Night rafting behaviour in Great Northern Divers *Gavia immer* and its potential use in monitoring wintering numbers

David Shackleton

Email: d.shackleton@btinternet.com
8 Burnbanks, Bampton, Penrith, Cumbria CA10 2RW, UK.

Abstract
Night roosts (rafts) of Great Northern Divers *Gavia immer* were searched for and located around the coast of Mull, western Scotland. Observations on the location, formation and size of roosts were made between late September and late May in three successive non-breeding seasons. The locations of roosts in four sea lochs remained constant between months and years, and numbers of birds involved in early and late winter was broadly similar between years, as was their behaviour. Comparisons made between day-time and evening roost counts in the same sea lochs suggest the latter are a more accurate and time-efficient method of monitoring numbers in defined areas.

Introduction

The preferred coastal areas in the British Isles for wintering Great Northern Divers *Gavia immer* are in and around the bays and sea lochs of western Ireland, the west coast of Scotland and the Northern Isles (Parrack 1986). There have been rather few published studies on the behaviour of Great Northern Divers *Gavia immer* (hereafter 'divers') during winter. In the USA, McIntyre (1978) described how birds that defended inshore feeding territories during the day at a location in Virginia rafted together over deeper water at night, but no evidence of such rafting was found at a site in Rhode Island (Daub 1989; Ford & Gieg 1995). More recently, night rafting has been recognised among wintering divers in Morro Bay, California (Morro Coast Audubon Society website), but it was not observed during a 5-year behavioural study in southwest Norway (Byrkjedal 2011). In Britain, communal night rafting of Great Northern Divers during winter has only been reported from Shetland and the Inner Hebridean island of Skye (Suddaby 1992; McMillan 2008). I observed the phenomenon of night rafting while conducting counts of Great Northern Divers around the coast of Mull, Inner Hebrides. This paper describes this behaviour, and discusses it in terms of monitoring wintering numbers of Great Northern Divers.

Methods

This work was part of a wider project to map the numbers and distribution of Great Northern Divers around the Island of Mull, Argyll (Figure 1), which lies within the main wintering range of the species on the west coast of Scotland (McGowan 2007). Fieldwork was carried out in 2010–12, between late September and late

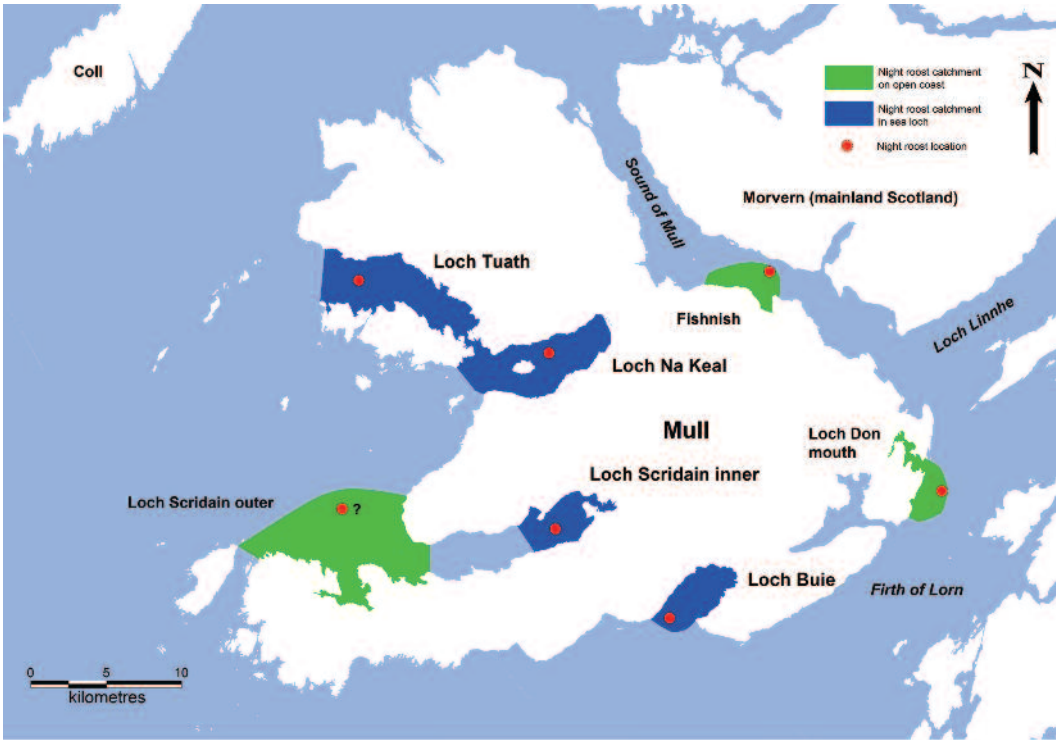

Figure 1. Map of Mull showing locations mentioned in the text, roost catchment areas of the four main sea lochs, and the location of evening roosts.

May. Mull has a deeply indented coastline, with several narrow sea lochs that are overseen by vantage points easily accessible from coastal roads. A total of nine visits were made to each of the four largest sea lochs: Lochs Tuath, Na Keal, Scridain (inner) and Buie. Observations were made from one vantage point per loch from one hour before sunset until dark, in calm seas of sea state 3 or less (wind ≤ 10 knots, swell ≤ 0.6m) and in excellent to good visibility with no precipitation, using a telescope with a 20–60x zoom lens. Casual observations made of smaller roosts in outer Loch Scridain, the Sound of Mull, and the Firth of Lorn are also described.

Results

Behaviour and roost locations: In all four sea lochs divers predominantly foraged in water depths of up to 20 m (Milne 1972; Dipper *et. al*. 2007), and roosts were located by following divers visually once they had stopped feeding in the late afternoon. This was not synchronous within lochs, with some feeding almost until dusk while others stopped and began to drift, preen or swim much earlier. However around sunset most birds had ceased feeding and begun to swim towards a roost area, at first as individuals or in groups of 2–3 if other birds had been feeding nearby; 'strings' would form as they were joined by birds that had been foraging closer to the roost location. In the four lochs the birds' swim direction was always the same, to roughly the same location irrespective of tide or weather. These

'strings', along with late stragglers, eventually coalesced at the roost site (Figure 2), though not all birds always arrived before darkness prevented further observations. All birds observed swam towards roosts and were never seen to fly in the evening. The longest swim distances observed were c. 11 km in outer Loch Scridain and, within the four main roost lochs, c. 6.5 km in Loch Tuath. At first light in the morning only limited observations were made as birds began to disperse from the roost in poor light and were difficult to follow, making counting difficult. However in contrast to the evenings, some birds flew or 'ran' on the sea surface in the morning when dispersing from the roost area.

Figure 2. Part of an evening roost of Great Northern Divers *Gavia immer*, Loch Tuath, Mull, 28 March 2011. © David Shackleton.

In Lochs Tuath and Buie, roosts formed in or near the mouth of the lochs, while in Loch Na Keal the roost was in the middle of the loch (Figure 3). In Loch Scridain, at least two roosts probably formed, although only one was located. This was in the inner loch near its head and attracted birds from the head of the loch to about half way down its length, a distance of c. 6 km. Birds that had been feeding in the outer reaches of Loch Scridain swam westwards out of the mouth of the loch, where they were joined by others from the bays to the south and the open coast off the peninsula to the north. On the only occasion where conditions were good enough to follow them until dark (4 March 2010), 11 birds swam as a group in a broad semi-circle, doubling back on themselves. Darkness fell before the final roost location was determined.

In Loch Na Keal and inner Loch Scridain the roosts were always in the same areas; the divers were relatively tightly grouped where the water was c. 20 m deep. In Loch Buie, divers swam relatively slowly to the roost, which never coalesced fully before dark, though a nucleus would form (at c. 100 m water depth) and it was assumed most birds eventually joined it. In Loch Tuath the roost location was constant in winter (c. 35 m water depth) though birds were less tightly grouped

Figure 3. Location of the Loch Na Keal roost site, viewed from the south side of the loch looking northeast, October 2008. © David Shackleton.

than at Lochs Scridain and Na Keal. In late March when large numbers were present in both 2011 and 2012, two nuclei formed before dark, one in the usual location within the mouth of the loch and another in the central area of the loch. These roosts were c. 4 km apart and it was not known if they eventually coalesced.

Around the more open coasts of Mull the location of roosts was more difficult to establish as birds swam away from the land as the light faded. Nevertheless, in areas of high day-time bird density the same purposeful swim in a common direction by individuals that had stopped feeding was observed and roosts were presumably formed. However in some areas, particularly where day-time densities were low, there was no evidence that divers formed roosts.

In the Sound of Mull the formation and location of roosts appeared to be less predictable, possibly due to the strong and complex tidal currents. A raft of 12 divers located (off Fishnish) in March 2010 was not replicated in November 2010, for although birds drifted towards the same location from the west and east, they later drifted apart. Strong tidal currents also exist in the Firth of Lorn, where in March 2010 a string of five divers swimming northeast from the Mull coast off the mouth of Loch Don was joined by five others from the north. The group of ten then doubled back southwest to a point nearer the centre of the Firth and were still drifting when darkness prevented further observation.

Roost size: No visits were made to Mull in October, December or January, so it was not possible to determine the period of arrival in autumn, or the numbers present in mid winter (Table 1). Numbers in late November 2010 and in late February 2011 were the same at Loch Tuath, had increased by 25% and 50% at Lochs Na Keal and Scridain, respectively, but had more than doubled at Loch Buie. It is possible that peak wintering numbers had not been reached by late November and/or spring

influxes may have already started by late February. However, the similarity of counts in late February and in early March does suggest stable numbers at that time, even when comparing numbers between years.

The increase in numbers in Loch Tuath between late February and late March 2011, with high numbers again in late March to late April 2012, suggests the loch is used as a spring staging area. Numbers counted during the day along the coast north of Loch Tuath (on the same dates as the roost counts) increased from late February (20 birds) to late March 2011 (34 birds) so it is unlikely that birds that had been wintering nearby had simply moved into Loch Tuath (pers. obs.). The similarity in numbers at the other three lochs in late February and late March 2011 and 2012 suggests these roosts comprised mainly wintering individuals.

Comparison with counts during the day: Day counts were made in Lochs Na Keal, Scridain and Buie on three occasions in early March 2010, with evening roosts counted either on the same day, or one day before or after. These counts found only 48–59% of the totals counted in the evening rafts (Table 2), suggesting the latter may be a better method of detecting the number of birds in a given area.

Table 1. Evening counts of Great Northern Divers *Gavia immer* at roosts in four sea lochs around the Island of Mull, 2009–2012.

Roost location	Season	Sep. 27–30	Nov. 20–26	Feb. 20–26	Mar. 01–04	Mar. 27–29	Apr. 27–30	May 14–16	May 27–29
Loch Tuath	2009/10				31				
30.6 sq km	2010/11	1	38	38		112		21	
44.2 km coast	2011/12					87	76		11
Loch Na Keal	2009/10			55	54				
28.0 sq km	2010/11	0	51	64		61		46	
32.9 km coast	2011/12					76	58		3
Loch Scridain inner	2009/10			31	37				
12.4 sq km	2010/11	0	22	34		36		24	
29.6 km coast	2011/12					36	38		2
Loch Buie	2009/10				25				
13.2 sq km	2010/11	0	11	24		28		20	
19.9 km coast	2011/12					29	19		1

Table 2. Counts of Great Northern Divers *Gavia immer* at three sea lochs on Mull, during the day and at evening roosts, late February/early March 2010. Count dates are in brackets.

	Loch Na Keal	Loch Scridain inner	Loch Buie
Roost count	54 (1 Mar)	37 (4 Mar)	25 (3 Mar)
Day count	26 (28 Feb)	22 (4 Mar)	12 (2 Mar)
Difference	-52 %	-41 %	-52 %

Discussion

Great Northern Divers winter in a variety of coastal habitats and at variable densities, factors which are likely to influence their behaviour (McIntyre 1988). The function of rafting at night in winter, and how widespread this is within the species' range, is unclear given the few published references. Benefits of communal night roosting in other birds include defence against predators, reduced thermoregulation demands, information sharing (particularly on foraging areas), and maintaining family relationships (Beauchamp 1999). However, in Mull Great Northern Divers have no known predators, do not roost close enough together to generate communal warmth, and do not forage communally. In southwest Norway, they are believed to arrive at wintering areas in family groups that persist only into early December, although older pair members may winter close to each other and rejoin at the end of winter (Byrkjedal 2011). Rafting was not observed, however the study area was a shallow coast exposed to the North Sea. Apparent family parties of adults with juveniles also occur in Shetland in early winter, with field observations and examination of oil spill victims suggesting that most juveniles move further south as winter progresses (Heubeck *et al*. 1993; Weir *et al*. 1996). Regular evening rafts of Great Northern Divers are known at several locations in Shetland in winter, similar to those on Mull, i.e. broad open bays and long sea lochs (Suddaby 1992; M. Heubeck pers. comm.).

McIntyre (1978) suggested that offshore rafting in deeper water might help divers avoid human disturbance, and minimise the chance of being washed ashore in storms. However, McIntyre (1978) also noted that while there was little social activity among wintering divers, rafting might facilitate synchronous arrival of males on the breeding grounds, which would maximise the chance of occupying the same territory as the previous year. This would imply that adults from the same breeding area either winter together, or use the same pre-migratory staging area, but as yet there is no evidence for this. There is evidence from Iceland (a likely breeding area of some Scottish wintering birds) that pairs return to their breeding lakes together (Sjölander & Agren 1972), but whether they wintered and migrated together or met at sea off the Icelandic coast was unknown.

The most recent estimate of the British wintering population, derived from WeBS counts and county bird reports, is of 2,500 individuals, mostly in north and west Scotland (Musgrove *et al*. 2011), while McGowan (2007) suggested that 2,000–3,000 birds was nearer the true figure for the Scottish population. These figures will largely be based on counts made during daytime, and probably at the same time as species such as grebes and seaduck were also being counted. However, Great Northern Divers are notoriously difficult to count accurately in winter, as individuals can spend 50% or more of daylight hours foraging underwater (McIntyre 1978; Byrkjedal 2011), and birds can occur at some distance (up to 10 km) from the shore (Barrett & Barrett 1985; Lewis *et al*. 2008). Calm seas and good light are essential for obtaining meaningful counts (Suddaby 2010), but such conditions can be infrequent in winter, limiting opportunities for surveys. The daytime and evening counts at the three sea lochs on Mull in late February and early March 2010 suggest

that even at a relatively enclosed location, an observer familiar with the site might still fail to detect a substantial proportion of the divers actually present when only counting during daylight. Counts of rafting birds in the evening provide a more accurate and efficient assessment of numbers. Evening counts still require good conditions, but an entire sea loch can be counted from one vantage point in little more than an hour by watching birds heading towards a known rafting area.

Recommendations for monitoring:

- Prior to census, determine if one or more roost locations exist at a given site (loch).
- Commence observations about one hour before last light when most birds have ceased feeding and begun swimming towards the roost.
- Make repeat counts of numbers at the roost and of birds swimming towards it, to build a full picture of roost formation.
- Particularly during passage, serial observations should be made over periods of a few days, as numbers are likely to be more variable than during mid winter.

Evening roost counts may be less appropriate on open coasts as birds will probably be swimming away from the observer and communal rafting site(s), if any, may not be located. Nevertheless counts made towards sunset have the advantage that divers are much easier to observe when they have ceased feeding.

Repeated counts of roosts should prove an effective method for monitoring numbers and trends, and for establishing site importance outwith the breeding season. For monitoring numbers over larger areas of coastline, a combination of day counts on open coasts and evening roost counts at more enclosed locations seems to be advantageous. The resulting totals will be minima as day counts appear to underestimate the true numbers of divers present.

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