

- JOHNSON, G. D., J. L. PEDWORTH, AND H. O. KRUEGER. 1991. Retention of transmitters attached to passerines using a glue-on technique. *J. Field Ornithol.* 62:486–491.
- MALTBY, F. 1915. Nesting of the Yellow Rail in North Dakota. *Oologist* 32:122–124.
- OWEN, M., AND J. M. BLACK. 1990. Waterfowl ecology. 1st ed. Blackie and Son, Glasgow.
- PEABODY, P. B. 1922. Haunts and breeding habits of the Yellow Rail. *J. Mus. Comp. Oology* 2:33–44.
- PERRY, M. C., G. H. HAAS, AND J. W. CARPENTER. 1981. Radio transmitters for Mourning Doves: a comparison of attachment techniques. *J. Wildl. Manage.* 45:524–527.
- POSPICHAL, L. B., AND W. H. MARSHALL. 1954. A field study of Sora Rail and Virginia Rail in Central Minnesota. *Flicker* 26:2–32.
- REMSEN, J. V., JR., AND T. A. PARKER III. 1990. Seasonal distribution of the Azure Gallinule (*Porphyryla flavirostris*), with comments on vagrancy in rails and gallinules. *Wilson Bull.* 102:380–399.
- ROBERT, M., AND P. LAPORTE. 1996. Le Rôle jaune dans le sud du Québec: inventaires, habitats et nidification. Tech. Rep. No. 247, Can. Wildl. Serv., Environment Canada, Sainte-Foy, Quebec, Canada.
- ROBERT, M., AND P. LAPORTE. 1997. Field techniques for studying breeding Yellow Rails. *J. Field Ornithol.* 68:56–63.
- SALOMONSEN, F. 1968. The moult migration. *Wildfowl* 19:5–24.
- STALHEIM, P. S. 1974. Behavior and ecology of the Yellow Rail (*Coturnicops noveboracensis*). M.Sc. thesis, Univ. Minnesota, Minneapolis, MN.
- ST. LAWRENCE CENTRE. 1996. State of the environment report on the St. Lawrence River. Vol. 1. The St. Lawrence ecosystem. Environment Canada, Quebec Region, and Éditions MultiMondes, Montreal.
- STENZEL, J. R. 1982. Ecology of breeding Yellow Rails at Seney National Wildlife Refuge. M.Sc. thesis, Ohio State Univ., Columbus, OH.
- USFWS 1995. Migratory nongame birds of management concern in the United States: the 1995 list. Office of Migratory Bird Management, U.S. Fish Wildl. Serv., Washington, DC.
- WALKINSHAW, L. H. 1939. The Yellow Rail in Michigan. *Auk* 56:227–237.

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## SEASONAL MOVEMENTS OF MARBLED MURRELETS: EVIDENCE FROM BANDED BIRDS<sup>1</sup>

WENDY D. BEAUCHAMP<sup>2</sup>, FRED COOKE<sup>3</sup>, CECILIA LOUGHEED AND LYNN W. LOUGHEED  
*Department of Biological Sciences, Simon Fraser University, 8888 University Drive, Burnaby, British Columbia, V5A 1S6, Canada, and Pacific Wildlife Research Centre, Canadian Wildlife Service, RR# 1, 5421 Robertson Road, Delta, British Columbia, V4K 3N2, Canada, e-mail: fcooke@sfu.ca*

C. JOHN RALPH  
*Redwood Sciences Laboratory, U.S. Forest Service, 700 Bayview Drive, Arcata, CA 95521*

STEPHEN COURTNEY  
*Sustainable Ecosystems Institute, 0605 SW Taylors Ferry Road, Portland, OR 97219*

**Abstract.** Recent techniques for capturing Marbled Murrelets (*Brachyramphus marmoratus*) have created opportunities for studying them through systematic banding programs. One murrelet banded in breeding plumage during the summer of 1995 at Theodosia Inlet, on the Sunshine Coast of British Columbia, was recaptured in basic plumage in the fall of 1996 near Orcas Island in the San Juan Islands, Washington State, a distance of 220 km southeast from the original banding location. It was captured again at Theodosia Inlet in breeding plumage in the summer of 1997. This

is the first evidence of long distance movement for the Marbled Murrelet. Seven color-marked individuals from the Theodosia Inlet population were located in the same geographic area outside the breeding season. Although our sample size is small, this suggests that both nonmigratory and migratory individuals occur within a single summering population.

**Key words:** *Brachyramphus marmoratus*, *Marbled Murrelet*, *migration*, *population movements*.

Marbled Murrelets (*Brachyramphus marmoratus*) are year-round residents in Washington and British Columbia (Rodway et al. 1992, Speich and Wahl 1995), but marine surveys show that they have different distribution patterns at different times of year. Campbell et al. (1990) hypothesized that some portion of the Brit-

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<sup>2</sup> Current address: 307-4711 57 Street, Delta, British Columbia, V4K 3E6, Canada.

<sup>3</sup> Corresponding author.

ish Columbia population may undergo a north-south migration. Sometimes these movements are from more exposed areas of their breeding range to more sheltered waters during the nonbreeding season (Burger 1995, Courtney et al. 1996). Partial seasonal shifts in distribution also have been observed in other parts of the murrelet's range, including California (Naslund 1993), Oregon (Strong et al. 1995), and Alaska (Agler et al. 1998).

Although these inland-nesting seabirds tend to concentrate during the breeding season in areas of coastline close to potential nesting areas near old-growth forests, their distribution during the nonbreeding season is poorly known. The use of marked individuals makes it possible to relate wintering populations to specific breeding (summer) populations. Our objectives in this paper are to document the first recapture of a banded Marbled Murrelet at a considerable distance from the original study site and outside the breeding season and report other resightings of marked individuals outside the breeding season.

## METHODS

Since 1991, we have banded Marbled Murrelets with stainless steel leg bands in Theodosia Inlet (50°04'N, 124°42'W), part of Desolation Sound, British Columbia. Birds are caught in a floating mist-net array which is strung across the mouth of the inlet (Kaiser et al. 1995). In 1996 and 1997, we enhanced the detectability of birds by using color marks. We marked 20 adults (10 year<sup>-1</sup>) with 5 mm plastic nasal discs attached by a strand of 11.34-kg test monofilament through the nares. We also marked 48 birds by looping temporary plasticized paper wing markers in the shape of a covert feather around the forearm. Color-marked birds were located during marine surveys in the study area during summer and on two nonbreeding season expeditions to the study area, on 22 September 1996, and 9 February 1997. We sexed murrelets using a DNA fingerprinting technique modified from Griffiths et al. (1996) by Vanderkist et al. (1999) using DNA from blood and in some cases, feathers. We captured murrelets out of breeding season near Orcas Island (48°36'N, 123°00'W) in northern Puget Sound, Washington in September 1996 using a night-lighting and dip netting technique from small or medium sized boats (Whitworth et al. 1997).

To check on past captures of Marbled Murrelets, we examined all published papers and reports related to the banding of Marbled Murrelets that we could find. We cross-referenced this with banding and recovery data available from the Canadian Wildlife Service Bird Banding Office (CWS-BBO; Ottawa), which documents all birds reported banded by Canadian and U.S. banders and all recoveries other than those in the same degree block reported by the original bander. Some banding data supplied by the CWS-BBO were not found in any published source and some published studies were not in the CWS database. If discrepancies were found between published and CWS-BBO records, we assumed that the published information was correct.

## RESULTS

Because of the difficulty of capturing this species, only 684 Marbled Murrelets have ever been reported banded up to 1996, at 17 locations between Alaska and California. Of the 684 records, 90 are from Alaska (Quinlan and Hughes 1992, Burns et al. 1994), 543 from British Columbia, of which 493 are from our own study and others from Burns et al. (1995) and Kaiser et al. (1995), 7 from Washington State, 33 from Oregon and 11 from California (Paton et al. 1991). From this total we found no records of recaptures or dead recoveries outside of the original study area. Recaptures of birds within our study area during the breeding season are documented elsewhere (Cooke, in press), but we have no records of recaptures or recoveries within the study area from other studies.

We report here a female Marbled Murrelet banded at Theodosia Inlet, British Columbia, recaptured near Orcas Island in northern Puget Sound, Washington, in the fall, and then recaptured again back at the banding site. The bird was initially banded at 04:44 on 14 June 1995, one of 189 caught and banded that summer at Theodosia Inlet. It was in breeding plumage with a large, vascularized brood patch. We recaptured this bird 15 months later on 13 September 1996 south of Orcas Island, approximately 220 km from the original banding site. It was in winter plumage, and was one of 12 Marbled Murrelets caught and released in the same area over a 3-day period. We caught the bird again at the original banding site at 05:35 on 29 June 1997, one of 206 caught during the summer. Its plumage and brood patch were almost identical to its condition at the original capture, and its weight was similar (195 g vs. 193 g). It was again independently sexed as a female. As on the first capture event, it was caught flying out of the inlet towards the ocean.

In addition to this recaptured bird, seven individually color marked birds were resighted in the Desolation Sound area (all within 10 km of the capture site) during the fall 1996 and winter 1997 surveys. On 22 September 1996, six color-marked murrelets were observed in various states of body molt. On 9 February 1997, one color-marked individual was observed in winter plumage and as a member of a pair. All had probably nested near the Desolation Sound area, given that they were in breeding plumage and had vascularized brood patches when banded between June and July 1996. Four were females and three males.

## DISCUSSION

The doubly recaptured bird reported here provides the first direct evidence of migration between breeding and nonbreeding areas for this species. The bird's plumage and brood patch at the original capture, along with the fact that it was caught at dawn flying out of the inlet on a known flight path from the forest to the ocean, suggests that it was breeding in the area. The first recapture in Puget Sound suggests movement to a wintering location. The second recapture indicates a return to the original capture location in a subsequent nesting season and in the year following the Puget Sound capture. Our finding is thus consistent with the suggestion that the breeding birds from British Columbia comprise at least part of the seasonal influx of murrelets

into the sheltered waters of Puget Sound in northern Washington in fall and winter.

Although this particular bird moved considerable distances between breeding and nonbreeding locations, not all birds left the Desolation Sound area. Resightings of individually color-marked birds, indicate that at least part of the murrelet population remains in the Desolation Sound area in the fall and winter. This evidence of residency outside the breeding season also is consistent with previous suggestions that only a portion of Marbled Murrelets disperses away from concentrated breeding areas during the nonbreeding season.

Different subgroups of the population (e.g., sex, age, or status) may adopt different movement strategies. Our small sample shows no evidence of sex differences in overwintering sites, although it is evident that some individuals of both sexes remain close to the nesting areas. All our detected birds were adults when banded, so we are not able to confirm the age differences in migration reported by Kuletz and Kendall (1998), but in our study at least some of the adults remained close to the breeding area. Birds may be trading off the advantages of a suitable wintering location against the advantages of being able to visit nesting areas during the winter months, as shown by Naslund (1993). Only the accumulation of data on individuals (such as the observation we report) will allow us to discriminate between these various hypotheses.

Although our recent findings offer only incomplete evidence of seasonal behavior for Marbled Murrelet populations in Desolation Sound and Puget Sound, they represent important advances in knowledge for this internationally threatened species whose seasonal movement patterns are little understood. Without marked individuals, it is impossible to distinguish between migrant and resident birds.

Basic information on seasonal movements and distributions of populations of Marbled Murrelets is crucial for understanding the critical breeding and wintering areas of this threatened species and to provide a focus for conservation efforts and a basis on which to evaluate these efforts. Such studies will complement population genetic analyses currently under way with this species.

The research in Desolation Sound is a result of cooperation between Simon Fraser University (SFU), the Canadian Wildlife Service (CWS), and the British Columbia Ministry of Forests (MOF). Numerous field assistants and volunteers disrupted nights of sleep to catch birds. Brett Vanderkist sexed the birds. Louise Laurin of the CWS Banding Office (Ottawa) supplied banding and recovery data. Other unpublished banding data were provided by Gary Kaiser and Pat Jodice. Funding for the Desolation Sound project was provided by grants from the Natural Sciences and Engineering Research Council of Canada, CWS, SFU, MOF, MacMillan Bloedel Ltd., TimberWest Ltd., Pacific Forest Products Ltd., International Forest Products Ltd., Western Forest Products Ltd., and Forest Renewal British Columbia (FRBC) through the Science Council of British Columbia. Research in the Puget Sound is a cooperative effort between the National Council for Air and Stream Improvement, the Northwest Indian

Fisheries Commission, Sustainable Ecosystems Institute, the U.S. Army, the U.S. Forest Service, and Washington Department of Wildlife. Peter Noah, formerly of the Oregon Coast Aquarium, was instrumental in processing the birds in Puget Sound. Martin Raphael provided logistical support, and Diane Evans led the capture crew. Doug Bertram, Sean Boyd, Alan Burger, Diane Evans, Kathy Kuletz, Tony Williams, and an anonymous reviewer offered constructive comments on an earlier draft.

## LITERATURE CITED

- AGLER, B. A., S. J. KENDALL, AND D. B. IRONS. 1998. Abundance and distribution of Marbled and Kittlitz's Murrelets in southcentral and southeast Alaska. *Condor* 100:254-265.
- BURGER, A. E. 1995. Marine distribution, abundance, and habitats of Marbled Murrelets in British Columbia, p. 295-312. *In* C. J. Ralph, G. L. Hunt, M. G. Raphael, and J. F. Piatt [eds.], *Ecology and conservation of the Marbled Murrelet*. U.S. Dept. Agriculture, For. Serv., Pacific Southwest Res. Sta. Gen. Tech. Rep. PSW-GTR-152, Albany, CA.
- BURNS, R. A., L. M. PRESTASH, AND K. J. KULETZ. 1994. Pilot study on the capture and radio tagging of murrelets in Prince William Sound, Alaska, July and August, 1993. Proj. 93051B-Exxon Valdez Restoration Project Final Rep., U.S. Fish Wildl. Serv., Anchorage, AK.
- BURNS, R. A., G. W. KAISER, AND L. M. PRESTASH. 1995. Use of mist nets to capture Marbled Murrelets over the water. *Northwest Nat.* 76:106-111.
- 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*. Vol. 2. R. BC Mus., Can. Wild. Serv., Victoria, British Columbia, Canada.
- COOKE, F. *In press*. Population studies of Marbled Murrelets (*Brachyramphus marmoratus*) in British Columbia. *Symp. Soc. Can. Ornithologists*, Fredericton, New Brunswick, Canada.
- COURTNEY, S. P., T. GRUBBA, W. BEATTIE, AND D. M. BROSNAN. 1996. Seabird surveys in Puget Sound, 1995. Report of Sustainable Ecosystems Institute, Portland, OR.
- GRIFFITHS, R., S. DAAN, AND C. DIJKSTRA. 1996. Sex identification in birds using two CHD genes. *Proc. R. Soc. Lond. B.* 264:1249-1264.
- KAISER, G. W., A. E. DEROCHE, S. CRAWFORD, M. J. GILL, AND I. A. MANLEY. 1995. A capture technique for Marbled Murrelets in coastal inlets. *J. Field Ornithol.* 66:321-333.
- KULETZ, K. J., AND S. J. KENDALL. 1998. A productivity index for Marbled Murrelets in Alaska based on surveys at sea. *J. Wildl. Manage.* 62:446-460.
- NASLUND, N. L. 1993. Why do Marbled Murrelets attend old-growth forest nesting areas year-round? *Auk* 110:594-602.
- PATON, P. W. C., C. J. RALPH, AND J. SEAY. 1991. A mist net design for capturing Marbled Murrelets. *N. Am. Bird Bander* 16:123-126.
- QUINLAN, S. E., AND J. H. HUGHES. 1992. Techniques for capture and radio-tagging of Marbled Murrelets. *Proc. West. Found. Vertebr. Zool.* 5:117-121.

- RODWAY, M. S., H. R. CARTER, S. G. SEALY, AND R. W. CAMPBELL. 1992. Status of the Marbled Murrelet in British Columbia. *Proc. West. Found. Vertebr. Zool.* 5:17-41.
- SPEICH, S. M., AND T. R. WAHL. 1995. Marbled Murrelet populations of Washington-marine habitat preferences and variability of occurrence, p. 313-326. *In* C. J. Ralph, G. L. Hunt, M. G. Raphael, and J. F. Piatt [eds.], *Ecology and conservation of the Marbled Murrelet*. U.S. Dept. Agriculture, For. Serv., Pacific Southwest Res. Sta. Gen. Tech. Rep. PSW-GTR-152, Albany, CA.
- STRONG, C. S., B. S. KIETT, W. R. McIVER, C. J. PALMER, AND I. GAFFENEY. 1995. Distribution and population estimates of Marbled Murrelets at sea in Oregon during the summers of 1992 and 1993, p. 247-253. *In* C. J. Ralph, G. L. Hunt, M. G. Raphael, and J. F. Piatt [eds.], *Ecology and conservation of the Marbled Murrelet*. U.S. Dept. Agriculture, For. Serv., Pacific Southwest Res. Sta. Gen. Tech. Rep. PSW-GTR-152, Albany, CA.
- VANDERKIST, B. A., X-H. XUE, R. GRIFFITHS, K. MARTIN, W. BEAUCHAMP, AND T. D. WILLIAMS. 1999. Evidence of male bias in capture samples of Marbled Murrelets from genetic studies in British Columbia. *Condor* 101:39-402.
- WHITWORTH, D. L., J. Y. TAKEKAWA, H. R. CARTER, AND W. R. McIVER. 1997. A night-lighting technique for at-sea capture of Xantus' Murrelets. *Colonial Waterbirds* 20:525-531.

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## DIFFERENTIAL AUTUMN MIGRATION OF SHARP-SHINNED AND COOPER'S HAWKS IN WESTERN NORTH AMERICA<sup>1</sup>

JOHN DELONG<sup>2</sup> AND STEPHEN W. HOFFMAN

*HawkWatch International, Inc., P.O. Box 660, Salt Lake City, UT 84110*

**Abstract.** Sharp-shinned Hawks (*Accipiter striatus*) and Cooper's Hawks (*A. cooperii*) showed differential migration timing during autumn migration in New Mexico and Nevada. Age-sex classes passed through both sites in this order: juvenile females, juvenile males, adult females, and adult males. We compared the magnitude of differential migration timing in these two species. The number of days separating mean passage dates of age classes (juvenile and adult) was greater for Sharp-shinned Hawks than for Cooper's Hawks. The number of days separating the mean passage dates of sex classes was mostly similar between the two species. In the Manzano Mountains of New Mexico, however, adult male and female Sharp-shinned Hawks were more separated than adult male and female Cooper's Hawks. In Sharp-shinned and Cooper's Hawks, it seems likely that differences in rate of travel between males and females may best explain sex-specific differential migration timing and that foraging efficiency (i.e., hunting skill level) may best explain age-specific differential migration timing.

**Key words:** *Accipiter cooperii*, *Accipiter striatus*, Cooper's Hawks, differential migration, foraging efficiency, Sharp-shinned Hawks.

Sharp-shinned Hawks (*Accipiter striatus*) and Cooper's Hawks (*A. cooperii*) show differential migration timing at many locations throughout North America (Broun 1949, Mueller and Berger 1967, Devereux et al. 1985). Although there is considerable overlap, juveniles of these species precede adults, and females precede males past stationary observation sites (Rosenfield and Evans 1980, Hoffman 1985). The passage order shown by Sharp-shinned and Cooper's Hawks differs from that predicted by some prominent theories of differential migration, such as the social dominance (Gauthreaux 1982) and body size hypotheses (Kerlinger 1989), thus requiring the examination of other hypotheses. Temporal separation of age-sex classes during migration may arise from differences in onset or rate of migration among age-sex classes (Woodrey and Chandler 1997). We have found no literature describing age-sex class differences in onset or rate of migration for Sharp-shinned or Cooper's Hawks. Therefore, it is still unclear which process causes timing differences in these species.

Woodrey and Chandler (1997) suggested that comparing the magnitude of differential migration timing between species might create opportunities for examining hypotheses that explain this phenomenon. We follow their suggestion and compare the magnitude of differential migration shown by Sharp-shinned and Cooper's Hawks and discuss possible explanations for differential migration timing by age and sex for these two species.

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<sup>2</sup> Current address: Utah State University, Department of Biology, Logan, Utah 84322, e-mail: jdelong@biology.usu.edu