Reproductive Phenology and Early Survivorship in Red-throated Loons, *Gavia stellata*

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Red-throated Loons, *Gavia stellata*, occupied breeding territories on the Queen Charlotte Islands, British Columbia, in the middle of April. Eggs were laid between 10 May and 20 July; mean incubation time was 27 d (range 24.5–31 d). Replacement clutches were laid after loss of eggs and after loss of a 4-d old chick. Mean period from hatch to fledge was 48 d (range 46–50 d) with the latest fledging date 14 September. Number of fledged young was 0.86/pair/y (N = 17 nests). Egg mortality was attributed to nest flooding and chick mortality to Bald Eagle, *Haliaeetus leucocephalus*, predation.

Key Words: Red-throated Loon, *Gavia stellata*, reproductive phenology, incubation, pre-fledging, survivorship, Queen Charlotte Islands.

During studies of the breeding biology of Red-throated Loons (*Gavia stellata*) on the Queen Charlotte Islands (Reimchen and Douglas 1984a, 1985; Douglas and Reimchen 1988), we monitored 17 nests for timing and duration of breeding behaviour and for survivorship of eggs and young. The Queen Charlotte Islands [55°N] is at the southerly edge of the species' breeding distribution and, compared to regions north of 70° where ice-free conditions on nesting lakes are relatively short (see Allen 1964), loons can be expected to show a less circumscribed period for breeding. Although the number of nests in this study was small, the data provides a useful comparison with the growing body of information on the species (Bergman and Derksen 1977; Lokki and Eklöf 1984; Schamel and Tracy 1985; Gomersall 1986; Eriksson et al. 1988) at different latitudes and in diverse areas circumboreally.

Study Area and Methods

Nesting waters in the Drizzle Lake Ecological Reserve, Queen Charlotte Islands, included Drizzle Lake, an oligotrophic lake (114 ha; see Reimchen and Douglas 1980 for details), Drizzle inlet, a small stream 4 m wide at its mouth, and shallow ponds (< 1 ha) within 1 km of the lake in an area dominated by *Sphagnum* moss. Fourteen clutches were laid in nests at Drizzle Lake and inlet, 8 of these on the shore and 6 on an artificial floating island; 3 clutches were laid in shore nests at two ponds. The 17 clutches represented the reproductive output of a minimum of six different pairs of Red-throated Loons over 10 years (1976–1986). At ten nests, observations were made at least twice a week, at six nests, every 10 days, and at one nest, the datum is a single observation of two dead chicks.

The floating island (1 m^2) consisted of a frame of logs supporting a board platform and bolster of *Sphagnum* moss; polyurethane foam beneath the platform provided additional flotation. It was anchored in water 0.5 m deep near a previous nest site on the lake.

Results and Discussion

Pairs of Red-throated Loons first arrived in breeding territories at Drizzle Lake from 11–19 April (1982–1986). Similarly, on the Shetland Islands [60°N], Scotland, territories are occupied by early April (Bundy 1976). Both areas are in the southern part of the species' breeding distribution, where winter ice is not persistent. In contrast, at nesting areas near the Beaufort Sea [70°], Alaska (Bergman and Derksen 1977) and in Spitsbergen [78°] (Keith 1937), Red-throated Loons did not arrive on territories until June, when nesting ponds are first free of ice.

Timing and duration of incubation and pre-fledging periods is shown in Figure 1. The earliest date for egg-laying was between 10 and 13 May and the latest was 20 July. On the Shetland Islands, the earliest reported clutch was 19 May and the latest, 25 June (Bundy 1976). In the western Canadian arctic and southern Greenland [60°–70° N] (Palmer 1962) and in Novaya Zemlya, USSR [70°–75° N] (Dement'ev and Gladkov 1969), clutches were produced during the first half of June. At those northerly latitudes, timing of first clutches appears to be governed primarily by availability of ice-free conditions.

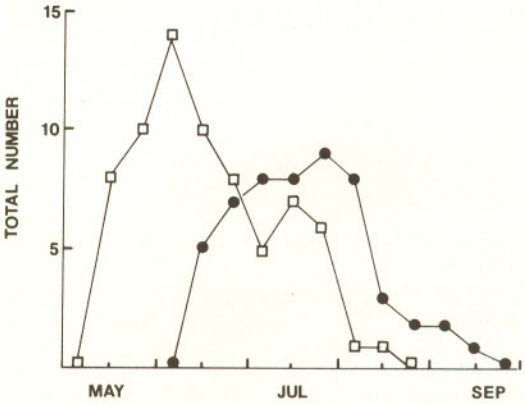

FIGURE 1. Number of eggs (open square) and pre-fledged young (closed circle) at 10-d intervals for 12 nests (1979–1986) at Drizzle Lake Ecological Reserve, Queen Charlotte Islands. Mean incubation period and pre-fledging period is 27 d and 48 d, respectively.

On the Queen Charlotte Islands, early occupation of lakes and early egg-laying may depend on the presence of a territory from the previous year. For example, in 1982, a pair established a territory where there had been no nest for six years, laying eggs on 1 July; in the following year, they returned to the territory and laid a clutch in May. Similarly, in 1983, a second pair laid eggs on 1 July on a newly-established territory, returning the next year to lay the first clutch in May.

All clutches had two eggs; incubation began when the first egg was laid. In four observed clutches, eggs were laid 1 d apart; in one clutch, the second egg was produced 33–45 h after the first. Mean size of eggs measured (N = 8) was 72.9 mm by 44.8 mm (ranges 68.2 – 76.7 by 44.1 – 45.5) which is comparable to those from northern Europe and the Soviet Union (Dement'ev and Gladkov 1969; Cramp and Simmons 1977; Furness 1983). Mean incubation time was 27 d (range 24.5 – 31 d, N = 11 eggs), similar to incubation periods for Red-throated Loons on the Shetland Islands ($\bar{x}$ = 27 d, N = 17, Bundy 1976; $\bar{x}$ = 26 d, N = 11, Furness 1983).

Prolonged incubation of eggs was observed in one clutch, where one egg was incubated for a minimum of 36 d (found floating beside the nest) and the other for a minimum of 57 d (found abandoned in the nest). On the Shetland Islands, a pair incubated infertile eggs for 42 d one year and 47 d the next (Bundy 1976). In Common Loons, which average 29 days incubation (Palmer 1962), incubation of two eggs for 74 and 68 d, respectively, has been reported (Sutcliffe 1982).

Replacement clutches were laid after loss of eggs in two nests and after loss of a 4-d old chick in one nest. On the Shetland Islands, 64% of lost first clutches were replaced, but there were no instances of replacement clutches after chick loss (Bundy 1976). In western Alaska [66°], replacement clutches were laid in three of four nests 12–15 d after experimental removal of 5-d old eggs (Schamel and Tracy 1985).

The mean period from hatch to fledging was 48 d (range 46–50 d, N = 5); on the Shetland Islands, mean fledging time on different islands was 43 d (range 39–48 d; Bundy 1976) and 48 d (range 39–55; Furness 1983). Variation in published fledging times may reflect inconsistencies in what is accepted as "fledging". In this study, fledging was recognized as the attainment of sustained flight ($>$ 1 min in duration). Chicks on the lake lifted off the water for horizontal distances up to 150 m in the 2 d previous to sustained flight and flew to the ocean within 1 to 4 d after sustained flight capabiity.

The latest date observed for fledging was 14 September; by this time one of the adults was beginning the molt into basic plumage with replacement of feathers on the side of the neck. In Scotland, an unfledged chick was observed on a breeding lake on 23 September (Booth 1982).

Based on the data from this study, the mean duration from egg- laying to fledging of the young in Red-throated Loons is 75 d. On the Queen Charlotte Islands and in areas at equivalent latitudes, breeding pairs can occupy lakes during at least a 170-d period, a duration long enough for replacement clutch success. In regions north of 70°, where lakes are ice-free for less than about 100 d a year (Allen 1964), renesting after a failed clutch or brood may be precluded. At those latitudes, the disadvantage of a shorter breeding season may be counterbalanced by the advantage of longer day lengths for feeding the young.

Yearly number of young fledged per pair of adult loons was 0.86 (Table 1). Fledging success was 0.45 young/pair/y on the Shetland Islands (range 0.36–0.63 on different islands; Gomersall 1986), 0.79 on the Orkney Islands, Scotland (Booth 1982) and 1.2 in Finland (Lokki and Eklöf 1984).

Nine percent of the eggs failed to hatch, 12% died from flooding, and 18% disappeared from nests, presumably from terrestrial predators. Raccoon (*Procyon lotor*), Marten (*Martes americana*), and Black Bear (*Ursus americanus*) on the lake shore in the vicinity of nests, although none have been seen

TABLE 1. Survivorship of Red-throated Loon eggs and pre-fledged young on a floating island and shore nests at Drizzle Lake Ecological Reserve, Queen Charlotte Islands.

	pair-years	eggs laid	Survivorship[1]		Fledged young (no./pair/y)
			eggs	chicks	
floating island	5	12	0.92	0.64	1.4
shore nests	9	22	0.45	0.50	0.56

[1]eggs: eggs hatched/eggs laid; chicks: chicks fledged/eggs hatched

taking eggs. From tracks on the shore, we suspect have been observedthat Raccoon (an exotic species on the Queen Charlotte Islands) is the major egg predator.

Twenty-four percent of pre-fledged chicks were taken by Bald Eagles (*Haliaeetus leucocephalus*) and 19% died from unknown causes (three dead beside nest, one missing). Predators on eggs and chicks in this study differed from those observed in other parts of the breeding distribution of Red-throated Loons [gulls, skuas, jaegers and foxes] (Johnson and Johnson 1935; Bundy 1976; Cyrus 1971; Bergman and Derksen 1977; Furness 1983; Schamel and Tracy 1985; Gomersall 1986). None of these groups, except for gulls, occurs on the Queen Charlotte Islands.

Egg survivorship on the floating island was significantly higher than on shore nests (Fisher's Exact Test, $P = 0.018$) but there was no difference in chick survivorship ($P > 0.05$). Greater egg survivorship was partly due to lack of mortality from flooding. In Finland, flooding was a major source of egg death (Lokki and Eklöf 1984) and on the Shetland Islands, 4.5% of eggs were lost in this way (Gomersall 1986). As well, egg survivorship may have been greater on the floating island because island nests have reduced disturbance from terrestrial predators which often use lake shores for travel and foraging routes (Davis 1972; Bergman and Derksen 1977; Lokki and Eklöf 1984).

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