CALL TYPES OF THE RED CROSSBILL IN THE SAN GABRIEL, SAN BERNARDINO, AND SAN JACINTO MOUNTAINS, SOUTHERN CALIFORNIA

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ABSTRACT: The Red Crossbill (*Loxia curvirostra*) is notable for its extensive morphological and vocal variation, which may represent a complex of incipient and cryptic species differing by flight call. To date, at least 10 distinct flight-call groups have been identified in North America. To our knowledge, however, the flight calls of the Red Crossbills of southern California have not been studied. To begin to address this deficit, we recorded Red Crossbill flight calls at 17 locations in and near the Transverse and northern Peninsular ranges from January 2011 through April 2014. These crossbills were associated with multiple species of conifers, including Jeffrey Pine, Sugar Pine, White Fir, and ornamental plantings of non-native Aleppo Pine, at elevations from 380 to 2700 m. Analysis of sonograms of these flight calls reveals primarily type 2 of Groth's (1993) classification system but also migrants of type 3 in the Mojave Desert.

The nomadic Red Crossbill (*Loxia curvirostra*) is found throughout the coniferous forests of North America and is notable for its large irruptions, which are modulated primarily by the waxing and waning of cone crops (Dickerman 1987, Knox, 1992, Benkman, 1993). The Red Crossbill is further distinguished by its complex morphological and vocal variation (Groth 1993, Smith and Benkman 2007), characteristics that may help create or reinforce reproductively isolated populations. Although often difficult to discern under field conditions, these vocal variations, particularly in flight calls, may be used to assign individual crossbills to groups that may represent incipient or cryptic species. The physical differences, primarily in body and bill size, by which the various subspecies have been defined are not obvious under field conditions (Groth 1993).

In southern California, the occurrence of the Red Crossbill has been documented in the literature since the end of the 19th century (Daggett 1899, Grinnell and Miller 1944). Much work on the variation of the Red Crossbill has been done since the publication of the most recent regional survey (Garrett and Dunn 1981), yet no study, to our knowledge, has categorized the Red Crossbills of southern California by flight calls. To address this deficit, we audio-recorded the species in the San Gabriel (Kern and Los Angeles counties), San Bernardino (San Bernardino County), and San Jacinto mountains (Riverside County) from January 2011 to April 2014. Here, we describe the results of the analysis of these audio recordings.

Distributional Summary

Red Crossbills inhabit coniferous forest throughout North America. In California, they are widespread in the northern half of the state, with breed-

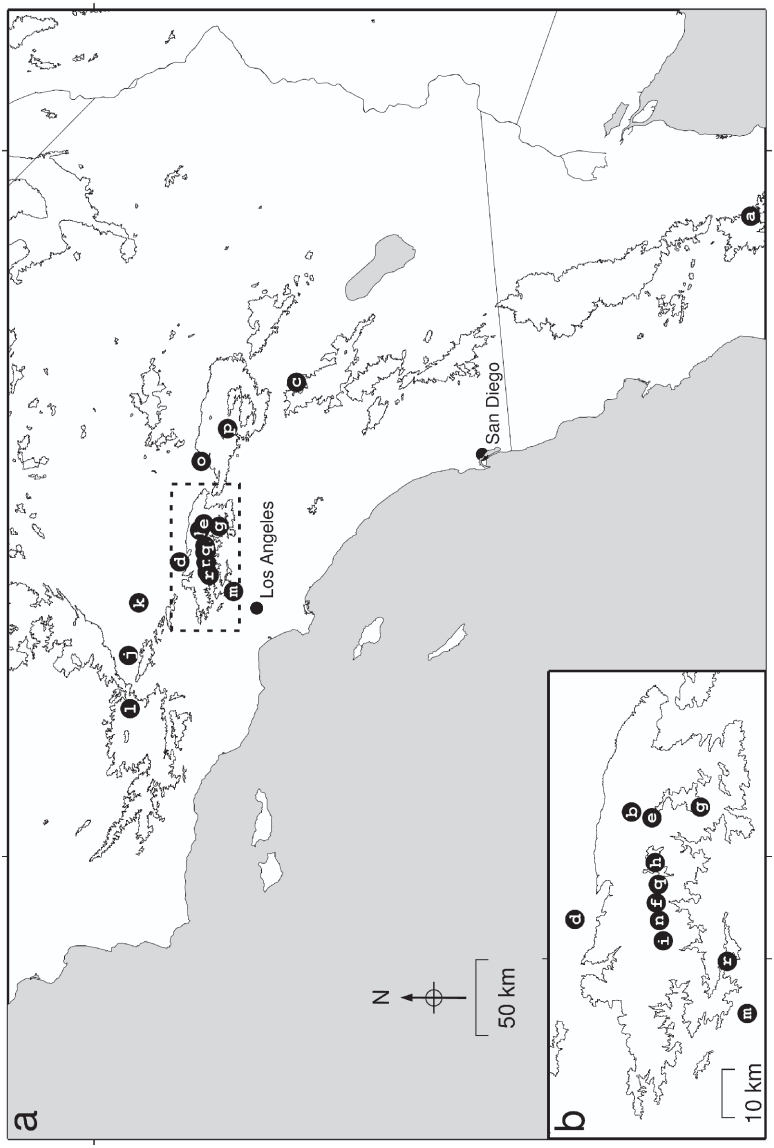

Figure 1. Locations of Red Crossbill recordings discussed in this paper. Letters refer to locations keyed in Table 1. Contour interval 1200 m. (a) Southern and Baja California. Dashed box shows region of detail. (b) Detail of sites of Red Crossbill recordings in the San Gabriel Mountains.

ing populations in the southern Cascade Range, northern Coast Ranges, Klamath Mountains, Modoc Plateau, and the Sierra Nevada (Adkisson 1996). In southern California, the occurrence of Red Crossbill is erratic, with most records from the mountains of the Transverse and Peninsular ranges, supplemented with exceptional records, both toward the coast and in the desert, primarily in ornamental plantings, during irruption years (Garrett and Dunn 1981, Unitt 2004).

In the Transverse Ranges, nesting has been recorded on Mt. Pinos (elevation ~2600 m), Ventura County, but is still only suspected elsewhere despite an abundance of apparently suitable habitat (K. L. Garrett pers. comm. 2011). Farther south, potential breeding has been observed on only one occasion, in coastal ornamental plantings in San Diego County (Unitt 2004).

The morphological variation in the Red Crossbill has led to various classification schemes over the past century (Griscom 1937, Monson and Phillips 1981, Payne 1987, Groth 1993). However, most of the recent work has focused on variations in flight calls, which in North America have been grouped into 10 types (Groth 1993, Benkman et al. 2009, Irwin 2010).

Birds of each call-type differ in bill structure, and these differences influence their ability to feed on cones of various sizes (Benkman 1993, Benkman et al. 2010). These differences in bill structure are thought to cause each call-type to preferentially forage on and associate with specific conifers. This preferential foraging may be especially apparent during periods of food scarcity (Benkman 1993). During failures of cone crops of a call-type's key conifer, crossbills may irrupt in search of other seed sources.

Observations

In southern California Red Crossbills are sporadically reported to ornithological mailing lists and to the online database at http://www.ebird.org. We drew upon both of these sources in choosing locations to search for Red Crossbills. Garrett's observations near Big Pines, San Gabriel Mountains, provided the impetus for beginning our search on nearby Table Mountain.

We recorded the birds with a Sennheiser ME66 shotgun microphone connected to a Marantz PMD 670 digital recorder sampling at 44 kHz and a Sennheiser MKE-400 short shotgun microphone connected to an Olympus LS-10. One exception is the recording made on 25 June, which was extracted from a video taken with a Canon A720 IS digital camera. Table 1 lists our observations and recordings. We are aware of one additional recording from the Peninsular ranges, made by Richard Webster on 24 September 2010, in the Sierra San Pedro Mártir of Baja California, Mexico (XC71803, accessible at http://www.xeno-canto.org/71803).

Our observations in the mountains were made mostly above 2000 m elevation in mixed-conifer forests (Minnich 2007). In addition, we observed crossbills in subalpine forests on Throop Peak and at Bluff Lake as well as in ornamental plantings of Aleppo Pine (*Pinus halepensis*) in the Mojave Desert. Mixed-conifer forests in the Transverse and Peninsular ranges consist primarily of Jeffrey Pine (*P. jeffreyi*), Sugar Pine (*P. lambertiana*), and White Fir (*Abies concolor*), infrequently of Ponderosa Pine (*P. ponderosa*), while subalpine forests at high elevations consist of Lodgepole Pine (*P. contorta* subsp. *murrayana*) and Limber Pine (*P. flexilis*).

Table 1 Recordings of Flight Calls of the Red Crossbill from Southern California and Northern Baja California

Location	Map key[a]	Elevation (m)	Coordinates	Forest type	Date	Call type(s)	Notes[b]
Kern County							
Frazier Mountain	l	2322	34.792° N, 118.954° W	Jeffrey Pine	12 May 2013	2	XC133514
Los Angeles County: Mojave Desert							
Pearblossom Park, Pearblossom	d	950	34.502° N, 117.911° W	Aleppo Pine (ornamental)	5 Mar 2011	2	
					4 Nov 2012	3	XC112383, XC112571
					10 Nov 2012	3	XC112570
					12 Nov 2012	2 and 3	
					26 Jan 2013	2 and 3	XC120276, XC120295, XC120319
Holiday Lake, Neenach	j	879	34.800° N, 118.576° W	Aleppo Pine (ornamental)	23 Feb 2013	2	
					2 Mar 2013	2	XC123662
Apollo Park	k	710	34.742°N, 118.200°W	Aleppo Pine (ornamental)	2 Mar 2013	3	
Los Angeles County: San Gabriel Mountains							
Table Mountain, Big Pines	b	2200	34.386° N, 117.687° W	Ponderosa/Jeffery Pine	8 Jan 2011	2	
					15 Jan 2011	2	
					13 Apr 2014	2	XC175904
					25 Apr 2014	2	XC176661
Blue Ridge Campground	e	2400	34.359° N, 117.686° W	Jeffrey Pine/White Fir	24 Apr 2011	2	
Angeles Crest Hwy., Mile 60.7	f	2100	34.352° N, 117.890° W	Jeffrey Pine/White Fir	3 Jun 2011	2	
					15 Jun 2011	2	
Throop Peak	h	2700	34.353° N, 117.800° W	Lodgepole Pine	19 Jun 2011	2	
					17 Aug 2013	2	XC145609
					14 Sep 2013	2	XC147715

(*continued*)

Table 1 (*continued*)

Location	Map key[a]	Elevation (m)	Coordinates	Forest type	Date	Call type(s)	Notes[b]
Mt. Waterman	i	2117	34.350° N, 117.929° W	Jeffrey Pine	25 Jun 2011	2	Specimen LACM 115904
Altadena	m	380	34.184° N, 118.122° W	Suburban	3 Jun 2013	2	XC136217
Buckhorn Campground	n	1980	34.346° N, 117.915° W	Jeffrey Pine	8 Jun 2013	2	XC139367, XC139365
Grassy Hollow	o	2230	34.375° N, 117.20° W	Jeffrey Pine	16 Jun 2013	2	XC139364
Little Jimmy Spring	q	2290	34.348° N, 117.834° W	Jeffrey Pine	14 Sep 2013	2	XC147717
Chilao Visitors Center	r	1610	34.327° N, 118.006° W	Jeffrey Pine	19 Jan 2014	2	XC165047
San Bernardino County: San Bernardino Mountains							
Mt. Baldy Ski Lodge	g	1974	34.270° N, 117.622° W	Jeffery Pine, Sugar Pine, White Fir	18 Jun 2011	—	
Bluff Lake, Big Bear Lake	p	2315	34.221° N, 116.969° W	Lodgepole Pine	20 Jul 2013	2	XC143040, XC143041, XC143042, XC143043
Riverside County: San Jacinto Mountains							
Mountain Station, Palm Springs Aerial Tramway	c	2600	33.813° N, 116.639° W	Sugar Pine	23–24 Jan 2011	2	XC124421
Baja California: Sierra San Pedro Mártir							
National Observatory	a	2400	31.014° N, 115.463° W	Jeffrey Pine, Sugar Pine, White Fir	24 Sep 2010	2	XC71803[c]

[a]See Figure 1.

[b]Recording available at www.xeno-canto.org or specimen.

[c]Recording by Richard E. Webster. All others by Benner.

Flocks of Red Crossbills ranged in size from as few as two adults to in excess of 30 individuals, including adults and juveniles. One juvenile, from a flock of call-type 2, was killed by striking a window at the Mt. Waterman ski area on 25 June 2011 and is deposited as a specimen in the Natural History Museum of Los Angeles County (LACM 115904).

We observed crossbills feeding on seeds of Sugar Pine (once, Mt. San Jacinto), Jeffrey Pine (Angeles Crest Highway, Mt. Waterman Ski Area, Table Mountain), Lodgepole Pine (Throop Peak, Bluff Lake), and Aleppo Pine (Holiday Lake, Apollo Park, Pearblossom Park), as well as visiting a feeder (Grassy Hollow). On many occasions, we saw individuals perching, but not feeding, in White Fir. We also noted birds taking grit at Mt. Waterman and gleaning insects from branch tips on Mt. San Jacinto. In addition, we observed adults feeding juveniles on at least two occasions (25 June 2011 and 14 September 2013). Because of the species' nomadism, however, this behavior does not necessarily indicate breeding in the immediate area.

Analysis and Discussion

Identification of crossbill calls from audio recordings requires analysis of the calls' time-frequency content. Figures 2 and 3 show spectrograms of representative flight calls. Groth (1993) provided sample spectrograms and written descriptions of the eight flight-call categories he defined.

Of these eight, four (types 1, 2, 3, and 5) are dominated by a downward modulation in frequency over time, similar to the recordings shown in Figures 2 and 3. The frequency modulation of flight calls of type 1 is rapidly upward followed by rapidly downward. Flight calls of type 2 have a downward frequency modulation interrupted by a hesitation (Figure 2). Flight calls of call-type 3 feature a zigzag modulation in frequency, so that the trace resembles a lower case "n" stretched horizontally (Figure 3). Flight calls of type 5 have two parallel frequency components, both with an overall downward frequency modulation.

In comparison with those presented by Groth (1993) and one of type 2 from New York (Figure 2D), spectrograms of most of our recordings resemble call-type 2. In addition, Webster's recording from the Sierra San Pedro Mártir, 24 September 2010, is most similar to call type 2. However, comparison with Groth (1993) and examples of type 3 from Washington and New York (Figures 3B and C) shows that some flight calls recorded at Pearblossom Park during November 2012 (Figure 3A) are most similar to that type.

Our record of call-type 3 is notable. Crossbills of call-type 3 are considered specialists on Western Hemlock (*Tsuga heterophylla*) and occur primarily in the Pacific Northwest and, during irruptions, locally in the Eastern Hemlock (*T. canadensis*) forests of the north-central U.S. and Canada (Benkman 1993, Groth, 1993). Although call-type 3 is plentiful in the Coast Ranges of northern California, there appear to be few records south of the San Francisco Bay area or elsewhere in the southwestern U.S. The occurrence of call-type 3 in the Mojave Desert during the winter of 2012–2013 coincided with a broad irruption of that call-type throughout the western U.S. (M. Young pers. comm.). One record of call-type 3 from the Pinaleno Mountains of southern Arizona during an irruption in the

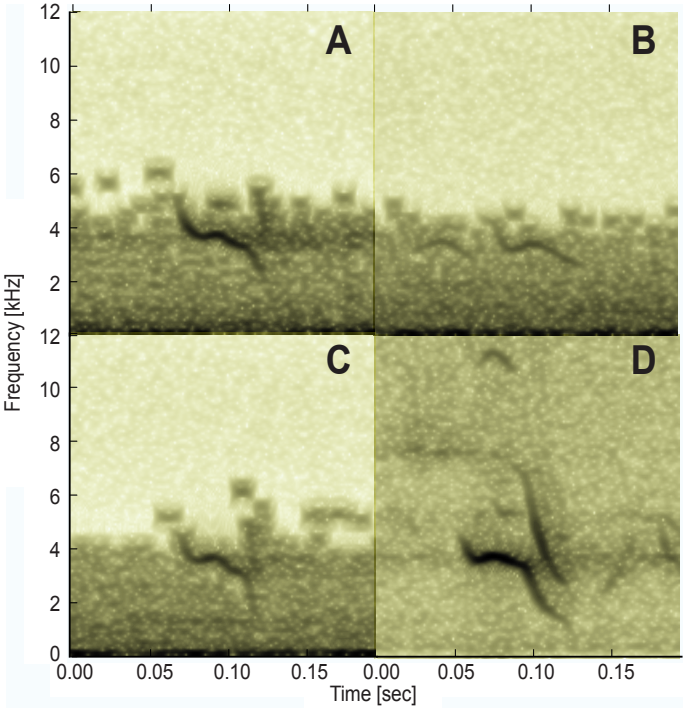

Figure 2. Comparison of type 2 flight calls. (A) Recorded on 23 January 2011 at Mt. San Jacinto, San Jacinto Mountains, (B) recorded on 8 January 2011 at Table Mountain, San Gabriel Mountains, (C) recorded on 5 March 2011 at Pearblossom Park, Los Angeles Co., (D) recorded in Cayuga County, New York (M. Young; Macaulay Library of Natural Sounds [LNS] 161296). Digitization artifacts from file compression are apparent in A, B, and C.

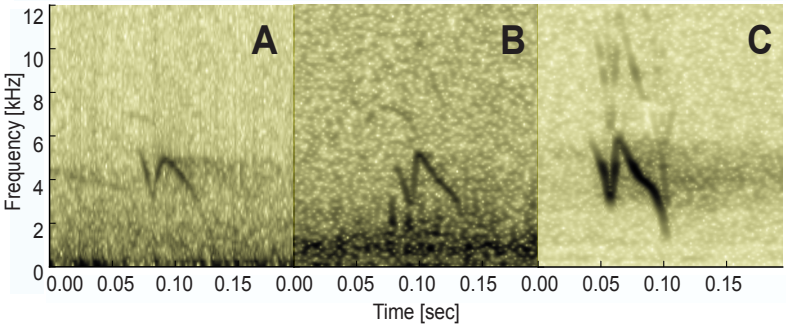

Figure 3. Comparison of call type 3 flight calls. (A) Recorded on 4 November 2012 at Pearblossom, Los Angeles Co., (B) recorded on 3 September 2011 at Tucquala Meadows, Kittitas Co., Washington, (C) recorded in Pharsalia, Chenango Co., New York (M. Young; LNS 136592)

summer of 1986 (Groth 1993), however, hints at prior far-ranging irruptions. Crossbills making call-type 3 correspond with the smallest North American subspecies, *minor*, of which *sitkensis* is a synonym (Monson and Phillips 1981, Groth 1993). This subspecies has been reported from southern California previously on the basis of measurements of two small specimens from Pasadena collected on 26 December 1898 and of one small specimen from Riverside collected 17 January 1909 (Daggett 1899, Willett 1933, Grinnell and Miller 1944). So long ago, of course, these specimens' vocalizations were not reported.

The habitat requirements inferred from Benkman (1993) suggest that the mountains of southern California could support resident populations of crossbills of up to four call-types (Figure 4). The preponderance of mixed-conifer forest throughout the Transverse and Peninsular ranges (Figure 4a and Minnich 2007) suggests that birds of call-type 2, a Ponderosa Pine specialist, should be the most abundant, as we confirmed.

Crossbills of call-type 4, specializing on Douglas-fir (*Pseudotsuga menziesii*), occur throughout the Pacific Northwest. In southern California, Douglas-fir is replaced by the endemic Bigcone Douglas-fir (*P. macrocarpa*) (Burns and Honkala 1990). Although the massive cones of Bigcone Douglas-fir appear to provide ideal forage for Red Crossbills, the late age at which the trees bear cones and smaller size of their cone-crop size in comparison with *P. menziesii* (Burns and Honkala 1990), combined with the absence of large, continuous stands (Minnich 2007), suggest that Bigcone Douglas-fir may not provide enough nourishment to support a resident population of the Red Crossbill. However, crossbills of call-type 4 could occur in Bigcone Douglas-fir during irruption years (Figure 4b).

The presence of small yet continuous stands of subalpine forest, containing primarily Sierra Lodgepole Pine (*P. contorta* subsp. *murrayana*), scattered about the Transverse and Peninsular ranges (Minnich 2007), suggests that small populations of call-type 5, a specialist on the Rocky Mountain subspecies of the Lodgepole Pine (*P. contorta* subsp. *latifolia*), are possible (Figure 4c). However, differences in serotiny between *latifolia* and *murrayana* should lead to an increase in competition for seed from other, nonspecialized consumers, reducing the likelihood of a resident type-5 population in southern California (Critchfield 1980, Benkman, 1999).

Finally, call-type 6, equivalent to the Mexican Crossbill (*L. c. stricklandi*), is presumed to occur in the southern Peninsular Ranges of the Mexican state of Baja California and may disperse northward toward the international border, just as it does in Arizona (Monson and Phillips 1981). Although we are not aware of any audio recordings of call-type 6 from the Sierra Juárez and Sierra San Pedro Mártir of Baja California, the presence of a single specimen of *L. c. stricklandi* collected at Campo, San Diego County (Unitt 2004, San Diego Natural History Museum 873), coupled with reports of *L. c. stricklandi* from Santa Cruz Island (Howell 1917, Dickey and van Rossem 1923) suggests that call-type 6 may, at least, be considered accidental. Additional recordings and new specimens from Baja California are needed to assess the status of call-types 2 and 6 there.

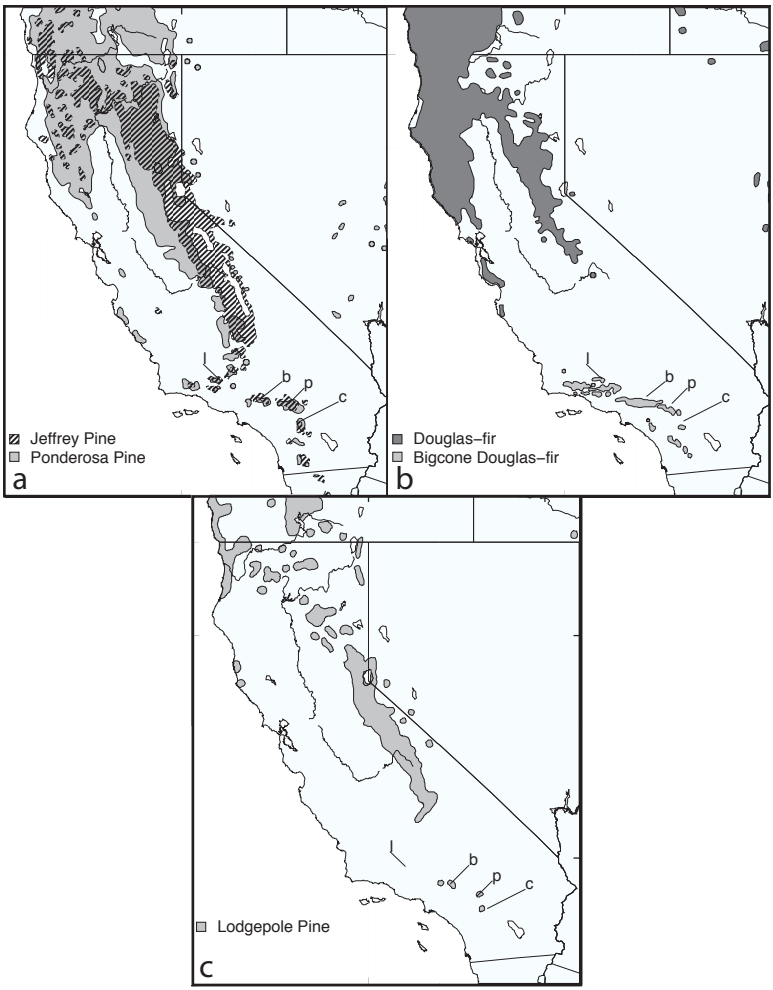

Figure 4. Ranges of conifer species key for Red Crossbills of various call-types, from Little (1971). (a) Sister species Jeffrey (diagonal hatching) and Ponderosa Pine (solid gray), on which call-type 2 is a specialist; (b) Bigcone Douglas-fir (light gray) and Douglas-fir (dark gray), on which call-type 4 is a specialist; (c) Sierra Lodgepole Pine; call-type 5 is considered a specialist on Rocky Mountain Lodgepole Pine. Letters correspond to the locations of recordings in listed Table 1.

CONCLUSIONS

We have obtained recordings of the Red Crossbill from the San Gabriel, San Bernardino, and San Jacinto Mountains and surrounding desert valleys demonstrating the occurrence of individuals of call-types 2 and 3. While

call-type 2 is expected on the basis of habitat and wide range elsewhere in western North America, call-type 3 is notable, possibly representing vagrancy from the Pacific Northwest. Furthermore, the presence of Red Crossbills of call-type 2 in the mountains of southern California continuously from 2011 to 2014 suggests they are resident. The recordings we obtained in southern California cover a little over three years, and continued observation may demonstrate the occurrence of other call-types, especially during irruption years. Diagnostic recordings are often obtainable with readily available technology, such as cell phones, and we encourage bird watchers to continue collecting data.

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Red Crossbill

Photo by Lance Benner