INDICATIONS THAT THE COMMON REDPOLL IS DOUBLE BROODED IN ALASKA

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ABSTRACT: Successfully rearing two broods in one season (double brooding) is rare at high latitudes, and few well-documented cases exist in the Arctic. There are numerous suggestions in the literature that the Common Redpoll (*Acanthis flammea*) is occasionally a double-brooded species. We examined banding data sets from interior Alaska, specimens in the University of Alaska Museum bird collection, and Alaska nest-record cards to understand the timing of reproduction in Alaska boreal forest and tundra. In interior Alaska Common Redpolls exhibit characteristics of breeding for over four months, plenty of time to successfully raise two broods. Furthermore, tundra breeding takes place after most boreal forest breeding, making it possible that individuals could rear two broods in different regions, as has been suggested in northern Europe. Finally, pronounced annual variation in production of young in Fairbanks was not correlated with production of tree seeds in the previous summer.

Many passerines increase reproductive success by multiple brooding, raising two or more broods in a single breeding season. The possibility of having more than one brood is determined primarily by the length of the breeding season, as well as by other environmental factors, such as food availability, microhabitat of the nest site, and the amount of parental care needed for the first brood (Hussell 1983, Gill 2007, Mulvihill et al. 2009, Jacobs et al. 2013). The Common Redpoll, *Acanthis flammea*, breeds during the summer in boreal taiga and shrubby tundra habitats. Individual redpolls depart their wintering areas from mid-March through April and arrive at their breeding grounds by mid-May (Knox and Lowther 2000). During the breeding season, the female, often attended by the male, takes about three days to build a nest, then lays a clutch of three to five eggs; incubation lasts 11 days and is performed solely by the female with the male occasionally bringing her food (Knox and Lowther 2000). Nestlings normally fledge after 12–15 days, although Walkinshaw (1948) reported young leaving the nest after only 9 days. Offspring begin their first prebasic molt shortly after fledging, molting from as early as mid-July to as late as late October, but primarily from August through September (Cramp and Perrins 1994). Records of post-fledging care suggest that it may be very limited (Alekseeva 1986, Haftorn 2002). For example, in Finnmark, Norway, fledglings were seen at the nest site of their presumed parents, which were in the process of renesting, but neither male nor female acknowledged the offspring and the young eventually flew off (Haftorn 2002). In total, these reproductive activities, from nest building to fledging, require 29–34 days.

It is uncommon for passerines to double brood at high latitudes. The short summers provide less time for breeding, particularly if late thaws reduce chances for successful reproduction (Elkins 1983). At Baffin Island, Canada, Hussell et al. (2014) reported unequivocal evidence of double brooding in the Northern Wheatear (*Oenanthe oenanthe*), the only species of seven small passerines in the North American Arctic so far definitively shown to do so. Close relatives of the redpoll, such as the Twite (*Carduelis flavirostris*) and

the Greenfinch (*Chloris chloris*), are known to double brood (Kosiński 2001, Raine et al. 2006). There is evidence that female Common Redpolls can lay replacement clutches if their first nesting attempt is not successful, and up to three clutches have been observed (Sheldon 1911, Troy and Shields 1979, Alekseeva 1986). But so far there seems to be no concrete documentation of their successful double brooding, although observations suggest that it probably does take place (e.g., Brandt 1943, Troy and Shields 1979, Seutin et al. 1991, Haftorn 2002). Relatively long periods of reproductive activity have led many to infer that the Common Redpoll is double-brooded, maybe even commonly (e.g., Evans 1966, Hildén 1969, Kessel 1989, Cramp and Perrins 1994, Knox and Lowther 2000).

There are two distinct ways in which double brooding has been inferred in the Common Redpoll: through the typical avian behavior of renesting in the same general area, and, in northern Europe, through nesting first in one region and then moving substantial distances to renest in another region where spring arrives later (e.g., Peiponen 1957, Hildén 1969, Götmark 1982, Haftorn 2002).

After breeding and before migration, adults undergo a complete prebasic molt, from around July through early September (Cramp and Perrins 1994). Small flocks start to form around mid-July and continue through August. Kessel (1989) found that on the Seward Peninsula, Alaska, departure from the breeding grounds happens mostly in September, but in some years some birds remain as late as December.

Here we examine data on Common Redpoll breeding in Alaska to determine whether the species might be double brooded there.

METHODS

We began by examining two datasets on birds banded in interior Alaska, one from the Alaska Bird Observatory and Alaska Songbird Institute (1992–2012), at Fairbanks (64° 50′ N), and one from Tetlin National Wildlife Refuge (1993–2013), at Tok (63° 20′ N). We considered the timing and incidence of incubation patches, eggs in oviduct, cloacal protuberances, juvenal plumage, flight-feather molt, and relative abundances of adults and birds of the year (hatch-year individuals). Proportions of adults with incubation patches, cloacal protuberances, and flight-feather molt were also calculated (on the basis of total adults, rather than of males or females, because many individuals could not be sexed). Because banding was standardized temporally, we were able to compare years directly. We did not consider flight-feather molt at Tok because of diminished banding there in June or July. All date data were analyzed on the basis of Julian dates, but we report results in calendar dates for non-leap years.

With specimens from the bird collection at the University of Alaska Museum (1963–2013) we compared evidence of redpoll breeding at Fairbanks and Tok with data from tundra in arctic Alaska (where we do not have banding data), "arctic" being defined as territory north of the Arctic Circle or north and west of the Porcupine, Yukon, and Kuskokwim rivers, and other tundra-dominated regions of western Alaska, including the Alaska Peninsula and Aleutian Islands (Arctic Research and Policy Act of 1984, amended 1990;

www.nsf.gov/geo/plr/arctic/iarpc/arc_res_pol_act.jsp). Brown streaking on the head, lack of a red cap, and/or an incompletely ossified skull identified a specimen as in its year of hatching. Flight-feather molt was specified on the label or identified by missing or uneven flight feathers. Also, we noted if the label recorded a cloacal protuberance, incubation patch, or egg in the oviduct. A few additional individuals were included from tundra-dominated regions such as Cape Peirce and Mother Goose Lake; while these western Alaska locations are not technically in the arctic, they are dominated by tundra habitats and thus provide data that complement the banding data from forested habitats in interior Alaska. We also used Alaska nest-record cards from the University of Alaska Museum, primarily from arctic Alaska.

Finally, we examined annual seed-crop data for five species of trees from the Bonanza Creek site of long-term ecological research (LTER) in the boreal forest near Fairbanks (www.lter.uaf.edu/data_detail.cfm?datafile_pkey=14) to see if there was a correlation between the abundance of juvenal-plumaged redpolls and the abundance of these seed crops. Surveys are standardized, and the sites that we used were those that had complete data for the years 1992–2012. Tree species included tamarack, *Larix laricina*, from site FP5A; white spruce, *Picea glauca,* from sites FP2A, FP4A, UP1A, and UP3A; black spruce, *P. mariana*, from site FP3A; birch, *Betula papyrifera*, from sites FP4A and UP3A; and alder, *Alnus crispa*, from sites FP4A and UP3A. We calculated annual seed fall for each tree species and the total from all five.

RESULTS

Data on Common Redpolls captured by the Alaska Bird Observatory began on 21 April and ended 30 September. The species was abundant from 25 April to 19 May, and eight of these days had over a hundred captures each (in aggregate), with only a portion of these birds apparently remaining later to breed. Females had incubation patches from 22 April to 31 August, a period of 132 days (Figure 1); an outlier (recording error?) on 27 September was excluded. The interval encompassing the days on which the proportion of adults with incubation patches reached 1.0 extended from 18 June to 22 August, a period of 66 days (Figure 2). Females with eggs in the oviduct were found over 47 days from 21 April to 6 June, though Alaska nest records extend laying in Fairbanks to 23 June and even later, with a record of hatching on 6 August.

We found cloacal protuberances from 21 April to 19 August, a total of 120 days of males' possible breeding, with the highest proportion from 20 June to 19 August; Figure 3). Juvenal plumage was noted from 6 May to 29 September, a total of 146 days. Flight-feather molt was recorded from 21 April to 30 September, suggesting that post-breeding molt of adults can extend over approximately 162 days. However, only a few individuals showed flight-feather molt early in the season, increasing until 50% of captures showed it on 6 June and 15 July and more than 50% only on 22 July and afterwards. Numbers of juvenal-plumaged individuals peaked in 1995, 1998, 2003, 2006, 2009, and 2011 (Figure 4).

Redpoll data from the Tetlin bird-banding station began on 21 April and

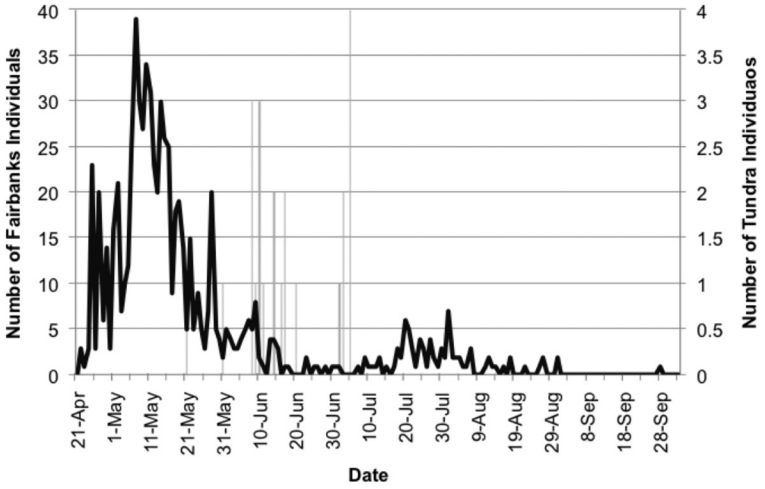

Figure 1. Abundance by date of redpolls with incubation patches at Fairbanks (black line starting from 21 April; Alaska Bird Observatory data) and in arctic Alaska (gray bars starting at 21 May; data from specimens in the University of Alaska Museum and Alaska nest-record cards; eggs assumed to correspond with incubation patches in the adult female).

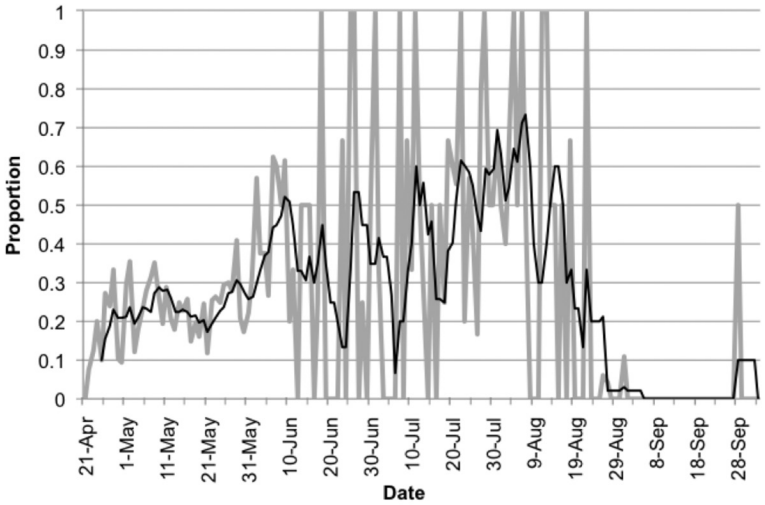

Figure 2. Proportion by date of Common Redpolls at Fairbanks with incubation patches. Gray line, daily proportion; black line, five-day moving average.

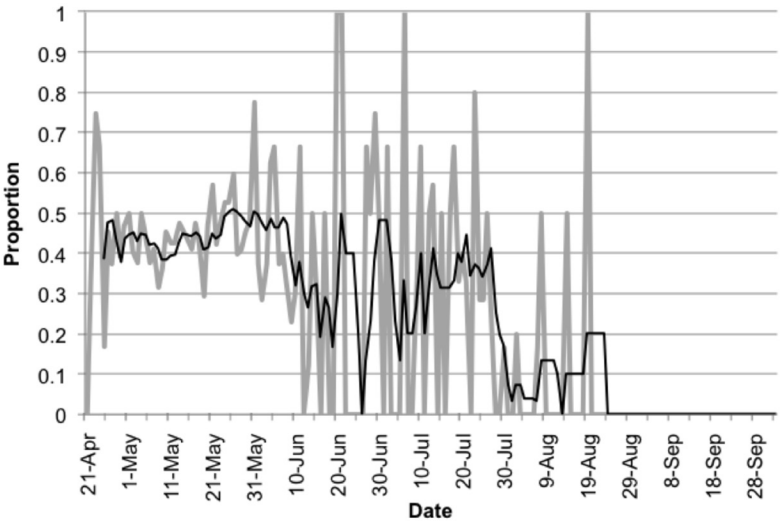

Figure 3. Proportion by date of Common Redpolls at Fairbanks with cloacal protuberances. Gray line, daily proportion; black line, five-day moving average.

ended on 2 October. Individuals exhibited incubation patches from 23 April to 8 September, giving a total of 140 days of birds in condition to incubate or brood. There were no records for eggs in the oviduct in this dataset. Cloacal protuberances were identified from 22 April to 10 June, a total of 50 days

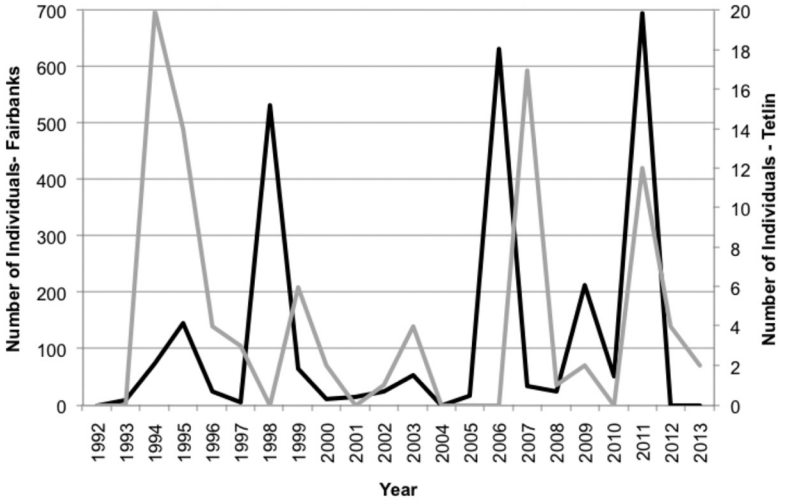

Figure 4. Numbers of redpolls in juvenal plumage banded each year at Fairbanks (black line) and Tok (gray line), Alaska (1992–2013).

of males in condition to breed. Juvenal plumage was found from 30 July to 2 October, a period of 65 days. These dates are roughly similar to those in the larger Alaska Bird Observatory dataset (not shown), but banding at Tok in June and July was insufficient to reflect the full duration of breeding and molting. The number of juvenal-plumaged birds per year peaked in 1994, 1999, 2003, 2007, 2009, and 2011 (Figure 4).

In the UAM bird collection, 23 specimens from arctic and tundra areas of Alaska had incubation patches, on dates from 21 May to 5 July (Figure 1). Three, collected on 26 July, 5 August, and 6 August, showed flight-feather molt. Thirteen, dated 3 July–31 August, were nestlings or in juvenal plumage. One with a cloacal protuberance was dated 21 July. No specimen had an egg in the oviduct. An additional seven nestings in arctic Alaska are documented in the Alaska nest records, with laying reported on 15 June, eggs in the nest on 6 June and 1 and 5 July, and hatching on 20 and 30 June and 6 July.

We found no correlation between the production of juvenal-plumaged birds by year and the seed data from Bonanza Creek LTER (seed abundance for birch, *Betula*, and white spruce, *Picea*, is in Figure 5).

DISCUSSION

Although we found no direct evidence for double brooding of the Common Redpoll in Alaska, we can infer that it probably takes place, given 29–34 days needed for a successful nesting and the relatively long period during which redpolls exhibit breeding activity in interior Alaska: 132 days of incubation

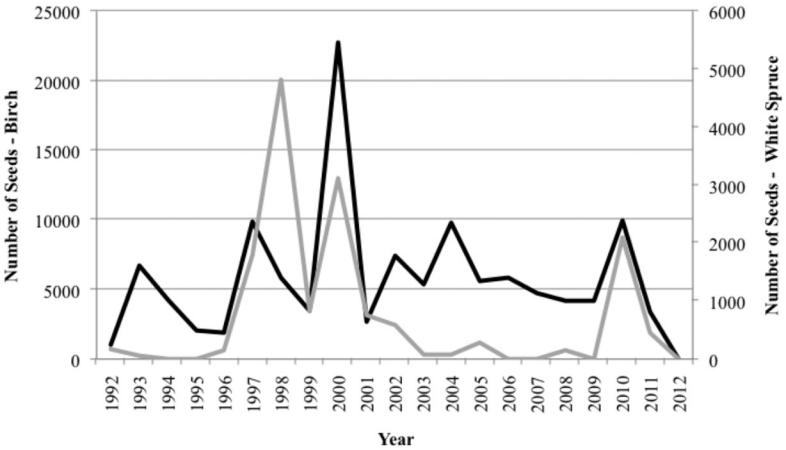

Figure 5. Annual counts of fallen seeds (1992–2012) of birch, *Betula papyrifera* (black line), and white spruce, *Picea glauca* (gray line), at the Bonanza Creek site of long-term ecological research near Fairbanks. Note that years of peak seed production do not correspond with years of peak captures of juvenal redpolls at Fairbanks in Figure 4.

patches, 120 days of cloacal protuberances, 146 days of juvenal plumage, or 162 days total of some evidence of breeding. On and near the Seward Peninsula, Alaska, Troy and Shields (1979) observed one female attempt three successive nests (only the last clutch was successful), and both they and Kessel (1989) inferred from observations and the long breeding season that this species might be double brooded there. Our data imply an even longer breeding season in interior Alaska, suggesting that seeking direct evidence of double brooding in boreal forests should be worthwhile as well.

Furthermore, comparing the timing of reproduction of redpolls in interior forest and on the tundra implies that birds breeding early at Fairbanks have time to relocate to tundra and breed again there (Figure 1). The complementarity of the timing of breeding in the two regions is highly suggestive, as is the relative scarcity of postbreeding molt in the interior until 22 July (one might expect postbreeding molt to be initiated earlier than this in single-brooded adults breeding from late April through early June). Despite the numbers of females with incubation patches in the interior early in the breeding season (Figure 1), many other redpolls in that area are apparently not breeding then (Figure 2), so not all individuals pursue a two-site strategy of double brooding. Nor may such a strategy be pursued every year. The great variation from year to year in numbers of birds in juvenal plumage (Figure 4) suggests that such a strategy may be followed only in years of ample food, as suggested in Europe (Peiponen 1957, Hildén 1969, Götmark 1982). Although we thought that this annual variation might be correlated with the production of tree seeds, we found no evidence for this (Figures 4 and 5). Common Redpolls consume the types of tree seeds that are counted at Bonanza Creek, such as those of birch, alder, and spruce; they forage primarily for seeds still in the trees, moving to the ground when seeds in the trees are exhausted or fallen (Cramp and Perrins 1994). It is possible that tree-seed production during a summer is not correlated with tree-seed availability during the following breeding season (e.g., if storms knock seeds out of the trees).

In Fairbanks, the redpoll's breeding season extends over the rather long span of approximately four months, suggesting that the species is capable of a second brood in this area. It is also possible, given the difference in timing of breeding between the forested interior and tundra, that some individuals that raise a first brood around Fairbanks then move to tundra to raise a second brood. To test this hypothesis, one should examine redpolls arriving in the tundra for evidence of regressing incubation patches, post-ovulatory follicles, and for the possible arrival of hatch-year birds. Birds breeding in the boreal forest should be marked individually to assess whether double brooding is taking place and with what frequency.

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