	0	N	N	0	0
13.2	TEETA CREEK	910614	100	95	F	N	0	0
13.2	TEETA CREEK	910627	100	100	F	N	0	0
14.0	CAYUSE CREEK	910613	100	40	F	N	0	0
14.0	CAYUSE CREEK	910628	0	0	N	N	1	1
26.0	TAHSISH R. (UPSTREAM)	910630	100	100	N	D	0	0
26.0	TAHSISH R. (UPSTREAM)	910708	0	50	N	N	2	2
28.0	ARTLISH R. (UPPER)	910701	100	100	N	D	0	3
28.0	ARTLISH R. (UPPER)	910705	100	50	N	N	3	0
29.0	ARTLISH R.–TURBINE CK.	910628	0	0	N	N	0	0
29.0	ARTLISH R.–TURBINE CK.	910705	95	15	N	N	0	0
30.0	KAOUK RIVER	910705	60	50	N	N	3	1
30.0	KAOUK RIVER	910716	100	100	D	N	1	0
34.0	NOMASH R. (ZEBALLOS R.)	910704	0	0	N	N	1	1
34.0	NOMASH R. (ZEBALLOS R.)	910715	100	100	R	R	3	1
36.0	KAPOOSE–PORRITT CK	910724	70	30	N	N	1	1
37.0	TARA CK.–TATCHU CK	910709	5	5	N	F	1	1
37.0	TARA CK.–TATCHU CK	910710	100	95	D	N	1	1
38.0	GOLD RIVER(UPPER)	910628	0	10	N	N	2	1
38.0	GOLD RIVER(UPPER)	910710	100	100	F	F	0	0
39.0	CONUMA RIVER	910621	100	80	F	F	2	0
39.0	CONUMA RIVER	910704	0	0	N	N	4	2
41.0	CANTON CREEK	910627	100	100	N	N	0	2
41.0	CANTON CREEK	910709	40	20	F	N	1	1
42.0	UPANA RIVER	910620	60	30	N	N	1	0
42.0	UPANA RIVER	910708	0	0	N	F	4	1
43.0	NESOOK RIVER	910619	0	0	N	N	1	0
43.0	NESOOK RIVER	910703	100	80	F	F	2	1
48.0	PAMELA CK.(UCONA R.)	910626	100	100	F	N	0	0
48.0	PAMELA CK.(UCONA R.)	910705	80	60	N	N	0	0
48.0	PAMELA CK.(UCONA R.)	910715	100	100	R	D	0	0
49.0	MOOYAH RIVER	910628	100	50	N	N	0	0
49.0	MOOYAH RIVER	910710	100	100	N	N	0	0
57.0	CYPRE RIVER	910612	100	100	R	D	1	1
57.0	CYPRE RIVER	910627	30	50	N	N	0	0
59.0	TRANQUIL CREEK	910626	100	100	F	N	0	0
59.0	TRANQUIL CREEK	910709	100	100	F	F	0	0
60.0	TOFINO CREEK	910618	0	5	N	N	1	1

APPENDIX 5. WEATHER PARAMETERS ASSOCIATED WITH EACH ROAD TRANSECT SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
60.0	TOFINO CREEK	910704	100	100	N	N	1	1
64.0	SANDHILL CREEK (INLAND)	910620	80	100	D	D	1	1
64.0	SANDHILL CREEK (INLAND)	910705	0	0	N	N	1	1
66.1	KENNEDY R.(LOWER)	910620	100	100	R	N	2	2
66.1	KENNEDY R.(LOWER)	910703	100	100	D	N	0	0
66.2	CANOE CK.(KENNEDY R.)	910719	100	100	N	N	1	1
67.0	KENNEDY R.(MID)	910621	100	100	R	D	1	1
67.0	KENNEDY R.(MID)	910704	0	100	N	F	0	0
67.0	KENNEDY R.(MID)	910718	100	100	N	N	2	0
68.0	SPROAT LAKE	910622	100	100	F	R	0	0
68.0	SPROAT LAKE	910714	100	100	D	D	1	1
69.0	NAHMINT R.(UPPER)	910622	100	100	D	R	0	0
70.0	TOQUART-LUCKY CREEK	910618	0	0	N	N	1	1
70.0	TOQUART-LUCKY CREEK	910627	80	0	N	N	1	1
70.0	TOQUART-LUCKY CREEK	910718	30	70	N	N	1	1
71.0	MAGGIE LK(TOQUART BAY)	910618	0	0	N	N	0	0
71.0	MAGGIE LK(TOQUART BAY)	910707	100	100	N	N	1	1
72.0	SKULL LK(PIPESTEM-EF.HAM)	910618	0	0	N	N	1	1
72.0	SKULL LK(PIPESTEM-EF.HAM)	910703	100	100	F	F	0	1
73.0	BROKEN ISLANDS	910606	0	0	N	N	1	1
73.0	BROKEN ISLANDS	910704	100	100	N	N	2	2
73.0	BROKEN ISLANDS	910719	100	100	N	N	0	0
74.0	STAMP RIVER	910624	90	90	N	N	1	1
74.0	STAMP RIVER	910708	0	0	N	N	0	0
76.0	CHINA CREEK (LOWER)	910614	100	80	F	N	3	1
76.0	CHINA CREEK (LOWER)	910628	0	0	N	N		
77.0	SARITA RIVER(UPPER)	910703	100	100	F	F	1	0
77.0	SARITA RIVER(UPPER)	910711	100	100	D	N	0	0
78.0	SARITA RIVER (LOWER)	910613	20	10	N	N	1	1
78.0	SARITA RIVER (LOWER)	910628	0	0	N	N	0	0
79.0	PACHENA R. (LOWER)	910613	10	5	N	N	1	1
79.0	PACHENA R. (LOWER)	910628	0	100	N	F	0	0
80.0	KLANAWA RIVER (LOWER)	910703	100	100	N	F	0	0
80.0	KLANAWA RIVER (LOWER)	910711	100	100	R	D	0	0
81.0	KLANAWA R.-EAST(UPPER)	910613	90	90	F	F	1	0
81.0	KLANAWA R.-EAST(UPPER)	910628	0	80	N	F	1	1
83.0	NITINAT RIVER	910703	100	100	F	F	0	0
83.0	NITINAT RIVER	910711	100	100	N	N	0	0
86.0	CAYCUSE RIVER	910618	0	0	N	N	0	1
87.0	CAYCUSE RIVER	910618	0	0	N	N	0	0
87.0	CAYCUSE RIVER	910703	0	0	N	N	0	0
91.0	GORDON RIVER	910620	100	100	F	F	0	2
91.0	GORDON RIVER	910704	0	0	F	F	3	1
92.0	BRADEN CK.(GORDON R.)	910620	100	100	N	N	3	0
92.0	BRADEN CK.(GORDON R.)	910704	100	100	F	F	0	0
93.0	SAN JUAN-RENFREW-HARRIS	910620	100	100	F	F	4	4
93.0	SAN JUAN-RENFREW-HARRIS	910704	100	100	D	D	0	0
94.0	LOSS CREEK	910603	80	15	N	N	1	1
94.0	LOSS CREEK	910608	100	100	F	F	0	0
95.0	SAN JUAN RIVER(UPPER)	910619	0	0	N	N	1	1
95.0	SAN JUAN RIVER(UPPER)	910703	0	0	N	N	3	1
96.0	SAN JUAN RIVER (UPPER)	910619	0	0	N	N	0	0

APPENDIX 5. WEATHER PARAMETERS ASSOCIATED WITH EACH ROAD TRANSECT SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
96.0	SAN JUAN RIVER (UPPER)	910703	0	0	N	N	0	0
96.0	SAN JUAN RIVER (UPPER)	910717	100	100	N	N	0	0
97.0	SAN JUAN RIVER(UPPER)	910619	0	0	N	N	0	0
97.0	SAN JUAN RIVER(UPPER)	910703	0	0	N	N	0	0
98.0	SAN JUAN RIVER(UPPER)	910619	0	0	N	N	0	0
98.0	SAN JUAN RIVER(UPPER)	910703	0	0	N	N	0	0
99.1	ROBERTSON RIVER	910619	10	10	N	N	1	1
99.1	ROBERTSON RIVER	910703	10	5	N	N	1	1
99.2	ROBERTSON RIVER	910717	60	90	N	N	0	0
101.0	CHEMAINUS R. (UPPER)	910619	0	0	N	N	0	1
101.0	CHEMAINUS R. (UPPER)	910703	0	0	N	N	0	2
102.0	COWICHAN LAKE	910704	0	100	N	F	0	0
103.0	JUMP CK. SOUTH (NANAIMO R.)	910619	0	0	N	N	1	2
103.0	JUMP CK. SOUTH (NANAIMO R.)	910703	0	0	N	N	1	1
104.0	NANAIMO R. JUMP CK.	910621	100	100	F	F	0	4
104.0	NANAIMO R. JUMP CK.	910705	0	0	N	N	0	1
105.0	DUNSMUIR CK (NANAIMO R)	910619	0	0	N	N	1	0
105.0	DUNSMUIR CK (NANAIMO R)	910703	0	0	N	N	0	0
106.0	NANAIMO R. NANAIMO LAKES	910621	100	100	N	N	0	1
106.0	NANAIMO R. NANAIMO LAKES	910705	0	0	N	N	0	0
107.1	ENGLISHMAN R. (LOWER)	910613	100	100	N	N	0	0
107.1	ENGLISHMAN R. (LOWER)	910626	50	50	N	N	0	0
107.2	ENGLISHMAN R.(UPPER)	910613	2	0	N	N	0	0
107.2	ENGLISHMAN R.(UPPER)	910626	25	0	N	N	0	0
108.0	CAMERON RIVER (UPPER)	910614	85	100	N	N	1	1
108.0	CAMERON RIVER (UPPER)	910628	0	0	N	N	0	2
111.0	OYSTER R.	910625	80	80	N	N	0	0
111.0	OYSTER R.	910710	40	0	N	N	0	0
112.0	OYSTER R.	910625	100	100	N	N	0	1
112.0	OYSTER R.	910710	20	0	N	N	2	3
115.0	WHITE R. (UPPER)	910618	0	5	N	N	0	0
115.0	WHITE R. (UPPER)	910709	45	15	N	N	0	0
116.0	MEMEKAY R. (EAST)	910617	70	100	N	N	1	1
116.0	MEMEKAY R. (EAST)	910705	0	0	N	N	0	1
117.0	SALMON RIVER(UPPER)	910614	100	80	N	N	0	0
117.0	SALMON RIVER(UPPER)	910705	0	0	N	N		
118.0	WHITE R.(LOWER)	910617	15	75	N	N	0	0
118.0	WHITE R.(LOWER)	910708	80	60	N	N	1	1
119.0	QUADRA I. VILLAGE BAY ML	910626	100	100	D	D	1	1
119.0	QUADRA I. VILLAGE BAY ML	910711	100	100	D	R	0	0
120.0	QUADRA I. GRANITE BAY	910626	100	100	D	D	0	0
120.0	QUADRA I. GRANITE BAY	910711	100	100	D	D	0	0
121.0	SEBALHALL CK.(NIMPKISH R)	910626	5	100	N	N	0	0
121.0	SEBALHALL CK.(NIMPKISH R)	910709	30	10	N	N	0	0
122.0	YOOKWA CK.(NIMPKISH R.)	910618	5	5	N	N	0	0
122.0	YOOKWA CK.(NIMPKISH R.)	910703	100	100	N	N	0	0
123.0	NIMPKISH R. (UPPER)	910628	0	0	N	N	0	0
123.0	NIMPKISH R. (UPPER)	910705	90	30	N	N	0	0
124.0	KAIPIT CK(NIMPKISH R)	910625	95	95	N	N	0	0
124.0	KAIPIT CK(NIMPKISH R)	910704	0	0	N	N	0	1
125.0	PINDER CK.(NIMPKISH R)	910626	100	100	N	N	0	0
125.0	PINDER CK.(NIMPKISH R)	910704	0	0	N	N	0	0

APPENDIX 5. WEATHER PARAMETERS ASSOCIATED WITH EACH ROAD TRANSECT SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
126.0	EVE RIVER	910627	100	100	N	N	0	0
127.0	TSITIKA R.(LOWER)	910614	100	100	D	D	1	0
127.0	TSITIKA R.(LOWER)	910703	100	100	F	F	3	1
127.0	TSITIKA R.(LOWER)	910711	100	100	R	R	0	0
128.0	TSITIKA R.(MID-LOW)	910723	0	0	N	N	0	0
129.0	CLAUDE-ELLIOT (TSITIKA R)	910617	100	100	N	N	0	0
129.0	CLAUDE-ELLIOT (TSITIKA R)	910704	0	0	N	N	0	0
130.0	KOKISH R. EAST FORK	910627	100	100	F	F	1	2
130.0	KOKISH R. EAST FORK	910712	100	100	N	N	2	2
131.0	BONANZA R.(KOKISH R)	910626	100	90	N	N	0	0
131.0	BONANZA R.(KOKISH R)	910712	30	20	N	N	0	0
134.0	KILPALA R.(NIMPKISH)	910627	100	100	N	N	0	0
134.0	KILPALA R.(NIMPKISH)	910706	0	50	N	N	0	0
137.0	KEOGH RIVER	910608	100	100	N	N	1	1
137.0	KEOGH RIVER	910728	100	100	R	R	1	1

CLO BEG=% of cloud cover at the beginning of the survey
CLO END=% of cloud at the end of the survey
PREC BEG=Precipitation at the beginning of the survey
PREC END=Precipitation at the end of the survey
WIND BEG=Wind at the beginning
WIND END=Wind at the end of the survey

FOR ABBREVIATIONS AND NUMBER CODE SEE APPENDIX 2 SURVEY SHEET.

APPENDIX 6. COMMENTS ON SOME ROAD TRANSECTS

NUMBER	DATE	COMMENTS
4.00	910628.00	Surveyed for longer than 10 minutes at each station
4.1	910705.00	Different route than 4.0 – surveyed for longer than 10 minutes at each station
5.0	910712.00	Surveyed for longer than 10 minutes at each station
6.0	910628.00	May have been more detections
6.0	910614.00	May have been more detections
7.0	910704.00	Possibly surveyed for 30 minutes at each station
7.0	910621.00	Surveyed for longer than 10 minutes at each station
13.2	910627.00	No detections at distances greater than 150m
14.0	910628.00	Number of keer calls/detection not recorded
26.0	910630.00	Behavior, distance and height of detections unknown
28.0	910701.00	Detections continued for 52 minutes (12 more detections)
29.0	910705.00	One detection at 03:09 before survey began
30.0	910716.00	Stationary behavior now classified as unknown
34.0	910715.00	Stationary behaviour, uncertain
37.0	910709.00	Survey incomplete; vehicle trouble
37.0	910710.00	Some recorded stationary behaviors are not included
38.0	910628.00	Stationary behavior not included – too distant to be certain that it is stationary
38.0	910710.00	11 Stationary behaviors were recorded; but not included in report
39.0	910704.00	2 Stationary behaviors were recorded; but not included in report
41.0	910627.00	4 Stationary behaviors were recorded; but were distant so not included in report
42.0	910620.00	7 Stationary behaviors were recorded; but not included in report
42.0	910708.00	4 Stationary behaviors were recorded; but not included in report
43.0	910703.00	Stationary behaviors are uncertain
57.0	910627.00	Number of keer calls/detection were not recorded
59.0	910709.00	Detection continued for 16 min. more (10 more detections)
68.0	910622.00	Number of keer calls/detections were not recorded
68.0	910714.00	Survey last 3 hours
73.0	910606.00	Survey done from boat
73.0	910719.00	Survey done from boat
73.0	910704.00	Survey done from boat
76.0	910614.00	Uncertain detections
77.0	910703.00	Number of keer calls/detections were not counted
95.0	910703.00	Some data recording problems, may be more detections
99.2	910717.00	Half hour at each station; number of keer calls/detection were not recorded
115.0	910618.00	Number of keer calls may not be accurate
117.0	910705.00	Form completed incorrectly; may be more detections
121.0	910709.00	Stationary behavior may not be reliable
122.0	910618.00	Stationary behavior may not be reliable
122.0	910703.00	Stationary behavior may not be reliable
123.0	910628.00	Stationary behavior may not be reliable
125.0	910626.00	Number of keer calls/detection were not recorded
128.0	910723.00	Only one road survey completed
130.0	910712.00	Since not all detections were visual, all behaviors shouldn't be known
134.0	910706.00	Stationary behavior may be not reliable
134.0	910627.00	Detections continued for 20 minutes past end of survey time; 7 more detections
137.00	910728.00	Survey completed late in season

APPENDIX 7. NUMBER OF MARBLED MURRELET DETECTIONS IN THE 1991 ROAD TRANSECTS.

NO	DATE	NO. STA	STA W.DET	TOT DET	DET/ STA	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	NO.DET. VISUAL	DUR. (MIN)
4.0	910628	5	0	0	0.0	0	0	0	0	0	0	0
4.1	910705	4	1	2	0.5	6	0	0	0	0	0	3
5.0	910712	4	4	42	10.5	666	1	2	0	0	8	117
6.0	910614	9	3	4	0.4	52	0	0	0	0	0	38
6.0	910628	9	3	4	0.4	15	0	5	0	0	0	28
7.0	910621	4	3	21	5.3	78	0	5	0	0	5	78
7.0	910704	4	3	26	6.5	186	10	0	0	1	12	82
9.0	910626	10	0	0	0.0	0	0	0	0	0	0	0
9.0	910708	10	2	4	0.4	19	0	0	0	0	2	48
12.1	910614	10	5	13	1.3	82	0	0	0	0	0	66
12.1	910627	10	7	19	1.9	240	12	0	0	0	0	77
12.2	910612	10	3	4	0.4	20	0	0	0	0	0	52
12.2	910628	10	5	6	0.6	70	0	0	1	0	2	63
13.1	910612	10	8	11	1.1	52	0	0	0	0	0	116
13.1	910628	10	3	3	0.3	11	0	0	0	0	0	60
13.2	910614	10	6	11	1.1	62	3	1	1	0	1	69
13.2	910627	10	8	57	5.7	469	36	2	1	0	1	89
14.0	910613	10	3	6	0.6	15	0	1	0	0	0	24
14.0	910628	10	6	23	2.3		0	0	0	0	4	63
26.0	910630	10	4	5	0.5	59	0	0	0	0	0	64
26.0	910708	10	5	16	1.6	206	0	0	0	0	0	109
28.0	910701	10	6	21	2.1	350	0	0	0	0	1	75
28.0	910705	10	9	31	3.1	141	0	3	0	0	0	95
29.0	910628	9	2	2	0.2	7	0	0	0	0	0	13
29.0	910705	9	4	9	1.0	83	0	0	0	0	1	93
30.0	910705	9	0	0	0.0	0	0	0	0	0	0	0
30.0	910716	9	5	18	2.0	148	12	2	0	0	0	89
34.0	910704	9	3	3	0.3	0	0	2	0	0	2	30
34.0	910715	9	4	7	0.8	61	12	0	0	0	0	90
36.0	910724	8	4	9	1.1	108	12	2	0	0	0	62
37.0	910709	4	1	1	0.3	1	0	0	0	0	0	1
37.0	910710	8	4	8	1.0	35	4	0	0	0	0	80
38.0	910628	9	5	9	1.0	82	2	0	0	0	0	85
38.0	910710	9	4	17	1.9	77	10	0	0	0	2	70
39.0	910621	10	1	1	0.1	0	0	0	0	0	1	1
39.0	910704	10	3	5	0.5	16	0	0	0	0	2	21
41.0	910627	9	3	4	0.4	50	2	0	0	0	0	35
41.0	910709	9	2	2	0.2	14	0	0	0	0	0	18
42.0	910620	10	4	7	0.7	75	0	0	0	0	0	98
42.0	910708	10	4	8	0.8	61	0	0	0	0	0	47
43.0	910619	10	4	4	0.4	33	0	0	0	0	2	41
43.0	910703	10	5	14	1.4	93	15	0	0	0	5	83
48.0	910626	10	0	0	0.0	0	0	0	0	0	0	0
48.0	910705	10	0	0	0.0	0	0	0	0	0	0	0
48.0	910715	10	0	0	0.0	0	0	0	0	0	0	0
49.0	910628	9	0	0	0.0	0	0	0	0	0	0	0
49.0	910710	9	8	23	2.6	273	0	0	0	0	0	98
57.0	910612	10	1	1	0.1	0	0	0	0	1	0	1
57.0	910627	9	3	7	0.8		0	0	0	0	2	43
59.0	910626	7	4	6	0.9	110	0	0	0	0	3	47
59.0	910709	7	6	36	5.1	433	89	0	0	0	7	96
60.0	910618	8	2	3	0.4	52	0	0	0	0	0	13

APPENDIX 7. NUMBER OF MARBLED MURRELET DETECTIONS IN THE 1991 ROAD TRANSECTS.

NO	DATE	NO. STA	STA W.DET	TOT DET	DET/ STA	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	NO.DET. VISUAL	DUR. (MIN)
60.0	910704	9	5	13	1.4	80	8	1	0	0	1	70
64.0	910620	10	6	9	0.9	70	4	1	0	0	0	91
64.0	910705	10	7	15	1.5	57	0	1	0	0	7	97
66.1	910620	10	9	10	1.0	20	0	0	2	0	5	104
66.1	910703	10	7	32	3.2	217	0	0	0	0	15	113
66.2	910719	10	6	11	1.1	51	0	0	0	0	2	69
67.0	910621	10	2	3	0.3	8	0	1	0	0	0	15
67.0	910704	10	5	13	1.3	219	0	0	0	0	0	68
67.0	910718	10	6	8	0.8	173	0	0	0	0	1	79
68.0	910622	10	6	6	0.6		0	0	0	0	2	67
68.0	910714	12	2	3	0.3	9	0	0	0	0	0	48
69.0	910622	10	7	16	1.6	77	1	0	0	0	8	127
70.0	910618	8	1	1	0.1	1	0	0	0	0	0	1
70.0	910627	8	1	1	0.1	3	0	0	0	0	0	1
70.0	910718	8	0	0	0.0	0	0	0	0	0	0	0
71.0	910618	9	1	1	0.1	0	0	0	1	0	1	1
71.0	910707	9	0	0	0.0	0	0	0	0	0	0	0
72.0	910618	8	2	2	0.3	5	0	1	0	0	0	30
72.0	910703	8	7	20	2.5	188	8	0	14	0	4	100
73.0	910606	5	2	2	0.4	1	5	0	0	0	1	30
73.0	910704	5	4	7	1.4	62	0	0	1	0	1	71
73.0	910719	5	3	5	1.0	33	0	0	0	0	1	37
74.0	910624	8	0	0	0.0	0	0	0	0	0	0	0
74.0	910708	8	0	0	0.0	0	0	0	0	0	0	0
76.0	910614	10	1	1	0.1	8	0	0	0	0	0	1
76.0	910628	10	0	0	0.0	0	0	0	0	0	0	0
77.0	910703	10	5	20	2.0			0	0	0	2	50
77.0	910711	10	5	9	0.9	52	0	0	0	0	0	75
78.0	910613	10	0	0	0.0	0	0	0	0	0	0	0
78.0	910628	10	1	2	0.2	18	0	0	0	0	0	2
79.0	910613	10	0	0	0.0	0	0	0	0	0	0	0
79.0	910628	10	1	1	0.1	0	0	0	0	0	1	1
80.0	910703	10	10	64	6.4	445	60	0	0	0	1	121
80.0	910711	10	10	58	5.8	414	3	0	0	0	5	106
81.0	910613	10	7	20	2.0	20	0	0	0	0	15	78
81.0	910628	10	6	16	1.6	104	5	0	0	1	2	64
83.0	910703	10	3	4	0.4	4	0	0	0	0	4	33
83.0	910711	10	0	0	0.0	0	0	0	0	0	0	0
86.0	910618	9	3	8	0.9	14	4	0	0	0	4	25
86.0	910703	10	8	40	4.0	483	23	1	0	0	9	80
87.0	910618	9	9	24	2.7	143	0	0	0	0	0	104
87.0	910703	10	8	20	2.0	310	0	0	0	0	0	94
91.0	910620	9	5	16	1.8	51	0	0	0	0	0	68
91.0	910704	11	8	45	4.1	438	9	0	0	0	10	88
92.0	910620	10	7	33	3.3	481	42	0	0	0	9	84
92.0	910704	10	9	61	6.1	1092	24	0	0	0	9	98
93.0	910620	11	5	9	0.8	59	0	0	0	0	0	110
93.0	910704	9	4	6	0.7	65	0	0	0	0	0	77
94.0	910603	8	2	2	0.3	9	0	0	0	0	0	10
94.0	910608	8	2	2	0.3	3	0	0	0	0	1	16
95.0	910619	9	3	3	0.3	27	0	0	0	0	0	51
95.0	910703	9	5	5	0.6	38	10	0	1	0	2	60

APPENDIX 7. NUMBER OF MARBLED MURRELET DETECTIONS IN THE 1991 ROAD TRANSECTS.

NO	DATE	NO. STA	STA W.DET	TOT DET	DET/ STA	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	NO.DET. VISUAL	DUR. (MIN)
96.0	910619	13	0	0	0.0	0	0	0	0	0	0	0
96.0	910703	13	0	0	0.0	0	0	0	0	0	0	0
96.0	910717	13	1	1	0.1	3	0	0	0	0	0	1
97.0	910619	10	0	0	0.0	0	0	0	0	0	0	0
97.0	910703	10	1	1	0.1	2	0	0	0	0	1	1
98.0	910619	10	0	0	0.0	0	0	0	0	0	0	0
98.0	910703	10	0	0	0.0	0	0	0	0	0	0	0
99.1	910619	9	0	0	0.0	0	0	0	0	0	0	0
99.1	910703	9	0	0	0.0	0	0	0	0	0	0	0
99.2	910717	3	3	7	2.3	54	0	0	0	0	1	65
101.0	910619	10	0	0	0.0	0	0	0	0	0	0	0
101.0	910703	10	0	0	0.0	0	0	0	0	0	0	0
102.0	910704	9	2	6	0.7	44	0	0	0	0	1	24
103.0	910619	10	0	0	0.0	0	0	0	0	0	0	0
103.0	910703	10	0	0	0.0	0	0	0	0	0	0	0
104.0	910621	10	2	2	0.2	16	0	0	0	0	0	40
104.0	910705	12	0	0	0.0	0	0	0	0	0	0	0
105.0	910619	8	0	0	0.0	0	0	0	0	0	0	0
105.0	910703	8	0	0	0.0	0	0	0	0	0	0	0
106.0	910621	10	4	8	0.8	76	0	0	0	0	0	111
106.0	910705	10	2	3	0.3	6	0	0	0	0	2	40
107.1	910613	11	0	0	0.0	0	0	0	0	0	0	0
107.1	910626	11	0	0	0.0	0	0	0	0	0	0	0
107.2	910613	10	0	0	0.0	0	0	0	0	0	0	0
107.2	910626	10	0	0	0.0	0	0	0	0	0	0	0
108.0	910614	10	0	0	0.0	0	0	0	0	0	0	0
108.0	910628	10	0	0	0.0	0	0	0	0	0	0	0
111.0	910625	10	4	4	0.4	36	0	0	0	0	0	77
111.0	910710	10	6	12	1.2	168	0	0	0	0	1	97
112.0	910625	9	2	3	0.3	21	0	0	0	0	0	52
112.0	910710	9	5	21	2.3	332	60	0	0	0	2	58
115.0	910618	10	5	7	0.7	9	0	0	0	0	2	99
115.0	910709	10	0	0	0.0	0	0	0	0	0	0	0
116.0	910617	10	1	1	0.1	25	0	0	0	0	0	1
116.0	910705	10	4	4	0.4	12	18	0	0	0	0	46
117.0	910614	10	1	1	0.1	0	0	0	0	0	1	1
117.0	910705	12	4	4	0.3	4	7	0	0	0	1	49
118.0	910617	10	2	4	0.4	0	0	0	0	0	4	73
118.0	910708	10	5	13	1.3	21	0	0	0	0	7	54
119.0	910626	9	0	0	0.0	0	0	0	0	0	0	0
119.0	910711	8	1	1	0.1	3	0	0	0	0	0	1
120.0	910626	10	2	3	0.3	30	0	0	0	0	0	39
120.0	910711	10	1	1	0.1	8	0	0	0	0	0	1
121.0	910626	10	5	6	0.6	106	0	0	0	0	0	54
121.0	910709	10	5	26	2.6	366	12	0	0	0	4	67
122.0	910618	10	6	29	2.9	423	12	0	0	0	0	74
122.0	910703	10	9	47	4.7	805	36	0	0	0	4	108
123.0	910628	10	4	6	0.6	18	0	0	0	0	2	92
123.0	910705	10	1	2	0.2	12	0	0	0	0	0	5
124.0	910625	10	5	17	1.7	264	0	0	0	0	0	57
124.0	910704	9	5	11	1.2	37	0	0	0	0	1	47

APPENDIX 7. NUMBER OF MARBLED MURRELET DETECTIONS IN THE 1991 ROAD TRANSECTS.

NO	DATE	NO. STA	STA W.DET	TOT DET	DET/ STA	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	NO.DET. VISUAL	DUR. (MIN)
125.0	910626	9	4	21	2.3				0	0	7	40
125.0	910704	9	3	9	1.0	29	0	0	0	0	3	30
126.0	910627	10	1	1	0.1	3	0	0	0	0	0	1
127.0	910614	10	10	43	4.3	160	0	25	0	0	0	121
127.0	910703	10	8	45	4.5	288	6	0	0	0	1	114
127.0	910711	10	9	32	3.2	320	0	24	0	0	1	140
128.0	910723	10	4	12	1.2	218	2	0	0	0	0	35
129.0	910617	9	0	0	0.0	0	0	0	0	0	0	0
129.0	910704	10	4	7	0.7	57	12	0	0	0	1	44
130.0	910627	11	7	27	2.5	406	0	0	0	0	3	86
130.0	910712	10	7	34	3.4	212	0	0	0	0	5	71
131.0	910626	10	4	6	0.6	54	0	0	0	0	0	69
131.0	910712	10	1	3	0.3	62	0	0	0	0	0	3
134.0	910627	10	6	22	2.2	404	0	0	0	0	3	80
134.0	910706	10	6	20	2.0	237	0	2	0	0	1	80
137.0	910608	9	0	0	0.0	0	0	0	0	0	0	0
137.0	910728	9	0	0	0.0	0	0	0	0	0	0	0

NO=location number on Fig 1
NO STA=Number of stations on the road transect
STA W. DET=Number of stations with murrelet detections
TOT DET=Total number of detections
DET/STA=Number of detections per station
TOT KEER=Total number of keer calls
TOT ALT=Total number of alternate calls
TOT S=Single isolated call
TOT WING=Number of wing beats heard
TOT JET=Number of jet sounds heard
NO.DET VISUAL=Number of visual detections
DUR.(MIN)=Length of time between first and last detection

APPENDIX 8. BEHAVIORS OF MARBLED MURRELETS DETECTED DURING 1991 ROAD TRANSECTS

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS					HEIGHTS			CLOSEST DISTANCE (m)			
				D	C	S	A	L	A	B	C	0–50	51–150	151–500	>501
4.0	910628	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.1	910705	2	0	0	0	0	0	0	0	0	0	0	0	2	0
5.0	910712	42	8	28	6	0	0	0	38	3	1	19	20	3	0
6.0	910614	4	0	2	1	1	0	0	3	0	0	0	0	3	0
6.0	910628	4	0	0	0	0	0	0	0	0	0	0	0	4	0
7.0	910621	21	5	2	7	0	0	0	12	0	1	0	5	0	0
7.0	910704	26	12	8	10	0	0	0	16	0	0	3	9	14	0
9.0	910626	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0	910708	4	2	2	2	0	0	0	2	2	0	1	1	2	0
12.1	910614	13	0	0	0	0	0	0	5	7	1	0	11	2	0
12.1	910627	19	0	10	0	0	0	0	5	11	1	0	18	1	0
12.2	910612	4	0	0	0	0	0	0	1	3	0	0	4	0	0
12.2	910628	6	2	5	0	0	0	0	2	2	1	2	2	2	0
13.1	910612	11	0	3	0	0	0	0	1	7	3	1	10	0	0
13.1	910628	3	0	0	0	0	0	0	0	0	0	0	3	0	0
13.2	910614	11	1	2	2	0	0	0	1	0	1	1	10	0	0
13.2	910627	57	1	4	11	0	0	0	6	1	3	32	24	0	0
14.0	910613	6	0	6	0	0	0	0	4	2	0	0	6	0	0
14.0	910628	23	4	11	7	2	0	0	12	8	2	0	14	9	0
26.0	910630	5	0	1	0	0	0	0	0	0	0	0	0	0	0
26.0	910708	16	0	0	2	0	0	0	0	0	0	0	0	0	0
28.0	910701	21	1	7	9	0	0	0	0	1	0	1	0	0	0
28.0	910705	31	0	6	17	0	0	0	30	0	0	0	11	8	0
29.0	910628	2	0	0	0	0	0	0	0	0	0	0	0	0	0
29.0	910705	9	1	3	4	0	0	0	0	0	0	0	0	0	0
30.0	910705	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30.0	910716	18	0	4	0	0	0	0	6	1	0	2	2	14	0
34.0	910704	3	2	1	1	0	0	0	0	2	0	0	1	2	0
34.0	910715	7	0	0	2	3	0	0	2	0	0	0	1	6	0
36.0	910724	9	0	2	1	0	0	0	2	0	0	0	1	8	0
37.0	910709	1	0	0	0	0	0	0	0	0	0	0	0	1	0
37.0	910710	8	0	0	0	0	0	0	1	5	0	0	2	6	0
38.0	910628	9	0	0	3	0	0	0	0	0	0	0	3	6	0
38.0	910710	17	2	0	5	0	0	0	0	1	3	2	9	6	0
39.0	910621	1	1	1	0	0	0	0	1	0	0	1	0	0	0
39.0	910704	5	2	0	3	0	0	0	0	2	2	2	3	0	0
41.0	910627	4	0	0	0	0	0	0	0	0	0	0	0	4	0
41.0	910709	2	0	0	1	0	0	0	0	0	0	0	0	2	0
42.0	910620	7	0	0	0	0	0	0	0	0	0	0	2	5	0
42.0	910708	8	0	3	0	0	0	0	0	1	2	2	3	3	0
43.0	910619	4	2	1	0	0	1	0	0	0	2	1	1	2	0
43.0	910703	14	5	2	6	6	0	0	6	1	0	7	1	6	0
48.0	910626	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48.0	910705	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48.0	910715	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.0	910628	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49.0	910710	23	0	9	2	0	0	0	15	8	0	1	1	11	1
57.0	910612	1	0	0	0	0	1	0	0	0	0	1	0	0	0

APPENDIX 8. BEHAVIORS OF MARBLED MURRELETS DETECTED DURING 1991 ROAD TRANSECTS

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS					HEIGHTS			CLOSEST DISTANCE (m)			
				D	C	S	A	L	A	B	C	0–50	51–150	151–500	>501
57.0	910627	7	2	2	0	0	0	0	0	0	0	0	0	0	0
59.0	910626	6	3	1	2	0	0	0	2	1	0	0	2	1	0
59.0	910709	36	7	13	7	0	0	0	12	4	2	1	5	1	0
60.0	910618	3	0	0	0	0	0	0	0	0	0	0	0	0	0
60.0	910704	13	1	3	2	0	0	0	2	1	3	0	1	4	0
64.0	910620	9	0	1	0	0	0	0	0	0	0	0	0	0	0
64.0	910705	15	7	7	0	0	0	0	4	6	0	6	5	4	0
66.1	910620	10	5	1	4	0	0	0	3	1	1	5	0	0	0
66.1	910703	32	15	12	4	0	0	0	4	26	0	0	27	2	0
66.2	910719	11	2	2	0	0	0	0	11	0	0	1	0	0	9
67.0	910621	3	0	0	0	0	0	0	3	0	0	0	3	0	0
67.0	910704	13	0	0	0	0	0	0	3	0	0	0	0	3	0
67.0	910718	8	1	4	1	0	0	0	8	0	0	0	3	2	3
68.0	910622	6	2	6	0	0	0	0	6	0	0	0	2	0	0
68.0	910714	3	0	3	0	0	0	0	1	0	0	0	0	0	0
69.0	910622	16	8	10	5	0	0	0	2	6	1	9	4	3	0
70.0	910618	1	0	0	0	0	0	0	0	0	0	0	0	0	0
70.0	910627	1	0	0	0	0	0	0	0	0	0	0	0	0	0
70.0	910718	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71.0	910618	1	1	1	0	0	0	0	1	0	0	0	1	0	0
71.0	910707	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72.0	910618	2	0	0	0	0	0	0	0	1	0	1	0	1	0
72.0	910703	20	4	16	2	1	0	0	0	13	7	15	4	1	0
73.0	910606	2	1	0	1	0	0	0	0	0	1	1	0	0	0
73.0	910704	7	1	1	1	0	0	0	0	1	0	2	0	0	0
73.0	910719	5	1	1	0	0	0	0	0	0	1	1	0	0	0
74.0	910624	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74.0	910708	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76.0	910614	1	0	1	0	0	0	0	0	1	0	0	1	0	0
76.0	910628	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77.0	910703	20	2	2	1	0	0	0	15	0	0	0	4	11	0
77.0	910711	9	0	0	0	0	0	0	0	0	0	0	0	0	0
78.0	910613	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78.0	910628	2	0	0	0	0	0	0	0	2	0	0	0	2	0
79.0	910613	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79.0	910628	1	1	1	0	0	0	0	0	1	0	1	0	0	0
80.0	910703	64	1	45	2	0	0	0	5	56	3	16	14	34	0
80.0	910711	58	5	1	0	0	0	0	53	5	0	1	10	47	0
81.0	910613	20	15	5	11	0	0	0	0	3	12	11	1	8	0
81.0	910628	16	2	1	1	0	1	0	0	3	13	1	0	15	0
83.0	910703	4	4	3	1	0	0	0	0	4	0	2	1	0	0
83.0	910711	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86.0	910618	8	4	3	1	0	0	0	1	2	0	0	2	6	0
86.0	910703	40	9	22	14	0	0	0	10	27	1	9	15	15	0
87.0	910618	24	0	1	1	0	0	0	19	4	0	0	0	23	0
87.0	910703	20	0	6	9	0	0	0	18	2	0	1	5	14	0
91.0	910620	16	0	10	0	0	0	0	2	0	0	0	2	13	0
91.0	910704	45	10	16	16	0	0	0	14	21	2	1	20	24	0

APPENDIX 8. BEHAVIORS OF MARBLED MURRELETS DETECTED DURING 1991 ROAD TRANSECTS

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS					HEIGHTS			CLOSEST DISTANCE (m)			
				D	C	S	A	L	A	B	C	0–50	51–150	151–500	>501
92.0	910620	33	9	10	7	0	0	0	29	4	0	11	13	9	0
92.0	910704	61	9	18	35	0	0	0	54	6	0	10	22	29	0
93.0	910620	9	0	4	2	0	0	0	1	8	0	0	3	6	0
93.0	910704	6	0	0	0	0	0	0	4	2	0	0	2	4	0
94.0	910603	2	0	0	0	0	0	0	0	0	0	0	0	2	0
94.0	910608	2	1	1	0	0	0	0	1	0	1	1	0	1	0
95.0	910619	3	0	0	0	0	0	0	3	0	0	0	2	1	0
95.0	910703	5	2	0	4	0	0	0	4	1	0	0	2	3	0
96.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96.0	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96.0	910717	1	0	1	0	0	0	0	1	0	0	0	0	1	0
97.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97.0	910703	1	1	0	1	0	0	0	0	0	1	0	1	0	0
98.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98.0	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99.1	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99.1	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99.2	910717	7	1	0	1	0	0	0	1	0	0	0	1	0	0
101.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
101.0	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102.0	910704	6	1	1	2	0	0	0	4	2	0	0	1	5	0
103.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
103.0	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
104.0	910621	2	0	0	0	0	0	0	0	0	0	0	0	2	0
104.0	910705	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
105.0	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
106.0	910621	8	0	1	0	0	0	0	8	0	0	0	0	8	0
106.0	910705	3	2	0	2	0	0	0	3	0	0	0	0	3	0
107.1	910613	0	0	0	0	0	0	0	0	0	0	0	0	0	0
107.1	910626	0	0	0	0	0	0	0	0	0	0	0	0	0	0
107.2	910613	0	0	0	0	0	0	0	0	0	0	0	0	0	0
107.2	910626	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108.0	910614	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108.0	910628	0	0	0	0	0	0	0	0	0	0	0	0	0	0
111.0	910625	4	0	0	0	0	0	0	4	0	0	0	0	4	0
111.0	910710	12	1	6	3	0	0	0	12	0	0	0	3	9	0
112.0	910625	3	0	1	1	0	0	0	3	0	0	0	2	1	0
112.0	910710	21	2	4	15	0	0	0	21	0	0	0	1	17	3
115.0	910618	7	2	1	1	0	0	0	0	2	0	0	2	5	0
115.0	910709	0	0	0	0	0	0	0	0	0	0	0	0	0	0
116.0	910617	1	0	1	0	0	0	0	0	0	0	0	0	0	0
116.0	910705	4	0	1	0	1	0	0	0	0	1	1	0	0	0
117.0	910614	1	1	1	0	0	0	0	1	0	0	1	0	0	0
117.0	910705	4	1	0	1	0	0	0	0	1	0	0	1	0	0
118.0	910617	4	4	3	1	0	0	0	2	2	0	1	1	2	0
118.0	910708	13	7	6	1	0	0	0	6	1	0	1	4	2	0
119.0	910626	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 8. BEHAVIORS OF MARBLED MURRELETS DETECTED DURING 1991 ROAD TRANSECTS

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS D	C	S	A	L	HEIGHTS A	B	C	CLOSEST DISTANCE (m) 0–50	51–150	151–500	>501
119.0	910711	1	0	0	0	0	0	0	0	1	0	0	0	1	0
120.0	910626	3	0	2	0	0	0	0	3	0	0	0	0	3	0
120.0	910711	1	0	0	0	0	0	0	1	0	0	0	0	1	0
121.0	910626	6	0	0	0	0	0	0	0	0	0	0	0	0	0
121.0	910709	26	4	6	16	1	0	0	2	2	1	0	3	1	0
122.0	910618	29	0	3	1	7	0	0	0	0	0	0	0	0	0
122.0	910703	47	4	5	26	5	0	0	0	1	3	0	3	0	0
123.0	910628	6	2	1	1	3	0	0	1	1	0	0	1	1	0
123.0	910705	2	0	0	0	0	0	0	2	0	0	0	0	2	0
124.0	910625	17	0	1	0	0	0	0	0	0	0	0	0	0	0
124.0	910704	11	1	5	4	0	0	0	10	0	0	1	3	7	0
125.0	910626	21	7	15	5	0	0	0	6	0	1	7	0	0	0
125.0	910704	9	3	1	3	0	0	0	7	2	0	3	1	5	0
126.0	910627	1	0	0	0	0	0	0	0	1	0	0	0	0	1
127.0	910614	43	0	19	5	0	0	0	5	36	1	10	30	3	0
127.0	910703	45	1	34	3	3	0	0	43	2	0	1	2	23	19
127.0	910711	32	1	29	1	0	0	0	32	0	0	4	0	17	11
128.0	910723	12	0	6	0	2	0	0	12	0	0	0	0	3	9
129.0	910617	0	0	0	0	0	0	0	0	0	0	0	0	0	0
129.0	910704	7	1	0	3	0	0	0	0	0	1	0	1	0	0
130.0	910627	27	3	6	19	1	0	0	8	15	1	2	3	20	0
130.0	910712	34	5	11	20	2	0	0	18	8	8	6	3	24	1
131.0	910626	6	0	0	1	0	0	0	6	0	0	0	1	5	0
131.0	910712	3	0	0	1	0	0	0	3	0	0	0	1	2	0
134.0	910627	22	3	2	1	0	0	0	1	1	0	1	1	0	0
134.0	910706	20	1	7	2	9	0	0	0	0	10	0	1	0	0
137.0	910608	0	0	0	0	0	0	0	0	0	0	0	0	0	0
137.0	910728	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NO = Number of the road transect
TOT DET = Total number of detections
TOT SEEN = Total number of visual detections
BEHAVIORS: D = Direct flight
C = Circling bird(s)
S = Call stationary
A = Aerial dive
L = Bird landing

HEIGHTS: A = >1 tree height above canopy
B = <1 tree height above canopy
C = Below canopy
CLOSEST DISTANCE = Distance (horizontal) of the detection from the observer

APPENDIX 9. LOCATION OF MARBLED MURRELET FIXED STATIONS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
1.0	CAPE SCOTT	NEL'S BIGHT	CWS SH	910623
2.0	FISHERMAN RIVER	MOUTH-HANSON LAG	BCPARK SB,LS	910629
2.0	FISHERMAN RIVER	MOUTH-HANSON LAG	BCPARK SB,GC	910722
3.0	SAN JOSEF RIVER	SAN JO.BAY CAMP	CWS SH	910621
3.0	SAN JOSEF RIVER	SAN JO.BAY CAMP	CWS SH	910622
4.1	SAN JOSEF RIVER	SANJ. NR MOUTH	WFP GY	910728
6.0	HUSHAMU CREEK	HUSHAMU M/L#5	WFP JB	910726
7.0	SIMPSON R.	SIMPSON #1	WFP JM	910719
8.0	WAUKWAAS CREEK	MOUTH RUPERT IN.	CWS KJ	910508
8.0	WAUKWAAS CREEK	MOUTH RUPERT IN.	CWS MJFL	910618
8.0	WAUKWAAS CREEK	MOUTH RUPERT IN.	CWS MJFL	910718
9.0	WAUKWAAS CREEK	WAUKWAAS #7	WFP KM,KMCG	910723
10.0	MARBLE RIVER	OUTLET ALICE L	CWS CRM	910508
10.0	MARBLE RIVER	OUTLET ALICE L	CWS CRM	910618
10.0	MARBLE RIVER	OUTLET ALICE L	CWS CRM	910718
11.0	ALICE LAKE	W. OF MARBLE R	CWS MJFL	910508
12.1	INGERSOLL R	EAST M/L#7	WFP TL	910711
12.2	INGERSOLL R.	K MAIN #5	WFP TL	910712
13.1	TEETA CREEK	TEETA VALLEY #3	WFP MD	910715
13.2	TEETA CREEK	TEETA UPSLOPE#4	WFP MD	910711
14.0	CAYUSE CK	CAYUSE #7	WFP RR,LM	910712
15.0	CAYUSE CREEK	NEAR MOUTH	CWS CRM	910509
15.0	CAYUSE CREEK	NEAR MOUTH	CWS MJFL	910524
15.0	CAYUSE CREEK	NEAR MOUTH	CWS CRM	910714
16.0	CAYEGHLE R.(NR COLONIAL)	NEAR MOUTH	CWS KJ	910509
17.0	CAYEGHLE RIVER(SW FORK)	MID VALLEY	CWS MJFL	910509
17.0	CAYEGHLE RIVER(SW FORK)	MID VALLEY	CWS MJFL	910714
18.1	KLASKINO ANCHOR.(I.R. RIV)	ESTUARY	CWS MJFL	910623
18.1	KLASKINO ANCHOR.(I.R. RIV)	ESTUARY	CWS MJFL	910715
18.2	KLASKINO ANCHOR(W. DRAIN)	ISLET(BEACH)	CWS CRM	910623
18.2	KLASKINO ANCHOR(W. DRAIN)	ISLET(BEACH)	CWS CRM	910715
19.1	KLASKISH RIVER(MAIN)	UPSTREAM OF EST	CWS MJFL	910621
19.1	KLASKISH RIVER(MAIN)	UPSTREAM OF EST	CWS MJFL	910717
19.2	KLASKISH RIVER(MAIN)	ESTUARY MOUTH	CWS CRM	910621
19.2	KLASKISH RIVER(MAIN)	ESTUARY MOUTH	CWS CRM	910717
20.1	SOUTH KLASKISH(EAST CK)	TOP END ESTUARY	CWS MJFL	910622
20.1	SOUTH KLASKISH(EAST CK)	TOP END ESTUARY	CWS MJFL	910716
20.2	SOUTH KLASKISH(EAST CK)	MOUTH OF RIVER	CWS CRM	910622
20.2	SOUTH KLASKISH(EAST CK)	MOUTH OF RIVER	CWS CRM	910716
21.0	AMOS CREEK	ESTUARY	BCPARK RS,RQ	910625
22.1	NASPARTI RIVER	ESTUARY NORTH	CWS MJFL	910629
22.1	NASPARTI RIVER	ESTUARY NORTH	CWS MJFL	910725
22.2	NASPARTI RIVER	ESTUARY SOUTH	CWS CRM	910629
22.2	NASPARTI RIVER	ESTUARY SOUTH	CWS CRM	910725
23.0	BATTLE RIVER	150M UP RIVER	CWS MJFL	910628
24.0	BATTLE BAY	NE OF RIVER	CWS CRM	910628
25.1	POWER RIVER	UP RIVER	CWS CRM	910724
25.2	POWER RIVER	ESTUARY NR IR	CWS MJFL	910724
26.0	TAHSISH R.	UPSTREAM #2	CANFOR AM	910712
27.1	TAHSISH RIVER	MOUTH WEST SIDE	CWS CRM	910515
27.1	TAHSISH RIVER	MOUTH WEST SIDE	CWS CRM	910702
27.2	TAHSISH RIVER	ISLAND S.END	CWS KJ	910515
27.2	TAHSISH RIVER	ISLAND S. END	CWS MJFL	910702
27.3	TAHSISH RIVER	ISLAND N.END	CWS MJFL	910515
28.0	ARTLISH R.(UPPER)	SALLY RD #10	CANFOR BD	910712
29.0	ARTLISH R.-TURBINE CK	TURBINE CK #7	CANFOR HB	910711
30.0	KAOUK R.	KAOUK M/L #7	CPF CB	910719

APPENDIX 9. LOCATION OF MARBLED MURRELET FIXED STATIONS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
31.0	ZEBALLOS RIVER	HEAD	CWS MJFL	910514
32.0	ZEBALLOS RIVER	MID-UPPER	CWS KJ	910514
33.0	ZEBALLOS RIVER	MOUTH(BRIDGE)	CWS CRM	910514
34.0	NOMASH R.(ZEBALLOS R.)	NOMASH R #8	CPF CB	910718
35.1	"RUGGED POINT"	NEAR CABIN	CWS MJFL	910517
35.2	"RUGGED POINT"	S. SIDE BEACH	CWS KJ	910517
35.3	"RUGGED POINT"	ROBIN PT LOG	CWS CRM	910517
35.3	"RUGGED POINT"	ROBIN PT LOG	CWS CRM	910518
35.3	"RUGGED POINT"	ROBIN PT LOG	CWS CRM	910630
35.4	"RUGGED POINT"	ROBIN P.OPENING	CWS MJFL	910518
35.5	"RUGGED POINT"	ROBIN PT. TREE	CWS KJ	910518
35.5	"RUGGED POINT"	ROBIN PT. TREE	CWS KJ	910519
35.5	"RUGGED POINT"	ROBIN PT. TREE	CWS MJFL	910630
35.6	"RUGGED POINT"	ROBIN PT. HILL	CWS MJFL	910519
35.7	"RUGGED POINT"	ROBIN P.HILL S	CWS CRM	910519
36.0	KAPOOSE CK PORRITT CK	KAPOOSE CK #4	CPF CB	910725
37.0	TARA CK - TATCHU CK	TARA CK-MOUTH#4	CPF CB	910726
38.0	GOLD RIVER (UPPER)	TWADDLE LK #5	CPF RT	910717
39.0	CONUMA R.	CONUMA M/L#5	CPF RT	910712
40.0	CONUMA RIVER	NR WINT.DEER	CWS MJFL	910711
41.0	CANTON CK	E.CANTON M/L#4	CPF RT	910718
42.0	UPANA R.	NEAR UPANA LK#5	CPF RT	910716
43.0	NESOOK R.	NESOOK M/L#3	CPF RT	910711
44.0	NESOOK RIVER	ABOVE CANYON	CWS MJFL	910614
44.0	NESOOK RIVER	ABOVE CANYON	CWS MJFL	910710
45.0	COUGAR CREEK	FLATS 300M UP	CWS CRM	910616
45.0	COUGAR CREEK	FLATS 300M UP	CWS CRM	910710
46.1	DEADMAN CREEK(SITE#1)	ABOVE CAMPSITE	CWS ML,CM,KJ	910504
46.2	DEADMAN CREEK(SITE#2)	PULLOUT BY CK	CWS MJFL	910505
46.2	DEADMAN CREEK(SITE#2)	PULLOUT BY CK	CWS CRM	910614
46.2	DEADMAN CREEK(SITE#2)	PULLOUT BY CK	CWS MJFL	910615
46.2	DEADMAN CREEK(SITE#2)	PULLOUT BY CK	CWS CRM	910711
46.3	DEADMAN(NR COUGAR CK)	AT CAMPSITE	CWS MJFL	910616
47.0	HANNA CREEK	EAST SIDE	CWS CRM	910615
49.0	MOOYAH RIVER	REHAB RD #4	FCC MP	910724
50.0	ESCALANTE R.	35K CK CROSS	FCC SV	910626
50.0	ESCALANTE R.	35K CK CROSS	FCC SV	910710
50.0	ESCALANTE R.	35K CK CROSS	FCC SV	910724
51.0	HESQUIAT LAKE	OUTLET	FCC DJL	910625
51.0	HESQUIAT LAKE	OUTLET	FCC MP	910709
51.0	HESQUIAT LAKE	OUTLET	FCC MP	910723
52.0	HESQUIAT PT. CK.	BRIDGE NR MOUTH	FCC MP,SV	910625
52.0	HESQUIAT PT. CK.	BRIDGE NR MOUTH	FCC SV	910709
52.0	HESQUIAT PT. CK.	BRIDGE NR MOUTH	FCC SV	910723
53.0	MEGIN RIVER	MEGIN ESTUARY	BCPARK DF,LB	910620
53.0	MEGIN RIVER	MEGIN ESTUARY	BCPARK DF,EA	910725
53.1	MEGIN RIVER(UPPER)	BELOW MEGIN LAKE	MOE T.C.	910714
53.2	MEGIN RIVER(UPPER)	MEGIN LK(E END)	MOE T.C.	910713
54.0	MOYEHA RIVER	ESTUARY ISLAND	BCPARK DF,LB	910619
54.0	MOYEHA RIVER	ESTUARY ISLAND	BCPARK JM	910725
55.0	BEDWELL R.-URSUS CREEK	NR URSUS MOUTH	MACBLO JD,WL	910628
56.0	URSUS CREEK	LOWER RIVER	MACBLO JD WL	910626
56.0	URSUS CREEK	LOWER RIVER	MACBLO JD,WL	910627
57.0	CYPRE R.	CYPRE #6	MACBLO LM	910718
58.1	BULSON CREEK	BULSON E.SIDE	MACBLO JM	910619
58.2	BULSON CREEK	BULSON MOUTH	MACBLO JM	910703
58.3	BULSON CREEK	BULSON UPSTREAM	MACBLO JM	910718

APPENDIX 9. LOCATION OF MARBLED MURRELET FIXED STATIONS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
59.0	TRANQUIL CREEK	TRANQUIL #1	MACBLO JM	910726
60.0	TOFINO CREEK	TOF. CK #4	MACBLO GJ	910719
61.0	KOOTOWIS CREEK	ESTUARY(MOUTH)	NPARK KA,BA	910620
61.0	KOOTOWIS CREEK	ESTUARY(MOUTH)	NPARK KA,ML	910716
62.0	KENNEDY LK CLAYOQUOT ARM	CLAY.ARM BRIDGE	MACBLO GJ	910620
62.0	KENNEDY LK CLAYOQUOT ARM	CLAY.ARM BRIDGE	MACBLO GJ	910710
63.1	SANDHILL CREEK	RIVER MOUTH	NPARK ML	910620
63.1	SANDHILL CREEK	RIVER MOUTH	NPARK MO	910719
63.2	SANDHILL CREEK	SANDDUNES	NPARK PB	910620
63.2	SANDHILL CREEK	SANDDUNES	NPARK BA	910719
64.0	SANDHILL CREEK (INLAND)	ROAD STAT.#2	NPARK BC	910718
65.1	LOST SHOE CREEK	FOOTBRIDGE	NPARK MO	910620
65.2	LOST SHOE CREEK	FLORENCIA BEACH	NPARK LI	910620
65.2	LOST SHOE CREEK	FLORENCIA BEACH	NPARK DC,MK	910719
65.3	LOST SHOE CREEK	INFO CENTER	NPARK BA,ML	910705
69.0	NAHMINT RIVER (UPPER)	NAHMINT #3	MACB-CWS AB	910723
72.0	PIPESTEM INLET SKULL LAKE	SKULL LK#7	MFOR SM	910717
75.0	CHINA CREEK	MID VALLEY	CWS MJFL	910527
76.0	CHINA CREEK (LOWER)	CHINA CK PK #4	MACBLO BL	910719
77.0	SARITA RIVER (UPPER)	NR LAKE #7	MACBLO KH,MD	910719
78.0	SARITA RIVER (LOWER)	SARITA M/L #5	MACBLO EP,DF	910712
79.0	PACHENA R. (LOWER)	PACHENA M/L #1	MACBLO KH,MD	910712
80.0	KLANAWA R.(LOWER)	E-W FORK KLAN#5	MACBLO EP,DF	910719
81.0	KLANAWA R.-EAST (UPPER)	E.KLAN BAGLEY#7	MACBLO CN,EG	910712
82.0	NITINAT R.	UPPER BRIDGE	FCC DL,GF	910619
82.0	NITINAT R.	UPPER BRIDGE	FCC DL	910703
82.0	NITINAT R.	UPPER BRIDGE	FCC MP	910719
83.0	NITINAT RIVER (LOW-MID)	GRANITE JCTN#9	MACBLO CN,DO	910719
84.0	NITINAT R.(LOWER)	RED ROCK CORNER	FCC LG,SV	910619
84.0	NITINAT R.(LOWER)	RED ROCK CORNER	FCC MP	910703
84.0	NITINAT R.(LOWER)	RED ROCK CORNER	FCC MP	910711
85.0	CHEEWHAT RIVER	RIVER MOUTH	NPARK BA,BH	910709
85.0	CHEEWHAT RIVER	RIVER MOUTH	NPARK BA,BH	910710
86.0	CAYCUSE R.(LOWER)	CARM/HATT #2	FCC SV	910711
87.0	CAYCUSE R.(UPPER)	HATTON M/L #6	FCC GF	910717
88.0	WALBRAN CREEK(UPPER EAST)	NR S.END MCLURE	CWS MJFL	910612
89.0	WALBRAN CREK(UPPER EAST)	MCCLURE BRIDGE	CWS CRM	910529
89.0	WALBRAN CREK(UPPER EAST)	MCCLURE BRIDGE	CWS CRM	910612
90.0	WALBRAN CREEK(MID EAST)	GLAD LK M/L	CWS MJFL	910529
91.0	GORDON RIVER	G.R. M/L#6	FCC SV	910718
92.0	BRADEN CK.(GORDON R.)	REID CK.#6	FCC MP	910718
93.0	SAN JUAN-RENFREW-HARRIS	FAIRY LK.#10	FCC GF	910718
94.0	LOSS CREEK	LOSS CK #4	WFP MW	910610
95.1	SAN JUAN RIVER (UPPER)	SAN JUAN Y1400	MACBLO BC	910717
97.0	SAN JUAN RIVER (UPPER)	X45.5 JNCT #?	MACBLO TN	910717
100.0	COWICHAN R.	SKUTZ FALLS	FCC GF	910621
100.0	COWICHAN R.	SKUTZ FALLS	FCC GF	910704
100.0	COWICHAN R.	SKUTZ FALLS	FCC GF	910716
102.0	COWICHAN L. NORTH SHORE	SHAW CREEK#9	FCC DL	910720
104.0	NANAIMO R. JUMP CK.	S. JUMP CK.#4	FCC MP	910712
106.0	NANAIMO R.NANAIMO LKS	SEC. LAKE#1	FCC SV	910719
107.1	ENGLISHMAN R.	ENGL.R. PARK	MACBLO PP,LP	910712
108.0	CAMERON R. (UPPER)	FIREBREAK (#2)	MACBLO TT,DP	910719
109.1	CAMERON RIVER(CATH GR)	CATH.GROVE(UP)	CWS MJFL	910526
109.1	CAMERON RIVER(CATH GR)	CATH.GROVE(UP)	CWS MJFL	910705
109.2	CAMERON RIVER (CATH GR)	CATH.GROVE(MID)	CWS KJ	910526
109.3	CAMERON RIVER (CATH GR)	W.CAMERON LK	CWS CRM	910526

APPENDIX 9. LOCATION OF MARBLED MURRELET FIXED STATIONS SURVEYED IN 1991.

NO	WATERSHED	SITE	OBSERVER	DATE
110.0	TSABLE R.	TSABLE BRIDGE	MACBLO M	910712
111.0	OYSTER R.	UPPER-NORM L.	FCC WBW	910725
112.0	OYSTER R.	LOWER R. #6	FCC GF	910725
113.0	TLOOLS CREEK(ELK R)	WEST UP CAMP.LK	CWS MJFL	910512
113.0	TLOOLS CREEK(ELK R)	WEST UP CAMP.LK	CWS CRM	910613
114.0	CERVUS R.(ELK R)	LADY FALLS	CWS KJ	910512
114.0	CERVUS R.(ELK R)	LADY FALLS	CWS MJFL	910613
115.0	WHITE RIVER(UPPER)	STEWART LAKE #3	MACBLO MR	910719
116.0	MEMEKAY R. (EAST)	LEAH CK.M/L#6	MACBLO KB	910716
116.0	MEMEKAY R. (EAST)	LEAH CK.M/L#6	MACBLO KB	910726
117.0	SALMON RIVER (UPPER)	CANYON(UPPER)	MACBLO SP	910716
117.0	SALMON RIVER (UPPER)	CANYON(UPPER)	MACBLO SP	910726
118.0	WHITE RIVER(LOWER)	A-BR.LOWER#4	MACBLO RR	910719
119.0	QUADRA I. VILLAGE BAY M/L	MID-IS #8	FCC GF	910726
120.0	QUADRA I. GRANITE BAY	STAT. 5	FCC WBW	910726
121.0	SEBALHALL CK(NIMPKISH R)	SEBALHALL #7	CANFOR AM	910713
122.0	YOOKWA CK(NIMPKISH R)	YOOKWA #5	CANFOR AM	910710
123.0	NIMPKISH R.(ABOVE LAKE)	DUNCAN RD #9	CANFOR RW	910711
124.0	KAIPIT CK(NIMPKISH R)	KAIPIT CK #9	CANFOR PW	910712
125.0	PINDER CK(NIMPKISH R)	PINDER-WOLFE #6	CANFOR KH	910712
127.0	TSITIKA R.(LOWER)	CATHERINE C(TS)	MACBLO MMP	910722
129.0	CLAUDE-ELLIOT R.(TSITIKA R)	CLA.ELLIOT#6	CANFOR PW GP	910711
130.0	KOKISH R. EAST FORK	EAST FK #8	FCC GF	910724
130.1	KOKISH R. EAST FORK	EAST #6	FCC WBW	910724
132.1	TSITIKA RIVER	UPSTREAM OF EST	CWS KJ	910521
132.1	TSITIKA RIVER	UPSTREAM OF EST	CWS KJ	910522
132.2	TSITIKA RIVER	WEST SIDE EST.	CWS MJFL	910521
132.2	TSITIKA RIVER	WEST SIDE EST	CWS MJFL	910522
132.3	TSITIKA RIVER	W.ALONG J.S.	CWS CRM	910521
132.3	TSITIKA RIVER	W. ALONG J.S.	CWS CRM	910522
133.0	"BAUZA COVE DRAINAGE"	CAMP. AT BEACH	CWS KJ	910511
133.0	"BAUZA COVE DRAINAGE"	CAMP. AT BEACH	CWS CRM	910625
134.0	KILPALA R.(NIMPKISH R)	KILPALA #10	CANFOR AM	910711
135.0	CLUXEWE RIVER	MIDVALLEY OP.OG	CWS MJFL	910520
135.0	CLUXEWE RIVER	MIDVALLEY OP.OG	CWS MJFL	910625
136.0	MILLS CREEK	UPPER SLOPE	CWS MJFL	910511
138.0	GEORGIE LK(SONGHEES CK)	EAST END LAKE	CWS MJFL	910712
139.0	GEORGIE LK(SONGHEES CK)	MID SOUTH SIDE	CWS CRM	910712
140.1	SHUSHARTI RIVER	MAIN CK MOUTH	CWS CRM	910728
140.2	SHUSHARTI R(EAST TRIB)	EAST TRIB.MOUTH	CWS MJFL	910728

OBSERVERS

BC PARK: B.C. MINISTRY OF LANDS AND PARKS
CWS: CANADIAN WILDLIFE SERVICE
MOE: B.C. MINISTRY OF ENVIRONMENT
MFOR: B.C. MINISTRY OF FORESTS
NPARK: CANADIAN PARKS SERVICE
CPF: CANADIAN PACIFIC FOREST PRODUCTS LTD.
CANFOR: CANADIAN FOREST PRODUCTS LTD.
FCC: FLETCHER CHALLENGE CANADA LTD.
MACBLO: MacMILLAN BLOEDEL LTD.
WFP: WESTERN FOREST PRODUCTS LTD.

SITE:
EST = Estuary
IR = Indian Reserve
M/L = Mainline
JCTN = Junction
J.S. = Johnston Strait
OP.OG = opposite old growth

For the second set of initials in the observer column see acknowledgements.

APPENDIX 10. CHARACTERISTICS OF THE 1991 FIXED STATIONS: DISTANCE FROM OCEAN AND FOREST COVER.

NO	COAST	DIST S.W1. (km)	DIST S.W2. (km)	DIST V.S.W. (km)	DIST OCEAN (km)	% up W.	DIST OLD GROWTH (m)	W.	FORESTED AREA (ha)	% OLD GROWTH
1.0	W	0.3		0.3	0.3		0			
2.0	W	4.0		4.0	4.5	21	0	1	8924	90
3.0	W	1.5		2.0	6.0	9	0	1	12521	58
4.1	W	2.0		3.2	9.2	15		1	12521	58
6.0	W	3.0		5.5	27.0	55		1	1848	70
7.0	W	2.0		2.0	14.0	22		2	1565	66
8.0	W	0.3		0.3	41.3	1.5	>500	1	14726	39
9.0	W	9.0		11.0	47.0	65		1	14726	39
10.0	W	6.0		7.0	38.0	17	0	1	44605	48
11.0	W	7.0		9.0	38.0	21	>500	1	44605	48
12.1	W	2.5		3.0	20.8	19	180	1	7690	60
12.2	W	5.5		5.5	20.8	34	300	1	7690	60
13.1	W	6.5		6.5	22.0	72	150	1	2824	80
13.2	W	4.0		4.0	24.6	44	0	1	2824	80
14.0	W	3.0		3.0	26.5	30	0	1	3075	95
15.0	W	2.0		2.0	26.5	22	200	1	3075	95
16.0	W	1.5		1.5	28.0	14	100	1	7649	58
17.0	W	2.8		4.0	25.0	36	100	2	3731	49
18.1	W	0.0		0.0	4.5	0	0	1	1083	90
18.2	W	0.0		0.0	4.0	0	0	1	870	95
19.1	W	0.5		0.5	6.5	4	0	1	5048	100
19.2	W	0.1		0.1	6.0	0	0	1	5048	100
20.1	W	0.5		0.5	6.0	4	0	1	4900	100
20.2	W	0.1		0.1	5.5	0	0	1	4900	100
21.0	W	0.0		0.0	0.0	0	0	1	2370	100
22.1	W	0.6		0.6	8.0	3	0	1	5856	100
22.2	W	0.6		0.6	8.0	3	>500	1	5856	100
23.0	W	0.5		0.5	2.0	4	0	1	3320	100
24.0	W	0.0		0.0	2.0	0	0	1		100
25.1	W	1.0		1.0	11.0	6	0	1	4934	98
25.2	W	0.5		0.5	11.0	3	0	1	4934	98
26.0	W	8.5		12.0	31.0	46	170	1	26673	79
27.1	W	1.3		1.3	22.0	5	0	1	26673	79
27.2	W	1.3		1.3	22.0	5	0	1	26673	79
27.3	W	1.5		1.5	22.0	5	0	1	26673	79
28.0	W	9.0		15.0	31.0	83	180	1	11932	82
29.0	W	11.0		12.0	32.0	67	120	1	11932	82
30.0	W	11.0		11.0	26.0	61	0	1	11042	55
31.0	W	19.0		23.0	37.5	96	0	1	15057	72
32.0	W	17.0		19.0	34.0	79	0	1	15057	72
33.0	W	0.2		0.2	20.0	1	>500	1	15057	72
34.0	W	9.0		16.0	30.0	57	0	2	3466	69
35.1	W	0.1		0.1	0.2	0	0	1	1077	50
35.2	W	0.0		0.0	0.0	0	0	1	1077	50
35.3	W	0.1		0.1	1.0	0	0	1	1077	50
35.4	W	0.1		0.1	1.0	0	0	1	1077	50
35.5	W	0.1		0.1	1.0	0	0	1	1077	50
35.6	W	0.1		0.1	1.0	0	0	1	1077	50
35.7	W	0.1		0.1	1.0	0	0	1	1077	50
36.0	W	3.0		4.5	3.0	45	150	1	4023	50
37.0	W	0.6		0.6	0.6	12	0	1	4952	67
38.0	W	31.0	46.0	36.0	56.5	40	0	3	2651	55
39.0	W	8.0		12.0	34.5	55	0	1	9831	74
40.0	W	8.0		12.0	34.0	55	20	1	9831	74
41.0	W	5.5		6.0	30.0	60	240	1	2936	80

APPENDIX 10. CHARACTERISTICS OF THE 1991 FIXED STATIONS: DISTANCE FROM OCEAN AND FOREST COVER.

NO	COAST	DIST S.W1. (km)	DIST S.W2. (km)	DIST V.S.W. (km)	DIST OCEAN (km)	% up W.	DIST OLD GROWTH (m)	W.	FORESTED AREA (ha)	% OLD GROWTH
42.0	W	12.0		27.0	36.0	100	200	2	5378	70
43.0	W	7.0		7.4	26.5	41	0	2	5766	92
44.0	W	7.0		7.5	27.0	42	120	2	5766	92
45.0	W	0.5		0.8	19.3	16	100	1	1560	65
46.1	W	0.2		0.2	18.0	5	100	1	352	90
46.2	W	0.2		0.2	18.0	5	100	1	352	90
46.3	W	0.1		0.1	18.0	2	150	1	352	90
47.0	W	1.6		2.0	14.7	33	100	1	956	60
49.0	W	3.5		4.5	13.0	45		1	3960	58
50.0	W	6.0		11.5	11.0	77	0	1	8174	60
51.0	W	0.5		0.5	7.5	4	0	1	5010	95
52.0	W	0.5		0.5	0.5	6	0	1	1775	77
53.0	W	0.0		0.0	17.0	0	0	1	23638	100
53.1	W	5.0		5.0	18.0	16	0	1	23638	100
53.2	W	3.5		11.0	21.0	68	0	1	23638	100
54.0	W	0.0		0.0	25.0	0	0	1	13694	100
55.0	W	3.0		3.0	32.0	12	>500	1	16513	88
56.0	W	5.0		7.0	32.0	27	0	2	6685	100
57.0	W	2.5		2.5	12.0	15	0	1	5442	64
58.1	W	1.5		1.5	21.6	7	0	1	7361	98
58.2	W	1.0		1.0	21.6	5	0	1	7361	98
58.3	W	1.5		1.5	21.6	7	150	1	7361	98
59.0	W	5.5		6.0	23.0	44	150	1	5305	75
60.0	W	2.5		2.5	24.6	25	200	1	5670	90
61.0	W	0.0		0.0	3.0	0	0	1	2646	20
62.0	W	8.0		8.0	10.0	0	>500	2	13856	75
63.1	W	0.0		0.0	0.0	0	0	1	2118	60
63.2	W	0.0		0.0	0.0	0	0	1	2118	60
64.0	W	2.0		4.0	2.0	67	200	1	2118	60
65.1	W	0.0		0.0	0.0	0	100	1	2934	50
65.2	W	0.0		0.0	0.0	0	100	1	2934	50
65.3	W	1.8		1.8	1.8	22	100	1	2934	50
69.0								1	18833	80
72.0	W	1.0		1.0	13.0	50	100	1	3143	60
75.0	W	7.0	24.0	8.0	45.0	38	1140	1	11418	27
76.0	W	2.5	28.0	3.0	40.0	15	>500	1	11418	27
77.0	W	7.0		11.0	25.0	55	300	1	18369	30
78.0	W	3.5		3.5	20.5	17.5	>500	1	18369	30
79.0	W	0.6		0.6	4.5	5	0	1	5073	23
80.0	W	7.0		7.0	7.0	26	300	1	23955	66
81.0	W	17.0		19.0	17.0	70	0	1	23955	66
82.0	W	26.0		39.0	38.3	61	>500	1	76645	32
83.0	W	23.5		26.0	27.0	41	>500	1	76645	32
84.0	W	24.0		24.0	24.0	38	300	1	76645	32
85.0	W	0.0		0.0	0.0	0	0	1	2490	87
86.0	W	22.7		25.0	22.7	20	0	2	19525	28
87.0	W	27.0		32.0	27.0	50	200	2	19525	28
88.0	W	19.0		20.0	19.0	83	100	1	13152	86
89.0	W	17.5		18.5	17.5	77	200	1	13152	86
90.0	W	14.0		16.0	14.0	67	100	1	13152	86
91.0	W	6.0		6.0	11.0	15		1	30972	21
92.0	W	8.0		10.0	14.4	45	100	2	5099	50
93.0	W	5.0		5.0	9.0	11		1	64485	24
94.0	W	7.5		17.0	7.5	89	0	1	7531	61
95.1	W	24.0	36.5	34.0	24.0	30	0	2	6106	22

APPENDIX 10. CHARACTERISTICS OF THE 1991 FIXED STATIONS: DISTANCE FROM OCEAN AND FOREST COVER.

NO	COAST	DIST S.W1. (km)	DIST S.W2. (km)	DIST V.S.W. (km)	DIST OCEAN (km)	% up W.	DIST OLD GROWTH (m)	W.	FORESTED AREA (ha)	% OLD GROWTH
97.0	W	32.0	32.0	44.0	32.0	87	360	2	6106	22
100.0	E	23.0		23.0	23.0	32	>500	1	116024	6
102.0	E	36.4		56.0	44.0	79	>500	1	116024	6
104.0	E	28.3		35.0	30.7	83		2	20998	22
106.0	E	18.0		28.0	20.8	50		1	84724	13
107.1	E	8.0		13.0	10.0	39	>500	1	30944	12
108.0	E	19.0	13.0	29.0	19.0	62		1	24507	19
109.1	E	13.0	12.0	18.0	13.0	40	0	1	24507	19
109.2	E	12.0	12.0	17.5	12.0	39	0	1	24507	19
109.3	E	11.5	12.0	17.0	11.5	38	0	1	24507	19
110.0	E	5.0		6.0	5.0	30	>500	1	10910	38
111.0	E	25.0		30.0	25.0	73	0	1	32860	37
112.0	E	19.0		22.0	19.0	54	0	1	32860	37
113.0	E	38.0	34.4	52.0	39.4	0	200	2	4499	100
114.0	E	42.0	30.3	56.0	42.4	0	0	2	4180	100
115.0	E	38.0		39.0	38.0	50	0	3	4855	80
116.0	E	30.0		34.0	30.0	56	0	2	22628	60
117.0	E	24.0		43.0	26.0	63	0	1	130970	48
118.0	E	10.0		11.0	12.0	11	500	2	32542	72
119.0	E	1.0			2.0		>500			
120.0	E	4.0			4.0		>500			
121.0	E	58.0	17.0	88.0	58.0	44	270	3	5368	70
122.0	E	49.0	17.0	77.0	49.0	60	90	3	3259	64
123.0	E	38.7	26.0	65.0	38.7	57	0	2	41338	56
124.0	E	37.0	23.0	48.0	37.0	85	0	2	7619	72
125.0	E	38.0	17.0	43.0	38.0	79	0	2	12569	56
127.0	E	5.0		5.0	6.0	14		1	36260	87
129.0	E	19.0		21.0	21.0	41	0	2	4958	87
130.0	E	9.0		19.0	9.0	86		1	34700	46
130.1	E	10.0		14.0	10.0	64		1	34700	46
132.1	E	0.6		0.6	0.6	1.6	0	1	36260	87
132.2	E	0.5		0.5	0.5	1	0	1	36260	87
132.3	E	0.2		0.2	0.2	0.5	0	1	36260	87
133.0	E	0.0		0.0	0.5	0	0	1	1015	50
134.0	E	22.0		27.0	23.0	75	0	2	9083	74
135.0	E	14.5		19.0	16.0	73	150	1	8888	36
136.0	E	9.0		10.0	10.0	83	200	1	2670	13
138.0	E	5.5		11.0	5.5	48	0	1	7135	93
139.0	E	7.0		10.0	7.0	48	300	1	7135	93
140.1	E	0.0		0.1	1.0	0	0	1	6929	100
140.2	E	0.0		0.1	1.0	0	0	1	6929	100

COAST=Coast where the watershed empties
DIST S.W1.=Straight distance to the salt water where the watershed empties
DIST S.W2.=Straight distance to salt water on opposite coast
DIST V.S.W.=Distance to salt water along the watershed
DIST OCEAN=Straight distance to open ocean on coast where watershed empties
% UP W.=Location of station in the watershed
W.=Primary,secondary or tertiary watershed

APPENDIX 11. CHARACTERISTICS OF THE 1991 FIXED STATIONS; AREA, % OLD GROWTH

		WATERSHED AREA (HA)								
		PRIMARY		SECONDARY		TERTIARY		% OG	% OG	% OG
NO	W.	ALL	FOR	ALL	FOR	ALL	FOR	1	2	3
1.0										
2.0	1	8924	8924					90		
3.0	1	12521	12521					58		
4.1	1	12521	12521					58		
6.0	1	1848	1848					70		
7.0	2	6334	6334	1565	1565			63	66	
8.0	1	14985	14726					39		
9.0	1	14985	14726					39		
10.0	1	51942	44605					48		
12.1	1	7966	7690					60		
12.2	1	7966	7690					60		
13.1	1	2954	2824					80		
13.2	1	2954	2824					80		
14.0	1	3075	3075					95		
15.0	1	3075	3075					95		
16.0	1	8758	7649					58		
17.0	2	8758	7649	4427	3731			58	49	
18.1	1	1083	1083					90		
18.2	1	870	870					95		
19.1	1	5204	5048					100		
19.2	1	5204	5048					100		
20.1	1	4960	4900					100		
20.2	1	4960	4900					100		
21.0	1	2370	2370					100		
22.1	1	5992	5856					100		
22.2	1	5992	5856					100		
23.0	1	3320	3320					100		
24.0	1							100		
25.1	1	5354	4934					98		
25.2	1	5354	4934					98		
26.0	1	28418	26673					79		
27.1	1	28418	26673					79		
27.2	1	28418	26673					79		
27.3	1	28418	26673					79		
28.0	1	12859	11932					82		
29.0	1	12859	11932					82		
30.0	1	11308	11042					55		
31.0	1	18850	15057					72		
32.0	1	18850	15057					72		
33.0	1	18850	15057					72		
34.0	2	18850	15057	4805	3466			72	69	
35.1	1	1077	1077					50		
35.2	1	1077	1077					50		
35.3	1	1077	1077					50		
35.4	1	1077	1077					50		
35.5	1	1077	1077					50		
35.6	1	1077	1077					50		
35.7	1	1077	1077					50		
36.0	1	4023	4023					50		
37.0	1	4952	4952					67		
38.0	3	99785				2741	2651			55
39.0	1	12022	9831					74		
40.0	1	12022	9831					74		
41.0	1	3956	2936					80		

APPENDIX 11. CHARACTERISTICS OF THE 1991 FIXED STATIONS; AREA, % OLD GROWTH

		WATERSHED AREA (HA)								
		PRIMARY		SECONDARY		TERTIARY		% OG	% OG	% OG
NO	W.	ALL	FOR	ALL	FOR	ALL	FOR	1	2	3
42.0	2	99785		5649	5378				70	
43.0	2	11236	10945	6046	5766			82	92	
44.0	2	11236	10945	6046	5766			82	92	
45.0	1	1560	1560					65		
46.1	1	352	352					90		
46.2	1	352	352					90		
46.3	1	352	352					90		
47.0	1	956	956					60		
49.0	1	3960	3960					58		
50.0	1	8174	8174					60		
51.0	1	5440	5010					95		
52.0	1	1775	1775					77		
53.0	1	25893	23638					100		
53.1	1	25893	23638					100		
53.2	1	25893	23638					100		
54.0	1	17749	13694					100		
55.0	1	21474	16513					88		
56.0	2	21474	16513	7756	6685			88	100	
57.0	1	5652	5442					64		
58.1	1	8176	7361					98		
58.2	1	8176	7361					98		
58.3	1	8176	7361					98		
59.0	1	6170	5305					75		
60.0	1	5930	5670					90		
61.0	1	2646	2646					20		
62.0	2	53525	45103	16075	13856			67	75	
63.1	1	2118	2118					60		
63.2	1	2118	2118					60		
64.0	1	2118	2118					60		
65.1	1	2934	2934					50		
65.2	1	2934	2934					50		
65.3	1	2934	2934					50		
69.0	1	20398	18833					80		
72.0	1	3143	3143					60		
75.0	1	11418	11418					27		
76.0	1	11418	11418					27		
77.0	1	18498	18369					30		
78.0	1	18498	18369					30		
79.0	1	5073	5073					23		
80.0	1	23955	23955					66		
81.0	1	23955	23955					66		
82.0	1	79902	76645					32		
83.0	1	79902	76645					32		
84.0	1	79902	76645					32		
85.0	1	2490	2490					87		
86.0	2	79902	76645	19525	19525			32	28	
87.0	2	79902	76645	19525	19525			32	28	
88.0	1	13152	13152					86		
90.0	1	13152	13152					86		
91.0	1	30972	30972					21		
92.0	2	30972	30972	5099	5099			21	50	
93.0	1	64485	64485					24		
94.0	1	7531	7531					61		

APPENDIX 11. CHARACTERISTICS OF THE 1991 FIXED STATIONS; AREA, % OLD GROWTH

		WATERSHED AREA (HA)								
		PRIMARY		SECONDARY		TERTIARY		% OG	% OG	% OG
NO	W.	ALL	FOR	ALL	FOR	ALL	FOR	1	2	3
95.1	2	64485	64485	6106	6106			24	22	
97.0	2	64485	64485	6106	6106			24	22	
100.0	1	122485	116024					6		
102.0	1	122485	116024					6		
104.0	2	85248	84724	21144	20998			13	22	
106.0	1	85248	84724					13		
107.1	1	31640	30944					12		
108.0	1	25061	24507					19		
109.1	1	25061	24507					19		
109.2	1	25061	24507					19		
109.3	1	25061	24507					19		
110.0	1	11180	10910					38		
111.0	1	36455	32860					37		
112.0	1	36455	32860					37		
113.0	2	171140		5631	4499			50	100	
114.0	2	171140		6038	4180			50	100	
115.0	3	134350	130970	35922	32542	6134	4855	48	72	80
116.0	2	134350	130970	22628	22628			48	60	
117.0	1	134350	130970					48		
118.0	2	134350	130970	35922	32542			48	72	
119.0										
120.0										
121.0	3	177180	159253	46058	41338	6500	5368	55	56	70
122.0	3	177180	159253	46058	41338	3598	3259	55	56	64
123.0	2	177180	159253	46058	41338			55	56	
124.0	2	177180	159253	8277	7619			55	72	
125.0	2	177180	159253	13950	12569			55	56	
127.0	1	38654	36260					87		
129.0	2	38654	36260	5582	4958			87	87	
130.0	1	37164	34700					46		
132.1	1	38654	36260					87		
132.2	1	38654	36260					87		
132.3	1	38654	36260					87		
133.0	1	1015	1015					50		
134.0	2	177180	159253	10562	9083			55	74	
135.0	1	9380	8888					36		
136.0	1	2670	2670					13		
138.0	1	7640	7135					93		
139.0	1	7640	7135					93		
140.1	1	6929	6929					100		
140.2	1	6929	6929					100		

W.=Primary,secondary or tertiary watershed
ALL=Area of watershed
FOR=Forested area

% OG = % of forested area in old growth
1,2,3=Primary,secondary or tertiary watershed

APPENDIX 12. WEATHER PARAMETERS ASSOCIATED WITH EACH FIXED STATION SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
1.0	CAPE SCOTT	910623	100					
2.0	FISHERMAN RIVER	910629	100	100	F	F	0	0
2.0	FISHERMAN RIVER	910722	100	90	N	N	2	0
3.0	SAN JOSEF RIVER	910621	100	100	N	N	0	0
3.0	SAN JOSEF RIVER	910622	100	100	D	D	0	0
4.1	SAN JOSEF RIVER	910728	80	99	N	N	3	2
6.0	HUSHAMU CREEK	910726	100	100	D	N	1	1
7.0	SIMPSON R.	910719	95	95	N	D	0	2
8.0	WAUKWAAS CREEK	910508	100	50	N	N	2	2
8.0	WAUKWAAS CREEK	910618	100	85	N	N	0	0
8.0	WAUKWAAS CREEK	910718	95	75	N	N	0	0
9.0	WAUKWAAS CREEK	910723	0	0	N	N	0	0
10.0	MARBLE RIVER	910508	100	50	D	N	1	0
10.0	MARBLE RIVER	910618	100	100	N	N	0	0
10.0	MARBLE RIVER	910718	65	20	N	N	0	0
11.0	ALICE LAKE	910508	100	50	N	N	0	0
12.1	INGERSOLL R	910711	100	100	N	N	0	0
12.2	INGERSOLL R.	910712	95	85	N	N	0	0
13.1	TEETA CREEK	910715	100	100	D	D	0	0
13.2	TEETA CREEK	910711	100	95	N	D	3	2
14.0	CAYUSE CK	910712	70	50	N	N	0	0
15.0	CAYUSE CREEK	910509	90	90	D	N	0	0
15.0	CAYUSE CREEK	910524	100	100	D	N	0	1
15.0	CAYUSE CREEK	910714	100	100	D	R	2	2
16.0	CAYEGHLE R.(NR COLONIAL)	910509	100	100	F	F	0	0
17.0	CAYEGHLE RIVER(SW FORK)	910509	100	100	F	N	0	0
17.0	CAYEGHLE RIVER(SW FORK)	910714	100	100	R	R	0	0
18.1	KLASKINO ANCHOR.(I.R. RIV)	910623	100	100	N	N	0	0
18.1	KLASKINO ANCHOR.(I.R. RIV)	910715	100	100	D	N	3	2
18.2	KLASKINO ANCHOR(W. DRAIN)	910623	100	100	N	N	2	2
18.2	KLASKINO ANCHOR(W. DRAIN)	910715	100	90	D	F	3	3
19.1	KLASKISH RIVER(MAIN)	910621	100	100	N	N	3	2
19.1	KLASKISH RIVER(MAIN)	910717	50	0	N	N	0	0
19.2	KLASKISH RIVER(MAIN)	910621	95	95	N	D	4	4
19.2	KLASKISH RIVER(MAIN)	910717	100	50	N	N	1	1
20.1	SOUTH KLASKISH(EAST CK)	910622	100	100	N	N	0	0
20.1	SOUTH KLASKISH(EAST CK)	910716	100	100	F	N	0	0
20.2	SOUTH KLASKISH(EAST CK)	910622	100	100	N	N	1	1
20.2	SOUTH KLASKISH(EAST CK)	910716	100	100	D	N	0	1
21.0	AMOS CREEK	910625	100	100	N	D	0	0
22.1	NASPARTI RIVER	910629	100	100	F	R	2	3
22.1	NASPARTI RIVER	910725	90	95	N	N	3	4
22.2	NASPARTI RIVER	910629	100	100	D	D	2	2
22.2	NASPARTI RIVER	910725	85	65	N	N	4	4
23.0	BATTLE RIVER	910628	0	0	N	N	0	0
24.0	BATTLE BAY	910628	0	0	N	N	0	0
25.1	POWER RIVER	910724	30	0	N	N	0	0
25.2	POWER RIVER	910724	25	25	N	N	0	0
26.0	TAHSISH R.	910712	100	100	N	N	0	0
27.1	TAHSISH RIVER	910515	100	100	D	R	0	1
27.1	TAHSISH RIVER	910702	100	95	D	F	0	0
27.2	TAHSISH RIVER	910515	100	100	R	R	0	0
27.2	TAHSISH RIVER	910702	100	99	F	N	0	0
27.3	TAHSISH RIVER	910515	100	100	R	R	0	0
28.0	ARTLISH R.(UPPER)	910712	100	90	F	F	0	0
29.0	ARTLISH R.–TURBINE CK	910711	100	100	R	D	0	0

APPENDIX 12. WEATHER PARAMETERS ASSOCIATED WITH EACH FIXED STATION SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
30.0	KAOUK R.	910719	5	1	N	N	1	0
31.0	ZEBALLOS RIVER	910514	20	10	N	N	1	2
32.0	ZEBALLOS RIVER	910514	50	20	N	N	0	0
33.0	ZEBALLOS RIVER	910514	95	95	N	N	1	0
34.0	NOMASH R.(ZEBALLOS R.)	910718	100	99	F	N	1	1
35.1	"RUGGED POINT"	910517	0	0	N	N	6	7
35.2	"RUGGED POINT"	910517	0	0	N	N	2	0
35.3	"RUGGED POINT"	910517	0	0	N	N	0	0
35.3	"RUGGED POINT"	910518	0	0	N	N	1	1
35.3	"RUGGED POINT"	910630	100	100	N	D	0	1
35.4	"RUGGED POINT"	910518	0	0	N	N	0	0
35.5	"RUGGED POINT"	910518	0	0	N	N	0	0
35.5	"RUGGED POINT"	910519	0	0	N	N	0	0
35.5	"RUGGED POINT"	910630	100	100	N	R	0	0
35.6	"RUGGED POINT"	910519	0	0	N	N	1	1
35.7	"RUGGED POINT"	910519	0	0	N	N	2	4
36.0	KAPOOSE CK PORRITT CK	910725	100	100	N	D	0	1
37.0	TARA CK – TATCHU CK	910726	100	100	R	R	0	2
38.0	GOLD RIVER (UPPER)	910717	100	100	D	F	0	0
39.0	CONUMA R.	910712	100	100	N	F	0	0
40.0	CONUMA RIVER	910711	100	100	D	R	0	0
41.0	CANTON CK	910718	100	100	F	N	0	0
42.0	UPANA R.	910716	100	100	D	N	1	0
43.0	NESOOK R.	910711	100	100	F	D	1	0
44.0	NESOOK RIVER	910614	100	97	N	N	0	0
44.0	NESOOK RIVER	910710	100	100	F	N	1	2
45.0	COUGAR CREEK	910616	80	60	N	N	0	0
45.0	COUGAR CREEK	910710	95	95	D	D	1	1
46.1	DEADMAN CREEK(SITE#1)	910504	100	90	N	N	0	1
46.2	DEADMAN CREEK(SITE#2)	910505	100	100	D	N	2	0
46.2	DEADMAN CREEK(SITE#2)	910614	90	90	N	D	0	0
46.2	DEADMAN CREEK(SITE#2)	910615	100	75	D	N	0	0
46.2	DEADMAN CREEK(SITE#2)	910711	100	100	N	D	0	0
46.3	DEADMAN(NR COUGAR CK)	910616	100	100	N	D	0	0
47.0	HANNA CREEK	910615	50	50	D	N	0	1
49.0	MOOYAH RIVER	910724	100	80	D	D	0	0
50.0	ESCALANTE R.	910626	100	100	F	F	0	0
50.0	ESCALANTE R.	910710	100	100	F	F	0	1
50.0	ESCALANTE R.	910724	100	100	F	F	1	2
51.0	HESQUIAT LAKE	910625	100	100	F	F	0	0
51.0	HESQUIAT LAKE	910709	100	100	F	D	1	1
51.0	HESQUIAT LAKE	910723	0	0	N	N	2	1
52.0	HESQUIAT PT. CK.	910625	100	100	F	F	0	0
52.0	HESQUIAT PT. CK.	910709	100	100	F	F	0	0
52.0	HESQUIAT PT. CK.	910723	0	0	N	N	0	0
53.0	MEGIN RIVER	910620	100	100	N	N	2	2
53.0	MEGIN RIVER	910725	100	100	N	N	2	2
53.1	MEGIN RIVER(UPPER)	910714	85	85	N	N		
53.2	MEGIN RIVER(UPPER)	910713	100	100	D	D		
54.0	MOYEHA RIVER	910619	0	0	N	N	0	0
54.0	MOYEHA RIVER	910725	100	100	N	D	0	0
55.0	BEDWELL R.–URSUS CREEK	910628	0	0	N	N	0	0
56.0	URSUS CREEK	910626	90	90	N	N	2	0
56.0	URSUS CREEK	910627	40	40	N	N	0	0
57.0	CYPRE R.	910718	50	20	F	F	0	0
58.1	BULSON CREEK	910619	0	0	N	N	1	1
58.2	BULSON CREEK	910703	100	100	F	F	0	1

APPENDIX 12. WEATHER PARAMETERS ASSOCIATED WITH EACH FIXED STATION SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
58.3	BULSON CREEK	910718	0	5	N	N	0	0
59.0	TRANQUIL CREEK	910726	100	100	D	D	1	0
60.0	TOFINO CREEK	910719	100	100	N	F	1	1
61.0	KOOTOWIS CREEK	910620	100	100	D	D		
61.0	KOOTOWIS CREEK	910716	100	100	F	N	0	1
62.0	KENNEDY LK CLAYOQUOT ARM	910620	100	100	N	N	1	2
62.0	KENNEDY LK CLAYOQUOT ARM	910710	100	100	F	F	0	0
63.1	SANDHILL CREEK	910620	100	100	N	R	2	2
63.1	SANDHILL CREEK	910719	90	60	F	F	1	1
63.2	SANDHILL CREEK	910620	100	100	N	R	1	1
63.2	SANDHILL CREEK	910719	100	100	F	F	1	1
64.0	SANDHILL CREEK (INLAND)	910718	80	80	F	F	1	1
65.1	LOST SHOE CREEK	910620	100	100	F	F	2	2
65.2	LOST SHOE CREEK	910620	100	100	F	D	2	1
65.2	LOST SHOE CREEK	910719	80	90	N	N	1	0
65.3	LOST SHOE CREEK	910705	0	0	N	N	1	1
69.0	NAHMINT RIVER (UPPER)	910723	0	0	N	N	0	0
72.0	PIPESTEM INLET SKULL LAKE	910717	100	85	N	N	0	1
75.0	CHINA CREEK	910527	70	80	N	N	0	1
76.0	CHINA CREEK (LOWER)	910719	20	65	N	N	0	0
77.0	SARITA RIVER (UPPER)	910719	60	0	N	F	0	1
78.0	SARITA RIVER (LOWER)	910712	100	100	D	N	0	0
79.0	PACHENA R. (LOWER)	910712	100	90	F	R	0	0
80.0	KLANAWA R.(LOWER)	910719	100	100	N	N	0	0
81.0	KLANAWA R.-EAST (UPPER)	910712	100	100	F	F	0	0
82.0	NITINAT R.	910619	0	0	N	N	0	1
82.0	NITINAT R.	910703	100	100	F	F	0	0
82.0	NITINAT R.	910719	100	50	D	D	0	0
83.0	NITINAT RIVER (LOW-MID)	910719	100	100	N	N	1	1
84.0	NITINAT R.(LOWER)	910619	0	0	N	N	0	2
84.0	NITINAT R.(LOWER)	910703	100	100	F	F	0	0
84.0	NITINAT R.(LOWER)	910711	100	100	N	N	0	0
85.0	CHEEWHAT RIVER	910709	100	100	N	N	2	2
85.0	CHEEWHAT RIVER	910710	100	100	D	D	0	0
86.0	CAYCUSE R.(LOWER)	910711	100	100	N	D	0	0
87.0	CAYCUSE R.(UPPER)	910717	100	100	N	N	0	1
88.0	WALBRAN CREEK(UPPER EAST)	910612	100	100	N	N	0	0
89.0	WALBRAN CREK(UPPER EAST)	910529	100	100	N	N	1	1
89.0	WALBRAN CREK(UPPER EAST)	910612	100	95	D	N	2	0
90.0	WALBRAN CREEK(MID EAST)	910529	100	100	N	N	1	2
91.0	GORDON RIVER	910718	0	0	F	N	0	1
92.0	BRADEN CK.(GORDON R.)	910718	10	10	N	N	0	0
93.0	SAN JUAN-RENFREW-HARRIS	910718	20	0	F	F	1	2
94.0	LOSS CREEK	910610	100	100	N	N	0	0
95.1	SAN JUAN RIVER (UPPER)	910717	100	100	F	F	1	1
97.0	SAN JUAN RIVER (UPPER)	910717	100	100	N	N	0	0
100.0	COWICHAN R.	910621	100	100	F	N	1	1
100.0	COWICHAN R.	910704	0	0	N	N	1	3
100.0	COWICHAN R.	910716	100	90	N	N	0	0
102.0	COWICHAN L. NORTH SHORE	910720	20	90	N	F	0	0
104.0	NANAIMO R. JUMP CK.	910712	100	100	D	N	0	0
106.0	NANAIMO R.NANAIMO LKS	910719	10	0	N	N	1	2
107.1	ENGLISHMAN R.	910712	90	80	N	N	1	1
108.0	CAMERON R. (UPPER)	910719	30	0	N	N	0	0
109.1	CAMERON RIVER(CATH GR)	910526	100	100	N	N	0	1
109.1	CAMERON RIVER(CATH GR)	910705	0	0	N	N	0	2
109.2	CAMERON RIVER (CATH GR)	910526	100	100	N	N	0	0

APPENDIX 12. WEATHER PARAMETERS ASSOCIATED WITH EACH FIXED STATION SURVEY.

NO	WATERSHED	DATE	CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END
109.3	CAMERON RIVER (CATH GR)	910526	100	100	N	N	1	1
110.0	TSABLE R.	910712	50	80	N	N	1	1
111.0	OYSTER R.	910725	100	100	F	F	0	0
112.0	OYSTER R.	910725	100	100	N	F	3	3
113.0	TLOOLS CREEK(ELK R)	910512	90	25	N	N	3	3
113.0	TLOOLS CREEK(ELK R)	910613	90	70	N	N	2	2
114.0	CERVUS R.(ELK R)	910512	90	25	N	N	2	2
114.0	CERVUS R.(ELK R)	910613	100	75	N	N	0	0
115.0	WHITE RIVER(UPPER)	910719	80	80	N	N	0	1
116.0	MEMEKAY R. (EAST)	910716	100	100	F	D	0	0
116.0	MEMEKAY R. (EAST)	910726	100	100	N	N	0	0
117.0	SALMON RIVER (UPPER)	910716	100	100	F	F	0	0
117.0	SALMON RIVER (UPPER)	910726	100	100	N	N	0	0
118.0	WHITE RIVER(LOWER)	910719	10	10	N	N	0	0
119.0	QUADRA I. VILLAGE BAY M/L	910726	100	100	N	N	2	1
120.0	QUADRA I. GRANITE BAY	910726	100	100	N	N	0	0
121.0	SEBALHALL CK(NIMPKISH R)	910713	100	100	D	D	0	0
122.0	YOOKWA CK(NIMPKISH R)	910710	100	100	N	N	0	0
123.0	NIMPKISH R.(ABOVE LAKE)	910711	100	100	R	R	0	0
124.0	KAIPIT CK(NIMPKISH R)	910712	10	50	N	N	0	3
125.0	PINDER CK(NIMPKISH R)	910712	100	50	N	N	1	1
127.0	TSITIKA R.(LOWER)	910722	0	0	N	N	2	2
129.0	CLAUDE-ELLIOT R.(TSITIKA R)	910711	100	100	D	R	0	0
130.0	KOKISH R. EAST FORK	910724	100	100	N	N	1	1
130.1	KOKISH R. EAST FORK	910724	95	95	N	N	0	0
132.1	TSITIKA RIVER	910521	10	10	N	N	0	0
132.1	TSITIKA RIVER	910522	100	100	N	N	0	2
132.2	TSITIKA RIVER	910521	10	25	N	N	1	1
132.2	TSITIKA RIVER	910522	100	90	N	N	0	2
132.3	TSITIKA RIVER	910521	10	10	N	N	2	3
132.3	TSITIKA RIVER	910522	95	100	N	N	1	1
133.0	"BAUZA COVE DRAINAGE"	910511	100	10	N	N	0	0
133.0	"BAUZA COVE DRAINAGE"	910625	100	100	F	F	1	1
134.0	KILPALA R.(NIMPKISH R)	910711	100	100	D	D	0	0
135.0	CLUXEWE RIVER	910520	0	10	N	N	2	1
135.0	CLUXEWE RIVER	910625	100	100	F	F	0	1
136.0	MILLS CREEK	910511	100	40	N	N	1	0
138.0	GEORGIE LK(SONGHEES CK)	910712	85	25	N	N	0	0
139.0	GEORGIE LK(SONGHEES CK)	910712	30	10	N	N	2	1
140.1	SHUSHARTI RIVER	910728	90	75	N	N	0	1
140.2	SHUSHARTI R(EAST TRIB)	910728	100	95	N	N	0	1

CLO BEG=% of cloud cover at the beginning of the survey
CLO END=% of cloud at the end of the survey
PREC BEG=Precipitation at the beginning of the survey
PREC END=Precipitation at the end of the survey
WIND BEG=Wind at the beginning
WIND END=Wind at the end of the survey

For abbreviations and number code, see Appendix 2 survey sheet.

APPENDIX 13. COMMENTS ON SOME FIXED STATION SURVEYS.

NO	DATE	COMMENTS
2.0	910629	Not clear on form whether visual detections are silent or vocal
3.0	910622	Number of keer calls/detection were not recorded; uncertain if times are in PST
3.0	910621	Number of keer calls/detection were not recorded; uncertain if times are in PST; evening survey
7.0	910719	More detections present in mid-survey, than were recorded
15.0	910714	Heavy rain at end of survey
15.0	910524	Survey done during training session
17.0	910714	Heavy rain at times, during survey
18.1	910715	Gale to storm force winds on ocean, but quieter in forest
18.2	910715	Noisy on beach, where the survey was conducted; gale on ocean nearby
19.1	910717	Fog heavy in inlet adjacent to survey area
19.2	910621	Murrelets began calling very early; so may have been more detections; duration of activity could have been longer
20.1	910716	Bugs were very bad and disruptive to survey
20.1	910622	Birds began calling very early
21.0	910625	Survey may be early in season
22.1	910629	Some detections heard before survey began
22.2	910629	Cloud level was low, so obscured visual detections
23.0	910628	Very bright night, which may have affected birds behavior
24.0	910628	Very bright night, which may have affected birds behavior
25.1	910724	Survey location near a river that was a bit noisy
26.0	910712	Detections may have continued after survey ended
28.0	910712	Detections may have continued after survey ended
29.0	910711	Detections may have continued after survey ended. No distance or heights of detections were recorded
32.0	910514	Road traffic beside survey site was noisy
35.1	910517	Wind was very noisy, may have obscured some detections
35.4	910518	Stormy winds, noisy in the open water nearby
35.5	910519	Detections began before survey start
35.5	910518	Stormy winds noisy over the open water nearby
35.6	910519	Surveyed during testing of night vision equipment
35.7	910519	Detections began before survey start
37.0	910726	Some heavy rain during survey
40.0	910711	Rain frequent during survey
46.1	910504	Survey done during training session
46.2	910505	Survey done by 3 observers and recorded separately, results of survey with the middle value taken
50.0	910710	Possibly 2 other visual detections
51.0	910723	Survey carried out late in season
51.0	910709	Detections may have continued after survey completed; many "Multiple" keer calls/detection
53.0	910620	Number of keer calls/detection not recorded; possibly missed some auditory detections
53.1	910714	Uncertain whether times are recorded in PST
54.0	910725	Detections may have continued later after survey ended
54.0	910619	Number of keer calls/detections not recorded
55.0	910628	Weather very clear and sunny on survey in June, which may have some effect on the absence of detections
56.0	910626	Survey done in evening
56.0	910627	All detections are visual; some auditory detections may have been missed
57.0	910718	Height, distance and keer calls/detection were not recorded
58.1	910619	Distant behaviors recorded as stationary, could have been circling bird
58.2	910703	Distant behaviors recorded as stationary, could have been circling bird
58.3	910718	Many detections recorded with "Multiple" keer calls
59.0	910726	Survey done late in season
61.0	910620	Detections may have continued after survey ended
61.0	910716	Detections may have continued after survey ended
63.1	910719	No behavior, height or distance recorded for detections. May have been more detections after the survey ended
63.1	910620	No heights or behaviors recorded for detections
63.2	910719	Uncertain if time is recorded in PST
65.2	910620	Detections are all visual, some auditory detections may have been missed. Detections may have continued after survey ended.
69.0	910723	Survey conducted late in season
72.0	910717	Stationary behaviors, may actually have been flying birds
77.0	910719	No behavior, height or distances recorded for detections; auditory detections coming from old growth
81.0	910712	In some cases one detection may have been recorded as two, since there is no keer value over 8
85.0	910709	Survey done in evening
85.0	910710	Uncertain whether times are recorded in PST
88.0	910612	Survey done during training session

APPENDIX 13. COMMENTS ON SOME FIXED STATION SURVEYS.

NO	DATE	COMMENTS
94.0	910610	Survey done in June, earlier than other surveys that were all done in July
95.1	910717	Fixed station does not correspond with any of the stations on the road transect
97.0	910717	Location of this fixed station along the road transect is not recorded
109.2	910526	Road traffic nearby is noisy
114.0	910613	Survey conducted during training session
114.0	910512	Visual detections were possibly all of the same birds
115.0	910719	Number of keer calls/detection were not recorded
116.0	910716	Doubtful whether behaviors recorded as stationary were perched birds. Activity may continue after survey ended
117.0	910716	No heights or distances recorded. Activity may have continued after survey ended
121.0	910713	Activity may have continued after survey ended
122.0	910710	Many number of keer calls/detection recorded as "multiple"
124.0	910712	Stationary behavior recorded on form are doubtful
129.0	910711	Activity may have continued after survey ended
130.0	910724	No visual detections to confirm the recorded circular behaviors
132.1	910521	Gale force winds on the ocean nearby
132.2	910522	Strong wind on the ocean nearby
132.2	910521	Gale force winds on the ocean nearby
132.3	910521	Wind strong and noisy in the forest
134.0	910711	Many numbers of keer calls/detection were recorded as "multiple"

APPENDIX 14. NUMBER OF MARBLED MURRELET DETECTIONS AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	TOT VIS	TOT MULT	TIME SUNRISE	TIME DET.1	DUR (MIN)
1.0	910623	0	0	0	0	0	0	0		04:21		
2.0	910629	7	0	0	0	1	0	6		04:23	04:02	73
2.0	910722	2	0	0	0	0	0	2		04:46	04:31	65
3.0	910621	5	36	0	1	0	0	0		20:51	20:35	40
3.0	910622	23	153	9	2	2	0	6		04:20	04:42	78
4.1	910728	2	26	0	0	0	0	0		04:54	03:55	109
6.0	910726	18	190	0	0	0	0	0	1	04:49	04:20	77
7.0	910719	15	178	0	0	0	0	7	6	04:40	04:49	61
8.0	910508	0	0	0	0	0	0	0		04:52		0
8.0	910618	0	0	0	0	0	0	0		04:16		0
8.0	910718	1	0	0	0	0	0	1		04:37	04:23	1
9.0	910723	2	19	2	0	0	0	0		04:43	04:02	28
10.0	910508	0	0	0	0	0	0	0		04:52		0
10.0	910618	0	0	0	0	0	0	0		04:16		0
10.0	910718	0	0	0	0	0	0	0		04:37		0
11.0	910508	0	0	0	0	0	0	0		04:52		0
12.1	910711	16	206	3	0	0	0	0	6	04:31	03:45	67
12.2	910712	10	26	7	0	0	0	3		04:32	03:45	55
13.1	910715	40	580	3	0	0	0	3	14	04:35	04:06	79
13.2	910711	64	695	2	3	0	3	4	6	04:31	03:31	112
14.0	910712	58	524	3	0	0	0	25	14	04:33	03:48	78
15.0	910509	14	106	0	0	0	0	1		04:52	04:25	62
15.0	910524	10	177	0	0	0	0	0	3	04:31	04:04	78
15.0	910714	39	542	2	0	0	0	6		04:34	03:52	98
16.0	910509	5	62	0	0	0	0	0	2	04:52	04:01	100
17.0	910509	5	44	0	0	0	0	0		04:52	04:29	57
17.0	910714	47	1018	20	0	0	0	7		04:34	04:02	111
18.1	910623	48	740	62	0	0	0	1	3	04:20	03:21	116
18.1	910715	44	369	4	0	0	0	10		04:36	03:52	127
18.2	910623	52	469	2	0	0	0	0		04:20	03:16	110
18.2	910715	16	111	0	0	0	0	0		04:36	03:58	80
19.1	910621	38	243	0	0	0	0	1	1	04:19	03:24	97
19.1	910717	67	1164	0	0	0	0	7	10	04:39	03:31	122
19.2	910621	37	155	7	0	0	0	10		04:19	03:14	105
19.2	910717	48	945	0	0	0	0	2		04:39	03:31	84
20.1	910622	39	386	8	0	0	0	1	2	04:19	03:17	142
20.1	910716	45	473	0	0	0	0	3	1	04:38	03:52	117
20.2	910622	20	176	5	0	0	0	1		04:19	03:15	97
20.2	910716	21	273	0	0	0	1	0		04:38	03:53	101
21.0	910625	4	7	0	0	0	0	1		04:20	04:20	45
22.1	910629	142	1255	144	0	0	0	37	2	04:22	03:16	184
22.1	910725	66	819	48	0	0	0	6		04:48	03:37	113
22.2	910629	113	1195	32	0	0	0	1		04:22	03:17	138
22.2	910725	49	892	10	0	0	0	1		04:48	03:52	89
23.0	910628	11	107	0	0	0	0	0		04:21	04:06	57
24.0	910628	1	8	0	0	0	0	0		04:21	04:15	1
25.1	910724	4	22	0	0	0	0	0		04:47	03:55	61
25.2	910724	29	183	0	0	0	0	1		04:47	03:31	98
26.0	910712	26	606	0	0	0	0	11	24	04:31	03:45	107
27.1	910515	4	15	0	0	0	0	0		04:41	04:25	11
27.1	910702	21	138	7	0	0	1	0		04:22	03:17	105
27.2	910515	12	153	0	0	0	0	0	4	04:41	04:04	96
27.2	910702	29	290	0	6	0	0	3		04:22	03:10	113
27.3	910515	4	10	0	0	0	0	1		04:41	04:30	51
28.0	910712	42	377	0	0	7	0	4	3	04:31	03:40	104

APPENDIX 14. NUMBER OF MARBLED MURRELET DETECTIONS AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	TOT VIS	TOT MULT	TIME SUNRISE	TIME DET.1	DUR (MIN)
29.0	910711	29	142	23	1	0	0	1		04:30	03:57	94
30.0	910719	38	281	5	8	0	0	20		04:39	03:48	67
31.0	910514	1	3	0	0	0	0	0		04:42	04:25	1
32.0	910514	12	108	0	0	0	0	0	2	04:42	04:01	57
33.0	910514	1	2	0	0	0	0	0		04:42	04:31	1
34.0	910718	92	1371	269	4	0	0	2		04:38	03:41	192
35.1	910517	1	0	0	0	0	0	1		04:38	04:28	1
35.2	910517	9	68	0	0	0	0	7	2	04:38	04:16	61
35.3	910517	16	109	0	0	0	0	1		04:38	03:55	48
35.3	910518	13	87	6	0	0	0	3		04:37	03:49	68
35.3	910630	6	79	0	0	0	0	1		04:21	03:27	58
35.4	910518	13	108	0	0	0	0	2		04:37	03:49	34
35.5	910518	17	152	0	0	1	0	4	4	04:37	03:48	35
35.5	910519	17	133	0	0	0	0	1	4	04:36	03:35	42
35.5	910630	12	127	9	0	0	0	0	1	04:21	03:02	114
35.6	910519	14	125	10	0	0	0	0		04:36	03:35	43
35.7	910519	17	91	2	0	0	0	3		04:36	03:35	42
36.0	910725	85	1104	189	13	0	0	21		04:46	03:56	147
37.0	910726	18	247	0	1	0	0	0		04:48	04:12	88
38.0	910717	64	451	22	3	0	0	20		04:34	03:58	134
39.0	910712	44	492	21	0	0	0	5	3	04:31	03:58	98
40.0	910711	142	1499	4	0	9	0	72	13	04:30	04:02	156
41.0	910718	18	193	0	0	0	0	0	1	04:38	04:02	94
42.0	910716	19	115	0	0	0	0	2		04:35	03:57	72
43.0	910711	35	226	0	0	0	0	12		04:30	04:01	102
44.0	910614	3	5	0	0	0	0	2		04:17	03:50	59
44.0	910710	111	2240	27	0	1	0	12	4	04:29	03:39	198
45.0	910616	52	145	0	0	0	0	26		04:17	03:42	56
45.0	910710	82	832	14	0	0	0	6		04:29	03:38	134
46.1	910504	27	223	0	0	0	0	2	1	04:58	04:20	64
46.2	910505	43	646	6	0	0	0	13	4	04:56	04:21	59
46.2	910614	10	38	0	0	0	0	0		04:17	03:53	60
46.2	910615	6	85	0	0	0	0	0		04:17	03:31	74
46.2	910711	25	313	0	0	0	0	3		04:30	04:13	61
46.3	910616	5	12	0	0	0	0	0		04:17	03:31	95
47.0	910615	9	30	3	0	0	0	0		04:17	03:31	56
49.0	910724	4	67	0	0	0	0	0	2	04:45	04:10	74
50.0	910626	26	179	0	0	0	0	4		04:19	03:30	85
50.0	910710	92	1520	109	0	0	1	45		04:29	03:40	120
50.0	910724	54	1037	18	15	0	0	12		04:45	04:18	92
51.0	910625	25	418	0	0	1	0	1	11	04:19	03:17	110
51.0	910709	166	2098	345	0	3	0	26	85	04:28	03:32	178
51.0	910723	2	4	0	0	0	0	0		04:44	03:31	46
52.0	910625	98	144	0	0	1	0	90		04:19	03:46	107
52.0	910709	96	642	0	0	0	0	57		04:28	03:35	137
52.0	910723	63	367	5	0	0	0	50		04:44	04:03	66
53.0	910620	4	9	0	0	0	0	4		04:15	03:05	115
53.0	910725	0	0	0	0	0	0	0		04:44		0
53.1	910714	46	589	0	0	0	0	0		04:31	03:45	115
53.2	910713	1	0	1	0	0	0	0		04:30	05:25	1
54.0	910619	1	9	0	0	0	0	0		04:15	04:00	1
54.0	910725	8	54	0	1	0	0	0		04:44	05:00	20
55.0	910628	0	0	0	0	0	0	0		04:18	0	0
56.0	910626	0	0	0	0	0	0	0		20:34	0	0
56.0	910627	9	65	0	0	0	0	9	2	04:18	04:05	21

APPENDIX 14. NUMBER OF MARBLED MURRELET DETECTIONS AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	TOT VIS	TOT MULT	TIME SUNRISE	TIME DET.1	DUR (MIN)
57.0	910718	37		0	0	0	0	10		04:35	03:45	86
58.1	910619	14	128	87	2	0	0	2	5	04:17	03:35	47
58.2	910703	82	1189	315	0	1	0	34	57	04:23	03:22	145
58.3	910718	34	407	84	0	0	0	18	18	04:37	03:45	83
59.0	910726	7	72	0	0	0	0	0	2	04:47	04:26	34
60.0	910719	12	72	2	21	0	0	0		04:38	03:48	92
61.0	910620	38	279	28	0	3	0	12	10	04:16	03:00	148
61.0	910716	46	517	3	0	1	0	17	19	04:34	03:40	104
62.0	910620	1	7	0	0	0	0	0		04:17	03:31	1
62.0	910710	0	0	0	0	0	0	0		04:29		0
63.1	910620	6	34	0	2	0	0	0	1	04:16	03:05	65
63.1	910719	17	150	0	0	0	0	0	4	04:38	04:35	67
63.2	910620	0	0	0	0	0	0	0		04:16		0
63.2	910719	4	10	0	1	0	0	0		04:38	03:19	52
64.0	910718	3	33	0	0	0	0	2	1	04:37	05:13	4
65.1	910620	5	1	0	0	0	0	5		04:16	04:07	26
65.2	910620	13	2	0	0	0	0	13		04:16	04:00	66
65.2	910719	5	4	0	0	0	0	3		04:38	03:15	105
65.3	910705	6	38	0	0	0	0	0		04:24	03:47	36
69.0	910723	0	0	0	0	0	0	0		04:39		0
72.0	910717	34	516	12	2	1	0	4		04:32	03:58	82
75.0	910527	2	32	0	0	0	0	0		04:23	04:29	4
76.0	910719	0	0	0	0	0	0	0		04:34		0
77.0	910719	35	656	17	0	0	0	0		04:34	03:36	106
78.0	910712	4	25	0	0	0	0	2		04:27	03:33	74
79.0	910712	11	9	6	0	0	0	10		04:29	03:30	55
80.0	910719	34	359	10	0	0	0	12		04:37	03:34	113
81.0	910712	112	223	30	0	0	1	19		04:29	03:49	77
82.0	910619	4	0	0	0	1	0	3		04:15	03:22	94
82.0	910703	0	0	0	0	0	0	0		04:21		0
82.0	910719	0	0	0	0	0	0	0		04:36		0
83.0	910719	9	32	0	1	0	0	0		04:33	04:45	33
84.0	910619	0	0	0	0	0	0	0		04:16		0
84.0	910703	10	104	0	0	0	0	1	3	04:22	03:34	112
84.0	910711	0	0	0	0	0	0	0		04:29		0
85.0	910709	1	0	0	0	0	0	1		20:21	19:50	1
85.0	910710	2	4	0	0	0	0	0		04:28	03:25	35
86.0	910711	39	393	31	0	0	1	17		04:27	03:45	63
87.0	910717	39	785	0	10	0	0	0		04:33	04:19	73
88.0	910612	2	12	0	0	0	0	0		04:16	03:29	75
89.0	910529	7	126	2	0	0	0	0		04:23	04:35	24
89.0	910612	4	30	0	0	0	0	1		04:16	03:20	70
90.0	910529	7	73	0	0	0	0	0		04:23	03:56	57
91.0	910718	18	110	8	0	0	0	13		04:35	04:00	62
92.0	910718	8	71	0	0	0	0	0		04:35	04:03	56
93.0	910718	6	37	0	1	0	0	0		04:35	03:44	37
94.0	910610	1	5	0	0	0	0	0		04:15	04:18	1
95.1	910717	74	992	466	0	2	1	53		04:32	03:40	143
97.0	910717	2	1	0	0	0	1	1		04:32	03:59	2
100.0	910621	0	0	0	0	0	0	0		04:12		0
100.0	910704	0	0	0	0	0	0	0		04:18		0
100.0	910716	0	0	0	0	0	0	0		04:29		0
102.0	910720	12	206	0	0	0	0	1	6	04:34	03:40	82
104.0	910712	3	41	0	0	0	0	0	1	04:25	03:47	92
106.0	910719	2	22	0	0	0	0	0		04:32	03:50	105

APPENDIX 14. NUMBER OF MARBLED MURRELET DETECTIONS AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT KEER	TOT ALT	TOT S	TOT WING	TOT JET	TOT VIS	TOT MULT	TIME SUNRISE	TIME DET.1	DUR (MIN)
107.1	910712	0	0	0	0	0	0	0		04:27		0
108.0	910719	0	0	0	0	0	0	0		04:34		0
109.1	910526	3	35	0	0	0	0	0		04:24	03:26	79
109.1	910705	5	27	0	0	0	0	1		04:21	03:45	34
109.2	910526	2	32	0	0	0	0	0		04:24	03:26	2
109.3	910526	5	18	2	0	0	0	0		04:24	03:33	92
110.0	910712	0	0	0	0	0	0	0		04:26		0
111.0	910725	3	28	0	0	0	0	0		04:41	05:07	19
112.0	910725	12	79	0	0	0	0	0		04:41	04:44	53
113.0	910512	0	0	0	0	0	0	0		04:42		0
113.0	910613	1	25	0	0	0	0	0		04:14	03:57	1
114.0	910512	17	88	0	0	0	0	10		04:42	04:19	56
114.0	910613	6	0	0	0	0	0	6		04:14	04:04	16
115.0	910719	23		0	0	0	0	1		04:36	03:50	98
116.0	910716	46	731	0	0	0	0	5	24	04:30	04:10	89
116.0	910726	10	42	0	0	0	0	6	1	04:42	04:17	66
117.0	910716	25	344	0	0	0	0	0	11	04:30	03:46	112
117.0	910726	13	27	0	0	0	0	4		04:42	03:51	89
118.0	910719	3	2	0	0	0	0	2		04:36	04:15	30
119.0	910726	0	0	0	0	0	0	0		04:42		0
120.0	910726	0	0	0	0	0	0	0		04:42		0
121.0	910713	30	591	0	0	0	0	9	23	04:32	04:01	97
122.0	910710	27	421	30	0	0	0	6	16	04:29	03:44	97
123.0	910711	42	653	86	0	0	0	17	23	04:30	03:50	120
124.0	910712	16	108	5	0	0	0	2	1	04:31	04:11	58
125.0	910712	32	368	0	0	0	0	11	10	04:31	03:49	68
127.0	910722	25	240	0	0	0	0	1		04:40	03:50	54
129.0	910711	23	149	1	0	0	0	4		04:26	04:01	84
130.0	910724	36	266	0	9	0	0	7		04:43	04:04	65
130.1	910724	70	1110	30	0	0	0	32		04:43	04:08	97
132.1	910521	24	293	0	0	0	0	6	7	04:31	03:48	62
132.1	910522	27	268	0	0	0	0	2	6	04:30	03:31	77
132.2	910521	12	154	4	0	0	0	0		04:31	03:37	57
132.2	910522	18	163	0	0	0	0	1		04:30	03:35	69
132.3	910521	2	20	0	0	0	0	0		04:31	03:37	2
132.3	910522	8	94	0	0	0	0	0		04:30	03:40	61
133.0	910511	0	0	0	0	0	0	0		04:47		0
133.0	910625	13	202	0	0	0	0	0		04:18	03:13	108
134.0	910711	27	489	52	0	0	0	2	18	04:27	03:50	85
135.0	910520	5	49	0	0	0	0	0		04:34	03:59	45
135.0	910625	39	449	16	0	0	0	1		04:18	03:44	93
136.0	910511	2	13	0	0	0	0	0		04:47	04:21	2
138.0	910712	0	0	0	0	0	0	0		04:30		0
139.0	910712	0	0	0	0	0	0	0		04:30		0
140.1	910728	10	208	0	0	0	0	1		04:50	04:41	53
140.2	910728	16	246	5	0	0	0	0		04:50	04:41	38

TOT DET=Total number of detections
TOT KEER=Total number of keer calls
TOT ALT=Total number of alternate calls
TOT S=Total single isolated calls
TOT WING=Number of times wing beats were heard
TOT JET=Number of jet sounds heard
DUR(MIN)=Length of time between first and last detection
TOT VIS=Number of detections that were visual
TOT MULT=Number of multiple calls(included in total keer)
TIME DET.1=Time of first detection.

APPENDIX 15. BEHAVIORS OF MARBLED MURRELETS DETECTED AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS D	C	S	A	L	HEIGHTS A	B	C	CLOSEST DISTANCE (m) 0–50	51–150	151–500	>501
1.0	910623	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0	910629	7	6	6	0	0	0	0	2	0	4	4	2	0	0
2.0	910722	2	2	2	0	0	0	0	0	1	1	1	1	0	0
3.0	910621	5	0	2	2	1	0	0	4	0	1	0	5	0	0
3.0	910622	23	6	11	4	3	0	2	16	0	7	9	12	2	0
4.1	910728	2	0	0	0	0	0	0	1	0	0	0	2	0	0
6.0	910726	18	0	4	6	0	0	0	15	0	0	0	0	18	0
7.0	910719	15	7	4	7	0	0	0	6	0	1	0	4	3	0
8.0	910508	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0	910618	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0	910718	1	1	1	0	0	0	0	0	1	0	1	0	0	0
9.0	910723	2	0	2	0	0	0	0	1	0	0	0	0	2	0
10.0	910508	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0	910618	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0	910718	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.0	910508	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.1	910711	16	0	11	1	1	0	0	10	5	1	0	15	1	0
12.2	910712	10	3	5	3	0	0	0	10	0	0	3	7	0	0
13.1	910715	40	3	10	23	0	0	0	16	17	0	12	28	0	0
13.2	910711	64	4	4	43	2	2	0	42	11	5	23	41	0	0
14.0	910712	58	25	32	18	0	0	0	37	12	1	3	27	20	0
15.0	910509	14	1	2	0	0	0	0	1	0	0	0	2	12	0
15.0	910524	10	0	3	1	0	0	0	2	0	0	4	1	3	0
15.0	910714	39	6	1	9	2	0	0	5	1	2	0	7	31	0
16.0	910509	5	0	0	0	0	0	0	0	0	0	0	0	5	0
17.0	910509	5	0	2	0	0	0	0	1	0	0	1	0	4	0
17.0	910714	47	7	13	8	0	0	0	22	1	0	17	6	24	0
18.1	910623	48	1	22	3	1	0	0	30	0	0	13	19	16	0
18.1	910715	44	10	12	4	2	0	0	13	7	2	15	10	19	0
18.2	910623	52	0	4	3	0	0	0	2	0	0	1	8	43	0
18.2	910715	16	0	1	0	1	0	0	0	0	1	0	2	14	0
19.1	910621	38	1	8	1	0	0	0	9	1	0	1	13	24	0
19.1	910717	67	7	21	11	0	0	0	11	5	2	30	10	25	0
19.2	910621	37	10	9	2	0	0	0	10	1	0	10	2	25	0
19.2	910717	48	2	5	3	0	0	0	27	6	1	1	2	45	0
20.1	910622	39	1	8	2	0	0	0	12	0	0	4	9	26	0
20.1	910716	45	3	11	3	1	0	0	11	3	0	10	13	20	0
20.2	910622	20	1	2	2	0	0	0	3	1	0	1	2	17	0
20.2	910716	21	0	1	4	0	1	0	4	0	1	3	4	14	0
21.0	910625	4	1	4	0	0	0	0	0	1	0	0	0	0	0
22.1	910629	142	37	41	27	1	0	0	38	9	15	65	42	31	0
22.1	910725	66	6	16	6	2	0	0	11	5	0	16	16	34	0
22.2	910629	113	1	4	1	0	0	0	4	1	0	3	58	52	0
22.2	910725	49	1	1	4	3	0	0	33	0	3	0	6	43	0
23.0	910628	11	0	6	0	0	0	0	8	0	0	3	3	5	0
24.0	910628	1	0	0	1	0	0	0	1	0	0	0	0	1	0
25.1	910724	4	0	3	0	0	0	0	4	0	0	0	1	3	0
25.2	910724	29	1	8	1	0	0	0	8	2	0	6	5	17	0
26.0	910712	26	11	5	17	0	0	0	10	0	1	6	1	4	0
27.1	910515	4	0	0	0	0	0	0	0	0	0	0	0	4	0
27.1	910702	21	0	1	1	3	1	0	2	0	3	1	3	17	0
27.2	910515	12	0	0	0	0	0	0	0	0	12	0	1	11	0
27.2	910702	29	3	10	2	2	0	0	5	2	2	2	10	17	0
27.3	910515	4	1	1	0	0	0	0	1	1	0	1	0	3	0
28.0	910712	42	4	20	0	1	0	0	15	13	2	6	9	24	0
29.0	910711	29	1	17	11	1	0	0	2	0	0	1	0	0	0
30.0	910719	38	20	18	7	0	0	0	5	9	12	20	10	8	0
31.0	910514	1	0	0	0	0	0	0	0	0	0	0	0	1	0
32.0	910514	12	0	0	0	0	0	0	0	0	0	0	0	12	0
33.0	910514	1	0	0	0	0	0	0	0	0	0	0	0	1	0

APPENDIX 15. BEHAVIORS OF MARBLED MURRELETS DETECTED AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS D	C	S	A	L	HEIGHTS A	B	C	CLOSEST DISTANCE (m) 0–50	51–150	151–500	>501
34.0	910718	92	2	14	26	3	0	0	17	3	3	4	10	78	0
35.1	910517	1	1	1	0	0	0	0	0	0	1	1	0	0	0
35.2	910517	9	7	3	4	0	0	0	3	3	1	0	2	7	0
35.3	910517	16	1	0	0	4	0	0	0	1	5	1	10	5	0
35.3	910518	13	3	1	1	1	0	0	1	4	1	2	8	2	0
35.3	910630	6	1	1	0	0	0	0	1	0	0	1	0	5	0
35.4	910518	13	2	2	6	1	0	0	0	0	4	8	3	1	0
35.5	910518	17	4	0	2	0	0	0	0	1	3	12	2	0	0
35.5	910519	17	1	1	0	0	0	0	0	0	1	6	8	2	0
35.5	910630	12	0	1	1	1	0	0	1	0	1	0	9	3	0
35.6	910519	14	0	1	1	1	0	0	0	0	1	5	7	1	0
35.7	910519	17	3	2	0	9	0	0	3	0	9	0	12	3	0
36.0	910725	85	21	23	14	0	0	0	18	7	2	19	22	44	0
37.0	910726	18	0	3	0	0	0	0	0	0	0	0	0	18	0
38.0	910717	64	20	29	18	8	0	0	0	4	18	22	30	12	0
39.0	910712	44	5	23	8	3	0	0	0	2	2	8	20	15	0
40.0	910711	142	72	35	53	0	0	0	18	20	40	68	41	32	0
41.0	910718	18	0	1	6	2	0	0	0	0	2	0	3	15	0
42.0	910716	19	2	1	5	5	0	0	0	2	0	0	1	18	0
43.0	910711	35	12	6	14	4	0	0	3	8	2	6	13	16	0
44.0	910614	3	2	2	0	0	0	0	1	1	1	1	1	1	0
44.0	910710	111	12	33	23	4	0	0	28	4	10	32	33	45	0
45.0	910616	52	26	10	16	18	0	0	7	5	27	2	12	30	0
45.0	910710	82	6	5	7	21	0	0	9	1	22	5	25	51	0
46.1	910504	27	2	5	2	0	0	0	0	1	1	2	8	17	0
46.2	910505	43	13	14	11	0	0	0	4	5	0	13	5	19	0
46.2	910614	10	0	1	0	1	0	0	1	0	0	0	0	9	0
46.2	910615	6	0	5	0	0	0	0	4	0	0	0	2	4	0
46.2	910711	25	3	2	6	3	0	0	6	0	2	5	3	16	0
46.3	910616	5	0	0	0	0	0	0	2	0	0	0	3	2	0
47.0	910615	9	0	0	0	0	0	0	0	0	0	1	3	5	0
49.0	910724	4	0	3	0	0	0	0	4	0	0	0	0	4	0
50.0	910626	26	4	21	1	0	0	0	11	0	1	1	0	23	0
50.0	910710	92	45	24	51	0	0	0	44	17	10	8	57	27	0
50.0	910724	54	12	36	15	0	0	0	19	31	1	8	39	7	0
51.0	910625	25	1	2	8	0	0	0	21	1	1	3	1	10	0
51.0	910709	166	26	57	19	0	0	0	28	123	15	48	43	75	0
51.0	910723	2	0	0	0	0	0	0	2	0	0	0	0	2	0
52.0	910625	98	90	49	45	0	0	0	2	77	11	5	31	57	0
52.0	910709	96	57	65	21	0	0	0	2	43	34	44	49	3	0
52.0	910723	63	50	42	18	0	0	0	6	30	26	21	40	2	0
53.0	910620	4	4	4	0	0	0	0	3	1	0	0	0	0	0
53.0	910725	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53.1	910714	46	0	0	4	0	0	0	0	0	0	1	8	28	9
53.2	910713	1	0	0	0	0	0	0	0	0	0	1	0	0	0
54.0	910619	1	0	0	1	0	0	0	0	0	0	0	0	0	0
54.0	910725	8	0	5	3	0	0	0	0	8	0	8	0	0	0
55.0	910628	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56.0	910626	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56.0	910627	9	9	4	5	0	0	0	4	4	1	2	3	4	0
57.0	910718	37	10	9	1	0	0	0	0	1	6	7	0	0	0
58.1	910619	14	2	0	2	10	0	0	0	0	12	1	1	10	0
58.2	910703	82	34	34	23	16	0	0	29	16	16	0	39	2	0
58.3	910718	34	18	7	10	1	0	2	13	4	3	1	15	3	0
59.0	910726	7	0	1	0	2	0	0	1	0	0	0	0	0	0
60.0	910719	12	0	5	0	0	0	0	0	1	1	0	0	1	0
61.0	910620	38	12	7	5	0	0	0	2	10	0	9	23	5	0
61.0	910716	46	17	9	3	0	0	0	8	1	1	10	30	2	0
62.0	910620	1	0	1	0	0	0	0	0	0	0	0	0	1	0
62.0	910710	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 15. BEHAVIORS OF MARBLED MURRELETS DETECTED AT THE 1991 FIXED STATIONS.

NO	DATE	TOT DET	TOT SEEN	BEHAVIORS D	C	S	A	L	HEIGHTS A	B	C	CLOSEST DISTANCE (m) 0–50	51–150	151–500	>501
63.1	910620	6	0	0	0	0	0	0	0	0	0	0	6	1	0
63.1	910719	17	0	0	0	0	0	0	0	0	0	0	0	0	0
63.2	910620	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63.2	910719	4	0	1	0	0	0	0	0	0	0	0	4	0	0
64.0	910718	3	2	2	0	0	0	0	2	0	0	0	2	0	0
65.1	910620	5	5	4	1	0	0	0	0	3	2	5	0	0	0
65.2	910620	13	13	12	1	0	0	0				3	10	0	0
65.2	910719	5	3	3	0	0	0	0	0	0	3	5	0	0	0
65.3	910705	6	0	0	1	0	0	0	0	0	2	1	3	2	0
69.0	910723	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72.0	910717	34	4	20	7	2	0	0	29	2	0	15	7	9	0
75.0	910527	2	0	1	0	0	0	0	1	0	0	0	0	2	0
76.0	910719	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77.0	910719	35	0	0	0	0	0	0	0	0	0	0	0	0	0
78.0	910712	4	2	0	1	0	0	0	3	0	1	0	4	0	0
79.0	910712	11	10	6	5	0	0	0	5	6	0	5	5	1	0
80.0	910719	34	12	10	2	0	0	0	31	3	0	3	10	21	0
81.0	910712	112	19	17	9	0	1	0	1	16	0	2	5	105	0
82.0	910619	4	3	3	1	0	0	0	1	0	3	3	0	1	0
82.0	910703	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82.0	910719	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83.0	910719	9	0	0	0	0	0	0	0	0	0	0	0	9	0
84.0	910619	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84.0	910703	10	1	4	0	0	0	0	5	4	1	3	2	5	0
84.0	910711	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85.0	910709	1	1	1	0	0	0	0	0	0	0	0	1	0	0
85.0	910710	2	0	0	0	0	0	0	0	0	0	0	0	0	0
86.0	910711	39	17	23	9	0	0	0	13	13	2	3	28	8	0
87.0	910717	39	0	9	30	0	0	0	38	1	0	0	0	33	6
88.0	910612	2	0	0	0	0	0	0	0	0	0	0	0	2	0
89.0	910529	7	0	0	2	0	0	0	0	0	0	0	0	7	0
89.0	910612	4	1	1	0	0	0	0	0	0	0	0	1	3	0
90.0	910529	7	0	1	0	0	0	0	4	0	0	2	1	4	0
91.0	910718	18	13	13	2	0	0	0	12	1	1	0	8	10	0
92.0	910718	8	0	2	0	0	0	0	3	2	0	0	0	7	1
93.0	910718	6	0	1	4	0	0	0	0	4	2	0	1	5	0
94.0	910610	1	0	0	0	0	0	0	1	0	0	0	0	1	0
95.1	910717	74	53	3	67	1	0	0	53	14	6	5	7	60	0
97.0	910717	2	1	0	1	0	0	0	0	0	1	1	0	0	0
100.0	910621	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100.0	910704	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100.0	910716	0	0	0	0	0	0	0	0	0	0	0	0	0	0
102.0	910720	12	1	4	7	1	0	0	11	0	1	1	7	4	0
104.0	910712	3	0	0	0	0	0	0	3	0	0	0	0	3	0
106.0	910719	2	0	0	0	0	0	0	0	0	0	0	0	2	0
107.1	910712	0	0	0	0	0	0	0	0	0	0	0	0	0	0
108.0	910719	0	0	0	0	0	0	0	0	0	0	0	0	0	0
109.1	910526	3	0	1	0	0	0	0	0	0	0	0	2	1	0
109.1	910705	5	1	2	0	0	0	0	0	1	0	1	3	1	0
109.2	910526	2	0	0	0	0	0	0	0	0	0	0	0	2	0
109.3	910526	5	0	0	1	0	0	0	0	0	0	0	0	5	0
110.0	910712	0	0	0	0	0	0	0	0	0	0	0	0	0	0
111.0	910725	3	0	0	1	0	0	0	2	1	0	0	2	1	0
112.0	910725	12	0	4	8	0	0	0	9	3	0	0	3	9	0
113.0	910512	0	0	0	0	0	0	0	0	0	0	0	0	0	0
113.0	910613	1	0	0	0	0	0	0	0	0	0	0	0	1	0
114.0	910512	17	10	0	10	0	0	0	8	2	0	4	5	8	0
114.0	910613	6	6	4	0	0	0	0	1	5	0	6	0	0	0
115.0	910719	23	1	6	0	0	0	0	21	0	0	1	0	8	8
116.0	910716	46	5	19	1	10	0	0	0	0	10	14	0	0	0

APPENDIX 15. BEHAVIORS OF MARBLED MURRELETS DETECTED AT THE 1991 FIXED STATIONS.

		TOT	TOT	BEHAVIORS					HEIGHTS			CLOSEST DISTANCE (m)			
NO	DATE	DET	SEEN	D	C	S	A	L	A	B	C	0–50	51–150	151–500	>501
116.0	910726	10	6	5	1	0	0	0	2	4	0	6	0	0	0
117.0	910716	25	0	17	8	0	0	0	0	0	0	0	0	0	0
117.0	910726	13	4	11	2	0	0	0	0	0	0	0	0	0	0
118.0	910719	3	2	2	0	0	0	0	2	0	0	0	1	0	0
119.0	910726	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120.0	910726	0	0	0	0	0	0	0	0	0	0	0	0	0	0
121.0	910713	30	9	6	19	5	0	0	6	0	8	6	1	2	0
122.0	910710	27	6	6	16	4	0	0	6	0	4	4	1	1	0
123.0	910711	42	17	11	13	14	0	0	8	6	17	3	9	5	0
124.0	910712	16	2	1	1	0	0	0	5	11	0	2	1	13	0
125.0	910712	32	11	12	4	0	0	0	5	13	3	24	0	0	0
127.0	910722	25	1	17	0	2	0	0	16	2	2	6	1	10	8
129.0	910711	23	4	2	6	0	0	0	11	5	0	1	3	13	6
130.0	910724	36	7	4	32	0	0	0	15	20	1	9	12	15	0
130.1	910724	70	32	16	41	0	0	0	48	17	3	26	25	19	0
132.1	910521	24	6	5	1	0	0	0	4	2	0	1	4	19	0
132.1	910522	27	2	2	0	0	0	0	1	1	0	1	4	22	0
132.2	910521	12	0	3	1	0	0	0	5	0	0	0	3	9	0
132.2	910522	18	1	7	0	0	0	0	5	0	0	2	8	8	0
132.3	910521	2	0	2	0	0	0	0	0	0	0	0	0	2	0
132.3	910522	8	0	1	3	1	0	0	2	0	1	0	2	6	0
133.0	910511	0	0	0	0	0	0	0	0	0	0	0	0	0	0
133.0	910625	13	0	1	4	0	0	0	3	0	0	0	3	6	0
134.0	910711	27	2	1	26	0	0	0	0	1	1	2	1	0	0
135.0	910520	5	0	3	0	0	0	0	1	0	0	0	0	5	0
135.0	910625	39	1	13	2	0	0	0	2	1	0	9	12	18	0
136.0	910511	2	0	0	0	0	0	0	0	0	0	0	0	2	0
138.0	910712	0	0	0	0	0	0	0	0	0	0	0	0	0	0
139.0	910712	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140.1	910728	10	1	1	1	0	0	0	2	0	1	0	2	8	0
140.2	910728	16	0	4	1	0	0	0	8	1	0	1	2	13	0

TOT DET=Total number of detections
TOT SEEN=Number of detections that were visual
BEHAVIORS:No.of detections of :
D=Direct flight
C=Circling birds
S=Stationary call
A=Aerial dive
L=Bird landing

HEIGHTS:No.of detections :
A=>1 tree height above canopy
B=<1 tree height above canopy
C=Below canopy
CLOSEST DISTANCE=Distance (horizontal) of the detection from the observer

APPENDIX 16. INCIDENTAL MARBLED MURRELET ROAD TRANSECT SURVEYS ON VANCOUVER ISLAND AND IN THE QUEEN CHARLOTTE ISLANDS IN 1991 AND 1992.

NO.	LOCATION	WATERSHED	SITE	OBSERVER	DATE	WEATHER CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END	TRAN LENG (KM)	NUM STA	STA W.DET	TOT DET	DET/ STA	TIME SUNRISE
1	Tasu Snd.(Q.C.I.)	Lomgon Creek	Lomgon–Newcombe	WFP DM,GL,VV	910615	100	100	N	N	0	0	6	8	3	6	0.8	04:19
2	Tasu Snd.(Q.C.I.)	Lomgon Creek	Lomgon–Newcombe	WFP GL	910711	100	100	N	D	0	0	6.0	8	7	25	3.1	04:34
3	Tasu Snd.(Q.C.I.)	Lomgon Creek	Lomgon–Newcombe	WFP GL	910731	10	15	N	N	0	0	6.0	8	7	34	4.3	05:02
4	Tasu Snd.(Q.C.I.)	Flat Creek	lower river	WFP DM,GL,VV	910614	100	100	N	N	0	0	3.5	9	3	4	0.4	04:19
5	Tasu Snd.(Q.C.I.)	Flat Creek	lower river	WFP VV	910711	100	100	N	N	1	2	3.5	9	2	3	0.3	04:34
6	Tasu Snd.(Q.C.I.)	Flat Creek	lower river	WFP VV	910731	100	95	N	N	1	1	3.5	9	5	9	1.0	05:02
7	nr Sewell In.(Q.C.I)	Pacofi Creek	main valley	WFP GL	910712	100	100	D	N	0	1	3.5	9	9	32	3.6	04:35
8	Pacofi Bay (Q.C.I.)	Pacofi Creek	main valley	WFP VV	910728	100	100	D	D	2	2	3.5	9	6	24	2.7	04:57
9	Tasu Snd.(Q.C.I.)	Tasu Creek	lower creek	WFP DM	910612	100	100	D	D	0	1	4.5	10	1	1	0.1	04:20
10	Tasu Snd.(Q.C.I.)	Tasu Creek	lower creek	WFP VV	910712	100	100	D	D	1	1	4.5	9	5	6	0.7	04:35
11	Tasu Snd.(Q.C.I.)	Tasu Creek	lower creek	WFP GL	910801	100	95	N	N	0	0	4.5	10	6	14	1.4	05:04
12	Vancouver Island	Tofino Creek		MOE/F TM,CM.	920706	100	100	N	D	0	0		10	10	44	4.4	04:25
13	Vancouver Island	Tofino Creek		MOE/F TM,CM	920707	100	100	N	N	0	0		10	9	37	3.7	04:25

NO.	TIME DET.1	DUR (MIN)	TOT KEER	TOT ALT	TOT S	TOT WING	TOT MULT	TOT VIS	BEHAVIORS D	C	S	HEIGHTS A	B	C	CLOSEST DISTANCE(m) 0–50	51–150	151–500	>501
1	04:09	44	85	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0
2	03:58	91	219	0	0	0	0	0	0	0	0	0	0	0	0	6	19	0
3	04:11	79	471	14	0	0	0	2	0	3	0	0	1	1	1	10	23	0
4	03:37	47	134	0	0	0	0	0	1	1	0	0	4	0	0	1	3	0
5	04:45	8	16	0	0	0	0	0	0	0	1	0	2	1	0	0	3	0
6	04:23	49	223	0	0	0	0	0	1	0	0	0	0	1	1	0	8	0
7	03:44	98	443	77	0	0	0	2	6	5	2	4	0	0	2	8	22	0
8	04:17	69	362	0	0	0	0	0	5	0	2	1	1	2	1	6	17	0
9	04:51	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
10	03:57	94	52	0	0	0	0	0	2	0	1	0	1	1	0	2	4	0
11	04:19	76	206	0	0	0	0	0	0	0	0	0	0	0	0	4	10	0
12	03:27	113	230	0	0	0	1	19	19	16	0	21	3	4	7	18	3	0
13	03:37	95	208	0	0	0	1	11	24	8	0	19	3	3	15	8	3	0

OBSERVERS
MOE: B.C.MINISTRY OF ENVIRONMENT
MOF: B.C. MINISTRY OF FORESTS
WFP: WESTERN FOREST PRODUCTS LTD.
For the second set of initials in observer column see acknowledgements

CLO BEG= % cloud cover at survey beginning
CLO END= % cloud cover at survey end
PREC BEG= precipitation at survey beginning
PREC END= precipitation at survey end
WIND BEG= wind at survey beginning
WIND END= wind at survey end
Abbreviations and number codes are in appendix 2 survey sheet

BEHAVIORS= No. of detections of:
D: direct flight
C: circling birds
S: stationary call
HEIGHTS= No. of detections of:
A: >1 tree height above canopy
B: <1 tree height above canopy
C: below canopy
CLOSEST DISTANCE= distance (horizontal) of the detection from the observer

TRAN LENGTH= length of road transect
NUM STA= number of stations on the road transect
STA.W.DET= number of stations that had murrelet detections
TOT DET= total number of detections
DET/STA= number of detections per station
TIME DET.1= time of first detection
DUR(MIN)= length of time between first and last detection

TOT KEER= total number of keer calls
TOT ALT= total number of alternate calls
TOT S= single isolated calls
TOT WING= number of wing beats heard
TOT MULT= number of calls recorded as multiple (included in total keer)
TOT VIS= number of detections that were visual

COMMENTS: Tofino Creek surveys were done by two observers who surveyed alternate stations on each survey.

APPENDIX 17. INCIDENTAL MARBLED MURRELET FIXED STATION SURVEYS ON VANCOUVER ISLAND AND IN THE QUEEN CHARLOTTE ISLANDS IN 1991 AND 1992.

NO.	LOCATION	WATERSHED	SITE	OBSERVER	DATE	WEATHER CLO BEG	CLO END	PREC BEG	PREC END	WIND BEG	WIND END	TIME SUNRISE	TIME DET. 1	DUR (MIN)	TOT DET	TOT VIS
1	Moresby I.(Q.C.I.)	Deena River	upper br.115	FCC GL,CC	910625	100	100	N	N	1	1	04:20	03:41	84	25	2
2	Moresby I.(Q.C.I.)	Deena River	upper br.115	FCC CC	910718	70	70	N	N	2	2	04:43	04:12	122	53	7
3	Moresby I.(Q.C.I.)	Deena River	upper west main	FCC CC	910726	100	100	D	D	0	0	04:54	05:11	129	109	39
4	Vancouver Island	Tofino Creek	5km from estuary	MOE/F TM	920708	100	100	N	N	0	0	04:26	03:50	71	39	23
5	Vancouver Island	Tofino Creek	1000m elevation	MOE/F CM	920710	100	100	R	R	0	0	04:27	04:07	1	1	0

NO.	TOT KEER	TOT ALT	TOT JET	TOT MULT	BEHAVIORS D	C	S	A	HEIGHTS A	B	C	CLOSEST DISTANCE(m) 0–50	51–150	151–50	>501
1	159	0	0	0	1	2	3	0	2	18	3	4	7	14	0
2	535	9	0	0	4	2	0	0	46	0	1	6	2	13	0
3	1224	29	2	0	2	17	2	1	6	96	4	44	55	7	0
4	240	0	0	2	25	12	0	0	36	2	1	35	4	0	0
5	3	0	0	0	1	0	0	0	0	0	0	0	0	1	0

OBSERVERS
MOE: B.C. MINISTRY OF ENVIRONMENT
MOF: B.C. MINISTRY OF FORESTS
FCC: FLETCHER CHALLENGE CANADA LTD.
For second set of initials in observer column see acknowledgements

CLO BEG= % cloud cover at survey beginning
CLO END= % cloud cover at survey end
PREC BEG= precipitation at survey beginning
PREC END= precipitation at survey end
WIND BEG= wind at survey beginning
WIND END= wind at survey end
Abbreviations and number codes for weather are in appendix 2 survey form

TIME DET. 1= time of first detection
DUR.(MIN)= length of time between first and last detection
TOT DET= total number of detections
TOT VIS= number of detections that were visual
TOT KEER= total number of keer calls
TOT ALT= total number of alternate calls
TOT JET= number of "jet" sounds heard
TOT MULT= number of calls recorded as multiple (included in total keer)

BEHAVIORS= No. of detections of:
D: direct flight
C: circling birds
S: stationary call
A: aerial dive
HEIGHTS= No. of detections of:
A: >1 tree height above canopy
B: <1 tree height above canopy
C: below canopy
CLOSEST DISTANCE= distance (horizontal) of the detection from the observer

Appendix 18

MARBLED MURRELET ACTIVITY IN VARIOUS WATERSHEDS

We briefly summarize below the sampling effort and the level of Marbled Murrelet detections for each watershed surveyed. As expected, there is considerable variability in the data. Some watersheds were surveyed more intensively than others so that the results have to be interpreted cautiously. We would like to stress again here that the meaning of the number of detections and calls in a given area is still unclear. Some areas are mostly flying corridors whereas others are likely nesting areas or both. Also the area measurements given for each watershed and the proportion of old growth present in the watershed are rough approximations (see methods). Each watershed is regrouped by ecoregions. No differences were made between various types of old growth (commercial, non commercial, high altitude, low elevation) which may be used differently by murrelets.

COAST AND MOUNTAINS ECOPROVINCE (WESTERN VANCOUVER ISLAND ECOREGION)

NORTHERN ISLAND MOUNTAINS ECOSECTION

115 White River (upper):

Tertiary watershed of 6,134 ha, 4,855 forested with still 80% of the forest old growth. It is located in the White River watershed, a tributary to the Salmon River (see station 118 in the Leeward Island Mountain ecosection). The 5 km road transect was located 41 km from the coast and consisted of 10 stations 0.5 km apart. On June 18, Marbled Murrelets were detected at 5 stations (7 detections, 9 calls) but none were detected on July 9. The fixed station was located in old growth 39 km from the coast. It yielded 23 detections on July 19, calls were not recorded.

38-42-48 Gold River:

All three road transects were located in different secondary or tertiary watersheds. The primary watershed covered 99,785 ha, but the proportion of old growth left in the entire watershed was not estimated. The first road transect (38) was located in the upper portion of Gold River, near Twaddle Lake, a tertiary watershed with 2,651 ha forested of which 55% was old growth. The 6 km transect was located 36 km up the watershed and consisted of 9 stations 0.8 km apart. On June 28, murrelets were detected at 5 stations (9 detections, 84 calls) and on July 10 at 4 stations (17 detections, 87 calls). The fixed station was located in old growth, 36 km from the west coast. On July 17, 64 detections (476 calls, 20 visuals) were recorded there. Twenty-nine detections were of birds flying in a straight line, 18 of circling birds and 8 of birds stationary in the forest. Twenty-two of the detections were less than 50 m away, 30 between 50 and 150 m and 12 between 150 and 500 m. Eighteen detections were of birds, mostly silent, flying below canopy. The second road transect (42) was located along the Upana River, a secondary watershed with 70% of its 5,378 ha still in old growth. The 4.5 km transect was located 27 km up the valley and consisted of 10 stations 0.5 km apart. On June 20, murrelets were detected at 4 stations (7 detections, 75 calls) and on July 8, at 4 stations also (8 detections, 61 calls). The fixed station, located at 27 km and 200 m from the nearest old growth, yielded 19 detections (115 calls) on July 16. The third road transect was located on a tertiary watershed 3,235 ha in size, 69% of which was old growth. The 4.5 km transect was 15 km up the valley and consisted of 10 stations 0.5 km apart. No Marbled Murrelets were detected on any of the three surveys conducted there (June 26, July 5, July 15). Given the relatively high number of murrelet detections in the other watersheds of this area, the

absence of detections in this watershed is surprising. Fixed stations located near old growth should be surveyed there to better assess murrelet use of the area.

121-125,134 Nimpkish Watershed:

This large watershed containing Nimpkish Lake covers 177,180 ha, 159,253 ha forested, 55% still in old growth. Six road transects were located in various secondary watersheds. The first (121) was located near Sebalhall Creek 88 km up the valley in a tertiary watershed of 5,368 ha forested land, 70% still in old growth. The 8 km long transect had 10 stations 0.9 km apart. On June 26, murrelets were detected at 5 stations (6 detections, 106 calls) and on July 9, at 5 stations also (26 detections, 378 calls). The fixed station was located 88 km up the valley but 58 km in direct line from the east coast where the river flows and only 17 km from the west coast. On July 13, 30 detections (591 calls) were recorded at that station. The second road transect (122) was located in a tertiary watershed along the Yookwa River which had 3,259 ha forested. Sixty-four percent of the forest was old growth. The 4.5 km transect was located 77 km up the valley and consisted of 10 stations 0.5 km apart. On June 18, murrelets were detected at 6 stations (29 detections, 435 calls) and on July 3, at 9 stations (47 detections, 841 calls). The fixed station was located 90 m from old growth, 77 km up the valley but only 49 km and 17 km in a straight line from the east and west coast respectively. On July 10, it yielded 27 detections (451 calls). Most of the detections (16) were of circling birds and 4 were birds flying below the canopy.

The third road transect (123) was located in a secondary watershed with 41,338 ha forested area, 56% in old growth. The 9 km long transect was located 65 km up the valley and consisted of 10 stations 1 km apart. On June 28, murrelets were detected at 4 stations (6 detections, 18 calls) but on July 5, only at one (2 detections, 12 calls). The fixed station was located in old growth 65 km up the valley but only 38.7 km from the east coast and 26 km from the west coast. On July 11, it yielded 42 detections (739 calls). At least 17 detections were of birds flying below the canopy. Several of the detections were thought to be coming from stationary locations within the old growth patch.

The fourth road transect (124) was located near Kaipit Creek, 48 km up the valley in a secondary watershed 8,277 ha in size, 7,619 of which was forested with 72% old growth. The 6 km long transect had 10 stations 0.6 km apart. On June 25, murrelets were detected at 5 stations (17 detections, 264 calls) and on July 4 at 5 stations also (11 detections, 37 calls). The fixed station was located in old growth, 48 km up the valley and 37 km and 23 km from the east and west coasts. On July 12, it yielded 16 murrelet detections (113 calls) most (11) birds were less than one tree height above the canopy.

The fifth road transect (125) was located near Pinder Creek, a large secondary watershed with 12,569 ha forested, 56% in old growth. The 7.5 km transect was 43 km up the valley and had 9 stations 0.9 km apart. On June 26, murrelets were detected at 4 stations (21 detections) and on July 4 at 3 stations (9 detections, 29 calls). The fixed station was located in old growth, 43 km up the valley, 38 and 17 km from the east and west coast respectively. On July 12 it yielded 32 detections (368 calls, 11 visuals).

The last road transect (134) was located in a secondary watershed along the Kilpala River. It covers nearly 9,000 ha, 74% still in old growth. The 8 km transect was located 24 km up the valley and had 10 stations approximately 1 km apart. On June 27, murrelets were detected at 6 stations (22 detections, 404 calls) and on July 6 at 6 stations also (20

detections, 239 calls). Ten detections were of birds flying below canopy. The fixed station was located in old growth, 27 km up the valley but only 22 km in a straight line from the east coast. On July 11, it yielded 27 detections, 541 calls with most detections (26) being of circling birds.

The Nimpkish Valley appears to be well used by murrelets as all transects and fixed stations recorded murrelet detections.

126 Eve River:

The road transect was located on a secondary watershed with 24,079 forested ha, 69% still in old growth. All 10 stations of the transects were located over 0.5 km from old growth. This transect was only surveyed once on June 27 and only one murrelet detection was recorded (3 calls) more than 0.5 km from the observer. Obviously more surveys are needed to assess the use of this watershed by murrelets.

127-129-132 Tsitika River:

This watershed has 36,260 forested ha, 87% still in old growth. Three road transects and five fixed stations were surveyed there. The first road transect (128) was located 18 km up the valley and consisted of 10 stations 0.9 km apart. It was surveyed only once on July 23 when murrelets were detected at 4 stations (12 detections, 220 calls) all birds detected were flying high above the canopy. The second road transect (127) was located 6 km up the valley and covered 9 km with 10 stations 1 km apart. On June 14, murrelets were detected at all stations (43 detections, 185 calls); on July 3 at 8 stations (45 detections, 294 calls) and on July 11 at 9 stations (32 detections, 344 calls). Most birds were flying high above the canopy in a straight line. The fixed station associated with this transect was located 5 km up the valley. It yielded 25 detections (240 calls) on July 22, mostly of birds flying high above the canopy in a straight line. The third road transect (129) was located in a secondary watershed, Claude-Elliott Creek, nearly 5,000 ha in size with 87% in old growth. The 4.5 km transect was located 21 km up the valley and consisted of 9-10 stations 0.5 km apart. No birds were detected on June 17 but murrelets were detected at 4 stations (7 detections, 69 calls) on July 4, a clear day. The fixed station of that transect was located in old growth and yielded on July 11, 23 detections (150 calls). The other three fixed stations (132.1 - 132.3) were located in the lower portion of the valley less than 0.6 km from the coast, all were located in old growth and were surveyed in May only. On May 21, they yielded 24, 12 and 2 detections, with 293, 158 and 26 calls respectively. The following morning, the three stations recorded 27, 18 and 8 detections, with 268, 163 and 94 calls respectively.

130-131 Kokish River:

A watershed with nearly 34,700 ha forested, surveyed with two road transects and two fixed stations. The first road transect (130) was located along the east fork of the river, 14 km up the valley. It covered 10 km with 10-11 stations 1 km apart. On June 27, murrelets were detected at 7 stations (27 detections, 406 calls) and on July 12 at 7 stations as well (34 detections, 212 calls). Two fixed stations were surveyed along that transect. The first (130.0) was located 19 km up the valley and yielded 36 detections (266 calls) on July 24. The second (130.1) yielded 70 detections (1140 calls, 32 visuals) on July 24. Most detections (41) were of birds circling. The second road transect (131) was located along the Bonanza River 11.4 km up the valley in a secondary watershed of 14,675 ha and 54% old growth. It covered approximately 8 km with 10 stations.

On June 26, murrelets were detected at 4 stations (6 detections, 54 calls) and at only 1 station on July 12 (3 detections, 62 calls).

133 Bauza Cove Drainage:

Located east of the mouth of the Kokish River this 1000 ha drainage had only 50% of its forested area in old growth. The fixed station was located in old growth near the coast. No murrelets were detected on May 11 but on June 25, 13 detections (202 calls) were recorded.

135 Cluxewe River:

A 9,000 ha watershed with only 36% of its forested area still old growth. The fixed station was located 19 km up the valley 150 m from old growth. On May 20 it yielded 5 murrelet detections (49 calls) and on June 25, 39 detections (449 calls).

NAHWITTI LOWLAND ECOSECTION (NORTH WEST TIP OF VANCOUVER ISLAND)

1 Cape Scott:

The station was located near the coast. It was surveyed only once with a fixed station on June 23. No detections.

2 Fisherman River:

This 8,924 ha watershed is nearly pristine with 90% old growth. The fixed station was located in old growth 4 km up the valley near the mouth of the river. It was surveyed twice for 7 detections on June 29 but 2 only on July 22. Most detections were close to the observer.

3-4 San Joseph River:

This 12,521 ha watershed has been logged with only 58% of its forested area still in old growth. One fixed station was located at the mouth of the river, 2 km up the watershed, near old growth. It was surveyed twice with 5 detections on June 21 in the evening and 23 detections, 6 of which were visual, the following morning. Twenty-one of the detections were within 150m of the observer. Two road transects were located 3.2 km up the valley. The first 2.4 km long road transect had only 5 stations but more than 10 min. were spent at each station. No murrelets were detected there on June 28. The second transect had 4 stations and murrelets were detected twice at one station on July 5. A fixed station was subsequently done at that station on July 28. Only 26 calls were heard in two detections.

5 Ronning Creek:

Small secondary watershed of 2,552 ha, with 75% of its forest old growth. Only four stations were surveyed on this road transect on July 12 but survey length lasted more than 10 minutes at each station. A total of 42 detections were recorded for an average of 10.5 per station. Birds were very vocal with 669 calls being heard during those detections.

6 Hushamu Creek:

This is a relatively small watershed (2,000 ha) with still 70% of its forested area in old growth. The 6 km long road transect was located 5.5 km up the valley and consisted of 9 stations 0.8 km apart. Marbled Murrelets were detected at 3 of 9 stations on the 2 surveys of the road transect. Although only 4 detections were recorded in both surveys, there

might have been more detections as field sheets were not recorded as prescribed. During the fixed station on July 26; 190 calls were recorded within 18 detections. All detections were of birds flying high above the canopy with some possibly circling.

7 Simpson Creek:

Located within a 1,565 ha secondary watershed with still 66% old growth. The road transects had only 4 stations but the observation time at each station was over 10 minutes. The transect was 4 km from the coast with stations 0.8 km apart. The road transects yielded 21 detections (78 calls) on June 21 and 26 detections (196 calls) on July 4. Five visual detections were recorded on June 21 and 12 on July 4. On June 21, 1 bird was seen flying below the canopy but the 12 other detections for which height was recorded occured high above the canopy. The fixed station on July 19 yielded 178 calls and 7 visuals in 15 detections. Some birds were circling and one bird flew below the canopy. There were possibly more detections than recorded.

8-9 Waukwass Creek:

This watershed has been heavily logged with only 39% of its forested area still in old growth forests. The fixed station at the mouth of this creek was located more than 0.5 km from any old growth which may partially explain the low level of murrelet detections there. The fixed station at the mouth of Waukwass Creek was surveyed three times yielding only 1 detection overall on July 18, a visual one of a silent bird flying just above the canopy. Further up the creek near O'Connor Lake one road transect and a fixed station were surveyed. The 10 km road transect had 10 stations, 1 km apart and was located 8 km up the valley. No murrelets were detected on June 26 but 2 of 10 stations had detections on July 8 for a total of 19 calls grouped in 4 detections. Two of the detections were of birds flying in a straight line and two of birds circling. The fixed station located 11 km up the valley yielded only 21 calls in 2 detections on July 23.

10-11 Marble River, Alice Lake:

These two fixed stations were located in a watershed with less than 50% of its forest still in old growth. The Marble River station was located 7 km up the valley in an area that still had some old growth trees despite a history of fires. The Alice Lake fixed station, 9 km up the valley, was nearly 0.5 km from old growth. The Marble River fixed station (10) was surveyed in May, June and July with no detections of Marbled Murrelets. The Alice Lake fixed station (11) was located just up river from the previous station but surveyed only in May, no birds were detected.

136 Mills Creek:

This station is located in a 2,670 ha heavily logged watershed with only 13% still in old growth. The station was located 10 km up the valley, 200 m from old growth. This fixed station was surveyed only on May 11 and yielded only 2 distant detections (13 calls). This is insufficient to properly assess murrelet use of this watershed.

137 Keogh River:

Large watershed of 12,978 ha. Only 26% of this watershed is still old growth and it was not recorded whether the road transect was located near old growth. The transect had 9 stations 1 km apart and was located 5.5 km up the valley. It was surveyed in early June and late July with no murrelets being detected. The profile of this watershed is flat which may

mean that there is no dominant flight corridor for the birds. Monitoring murrelet use in this area may be difficult. More surveys are needed there to confirm the absence of Marbled Murrelets.

138-139 Georgie Lake:

These two stations were located in a nearly pristine 7,135 ha watershed with 93% of its forested area still in old growth. Both fixed stations were surveyed on July 12 and no murrelets were detected. Station 138 was in old growth whereas station 139 was 300 m from old growth. The trees at these stations are however, fairly small.

140 Shusharti River:

This is a pristine 6,929 ha watershed with 100% of its forest in old growth. Two fixed stations were surveyed there on July 28, one at the mouth of the river and one at the mouth of an eastern tributary. Marbled Murrelets were detected at both stations (10 and 16 detections with 208 and 251 calls). This is a large number of detections for such a late survey.

WINDWARD ISLAND MOUNTAINS ECOSECTION

A) **Brooks Peninsula area**

12 Ingersol River:

This 7,690 ha watershed had 60% of its forested area still in old growth. Two road transects were conducted in this watershed, one (12.1) 4 km up the valley and one on the upper slope, 5.5 km up the valley (12.2). Marbled Murrelet activities were three times higher in the downslope transect (12.1) than in the upslope one (13 vs 4 detections in early June and 19 vs 6 detections in late June). Fixed stations also indicated higher murrelet activities at East Main (16 vs 10 detections, 206 vs 26 calls). The difference in murrelet activity between the two stations is likely related to the greater proximity to old growth of the East Main transect (12.1) and fixed station (180 m vs 300 m).

13 Teeta Creek:

This 2,824 ha watershed had 80% of its forested area in old growth. Two road transects were surveyed. One (13.1) along the valley floor 4 km up the valley and one (13.2) on the upper slope, 3 km up the valley. Murrelet detections were similar in both transects in early June (11 detections) but significantly greater in the upslope transect in late June (57 vs 3 detections). Fixed stations at both transects had high levels of detections (40 valley vs 64 upslope). A large proportion of the sightings occurred at close distance and just above the canopy. Again the slight higher level of detections in the upslope transect may be due to its closer proximity to old growth (0 vs 150 m).

14-15 Cayuse Creek:

Nearly pristine 3,075 ha watershed with 95% old growth. A fixed station at the mouth of the creek was surveyed 3 times. Marbled Murrelet detections ranged between 10 and 39 and calls between 106 and 544. The greatest number of detections occurred in July. The station was 2 km up the valley and 200 m from the nearest old growth which may explain the concentration of detections over 200 m from the station. A road transect was located 4.5 km up the valley and yielded 6 detections (16 calls) on June 13 and 23 detections (calls not recorded) on June 28. The fixed

station, located 3 km up the valley in old growth, yielded 58 detections, 25 of which were visuals (527 calls) on July 12.

16-17 Cayeghle River:

This 8,758 ha watershed had 58% of its 7,649 ha forested area still in old growth. A fixed station (16) located 1.5 km up the watershed yielded 5 detections (62 calls) on May 9. A second fixed station was located in a 3,731 ha secondary watershed with 49% of its forested area in old growth. That station yielded 47 detections and 1038 calls on July 14.

18 Klaskino Anchorage:

This small nearly pristine area of 1,083 ha had over 90% of its forested area in old growth. Two fixed stations, both located in old growth, were surveyed. High levels of Marbled Murrelet activities were recorded at both stations: on June 23, 48 detections (740 calls) at one (18.1) and 52 detections (469 calls) at the other (18.2). On July 15 they yielded respectively 44 detections (369 calls) and 16 detections (111 calls). Boat surveys in this area revealed concentrations of Marbled Murrelets on the open coastal waters of Brooks Bay.

19 Klaskish River:

Pristine 5,048 ha watershed surveyed with 2 fixed stations, one just upstream of the estuary and one at the mouth of the river. Both stations had high levels of murrelet activities (38 and 37 detections, 243 and 155 calls on June 21; and 67 and 48 detections, 1164 and 945 calls on July 17). Again, murrelets were found in large numbers along the open stretch of Brooks Bay.

20 South Klaskish (East Creek):

Pristine 4,900 ha watershed surveyed with 2 fixed stations, one at the top end of the estuary and one at the mouth of the river. The station at the mouth of the river (20.2) had slightly fewer detections 20 (176 calls), and 21 (273 calls) than the one at the top end of the estuary (39 (394 calls) and 45 (473 calls)) on June 22 and July 16 respectively. However, murrelets were detected in relatively high numbers during all surveys.

21 Amos Creek:

This station, located at the tip of Brooks Peninsula in a 2,370 ha pristine watershed, was surveyed once on June 25 and yielded only 4 detections and 7 calls. More surveys are needed to characterize the use of this area by Marbled Murrelets.

22 Nasparti River:

Pristine 5,856 ha watershed surveyed from 2 fixed stations located near the estuary. The highest level of Marbled Murrelet activity was recorded at these two stations with over 100 detections (142;113) and 1000 calls (1399;1227) in late June. Detection numbers were lower but still high on July 25 (66 and 49; 867 and 902 calls). Visual detections in the northern section of the estuary were frequent on June 29 with circling pairs being the most common. Activity continued for 3 hours. This high level of activity makes this area a good location for murrelet studies.

23-24 Battle River:

Pristine 3,320 ha watershed surveyed with 2 fixed stations. These stations were located close to the coast and surveyed only once on June

28. The station (#23) furthest inland (150 m) had more detections (11 vs 1). Both stations were surveyed on the same day, a very bright night and bright morning. This may have reduced murrelet activity on that day. Further surveys are needed to fully assess the value of this area for Marbled Murrelets.

25 Power River:

Nearly pristine watershed with a 4,934 ha forested area (98% old growth) surveyed only once with 2 fixed stations on July 24. In this case the station closest to the coast had the most detections (29 (183 calls) vs 4 (22 calls). Because of the late date, the level of Marbled Murrelet activity may have been underestimated at that location.

B) **Kyuquot area**

26-27 Tahsish River:

This watershed of 26,673 forested ha had 79% of its forested area in old growth. One road transect and four fixed stations were surveyed there. The road transect was conducted in the upper portion of the watershed 11 km up the valley and yielded Marbled Murrelet detections at 5 of its 10 stations for a total of 16 detections and 206 calls on July 8. murrelets were also detected on June 30 but in lower numbers. The fixed station associated with the road transect yielded 26 detections and 606 calls on July 12. Eleven detections were visuals. The other three fixed stations were located near the mouth of the river. All three were surveyed on May 15 and had respectively 4,12 and 4 detections. Two were resurveyed on July 2 and had respectively 21 and 29 detections. A few birds were seen flying below the canopy. This river valley is fairly wide which may result in lower numbers of murrelet detections at any given point.

28-29 Artlish River:

This watershed had 82% of its 11,932 ha forested area in old growth. Two road transects and two fixed stations were surveyed. Marbled Murrelet detections were higher in the road transect (#28) located in the upper part of the watershed (21 and 31 detections) than near Turbine Creek (#29) (2 and 9 detections). The fixed stations on these two transects confirmed the greater murrelet activity level at the upper transect with 42 detections and 377 calls vs 29 detections and 166 calls at the lower transect. Some murrelets were also seen flying below the canopy in the upper station. More stations (9 vs 6) of the road transects were within 0.5 km of old growth in the upper transect. However the fixed station of the upper transect was located slightly further from old growth (180 vs 120 m). In both surveys, total detections may well have been greater because the survey did not continue for the required 15 min. of silence after the final detection.

30 Kaouk River:

This 11,042 ha watershed had been more intensively logged than the two previous ones with only 55% of its forest still in old growth. No murrelets were detected on the road transect on July 5, but 18 detections were recorded on July 16. The fixed station surveyed on July 19 yielded 38 detections and 294 calls. Several birds (12) were seen flying below canopy. The fixed station, located in old growth, was surveyed on a clear morning and may have yielded more detections on a cloudy day.

31-32-33 Zeballos River:

The 15,057 ha forested area of this watershed is still 72% old growth. Three fixed stations were surveyed once on May 14. The station located in the mid-upper portion of the watershed had 12 detections (108 calls) compared to only one detection each for the other two stations. All 12 detections were of birds in the distance (150 m away). Murrelet activity levels may have been underestimated in the watershed because overall, May surveys yielded significantly fewer detections than June and especially July surveys. The day of the survey was also a relatively cloud free morning which usually produces fewer detections. Finally, the station at the mouth of the river (33) was more than 0.5 km from old growth. More surveys are needed to fully assess the use of this watershed by murrelets.

34 Nomash River:

This is a tributary of the Zeballos River with 69% of its 3,466 ha forested area in old growth. On July 4, Marbled Murrelets were detected at 3 of 9 road stations (3 detections of which 2 were visuals) and on July 15 at 4 of 9 stations (7 detections). The fixed station, located in old growth was surveyed on July 18 and yielded 92 detections (1644 calls). Most detections (78) were >150 m from the observer and 4 were within 50 m. Possibly July surveys on the Zeballos River could produce similar numbers.

35 Rugged Point:

Small area of approximately 1,000 ha with still 50% of its forest in old growth. Seven fixed stations were surveyed there, mostly in May. Marbled Murrelet detections ranged between 1 and 17 (0-152 calls). Visual detections ranged between 0 and 7, and several birds (up to 9 on one survey) were seen or heard flying below the canopy within 50m of the observers. All stations were located within old growth patches. Several birds were seen to fly silently out of and into trees near observers, but efforts to determine which trees were unsuccessful.

36 Kapoose and Porrit creeks:

These two small watersheds, totalling 4,000 ha (50% old growth) were surveyed along one road transect with 4 stations in each valley. A road transect on July 24 yielded murrelet detections at 4 of 8 stations for a total of 9 (122 calls). A fixed station surveyed the next morning 4.5 km up Kapoose Creek, yielded 85 detections (1306 calls) with 22% of the detections within 50 m of the observer, 26% between 50-150 m and 52% over 150 m. This is interesting given that the station was 150 m from the nearest old growth. Twenty one of the detections were visual, with the majority of birds above the canopy.

37 Tara and Tatchu creeks:

These two small watersheds were surveyed along one road transect, with 4 stations in each valley. The combined area of the two drainages is 5,000 ha of which 67% was old growth. Only half the stations were surveyed on July 9 yielding only one detection. On July 10, murrelets were detected at 4 of the 8 stations for a total of 8 detections (39 calls). The fixed station surveyed on July 26 near the mouth of Tara Creek yielded 18 detections (248 calls) all over 150 m from the observer. The station was in an old growth patch.

The watersheds of this section were all used by Marbled Murrelets but the level of detections is not overly high, usually under 50 detections. However, three stations were only surveyed in May and one in the same area

had 92 detections in July. Thus there might be more murrelet activity in this sector than the data shows.

C) Nootka Sound area

39-40 Conuma River:

A 1,200 ha watershed with still 74% of its 9,831 ha forested area in old growth. One road transect and two fixed stations were surveyed there. On June 21 Marbled Murrelets were detected only once visually but on July 4 they were detected at 3 of 10 stations (5 detections, 16 calls). The fixed station associated with the road transect yielded, on July 12, 44 detections (513 calls), 5 of which were visuals. The other fixed station (#40) surveyed on July 11, yielded 142 detections (1503 calls), 72 of which were visuals with a large proportion of silent circling birds flying below the canopy. Most detections (48%) were within 50 m of the observer and 29% between 50 and 150 m. Murrelet activity was concentrated in the old growth forest across the creek from the survey site and the station may prove a good place for more detailed observations of murrelet behaviour.

41 Canton Creek:

Small watershed of 4,000 ha with still 80% of its 2936 ha forested area in old growth. A few murrelets were detected during the two road transects (4 on June 27 and 2 on July 9). The fixed station surveyed on July 18 yielded 18 detections (193 calls). The station was located 240 m from old growth which may explain that 83% of the detections were between 150-500 m from the observer.

43-44 Nesook River:

Nearly pristine secondary watershed of 5,766 ha with 92% in old growth. On the road transect (#43), murrelets were detected at 4 of 10 stations (4 detections) on June 19 and at 5 of 10 stations (14 detections) on July 3. The fixed station on that road transect yielded 35 detections (226 calls) on July 11 with 12 visual detections. Another fixed station (#44) surveyed on June 14 and July 10 yielded respectively 3 and 111 detections (5 and 2267 calls). Twelve of the detections on July 10 were visual, mostly of silent birds below the canopy. The activity on that day continued for nearly 3½ hours.

45 Cougar Creek:

Small watershed of 1,500 ha with 65% of its forested area in old growth. The two surveys at the fixed station yielded 52 detections (145 calls) on June 16 with 26 visual detections and 82 detections (846 calls) on July 10. In both surveys 27 and 22 birds were seen flying below canopy. Many of the visual sightings were of silent birds. Ease of access in this area and the concentration of murrelet activity makes the area a good location for murrelet observations.

46 Deadman Creek:

Very small watershed of 350 ha still 90% old growth. Three fixed stations were surveyed there. One station (46.1) was used as a training session on May 4 and yielded 27 detections (223 calls). The second station (46.2) was surveyed 5 times between May 5 and July 11 and yielded a maximum of 43 detections (652 calls) on May 5. The third station (46.3) was surveyed on June 16 and produced 5 detections (12 calls).

47 Hanna Creek:

Small watershed of 950 ha with only 60% of its forest in old growth. Surveyed only once on June 16, the fixed station yielded 9 detections (33 calls). Cloud cover was only 50% during the survey which may have reduced murrelet activity that day.

49 Mooyah River:

A large watershed (4,000 ha) with only 58% still in old growth. No murrelets were detected during the first survey of the road transect on June 28 but murrelets were detected at 8 of 9 stations for 23 detections (273 calls) on the second survey on July 10. The fixed station surveyed on July 24 yielded only 4 detections (67 calls). We have no explanation for such a variability there, although the 3rd survey was quite late in the season, perhaps after most birds had left. But such variability cautions about interpreting too closely detection values.

50 Escalante River:

A 8,000 ha watershed with still 60% of its forested area in old growth. The only fixed station was surveyed 3 times yielding: 1) on June 26, 26 detections (179 calls); 2) on July 10, 92 detections (1629 calls) including 45 visual detections (10 birds, 7 of which were silent were seen flying below the canopy) and; 3) on July 24, 54 detections (1070 calls), 12 visual detections.

51 Hesquiat Lake:

A nearly pristine watershed (95% old growth) covering 5,500 ha surveyed by a fixed station. Marbled Murrelet detections varied greatly between the 3 surveys done at that station. On June 25, 25 detections (418 calls) were recorded compared to 166 (26 visual detections, 2446 calls) on July 9. Only 2 detections (4 calls) were recorded on July 23 possibly a result of weather conditions (a very clear morning) and the late date of the survey. Marbled Murrelet forest activity decreases considerably in late July (Rodway *et al.* 1991).

52 Hesquiat Point Creek:

Small watershed of nearly 2,000 ha and with 77% of its forest in old growth. High levels of Marbled Murrelet activities were detected during all three surveys at the fixed station: 98 detections (144 calls) on June 25, 96 detections (642 calls) on July 9 and 63 detections (372 calls) on July 23. This station had an exceptionally high number of visual detections (90, 57 and 50) which permits a close look at the behaviour of the birds. The proportion of circling birds as opposed to birds with direct flights was 48% on June 25, 24% on July 9 and 30% on July 23. Most birds flew less than one tree height above canopy (86%, 54%, 48% on respective surveys). Several of the birds even flew below the canopy (12%, 43%, 42%). On June 25, most detections (61%) were between 150 and 500 m of the observer with only 5% within 50 m. However, on the subsequent two surveys only 3% of the detections were over 150 m with 46% within 50 m on July 9 and 33% on July 23.

The sector covered by stations 50 (Escalante River), 51 (Hesquiat Lake) and 52 (Hesquiat Point Creek) seemed to be heavily used by Marbled Murrelets and would make suitable sites for further studies. Marbled Murrelets were detected in all surveyed watersheds of the Nootka Sound area suggesting that this portion of the coast is well used by murrelets.

D) Clayoquot Sound and Tofino area

53 Megin River:

This large watershed of nearly 26,000 ha is still pristine with a forested area of 23,600 ha. Three fixed stations were surveyed there. The station at the mouth of the river had very few detections (4 on June 20 and 0 on July 25). The station below Megin Lake (50.1)had the most detections, 46 (589 calls) on July 14 and the station at the east end of Megin Lake (53.2) had only 1 detection on July 13. Whether this low level of detections represents poor use of the area by murrelets or merely reflects poor location for the stations is unknown. The station below Megin Lake suggests that murrelets use the watershed but more surveys may be required to fully evaluate levels of murrelet activity in that watershed.

54 Moyeha River:

Large pristine watershed of nearly 18,000 ha (13,694 ha forested). The single fixed station survey on June 19 was done under a clear sky (which has been shown to decrease murrelet activity) and yielded only 1 detection (9 calls). The second survey on July 25 was done under cloudy conditions but only 8 detections (54 calls) were recorded. However, surveys indicate that murrelet activity levels in the forest decrease by late July. This low level of detections in a pristine watershed is puzzling but may again be due to local conditions at the station. Pristine watersheds may be more difficult to survey because of access problems and possible difficulties in finding open areas. Further surveys are needed to assess murrelet use of this watershed.

55 Bedwell River:

A 21,474 ha watershed with only 16,513 ha forested. It still has 88% of its forest in old growth. The station was located near the mouth of Ursus Creek more than 500 m away from old growth. A single fixed station was surveyed once on a sunny day on June 28 and no murrelets were detected. Clearly more surveys are needed to assess murrelet use of this watershed.

56 Ursus Creek:

A tributary to the Bedwell River, this pristine secondary watershed, 7,756 ha in area, has 6,685 ha forested. It was surveyed in the evening of June 26 with no murrelets being detected. The following morning 9 detections (65 calls) were recorded under a partially clear sky. All the detections were visual, 5 detections were of circling birds and 4 of birds flying in a straight line. 1 detection was of a bird flying below canopy. Again one would expect more detections from such a pristine watershed.

57 Cypre River:

A smaller primary watershed, only 5,652 ha in size and with 64% of its 5,442 ha forested area in old growth. Ony one Marbled Murrelet detection was recorded on the road transect on June 12 but 7 detections were spread over 3 of 9 stations on June 27. The number of calls were not recorded during these two surveys. The fixed station, located in old growth, yielded 37 detections, 10 of which were visuals. The partially clear sky on both the road transect and at the fixed station, were not ideal survey conditions.

58 Bulson Creek:

Nearly pristine watershed with 98% of its 7,361 ha forested area still in old growth. Three fixed stations were surveyed there. The first, located

on the east side of Bulson Creek, was surveyed on a clear morning on June 19 and yielded 14 detections (217 calls). The second station, at the mouth of the creek, was surveyed on a cloudy day on July 3. It yielded 82 detections (1504 calls), with 34 visual detections of which 30 were vocal. Seven of the visual detections were of birds flying below canopy. The third station was upstream, and was surveyed on a clear morning on July 18. It yielded 34 detections (491 calls), with 18 visual detections. These observations suggest that the watershed is used substantially by Marbled Murrelets.

59 Tranquil Creek:

This watershed covers 6,170 ha, 5,305 of them forested. Old growth still represents 75% of the forested area mostly in the upper parts of the watershed. The road station was located mid-way up the watershed. Marbled Murrelets were detected at 4 of 7 stations (6 detections, 110 calls) on June 26 and at 6 of 7 stations (36 detections, 522 calls) on July 9. The fixed station may have been surveyed too late in the season (July 26) as it yielded only 7 detections (72 calls).

60 Tofino Creek:

Nearly pristine watershed (90% old growth) almost 6,000 ha in area. The road transect was located about 25% of the way up the watershed. On the June 18 survey, Marbled Murrelets were detected at 2 of 8 stations (3 detections, 52 calls) and on July 4 at 5 of 9 stations (13 detections, 89 calls). The fixed station, surveyed on July 19 and located 200 m from old growth, yielded 12 detections (95 calls).

61 Kootowis Creek:

Small watershed of 2,646 ha with only 20% of its forested area still in old growth located mostly in the lower portion of the creek in Pacific Rim National Park. The fixed station was situated at the mouth of the creek near the estuary. On June 20, 38 detections (307 calls, (12 visual detections) were recorded and on July 16, 46 detections (520 calls, 17 visual detections) were noted. In both surveys the majority of birds were above the canopy. This level of detection is much higher than in several of the pristine watersheds surveyed. More surveys are needed to determine whether this high number of detections is due to an intensive use of the remnant old growth or the use of a flight corridor for birds travelling to the Kennedy Lake watershed. Murrelets were seen frequently in the waters of Grice Bay, adjacent to the estuary of Kootowis Creek.

62 Kennedy Lake, Clayoquot Arm:

Secondary watershed with a forested area of 13,856 ha, 75% still in old growth forest. On June 20, only 1 detection (7 calls) was recorded and none were recorded on July 16. The station was located 500 m from the nearest old growth which may partially explain the low detection levels obtained. Clearly more surveys are needed at different locations of the watershed to assess murrelet use of that system.

63-64 Sandhill Creek:

Small 2,118 ha watershed of low relief with still 60% of its area in old growth. Three fixed stations and one road transect were surveyed, one at the mouth of the river (63.1), one on the sand dunes (63.2) and one slightly inland (64). The station at the mouth of the river had the highest level of detections with 6 (36 calls) on June 20 and 17 (150 calls) on July 19. The sand dune station had no detections on June 20 and 4 (11 calls) on July 19. One road transect was surveyed twice; on June

20, 6 of 10 stations had murrelet detections for a total of 9 detections (75 calls) and on July 5, 7 of 10 stations had murrelet detections totalling 15 (58 calls) with 7 visual detections, of birds flying in a direct line above the canopy. A fixed station associated with this road transect was surveyed on July 18 and only 3 detections (33 calls) were recorded.

65 Lost Shoe Creek:

A watershed of nearly 3,000 ha with 50% of its forest still old growth. Lost Shoe Creek is located in Pacific Rim National Park in the low elevation land west of Kennedy Lake. Three fixed stations were surveyed. The first station was near the mouth of the creek (65.1) and surveyed only on June 20. It yielded only 5 detections, all visuals, with one of the bird calling once. Two of the birds flew below the canopy and three just above. The second station was at Florencia Beach. On June 20, 13 detections were recorded, all visual with only 2 calls heard. One bird was seen circling while the others flew in a straight line. A second survey at this station on July 19, yielded only 5 detections. The third station was located near the information center, futher inland, and it yielded 6 detections (38 calls) with no birds seen on July 5.

66-67 Kennedy River:

A large watershed of nearly 45,000 ha, 67% of its forested area still in old growth. Three road transects were surveyed there but no fixed stations. The first road transect (66.1) was located in the lower portion of the Kennedy River: on June 20 Marbled Murrelets were detected at 9 of 10 stations for a total of 10 detections (20 calls) and on July 3, murrelets were detected at 7 of 10 stations but more often (32 detections, 217 calls). The second transect (66.2) was located near Canoe Creek and surveyed on July 19. Murrelets were detected at 6 of 10 stations (11 detections, 51 calls). The third transect (67) was near the mid-section of the watershed and was surveyed three times: Birds were detected at 2 stations, (3 detections, 8 calls) on June 21, at 5 stations (13 detections, 219 calls), on July 4 and at 6 stations (8 detections, 173 calls) on July 18.

69 Nahmint River:

This watershed contains 18,833 ha forested land (80% old growth). A road transect located upstream of the lake was surveyed on June 22 and yielded 16 detections (78 calls) over 7 of the 10 stations. A fixed station associated with that transect was surveyed on July 23. No murrelets were detected, but the season was well advanced and the day clear, conditions usually associated with lower detections.

70 Toquart-Lucky Creek:

Nearly pristine primary watershed with a forested area of 13,417 ha, 88% of which was still old growth forest. The 8 km long road transect was located 3 km up the valley with a distance of 1 km between the 8 stations. The transect was surveyed three times but yielded few murrelet detections: 1 (1 call) on June 18, 1 (3 calls) on June 27 and none on July 18. The transect was along a road that did not follow a valley system which may have decreased the chances of detecting murrelets.

71 Maggie Lake (Toquart Bay):

Small watershed with a forested area of 5,100 ha and with only 27% old growth remaining. The 6 km long road transect was located 2 km up the

valley and stations were 0.8 km apart. One murrelet was seen on June 18 but none on July 7.

72 Skull Lake:

Small watershed of 3,143 ha with still 60% of its forested area in old growth. The 3 km long road transect was 2 km up the valley and the 8 stations were 0.5 km apart. Marbled Murrelet detections were higher there than in the previous two areas: on June 18, 2 detections (5 calls) were recorded and on July 3, 20 detections (196 calls) distributed between 7 stations were registered. Seven of the detections were of birds flying below the canopy and 13 were of birds flying just above the canopy. Most of the detections (15) were within 50 m of the observer. The fixed station was located 1 km up the valley approximately 100 m from old growth and surveyed on July 17. A total of 34 detections (530 calls) were recorded. Two detections were from birds calling from a stationary point, 7 of birds circling and 20 of birds flying in a straight line. Most detections (29) were of birds flying high (>1 tree height) above the canopy . Fifteen detections were within 50 m of the observer, 7 between 51 and 150 m and 9 beyond 150 m.

E) Bamfield area

77-78 Sarita River:

This large watershed with a forested area of 18,369 ha has been extensively logged with only 30% of its forest still old growth. Two road transects were surveyed there, one (77) located 10 km up the valley and the other (78) only 3.5 km up the valley. Both transects had 10 stations located 0.5 km apart and were approximately 5 km in length. The lower transect (78) was surveyed in June and had fewer murrelet detections (0 on June 13 and 2 on June 28) than the upper transect (77) (20 on July 3 and 9 on July 11) surveyed in July. However, both fixed stations along these transects were surveyed in July and they confirmed the pattern observed in the transects with the upper station (77) having more murrelet detections (35 detections, 673 calls, on July 19) than the lower station (78) (4 detections, 25 calls on July 12). The upper fixed station was, however, located closer to old growth (300 m) than the lower station (>500 m).

79 Pachena River:

This watershed covers 5,073 ha and has been heavily logged also, with only 23% of its forested land still old growth. The road transect was located 2.4 km up the valley and was 4.5 km in length with 10 stations 0.5 km apart. During two surveys in June, only one Marbled Murrelet was detected, a visual detection on June 28. None had been detected on the June 13 survey which was carried out on a very clear morning. The fixed station was located in old growth, 0.5 km from the mouth of the river. Only 11 detections (15 calls) were recorded there. Ten of the detections were visuals. Six were of birds flying in a straight line above the canopy and 5 were of birds circling high above the canopy. Ten of the detections were within 150 m of the observer.

80-81 Klanawa River:

Large forested watershed, nearly 24,000 ha in size with still 66% of its forested area old growth. Two road transects were surveyed in this watershed, one (80) located 7 km up the valley and the other (81) located 17 km up the valley. Both transects had 10 stations located 0.5 km apart covering approximately 5 km. The upper transect (81) had fewer numbers

of murrelet detections (20 on June 13 and 16 on June 28) than the lower transect (80) (64 on July 3 and 58 on July 11). This may be due to the survey date. The two fixed stations were both surveyed in July. The upper transect (81) had a higher level of detections (112 detections, 253 calls on July 19) than the lower transect (80) (34 detections, 369 calls). However, the lower fixed station was located 300 m from old growth whereas the upper one was in old growth, which may account in part for the differences in detection numbers. Overall, this watershed is well used by Marbled Murrelets.

82-83-84 Nitinat River:

This very large watershed covers nearly 80,000 ha with 76,645 ha being forested. Only 32% of its forested area is still covered by old growth. One road transect and three fixed stations were surveyed in that watershed. The road transect was located 29 km up the valley and had 10 stations 0.5 km apart. Only 3 stations had Marbled Murrelet detections on July 3 for a total of only 4 detections and 4 calls. No murrelets were detected on July 11. The fixed station associated with this transect (83) was located 26 km up the valley and more than 0.5 km from the nearest old growth. Nine detections (33 calls) were recorded there on July 19. The second fixed station (82) was located 39 km up the valley but still more than 0.5 km from old growth. Marbled Murrelets were detected in only one of the 3 surveys at that station (4 detections on June 19, none on July 3 or 19). The third fixed station (84) was located 24 km up the valley and 300 m from old growth. Again Marbled Murrelets were only detected on one of the three surveys (10 detections, 104 calls on July 3, none on June 19 or July 11). Results suggest low use of the valley by Marbled Murrelets. However, all survey stations were located near or in second growth forest. It would have been difficult to detect any murrelets using the remaining old growth. Surveys closer to the remaining old growth would be necessary to assess whether Marbled Murrelets use the valley in any numbers.

85 Cheewhat River:

This small low relief watershed adjacent to Nitinat Lake within Pacific Rim National Park had 87% of its 2,490 ha forested land in old growth. A station at the mouth of the creek was surveyed twice. An evening survey on July 9, yielded a detection of 3 silent birds, and the following morning, 2 detections (4 calls).

86-87 Caycuse River:

A secondary watershed within the Nitinat River watershed. It covers nearly 19,600 ha and has been extensively logged with only 28% of its forested area still old growth. Two road transects and two fixed stations were surveyed there. The first road transect (86) was located 26% up the watershed and the second (87) in the mid-portion of the watershed. Both had 9-10 stations located 0.8 km apart and covered approximately 7 km. All surveys of the road transect occurred on clear days. Both road transects yielded high numbers of murrelet detections. In the lower transect (86) Marbled Murrelets were detected at 3 of 9 stations on June 18 (8 detections, 18 calls) and at 8 of 10 stations on July 3 (40 detections, 507 calls). In the upper transect (87) murrelets were detected at 9 of 9 stations on June 18 (24 detections, 143 calls) and at 8 of 10 stations on July 3 (20 detections, 310 calls). The fixed station associated with the lower transect (86) was located in old growth and yielded on July 11, 39 detections (424 calls) 17 of the detections being visual. The fixed station associated with the upper transect (87) was located 200 m from old growth and yielded on July 17, 39 detections (795 calls). Apparently the distance of these fixed stations from old growth

affected the distance at which murrelets were detected. In the station located in old growth (86), 79% of the detections were within 150 m of the observer compared to 0% at the station (87) 200 m from old growth. There was also interesting differences in the flight behaviours of birds. At station 86 in old growth, 23 detections were of birds flying in a straight line and only 9 of birds circling, whereas at station 87, 9 detections were of birds flying straight and 30 of circling birds. This may explain the higher number of calls heard at station 87 as circling birds would be heard more often than birds moving away. Finally, birds at station 87 were flying high above the canopy, where circling birds are often seen, whereas those at station 86 tended to fly closer to the canopy.

88-89-90 Walbran Creek:

Primary watershed of 13,152 ha with still 86% of its forested area in old growth. Three fixed stations were surveyed in this watershed. The first (88) was located 20 km up the valley in the headwaters, about 100 m from old growth forest. It was surveyed only once on June 12 and yielded only 2 detections (12 calls). The second station (89) was located 18.5 km up the valley and 200 m from old growth. It yielded 7 detections (128 calls) on May 29 and 7 detections (30 calls) on June 12. The third station was located 16 km up the valley and 100 m from old growth. It was surveyed once on May 29 and yielded 7 detections (73 calls). It is in this watershed that the first Marbled Murrelet nest in British columbia was found. Two more nests were found in this valley in 1992 (Burger, pers. comm.). The survey stations of this study were located near the headwaters of the creek, and none of the fixed stations were surveyed in July, which may partially explain the relatively low number of detections recorded.

F) Port Renfrew area

91-92 Gordon River:

This watershed covers 30,972 ha and has been extensively logged with only 21% of its forest still old growth. Station 92 on Braden Creek was located in a secondary watershed covering 5,099 ha and with still 50% of its forested area old growth. The first road transect (91) was located 7 km up the valley and had between 9 and 11 stations approximately 0.6 km apart. On June 20, Marbled Murrelets were detected at 5 of 9 stations (16 detections, 51 calls) and on July 4, murrelets were detected at 8 of 11 stations (45 detections, 447 calls with 10 visual detections). The fixed station associated with that transect was located 6 km up the valley but its distance from old growth was not recorded. On July 18, it yielded 18 detections (118 calls) of which 13 were visual. However, it was surveyed on a clear morning and more detections may have been obtained on a cloudy morning. The second road transect (92) was located 10 km up the Gordon River watershed in a side valley (Braden Creek). It covered 8 km with 10 stations located 0.8 km apart. On June 20, Marbled Murrelets were detected at 7 stations (33 detections, 523 calls) and on July 4 at 9 stations (61 detections, 1116 calls). The fixed station was located 100 m from old growth and was also surveyed on a clear day. On July 18 it yielded 8 murrelet detections (71 calls).

93,95-98 San Juan River:

This watershed covers nearly 64,500 ha and has only 24% of its forested area in old growth. One road transect (93) and one fixed station (93) were located in the lower portion of the watershed. The transect was located 9 km up the watershed and covered 10 km with 9-11 stations 1 km apart. On June 20, murrelets were detected at 5 of 11 stations (9

detections, 59 calls) and on July 4 at 4 of 9 stations (6 detections, 65 calls). The fixed station was located 5 km up the watershed at an unknown distance from old growth. It was surveyed on a clear morning on July 18 and yielded 6 detections (38 calls). The four other road transects and two fixed stations were all located in the upper portion of the watershed. They were in a secondary watershed of 6,106 ha with only 22% of its forest in old growth. The first road transect (95) was located in a secondary watershed 34 km up the valley and consisted of 9 stations 0.5 km apart. On June 19, murrelets were detected at 3 stations (3 detections, 27 calls) and on July 3 at 5 stations (5 detections, 48 calls). The fixed station of this transect was located 34 km up the main watershed in old growth but not on the transect itself. On July 17, 74 detections (1458 calls) were recorded at that station. Most detections (67) were of birds circling, again a likely cause of the large number of calls. Most birds were detected at least 150 m from the observer high above tree canopy. There were 53 visual detections and 6 birds seen flying through the canopy. The second road transect (96) was located 46 km up the main watershed. The transect consisted of 13 stations 0.5 km apart, covering 7 km. It was surveyed three times with only 1 detection (3 calls) being recorded on July 17, none were recorded on June 19 and July 3. No fixed station was surveyed there. The third road transect (97) was located 44 km up the main watershed. It was 4.5 km long with 10 stations 0.5 km apart. No birds were detected on June 19 and only 1 (2 calls) on July 3. The fixed station was 360 m from old growth and yielded only 2 detections (1 call) one of which was visual on July 17. The fourth road transect (98) was 45 km up the main watershed and similar to the previous one. No birds were detected on either June 19 or July 3. All transects surveyed had low Marbled Murrelet detections with the transect in the lower portion of the secondary watershed having the most detections. However, the only fixed station that was located in old growth recorded a high number of detections suggesting that the remaining old growth of this watershed may still be used by Marbled Murrelets. Further surveys are needed, however, to confirm this. It is also interesting to note, that any birds using this area, are nearly equidistant in a straight line from both the east and west coast of Vancouver Island.

94 Loss Creek:

This watershed of 7,531 ha had still 61% of its forested area in old growth. The road transect was located 17 km up the watershed and had 8 stations about 3 km part. On June 3, only 2 detections (9 calls) were recorded and 2 (3 calls) on June 8. The fixed station was located in old growth and was surveyed early, on June 10, yielding only 1 detection (5 calls). Further surveys are needed in this watershed, especially in July to better assess its use by Marbled Murrelets.

GEORGIA DEPRESSION ECOPROVINCE (EASTERN VANCOUVER ISLAND ECOREGION)

NANAIMO LOWLAND ECOSECTION

107 Englishman River:

This large watershed covers 31,640 ha, with only 12% of the 30,944 ha forested area still in old growth. Two road transects and one fixed station were surveyed in this watershed. The 10 stations were 0.5 km apart. The first transect (107.1) was located 11 km up the watershed with all the stations being at least 0.5 km from any old growth. No birds were detected on the two surveys of this transect (on June 13 and 26). The fixed station was located 13 km up the watershed and more than 0.5 km from old growth. No birds were detected on July 12. The second road transect (107.2) was located 15 km up the watershed and all stations were at least

0.5 km from old growth. No murrelet detections were recorded on either survey (June 13 and 26). The absence of detections is not surprising given the distance of the stations from old growth. It would be very interesting to assess whether the limited old growth left in that watershed is used at all by murrelets.

110 Tsable River:

This watershed covers 11,180 ha, 10,910 forested but only 38% still in old growth. One fixed station was surveyed only once on July 12 with no murrelet detections being recorded. The station was located 6 km up the valley and was > 0.5 km from old growth. This watershed has not been surveyed adequately. More surveys are needed, especially in areas closer to the old growth still present in the watershed, to determine the level of use by murrelets.

112 Oyster River:

This large watershed covers 35,455 ha, 32,860 being forested. It has been intensively logged but 37% of its forest is still old growth. The watershed covers two ecosections and was surveyed with one transect in each ecosection. The road transect in this ecosection was located 22 km up the watershed and consisted of 9 stations 1 km apart. On June 25, 2 stations had murrelet detections (3 detections, 21 calls) and on July 10, 5 stations had detections (21 detections, 392 calls). Fifteen of the detections were of circling birds and only 4 of birds flying in a straight line. All detections were of birds flying high above the trees. The fixed station was located 22 km up the watershed and in old growth. It was surveyed late in the season on July 25, and this may have resulted in a lower number of detections. Twelve detections (79 calls) were recorded. Marbled Murrelets used the valley but more surveys are needed in mid-July to fully assess the level of use.

LEEWARD ISLAND MOUNTAIN ECOSECTION

99 Robertson River:

This secondary watershed covers 10,645 ha and has been almost completely logged with only 7% of its forested area still in old growth. The road transect consisted of 9 stations 0.5 km apart located 55 km up the main watershed (Cowichan River). No birds were detected on either June 19 or July 3. A third survey was conducted on July 17 along a spur road near the previous survey at 3 stations within an old growth patch for half an hour per station instead of 10 minutes. Murrelets were detected at all 3 stations (7 detections, 54 calls). Again fixed stations should be surveyed in this watershed especially in areas with patches of old growth.

100,102 Cowichan River:

This is one of the largest watersheds surveyed, covering a forested area of 116,024 ha, of which only 6% is still in old growth. Only one road transect and two fixed stations were surveyed in this watershed. One of the fixed stations (100) was located 23 km up the watershed more than 0.5 km away from old growth. No murrelets were detected on any of the three surveys (June 21, July 4, July 16). The road transect (102) and the other fixed station were located on the north-east shore of Cowichan Lake. The road transect had 9 stations located 1 km apart. On July 4, murrelets were detected at 2 stations (6 detections, 44 calls). The fixed station was more than 0.5 km from old growth and 45 km from the coast. It yielded 12 detections (206 calls) on July 20. Seven of the detections were

circling birds high above the canopy. The remnant old growth should be surveyed in this watershed to determine whether Marbled Murrelets still use it. More stations need to be surveyed in this large watershed to properly assess its use by murrelets.

101 Chemainus River:

Heavily logged watershed covering 35,483 ha and with only 5% of this area still in old growth. The single road transect was located 45 km up the watershed and covered 6.5 km with 10 stations 0.9 km apart. No murrelets were detected on either June 19 or July 3. However, all the road stations were more than 0.5 km away from any old growth and no fixed stations were surveyed in this watershed. Greater survey effort is needed, especially near remaining old growth, to determine if any murrelets use the watershed.

103-106 Nanaimo River:

This watershed covers 85,248 ha, 84,724 of which are forested, but heavily logged in the past. Only 13% was still in old growth forest. Four road transects and two fixed stations were located on various secondary watersheds. The first road transect (103) was located in a secondary watershed nearly 21,000 ha in size and with 22% of its forest in old growth. It had 10 stations 0.9 km apart located 40 km up the main watershed and all more than 0.5 km from any old growth. No murrelets were detected in the two surveys conducted (June 19, July 3). The second road transect (104) was located in the same secondary watershed near Jump Creek, 35 km up the main watershed. Ten to twelve stations, 1 km apart were surveyed. Two murrelet detections (16 calls) were recorded in the distance on June 21 but none on July 5. A fixed station was surveyed on July 12 yielding only 3 detections (41 calls) all very distant birds. The third transect (105) was again in the same secondary watershed near Dunsmuir Creek, 36 km up the main watershed. It consisted of 8 stations 1 km apart with 3 at least within 0.5 km of old growth. No murrelets were detected in either of the two surveys (June 19, July 3). The fourth road transect (106) was located 32.5 km up the main watershed. It consisted of 10 stations 1 km apart. On June 21, murrelets were detected at 4 stations (8 detections, 76 calls) and on July 5 at 2 stations (3 detections, 6 calls). The fixed station surveyed on July 19 yielded only 2 detections (22 calls). Few murrelets were detected in this watershed, again surveys concentrated on the remnant old growth are needed to better assess the level of use of this valley by Marbled Murrelets.

75-76 China Creek:

This 11,418 ha watershed had only 27% of its forested area still in old growth. One road transect and two fixed stations were surveyed there. The road transect (76) was located 3 km up the valley and consisted of 10 stations 0.5 km apart. Murrelets were only detected at one station (1 detection, 8 calls) on June 14, none were detected on June 28. The fixed station on this road transect was located over 0.5 km from old growth. No murrelets were detected there on July 19. The other fixed station (75) was located 8 km up the valley over 1 km away from old growth. On May 27, two distant detections of 32 calls were heard. As in many of the heavily logged watersheds more surveys in the remnant old growth are needed to determine if murrelets still use the area.

68-74 Sproat and Great Central Lake:

This huge watershed covers nearly 131,000 ha, 113,000 forested and 45% of which still in old growth forest. Two road transects were located within this watershed. One near Stamp River (74) 14 km up the watershed. It had

8 stations located 0.6 km apart, all over 0.5 km from old growth. No murrelets were detected there during the two surveys (June 24, July 8). The other road transect (68) was located at the northwest end of Sproat Lake within a secondary watershed with a forested area of 33,618 ha, 47% still in old growth forest. On June 22, murrelets were detected at 6 of 10 stations (6 detections, calls not recorded) and on July 14 at only 2 of 12 stations (3 detections, 9 calls). Few murrelet detections were recorded in this watershed but given the size of the area more surveys are needed.

108-109 Cameron River:

Like most watersheds on the southern east coast of Vancouver Island, this 25,061 ha watershed has been extensively logged and had only 19% of its 24,507 ha forested land in old growth. One transect and four fixed stations were surveyed. The road transect (108) was located 29 km up the watershed and had 10 stations 0.5 km apart. No murrelets were detected during the two surveys of that transect (June 14, June 28). Nor were murrelets detected during the survey of the fixed station associated with the road transect on July 19. However, the survey was done on a partially clear morning which may have reduced chances of detection. The other fixed stations (109) were all located in Cathedral Grove, all in an old growth patch, approximately 18 km up the valley. The second station (109.1), at the south end of Cathedral Grove was surveyed twice. On May 26 it yielded 3 detections (35 calls) and on July 5, 5 detections (27 calls). The third station (109.2) in the middle of Cathedral Grove was surveyed only on May 26 and produced 2 detections (32 calls). The fourth station near Cameron Lake (109.3) yielded 5 detections (20 calls) on May 26. Most of the detections were from birds over 200 m away.

111 Oyster River:

This watershed (32,860 ha), 37% in old growth, extends over two eco-regions. This road station is located 32 km up the watershed and has 10 stations 1 km apart. On June 25, murrelets were detected at 4 stations (4 detections, 36 calls) all were flying high above the canopy. On July 10, murrelets were detected at 6 stations (12 detections, 168 calls) again all of birds flying high above the canopy. The fixed station was located 30 km up the valley near old growth and surveyed on July 25, yielding only 3 detections (28 calls).

113-114 Elk River:

This is a large watershed covering 171,140 ha and still with 50% of its forested area in old growth. Two fixed stations were located within secondary watersheds. The first station (113) was located along Tlools Creek, a pristine secondary watershed covering 5,631 ha (4,500 forested). It was located 52 km from the coast and 200 m away from old growth. No murrelets were detected there on May 12 but there was one distant detection (25 calls) on June 13. The second station (114) was located along the Cervus River another pristine secondary watershed 6,038 ha in size (4,180 ha forested). On May 12, 17 detections (88 calls) were recorded there with 10 visual sightings, all circling birds. On June 13 only 6 visual sightings were recorded there. These valleys which drain to the east coast, are actually closer in a straight line distance to the heads of inlets on the west coast. Both these secondary watersheds have a history of forest fires, resulting in discontinuous old growth forest.

116-118 Salmon River:

Large watershed covering nearly 131,000 ha of forested land with several secondary watersheds. Nearly half (48%) of the forested area is old

growth. Three road transects and three fixed stations were located within this watershed in this ecosection. The first (117) was located along the Salmon River, 45 km from the coast. Ten to twelve stations 0.5 km apart were surveyed. On June 14, murrelets were detected at 1 of 10 stations by sight only and on July 5 at 4 of 12 stations (4 detections, 4 calls). The fixed station (117) was located 43 km from the coast in old growth and was surveyed twice. On July 16, 25 detections (344 calls) were recorded and on July 26, 13 detections (27 calls) were noted. In both cases birds were seen flying straight and in circles. The second road transect (116) was located in a secondary watershed (26,628 ha) along the Memekay River. Sixty percent of the forest was still old growth. The transect was located 34 km from the coast and comprised 10 stations 0.6 km apart. On June 17, murrelets were detected at a single station (25 calls) and on July 5 at 4 stations (4 detections, 30 calls). The fixed station was located 34 km from the coast in old growth. On July 16, 46 detections (731 calls) were recorded with 5 visual detections. Ten detections were of birds flying below the canopy. On July 26, 10 detections (42 calls) were noted there with 6 visual detections. The late date of that survey may account for the lower number of detections. The third road transect (118) was located only 12 km from the coast along the White River. This secondary watershed (32,542 ha forested) still had 72% of its forest in old growth. On June 17, murrelets were detected at two stations (4 visual sightings) and at 5 stations (13 detections, 21 calls) on July 8. Most birds (6 of the 7 visual detections) were flying in a straight line high above the canopy. The fixed station was 11 km from the coast and 0.5 km from old growth. Only three detections were recorded on July 19 on a clear morning.

It is difficult to interpret negative results in such low intensity sampling. Absence of detections could be due to a multitude of factors, so that the conclusions drawn for an area with few detections, is the need for more structured and localized surveys. For the areas with some detections, this indicates some use of the watershed by murrelets. In fact the main purpose of this survey was to assess the broad distribution of murrelet activity on the Island. Again because of the small number of surveys, the variety of observers, weather conditions and survey dates, it can only roughly compare detection levels in various watersheds. More structured surveys are required before comparison of activity levels between watersheds can be safely done. The results of our surveys, and it was the intent of the study, can be used to identify areas and watersheds that can be used for more intensive surveys.

There is a clear need for more intensive and localized surveys in heavily logged watersheds to assess whether Marbled murrelets use the remnant old growth there.