

Age at First Return and Breeding of Razorbills (*Alca torda*) on the Gannet Islands, Labrador and Machias Seal Island, New Brunswick

JENNIFER L. LAVERS^{1,2}, IAN L. JONES¹ AND ANTONY W. DIAMOND³

¹Department of Biology, Memorial University of Newfoundland, St. John's, NL, A1B 3X9, Canada

²Present address: University of Tasmania, Hobart, Tasmania, 7001, Australia
Internet: Jennifer.Lavers@csiro.au; Phone: 61-03-6232-5091; Fax: 61-03-6232-5187

³Atlantic Cooperative Wildlife Ecology Research Network, University of New Brunswick, Fredericton, NB, E3B 6E1, Canada

Abstract.—Resightings of Razorbills (*Alca torda*) banded as chicks on the Gannet Islands, Labrador (N = 1,873 resightings of 638 individuals) and Machias Seal Island, New Brunswick (N = 870 resightings of 291 individuals) were used to estimate the timing and age at first return to the natal colony and age at first breeding. In total, 14 one-year-old and 110 two-year-old birds were observed on land. All one- and two-year-old birds were seen for the first time on the islands late in the breeding season after laying had occurred, with two-year-olds returning to the colony on average three weeks earlier than one-year-old birds. Age at first breeding was significantly lower on Machias Seal Island than the Gannet Islands, 3.88 ± 0.13 SE and 4.40 ± 0.13 SE years, respectively (range two to six years, N = 123). Four two-year-old birds were observed engaging in courtship and breeding behaviors, including copulation. Overall, age at first return and breeding was lower than for known European Razorbill colonies and is likely due to low breeding densities and fidelity at the two North American colonies studied. Received 27 February 2007, accepted 09 October 2007.

Key words.—Age at first breeding, *Alca torda*, Razorbill, recruitment.

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Prior to their first breeding attempt, many seabirds return to their natal colony as non-breeders, or prospectors (Ashcroft 1979; Jones 1992; Halley *et al.* 1995; Breton *et al.* 2006). The timing of their return and duration of stay has been shown to vary between species and may have important implications for researchers attempting to census the population, carry out management, as well as the birds themselves as they gather information about suitable breeding sites and foraging areas prior to their first breeding attempt (Jones 1992; Cadiou *et al.* 1994; Halley *et al.* 1995; Dittmann and Becker 2003; Breton *et al.* 2006). In the family Alcidae, individuals typically delay breeding for four to six years (Kress and Nettleship 1988; Harris *et al.* 1994), while other seabirds begin breeding as young as three years and some not until 13 years of age (Austin and Austin 1956, 1992; Waugh *et al.* 1999).

When developing a demographic model, accurate estimation of the age at first breeding is essential since the proportion of individuals that die without breeding increases each year that breeding is delayed (Clobert and Lebreton 1991; Harris *et al.* 1994; Ham-

er *et al.* 2002). However, determination of the age of first breeding is made difficult in some species due to low return rates of marked fledglings as a result of high over-winter mortality and low site fidelity (Porter and Coulson 1987; Court *et al.* 1989). In addition, many seabirds breed in concealed sites such as crevices making the collection of long-term quantitative data challenging (Birkhead and Harris 1985; Brooke 1990; Harris *et al.* 1994).

Razorbills (*Alca torda*) have been shown to exhibit delayed breeding, and nest primarily in enclosed sites. As a result, only two studies have successfully estimated age at first breeding (Lloyd and Perrins 1977; P. Lyngs in Hipfner and Chapdelaine 2002). Both studies are of European colonies and suffer from small sample size (N < 40). Therefore, there is a need to quantify age at first breeding for North American Razorbill populations. Here we report age at first return and breeding for a small, increasing North American Razorbill population and a large, decreasing population over a twelve year period, and compare the results with European figures.

METHODS

Study Sites

The field study sites for this project were the Gannet Islands, Labrador, Canada (53°56'N, 56°30'W) and Machias Seal Island, New Brunswick, Canada (MSI; 44°3'N, 67°06'W). The Gannet Islands cluster includes six islands (GC1-GC6) and is home to the largest Razorbill breeding colony in Atlantic Canada with an estimated 9,800 breeding pairs (Chapdelaine *et al.* 2001). MSI is a four ha island located in the Bay of Fundy and is home to approximately 543 Razorbill pairs (Grecian *et al.* 2003).

Banding and Resighting

Banding and resighting of Razorbills breeding on MSI and the Gannet Islands, began in 1995 and 1996 respectively and continued until 2006. More than 6,200 chicks were banded during this period resulting in a large number of known-age birds. Resighting stints were conducted from blinds and cliff ledges using a spotting scope. Breeding status was confirmed through observations of copulation, incubation of an egg or chick, feeding event, or presence of a brood patch (when recaptured). The first record of breeding was equated to the first instance of breeding, although some birds could have bred one or more years before. A one-way ANOVA (Minitab, Inc., 2000) was used to determine whether age at first breeding differed between the Gannet Islands and MSI.

RESULTS

Resighting Effort

From 1998-2006, 1,873 resightings of 678 known-age birds were recorded on the Gannet Islands. On MSI, 870 resightings of 291 known-age birds were recorded from 1995-2006. From these resightings, the sex of 40 known-age birds were determined (Gannet Islands: nine males, five females; MSI: twelve males, 14 females).

Return of Young Birds to the Breeding Colony

Twelve one year-old Razorbills and 72 two year-olds were observed on the Gannet Islands from 1998 to 2006. On MSI, two one

year-old and 38 two year-old birds were resighted during 1999 to 2006. These birds could quickly be distinguished from more mature birds by the lack of a white bill stripe or a noticeably shorter, less deep bill with no obvious grooves. All one- and two-year-old birds were seen for the first time late in the breeding season after laying had occurred (Table 1). On average, two-year-old birds arrived three weeks earlier than one-year-olds on MSI, but no difference in arrival dates was detected on the Gannet Islands (Table 1).

Age at First Breeding

Seventy-five known-age individuals were observed breeding on the Gannet Islands. Their ages at first recorded breeding were two years (three birds), three years (16), four years (18), five years (24), and six years (14; Table 2). The median and modal ages were both five years while the mean age of first breeding was 4.40 ± 0.13 SE years. On MSI, the median and modal ages of first breeding for 48 known-age Razorbills were four years and the mean age at first breeding was 3.88 ± 0.13 SE years. Ages at first recorded breeding were two years (one bird), three years (14), four years (24), five years (five), and six years (three; Table 2). Overall, mean age at first breeding was significantly lower on MSI compared to the Gannet Islands ($F_{122} = 7.44$, $P < 0.01$). No significant difference in the age at first breeding for males and females was detected at either location ($P > 0.05$).

DISCUSSION

Our observations on the age at first return for Razorbills banded as chicks contrast with what has been reported for European Razorbill colonies and other closely related auks such as the Common Murre (*Uria aalge*,

Table 1. Mean date when one and two year-old Razorbills were resighted on the Gannet Islands and Machias Seal Island in relation to the timing of breeding, 1998-2006.

Location	Peak laying	Peak fledging	Mean day one-year-old birds seen (n)	Mean day two-year-old birds seen (n)	Source
Gannet Islands	18-24 June	10-16 August	27 July (12)	26 July (72)	This study
Machias Seal Island	15-25 May	8-17 June	16 July (2)	25 June (38)	Bond <i>et al.</i> 2007

Table 2. Proportions of Razorbills breeding for the first time at four colonies in North America and Europe.

Proportion breeding for the first time at each age (years)	Gannet Islands 1996-2006 (N = 75)	Machias Seal Island 1995-2006 (N = 48)	Skokholm 1971-1973 (Lloyd & Perrins 1977) (N = 20)	Græsholmen (Hipfner and Chapdelaine 2002) (N = 38)
2	0.04	0.02	0.00	0.00
3	0.21	0.30	0.00	0.32
4	0.24	0.51	0.35	0.47
5	0.32	0.11	0.60	0.21
6	0.19	0.06	0.05	0.00

Lloyd and Perrins 1977; Gaston and Nettleship 1981; Hudson 1985; Gaston *et al.* 1994; Halley *et al.* 1995). On Skokholm and Skomer, no one year-old Razorbills and only a few two year-olds were observed on land (Lloyd and Perrins 1977; Birkhead and Hatchwell 2004) compared to relatively large numbers of these age classes observed on the Gannet Islands and MSI during this study (Table 2). This is behaviorally significant as immature Razorbills were previously thought to live exclusively at sea until at least two years of age (Lloyd 1974). Like the Gannet Islands, Skokholm's Razorbill population was thought to be in decline (Nettleship and Evans 1985; Lloyd *et al.* 1991), yet very few juveniles were seen (Lloyd and Perrins 1977). It is unclear why Razorbills at the Gannet Islands and MSI are returning to the colony at such a young age, but the presence of these prospectors has important implications for the stability and persistence of each population by providing replacements for vacancies created by the loss of established breeders.

In many seabirds, the timing of the arrival of individuals on the breeding grounds varies with age with younger birds arriving later in the season (Ashcroft 1979; Jones 1992; Breton 2001; Dittmann and Becker 2003). This was also true for Razorbills, with one and two year-old birds arriving after laying had occurred. Overall, two-year-old birds arrived earlier in the breeding season than one-year-olds. This pattern has been reported in other auks including Atlantic Puffins (*Fratercula arctica*), Common Murres, and Least Auklets (*Aethia pusilla*; Ashcroft 1979; Jones 1992; Halley *et al.* 1995; Breton 2001) suggesting that as individuals gain experience at a colony, they return progressively

earlier leading up to their first breeding attempt. This is thought to be due to an increased familiarity with the area (Beletsky and Orians 1989; Cadiou *et al.* 1994) as well as earlier physiological responses that induce migration to the breeding grounds (Halley *et al.* 1995; Dittmann and Becker 2003).

A major interest of this study was the demographic comparison between the Gannet Islands and MSI where populations show different trends. On MSI, Razorbill survival and breeding success are high and the population is thought to be increasing and is expanding into new colonies in the Gulf of Maine (Bond *et al.* 2007; Lavers *et al.* 2007b, 2008; L. Welch and S. Hall, pers. comm.). In contrast, the Gannet Islands population suffers from low survival and productivity and in the absence of immigration, is predicted to decline (Lavers 2007; Lavers *et al.* 2007a, 2008). The status of these two populations is due at least in part to differences in the recruitment of new breeders and therefore age at first breeding.

Age at first breeding at the Gannet Islands and MSI was a year lower on average compared to Razorbill populations breeding on Skokholm and Græsholmen (Lloyd and Perrins 1977; Hipfner and Chapdelaine 2002). However, expanding populations in both Europe and Canada exhibited a lower age at first breeding. On Græsholmen and MSI, small populations (<1,000 pairs) thought to be increasing (Hipfner and Chapdelaine 2002; Lavers 2007), age at first breeding was lower compared to Skokholm and the Gannet Islands, large populations (>3,500 pairs) thought to be in decline (Lloyd and Perrins 1977; Stowe 1982; Lavers 2007). Age at first breeding has been shown

to vary with the size and status of a population in other seabirds, and is thought to be due to a reduction in competition among potential recruits for breeding sites and mates when populations are small or in decline (Chabryk and Coulson 1976; Porter and Coulson 1987; Pyle 2001). Breeding densities were low on the Gannet Islands due to low site fidelity and survivorship (Lavers *et al.* 2007b, 2008) and small population size and emigration in the case of MSI (Grecian *et al.* 2003; Lavers *et al.* 2007b). Therefore, competition for breeding sites was likely low allowing young birds to attempt breeding at earlier ages.

Harris *et al.* (1984) suggested that observations should be made at both the natal colony and elsewhere to determine whether age at first breeding differs between individuals returning to the natal colony and those that emigrate. Three Razorbills from the Gannet Islands and MSI were observed breeding elsewhere during this study at the age of three (N = 2) and four (N = 1) years old. All two year-old birds (N = 3) observed breeding had returned to their natal colony, therefore our data do not suggest that birds which emigrate breed at a younger age. However, a potential bias in our estimates concerns the degree to which we failed to detect an individual on the first occasion that it bred. Since most Razorbills breed in enclosed sites that are not readily visible (Stowe 1982; Rowe and Jones 2000), it is possible that some birds may have bred previously and were not detected. In addition, in some seabirds, non-breeders occasionally exhibit sexual activity (Cramp and Simmons 1984; Halley *et al.* 1995; Hamer *et al.* 2002); therefore it is possible that some Razorbills observed copulating may not have been breeding. We acknowledge these potential biases, but emphasize that resighting of banded, known-age individuals is a widely used technique to establish breeding status in seabirds (Lloyd and Perrins 1977; Harris *et al.* 1994; Pyle 2001; Dittmann and Becker 2003). Furthermore, we feel that alternative methods such as checking for breeding birds on their nests, is too invasive for a species that is known to abandon the nest following human distur-

bance (Lyngs 1994; Hipfner and Bryant 1999; Rowe and Jones 2000).

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