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Body mass variation in Marbled Murrelets in British Columbia, Canada

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[1]*Canadian precursors. Adult males weighed 203.7*

14.2 g, n = 495 (juveniles 166.6 28.8 g, n = 31) and females weighed 201.2 20.5 g, n = 344 (juveniles 148.3 23.5 g, n = 20). Murrelets caught in mist-nets were signiÞcantly lighter than those caught by night-lighting. Female mass was constant across years of the study, but males caught by night-lighting were heavier in 1998 than in 1997. Females declined in mass during the egg-laying period, but when gravid females were removed from the analysis, or when the post-laying data were analysed, no declines were found. Marbled Murrelets appear to maintain mass at a constant level all season, and are probably more income than capital breeders. Variation in body mass in this species may be constrained by the need to ßy with speed and agility to avoid aerial predators.

Marbled Murrelets Brachyramphus marmoratusare small alcids found along the PaciÞc north-west of North America from California to Alaska. They are long-lived seabirds with low fecundity (Nelson & Hamer 1995). While a great deal of research has been conducted on Marbled Murrelets in recent years, particularly assessing habitat use, there is still much to be understood about the species. For example, little is known about seasonal and geographical variation in body mass of Marbled Murrelets (Nelson 1997); there is only one published study on body mass variation in this species, carried out at Langara Island (Queen Charlotte Islands Ð Haida Gwaii), British Columbia during 1970 and 1971 (Sealy 1975).

The purpose of this study was to describe body mass changes in Marbled Murrelets across a number of years and at two sites, thereby providing more information on this poorly understood threatened species. Inter- and intra-annual changes in body mass were examined, as were comparisons between the sexes, sites and different capture techniques.

METHODS

Marbled Murrelets were captured at Desolation Sound (50 05 N, 124 40 W) from 1994 to 1998, and Mussel Inlet (52 51 N, 128 10 W) British Columbia, Canada, during 23 JuneÐ12 July 1997. Two capture techniques were used. A ßoating mist-net system (Kaiser et al. 1995) was used to catch birds as they ßew through Theodosia Inlet, Desolation Sound at dawn (04:00Ð07:00 h) and dusk (20:00Ð23:00 h), from early June to early August (the only period when murrelets could be caught using this technique). Mist-netting was unsuccessful at Mussel Inlet, so Ônight-lightingÕ was used instead. Night-lighting (modiÞed from Whitworth et al. 1997), involved searching for birds from an inßatable boat and, once spotted, they were approached slowly and scooped into the boat with a landing net. Night-lighting was conducted between 23:00 and 05:00 h. It was also used to catch birds on the open waters of Desolation Sound from mid-May to mid-August, 1997 and 1998. Night-lighting allowed the capture of birds earlier in the breeding season and, for the Þrst time at Desolation Sound, recently ßedged juveniles. All birds were uniquely

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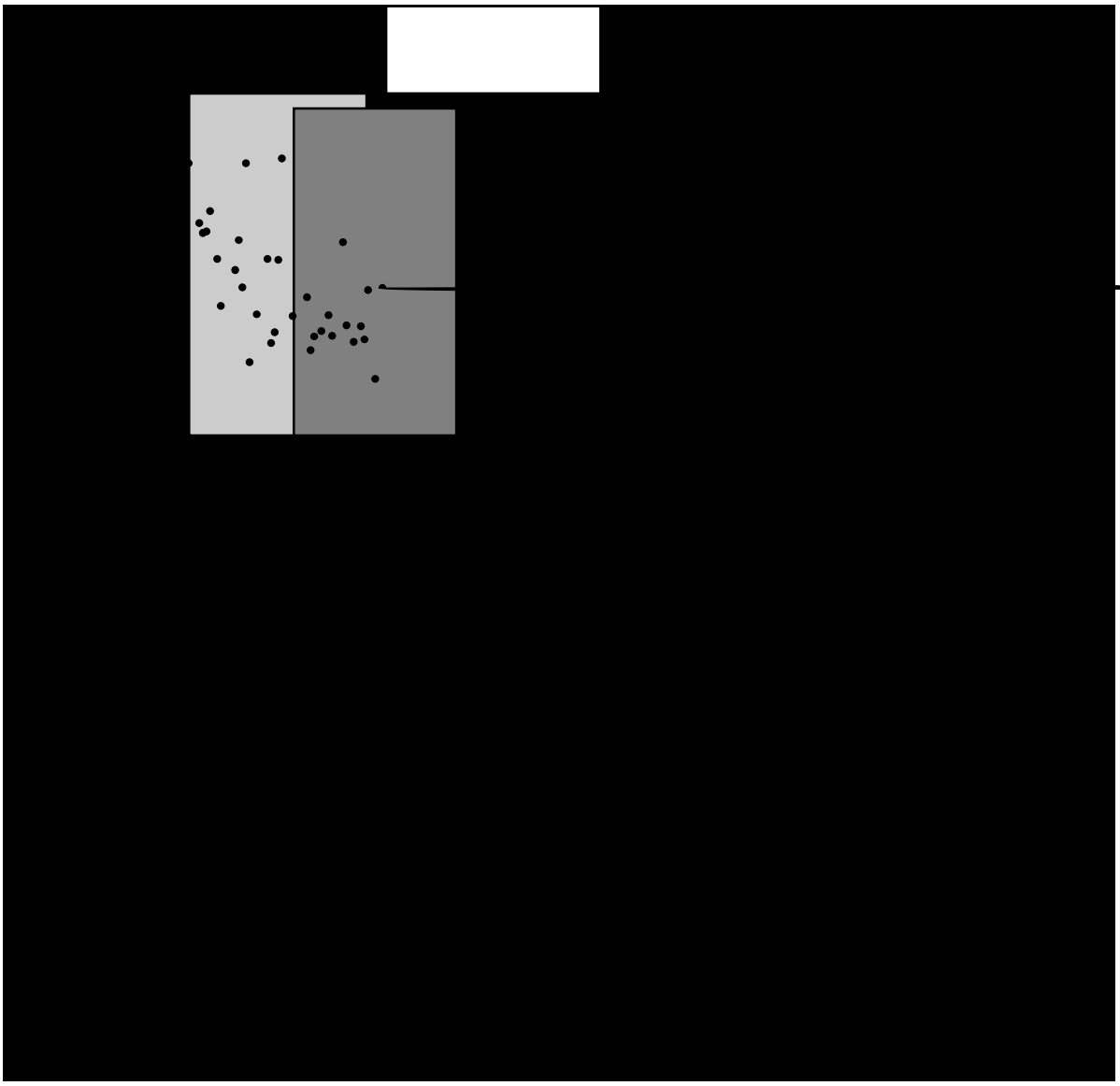
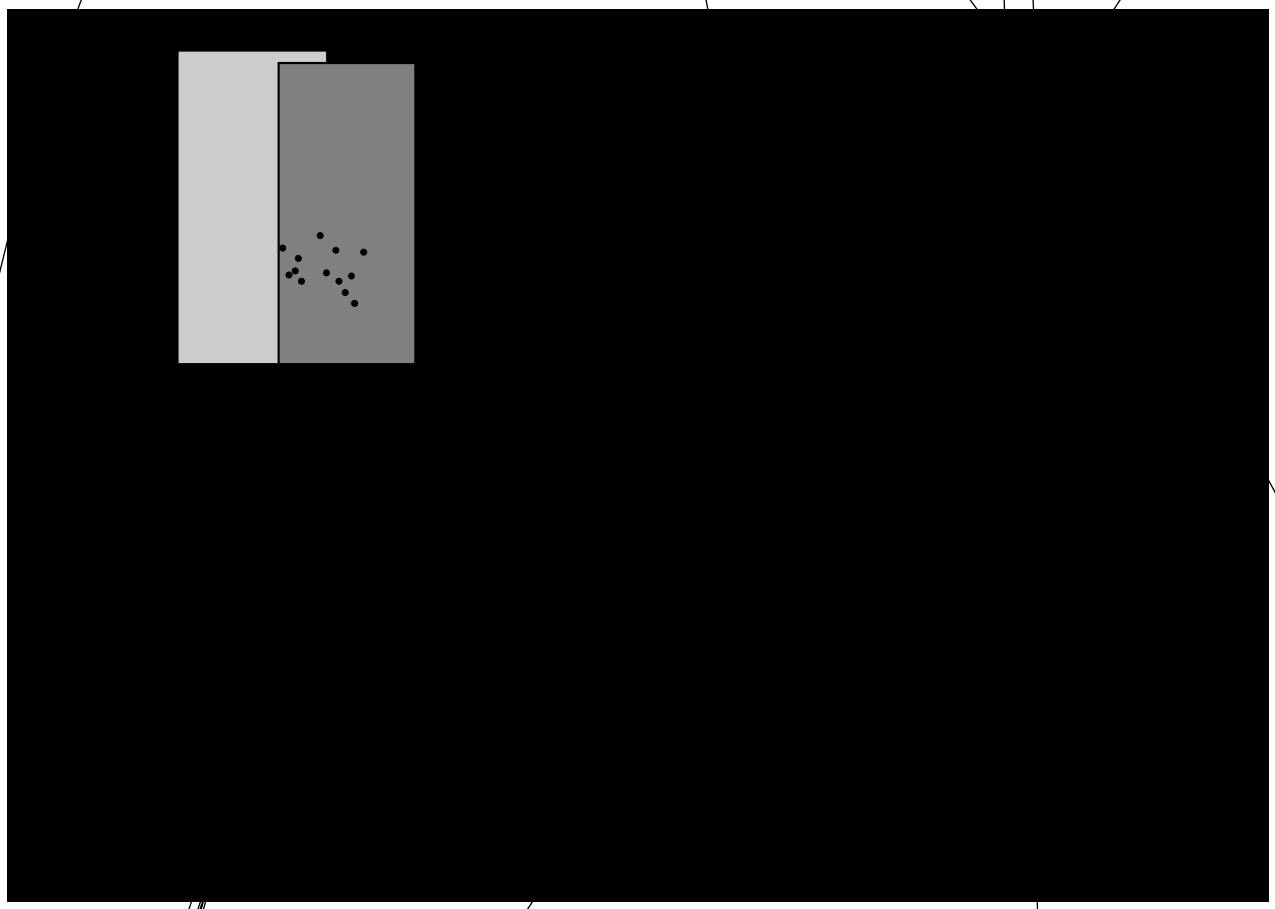


($F_{1,198}$ = 2.1, ns) and 1995 ($F_{1,112}$ = 3.2, ns). However, during 1996, 1997 and 1998 males were signiÞcantly heavier than females (1996: $F_{1,91}$ = 13.1, P < 0.001; 1997: $F_{1,376}$ = 22.6, P < 0.001; 1998: $F_{1,167}$ = 5.9, P < 0.02). Females from Mussel Inlet did not differ signiÞcantly in mass from males (t_{83} = 0.8, ns, Figs 1 and 2).

Similarly, Desolation Sound and Mussel Inlet did not differ signiÞcantly in either mean male or female mass (males t_{143} = 0.02, ns; gravid females t_{34} = 1.9, ns; non-gravid females t_{34} = 1.4, ns, Fig. 2).

A signiÞcant decline in female mass was found during 1997 and 1998 at Desolation Sound, but not



during the other years, or at Mussel Inlet (Table 2). When gravid females were removed from the 1997 analysis, mass did not change with date ($F_{1,83} = 2.4$, ns). Female mass remained constant after 18 June during both 1997 and 1998 (1997: $F_{1,68} = 1.2$, ns, $r^2 = 0.02$; 1998: $F_{1,62} = 3.0$, ns, $r^2 = 0.05$).

Females captured by night-lighting showed a significant decline in mass over the breeding season

in 1997 and 1998 (1997: $F_{1,52} = 30.7$, $P < 0.001$, $r^2 = 0.4$; 1998: $F_{1,90} = 37.7$, $P < 0.001$, $r^2 = 0.3$), but those caught by mist-netting did not (1997: $F_{1,55} = 3.9$, ns, $r^2 = 0.03$; 1998: $F_{1,39} = 2.7$, ns, $r^2 = 0.06$).

Males did not exhibit a decline in mass either when caught by mist-netting (1997: $F_{1,91} = 0.007$, ns, $r^2 = 0.0$; 1998: $F_{1,85} = 0.9$, ns, $r^2 = 0.01$) or by night-lighting (1997: $F_{1,47} = 1.3$, ns, $r^2 = 0.03$; 1998: $F_{1,81} = 0.007$, ns, $r^2 = 0.0$, Fig. 3).

The masses of juveniles did not differ between 1997 and 1998 (males: $t_{29} = 1.1$, ns; females: t_{18}

DISCUSSION

Male and female Marbled Murrelets in this study weighed 204 g and 201 g, respectively. These are lighter than those weighed by Sealy (1975) at Langara Island (males: 217.0 g, range 196.2–252.5 g; and females: 222.7 g, range 188.1–269.1 g). This difference can be explained, in part, by the inclusion of gravid females in SealyÕs (1975) sample. Gravid females in our study were on average 35 g heavier than non-gravid females. Sealy sampled birds across the breeding season, but sample sizes were greater during the egg-laying period, and included breeding females.

The differences in male masses between the two studies are more difficult to explain. Males were lighter in our study perhaps because of site or geographical differences. There are some methodological differences between the studies, with SealyÕs birds obtained in the middle of the day when they may have consumed more food than during the night as they are foraging primarily for self-maintenance. In contrast, nocturnal foraging may be primarily to provision chicks and less food may be caught at that time.

Mussel Inlet is at almost the same latitude, and within 200 km of Langara Island, hence the difference is probably not related to latitude, although there may still be a difference between sites. Murrelets could be lighter now than they were in the early 1970s, but this is difficult to confirm due to the paucity of data. Furthermore, recently fledged juveniles were 157 ± 19 g in SealyÕs (1975) study compared to 158 ± 26 g in our study, which would counter this explanation.

Marbled Murrelets caught by night-lighting were heavier than those caught by mist-netting, indicating that either these two capture techniques sampled different sections of the population (such as different proportions of breeders and non-breeders, with one group being heavier than the other), or they sampled birds at different stages in the breeding cycle. Recent data from this site have indicated that mist-netted captures include breeding birds, primarily chick-rearing birds (L. Tranquila unpubl. data, R. Bradley unpubl. data). Therefore, breeding birds may be lighter in mass than non-breeders or failed breeders. These latter birds may be more abundant in the open waters of Desolation Sound caught by night-lighting.

The difference in mass between birds caught with mist-nets and those caught by night-lighting may occur because birds on the open waters of Desolation Sound (those caught by night-lighting) may still be foraging and have recently caught food for themselves, adding to their mass. However, this explanation does not seem adequate to explain the approximately 20 g difference in mass, although it is unknown how much food Marbled Murrelets consume during foraging, and whether it would be digested prior to their flight to the forest.

Female body mass was constant across years of the study, while that of males was not. Males caught by night-lighting were heavier in 1998 than 1997. Inter-annual variability in mass may have been more difficult to detect in earlier years of the study as night-lighting was not used to catch birds. Night-lighting detects more egg-producing birds than are detected amongst birds caught by mist-netting. However, night-lighting captures birds earlier in the season, hence there are fewer birds producing eggs, although not necessarily fewer breeders. The heavier male masses found during 1998 may be related to improved foraging efficiency due to a greater abundance and distribution of prey. It is unknown why only males exhibited this difference in mass between years.

Birds at Desolation Sound did not differ in mass from those at Mussel Inlet. Desolation Sound is an area of substantially fragmented forest, while Mussel Inlet is near-pristine forest. While there may be differences in the availability of nesting habitat between the sites, the abundance and availability of food may be similar.

The work conducted at Mussel Inlet during the current study was of short duration (23 June–12 July) and, as indicated by the presence of gravid females (determined from egg-yolk precursors in their plasma), it coincided with the egg-laying period. This suggests that the breeding season of Marbled Murrelets at Mussel Inlet during 1997 may have been up to 30–40 days later than at Desolation Sound, and later than Sealy (1975) found at Langara Island. The egg-laying period at Langara Island, determined by the follicular development of 20 females, was thought to extend from 15 May until the end of June (Sealy 1975). The breeding season of Marbled Murrelets is believed to be quite protracted and less synchronous than that of other alcids (Hamer & Nelson 1995, Lougheed 1999). In British Columbia it is thought to last 137 days, extending from mid-June (onset of incubation) until early September (Lougheed 1999).

Male Marbled Murrelets were constant in mass across the breeding season in all years. Females