DAWN AND MORNING GOSHAWK COURTSHIP VOCALIZATIONS AS A METHOD FOR DETECTING NEST SITES

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Abstract: My paper discusses a northern goshawk (*Accipiter gentilis*) nest-detection method that relies on listening for spontaneous dawn and morning vocalizations. The study was conducted in a woodland area (approx 4,000 ha) of the Burgundy region, France, in 1996. To determine the frequency and the distribution of annual and daily vocalizations, I conducted systematic listening sessions throughout the year. The duration of adult goshawk vocal events during the year displays 1 major peak in the courtship period. In this period, the vocal events have 1 major peak in the first hour preceding sunrise and in the following 3 hr. In 1997, to test the efficacy of the method, I performed an investigation on 21 known goshawk nest sites: I detected goshawk presence in 100% of trials. To achieve the highest effectiveness in the use of spontaneous goshawk vocalizations, listening sessions should take place during the 3 months preceding egg laying and be conducted from 30 min before sunrise to about 200 min afterwards.

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The northern goshawk (hereafter, goshawk), which essentially nests in old-growth or mature forest, may be affected by forest management policies (Crocker-Bedford 1990, Reynolds et al. 1992, Block et al. 1993, Penteriani and Faivre 1997); hence, the goshawk is frequently studied both in Europe and the United States. The U.S. Fish and Wildlife Service placed the goshawk on the Category 2 list of the Endangered Species Act in 1991, and several regions of the U.S. Forest Service classify the goshawk as a "Sensitive" species (Squires and Ruggiero 1996). Between 1985 and 1994, in central Italy, the Abruzzi National Park and the Research Center of Apennines Ecology planned and completed a study that focused on the goshawk as a species of paramount importance in forest management planning (Penteriani 1993, 1997; Penteriani and Faivre 1997).

Biologists have sought a fast and effective

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method to detect goshawk nest sites. Current survey techniques (single or combined) include (1) broadcasting tape-recorded goshawk calls (Kimmel and Yahner 1990, Cerasoli and Penteriani 1992, Kennedy and Stahlecker 1993, Joy et al. 1994); (2) foot searches for nests (Reynolds 1982, Crocker-Bedford and Chaney 1988, Penteriani 1997), and (3) aerial surveys with helicopter, fixed-wing, or ultralight aircraft (McGowan 1975, Doyle and Smith 1994, Younk and Bechard 1994). Other methods used more sporadically include (1) observation of goshawk behavioral events (e.g., aerial displays and food-calls of young [Anonymous 1989, Petty 1989, Kostrzewa and Kostrzewa 1990]), and (2) visual searching for birds and signs of presence (e.g., whitewash, molt feathers, prey remains, pellets [Petty 1989, Penteriani 1997]).

The issue that arises in any type of fieldwork is finding a method with an efficacy of nearly 100% (i.e., all goshawk nest sites in a given area must be found), while considering (1) speed of nest-detection, (2) use of a universally applicable method, (3) time range (daily and annual) of application of the method, and (4) cost of the search method.

My paper discusses a goshawk nest-detection method that relies on listening for spontaneous dawn and morning adult goshawk vocalizations.

STUDY AREA

The study was conducted in a woodland area located in Côte d'Or, Burgundy region, France (47°31′N, 5°06′E). The area ranges in elevation between 300 and 450 m above sea level and consists mostly of a beech (*Fagus sylvatica*) forest (approx 4,000 ha), with surrounding grazed and fallow farmland. In the study area, the goshawk density is 6.7 pairs/100 km^2, and the minimum distance between pairs averaged 3.02 km (range = 2–3.9 km, SD = 0.63; V. Penteriani, unpublished data).

METHODS

I systematically listened to adult goshawk vocalizations and recorded frequency and distribution of 2 main call-types of 8 neighboring pairs of goshawks: (1) the guttural, chattering "*kek-kek-kek*. . ."; and (2) the plaintive, wailing "*whee-oo*" (Glutz et al. 1971, Cramp and Simmons 1980). The sessions were held from 1 January to 31 December 1996. For the listening sessions, I divided each month into 3 10-day intervals. For each 10-day interval and each solar day in the interval, I computed the number of minutes per interval and equally distributed them among the 8 goshawk pairs. Consequently, an hourly block was assigned to each pair on a rotation basis, and during each day of each 10-day interval, I recorded the vocalizations of the 8 pairs. During each 10-day interval, I recorded the times of the first and last calls of the day. For each call-type, I collected the following data: (1) time when a vocal event began; (2) duration of the vocal event, by series of single calls (e.g., "*kek*. . ." and "*whee-oo*. . .") or call-series (e.g., "*kek-kek-kek*. . ." "*kai-kai-kai*. . ." "*kew-kew-kew*. . ."); and (3) number of vocal events. My listening sessions started 1 hr before sunrise and ended 1 hr after sunset.

I used a stopwatch to determine the duration of a vocal event. I identified the end of calling as the last call heard >60 sec before the next call (i.e., 1 min of silence between calls or between sequences was regarded as a dividing unit of time). A value of 1 sec was arbitrarily ascribed to 1 isolated call. In each place, I always recorded the vocalizations from the same location and from the same distance (maximum distance was approx 100 m from the nest), trying not to disturb the pair. I regularly monitored each site during the breeding period to record changes in the breeding cycle that might alter the vocalization data. Reproduction at each site was successful, without major interferences with the biological cycle (e.g., forestry operations, failure of the first hatch, death of young) and, consequently, with the vocalization data collected; hence, I could use all the annual vocalization data of the 8 pairs. For the listening sessions, I did not use data collected on windy or rainy days.

I used a Mann-Whitney *U*-test (Sokal and Rolf 1981) to compare call duration and number during the breeding periods and in consecutive months of the year (1996). If 1 vocal event involved multiple groups of call numbers, I used the mean value. I used chi-square analyses to determine the distribution of the vocal events among the hourly blocks of the day during courtship only (Daniel 1990). I analyzed the data in relation to the 10-day periods and to the months and different stages of the annual cycle: nonbreeding (Sep–Jan), courtship (Feb–Mar), incubation (Apr), nestling (May–early Jun), and fledgling (late Jun–early Aug).

In 1997, to test the efficacy of the method, I listened at 21 known goshawk nest sites of Côte

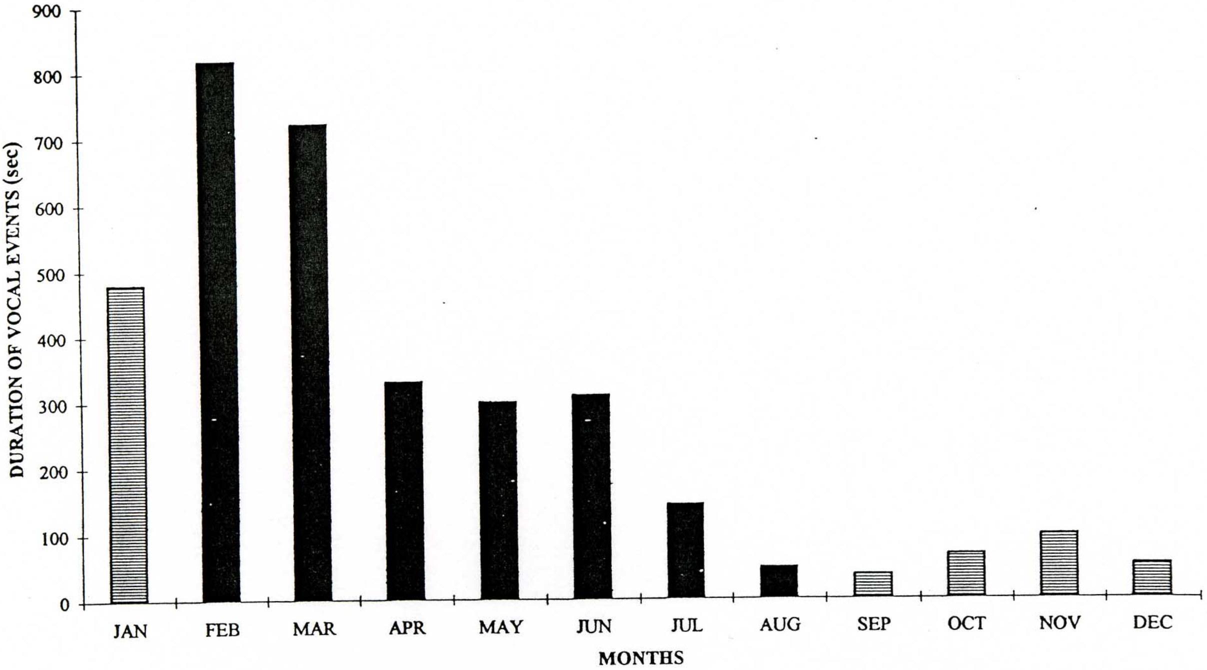

Fig. 1. Duration (sec) of adult northern goshawk vocal events by month (n = 8 pairs), Côte d'Or, France, 1996. Black = breeding period; hatched = nonbreeding period.

d'Or. From 1 hr before to 3 hr after sunrise, I listened during the peak vocalization periods identified during my 1996 surveys.

RESULTS

Duration of adult goshawk vocal events peaked between late winter (Jan) and early spring (Feb–Mar; Fig.1). Duration of a vocal event differed (Table 1) from January to February (beginning of courtship), when call duration was longest, as well as from March (courtship) to April (incubation), when duration of calls decreased. I found a difference in call duration between the nonbreeding (Sep–Jan; n = 51) and the courtship periods (U = 4.32, $P \leq 0.001$, n = 64) and between the courtship and incubation periods (U = 3.38, $P \leq 0.001$, n = 32). I found no difference between incubation and nestling periods (U = 1.49, P = 0.13, n = 23), nestling and fledgling periods (U = 1.11, P = 0.27, n = 23), and fledgling and nonbreeding periods (U = 0.72, P = 0.47).

Within the courtship period (peak of adult goshawk vocal activity), the first call was recorded before sunrise (range = 45–4 min before sunrise); in the other stages of the annual cycle, the time of the first call was more variable. The distribution of vocalization durations among the hourly blocks differed during the courtship stage of the breeding period (χ^2_{12} = 8,109, $P \leq$ 0.001; Fig. 2). Vocal event durations peaked from 1 hr before to 3 hr after sunrise (Fig. 2). In January, vocal activity similar to that of the courtship period was observed, albeit with a shorter mean vocal event duration. (Table 1).

Goshawk calls were always heard (1) in the immediate vicinity of nest trees, (2) at each listening session, and (3) at an interval not >26 min before sunrise and 90 min after sunrise. At the 21 goshawk nest sites used to validate effectiveness of the method, goshawk presence was detected in 100% of the cases and during the first listening session (a second session was never required).

DISCUSSION

The distribution of annual vocal duration of adult goshawks highlights the 3 months preceding egg laying as the best period for systematic listening for dawn and morning vocalizations to detect goshawk nest sites. Similar results were also obtained for the Cooper's hawk (*Accipiter cooperii*), whose vocalizations are especially concentrated during the preincubation stage (Rosenfield and Bielefeldt 1991, Stewart et al. 1996).

To achieve the highest effectiveness in use of spontaneous goshawk vocalizations, listening

Table 1. Characterization of annual vocalizations of adult northern goshawks (n = 8 pairs), Côte d'Or, France, 1996. Duration of vocalizations (min) and time interval (min) between 1 adult goshawk vocal event and the next in the period from the first call to 200 min after sunrise. Differences among mean vocalization duration for the 3 10-day intervals in consecutive months were tested with the Mann-Whitney U-test.

	Montly call duration		Interval between calls	
Months	$\bar{x}$	SE	$\bar{x}$	SE
JAN	61.2	75.2	6.5	4.3 –[a]
JAN	296.8	407.4*	16.2	9.8 +[b]
JAN	121.2	100.9		
FEB	238.2	228.4	6.7	3.8 –
FEB	242.0	251.5 n.s.	9.9	13.4 +
FEB	337.3	316.9		
MAR	451.6	553.4	16.0	9.8 –
MAR	182.8	252.9 α	12.5	13.4 +
MAR	87.8	85.2		
APR	112.9	140.3		
APR	181.9	310.3 n.s.		
APR	35.4	24.5		
MAY	22.9	21.8		
MAY	211.3	196.6 n.s.		
MAY	65.0	45.7		
JUN	95.6	72.7		
JUN	163.3	274.3 n.s.		
JUN	50.0	43.9		
JUL	111.0	119.6		
JUL	114.0	n.s.		
JUL	32.5	35.2		
AUG	25.2	15.8		
AUG	9.7	7.4 n.s.		
AUG	12.7	6.7		
SEP	12.5	4.1		
SEP	2.7	0.5 n.s.		
SEP	21.5	12.0		
OCT	38.0			
OCT	22.5	24.7 n.s.		
OCT	45.0	71.9		
NOV	51.6	59.2		
NOV	45.0	58.1 n.s.		
NOV	0			
DEC	0			
DEC	0			
DEC	52.3	38.7		

* $P < 0.05$; n.s. = $P > 0.05$.
[a] – = interval before sunrise.
[b] + = interval after sunrise.

sessions should take place in the 3 months preceding egg laying, from 30 min before to about 200 min after sunrise. A site where no vocalizations are heard in the time interval from 30 min before to 5 min after sunrise can be considered not occupied by nesting goshawks after 2 listening sessions held during the month most distant from egg laying (Jan in my study area), or after a single listening session in the 2 months closest to egg laying (Feb and Mar in my study area). During the 200 min following sunrise, the listening session at each site should not last >90 min. A site where no vocalizations are heard in 2 consecutive sessions (possibly separated by a 1-month interval) can be considered not occupied by nesting goshawks.

Depending on whether monitoring is conducted, the minimum area to be covered around each monitoring station should have a radius of 500 m from a dominant point outside the forest (e.g., hilltop), and 250 m inside the forest. These values represent the minimum detectability distances for a vocalizing goshawk both for chattering- and wailing-type calls (V. Penteriani, unpublished data). Under particularly favorable sound and weather conditions, a chattering-type call can be heard by an experienced observer 1 km away (V. Penteriani, unpublished data). Days with wind (greater than about 15 km/hr) and intense precipitation are not suitable for surveying using these techniques.

Based on the sessions held in 1997 on a sample of 21 goshawk nest sites, the efficacy of the method was 100%. This result is substantiated by a 10-year study (1984–93) conducted on a goshawk population of central Italy (Penteriani 1997). During that study, at sunrise and during the courtship period, the presence of a goshawk pair at a nest site was always signaled by repeated vocalizations (V. Penteriani, unpublished data).

MANAGEMENT IMPLICATIONS

The systematic listening for spontaneous vocalizations of adult goshawks is particularly effective, especially in the 3 months preceding egg laying, and relies on a natural, specific and regular behavior of goshawks. This method does not depend on the possible response to an external stimulus (i.e., broadcast calls), a response which varies with individuals and sex. The relatively short time that surveyors need to remain in a point (from 30 min before to 5 min after sunrise, and not >90 min during the 200 min following sunrise) enables the observer to quickly cover relatively large areas. Nest detection is facilitated because vocalizations always occur near nests.

The courtship period is crucial in the annual cycle of goshawks, when they are poorly responsive to external stimuli (e.g., broadcast calls). In this period, the method reported here is a highly effective alternative that does not seem to interfere with the regular activities of

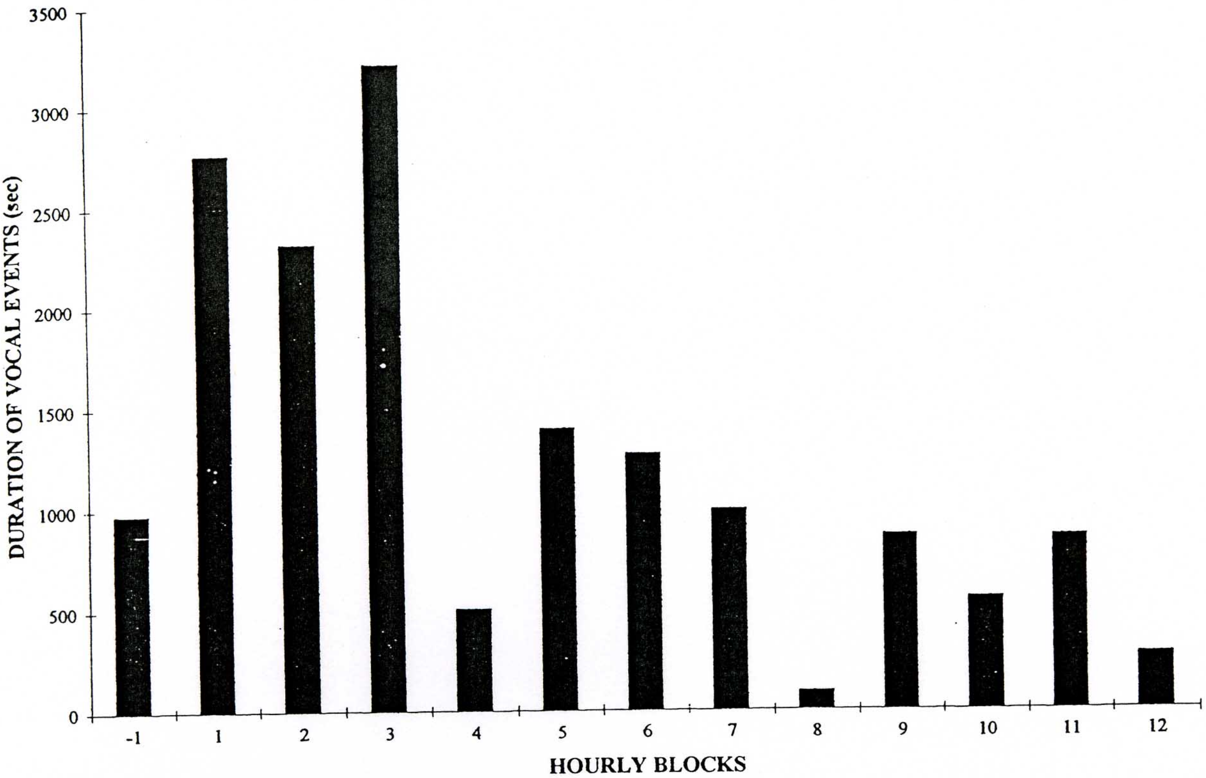

Fig. 2. Duration (sec) of adult northern goshawk vocalizations by time of day in January, February, and March (n = 8 pairs), Côte d'Or, France, 1996. Hourly blocks represent the intervals of a day, from 1 hr before sunrise to sunset.

the pair and that enables investigators to cover relatively extensive areas without requiring long foot searches. Moreover, this technique can broaden the portion of the year during which goshawk nest surveys can occur. For example, the common technique used by most observers in North America is the broadcast technique, which is usually restricted to the length in months of the nestling and fledgling periods (Kennedy and Stahlecker 1993). In addition to lengthening the useful survey season, the discovery of occupied nest sites 3 months before egg laying would allow the extension of goshawk studies into the period of courtship and incubation, critical periods for which few data are currently available. Knowing whether nest sites are occupied during the courtship period would provide useful information in relation to habitat degradation or for long-term trends. Hence, biologists could determine if goshawks present early in the nesting season participate in courtship yet fail before egg laying, or identify the portion of the population on territories in late winter–early spring that really bred.

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LITERATURE CITED

ANONYMOUS. 1989. Goshawk breeding habitat in lowland Britain. British Birds 82:56–67.

BLOCK, W. M., M. L. MORRISON, AND M. H. REISER, editors. 1993. The northern goshawk: ecology and management. Studies in Avian Biology 16.

CERASOLI, M., AND V. PENTERIANI. 1992. Effectiveness of censusing woodland birds of prey by playback. Avocetta 16:35–39. (In English).

CRAMP, S., AND K. E. L. SIMMONS. 1980. Handbook of the birds of Europe, the Middle East and North Africa. Volume 2. Oxford University Press, Oxford, United Kingdom.

CROCKER-BEDFORD, D. C. 1990. Goshawk reproduction and forest management. Wildlife Society Bulletin 18:262–269.

———, AND B. CHANEY. 1988. Characteristics of goshawk nesting stands. Pages 210–217 *in* R. L. Glinski, B. A. Giron Pendleton, M. B. Moss, M. N. LeFranc, Jr., B. A. Millsap, and S. W. Hoffman, editors. Proceedings of the Southwest raptor management symposium and workshop. National Wildlife Federation Scientific and Technical Series 11.

DANIEL, W. W. 1990. Applied nonparametric statistics. Second edition. PWS-KENT Publishing, Boston, Massachussetts, USA.

DOYLE, F. I., AND J. M. N. SMITH. 1994. Population responses of northern goshawks to the 10-year cycle in numbers of snowshoe hares. Studies in Avian Biology 16:122–129.

GLUTZ VON BLOTZHEIM, U. N., K. BAUER, AND E. BEZZEL. 1971. Handbuch der Vögel Mitteleuropas, Volume 4. Akademische Verlagsgesellschaft, Frankfurt, Germany. (In German).

JOY, S. M., R. T. REYNOLDS, AND D. G. LESLIE. 1994. Northern goshawk broadcast surveys: hawk response variables and survey cost. Studies in Avian Biology 16:24–30.

KENNEDY, P. L., AND D. W. STAHLECKER. 1993. Responsiveness of nesting northern goshawks to taped broadcasts of 3 conspecific calls. Journal of Wildlife Management 57:249–257.

KIMMEL, J. T., AND R. H. YAHNER. 1990. Response of northern goshawks to taped conspecific and great horned owl calls. Journal of Raptor Research 24:107–112.

KOSTRZEWA, A., AND R. KOSTRZEWA. 1990. The relationship of spring and summer weather with density and breeding performance of the buzzard *Buteo buteo,* goshawk *Accipiter gentilis* and kestrel *Falco tinnunculus*. Ibis 132:550–559.

MCGOWAN, K. D. 1975. Nesting habits and reproductive success of goshawks in interior Alaska. Pages 147–152 *in* J. R. Murphy, C. M. White, and B. E. Harrell, editors. Population status of raptors. Raptor Research Report 3.

PENTERIANI, V. 1993. L'Astore, *Accipiter gentilis,* nell'Appennino Abruzzese: densità, distribuzione, analisi del sito di nidificazione e sue implicazioni nella gestione degli ambienti forestali. Parco Nazionale d'Abruzzo / Centro Studi Ecologici Appenninici, Internal Technical Report, Protocollo 4558. (In Italian).

———. 1997. Long-term study of a goshawk breeding population on a Mediterrain mountain: density, breeding performance and diet. Journal of Raptor Research 31:308–312.

———, AND B. FAIVRE. 1997. Breeding density and nest site selection in a goshawk *Accipiter gentilis* population of the central Apennines (Abruzzo, Italy). Bird Study 44:136–145.

PETTY, S. J. 1989. Goshawks: their status, requirements and management. Forestry Commission Bullettin 81. London, United Kingdom.

REYNOLDS, R. T. 1982. North American accipiter hawks. Pages 288–289 *in* D. D. Davis, editor. CRC handbook of census methods for terrestrial vertebrates. CRC Press, Boca Raton, Florida, USA.

———, R. T. GRAHAM, M. H. REISER, R. L. BASSET, P. L. KENNEDY, JR., D. A. BOYCE, G. GOODWIN, R. SMITH, AND E. L. FISHER. 1992. Management recommendations for the northern goshawk in the southwestern United States. U.S. Forest Service General Technical Report RM-217.

ROSENFIELD, R. N., AND J. BIELFELDT. 1991. Vocalizations of Cooper's hawk during the pre-incubation stage. Condor 93:659–665.

SOKAL, R. R., AND F. J. ROLF. 1981. Biometry. W. H. Freeman, San Francisco, California, USA.

SQUIRES, J. R., AND L. F. RUGGIERO. 1996. Nest-site preference of northern goshawks in southcentral Wyoming. Journal of Wildlife Management 60: 170–177.

STEWART, A. C., R. W. CAMPBELL, AND S. DICKIN. 1996. Use of dawn vocalizations for detecting breeding Cooper's hawk in an urban environment. Wildlife Society Bulletin 24:291–293.

YOUNK, J. V., AND M. J. BECHARD. 1994. Breeding ecology of the northern goshawk in high-elevation aspen forests of northern Nevada. Studies in Avian Biology 16:119–121.

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