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WINTER OBSERVATIONS OF SOUTHERN RESIDENT KILLER WHALES (*ORCINUS ORCA*) NEAR THE COLUMBIA RIVER PLUME DURING THE 2005 SPRING CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*) SPAWNING MIGRATION

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Key words: southern resident Killer Whale, *Orcinus orca,* Chinook Salmon, *Oncorhynchus tshawytscha,* foraging behavior, spawning migration, Columbia River, plume front

In the northeastern Pacific Ocean, the North American population of southern resident Killer Whales (*Orcinus orca,* hereafter ''SRKW'') was listed as ''Endangered'' by the United States government effective 16 February 2006 (NMFS 2005a). There is significant scientific interest in filling data gaps regarding SRKW habitat use and ecology from November to April because few data are available about the winter distribution and feeding behavior of SRKW (Ford and Ellis 2006; Krahn and others 2004). From May to October, these whales occur primarily in US and Canadian waters of Juan de Fuca Strait, the Canadian Gulf Islands, the US San Juan Islands, and Georgia Strait (Fig. 1), where their diet appears to be dominated by adult Chinook Salmon (*Oncorhynchus tshawytscha*) (Ford and Ellis 2006; Ford and others 1998). After October, the southern residents expand their range to include Puget Sound as well as the outer coast of Vancouver Island, Washington, Oregon, and California (Krahn and others 2004). Between 1975 and 2004, there have been only 17 confirmed sightings of SRKW between November to April (Krahn and others 2004), and 12 of those winter sightings were from the outer coast.

To our knowledge, this is the first published report that describes SRKW behavior at the mouth of the Columbia River and also positively identifies individual SRKW associated with that behavior (Krahn and others 2004; NMFS 2005b). We report confirmed sightings of at least 13 photo-identified SRKW individuals from L-pod, the largest of the 3 pods in the southern resident population (NMFS 2005b).

The Columbia River mouth is approximately 245 km south of the entrance to the Strait of Juan de Fuca. The river forms the border between southern Washington and northern Oregon, USA, and it supports spring, summer, and fall runs of Chinook Salmon, with the fall run being the largest (Healey 1991). Beginning in August 2004, 2 of the authors (JEZ and TJG) conducted year-round, weekly or bi-weekly surveys of marine birds and mammals from a land-based observation site 6 km north of the Columbia River mouth. From dawn to dusk we counted birds and mammals within a specific 1.8 km^2 area every half-hour during all daylight hours using a 20× spotting scope from an overlook at the North Head Lighthouse in Washington State (NAD 1983 UTM zone 10: Easting 417191.55, Northing 5127731.94; elevation 59 m above sea level). Additionally, we used 8× binoculars and Fujinon 25× ''Big Eyes''[1] to aid species identification and to observe behavior between the half-hourly counts. These surveys documented variation in marine bird and mammal abundance relative to changes in tidal phase, time of day, and the strength and position of a visible boundary between river water and oceanic water. This boundary between newly discharged river water and oceanic water, hereafter called the ''plume front'', often manifests as a continuous, turbulent white foam line extending from river mouth offshore for up to 46 km (Morgan and others 2005).

On 22 March 2005, the survey began at 06:45 local time. At 06:51, the observers (JEZ

[1] Use of trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

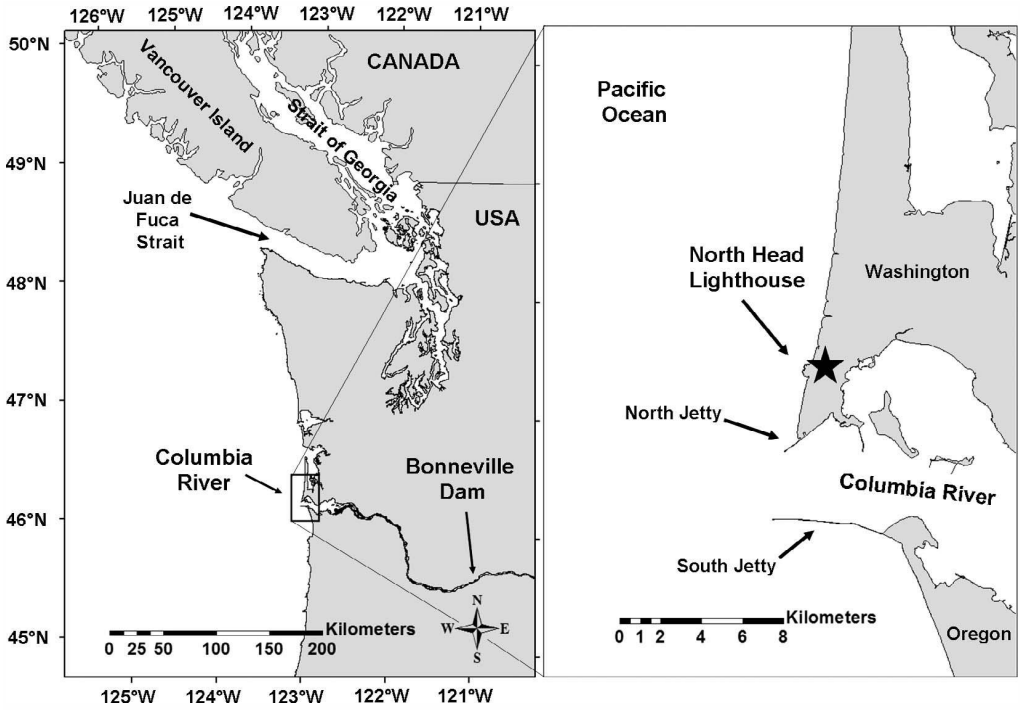

FIGURE 1. Map of coastal US and Canada and panel showing the observation site.

and TJG) detected Killer Whales within 3–7 km of shore. The whales remained visible most of the day, allowing near-continuous *ad hoc* observations throughout the morning and early afternoon even though the whales were never present in the quantitative survey area. We recorded notes on environmental conditions, whale abundance, whale appearance, and whale behavior into our field notebook. Winds were light from the north (<3 m/s) and the sea-state was relatively calm (Beaufort 1–2) until 13:30 when north winds increased to 3.5 m/s, building to 5.7 m/s thereafter (Beaufort 3–4). Water depths in the area of observation were generally <50 m deep over a sandy, gently sloping seabed. The last sighting of the day was at 15:00, several kilometers south and west of the tip of the North Jetty at the Columbia River entrance.

No more than 13 whales were seen simultaneously at the surface, although observers initially estimated that perhaps 20–25 total individuals were in the area given the frequency and dispersion of surfacing whales. Visual observations indicated the group included at least 3 adult males and 2 mother-calf pairs, as well as other individuals. These animals were engaging in tail-slapping, spy-hopping, side-slapping, and breaching within 1–5 km of shore. On occasion, 10–15 whales would swim parallel to each other in a line with less than 2 body lengths between individuals. The combination of more than 1 adult male, group size of more than 5 individuals, extensive surface social behaviors, and aerial displays initially suggested that these were not mammal-eating transient whales, but fish-eating resident whales (Baird and Whitehead 2000, Bigg and others 1990, Morton 1990). The whales were near enough to shore on some occasions that 1 author (TJG) was able to take photographs of dorsal fins and saddle patches for photo identification of individuals using a digital camera with a 420 mm f/4L image stabilized lens. Independent verification of all available photographs by 2 of the authors (KB and DE) later confirmed the presence of 13 individuals from the southern resident L-pod (Table 1), including one adult male (L-41). Field sketches of fin and saddle patch shapes made after inspecting

TABLE 1. Individual whales from L-pod identified from photographs taken on 22 March 2005 in the Columbia River plume area. Identification numbers for individuals follow standard nomenclature used by the Center for Whale Research (Center for Whale Research 2006). Field sketches indicated 2 additional mature males (L-57 and L-71) were likely present but not identified in photographs.

Whale ID	Gender	Age in 2005
L-5	Post-reproductive female	Unknown, but >40 y
L-21	Post-reproductive female	Unknown, but >40 y
L-41	Adult male	28 y
L-43	Adult female	33 y
L-53	Adult female	28 y
L-54	Adult female	18 y
L-55	Adult female	28 y
L-67	Adult female	20 y
L-82	Juvenile female	15 y
L-83	Juvenile female	15 y
L-88	Juvenile male	12 y
L-95	Juvenile male	9 y
L-101	Juvenile, unknown	3 y

the dorsal fins of all adult males with the 25× magnification Big Eyes strongly suggested the presence of L-57 and L-71 as well as L-41. The photo identifications and field sketches indicated at least 7 different matrilines from L-pod were present (Center for Whale Research 2006). It is possible that other whales were in the immediate area but not successfully photographed for identification purposes. If all members of the L-pod matrilines represented in the photographs were present, then up to 38 individuals from L-pod (80% of the 2005 population) could have been in the area.

Throughout our observations SRKW appeared to be following a large, counterclockwise circuit between the tip of the North Jetty of the Columbia River to the south (NAD 1983 UTM zone 10: Easting 416173.65, Northing 512391.28) and North Head to the north (NAD 1983 UTM zone 10: Easting 417191.55, Northing 5127731.94), a distance of approximately 4 km. The circuit extended offshore some unmeasured distance but was visually estimated to be within 15 km of shore. Whales appeared to complete this circuit at least twice, passing within 2 km of our observation site at 09:12 and again at 12:00.

Between 07:15 and 08:15, we witnessed several chase-type behaviors occurring within 2 km of the plume front. During this behavior, several individuals would spread out loosely on the seaward (north) side of the front. Individuals were spaced >10 body lengths apart, but in a line roughly perpendicular to the plume front. The whales oriented their bodies parallel to the front, moved east towards the Washington shore, and would occasionally swim very rapidly at or near the surface, apparently chasing a target just below the surface. The rapid swimming left a clearly visible wake in the water, whereas the slower movements did not. In one instance a whale was seen tossing an unidentified object less than 2 m in length about at the surface. We saw no signs of blood or flesh on the water surface anywhere near that area when it was examined with 25× magnification, nor were any marine mammals seen leaping or fleeing from the surface chases. No bird flocks or scavenging gulls were observed foraging in association with the whales.

During the time SRKW were swimming near the plume front, there were 25–30 California Sea Lions (*Zalophus californianus*), 6 Steller Sea Lions (*Eumetopias jubatus*), and hundreds of seabirds (primarily gulls *Larus* spp., Common Murres *Uria aalge,* and cormorants *Phalacrocorax* spp.) feeding or resting in the same general area occupied by SRKW. Several California Gray Whales (*Eschrichtius robustus*) were also moving through or milling about the river mouth throughout the day. Although SRKW were often within 2 km or less of pinnipeds and birds, the Killer Whales did not interact visibly with these animals in any way, nor did the mammals or birds stop their feeding or resting behaviors and leave the area.

While we were making our observations, salvage crews were working to recover the partially submerged wreckage of the empty oil barge *Millicoma,* which had come ashore at North Head 2 d prior to our survey (see http://www.freddevinedivingandsalvage.com/Millicoma.html). Some Killer Whales came within 2 km of ongoing salvage operations that included the use of helicopters and pumps. The whales were spy-hopping and milling near the cove where the barge was lodged. Salvage crews told us that they had also observed similar numbers of Killer Whales previously on 21 March 2005. It is therefore very likely that L-pod had been in this area for at least 2 d. Killer Whales in groups of more than 5 individuals also were reported near the Columbia River mouth in early

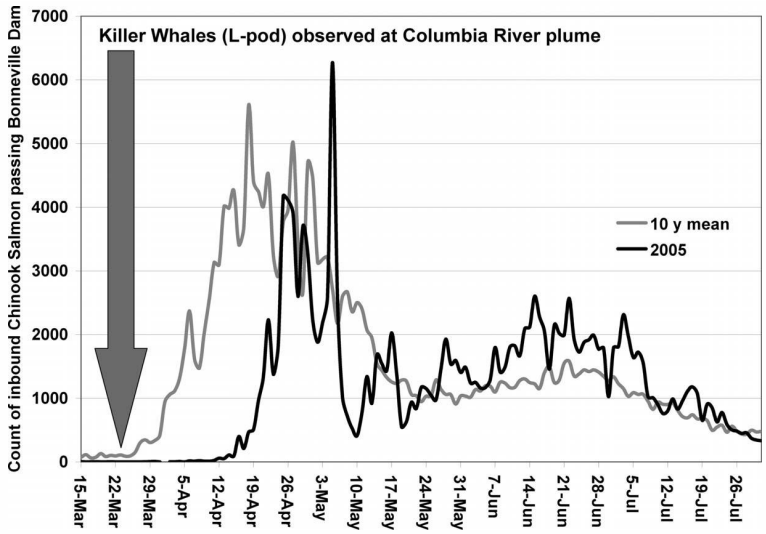

FIGURE 2. The total daily count of adult and jack (early maturing male) spring Chinook Salmon passing Bonneville Dam in 2005 and the 10-y mean count compared to the date of our Killer Whale sightings. Salmon data were extracted from the Fish Passage Center database (http://www.fpc.org/fpc_homepage.html).

2006. During the weeks of 27 March 2006 and 08 April 2006, experienced interpreters from Cape Disappointment State Park's North Head Lighthouse and trained volunteers with the Oregon State Parks and Recreation Department ''Whale Watch Spoken Here'' Gray Whale surveys reported Killer Whales exhibiting the same behaviors described in this manuscript. We attempted to locate and photograph individual whales in 2006 but were unable to do so.

Sightings of SRKW in eastern Juan de Fuca Strait, the San Juan Islands, and Puget Sound are known to correlate significantly with the timing of salmon runs (Heimlich-Boran 1986). Examination of fish counts at Bonneville Dam demonstrates that our observations of SRKW in 2005 and the additional reports of Killer Whales in 2006 coincide with the March to May period when spring Chinook Salmon return to the Columbia River (Fig. 2). Bonneville Dam is approximately 235 km upriver from where Killer Whales were observed. Therefore fish counted at Bonneville Dam must have passed through the Columbia River plume front to enter the river some unknown number of days before. The migration timing, paths, and speeds of adult spring Chinook Salmon moving from the Columbia River plume front into the river below Bonneville Dam have yet to be studied, so we do not know whether whale presence in 2005 and 2006 anticipated, coincided with, or followed a peak in adult salmon numbers at the river mouth or in the lower river. Whale behavior observed near the plume front during the early part of the morning resembled that described for Killer Whales foraging on Chinook Salmon (e.g. Heimlich-Boran 1986, Hoelzel 1993). Although several other salmon species spawn in the Columbia River and its tributaries, in recent history spring Chinook Salmon are the only significant salmon species returning to the Columbia River during March–April (Groot and Margolis 1991). While several species of schooling fish such as Northern Anchovy (*Engraulis mordax*) are known from this area, peak numbers of these fishes are not thought to occur near the Columbia River mouth until after late April or early May (Emmett and others 2006).

The behaviors we observed, the identity of the individual whales, and the presence of a spring Chinook Salmon run lead us to hypothesize that the southern residents from L-pod observed in the plume area were feeding on adult Chinook Salmon in March 2005. The additional 2006 sightings, when combined with Washington outer coast sightings reported in Krahn et al. (2004), suggest that a March–April

appearance of Killer Whales near the Columbia River may be a recurring phenomenon not unique to the detailed March 2005 observations reported here. Many piscivorous marine bird and mammal species aggregate and feed at the Columbia River plume front throughout the year. The physical-biological dynamics of the plume front serve important ecological functions in the local food web (De Robertis and others 2005, Morgan and others 2005), although how those dynamics affect Killer Whale behavior or adult spring Chinook Salmon migration behavior is unknown. Alternatively, the appearance of SRKW at the same time as a spring Chinook Salmon run could be entirely coincidental. Further field investigations are required to determine whether or not the Columbia River plume is consistently visited by the southern residents and what role, if any, the plume and Columbia River salmon play in SRKW winter habitat use, feeding ecology, and diet.

Acknowledgments.—We are grateful to the park managers and staff of Cape Disappointment State Park, Washington State for allowing us to conduct marine bird and mammal surveys at their facility. We thank R Emmett, B Hanson, J Estes, and three anonymous reviewers for providing critiques of the manuscript. C Wilson at the Northwest Fisheries Science Center provided critical library services to our remote field site. This work is funded in part by a grant from the Bonneville Power Administration to the Fish Ecology Division of NOAA Fisheries Northwest Fisheries Science Center, and by an equipment grant from Northwest Fisheries Science Center public outreach programs.

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REVISITING WASHINGTON'S NESTING RECORD OF THE ANCIENT MURRELET

SPENCER G SEALY AND HARRY R CARTER

Key words: Ancient Murrelet, *Synthliboramphus antiquus*, Washington, Carroll Island, museum specimen, nest, eggs, British Columbia, Queen Charlotte Islands/Haida Gwaii, Langara Island

The southernmost colonies of Ancient Murrelets (*Synthliboramphus antiquus*) in the northeastern Pacific Ocean have been documented on the Queen Charlotte Islands/Haida Gwaii, British Columbia (Campbell and others 1990, Springer and others 1993). However, over the past 15 y or so, family groups of Ancient Murrelets have been recorded at sea as far away as Washington and Oregon (Hodder 2003, Wahl 2005), at straight-line distances of approximately 600 to 900 km south of the southernmost colonies. The question of whether these family groups, as well as groups recorded over the last several decades off Vancouver Island (Sealy and Campbell 1979; Cecile 2004; Sealy and others, unpubl. data), originated from isolated, non-colonial nests on islands along these coasts prompted us to examine details of the nesting record of the Ancient Murrelet for Washington (Hoffmann 1924a). If valid, this unusual record supports the possibility that some chicks with their putative parents observed along these coasts came from nearby nests, rather than all chicks dispersing by swimming with adults long distances from colonies to the north.

Ralph Hoffmann described this nesting record in a brief note (Hoffmann 1924a, p 191) published in *The Condor*, which is reprinted below in its entirety:

> **Breeding of the Ancient Murrelet in Washington.**—On May 9, 1924, I took a female Ancient Murrelet (*Synthliboramphus antiquus*) and two eggs from a burrow on Carroll Island, Washington. I gave the eggs to Mr. J. Hooper Bowles, of Tacoma, who informs me that they were on the point of hatching. The bird is now in the Santa Barbara Museum of Natural History and Comparative Oology. As far as I can learn this is the first record for the breeding of this bird south of British Columbia.—RALPH HOFFMANN, *Carpinteria, California, July 18, 1924.*

Hoffmann's record has been accepted at face value (Jewett and others 1953), even though the nest was about 900 km from the nearest Ancient Murrelet colonies known at the time, on Langara Island, Queen Charlotte Islands (Fig. 1). Additional details summarized below nevertheless support its validity. We also provide brief notes on the travels of this early naturalist and egg collector during his trip to Washington around the time of the discovery of this nest, as well to give a sense of the magnitude of this record at a time when the nesting distributions of seabirds along the northeastern coast of the Pacific Ocean, including the Ancient Murrelet's, were relatively poorly known.

Hoffmann collected an Ancient Murrelet in breeding plumage (Fig. 2) and a typical clutch of 2 eggs from a burrow, which is the most com-

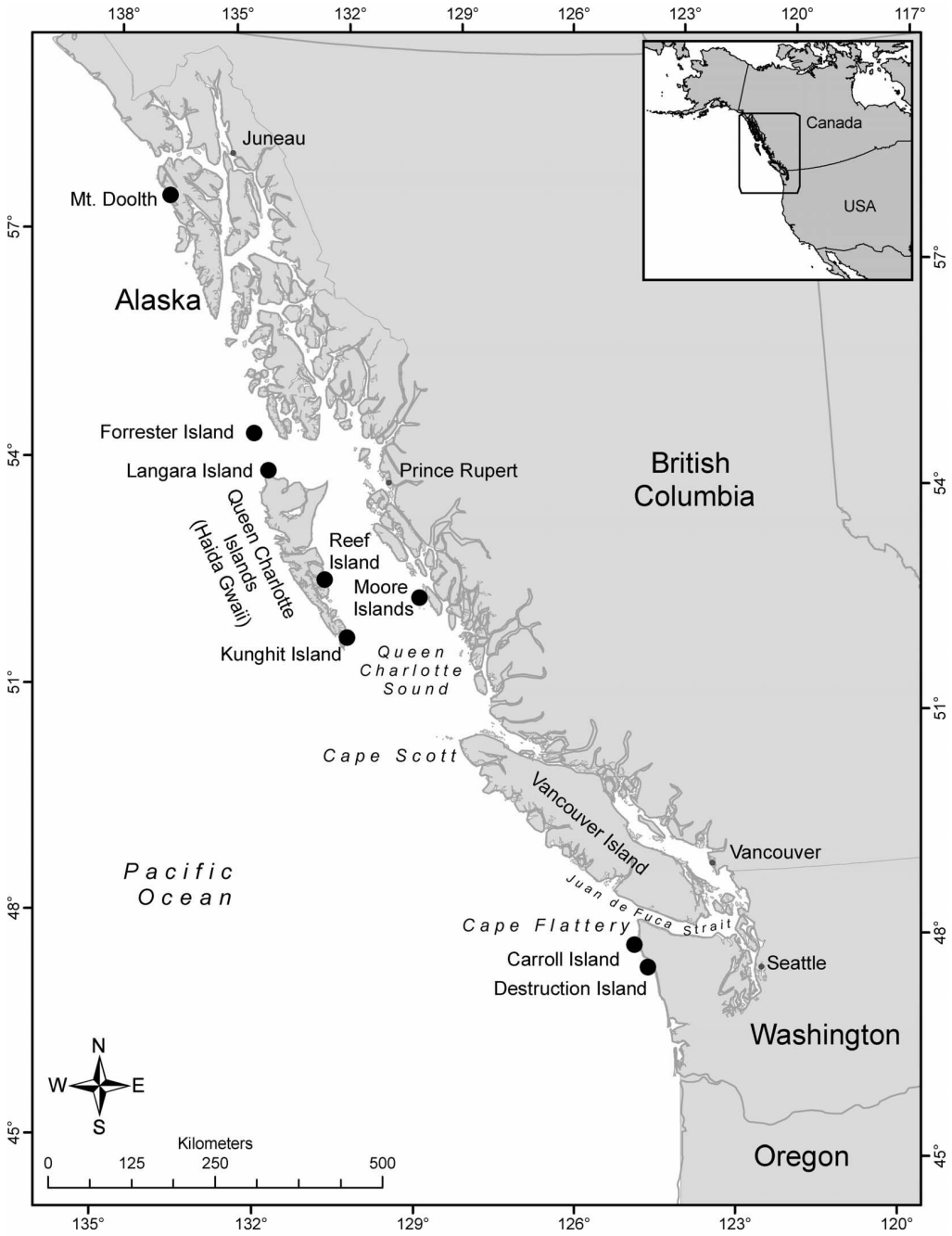

FIGURE 1. Place names mentioned in the text. Carroll Island is the site of the only confirmed nest of the Ancient Murrelet in Washington.

FIGURE 2. Female Ancient Murrelet (USNM 287907) in breeding plumage, collected by R. Hoffmann on Carroll Island, Clallam County, Washington, 8 May 1924.

mon nest type of this species (Gaston 1992). Hoffmann realized this record was unusual and noted that Ancient Murrelets were not known to nest farther south than British Columbia, although in 1924 published information on nesting of this species was meager. Ancient Murrelets had been discovered nesting on Langara Island, a large island off the northwestern tip of the Queen Charlotte Islands, between 1910 and 1920 (Drent and Guiguet 1961). In 1910, Charles de Blois Green collected an egg on 25 May (RBCM E0238 [museums named in acknowledgments]) and EM Anderson collected another egg (RBCM E0239) and a chick (MVZ 101547) on 10 June (see also Brooks 1930). Allan Brooks, James A Munro, and Green collected 2 adults (MVZ 84767, 101548) on 17 April 1913, and on 1 May of the same year Green collected another egg (MVZ 5820). Between 20 April and 1 May 1914, Green (1916, p 474) noted ''hundreds'' and ''thousands'' of nesting murrelets taken for food by Peregrine Falcons (*Falco peregrinus*) and humans, respectively. Green collected 2 more eggs on 1 May 1914 (WFVZ 145, 155) and 1 May 1915 (WFVZ 157, 823). Brooks collected an adult Ancient Murrelet (MVZ 82135) and 2 juveniles (MVZ 82136, 101546) on Langara Island in 1920. Large colonies of Ancient Murrelets also were documented at this time (1913–14) on Forrester Island, Alaska (Heath 1915, Willett 1915), about 70 km north of the Langara Island (Fig. 1). Colonies along the southeast coast of the Queen Charlotte Islands, for example, Reef Island and Kunghit Island, were not discovered until much later, 1960 and 1977, respectively (Drent and Guiguet 1961, Campbell and others 1990).

The murrelet specimen, a female, was transferred from the Santa Barbara Museum of Natural History and Comparative Oology ([SBMNH]; where Hoffmann was Director from 1923 to 1932) to the United States National Museum of Natural History (USNM 287907) on 28 February 1925 (J. Dean, *in litt.*, 7 February 2007). (The date of collection given on the specimen's original label was 8 [not 9] May 1924, although Hoffmann recorded it as 9 May in his notebook [SBMNH library] and in his paper.) The initials, ''R.H.'' (Ralph Hoffmann), are visible on the label (Fig. 3). The bare, bilateral brood patches noted by Dean indicate the bird was incubating (Sealy 1976). Hoffmann's detailed description of the adult's plumage in his notebook was apparently used in his book (Hoffmann 1927).

There is no record of J Hooper Bowles turning over the eggs to the SBMNH (K Fahy, Santa Barbara Museum of Natural History, Santa Barbara, CA, pers. comm.). Our inquiries with several other museums, including the Washington State Historical Society, to which Bowles had donated most of his egg collection upon his

FIGURE 3. Two views of the labels attached to Ancient Murrelet (USNM 287907). Top, original label showing Santa Barbara Museum of Natural History crossed out, plus USNM label with collecting date. Below, other side of original SBMNH label, showing the initials R.H. (Ralph Hoffmann).

death (Jewett and others 1953), did not turn up the eggs. Of interest, the 1st egg of the Marbled Murrelet (*Brachyramphus marmoratus*) collected on Mt Doolth, Alaska, that was loaned to Bowles by the finder, S Warburton, Jr., is mentioned as ''A47'' in Bowles's will that is preserved at the Washington State Historical Research Center (Nancy Jackson, Washington State Historical Research Center Tacoma, WA, pers. comm.). This egg, as well as several other birds and eggs from the Bowles collection, but not the Ancient Murrelet clutch from Washington (Gary Shugart, University of Puget Sound, Tacoma, WA, pers. comm.), are now in the Slater Museum of Natural History (Carter and Sealy 2005).

Carroll Island (48°00′20″N, 124°43′16″W) is a relatively small non-forested rock located about 2 km offshore of the northwest coast of the Olympic Peninsula, north of LaPush, Clallam County, Washington. From 1906 to 1916 and 1967 to 1982, ornithologists surveyed burrow-nesting seabirds on this island and recorded hundreds and thousands of nests of Leach's Storm-Petrel (*Oceanodroma leucorhoa*) and Cassin's Auklet (*Ptychoramphus aleuticus*), respectively, but none of the Ancient Murrelet (Speich and Wahl 1989). Ancient Murrelets occasionally use old Cassin's Auklet burrows (Bendire 1895, see also Davie 1898, Bent 1919), but it was not noted whether this was the case on Carroll Island.

While returning from Washington in 1924, Hoffmann detected singing Gray Flycatchers (*Empidonax griseus*) in the Klamath Falls area, Oregon, on 26 May (Hoffmann 1924b) and observed Wilson's Snipes (*Gallingo delicata*) on 1 June at Eagle Lake, California (Hoffmann 1924c), again providing few details of either observation. G Shugart (pers. comm.) located another seabird egg collected by Hoffmann in Washington in 1924 — a Rhinoceros Auklet (*Cerorhinca monocerata*) egg taken in Clallam County (probably Destruction Island in nearby Jefferson County) on 17 May (Kansas University Museum of Natural History [KUMNH 74397], with no other details [M. Robbins, Kansas University Museum, Lawrence, KS, pers. comm.]). Hoffmann (1927) described in some detail Rhinoceros Auklets nesting at Destruction Island when this was the only colony of this species known in northwestern Washington early in the 20th century (Dawson 1908).

This is the only confirmed nesting record of the Ancient Murrelet for Washington and elsewhere south of the Queen Charlotte Islands. At least one other isolated nesting, however, has been recorded along the north mainland coast of British Columbia. In May 1970, R Wayne Campbell (Biodiversity Centre for Wildlife Studies, Victoria, BC, pers. comm.; see Campbell and others 1990) discovered an incubating Ancient Murrelet in a burrow in a Cassin's Auklet colony on Gander Island in the Moore Islands (Fig. 1). As Ancient Murrelets normally nest in large colonies, usually thousands but sometimes hundreds of pairs (Gaston 1992), it is difficult to imagine that naturalists and egg collectors overlooked colonies along these coasts during their travels in the late 19th and early 20th centuries, and seabird biologists doing the same during surveys in the late 20th

century (Varoujean and Pitman 1979, Speich and Wahl 1989, Rodway 1991). Single nests, on the other hand, would be easy to overlook, or they may be infrequent, and may be the source of some family groups observed in late spring and summer. In light of the spate of records of groups recorded since the mid-1990s (Cecile 2004; Wahl 2005; Sealy and others, unpubl. data), we are currently exploring another possibility, rapid dispersal of family groups from the Queen Charlotte Islands (Sealy and others, unpubl. data).

Acknowledgments.—In addition to online searches and visits to museums, several people provided information. K Fahy and T Sullivan, Santa Barbara Museum of Natural History (SBMNH), California, responded to inquiries regarding the specimen collected by R Hoffmann and located Hoffmann's notebook in the library, respectively. J Dean (United States National Museum [USNM], Washington, DC) examined the specimen, provided additional information, and took the photographs. Several curators assisted our museum visits or examined specimens at out request: C Cicero (Museum of Vertebrate Zoology, University of California [MVZ], Berkeley), R Corado (Western Foundation of Vertebrate Zoology [WFVZ], Camarillo, California), R Faucett (Burke Museum, University of Washington, Seattle), K Garrett (Los Angeles County Museum, California), N Jackson (Washington State Historical Research Center, Tacoma, Washington), R Kenner (Cowan Vertebrate Museum, University of British Columbia, Vancouver), MCE McNall (Royal British Columbia Museum [RBCM], Victoria), M Robbins (University of Kansas Museum of Natural History [KUMNH], Lawrence), G Shugart (Slater Museum, University of Puget Sound, Tacoma, Washington), J Trimble (Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts), P. Unitt (San Diego Museum of Natural History, San Diego, California), and K Zyskowski (Yale Peabody Museum, Yale University, New Haven, Connecticut). RW Campbell and an anonymous reviewer commented on an early draft of the manuscript. The map was prepared by Clover Point Cartographics, Inc, Victoria, BC. We thank everyone for their support. Permission to reproduce Ralph Hoffmann's original note was granted by the Cooper Ornithological Society, holder of the copyright.

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