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Owls and woodpeckers in montane forests: mapping nocturnal hooting and diurnal drumming in German SPAs

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Abstract – Natura 2000 requires the nations of Europe to monitor bird populations, thereby enabling scientists to detect changes in biodiversity levels. Since conflicting methods and evaluations have been used throughout Germany, the results of the various studies are difficult to compare. The research presented here involved the short-term monitoring of woodpeckers and owls in the Black Forest in southwestern Germany, combining different census techniques. The species monitored were the primary excavators of nesting cavities in these montane forests, i.e., the great spotted woodpecker *Dendrocopos major*, the black woodpecker *Dryocopus martius* and the three-toed woodpecker *Picoides tridactylus*, as well as potential secondary cavity nesters such the pygmy owl *Glaucidium passerinum*, Tengmalm's owl *Aegolius funereus* and the tawny owl *Strix aluco*. Woodpeckers and owls are among the species most difficult to monitor in the SPAs of the Black Forest mountain range. The monitoring method employed was territory mapping. In addition to documenting territoriality and the species' behaviour prior to and during breeding season, potential breeding sites were also examined. The playback of voice recordings was found to increase the number of contacts and sightings at the beginning of the breeding season, but was almost useless later in the season. For the owl species, evidence of breeding was detected by means of selective and systematic controls. The accurate monitoring of the populations of these species requires expertise with forest species and knowledge of their habitat requirements. One major task involves the designation of appropriate census periods that incorporate the periods of highest acoustic activity for each study species, to ensure optimal detectability during territory mapping. A standardisation of procedures, taking into account the species' activity patterns, is urgently required on both the national and international levels.

INTRODUCTION

This article provides recommendations for the most suitable methods concerning the monitoring of woodpeckers and owls in forests in Central Europe. The monitoring process took place in managed forests located in a mountainous region that is subject to long winters with heavy snow cover. The population densities of two ubiquitous species, tawny owl and great-spotted woodpecker, were lower than in lowland deciduous forests.

To assure compliance with the requirements of the EU Birds Directive concerning censuses of bird populations within Special Protected Areas (SPAs), methods have been developed to facilitate efficient counts of the actual number of protected species and their respective abundance, as well as the determination of ideal coverage. To ensure effective monitoring, these methods have to be adopted across large areas (extended protected areas).

The current recommendations for the census mapping of problem species can be supplemented. Through the observation of specific behavioural patterns in woodpeckers and owls, the precision of species mapping can be improved considerably. The 'phenology' of acoustic activities during the courting and brooding periods plays a significant role.

The preconditions for the census are in fact favourable, since the biology of the species that can be mapped is known (Snow and Perrins 1998, Bauer *et al.* 2005). All woodpeckers and owls in this study occupy territories during breeding season and are non-migratory (Hölzinger and Mahler 2001). From late winter until spring the location of territories can be determined by mapping birds in the vicinity of trees with nesting cavities. The monitoring focussed on whether a territory was occupied throughout the entire season, whether a pair moved into a cavity, whether young were observed and whether the young fledged (as an indicator of excellent habitat quality). These observations provided detailed data on the abundance and status of the local subpopulations. For example, the species' acoustic expressions are known and documented and are available for playback if required. All species of woodpeckers and owls examined in this study displayed species-specific

patterns of territorial behaviour. By integrating the knowledge of these patterns into the census methodology, a considerable improvement of census results can be expected.

METHODS

The method applied in this study was a true census, as outlined by Gregory *et al.* (2004). For detailed results, territories were mapped for the great spotted woodpecker *Dendrocopos major*, the black woodpecker *Dryocopus martius* and the three-toed woodpecker *Picoides tridactylus*, and for the pygmy owl G*laucidium passerinum*, Tengmalm's owl *Aegolius funereus* and the tawny owl *Strix aluco*. Each habitat was visited at least 3 times (in compliance with the recommendations by Südbeck *et al.* 2005), unless used cavities were located earlier. For every species, attempts were made to cover the habitat at the species' periods of highest aural activity (see discussion and figures 1, 2) and to search for cavities later the same day. This included the season from late February to July, and all hours of the day except from noon to late afternoon.

To benefit from the synergetic effect by monitoring both owls and woodpeckers the same days, more inspections were scheduled for the morning (before break of dawn). Thus the evening is unequally represented.

The study area comprised two sections of the southern Black Forest SPA in south western Germany. Accessibility is limited by the presence of only a few roads, topography and slope. Altitude ranges from 900 to 1200 m a.s.l.. The landscape consists of uneven-aged forest, with irregular shelterwood systems in which all managed age classes are represented. The predominant permanent forests are dominated by Norway spruce *Picea abies*, European silver fir *Abies alba* and beech *Fagus sylvatica*. In one of the sections, even-aged stands of spruce and beech are characteristic for the habitat.

One of the stated objectives was to obtain data on the abundances of both woodpeckers and owls in the forests by means of intensive observations carried out during the breeding season in 2005 and 2006. It was, in short, a territory mapping adapted to woodpeckers and owls in forests complemented by cavity searches and nesting records (Bibby *et al.* 2000). April 1 and May 15 were chosen as realistic and exemplary dates for the census.

RESULTS

Based on the observations made during the breeding season, 47 territories of woodpeckers (25 confirmed by nests) and 27 territories of owls (10 nests) were identified. The observation period also permitted the comparison of a good breeding season in 2005 (9 pygmy owl territories) with a less successful season in 2006 (4 pygmy owl territories - high and low rodent populations, respectively). More important, however, was the pattern of acoustic activity, which was used primarily to determine the presence of a species, secondly to identify occupied territories and finally to document breeding. The results demonstrated the general range of application of acoustic signals.

For a time period of ten days (March 27 - April 5 and May 10 - May 19) all the observations during monitoring were added in intervals of 15 minutes. On the first of April mountainous forests are fairly accessible. Mid May was chosen for controls of cavities and late season activities of the birds. Observations of the monitored species are given in fig. 1 and fig. 2. Complemented by rules derived from published data (Kuhk 1953, Blume 1996, Blume and Tiefenbach 1997, Mebs and Scherzinger 2000) and additional observations (Purschke unpublished data), this provided the background for vocal and instrumental activity heard and shown as a generalised pattern in the figures.

Aural activity of Tengmalm's owl (14 territories) was recorded mostly all night in early April. Higher levels of activity were found just before dawn (70 % of morning counts in an interval of one hour) and (not represented in the ten day periods) after dusk to midnight. In contrast to a period with a good food supply, acoustic activities can cease completely later in the season. Acoustic activity might also be restricted, even without disturbance by the observer, to just the first hour of darkness after dusk and before dawn. Tengmalm's owls called rarely and during some nights with favourable weather (e.g. no wind, no precipitation) not a single owl was heard.

Unsolicited aural activity in the Pygmy owl (13 territories) was found to be flexible starting at dawn with a peak at sunrise and ends in April before noon. A second shorter phase was observed with sunset, yet this small owl was never heard in the middle of the night. During April, pygmy owl hooting behaviour becomes almost strictly crepuscular (although breeding pairs communicate with soft calls and the feeding of young can be observed at all times of day).

Both the black and great spotted woodpeckers were only heard at low levels of daylight. Territorial activity started at sunrise on about the first of April, drumming activity in the great spotted woodpecker was observed for three hours beginning at sunrise. 73 % were counted in 1 ¾ hours (starting ¼ h after sunrise). Besides alarm calls, drumming on favourable dead branches and dead conifers and calls in a territorial context occurred between the end

of May and the first part of June, for the same duration each day with very low activity in the weeks between early April and the end of May.

In the six territories with black woodpeckers present, only two and three counted activities can be reported for each of the ten day periods, respectively. Different calls of this largest woodpecker were recorded from sunrise to early and late morning.

In multi-storied forest stands it is seldom possible to simultaneously obtain acoustic and visual recordings. More than 90 % of the observations were solely acoustic, with direct sightings concentrated around the cavity trees. Young owls and woodpeckers were located prior to fledging. For pygmy owls, pellets were found on the trunks of cavity trees in all six nesting records in 2005. In the case of Tengmalm's owl, no such indirect measures were applicable. The mobbing behaviour of small passerine birds (an indicator of a pygmy owl territory) was included in the census (Curio 1978, Friedrich 1997). This was used as a hint to go for an authoritative observation of this owl within the particular forest stand.

The locations of calling owls and drumming woodpeckers alone were found to be insufficient for defining a territory centres with the requisite tree cavity. The behaviour approach to mapping forest species is based almost exclusively on records of acoustic activity, with spontaneous calls or reactions to calls the sole indicator.

One of the main findings during the monitoring activity in this study was the significance of different periods of activity by the different species and activity maxima during the breeding season. The significance of these findings and their consequences are discussed in the next chapter, followed by some recommendations.

DISCUSSION

Woodpeckers and owls are too rare to be successfully monitored as part of a general census of all bird species, using standard methods. They require a species-specific approach (e.g. Südbeck *et al.* 2005). It is very important that the monitoring be carried out by an observer with prior experience and knowledge of the census methods for both owls and woodpeckers. The total number of potential observers in a region might be limited by a shortage of experienced personnel. This may pose a dilemma with respect to the differences in the size of observation areas, ranging from a more manageable few hectares to regions covering many square kilometres. Another essential precondition, therefore, is the availability of information pertaining to the habitat in question prior to a census or survey.

Territory mapping that includes the monitoring of cavity trees provides the most detailed information on species abundance, but it is a costly approach. Usually, available budgets will only cover the cost of a census of nesting birds for a restricted and limited area. Surveys carried out at the regional level may cover large tracts, only a small part of which represents in fact suitable habitat. In large SPAs that contain more than 10 km² of suitable habitat, monitoring may be based on censuses carried out in representative plots or strips. Certain areas will always be less accessible, and the cost of monitoring in these areas needs to be weighed against their representational value. The minimum sampling intensity applied in this study was higher than the preliminary guidelines prescribed for the monitoring of most bird species (Südbeck *et al.* 2005).

The main problems encountered during the monitoring of bird species in the montane forests concerned logistics. The study areas were often remote and largely inaccessible by road; there was a high degree of forest cover and dense vegetation, which acted as sound insulation; and the observation conditions were generally poor (low visibility and poor light in the dense forest stands). The latter poses a particular problem with the nocturnal owls, which are rarely seen by human observers. Night vision devices helped substantially with walking and orientation in the forests at night. Woody debris, rough terrain and snow cover also posed additional challenges to the observers.

The scale and 'accuracy' of a census (i.e., the recorded status of bird species habitation) are highly dependent upon the available resources and the monitoring objectives. To calculate species abundance, it is necessary to monitor several home ranges. In the case of the species referred to here, this involves a minimum area of several square kilometres. Areas with a high degree of habitat potential should ideally be covered in their entirety by the census.

The occurrence of breeding birds can be classified based of the following gradient:

- observation (species present);
- presence during a specific breeding period;
- territoriality (both in woodpeckers and owls);
- explicit territory defence against a competitor (indicating a territory border);
- attempted breeding;
- successful breeding (egg shells, adult feeding young) and finally fully fledged young, representing the highest detectable status.

If data pertaining to the habitat quality of a specific area (e.g., SPA) are required, information on the species status is necessary. Successful nesting presence or the absence of fledged young is the best measure of good habitat

quality for a particular species, available from bird count observations.

With a focus on species listed in Annex I of the EU Birds Directive, nesting trees were detected with a high degree of success. However, without nest boxes, which are easy to monitor, it is difficult to tell how many cavity trees might have been missed.

The mobbing behaviour of small passerine birds (indicator of pygmy owl territory) was included in the census (Curio 1978, Friedrich 1997). This helped to confirm presumed territories. Although this aided in the identification of pygmy owl habitat, it was no substitute for direct observation. Indirect measures, such as the adoption of mobbing as an indicator of pygmy owl presence, contain an inherent location error.

In the montane elevations of central Europe, pygmy owl, Tengmalm's owl, three-toed woodpecker and black woodpecker are restricted to forest habitat. Therefore, investigation of these species can be limited to areas with forests as the appropriate land use type and land cover. Specifically, studies can more efficiently focus directly on areas of potential habitat (e.g., as derived from maps); or zoom in on home ranges, core areas, or even specific nest cavities (i.e., a tree with a cavity) subject to study goals.

The applicable survey periods differ from one bird species to the next (Bibby *et al.* 2000; Südbeck *et al.* 2005). For the forest dwelling owl and woodpecker species of Central Europe the survey periods (i.e. hooting, drumming) overlap, ranging from mid-March through to the end of April.

In Tengmalm's owl, a nocturnal species, acoustic activity mainly occurs biphasic at dawn and dusk (Mebs and Scherzinger 2000). The hooting of male Tengmalm's owls can be heard throughout the night (Kuhk 1953, März 1995). They remain silent during the daytime when paired (Mebs and Scherzinger 2000).

High levels of activity around mid-May does not always occur. This second peak in acoustic activity may occur in years with a very high availability of prey (Kuhk 1953, Mebs and Scherzinger 2000). In many years, however, Tengmalm's owl suffers from a paucity of prey resulting in low vocal activity and in such cases low probability of recording a territory. This leads to enormous fluctuations from year to year (Saurola 1997, Snow and Perrins 1998, Mammen and Stubbe 2003). In years of low abundance, the acoustic activity of Tengmalm's owl may cease altogether. Because of this, one year censuses have very low explanatory power for habitat and population in an SPA.

The pattern of the acoustic activities of the pygmy owl contrasts with that of the nocturnal species. As in Tengmalm's owl, activity is highest at dusk and dawn (Scherzinger 1970, Schönn and Scherzinger 1995). Otherwise there is only a small overlap in the acoustic activities of the pygmy and Tengmalm's owls. The pygmy owl's avoidance of the larger Tengmalm's owl may be important in areas where both species compete for the same prey. The charted acoustic activities confirm the pygmy owl's generally crepuscular to diurnal pattern of activity (Glutz von Blotzheim and Bauer 1994, Bauer *et al.* 2005). After mating, aural activity occurs strictly at dusk and dawn. At that point, pygmy owls may reveal their presence with a single call, audible to an observer's ear up to a distance of 100 m. Undoubtedly, this is easily missed. Therefore, indirect indicators such as mobbing by passerines or direct records earlier in the season often have to be evaluated additionally.

The acoustic activities encountered by field ornithologists monitoring bird populations are highly dynamic, influenced by weather conditions over the course of the season and by the mating status of the birds (Bibby *et al.* 2000, Bauer *et al.* 2005, Südbeck *et al.* 2005). During periods of low activity the acoustic signals may be insufficient to provide any valuable census data, whereas the observer may be able to obtain the necessary data for a high percentage of all territorial birds within a short period of time during periods of high activity. In the case of the unobtrusive forest owls, those commissioned with carrying out the census should know the species' typical periods of greatest acoustic activity.

The monitoring of woodpeckers is best carried out during morning hours (Blume 1996, Blume and Tiefenbach 1997, Hölzinger and Mahler 2001, Michalek and Miettinen 2003). The black and great spotted woodpeckers exhibit similar patterns (Fig. 2) (Blume 1996, Blume and Tiefenbach 1997). Both species excavate cavities in trees also located in managed stands. Although their habitat requirements differ (Scherzinger 2002), their acoustic activities follow a similar pattern. The territory of a black woodpecker may easily cover many square km, potentially overlapping several territories of great spotted woodpeckers (Bauer *et al.* 2005). In the uneven-aged permanent forest stands there are no visible habitat boundaries, *e. g.*, different age classes of neighbouring stands, which could be used by an observer to help determine territory boundaries. In these cases, neighbouring territories can best be identified by the location of the respective nesting cavities (Bauer and Hölzinger 2001, Sikora 2004, Bauer *et al.* 2005). The three-toed woodpecker rarely occupies territories within managed forests in the Black Forest region and is therefore omitted from further consideration.

Mapping of owls and woodpeckers?

Südbeck *et al.* (2005) documented the essential steps required for a standardisation of the census techniques for

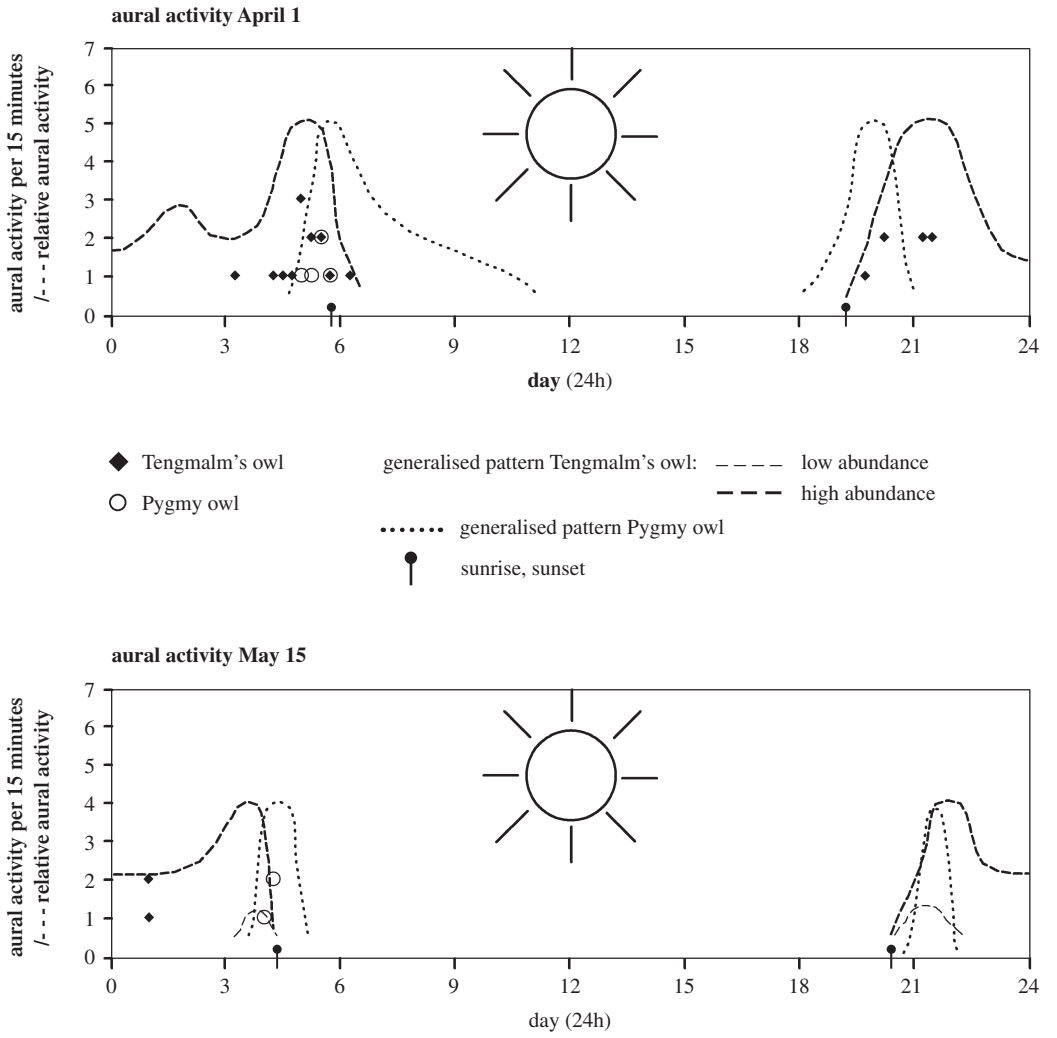

Figure 1. General activity of Tengmalm's owl and pygmy owl in early March (top) and mid- May (bottom). Markers indicate sunrise and sunset, when the pygmy owl's aural activity is greatest. The second period (bottom) of high aural activity by Tengmalm's owl pertains only to years in which the availability of prey is high.

breeding birds. The most suitable periods for censusing are documented for every species breeding in Germany. A minimum of three inspections is proposed for all forest species mentioned. Although designed for Germany, the census periods are applicable elsewhere in the middle latitudes of Europe.

The optimal census periods for different species do not necessarily overlap. In the case of the woodpecker and owl species discussed here, the periods range from February to July. As a compromise between the recommended monitoring periods and the optimal accommodation of accessibility and weather considerations (Bibby *et al.* 2000), the best results for most species in mountainous regions can be obtained between the end of March and mid-May. In practice, most inspections will take place during this period. The activity of forest birds is not uniform throughout the daytime hours, but is characterised by highs and lows in activity.

Generally, acoustic activity decreases in the hours after sunrise and sunset. The lowest rates of activity are observed shortly after noon and around midnight.

Without prior knowledge of the species' activities that may be detected during a census, a significant number of territories will remain undiscovered. Between phases of pronounced hooting and drumming, an observer might happen to carry out the observations during a prolonged period in which the birds behave inconspicuously, as was documented for the tawny owl by Melde (1989).

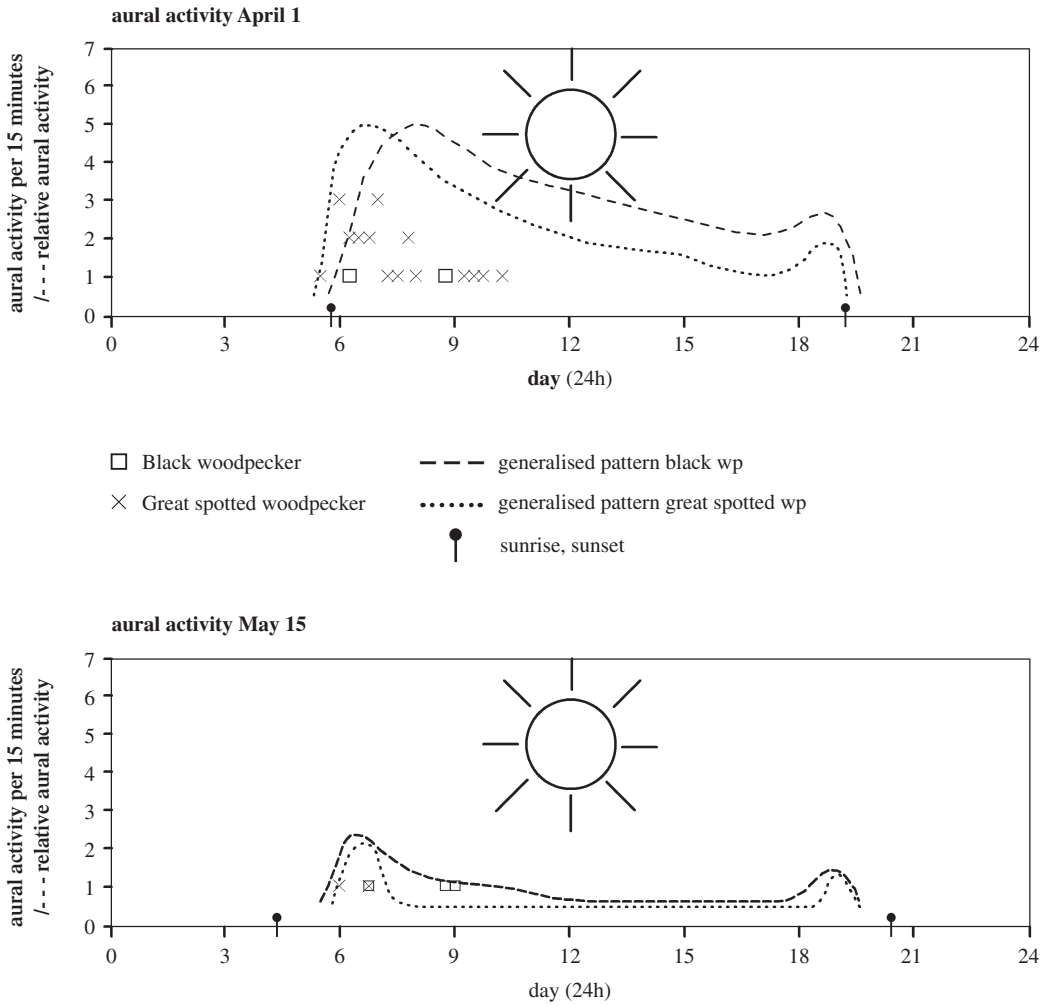

Figure 2. Woodpecker activity (drumming and calls) is highest early in the breeding season (top). Whereas the early daily activity pattern of the great spotted woodpecker is higher early in the breeding season, that of the black woodpecker decreases less drastically later on. Calls and drumming activities decline to a minimum before mid May.

Playback

With the help of voice recordings and a playback device, the observer may be able to provoke acoustic activity. However, there are limits to the success of this method, subject to season and mating status (Stübing and Bergmann 2006, Purschke unpublished data). Investigations on this issue need to be done. The playback method allows observers to cover larger areas, but many restrictions apply when censusing woodpeckers and owls. Woodpeckers do not necessarily react with drumming to indicate their presence to an intruder in their territory, nor do owls always respond with hooting (Mebs and Scherzinger 2000, Stübing and Bergmann 2006). Short unsolicited calls may have to be used to determine the presence of a species. Potential prey species such as small passerine birds (*e.g.* the crested tit, *Parus cristatus*), on the other hand, react to the pygmy owl advertising calls within their territory with intense mobbing.

Experience, as well as distance to its neighbours, may also alter a species' reaction to territorial vocalisations. In the little owl *Athene noctua* (a non-forest species), Hardouin *et al.* (2006) were able to demonstrate a neighbour/stranger discrimination on the basis of different reactions to known/unknown neighbours and locations. Intraspecific relations also alter acoustic activities, and this can occur long before an observer begins using playback or imitation calls (Crozier *et al.* 2006, on the spotted owl *Strix occidentalis* and barred owl *Strix varia*). Pygmy owls were generally silent while Tengmalm's owls were active. The

few exceptions to this rule may be have been triggered by the observer's playback or imitation. However, one species showed a delayed response to imitation, so that its period of activity actually overlapped that of the other species.

The playback method proved helpful as a means of extending periods of acoustic activity in early spring. Later in the spring the acoustic substitute was found to act as a disturbance, but was not sufficient to elicit a territorial response. The sensitivity of species and individuals was found to differ.

Every playback or vocal imitation by an observer represents a disturbance. These disturbances become crucially relevant when the subject of the census is a species suffering from a high rate of predation. In the case of owls and woodpeckers, a delayed reaction to the call of a natural or artificial competitor by five minutes or more was often the rule, rather than an immediate response. For the observer to detect either the drumming or hooting as a response to a vocal imitation, he needs to be patient and able to move quietly.

The authors of the 'Manitoba nocturnal owl survey' (Mazur 2000, den Haan 2001) discontinued the use of playback after including it in previous surveys.

Debus (1995) states that the playback of calls can more than double the probability of detecting the presence of most owl species in Australia. This is significant for the monitoring of birds across vast regions. Playback cannot be applied without reservations, however, since the responsiveness of woodpeckers and owls varies, depending on the season and the time of day.

Recommendations

In order to gather detailed information on woodpeckers and owls inhabiting montane forests, specific knowledge of the focal species is required, particularly in relation to the times of maximal acoustic activity. Monitoring techniques ought to follow strict procedures, in order to minimise errors and to allow for the compatibility of results from different studies and years.

Censuses can be based initially on a method involving the playback of voice recordings when done carefully by experts, and with a focus on potential habitat areas (local experience). In areas new to the observer, where the focal species are likely to occur, playback should be attempted, but the observer should be aware of disturbances, the time of the season, the different behaviour, vocal reactions of the species and the predation risk. Later in the season playback will not improve the census results and may actually lead to the suppression of short calls restricted to the core areas (*i.e.* near cavity), so that additional information may be missed.

Differences between the species must also be accounted for, rendering simultaneous surveys of multiple species difficult. Even the two species groups monitored as part of this study, the forest woodpeckers and small forest owl species, require different survey periods. There is no single ideal survey period. As a consequence, replications are an indispensable component in the collection of comprehensive census data. A one-time event, such as a single response, cannot be taken as proof of territorial presence. A comprehensive census is a time-consuming process and is fraught with restrictions. For example, observers should avoid the use of a car in the vicinity of the monitoring area during a comprehensive census, since many acoustic signals cannot be heard from inside a vehicle. In surveys where point counts are used simply to determine the relative abundance in different habitat types, cars might be appropriate to cover larger areas.

The few spontaneous calls at night can be heard up to a distance of several hundred metres. At the same time, an observer may easily fail to hear a call. In the case of owls, the response to an advertising call may be delayed by several minutes. One must therefore be patient; otherwise the efforts expended in employing the playback method are likely to be in vain.

A census based on a territorial mapping of cavity trees and on nesting records can be conducted for larger forests of up to several square kilometres in size. In the case of areas too large to cover within the recommended period, a possible solution is monitoring along transects. Dividing the proposed study area into units, scheduling monitoring on the basis of the units accessibility and taking into consideration the distance of potential audibility of acoustic activity as a function of the topography, will allow for efficient monitoring of a higher percentage of the overall area, even in late winter.

Census techniques need to be developed to extend the monitoring of individual forest stands to the surveying of entire regions on the basis of a plot method. For accurate data on abundance and status, a detailed census might be conducted for an entire SPA on the basis of a subset. Since the area to be surveyed covers an expanse of a dozen square kilometres of dense forest, it may be appropriate to concentrate on core areas first to obtain at least some information on the status of the species.

A monitoring scheme may be applied for the most suitable areas (according to the EU birds directive 79/409/EEC; 4) as a practical approach.

Trends and variations in population levels shall be taken into account as a background for evaluations.

A guideline for the censusing methods for forest-dwelling owls and woodpeckers in Europe would prove to

be valuable (Takats *et al.* 2000, nocturnal owls in North America) and would indeed represent a challenging but important contribution to survey techniques for the world's owls as a whole (Johnson and Marcot 2003).

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