Nesting chronology of northern goshawks (*Accipiter gentilis*) in Wales: implications for forest management

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Summary

Northern Goshawks (*Accipiter gentilis*) in Wales built or refurbished nests between September and April in a semi-upland environment. Dates of first egg-laying ranged between late March and mid-May. There was no statistically significant annual difference in these dates. Most young hatched in late May and juveniles had left their nesting territories by early August. Goshawks did not tolerate disturbance from forestry operations during incubation and the early chick stage, and breeding failures occurred as a result of disturbance. However, once the young fledged (mid-July), forestry operations were no longer detrimental as adults and young moved to adjacent forested areas.

Introduction

The northern goshawk (*Accipiter gentilis*), hereafter referred to as goshawk was eradicated in Wales at the start of the nineteenth century as a result of persecution and habitat loss (Marquiss and Newton 1982, Lovegrove *et al.*, 1994). Since then, the first breeding record for goshawks in Wales was in 1969 (Lovegrove *et al.*, 1994). Goshawks are expanding their range and numbers following re-establishment by falconers; and there are at least 400 pairs in Britain (Petty, 1996a and 1996b), of which 200 pairs are in Wales (Toyne, 1994). However, there is no account of their nesting behaviour in Wales.

Goshawks in Wales, as elsewhere in the United Kingdom, are fully protected and listed on Schedule 1 of the Wildlife and Countryside Act 1981 (Petty, 1989; Batten *et al.*, 1990). Penalties are imposed for killing, injuring or taking birds, and for taking, damaging or destroying nests or eggs. In addition, intentionally disturbing nesting birds between the start of nest building and juvenile dispersal is illegal.

Goshawks nest in a variety of wooded habitats

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including plantations, where they often nest in crops due for felling (40–50 years). This can cause problems as nesting goshawks can be disturbed by forestry operations. Information on goshawks, and guidance on how to reduce disturbance to breeding pairs in Britain is given by Petty (1989 and 1996a). However, in many cases there is need for regional advice which this paper aims to provide. Here, data is presented on the timing of breeding in goshawks, focusing on nest building, egg-laying, incubation and juvenile dispersal. Of these stages it will be argued that forestry operations during the nest building, egg-laying and incubation periods affect nesting attempts more than in the later stages of breeding. Implications for management of goshawk nesting territories in Wales are discussed.

Background information, study area and methods

Nesting territory is defined as the area around a nest that was defended by the pair against other goshawks. It contains the nest tree and other activity areas such as roost sites, plucking areas and a nursery area which juveniles use after fledging but does not include their hunting range (Newton and Marquiss, 1976; Petty, 1989). Median nesting territories size within this study area was 5.6 ha (range 2–9 ha, n=10; Toyne, 1994). A nesting territory was classified as occupied when it contained a new or re-used nest, or showed signs of occupation such as moulted feathers, pellets and faeces. An active nest was one used for breeding. Dispersal was after juveniles left the nesting territory and its immediate vicinity (more than 400 m from the nest).

The study area was located in mid-Wales, within which breeding first occurred in 1977 (Toyne, 1994). The original population was of deliberately released birds and losses of falconry birds (Toyne, 1994). During the early 1970s goshawks from Scandinavia were released on the Welsh–English border (R.E. Kenward personal communication in Toyne, 1994). Measurements of the second primary feather of breeding birds have been used to indicate size and origin of goshawks (Marquiss, 1981). Results using this method revealed the population in Wales comprised large birds from Scandinavia, smaller ones from central Europe and intermediate-sized birds that may have been hybrids (Toyne, 1994, Toyne unpublished data).

The study area measured approximately 325 000 ha of which about 50 per cent was forested. The rest of the area mostly comprised hill sheep farms, grass moorland and watercourses. Rainfall (1500–2000 mm a^{-1}) varied, with the western part of the study area receiving more rain. The elevation of nesting territories ranged between 90 m and 400 m. Nesting territories where situated in managed forests, these consisted mainly of larch (*Larix* sp.), spruce (*Picea abies* and *Picea sitchensis*), pine (*Pinus silvestris* and *Pinus cortorta*) and Douglas fir (*Pseudotsuga menzeii*). Most crops were first thinned when 15–25 years of age and clear felled around 50 years of age.

Since the mid-1980s nest surveys for goshawks were conducted in one forest (3463 ha) and surrounding smaller forests. Between 1991 and 1995 a more comprehensive study involved nest surveys within the larger area, and studies on breeding performance, habitat requirements and diet (Toyne, 1994; 1996a, b; Toyne unpublished data). Forests were systematically searched between March and June, although some areas were checked from January onwards for nest building. Methods employed were; inspection of previous nesting territories, forest road surveys in March and April of larch stands with suitable nesting trees (trees $\geq$25 years) before their needles flushed, and systematic searches on foot of larch stands after flushing and of other suitable crops during March–June (Toyne, 1994).

When an active nest was found, the status and stage of the nesting attempt was determined by either climbing to the nest, observing the nest with binoculars from the ground, or using a mirror with telescopic poles to see into the nest. The latter method was usually employed for assessing clutch size. The date of first egg-laying was estimated from the age of the oldest nestling in the brood plus the average incubation period of 36 days plus 2 days, as the hen does not start incubating until the second egg is laid, approximately 2 days after the first is laid (Cramp and Simmons, 1980). Nestlings were aged using equations based on growth curves of wing

lengths of male and female nestling goshawks from Sweden, these gave a maximum error of ±3.8 days for Swedish birds (Kenward *et al.*, 1993). Wing length was the longest primary feather from radiale joint to the tip, measured using a wing rule (±1.0 mm). This is the standard British Trust for Ornithology maximum chord measurement (Spencer, 1984). In 1992 and 1993 repeat visits were made to nesting territories until mid August to document the timing of juvenile dispersal. All of the above activities that involved disturbing breeding goshawks were covered by a licence issued by the Countryside Council for Wales.

Results

Timing of nest building

Goshawks were sedentary within the study area. There were numerous observations of goshawks within, and soaring above, nesting woods during the winter period (H. Ostroznik personal communication, M. Coleman personal communication and personal observation). During December–March goshawks were regularly observed displaying above known nesting territories and other wooded areas. The actual timing of nest building was difficult to study as most active nests were found between March and May, when most nests were already completed. Some nests were built during the autumn and winter, and old nests were re-furbished at any time (Toyne and Ostroznik, 1995).

Timing of egg-laying, hatching and juvenile dispersal

The dates when the first eggs were laid did not vary between years 1991 and 1995 (Kruskal–Wallis chi-squared approximation test χ^2_4=4.186, P=0.384, n.s. n=126). Overall, the median first egg date was 11 April (range 23 March–16 May, n=126). Forty-six per cent of first egg-laying occurred between 7 and 15 April, and 95 per cent had started by 23 April (Table 1). If the first clutch failed, there was no evidence found of re-laying. Young hatched approximately 38 days after the first egg was laid and the nestling period averaged 38–45 days (Cramp and Simmons, 1980). Hatching at most nests occurred from 16 May onwards.

Juvenile dispersal from nesting territories in 1992 and 1993 occurred before the 16 August with most dispersing in the first week of August when fledglings were 75 days or more old (Table 2). Data from 1991 and 1994 confirmed that the majority of nesting territories still had fledglings present in the last week of July suggesting dispersal in August was usual (Table 2).

Table 1: Date of first egg-laying in weekly periods

Laying date	1991 n=14	1992 n=25	1993 n=24	1994 n=23	1995 n=40	Σ 126
23–30 March	0	0	1 (4)	0	0	1 (1)
24–31 March	1 (7)	1 (4)	0	1 (4)	1 (2.5)	4 (3)
1–7 April	3 (21)	2 (8)	7 (29)	7 (30)	15 (37.5)	34 (27)
8–15 April	6 (43)	15 (60)	13 (54)	10 (43)	14 (35)	58 (46)
16–23 April	3 (21)	5 (20)	2 (8)	5 (22)	8 (20)	23 (18)
24–31 April	0	1 (4)	1 (4)	0	1 (2.5)	3 (2)
1–7 May	0	1 (4)	0	0	1 (2.5)	2 (2)
8–15 May	0	0	0	0	0	0
16–23 May	1* (7)	0	0	0	0	1 (1)
Median	11–12 April	13 April	9–10 April	13 April	10–11 April	11 April
Range	29 March–16 May	28 March–3 May	23 March–27 April	31 March–23 April	30 March–2 May	23 March–16 May

Values in parentheses are percentages

*Late egg-laying on 16 May 1991 at one nesting territory by an adult (3 year plus) female was due to a change in the male partner. The hen was still incubating on 27 May but the nest was deserted by 19 June.

Table 2: Timing of juvenile dispersal

Year	Number of nesting territories that were vacated in weekly periods. 1992 and 1993 = 48 nests (%)			
	23 July	24–31 July	1–8 August	9–16 August
1992	2 (4.2)	1 (2.1)	17 (35.4)	4 (8.4)
1993	1 (2.1)	10 (20.8)	10 (20.8)	3 (6.3)
Σ	3 (6.3)	11 (22.9)	27 (56.3)	7 (14.6)

1991 Young from 3 nesting territories had dispersed before 31 July while young from 8 nesting territories had not.
1994 Young from 4 nesting territories had dispersed before the 28 July, while young at 18 nesting territories had not.
1995No young at 24 nesting territories had dispersed before 15 July and young were seen at two out of three nesting territories visited on 24 July.

Effects of forestry operations on breeding success

As each nesting territory was regularly monitored, foresters were informed of nest locations so that forestry operations could be re-scheduled to avoid disturbance. However, disturbances did occur in the vicinity of nine nests during 1991–1995 (Table 3) and their effect depended on when disturbances occurred. Of the five cases of disturbance during incubating or the early nestling stage (chick ≤10 days old), only one successfully reared chicks. At the latter nest the female continued to incubate while adjacent trees were felled. No forest operations occurred around nests in June (late nestling stage). Forestry operations (n=4) after fledging (July onwards) were not detrimental, even in small woods (25 ha; n=1, Table 3). In all cases the adults moved the fledglings to nearby areas or adjacent woods. No deaths occurred as a result of these premature movements.

The low sample sizes preclude statistical analysis to determine whether productivity at disturbed sites was significantly lower than at undisturbed sites. However, these incidents suggest that forestry operations after fledging (mid-July onwards) were tolerated by goshawks but those before were not. Although goshawks may fail in a breeding attempt due to inexperience, bad weather or a combination of both (22 out of 29 failures between 1990 and 1993; Toyne, 1994), disturbances from forestry operations can also be detrimental.

Discussion

The timing of egg-laying in raptors is affected by many factors such as food supply, age and condition of the parents (Newton, 1979). In goshawks, it has been shown to be related to altitude, with eggs being laid earlier at lower elevations (Marquiss and Newton, 1982; Anon, 1990; Toyne, 1994). So goshawks nesting at lower elevations in Wales than in the present study might lay eggs earlier. Other factors such as a change in breeding partner can also influence laying date (Toyne, 1994), so each nesting territory should be checked between March and April for occupancy and in June for breeding success.

A strategy for managing goshawks nesting in managed forests in Wales should be based on information about goshawk nesting chronology, breeding productivity and the response of adults and young to disturbance. Productivity data from 94 nests showed that most losses occurred during the incubation stage (30 per cent) with fewer during the nestling stage (18 per cent) (Table 4). The latter deaths were probably caused by starvation and/or disease (Toyne,

Table 3: Effects of forestry operations at nine nesting territories (April–August 1991–1995)

Nesting stage	Type of disturbance	Duration	Distance disturbance to nest	Effect on breeding
Incubation (April)	Felling of adjacent stand, but extraction rack only 60 m from nest.	Unknown, from mid-April onwards.	Approx. 60 m from nest tree.	Failed at egg-laying (2 eggs) or early incubation.
Incubation (May)	Clearfelling of larch stand that included nest tree. Stopped at nest tree.	Approx. 2–3 weeks from early May to late May.	Immediate – 6 m to nest.	Nesting attempt aborted at egg stage (early May).
Incubation (May)	Dismantling of a forwarder that caught fire on forest road next to nest tree.	Two days.	Approx. 40 m from nest tree.	Failed at incubation. The female sat incubating while forwarder passed nest tree a minimum of six times per day. Constant noise from dismantling the forwarder caused disturbance.
Incubation/ nestling (late April–August)	Clearfelling of spruce adjacent to a larch nest stand with some larch felled.	Approx. 11 weeks.	Immediate. Left nest tree but most adjacent trees felled by early June. In August cutters still 300 m from nest.	None – three young fledged.
Incubation/ nestling	Extraction road built through larch stand with nest.	Operations started in May and ended in June.	Road approx. 60 m from nest tree.	Failed at either incubation or young chick stage.
Young fledged (late July–August)	Thinning Sitka spruce nest stand (planted 1950).	Approx. 1 week.	100 m from nest tree.	None – birds moved from nesting territory.
Young fledged (August)	Clearfelling larch stand adjacent to nest tree.	Unknown, from early August onwards.	Approx. 400 m.	None – birds had dispersed.
Young fledged (August)	Clearfelling of larch stand but left nest tree and small stand of larch.	Work started first week in August for at least 2 weeks.	Approx. 80 m from nest.	None – birds moved to a larger oakwood 500 m away.
Young fledged (July)	Clearfelling of part of larch stand (planted 1956).	Work commenced from early July onwards for over two weeks.	Approx. 60 m from nest.	None – young approx. 50 days old moved from nesting territory.

Table 4: Productivity data from 94 goshawk nests

Parameter	Total	Mean (s.d.) n=94	% maximum of productivity
Eggs laid	294	3.1 (0.93)	100
Unhatched eggs	87	0.9 (1.11)	29.6
Chicks hatching	207	2.2 (1.49)	70.4
Chicks dying	53	0.6 (0.87)	18.0
Chicks fledging	154	1.6 (1.33)	52.4
Juveniles dying after fledging	4	0.04 (0.25)	1.4
Juveniles leaving nesting area	150	1.6 (1.34)	51.0

Notes: Data were from 1991 (n=16 nests), 1993 (n=21), 1994 (n=27), 1995 (n=30). Clutch sizes were not measured in 1992. All nests were searched for unhatched eggs in nesting material, and it was assumed that losses after the egg-laying stage that could not be accounted for occurred at the nestling stage (1–14 days). It was likely that the numbers of juveniles dying after fledging were probably under-recorded as carcases can be difficult to find in the forest floor vegetation or they may have been removed by scavengers such as fox (*Vulpes vulpes*).

1994; Toyne and Ashford, in press). Of these 94 nests, 63 (67 per cent) successfully reared at least one chick. However, the purpose of this paper is not to investigate the causes of losses but to stress that incubation was a critical time in the birds' reproductive cycle. After the young have fledged mortalities were low (Table 4) and young at most territories dispersed by the end of the first week of August (Table 2).

For the purpose of managing nesting territories it is essential to know when nest building and incubation commence and when the nesting territory will be vacated. Site visits can be made to assess whether the breeding attempt is successful, but these require to be licensed (Petty, 1996a). In the present study the low number of forestry-related disturbances to nesting goshawks was due to monitoring nesting territories by volunteers and Forest Enterprise (F.E.) rangers, and F.E.'s flexibility in re-scheduling work plans when nesting territories would have been affected. A database with information about each nesting territory, such as nest tree location and compartment details, was updated annually to include new nesting territories. Work schedules were then cross-checked with the database to avoid disturbance to occupied nesting territories during February–July. A few problems arose, either when goshawks moved nesting territories or when newly occupied nesting territories were found during forestry operations (n=3), or when foresters failed to check the database against work programmes (n=3). But, overall this system worked well.

Based on this work in Wales, it is recommended that forestry operations should be avoided within nesting territories from February to July (inclusive), and that care should be taken if territories are disturbed in early August when juveniles are dispersing. These findings support Petty's recommendations (Petty, 1989 and 1996a), which should be seen as the standard for the management of goshawk nesting territories in the UK.

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