Activity patterns of birds in the central Free State, South Africa

by

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Abstract

Activity patterns of bird species were studied at Glen Agricultural College within the grassland area of the central Free State, South Africa, during a period of 11 years (July 1997 – July 2008). The study focused on a specific grassland locality where 5-minute checklists were compiled continuously from dawn to dusk at least once a week for a total of 656 days. Data were also collected each minute for selected species. Additional observations in an adjacent tree and shrub dominated drainage line included 1-minute checklists compiled during transects over a two-year period (late autumn 2000/1 to mid-autumn 2002/3) as well as surveys from a fixed position from dawn to approximately 70 minutes after sunrise during 2007/8. The central aim of the study was to quantify and explain annual, seasonal and daily activity patterns of all bird species recorded in the study area. This data is summarised in separate species accounts where aspects of the annual cycle, particularly breeding and moulting, were also considered. In addition, the potential influence of rainfall was investigated.

The study reveals, for the first time, how the activity patterns of a southern African bird community change through time, and how the amount and timing of rainfall can influence these patterns. In spite of similarities amongst species when daily, seasonal and annual patterns are considered separately, the study also shows that each species is unique when all its data is considered simultaneously. Because activity patterns can have a substantial influence on the detectability of a species, the accuracy and usefulness of surveys aimed at estimating bird numbers is consequently questioned. The study at Glen also shows how activity patterns can be used to help unravel the annual cycle of species in a time and cost effective way.

Keywords: activity pattern; annual cycle; birds; circadian rhythm; circannual rhythm; drainage line; grassland; rainfall

1 Introduction

Nature is in some ways like a puzzle. For example, both have pieces that fit together to form a larger whole. The main problem with nature, of course, is that there is no "picture on the box". While this type of problem is sure to slow down the progress of both the conventional puzzle builder and that of a scientist trying to piece together nature, the scientist's problems do not end with the box — nature's pieces are multidimensional, and there are an unknown number of them, *i.e.* pieces and dimensions. In fact, each piece is a puzzle in itself and investigation of one of them inevitably reveals new puzzles, in a process that seems to continue indefinitely, to the delight of the scientist.

In December 1994, a study was initiated at Glen Agricultural College within the grassland area of the central Free State, South Africa, to unravel one of nature's puzzles, the Spike-heeled Lark *Chersomanes albofasciata*. Although known to science since the 1800s (Macdonald 1953), the behaviour of these common birds has been poorly studied. Taxonomic investigations of the 1950s focused on distributional, plumage and morphometric aspects (Macdonald 1953, 1957; Meinertzhagen 1951; Winterbottom 1958). In the 1960s Maclean (1970b,c) and Willoughby (1971) studied the biology of Spike-heeled and other lark species in the Kalahari Gemsbok National Park and central Namib Desert respectively. Both these authors focused mainly on breeding and related aspects and covered relatively large areas. Apart from some incidental notes, for example Steyn (1988) who recorded cooperative breeding, no further studies have been conducted on the Spike-heeled Larks since Willoughby published his work in 1971.

The study at Glen is unique in many ways. During the first year, colour ringed Spike-heeled Larks were observed from a fixed location for a total of 37 days, with observations commencing before sunrise and ending after sunset (Van Niekerk 2000). At that stage the study area was limited to a trampled area around a water manger. The area constituted part of the territories of two groups, each defending its own exclusive area. In addition to territorial disputes, valuable information was also collected on feeding, thermoregulation and other aspects of the larks' behaviour (Van Niekerk 2000), even though the study area covered only a fraction of their territory. Towards the end of 1995 the research entered a new phase when one of the lark groups, consisting of two males and one female, was followed on foot. This new strategy allowed for the collection of more detailed information on their behaviour because the birds allowed the observer to approach to within a few meters. Observations were intensified and at one stage every second week was spent in the veld, walking with a different member of the group every second day.

Meanwhile, the observer also became interested in other bird species in the study area, in particular the degree to which changes in their activity patterns would correlate with the behaviour of the larks. It was reasoned that such comparisons would be helpful in elucidating lark behaviour, particularly with reference to the influence of environmental variables on it. This was based on the assumption that many species would react similarly to environmental stimuli. Hence data collection on other bird species commenced during 1996. The aim was to quantify activity continuously from before sunrise until after sunset, on a temporal scale fine enough to allow daily comparisons to be made for each of the 12 equal-length segments between sunrise and sunset (see Van Niekerk 2000). Given a minimum duration of approximately 50 minutes per segment (during winter), it was decided to note activity separately for each 5-minute interval, resulting in at least $10 = 50/5$ intervals per segment which was considered a reasonable number from which percentage occurrence per segment could be calculated for each day. These observations were conducted from a fixed position in the veld once every second week, a day before or a day after a full day observation on the Spike-heeled Larks. This was not ideal since contrasting weather conditions on consecutive days made direct comparisons between the activity patterns of other species and the behaviour of the Spike-heeled Larks problematic. However, the observer was not yet able to collect both data-sets simultaneously at that stage. The method was refined during 1997 by monitoring the activity patterns of all bird species concurrently with the behaviour of the larks. After experimentation and practise, 10-minute checklists were used and after a few more months of practise the observer finally became sufficiently proficient to compile 5-minute checklists together with the behavioural data of the larks. This method was implemented on 22 October 1997.

Disappearance of the last Spike-heeled Lark at Glen during 1999 thwarted the study on them. Fortunately, there was another species that long interested the observer, and with no Spike-heeled Larks to follow it seemed natural to switch to the Eastern Clapper Lark *Mirafra fasciolata* instead. Even before the study on the Spike-heeled Larks commenced in 1994, a comparative behavioural study between these two lark species was envisaged. However, it was not possible to conduct concurrent studies because of time constraints and time-consuming nature of the work.

The Eastern Clapper Lark (henceforth clapper lark) is more difficult to study than the Spike-heeled Lark. The former species prefers taller grassland than the latter and it is surprising how quickly a habituated clapper lark can disappear before one's eyes, only to be found hours later. The situation is at its worse during their post-breeding moult when flying activity is limited. For the first number of years only limited observations could be made during that part of their annual cycle. In addition, it was also difficult to observe the birds when breeding, because even the habituated male would become 'wild' during that period. The spell was broken, so to speak, when one particular male finally accepted the observer's presence near its nest late in 2004. The stage was set for an exceptional series of observations that included a time when observations were made on him and a fledgling of his on alternate days for a few weeks. He disappeared in mid-2007.

It was around that time that an important decision was made. The work on the two lark species resulted in such a large volume of data with the end of 2007 seeing the start of field book X. The stenographic information in books B to W (192-page A4's) was not yet computerised, except for a large proportion of the 5-minute data in the database already. With the deadline of finishing a Ph.D. fast approaching, it was realised that the best course of action would be to enter the remaining 5-minute data and to use that for the thesis. To put this decision into perspective, the 5-minute data constitute a relatively small proportion of the total data-set, which consists of different levels of detail with the data used in this thesis comprising the upper level with the least amount of detail. At the second level there are counts of all clapper lark displays for each minute since 1999, and one level deeper one finds the displays of the clapper lark under observation, timed to the nearest second. At the bottom level, with the most detail, is the behavioural observations on the Spike-heeled and clapper larks, containing information on the number of pauses between activities (see Van Niekerk 2000), the duration of activities lasting more than 9 seconds, an indication of the type and size of prey, counts of preening movements and vocalisations, *etc.* The aim was to collect this information from dawn to dusk. However, it was often not possible to track a bird throughout the day. An additional level of information, collected since 2005, comprises the movements of the clapper lark male through his territory. A GPS device (Garmin Etrex Vista) was set to trace the path of the bird, or rather the path of the observer following the bird. By using this satellite technology it is possible to determine with great precision the boundaries of a territory, temporal changes in usage patterns of this area, the distances travelled by a bird, *etc.*

According to Underhill (see Anonymous 2002) there are approximately 50 bird species per ornithologist in Africa, and one "can more or less choose a bird species at random in Africa, and have it as your own private research playground". Once the study at Glen is concluded, the Spike-heeled Lark and Eastern Clapper Lark would count amongst the best-studied bird species in southern Africa, a distinction that they will share with only a handful of others. However, until then they will be considered part of another privileged group — the birds of Glen.

The 11-year study period at Glen (1997/8 to 2007/8) appears to be unequalled with the duration of several southern African studies investigating bird communities in a grassland setting — including studies in Zimbabwe (Snell 1963), the Eastern Cape (Skead 1946c, 1967; Winterbottom 1947), Northwest Province (Bouwman & Hoffman 2007; Farkas 1962; Milstein 1975; Skead & Dean 1977), KwaZulu-Natal (Davies & Maclean 1997; Nuttall 1993) and the Free State (Boddam-Whetham 1965; Kopij 1997, 1999, 2001, 2002a,b; Kopij & Esterhuizen 1994; MacLean 1957) — ranging from 1 day (Kopij 1997, 2002b) to 5 years (Skead 1967; Skead & Dean 1977; Snell 1963). Indeed, the incidence of terrestrial bird community studies in southern Africa longer than 5 years are rare, with the only example that could be located being the 6-year study of Dean & Milton (2001) in the southern Karoo.

One particular aspect of the study at Glen that sets it apart from other bird community studies is its emphasis on *daily activity patterns.* Whereas the unit of analysis in other southern African studies frequently involve the number of individuals (or 'pairs') and/or bird species (in addition to most of the references cited above, see also Beven 1945a,b; Brooke 1992; De Swardt 1994b; Dean *et al.* 2002; Engelbrecht 2002; Fraser 1989; Herremans 1997a, 2004; Kaphengst & Ward 2008; Koen 1992; Kok 1996; Maclean 1970a; Monadjem 2001, 2002a,b, 2003, 2005; Schwarzenberger & Dean 2003; Siegfried 1968; Skead 1946a,b, 1947, 1964; Symes & Perrin 2008; Symes *et al.* 2002; Taylor 1958; Tyler 2001; Wilson *et al.* 2007; Winterbottom 1968), the focus of this thesis is on the proportion of time that individual species have been active (in most cases referring to vocal behaviour) during the course of the day and how this changes seasonally and annually. The apparent novelty of this approach is surprising, because the above mentioned studies are frequently based on critical assumptions about the detectability — and by extension activity patterns, mostly vocal behaviour — of the species assessed, without there being any formal assessment of these assumptions.

Globally, the vast majority of bird community studies rely on index values (Rosenstock *et al.* 2002) that purport to reflect the relative abundance (synonymous with the (European) term dominance; Ralph 1981) of the species concerned. For example, birds are counted along transects and the resulting totals (*i.e.* index values) are assumed to reflect the true proportional abundance of each species. If there were, say, 20 individuals recorded of species A and five of species B, it is assumed that species A is $4 = \frac{20}{5}$ times more abundant than species B in real life. This assumes that the index value (c) is related to the true number of birds in the population (N) via the formula $c = pN$, where p is the detection probability (Anderson 2001). In other words, it assumes that the detectability of all species is the same. Similarly, if a study was conducted at the same locality but at different times (or habitats), changes in the numbers counted could only be interpreted as a change in population size if it is assumed that the detection probabilities were the same during the respective surveys (Farnsworth *et al.* 2002). These type of assumptions are unrealistic because there are numerous factors that influence detectability and hence the proportion of each species recorded (Buckland *et al.* 1993). This include factors related to the observer (*e.g.* his or her interest in the survey and skill), environmental variables (*e.g.* vegetation and topography), and the characteristics of the species being surveyed (*e.g.* daily, seasonal and annual changes in activity patterns). Numerous studies have investigated these issues (in addition to many articles and references in Ralph & Scott (1981) and Ralph *et al.* (1995), see also Amrhein *et al.* 2004; Bart & Schoultz 1984; DeSante 1986; Diefenbach *et al.* 2003; Farnsworth *et al.* 2002; Gibbs & Wenny 1993; Hayes *et al.* 1986; Jones *et al.* 2000; McLaren & Cadman 1999; McShea & Rappole 1997; Rollfinke & Yahner 1990; Rotella & Ratti 1986, 1988; Selmi & Boulinier 2003; Simon *et al.* 2002; Toms *et al.* 2006; Welling *et al.* 1995; Wilson & Bart 1985). The study at Glen is apparently the first to investigate daily, seasonal and annual activity patterns of a southern African bird community, albeit not specifically to evaluate census methods (population size was not formally assessed for any species). Little & Crowe (1992) investigated the use of call counts as an index of Grey-winged Francolin *Scleroptila africanus* population density; this bird is endemic to South Africa and Lesotho (Clancey 1986).

An alternative approach to raw index values (usually count data; Thogmartin *et al.* 2004) is to estimate true population numbers ($\hat{N}$) by estimating the detection probability ($\hat{p}$), and to use it in conjunction with the index value (c); *i.e.* the formula $c = pN$ becomes $\hat{N} = c/\hat{p}$ (Anderson 2003). A number of methods involve this approach (Anderson 2003), including distance sampling (Buckland *et al.* 1993; Thomas *et al.* 2009) and double sampling (Bart & Earnst 2002; Eberhardt & Simmons 1987). These methods are said to avoid the multitude of factors that influence detectability. In our example above, suppose that the detectability of species A was determined to be 0.8 and that of species B 0.2. It then follows that there are $25 = 20/0.8$ individuals of species A and $25 = 5/0.2$ of species B. In other words, there are equal numbers of both species, but raw counts (index values) gave the wrong impression that there are substantially more of species A than B. At least that is how it works in theory.

In spite of its seemingly superior nature, the use of population estimation methods via detection probability estimation is controversial (see Anderson 2001, 2003; Bart *et al.* 2004; Ellingson

& Lukacs 2003; Engeman 2003; Hutto & Young 2002, 2003; Rosenstock *et al.* 2002; Thompson 2002). Extreme opinions range from Caughley & Sinclair (quoted in Engeman 2003) who described population estimation procedures as requiring a "leap of faith", to Anderson (2003) who wrote: "Without empirical estimates of detection probability, index values are not reliable—they are just "numbers." Index values are feckless." Yet Temple (1981) suspected that *all* methods "produce results that are really nothing more than relative abundances." The controversy is perhaps best summarised by Hutto & Young (2002): "Again, we agree that unadjusted counts are biased by some unknown amount, but we question whether the conversion of those data to density estimates solves the problem. We also note that the use of adjusted counts tends to promote undue confidence in results, even though the number of violated assumptions is greater than for unadjusted counts." At present, most studies employ index counts (Rosenstock *et al.* 2002). Only one of the many southern African studies cited above considered one of the "more sophisticated methods"; Dean & Milton (2001) wrote: "More sophisticated methods of estimating bird populations, for example the program DISTANCE (Buckland *et al.* 1993) gave results with large variances that were intuitively unrealistic. The density of birds in the drainage line woodland is expressed in number of birds per linear km."

There are indeed situations were population estimation methods are clearly not feasible. For example, Bibby *et al.* (2000) considered the following six factors as causing problems with traditional bird counting methods, particularly in the tropics: 1) Large number of species; 2) Many species occurring at low densities; 3) Unknown seasonality of singing and breeding; 4) Varying lifestyles; 5) Low calling rates; 6) Dense vegetation and difficult terrain. Combinations of these difficulties may mean that the population estimation methods do not work effectively (Bibby *et al.* 2000; see also Recher 1981).

Furthermore, large scale projects relying on volunteers from the public ("citizen scientists") cannot afford to scare off potential participants with the relatively complicated methodology that the supposedly more accurate methods entail. For these and other reasons abundance indices are sometimes used instead of density estimates. For example, during the first Southern African Bird Atlas Project (SABAP1; 1987–1991; Harrison *et al.* 1997a,b) observers did not count birds but recorded the presence of identified species on checklists instead. Reporting rates were then calculated and used as an index of relative abundance. However, because reporting rates confounds numerical abundance, conspicuousness and identifiability, reporting rates are generally only comparable within a particular species (and then with great care) and not between species (Harrison & Underhill 1997; Underhill *et al.* 1992). Yet this important principle is completely ignored by contemporary protocols based on species sequences. For example, in the Timed Species Count (TSC) method (Freeman *et al.* 2003; Nachuha & Pomeroy 2001; Pomeroy & Dranzoa 1997; Pomeroy 1992; Trager & Mistry 2003) each species recorded in a survey is assigned a 'score' or 'weight' from 6 to 0 based on the 10 minute interval of a continuous 60 minute period during which it occurred as follows:

Minute interval	1-10	11-20	21-30	31-40	41-50	51-60	not recorded
Score/weight	6	5	4	3	2	1	0

The reasoning is that "commoner species are likely to be recorded, on average, before rarer ones." (Freeman *et al.* 2003). It is consequently assumed that the mean score for each species is an index of its abundance. However, as pointed out by Bibby *et al.* (2000), "it is not really clear whether there is any good theoretical basis for the weights used." This is even more pertinent for analyses based on the absolute sequence in which bird species are recorded, such as the "species ranking abundance analyses" of the second Southern African Bird Atlas Project (SABAP2; 2007–present; `http://sabap2.adu.org.za`). The study at Glen offers an unique opportunity to evaluate these and other census related issues, as is done in the final chapter of this thesis.

The study of activity patterns is in a way a study of the endogenous, genetically programmed clocks of organisms. These clocks, which are ubiquitous in eukaryotes and are also found in some prokaryotes, cause biological rhythms that continues unabated under constant conditions (Aschoff 1984; Dunlap 1999; Hardin 2004; Harmer *et al.* 2001; Hastings *et al.* 2007). Under natural conditions, these rhythms are entrained to the day-night (24 h), tidal (12.4 h), lunidian (24.8 h), semi-lunar (15 days) or annual (1 year) environmental cycles (Roenneberg & Merrow 2001; Tauber & Kyriacou 2008; Wikelski *et al.* 2008). Under constant conditions the rhythms approximates the length of the environmental cycles that they mimic (Enright 1970), hence terms such as circadian and circannual clocks, from the Latin *circa*, about; *dies*, day; *annus*, year (Berthold 1996).

The molecular workings of circadian clocks received much attention since the late 1980s (Dunlap 1999). The circadian programme as well as the physiological and molecular circuits involved are extremely complex (Roenneberg & Merrow 2001) and much remain to be discovered (*e.g.* Ball & Ketterson 2008; Cassone *et al.* 2008; Dawson 2008; Wikelski *et al.* 2008). The purpose of these elaborate clock systems in biota is to ensure that various aspects of behaviour, physiology and metabolism occur at appropriate times by anticipating periodic biotic and abiotic events (Bell-Pedersen *et al.* 2001; Emerson *et al.* 2008; Jacobs & Wingfield 2000; Sharp 1996; Tauber & Kyriacou 2008; Vitaterna *et al.* 2001).

Both circadian (Farner 1986) and circannual clocks (Gwinner 1996a; Wikelski *et al.* 2008) are found in birds. Experiments in which birds were exposed to seasonal photoperiodic cycles with periods deviating from 12 months showed convincingly that the internal annual cycle are indeed synchronised to photoperiod (Newton 2008). Under natural conditions, these clocks are entrained by day-length (*i.e.* the light fraction of the 24 h day; photoperiod), which is the environmental factor showing the most consistent seasonal change from year to year (Berthold 1996; Brandstätter 2003). The ability of organisms such as birds to measure day-length as well as the direction of change in day length is known as photoperiodism (Brandstätter 2003).

The circadian clock can control or modulate the daily timing of various behaviours and physiological processes (Cassone *et al.* 2008; Tauber & Kyriacou 2008). For example, experimental evidence indicates that it underlies the diurnal activity patterns involving two activity peaks per day with a quiescent stage after midday (Aschoff 1966), although environmental conditions and biological factors can suppress or accentuate parts of this pattern (*e.g.*, see Cuthill & MacDonald 1990; Kacelnik & Krebs 1982; Slagsvold 1996).

Experiments conducted under constant conditions indicate that many birds — including residents and migrants from temperate and tropical areas, passerines and non-passerines — have endogenous circannual rhythms which determine the sequence and timing of major annual events such as breeding (gonadal cycles), moult and migration (migratory restlessness; *Zugunruhe* in German) in a way that is characteristic for a particular species or population (Ball 1993; Gwinner 1996a; Newton 2008; Wikelski *et al.* 2008). Under these experimental conditions the rhythms tend to become either shorter (often) or longer than a year (Wikelski *et al.* 2008), typically lasting 9–13 months (Gwinner 1996a).

Under natural conditions, a dual system involving the endogenous rhythm acting as a template for seasonal activity and day-length as synchroniser ensures that different events occur at the appropriate time, and in the right sequence, each year (Newton 2008). Exceptions have been found in equatorial regions where the endogenous rhythm of some species appear to be free-running, *i.e.* there appears to be no coupling to environmental sychronisers, presumably because ecological conditions are almost uniform throughout the year for these species (Newton 2008). However, factors such as weather conditions and food supplies usually fluctuate during the year, but less predictably than day-length changes. For example, the first significant rains do not occur on the same date each year. Birds probably use these secondary environmental cues to fine-tune the timing of biological events (breeding, moult, *etc.*) after preparatory processes was initiated by changes in day-length (Ball 1993; Dawson 2008; Dawson & Sharp 2007; Helm 2009; Newton 2008; Schoech & Hahn 2008; Sharp 1996). In addition, it seems that female birds play a greater role in the "fine-tuning" of the onset and termination of breeding than do male birds (Ball 1993; Ball & Ketterson 2008).

Studies on a few seasonally breeding passerine species revealed what appears to be a general pattern of photoperiodism (Dawson *et al.* 2001; Sharp 1996). During the cooler times of the year when photoperiods are relatively short, birds are reproductively quiescent, but able to respond to an increase in photoperiod under experimental conditions. This is termed the photosensitive state. As day-length increases beyond a certain length towards spring, photostimulation occurs, resulting in increased gonadotropin-releasing hormone (GnRH-I) secretion and consequent gonadal maturation and eventually breeding. Breeding is followed by a photorefractory state triggered via an extended exposure to relatively long photoperiods. During this state the entire hypothalamo-pituitary-gonad (HPG) axis is switched off and (experimental) long days cease to stimulate gonadal recrudescence. The photorefractory state dissipates during short photoperiods, normally during autumn, and the bird returns once again to the photosensitive state. Other variations on this pattern include certain quail species where gonadal regression is caused by a decrease in photoperiod. In the Emu *Dromaius novaehollandiae*, a species that breeds during the short days of the cooler times of the year, breeding is initiated by the dissipation of photorefractoriness in autumn and terminated by prolactin which, unusual for birds, increases while the days are still short; Photorefractoriness develops subsequently with an increase in photoperiod (Blache *et al.* 2001). It is not yet clear how the control of the annual cycle in tropical and opportunistic breeding species work. One possibility suggests that the endogenous circannual rhythms, synchronised by non-photoperiodic cues, may play a major role (Dawson *et al.* 2001).

Singing behaviour is to a certain extent dependent upon the reproductive state of a bird.

Compared to males in a non-reproductive state, those in a reproductive state are more likely to sing or to sing in a different way (Ball *et al.* 2004). However, most of the work done to date on the mechanisms involved has been correlational in nature, and it proved very difficult to decipher the web of correlations between behavioural, morphological, endocrine and neurochemical factors (Ball *et al.* 2004).

Feathers are essential for flight (in most species) and insulation, and since they wear out they need to be replaced each year during a process called moult. In most bird species, especially in temperate regions, there is little if any overlap in breeding, moult and migration. Breeding is frequently followed by moult, especially in passerines (Dawson *et al.* 2001; Ginn & Melville 2007). Moult is normally initiated by long photoperiods, but if breeding activity continues beyond this photoperiodic timing of moult, the start of moult is delayed; the mechanism causing this delay is still unknown (Dawson *et al.* 2001). Yet a decrease in photoperiod once moult started increase the rate of moult (Dawson 1998), allowing the birds to start moult late but still finishing it before adverse winter conditions set in (Dawson *et al.* 2001). However, feathers grown during such a relatively rapid moult may lead to poorer plumage quality, which may effect survival negatively through decreased flight performance and increased thermoregulatory costs (Dawson *et al.* 2000).

In summary, photoperiod/day-length plays an important role in the annual cycle of a number of bird species, including many of those found at tropical latitudes (see Beebe *et al.* 2005).

Complementary to the behavioural studies on the two lark species, one of the primary objectives of the study at Glen was to answer the following interrelated questions: Is the activity patterns of all bird species similarly influenced by environmental variables such as seasons, rainfall and temperature, and why do the respective species react the way they do, *i.e.* can the observed patterns be explained in terms of biotic and abiotic factors, and what are the mechanisms involved. The study was designed to enable analyses on two temporal levels: 1) a short-term level focussing on day to day or week to week changes in activity patterns; and 2) a longer-term level investigating more general seasonal and annual patterns. The focus of the present analysis is on the latter level.

A number of authors stress the importance of replication in research (*e.g.* Bauernfeind 1968; Carver 1993; Johnson 1999, 2002a,b). The reasoning is that consistent results among multiple replications will give greater confidence in the generality of the findings than would any single observation. As such, multiple replications automatically make statistical significance testing unnecessary (Bauernfeind 1968; Carver 1993; Johnson 2002b; for a more general overview of statistical significance testing problems, see Anderson *et al.* 2000; Anderson *et al.* 2001; Cherry 1998; Cohen 1994; Guthery *et al.* 2001; Johnson 1999; Nester 1996). The extent to which similar findings in a replicate study can be generalised is determined by the degree to which the respective replications vary (Bauernfeind 1968). Towards the lower end of the scale is 'ordinary replication' where similar findings should be obtained under *similar* conditions. At the upper end of the scale is the replication of results in studies conducted in *different* years, at *different* sites, with *different* methodologies and by *different* investigators; this would represent an extreme case of 'metareplication' (see Bauernfeind 1968; Johnson 2002a). The study at Glen in general, and the data presented in this thesis in particular, owes much of its success to these replication principles.

For each species at Glen the days of each year or season was the statistical population sampled. During each sampled day, the activity of all species was continuously monitored from dawn to dusk for each five minutes. This enabled the calculation of a reporting rate (*i.e.* the percentage 5-minute checklists that record a species), a concept developed by Linsdale (1928) and subsequently adopted in a number of studies, including SABAP1 (Underhill *et al.* 1991; Underhill *et al.* 1992). Here, the reporting rate is assumed to be an index of activity levels. Sampling was systematic, *i.e.* (mostly) once a week, throughout the year for all 11 years. Statistically speaking, this is a valid form of sampling, as is random sampling (Hurlbert 1984). Sampling was random with regards to prevailing weather conditions, including rainfall events and cold-fronts, in that full-day observations were mostly done on a specific day of the week (*e.g.* each Wednesday), regardless of weather conditions. The resulting data-set affords analyses in various combinations in order to investigate a number of aspects.

Year-to-year variation in activity patterns can be assessed either by combining all the data separately for each year, or by considering the seasonal occurrence of activity during each year. In this case each year could be considered a replicate study where every thing is kept constant except time and variables that change with that (annual rainfall patterns, *etc.*). If the analysis shows that the activity patterns of one or more years deviates for the pattern established by other years (*e.g.* when the activity levels of one year was unusually high), this would warrant special investigation into correlations with other variables, particularly rainfall patterns. It is acknowledged that care should be taken to avoid mistaking correlation with causation (see Aschoff 1966), yet if a conclusion is consistent with reasonable mechanisms supported by other evidence, such mechanisms give credibility that the correlational smoke may in fact represent causational fire (Holland 1986; Johnson 2002a).

Day-length and changes in day-length were used to define seasons. Seasonal patterns in activity may be assessed in two ways. By grouping all the data by season (*i.e.* ignoring years) one may consider each season a replicate study. In other words, a study about the activity in late winter, in early spring, *etc.* Another way of viewing the same data is to consider each year as a separate study. Both strategies will show the extent to which activity is a seasonal phenomenon (including the phenology of migrants) and may provide clues as to the timing of breeding and moult, for example. In this regard, the detailed study on the clapper lark at Glen was instrumental in formulating the prediction that a well-defined post-breeding silent period coincides with moult. The extent to which the revealed seasonal pattern is restricted in time (*e.g.* a migrant species that arrives during the same narrow window period each year) may furthermore indicate the degree to which the activity is tied to day-length/circannual rhythms.

Although general statements to the effect that activity peaks during the morning abound, there appear to be no studies (at least not on the bird community level) that specifically illustrates this in southern African birds. The Glen data was analysed by combining the data for each segment (replicated 'study unit': segment) and by analysing the segment data by season (replicated 'study unit': season). In addition to determining the consistency of the daily pattern, the segment data may also provide further insights into the nature of seasonal variation in activity, *i.e.* it will show if the seasonal peaks are simply related to more intense activity during the same part of the day or if the activity period itself is extended to encompass other parts of the day too.

The study at Glen represents a case of extreme metareplication of numerous other studies. The literature was searched for each species and comparisons made where applicable. Although much effort was expended in locating original sources of information, there remain a number of references that could not be traced in time for inclusion in this thesis. The most useful bird community level study was SABAP1 (Harrison *et al.* 1997a,b), which was conducted during a different study period (1987-1991 vs. 1997-2008), on a larger geographical scale (southern Africa vs. Glen), using a relatively crude methodology (one checklist per month vs. continuous 5-minute checklists per day) applied by an army of "citizen scientist" compared to the single observer at Glen. In general, the SABAP1 data could only be analysed in terms of the seasonal occurrence of the birds. In terms of bird behaviour in general, the study at Glen also represents a metareplication of studies elsewhere in the world on different species.

The study area, including habitats, non-avian animals and abiotic variables, is described in the next chapter, followed by an explanation of field methods, data analyses and presentation in Chapter 3. All of the above mentioned analyses (and more) are presented in individual species accounts in Chapters 4 (Non-passerines) and 5 (Passerines), while Chapter 6 examines the data from a bird community perspective. Chapter 7 deals with species sequences and concludes with suggestions for further research.

2 Study Area

Glen Agricultural College is located in the central Free State, South Africa (28°54'S 26°21'E; Fig. 2.1). Situated in the western part of the Grassland Biome, and with a mean annual rainfall of less than 600 mm (mostly during the warmer seasons of the year), the area falls into the Dry Highveld Grassland Bioregion, a 'sweet' grassland type with a predominance of chloridoid grasses, more precisely the Winburg Grassy Shrubland unit (Gh 7) (Mucina & Rutherford 2006). The vegetation and landscape features of this unit include solitary hills, slopes and escarpments of mesas which create a mosaic of habitats ranging from open grassland to shrubland.

Hills[1] to the east of the study area at Glen form a watershed with a tree and shrub dominated drainage line running from the north-east to the south-west through undulating grassland (Fig. 2.2; Fig. 2.3; Fig. 2.4; Fig. 2.5). A part of the grassland area situated north-west of the drainage line (Fig. 2.3) was the focal area of the study, with limited observations also made in parts of the drainage line. These two areas form part of four large cattle enclosures (Fig. 2.3) separated by three internal 1.5 metre high fences, and are situated approximately 5 km north-east of Glen village (Fig. 2.2). Data was collected separately for the grassland and the drainage line (see next chapter). A number of *Eucalyptus* trees occur less than 1 km west of the grassland site.

Sources of noise pollution include the railway line between Bloemfontein and Brandfort which, at its closest approach, passes approximately 750 m north-west of the trampled area (Fig. 2.3). The R30 tarred-road between Bloemfontein and Brandfort passes more than 2.5 km north-west of the trampled area (Fig. 2.2), while the N1 highway between Bloemfontein and Winburg passes more than 5 km to the south and south-east. Air traffic between Bloemfontein and Johannesburg passes overhead on a daily basis, with the study area situated approximately 21 km north of the Bloemfontein airport.

2.1 Habitats

2.1.1 GRASSLAND

Observations in the grassland were made from within the territorial boundaries of the larks under observation. Spike-heeled Lark territories included at least part of a roughly circular trampled area (radius approximately 50 m) around a water manger and extended into the surrounding, undulating, tree dotted grassland (Fig. 2.4). One of the fences runs through the trampled area, dividing it into a northern and southern part (Fig. 2.3). In contrast to the Spike-heeled Lark, Eastern Clapper Lark territories included most of the grassland and were not specifically focused on the trampled area, but both species avoided the drainage line situated more than 300 m south-east of the trampled area (Fig. 2.3). Over the years, a succession of Eastern Clapper Lark males

[1] In this thesis the terms 'hill' and 'mountain' are used interchangeably to describe the elevated terrain to the east of the study area.

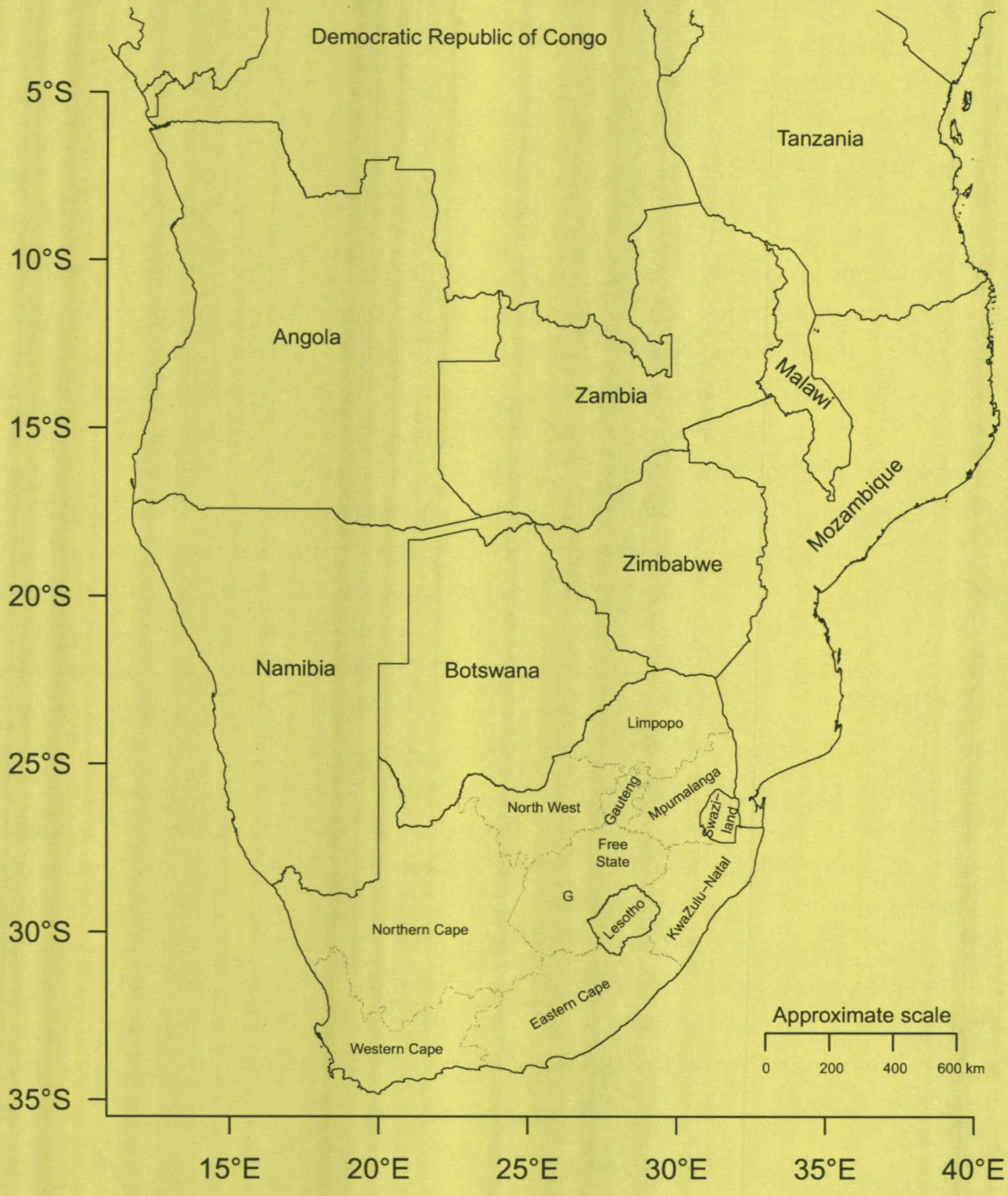


Figure 2.1: Geographical location of Glen Agricultural College (G) in the Free State, South Africa. International borders indicated by black and South African provincial borders by grey lines.

was observed in the grassland west of the trampled area. The western limit of their territories extended to a zinc dam at the top of a rise situated 300 m west of the trampled area, the highest point in the study area (Fig. 2.4). A vehicle track leads from the trampled area to this dam (Fig. 2.4).

Climatological factors (particularly rainfall) as well as grazing regime (principally by Bonsmara cattle) determined the condition of the veld, leading to local, seasonal and annual differences in veld condition. The vegetation cover of the trampled area varied from bare ground only to a thick carpet of Red Quick Grass *Cynodon hirsutus*. Most of the time, however, the cover of the trampled area was somewhere between these two extremes. Examples of vegetation cover in the trampled area are illustrated in Figure 2.6. In the surrounding grassland, Red Grass *Themeda triandra* was the most dominant grass species, but at any specific time the species composition and plant density are variable, being less dense on the more stony areas around the zinc dam (Figure 2.5) and most dense in less stony areas elsewhere in the study area. Figure 2.7 illustrates the variability in grass cover at one particular grassland site. A notable scrub component is also present and is most obvious when the grass is short (Fig. 2.7).

2.1.2 DRAINAGE LINE

In contrast to the open grassland through which it runs, the vegetation structure of the drainage line is characterised by various trees and shrubs, mainly Sweet Thorn *Acacia karroo*, but other species including Karee *Rhus lancea* and Buffalo-thorn *Ziziphus mucronata* are also common. The densest vegetation occurs around a farm dam. An example of habitat near the inlet of the farm dam is shown in Figure 2.8 and the farm dam is illustrated in Figure 2.9.

2.2 Non-avian animals

A number of other animals occur in the study area, in addition to birds. This section gives a summary of these animals with specific focus on potential interactions between them and birds. It is not intended as an exhaustive discourse and is based largely on observations on the Spike-heeled and Eastern Clapper Larks, particularly the section on arthropods. It is nonetheless considered useful. The following sources were used for taxonomic details and general information: Mammals, Skinner & Chimimba (2005); Reptiles, Branch (1988); Marais (1992); Amphibians, Du Preez & Carruthers (2009); Arthropods, Picker *et al.* (2002).

2.2.1 MAMMALS

Direct feeding associations between birds and mammals are limited to the few bird species, which feed habitually amongst cattle, most notably the Cattle Egret R071, Cape Wagtail R713 and Wattled Starling R760.[2] Rainfall and cattle are the main agents which keep the vegetation in check.

A number of bird species benefit from the burrowing and/or digging activities of mammals. South African Ground Squirrels *Xerus inauris* maintain extensive warrens, mostly in the trampled area. These warrens are also home to various kinds of other creatures, including Suricates *Suricata suricatta,* Yellow Mongoose *Cynictis penicillata*, snakes, spiders and millipedes. Spike-heeled Larks R506 utilise these holes too, but mainly as a refuge from certain predators (Van Niekerk 2000).

The Eastern Clapper Lark R495 was observed to forage on mounds thrown up by the African Mole-rat *Cryptomys hottentotus* and around diggings of Cape Porcupine *Hystrix africaeaustralis* and Springhare *Pedetes capensis.* The Common Warthog *Phacochoerus africanus* sometimes digs for food and birds may forage around these disturbed areas too. In general, the most beneficial

[2]See page 129 for an explanation of the number following bird names.

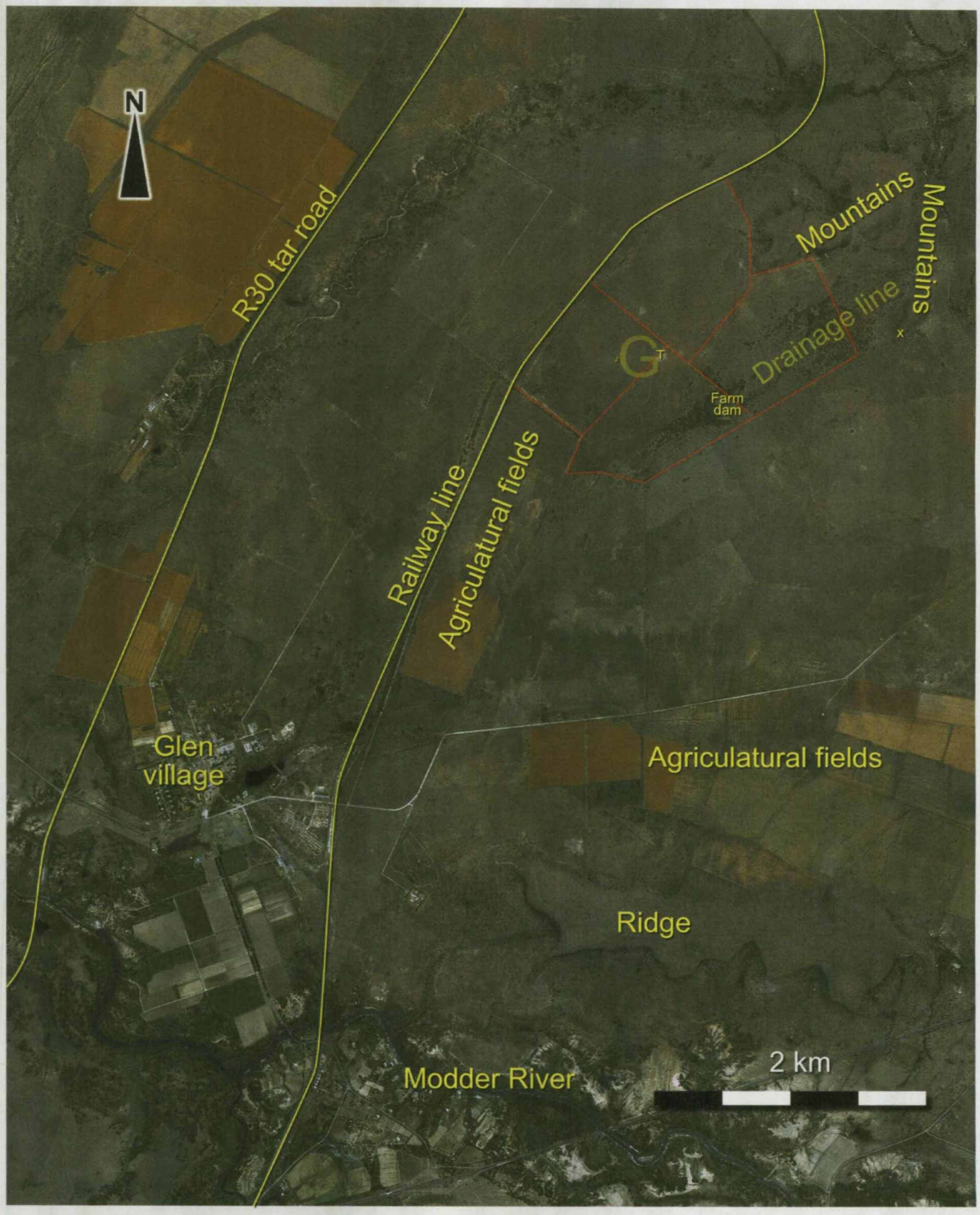


Figure 2.2: Study area and environs at Glen. G, core of the grassland part of the study area; T, trampled area (to the right of the G); z, zinc dam (to the left of the G). The 'x' in the mountains indicates the location from where the photographs in Figure 2.4 were taken. Red lines represent fences of the four cattle enclosures in the immediate vicinity of the core study area. Base map form Google Maps (`http://maps.google.co.za`).

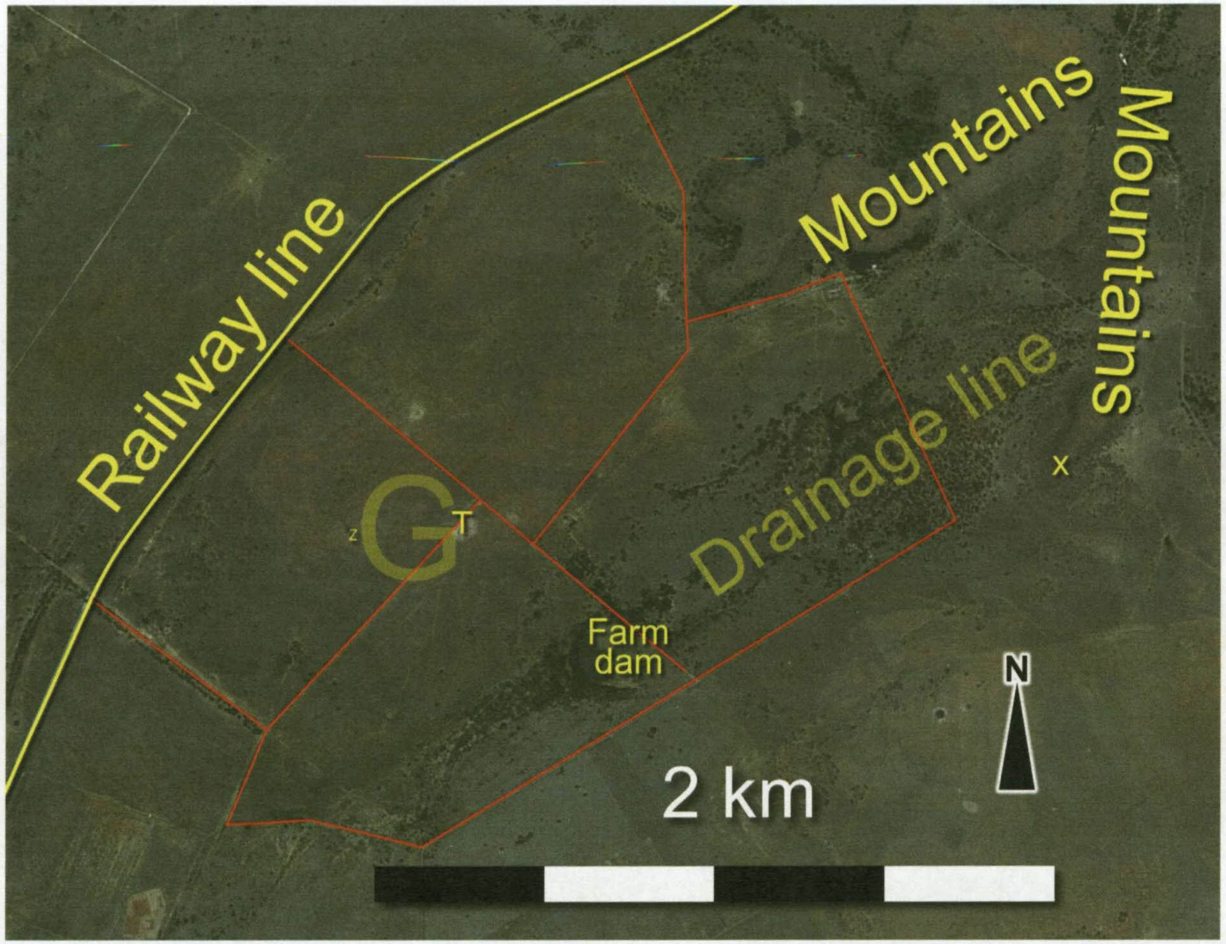


Figure 2.3: Study area and environs at Glen with the focus on the core study area (enlargement of Figure 2.2). G, core of the grassland part of the study area; T, trampled area; z, zinc dam. The 'x' in the mountains indicates the location from where the photographs in Figure 2.4 were taken. Red lines represent fences of the four cattle enclosures in the immediate vicinity of the core study area. Base map form Google Maps (`http://maps.google.co.za`).

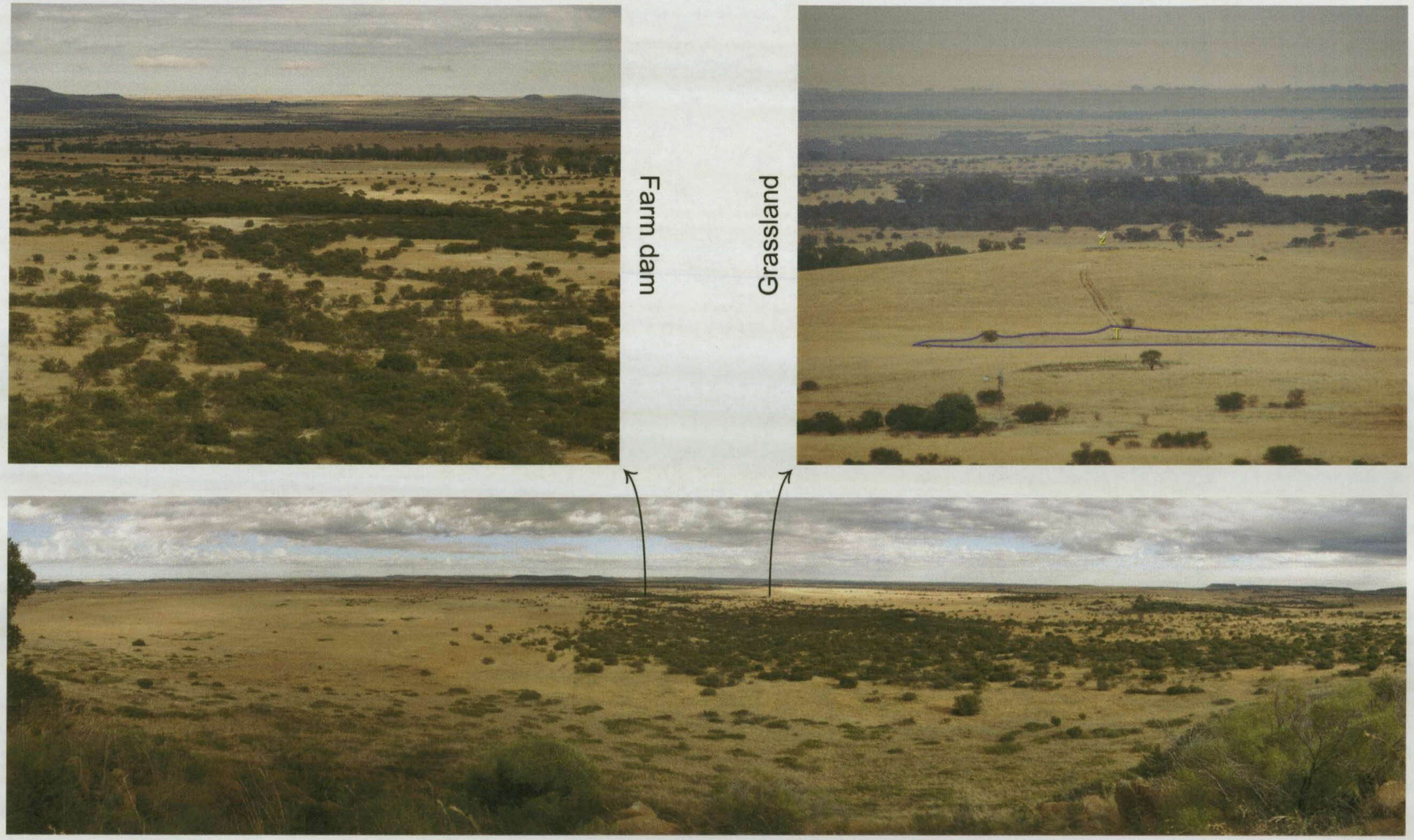
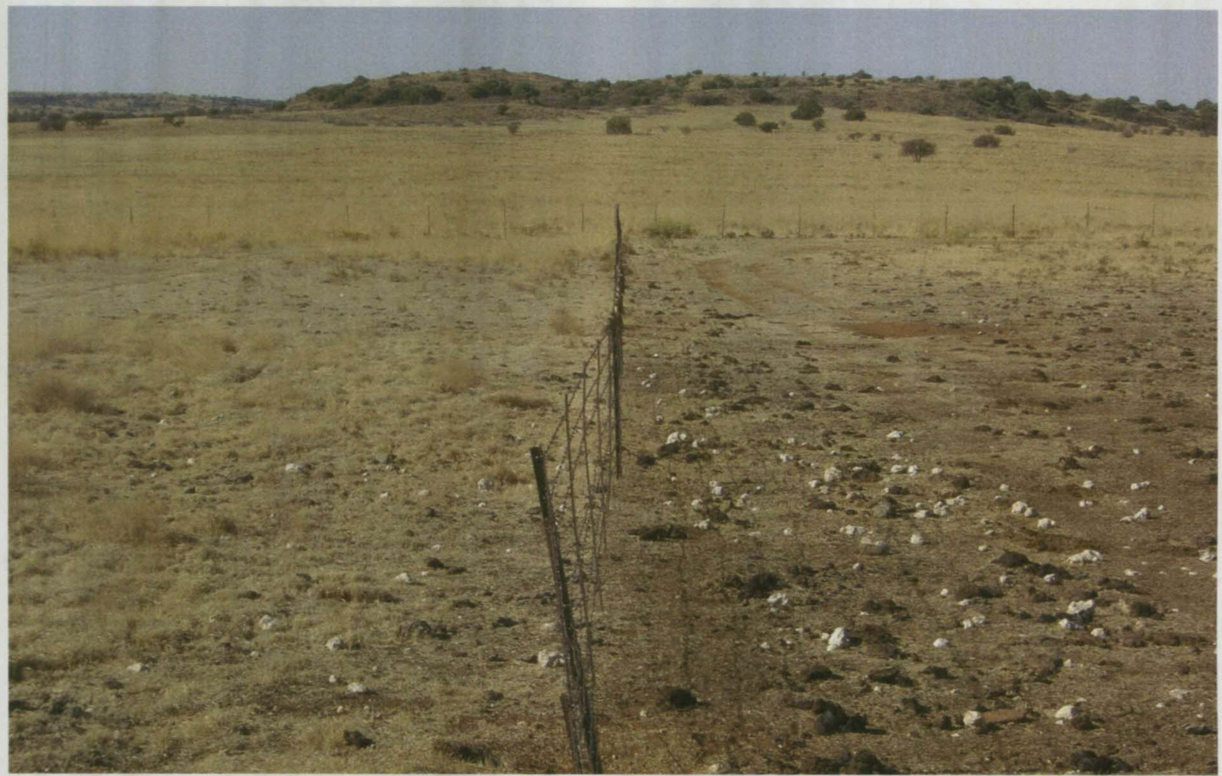


Figure 2.4: Photographs of the study area at Glen taken from the mountain situated in the east (see Figure 2.3). The bottom picture represents an approximately 180° view and illustrates the tree and shrub dominated drainage line running through undulating grassland. The enlargements are of the farm dam (left) and the grassland part of the study area beyond the drainage line (right). In the latter picture, the trampled area is delineated by a blue line with the bottom of the 'T' on the water manger. A 'z' hovers over the zinc dam (centre of picture) from where the picture in Figure 2.5 was taken.

Figure 2.5: The eastern horizon as seen from the highest point in the study area at the zinc dam at Glen. Note also the rocky substrate in the foreground and green trampled area further on. The photographs in Figure 2.4 were taken from the arrowed position.



9 September 2004

2 March 2006

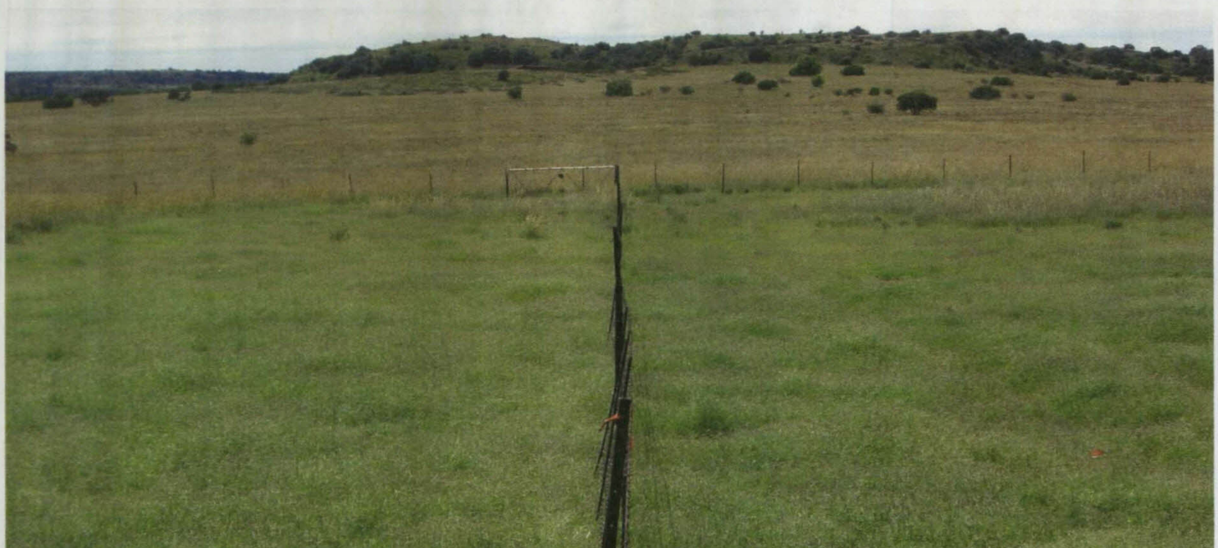


Figure 2.6: Variability in vegetation cover in the trampled area at Glen. In the top picture, the sparser vegetation cover to the right (southern part) is due to cattle. Both pictures taken from the water manger.

10 December 2003

23 March 2006

Figure 2.7: Potential seasonal variability in the grassland habitat at Glen. Both pictures taken a few metres from the south-eastern end of the trampled area, looking south-westwards towards Bloemfontein.

14 September 2007

13 December 2007

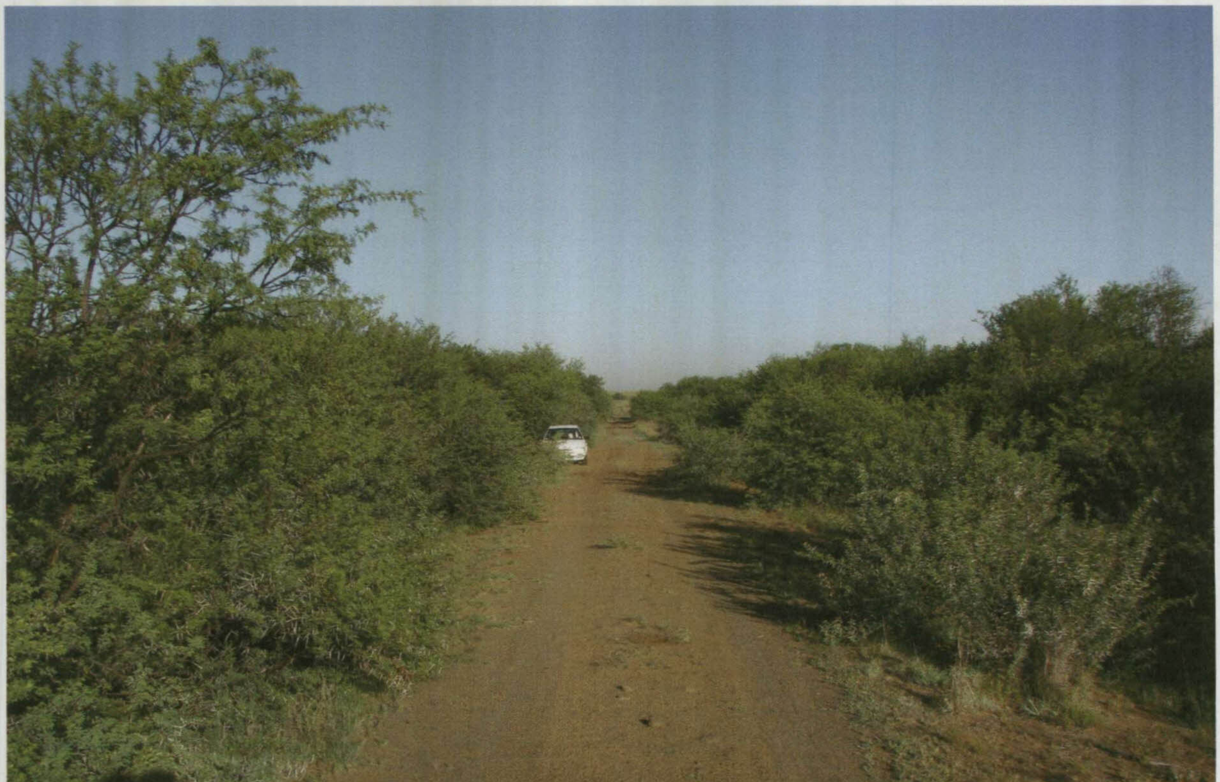


Figure 2.8: Seasonal change in habitat along the gravel road approximately hundred metres east of the farm dam in the drainage line at Glen. This is also where observations have been made since 2007/8 (see page 122).

21 August 2008

5 March 2009

Figure 2.9: Contrasting conditions at the farm dam in the drainage line at Glen.

mammals to grassland birds are the Aardvark *Orycteropus afer* and Aardwolf *Proteles cristatus.* Both species are obligate termitivores and their diggings at termitaria expose an abundant food source in the form of dead, half-dead or living *Trinervitermes* termites on which many birds feast for days after the termite mound was originally broken. The Ant-eating Chat R595 nests in Aardvark burrows.

A number of mammals are potential predators of birds, either adult birds and/or the contents of their nests. At Glen the list includes Suricate, Yellow Mongoose, Slender Mongoose *Galerella sanguinea,* Small-spotted Genet *Genetta genetta,* African Wild Cat *Felis silvestris,* Black-backed Jackal *Canis mesomelas* and Caracal *Caracal caracal.* In one exceptional case, circumstantial evidence also implicated a Bonsmara cow as responsible for the disappearance of recently hatched Spike-heeled Larks.

Various small rodents, including the Four-striped Grass Mouse *Rhabdomys pumilio*, Pygmy Mouse *Mus minutoides*, Southern Multimammate Mouse *Mastomys coucha* and Gerbil Mouse *Malacothrix typica,* are potential prey for diurnal and nocturnal predators.

Mammal species that presumably have a minimal influence on birds include the Common Duiker *Sylvicapra grimmia*, Steenbok *Raphicerus campestris* and Cape Hare *Lepus capensis.*

2.2.2 REPTILES

At Glen, the Puffadder *Bitis arietans* is the most commonly encountered snake species. Others include Cape Cobra *Naja nivea*, Striped Skaapsteker *Psammophylax tritaeniatus*, Red-lipped Snake *Crotaphopeltis hotamboeia*, Brown House Snake *Lamprophis fuliginosus*, Mole Snake *Pseudaspis cana* and Cape Wolf Snake *Lycophidion capense.* A number of these species are probable predators of bird eggs and nestlings.

The Leopard Tortoise *Geochelone pardalis* is fairly common at certain times, while the Common Terrapin *Pelomedusa subrufa* is common at the farm dam.

2.2.3 AMPHIBIANS

The species recorded at Glen include the Raucous Toad *Amietophrynus rangeri*, Bubbling Kassina *Kassina senegalensis*, Boettger's Caco *Cacosternum boettgeri*, Giant Bullfrog *Pyxicephalus adspersus* and Tremolo Sand Frog *Tomopterna cryptotis.* Recently, individuals of these species (all except the Raucous Toad) were found impaled on fences and on the thorns of acacia trees. This was most probably the work of the Common Fiscal R732.

2.2.4 ARTHROPODS

Insects constitute the major food source for many of the birds at Glen. In general, grasshoppers (Orthoptera) are one of the most common insects which are readily available for a relatively long time each year. Others such as mantids (Mantodea), stick insects (Phasmtodea) and ant eggs and larvae (Hymenoptera) are also fairly common, but more seasonal in occurrence than grasshoppers. The occurrence of Lepidoptera, particularly their larvae, is even more seasonal.

In general, insects are least available during the cooler times of the year. Fortunately, snouted harvester termites of the genus *Trinervitermes* (Isoptera) do sometimes become available at these times. These termites construct domed mounds which are a few tens of centimetres high with a thin but hard outer shell, too tough for most (any?) bird to penetrate under normal circumstances. Birds gain access to the termites under at least three circumstances (see also Figure 2.10):

1. The outer shell gets damaged, typically by Aardvark or Aardwolf. The Ant-eating Chat and Eastern Clapper Lark are known to associate with one or both of these mammals during their feeding forays (Anderson 1992; Taylor & Skinner 2001; Vernon & Dean 1988). At Glen, various bird species exploit newly damaged mounds for a day or more after damage was inflicted. Skead (1974b) recorded 16 bird species that fed on termites exposed when their mounds were destroyed for the construction of a tennis court;

2. During mound construction — typically after rain — when birds, including Eastern Clapper Lark and Ant-eating Chat, can easily penetrate damp building areas. Skead (1974b) recorded this behaviour for the White-browed Sparrow-Weaver R799;

3. When the termites wander outside the safety of the mound during the day, typically during the last few months before the rains start. This phenomenon may be particularly important at a time in the annual cycle of birds when food is relatively scarce. At Glen, no less than 24 bird species have been recorded to utilise this source of food (Table 2.1).

It is noted that the Northern Harvester Termite *Hodotermes mossambicus* is scarce at Glen, but no doubt favoured when available (see also Stenkewitz & Kamler 2008).

Other invertebrates which may be important as a source of food include spiders (Araneae) and sunspiders (Solifugae).

2.3 Abiotic variables

2.3.1 DAY-LENGTH

In this thesis day-length is defined as the time between sunrise (*i.e.* when the sun first becomes visible above the eastern horizon) and sunset (*i.e.* when the sun disappears below the western horizon), both measured to the nearest 10 seconds. Due to the undulating topography of the study area and the eastern horizon, the latter including hills (Fig. 2.5), the time of physical sunrise for any particular day may vary by a few minutes for different parts of the study area. In order to be consistent, the time of sunrise was always recorded from the water manger in the trampled area. Of the 365 days per year, sunrise times were recorded for 212 days (58.1%), with the time of sunrise interpolated for the remaining days.

Sunset was always recorded approximately 300 metres west of the trampled area at the zinc dam, from where the distant western horizon appears essentially flat (Fig. 2.4; Fig. 2.11). In certain parts of the study area physical sunset occurred a few minutes earlier than that recorded for the zinc dam. Of the 365 days in a year, the time of sunset was recorded for 176 days (48.2%), with the time of sunset interpolated for the remaining days.

Figure 2.10: *Trinervitermes* termite mounts and their utilisation by birds. Birds gain access to the *Trinervitermes* termites in their mounts in at least three ways: 1) When the outer shell gets damaged, typically by Aardvark or Aardwolf, the main picture showing an Eastern Clapper Lark R495 foraging on exposed/injured/dead termites at one such mount; 2) During mount construction, the picture top-left showing a freshly disturbed area caused by an Eastern Clapper Lark; 3) When the termites wander outside the safety of the mount during the day — typically occurring during the last few months before the first rains of the season — the picture bottom-right illustrating a hole made by the termites that renders them vulnerable to predation.

Table 2.1: Bird species recorded feeding on *Trinervitermes* spp. termites at undamaged mounds at Glen.

R193 Orange River Francolin	R515 Chestnut-backed Sparrowlark	R716 African Pipit
R239 Northern Black Korhaan	R516 Grey-backed Sparrowlark	R717 Long-billed Pipit
R255 Crowned Lapwing	R591 Sickle-winged Chat	R727 Cape Longclaw
R301 Double-banded Courser	R595 Ant-eating Chat	R760 Wattled Starling
R492 Melodious Lark	R596 African Stonechat	R824 Southern Red Bishop
R494 Rufous-naped Lark	R665 Desert Cisticola	R832 Long-tailed Widowbird
R495 Eastern Clapper Lark	R666 Cloud Cisticola	R852 African Quailfinch
R506 Spike-heeled Lark	R685 Black-chested Prinia	R856 Red-headed Finch

Figure 2.11: A view of the essentially flat western horizon from the zinc dam situated on a rise west of the study area at Glen. See also Figure 2.4.

Day-length was calculated by subtracting the time of sunrise from the time of sunset. Due mainly to the uneven topography in the east (Fig. 2.5), the resulting change in day-length curve was not smooth enough for the purposes it was needed for, *i.e.* the classification of seasons (see below). Consequently, the *splineDesign* function in the R package *splines* (R Development Core Team 2008) was used to obtain a smooth day-length curve from which the change in day-length was calculated for each day of the year. The result is shown in Figure 2.12.

Day-length ranged from 13.9 hours in December to 10.2 hours in June, with the change in day-length at its minimum during these two periods (Fig. 2.12). At a rate of minus 109 seconds per day, the change in day-length was at its minimum in March and reached its maximum of 108 seconds per day in September (Fig. 2.12).

2.3.2 SEASONS

While climate diagrams are useful for the identification of zono-biomes and the distinction of relatively humid and dry periods (Walter 1979), its use for the classification of wet and dry seasons (*e.g.* Anderson 1988; Kok 1999; Skead 1974b; Vrahimis 1990) or conventional seasons (summer, winter, *etc.*; *e.g.* Van Aswegen 1994) are problematic. Consider, for example, the climate diagram of a relatively arid area (*e.g.* Kenhardt in the Northern Cape Province) or a relatively humid area (*e.g.* East London in the Eastern Cape Province) where the whole year is classified as a dry and wet season respectively (Walter *et al.* 1975). In addition, the actual monthly rainfall during the study period may be very different from the long-term average values. Significant annual variation in the primary components of the climate diagram, especially rainfall, may also lead to inconsistency in the classification of seasons. Another frequently used strategy is to group data by month. While this may be sufficient to investigate temporal changes through the year, it tends to divert attention away from a potentially important environmental cue, namely changes in day-length.

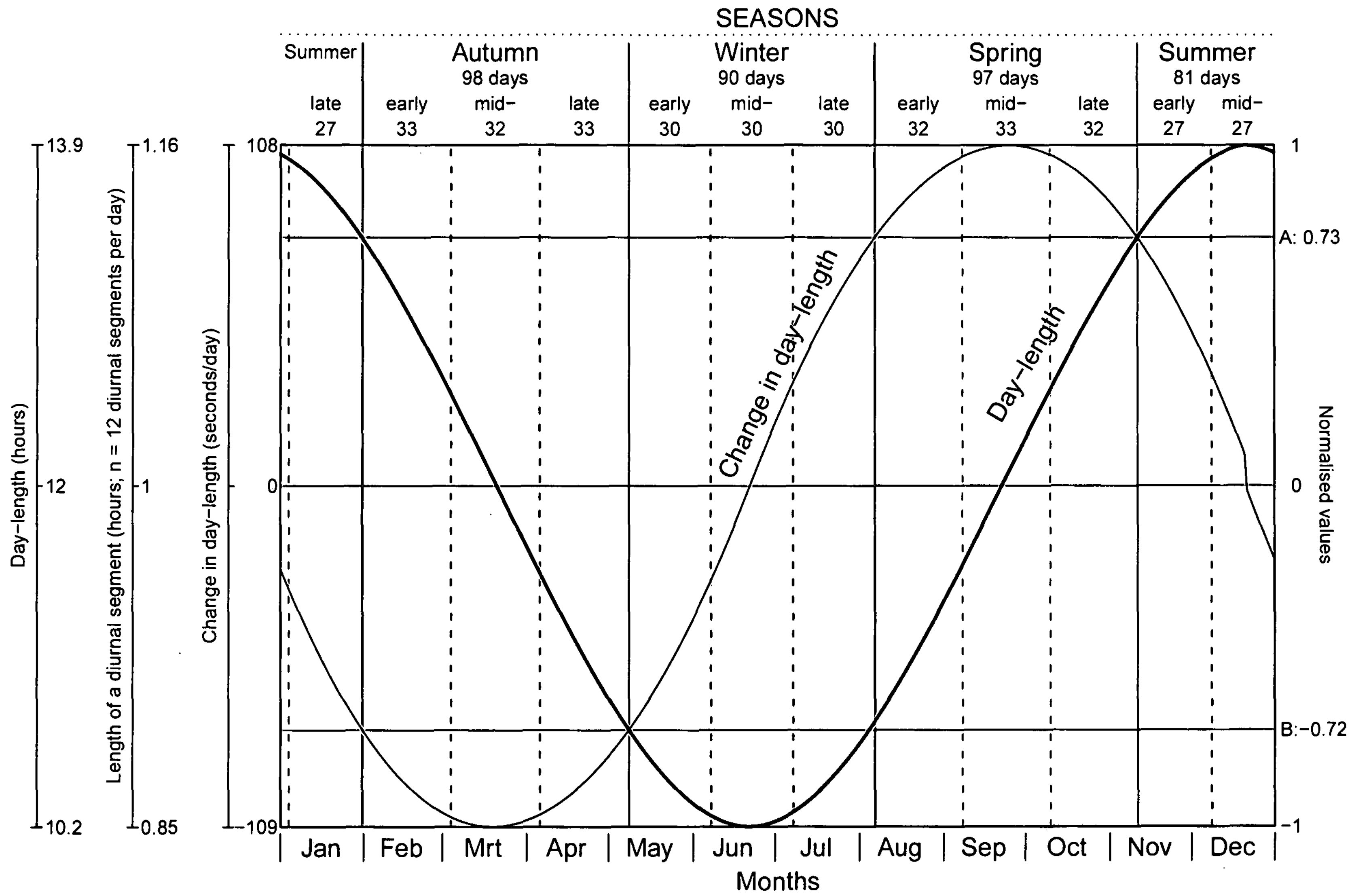


Figure 2.12: Day-length season classification diagram. The normalised day-length curve and the normalised change in day-length curve are superimposed with the x-axis ranging from 1 January to 31 December. In addition to the normalised values on the right y-axis, the absolute values of the following three parameters are given on the left y-axis: day-length in hours; length of a diurnal segment in hours (segments are explained on page 121); change in day-length in seconds per day.

In this thesis day-length is used as the primary criterion for the classification of seasons, thereby providing an effective way of investigating the influence of day-length on activity patterns. The specific method used, a refined version of an earlier attempt by Van Niekerk (2000), is explained below.

The day-length season classification diagram in Figure 2.12 shows the normalised day-length curve superimposed on the normalised change in day-length curve. The start of summer and winter was taken at the points where the day-length and change in day-length curves intersect at normalised values A and B (Fig. 2.12). The start and end dates of spring and autumn were then defined as the points where the change in day-length curve intersects values A and B (Fig. 2.12). According to this classification system, summer is the time of year with the longest days, autumn the season during which day-length decreases most rapidly, winter the interval with the shortest days and spring the period during which day-length increases are most marked; summer and winter represent periods during which day-length are comparatively stable (Fig. 2.12). Each season was divided into three equal length parts, termed early, mid- and late respectively, resulting in a total of $12 = 4 \times 3$ seasons (Fig. 2.12). The following conventions are adopted in this thesis regarding seasons:

- Square brackets are used to indicate the approximate seasonal equivalent of months. For example, "...September to December [mid-spring – mid-summer]..." means that the period from September to December is equivalent to the seasons from mid-spring to mid-summer, inclusive. This translation is approximate because the borders of seasons fall in various parts of the respective months (Fig. 2.12).

- Seasons included in quotes, *e.g.* "summer" or "...summer...", always refer to the use of these terms in other works where it typically has an undefined, broader and often vaguer meaning than that employed in this thesis.

2.3.3 RAINFALL

In the previous section it was shown how day-length was used to define 12 seasons (Fig. 2.12). The seasonal occurrence of rainfall, in turn, was used to define the beginning of a year, with the year boundary taken at the mid-point of the dry season, which in the present study fits neatly in between mid-winter and late winter (see below). Hence a year in this thesis starts with late winter, continues through spring, summer, autumn and early winter, and ends with mid-winter. Thus, each year spans part of two conventional years. For example, the first year of the present study started in late winter 1997 and ended in mid-winter 1998 (see Fig. 2.12) and is denoted as the year "1997/8" in the text. Similarly, the second year is noted as "1998/9", the third as "1999/0", the fourth as "2000/1", *etc.*

For species that are mainly active/present during the cooler parts of the year, here called '**cool-season birds/species**' (as opposed to '**warm-season birds/species**'), a year is defined as starting in late summer and terminating in mid-summer. The first year for the African Stonechat R596, for example, begins with late summer 1998 and ends in mid-summer 1998 (mid-summer extends only marginally into January 1999), and is simply referred to as the year "1998" (see Fig. 2.12). Likewise, its second year is 1999, the third year 2000, *etc.* It follows that the 'yyyy' notation (*e.g.* 1999) automatically implies cool-season species and 'yyyy/y' (*e.g.* 1999/0) warm-season species.

2.3.3.1 Glen weather station

Annual rainfall data, going all the way back to 1922/3, from the weather station at Glen Agricultural College situated approximately 5 km from the study area is shown in Figure 2.13. Overall, annual precipitation varied from 274 mm (1972/3) to 1 077 mm (1987/8; see Roos & Roos 1988 for details on this exceptional rain year), with a mean of 543.4 mm and median slightly less at 526.2 mm (Fig. 2.13).

The two years preceding the present study, 1995/6 and 1996/7, experienced relatively high rainfall, with that of the latter year higher than that of any of the 11 study years (Fig. 2.13).

Comparing the 11 study years (1997/8 – 2007/8), 2005/6 received the highest rainfall, being the only year within the upper 25% of rain years overall (Fig. 2.13). The rainfall of seven years falls within the middle 50% of rain years overall, with 1997/8, 2001/2 and 2007/8 receiving above average and 1998/9, 1999/0, 2002/3 and 2006/7 below average rainfall (Fig. 2.13). The rainfall of the years 2000/1, 2003/4 (lowest) and 2004/5 falls within the lower 25% of rain years overall (Fig. 2.13).

Rainfall was relatively high from late spring to mid-autumn, particularly during the last three seasons of that period (Fig. 2.14◧).[3] A similar pattern is seen when the proportion of days with rain is considered (Fig. 2.14□■□). Daily rainfall was usually less than 10 mm — with these days constituting approximately three quarters of all rain days (Fig. 2.14◨; Fig. 2.15) — and relatively higher from late spring to mid-autumn than during winter (Fig. 2.14◨). The period from late spring to mid-autumn is henceforth termed the **main rain period**.

The seasonal timing of rainfall was highly variable between the respective years (Fig. 2.16). For example, in 1997/8 rainfall occurred mainly from mid-summer to mid-autumn, but the following year little rain fell during autumn (Fig. 2.16). Nonetheless, cluster analysis suggests a degree of similarity between certain groups of years (Fig. 2.17). The bottom group of the dendrogram includes the five years during which rainfall occurred predominantly in the last half of the main rain period (Fig. 2.17). The six years in the top group consist of two years (2001/2 and 2006/7) which had relatively high rainfall in the beginning of the main rain period with the remaining four years (1998/9, 1999/8, 2000/1 and 2007/8) showing a more even spread of rainfall throughout the main rain period (Fig. 2.17).

During the main rain period, rainfall was most variable at its beginning in late spring and at its end in early and mid-autumn, and least variable during early and mid-summer (Fig. 2.18; note CV values). Seasons and years during which exceptionally high rainfall occurred include early spring 2002/3, late spring 2001/2 and 2006/7, and early autumn 1997/8 and 2005/6 (Fig. 2.18).

Cluster analysis further highlights the contrast between the main rain period and the rest of the year (Fig. 2.19). Within the main rain period, early and mid-autumn form a group of their own (Fig. 2.19). For seasons outside the main rain period, mid-spring and late autumn form a cluster of their own, reflecting the fact that these two seasons, which respectively precede and follow the main rain period, had fair amounts of rainfall in most years compared to early spring

[3]See page 130 for an introduction to box-and-whisker plots.

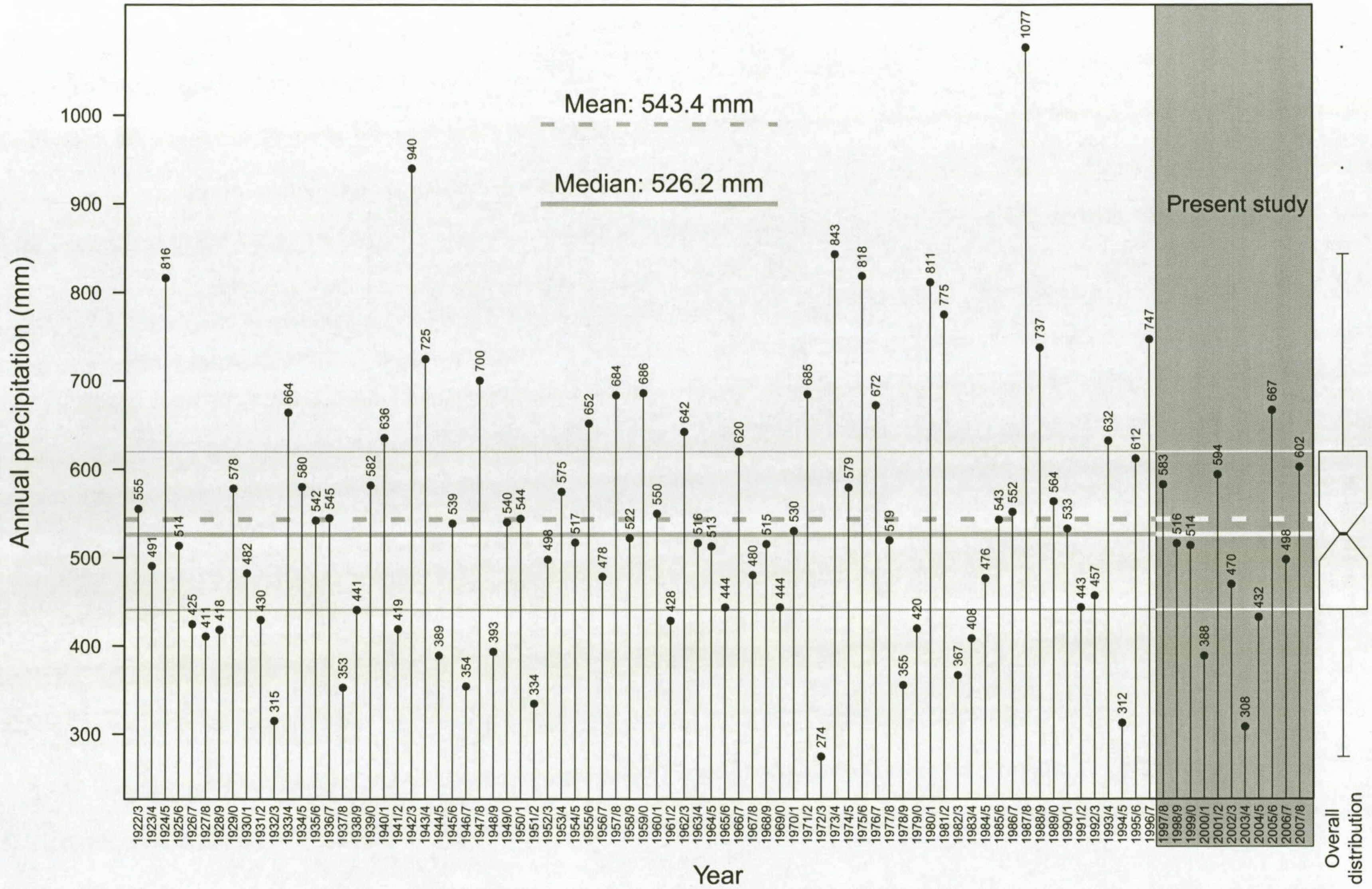


Figure 2.13: Annual precipitation recorded at the weather station at Glen since 1922/3. The 11-year study period is highlighted with overall statistics displayed to the right.

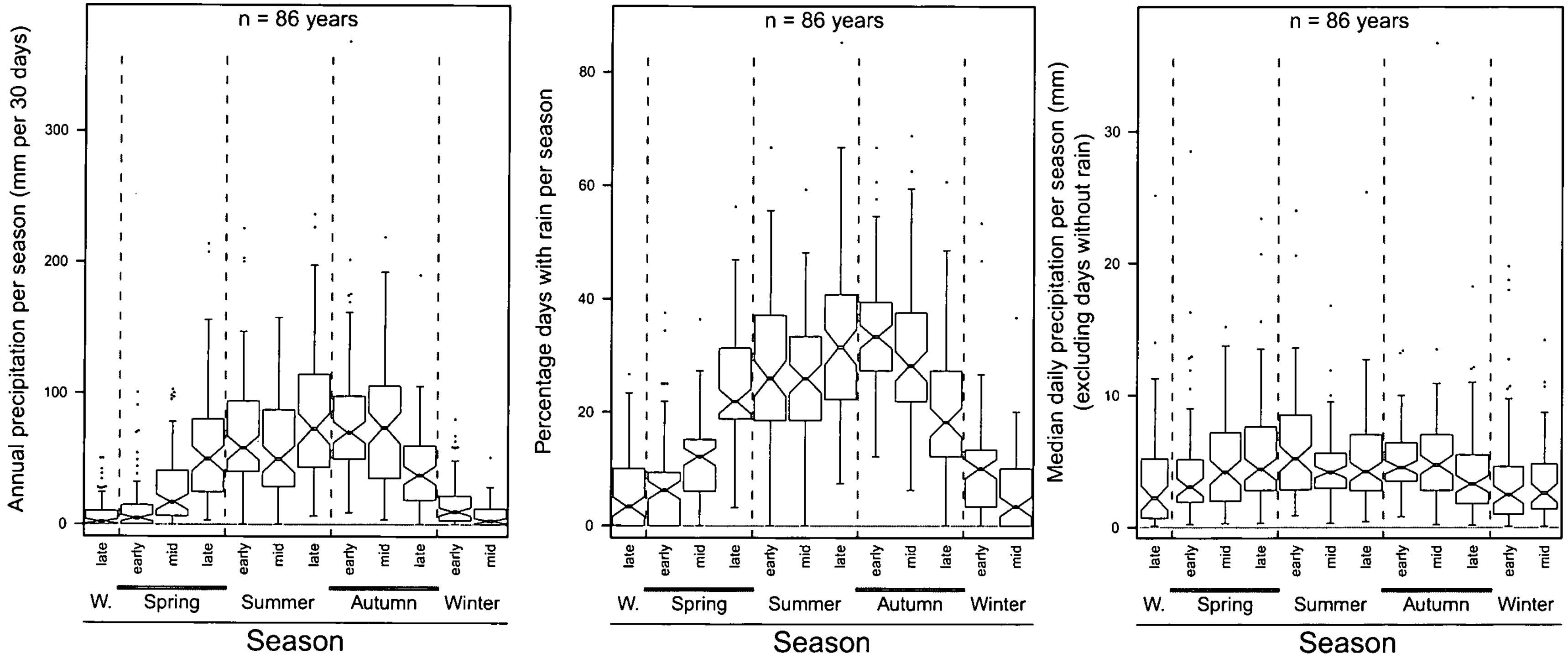


Figure 2.14: Seasonal variation in rainfall since 1922/3 based on data from the weather station at Glen.

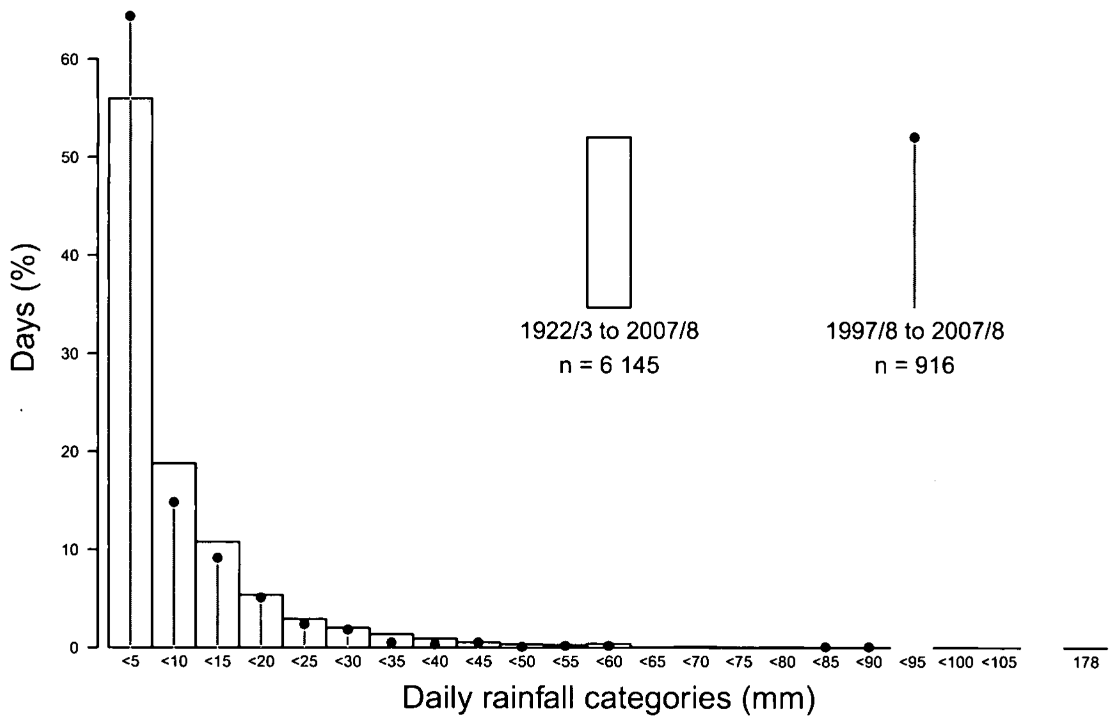


Figure 2.15: Frequency occurrence of different daily rainfall categories based on data from the weather station at Glen.

and winter during which fair amounts of rain fell in certain years only (Fig. 2.17).

2.3.4 TEMPERATURE

2.3.4.1 Glen weather station

Minimum, mean and maximum temperatures recorded at Glen village since 1922/3 have been summarised in Figure 2.20.[4] Based on median values, temperatures follow a seasonal cycle with highest values in mid-summer, late summer and early autumn, and lowest values during winter (Fig. 2.20). The daily temperature range was less during the warmer than during the cooler seasons (Fig. 2.21).

2.3.4.2 Study area

The foregoing was based on data collected at a standard weather station at Glen village. The micro climate in which animals live is often more extreme, particularly for species spending most of their time at or near ground level. Since the beginning of the study, temperature has been recorded in the sun on the ground (T0cm) and 5 cm above ground level (T5cm). Up until mid-autumn 2003/4, these temperatures were recorded using probes connected to a data logger that was programmed to record the average temperature for every minute for each probe (scan rate per minute = 60) at an accuracy of $0.1°C$. The data logger was replaced with Thermochron

[4]Until the end of 1999 the mean was simply computed by taking the average between the minimum and maximum. Since 2000, however, the 'true' mean temperature has been recorded.

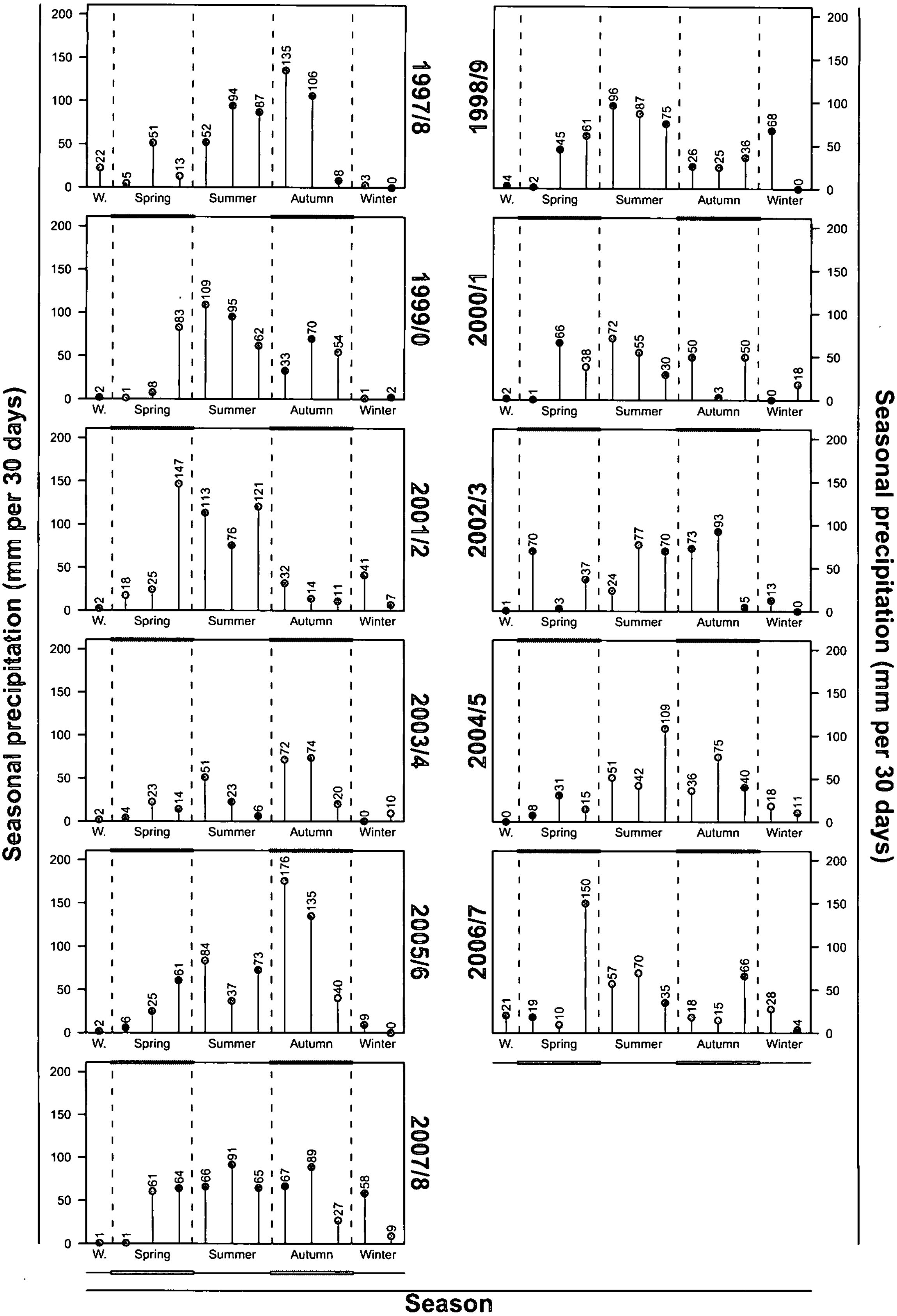


Figure 2.16: Seasonal variability in annual rainfall for the years 1997/8 to 2007/8 based on data from the weather station at Glen. See Figure 2.17 for the results of cluster analysis and Figure 2.18 for a seasonal arrangement of the data.

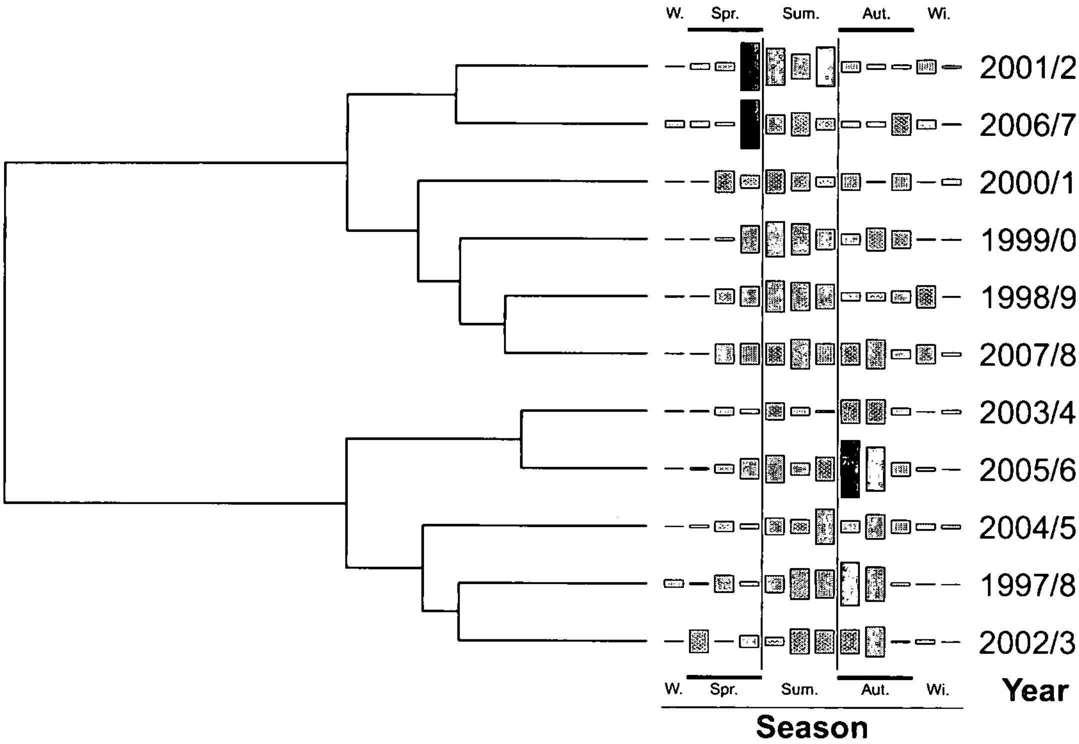


Figure 2.17: Clustering of the 11 study years at Glen based on proportional seasonal rainfall. The height and shading of the boxes in the middle part of the diagram is relative to the actual rainfall as shown in Figure 2.16. Vertical lines delineate summer.

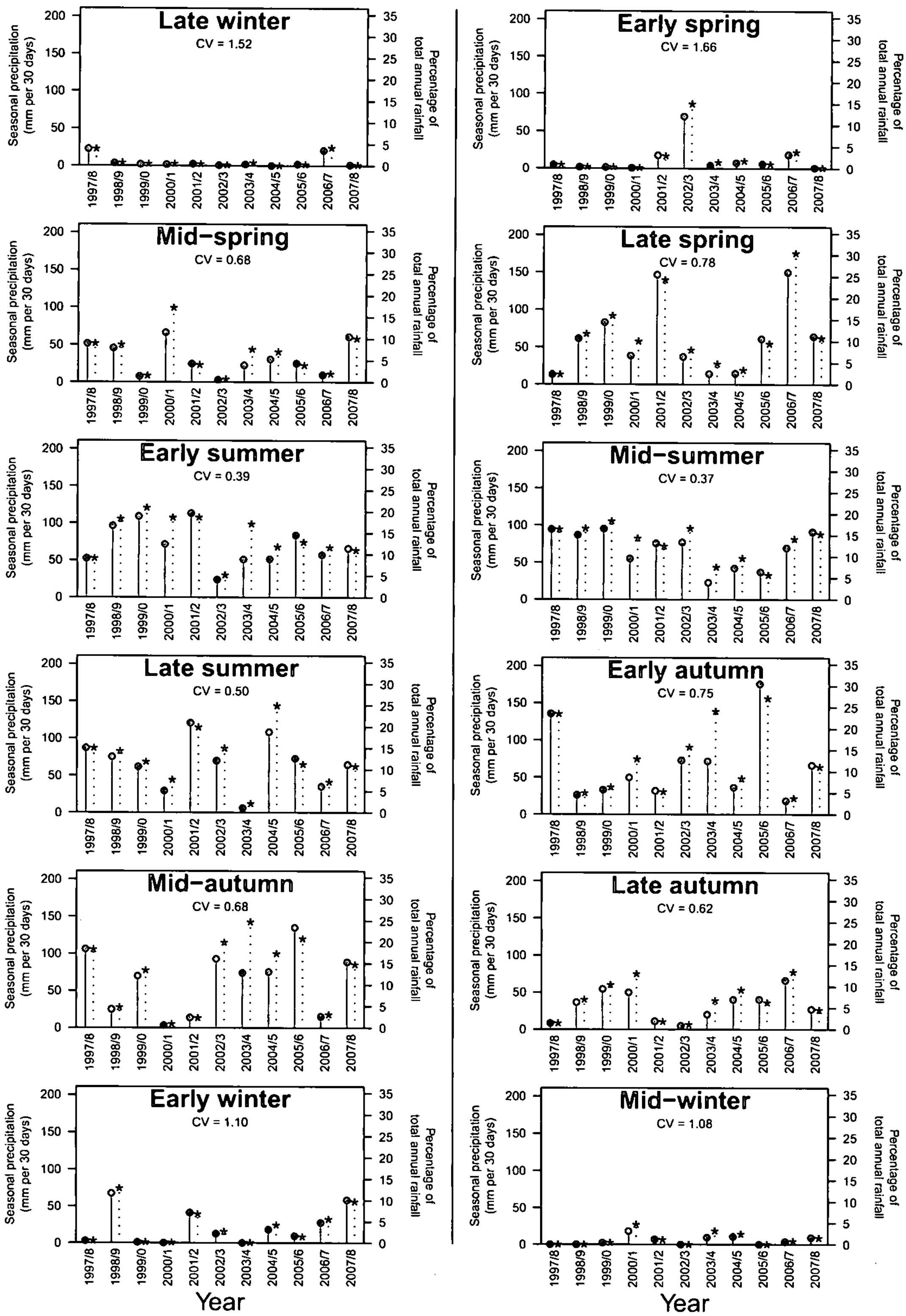


Figure 2.18: Inter annual variation in rainfall for the years 1997/8 to 2007/8 based on data from the weather station at Glen. Rainfall is indicated as mm per 30 days (solid lines and dots) as well as a percentage of annual rainfall (dotted lines with asterisks). The coefficient of variation (CV) is also indicated for each season. Based on Figure 2.16.

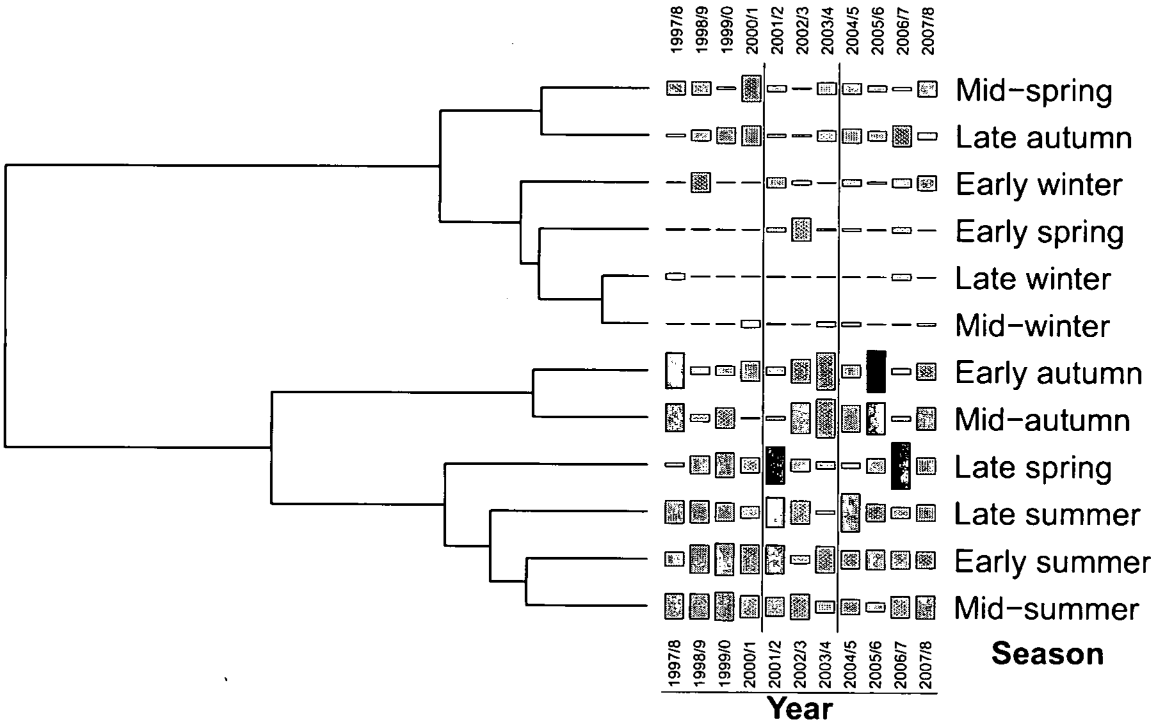


Figure 2.19: Clustering of the 12 seasons of a year based on proportional annual rainfall at Glen as per Figure 2.18. The height and shading of the boxes in the middle part of the diagram are relative to the maximum proportional rainfall. Vertical lines delineate the middle three years.

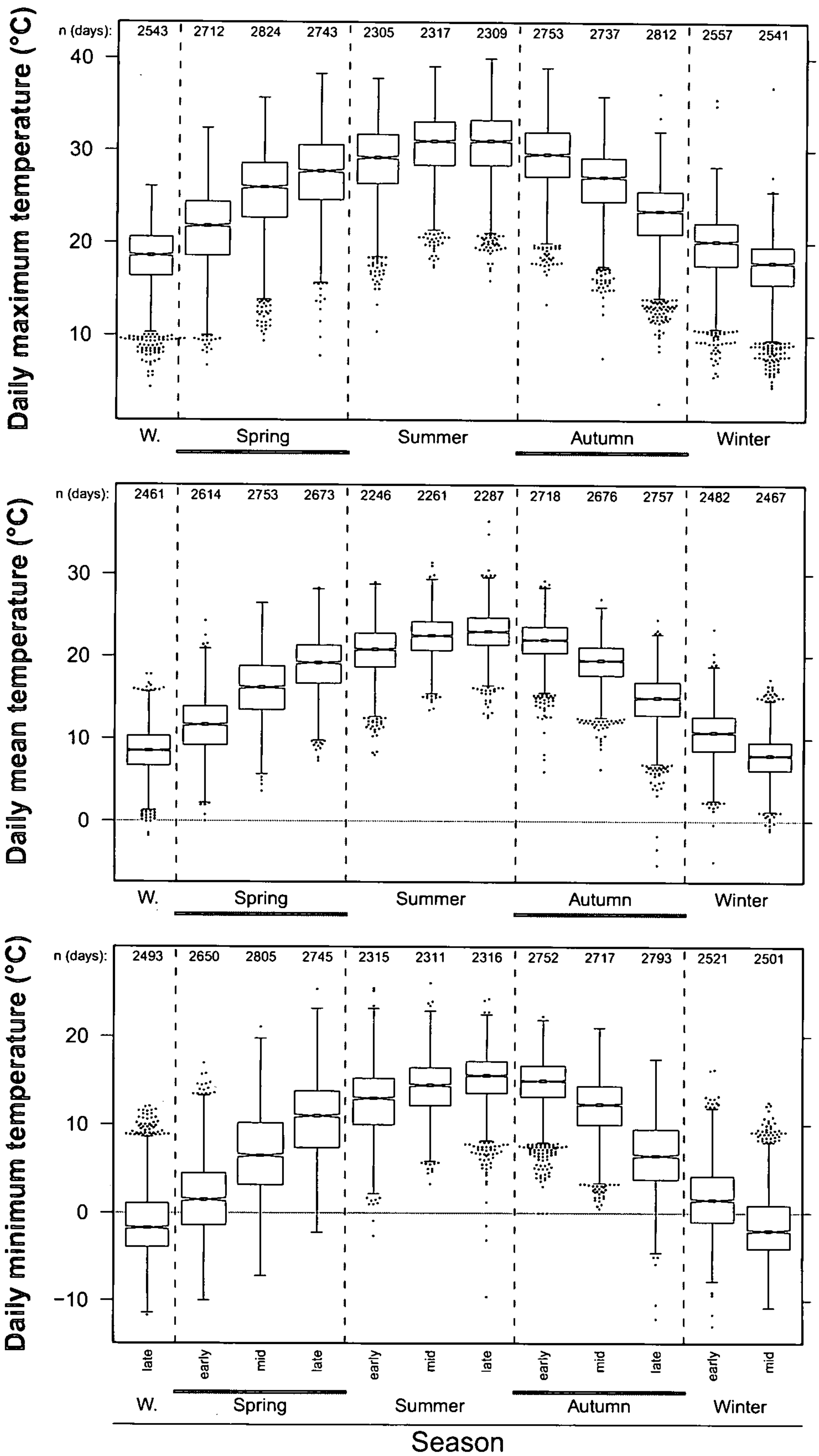


Figure 2.20: Seasonal fluctuation in minimum (bottom), mean (centre) and maximum (top) temperatures based on data from Glen weather station for the 86-year period 1922/3 to 2007/8.

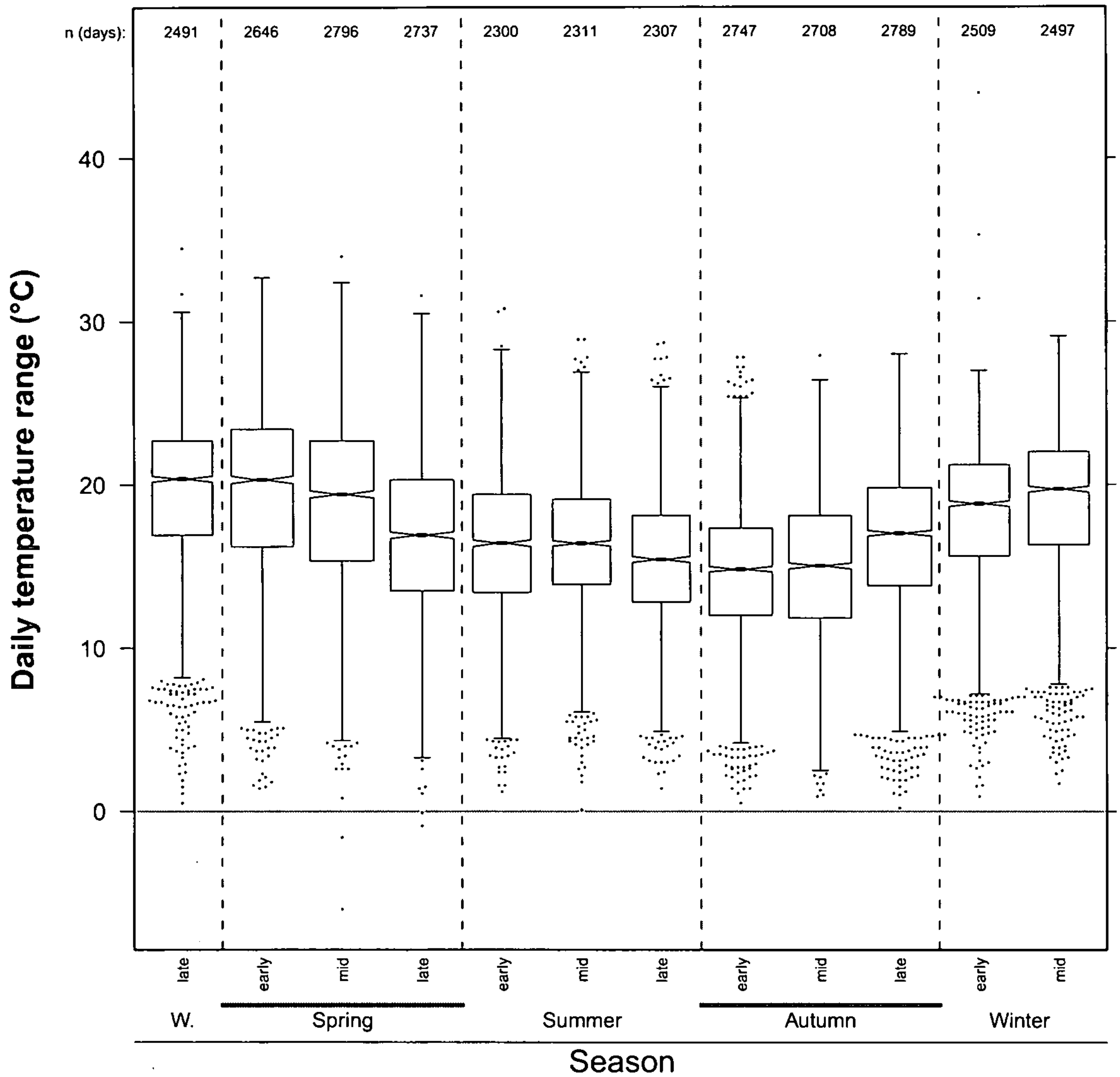


Figure 2.21: Seasonal fluctuation in daily temperature range (*maximum* – *minimum*) based on data from Glen weather station for the 86-year period 1922/3 to 2007/8.

iButtons during mid-autumn 2003/4. The iButtons record temperatures at pre-programmed intervals to an accuracy of $\pm 0.5^{\circ}C$. On observation days the iButtons were set to record the temperature every minute. In addition, since mid-autumn 2004/5, a set of iButtons was left in the veld between observations and set to record the temperature every five minutes. In the analysis no distinction is made between the data logger and iButton temperatures, with the database consisting of 1 170 552 and 1 171 326 temperature measurements for T0cm and T5cm respectively, amounting to a total of more than 2.3 million records. The focus of the current analysis is on the T5cm temperatures with its overall range shown in Figure 2.22. [Note: The remaining figures of this chapter follow from page 102].

The influence of height above ground level on temperature: During the latter part of December 2004, an experiment was conducted over a period of four days to investigate the influence of height above ground level on temperature. iButtons programmed to record the temperature for every 1 or 2 minutes was setup in the sun on the following heights above the ground: 0, 5, 10, 20, 30, 40, 60, 80 and 100 cm. For each height, the temperature difference relative to T5cm was calculated and the data grouped for each 5°C of T5cm (12.5 – 17.4; 17.5 – 22.4, *etc.*). The results are summarised in Figure 2.23.

In general, the profiles of temperatures measured from 10 to 100 cm above ground level were similar to one another, becoming progressively cooler relative to T5cm at higher temperatures (Fig. 2.23). The temperature difference at the highest temperatures was in the order of approximately 6°C. Temperatures on the ground show the opposite pattern, becoming progressively warmer than T5cm at higher temperatures (Fig. 2.23). These results indicate that there exists a notable temperature gradient within the first 10 cm from the ground, but not much above that height.

Seasonal variation in T5cm temperatures: Seasonal variation in average segment-temperatures during the night and day respectively is shown in Figure 2.24. The median average nighttime temperature was lowest during mid- and late winter (median *ca.* $2^{\circ}C$) and highest during late summer and early autumn (median *ca.* $18^{\circ}C$), with sub-zero temperatures occurring during winter and early spring (Fig. 2.24■□). Temperatures during the day were again at their lowest during winter (medians *ca.* $20^{\circ}C$) and highest during summer and early autumn (medians *ca.* $33^{\circ}C$) (Fig. 2.24□■).

A summary of the seasonal variation in minimum and maximum temperatures is shown in Figure 2.25. Daily minimum temperature was lowest during mid- and late winter (medians *ca.* $-2^{\circ}C$) and highest during late summer and early autumn (medians *ca.* $15^{\circ}C$) (Fig. 2.25⬓). Daily maximum temperatures showed a similar trend with median values during winter in the upper 20s, and in the low 40s during summer and early autumn (Fig. 2.25⬒). With a median value of approximately $28^{\circ}C$, the daily temperature range was similar for all seasons (Fig. 2.25◘).

Daily variation in T5cm temperatures: Seasonal variation in average segment-temperature is shown in Figure 2.26. It further illustrates the facts already discussed in the previous section regarding minimum and maximum temperatures. In addition, it introduces more detail regarding daily variation in temperature, further elaborated on below.

The general daily pattern shown in Figure 2.26 intuitively makes sense and could be summarised as follows (see exceptions below): After sunset temperatures decrease through the night to reach a minimum shortly before sunrise (segment −1; Fig. 2.26; Fig. 2.27). After sunrise temperatures increase and peak around or just after midday (segments 7/8; Fig. 2.26; Fig. 2.27). The midday temperature peak is followed by a temperature decrease towards sunset (Fig. 2.26). These patterns are similar irrespective of season (Fig. 2.26; Fig. 2.28).

There are, however, subtle differences between the seasons. Figure 2.28 reveals that from mid-winter to mid-spring the daily temperature maximum occurred during segments 7 or 8 on 82.9–86.4% of the days. By contrast, the comparable values for the period from late spring to mid-autumn range from only 59.8% (early autumn) to 71.3% (Fig. 2.28). The daily temperature minimum occurred during the last three segments before sunrise (segments -3, -2 and -1) on more than 70% of the days during all seasons except mid- and late summer when it occurred slightly less frequently (Fig. 2.28).

Another way of analysing the daily fluctuation in temperature is to examine the difference in temperatures between consecutive segments. Considering only median values, nighttime segments show the greatest rate of temperature decrease in the early evening (Fig. 2.29). After sunrise temperature increase peaks in going from S1 to S2 (Fig. 2.29). This is followed by a gradually diminishing temperature increase rate in consecutive segments, which reaches a plateau when temperature is constant between segments 7 and 8 (Fig. 2.29). This, in turn, is followed by a progressive increase in the rate of temperature decrease between consecutive segments, reaching a maximum between segment 11 and 12 and segment 12 and the first segment after sunset (Fig. 2.29).

The median values of each season indicate a similar trend to that illustrated above (*cf.* Figs. 2.29 & 2.30). However, there are two notable exceptions. The first of these relates to the relative magnitude of difference between S2 and S3 as compared to that between segments S1 and S2. Compared to other segment pairs, S1 and S2 usually had the highest median value, most notably from late autumn to mid-spring (Fig. 2.30). However, by late summer / early autumn the medians are similar (Fig. 2.30).

The second notable exception relates to the relative difference between segment pairs S11–S12 and S12–S-12. Whereas the median value of the former is usually higher than the latter during winter, it becomes the opposite during late summer, early and mid-autumn (Fig. 2.30).

Comparing the inter-quartile range among seasons, it can be seen from Figure 2.30 that the inter-quartile range — a measure of variability — at night is greater during winter than during summer (Fig. 2.30). This pattern is the reverse of what is observed after sunrise, particularly around midday, when the inter-quartile ranges are greater during summer than during winter (Fig. 2.30).

In spite of the intuitively satisfying daily patterns discussed until now, it is important to note that it was based on median values and that the actual values overlap extensively (*e.g.* nighttime temperatures). In addition, there are numerous 'outliers' (*i.e.* data points beyond the 'whiskers' in the figures) indicating 'odd' days, or at least 'odd' segment days. It is to these that we turn next.

How many days follow the classical bow shape in daily temperature? To address this question

Figure 2.29 was used to assess each segment-day. In the case of segment pairs S-1–S1 to S6–S7 their inter-quartile range was greater than zero (Fig. 2.29) and consequently a positive difference was considered 'normal'. Segment pair S7–S8 was not assessed because its median is approximately zero (Fig. 2.29), indicating that positive and negative values for this segment pair were approximately equally frequent (see also Fig. 2.27). The inter-quartile ranges of segment pairs S8–S9 to S12–S-12 were below zero and as a result negative values of these pairs were considered 'normal'. The result of the analysis is shown in Figure 2.31.

Half of the days assessed conformed 100% to the general daily temperature pattern, approximately 40% of the days differed by only one or two segment pairs and the remaining days differed for between three and seven segment pairs (Fig. 2.31■□). Days in which all segment pairs follow the 'normal' temperature pattern were most frequent from mid-winter to mid-spring and least frequent from late spring to mid-autumn (Fig. 2.31□■□). In addition, segment pairs that did not follow the normal pattern least frequently involved segment pairs around midday (Fig. 2.31□■).

2.3.5 CLOUD COVER

The influence of cloud cover on temperature is well known. During the day cloud layers reflect solar radiation from their tops, thus reducing daytime heating, and at night cloud layers reflect earth radiation from their bases, thus reducing nocturnal cooling of the earth surface (Elkins 2004).

2.3.5.1 Glen weather station

Data from the weather station at Glen village which relate most directly to cloud cover include the number of sunshine hours recorded from 1923 to 1999, and radiation measured in MJ since 2000. From a theoretical point of view, evaporation should correlate with radiation. Indeed, the data do indicate a strong monotonic and increasing relationship between these two variables (Fig. 2.32). Thus, evaporation can also be used as an index of cloud cover.

The median values for the hours of sunshine (Fig. 2.33■□), radiation (Fig. 2.33□■) as well as evaporation (Fig. 2.34) follow a cyclical pattern with highest and lowest values recorded during summer and winter respectively. These seasonal patterns are mostly a reflection of seasonal changes in day-length (see Fig. 2.12). However, seasonal changes in variability — which were least during winter (Fig. 2.33; Fig. 2.34; *cf.* inter-quartile ranges) — are at least partially explainable in terms of seasonal changes in cloud cover, with more cloud cover leading to greater variability. Thus, the data suggests that cloud cover was least during winter and greatest from late spring to early autumn, coinciding with the main rain period. Median relative humidity was lowest during spring and peaked during autumn (Fig. 2.35).

2.3.5.2 Study area

During observations cloud cover was scored on a scale from 0 (= no clouds) to 8 (= 100% cloud cover) for each 5-minute interval. Based on the overall median of average daily values, cloud cover was least during winter, early and mid-spring (Fig. 2.36■□), when the occurrence of 5-minute intervals with no clouds was also most frequent (Fig. 2.36□■). Cloud cover was highest during summer (early summer in particular) and early and mid-autumn (Fig. 2.36■□) when the occurrence of 5-minute intervals with no clouds was relatively infrequent (Fig. 2.36□■).

Seasonal changes in the daily variation of cloud cover are shown in Figure 2.37. At the beginning of the year (late winter), cloud cover is uniformly low with the upper limit of inter-quartile ranges less than two and medians mostly zero (Fig. 2.37). During spring the median cloud cover remains uniformly low throughout the day. The inter-quartile ranges, however, become larger, especially during late spring afternoons (Fig. 2.37). During summer and autumn, median cloud cover is greater in the afternoon than during the morning (Fig. 2.37). By early winter, inter-quartile ranges returned to values less than three (Fig. 2.37).

2.3.6 WIND

2.3.6.1 Glen weather station

The median wind speed values follow a cyclical pattern with a peak in late spring/early summer and reach its lowest values during late autumn and winter (Fig. 2.38).

2.3.6.2 Study area

For each 5-minute interval, wind was scored on a scale from one (little or no wind) to five (strong wind). Based on the median of daily values, wind speed followed a cyclical seasonal trend with a peak in early summer and lowest values during winter (Fig. 2.39■□). Considering 5-minute intervals, the incidence of no or little wind was least frequent during late spring and (particularly early) summer (Fig. 2.39□■).

Generally speaking, median wind speed was less during the earlier parts of the morning than later in the day (Fig. 2.40). A notable exception to this pattern is early summer, when median daily segment wind speed remains relatively high throughout the morning and early afternoon before it decreases towards sunset (Fig. 2.40). During all seasons the wind speed after sunset was always less than during the rest of the day (Fig. 2.40).

2.3.7 DISCUSSION

The abiotic variables considered above are interconnected to some extent. Seasons are by definition a reflection of changes in day-length (page 85). The study area fall in the "summer" rainfall region of southern Africa with the main rain period from late spring to mid-autumn, corresponding with the time of the year when cloud cover are greatest (Fig. 2.36). As a result, the hours sunshine and radiation is also more variable (Fig. 2.33) and the occurrence of days with segment pairs with 'abnormal' values greater (Fig. 2.31) during that period. In general, cloud cover is more extensive in the afternoon than in the morning during the main rain period (Fig. 2.37). As a result, average daily segment temperatures tend to be more variable in the afternoon (Fig. 2.26) and the maximum daily temperature also tend to occur less frequently during S7 or S8 (Fig. 2.28) during the main rain period than at other times. Cloud cover (Fig. 2.36) and wind speed (Fig. 2.39) was exceptionally high during early summer.

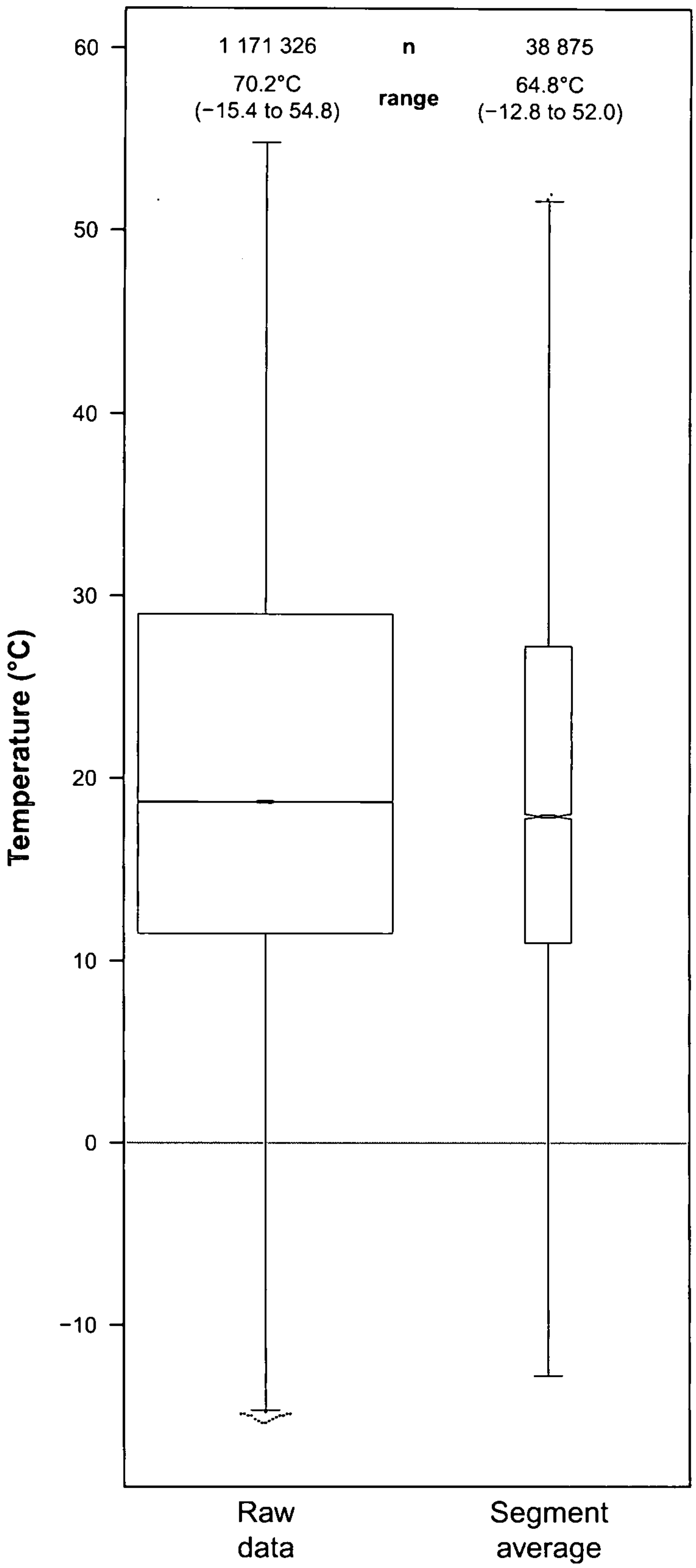


Figure 2.22: Range for temperatures measured 5 cm above the ground (T5cm) in the study area at Glen. *Left*: Individual temperature measurements; *Right*: Segment averages (segments are explained on page 121).

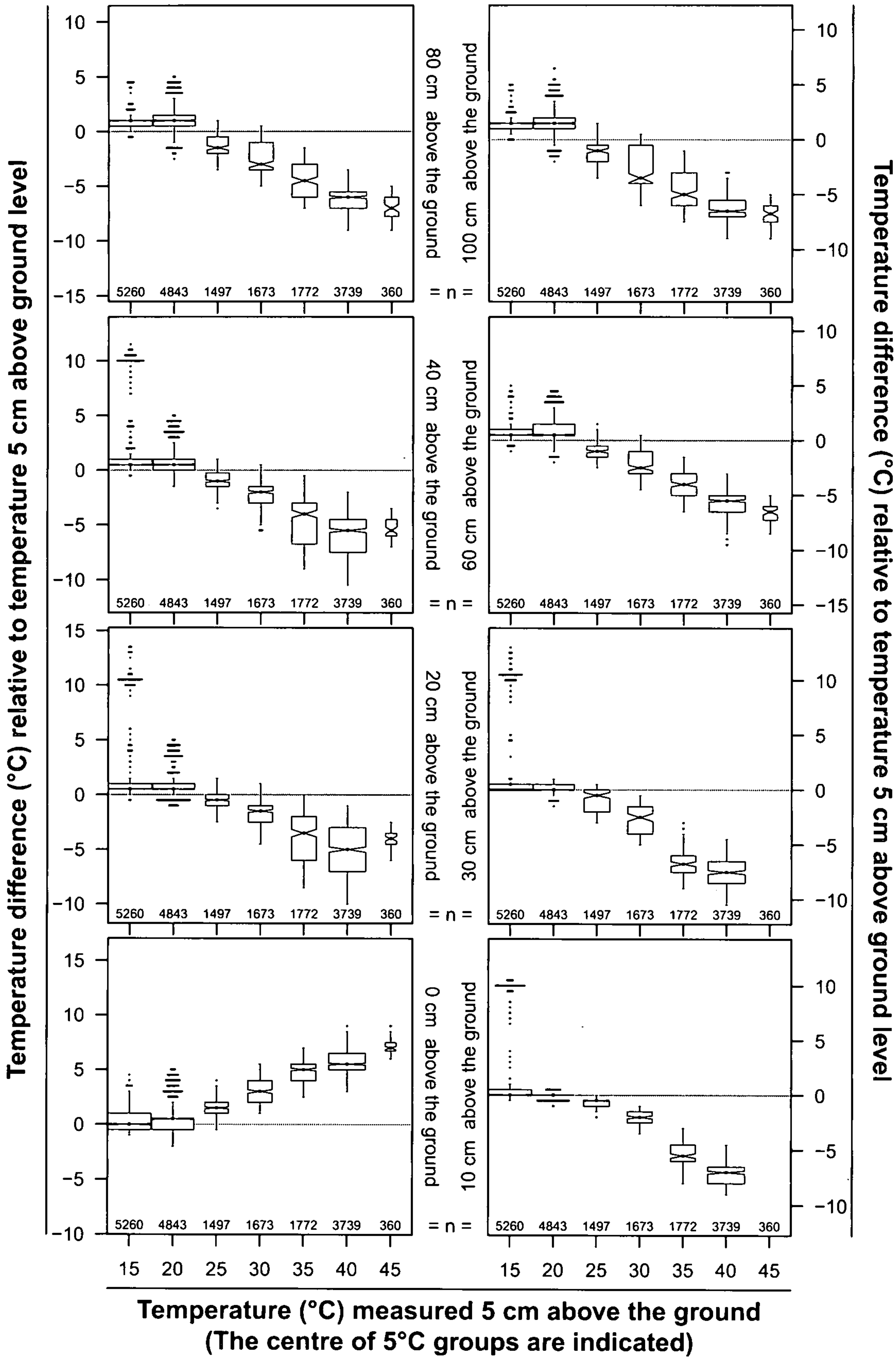


Figure 2.23: Difference between temperatures measured 5 cm above the ground and at various heights from 0 to 100 cm above the ground. The extent of the vertical scale is the same for all diagrams (27°C). Based on data collected with iButtons in the study area over four days during the latter part of December 2004.

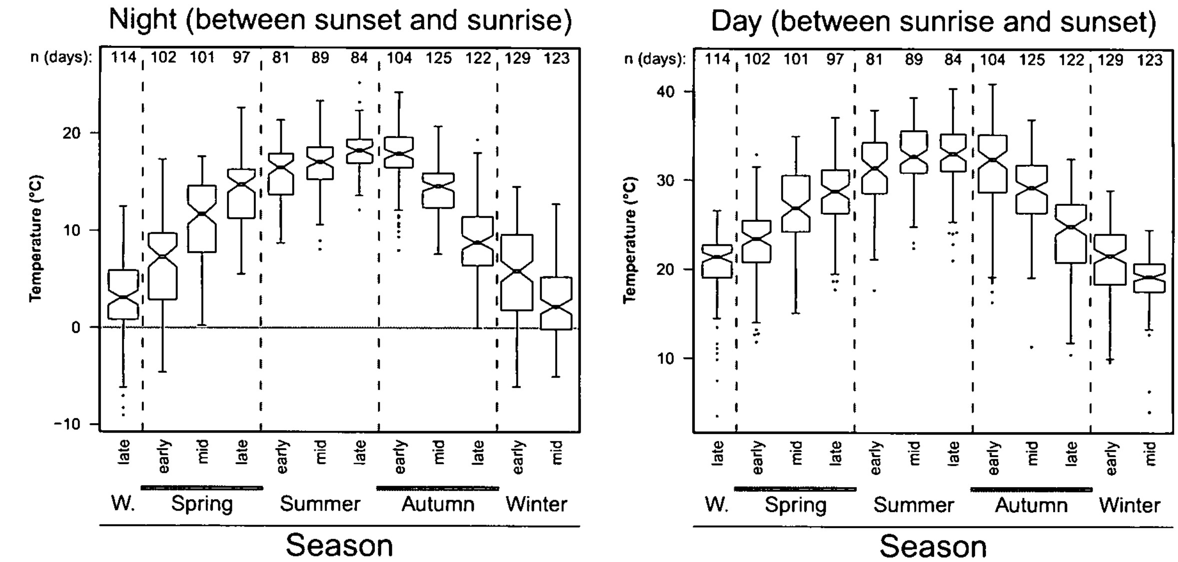


Figure 2.24: Seasonal fluctuation in average segment temperatures as measured 5 cm above ground level (T5cm) for the night (left) and day (right) in the study area at Glen.

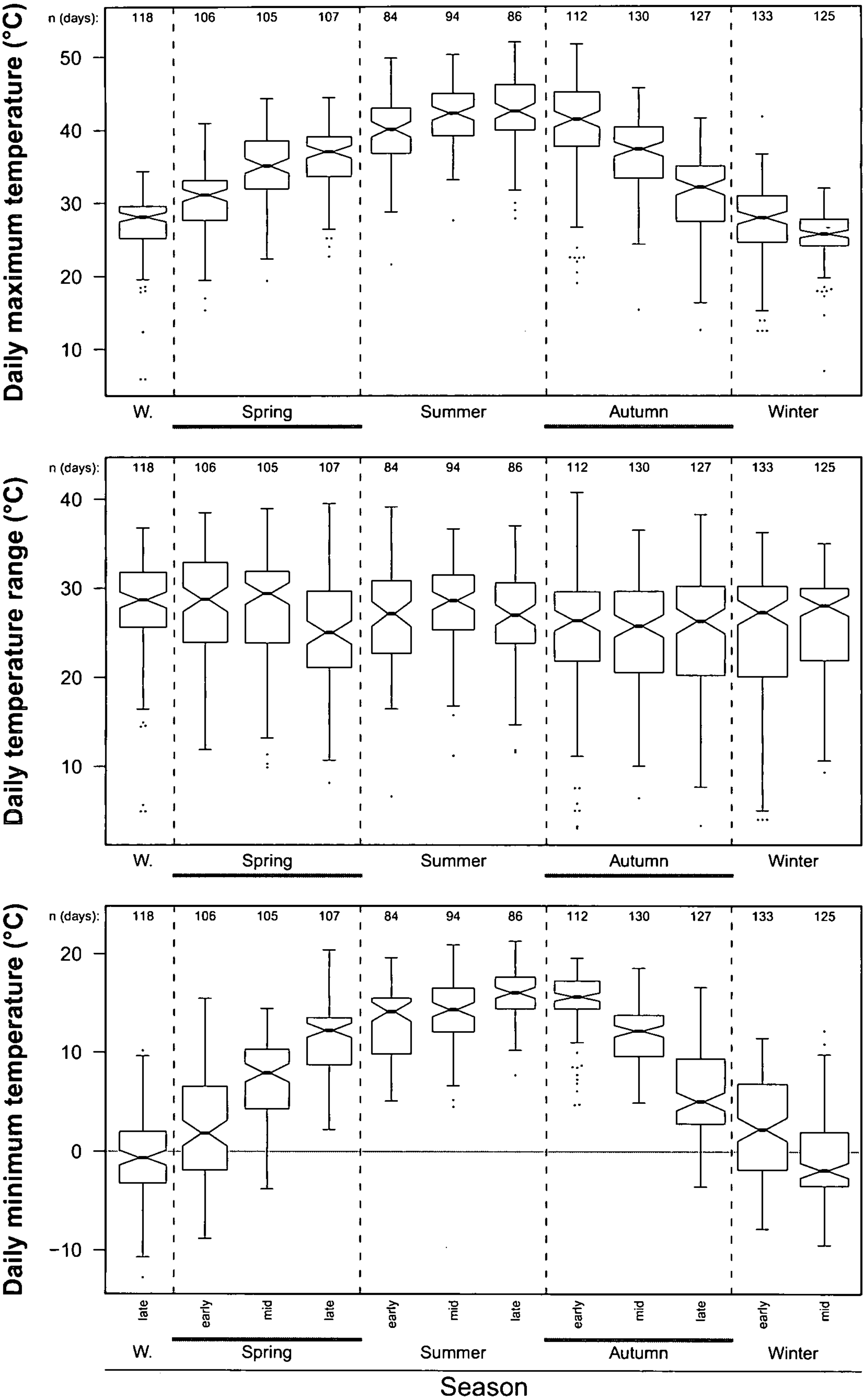


Figure 2.25: Seasonal variation in daily minimum (bottom) and maximum (top) temperatures based on average segment temperatures measured 5 cm above the ground in the study area at Glen. The daily temperature range (*maximum* – *minimum*) is also shown (centre).

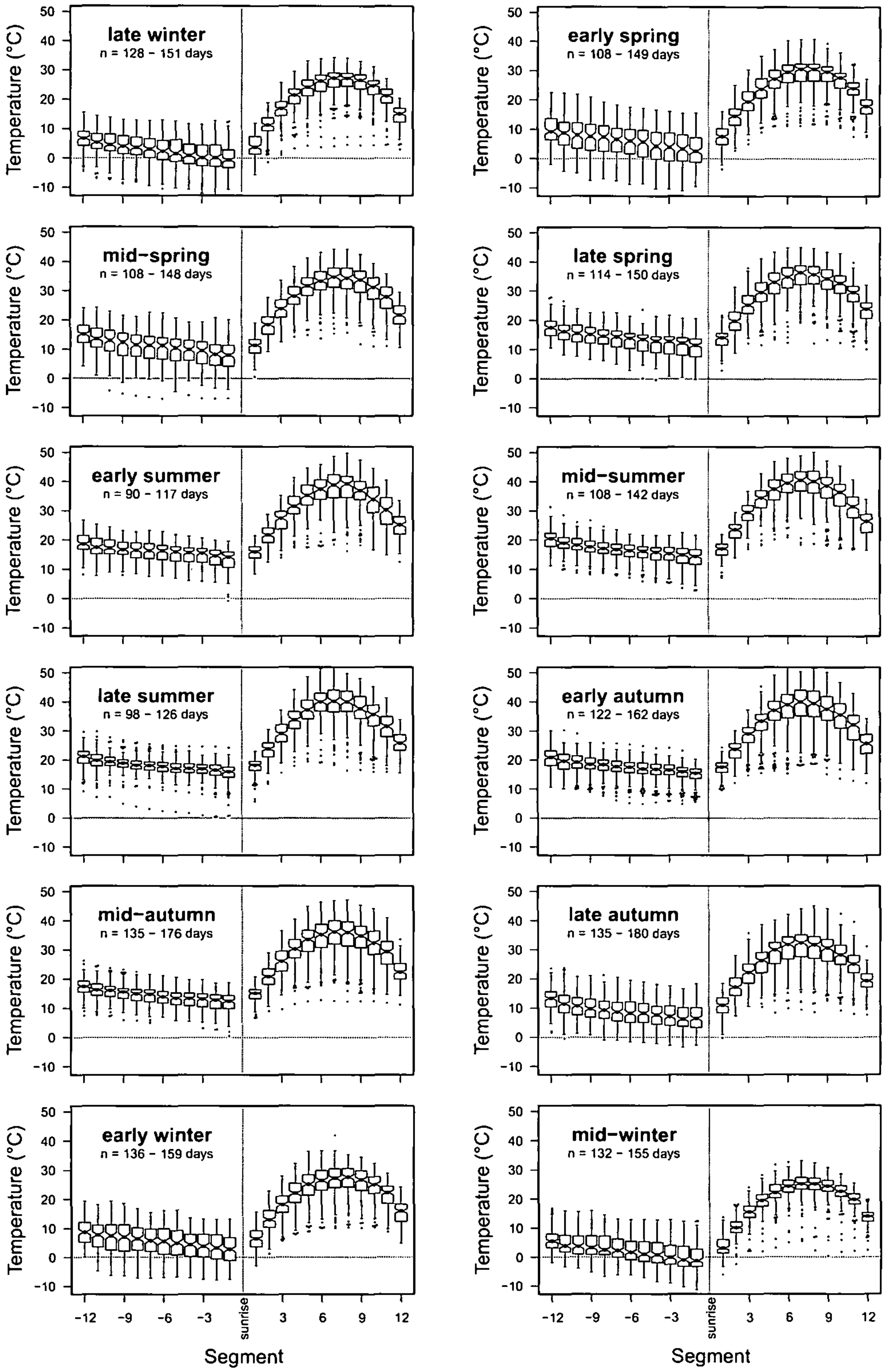


Figure 2.26: Seasonal variation in average segment temperatures measured 5 cm above the ground between consecutive sunsets at Glen. Negative segment numbers refer to 12 equal length segments between sunset and sunrise, and positive segment numbers refer to 12 equal length segments between sunrise and sunset. The last 12 segments are the same as those used elsewhere in this thesis (see page 121).

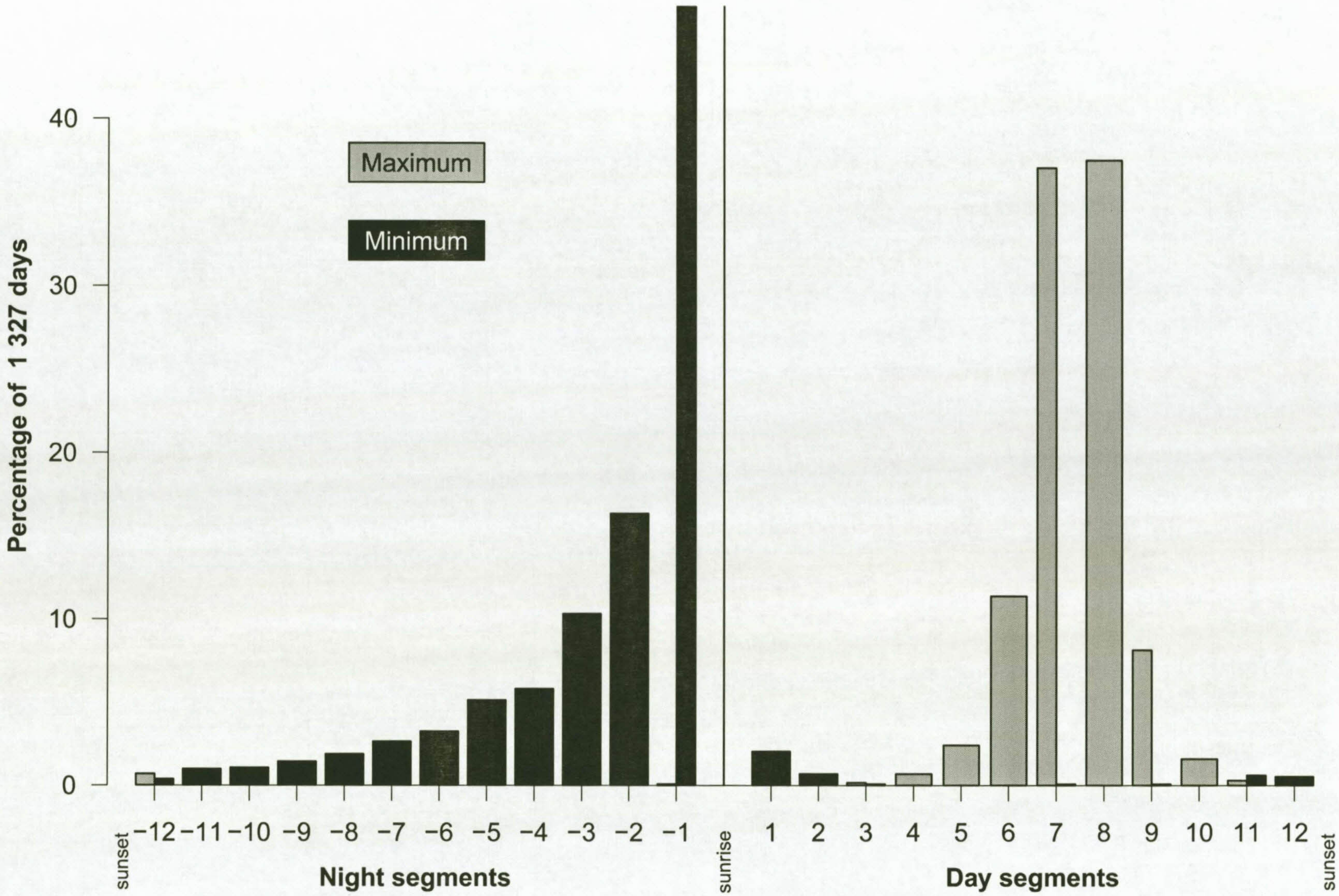


Figure 2.27: Occurrence of minimum and maximum temperatures between consecutive sunsets at Glen. Based on the average temperature measured 5 cm above the ground for each segment of the night and day.

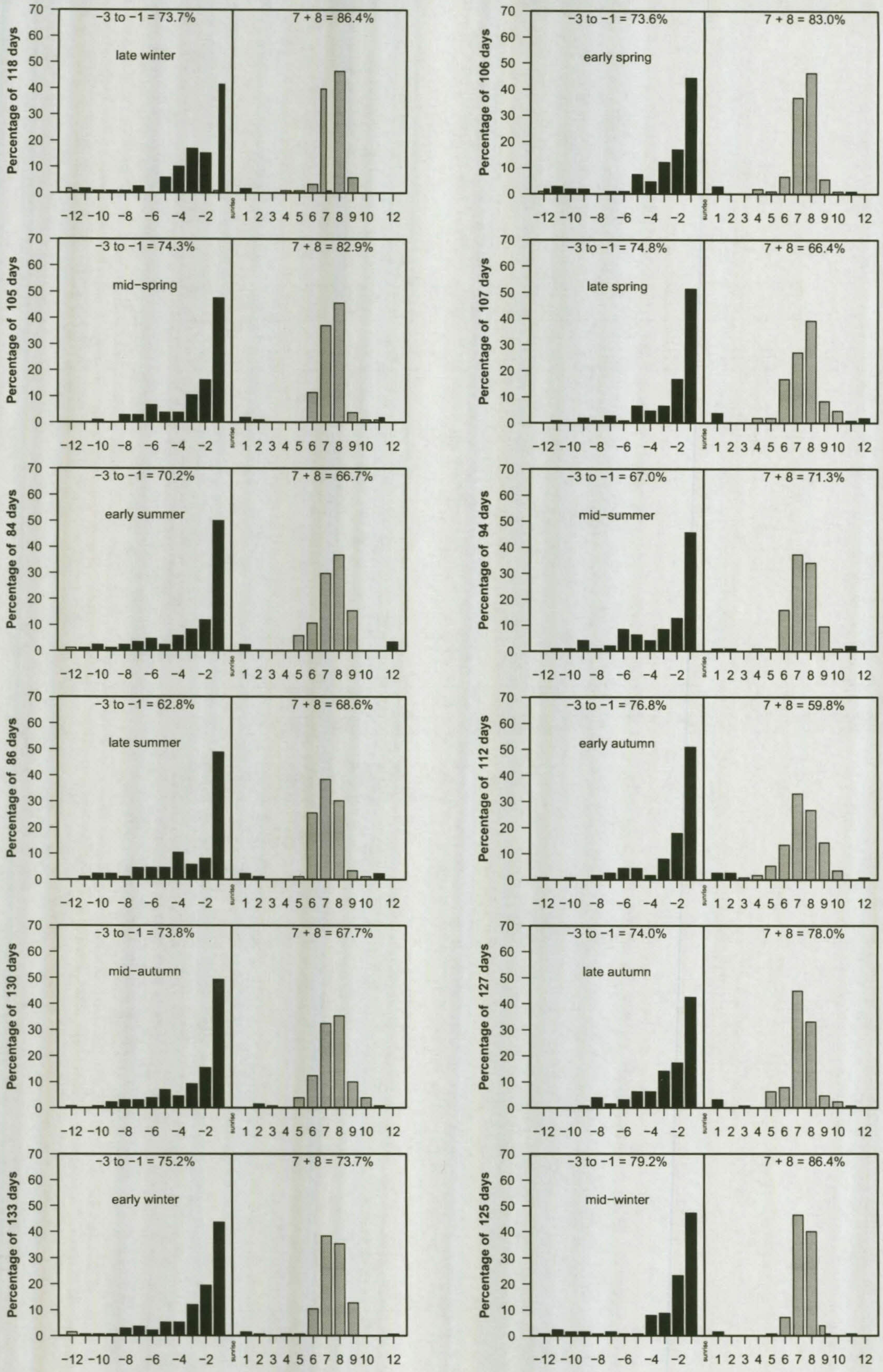


Figure 2.28: Seasonal occurrence of minimum (black) and maximum (grey) temperatures between consecutive sunsets at Glen based on the average temperature measured 5 cm above the ground for each segment.

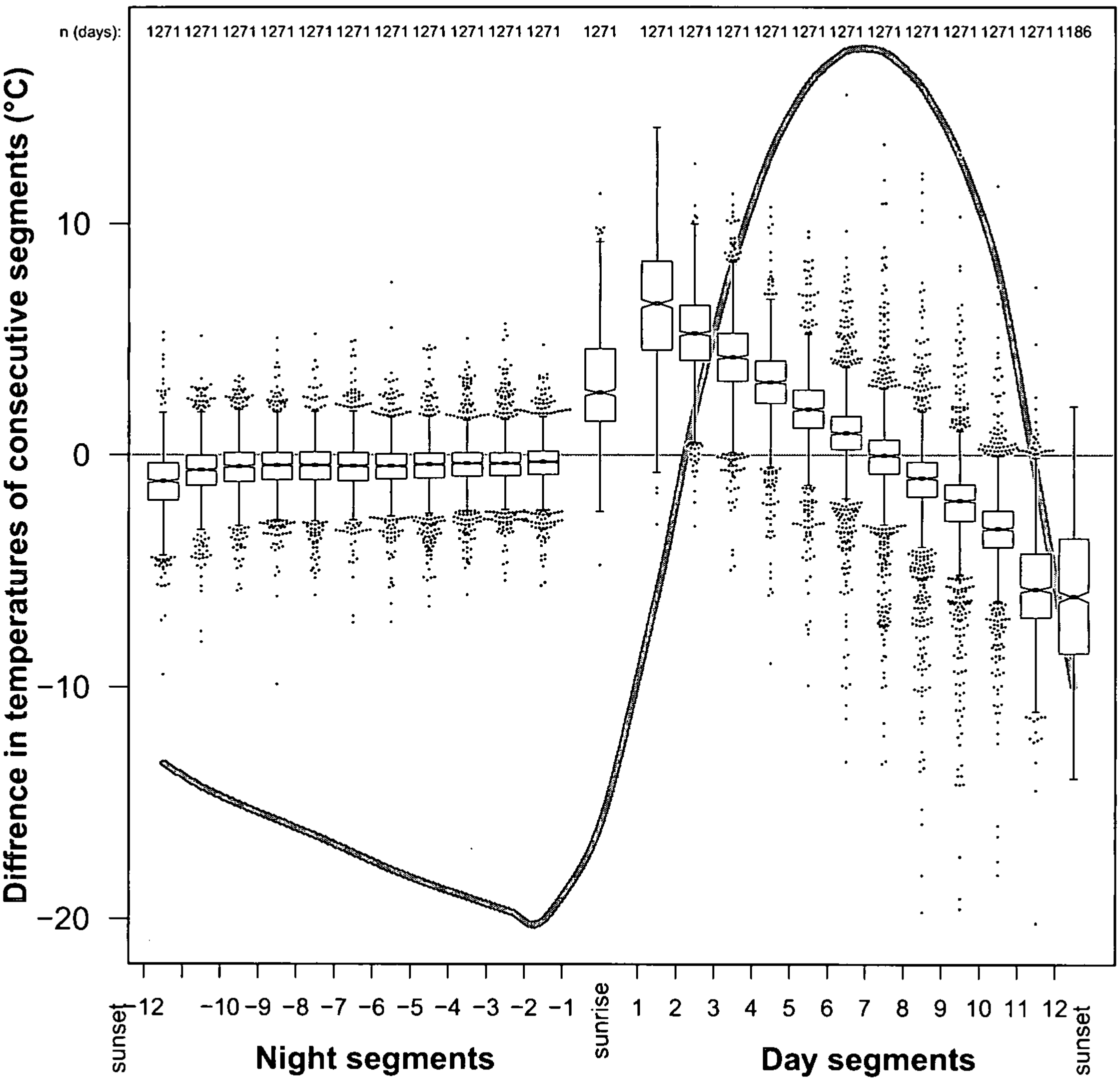


Figure 2.29: Difference in temperature between consecutive segments of the night and day. Based on days during which temperatures were recorded 5 cm above the ground continuously from sunset to sunset in the study area at Glen. The grey line in the background represents the daily variation in temperature based on the median values of temperature differences.

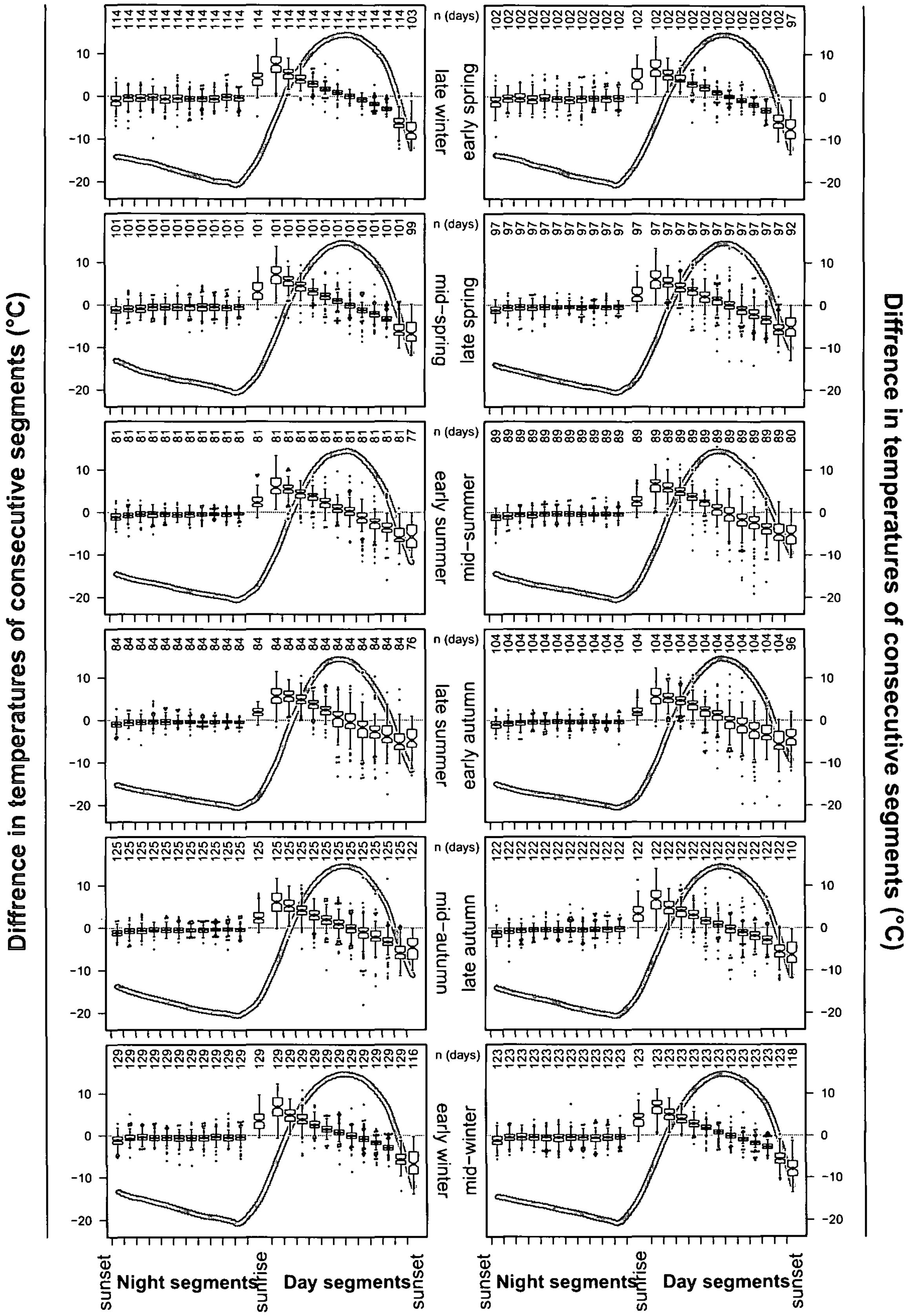


Figure 2.30: Seasonal variation in temperature difference between consecutive segments of the night and day. Based on days during which temperatures were recorded 5 cm above the ground continuously from sunset to sunset in the study area at Glen. The grey line in the background represents the daily variation in temperature based on the median values of temperature differences.

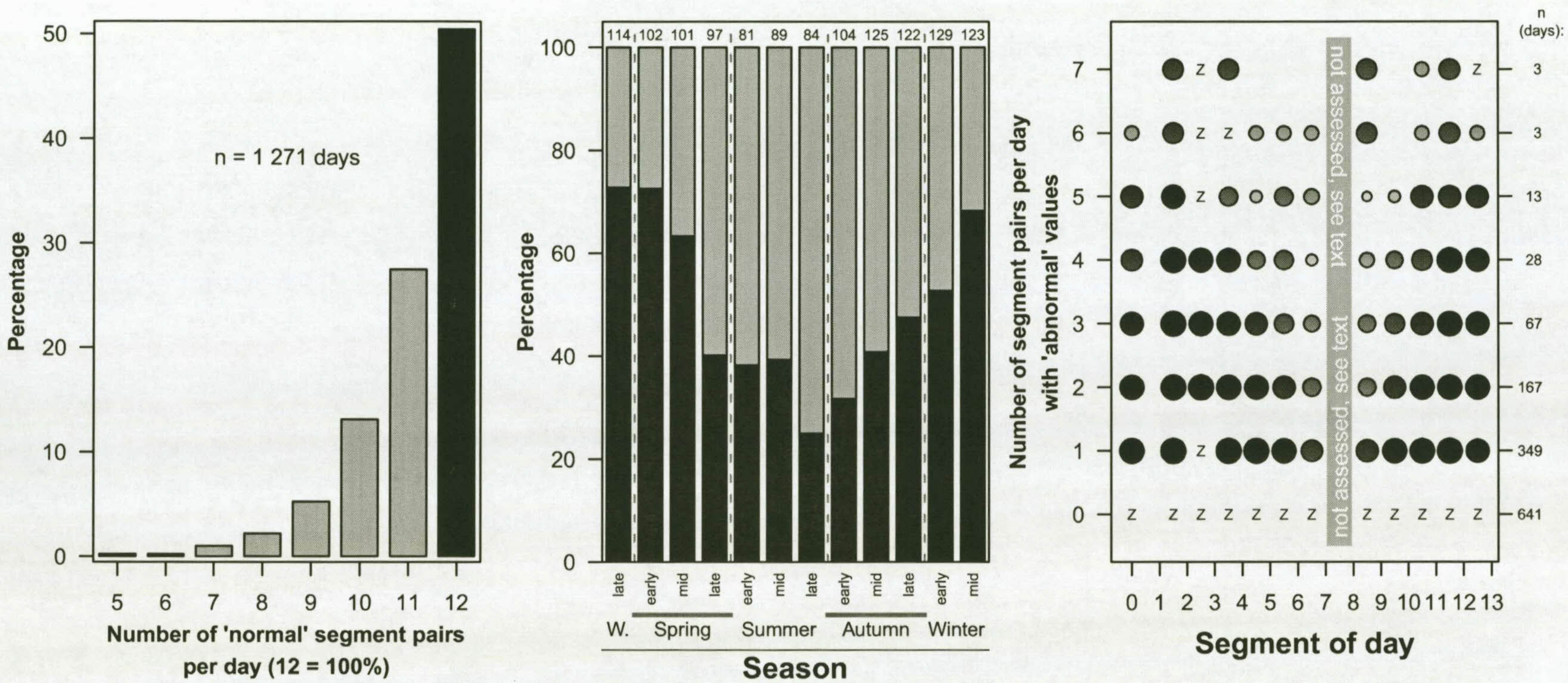


Figure 2.31: Occurrence of segment pairs showing 'normal' differences in temperature — see text. Based on temperatures measured 5 cm above the ground in the study area at Glen. *Left*: Relative occurrence of the number of 'normal' segment pairs; *Middle*: Seasonal occurrence of days (n-values at the top) during which all segment pairs followed the 'normal' pattern (black) versus days during which at least one segment pair deviated from the 'normal' pattern (grey); *Right*: Daily distribution of segment pairs that did not follow the 'normal' pattern with the colour and area of the circles being proportional to the percentage of segment days; z = zero.

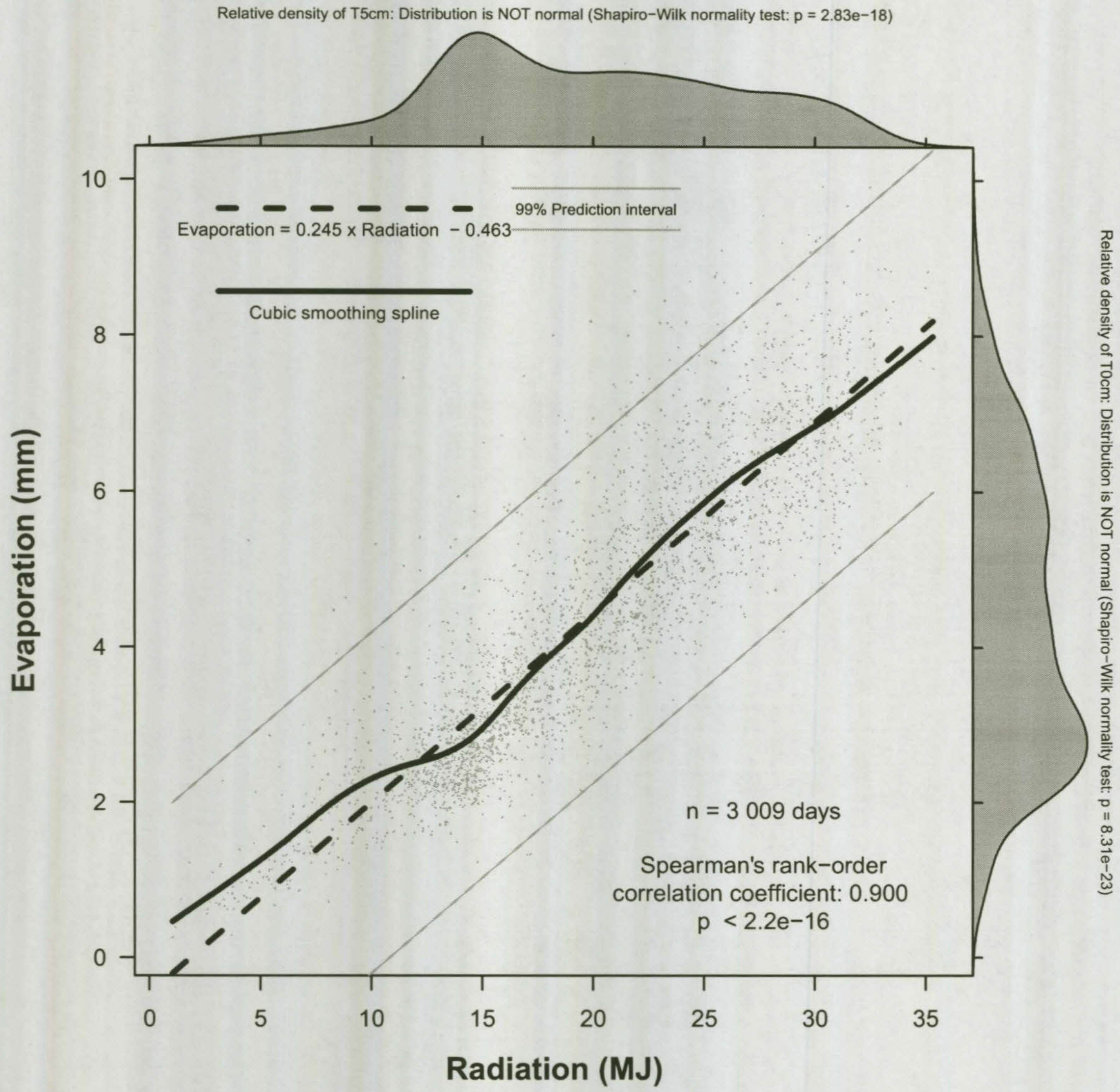


Figure 2.32: Correlation between radiation and evaporation based on data from the weather station at Glen from 2000 to 2008. Also see Figure 2.33 and 2.34.

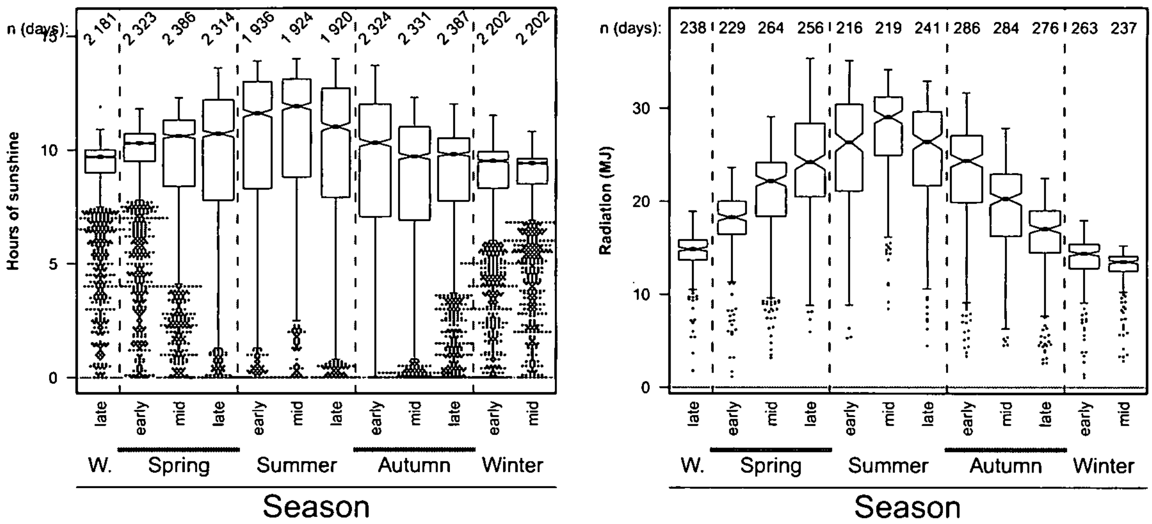


Figure 2.33: Seasonal variation in the daily hours of sunshine (1923–1999; left) and radiation (MJ; 2000–2008; right) as recorded at the Glen weather station.

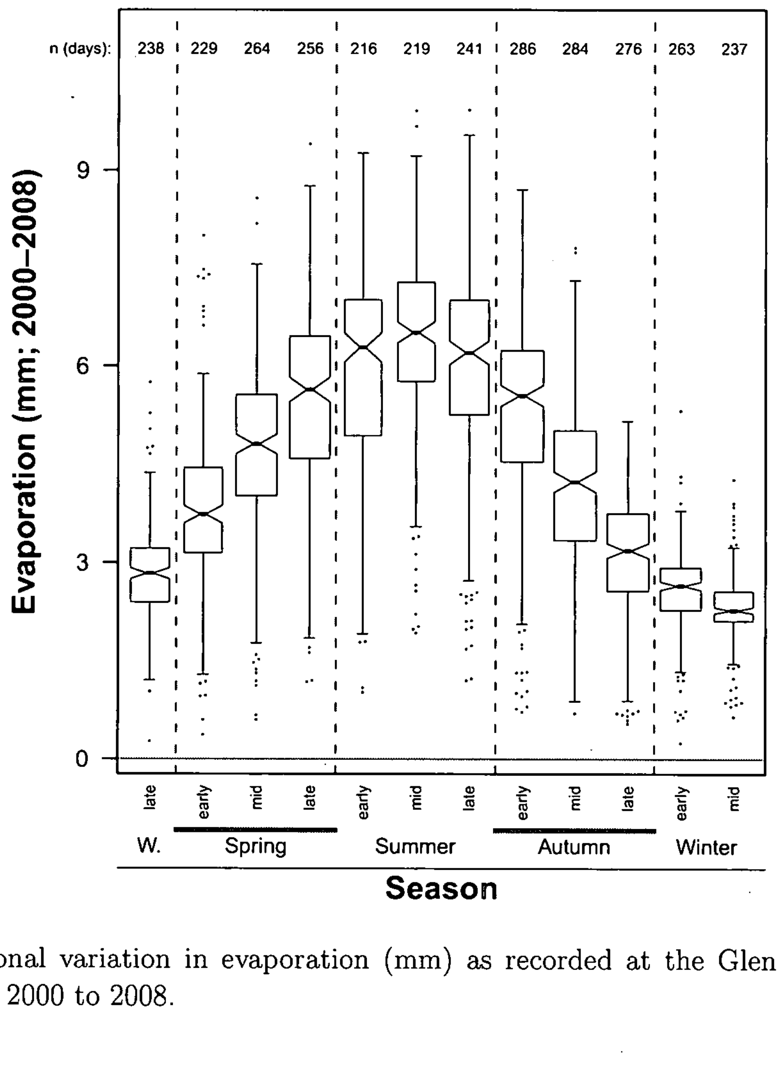


Figure 2.34: Seasonal variation in evaporation (mm) as recorded at the Glen weather station from 2000 to 2008.

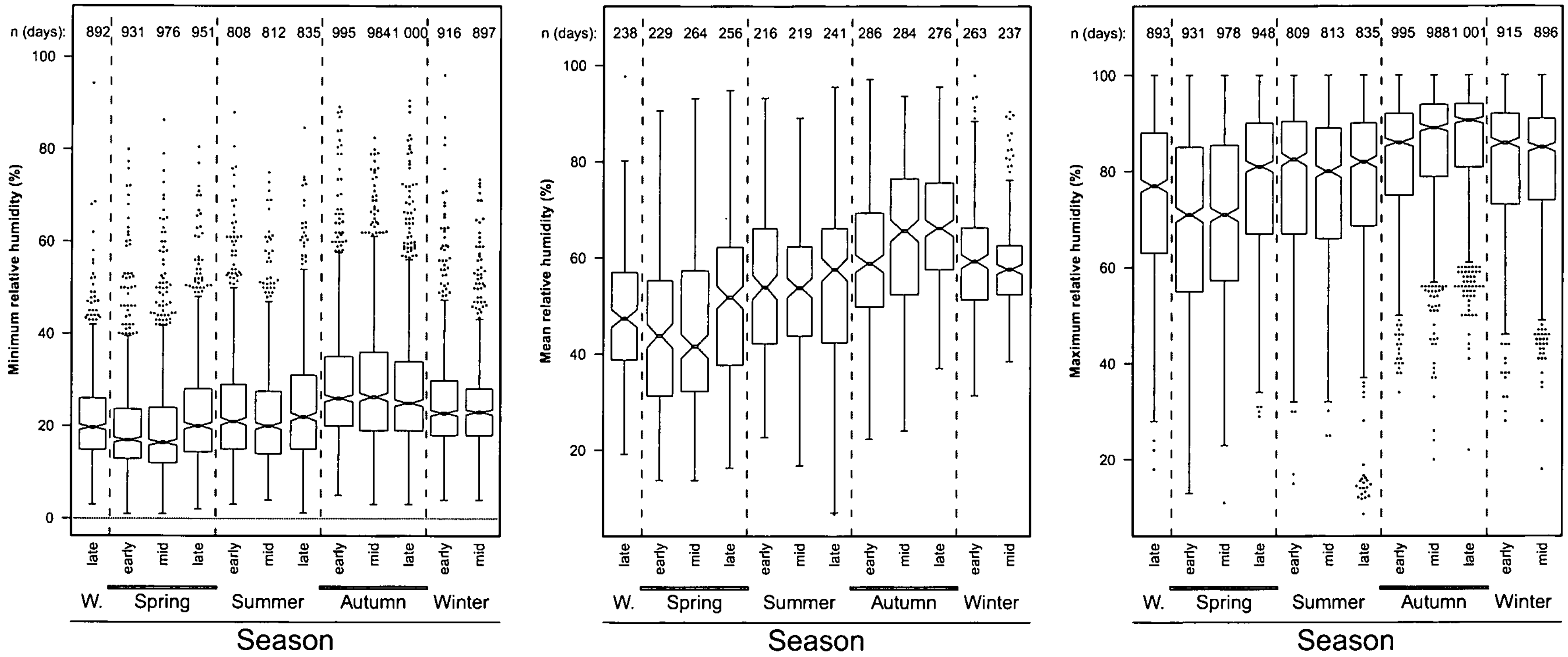


Figure 2.35: Summary of daily minimum, mean and maximum relative humidity as measured at the Glen weather station from 2000 to 2008.

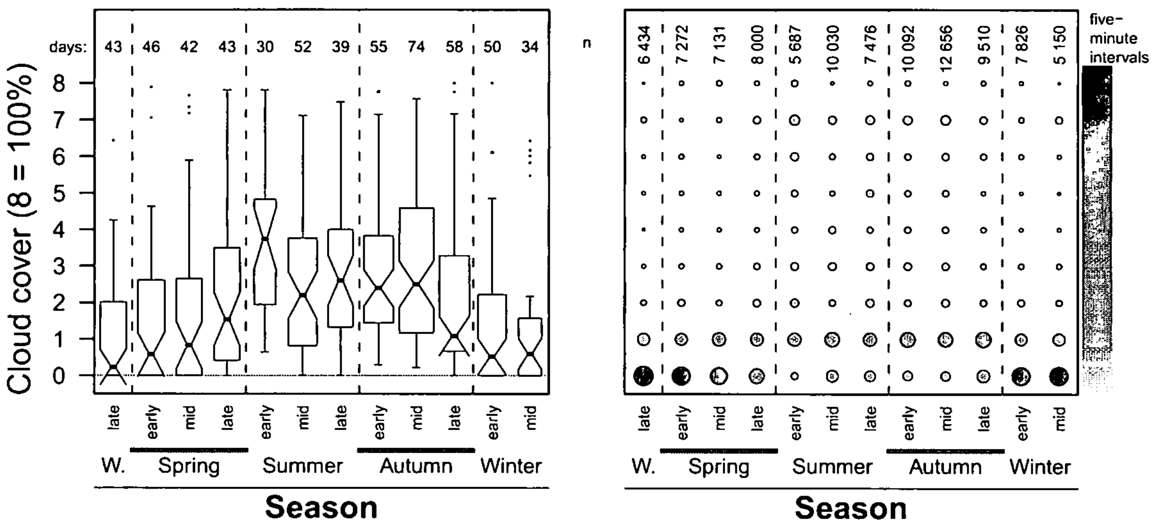


Figure 2.36: Seasonal fluctuation in cloud cover as measured during observations at the study site. *Left*: Summary of average daily values; *Right*: Proportion of 5-minute intervals each season during which the respective cloud cover scores (0–8) occurred.

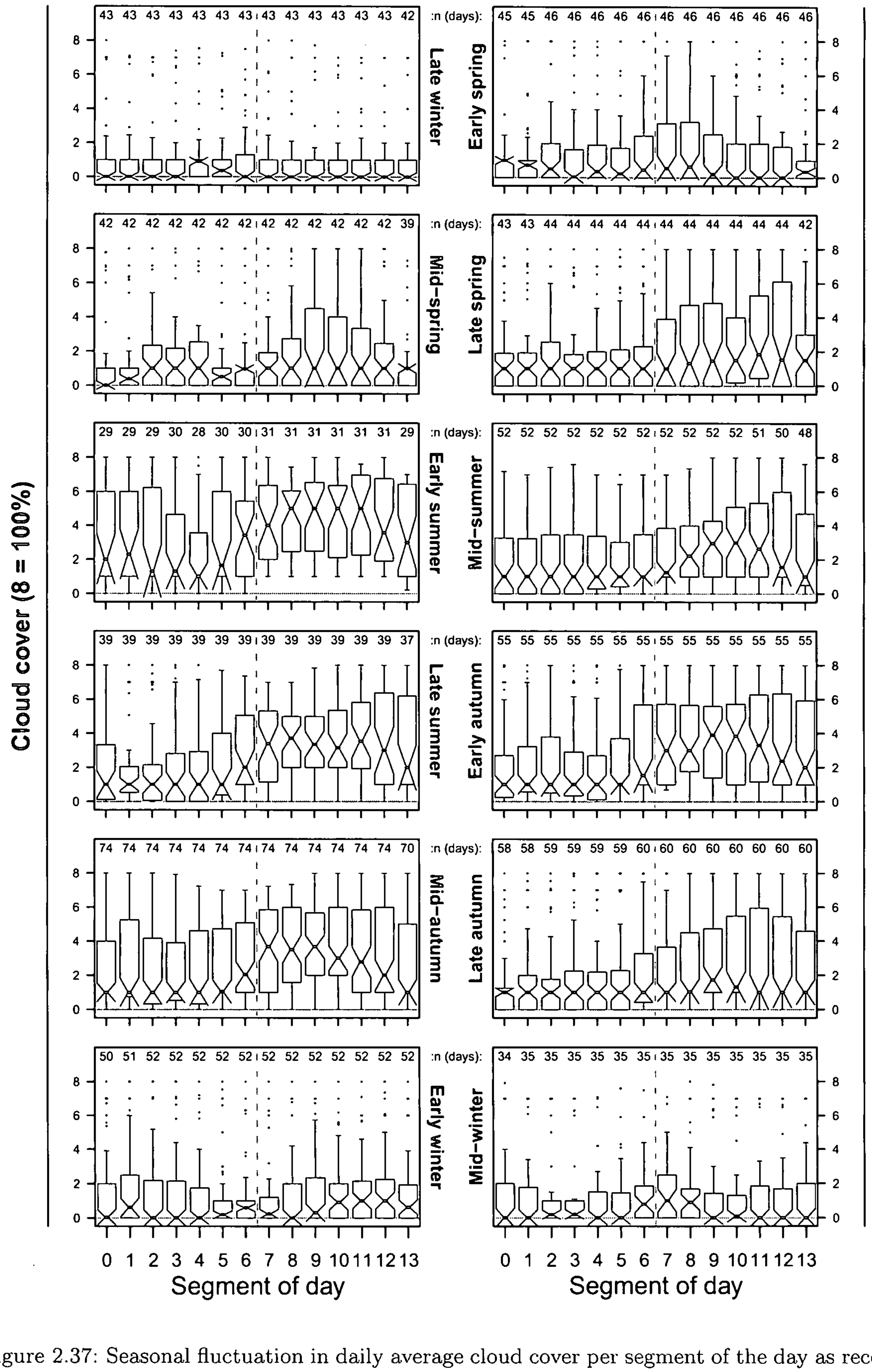


Figure 2.37: Seasonal fluctuation in daily average cloud cover per segment of the day as recorded in the study area at Glen from 1997/8 to 2007/8.

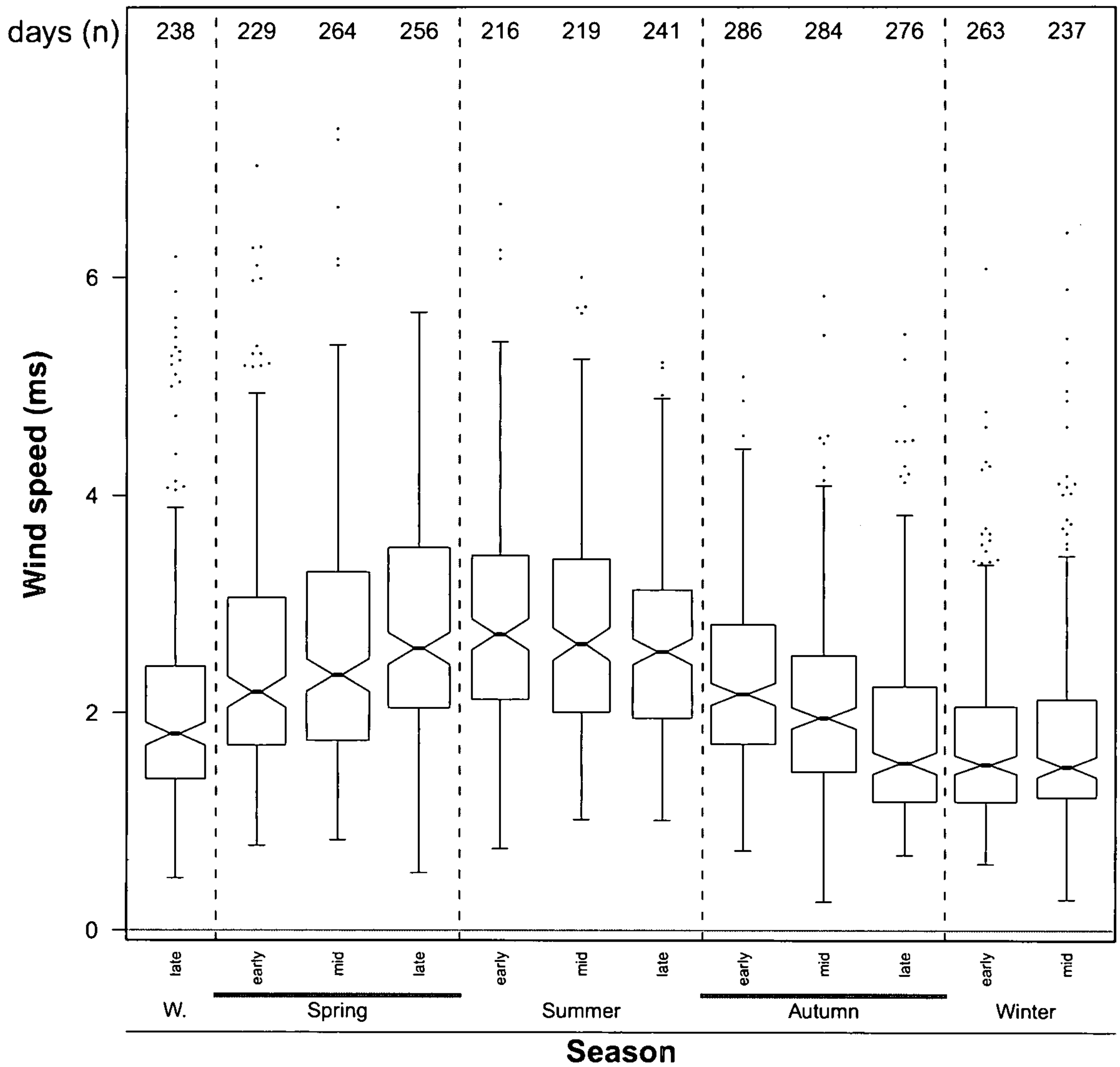


Figure 2.38: Seasonal variation in wind speed based on data from the weather station at Glen (2000 to 2008).

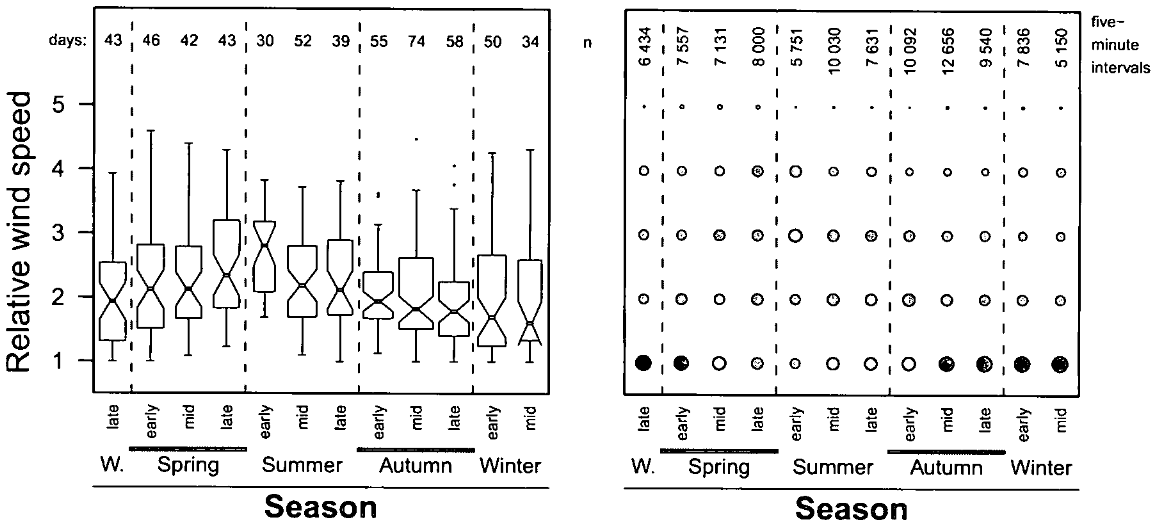


Figure 2.39: Seasonal variation in relative wind speed as recorded during observations in the study area at Glen from 1997/8 to 2007/8. *Left*: Summary of average daily values; *Right*: Proportion of 5-minute intervals each season during which the respective wind speed scores (1–5) occurred.

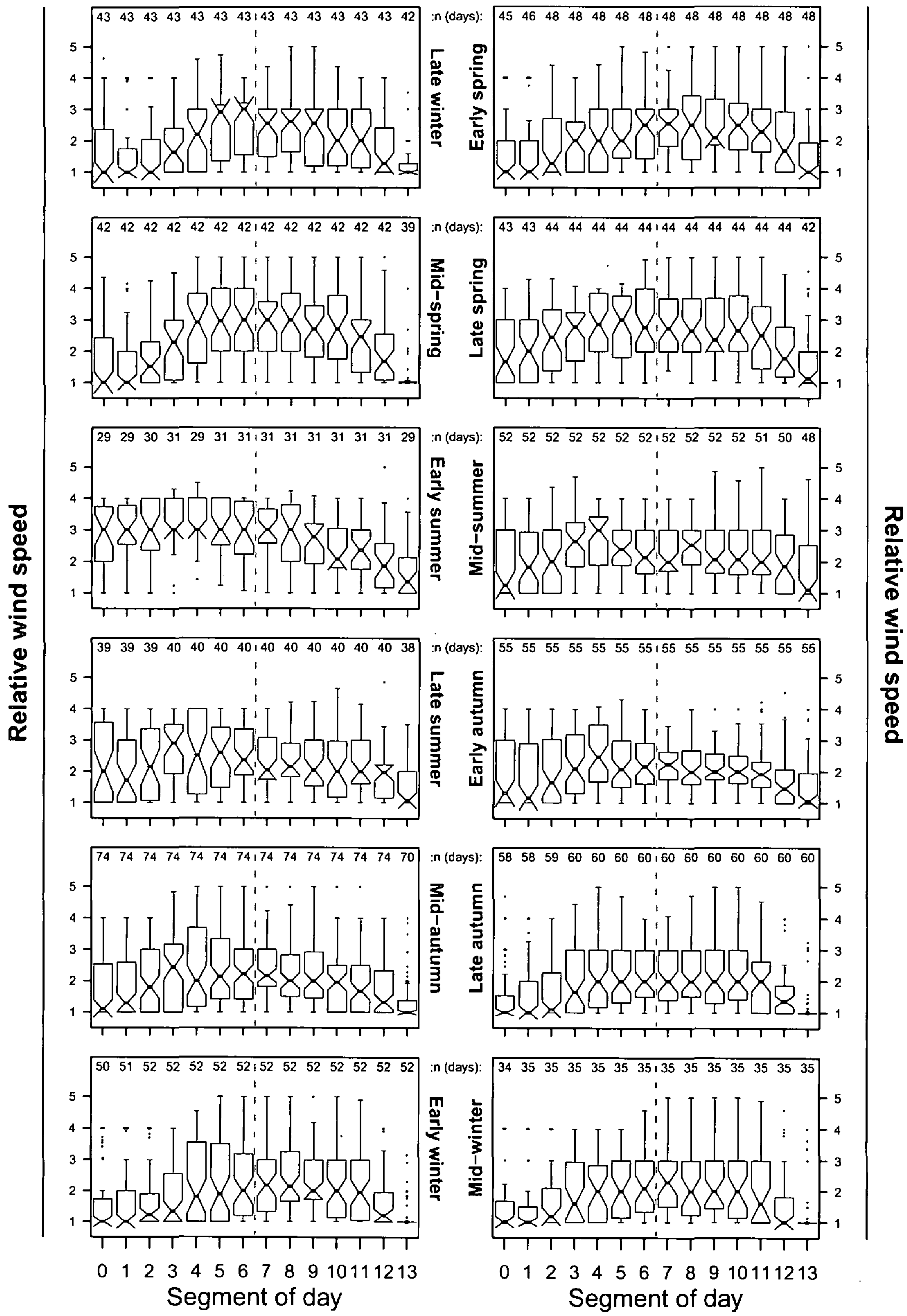


Figure 2.40: Seasonal variation in the daily wind speed pattern based on observations in the study area at Glen from 1997/8 to 2007/8.

3 Methods

The focus of this study is on the activity patterns of birds. More specifically, the study was designed to elucidate annual, seasonal and daily patterns. The classification of years and seasons was addressed in the previous chapter. Daily variation was assessed by dividing each day into 14 segments numbered from 0 to 13, with 12 equal length segments S1–S12 between sunrise and sunset, and S0 and S13 signifying the segment before sunrise and after sunset respectively (Fig. 3.1). Only segments with ten or more 5-minute checklists (see below) were considered in the analysis and are henceforth termed "observation segments."

3.1 Field methods

The data considered in this thesis spans the 11-year period from 8 July 1997 to 2 July 2008. In general, the most basic unit of the analysis is a 5-minute checklist, with each 5-minutes starting on times perfectly divisible by five, *i.e.*: Xh00, Xh05, Xh10, ... , Xh50, Xh55, where X can be any hour from 0 to 23. A *checklist* is defined as a list of species (including instances where no birds were recorded) recorded for each 5-minute interval.

In the field book, each species was recorded by noting its Roberts' number, as per Maclean (1985), with a line above the number indicating that the species was heard and a line below the number indicating that it was seen. For example, the Cape Turtle Dove was noted in the field book as $\underline{354}$ when seen, as $\overline{354}$ when heard, and as $\overline{\underline{354}}$ when both seen and heard. Further distinction

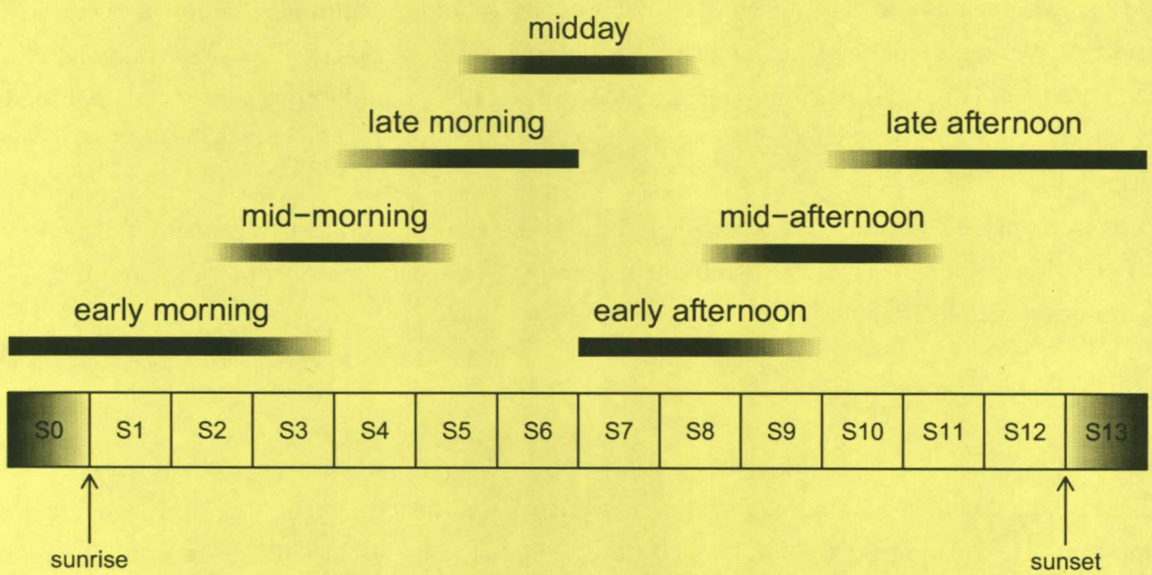


Figure 3.1: Division of a day into 12 equal length segments between sunrise and sunset indicating the terminology as used in the text.

was made between different types of vocalisations for selected species.

3.1.1 GRASSLAND

5-minute checklists were collected simultaneously with behavioural data on the Spike-heeled Lark (1997–1999) and the Eastern Clapper Lark (1999–2008) from 22 October 1997 to 2 July 2008. For selected species, the method was refined by collecting data for every minute. This was implemented at different stages of the project, depending on the species involved.

Because a year in this thesis starts in July (see page 87), it was decided to fill the first year by including experimental data based on 10-minute checklists collected from 8 July to 18 October 1997. Although not ideal, it was considered most practical to convert this data to 5-minute checklists by assigning the data for each 10 minutes to its equivalent 5-minute intervals, *e.g.* the 10-minute checklist for 8h30 (spanning 8h30–39) was assigned to the 5-minute intervals 8h30 (8h30–34) and 8h35 (8h35–39). Again, this manipulation of the data was only necessary for data from 8 July to 18 October 1997.

There is 795 days with at least one observation segment. The frequency occurrence of the number of observation segments per day is indicated in Figure 3.2. The relatively frequent occurrence of observations during two segments per day (11.2%; Fig. 3.2) represents observations during S0 and S1 following on full day observations, and less often observations during segments S12 and S13 preceding full day observations. The focus of the present study is on full day observations with the analysis primarily based on the 656 days (82.5%) with 10–14 observation segments (Fig. 3.2). These days are henceforth referred to as the "observation days."

The interval between consecutive observation days was mostly (89.0% of day-pairs) 0–7 days with a mode and median of six days (Fig. 3.3), reflecting the aim of conducting observations on the same day of the week (*e.g.* each Wednesday) regardless of weather conditions.

At the beginning of the study in 1997/8, observations mostly commenced shortly before sunrise and ended shortly after sunset, in contrast to subsequent years when observations commenced earlier and terminated later (Fig. 3.4). Consequently, only a limited number of the 1997/8 S0 and S13 segments qualified for inclusion in the analysis because they had less than the required ten checklists (Fig. 3.5), and most of the days during 1997/8 had only 12 observational segments in contrast to the days during subsequent years that mostly had 14 observational segments (Fig. 3.6).

A total of 187 species was identified during the 656 observation days amounting to 8 922 observation segments, 121 790 5-minute intervals, 541 479 5-minute data records and 479 330 1-minute data records.

3.1.2 DRAINAGE LINE

Although the focus of the study was on grassland birds, supplementary data was also collected in the drainage line (Fig. 3.7). Fixed transects were walked through part of the drainage line, mostly between late autumn 2000/1 and early spring 2002/3 (Fig. 3.7). Checklists were compiled for each minute during these transects, during which a total of 98 species were identified. However, this part of the data-set is largely ignored in the present analysis, being used only for species with very limited or no records otherwise.

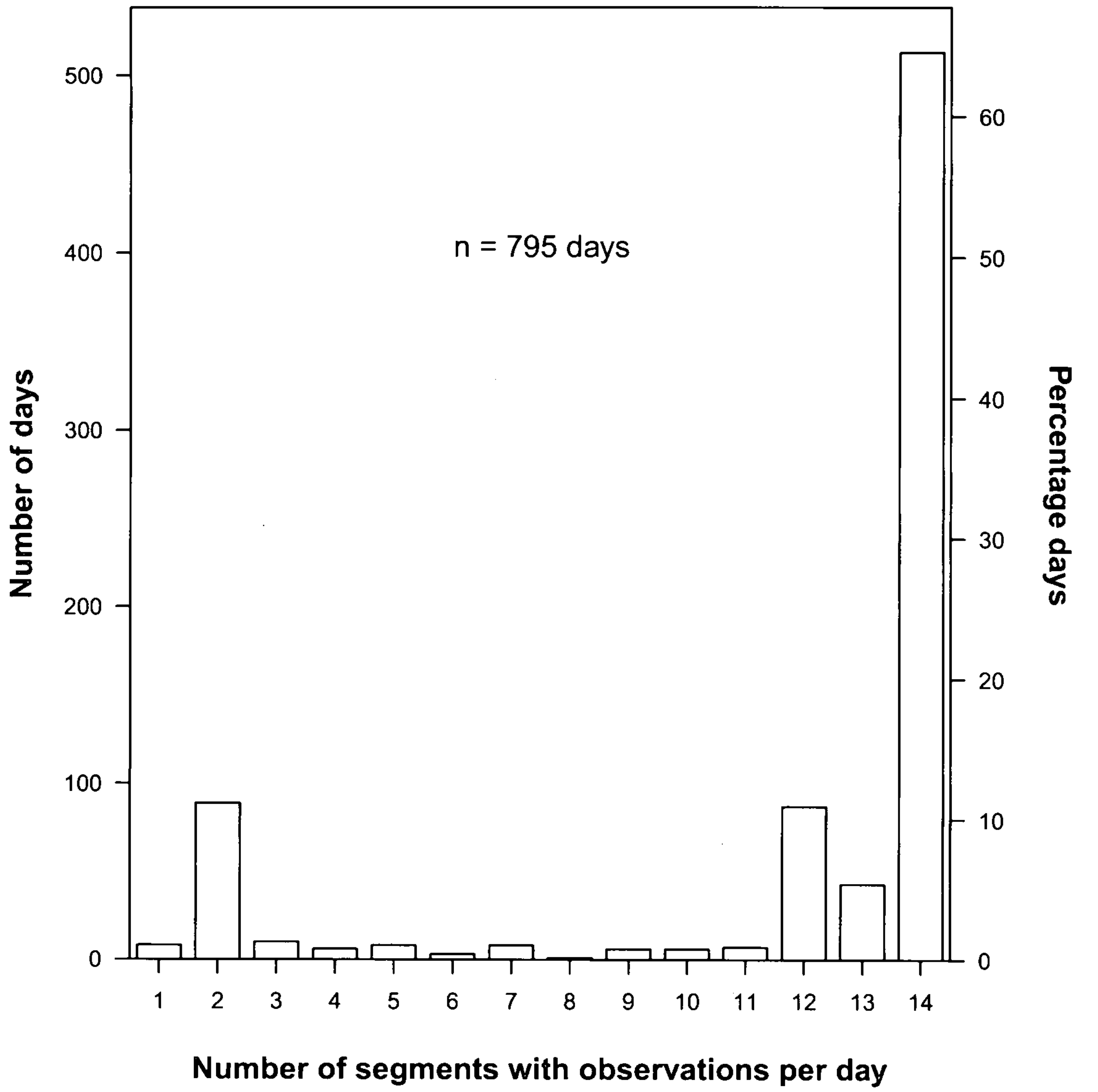


Figure 3.2: Frequency occurrence of days with n segments of observations in the grassland during the 11-year study period (1997/8 to 2007/8) at Glen.

Table 3.1: Basic statistics on the data collected during the early mornings (S0 and S1) of 2007/8 at Glen.

	Habitat	
Item	drainage line	grassland
mornings	43	43
species	107	98
5-minute checklists	1 198	1 202
data records	38 331	27 258

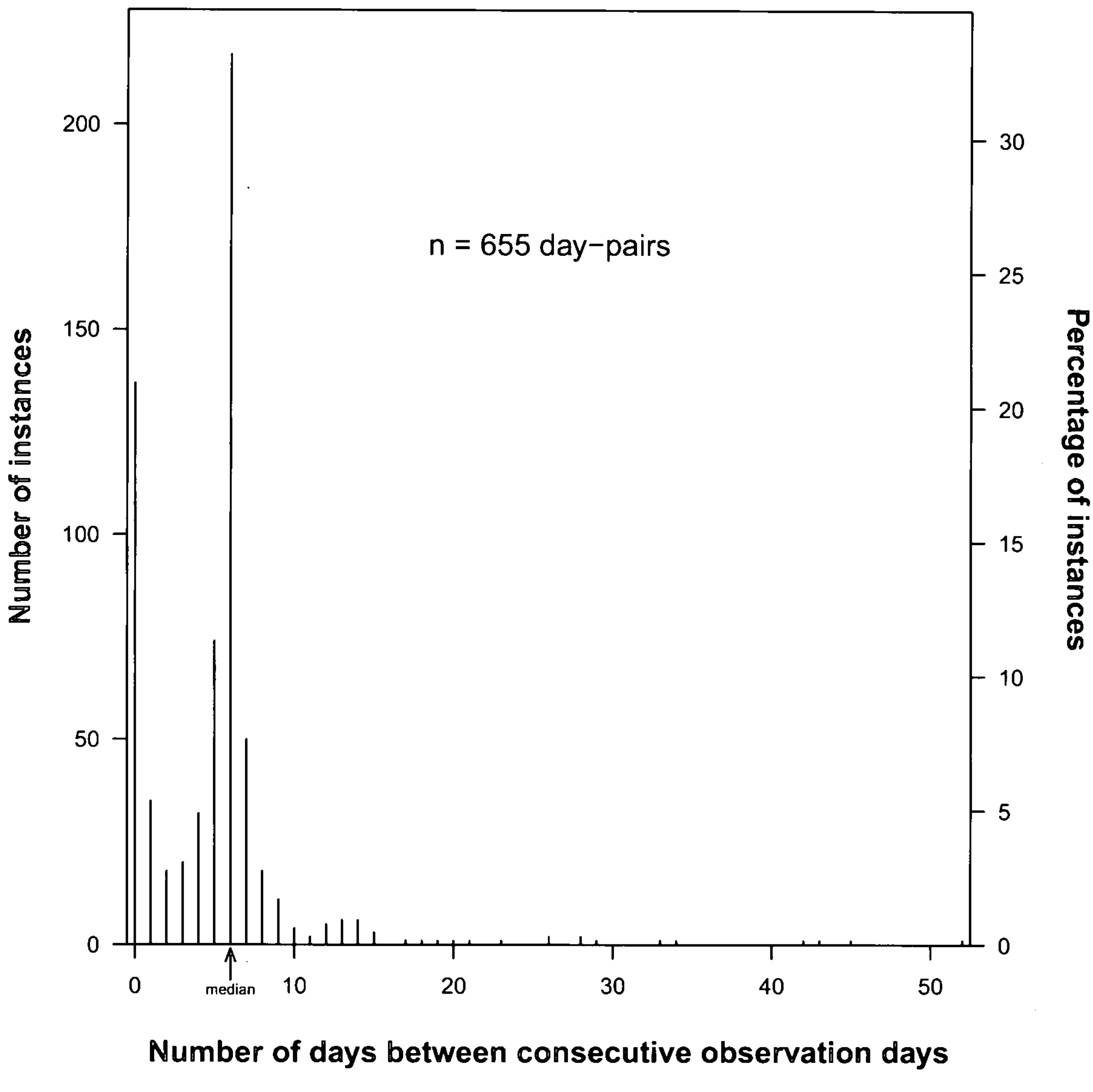


Figure 3.3: Summary of the frequency occurrence of intervals between consecutive observation days with 10–14 observation segments at Glen during the period 1997/8 to 2007/8.

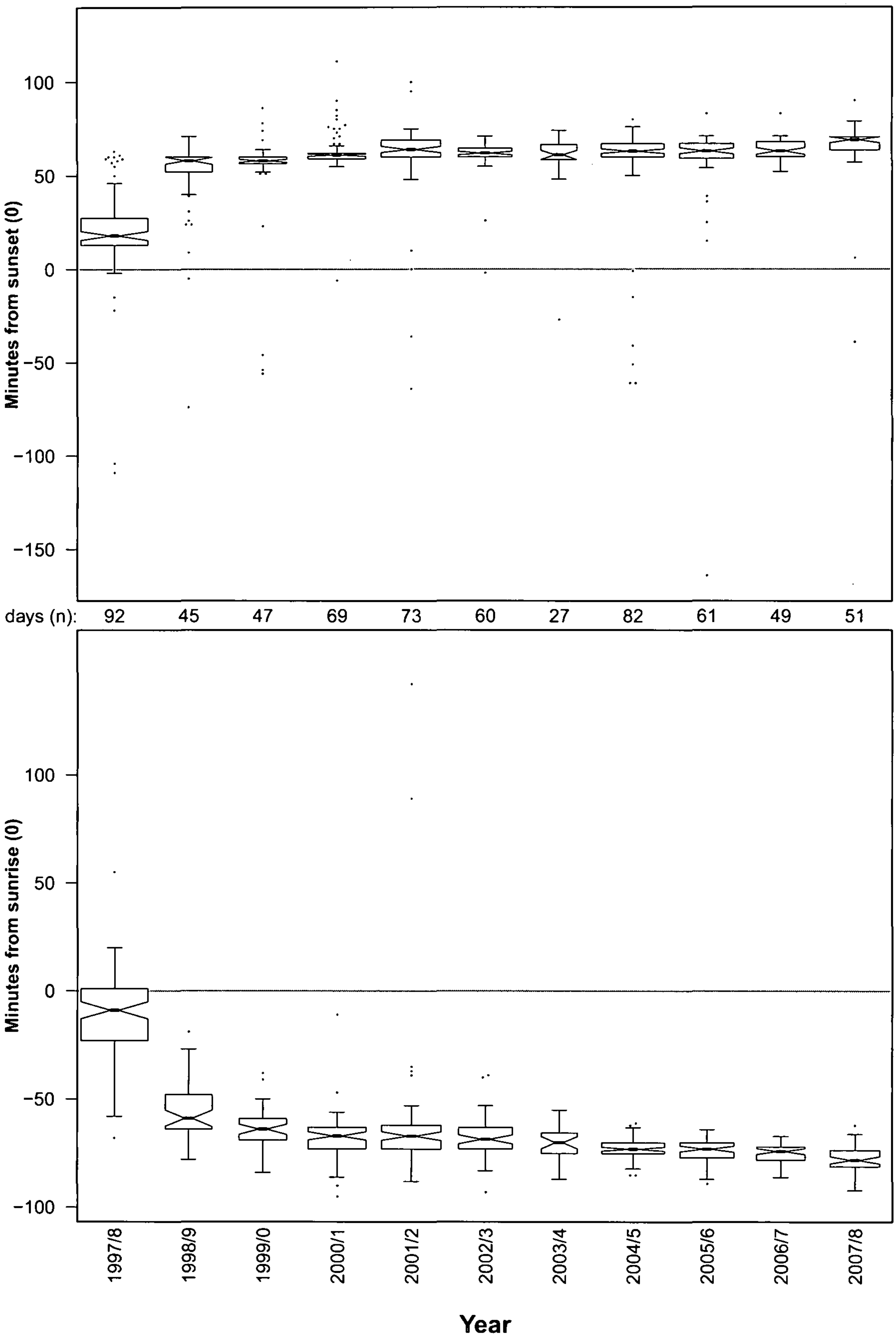


Figure 3.4: Annual variation in the timing of the start (bottom) and end (top) of observations in the grassland on days with 10–14 observation segments at Glen from 1997/8 to 2007/8.

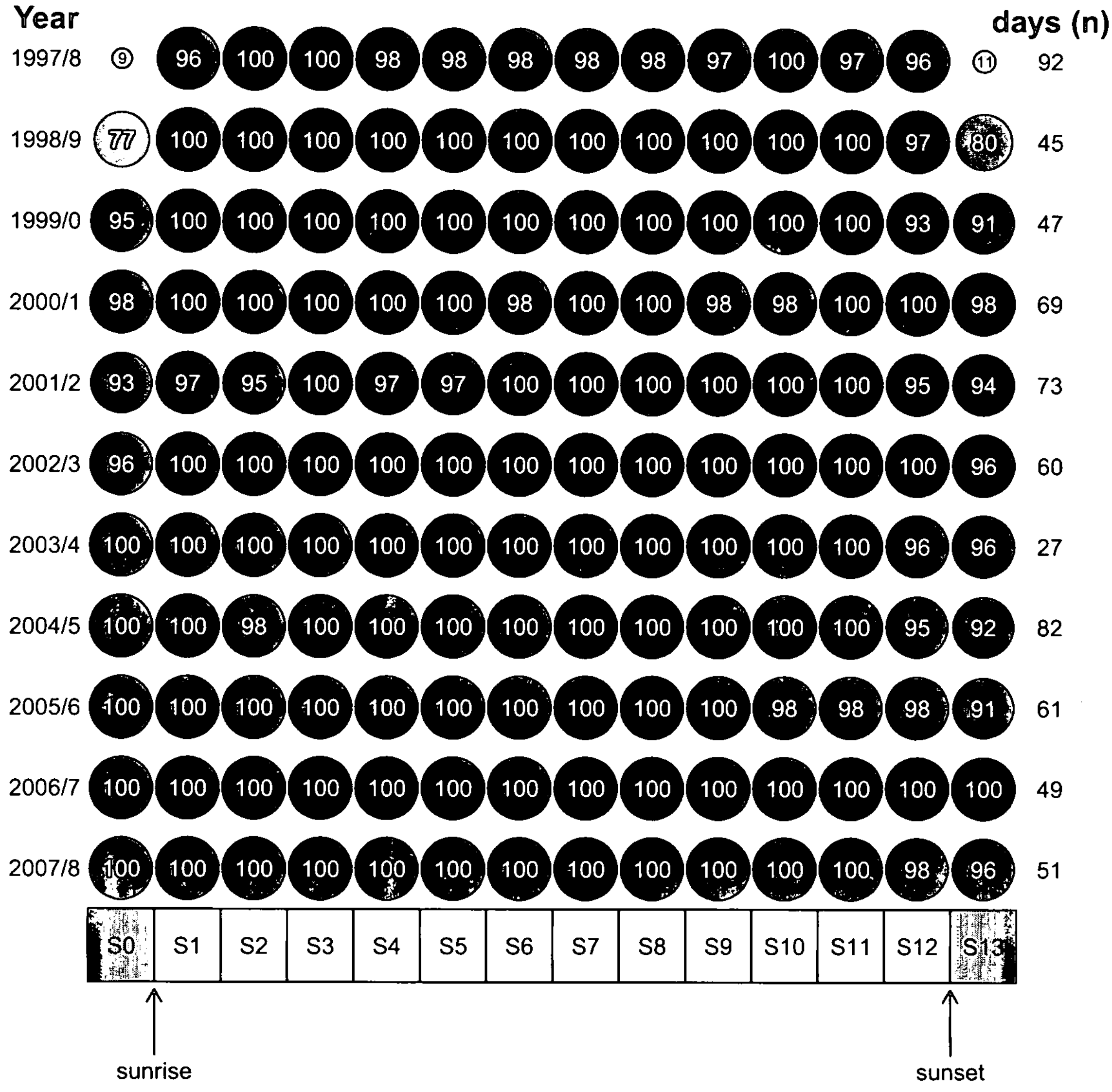


Figure 3.5: Annual variation in the proportion of days at Glen with observations during the various observation segments, *i.e.* segments with more than nine 5-minute checklists. The numbers in the circles represent the rounded percentage of days, also indicated by the shading (white–black; 0–100%), and the area of circles.

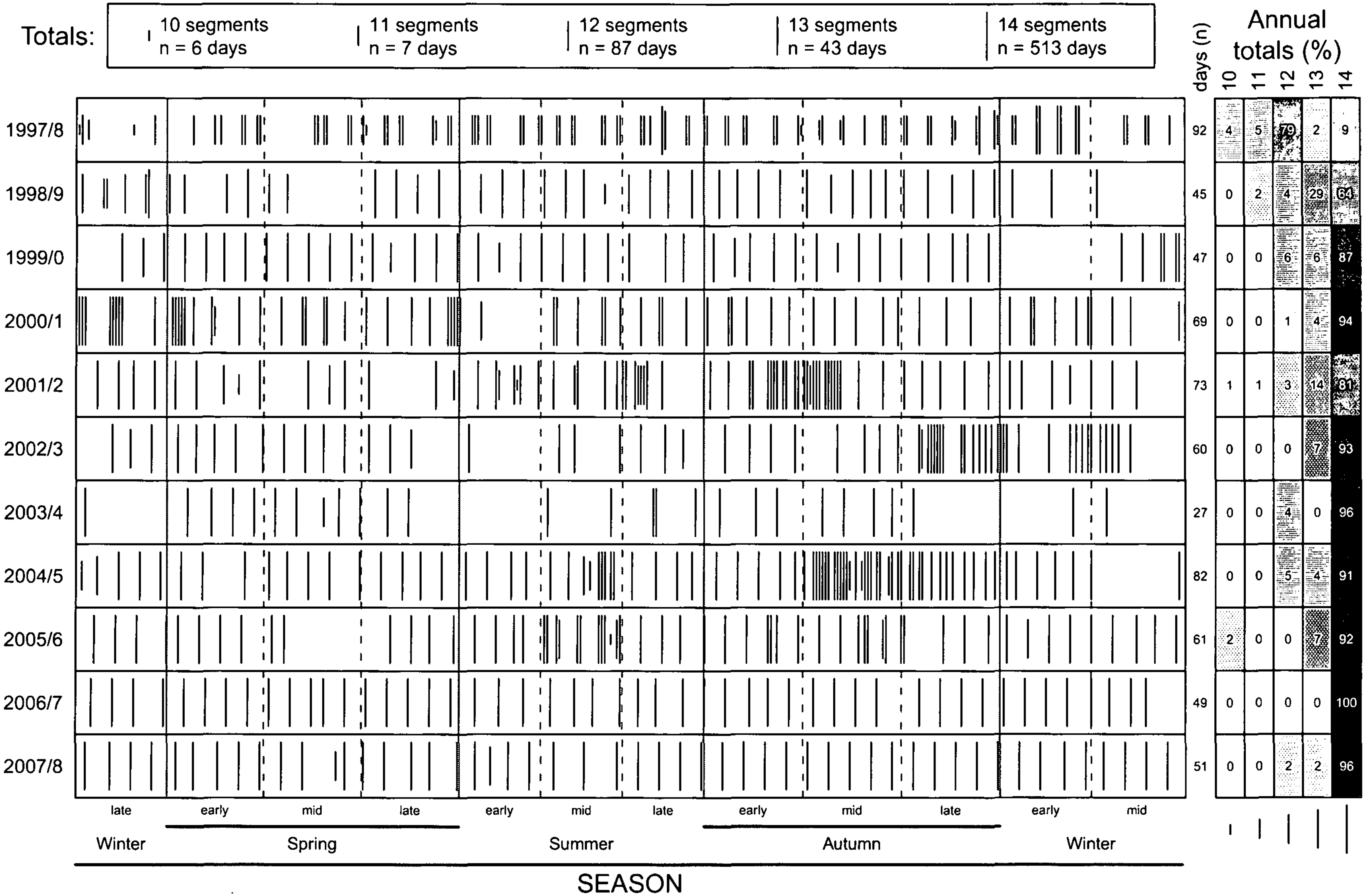


Figure 3.6: Temporal distribution of grassland observation days with 10–14 segments (see legend at the top) during the 11 years of the study at Glen. The frequency occurrence is summarised at the top and to the right.

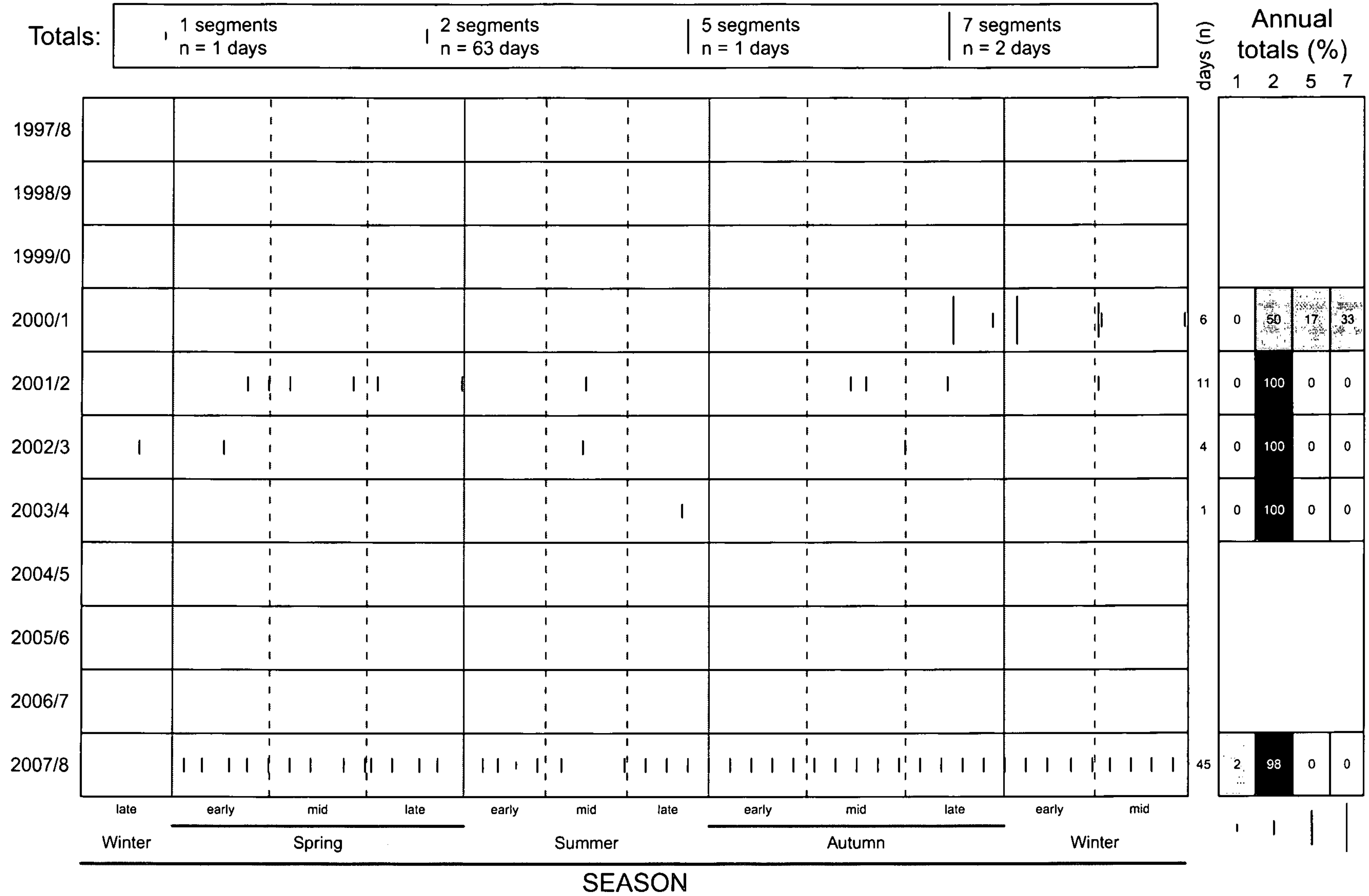


Figure 3.7: Temporal distribution of observations in the drainage line at Glen during the 11-year study period. The observations from 2000/1 to 2003/4 involved transects, and that during 2007/8 fixed point observations (see text).

On 10 August 2007 (early spring 2007/8) a more systematic study on the activity patterns of drainage line birds was initiated (Fig. 3.7). Weekly early morning observations were conducted during S0 and S1, following a full day observation in the grassland. These observations were conducted from a fixed position in the drainage line (*i.e.* part of a gravel road passing approximately 100 m east of the farm dam; see Fig. 2.8) with the focus on the vocal activity of birds. In addition to 5-minute checklists, the activities of all species were also recorded for each minute. Basic statistics on the data thus collected are presented in Table 3.1.

3.2 Data analyses and presentation

Roberts' numbers, referring to the unique number allocated to each southern African bird species by Maclean (1985, 1993), provides a convenient tool for easy reference — anyone can look up a number! The only troublesome part, of course, is to know which number belongs to which bird. That part is made easy by providing the number together with the bird's name the first time it is used within a particular context. For example, Black-shouldered Kite R127 or Cape Sparrow R803, the 'R' signalling the Roberts' number. Thus given, it is easy to locate species in the table of contents (Chapters 4 and 5), list of figures and tables, *etc.* When a species is referred to in the text only by its English and scientific name, *e.g.* "Black-necked Grebe *Podiceps nigricollis*", it means that the bird does not have an account in this thesis (Chapters 4 and 5).

Icons are used to indicate the position of a particular sub-figure (or sub-figures) within a figure. For example, if figure X consists of two sub-figures, one on top of another, reference to the top figure is indicated as follows: "Figure X⬒" or "(Fig. X⬒)". Similarly, reference to the bottom figure will look like this : "Figure X⬓" or "(Fig. X⬓)". As a final example, if figure Z consists of a 3 × 3 matrix of sub-figures, reference to the one in the middle is indicated by "Figure Z⊡" or "(Fig. Z⊡)".

3.2.1 STATISTICS

> "This book is about exploratory data analysis, about looking at data to see what it seems to say." (Tukey 1977). "Exploratory data analysis is detective work" (Tukey 1986).

The emphasis of the analysis is on biological, rather than statistical, significance (see Yoccoz 1991). In addition, a number of authors point out numerous problems with the null hypothesis testing paradigm, including that it is rarely informative, logically poor, that nearly all null hypotheses are false on a priori grounds, that the P-value is dependent on sample size and it does not provide information about either the size or the precision of the estimated effect (see Anderson *et al.* 2000; Anderson *et al.* 2001; Cherry 1998; Cohen 1994; Guthery *et al.* 2001; Johnson 1999; Nester 1996). Alternative or supplemental methods for the analysis and reporting of data (see DeVaney 2001) include multiple replications (Bauernfeind 1968; Carver 1993; Cohen 1994; Johnson 2002b; but beware of small sample size, see Robinson & Levin 1997) and reporting of effect-size estimates. As already explained in the Introduction, the study at Glen was based on the replication principle, with the focus of obtaining estimates of fluctuations in activity levels on temporal scales ranging from years and seasons down to the level of different parts of the day. The median was selected as an estimator of central tendency because the data frequently included outliers. The term 'significant' is used in its non-statistical sense throughout the thesis.

Box-and-whisker plots are a useful statistical tool employed in many diagrams. It was originally developed by Tukey (1977) as a graphical representation of 5-number summaries (extremes, first and third quartiles ('hinges') and the median), providing information on the size as well as variability of the parameter under investigation. Two subsequent refinements by McGill *et al.* (1978) included the following: 1) The width of each box-and-whisker plot is drawn proportional to the square-root of the number of observations in the corresponding group (*e.g.* Fig. 2.22); 2) Confidence intervals around the medians are indicated by 'notches'. Figure 3.8 illustrates the basic anatomy of a box-and-whisker plot as it is employed in this thesis, based on Tukey (1977) and McGill *et al.* (1978). The specific formula used for the calculation of the 'notch interval' was $\pm 1.58 \times IQR/\sqrt{n}$ (R Development Core Team 2008: *boxplot.stats(grDevices)*; Kafadar 1985; see Fig. 3.8). This calculation is "based on asymptotic normality of the median and roughly equal sample sizes for the two medians being compared, and are said to be rather insensitive to the underlying distributions of the samples. The idea appears to be to give roughly a 95% confidence interval for the difference in two medians." (R Development Core Team 2008; see also Kafadar 1985). Data points beyond the lower and upper inner fence (*cf.* Fig. 3.8) are plotted side-by-side if their y-axis values are similar (*e.g.* Fig. 2.29). When less than 12 data points were available, the individual points were plotted instead of a box-and-whisker plot with the median indicated by a horizontal line (*e.g.* Fig. 4.4B, page 149).

One of the techniques used in the analyses was to group the data into three fractions by dividing the overall range (*maximum* − *minimum*, excluding zero) of daily reporting rates into three equal parts and analysing them separately. For example, if the daily reporting rates for a species ranged from 10 to 40%, its data was analysed separately for days with reporting rates from 10 to <20% (*i.e.* low reporting rate days), from 20 to <30% (*i.e.* intermediate reporting rate days) and from 30 to 40% (*i.e.* high reporting rate days). In most cases there were more low than intermediate or high reporting rate days, and if only one category attained more than 11 days, the analysis was limited to the combined data.

All dendrograms (cluster analyses) were produced with the *hclust* function in the R Stats package (see below) and was based on Euclidean distances and Ward's method.

3.2.2 SPECIES ACCOUNTS

The species accounts in Chapters 4 and 5 are arranged by Roberts' number as it appears in Maclean (1985), with the taxonomy following Hockey *et al.* (2005).

A short introduction for each bird family is followed by the accounts of the species recorded at Glen. Original sources of information were used where possible. If these were not obtainable, general reference works were used instead, with priority given to older references, generally from Maclean (1985) onwards. Frequent reference is made to the first Southern African Bird Atlas Project (SABAP1; Harrison *et al.* 1997a,b), in particular to 'Zone 7' which includes the area from the Free State eastwards.

Each bird family is introduced by briefly noting the combined global occurrence of its members,

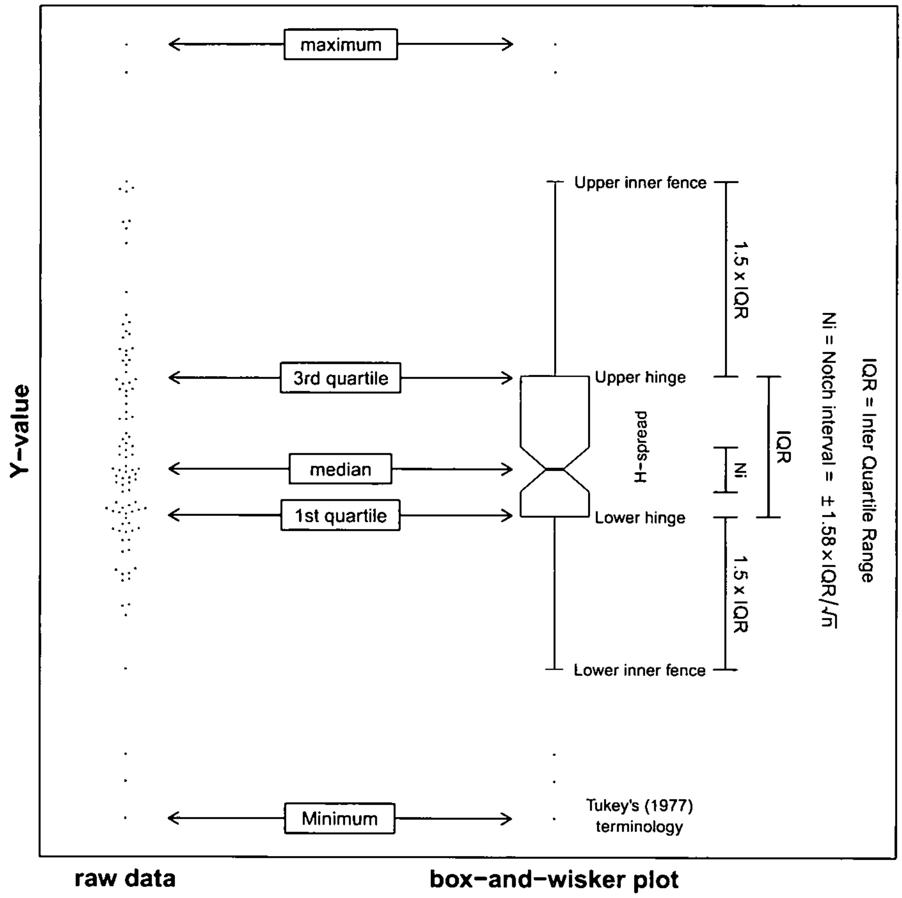


Figure 3.8: Basic anatomy of a box-and-whisker plot as employed throughout this thesis. Based on Tukey (1977) and McGill *et al.* (1978). Tukey (1977) termed values outside inner fences "outside" values and those beyond "outer fences" (*i.e.* 1.5×IQR beyond inner fences; not illustrated) "far out". See text for further details.

the total number of species in the family, and the number of species occurring in southern Africa, based on Hockey *et al.* (2005). Those found in the Free State are also indicated, followed by a brief synopsis of species recorded, or not recorded, at Glen.

The account for every species starts with its Roberts' number, English and scientific name. An introduction gives a general overview of the global and southern African distribution of the species, habitat preferences and information on movements. This is followed by a section on *The birds at Glen*, which often starts by giving an indication of the type of records considered (*e.g.* birds seen) and habitats frequented (grassland, drainage line, *etc.*). Concerning the former, pragmatic considerations determined which part of each species data-set was considered (*e.g.* only records where the bird was seen), or if the different records were combined (*e.g.* combining all records regardless of type, *i.e.* seen or heard). In most cases this introductory material is followed by headed paragraphs outlining the annual, seasonal and daily occurrence of the specific activity or activities of the bird. The section is concluded with the occurrence of activity during the early mornings of 2007/8 in the grassland and the drainage line. Because the latter data-set encompass only one year, patterns thus revealed should be considered provisional. For species recorded during less than 10% observation days, everything is discussed in paragraphs without headings. The text of most species is concluded with a *Discussion* where an attempt is made to explain the data presented in the forgoing sections. Circadian and circannual rhythms are not specifically considered, except when the seasonal data points to a narrow window of time during which activity commenced or ceased, *e.g.* the arrival of migrants or the start of displays or moult.

3.2.2.1 Tables

For species recorded on more than 5% (*i.e.* 32.8) observation days, a table giving a numerical data summary of 5-minute checklists is included. This table includes data for all observation days (a) and the early morning data-set of 2007/8 (S0 and S1 only) for the drainage line (b) and grassland (c). The table was designed to be self-explanatory (*e.g.* Table 4.1, page 145). The only entries in need of some explanation here are the "Proportion" and "Activity index" columns.

The proportion refers to the fraction of 5-minute checklists during which a specific activity occurred, based on the total number of checklists during which the species was recorded. Thus, when there is only one activity for the species, the proportion will be exactly one.

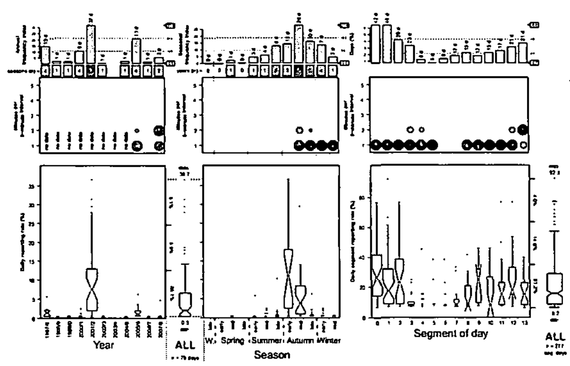
The activity index was calculated by dividing the number of 5-minute checklists during which the activity occurred by the number of bird-days. The resulting number was rounded to the nearest integer. This index gives a rough indication of activity levels of a species. For example, an activity index of 3 means that the species or a particular activity of that species was recorded during an average of 3 5-minute checklists per day.

For species where data was collected for each minute, a second table is included summarising the data (*e.g.* Table 4.2, page 145).

3.2.2.2 Figures

A number of figures were designed to investigate different aspects. Many of them analyse daily reporting rates and segment reporting rates. A daily reporting rate is the proportion of 5-minute checklists on which a species (and activity) was recorded for a particular day. Segment reporting rate refers to the proportion of 5-minute checklists on which a species (and activity) was recorded for a particular day and segment. In the paragraphs below, insets illustrate figure examples with the page number of the specific example indicated.

General summary figure: This figure summarise the annual (left), seasonal (centre) and daily (right) occurrence of activity in the grassland. It consists of a top and bottom section, some species also having a section in the middle. The annual and seasonal analyses are based on the 656 days with 10–14 observation segments, and the daily analysis is based on all observation segments.



Example, page 147.

The top section consists of bar-charts of the *annual frequency index* per year (left), the *seasonal frequency index* per season (centre) and the *percentage days* per segment (right). Bars are shaded from white, 0, through the various shades of grey to black, 100. In order to maximise the visual perception of differences, the bars in each diagram are scaled so that the minimum value is at the bottom and the maximum value at the top, with the actual value of the two extremes indicated in arrowed boxes in the right margin of each diagram. As an additional aid to gauge the magnitude of differences, the maximum value was divided by three and the limits of the resulting thirds indicated by a faded line in the background with the value printed in the right margin of each figure. Above each bar is a vertically printed number followed by a 'd'; this is the actual number of days involved and the n-value for each year (left), season (centre) or segment (right).

For each year, the annual frequency index (afi) was calculated as follows:

$$afi = \left(\frac{\left(\frac{x_1}{t_1} + \frac{x_2}{t_2} + \frac{x_3}{t_3} + \frac{x_4}{t_4} + \frac{x_5}{t_5} + \frac{x_6}{t_6} + \frac{x_7}{t_7} + \frac{x_8}{t_8} + \frac{x_9}{t_9} + \frac{x_{10}}{t_{10}} + \frac{x_{11}}{t_{11}} + \frac{x_{12}}{t_{12}} \right)}{12} \right) \times 100 \qquad (3.1)$$

where x is the number of days per season (1–12) during which activity was noted, and t the total number of observation days per season. This was necessary because the seasonal coverage was not the same during all years (Fig. 3.6). For the same reason a seasonal frequency index (sfi) was calculated for each season as follows:

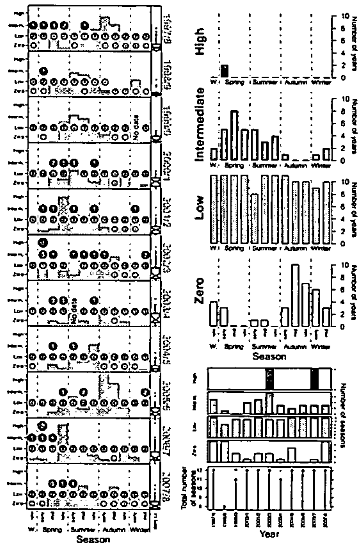
$$sfi = \left(\frac{\left(\frac{x_1}{t_1} + \frac{x_2}{t_2} + \frac{x_3}{t_3} + \frac{x_4}{t_4} + \frac{x_5}{t_5} + \frac{x_6}{t_6} + \frac{x_7}{t_7} + \frac{x_8}{t_8} + \frac{x_9}{t_9} + \frac{x_{10}}{t_{10}} + \frac{x_{11}}{t_{11}} \right)}{11} \right) \times 100 \qquad (3.2)$$

where x is the number of days per season per year (1–11) during which activity was noted, and t the total number of observation days per season per year. No conversion was necessary for the day frequency of the segment data because it was based on the proportion of days during which activity was noted during each segment.

The bottom part of the general summary figure uses box-and-whisker plots to summarise the daily reporting rates per year (left) and per season (centre), as well as daily segment reporting rates (right). The overall distribution of daily reporting rates is indicated by a box-and-whisker plot in between the annual and seasonal diagrams, with the proportion of low, intermediate and high reporting rate days indicated on the right-hand y-axis of the annual diagram. A similar summary is shown for daily segment reporting rates on the right.

Species for which 1-minute data are available, have a third set of diagrams in between the top and bottom panels. These diagrams indicate the proportion of 5-minute intervals — relative to the maximum as printed in the black circle — during which activity occurred during 1, 2, 3, 4 or 5 minutes during each year (left), season (centre) or segment (right). Both the shading and area of the circles are proportional to the maximum attained per year (left), season (centre) or segment (right). This data is referred to as activity intensity.

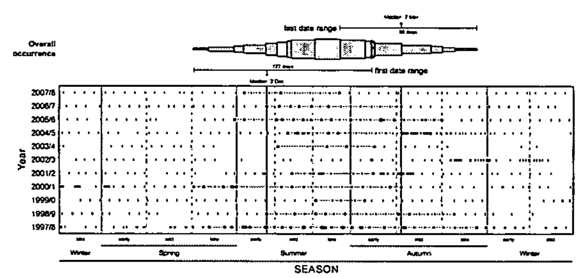
Yearly detail figure: Whereas the previous figure gives a good general summary of the annual and seasonal (and daily) fluctuations in activity patterns, the yearly detail figure allows for a more refined analysis. It consists of two main parts, left and right. On the left the seasonal occurrence of LIH-days is illustrated for each year, together with the occurrence of days during which no activity was noted. These different types of days are distinguished by stratification (zero, bottom; high, top), shading and size of the circles, the numbers in the circles referring to the number of days involved. The shaded background represents the rainfall for each season and is similar to that which appears in Figure 2.16. Collectively this presentation of the data illustrates the occurrence of LIH-days relative to rainfall. The box-and-whisker plots in the bottom left corner of the general summary figure are duplicated at the end of each year in the yearly detail figure.



`Example, page 176.`

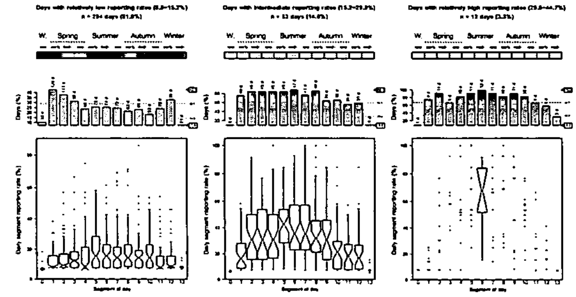
The diagrams in the right half of the figure represent summaries of the data on the left. The bottom part summarise the data per year with the asterisks in 1999/0 and 2003/4 representing the two season-years (early winter 1999/0 and early summer 2003/4) during which no observation days occurred (see Figure 3.6). The top part summarise the seasonal occurrence of LIH-days.

Migration figure: For the more common migrants, an additional figure investigates variation in arrival and departure dates. The figure is based on the entire data-set of each species and consists of two parts: a bottom section detailing the occurrence of the birds and a top section summarising the data. The bottom section shows the years on the y-axis and the seasons on the x-axis. For each year, dots indicate the occurrence of the species and short vertical lines days with zero records. A horizontal grey line connects the first and last date of occurrence for each year. The thickness of the diagram at the top is relative to the number of grey lines between specific dates. This top diagram is annotated with basic statistics on arrival and departure dates, including the median dates that are also indicated in the bottom figure by thin vertical black lines.



`Example, page 238.`

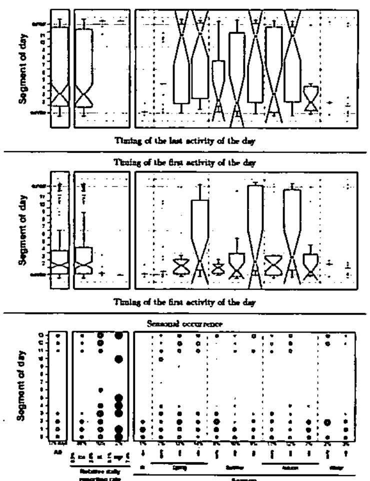
LIH figure: How do high reporting rate days differ from low reporting rate days? The LIH figure investigates this type of questions and shows the daily data for low (left), intermediate (centre) and high (right) reporting rate days. It is similar to the diagrams at the right of the general summary figure, except for some



`Example, page 164.`

statistics and seasonal diagrams at the top. The shading of the latter seasonal diagrams ranges from white to black to represent percentage occurrence from 0–100%. The LIH figure is only shown when at least two categories of low, intermediate or high reporting rate days attained a minimum of 12 bird-days. Although the data for all categories are shown in the figure, those that attained less than 12 bird-days are generally ignored in the text.

Daily activity figure: This figure views daily occurrence from a seasonal perspective. It is based only on days with 14 observation segments. There are three panels representing the relative occurrence of activity throughout the day (bottom), the timing of the first (centre) and last (top) activity of the day. Each panel is sub-divided into three parts, summarising from left to right all the data, data for LIH-days and for each season.



Example, page 215.

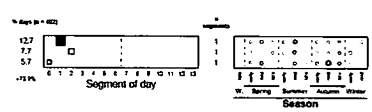
Statistics and x-axis captions in the bottom figure are also applicable to the centre and top figures. The number of bird-days are indicated above the "All" caption with percentages to its right indicating proportions from this number for LIH-days and seasons respectively. The vertically printed percentages above the "Relative daily reporting rate" caption indicate the daily reporting rate limits of LIH-days.

The area and shading of circles in the bottom figure are proportional to the percentage of days for the specific category, *e.g.* intermediate reporting rate days or mid-summer.

Box-and-whisker plots summarise the data for the occurrence of the first (centre) and last (top) activity of the day. If activity occurred during the first or last 5-minute interval of the day, the percentage of days involved is printed at the bottom (first 5-minute interval) or top (last 5-minute interval) of the diagram (*e.g.* Fig. 4.33B).

Bird-segment combination figure: Are there any bird-segment combinations per day during which activity occurred relatively frequently? This is the question addressed by the bird-segment combination figure. For activities with 100 or more bird-days, only bird-segment combinations that occurred on more than 5% bird-days are considered, and for activities with less than 100 bird-days only bird-segment combinations occurring on more than 5 bird-days.

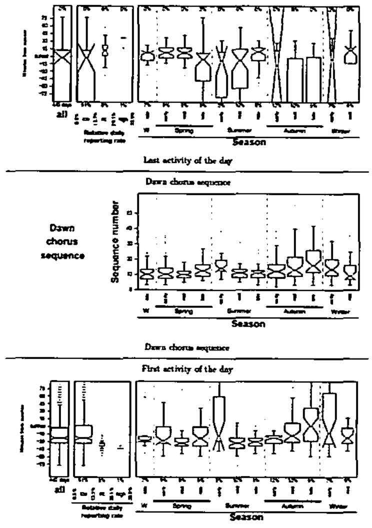
The statistics on the left include from top to bottom the total number of bird-days, the proportion of these days during which each particular bird-segment combination occurred, and at the bottom the "+..%" indicates the proportion of bird-days during which bird-segment combinations occurred during 5% (or 5) or less bird-days. The squares in the left half of the figure indicate which combination of bird-segments occurred during more than 5% (or 5) bird-days. The area and shading of these squares are relative to the percentage bird-days of the combination that occurred most frequently (always shown at the top).



Example, page 191.

In the right half of the figure, circles indicate the seasonal occurrence of each particular bird-segment combination, with the shading (white to black; 0–100%) and area of the circles indicating the relative frequency of occurrence.

Detailed first/last activity figure: For a number of species, the timing of the first and/or last activity of the day usually occurred during a narrow window early or late in the day. This will be clearly seen in the centre and top panels of the daily activity figure. However, those diagrams are based on the relative timing of occurrence within each segment of the day. The detailed first/last activity figure shows the absolute timing of the first and/or last activity of the day (depending on the occurrence of activity during the relevant times), with the y-axis fixed to 90 minutes either side of sunrise/sunset.



Example, page 180.

In addition, the '**dawn chorus sequence**' is indicated for species where the median timing of the first activity of the day was before sunrise during at least one season. It refers to the sequence in which birds were recorded each day, starting from at least 50 minutes before sunrise. The calculation procedure was as follows: Assume the following data-set (number refers to Roberts' numbers):

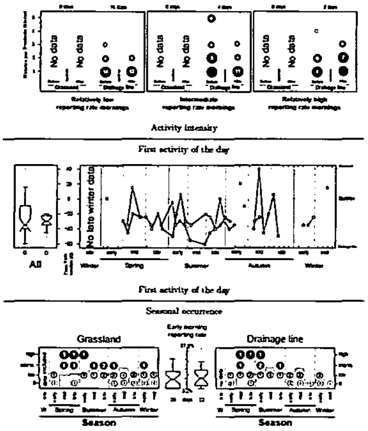
$$|^{5h25}\ 0\ |^{5h30}\ \overline{354},\overline{495}\ |^{5h35}\ \overline{354},\overline{495}\ |^{5h40}\ \overline{354},\overline{746},\overline{495},\overline{355}\ |^{5h45}\ \overline{354},\overline{495},\overline{567},\overline{746}$$

This would translate into the following dawn chorus sequence:
#1 Cape Turtle Dove R354, Eastern Clapper Lark R495;
#2 Bokmakierie R746, Laughing Dove R355;
#3 African Red-eyed Bulbul R567.

The title 'dawn chorus sequence' is used here in the sense that the assessment *commenced* at dawn before most or any of the species were awake/active. It is based on the combined data of each species.

Seasonal detail figure: This figure (see for example page 299) shows, for each season, the fluctuations in daily segment reporting rates and day-frequency, similar to the diagram right on the general summary figure. The scales are the same for all seasons.

Early morning figure: The focus of the previous figures was exclusively on the grassland part of the data-set. The early morning figure illustrates the data for both the grassland and the drainage line in a comparative way. Only consecutive mornings, *i.e.* grassland day one, drainage line day two (n = 43 morning-pairs), and S0 and S1 are considered, with as many as three diagrams stacked on top of one another. The bottom figure illustrates the seasonal occurrence of LIH-mornings in the grassland (left) and the drainge line (right), with the seasonal



Example, page 181.

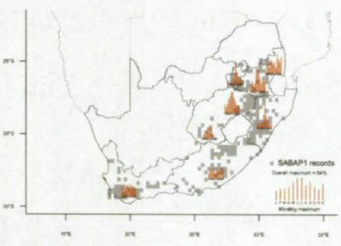
occurrence of rainfall during 2007/8 (Fig. 2.16) represented by the shading in the background. In the middle of this bottom diagram, two box-and-whisker plots summarise the early morning reporting rates in the two habitats. The overall minimum and maximum values are also indicated together with tick marks on either side indicating the limits of LIH-mornings in each habitat.

The second diagram, if shown at all, indicates the timing of the first activity of the day for each morning in both habitats, D for drainage line and G for grassland. Tick marks at the top (grassland) and bottom (drainage line) indicate mornings with no records for the species. Two box-and-whisker plots on the left summarise this data.

Because the early morning data for the drainage line is only available for 2007/8, the data in the above mentioned two diagrams are always illustrated for the seasons from late winter to mid-winter, even for cool-season species.

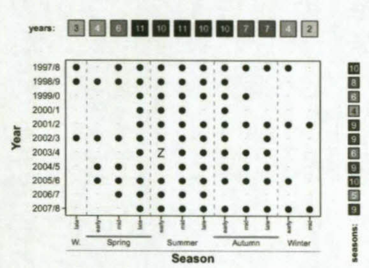
A third diagram, included only if there was sufficient data available, analyse the 1-minute data separately for S0 and S1, and for LIH-mornings. The area and shading of the circles are proportional to the maximum number of 5-minute intervals (printed in the black circle) during which activity occurred during 1, 2, 3, 4 or 5 minutes.

SABAP1 figure: Raw data from SABAP1, obtained via the second Southern African Bird Atlas Project (SABAP2) website (`http://sabap2.adu.org.za`), was used to investigate movement patterns of selected bird species in South Africa. The data was analysed separately for each of the nine South African provinces and subdivisions thereof. For each of these areas the percentage quarter degree grid-squares (QDGS) in which the particular species occurred was calculated for each month based on the total number of QDGS wherein the birds were encountered. The resulting data is plotted on a distribution map with a vertical red line for each month and region. A legend appears in the bottom right-hand corner of the map, indicating the maximum percentage of QDGS in which the species was recorded for each month as well as the actual value, 'Overall maximum'.



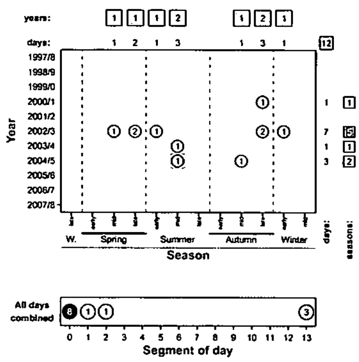
`Example, page 732.`

Combined data figure: For some species, particularly those for which more than one activity was recorded, an additional figure combines all the data for all observation segments to show the overall annual and seasonal occurrence of the species. The figure consists of a matrix with years on the y-axis, seasons on the x-axis and black dots indicating when the species was recorded. No observations were conducted during early summer 2003/4, hence the 'Z' in that month. A row of squares at the top shows the summation of the number of years during which the bird was recorded for each season, and a row of squares at right sum the number of seasons during which the bird was recorded each year. The squares are shaded from white, representing zero observations, to black, representing the maximum number of years/seasons.



`Example, page 575.`

Few records figure: The data for species recorded during less than 10% (65.6) observation days are summarised in a year/season matrix. The number of days during which the bird was recorded is printed in open circles in this matrix, with the totals at the top and to the right indicating the total number of days per season/year. Data from non-observation days are also included and indicated by a grey square with the number of days printed inside. Where the two sets of data coincided, the observation day data was given priority and its circle and number of days printed over the square and its number. The number of days during which activity was recorded per segment is indicated at the bottom of the figure with the shading of circles varying form white for the segment with the lowest number of days (at least one day) through shades of grey to black, representing the segment(s) with the highest number of days.



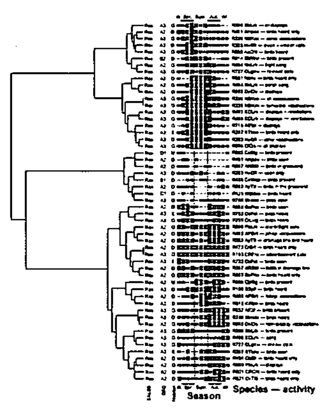
Example, page 144.

3.2.3 BIRD COMMUNITY

Chapter 6 derives its information mainly from the species accounts in Chapters 4 and 5, even though no explicit reference is normally made to them. For practical and aesthetic reasons, species are represented by their Roberts' number plus a short five character 'name hint' in figures and tables. For example, "R552 AyTit" for the Ashy Tit and "R716 AfPpt" for the African Pipit.

In order to assess annual, seasonal and daily patterns, the data for each species (particularly the general summary figure, page 132) was evaluated and scored on a scale from zero (no records) to three (a peak in activity) for each year, season and segment, respectively. In general, fluctuations in frequency indices as well as daily reporting rates were used to assess the situation for years and seasons. For the daily pattern, the maximum daily frequency of occurrence for the particular species was divided by three and all segments assigned a value of one, two or three corresponding to the lower, middle and top third in which the value of each segment falls. An exception was made when a segment had a day-frequency value of less than 2%, in which case it was assigned a value of one irrespective of the third in which it falls, and with zero records which are assigned a zero. This 0–3 scaling is termed "relative occurrence values" and is abbreviated ROVs.

ROVs are presented in diagrams showing from left to right a dendrogram, South African status (SALSS; including Lesotho and Swaziland), grassland frequency class (GFC) and habitat preference at Glen (Habitat) (Appendix A), the annual/seasonal/daily data with the height and shading of boxes relative to the 0–3 scaling (horizontal lines represent zero), and finally the species name and the specific activity involved, or "species-activities" as it is often referred to in the text. Species that have more than one entry per figure are indicated in **bold**.



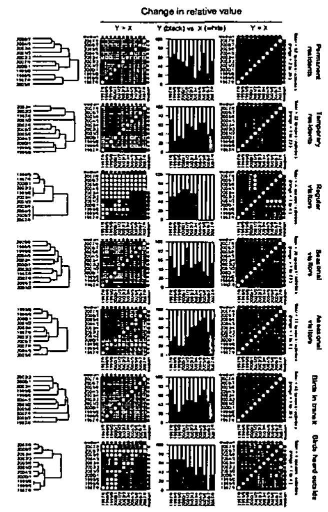
Example, page 1035.

Because the dendrogram computations required a value for every year (season and segment) and because it was desirable to include species for which no data was available for the first few years, the ROV of the first year for which data was available in such cases were duplicated in the preceding years, but the true state of the data is shown in the figures.

Vertical lines demarcate summer and the middle of the day in the seasonal and daily diagrams respectively. The data of cool-season species are analysed separately for each Glen status category.

Two sets of figures further summarise the data of the above mentioned diagrams. The first set shows for each year/season/segment the total number of species-activities grouped by Glen status category and ROVs (see page 1050 for an example).

The second set of figures investigates similarities and differences between the respective years, seasons and segments, based on ROVs. These figures, and the calculations on which they are based, are similar for years, seasons and segments; years are used here as an example. Each figure consists of four horizontally arranged diagrams for each Glen status category (Permanent residents, Temporary residents, *etc.*; See Appendix A). The one on the left shows the results of cluster analysis based on ROVs with the horizontal scale of the dendrogram relative to the maximum cluster distance of all status categories. The second and forth figure consist of a matrix comparing each year with other years. This comparison is based on the following calculations. For each species-activity, the ROV of each year was compared to that of each other year to determine if values decreased, stayed the same or increased. Below is an example comparing first the ROV of 1997/8 (*i.e.* 1) and then that of 1998/9 (*i.e.* 2) with that of the other years for a particular species-activity. Decreasing (–), the same (=) and increasing (+) values are indicated:



Example, page 1056.

	1997/8	1998/9	1999/0	2000/1	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
ROVs	1	2	2	1	0	2	3	2	1	1	1
Comparing 1997/8	X	+	+	=	–	+	+	+	=	=	=
Comparing 1998/9	–	X	=	–	–	=	+	=	–	–	–

Here, the 'X' indicates which year is compared with other years. Comparison with the same year, *e.g.* 1997/8 with 1997/8, logically results in no difference and is ignored. The procedure was repeated for every year within each species-activity of each grouping (*i.e.* Glen status category and cool-/warm-season species). This was followed by counting, separately for each grouping, the number of decreasing (–), the same (=) and increasing (+) values for each year combination (*e.g.* 1997/8 vs. 2000/1). These totals were then plotted separately for increasing and decreasing (Y > X) and the same (Y = X) values. The area of each dot in these diagrams is relative to the total number of species-activities attained within each grouping, with the range of values indicated in the right-hand margin of the figure, together with the total number of species-activities within each grouping. The overall median value for each year is indicated similarly. In the diagram on the left (marked "Y > X") the ROVs *decrease* in going from the year on the y-axis to the year on the x-axis and *increase* in going from the year on the x-axis to the year on the y-axis.

The histogram marked "Y (black) vs. X (white)", in between the above mentioned diagrams, is based on the median values indicated in the diagram to its left and indicates the proportion of species-activities where ROVs increased (black bars) and decreased (white bars) for each year.

3.2.4 APPENDICES

Appendix A (page 1175): Status determination of individual bird species at Glen.

Appendix B (page 1179): Summary of the status of 197 bird species recorded at Glen from 1997/8 to 2007/8. An additional six species where identification problems were experienced are also included.

Appendix C (page 1191): Glossary.

3.3 Software

The preparation of this thesis relied exclusively on the following freely available programs:

- **HeidiSQL** (`http://www.heidisql.com`) is an easy-to-use interface for the popular Open Source SQL database management system **MySQL** (`http://www.mysql.com`).

- **LyX** (`http://www.lyx.org`) is a typesetting program built upon the **LaTeX** — mostly pronounced as "Lah-tech" — document preparation system, which, in turn, is a macro package based on **TeX**. TeX is a markup language created by Donald Knuth to typeset documents attractively and consistently. Its name originates from the Greek word $\tau\epsilon\chi\nu o\lambda o\gamma\iota\alpha$ (*technologia*), from where the English technology is derived.

- **JabRef** (`http://jabref.sourceforge.net`) is a reference manager that works with **Bibtex** databases. Bibtex, in turn, is a utility that generates bibliographic references in LaTeX documents.

- **R** (`http://cran.r-project.org`) is an integrated suite of software facilities for data manipulation, calculation and graphical display. All the figures in this thesis were drawn with this program and it was utilised for a number of other purposes as well.

- **Tinn-R** (`http://www.sciviews.org/Tinn-R`) is a graphical user interface (GUI) and editor for the R language and environment.

- **jEdit** (`http://www.jedit.org`) is a text editor.

- **GIMP** (`http://www.gimp.org`) stands for GNU Image Manipulation Program. It was used for editing photos included in this thesis.

- **Autostitch** (`http://www.autostitch.net`) is an easy to use and very efficient photo stitcher.
- **ReadPlease** (`http://www.readplease.com`) is an easy to use application used to read the text of the thesis aloud from the computer. This was very helpful in locating errors in the text.
- **PDF Split and Merge** (`http://www.pdfsam.org`) was used to prepare the final pdf file for printing.

4 Species accounts: Non-passerines

4.1 Struthionidae: Ostriches

As the largest living birds, ostriches are flightless and cursorial with two species occurring in Africa (now extinct in Arabia) with the Common Ostrich occurring in southern Africa (Hockey *et al.* 2005).

R001 Common Ostrich . . . . *Struthio camelus*

The Common Ostrich is endemic to sub-Saharan Africa (Brown 1982a). It is widespread in southern Africa but absent from Lesotho (Dean 1997a) and rare in southern Mozambique (Parker 1999). In South Africa, the only places where undoubtedly 'wild' Common Ostriches still occur include specific areas in the Northern Cape Province (*e.g.* Kgalagadi Transfrontier Park), North-West Province and Mpumalanga Province (*e.g.* Kruger National Park) (Dean 1997a). Birds elsewhere in South Africa are probably of domesticated stock or escapes (Dean 1997a).

The birds at Glen

The nearest place to the study site where Common Ostriches are kept is approximately 3.5 km to the south-west. Additional birds may occur on some of the surrounding game farms. Records of Common Ostriches at the study site were limited to the deep booming sound of the males.

Heard on 12 days with records limited to the period 2000/1–2004/5, and seasonally from mid-spring to early winter (Fig. 4.1). Activity was particularly frequent during 2002/3 when heard during five seasons compared to the 1–2 seasons of other years. Activity was mostly recorded before sunrise (Fig.4.1).

Discussion

According to Dean (2005a), the booming vocalisations of the Common Ostrich occur mainly during the breeding season, which, in arid areas at least, may be dependant on rainfall (Maclean 1993). At Glen, the relatively frequent occurrence of these vocalisations during 2002/3 (Fig. 4.1) started after good rains in early spring of that year. This was the only year which had good rains so early (Fig. 2.16; Fig. 2.18). However, the sample size is too small to draw any definite conclusions.

4.2 Podicipedidae: Grebes

Podicipedids are excellent divers which can stand and move on land only with difficulty due to legs set far back on the body to aid propulsion in water (Hockey *et al.* 2005). As a consequence, they are dependant on open water such as lakes and dams (Hockey *et al.* 2005). The 22 species occur

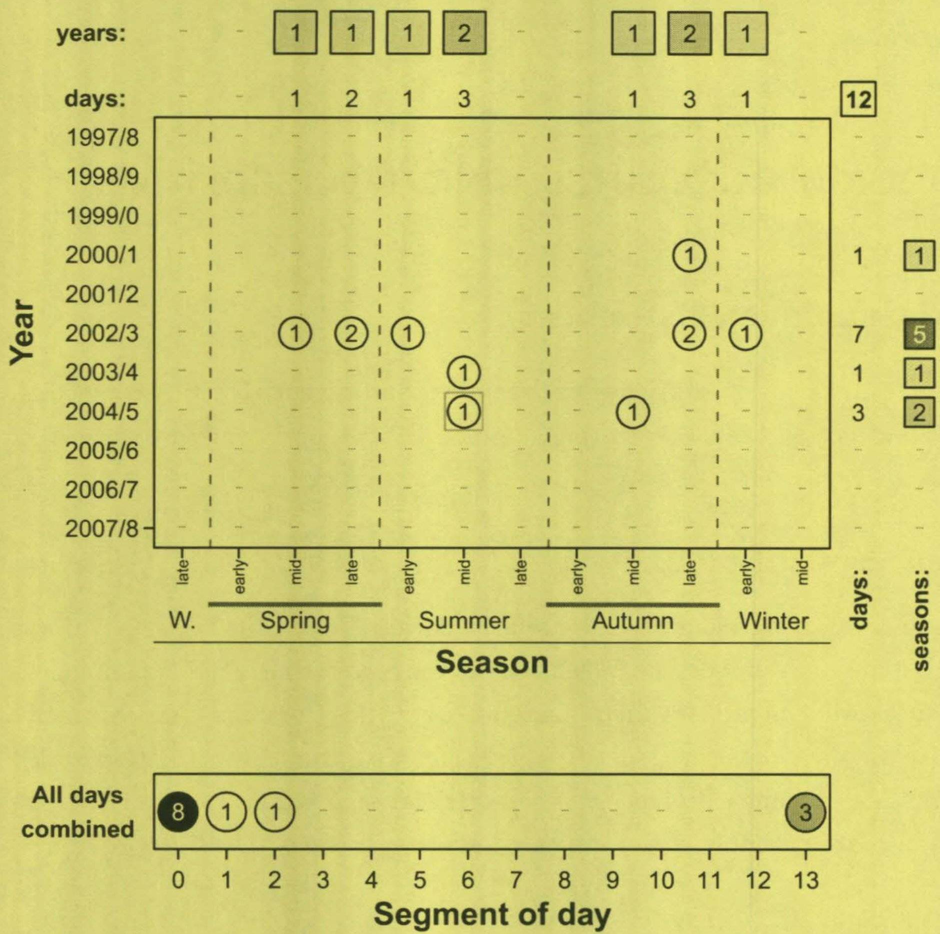


Figure 4.1: R001 Common Ostrich — birds heard only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

worldwide except in the polar regions, with three species occurring in southern Africa (Hockey *et al.* 2005). All three species occur in the Free State, but the Great Crested Grebe *Podiceps cristatus* and Black-necked Grebe *Podiceps nigricollis* are relatively scarce in the province, in contrast to the abundant Little Grebe R008 (Earlé & Grobler 1987; Harrison *et al.* 1997a), which was the only species recorded at Glen.

R008 Little Grebe.................................. *Tachybaptus ruficollis*

The Little Grebe occur in Eurasia and Africa (Llimona & del Hoyo 1992). It is widespread in southern Africa where largely concentrated in South Africa (scarce in the west), Zimbabwe, the northern and eastern parts of Botswana and in parts of Namibia (Dean 1997b); scarce in southern Mozambique (Parker 1999). In addition to sites with permanent water, breeding often occur at seasonal and ephemeral wetlands too (Tarboton 2001), after which they move to larger water-bodies as these breeding sites dry out (Taylor *et al.* 1999).

The birds at Glen

During the observations in the grassland, the distinctive calls of adult Little Grebes betrayed their presence on the farm dam in the drainage line, where they breed. Nests discovered there consisted of floating mounts of plant material in open water or along the edge of the dam. In the former case the nest is secured to aquatic vegetation while in the latter case the nest is anchored to a submerged branch. Calls of chicks were also heard, but only during the observations in the drainage line itself (Table 4.1). Data was recorded separately for each minute since mid-autumn 2005/6 (Table 4.2). Figures start on page 147.

Table 4.1: R008 Little Grebe: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	747	114 612	0.7	adults heard	12.0	656	79	9
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.741	80	1 190	6.7	adults heard	30.2	43	13	6
0.259	28	1 190	2.4	chicks heard	4.7	43	2	14
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–

Table 4.2: R008 Little Grebe: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
adults heard	mid-autumn 2005/6	49	101 380	0.0

Annual occurrence of drainage line adults heard in the grassland: Activity was noted on 12.0% of the days with an activity index of nine (Table 4.1a). Recorded during all years except 2003/4 (Fig. 4.2; Fig. 4.3). Compared to other years, 2001/2 was the year with the highest annual frequency index and number of seasons during which activity was recorded (7 vs. 0–4 seasons; Fig. 4.2; Fig. 4.3). In most years, daily reporting rates were less than 3% but as high as 36.7% in 2001/2, which was also the only year with intermediate and high reporting rate days (Fig. 4.2; Fig. 4.3). The median daily reporting rate of 2001/2 was also higher than that of all other years (Fig. 4.2). The activity intensity was slightly higher during 2007/8 when compared to 2005/6 (Fig. 4.2).

Seasonal occurrence of drainage line adults heard in the grassland: Activity was most frequent from late summer to early winter, being recorded only rarely from mid-winter to mid-summer (Fig. 4.2). Days with intermediate and high reporting rates were restricted to early and mid-autumn, with the 11.0% median daily reporting rate of early autumn being significantly higher than that of all other seasons with their median daily reporting rates < 1.3%, except mid-autumn which had a median daily reporting rate of 3.8% (Fig. 4.2; Fig. 4.3). Activity intensity was only slightly higher in early autumn (Fig. 4.2).

Daily occurrence of drainage line adults heard in the grassland: Overall, activity was most frequently recorded in the early morning and was least frequent from late morning to early afternoon (Fig. 4.2). The respective seasons showed a broadly similar trend with a distinct break in activity at mid-morning, and with activity resuming from late morning in early and mid-autumn (Fig. 4.4). The two bird-segment combinations occurring during more than five bird-days involved single segments S0 and S1, collectively accounting for 12.7% bird-days (Fig. 4.5).

The first activity of the day was often recorded in the morning, with activity tending to start earlier in early autumn than during other seasons (Fig. 4.4; Fig. 4.6). The dawn chorus sequence followed a pattern very similar to that of the first activity of the day (Fig. 4.6). The timing of the last activity of the day was more variable but tended to occur later in the day (often in the late afternoon) during early autumn (Fig. 4.4; Fig. 4.6).

Activity intensities were largely similar for most segments of the day (Fig. 4.2). Daily segment reporting rates ranged from 6.2 to 92.3% with 81.2% bird-segments attaining relatively low values (median daily segment reporting rates < 30%) with no clear daily trend (Fig. 4.2).

Early morning occurrence during 2007/8 of drainage line adult vocalisations: Activity was limited to the drainage line where it was recorded on 30.2% of the mornings and only during mid-autumn, late autumn and early winter (Table 4.1b; Fig. 4.7). First activity was often recorded approximately 50 minutes or more before sunrise (Fig. 4.7). Activity intensities before and after sunrise are comparable (Fig. 4.7).

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Chick vocalisations: Heard in the drainage line only where recorded on two days (Table 4.1b). This was towards the end of early autumn and the beginning of mid-winter.

Discussion

The occurrence of Little Grebe vocal records in the grassland mainly from the latter part of the main rain period (Fig. 4.2) coincides largely with the breeding season, which is from February to June [autumn to mid-winter] in the former Transvaal (Maclean 1985). It also corresponds to the time of the year when the dam in the drainage line is most likely to have water in. There is normally just enough space on the dam for one breeding pair, but when it is fully inundated more pairs could be accommodated. The last time that such a situation occurred was in 2001/2. The relatively high levels of activity during that year (Fig. 4.2; Fig. 4.3) were most probably caused by interactions between the various pairs on the dam at the time.

Two classes of factors contributed to the scarcity of vocal records in the grassland from mid-winter to mid-summer (Fig. 4.2). On the one hand it is possible that detectability changed seasonally, presumably being highest during the breeding season. On the other hand there where

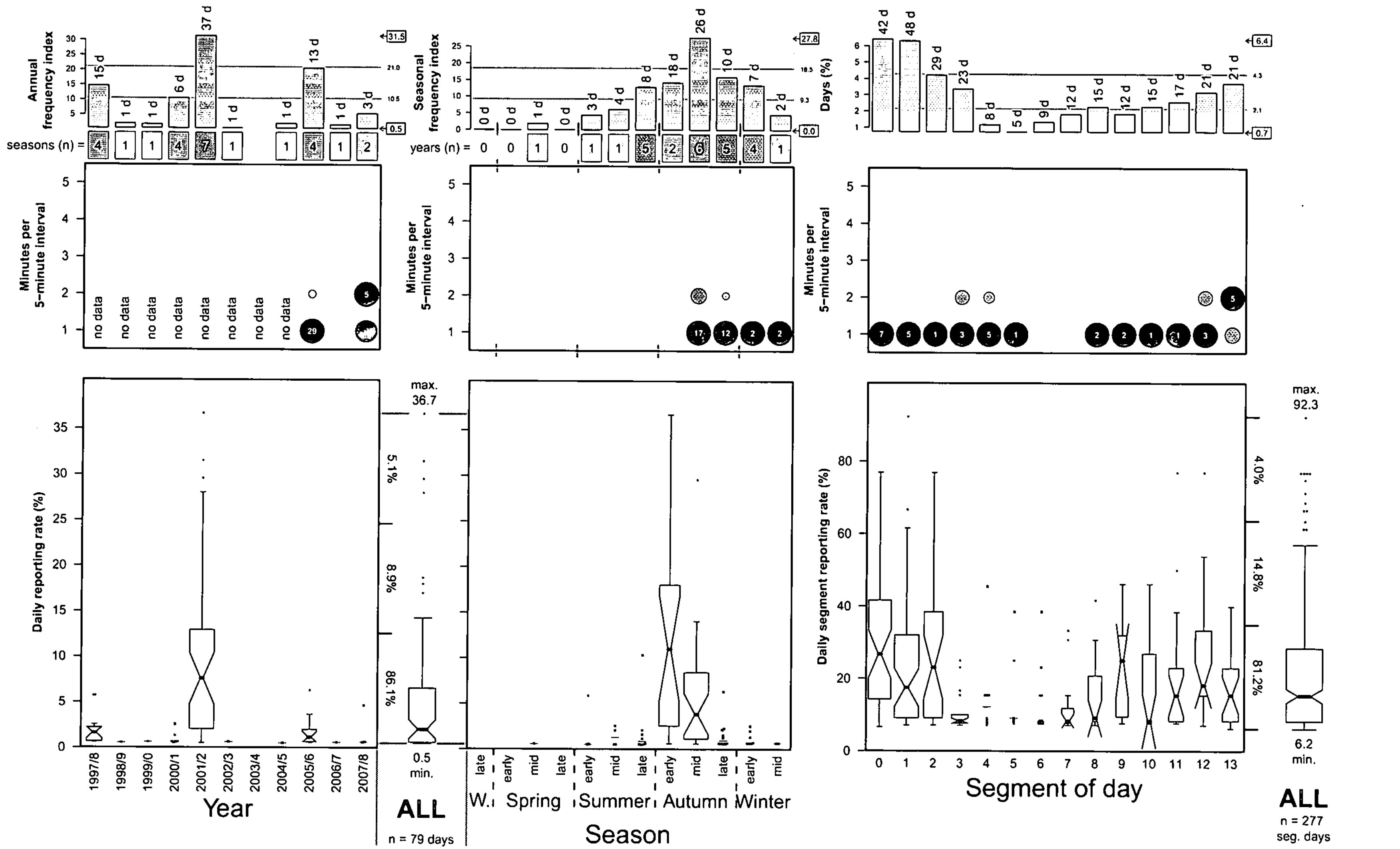


Figure 4.2: R008 Little Grebe — adults heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

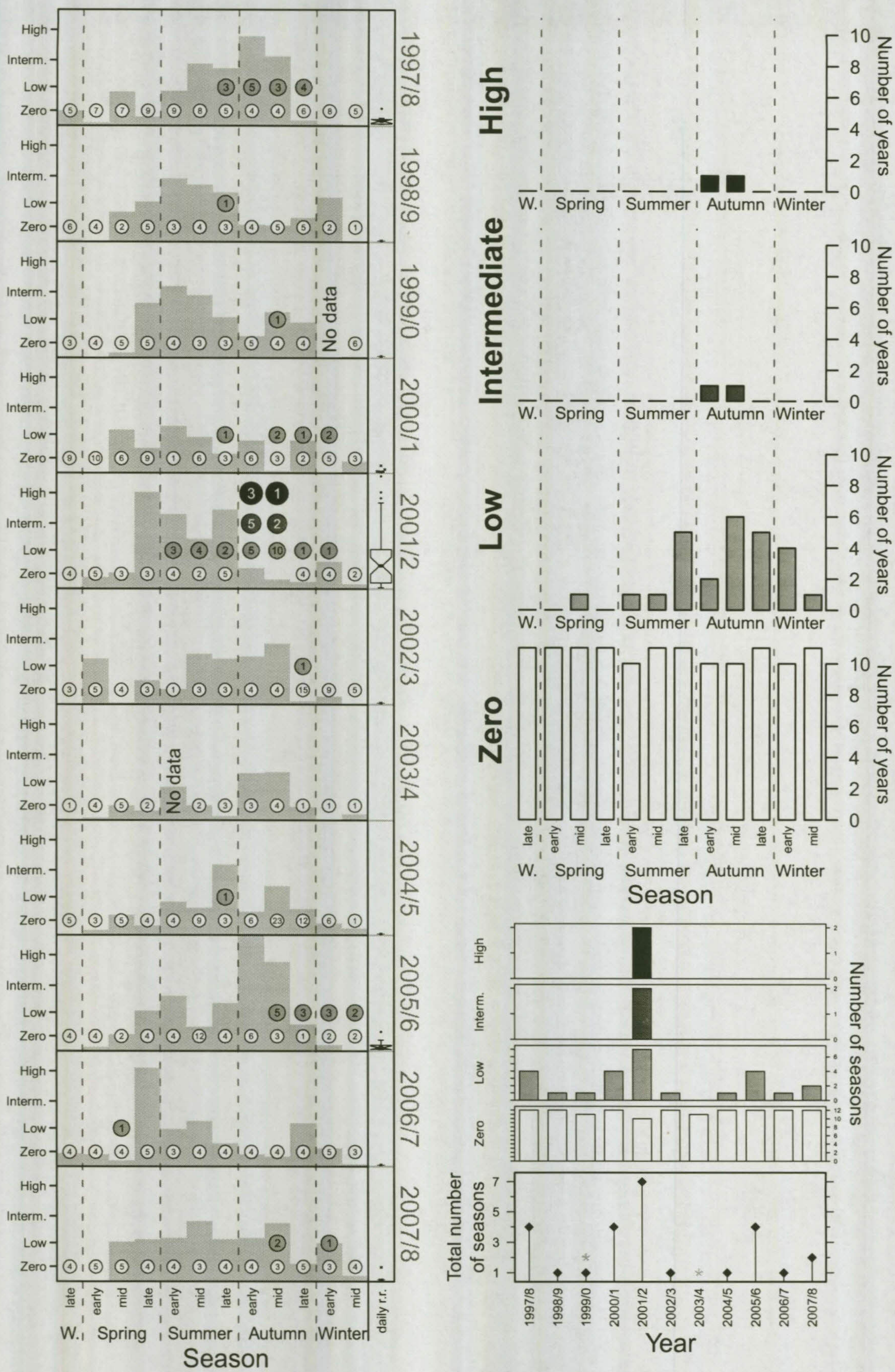


Figure 4.3: R008 Little Grebe — adults heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

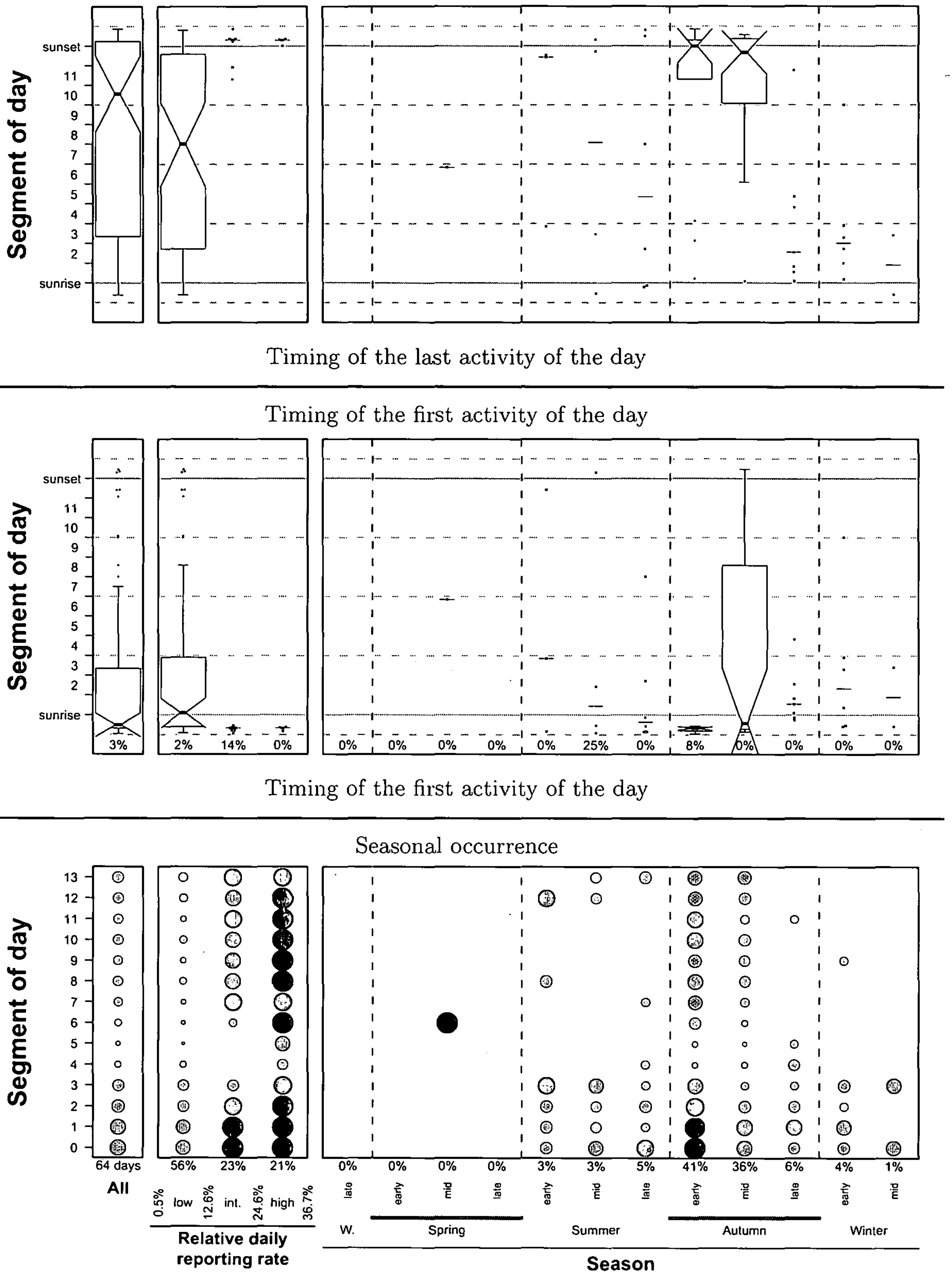


Figure 4.4: R008 Little Grebe — adults heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

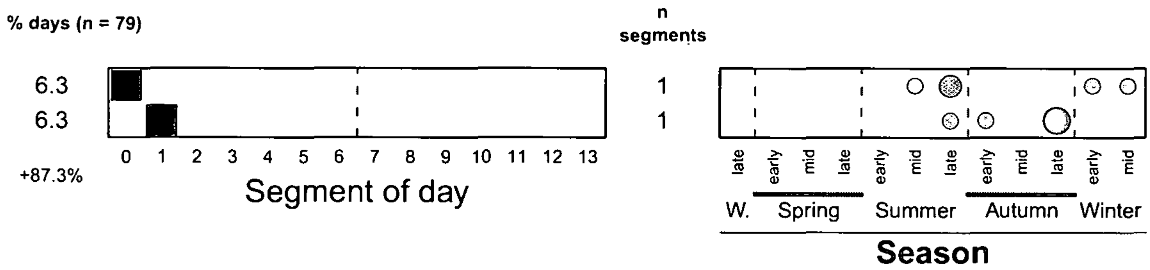


Figure 4.5: R008 Little Grebe — adults heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

times when the birds were truly absent, such as when the dam was dry. They are known to concentrate on more permanent water-bodies at these times (Milstein 1975; Skead & Dean 1977; Taylor *et al.* 1999).

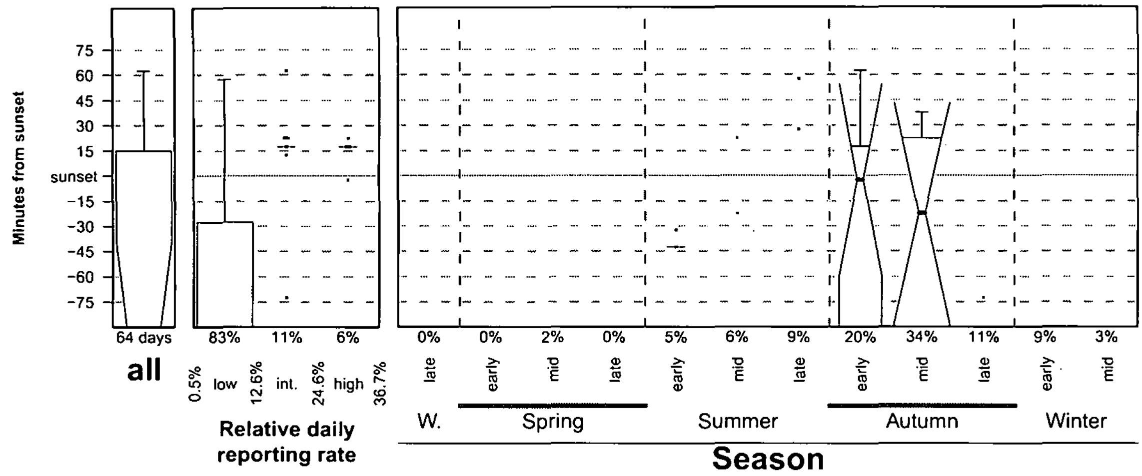
Another reason for the absence of the birds may be related to moult. In Europe adult birds undergo a complete post-breeding moult during which time they are flightless for three to four weeks (Cramp 1998; Ginn & Melville 2007). According to Dean (2005i) there is no evidence of a similar situation in southern Africa, presumably based on a single study in Zambia. However, early morning observations at the dam at Glen during 2007/8 and 2008/9 suggest that young may be permanently abandoned by their parents before they are capable of flight (but able to survive on their own) during early or mid-winter. This may point to the need of adult birds to get to permanent water-bodies for their flightless moult. More detailed studies are needed to clarify the moult strategy of Little Grebes in southern Africa.

4.3 Phalacrocoracidae: Cormorants

Members of this monogeneric family actively pursue prey underwater using their fully-webbed feet for propulsion, with the fairly small wings held closed under water (Hockey *et al.* 2005). The 39 species occur worldwide with five species found in southern Africa (Hockey *et al.* 2005). Unlike southern Africa's three (near-) endemic cormorants species which are restricted to marine habitats, the White-breasted Cormorant R055 and Reed Cormorant R058 also occur at inland wetlands (Hockey *et al.* 2005), including those in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a). Both species were recorded at Glen.

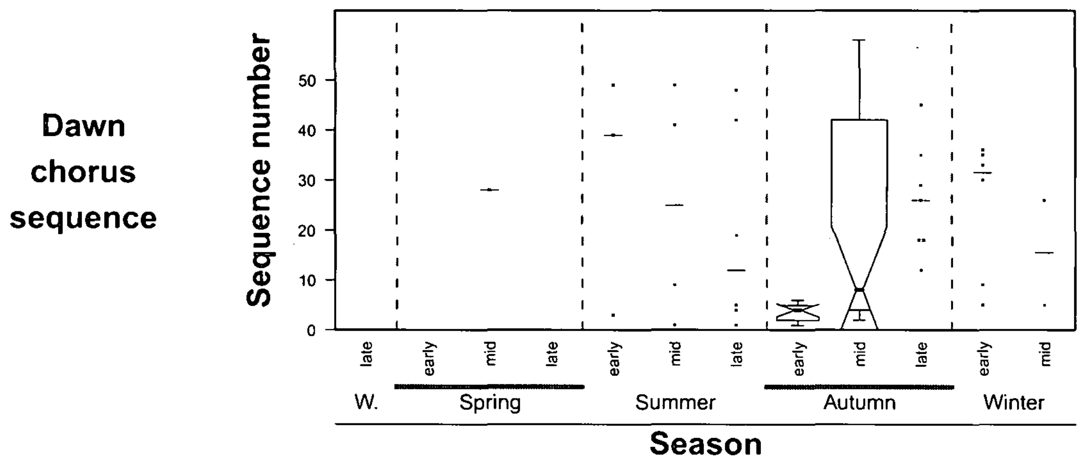
R055 White-breasted Cormorant .... *Phalacrocorax lucidus*

The White-breasted Cormorant is endemic to sub-Saharan Africa (Crawford 2005). In southern Africa it is widespread in Zimbabwe, Swaziland, Lesotho and South Africa (except the dry west) and less common elsewhere (Hustler & Underhill 1997). It is known to undertake nomadic movements in response to changing water levels, but ringing recoveries suggests that the majority of birds at the ringing sites are sedentary, with some birds undertaking long-range dispersal (Underhill *et al.* 1999). The seasonality model for SABAP1 Zone 7 shows no seasonal trend (Hustler & Underhill 1997).



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

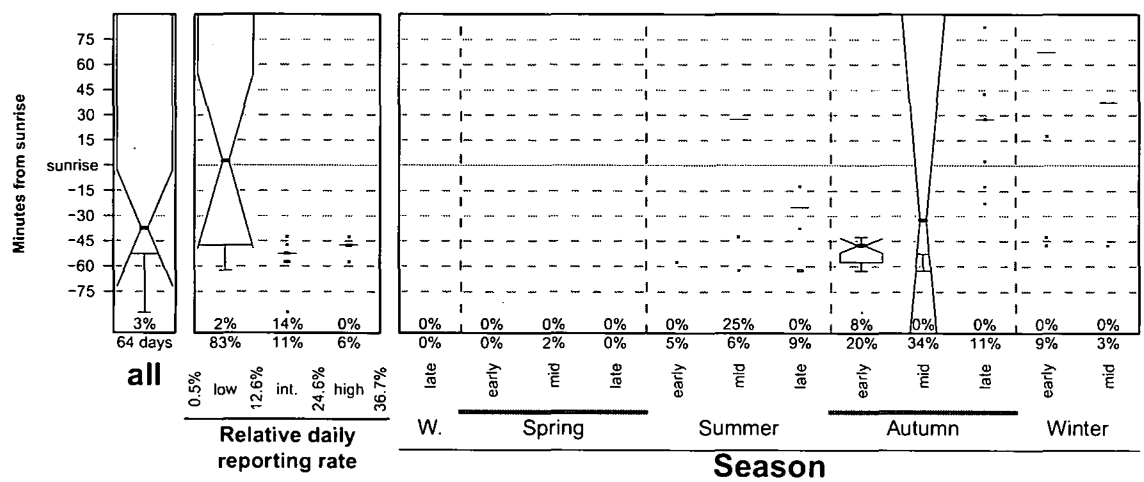
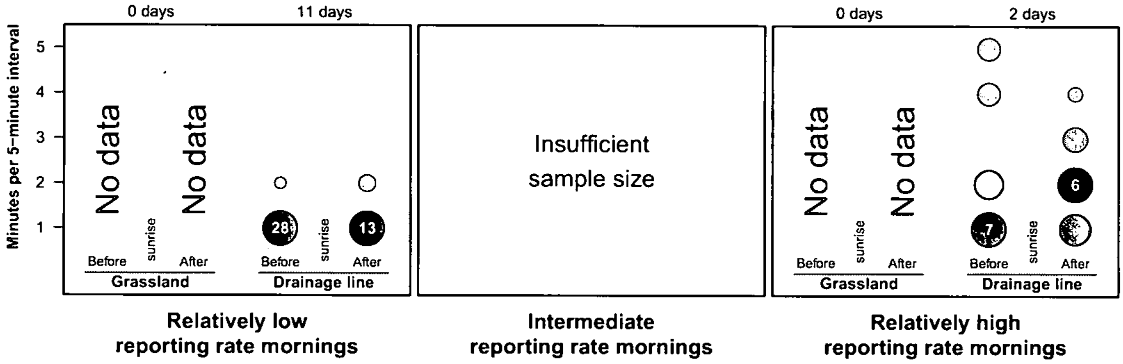
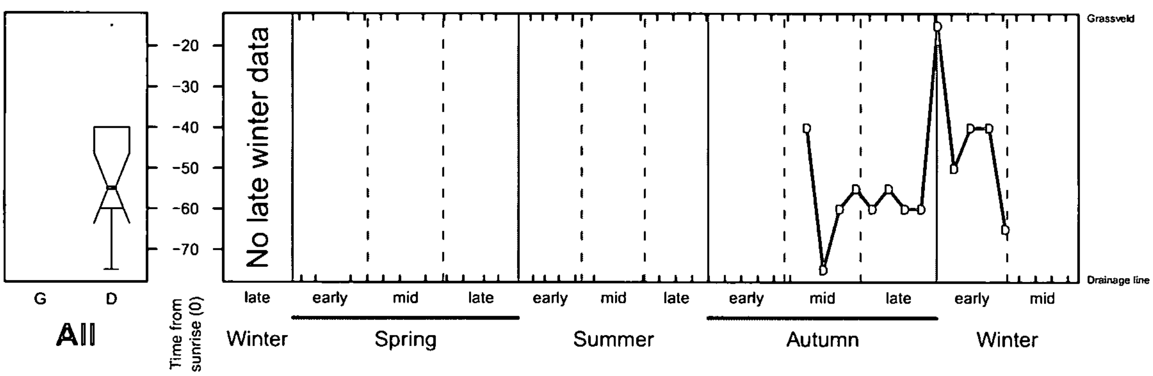


Figure 4.6: R008 Little Grebe — adults heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

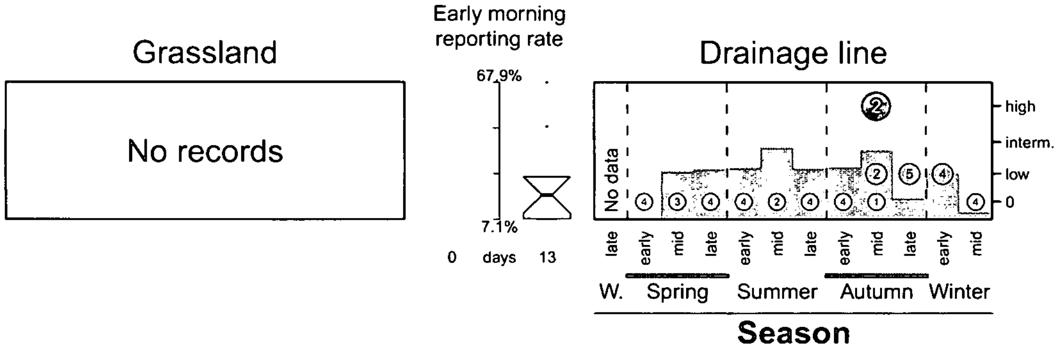


Figure 4.7: R008 Little Grebe — adults heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

The birds at Glen

In the grassland, only small flocks (1–3 individuals) of White-breasted Cormorants were seen as they flew overhead on five days in five years, with records limited to late summer, mid- and late autumn (Fig. 4.8). All records were during mornings (Fig. 4.8).

Discussion

Although the sample size is small, the Glen data do suggest an autumn centred seasonal occurrence pattern for the White-breasted Cormorant (Fig. 4.8). This period coincides with the beginning of the breeding season, which, according to Hustler & Underhill (1997) and Tarboton (2001), is mainly from March to June [mid-autumn to mid-winter] in the southern African interior. The observations at Glen possibly suggests movement of birds to breeding colonies, which, according to Tarboton (2001), usually number less than 30 nesting pairs.

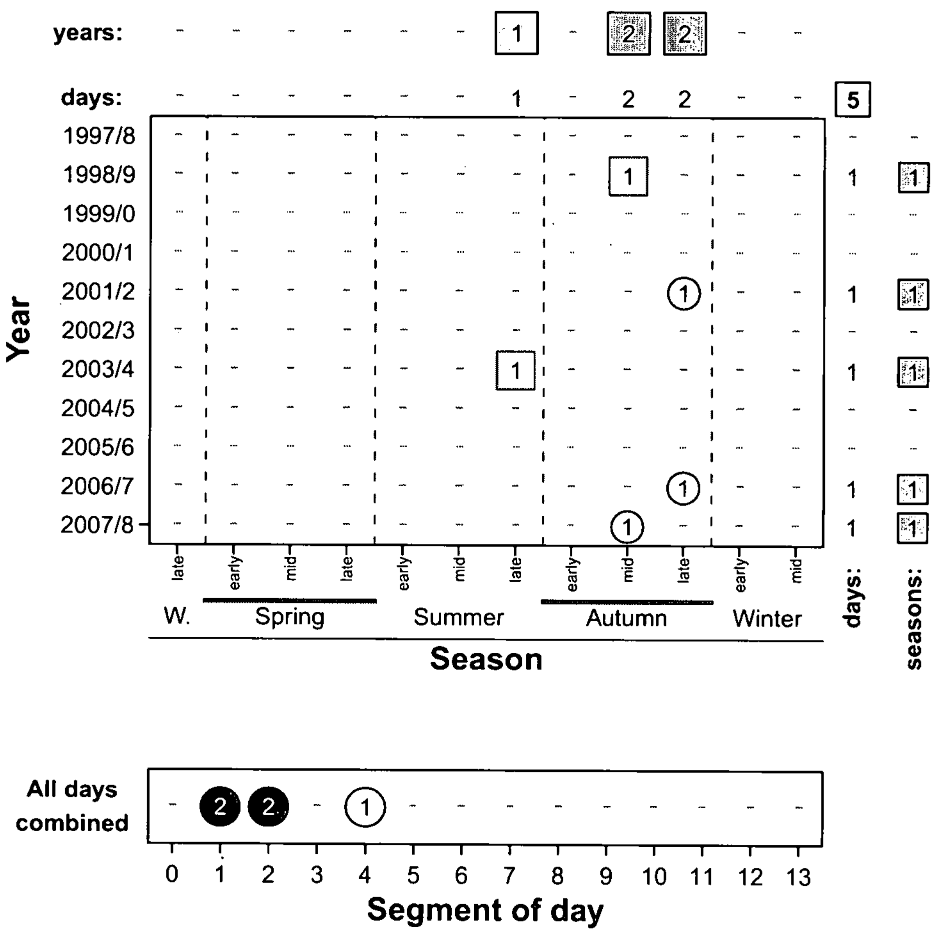


Figure 4.8: R055 White-breasted Cormorant — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R058 Reed Cormorant .... *Phalacrocorax africanus*

The Reed Cormorant occurs in sub-Saharan Africa and Madagascar (Orta 1992a). In southern Africa it is widespread in Zimbabwe, Swaziland and South Africa (except the dry west) with strongholds in the Okavango basin and the panveld region of the (former) southern Transvaal and Free State (Hustler 1997a). It occurs at freshwater wetlands of any size, including ephemeral habitats, rivers and fast-flowing streams with pools (Hustler 1997a). Seasonal fluctuations in numbers at several wetlands suggests that the Reed Cormorant is a partial migrant. However, the destination of these birds and direction of their movements are unknown (Hustler 1997a; Ryan 2005b; Underhill *et al.* 1999).

The birds at Glen

Records from the grassland and the drainage line were limited to flocks of 1–7 Reed Cormorants flying overhead. Recorded in the grassland on seven days spread over five years with records limited to mid-summer, late summer and mid-autumn (Fig. 4.9). Most frequently seen in the early morning shortly after sunrise (S1) (Fig. 4.9).

During the early mornings (S0 & S1) of 2007/8, seen on three occasions in the drainage line (mid- and late autumn) and on one morning in the grassland (late summer) (Table 4.3b & c).

Table 4.3: R058 Reed Cormorant: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	6	114 612	0.0	birds seen only	0.9	656	6	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	4	1 190	0.3	birds seen only	7.0	43	3	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 188	0.1	birds seen only	2.3	43	1	1

Discussion

As with the White-breasted Cormorant R055, the data of the Reed Cormorant also points to a seasonally consistent pattern (mid-summer to mid-autumn; Fig. 4.9). Egg-laying has been recorded throughout the year, but is mainly from November to March [summer to mid-autumn] (Hustler 1997a; Tarboton 2001). Its occurrence at Glen may be linked to breeding.

4.4 Anhingidae: Darters

Species belonging to the monogeneric family Anhingidae are fairly large, diving birds confined to still or slow-moving freshwater bodies in fairly warm regions (Hockey *et al.* 2005). They stalk

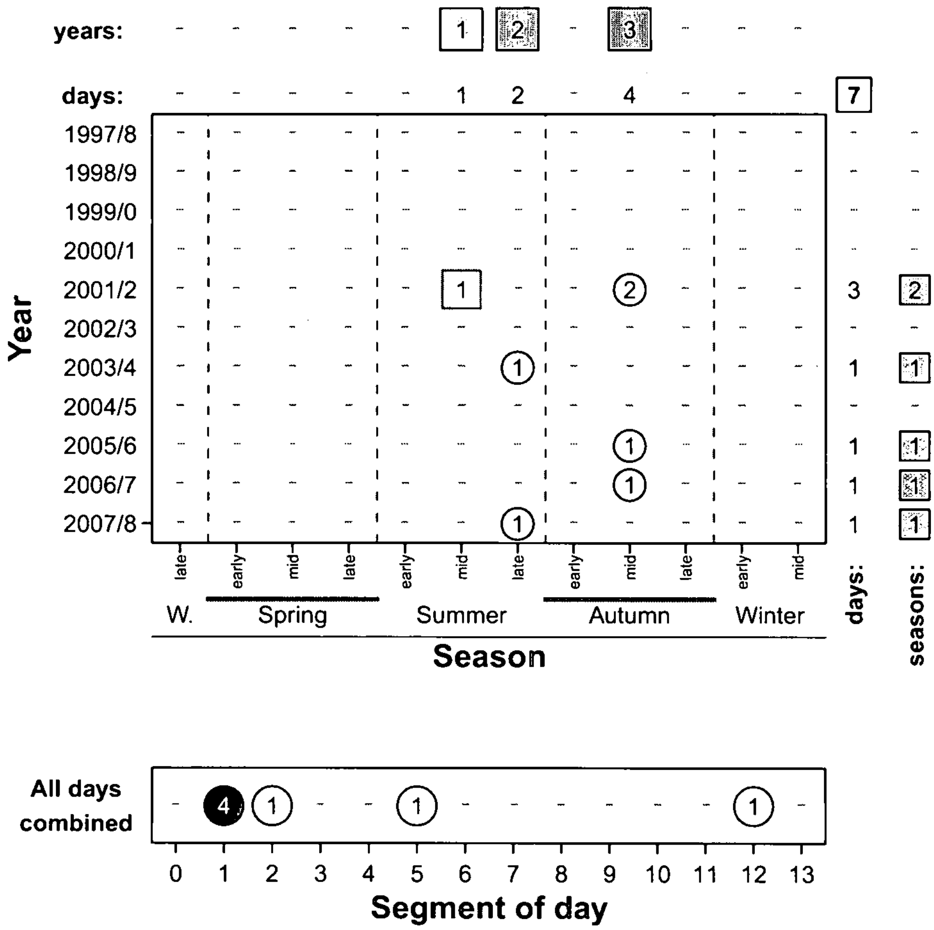


Figure 4.9: R058 Reed Cormorant — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

and spear prey underwater with their long dagger-like bills with backward-pointing serrations along the distal cutting edge, the long and slender neck also having a special hinge-mechanism (Hockey *et al.* 2005). Two to four species occur in tropical and warm temperate areas of the Old and New World, with the African Darter R060 found in southern Africa (Hockey *et al.* 2005).

R060 African Darter .... *Anhinga rufa*

The African Darter, often treated as a conspecific of the Asian *A. melanogaster* and Australasian *A. novaehollandiae*, occur in Africa and southern Iraq (Cramp 1998; Orta 1992b; Ryan 2005a). Its southern African stronghold is the Okavango Delta, but it is also widespread in Zimbabwe, Swaziland and South Africa where it occurs in the south and from the Free State eastwards, as well as along the Orange River (Hustler 1997b). Movements do occur, but little is known about the details thereof (Hustler 1997b; Taylor *et al.* 1999; Underhill *et al.* 1999).

The birds at Glen

The African Darter was recorded as birds flying overhead. Recorded on three days only: late winter 1997/8 (S8), mid-summer 2001/2 (S3) and early autumn 1997/8 (S3).

4.5 Ardeidae: Egrets, Herons, Bitterns

Most of the species belonging to the family Ardeidae are closely associated with water (Hockey *et al.* 2005). The 66 species occur worldwide except Antarctica, with 22 species occurring in southern Africa (Hockey *et al.* 2005). Approximately 16 of these species occur in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a), with six species recorded at Glen during the study period. The Black Heron *Egretta ardesiaca* was subsequently recorded too.

R062 Grey Heron .... *Ardea cinerea*

The Grey Heron occurs widespread in Eurasia, Africa and Madagascar (Cramp 1998). In Africa, Palearctic migrants occurring south of the equator are indistinguishable from the residents (Urban 1982c). In southern Africa the Grey Heron is widespread in Namibia, northern and eastern Botswana, Zimbabwe, Swaziland, Lesotho and South Africa (Martin 1997a), and southern Mozambique (Parker 1999). It is mainly associated with shallow waters and generally considered to be resident (Maclean 1985), but post-breeding dispersal and nomadism induced by the condition of wetlands do occur (Martin 1997a).

The birds at Glen

Grey Herons were recorded as single individuals that flew over the study area, their uniformly grey under-wing distinguishing them from the similar sized Black-headed Heron's R063 with its contrasting black-and-white under-wing. At times, however, identification was problematic, particularly when birds were heard only. Below, cases where birds were positively identified as Grey Herons are considered first, with records of uncertain identification considered separately under the Black-headed Heron.

Positively identified Grey Herons: Recorded on ten days spread over seven years with no records during winter (Fig. 4.10). All but one of the sightings were during the early mornings after sunrise (Fig. 4.10).

Discussion

See *Discussion* section under Black-headed Heron below.

R063 Black-headed Heron .... *Ardea melanocephala*

The Black-headed Heron is endemic to sub-Saharan Africa (Martínez-Vilalta & Motis 1992a; Urban 1982d). In southern Africa it is widespread in Namibia, northern and eastern Botswana, Zimbabwe, Swaziland, Lesotho and South Africa (Martin 1997b), and southern Mozambique

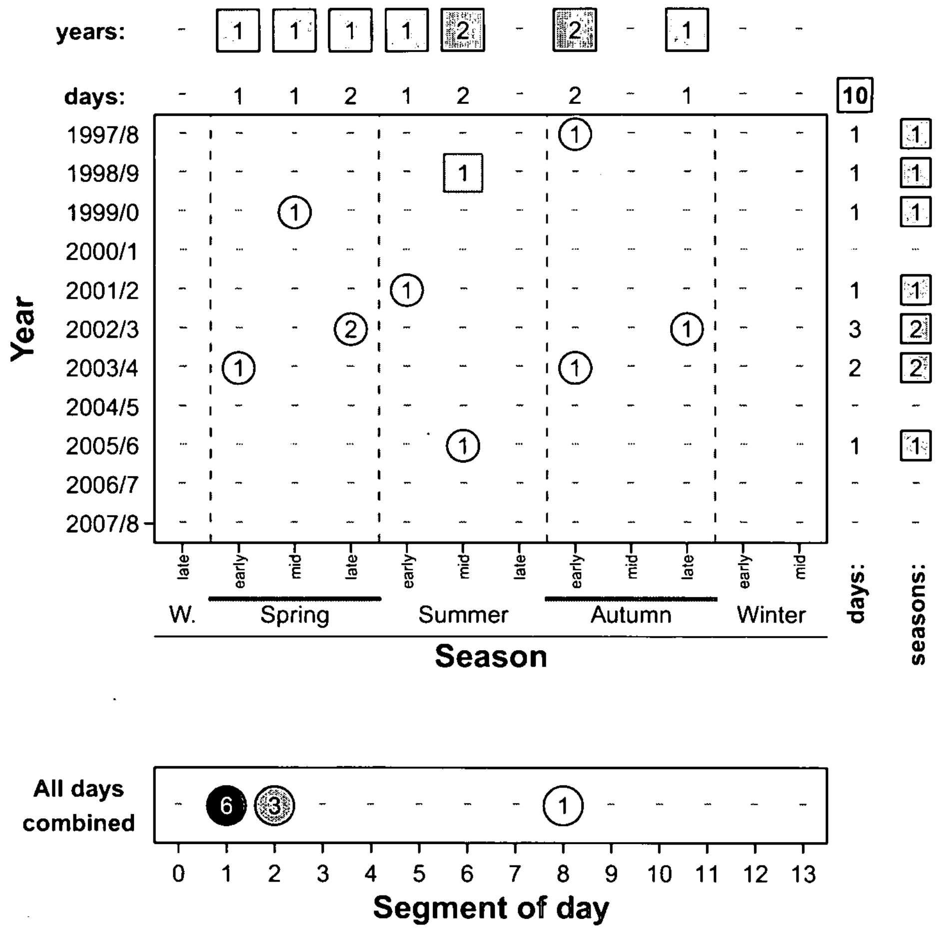


Figure 4.10: R062 Grey Heron — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

(Parker 1999). Preferring open grasslands and transformed or disturbed landscapes, the Black-headed Heron is the only *Ardea* spp. to feed predominantly in terrestrial habitats, although it may also be associated with wetlands (Maclean 1985; Martin 1997b). It is resident, though movements of several hundred kilometres are not uncommon, especially during juvenile dispersal (Martin 1997b).

The birds at Glen

The Black-headed Heron was usually recorded as individuals (rarely two birds) that flew over the study area, their contrasting black-and-white under-wing distinguishing them from the similar sized Grey Heron's R063 uniformly grey under-wing. At times, however, identification were problematic, particularly when birds were heard only. Records involving positively identified Black-headed Herons are considered first, followed by the problematic records.

Positively identified Black-headed Herons: Seen on 29 days spread through ten years (no records for 2006/7) and all 12 seasons (Fig. 4.11). Most frequently recorded during mid- and late summer when seen during five and four years respectively (Fig. 4.11). Most frequently seen in S1 with no observations during the middle part of the day (Fig. 4.11).

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Flight calls of Grey/Black-headed Herons: In this section the data for flight calls of unidentified herons — either Grey or Black-headed Heron — are considered. Recorded on 17 days in total, spread over eight years with the majority of the records (76.5% = 13/17) during autumn (Fig. 4.12). In most cases the activity occurred before sunrise and especially after sunset (Fig. 4.12).

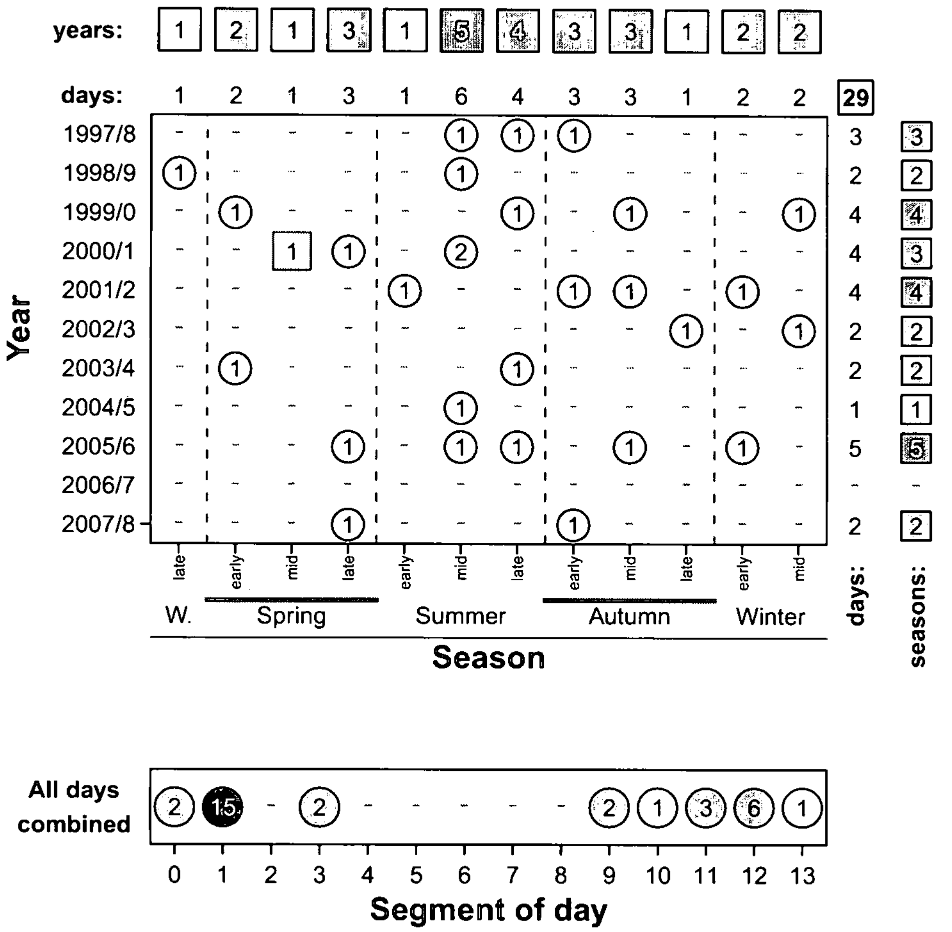


Figure 4.11: R063 Black-headed Heron — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Discussion

The strongly seasonal pattern shown by vocal birds (Fig. 4.12) contrasts with the largely aseasonal pattern of the sight-only records of the Grey Heron (Fig. 4.10) and Black-headed Heron (Fig. 4.11). The reporting rate model of SABAP1 Zone 7 was likewise aseasonal (Martin 1997a,b). Another contrast is the daily occurrence which peaked in the early morning after sunrise (S1) for the sight records of both species (Fig. 4.10; Fig. 4.11) and after sunset for birds that were heard only (Fig. 4.12). The sight records of birds are perhaps best explained as birds commuting between roosting and foraging areas. Both species are known to forage by day and night (Urban 1982d). It is unclear, however, why the vocalisations should be concentrated in autumn and the early evening. In both species breeding is largely aseasonal (Tarboton 2001).

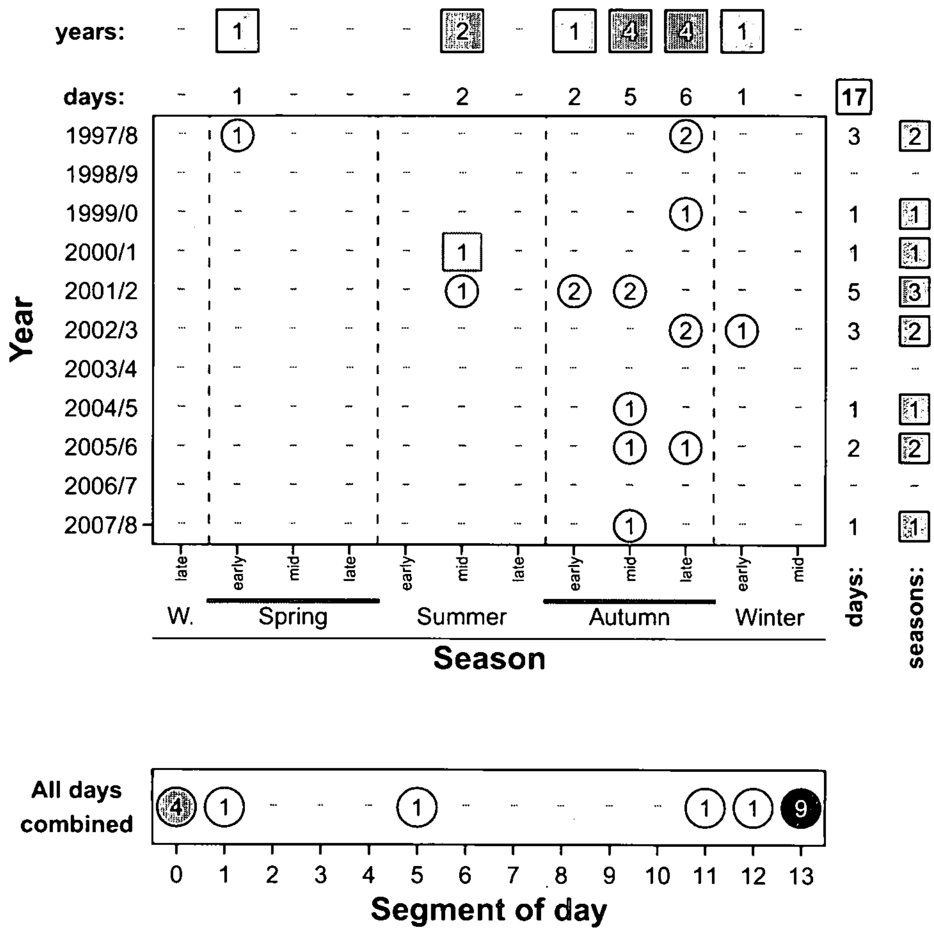


Figure 4.12: R062/3 Grey/Black-headed Heron — birds heard: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R066 Great Egret .... *Egretta alba*

The Great Egret occurs worldwide (Maclean 1985). Palearctic birds apparently cross the Sahara only rarely (Urban 1982b). In southern Africa its distribution is concentrated on the Okavango Delta, Zimbabwe, Swaziland and South Africa from the Free State eastwards and northwards (Martin 1997c). It requires shallow open water for foraging and breeds in reed beds or trees (Urban 1982b). It is generally considered to be a resident subject to local movements (Maclean 1985), with SABAP1 reporting rates for Zone 7 showing no seasonal trend (Martin 1997c).

The birds at Glen

The Great Egret was recorded once when an individual flew overhead in the drainage line during mid-spring 2007/8 (S1).

R067 Little Egret .... *Egretta garzetta*

The Little Egret occurs in Africa, Madagascar and from southern Eurasia to Australia (Maclean 1985). In southern Africa it is mainly concentrated in the Okavango Delta, Zimbabwe and South Africa, but is scarce west of the Free State due to lack of suitable habitat (Martin 1997d), which include the edges of inland and marine waters (Maclean 1985). Considered to be mostly resident in southern Africa, but local movements do occur (Maclean 1985).

The birds at Glen

Single Little Egrets were recorded twice, once in early autumn 2003/4 (S12) and once in early autumn 2007/8 (S1).

R071 Cattle Egret .... *Bubulcus ibis*

The Cattle Egret was historically confined to tropical Africa and southern and eastern Asia, but has undergone a dramatic range expansion since the 1800s and at present also occurs elsewhere in Africa, in the Mediterranean region, Australasia and North and South America (Maddock & Geering 1994). The Cattle Egret reached southern Africa during the early 1900s (Maddock & Geering 1994) and is now widespread, being least abundant in the western third of the region, except in the south where it is more common (Martin 1997e). It is primarily terrestrial, using open, short grasslands, pastures and cultivated fields, usually in flocks accompanying cattle or large game mammals (Maclean 1985). They congregate in large numbers to roost in trees or reed beds (Maclean 1985). In addition to nomadic movements tracking rainfall, it disperses over long distances (Urban 1982a). The data from SABAP1 shows a marked drop in reporting rates during winter (Martin 1997e). In addition, recoveries of ringed birds confirm winter emigration from the central plateau of South Africa to central Africa (Siegfried 1970; Underhill *et al.* 1999).

The birds at Glen

Cattle Egrets were usually recorded as birds seen in flight, birds foraging in the grassland among cattle, or as birds among resting cattle in the trampled area. Figures start on page 162.

Annual occurrence of birds seen in the grassland: Recorded on 54.7% of the days with an activity index of 13 (Table 4.4a). Mostly recorded during 10–11 seasons each year, but during only six seasons in 1998/9 and 2003/4 (Fig. 4.13; Fig. 4.14). Daily reporting rates ranged from 0.5 to 44.7% with values particularly low during the last four years of the study (Fig. 4.13).

Seasonal occurrence of birds seen in the grassland: The number of bird-years, the seasonal frequency index as well as the occurrence of intermediate and high reporting rate days suggest a strong seasonal peak from mid-spring to mid-autumn (Fig. 4.13; Fig. 4.14). In addition, the occurrence of days with zero records were least frequent from late spring to early autumn, occurring during 3–6 years compared to the 7–11 years of other seasons (Fig. 4.14). The median daily reporting rates were particularly high in mid-spring and late spring and relatively low during winter and early spring (Fig. 4.13).

Table 4.4: R071 Cattle Egret: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	4 787	114 612	4.2	birds present	54.7	656	359	13
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	21	1 190	1.8	birds present	34.9	43	15	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	35	1 188	2.9	birds present	41.9	43	18	2

Daily occurrence of birds seen in the grassland: Overall, activity was least frequent before sunrise and after sunset (Fig. 4.13). This was the same regardless of the magnitude of the daily reporting rate (Fig. 4.15). However, for low reporting rate days activity tended to be more frequent in the early morning after sunrise and in the late afternoon before sunset compared to the intermediate and high reporting rate days when the frequency occurrence of activity was similar for the all segments between sunrise and sunset (Fig. 4.15). The seasonal pattern in day-frequency was variable, but activity occurred with reasonable frequency during most segments of the day from mid-spring to late autumn (Fig. 4.16). The only bird-segment combination occurring on more than 5% bird-days involved S1, which accounted for 6.4% bird-days and was particularly frequent during early autumn (Fig. 4.17).

The first activity of the day was usually noted during the first half of the morning, earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.16). Seasonally, activity started earlier from mid-spring to late autumn than during winter or early spring (Fig. 4.16).

The occurrence of the last activity of the day was more variable, especially for low reporting rate days; on intermediate and high reporting rate days it often occurred in the late afternoon (Fig. 4.16). Seasonally, the timing of the last activity of the day was least variable in mid- and late spring as well as during mid-autumn when it occurred mostly during the late afternoon compared to other seasons when it often occurred earlier in the day too (Fig. 4.16).

Overall, daily segment reporting rates ranged from 5.3 to 100% (Fig. 4.13). Median daily segment reporting rates tended to be lowest early and late in the day (Fig. 4.15).

Early morning occurrence of birds seen during 2007/8: Activity was slightly more frequent in the grassland than in the drainage line (Table 4.4b & c; Fig. 4.18). The seasonal occurrence of intermediate and high reporting rate days differed too, with peaks occurring in the grassland during spring and early summer, and during various seasons in the drainage line (Fig. 4.18). The occurrence of the first activity of the day was comparable between the two habitats (Fig. 4.18).

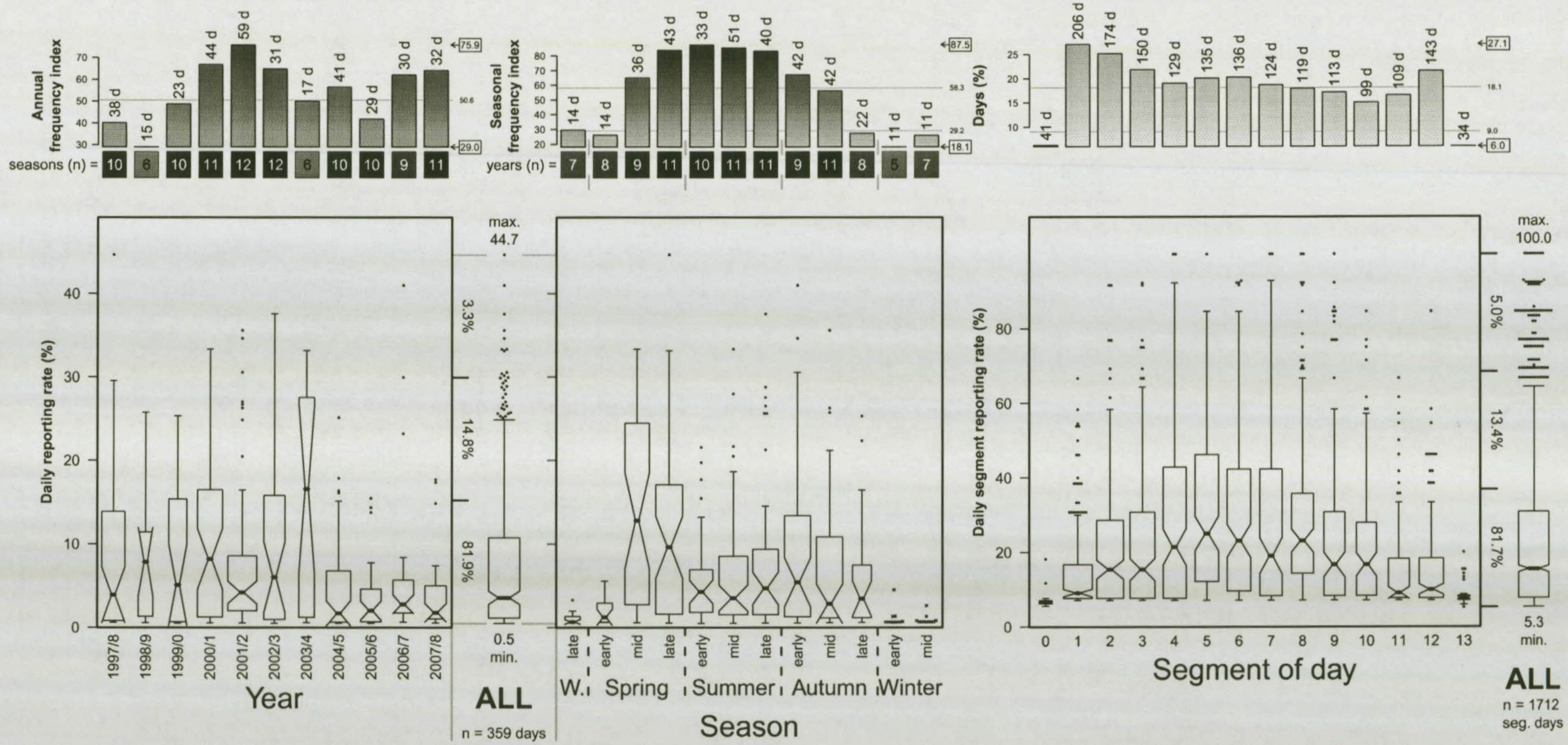


Figure 4.13: R071 Cattle Egret — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

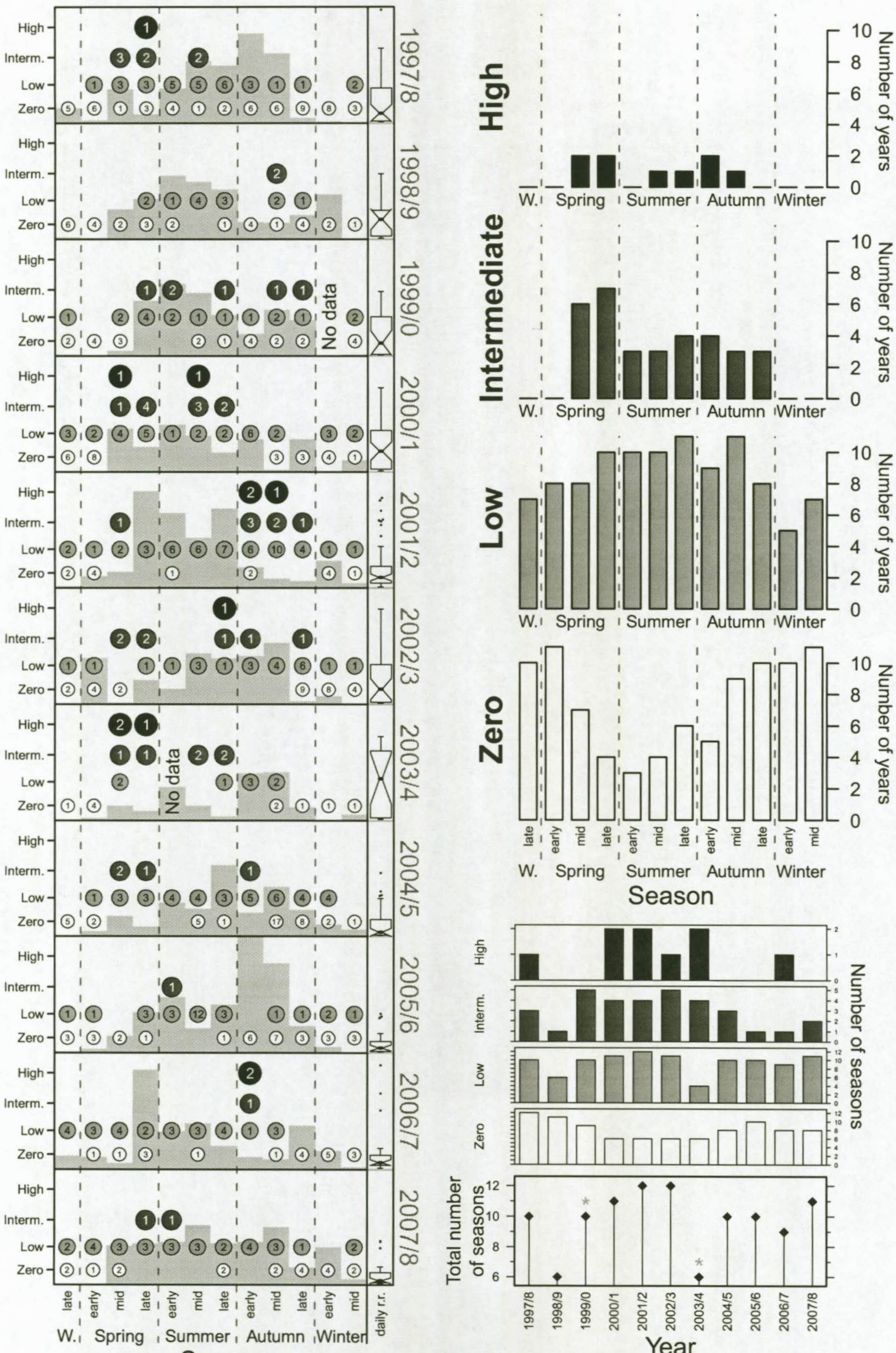


Figure 4.14: R071 Cattle Egret — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

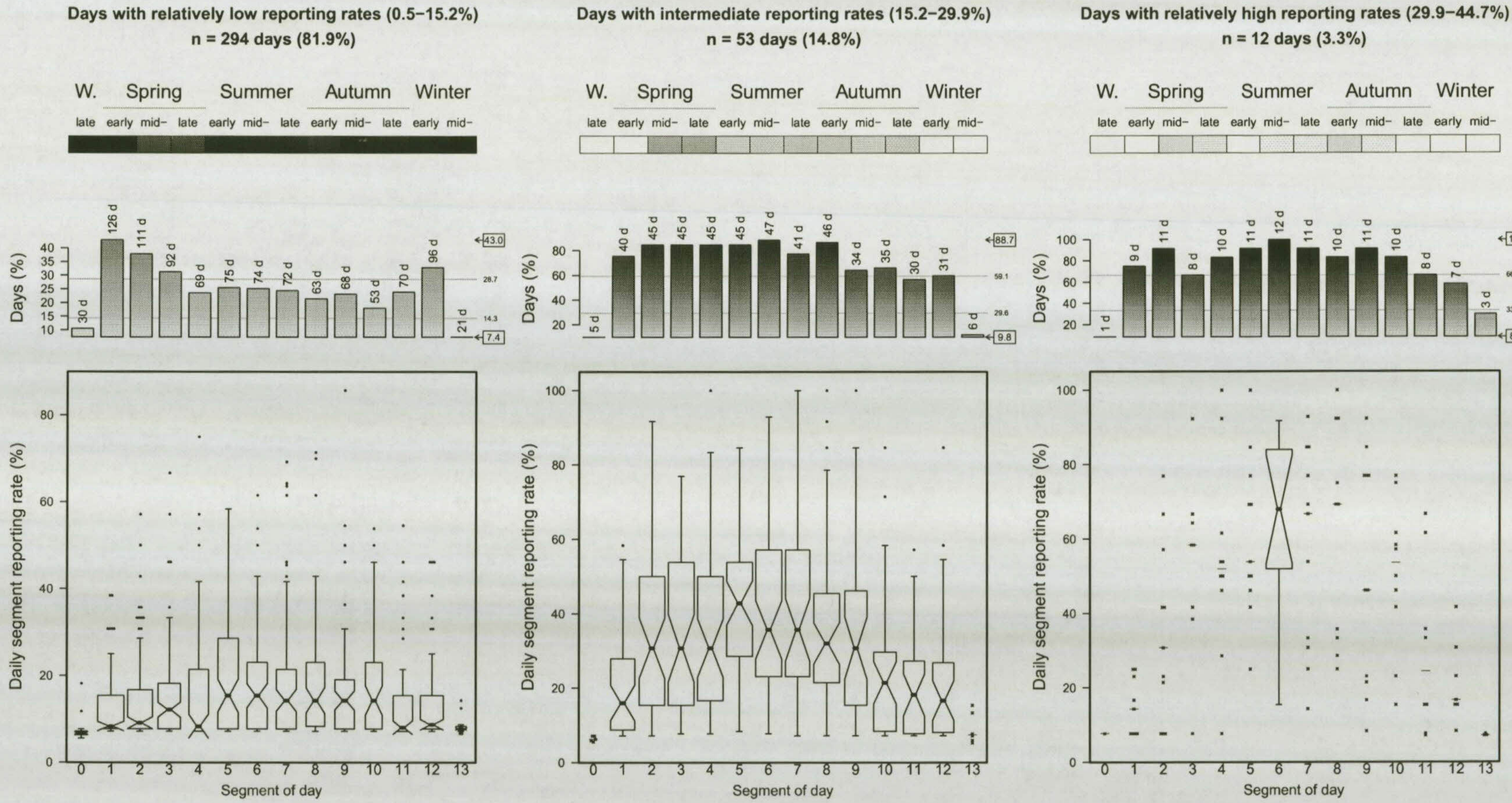


Figure 4.15: R071 Cattle Egret — birds present: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

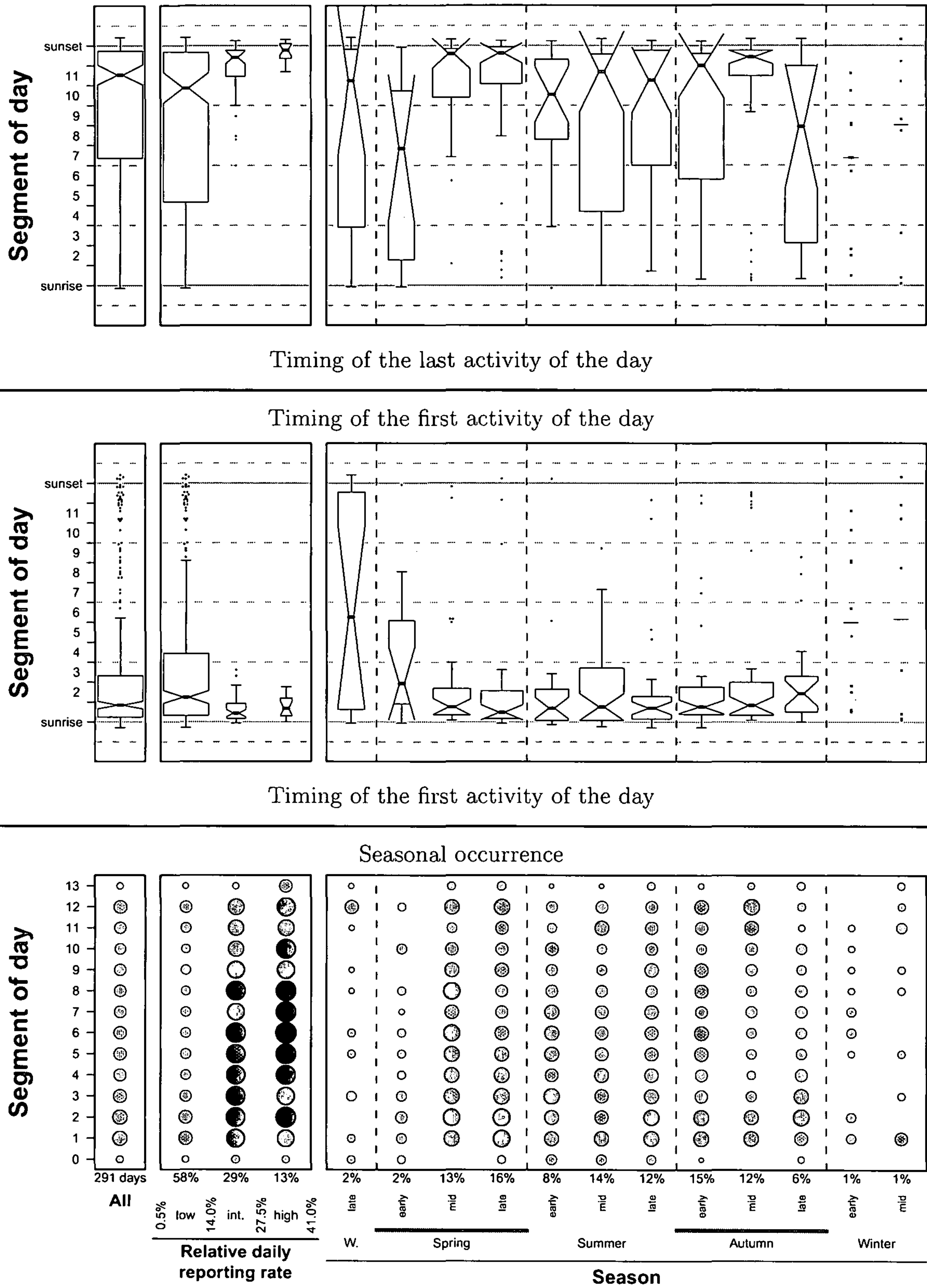


Figure 4.16: R071 Cattle Egret — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

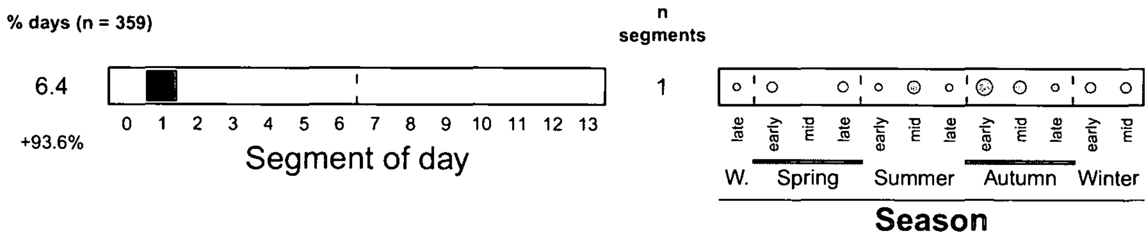


Figure 4.17: R071 Cattle Egret — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

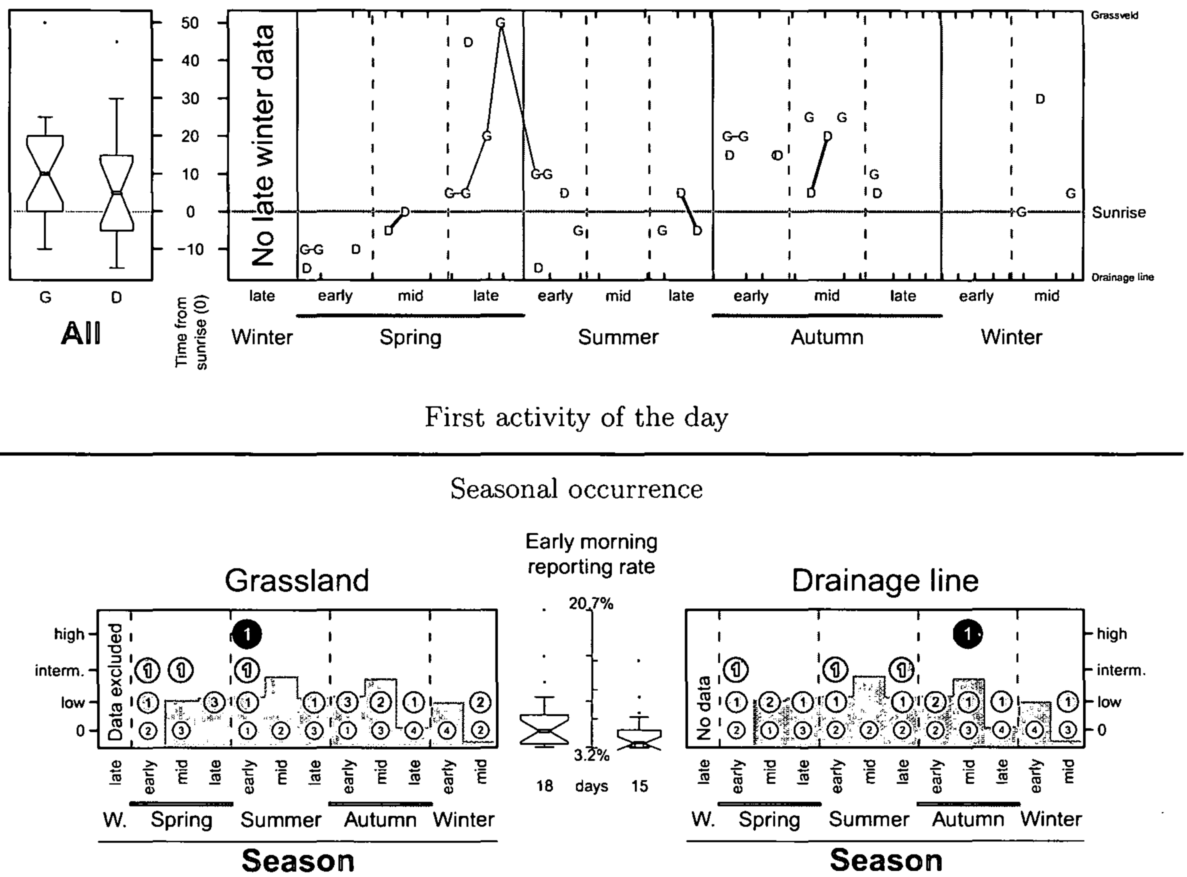


Figure 4.18: R071 Cattle Egret — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Top: Occurrence of the first activity of the day. See page 136 for more information on this early morning figure.

Discussion

The results for the Cattle Egret were partially influence by the presence or absence of cattle in and around the study area. Nevertheless, the results (Fig. 4.13) concur with previous findings indicating that the Cattle Egret is less common during the cooler part of the year (*e.g.* Martin 1997e). What are interesting, however, are the relatively high daily reporting rates during mid- and late spring (Fig. 4.13; Fig. 4.14), *i.e.* right at the start of the season. This is perhaps due to birds arriving from elsewhere. It is also noted that this peak coincides with the start of the breeding season, which peak from October to January [mid-spring to late summer] according to Tarboton (2001). The sudden and frequent occurrence of intermediate reporting rate days during mid-spring (Fig. 4.14) suggest the involvement of circannual rhythms that is strongly tied to increased day-length.

Cattle Egrets were seen most frequently during the early morning after sunrise, particularly on days with relatively low reporting rates (Fig. 4.15). This is best explained as birds commuting between their roost (somewhere towards the south-west) and their feeding grounds, either within the study area or beyond. A similar explanation is offered for the peak in activity in the late afternoon shortly before sunset, this time involving birds returning to their roost. Elsewhere they are known to assemble approximately one hour before sunset before flying to a roosting site, which may be a few kilometres away (Louw 2005e).

The daily segment reporting rates peaked during the latter part of the morning and during the first half of the afternoon (Fig. 4.13; Fig. 4.15). This pattern is readily explained with reference to the behaviour of cattle. Cattle often have a routine by which they would arrive in the trampled area around mid-morning and leave again around mid-afternoon. During this period the cattle are usually accompanied by the birds, which were then more readily recorded.

R076 Black-crowned Night-Heron . . . . *Nycticorax nycticorax*

The Black-crowned Night Heron is one of the most cosmopolitan herons, being found in the warmer parts of Eurasia, much of North and South America, Africa and in Madagascar (Martínez-Vilalta & Motis 1992b). In southern Africa it is widespread in the Okavango Delta, Zimbabwe and South Africa where they are scarce or absent west of the Free State (Martin 1997f). It is largely crepuscular and nocturnal, spending the day roosting in trees or skulking in dense riparian vegetation (Martin 1997f). It leaves its roost *ca.* 10-20 minutes after sunset, returning before sunrise (Louw 2005f). Only a small portion of the southern African population may be sedentary, but most are likely locally nomadic, dispersing in response to rainfall (Martínez-Vilalta & Motis 1992b; Martin 1997f; Underhill *et al.* 1999). The only evidence of Palearctic migrants in southern Africa is a Romanian-ringed bird recovered in Mozambique (Underhill *et al.* 1999).

The birds at Glen

In addition to a bird seen in flight shortly after sunrise (S1) in 2005/6, the Black-crowned Night Heron was once heard 55 minutes before sunrise and on an additional three days more than 35 minutes after sunset (Fig. 4.19). Records limited to late winter, mid-spring, early and mid-autumn with four of the five records during 2007/8 (Fig. 4.19).

Discussion

The Black-crowned Night Herons encountered at Glen probably involve birds commuting to and from roosting sites at unknown locations. It is possible that individuals may occasionally utilise the farm dam in the study area; however, they are probably irregular visitor there.

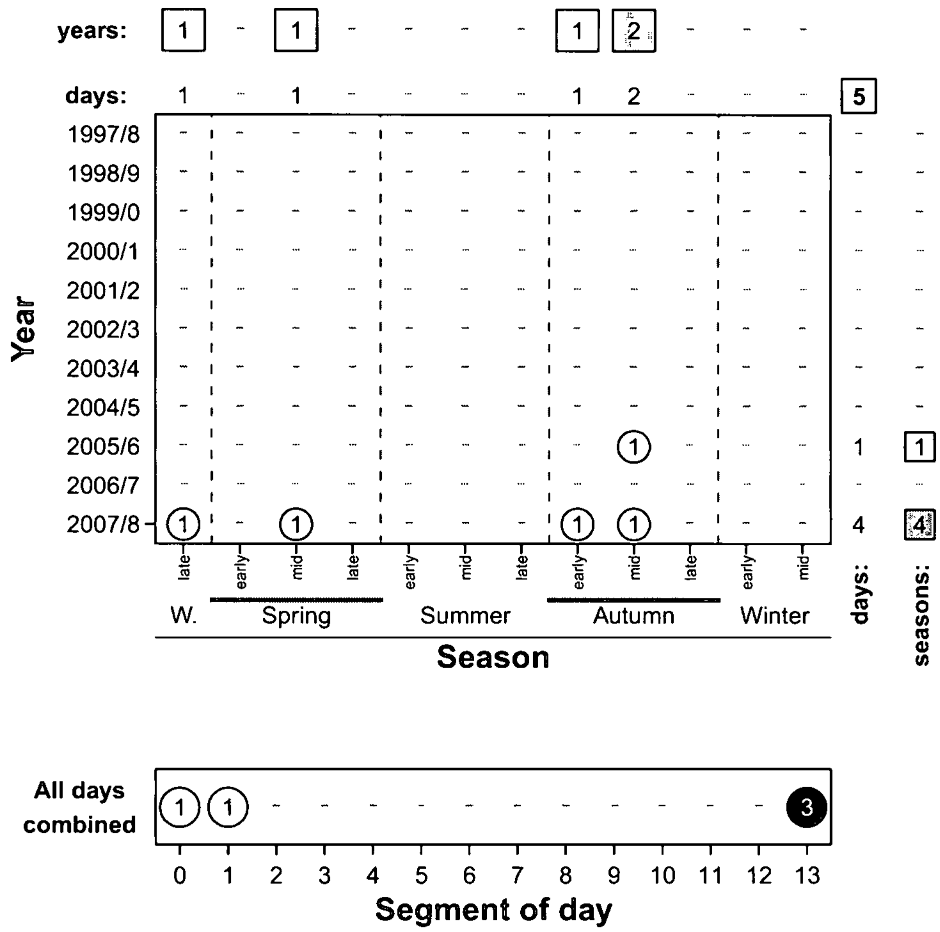


Figure 4.19: R076 Black-crowned Night-Heron — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

4.6 Scopidae: Hamerkop

The medium-sized Hamerkop with its brown plumage and characteristic crest is the only member of the family Scopidae (Hockey *et al.* 2005).

R081 Hamerkop .... *Scopus umbretta*

The Hamerkop occurs in south-western Arabia, sub-Saharan Africa and Madagascar (Maclean 1985). In southern Africa the focal part of its distribution is situated in the Okavango Delta of Botswana, Zimbabwe, Swaziland, Lesotho and South Africa where it is scarce west of the Free State (Anderson 1997a). As a species dependant on shallow water, it is a common resident in areas with permanent water, but it also exploits more ephemeral situations such as rainwater pools (Maclean 1985; Vernon & Dean 2005f).

The birds at Glen

The majority of Hamerkop records were of birds heard. Recorded on 16 days spread over seven years, being particularly frequent during 2001/2 (Fig. 4.20). Records limited to summer, autumn and early winter (Fig. 4.20). Encountered virtually throughout the day (Fig. 4.20).

Discussion

The occurrence of the Hamerkop at Glen often coincided with, or followed soon after, good rains (*cf.* Figs. 2.16 and 4.20). A likely explanation for this is that the birds recorded at Glen represent individuals in search of food at ephemeral waters after rain events.

Furthermore, their occurrence at Glen from early summer to early winter (Fig. 4.20) overlaps partially with the latter part of the breeding season. In South Africa egg-laying occur from July to January [late winter, spring and summer], with the incubation and nestling periods collectively stretching over *ca.* $2\frac{1}{2}$ months (Maclean 1985). It is not known if the records at Glen represent post-breeding movements.

4.7 Ciconiidae: Storks

The 19 species of these large to very large long-legged birds occur worldwide except for the polar regions, with eight species found in southern Africa (Hockey *et al.* 2005). All except the Woolly-necked Stork *Ciconia episcopus* have been recorded in the Free State, with the African Openbill *Anastomus lamelligrus*, Marabou Stork *Leptoptilos crumeniferus* and Saddle-billed Stork *Ephippiorhynchus senegalensis* recorded as vagrants in the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). None of these scarce species, nor the more common Black Stork *Ciconia nigra* or Abdim's Stork *Ciconia abdimii*, were recorded at Glen. Only the White Stork R083 and Yellow-billed Stork were recorded.

R083 White Stork .... *Ciconia ciconia*

The White Stork breeds in Eurasia and north-western Africa (rarely also in the Western Cape, South Africa) (Brown 1982b; Maclean 1985). After breeding the majority of birds migrate into tropical Africa, Iran and the Indian subcontinent (Cramp 1998; Grimmett *et al.* 1999). In southern Africa they occur mainly in the eastern half (excluding southern Mozambique, Parker 1999) as well as in the extreme south, the boundary being approximately the 500 mm rainfall isohyet (Allan 1997a). They forage in open woodland, grassland, Karroo, wetlands and cultivated fields (Allan 1997a). In SABAP1 Zone 7 they are present mainly from November to April [summer to autumn], but some birds overwinter (Allan 1997a).

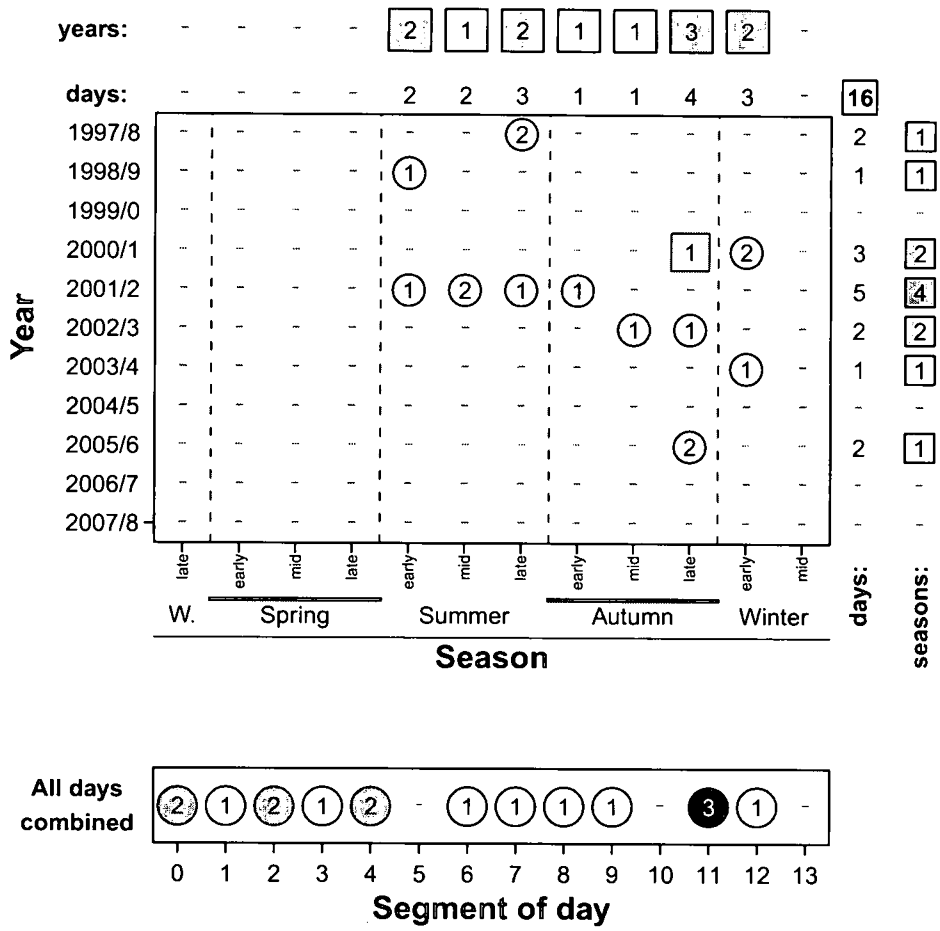


Figure 4.20: R081 Hamerkop — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

The birds at Glen

White Storks encountered at Glen include flocks of up to ten birds flying overhead, and once birds attended a veld fire in close proximity of the study area. It is possible that birds passing overhead were missed.

Seen on only seven days spread over four years with all records from mid-summer to late autumn (Fig. 4.21). Recorded only from mid-morning to mid-afternoon (Fig. 4.21).

The only encounter with foraging birds was on 15 January 2007 (late summer 2006/7). The previous day lightning caused a veld fire close to the study area, which was contained that same day. The next day (15 January 2007) a flock of 12 birds alighted at the farm dam at mid-morning (S3). Later that morning the veld caught fire again and during the early afternoon a maximum of five individuals attended the fire.

R090 Yellow-billed Stork . . . . *Mycteria ibis*

The Yellow-billed Stork is widely distributed in tropical Africa south of the Sahara, and it also occurs in Madagascar (Hancock *et al.* 1992). In southern Africa mainly confined to the Okavango

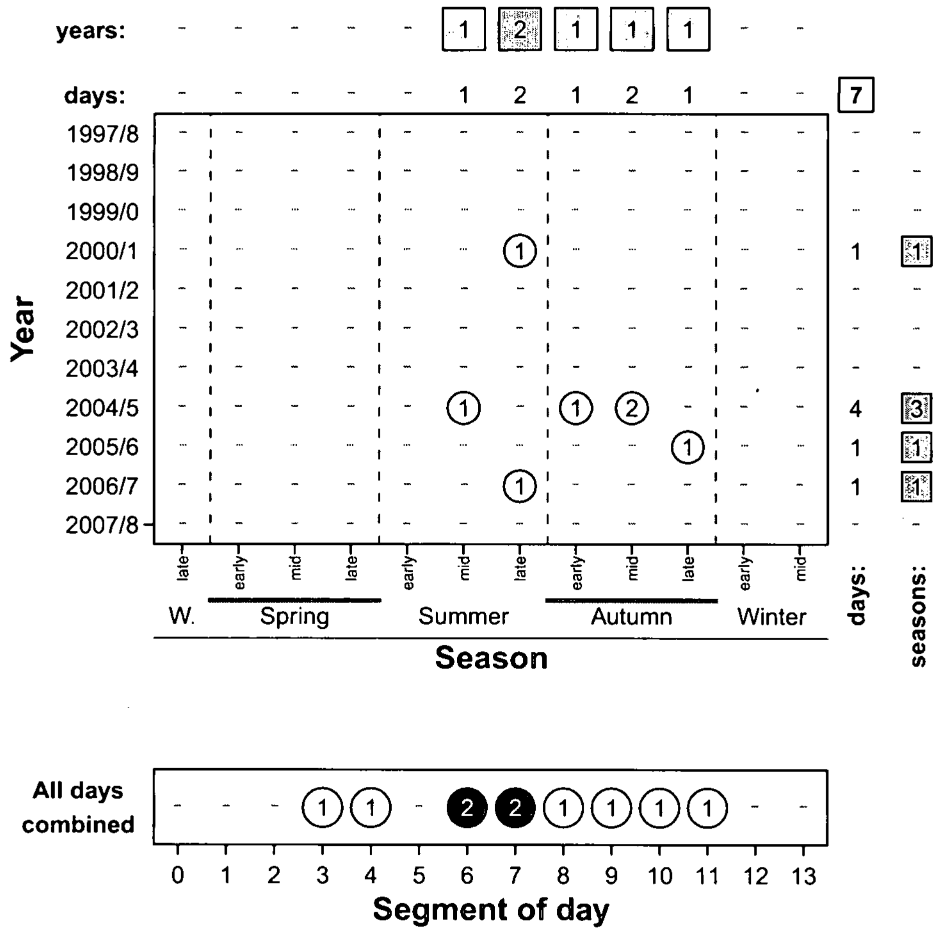


Figure 4.21: R083 White Stork — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

region in Botswana, Zimbabwe and South Africa from the Free State eastwards (Anderson 1997b). It is mainly a non-breeding intra-African migrant in South Africa (Anderson 1997b; Earlé & Grobler 1987; Maclean 1985; Taylor *et al.* 1999). It is found in a variety of wetland habitats (Hancock *et al.* 1992). The Yellow-billed Stork is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Johnson 2000).

The birds at Glen

The Yellow-billed Stork was recorded once when a single bird was seen in flight during mid-summer 2002 (S8).

4.8 Threskiornithidae: Ibises, Spoonbills

The 34 species of ibises and spoonbills occur worldwide except the polar regions, with five species occurring in southern Africa (Hockey *et al.* 2005). The Southern Bald Ibis *Geronticus calvus* occurs only in the eastern parts of the Free State, while the remaining four species have a widespread distribution in the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). These latter four species were recorded at Glen.

R091 African Sacred Ibis .... *Threskiornis aethiopicus*

The African Sacred Ibis occurs in sub-Saharan Africa, Madagascar and Iraq (Hancock *et al.* 1992; Matheu & Del Hoyo 1992). In southern Africa its distribution is centred on South Africa (scarce in the dry west) and the Okavango delta in Botswana (Anderson 1997c). Mainly associated with grassland habitats where it usually occurs at wetlands (Anderson 1997c; Maclean 1985). The southern African population consists of resident and nomadic/migratory components (Anderson 1997c; Maclean 1985; Taylor *et al.* 1999; Underhill *et al.* 1999), but Earlé & Grobler (1987) regarded them to be resident in the Free State.

The birds at Glen

There are only two African Sacred Ibis records. A flock of 13 birds was seen flying north during early autumn 1997/8 (S1) and an unknown number of birds were seen in flight during mid-spring 2006/7 (S5).

R093 Glossy Ibis .... *Plegadis falcinellus*

The Glossy Ibis is the most widespread of all ibises, occurring in parts of North, Central and South America, Africa, Eurasia, Australia and on various islands (Hancock *et al.* 1992). It's southern Africa distribution is centred on the South African highveld grasslands and the Okavango Delta and other wetlands in Botswana (Anderson 1997d). The breeding population of the western Palearctic is migratory and dispersive with a considerable nomadic component (Cramp 1998). The southern limit of the birds' movements in Africa is unknown, but Urban (1982e) suggested that they do not move beyond the equator. Recorded throughout the year in southern Africa, but more frequently from about September to March [mid-spring to mid-autumn] than during other times of the year (Anderson 1997d).

The birds at Glen

All three records of Glossy Ibis at Glen were of birds seen in flight shortly after sunrise (S1) and include flocks consisting of as many as 14 individuals seen during late spring (2000/1), mid-summer (2000/1) and late summer (2003/4).

R094 Hadeda Ibis .... *Bostrychia hagedash*

The Hadeda Ibis is endemic to sub-Saharan Africa (Urban 1982f). Its southern African range increased greatly during the 1900s with major expansions into the grasslands of the Free State as well as many other areas (Macdonald *et al.* 1986). In southern Africa it is currently found throughout most of South Africa (except the dry west), Lesotho, Swaziland, parts of Zimbabwe and the Okavango Delta in Botswana (Anderson 1997e), as well as parts of southern Mozambique (Parker 1999). It is dependant on soft soil for feeding and inhabits a wide range of habitats, including grasslands (Anderson 1997e; Hancock *et al.* 1992). It expanded its range during the last century and colonised the Free State during the last number of decades Macdonald *et al.* 1986.

They are mainly sedentary (Hancock *et al.* 1992), but some regional movements probably occur in response to localised rainfall events (Anderson 1997e). In addition, Vernon & Dean (2005g) noted increased numbers of birds at roosts during winter, suggesting seasonal movements.

The birds at Glen

Hadeda Ibis records consist almost exclusively (99.2%) of birds heard. The remainder of the records were of birds that were seen only. All the data were combined for analysis. Although not specifically quantified, many of the records involved birds commuting between roosting areas in the south-west and feeding areas somewhere towards the north-east. An unknown number of records were of birds in the drainage line. Figures start on page 175.

Annual occurrence of calls recorded in the grassland: Recorded on 84.8% of the days with an activity index of ten (Table 4.5a). Found during all seasons of all years, except 1998/9 when recorded during only eight seasons (Fig. 4.22). Daily reporting rates ranged from 0.5 to 38.9% with 90.1% of the days attaining relatively low reporting rates; high reporting rates were recorded during 2002/3 and 2006/7 only (Fig. 4.22; Fig. 4.23). Median daily reporting rates differed only slightly amongst the respective years (Fig. 4.22).

Table 4.5: R094 Hadeda Ibis: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	5 562	114 612	4.9	birds present	84.8	656	556	10
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	111	1 190	9.3	birds present	53.5	43	23	5
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	125	1 188	10.5	birds present	67.4	43	29	4

Seasonal occurrence of calls recorded in the grassland: Recorded during all seasons of all years, except 1998/9 when it was recorded from late winter to early autumn only (Fig. 4.23). Whereas high reporting rate days were restricted to early spring, intermediate reporting rate days occurred during all seasons except mid- and late autumn with a prominent seasonal pattern that peaked in mid-spring (Fig. 4.23). By contrast, days with zero records show an abrupt peak period from mid-autumn to early winter (Fig. 4.23), coinciding with low seasonal frequency index values (Fig. 4.22). The seasonal pattern for median daily reporting rates resembles that of the occurrence of intermediate reporting rate days with a peak in mid-spring and lowest values in mid- and late autumn (Fig. 4.22). Note, too, that the median daily reporting rate of early summer was low relative to that of the adjacent seasons (Fig. 4.22).

Daily occurrence of calls recorded in the grassland: Overall, activity occurred most frequently in the early morning with a secondary peak in activity in the late afternoon (Fig. 4.22). In general this pattern reflects the situation for both low and intermediate reporting rate days (Fig. 4.24). However, in the latter case the early morning peak is extended to include mid-morning and the secondary peak becomes more prominent and focused on the late afternoon before sunset (Fig. 4.24). Note, too, the general increase in day-frequencies from 6.2 to 66.3% for low reporting rate days to 23.1 to 98.1% for intermediate reporting rate days (Fig. 4.24).

In general, all seasons show a similar day-frequency pattern with activity occurring most frequently at the beginning and end of the day during all seasons (Fig. 4.25). Inter-seasonal differences include a relative dearth of activity in the late morning and most of the afternoon from mid-autumn to late winter when compared to the pattern for spring, summer and early autumn (Fig. 4.25). Furthermore, the secondary activity peak in the late afternoon is particularly poorly developed in mid- and late autumn (Fig. 4.25). The only bird-segment combination occurring on more than 5% bird-days was activity during S0 alone, which accounted for 6.7% of the bird-days and occurred most frequently during autumn and not at all during spring and most of summer (Fig. 4.26).

The first activity of the day typically occurred before sunrise, generally earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.25; Fig. 4.27). Seasonally the median values for the first activity of the day varied from *ca.* 35 minutes before sunrise (mid-spring, mid-summer and late summer) to sunrise (late autumn) (Fig. 4.27), with the seasonal variation in the dawn chorus sequence showing a very similar overall pattern (Fig. 4.27).

Whereas the last activity of the day was recorded before sunset on more than half of all low reporting rate days, it occurred after sunset on most intermediate reporting rate days and on all three high reporting rate days (Fig. 4.25; Fig. 4.27). The most prominent feature of the seasonal trend is the contrast between mid- and late autumn when the last activity of the day was typically recorded during the morning, and the period from mid-winter to late summer when the last activity of the day was recorded around sunset (Fig. 4.25; Fig. 4.27). Further subtle difference include greater variability in the late spring, early and mid-summer values (Fig. 4.25; Fig. 4.27).

Overall, daily segment reporting rates ranged from 4.3 to 100% with the median daily segment reporting rate slightly higher in the early morning than in the middle part of the day (Fig. 4.22). This general pattern becomes particularly well-defined when the data for intermediate reporting rate days are considered separately (Fig. 4.24).

Early morning occurrence of calls during 2007/8: Activity was similar in the drainage line and in the grassland, being recorded only slightly more frequently in the grassland (Table 4.5b & c; Fig. 4.28). In addition to similar median early morning reporting rates, the seasonal occurrence of high reporting rate mornings during mid-spring, late spring and early summer as well as the occurrence of mornings with zero records were exactly the same (Fig. 4.28).

The timing of the first activity of the day was more variable in the grassland than in the drainage line, but it frequently occurred before sunrise in both habitats (Fig. 4.28). Activity intensities tended to be slightly higher before sunrise than thereafter (Fig. 4.28).

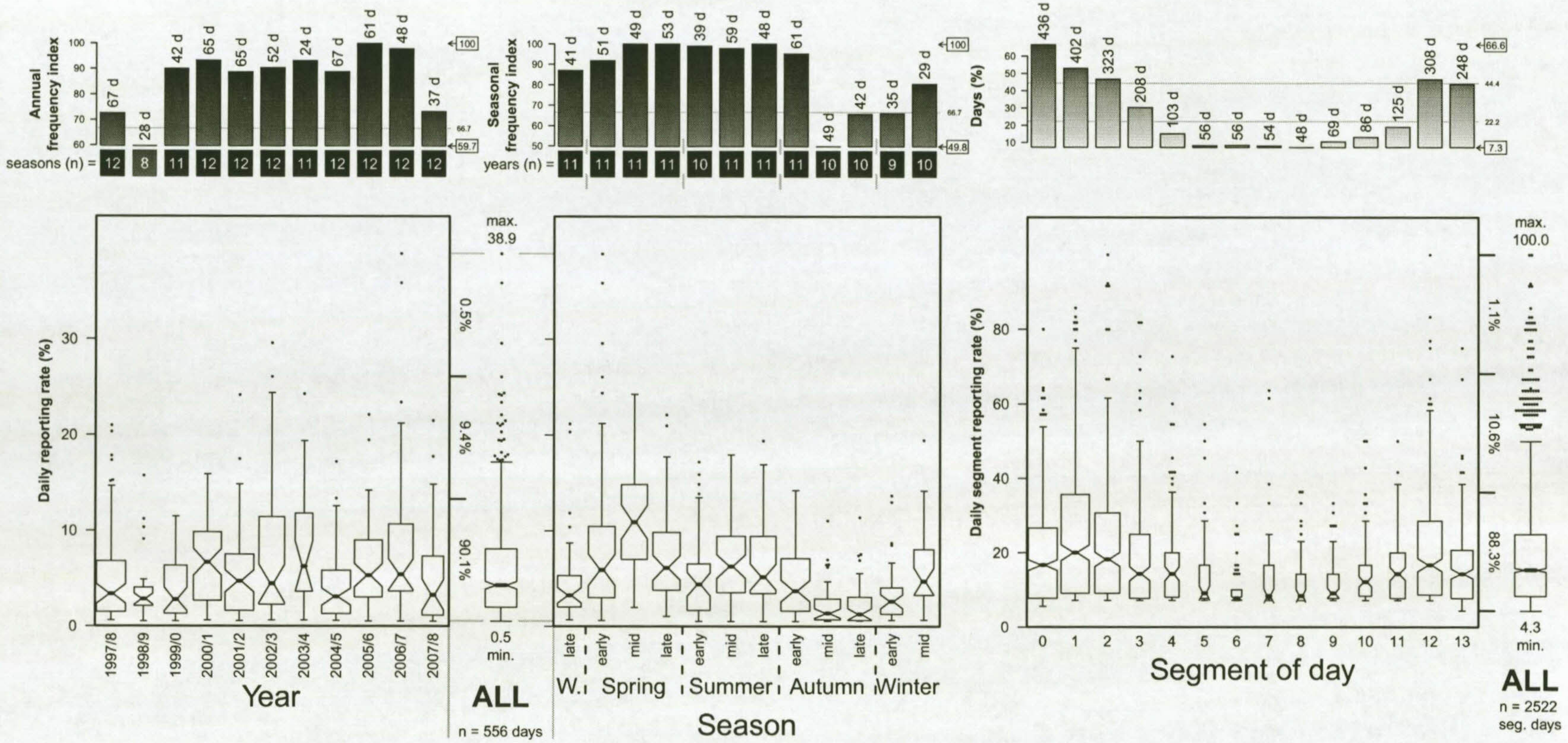


Figure 4.22: R094 Hadeda Ibis — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

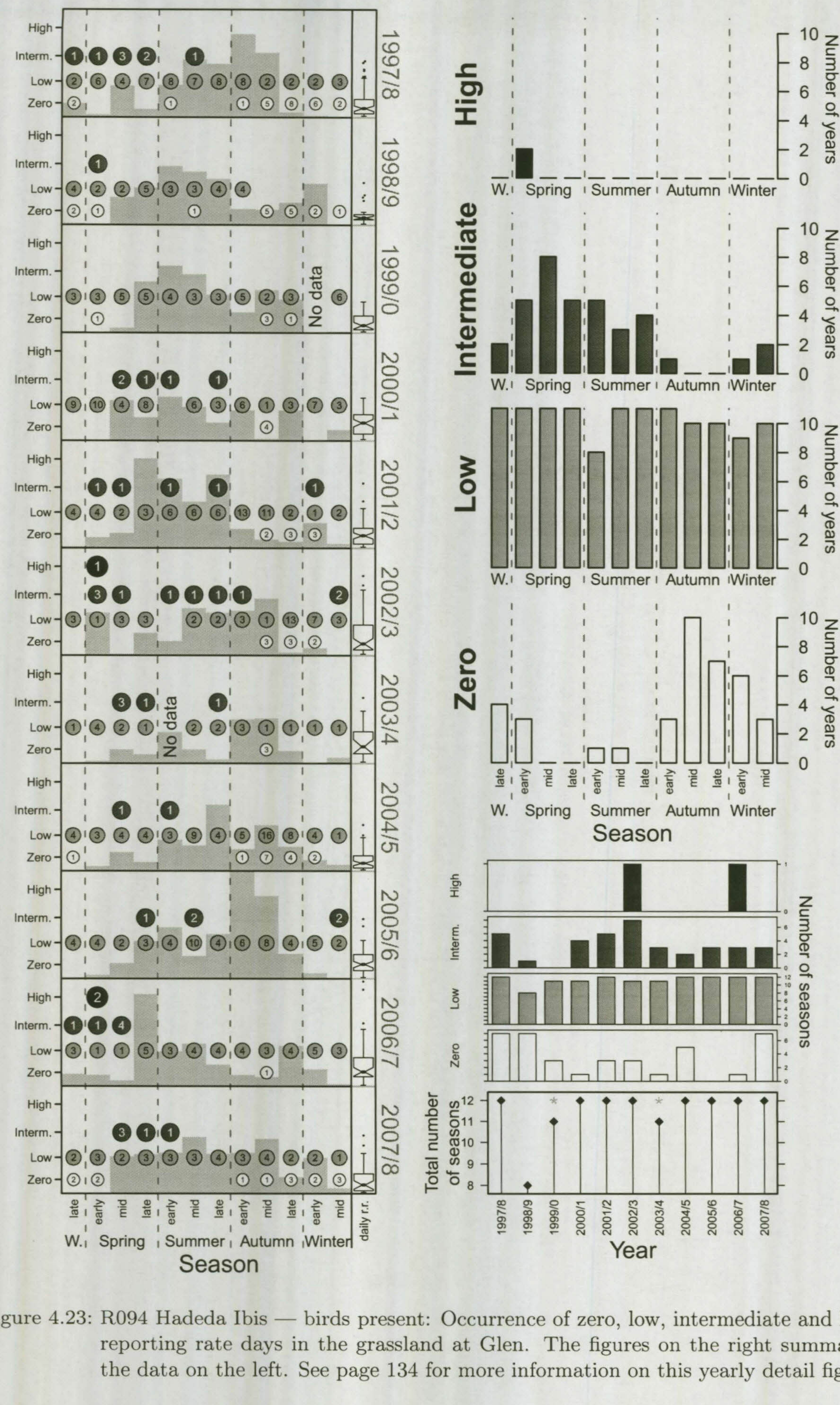


Figure 4.23: R094 Hadeda Ibis — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

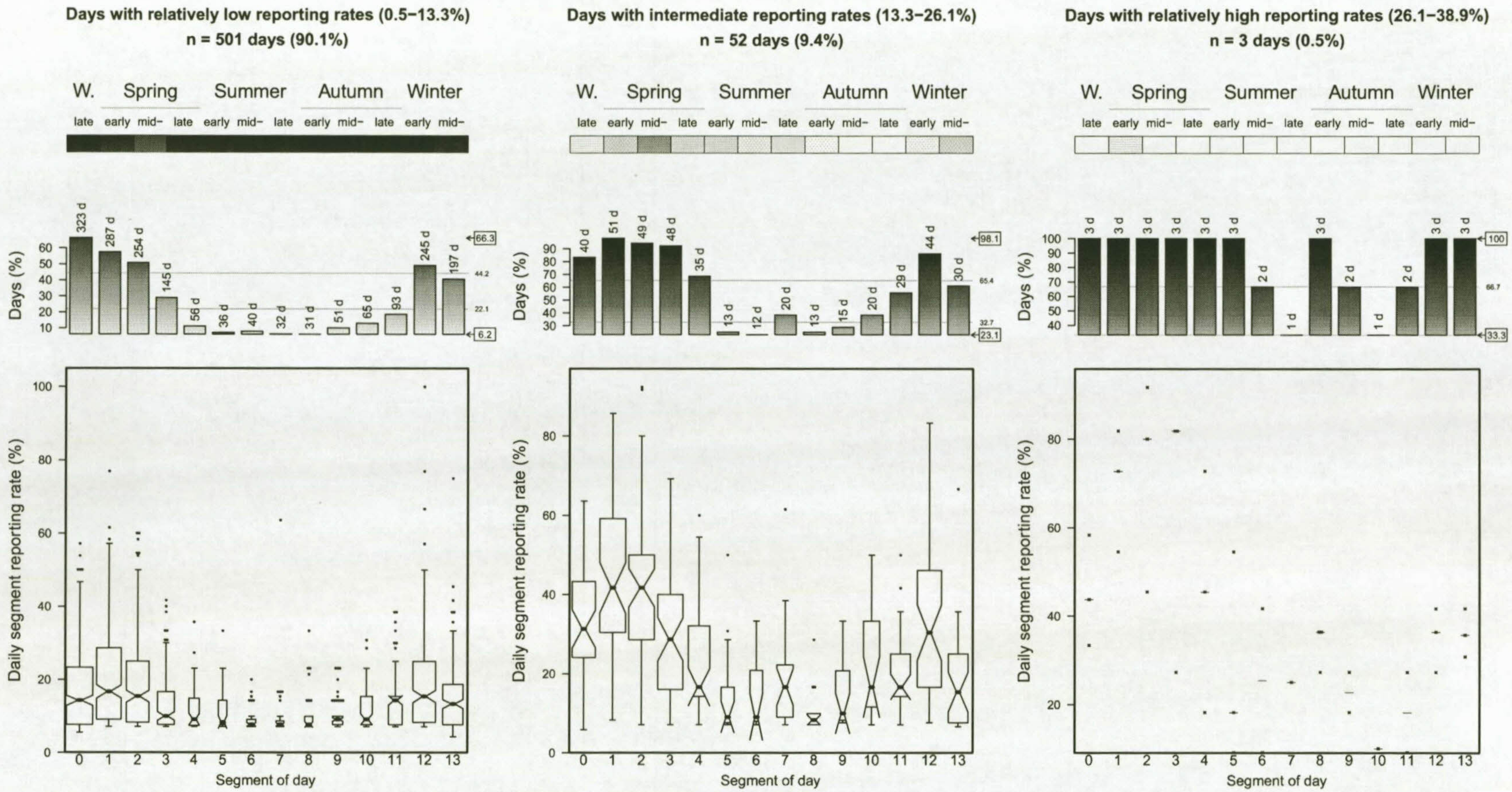


Figure 4.24: R094 Hadeda Ibis — birds present: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

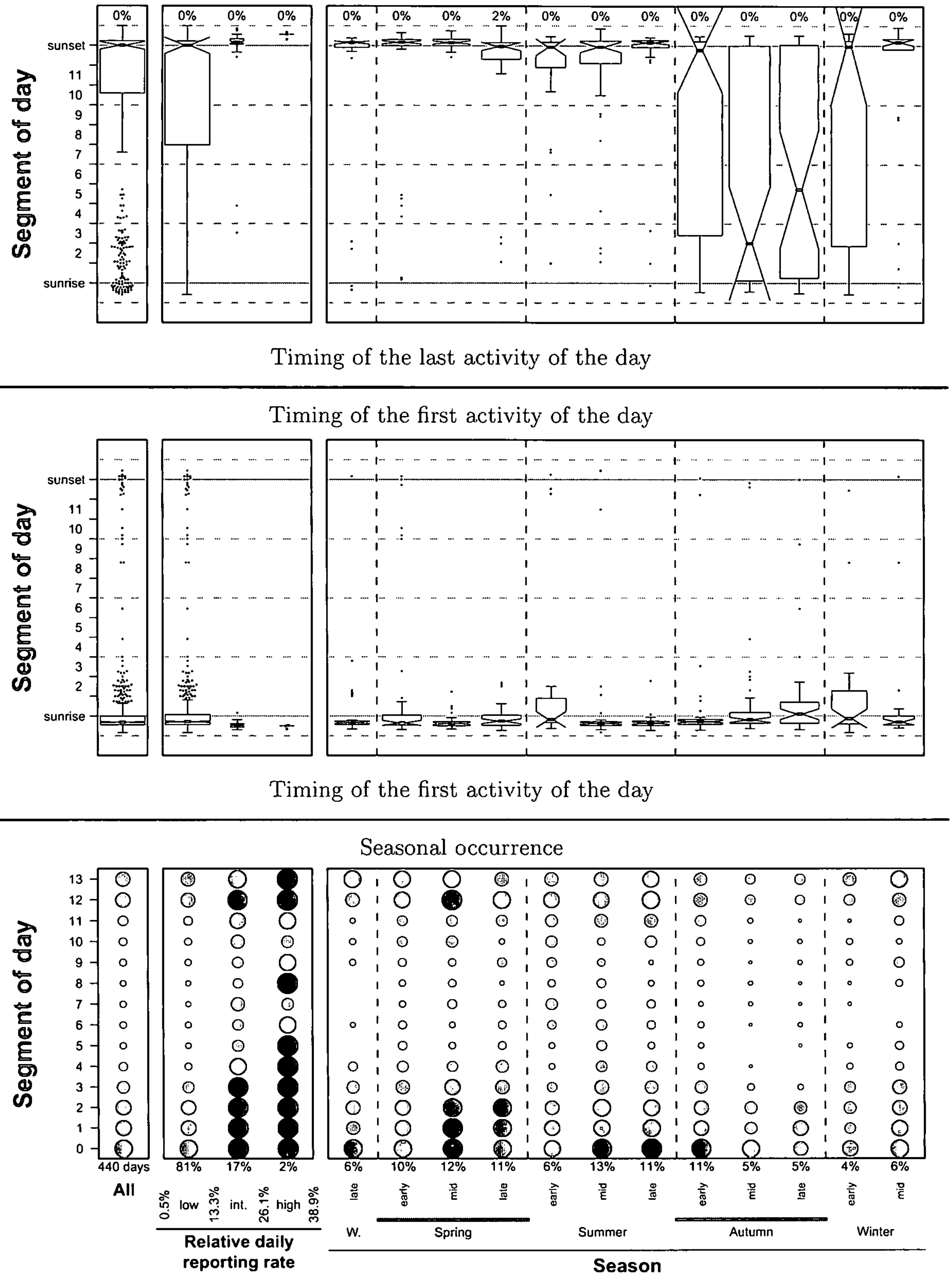


Figure 4.25: R094 Hadeda Ibis — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

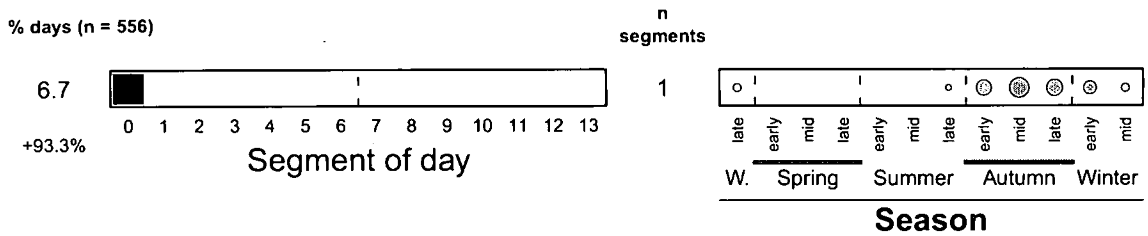


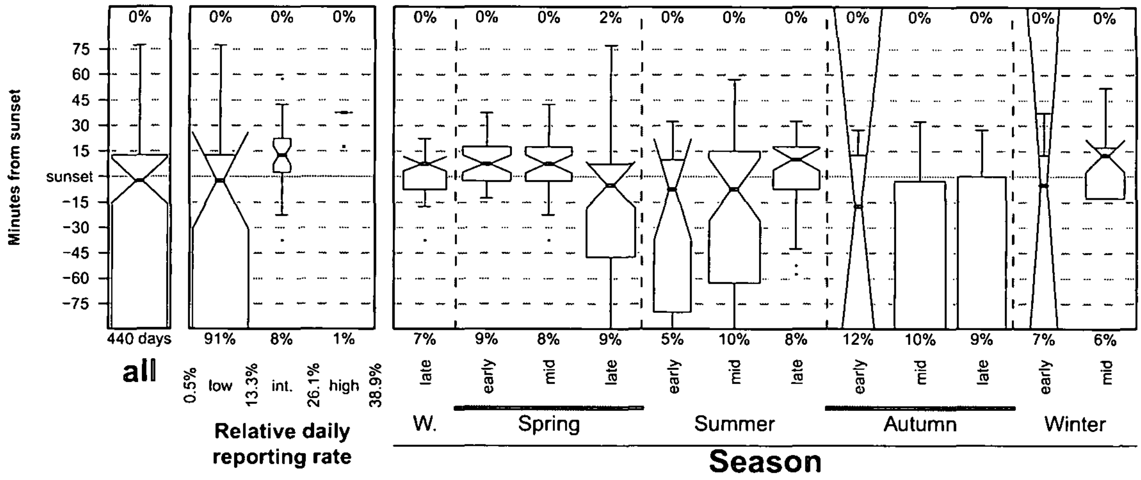
Figure 4.26: R094 Hadeda Ibis — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

Discussion

According to Vernon & Dean (2005g), egg-laying in the Hadeda Ibis occurs mainly from September to November [mid-spring to early summer]. At Glen, a nest with unknown contents and attending adults was found approximately 2 km south-west of the trampled area during early summer 2008/9 in one of the many *Eucalyptus* trees along the railway line. This area is seldom visited and it is unknown how regularly the birds breed in these trees. Nevertheless, it is likely that the mid-spring peak in activity at Glen (Fig. 4.22; Fig. 4.23) is related to the onset of the breeding season.

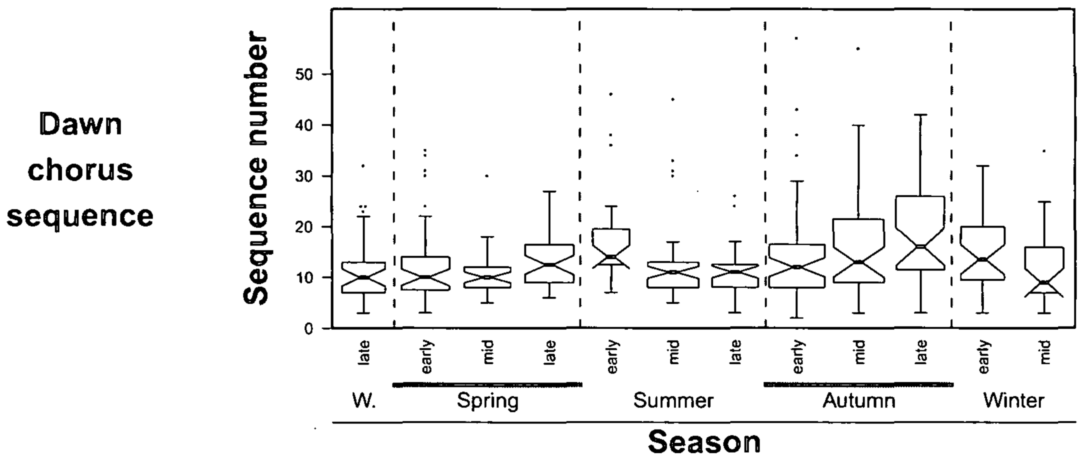
During the last few decades the Hadeda Ibis was considered to be a resident. Maclean (1985; 1993), for example, claimed it to be a very common resident in southern Africa, adding that their range is expanding into the highveld and the dry west (see also Macdonald *et al.* 1986). Anderson (1997e) stated that the Hadeda Ibis "is mainly sedentary, but some regional movements probably occur in response to localised rainfall events." In southern Lesotho the Hadeda Ibis was less widespread during a survey in April/May than during a similar survey the previous November, coinciding with an increase in the number of birds from 11 in November to 20 in April/May at one particular roost in the mountains over there (Van Niekerk 2004). Vernon & Dean (2005g) similarly noted increased numbers of birds at roosts during winter, which suggested to them that "some seasonal movements" do occur. At Glen, the birds were recorded less frequently, and daily reporting rates were generally lower, from mid-autumn to early winter (Fig. 4.22; Fig. 4.23). This may possibly be related to birds concentrating around communal roosts during this time of the year. Nothing is currently known about moult in these common birds (Vernon & Dean 2005g). However, it is suggested that the prominence of zero record days during mid-autumn (Fig. 4.23) signals the start of moult, which, if true, would indicate that it is tied to shortening day-lengths.

The daily pattern of activity peaks at the beginning and end of the day and is best explained by birds moving from their roosting site to feeding areas in the early morning and *vice versa* during the late afternoon. According to Vernon & Dean (2005g), they "fly up to 3 km to roost". At Glen, however, the distance between roosting sites and feeding areas may be greater, perhaps as much as 10 km or even more.



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

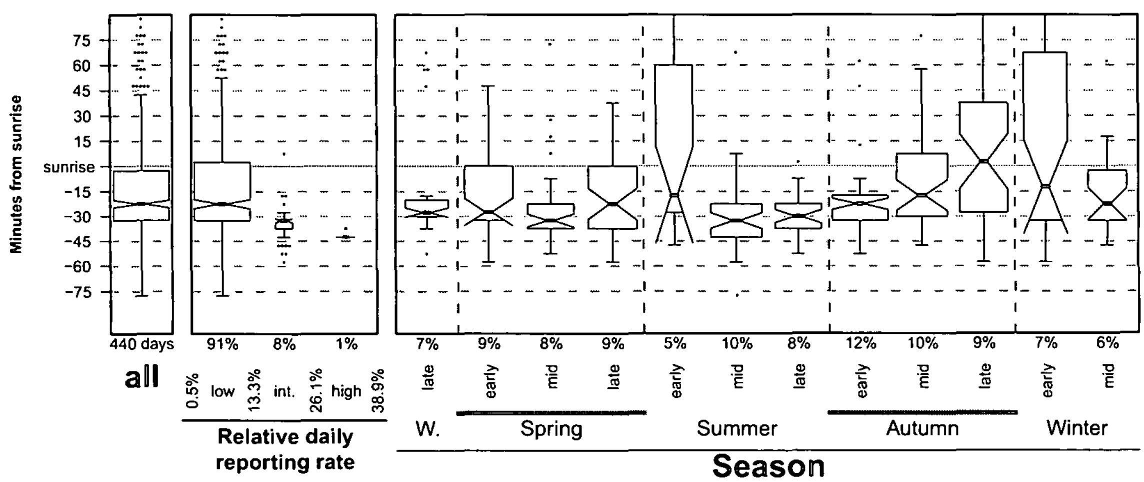
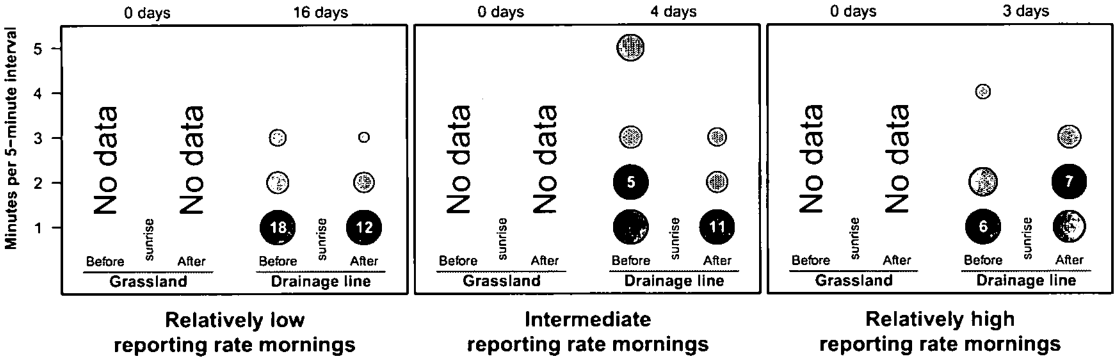
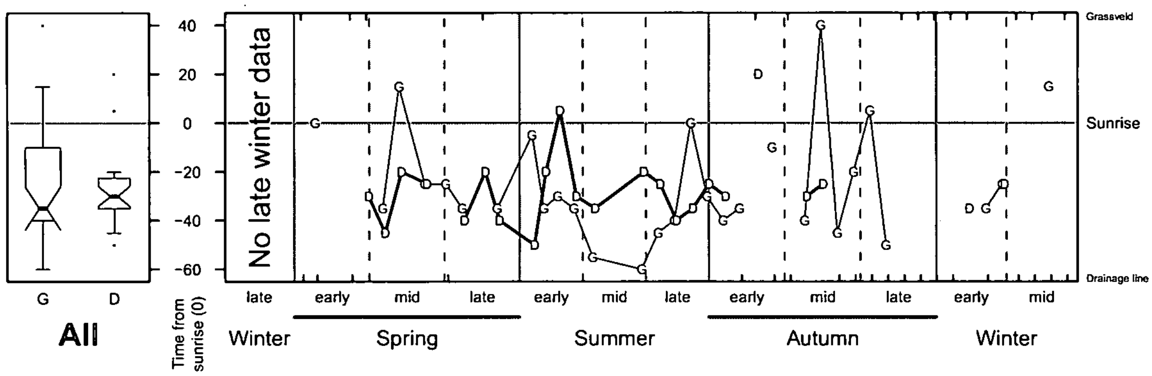


Figure 4.27: R094 Hadeda Ibis — birds present: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

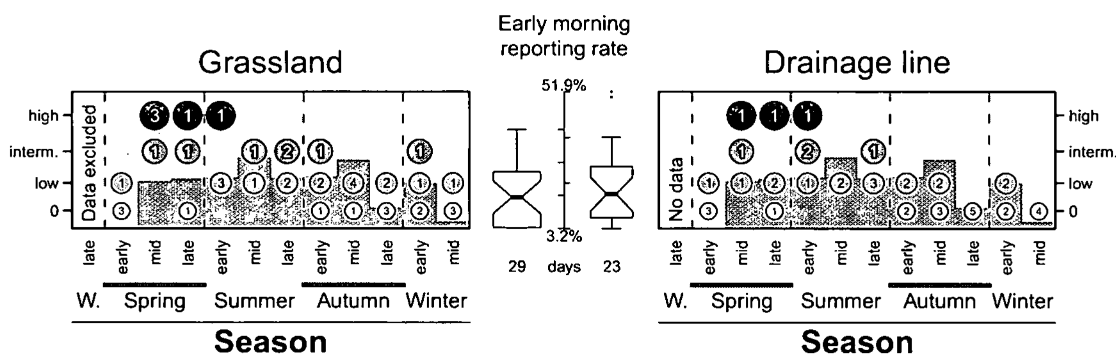


Figure 4.28: R094 Hadeda Ibis — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

R095 African Spoonbill .... *Platalea alba*

The African Spoonbill is endemic to sub-Saharan Africa and Madagascar (Urban 1982g). In southern Africa its distribution is largely confined to the central third of Namibia, the Okavango and other wetland areas in Botswana, Zimbabwe, Swaziland and South Africa where it becomes scarcer west of the Free State (Anderson 1997f). There is no evidence for large scale seasonal movements, although the birds do wander in response to local rainfall and the availability of shallow aquatic habitats on which they depend for their survival (Hancock *et al.* 1992).

The birds at Glen

Three of the five African Spoonbill records at Glen were of single birds seen in flight over the grassland (early and mid-summer 1997/8 and early autumn 2002/3), and two records were of birds (four and one, respectively) seen during early morning observations in the drainage line in 2007/8 (late autumn and mid-winter).

4.9 Dendrocygnidae: Whistling Ducks

Nine whistling duck species — with their specialised trachea for producing a clear, multi-syllabic whistle in most species — are found in the New and the Old World tropics and subtropics with three species occurring in southern Africa (Hockey *et al.* 2005). All three species have a widespread distribution in the Free State, but the Fulvous Duck *Dendrocygna bicolor* and White-backed Duck *Thalassornis leuconotus* are less common than the White-faced Duck R099 in the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). Only the latter species was recorded at Glen.

R099 White-faced Duck .... *Dendrocygna viduata*

The White-faced Duck is found in sub-Saharan Africa, Madagascar, Comoros and tropical South America (Maclean 1985). In southern Africa it is found mainly in the Okavango and other wetland areas of Botswana, as well as the region from the Free State northwards and eastwards, occurring only marginally in Lesotho (Maclean 1997a); it is relatively scarce in southern Mozambique (Parker 1999). It is found at a variety of wetlands, with non-breeding flocks favouring large expanses of shallow water and breeding pairs frequently encountered on small ephemeral pans, usually with emergent vegetation (Colahan 2005a; Maclean 1997a). The population consists of resident, nomadic and migratory elements (Clark 1974; Maclean 1997a; Tarboton *et al.* 1987; Taylor *et al.* 1999; Underhill *et al.* 1999). Nearly three quarters of 56 CWAC sites[1] showed peak numbers of White-faced Ducks during July [late winter] (Taylor *et al.* 1999).

The birds at Glen

All White-faced Duck records at Glen involved individuals or flocks that flew over the study area — probably on their way to or from the farm dam in the drainage line — in most cases (90.5%) giving their characteristic call. All records (vocal and visual) were combined in the analysis.

[1] CWAC: Coordinated Waterbird Counts. See Taylor *et al.* (1999)

Flock size was determined on 13 occasions and consisted of one (n = 7), two (n = 5) and 13 individuals (n = 1).

Birds in the grassland: Recorded on 5.9% days with an activity index of one (Table 4.6a). Found during almost all years, but was particularly scarce from 1999/0 to 2001/2 (Fig. 4.29). Records are mainly limited to the period from late spring to mid-autumn (Fig. 4.29). Often recorded more than 30 minutes before sunrise and more than 15 minutes after sunset, but recorded at other times of the day too (Fig 4.29).

Table 4.6: R099 White-faced Duck: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	57	114 612	0.0	birds present	5.9	656	39	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 190	0.1	birds present	2.3	43	1	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 188	0.1	birds present	2.3	43	1	1

Early morning occurrence of activity during 2007/8: Recorded in both habitats only once (Table 4.6b & c).

Discussion

It is known that the White-faced Duck forage during both the day and night (Petrie & Petrie 1998); however, breeding birds are mainly crepuscular (Colahan 2005a). In South Africa breeding occurs during the warmer parts of the year, mainly from December to February [summer to early autumn] (Clark 1976; Colahan 2005a; Siegfried 1973; Tarboton 2001; Tarboton *et al.* 1987). This corresponds with the pattern observed at Glen where the prominent daily pattern with peaks in activity before sunrise and after sunset indicative of crepuscular behaviour, and peak occurrence from late spring to mid-autumn (Fig. 4.29) corresponding neatly with the main rain period. Two factors probably contributed to the general scarcity/absence of White-faced Ducks from late autumn to mid-spring at Glen (Fig. 4.29). Firstly, the farm dam in the drainage line seldom retains water into spring. Secondly, flight feather replacement occurs mainly during "early winter or spring" (Petrie & Petrie 1998).

4.10 Anatidae: Ducks, Geese

The approximately 148 species of these water birds occur worldwide except Antarctica, with 17 species found in southern Africa (Hockey *et al.* 2005). Of the 12 species occurring in the Free

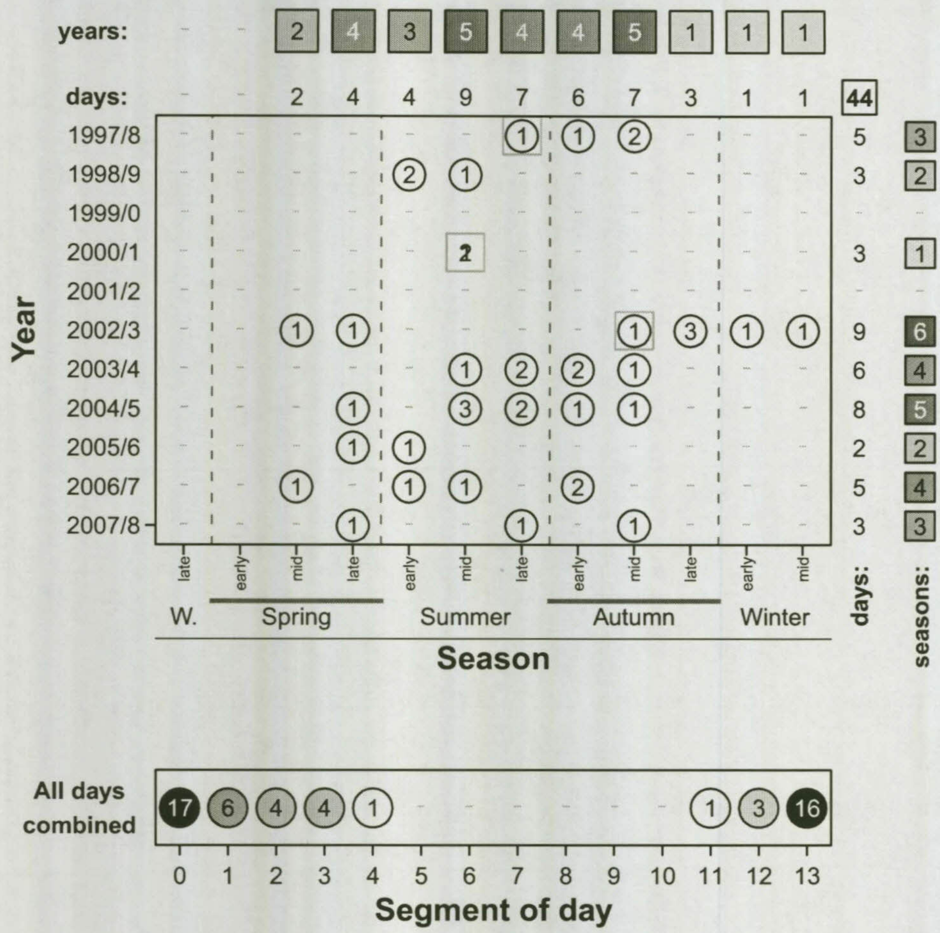


Figure 4.29: R099 White-faced Duck — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

State, most are widespread in the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). Seven species were not recorded at Glen, probably due to unsuitable types of aquatic habitats at the farm dam in the drainage line. The other five species were recorded at Glen.

R102 Egyptian Goose.................................. *Alopochen aegyptiaca*

The Egyptian Goose occurs in Africa and in certain parts of the western Palearctic (Cramp 1998; Maclean 1985). In southern Africa it occurs virtually throughout South Africa, Swaziland and Zimbabwe, with a more localised occurrence in Botswana and Namibia; scarce in Lesotho and southern Mozambique (Maclean 1997b; Parker 1999). Its habitat includes a variety of wetlands, with feeding occurring mainly on the edges of these wetlands and on crop fields (Davies & Allan 2005; Maclean 1997b; Van Niekerk 2007). Movement patterns are complex and not yet fully understood, but likely to be influenced by rainfall (Underhill *et al.* 1999). SABAP1 reporting rates tend to be slightly lower from approximately January to April [late summer and autumn](Maclean 1997b), while annual post-breeding moult movements are undertaken in "early winter" (Davies & Allan 2005).

The birds at Glen

The Egyptian Goose was recorded as birds in flight, usually to or from the farm dam in the drainage line. Most of the records (93.8%) involved birds heard with the remainder of the records involving birds seen only. All the data were combined in the analysis below. When seen, most frequently encountered as pairs, with a maximum flock size of 16 (Fig. 4.30). Figures start on page 187.

Annual occurrence of birds in the grassland: Recorded on 61.3% of the days with an activity index of four (Table 4.7a). Usually encountered during 11–12 seasons per year, but only 9–10 seasons during 1998/9, 1999/0 and 2000/1 (Fig. 4.31; Fig. 4.32). The daily reporting rates for all years were generally less than 10%, but reached an exceptional high value of 46.4% on a specific day in 2002/3 (Fig. 4.31). In addition, the median daily reporting rate of 2002/3 was higher than that of all other years, except 2003/4 (Fig. 4.31).

Table 4.7: R102 Egyptian Goose: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	1 709	114 612	1.5	birds present	61.3	656	402	4
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	94	1 190	7.9	birds present	65.1	43	28	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	30	1 188	2.5	birds present	39.5	43	17	2

Seasonal occurrence of birds in the grassland: Recorded during 10–11 years in most seasons, the exceptions being early autumn, late autumn and mid-winter when recorded during 8–9 years (Fig. 4.31; Fig. 4.32). Median daily reporting rates tended to be slightly higher during late autumn and winter (Fig. 4.31). This coincided with the occurrence of days with zero records which was slightly more frequent from mid-spring to mid-autumn than during late autumn, winter and early spring (Fig. 4.32).

Daily occurrence of birds in the grassland: Overall, activity occurred most frequently in the early morning and again in the late afternoon, with activity being infrequent in the late morning and early afternoon (Fig. 4.31). A similar pattern is evident for all seasons (Fig. 4.33). Bird-segment combinations occurring during more than 5% bird-days involved single segments S0, S1 and S2, which collectively accounts for more than a quarter of all bird-days (Fig. 4.34).

The first activity of the day usually occurred before mid-morning with no major seasonal differences (Fig. 4.33). The dawn chorus sequence fluctuated more or less in accordance with the occurrence of the first activity of the day (Fig. 4.35).

The timing of the last activity of the day was more variable and often occurred either in the morning or in the afternoon, with early and late winter being the only two seasons with activity on most of the days occurring during the late afternoon (Fig. 4.33; Fig. 4.35).

Daily segment reporting rates ranged from 5.6 to 92.3% with the upper quartile of segments below 20% and median daily segment reporting rates similar (*i.e.* <10%) for all segments (Fig. 4.31).

Early morning occurrence of birds during 2007/8: Activity was recorded more frequently in the drainage line than in the grassland (Table 4.7b & c), with the median early morning reporting rate also higher in the former habitat (Fig. 4.36). Another difference between the two habitats includes the timing of high reporting rate mornings which occurred in early summer, late autumn, early and mid-winter in the drainage line but early spring in the grassland (Fig. 4.36). The timing of the first activity of the day was variable, but tended to start later in the morning during the first part of the year than during the latter part (Fig. 4.36). In the drainage line, activity intensity was similar before and after sunrise (Fig. 4.36).

Discussion

The Egyptian Goose undergoes a moult during which the birds are flightless for approximately one month (Shewell 1959). In South Africa this may occur throughout the year, but tend to be more frequent during the cooler seasons (Dean 1978; Shewell 1959; Siegfried 1967). In the Free State a second peak from January to March [late summer to mid-autumn] suggests the involvement of birds from the winter rainfall areas (Geldenhuys 1975; Siegfried 1967). Breeding in the Free State peaks from August to December [spring and early summer] (Davies & Allan 2005). At Glen, daily reporting rates showed limited seasonal variation (Fig. 4.31).

The typical daily cycle of the Egyptian Goose includes an early morning flight from wetland to foraging area (often in crop fields), returning after approximately 90 minutes to the wetland where they preen, rest, sleep and feed a little until the late afternoon when they embark on a second feeding sortie (Halse 1985; Shewell 1959; Van Niekerk 2007). This neatly explains the pattern shown in Figure 4.33 which indicates that activity is largely restricted to the early morning and late afternoon, a pattern that remains remarkably consistent throughout the year. See also comparison with Spur-winged Goose R116 on page 210.

R103 South African Shelduck .... *Tadorna cana*

The South African Shelduck is endemic to southern Africa where it is largely confined to South Africa from the Free State south and westwards, extending into Namibia as far north as Etosha (Maclean 1997c). In the Free State optimum habitat occurs west of the 600 mm isohyet (Geldenhuys 1976). Changes in distribution and relative abundance in the Free State correlates with three phases according to their biological needs: breeding, moulting and post-moulting (Geldenhuys 1976). During breeding, which occurs mainly from July to August [mid-winter to early spring] (Maclean 1985), they are widely dispersed and often found around small water-bodies (Geldenhuys 1976; Maclean 1997c). After breeding, they aggregate on large bodies of water where they eventually undergo a flightless moult, mainly from November to December [late spring to

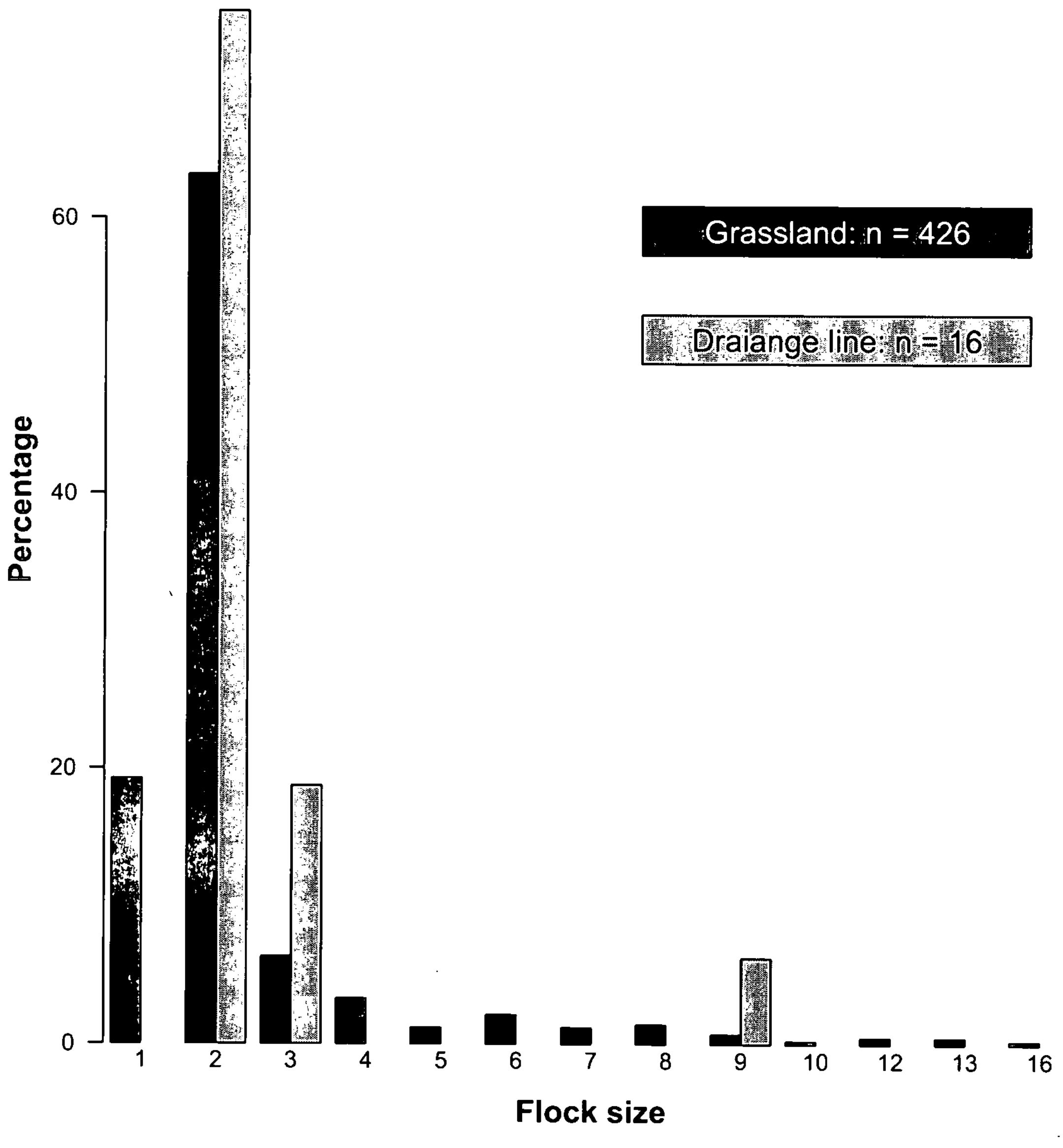


Figure 4.30: R102 Egyptian Goose: Flock size of birds seen in the study area at Glen.

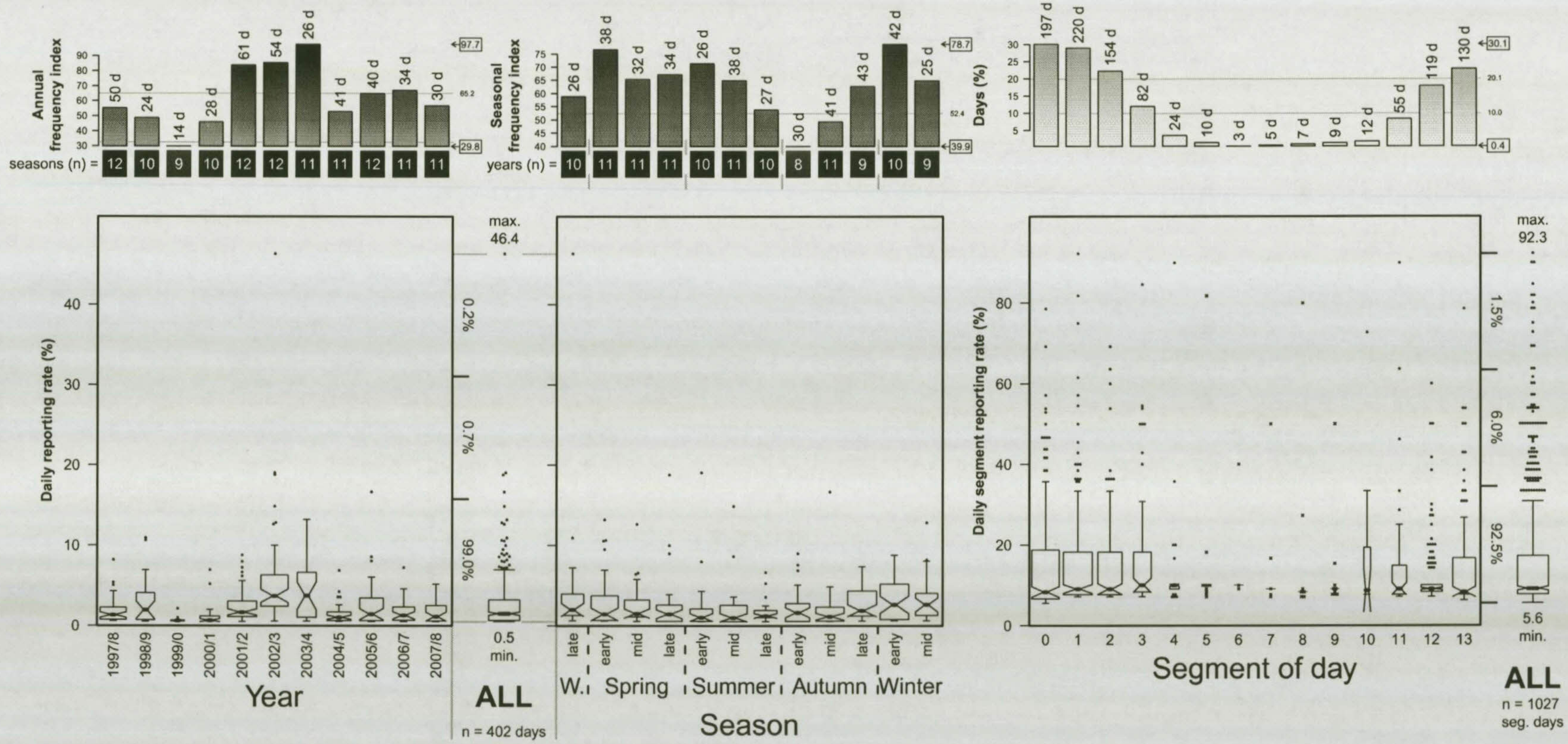


Figure 4.31: R102 Egyptian Goose — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

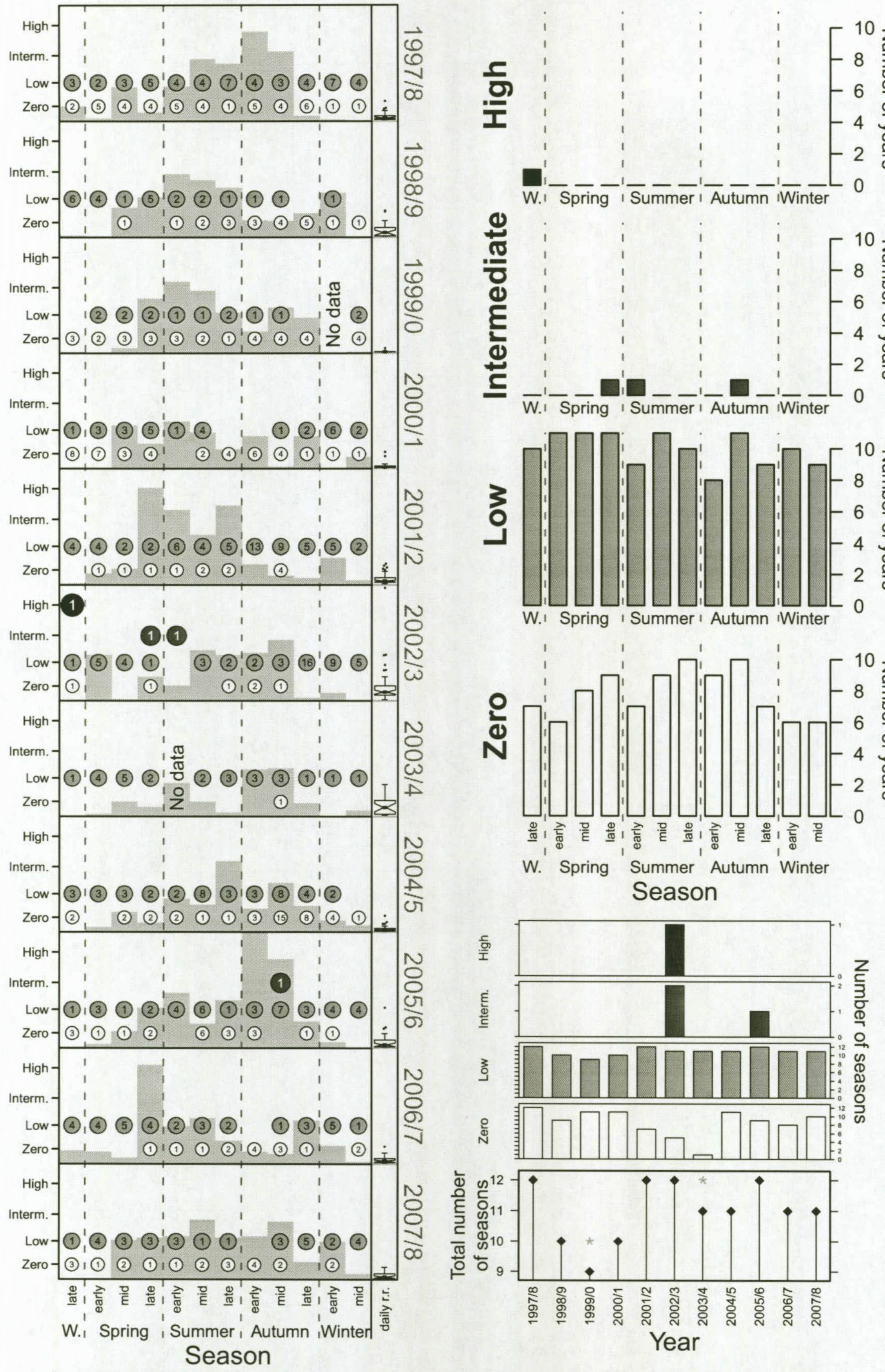


Figure 4.32: R102 Egyptian Goose — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

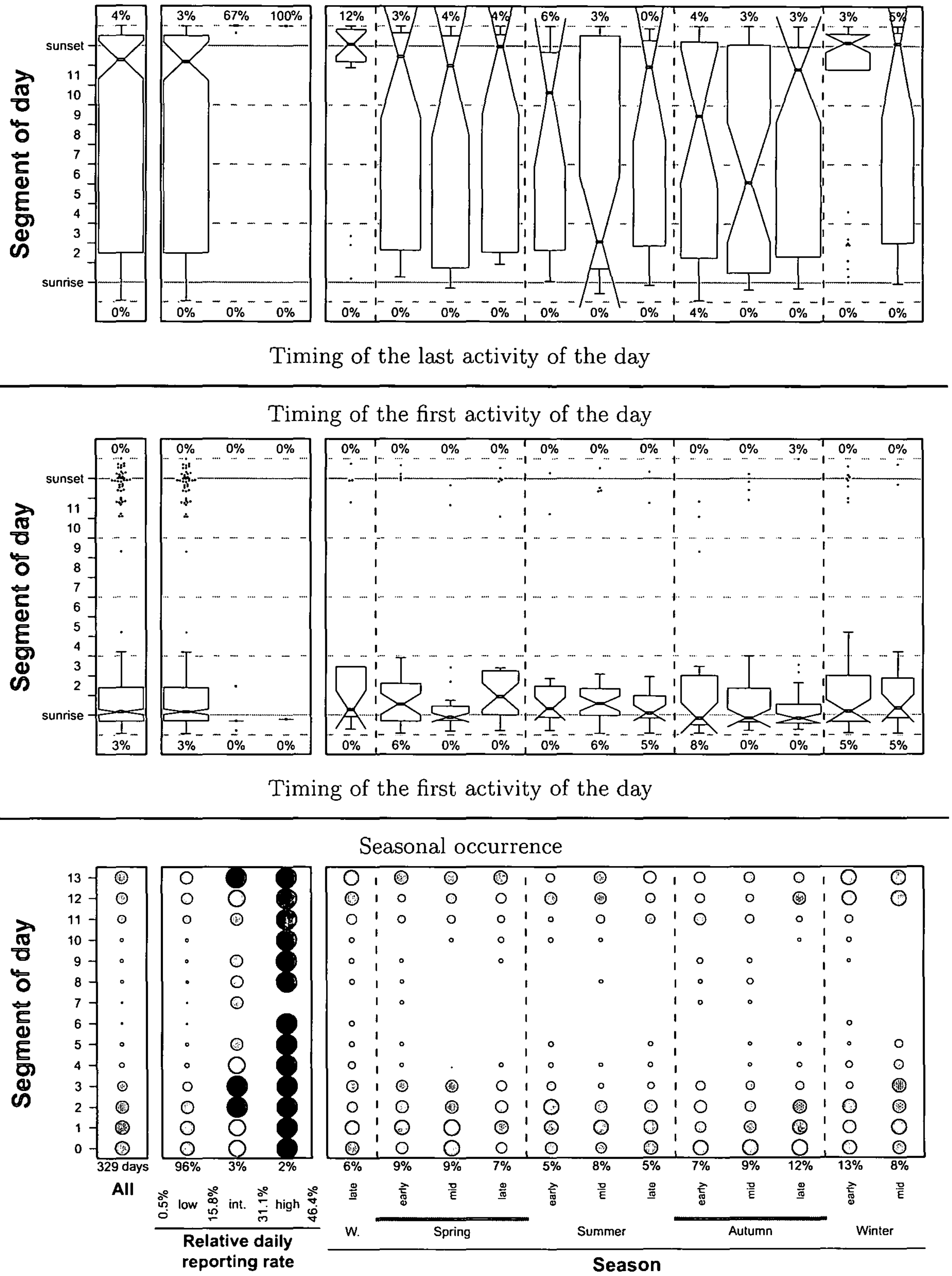


Figure 4.33: R102 Egyptian Goose — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

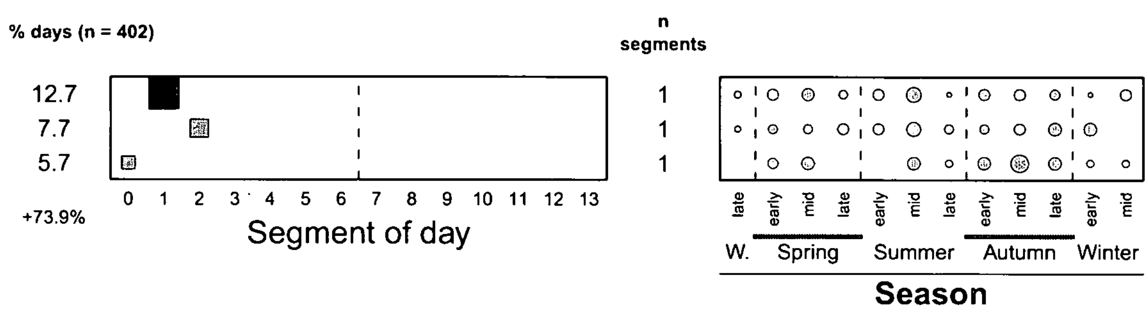
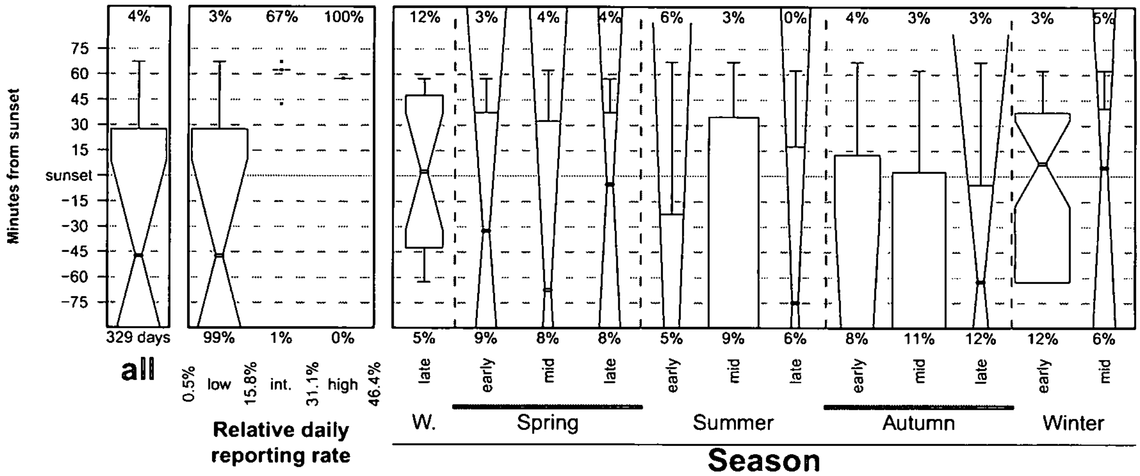
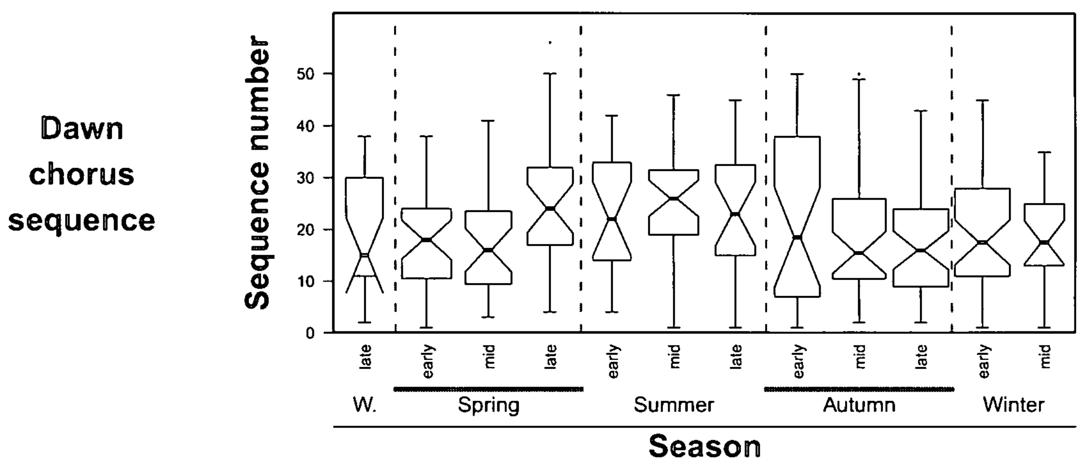


Figure 4.34: R102 Egyptian Goose — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

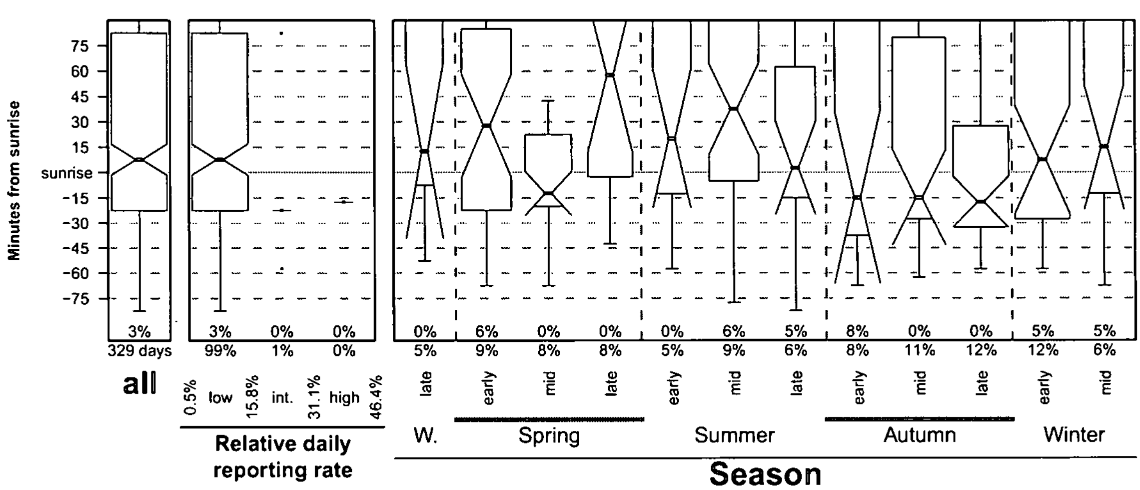
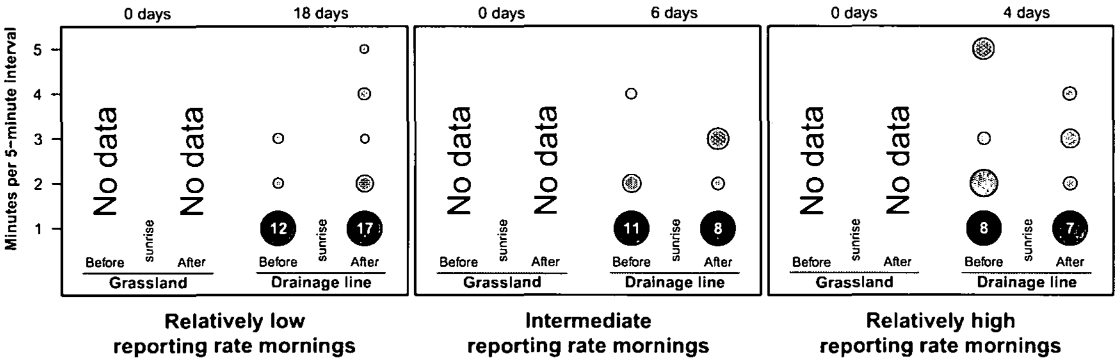
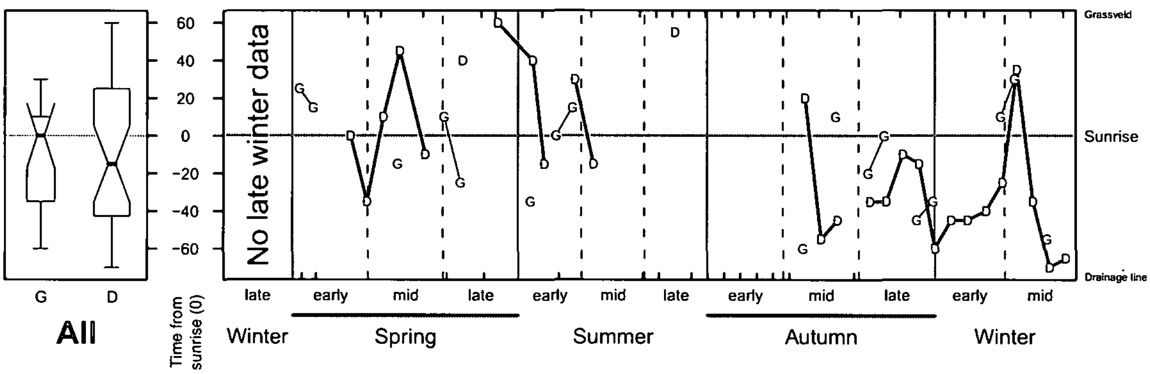


Figure 4.35: R102 Egyptian Goose — birds present: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

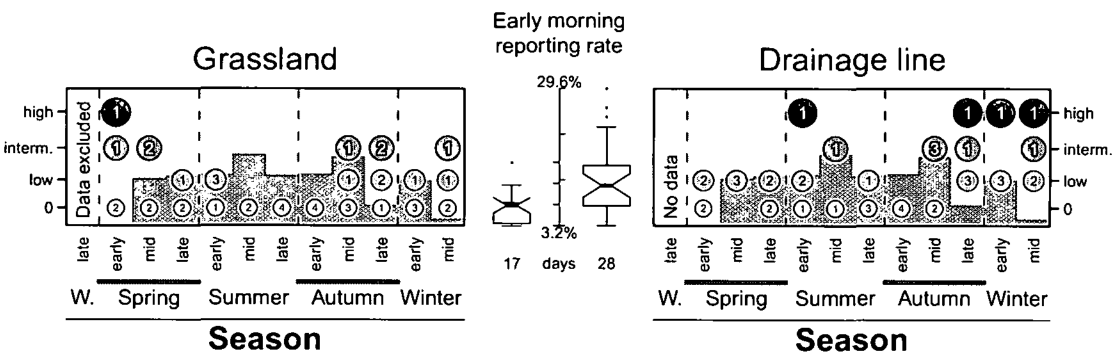


Figure 4.36: R102 Egyptian Goose — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

mid-summer] (Geldenhuys 1975). Most of the known wing-moult localities are situated in the Free State where approximately 60% of the global population may gather annually on large impoundments, mainly during November–December [early to mid-summer] (Maclean 1997c). They disperse again after moult.

The birds at Glen

In the grassland, the South African Shelduck was recorded as birds in flight, mainly to and from the farm dam in the drainage line. Most of the grassland records (97.2%) involved birds heard with the remainder consisting of birds seen only. All the data were pooled for analysis, which is based on a year starting in late summer. When seen, most frequently encountered as pairs (Fig. 4.37). Figures start on page 196.

Annual occurrence of birds in flight over the grassland: Recorded on 16.2% of the days with an activity index of three (Table 4.8a). Recorded for 1–9 seasons per year, being particularly frequent during 2006 and 2007 (Fig. 4.38; Fig. 4.39). Median daily reporting rates ranged from 0.5 to 14.5% with 95.5% bird-days attaining relatively low reporting rates (Fig. 4.38). Intermediate and high reporting rate days were restricted to 2006 and 2007 (Fig. 4.38; Fig. 4.39).

Table 4.8: R103 South African Shelduck: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	312	114 612	0.3	birds present	16.2	656	106	3
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	79	1 190	6.6	birds present	39.5	43	17	5
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	18	1 188	1.5	birds present	20.9	43	9	2

Seasonal occurrence of birds in flight over the grassland: Recorded during all seasons, but only rarely during summer or early autumn (Fig. 4.38). Median daily reporting rates were less than 2% for all seasons, with the occurrence of the few intermediate and high days limited to the period from mid-autumn to late winter (Fig. 4.38; Fig. 4.39).

Daily occurrence of birds in flight over the grassland: Overall, activity occurred most frequently in the early morning after sunrise and in the late afternoon before sunset; It seldom occurred during the middle of the day (Fig. 4.38). A similar pattern was seen during all seasons for which sufficient data was available (mid-autumn to mid-spring; Fig. 4.40). Bird-segment combinations occurring during more than 5 bird-days were limited to single segments S1, S2 and S3, collectively accounting for more than a third of all bird-days (Fig. 4.41).

The first activity of the day usually occurred during the morning (Fig. 4.40). The timing of the last activity of the day was more variable (Fig. 4.40).

The median daily segment reporting rate was the same for all segments of the day (Fig. 4.38).

Early morning occurrence of activity during 2007/8: Activity was more frequent in the drainage line than in the grassland (Table 4.8b & c), and the median early morning reporting rate was also higher in the former habitat (Fig. 4.42). The seasonal pattern, however, was similar with activity largely limited to autumn and winter in both habitats (Fig. 4.42). The occurrence of the first activity of the day was nearly always later in grassland (Fig. 4.42). Activity intensity was similar before and after sunset (Fig. 4.42).

Discussion

The dearth of South African Shelduck records during summer and early autumn at Glen (Fig. 4.38) are most probably due to birds aggregating at moult localities on larger bodies of water during this time of the year (see introductory section on page 186). The fact that the dam in the drainage line was often empty during this period also contributed to this pattern.

Regarding the daily pattern of occurrence, Van Niekerk (2007) found that South African Shelducks forage in recently harvested wheat fields in the morning and again in the afternoon. They typically arrived on the fields later, and departed earlier, than the Egyptian Goose R102 (Van Niekerk 2007). A similar situation was noted at Glen where the activity of the Egyptian Goose peaked earlier in the morning and later in the last part of the day when compared to the South African Shelduck (*cf.* Figs. 4.31 & 4.38).

R104 Yellow-billed Duck .... *Anas undulata*

The Yellow-billed Duck is endemic to Africa (Newman 1982). In southern Africa its distribution is largely limited to South Africa where it is scarce only in the arid west and in the north (Maclean 1997d; Parker 1999). It occurs on a large variety of inland waters, especially farm dams (Rowan 1963). Movements are linked to the flooding and drying of ephemeral wetlands, with populations concentrated at permanent wetlands towards the end of the the dry season and dispersing to breed once small wetlands are replenished after rains (Underhill *et al.* 1999).

The birds at Glen

Yellow-billed Ducks were recorded at Glen as birds that flew to and from the farm dam in the drainage line, where breeding has been was recorded in the past. Most of the records (90.0%) involved birds heard while the remainder consisted of birds seen only. All the data were combined in the analysis below. When seen, most frequently encountered as pairs, but flocks of up to five birds have been recorded (Fig. 4.43). Figures start on page 203.

[Recently a Yellow-billed Duck pair was observed to regularly roost in the zinc dam].

Annual occurrence of birds flying over the grassland: Recorded on 12.3% of the days with an activity index of two (Table 4.9a). Usually encountered during less than five seasons each year (not recorded at all during 2006/7), but during 6–8 seasons in 1997/8, 2002/3 and 2003/4; the

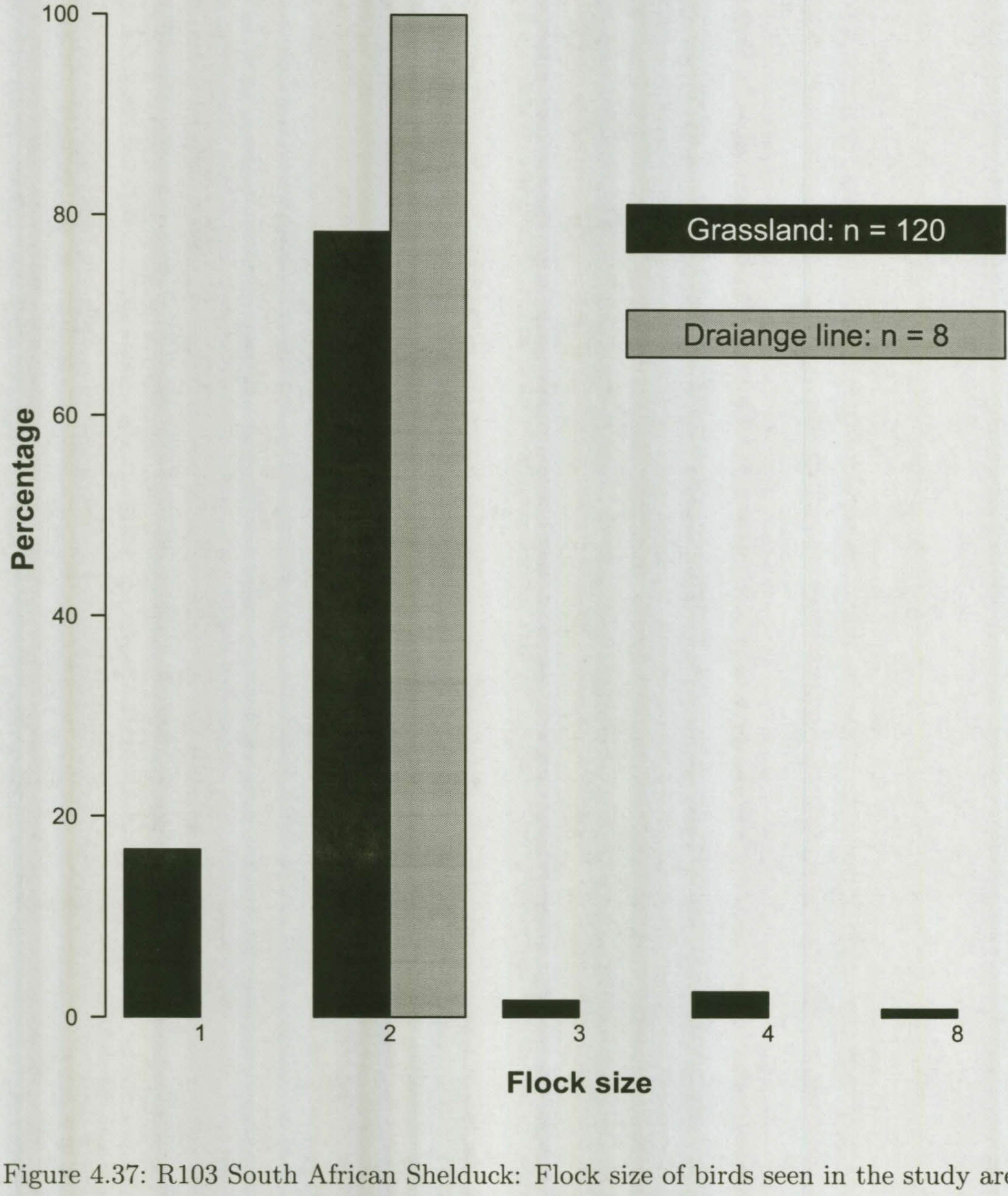


Figure 4.37: R103 South African Shelduck: Flock size of birds seen in the study area at Glen.

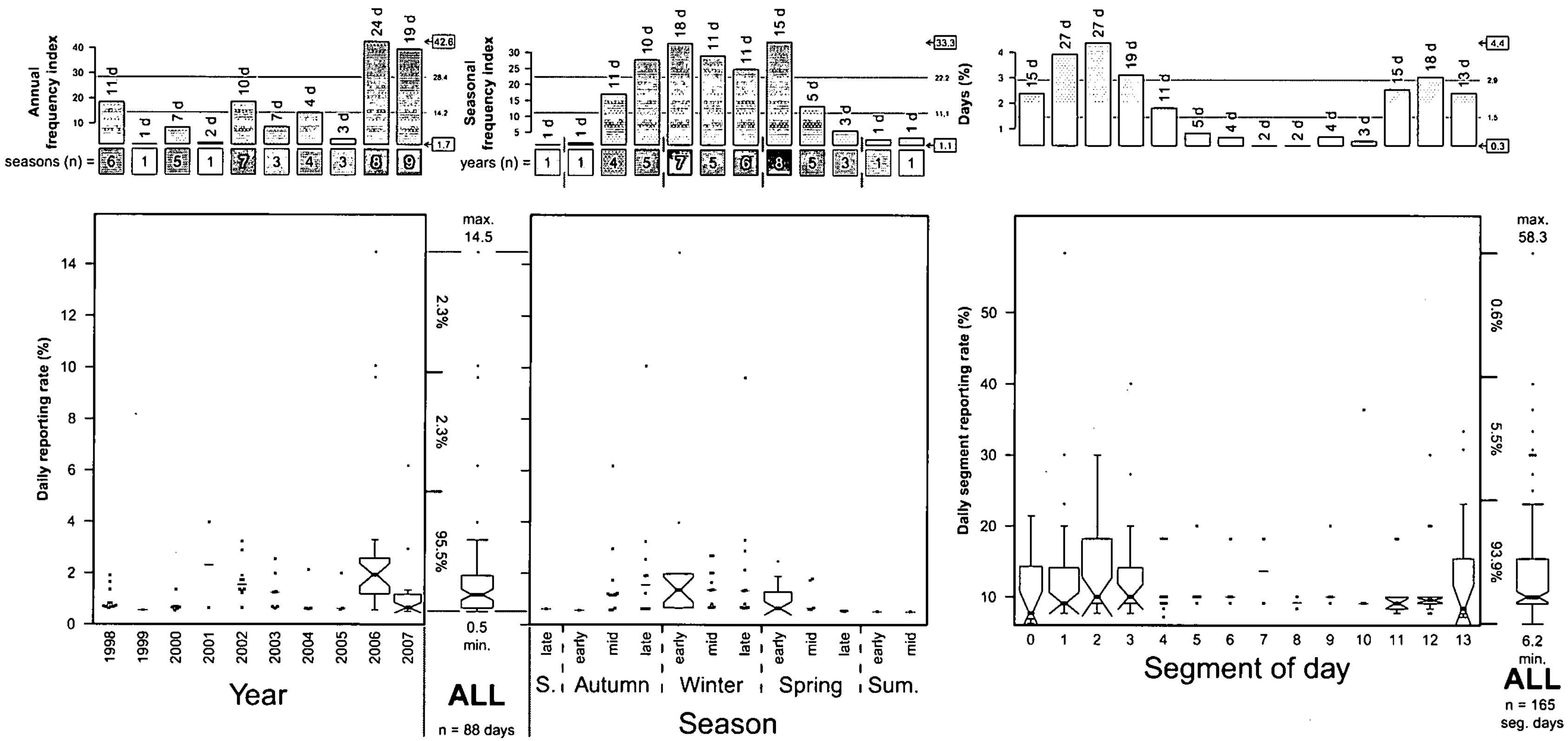


Figure 4.38: R103 South African Shelduck — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

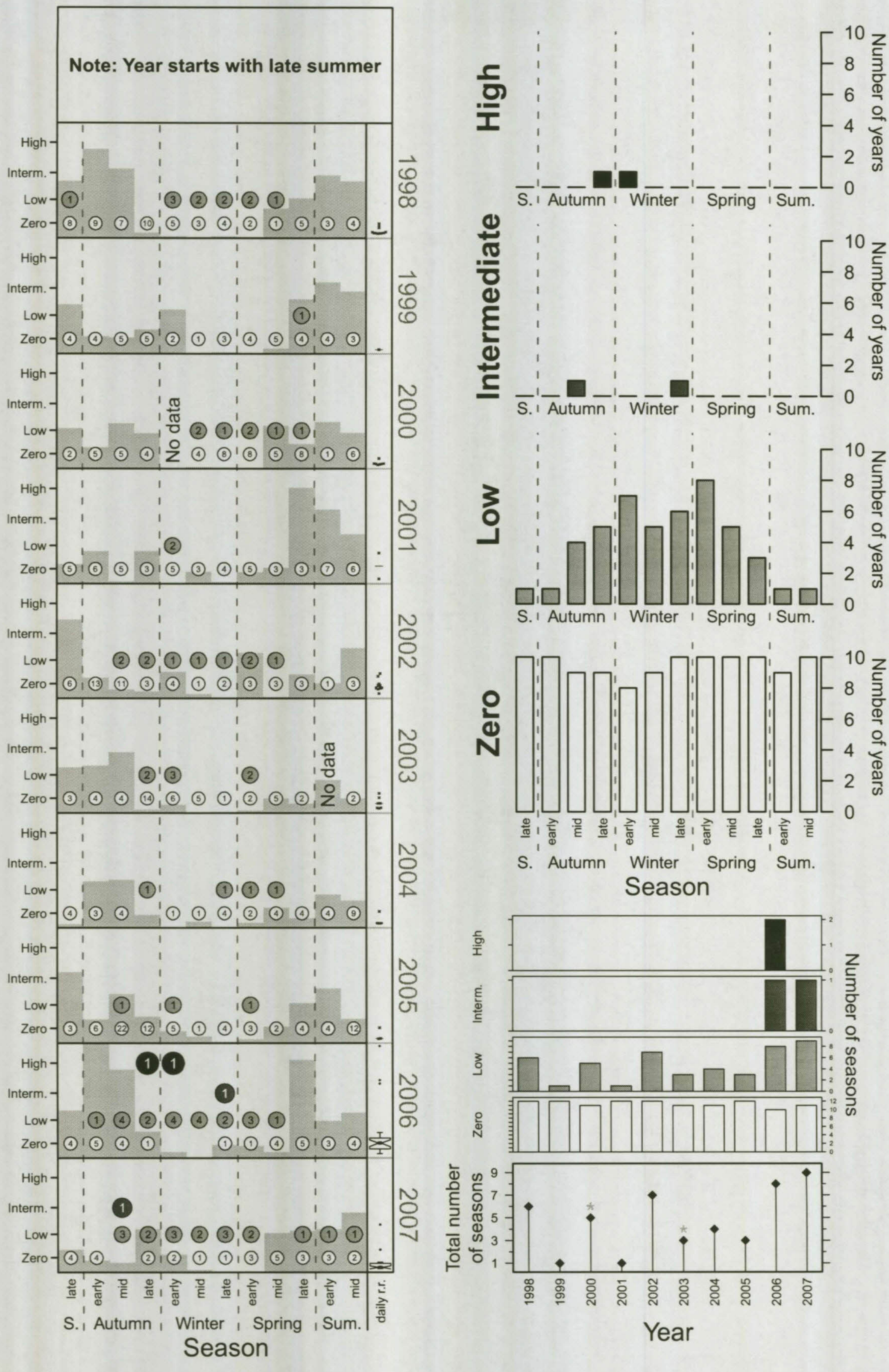


Figure 4.39: R103 South African Shelduck — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

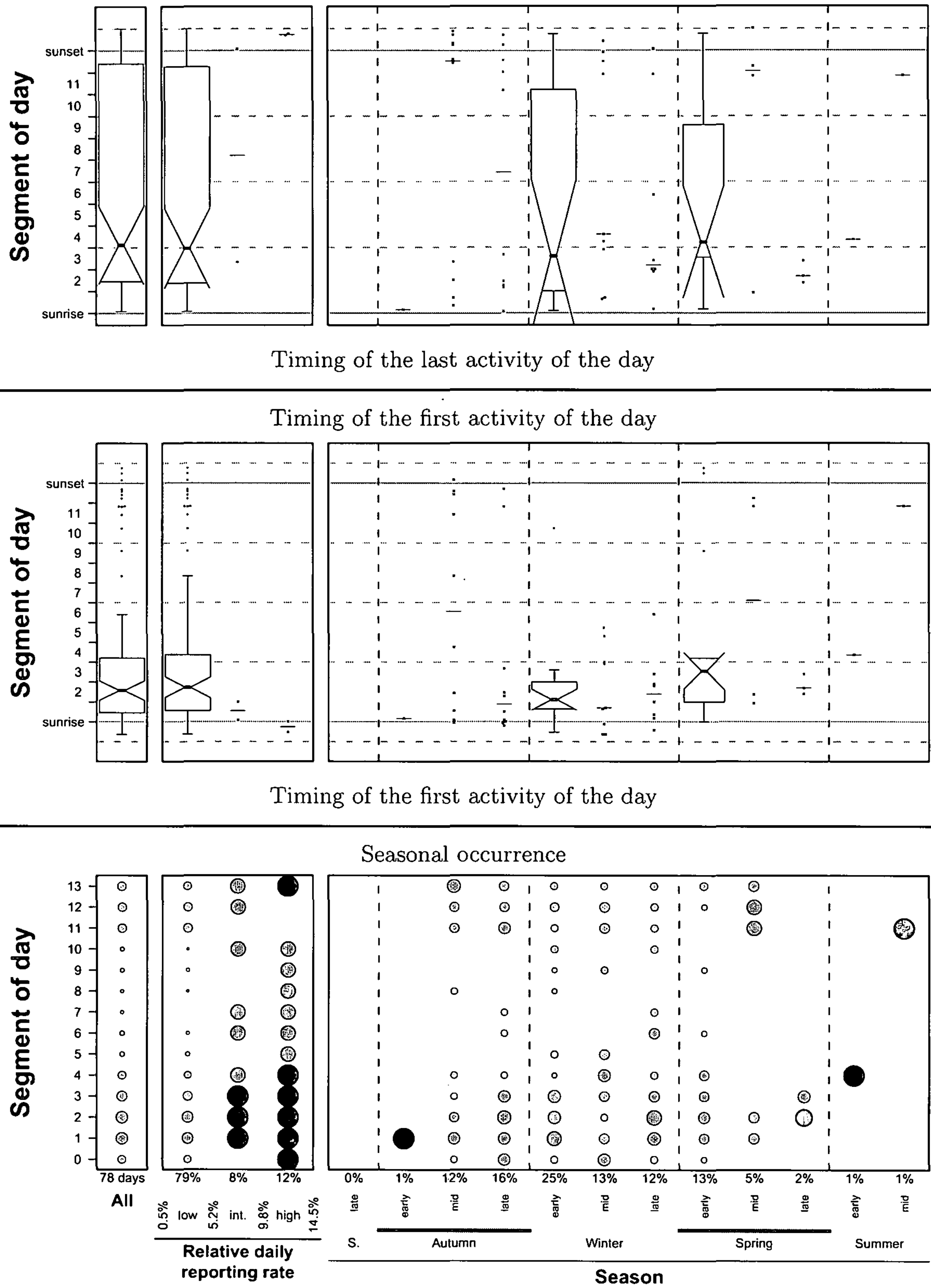


Figure 4.40: R103 South African Shelduck — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

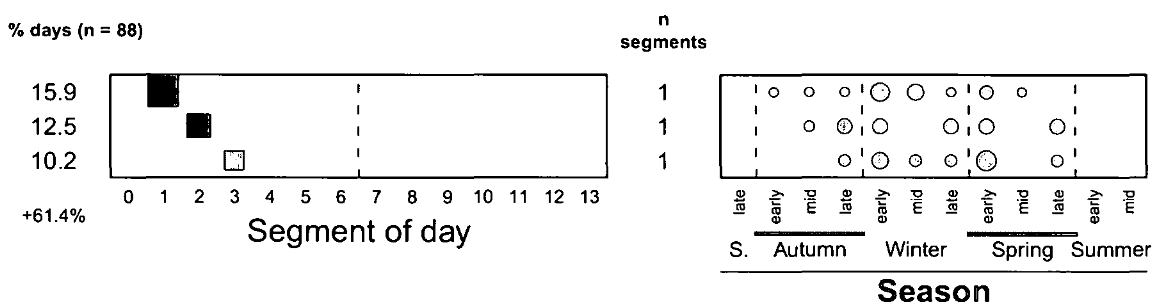
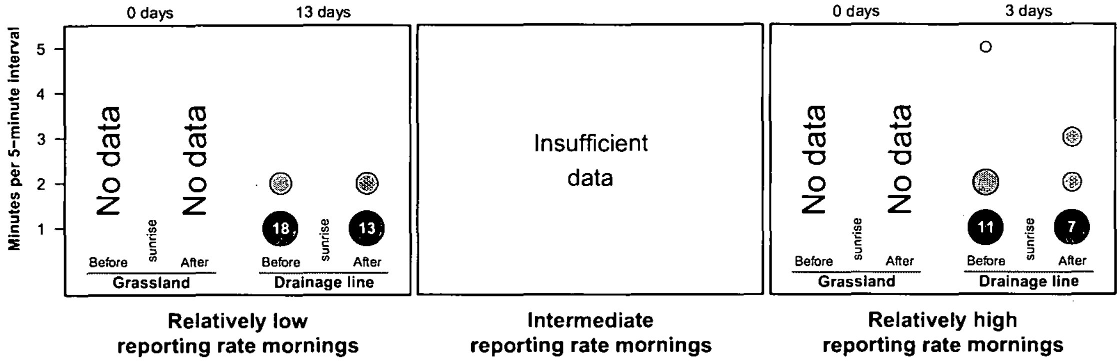
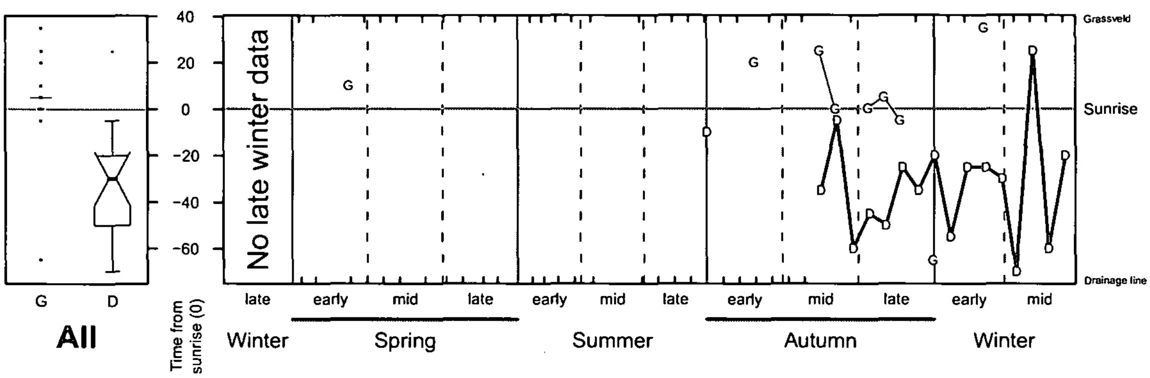


Figure 4.41: R103 South African Shelduck — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

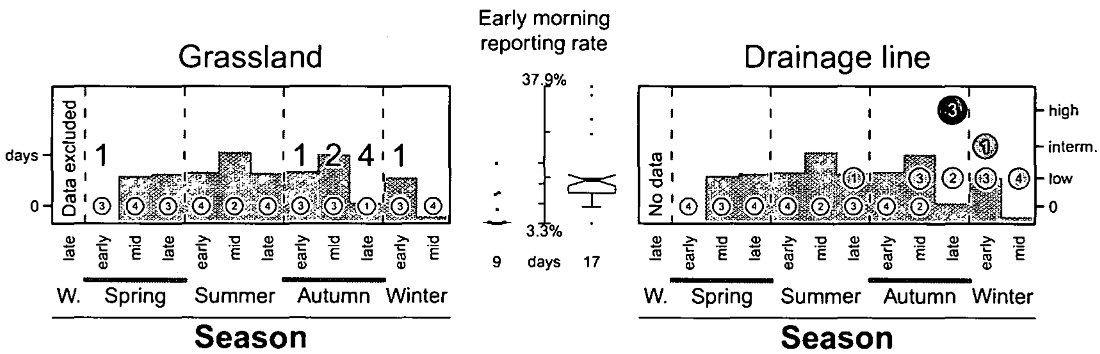


Figure 4.42: R103 South African Shelduck — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

latter three years also had the highest annual frequency indices (Fig. 4.44). Daily reporting rates ranged from 0.5 to 9.3% with intermediate and high reporting rate days occurring during 1997/8 and 2002/3 only (Fig. 4.44; Fig. 4.45).

Seasonal occurrence of birds flying over the grassland: The annual occurrence as well as the seasonal frequency index indicate a prominent peak period centred on autumn with activity least frequent from mid-winter to early summer (Fig. 4.44). Days with intermediate or high reporting rates were limited to late summer and autumn with the median daily reporting rates peaking in late autumn (Fig. 4.44; Fig. 4.45).

Daily occurrence of birds flying over the grassland: Overall, activity was most frequent in the early morning before sunrise and in the late afternoon after sunset; seldom recorded between mid-morning and mid-afternoon (Fig. 4.44). A similar pattern is evident for all seasons (Fig. 4.46). The four bird-segment combinations occurring on more than five bird-days involved single segments S0, S1, S12 and S13, collectively accounting for nearly two thirds of all bird-days (Fig. 4.47). These four combinations were particularly frequent during autumn (Fig. 4.47).

The first activity of the day frequently occurred in the early morning, but it often occurred in the late afternoon too (Fig. 4.46), with the occurrence of the last activity of the day showing the opposite trend (Fig. 4.46).

Daily segment reporting rates ranged from 5.9 to 64.3% with 91.5% of the values relatively low and median values similar for all segments (Fig. 4.44).

Early morning occurrence of birds in flight during 2007/8: Activity was limited to the drainage line (Table 4.9b & c), occurring during summer, late autumn, early and mid-winter (Fig. 4.48). The first activity of the day usually occurred more than 30 minutes before sunrise (Fig. 4.48).

Table 4.9: R104 Yellow-billed Duck: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	189	114 612	0.2	birds present	12.3	656	81	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	18	1 190	1.5	birds present	23.3	43	10	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–

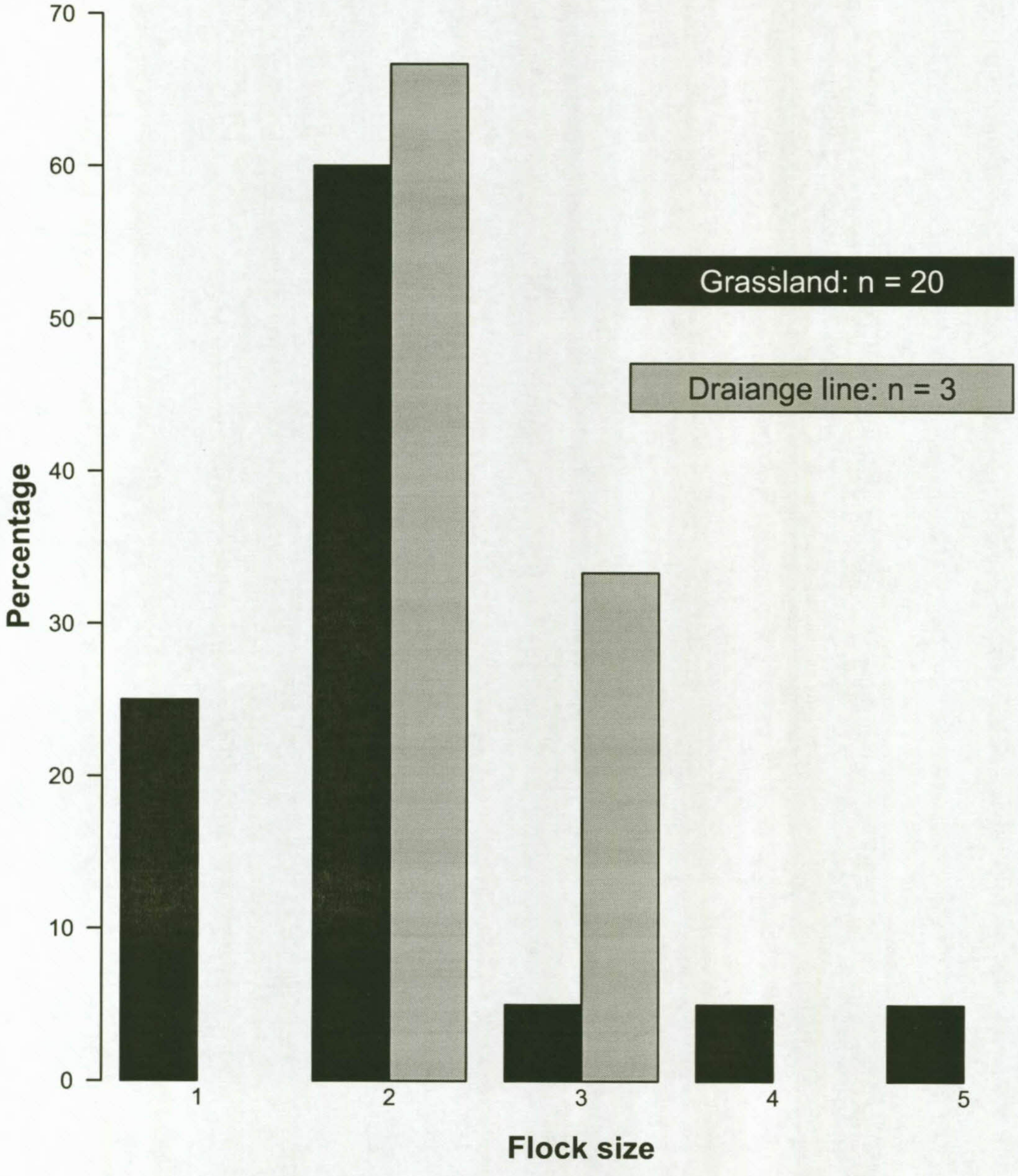


Figure 4.43: R104 Yellow-billed Duck: Flock size of birds seen in the study area at Glen.

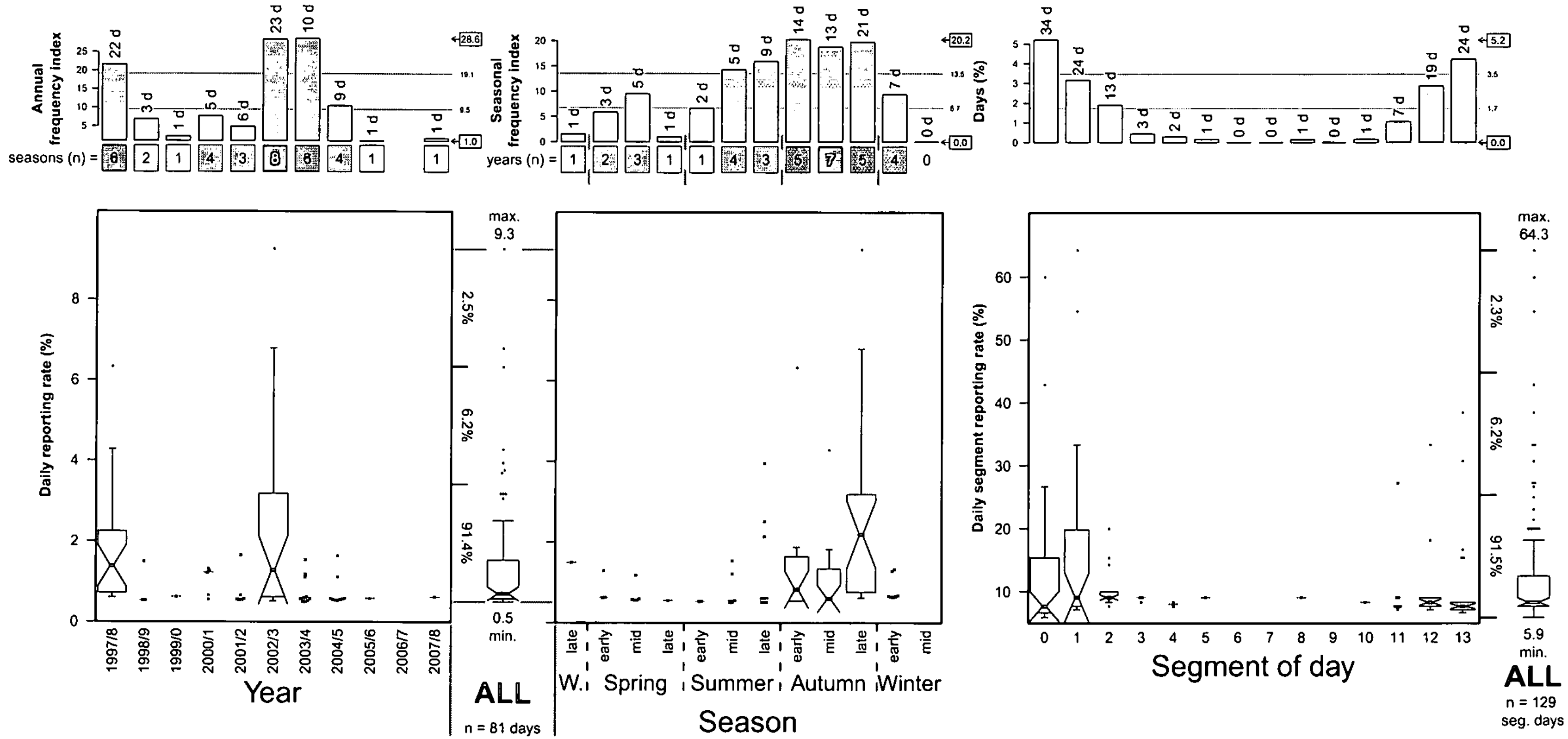


Figure 4.44: R104 Yellow-billed Duck — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

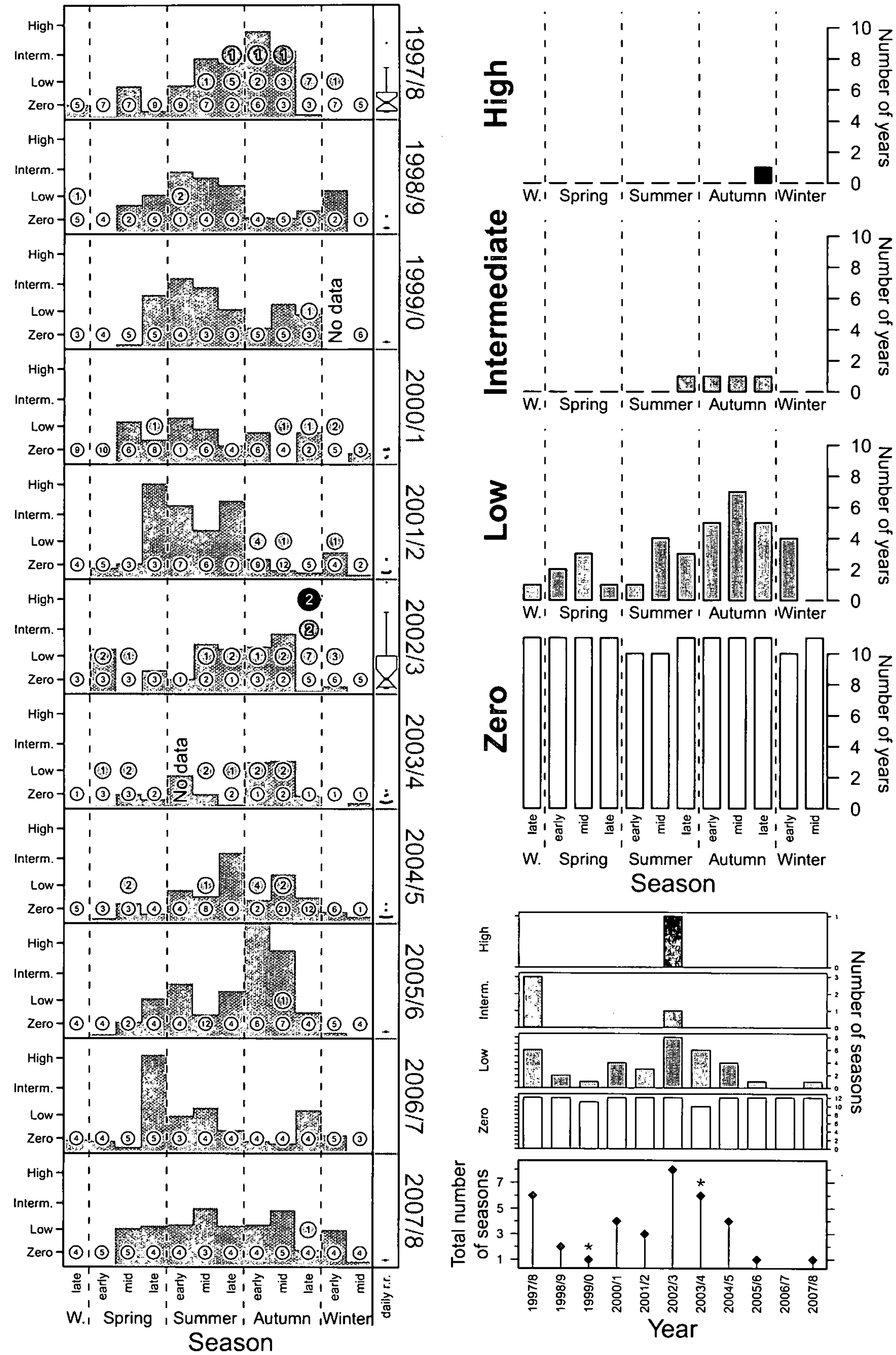


Figure 4.45: R104 Yellow-billed Duck — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

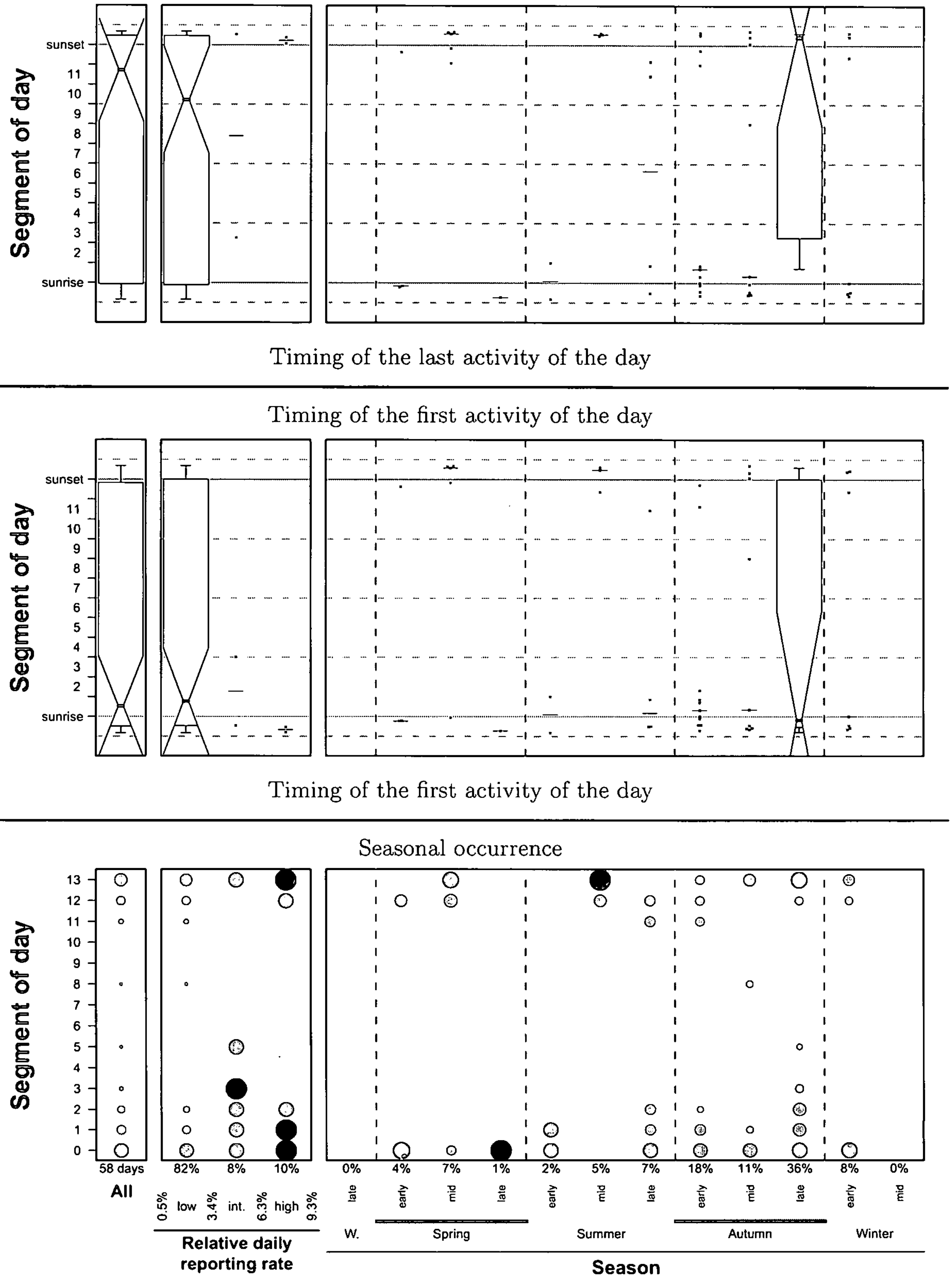


Figure 4.46: R104 Yellow-billed Duck — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

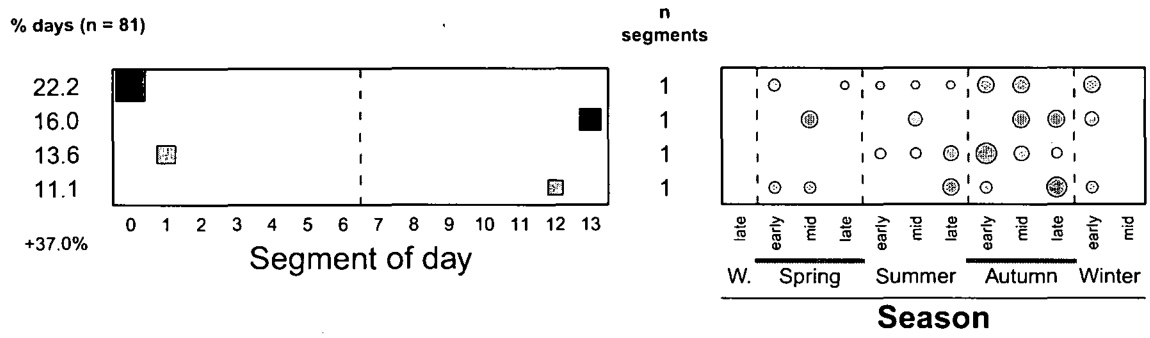


Figure 4.47: R104 Yellow-billed Duck — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

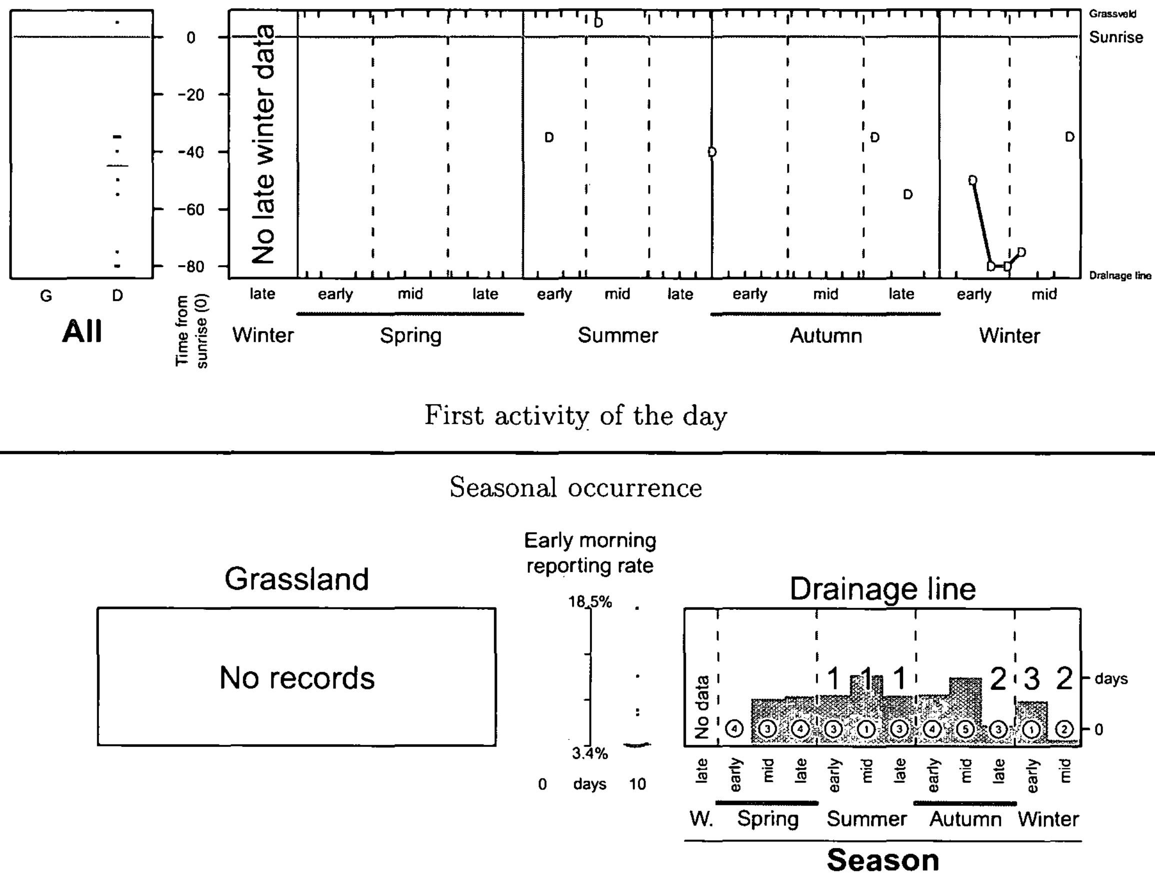


Figure 4.48: R104 Yellow-billed Duck — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Top: Occurrence of the first activity of the day. See page 136 for more information on this early morning figure.

Discussion

The fact that the Yellow-billed Duck was recorded only in the drainage line during the 2007/8 early mornings, a period of high activity (Fig. 4.44), suggests that the activity measured in the grassland is not always representative. Factors contributing to this include the crepuscular nature of their behaviour and the direction in which they moved from the farm dam. The data collected in the grassland represents birds moving between the farm dam and, presumably, feeding areas elsewhere.

Nevertheless, the autumn centred seasonal pattern (Fig. 4.44) corresponds with the time of year when the farm dam is most likely to contain water. However, this cannot explain why no birds were ever recorded during mid-winter and why it was recorded in late winter only once (Fig. 4.44). This may be due the annual flightless moult. In one study in the Free State moult was uncommonly recorded, but the largest number of flightless ducks found was during July [late winter] (Geldenhuys 1975). At Barberspan, flightless moult was recorded throughout the year with a peak from April to July [late autumn and winter] (Dean 1978; Shewell 1959). At the same locality breeding was also recorded throughout the year, but peaked from December to April [mid-summer to late autumn] (Dean 1978). Peak occurrence at Glen matched this period (Fig. 4.44).

The daily pattern of occurrence at Glen which shows prominent peaks in the early morning and again in the late afternoon/early evening (Fig. 4.44; Fig. 4.46) concur with observations elsewhere which indicate activity in the evenings and at night when foraging or flying to flooded areas (Vernon & Dean 2005a).

R108 Red-billed Teal .... *Anas erythrorhyncha*

The Red-billed Teal occurs in Africa and Madagascar (Carboneras 1992; Maclean 1993). It is widespread in southern Africa, but scarce or absent from the drier western areas, Lesotho and southern Mozambique (Maclean 1997e; Parker 1999). It occurs at most inland wetlands, but prefer ephemeral wetlands for breeding (Colahan 2005c), leading to dispersal over both short and long distances (Underhill *et al.* 1999). May undertake regular movements to large, permanent wetlands to moult during the dry season (Colahan 2005c).

The birds at Glen

Records of Red-billed Teal at Glen are limited to birds flying over the grassland to and from the farm dam in the drainage line. There are only three records: late spring (2006/7), late summer (2001/2) and late autumn (2005/6), with all the records limited to the time before sunrise and after sunset. Not recorded during the early morning observations in the drainage line.

Discussion

Additional observations at the farm dam during autumn 2007/8 and autumn 2008/9 indicated the presence of a Red-billed Teal pair, implying that the few observations in the grassland are not representative.

R116 Spur-winged Goose .... *Plectropterus gambensis*

The Spur-winged Goose is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa they are concentrated in the Western Cape, the eastern half of South Africa, parts of Zimbabwe and the Okavango basin in Botswana (Maclean 1997f). It occurs in a variety of inland waters, preferring larger water-bodies on which to gather for their flightless moult (during "winter"), and more secluded wetlands with emergent and/or fringing vegetation for breeding (Colahan 2005b; Maclean 1997f). Also found away from water in habitats such as natural grassland and in crops (Harebottle & Harrison 2003; Van Niekerk 2007). Apart from moult migration, it is probably nomadic in response to rain and cultivation of favoured food crops (Colahan 2005b).

The birds at Glen

The grassland records of Spur-winged Geese refer to birds flying over the grassland, in most cases to or from the farm dam in the drainage line. Approximately half of the instances where birds were seen and counted involved only single individuals with a maximum recorded flock size of 28 individuals (Fig. 4.49). Figures start on page 211.

Annual occurrence of birds flying over the grassland: Recorded on 36.9% of the days with an activity index of two (Table 4.10a). Recorded during 7–8 seasons in six years and during 10–12 seasons in the remaining five years, *i.e.* 1997/8, 2002/3 and 2005/6–2007/8 (Fig. 4.50; Fig. 4.51). This division corresponds only partially with the annual frequency index fluctuations (Fig. 4.50). Daily reporting rates ranged from 0.5 to 7.4% with 91.7% of the bird-days attaining low reporting rates and median daily reporting rates generally comparable (Fig. 4.50). High reporting rate days were restricted to 1997/8 and 2002/3 (Fig. 4.50; Fig. 4.51).

Seasonal occurrence of birds flying over the grassland: Activity was noted more frequently from mid-spring to late autumn than during winter and early spring (Fig. 4.50). Zero record days were least frequent during late spring (Fig. 4.51), corresponding with a peak in the seasonal frequency index (Fig. 4.50). Furthermore, days with high reporting rates were limited to late spring and early summer, while intermediate reporting rate days occurred from mid-spring to mid-autumn (Fig. 4.50; Fig. 4.51).

Daily occurrence of birds flying over the grassland: Overall, activity occurred most frequently in the early morning with a secondary peak in occurrence in the late afternoon; activity between mid-morning and mid-afternoon was relatively infrequent (Fig. 4.50). The pattern reflects the situation for both low and intermediate reporting rate days (sample size for high reporting rate days too small; Fig. 4.52). A similar pattern was evident for most seasons (Fig. 4.53). Bird-segment combinations which occurred on more than 5% bird-days were restricted to activity during single segments S0–S3 and S12–S13, collectively accounting for approximately half of all bird-days (Fig. 4.54). Peak occurrence of the various segments are represented in different seasons from mid-spring to mid-autumn (Fig. 4.54).

The first activity of the day normally occurred during the morning, with the median value (but not variability) similar for all seasons, occurring between sunrise and mid-morning (Fig. 4.53).

The timing of the last activity of the day was more variable with medians either in the early morning or late afternoon (Fig. 4.53).

Overall, daily segment reporting rates ranged from 5.6 to 33.3% with median values similar for all segments, except S0 which had a relatively low value (Fig. 4.50). Low and intermediate reporting rate days showed a similar pattern (Fig. 4.52).

Early morning occurrence of activity during 2007/8: Activity was equally frequent in the drainage line and the grassland (Table 4.10b & c). The median early morning reporting rates as well as the seasonal pattern of occurrence were also similar in the two habitats (Fig. 4.55).

Table 4.10: R116 Spur-winged Goose: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	525	114 612	0.5	birds present	36.9	656	242	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	18	1 190	1.5	birds present	25.6	43	11	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	13	1 188	1.1	birds present	25.6	43	11	1

Discussion

The fact that Spur-winged Goose activity was similar in the drainage line and the grassland (Table 4.10b & c; Fig. 4.55) indicates that the data collected in the grassland are representative.

At Glen, its relative scarcity during winter and early spring (Fig. 4.50) is probably the result of birds leaving the area for their annual flightless moult. In addition, the farm dam in the drainage line does not always retain water throughout winter.

They have a well-defined daily routine, spending the early morning and late afternoon feeding away from their wetland haunts, and the rest of the day and night at their favourite wetland, resting, preening, *etc.* (Halse 1985; Shewell 1959; Van Niekerk 2007). In the southern Free State, Van Niekerk (2007) found that Spur-winged Geese typically arrived on the fields later, and left earlier, than Egyptian Geese R102, both in the mornings and in the afternoons. This is compatible with the patterns observed at Glen (*cf.* Figs. 4.33 & 4.53). At Barberspan Halse (1985) found that, on average, the Spur-winged Goose left the wetland earlier and returned later in the morning than the Egyptian Goose R102, with the opposite pattern in the late afternoon. There the birds also spent less time away from the wetland in the late afternoon than in the early morning (Halse 1985). This probably explains why the peak in activity at Glen was more extensive in the early morning than in the late afternoon in both species (Fig. 4.31; Fig. 4.50).

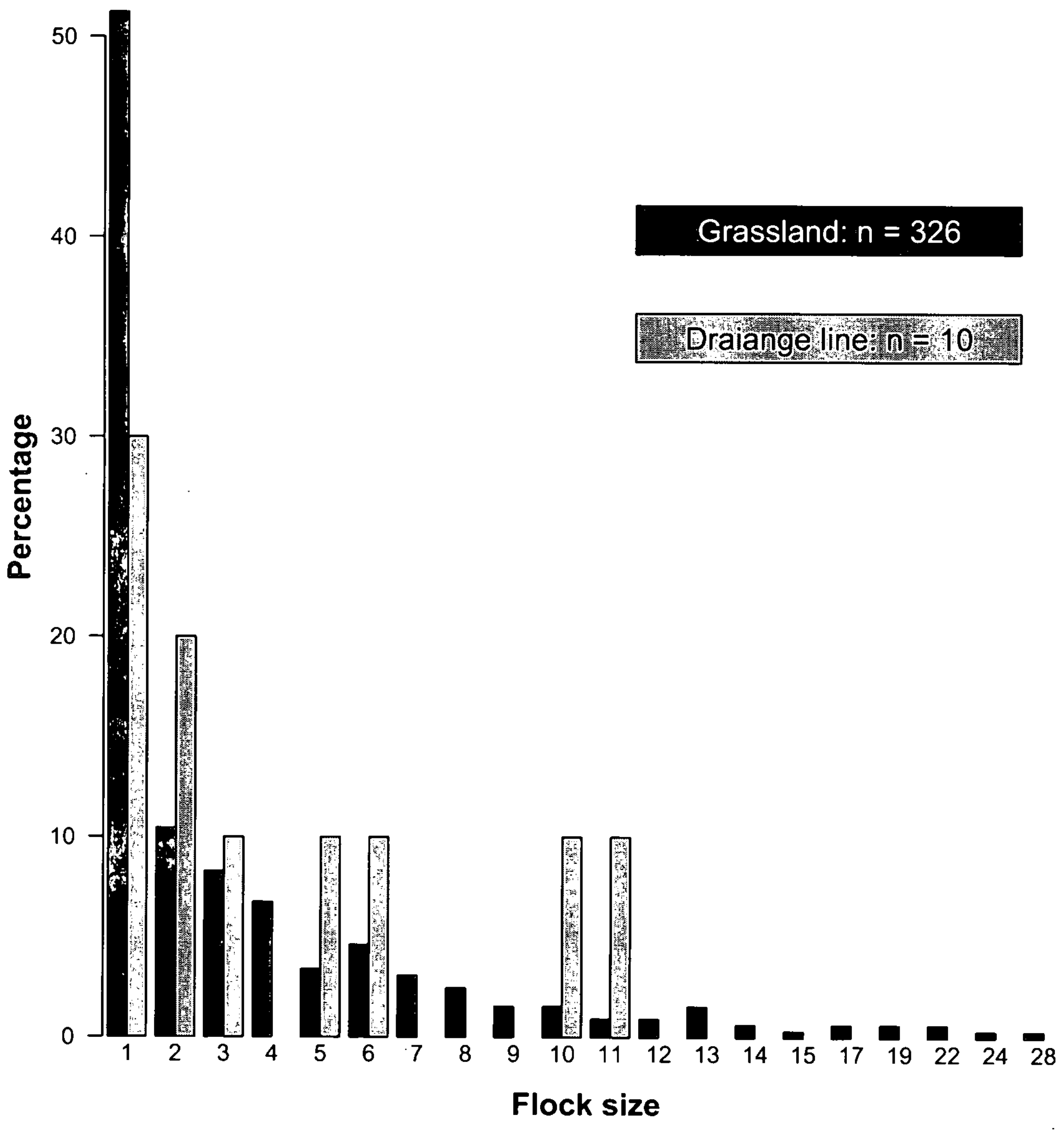


Figure 4.49: R116 Spur-winged Goose: Flock size of birds seen in the study area at Glen.

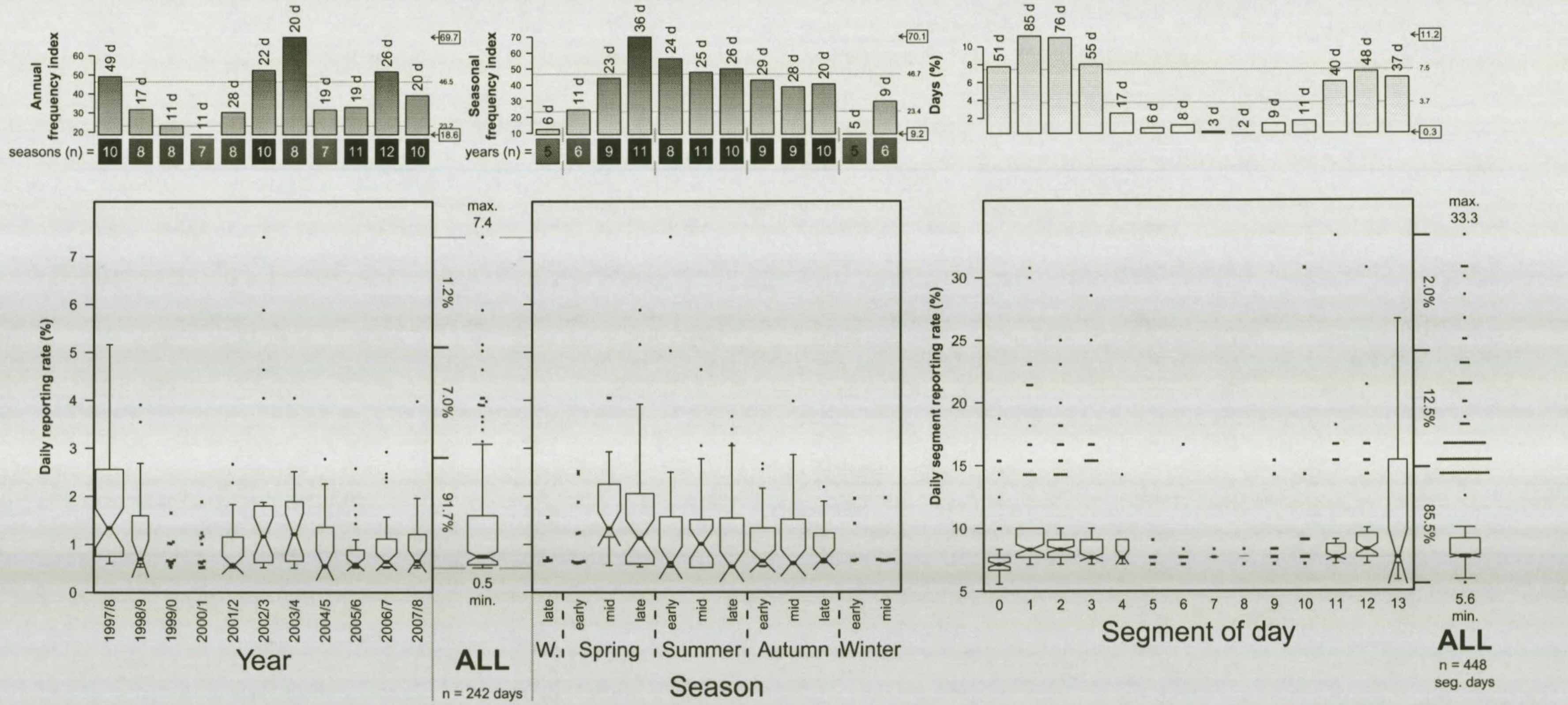


Figure 4.50: R116 Spur-winged Goose — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

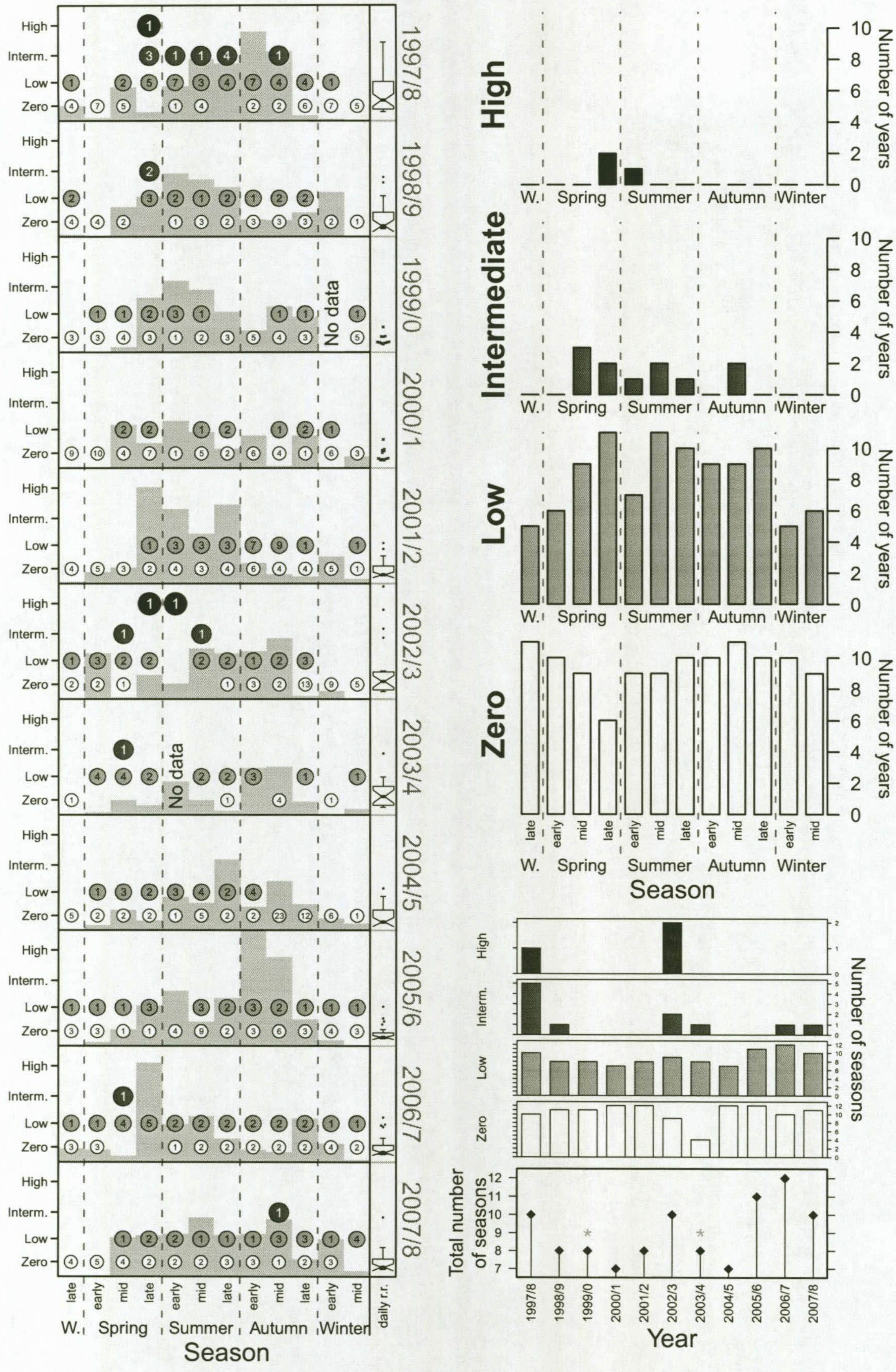


Figure 4.51: R116 Spur-winged Goose — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

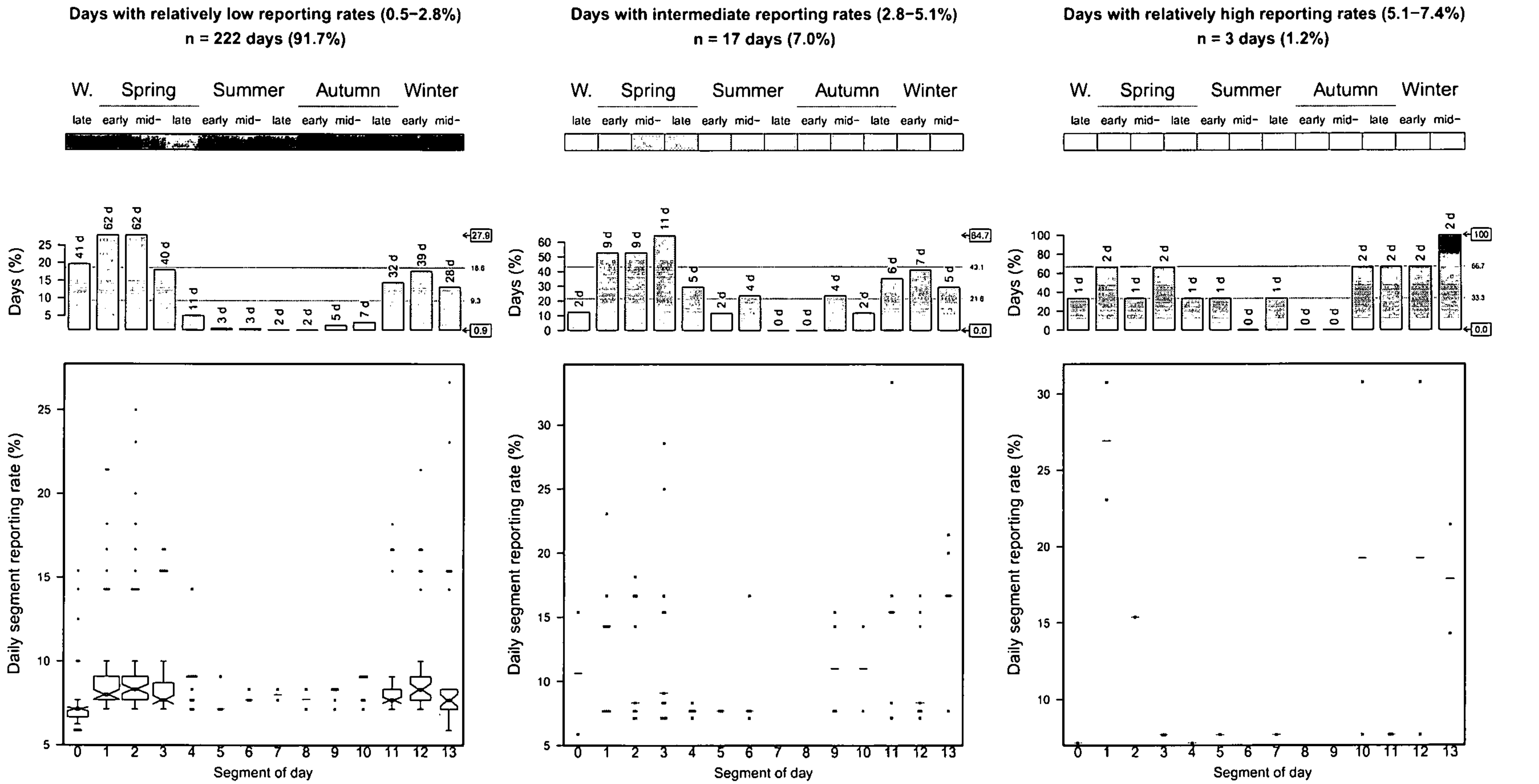


Figure 4.52: R116 Spur-winged Goose — birds present: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

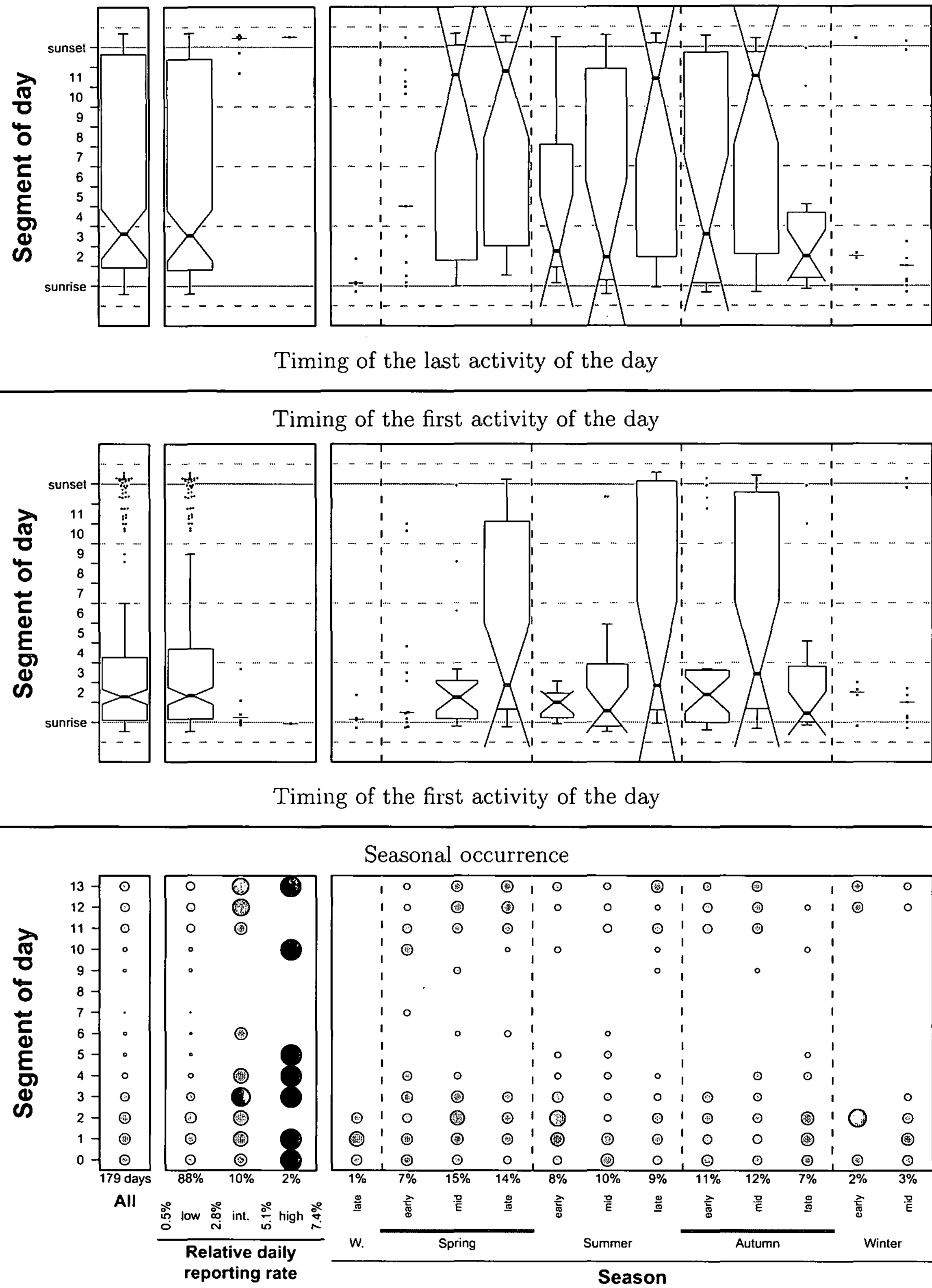


Figure 4.53: R116 Spur-winged Goose — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

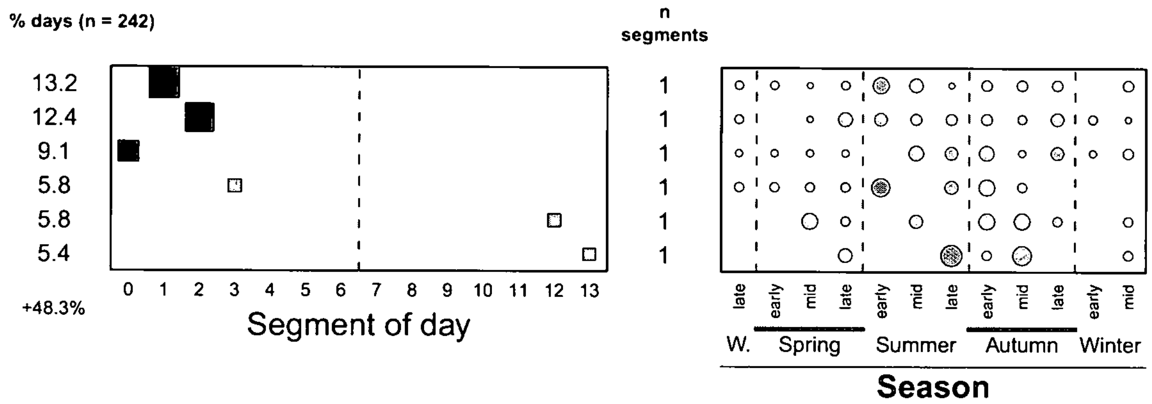


Figure 4.54: R116 Spur-winged Goose — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

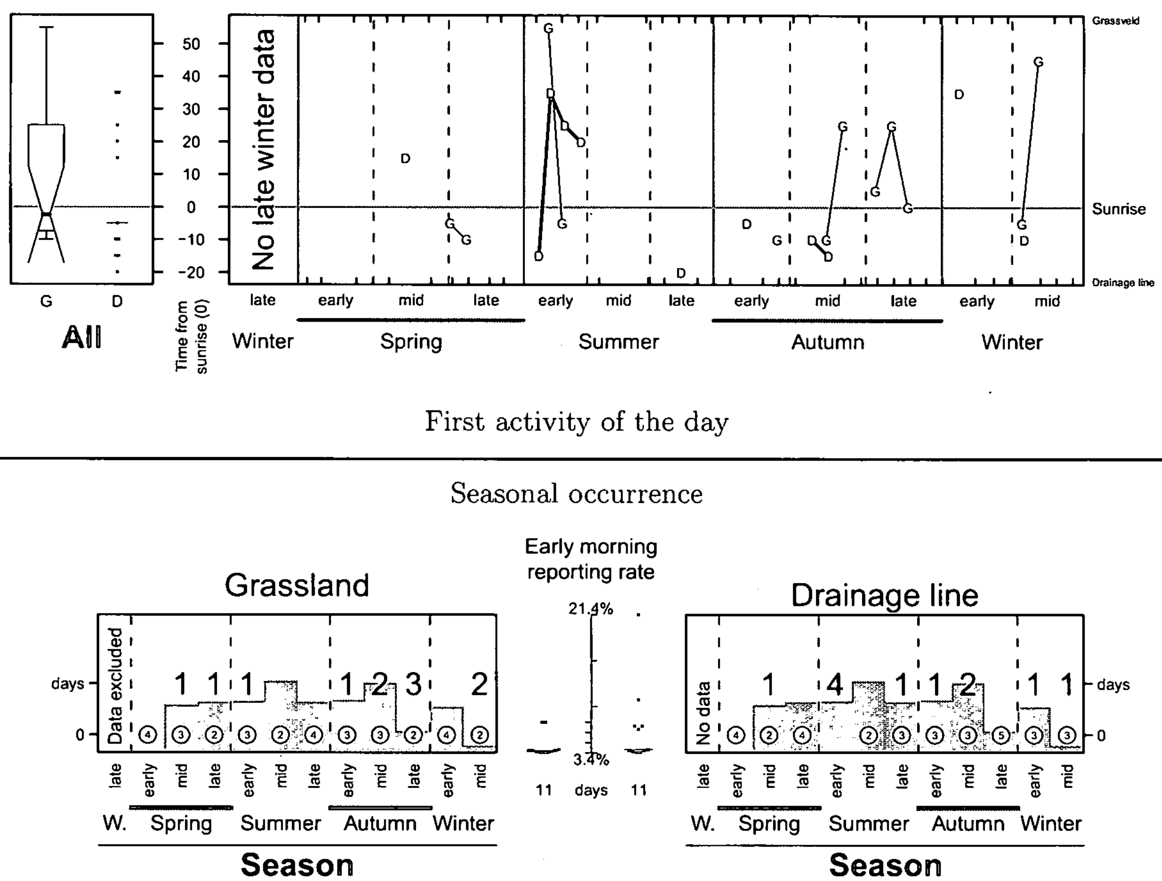


Figure 4.55: R116 Spur-winged Goose — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Top: Occurrence of the first activity of the day. See page 136 for more information on this early morning figure.

4.11 Sagittariidae: Secretarybird

This monotypic family is endemic to sub-Saharan Africa (Hockey *et al.* 2005).

R118 Secretarybird .... *Sagittarius serpentarius*

The Secretarybird occurs throughout southern Africa (Boshoff & Allan 1997a), except in southern Mozambique where it is scarce (Parker 1999). It prefers open country including grassland (Boshoff & Allan 1997a). Generally considered to be resident, but it is not sedentary (Dean & Simmons 2005). The Secretarybird is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Barnes 2000c).

The birds at Glen

Secretarybird records usually involved birds seen in flight, less often birds foraging in the grassland. Only recorded in the grassland where seen on 28 days with half of the records involving single birds, and the other half pairs. Heard calling only once.

Seen during all years except 1999/0, with sightings occurring during 1–4 seasons per year, most frequently during 2004/5, 2005/6 and 2006/7 (Fig. 4.56). Recorded during all seasons except early summer with no prominent seasonal pattern (Fig. 4.56). Records were limited to S2–S11 with many of the records during the middle part of the day (S5–S8; Fig. 4.56). A pair nested successfully approximately 1.3 km west of the study area in mid-summer 2008/9.

Discussion

According to Steyn (1982), Secretarybirds are not early risers, and when the grass is wet they may linger at their roosts until about two hours after sunrise. They are also known to be active in the heat of the day (Brown 1982f), and quite often they will soar around on thermals (Steyn 1982). At Glen, where many of the records refer to soaring birds, the midday activity peak (Fig. 4.56) is probably a reflection of the presence of thermals which enabled the birds to soar.

However, soaring birds are easily overlooked. It was often the case that such birds were seen only after the Spike-heeled Lark R506 or Eastern Clapper Lark R495 under observation exhibited anti-predatory behaviour, which prompted the observer to search the sky above. It is, therefore, not surprising to note that the Secretarybird was recorded relatively often in 2004/5, 2005/6 and 2006/7 (Fig. 4.56) when the observations on the Eastern Clapper Lark were most intense.

4.12 Accipitridae: Typical Raptors, Old World Vultures, Osprey

The 256 species of this diverse group of raptors occur worldwide except in Antarctica with 54 species occurring in southern Africa (Hockey *et al.* 2005). Almost half of these species have been recorded in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a). The 15 species recorded at Glen include all eight species that normally occur in the central parts of the province, four species which are generally scarce in the province, two that normally occur elsewhere in the province and one, the Bateleur R146, which represents an out of range record. A significant

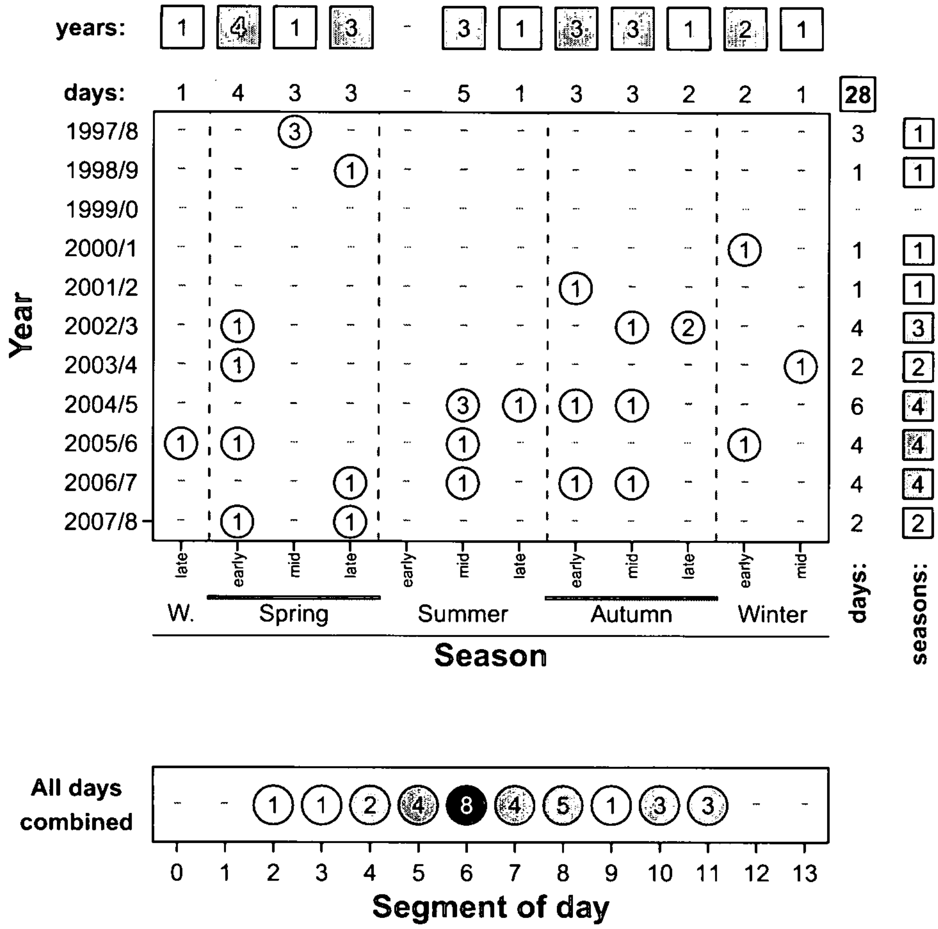


Figure 4.56: R118 Secretarybird — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

proportion of these sightings was first detected by the larks under observation (see Discussion of the Secretarybird R118 above).

R122 Cape Vulture .... *Gyps coprotheres*

Apart from vagrants outside the region, the Cape Vulture's distribution is restricted to southern Africa (Mundy *et al.* 1992; Mundy *et al.* 1997). Most sightings are concentrated around breeding colonies of which the bulk is situated in two discrete areas, the one from Lesotho eastwards and southwards and the other in the former Transvaal and adjacent Botswana (Mundy *et al.* 1997). In the Free State it is mainly recorded in the eastern and southern parts of the province (Earlé & Grobler 1987; Mundy *et al.* 1997; O'Connor 1980). It is a resident, but adults wander up to 750 km from the colony site during the non-breeding season (Mundy *et al.* 1992). The Cape Vulture is considered to be facing a high risk of extinction in the wild (Anderson 2000a).

The birds at Glen

A single soaring Cape Vulture was seen one day in late summer 1998/9 (S10).

R126 Black Kite .... *Milvus migrans*

Three sub-species occur in southern Africa (Clancey 1980). The Black Kite *M. m. migrans* breeds in the western Palearctic and many of these birds migrate to sub-Saharan Africa (Cramp 1998). They move as far south as the Free State, Lesotho and KwaZulu-Natal where present from approximately end October to the beginning of March [late spring to mid-autumn], but is uncommon in these southern areas (Mendelsohn 1997b).

M. m. lineatus breeds in the eastern Palearctic, China and Japan (Cramp 1998). They are resident in China and Japan but migratory elsewhere with birds migrating mainly to the Indian subcontinent and south-east Asia (Cramp 1998; Grimmett *et al.* 1999). Studies of museum specimens have shown that both *M. m. migrans* and *M. m. lineatus* reach southern Africa, but the comparative abundance of the two taxa in southern Africa is unknown (Mendelsohn 1997b).

Although treated as a subspecies of the Black Kite, the adult Yellow-billed Kite *M. m. parasitus* is readily identified in the field (Mendelsohn 1997a). They occur in sub-Saharan Africa and Madagascar, and occur in southern Africa as both breeding and non-breeding intra-African migrants from August to March [early spring to mid-autumn] (Mendelsohn 1997a). Overall, they are approximately six times more common in southern Africa than the Black Kite *M. m. migrans / M. m. lineatus*, but nonetheless scarce in the Free State (Mendelsohn 1997a). Mainly associated with woodlands (Mendelsohn 1997a).

The birds at Glen

Only the Yellow-billed Kite was recorded in the grassland at Glen. Single birds were seen in flight on six days, limited to five years in two distinct periods, the one during the beginning of the study and the other during the latter part of the study (Fig. 4.57). Most records from mid- and late summer, but once also recorded in mid-spring (Fig. 4.57). Seen during various times of the day (Fig. 4.57).

R127 Black-shouldered Kite .... *Elanus caeruleus*

The Black-shouldered Kite occurs in Africa, Arabia, Western Palearctic and from Pakistan eastwards to the Philippines and Indonesia (Cramp 1998). It is widespread in southern Africa where scarce in the drier western parts (Mendelsohn 1997c). Grassland is one of its favoured habitats (Maclean 1985; Mendelsohn 1997c). Movements are described as erratic and nomadic (Mendelsohn 1997c), however, there may be more regular seasonal movements between South Africa and the south-eastern parts of Botswana (Herremans & Herremans-Tonnoeyr 1994a).

The birds at Glen

The Black-shouldered Kite was the most common raptor recorded in the grassland. Recorded as birds seen in flight or perched. Of the 70 instances where birds were counted, 81.4% involved single birds, 17.1% involved two birds, and only once was three birds seen together. Crowned Lapwings R255 were once seen to mob a kite in late spring 1997/8. Figures start on page 222.

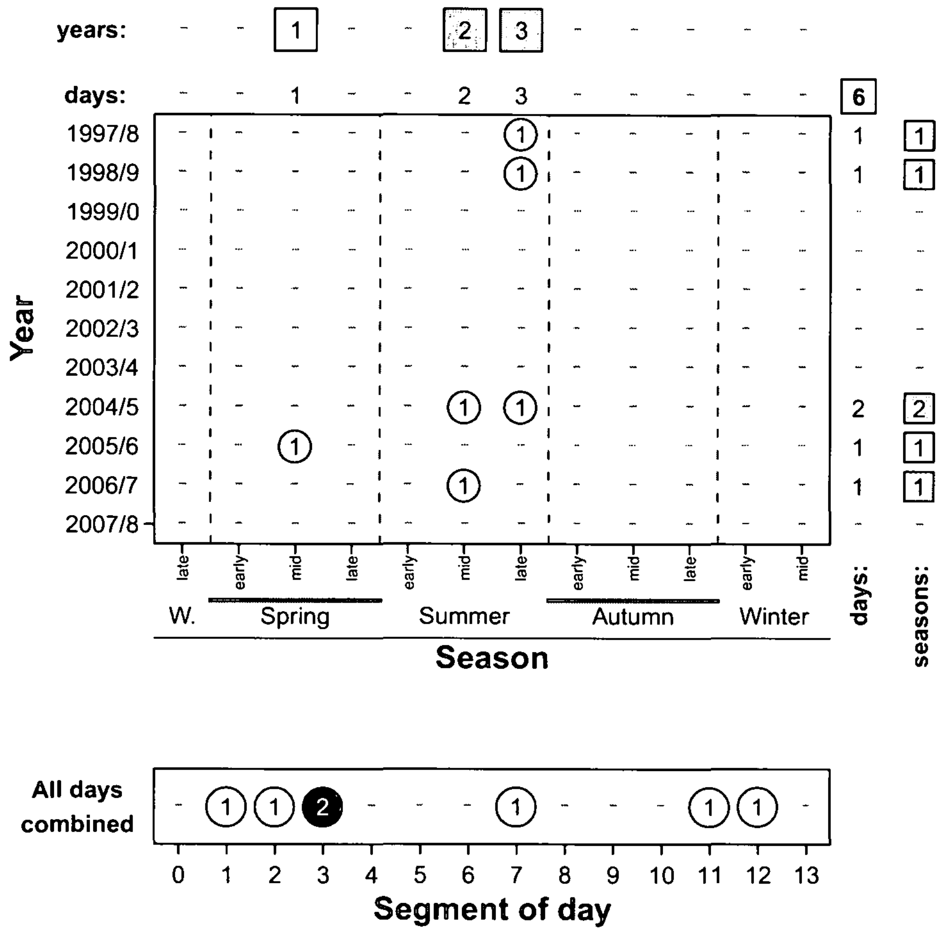


Figure 4.57: R126 Black Kite — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Annual occurrence of birds in the grassland: Seen on 23.2% of the days with an activity index of two (Table 4.11a). Based on the number of seasons that activity was noted each year, there appears to have been three peak periods: 1) 1997/8; 2) 2002/3–2003/4; 3) 2006/7. These periods are characterised by sightings during 9–11 seasons per year, with the peak year(s) flanked by years during which activity was noted during 5–7 seasons (Fig. 4.58; Fig. 4.59). The peak periods are also partially discernible in the annual frequency index fluctuations (Fig. 4.58).

Daily reporting rates ranged from 0.5 to 7.7% with 96.7% of the bird-days attaining low reporting rates and the median values similar for all years (Fig. 4.58). Days with intermediate and high reporting rates were limited to 1997/8 and 2002/3 (Fig. 4.58; Fig. 4.59).

Seasonal occurrence of birds in the grassland: Recorded during 4–8 years per season with no specific seasonal pattern (Fig. 4.58). Median daily reporting rates were also at the minimum value for all seasons (Fig. 4.58). Intermediate and high reporting rate days occurred during early spring, mid-autumn and mid-winter (Fig. 4.58; Fig. 4.59).

Table 4.11: R127 Black-shouldered Kite: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	242	114 612	0.2	birds seen	23.2	656	152	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 190	0.1	birds seen	2.3	43	1	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	3	1 188	0.3	birds seen	7.0	43	3	1

Daily occurrence of birds in the grassland: Overall, activity occurred most frequently in the early morning and again in the late afternoon before sunset and was infrequent during the rest of the day (Fig. 4.58). Seasonally the pattern was a bit more variable with peaks occurring in the morning (usually before sunrise from mid-summer to mid-winter) and in the late afternoon, even after sunset during certain seasons (Fig. 4.60). All six bird-segment combinations occurring during more than 5% birds-days involved single early to mid-morning and late afternoon segments (Fig. 4.61). Collectively these combinations accounted for nearly two-thirds of all bird-days (Fig. 4.61). The different combinations peaked during different seasons (Fig. 4.61).

The occurrence of the first activity of the day was rather variable, but medians nonetheless occurred frequently in the first half of the morning (Fig. 4.60). Timing of the last activity of the day was also variable, with medians again frequently during the morning (Fig. 4.60).

Daily segment reporting rates ranged from 5.3 to 40.0% with 90.1% of the values relatively low (Fig. 4.58). Excluding the midday segments which had too few data points for meaningful analysis, median daily segment reporting rates were similar for all other segments except S0 and S13 which had relatively low values (Fig. 4.58).

Early morning occurrence of birds during 2007/8: Activity was noted one morning in the drainage line (late spring) and on three mornings in the grassland (once in late spring and twice in late summer) (Table 4.11b & c).

Discussion

The Black-shouldered Kite's daily occurrence at Glen, peaking around sunrise and shortly before sunset (Fig. 4.58), is best explained as birds commuting between roosting areas (either in *Eucalyptus* trees along the railway line towards the south-west or around Glen village) and feeding areas in the study area and beyond.

The Black-shouldered Kite is a specialist small rodent hunter (Brown 1982c; Steyn 1982), and as such the availability of rodents is a crucial factor determining its occurrence (Hustler & Dean 2005a; Penry 1994). As long as the food supply is stable, the kites tend to stay in the same area, but once the food supply dwindles the kites move away too (Mendelsohn 1983). The

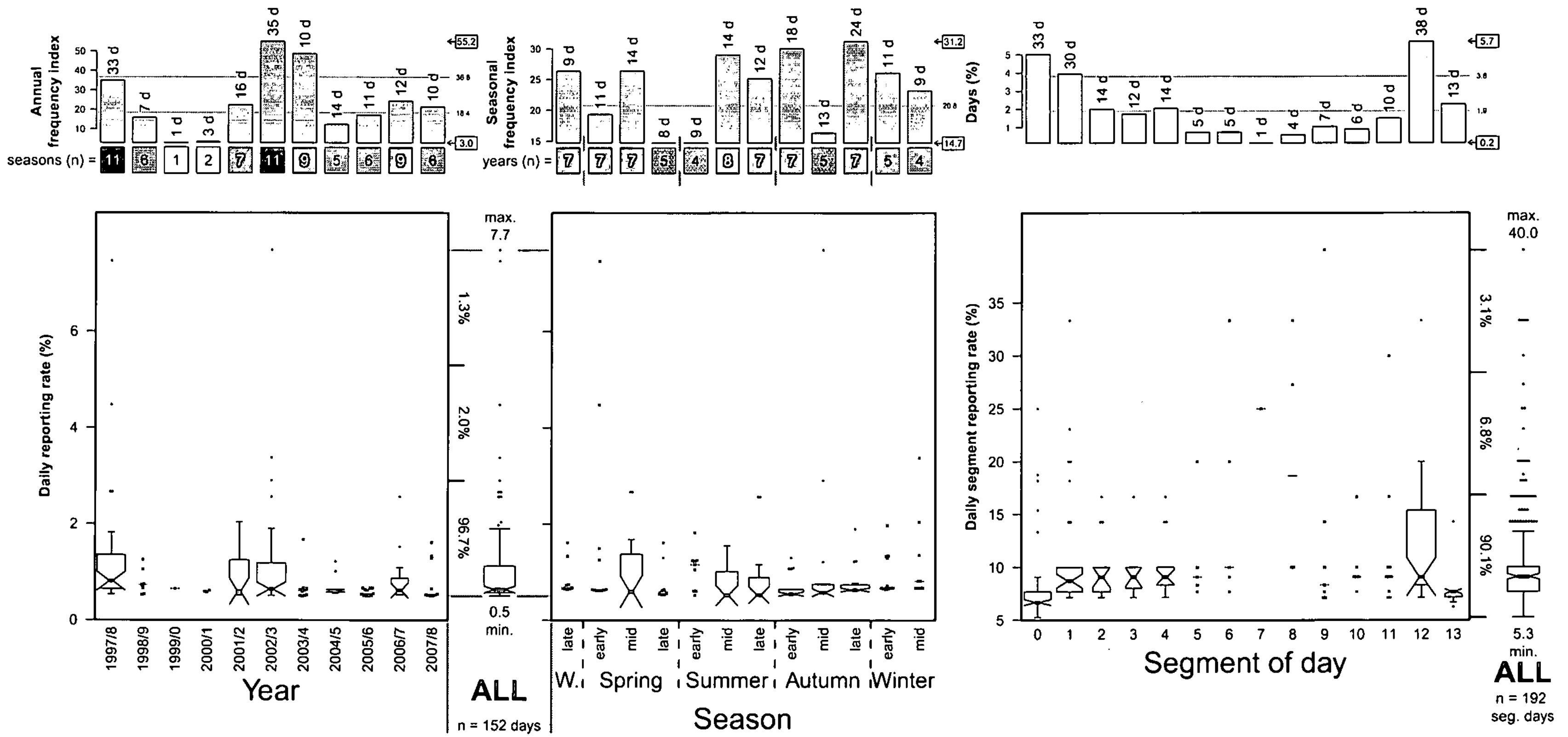


Figure 4.58: R127 Black-shouldered Kite — birds seen: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

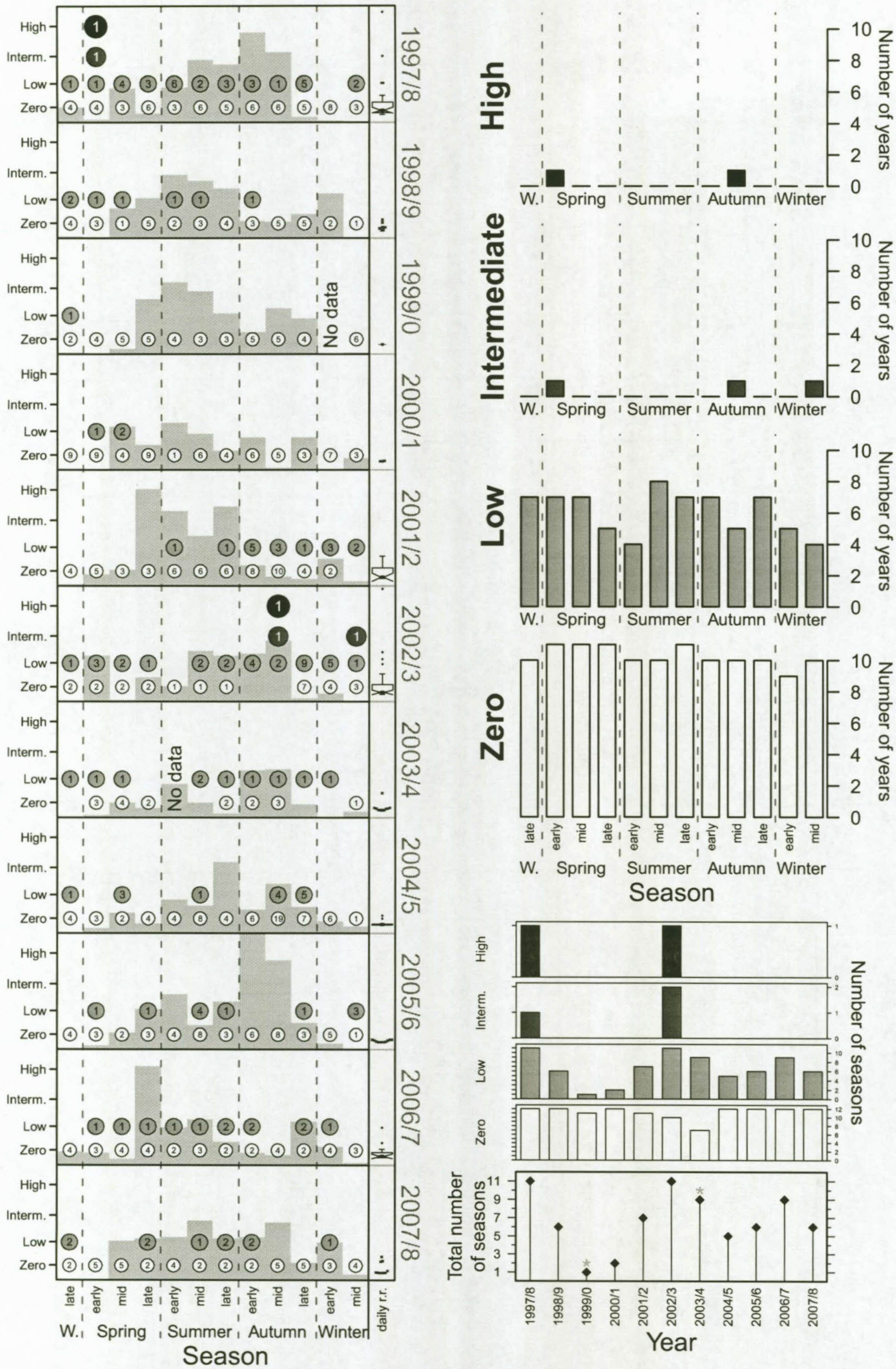


Figure 4.59: R127 Black-shouldered Kite — birds seen: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

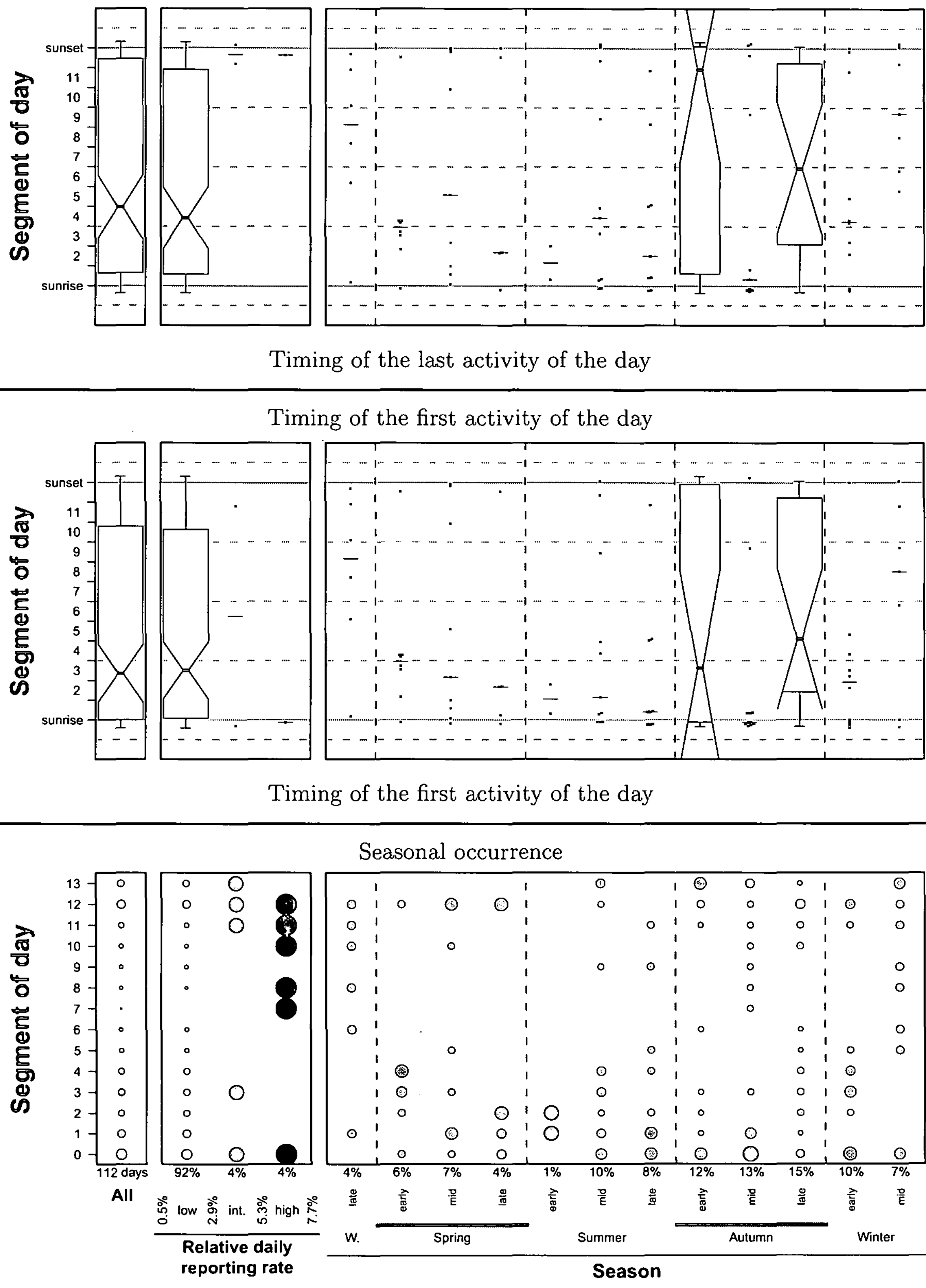


Figure 4.60: R127 Black-shouldered Kite — birds seen: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

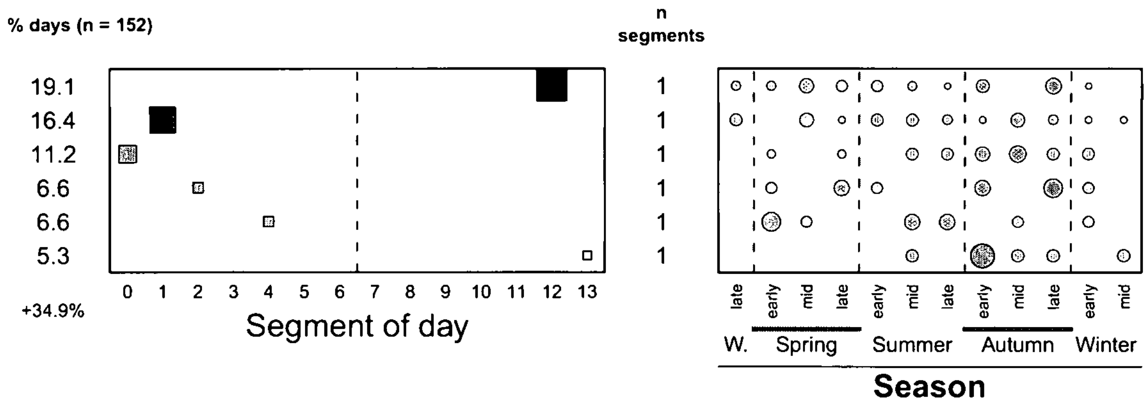


Figure 4.61: R127 Black-shouldered Kite — birds seen: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

birds are capable of exploiting areas with high prey concentrations and a number of authors have linked high numbers of kites with rodent plagues (*e.g.* Herremans & Herremans-Tonnoeyr 1994a; Irwin 1981; Malherbe 1963; Mendelsohn 1983; Skead 1974a). Rainfall and the ensuing plant growth strongly affects rodent breeding (Mendelsohn 1983) and kite numbers have been correlated with rainfall (Herremans & Herremans-Tonnoeyr 1994a; Skead 1974a).

It is likely that rainfall also influenced the occurrence of the Black-shouldered Kite at Glen, with the three peak periods following high rainfall years. With its 747 mm rain, 1996/7 was the wettest year since the 1987/8 flood year (Fig. 2.13). Above average rainfall was also recorded in the following year, 1997/8 (583 mm) (Fig. 2.13), coinciding with the first Black-shouldered Kite peak (Fig. 4.58; Fig. 4.59). This peak spilled over into the next year with the Black-shouldered Kite being recorded during most seasons until early autumn 1998/9 after which it disappeared (Fig. 4.59). It was subsequently recorded only in late winter 1999/0 and early and mid-spring 2000/1 (Fig. 4.59). The latter was also the second driest year of the study period, the driest year being 2003/4 (Fig. 2.13).

The birds reappeared in early summer 2001/2 (Fig. 4.59) — the first above average rainfall year (594 mm) since 1997/8 (Fig. 2.13) — its reappearance following shortly after exceptional good rains in late spring 2001/2 (Fig. 4.59). It was subsequently recorded during most seasons until mid-spring 2004/5 (Fig. 4.59), hence the 2002/3–2003/4 peak period (Fig. 4.58; Fig. 4.59).

After mid-spring 2004/5, the Black-shouldered Kite was seen intermittently, even during 2005/6 (Fig. 4.59) which was the second above average rainfall year (667 mm) since 1997/8 (Fig. 2.13). It did, however, become more frequent during 2006/7, which was the third Black-shouldered Kite peak year (Fig. 4.59).

The delay between high rainfall and the eventual occurrence of the Black-shouldered Kite at Glen is similar to the situation described by Skead (1974a) who encountered relatively high numbers of kites more than six months after "Abnormally heavy rains". It is suggested that rain above a certain threshold sets in motion a number of ecological processes which eventually lead to high rodent numbers, which, in turn, are exploited by the kites.

R136 Booted Eagle .... *Aquila pennatus*

The Booted Eagle breeds in the west Palearctic, from Iran east to the Himalayas and Lake Baykal, and in the former Cape Province, South Africa (Cramp 1998). It is recorded throughout southern Africa, but — as is the case in most other places (Cramp 1998) — it is thinly distributed almost everywhere; seldom recorded in the Free State (Boshoff & Allan 1997b; Earlé & Grobler 1987; Parker 1999). The majority of the west Palearctic breeding population is trans-Saharan migrants (Cramp 1998). It has been suggested that the Palearctic population are present in southern Africa from November to February [early summer *to* early autumn] (Steyn & Grobler 1985), however it is not possible to tell birds of the two populations apart, which complicates the interpretation of distributional data tremendously (Boshoff & Allan 1997b; Steyn & Grobler 1985). In southern Africa they are present on their breed grounds from July to March [late winter to mid-autumn] where after they disperse northwards, apparently mainly into Namibia and southern Angola, but some also throughout southern Africa (Martin 2005).

The birds at Glen

The Booted Eagle was recorded as soaring individuals seen on six days spread over five years (Fig 4.62). Recorded during two distinct periods: mid- to late spring, and late summer to mid-autumn (Fig. 4.62). Seen during the morning and afternoon (Fig. 4.62).

Discussion

In South Africa, Booted Eagles lay eggs from August to November [early spring to early summer] (Tarboton 2001), but mainly during September [mid-spring] (Steyn & Grobler 1981). It is, therefore, reasonable to suggest that the mid- and late spring records at Glen does not involve South African breeding birds, implying that birds from the Palearctic population is involved.

Furthermore, the incubation period in South Africa was determined twice as 40 days, the nestling period on two occasions as 50 and 54 days respectively, and a fledgling was seen with adults 64 days after its first flight (Steyn & Grobler 1981, 1985). Assuming these values to be typical, it follows that birds would normally not start moving away from their breeding areas for at least five months after egg-laying. This would mean that movements to the non-breeding range would normally not commence before early autumn. Therefore, the sightings at Glen from late summer to mid-autumn could possibly have been birds from the Palearctic population.

The above, together with the lack of observations from early to mid-summer, suggest that the records at Glen involved Palearctic birds on their way south (mid- and late spring) and back north again (late summer to mid-autumn). This would support the suggestion that a Steppe Buzzard R149 influx into the West Cape may also include Booted Eagles from the Palearctic (Martin 2005).

Finally, three of the six Booted Eagle records at Glen involved instances where the eagle was first spotted by the Eastern Clapper Lark under observation. It is suggested that the scarcity of Booted Eagle observations in the Free State and elsewhere is at least partially attributable to the inconspicuous nature of soaring birds.

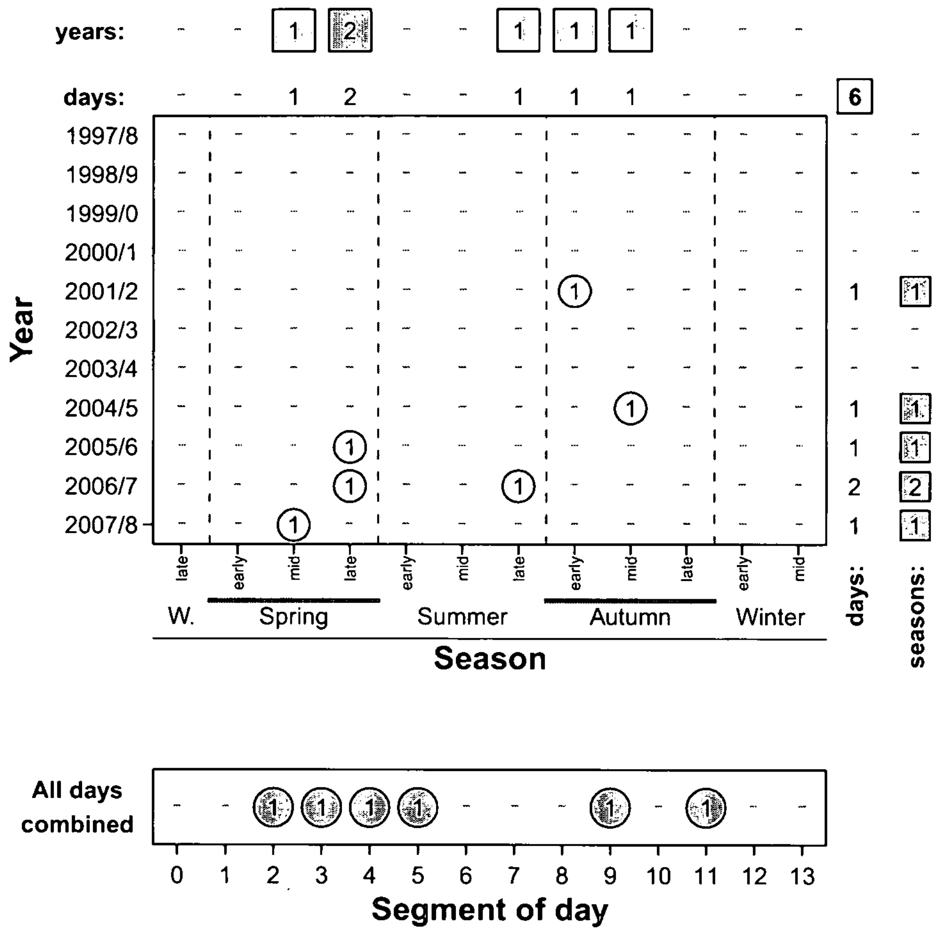


Figure 4.62: R136 Booted Eagle — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R140 Martial Eagle .... *Polemaetus bellicosus*

The Martial Eagle is endemic to sub-Saharan Africa (Maclean 1985). Its is widespread in southern Africa but is generally uncommon, and rare in habitats such as grassland (Boshoff 1997a). Although considered to be resident (Maclean 1993; Steyn 1982), ringed birds (including nestlings, juveniles, immatures and adults) were subsequently recovered at distance of up to 380 km from the ringing location (Simmons 2005d). The Martial Eagle is considered to be facing a high risk of extinction in the wild (Barnes 2000a).

The birds at Glen

The three Martial Eagle records at Glen involved single birds seen during mid-spring 1998/9, mid-summer 2003/4 and late summer 2005/6. Records were during S3, S4 (and S5 of the same day) and S11.

R143 Black-chested Snake-Eagle .... *Circaetus pectoralis*

The Black-chested Snake-Eagle is endemic to sub-Saharan Africa (Brown 1982d). In southern Africa it is widespread in Namibia, Botswana, Zimbabwe, southern Mozambique and the northern parts of South Africa; infrequently recorded in grassland in general and in the Free State in particular (Boshoff 1997b; Earlé & Grobler 1987; Van Niekerk 1996). The population consists of resident, migratory and nomadic components (Boshoff 1997b; Steyn 1982; Tarboton *et al.* 1987).

The birds at Glen

Single Black-chested Snake-Eagles were seen in flight on two days: during early autumn 1997/8 and 2006/7, with observations during segments S5 (and S9 on the same day) and S11.

Discussion

Van Niekerk (1996) suggested two separate annual Black-chested Snake-Eagle influxes into the Free State, with the birds present along the Orange River mainly from January to May [late summer, autumn and early winter] and again from September to November [spring and early summer]. He furthermore suggested that birds recorded in the central/southern parts of the province represent birds on passage to and from the Orange River (Van Niekerk 1996). If his analysis is correct, the two sightings at Glen during early autumn probably involved birds moving south.

R146 Bateleur .... *Terathopius ecaudatus*

The Bateleur occurs in sub-Saharan Africa and in south-western Arabia (Brown 1982e). In southern Africa it is widespread in north-eastern Namibia, Botswana, Zimbabwe (Simmons 1997a) and southern Mozambique (Parker 1999). In South Africa it is mainly confined to the Kgalagadi Transfrontier Park, Kruger National Park and northern parts of KwaZulu-Natal (Simmons 1997a). There have been recent sightings along the Western Cape coast (Elwell 2000). In the Free State, Earlé & Grobler (1987) listed the Bateleur in their list of "Species recorded but which need to be confirmed before inclusion" and it was not recorded in the province during SABAP1 (Simmons 1997a). It prefers a variety of woodland types (Maclean 1985). The Bateleur is considered to be facing a high risk of extinction in the wild (Barnes 2000b).

The birds at Glen

An immature Bateleur flew over the study area during late summer 1997/8.

R148 African Fish-Eagle .... *Haliaeetus vocifer*

The African Fish-Eagle is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa it is widespread in the wetland areas of Botswana as well as in Zimbabwe and South Africa where its distribution west of the Free State is virtually restricted to the Orange River (Boshoff 1997c). It is closely associated with rivers, dams and other wetlands (Maclean 1985). It is largely sedentary, but both adults and immatures may disperse widely from natal areas (Simmons 2005a).

The birds at Glen

The majority of African Fish-Eagle records involved birds that were heard (93.8%), with the remainder involving birds seen (6.2%). All the data were combined for analysis. Usually only single birds were seen (adults: n = 6; immatures: n = 1), and once also a pair. Figures start on page 230.

Annual occurrence of birds in the grassland Recorded on 10.2% of the days with an activity index of two (Table 4.12a). Based on the number of seasons recorded each year, there are three well defined peak periods: 1) 1997/8; 2) 2001/2–2002/3; 3) 2004/5–2006/7 (Fig. 4.63; Fig. 4.64). The annual frequency index was relatively low in 1997/8 but peaked in 2001/2 and again in 2006/7 (Fig. 4.63). Daily reporting rates ranged from 0.5 to 4.6% with 91.0% of the values relatively low (Fig. 4.63). Intermediate and high daily reporting rates were limited to the years 1997/8, 2001/2, 2004/5 and 2006/7 (Fig. 4.63; Fig. 4.64).

Table 4.12: R148 African Fish-Eagle: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	113	114 612	0.1	birds present	10.2	656	67	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–

Seasonal occurrence of birds in the grassland: Recorded during 2–6 years per season with no specific seasonal pattern (Fig. 4.63). The seasonal frequency index indicates two peak periods with the one in early and mid-summer and the other in mid-winter (Fig. 4.63). Median daily reporting rates were the same for all seasons (Fig. 4.63). The few intermediate and high reporting rate days were limited to late winter to mid-spring and autumn (Fig. 4.64).

Daily occurrence of birds in the grassland: Records were virtually limited to the period from late morning to mid-afternoon (Fig. 4.63; Fig. 4.65). Segment combinations occurring during more than five bird-days were limited to single segments S5–S11, collectively accounting for more than three quarters of all bird-days (Fig. 4.66). The first and last activity of the day frequently occurred in the early afternoon (Fig. 4.65).

Daily segment reporting rates ranged from 7.1 to 41.7% with median values the same for all segments during which activity was recorded (Fig. 4.63).

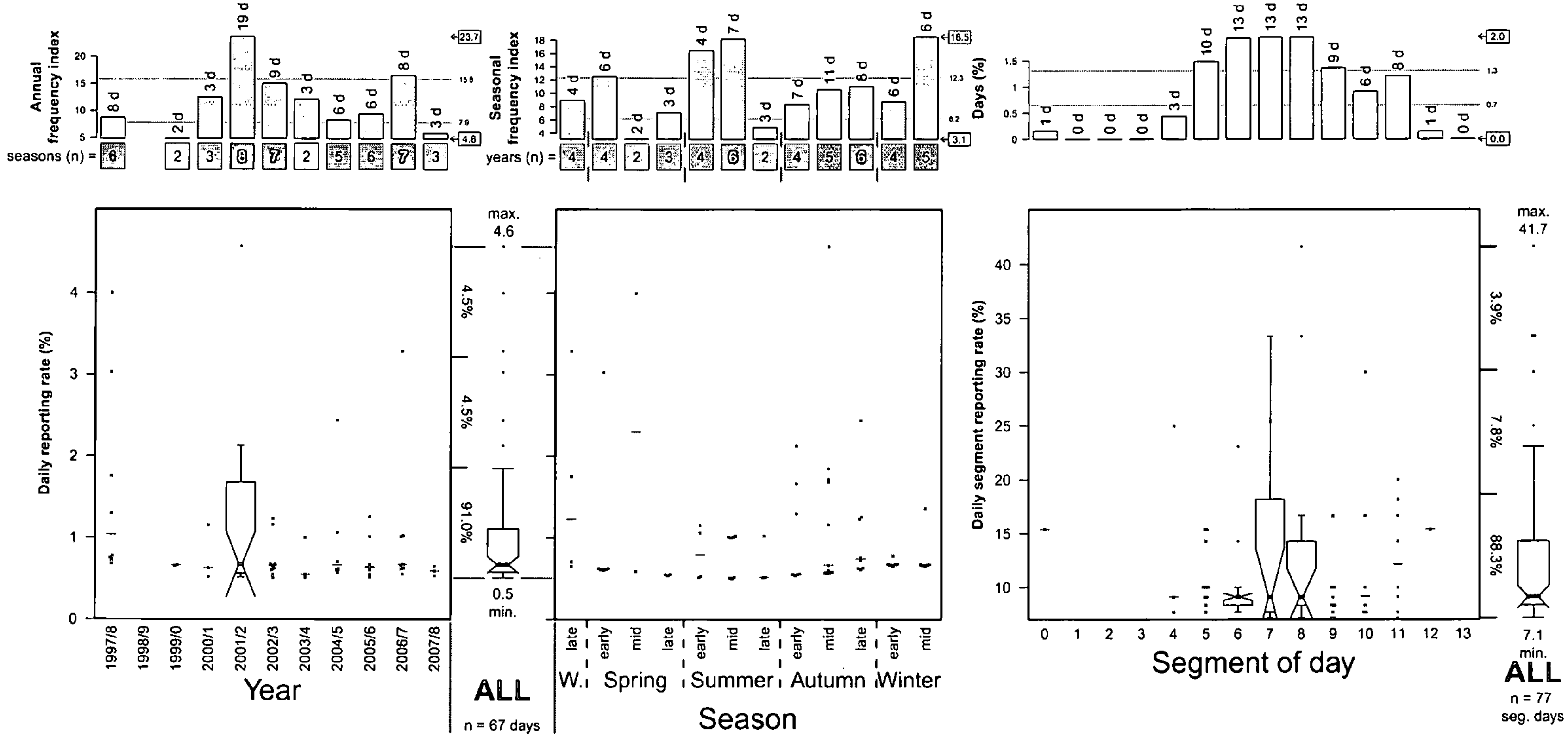


Figure 4.63: R148 African Fish-Eagle — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

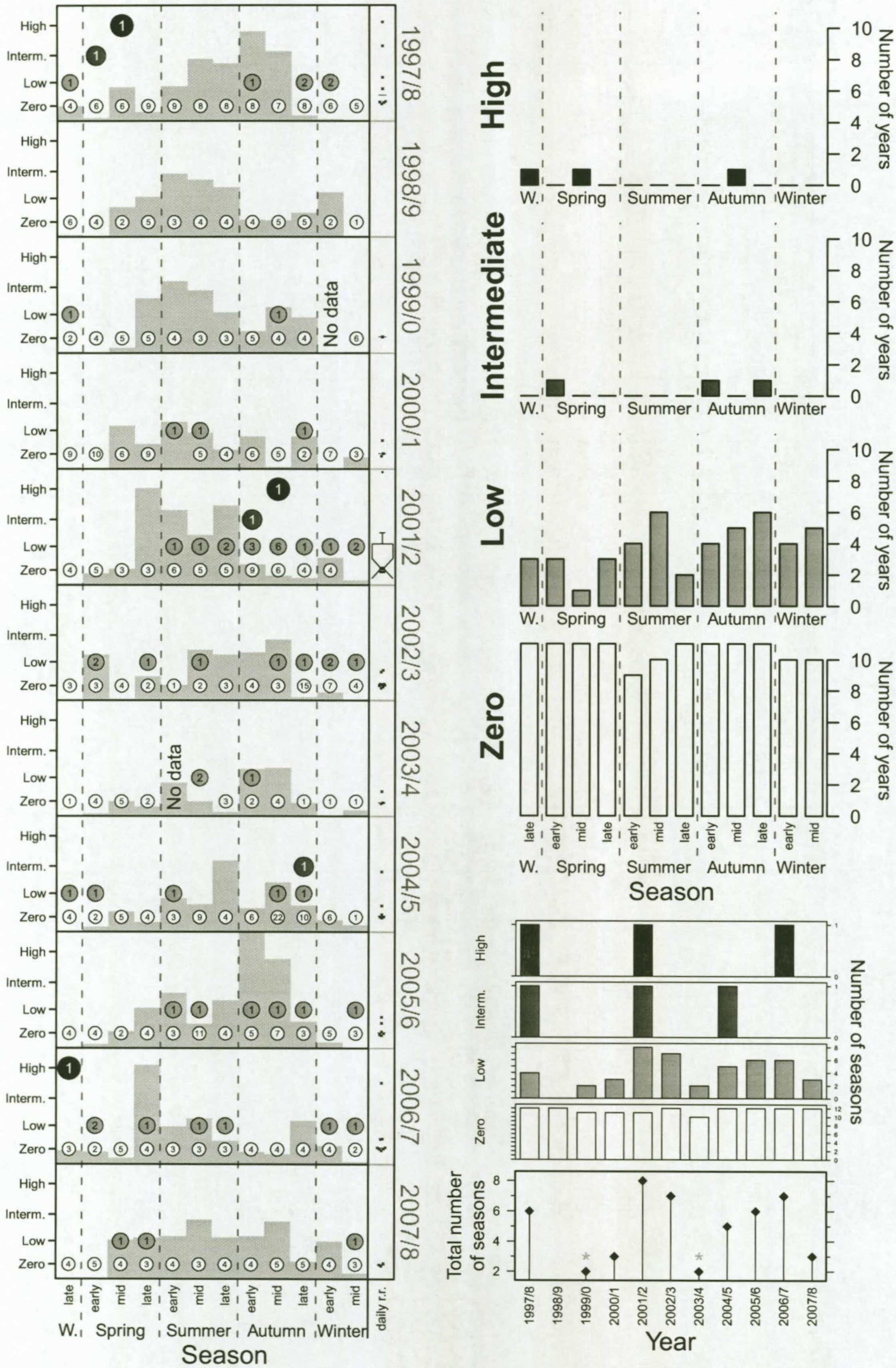


Figure 4.64: R148 African Fish-Eagle — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

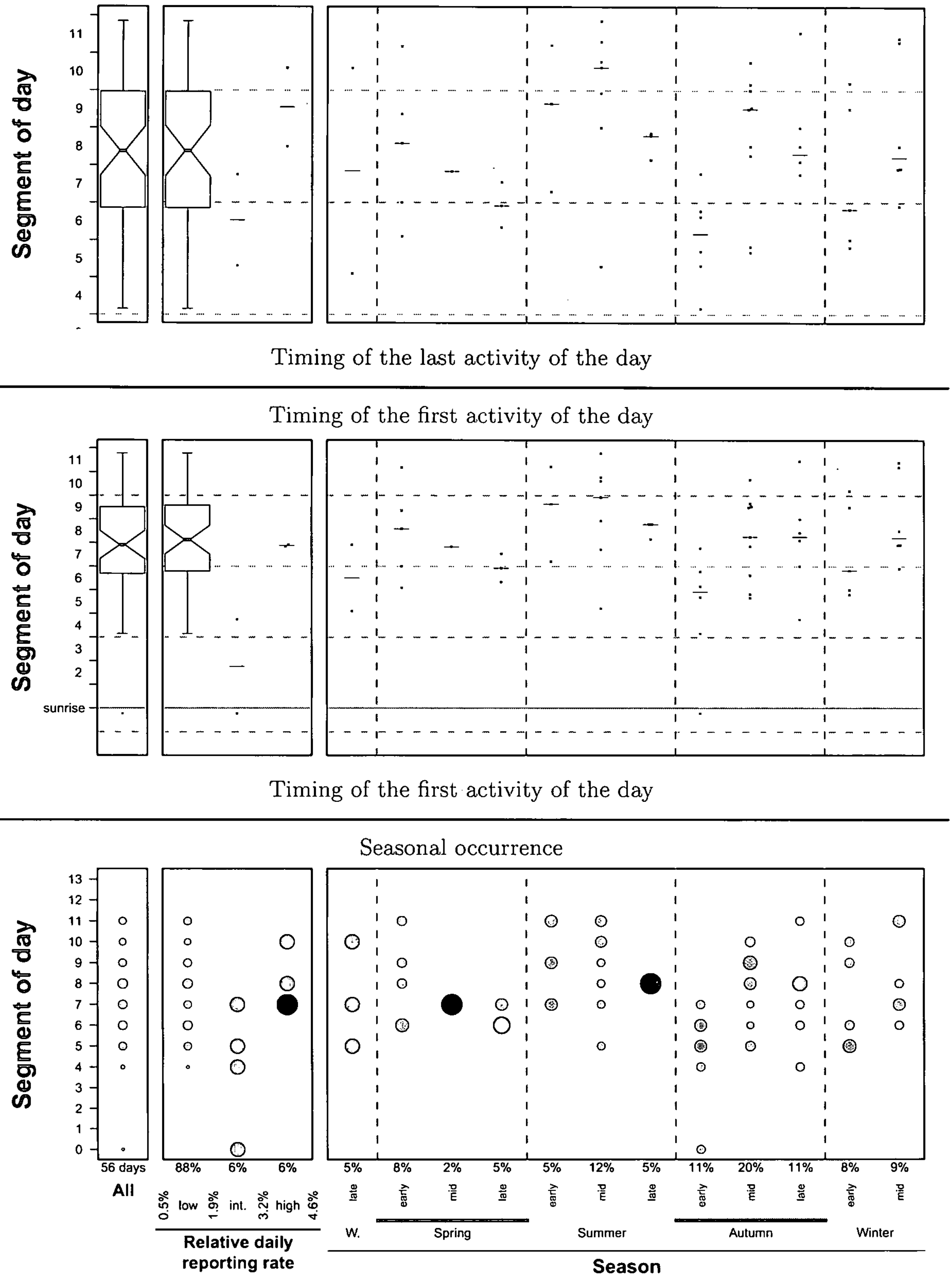


Figure 4.65: R148 African Fish-Eagle — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

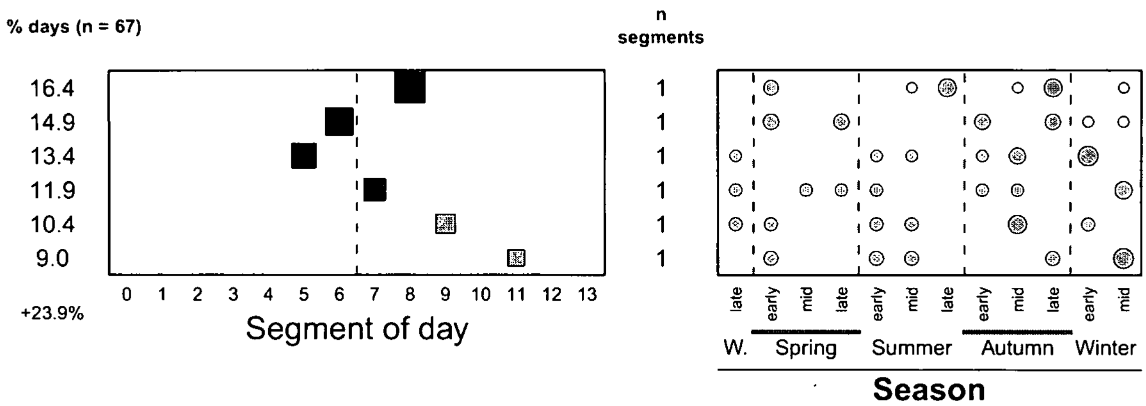


Figure 4.66: R148 African Fish-Eagle — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

Discussion

According to Steyn (1982) the call of the African Fish Eagle carries over great distances, even from a soaring bird that is almost invisible to the unaided eye. The birds recorded at Glen were in most instances not seen at all. Admittedly, the observer, or rather listener in this case, was not always able to search the skies for extended periods due to his preoccupation with the behaviour of ground-dwelling larks. Nonetheless, the calls were in most instances heard only in the distance — often in the direction of the Modder River to the south (see Fig. 2.2) — and assumed to originate from soaring birds. In the few instances where birds were seen this usually involved birds in the vicinity of the farm dam in the drainage line.

The African Fish Eagle usually starts calling during early dawn (Steyn 1982) and calls frequently while nesting with the pair often duetting in the nesting tree at dawn and dusk (Tarboton 2001). At Glen, however, activity was clearly concentrated in the late morning and early afternoon, being exceptional before sunrise and never occurring after sunset (Fig. 4.63; Fig. 4.65). This is explicable. Assuming there to be a resident breeding pair along the Modder River at its closest approach to the study area, both distance (approximately 5.3 km) and topography (there is a ridge between the study site and the river; see Figure 2.2, page 74) would probably degrade the sound waves originating from the birds at or near tree level to the extent that they are inaudible at the study site. Once the birds take to the air, however, it would become more likely to hear them at the study site because topography would no longer be an issue and the distance may also be less. Soaring birds are known to soar most towards midday when thermal activity is nearing its peak (Elkins 2004), and as able soarers (Steyn 1982) African Fish Eagles probably exploit thermals. This would neatly explain the midday peak observed at Glen (Fig. 4.63; Fig. 4.65).

Another interesting feature of the activity at Glen is that it occurred much more frequently during above average rainfall years (Fig. 2.13; Fig. 4.63; Fig. 4.64). It is possible that much rain stimulates breeding. Steyn (1982) noted that the birds called throughout the year, but that they are extremely vocal at the beginning of the breeding season when much calling take place aerially in combination with soaring displays. The timing of egg-laying, which mostly takes place from March to August [mid-autumn to early spring] (Tarboton 2001), do correspond with a period of relatively frequent occurrence at Glen (Fig. 4.63). However, activity was also relatively high in early and mid-summer, which falls outside the usual breeding season. Tarboton (2001) does note that breeding may occasionally occur in other months too.

A second possible explanation for the peaks during high rainfall years is that the birds become more mobile in order to investigate recently filled ephemeral wetlands. This is supported by the birds occasionally seen in the vicinity of the farm dam.

Finally, it should be noted that 2007/8 also experienced above average rainfall (Fig. 2.13), but this apparently did not have the same affect on the eagles as in the previous years discussed above (Fig. 4.63; Fig. 4.64). Perhaps this is related to the fact that rainfall in 2007/8 was much more evenly spaced amongst the seasons than during the previous years (Fig. 4.64).

R149 Steppe Buzzard .... *Buteo buteo vulpinus*

In spite of recognising that the genetic differences are small, Hustler & Dean (2005b) nonetheless accord the Steppe Buzzard specific status (*B. vulpinus*). However, in its Palearctic breeding range it interbreeds with the Common Buzzard *B. b. buteo* in all areas of contact, causing a broad zone of secondary integration (Cramp 1998). This thesis, therefore, espouse the traditional view (Boshoff 1997d; Cramp 1998; Maclean 1993) which considers the Steppe Buzzard a subspecies (*B. b. vulpinus*) of the Common Buzzard *B. buteo.*

The 9–11 subspecies of the Common Buzzard *B. buteo* range from sedentary to migratory, the Steppe Buzzard *B. b. vulpinus* being a long-distance migrant (Cramp 1998). It breeds in eastern Europe and Siberia and migrates to its non-breeding grounds, mainly sub-Saharan Africa (Cramp 1998). It has a widespread distribution in southern Africa but is less common or absent in the western and northern parts (Boshoff 1997d) as well as southern Mozambique (Parker 1999). It is found in a variety of habitats with sweet grassland amongst their most favoured habitats in southern Africa (Boshoff 1997d). Apart from a few overwintering birds, most arrive in SABAP1 Zone 7 mainly in October [mid-spring] and depart mainly in March or April [late autumn] (Boshoff 1997d).

The birds at Glen

The Steppe Buzzard was record exclusively as birds seen in flight. Apart from one occasion when two birds were seen together, the rest of the records involved single birds. Figures start on page 236.

Annual occurrence of birds in flight over the grassland: Recorded on 11.7% of the days with an activity index of one (Table 4.13a). Recorded during 1–4 seasons in most years, but in 5–7 seasons in 1997/8, 1998/9 and 2005/6 (Fig. 4.67; Fig. 4.68). Daily reporting rates ranged from 0.5 to 4.2% with 93.5% bird-days attaining low values (Fig. 4.63).

Seasonal occurrence of birds in flight over the grassland: Recorded from late spring to late autumn, most frequently during mid- and late summer (Fig. 4.67). The timing of the first and

Table 4.13: R149 Steppe Buzzard: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists n	5-minute checklists Total	5-minute checklists %	Activity	Days %	Days Total	Days n	Activity index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	107	114 612	0.1	birds seen only	11.7	656	77	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 188	0.1	birds seen only	2.3	43	1	1

last sighting of each year was variable (Fig. 4.69). Median daily reporting rates for all seasons were representative of observations during a single 5-minute interval per day (Fig. 4.67).

Daily occurrence of birds in flight over the grassland: Most frequently seen from mid-morning to mid-afternoon; seldom at other times (Fig. 4.67; Fig. 4.70). Eight bird-segment combinations occurred during more than five bird-days, all involving single segments S3 to S11 (except S10), which collectively accounted for three quarters of all bird-days (Fig. 4.71).

Median daily segment reporting rates were similar for all parts of the day and representative of observations during a single five minute interval per day (Fig. 4.67).

Discussion

The fact that soaring Steppe Buzzards were usually seen between mid-morning and mid-afternoon (Fig. 4.67) is at least partially explained by the occurrence of thermals, which, according to Elkins (2004), are more likely to develop at these times of the day than in the early morning or late afternoon.

The years 1997/8 and 2005/6 were the two years during which the Steppe Buzzard was seen during the highest number of seasons (Fig. 4.67; Fig. 4.68). They were also above average rainfall years (Fig. 2.13). If a direct link is assumed between the occurrence of the Steppe Buzzard and above average rain years, then the relative scarcity of the buzzards during the above average rainfall years 2001/2 as well as 2007/8 (Fig. 4.67; Fig. 4.68; Fig. 2.13) need to be explained. There is, in fact, a logical explanation.

Unless an observer is specifically focused on soaring raptors it can be difficult to see these birds and many birds undoubtedly pass unnoticed in this way. In fact, even when alerted to the presence of a soaring raptor it can be difficult or even impossible to see, as the writer has experienced many times. The years 1997/8 and 2005/6 coincided with periods during which behavioural observations on the Spike-heeled Lark R506 (1997/8) and Eastern Clapper Lark R495 (2005/6) were much more intense than during 2001/2 or 2007/8. These larks, and indeed many other birds, have hawk-eyes so to speak, able to spot a raptor long before a human observer can. The author was often alerted to the presence of soaring raptors by the anti-predatory behaviour

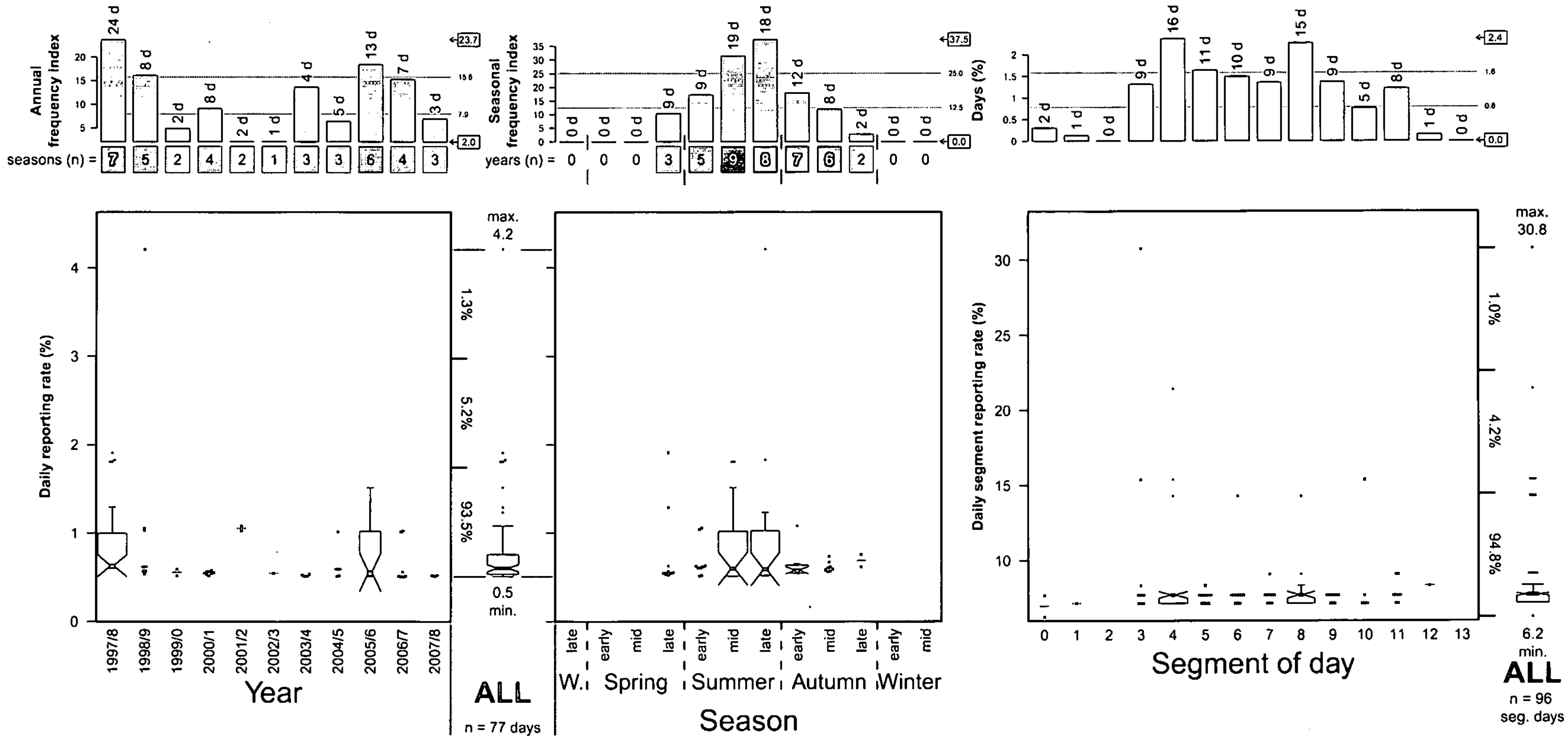


Figure 4.67: R149 Steppe Buzzard — birds seen only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

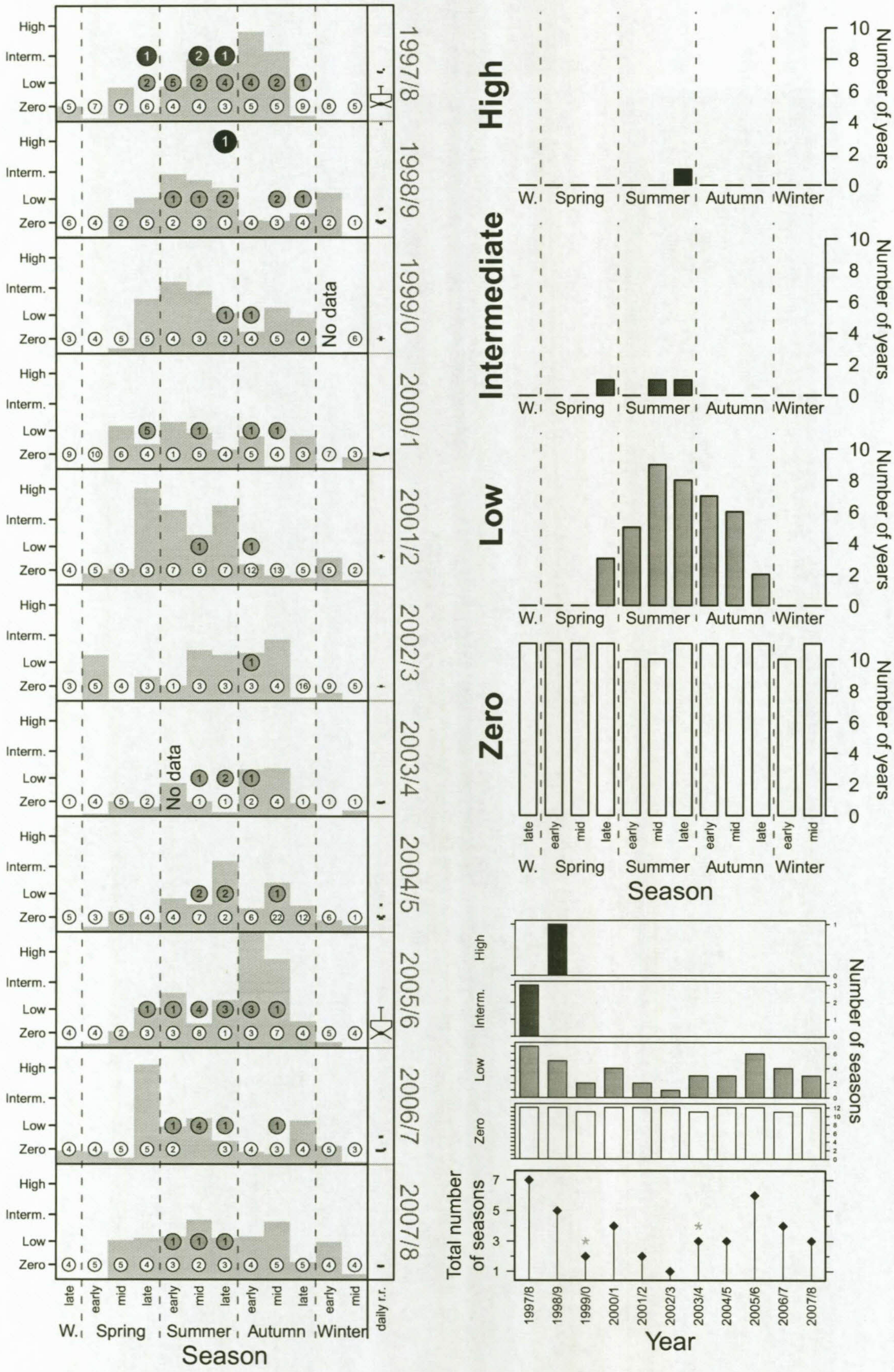


Figure 4.68: R149 Steppe Buzzard — birds seen only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

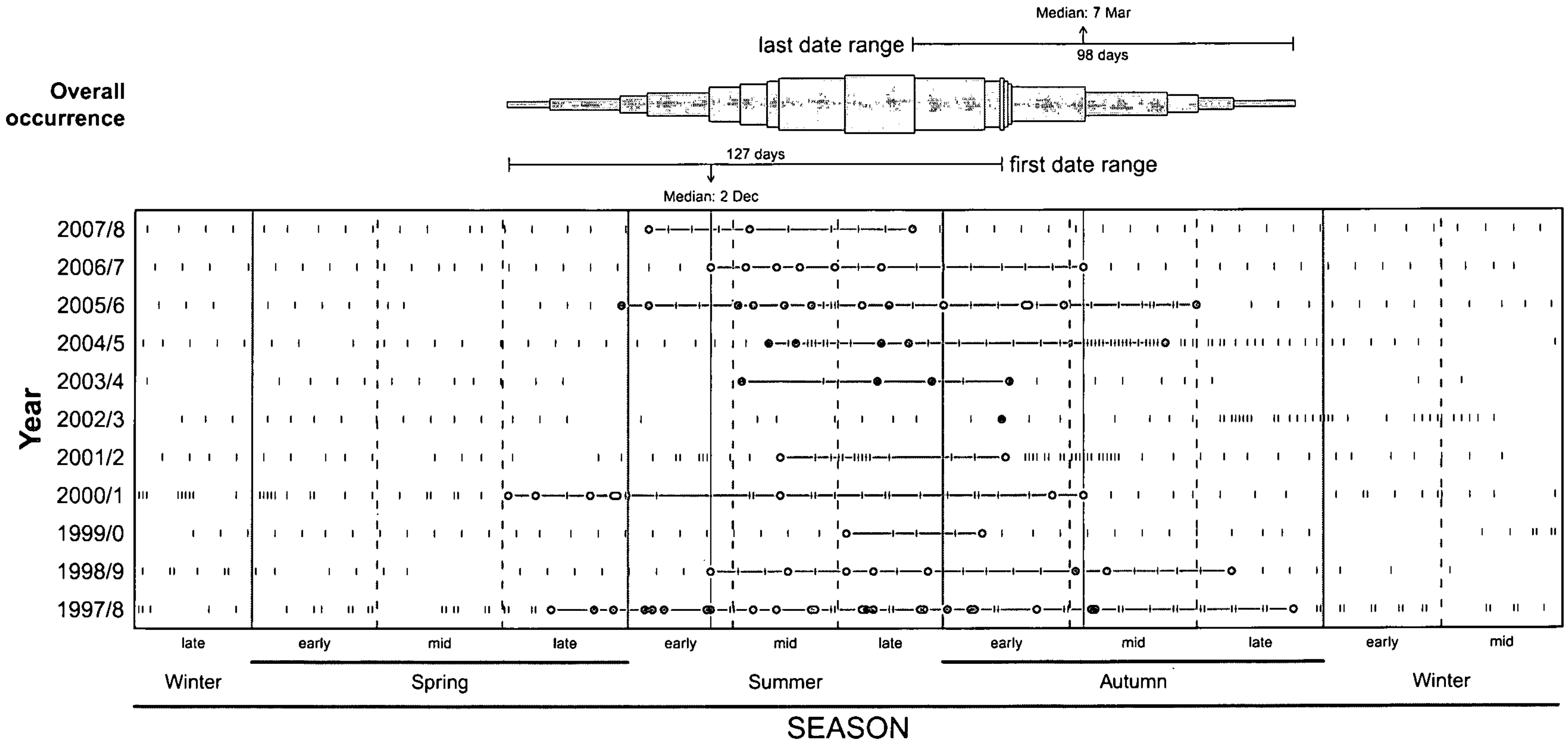
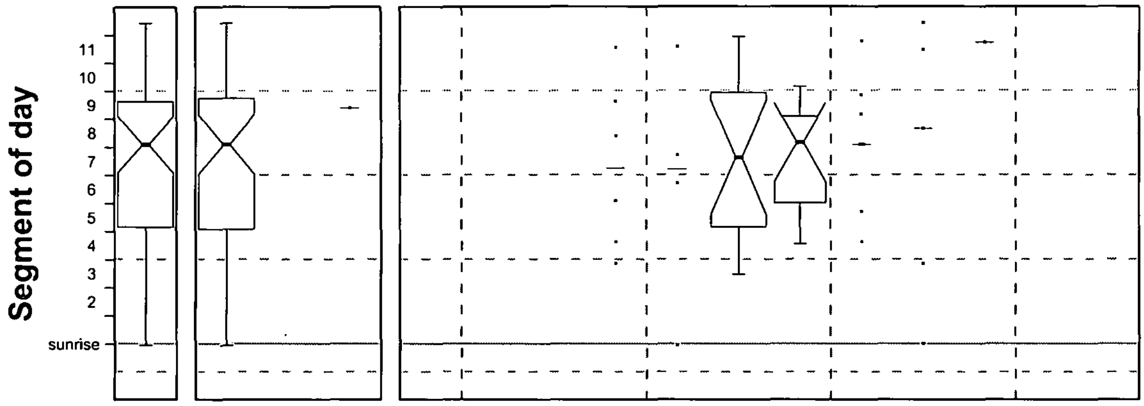
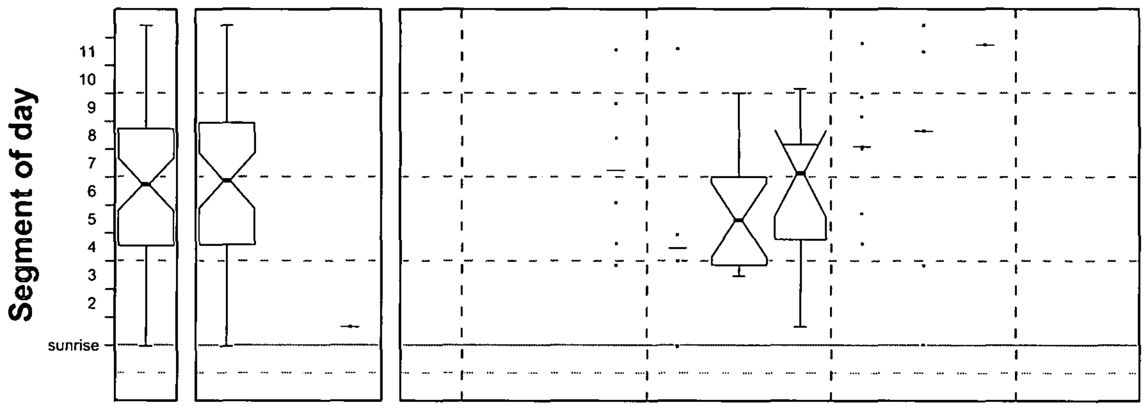


Figure 4.69: R149 Steppe Buzzard: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.



Timing of the last activity of the day

Timing of the first activity of the day



Timing of the first activity of the day

Seasonal occurrence

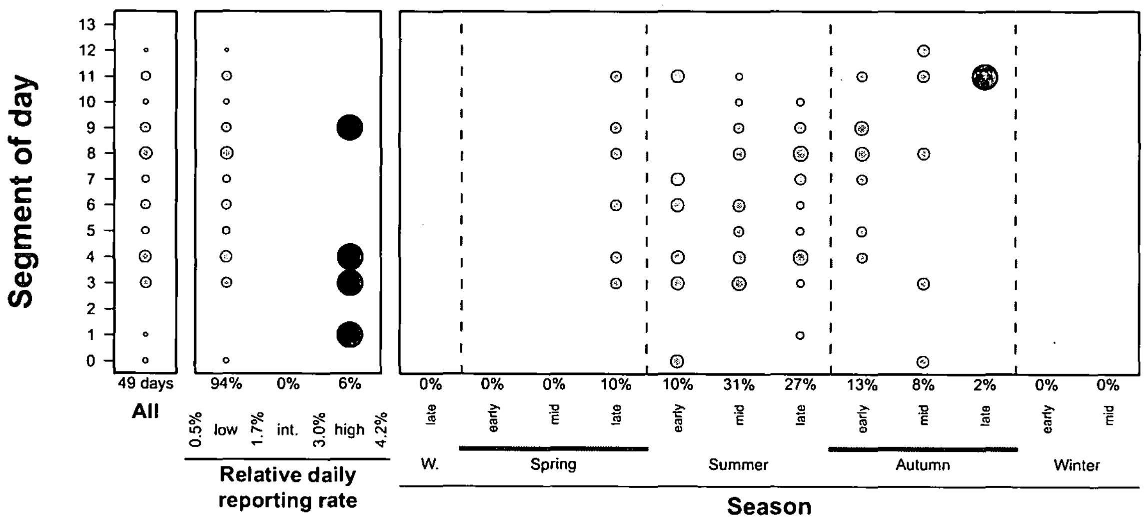


Figure 4.70: R149 Steppe Buzzard — birds seen only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

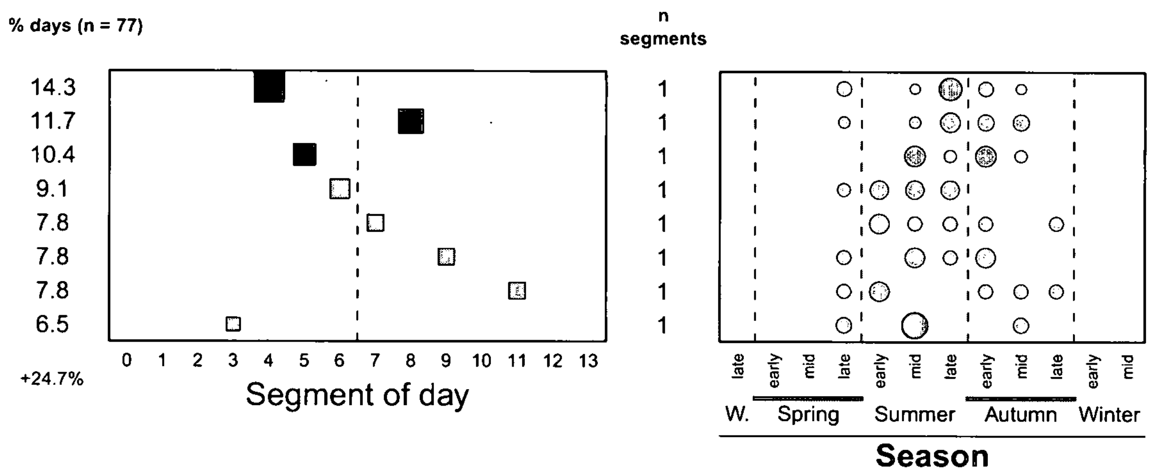


Figure 4.71: R149 Steppe Buzzard — birds seen only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

of the larks, hence the peaks in 1997/8 and 2005/6.

R152 Jackal Buzzard .... *Buteo rufofuscus*

The Jackal Buzzard is endemic to southern African, occurring throughout most of Swaziland, Lesotho and South Africa and also more sparsely in western Namibia (Mendelsohn 1997d). SABAP1 reporting rates do not suggest regular seasonal movements (Mendelsohn 1997d). However, ringing data indicate that birds undertake frequent movements (Allan 2005f; Mendelsohn 1997d; Schmitt *et al.* 1987). Based on this information Mendelsohn (1997d) suggested that their movements are primarily nomadic, involving mainly juvenile dispersal and perhaps movements in response to fluctuations in the availability of their rodent prey. In addition, Allan (2005f) notes that non-breeding birds and juveniles may wander into "flat regions."

The birds at Glen

The closest suitable habitat for the Jackal Buzzard involve hills situated approximately 6 km north of the study area. Single birds were seen in flight during midday (S6-8) on three occasions, twice in mid-winter 2005/6 and once during mid-summer 2007/8 when it was heard calling also.

Discussion

The fact that the Jackal Buzzards were seen during midday is probably related to the presence of thermals during that time of the day.

R155 Rufous-chested Sparrowhawk .... *Accipiter rufiventris*

The Rufous-chested Sparrowhawk is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa it is restricted to the southern and eastern parts of South Africa, Lesotho, western Swaziland and the eastern Zimbabwean highlands (Allan 1997b). It is mainly associated with

Afromontane forest or stands of alien trees interspersed with open grassland or fynbos, but is also well established in suburbia, *e.g.* Cape Town (Allan 2005e). Also recorded in Bloemfontein (DJvN personal observations). It is resident (Allan 1997b).

The birds at Glen

Rufous-chested Sparrowhawk records at Glen involve single individuals seen in flight. Recorded on a total of ten days during six years, being relatively frequent in 1997/8 when recorded during four seasons compared to the 1–2 seasons in other years (Fig. 4.72). Seen during eight seasons spread throughout the year, and recorded between mid-morning and the late afternoon (Fig. 4.72).

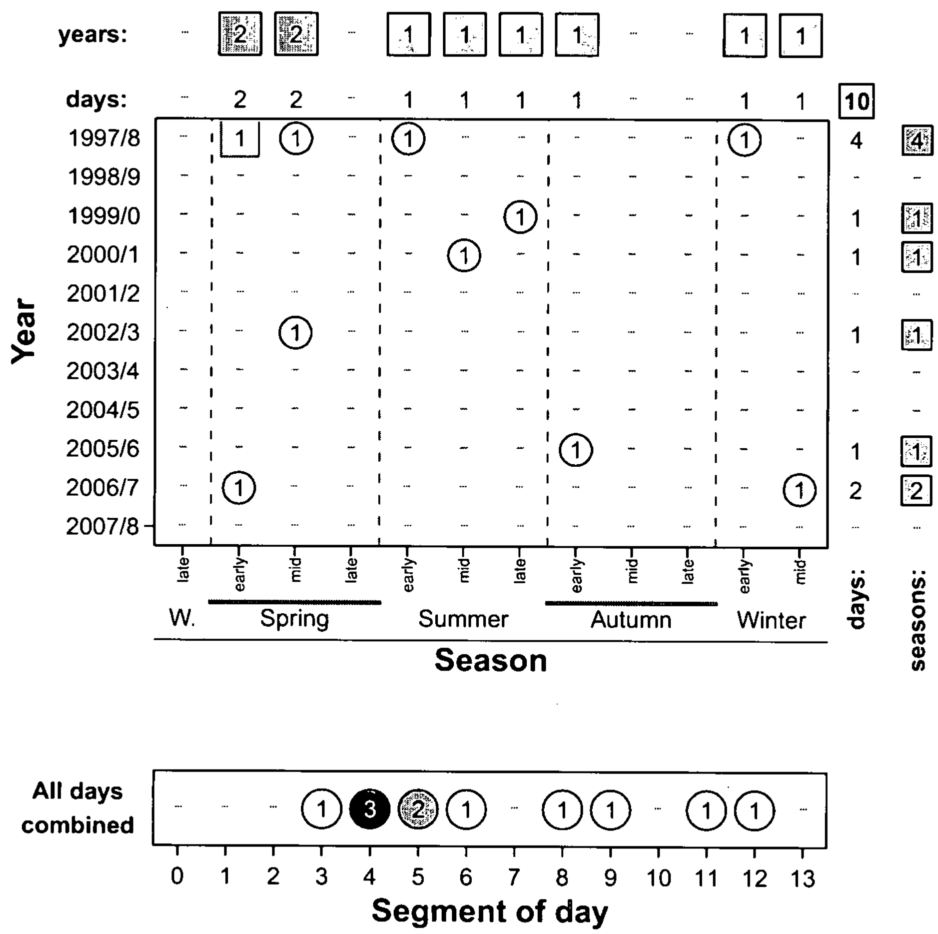


Figure 4.72: R155 Rufous-chested Sparrowhawk — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R162 Southern Pale Chanting Goshawk .... *Melierax canorus*

The distribution of the Southern Pale Chanting Goshawk is restricted to southern Africa and south-western Angola (Dean 2000; Maclean 1985). It is widespread in Namibia, Botswana and South Africa from the central Free State southwards, westwards and northwards, occurring only marginally in Zimbabwe and Lesotho (Malan 1997). In the Free State they occur mainly in the drier western parts of the province (Malan 1997), with the study area at Glen situated on the eastern edge of their distribution. The birds prefer areas with low rainfall (Steyn 1982) and require a mix of hunting perches and open ground (Malan & Crowe 1997). Whereas some birds are resident, others show extensive movements (Malan 1997)

The birds at Glen

The majority of grassland records of the Southern Pale Chanting Goshawk (86.6%; Table 4.14a) were of birds calling, with the remainder of the records involving birds seen only. These two types of activity are treated separately below. Sightings most frequently involved single birds. Figures start on page 244.

Annual occurrence of vocalisations in the grassland: Heard on 17.8% of the days with an activity index of two (Table 4.14a). Recorded during 5–8 seasons in most years, but during only 2–4 seasons in 2003/4, 2006/7 and 2007/8 (Fig. 4.73; Fig. 4.74). The annual frequency index was particularly high from 1998/9 to 2001/2 (Fig. 4.73). Daily reporting rates ranged from 0.5 to 16.0% with 97.4% of the bird-days attaining low values and the median values similar for all years (Fig. 4.73). Intermediate and high reporting rate days were limited to 1999/0 and 2000/1 (Fig. 4.73; Fig. 4.74).

Table 4.14: R162 Southern Pale Chanting Goshawk: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.866	284	114 612	0.2	birds heard	17.8	656	117	2
0.134	44	114 612	0.0	birds seen only	4.4	656	29	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.750	3	1 190	0.3	birds heard	4.7	43	2	2
0.250	1	1 190	0.1	birds seen only	2.3	43	1	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.750	3	1 188	0.3	birds heard	7.0	43	3	1
0.250	1	1 188	0.1	birds seen only	2.3	43	1	1

Seasonal occurrence of vocalisations in the grassland: Based on the number of bird-years per season as well as the seasonal frequency index there was a clear seasonal trend starting off at relatively low values in mid-winter and showing a steady increase in subsequent seasons, culminating in a peak during mid- and late autumn (Fig. 4.73). Median daily reporting rates were similar for the respective seasons with intermediate and high reporting rate days occurring during late spring and late summer only (Fig. 4.73; Fig. 4.74).

Daily occurrence of vocalisations in the grassland: Overall, most frequently heard before sunrise (Fig. 4.73), but seasonally this was true for autumn and winter only (Fig. 4.75). Five bird-segment combinations occurred during more than 5% bird-days with activity during S0 alone accounting for a quarter of all bird-days (Fig. 4.76). This combination together with most of the others were particularly frequent during autumn (Fig. 4.76).

The first activity of the day often occurred in the morning (Fig. 4.75), with the earliest starting time of activity being approximately 50 minutes before sunrise (Fig. 4.77). The timing of the last activity of the day was variable and occurred throughout the day (Fig. 4.75).

Daily segment reporting rates ranged from 5.6 to 46.2% with 81.8% of the values relatively low (Fig. 4.73). Median daily segment reporting rates were similar for the respective segments (Fig. 4.73).

Early morning occurrence of vocalisations during 2007/8: Activity was noted on two mornings in the drainage line and on three mornings in the grassland (Table 4.14b & c).

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Occurrence of birds seen only: Seen on 29 days (4.4%) in the grassland with an activity index of two (Table 4.14a). Recorded during all years. Based on the number of seasons seen each year it was more frequent during the first four and last year of the study than from 2001/2 to 2006/7 (Fig. 4.78). It was recorded during ten seasons, being slightly more frequent in winter and spring than during summer and autumn (Fig. 4.78). Seen on at least one day during almost all segments except after sunset when not recorded (Fig. 4.78).

During the early mornings (S0 and S1) of 2007/8, seen on one morning in the drainage line and on one morning in the grassland (Table 4.14b & c).

Discussion

According to Steyn (1982), the Southern Pale Chanting Goshawk is largely silent outside the breeding season, but they call throughout the breeding season, most frequently during display and nest building with activity starting at first light (Steyn 1982). In South Africa, egg-laying occurs from May (rarely March) to December [winter, spring, early and mid-summer] with incubation and nestling periods collectively covering a period of nearly 3 months (Allan 2005d; Tarboton 2001). Consequently, the following scenario is suggested for Glen. The peak in vocal activity occurring during mid- and late autumn (Fig. 4.73) correspond to Steyn's (1982) "display and nest building" phase before egg-laying starts in winter. Note, too, that it is mainly during this peak period that activity occurred most frequently before sunrise (Fig. 4.75). The dearth of activities in mid- and late winter (Fig. 4.73) signify incubation and the nestling period with vocal activity becoming more regular once the nestlings have fledged during spring (Fig. 4.73). Thus stated, this scenario is in agreement with Steyn's (1982) observations that vocal activity occurs most frequently during the display and nest building phase, but would contradict his statement according to which this species is largely silent outside the breeding season. In truth, the observer has yet to discover a nest at Glen (he has not really tried to date), but immature birds are encountered not too infrequently in the area.

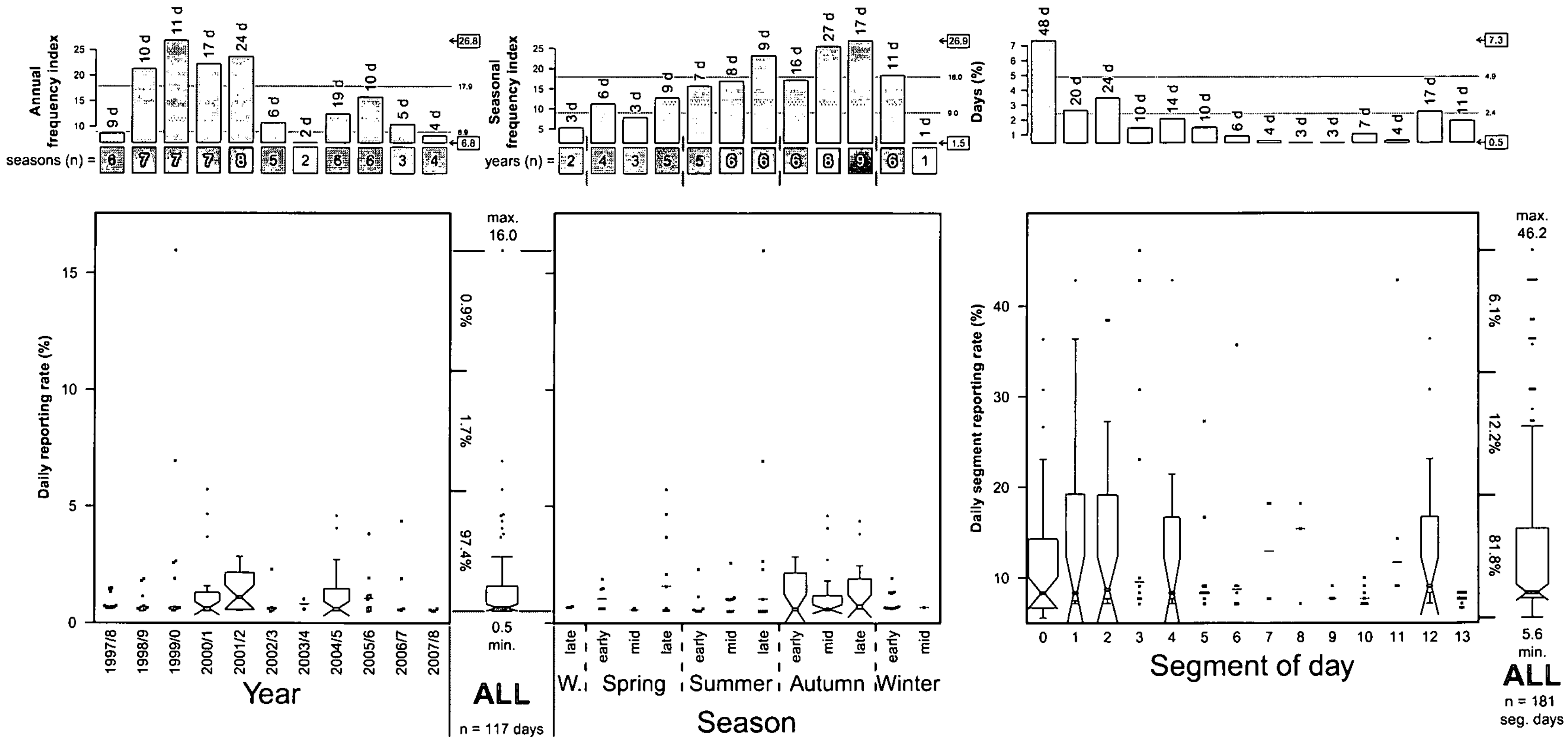

Figure 4.73: R162 Southern Pale Chanting Goshawk — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

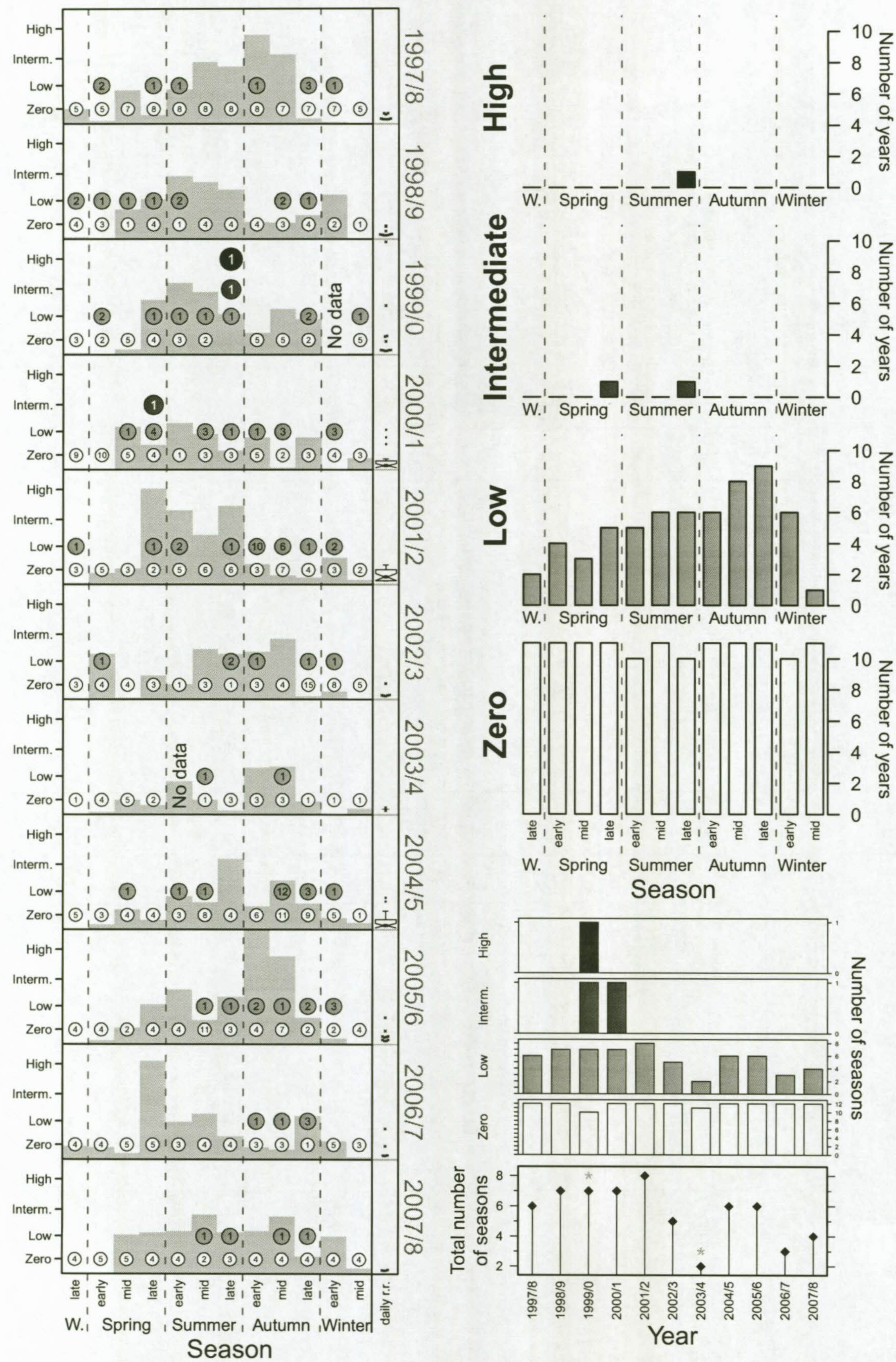

Figure 4.74: R162 Southern Pale Chanting Goshawk — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

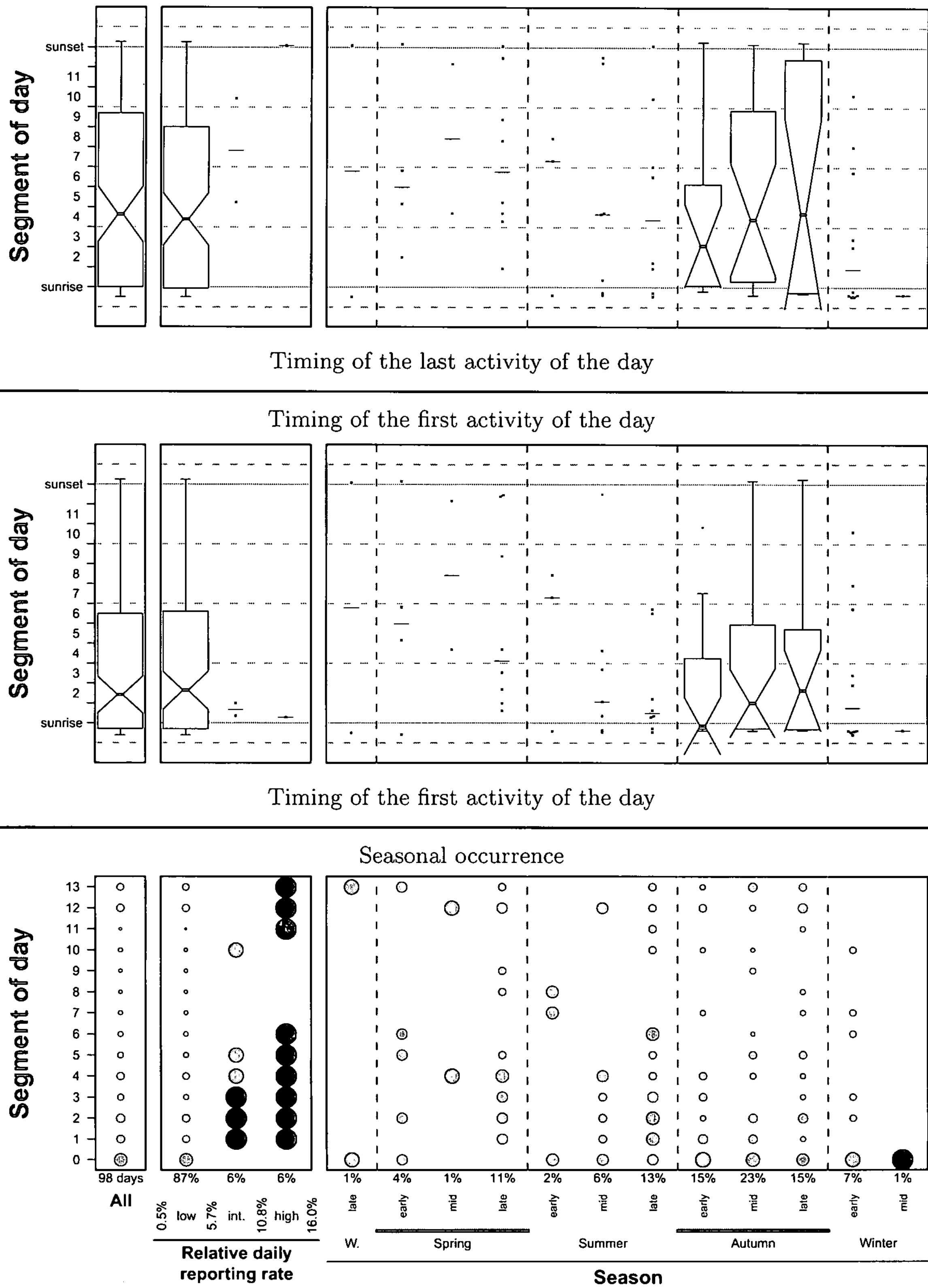

Figure 4.75: R162 Southern Pale Chanting Goshawk — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

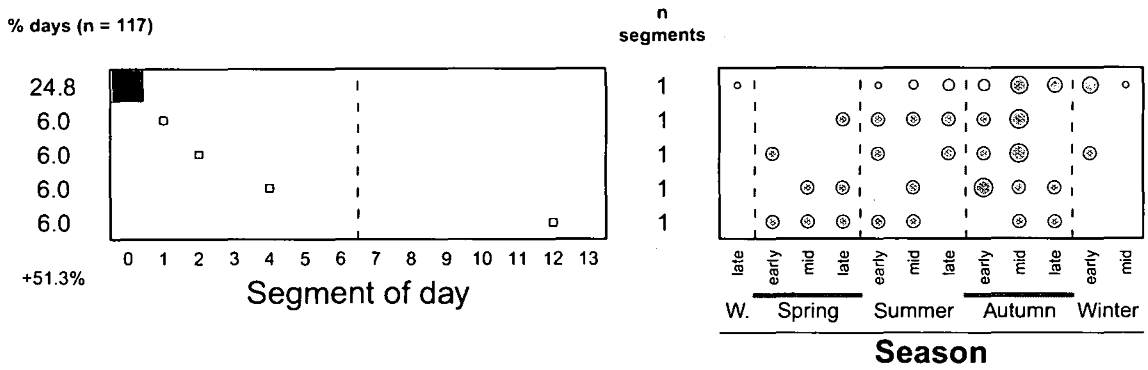

Figure 4.76: R162 Southern Pale Chanting Goshawk — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

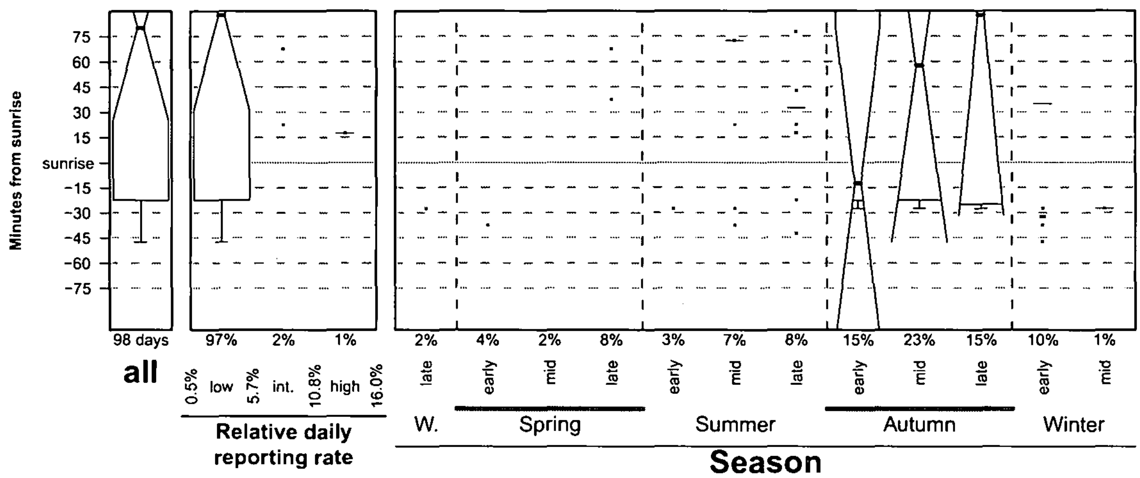

Figure 4.77: R162 Southern Pale Chanting Goshawk — birds heard: Details on the daily occurrence of the first activity of the day in the grassland at Glen. See page 136 for more information on this detailed first/last activity figure.

R166 Montagu's Harrier .... *Circus pygargus*

The Montagu's Harrier breeds in the Palearctic region, spending its non-breeding season in sub-Saharan Africa and on the Indian subcontinent (Cramp 1998). In southern Africa, where they are generally uncommon, they move as far south as the Free State where they may occur from November to March [early summer to mid-autumn] (Simmons 1997b). They prefer grassland associated with open pans or floodplains (Simmons 2005c).

The birds at Glen

Female and immature Montagu's Harriers and Pallid Harriers R167 are very difficult to tell apart in the field (Cramp 1998; Simmons 1997b), and at Glen two such birds were seen; these could have been either one of the two species, but are included here under Montagu's Harrier.

Recorded as single individuals quartering over grassland. Seen on four days, twice in 2001/2 (mid-summer and mid-autumn) and twice in 2004/5 (early and mid-autumn). Sightings were

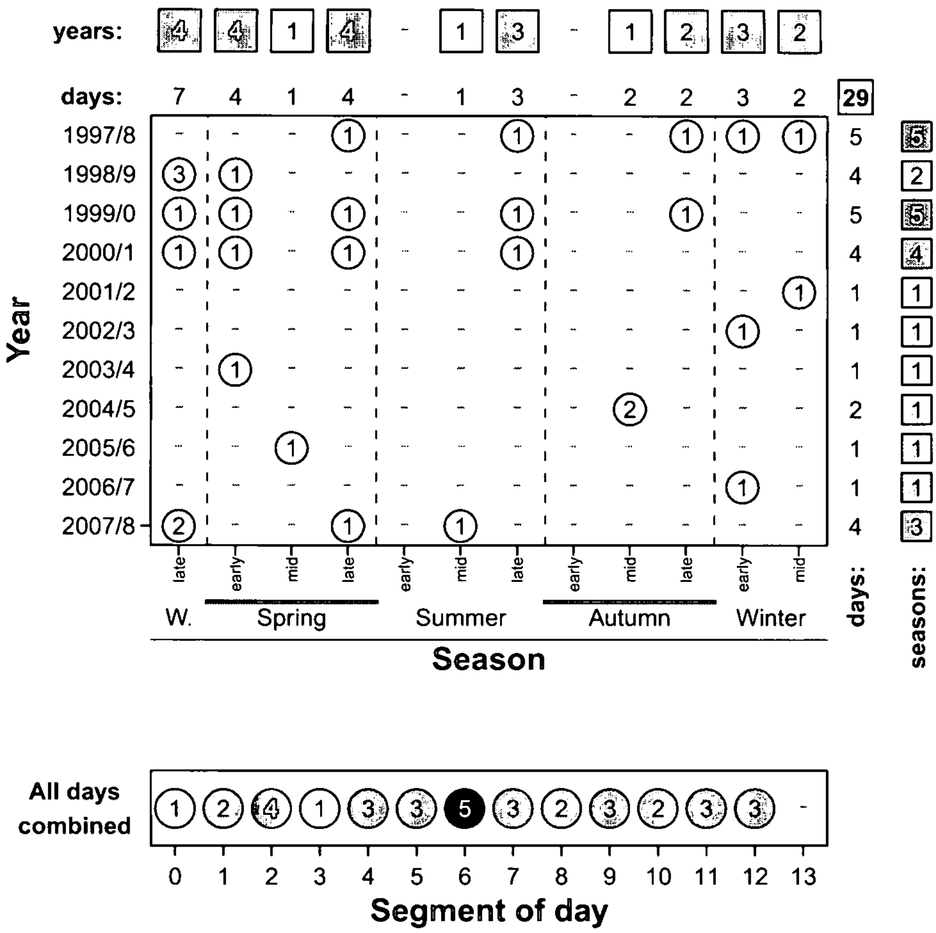

Figure 4.78: R162 Southern Pale Chanting Goshawk — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

during S1, S3, S4 and S9.

R167 Pallid Harrier .... *Circus macrourus*

The Pallid Harrier breeds in the Palearctic region, with the majority of birds spending the non-breeding season in sub-Saharan Africa and on the Indian subcontinent (Cramp 1998). It is sparsely distributed in southern Africa and occurs in the Free State where present from November to March [early summer to mid-autumn] (Simmons 1997c). They prefer grassland associated with open pans or flood plains (Simmons 2005b). The Pallid Harrier is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Barnes 2000d).

The birds at Glen

Female and immature Pallid and Montagu's Harriers R166 are very difficult to tell apart in the field (Cramp 1998; Simmons 1997b). Two of the sightings at Glen involved female/immature birds; these could have been either one of the two species but are included under Montagu's Harrier above.

Single male Pallid Harriers were seen quartering over the field on three days, twice during mid-summer 2005/6 (S4 and S6) and once during early autumn 2002/3 (S12).

R168 Black Harrier .... *Circus maurus*

Of the 13 harrier species in the world, the Black Harrier has the most restricted range and is endemic to southern Africa, occurring over much of South Africa (except for the part north of the Free State and in the far east), Lesotho and sparsely in Namibia; vagrant in Botswana (Penry 1994; Simmons 1997d). Part of the Western Cape population move north and east during the cooler months, perhaps as far as the grasslands of the Free State and KwaZulu-Natal (Simmons *et al.* 2005). It is irruptive in the grasslands of the Free State with years of abundance sometimes followed by complete absence in the following year (Simmons *et al.* 2005). This type of occurrence is thought to be related to fluctuations in the population of its main small mammal prey, the Vlei Rat, which breeds in response to good rains (Simmons 1997d; Simmons *et al.* 2005). The Black Harrier is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Barnes 2000e).

The birds at Glen

The Black Harrier was recorded as single adults quartering over open grassland. The data was analysed based on a year starting in late summer.

Seen on 17 days spread over six years with records limited to the period from late summer to mid-spring; recorded during various times of the day (Fig. 4.79).

4.13 Falconidae: Falcons

The 63 species of this diverse group of diurnal raptors occur worldwide except in Antarctica, with 16 species found in southern Africa (Hockey *et al.* 2005). Ten species have been recorded in the Free State, with half of the species found in the central parts of the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). All five these species were recorded at Glen. Whereas the smaller *Falco* species (kestrels) hover or hunt from perches and take smallish prey on the ground, the larger species often take aerial prey (mainly birds) at high speed strikes from aerial or perched vantage points (Hockey *et al.* 2005).

R171 Peregrine Falcon .... *Falco peregrinus*

The Peregrine Falcon occurs worldwide with a number of subspecies recognised (Cramp 1998; Maclean 1985). Two subspecies occur in southern Africa: *F. p. minor* is a widely distributed, but scarce, breeding resident, and *F. p. calidus* is a rare non-breeding summer visitor from the Palearcric (Jenkins 1997b). The two subspecies are difficult to distinguish in the field (Jenkins 1997b) and no distinction was made during the present study. The Peregrine Falcon is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Jenkins & Barnes 2000).

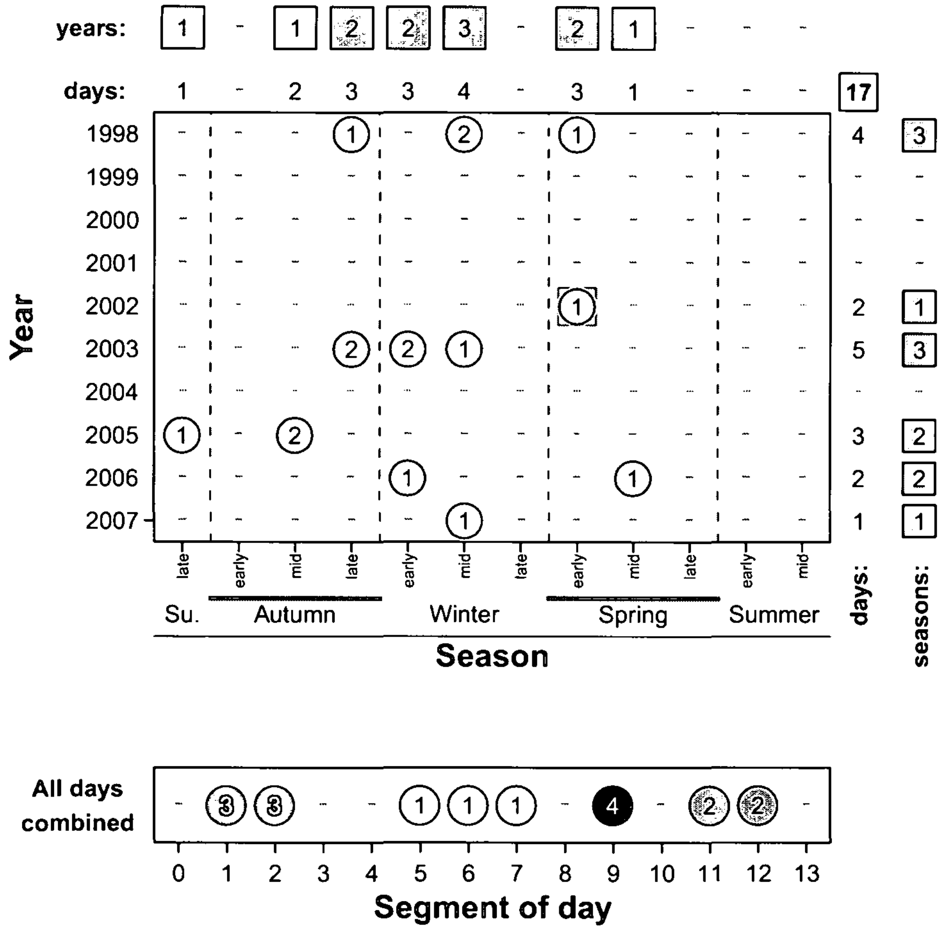

Figure 4.79: R168 Black Harrier — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

The birds at Glen

The Peregrine Falcon is superficially similar to the Lanner Falcon R172 (Jenkins 1997b). At Glen, insufficient views of high flying individuals precluded distinction between the two species. However, given the general scarcity of the former species and the fact that the Lanner Falcon was positively identified much more frequently (two vs. 33 records), it is considered likely that most or even all of the unidentified birds were Lanner Falcons. Nonetheless, the records of uncertain identification is treated separately under the species text of the Lanner Falcon, below.

Occurrence of positively identified Peregrine Falcons: The Peregrine Falcon was recorded twice: mid-autumn 2004/5 (S5) and late summer 2007/8 (S11).

R172 Lanner Falcon .... *Falco biarmicus*

The Lanner Falcon occurs in Africa, the Middle East and in southern Europe (Cramp 1998; Maclean 1985). It is widespread throughout southern Africa (except southern Mozambique where it is rare (Parker 1999)) with a stronghold in Lesotho and south-eastern South Africa

(Jenkins 1997a). It occurs in a wide range of habitats from mountainous regions with high rainfall to deserts (Steyn 1982). In their analysis on its seasonal occurrence in South Africa, Van Zyl *et al.* (1994) found that some birds are sedentary while others migrate, that immature birds were more mobile than adults, and that the extent of migration varies with environmental conditions, especially rainfall pattern and its effect on prey abundance. The falcons are most abundant in the east during the breeding season (*ca.* July to November [late winter to early summer]) with westward movements occurring during the non-breeding season(Van Zyl *et al.* 1994). The Lanner Falcon is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Barnes & Jenkins 2000).

The birds at Glen

The superficial similarity between the Peregrine Falcon R171 and the Lanner Falcon (Jenkins 1997b) coupled with insufficient views of high flying individuals at Glen precluded distinction between the two species on 28 occasions. Given the general scarcity of the former species and the fact that the Lanner Falcon was positively identified much more frequently (two versus 33 records), it is considered likely that most or even all of the unidentified birds were Lanner Falcons. These records of uncertain identity are nonetheless treated separately below.

The occurrence of positively identified Lanner Falcons: The Lanner Falcon was seen on 33 days, usually during 1–2 seasons per year, but during as many as seven and five seasons in 1997/8 and 2006/7 respectively (Fig. 4.80). Seen during all seasons with no prominent seasonal trend (Fig. 4.80). Recorded at least once during all segments except S13 when not recorded (Fig. 4.80). Not recorded for the drainage line or grassland during 2007/8 early mornings.

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Occurrence of unidentified falcons (Peregrine/Lanner): Seen on 26 days spread over nine years (Fig. 4.81). Most frequently recorded during the first two years of the study and in 2005/6 (Fig. 4.81). Seen during most seasons with a peak in occurrence during early autumn (Fig. 4.81). Observations were mostly during the middle part of the day and in the late afternoon shortly before sunset (Fig. 4.81).

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Occurrence of positively identified Lanner Falcons plus unidentified birds: Seen on 57 days spread over all 11 years (Fig. 4.82). Most frequently recorded during the first two years of the study and in 2005/6–2006/7 (Fig. 4.82). Seen during all seasons with a peak in occurrence from mid-summer to early autumn (Fig. 4.82). Observations occurred throughout the day (Fig. 4.82).

Discussion

As already indicated above, it is likely that most or all of the unidentified birds were actually Lanner Falcons. This discussion is based on that assumption and consequently Figure 4.82.

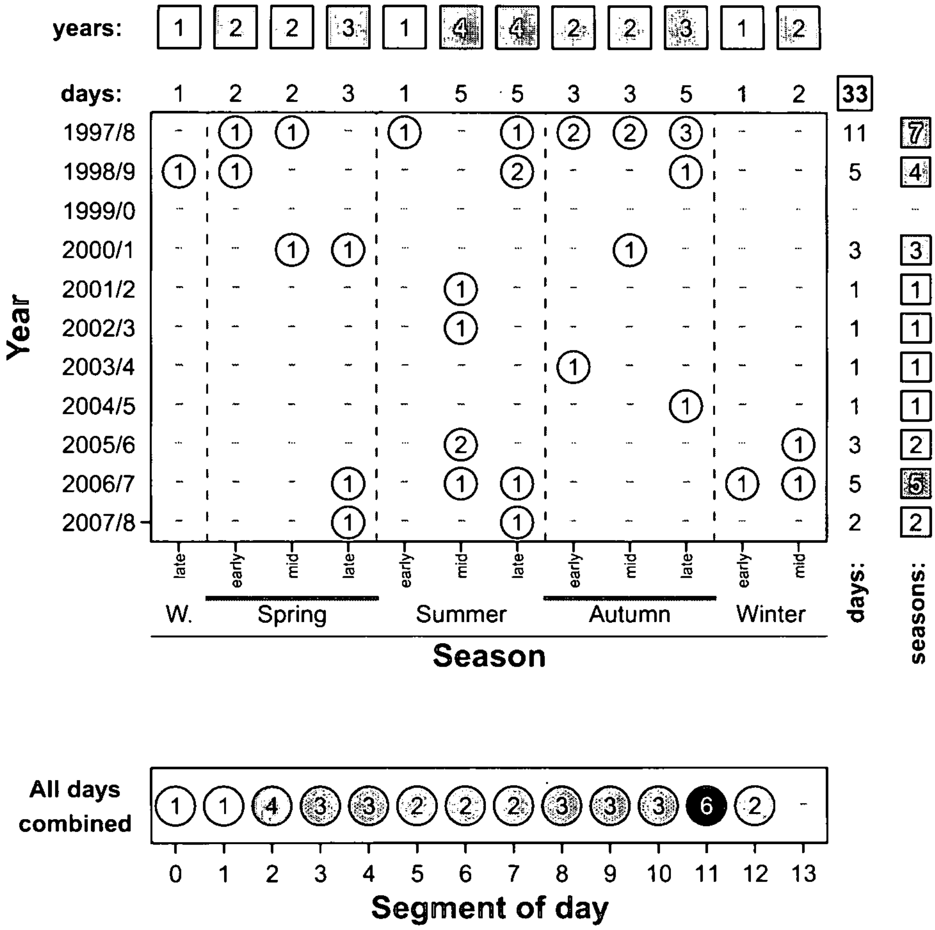


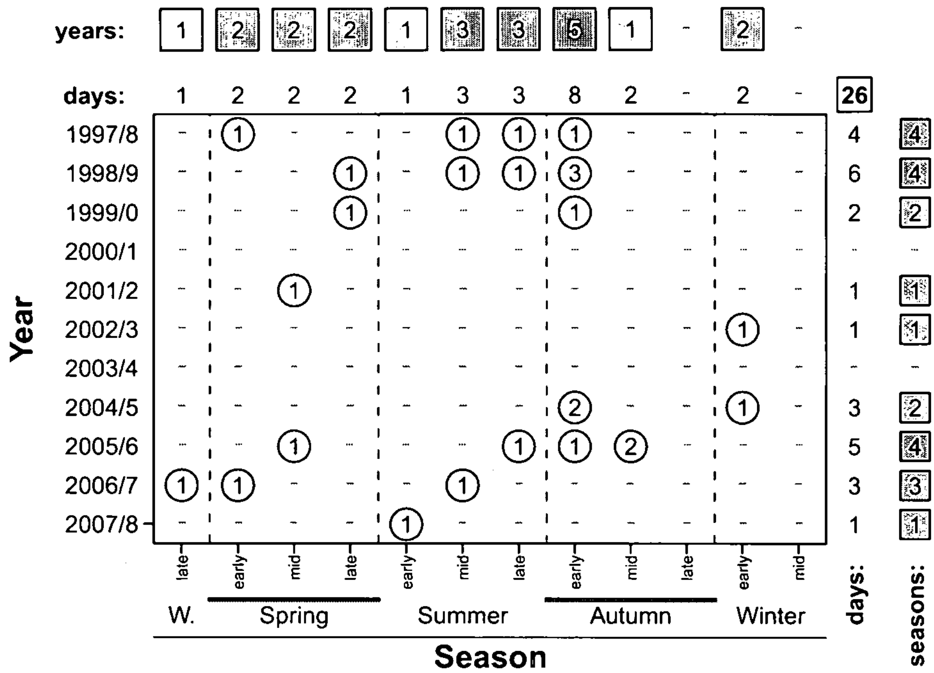
Figure 4.80: R172 Lanner Falcon — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

The peaks in occurrence during 1997/8–1998/9 and 2005/6–2006/7 are at least partially explained by the fact that many of the sightings occurred during behavioural observations on the Spike-heeled Lark R506 and the Eastern Clapper Lark R495. More specifically, many of the sightings of falcons were associated with anti-predatory behaviour noticed in these larks. Many of the raptors would have passed unnoticed if it were not for the vigilance of these birds.

The seasonal pattern at Glen showing a peak during the warmer period of the year lends further support for the idea of Van Zyl *et al.* (1994) regarding the seasonal movements of Lanner Falcons in southern Africa.

R181 Rock Kestrel .... *Falco rupicolus*

The Rock Kestrel was recently spilt from the European Kestrel *F. tinnunculus* based on genetic evidence as well as consistent morphological and plumage differences (Groombridge *et al.* 2002; Jenkins 2005a). It is endemic to sub-equatorial Africa (Steyn 1982). In southern Africa it is widespread in South Africa, Lesotho, most of Namibia and more sparsely distributed in Botswana, Zimbabwe and Swaziland (Van Zyl 1997). It utilises a variety of habitats (Van Zyl 1997). Van Zyl (1997) attributed SABAP1 reporting rate increases during "winter" to seasonal changes in



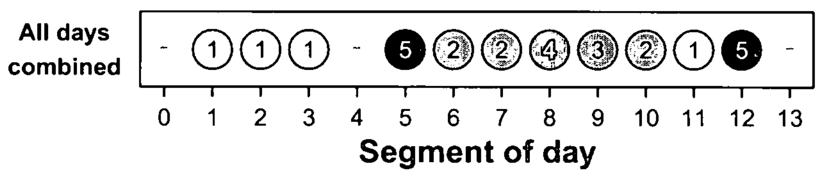


Figure 4.81: R171/2 Peregrine/Lanner Falcon — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

conspicuousness, rather than a large scale influx of migrants from outside the region. In addition, a more detailed analysis of SABAP1 data by Van Zyl *et al.* (1994) revealed that reporting rates in the northeastern Cape and southern Free State show little seasonal variation.

The birds at Glen

Insufficient view precluded distinction between the Rock Kestrel and the superficially similar Greater Kestrel R182. Only positively identified birds are considered here.

The occurrence of the Rock Kestrel: Recorded as birds seen in flight. In the grassland, the Rock Kestrel was positively identified on five days spread over four years (Fig. 4.83). These sightings were limited to early autumn, winter and mid-summer, and mainly occurred in the afternoon (Fig. 4.83).

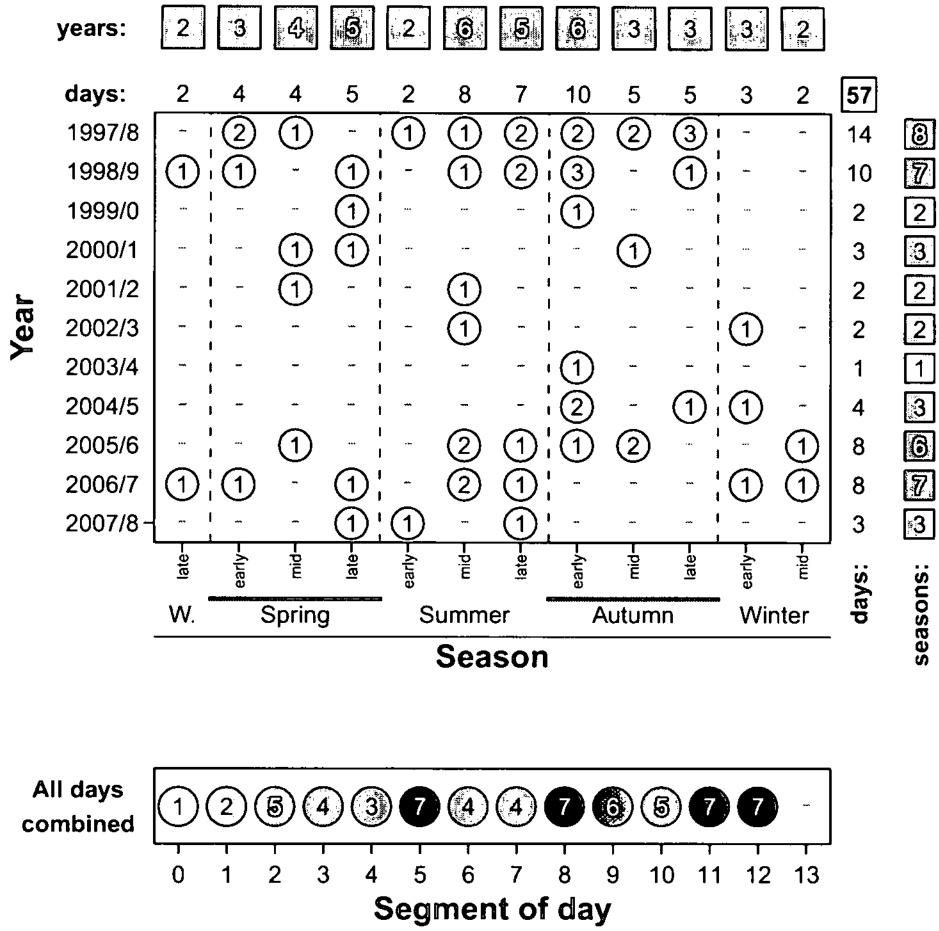


Figure 4.82: R172? Lanner Falcon plus unidentified falcons (Peregrine/Lanner Falcon) — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R182 Greater Kestrel .... *Falco rupicoloides*

The Greater Kestrel is endemic to sub-Saharan Africa (Maclean 1985; Steyn 1982). It is widespread in southern Africa but scarce or absent in Lesotho, Swaziland, Zimbabwe, the southern and far eastern parts of South Africa (Mendelsohn 1997e) and southern Mozambique (Parker 1999). It is associated with open arid and grassland habitats (Mendelsohn 1997e). No regular migratory movements are recorded (Jenkins 2005b; Mendelsohn 1997e). However, long-distance movements have been demonstrated by ringing recoveries and other observations point to nomadism in more arid areas (Jenkins 2005b; Mendelsohn 1997e).

The birds at Glen

The Greater Kestrel was seen only once, in mid-autumn 2004/5 (S1). Two additional records, late summer 2001/2 (S9) and mid-winter 2005/6 (S4), could have been Rock Kestrels R181.

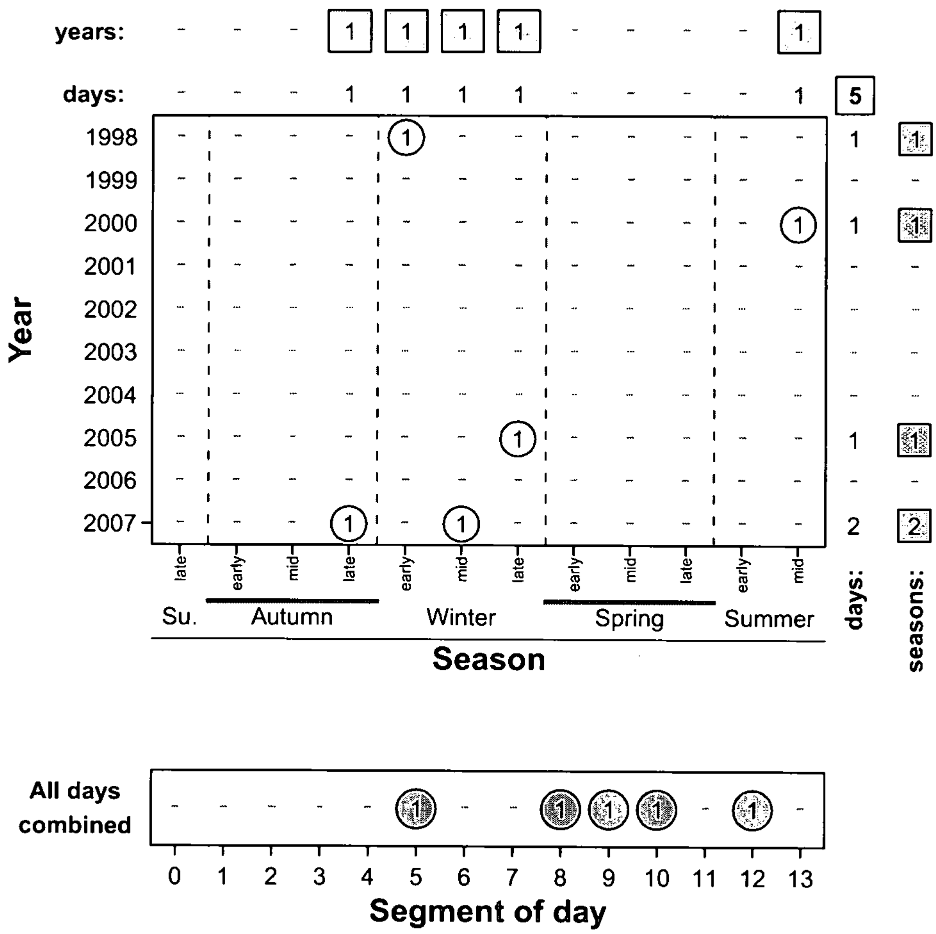


Figure 4.83: R181 Rock Kestrel — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R183 Lesser Kestrel .... *Falco naumanni*

The Lesser Kestrel breeds in the Palearctic with most of the birds migrating south (some birds resident on breeding ground) to spend the non-breeding season in sub-Saharan Africa (Cramp 1998). Its southern African distribution is centred on the Free State where they arrive during the latter part of October [late spring] and most depart in March [mid-autumn] (Colahan & Van Niekerk 2008; McCann 1997). In the Free State they are primarily associated with grasslands and also agricultural fields (McCann 1997), roosting communally in large trees (mainly eucalyptus or pines) situated in urban or peri-urban areas (Colahan & Van Niekerk 2008). The Lesser Kestrel is considered to be facing a high risk of extinction in the wild (Pepler 2000).

The birds at Glen

The Lesser Kestrel was recorded in the grassland only. Usually recorded as lose groups or as single individuals on their way to feeding grounds, which sometimes included the study area. Rarely heard calling (1.6% of all 5-minute checklists); all the data were combined for analysis. Figures start on page 257.

Annual occurrence of birds in the grassland: Recorded on 20.4% of the days with an activity index of three (Table 4.15a). Usually recorded during 4–7 seasons per year, but during only one in 2003/4 (Fig. 4.84; Fig. 4.85). Daily reporting rates ranged from 0.5 to 15.7% with 91.8% bird-days attaining low values; median values similar for all years (Fig. 4.84).

Table 4.15: R183 Lesser Kestrel: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	447	114 612	0.4	birds present	20.4	656	134	3
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–

Seasonal occurrence of birds in the grassland: The first record for each year occurred consistently during the latter part of late spring with a median arrival date of 1 November (Fig. 4.86; Note that there was no observation days during the arrival period in 2003/4). Departure dates was variable and ranged from mid-summer to late autumn (Fig. 4.86). Overall, it was recorded during all years in late spring and summer (except 2003/4 when no observations was made during the arrival period), during seven years in early and mid-autumn and during only one year in late autumn (Fig. 4.84; Fig. 4.85). The median daily reporting rates of late spring and particularly early summer were higher than those in late summer and autumn (Fig. 4.84), coinciding with the few instances of intermediate and high reporting rate days which were limited to late spring, early and mid-summer and the occurrence of days with zero record days which was least frequent in early summer (Fig. 4.84; Fig. 4.85).

Daily occurrence of birds in the grassland: Overall, activity was most frequent in the late morning (Fig. 4.84). This general pattern is most applicable for late spring and summer, with late spring also having activity relatively frequent in the late afternoon before sunset (Fig. 4.87). In contrast to late spring, early and mid-summer when activity was first noted in S2, it was first noted in S1 in late summer, early and mid-autumn and in S0 in late autumn (Fig. 4.87). The three bird-segment combinations occurring during more than 5% bird-days were limited to single segments S3, S4 and S12 (Fig. 4.88).

The median time of the first activity of the day was similar for all seasons, except late autumn which is represented by a single data point only, which, incidentally, was the only time that activity occurred before sunrise (Fig. 4.87). Although the median end times of activity suggest that activity ceased earlier in the day as the year progresses, the scatter in the data is extensive (Fig. 4.87) .

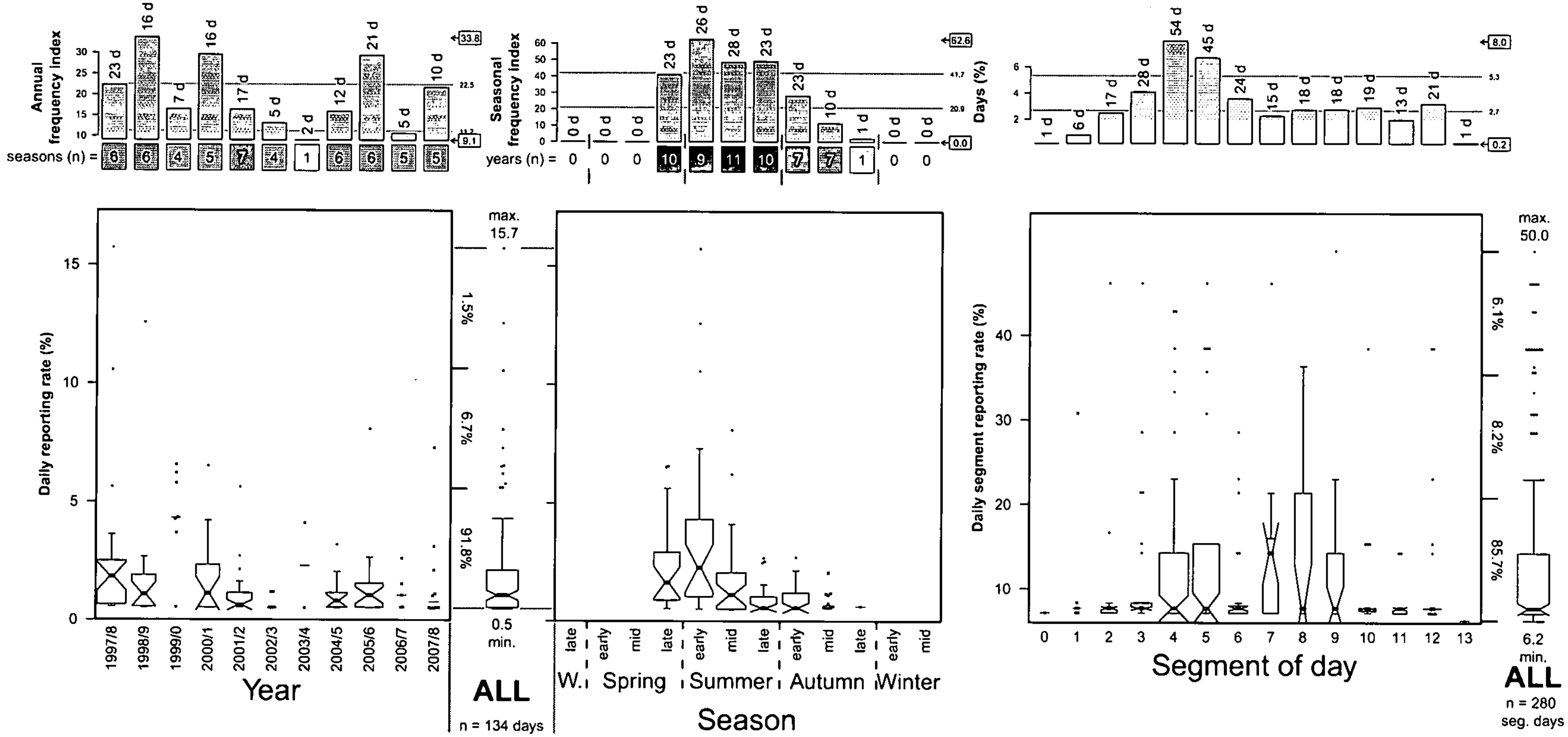


Figure 4.84: R183 Lesser Kestrel — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

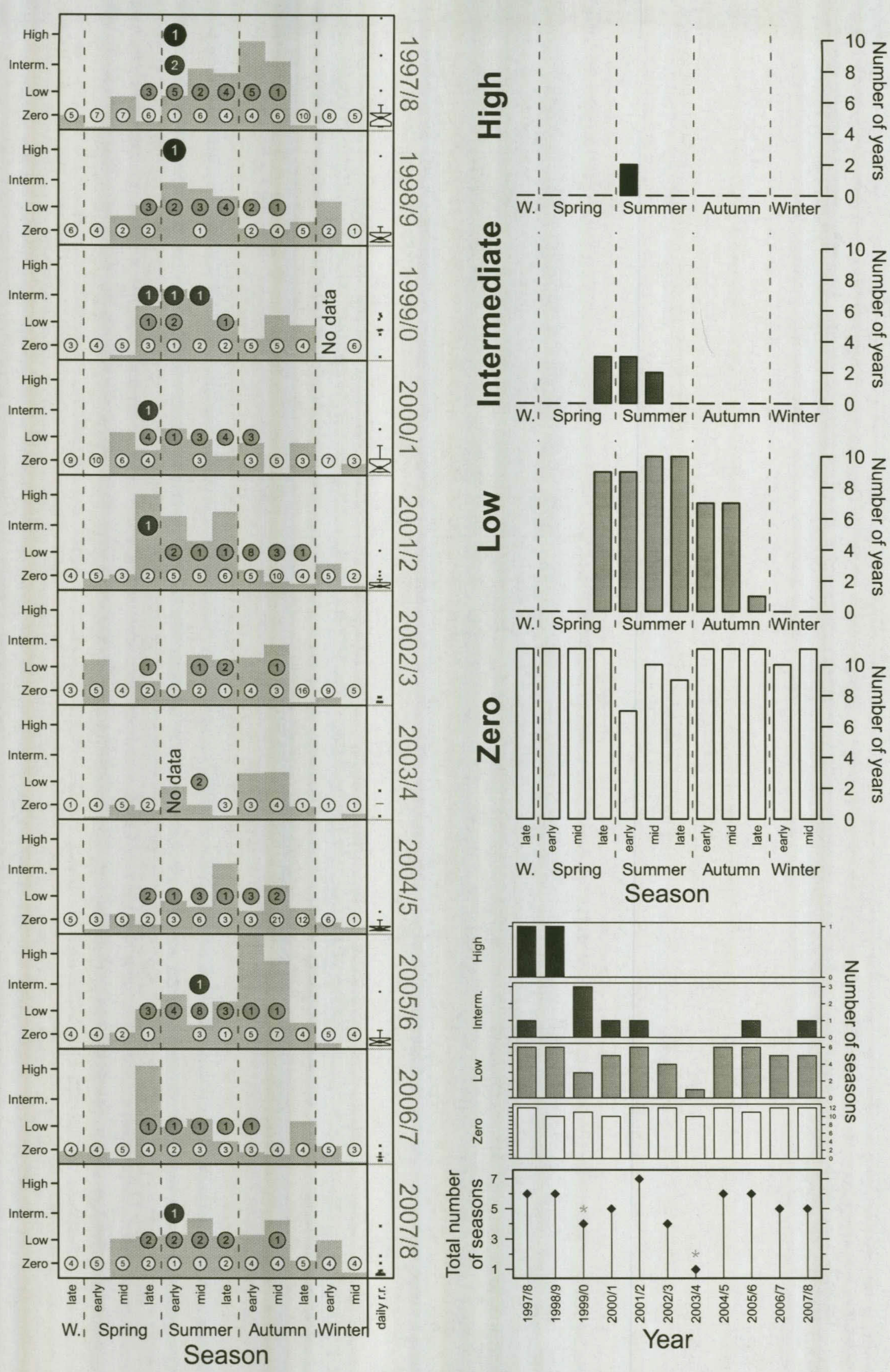


Figure 4.85: R183 Lesser Kestrel — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

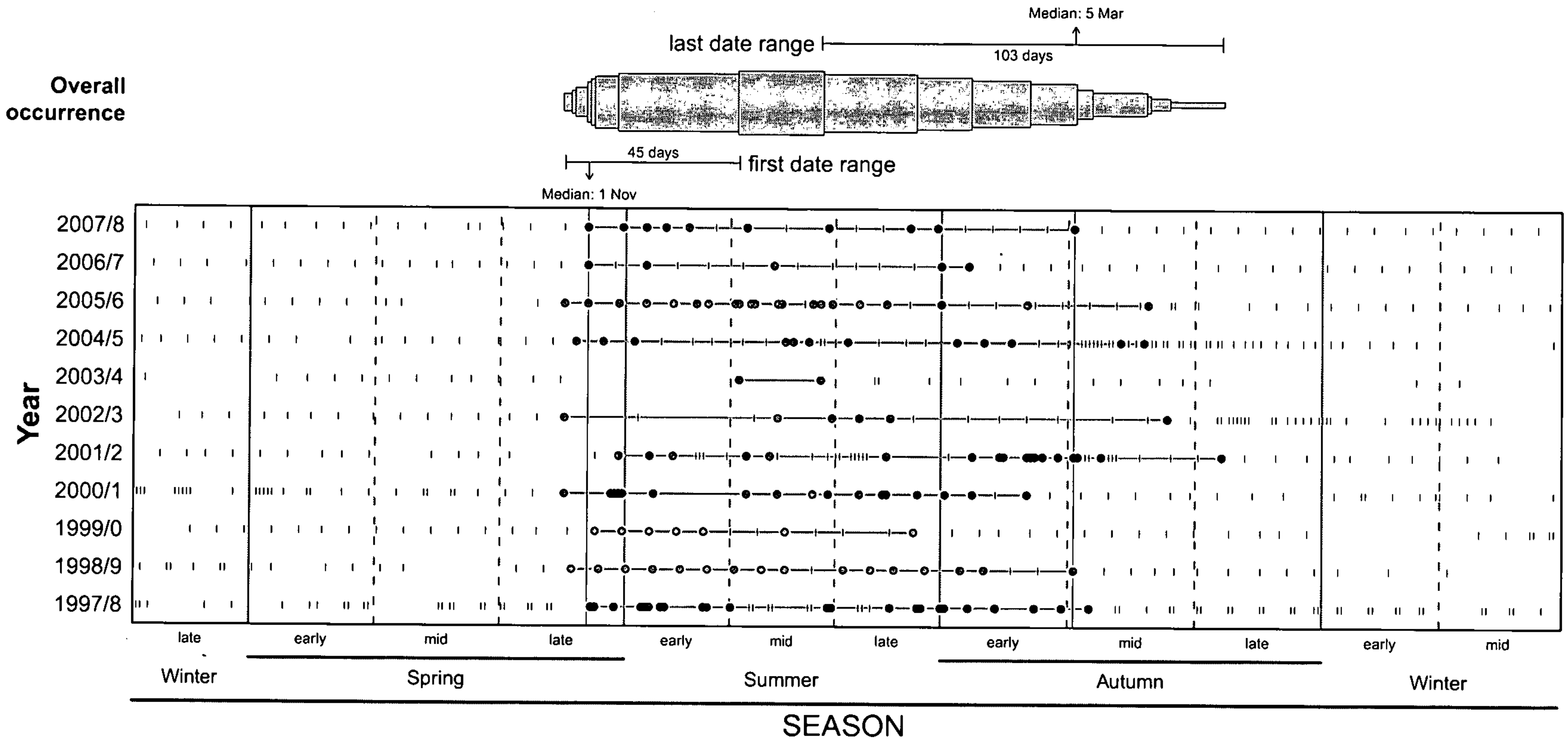


Figure 4.86: R183 Lesser Kestrel: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

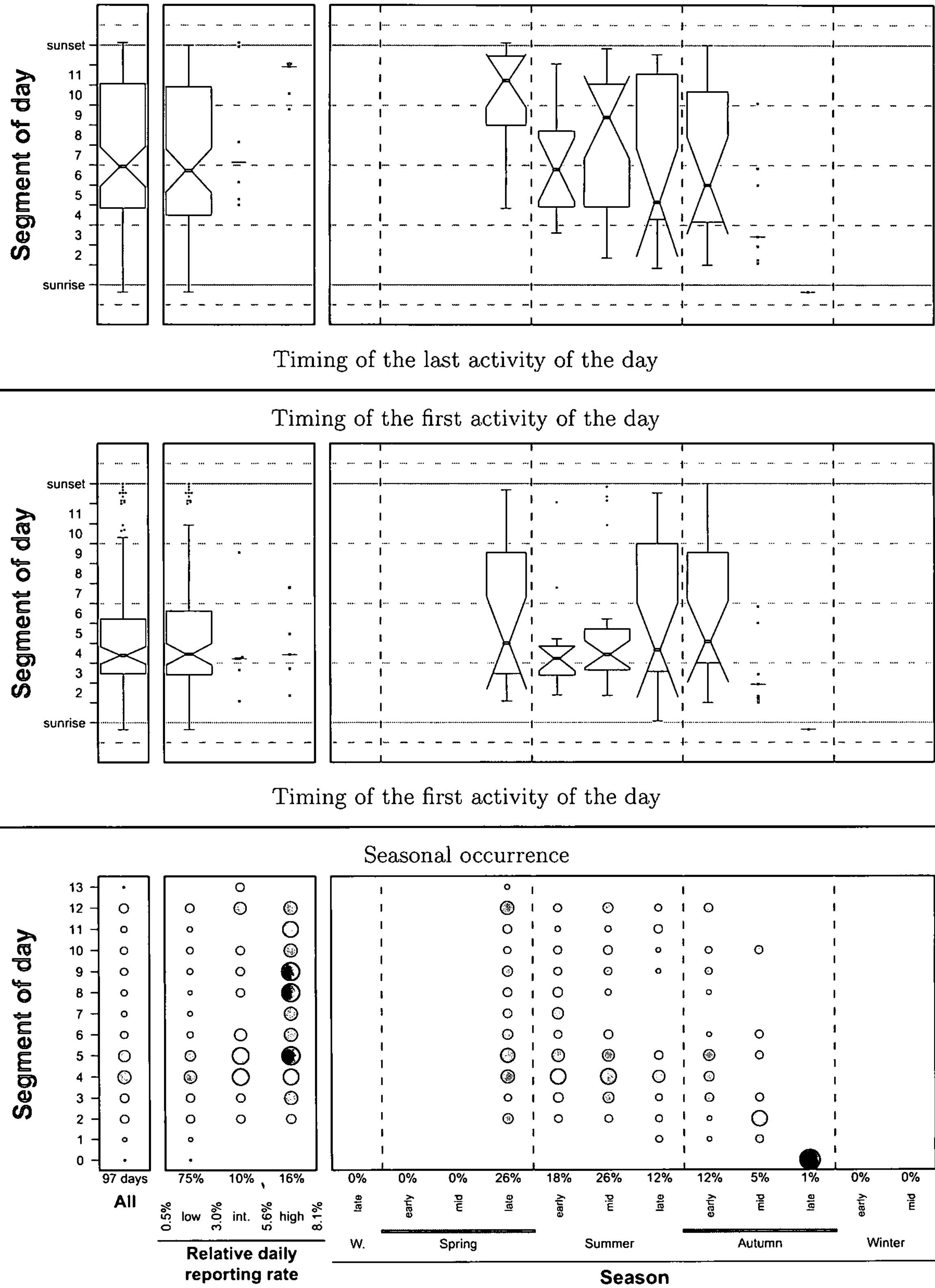


Figure 4.87: R183 Lesser Kestrel — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

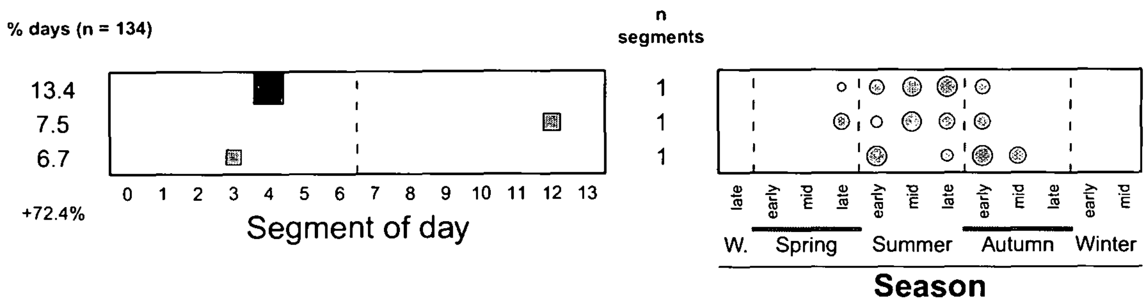


Figure 4.88: R183 Lesser Kestrel — birds present: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

Daily segment reporting rates ranged from 6.2 to 50.0% with medians similar for the respective segments of the day (Fig. 4.84).

Discussion

The study area is situated midway between two significant Lesser Kestrel roosts: the one at Bloemfontein in the south-west and the other at Brandfort in the north-east. These two roosts are approximately 50 km apart. The Bloemfontein roost houses more than 10 000 birds at least once in a season while the Brandfort roost held more than 3 000 birds during a count in 2005 (Colahan & Van Niekerk 2008; DJvN unpublished data). The birds usually leave their roost amass before sunrise, but many birds often linger for some time in the roosting area before departing to their feeding grounds. Since most of the birds present in the study area in the morning arrive from the south-west and those seen in the late afternoon travel towards the south-west, it is safe to say that these birds originates from, or are on their way to, the Bloemfontein roost.

The daily occurrence of birds is particularly interesting. Firstly, late spring was the only season when activity peaked in the late afternoon (Fig. 4.87). This may be due to birds on passage arriving from further north. In this regard it is noted that the birds arrived consistently during a narrow window in the latter part of late spring each year (Fig. 4.86). This is probably due to circannual rhythms tied to changes in day-length.

The first birds to arrive at the study site each day may do so earlier in the latter part of the season (*i.e.* late summer and autumn) than in the former part (Fig. 4.87). In addition, by mid-autumn activity in the late afternoon was scarce and by late autumn the only bird (or birds; number not recorded) to be seen was one that passed the study area before sunrise (Fig. 4.87). These earlier observations during the latter part of the season may be due to birds on their way further north towards their breeding grounds.

The relatively infrequent occurrence of the kestrels during 2003/4 (Fig. 4.84; Fig. 4.85) is most probably related to the prevailing drought conditions then.

4.14 Phasianidae: Francolins, Spurfowls, Quails

The approximately 180 species of the Phasianidae occur almost worldwide with 17 species found in southern Africa (Hockey *et al.* 2005; Little *et al.* 2000). Eight species occur in the Free State of which four are commonly found in the central parts of the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). Of the latter four only the Natal Spurfowl *Pternistis natalensis*, which occurs along wooded watercourses in open grassland in the Free State (R. J. Nuttall in Little 1997a), was not recorded at Glen. The three species recorded at Glen were the Orange River Francolin R193, Swainson's Spurfowl R199 and Common Quail R200.

R193 Orange River Francolin .... *Scleroptila levaillantoides*

All seven *Scleroptila* species (four in southern Africa) are endemic to sub-Saharan Africa (Hockey *et al.* 2005). Isolated populations of the Orange River Francolin occur in a number of places in Africa (Crowe *et al.* 1986a; Little *et al.* 2000). In addition to being the south-eastern limit of their range, the Free State also forms part of their core distribution in southern Africa form where its distribution extends north into Botswana and further westwards into the northern half of Namibia (Little & Allan 1997a). In the Free State they are resident and typically associated with grassland (Earlé & Grobler 1987; Little & Allan 1997a).

The birds at Glen

The Orange River Francolin was mostly recorded as birds calling (Table 4.16a). When flushed by the observer, individuals would often call sometime thereafter, presumably to reassemble the group. The number of individuals flushed was usually 1–2 birds, but flocks of 3, 4 and 7 were also encountered (Fig. 4.89). All vocalisations are considered here with the bulk consisting of advertisement calls, which Maclean (1985) described as a four-syllabled phrase *kibitele* repeated a few times. Data was collected separately for each minute since 2001/2 (Table 4.17). Figures start on page 265.

Table 4.16: R193 Orange River Francolin: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.980	6 850	114 612	6.0	advertisement calls	93.4	656	613	11
0.020	141	114 612	0.1	flushed birds	14.8	656	97	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	271	1 190	22.8	advertisement calls	81.4	43	35	8
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.993	402	1 188	33.8	advertisement calls	95.3	43	41	10
0.007	3	1 188	0.3	flushed birds	7.0	43	3	1

Table 4.17: R193 Orange River Francolin: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
advertisement calls	late winter 2001/2	13 008	345 105	3.8

Annual occurrence of advertisement calls in the grassland: Recorded on 93.4% of the days with an activity index of 11 (Table 4.16a). Activity was recorded during all seasons every year (Fig. 4.90; Fig. 4.91). Daily reporting rates ranged from 0.5 to 33.5% with 84.7% of the values relatively low (Fig. 4.90). Only four years had days with relatively high reporting rates (2000/1–2002/3 and 2004/5), and median daily reporting rates were relatively low in 1997/8, 1998/9, 2003/4 and 2006/7 (Fig. 4.90; Fig. 4.91). Since 2001/2 when the relevant data was recorded (Table 4.17), the activity intensity of 2003/4 and 2006/7 were relatively lower compared to that of other years (Fig. 4.90).

Seasonal occurrence of advertisement calls in the grassland: Recorded during all seasons each year (Fig. 4.90; Fig. 4.91). The seasonal frequency index for all seasons were very high (89.4–99.3%) and consequently the differences indicated (Fig. 4.90) are actually not as pronounced as it may at first appear. The few days with high reporting rates were limited to mid-spring, late spring and mid-summer (Fig. 4.91). However, neither the occurrence of intermediate or low reporting rate days, or days with zero records showed any prominent seasonal pattern (Fig. 4.91). Median daily reporting rates were likewise similar for all seasons (Fig. 4.90). Activity intensities were also comparable, except for mid-winter during which it was higher (Fig. 4.90).

Daily occurrence of advertisement calls in the grassland: Overall, activity was most frequent in the early morning during the two segments around sunrise and after sunset, but infrequent from mid-morning till mid-afternoon (Fig. 4.90). This pattern is mostly a reflection of low reporting rate days; On intermediate and high reporting rate days the early morning activity extended to mid-morning (Fig. 4.92). Seasonally, activity was most frequent during the two segments around sunrise and during the two segments around sunset during all seasons (Fig. 4.93). The three bird-day segment combinations occurring during more than 5% bird-days were also restricted to these four segments, but collectively these combinations accounted for less than 20% of all bird-days (Fig. 4.94). All three combinations tend to occur more frequently in autumn (Fig. 4.94).

The first activity of the day typically occurred before sunrise (median *ca.* 25 minutes), but slightly earlier during mid-winter than during summer or autumn (Fig. 4.93; Fig. 4.95), with the dawn chorus sequence showing a similar trend (Fig. 4.95). The last activity of the day was typically noted around sunset, occurring slightly later on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.93; Fig. 4.95). There was no marked seasonal pattern, however (Fig. 4.93; Fig. 4.95).

On low reporting rate days, activity intensity was highest in the early morning and in the late afternoon (Fig. 4.92). For intermediate reporting rate days the activity intensities were high during midday too (Fig. 4.92).

Overall, daily segment reporting rates ranged from 5.6 to 100% (Fig. 4.90). The median daily segment reporting rate of S1 was higher than that of other segments, a pattern which is particularly pronounced for intermediate reporting rate days (Fig. 4.92).

Early morning occurrence of advertisement calls during 2007/8: Activity was recorded slightly more frequently in the grassland than in the drainage line (Table 4.16b & c), and the median early morning reporting rate was higher in the grassland too (Fig. 4.96). Whereas the occurrence of high reporting rate mornings was limited to the period from late spring to late autumn in the drainage line, it occurred from early spring to early winter in the grassland (Fig. 4.96). The timing of the first activity of the day was very similar between the two habitats (median 30 minutes before sunrise; Fig. 4.96). In both habitats, activity intensity was higher before sunrise than after sunrise on low reporting rate mornings, with the opposite trend on intermediate and high reporting rate mornings (Fig. 4.96).

Discussion

According to Little *et al.* (2000) the Orange River Francolin is typically seen as pairs or relatively small coveys of three to five birds, and occasionally as many as eight (Little 2005a). Although pairs represented the dominant group size at Glen, single birds also featured prominently (Fig. 4.89).

Regarding the advertisement calls, Little *et al.* (2000) noted that calling mostly occurred in the early morning and evening, similar to the situation at Glen (Fig. 4.90; Fig. 4.93). They add that calling occur more often during the breeding season (Little *et al.* 2000). Limited information suggests that breeding may be linked to rainfall (Liversidge 1987). The Glen data, specifically Figure 4.91, shows no obvious trend in this regard. The largely aseasonal character of the data (Fig. 4.90; Fig. 4.91) is suggestive of opportunistic breeding that may or may not be linked to specific rainfall events. Moulting is probably also aseasonal and protracted. Limited data from birds in the Free State appears to be consistent with this conclusion (DJvN unpublished data). No published data is available on moult in South Africa, but in Namibia moult was recorded from November to January [summer] and in July [late winter] (Little 2005a).

R199 Swainson's Spurfowl .... *Pternistis swainsonii*

There appears to be a little confusion regarding the distribution of Swainson's Spurfowl outside southern Africa. In the species text for SABAP1, Little (1997b) wrote that "Swainson's Francolin is near-endemic to southern Africa, occurring in Zambia and southwards into northern Namibia, ...". A few years later in their book on the "Gamebirds of southern Africa" Little *et al.* (2000) stated that "Swainson's Spurfowl occurs almost exclusively in southern Africa, extending marginally into southern and south-eastern Zambia." Then, in Roberts 7, Little (2005b) stated: "Near-endemic [to southern Africa], extending marginally into se [south-eastern] Zambia." Thus, it started off as Zambia, then it became southern and south-eastern Zambia, and lately south-eastern Zambia only.

As it stands, it seems to imply that the range of Swainson's Francolin has contracted in Zambia. It also implies more directly that these birds do not occur in neighbouring countries such as Angola. However, the part quoted from Little (2005b) is from the "Distribution" section in Roberts 7, but later under the "Geographical Variation" section he wrote:

> "*P. s. swainsonii*. . . ; se [south-eastern] Angola, n [northern] Namibia and n [northern] Zambia, south to KwaZulu-Natal and E Cape. . . . *P. s. lundazi*. . . Lupamadzi R, e [eastern] Zambia. Western and n [northern] Zimbabwe and s [southern] Mozambique."

Note in particular south-eastern Angola, eastern and northern Zambia (see also Crowe *et al.* 1986b). Incidentally, the part about northern Zambia seems to be contradicted

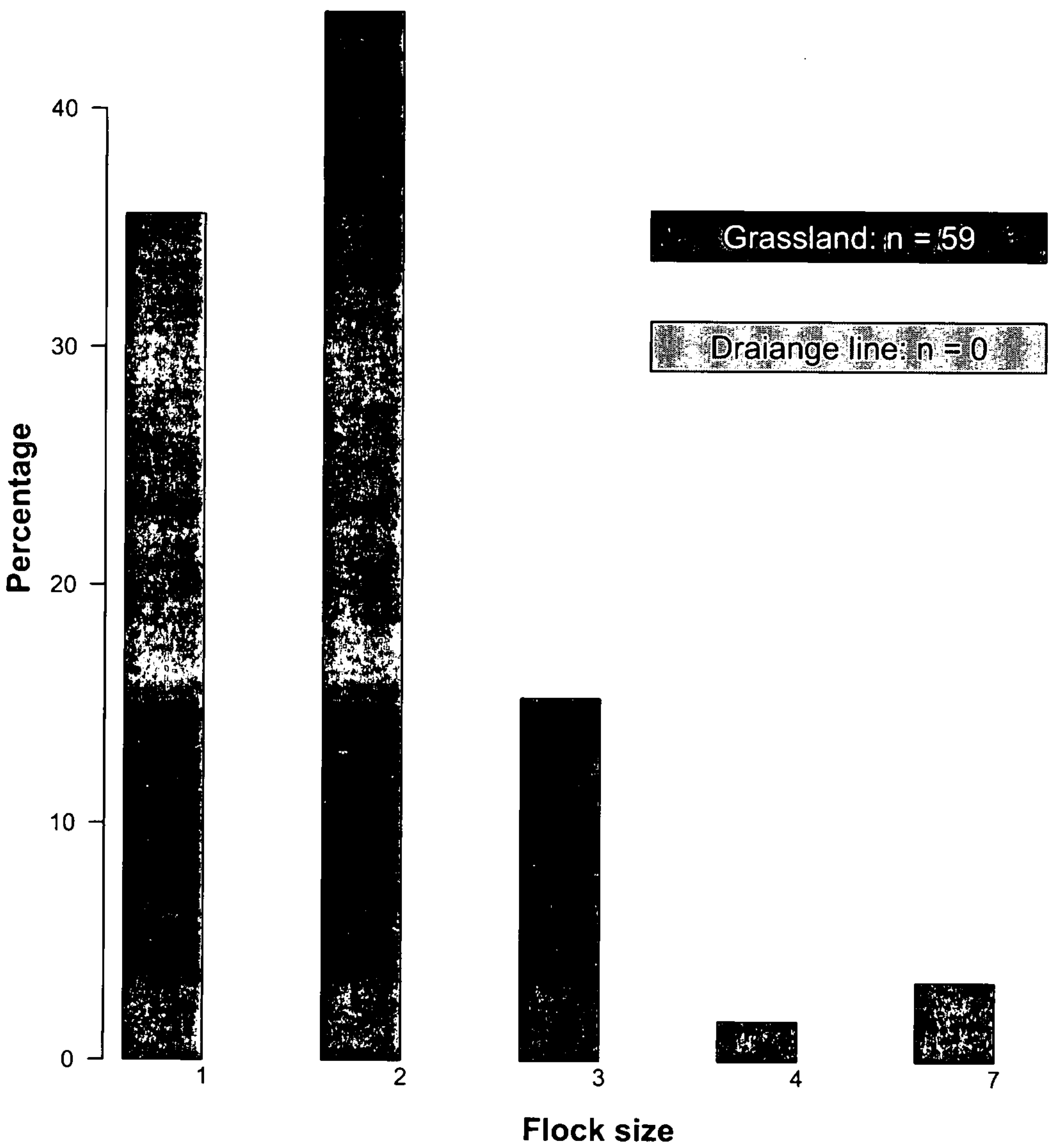


Figure 4.89: R193 Orange River Francolin: Flock size of birds seen in the study area at Glen.

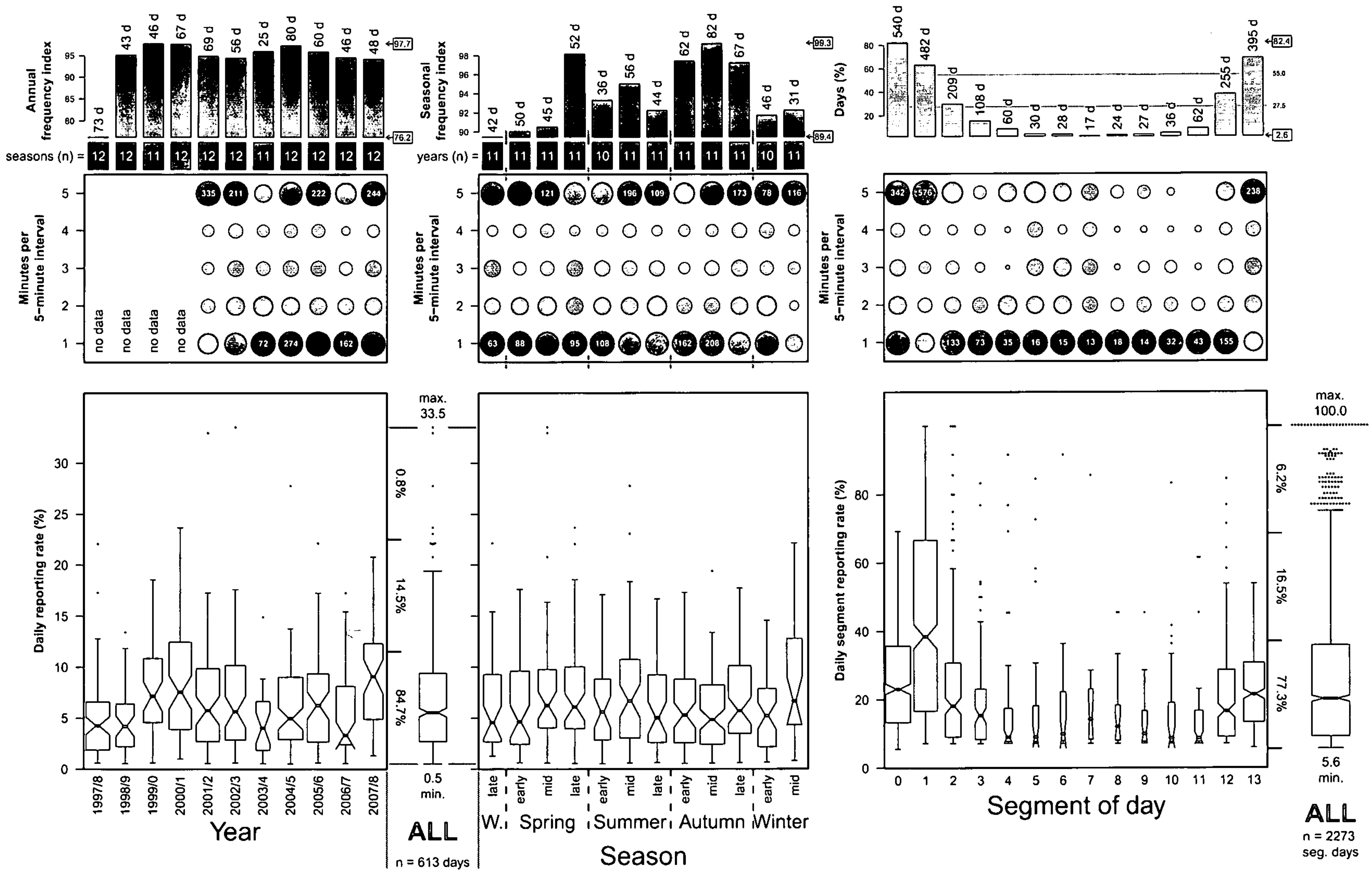


Figure 4.90: R193 Orange River Francolin — advertisement calls: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

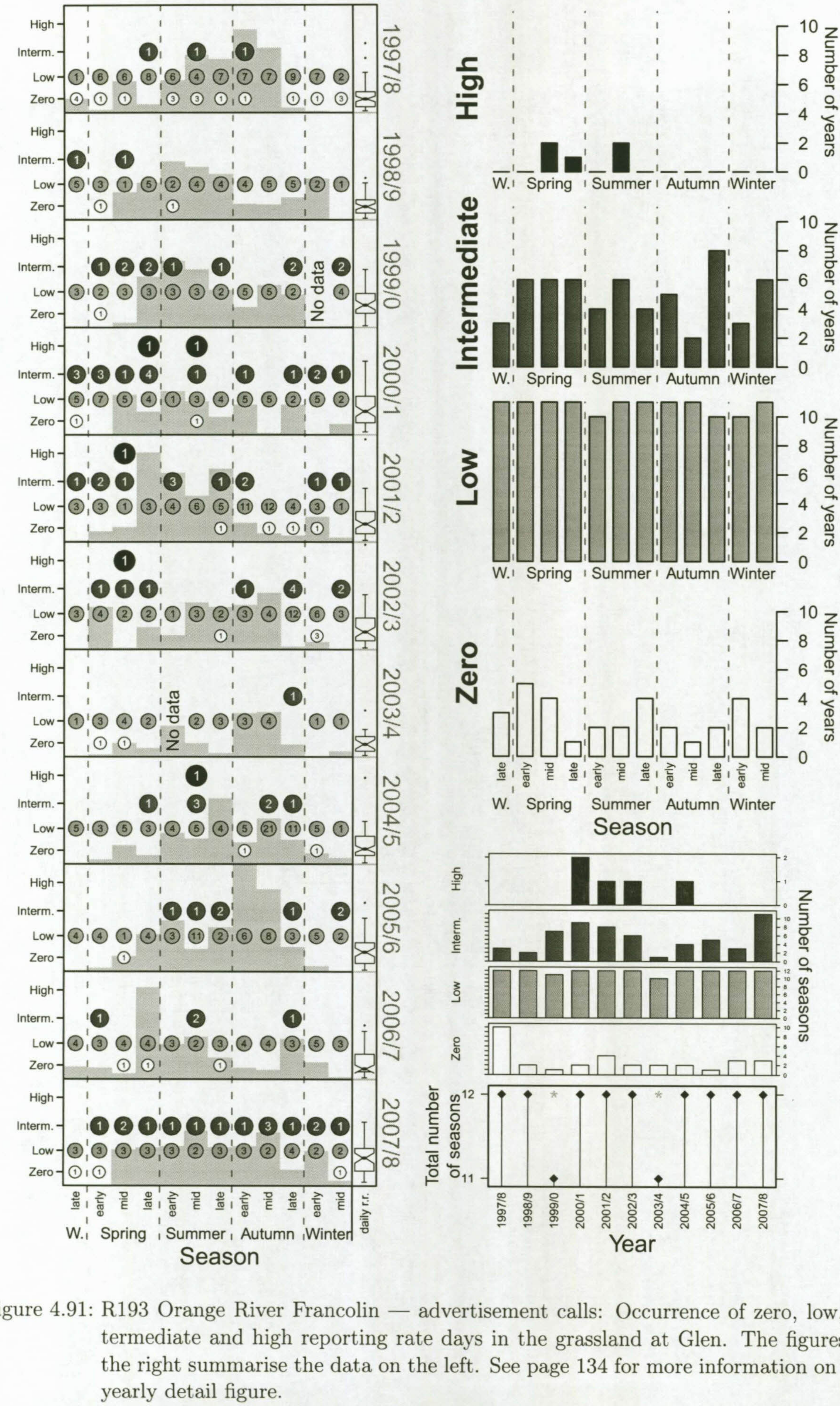


Figure 4.91: R193 Orange River Francolin — advertisement calls: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

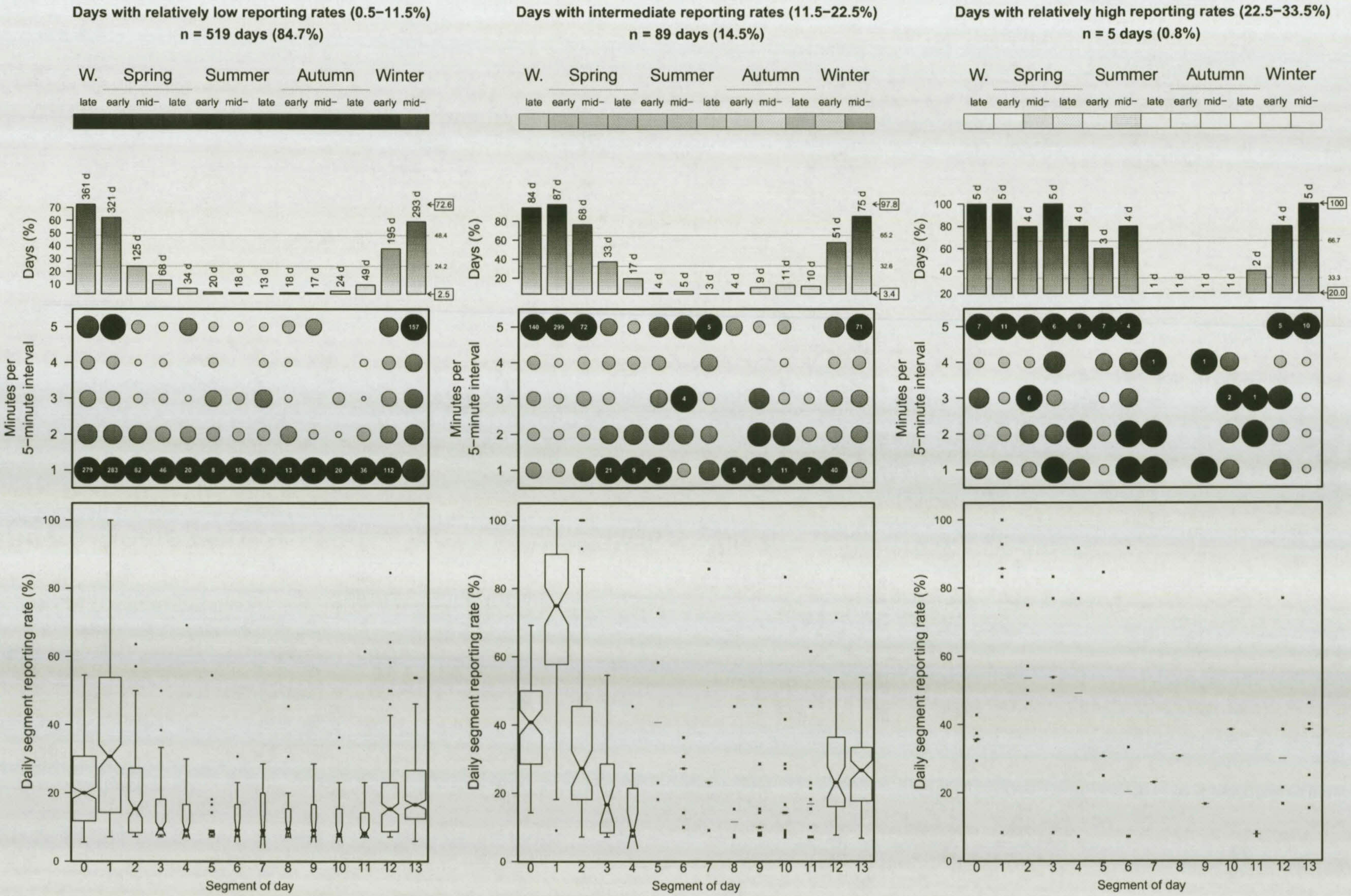


Figure 4.92: R193 Orange River Francolin — advertisement calls: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

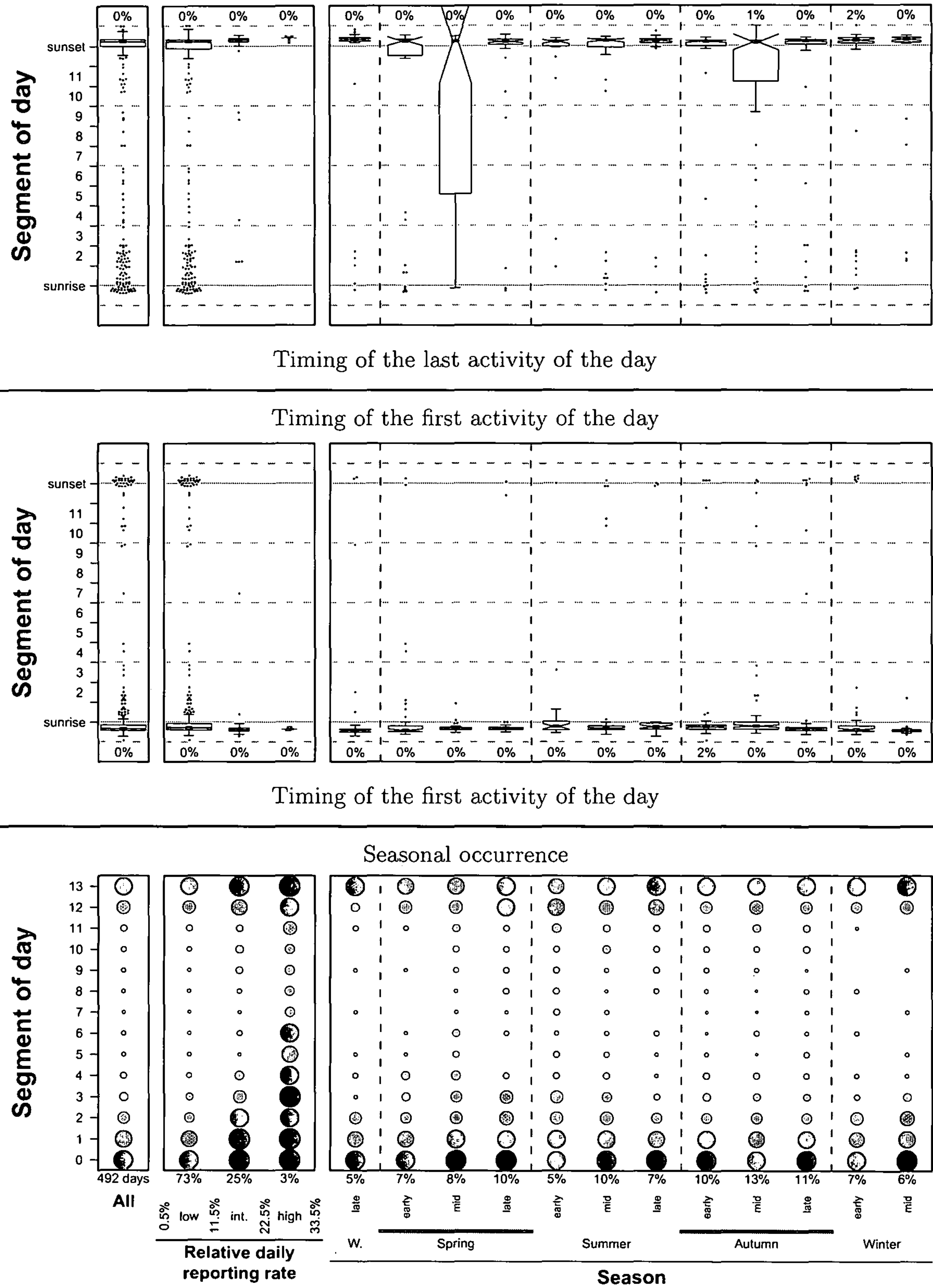


Figure 4.93: R193 Orange River Francolin — advertisement calls: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

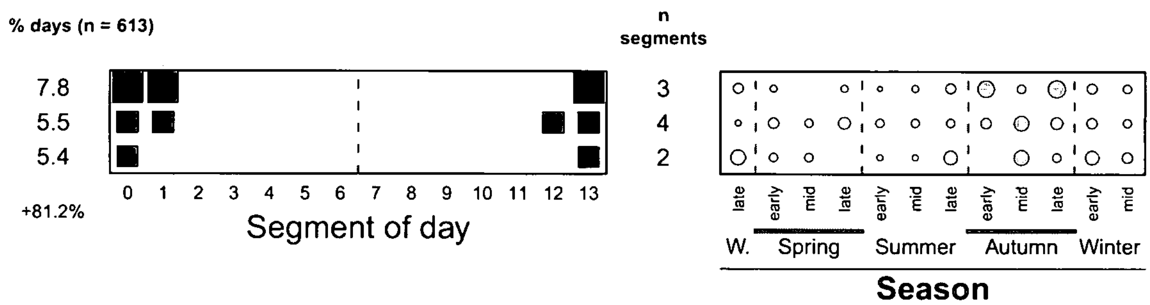


Figure 4.94: R193 Orange River Francolin — advertisement calls: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

by Sibley & Monroe (1990), according to which these birds occur in "Zambia (except n)". In addition, Sibley & Monroe (1990) referred to "nw Malawi", which is, perhaps, the same as Maclean's (1985; 1993) "Malawi".

To conclude, unless further study proves otherwise, a more appropriate statement on the distribution of the Swainson's Francolin outside southern Africa should include south-eastern Angola (Dean 2000), Zambia and perhaps also Malawi (Maclean 1985, 1993; Sibley & Monroe 1990). In addition, if its distribution beyond southern African borders is as extensive as current information suggests (see maps in Crowe *et al.* 1986b; Sinclair & Ryan 2003), its is perhaps time to drop Swainson's Spurfowl from southern Africa's "Near-endemic" list (*cf.* Little *et al.* 2000; Little 1997b, 2005b) as its distribution is not merely "extending marginally" into Zambia.

In southern Africa, Swainson's Spurfowl is widespread in the northern parts of Namibia, northern and eastern Botswana, Zimbabwe, south into South Africa (and Swaziland) as far as the Free State (Little 1997b). It utilises a variety of habitats, including tall grass in open country or in woodland (Earlé & Grobler 1987; Little 1997b). It is a sedentary resident found in pairs or small family parties (Little 1997b).

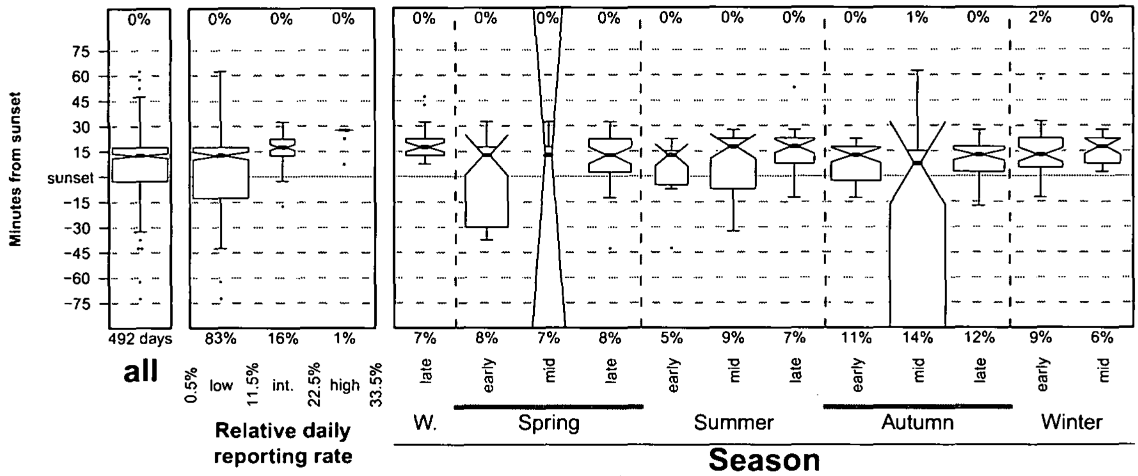
The birds at Glen

Virtually all Swainson's Spurfowl records were of vocalisations emanating from birds in the drainage line. Only rarely recorded in the trampled area in the grassland. Data was collected separately for each minute since early summer 2001/2 (Table 4.18). Figures start on page 275.

Table 4.18: R199 Swainson's Spurfowl: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

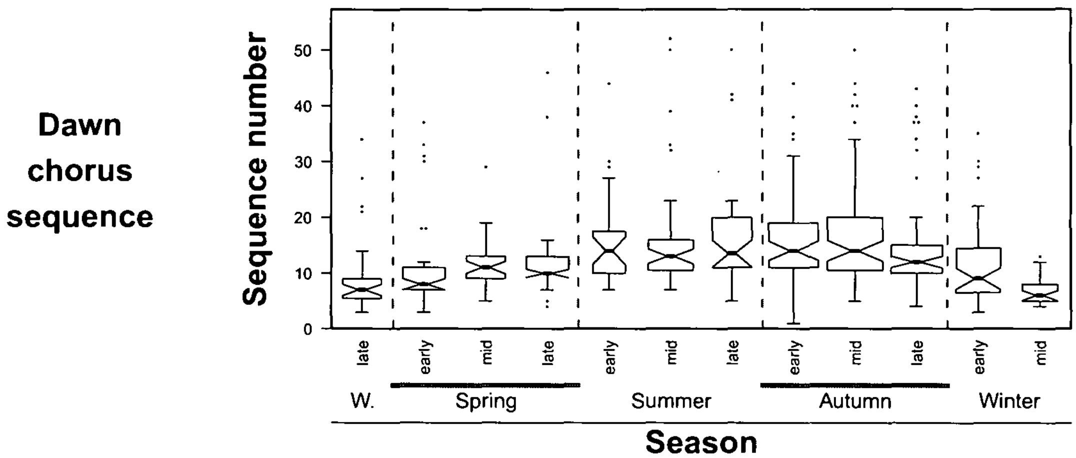
Activity	Recorded since...	n	Total	%
birds heard	early summer 2001/2	6 393	333 130	1.9

Annual occurrence of drainage line birds heard in the grassland: Heard on 86.7% of the days with an activity index of 11 (Table 4.19a). Recorded during 11–12 seasons in most years, but



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

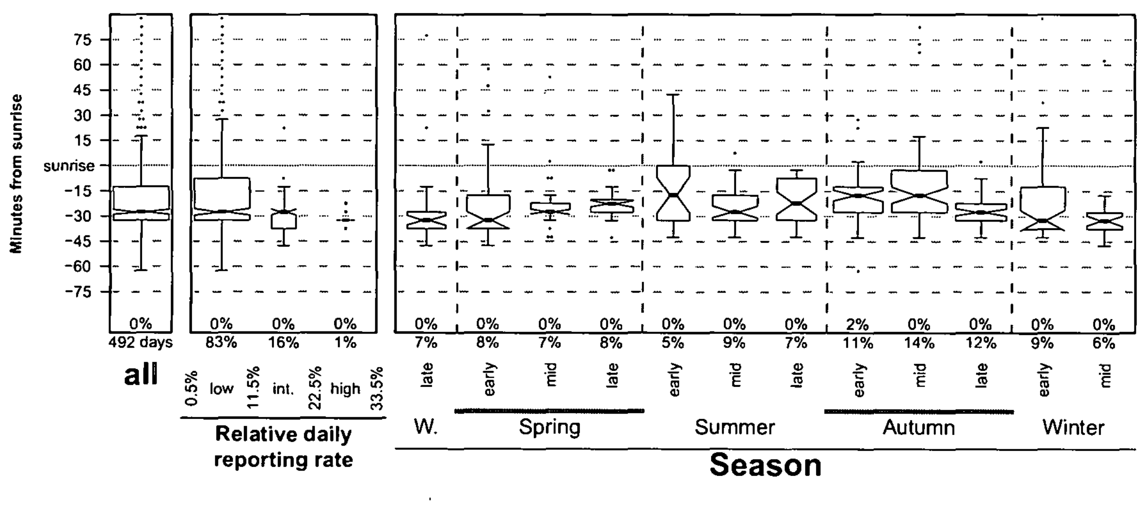


Figure 4.95: R193 Orange River Francolin — advertisement calls: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

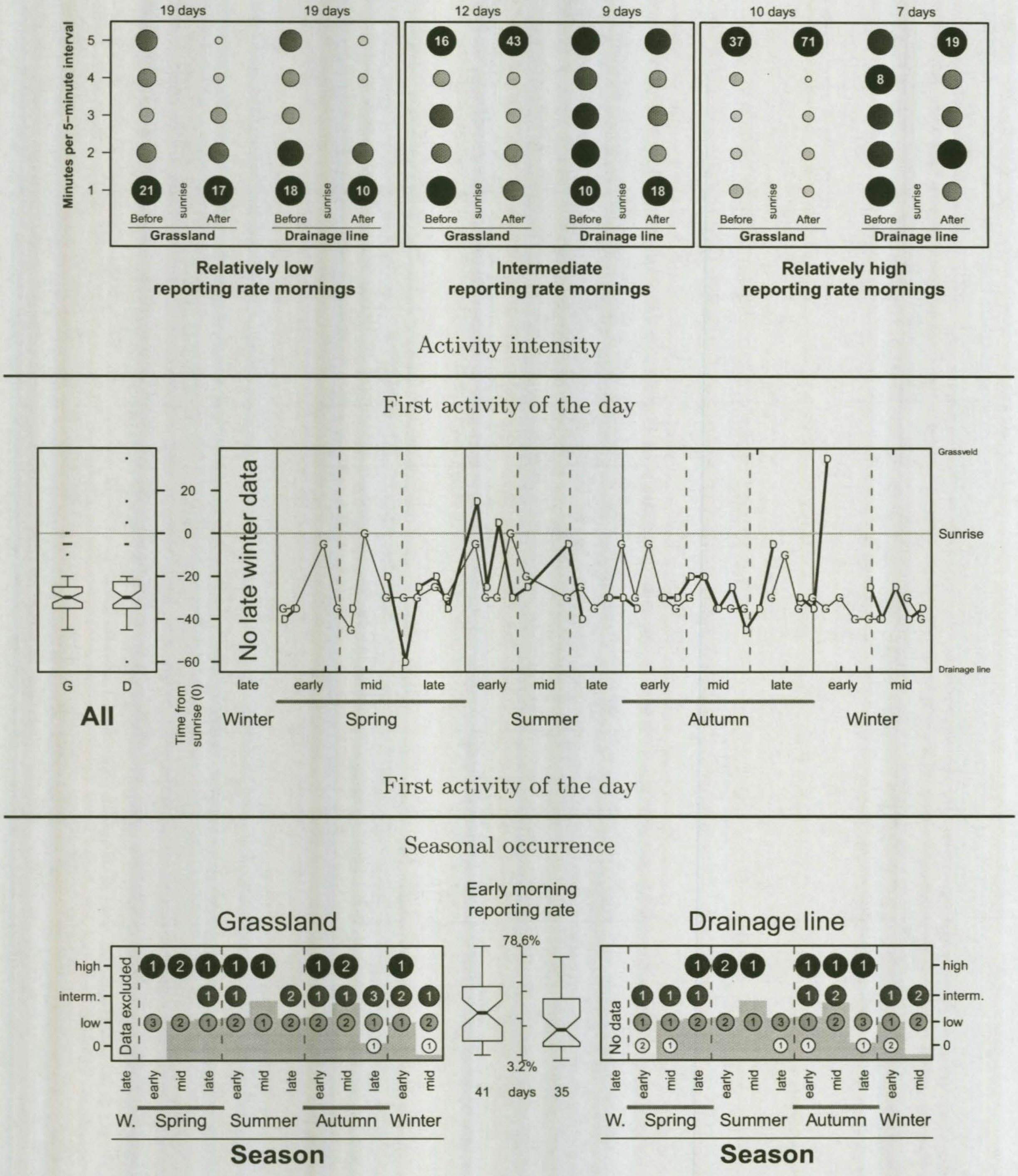


Figure 4.96: R193 Orange River Francolin — advertisement calls: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

during 9–10 in 1997/8 and 2003/4 (Fig. 4.97; Fig. 4.98). Daily reporting rates ranged from 0.5 to 32.1% with 80.5% of the days attaining relatively low reporting rates (Fig. 4.97). Two years that stand out include 2006/7 with its relatively low daily reporting rates and 2007/8 with its relatively high daily reporting rates (Fig. 4.97). Only five years had days with relatively high reporting rates and in all years except 1997/8 when it occurred during three seasons it occurred in one particular season only (Fig. 4.97; Fig. 4.98). Note also that 1997/8 was the year with the highest number of seasons with zero record bird-days (Fig. 4.98) and lowest number of seasons with bird-days (Fig. 4.97; Fig. 4.98). The reason why 1997/8 is so different is because pre-sunrise data was not collected for most of that year (Fig. 3.4; Fig. 3.5), leading to higher daily reporting rates and increased chances of missing out on activities that often occur before sunrise only (see below). Nonetheless, since the day with the highest reporting rate was during 2002/3 and not 1997/8 (Fig. 4.97), the determination of days with high, intermediate and low reporting rates (*i.e.* Fig 4.98) was not influenced by the 1997/8 data in this case. Activity intensities were similar for the respective years (Fig. 4.97).

Table 4.19: R199 Swainson's Spurfowl: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists n	5-minute checklists Total	5-minute checklists %	Activity	Days %	Days Total	Days n	Activity index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	6 109	114 612	5.3	birds heard	86.7	656	569	11
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	230	1 190	19.3	birds heard	74.4	43	32	7
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	206	1 188	17.3	birds heard	65.1	43	28	7

Seasonal occurrence of drainage line birds heard in the grassland: Recorded during 10–11 years from mid-spring to early winter and during nine years in mid-winter, late winter and early spring (Fig. 4.97). The seasonal frequency index was also higher from mid-spring to early winter than at other times (Fig. 4.97). The median daily reporting rates followed a clear seasonal pattern starting at its lowest during late winter and becoming progressively higher, peaking during late summer and in autumn followed by a sudden decrease in early and mid-winter (Fig. 4.97). This pattern is reflected by the occurrence of the few high reporting rate days that were limited to the period from mid-summer to late autumn, intermediate reporting rate days occurring most frequently in summer and autumn, and days with zero records that were most frequent from mid-winter to early spring (Fig. 4.98). Activity intensities showed a similar seasonal trend (Fig. 4.97).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity occurred most frequently during the two segments around sunrise and sunset respectively, with activity infrequent from mid-morning till mid-afternoon (Fig. 4.97). This general pattern was similar for low and intermediate reporting rate days with one difference: the early morning activity of the latter was also frequent during S2 (Fig. 4.99). Seasonally, activity was most frequent early and late in the day during all seasons (Fig. 4.100). The two bird-segment combinations that occurred during more than 5% bird-days were limited to S12 and S13, collectively accounting for 13.4% of all bird-days (Fig. 4.101). These combinations were particularly scarce during summer (Fig. 4.101).

The first activity of the day most frequently occurred during the early morning around sunrise with the median times showing no pertinent seasonal pattern (Fig. 4.100; Fig. 4.102). The slight seasonal variations in the timing of the first activity of the day (Fig. 4.102) are to some extent reflected in the seasonal fluctuation of the changes in dawn chorus sequence (Fig. 4.102).

The last activity of the day typically occurred (median 10 minutes) after sunset with the timing being slightly later during late spring and summer than during other seasons (Fig. 4.100; Fig. 4.102).

Activity intensities tended to be higher during the early morning and in the late afternoon than during the rest of the day (Fig. 4.97), a trend that is more obvious on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.99).

Overall, daily segment reporting rates ranged from 5.6 to 100% with the median daily segment reporting rates higher in S1 and S12 than during other parts of the day (Fig. 4.97), a trend that is more pronounced for intermediate and high reporting rate days than for low reporting rate days (Fig. 4.99).

Early morning occurrence of drainage line birds heard during 2007/8: The activity in the grassland was very similar to that recorded in the drainage line (Table 4.19b & c; Fig. 4.103). Activity intensity tended to be higher after sunrise than before sunrise (Fig. 4.96).

Discussion

At Glen, Swainson's Spurfowl is largely confined to the drainage line. The fact that the activity recorded in the grassland was so similar to that recorded in the drainage line during the early mornings in 2007/8 (Fig. 4.103) indicates that the data collected in previous years in the grassland is representative of the birds' real activity. That is, it is unlikely that calling birds were missed as the calls are audible over some distance.

The data presented here clearly shows that the calls of Swainson's Spurfowl occur most frequently in the early morning, any time from dawn until well after sunrise, and in the afternoon from well before sunset till dusk (Fig. 4.97; Fig. 4.99; Fig. 4.100; Fig. 4.102). These findings stand in contrast to others who claim that activity is limited to, or most frequent at, dawn and dusk. Consider these examples:

- "Calls from tree or termite mount at dawn and dusk." (Maclean 1985, 1993)
- "Calling is most frequent at dawn and dusk, ..." (Little *et al.* 2000)

The author was unable to trace any original studies that showed that activity is limited to, or most frequently occurred at, dawn or dusk. In the most recent edition of Roberts, Little (2005b)

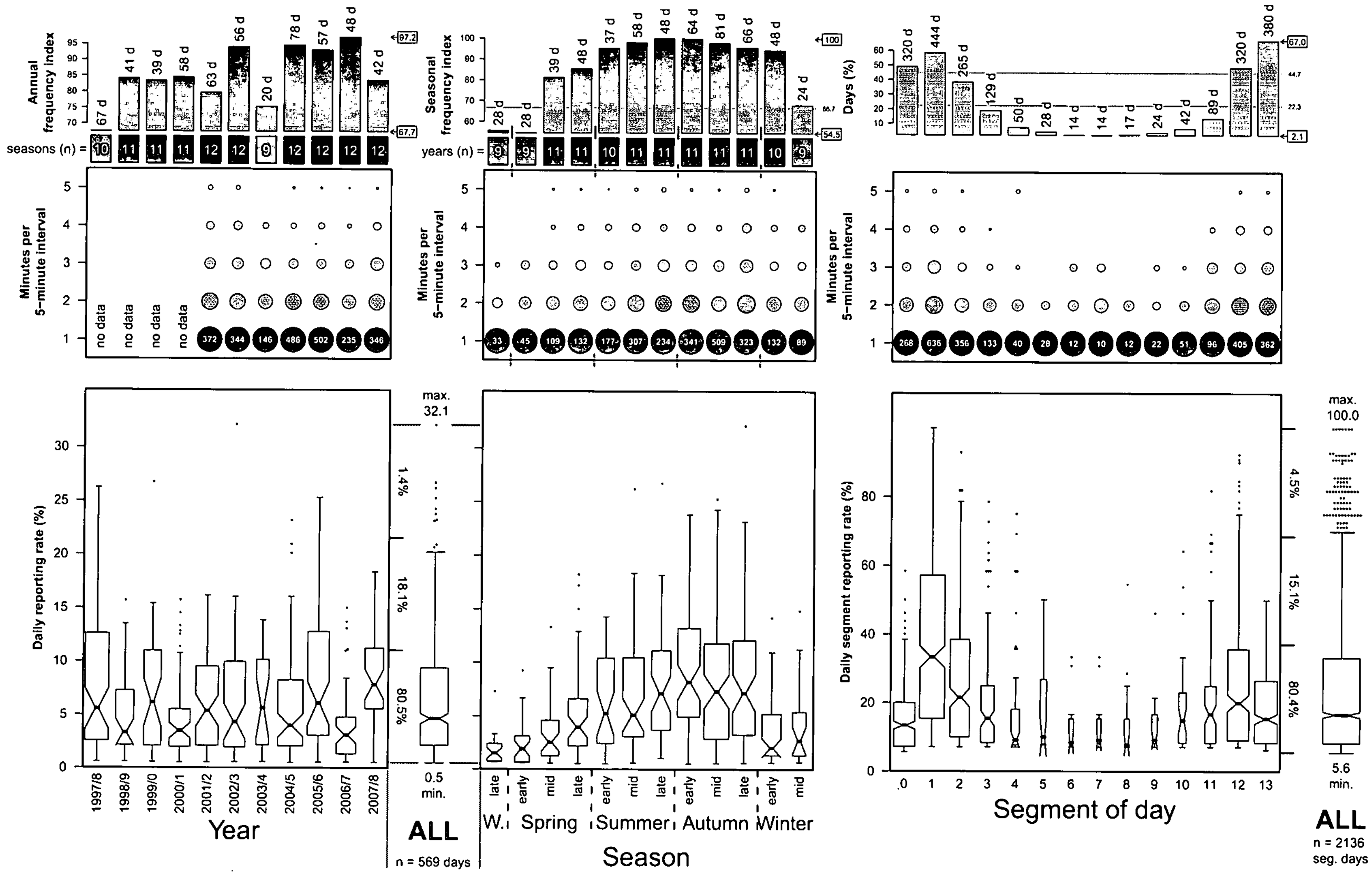


Figure 4.97: R199 Swainson's Spurfowl — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

Figure 4.98: R199 Swainson's Spurfowl — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

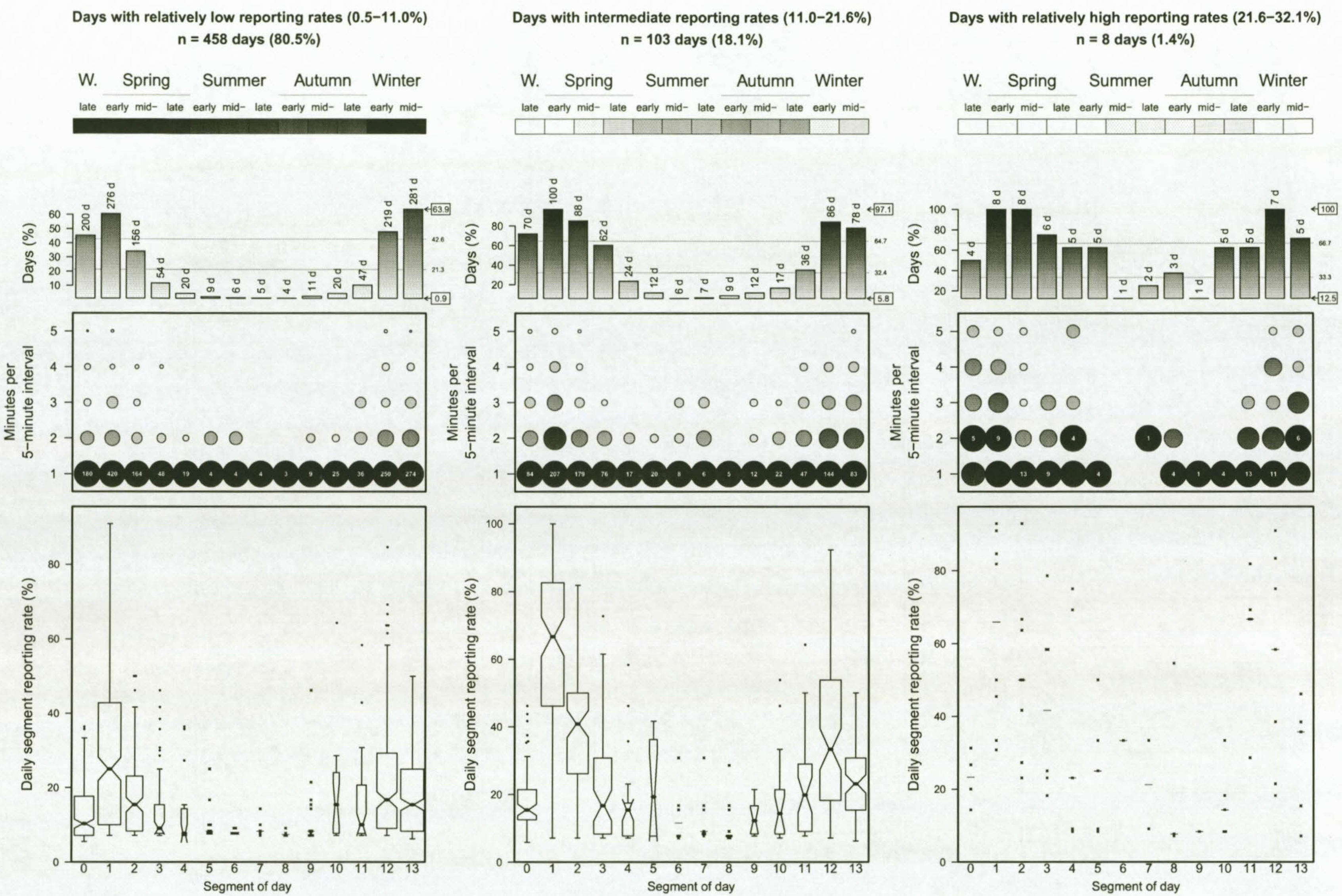


Figure 4.99: R199 Swainson's Spurfowl — birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

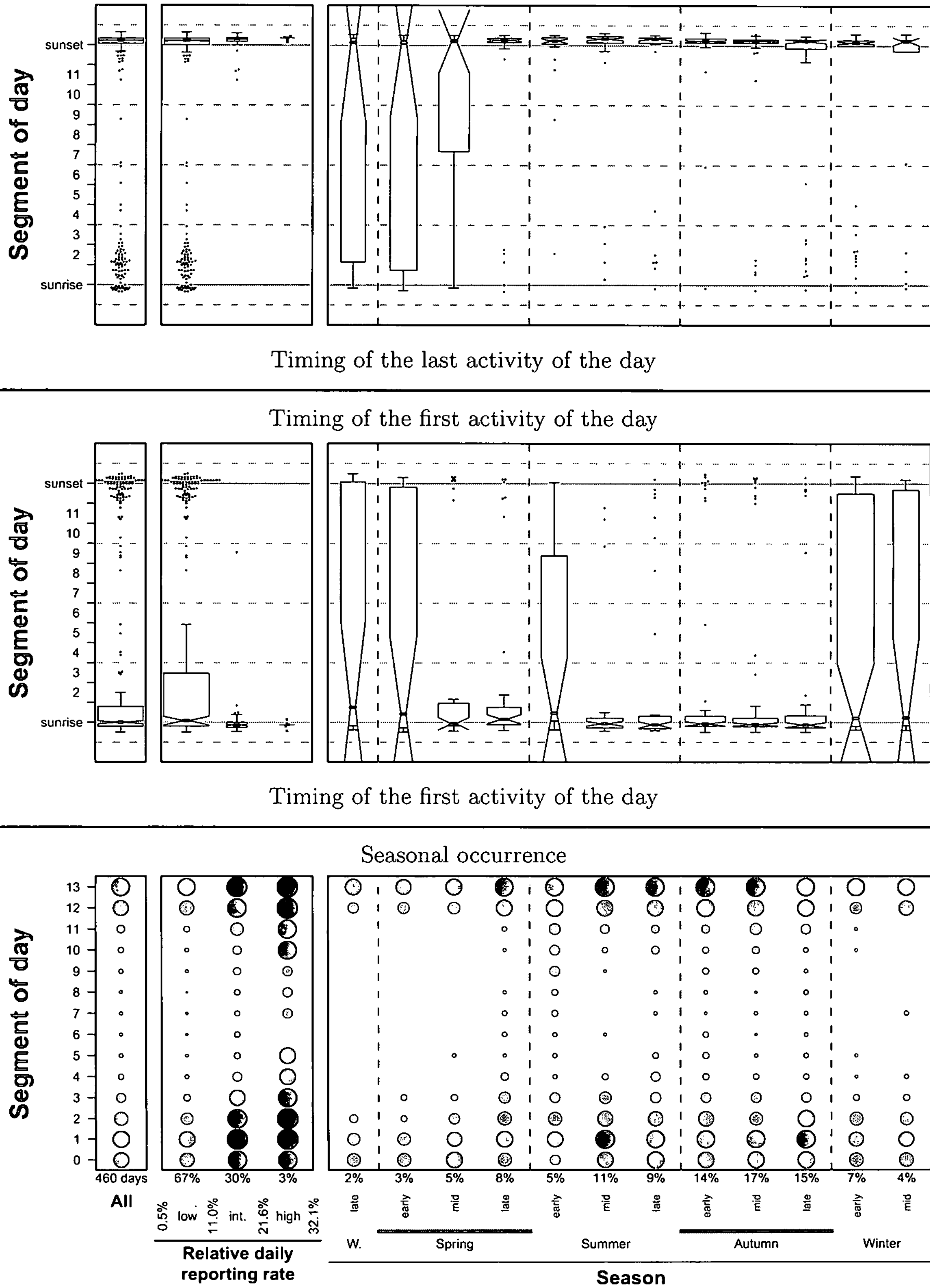


Figure 4.100: R199 Swainson's Spurfowl — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

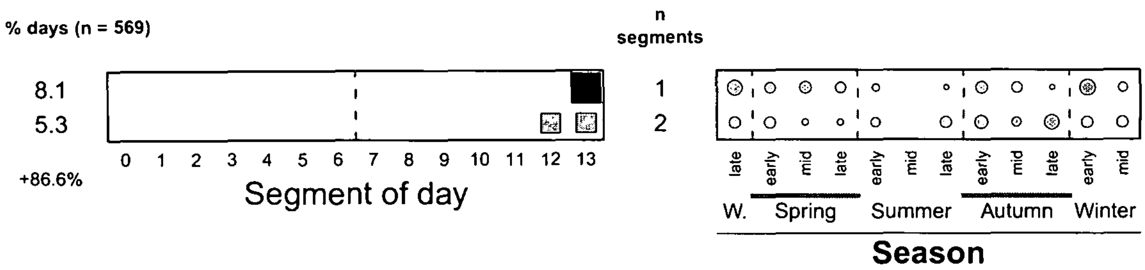


Figure 4.101: R199 Swainson's Spurfowl — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

refers back to Little *et al.* (2000). More studies at other localities are needed to determine to what extent the observations at Glen could be generalised.

Calling is more prominent during summer and autumn than during winter or spring (Fig. 4.97; Fig. 4.98; Fig. 4.100). None of the sources consulted give any indication of call seasonality. The seasonal model for SABAP1 Zone 7 is essentially flat (Little 1997b), *i.e.* it does not suggest any seasonality. The likely reason for this is that the birds do call during most days (86.7% in the present study, Table 4.19a; see also Fig. 4.97), but more often on some days (particularly during summer and autumn) than on others (particularly during winter and spring) (Fig. 4.97; Fig. 4.98; Fig. 4.100). This suggests that the protocol for SABAP1 is unable to detect these kinds of fluctuations.

Why do these birds call more often on summer and autumn than on winter and spring days (Fig. 4.97; Fig. 4.98; Fig. 4.100)? It is probably no coincidence that the higher calling intensity coincides with breeding. According to Tarboton (2001), egg-laying usually occur from January to June [late summer to mid-winter] with a February to April [autumn] peak. At Glen, there is an abrupt change in the frequency of high, and particularly intermediate reporting rate days in going from late autumn to early winter (Fig. 4.97; Fig. 4.98), and the occurrence of days with zero records is particularly high from mid-winter to early spring (Fig. 4.98). Could this be related to moult? Although no data on moult is available for southern African birds, adult birds do undergo a complete post-breeding moult from May to August [winter and early spring] in southern Zambia (Little 2005b). It is suggested, therefore, that the relatively low daily reporting rates during this period at Glen is due to birds moulting.

R200 Common Quail .... *Coturnix coturnix*

The Common Quail occurs in the Palearctic, India, Africa, Madagascar and Atlantic islands (Taylor 2005). In southern Africa it is widespread in South Africa and Lesotho, sparser in Namibia and very localised in Botswana, Zimbabwe (Little & Allan 1997b) and southern Mozambique (Parker 1999). It occurs in a variety of habitats, including grassland (Little & Allan 1997b; Maclean 1985; Taylor 2005). There are as many questions regarding its migration as about other aspects of its life-history (Cramp 1998; Little *et al.* 2000; Taylor 2005). In addition, the taxonomy of subspecies occurring in southern Africa are controversial (see "Taxonomic Note" in Taylor 2005). The majority of west Palearctic birds are thought to be trans-Saharan migrants,

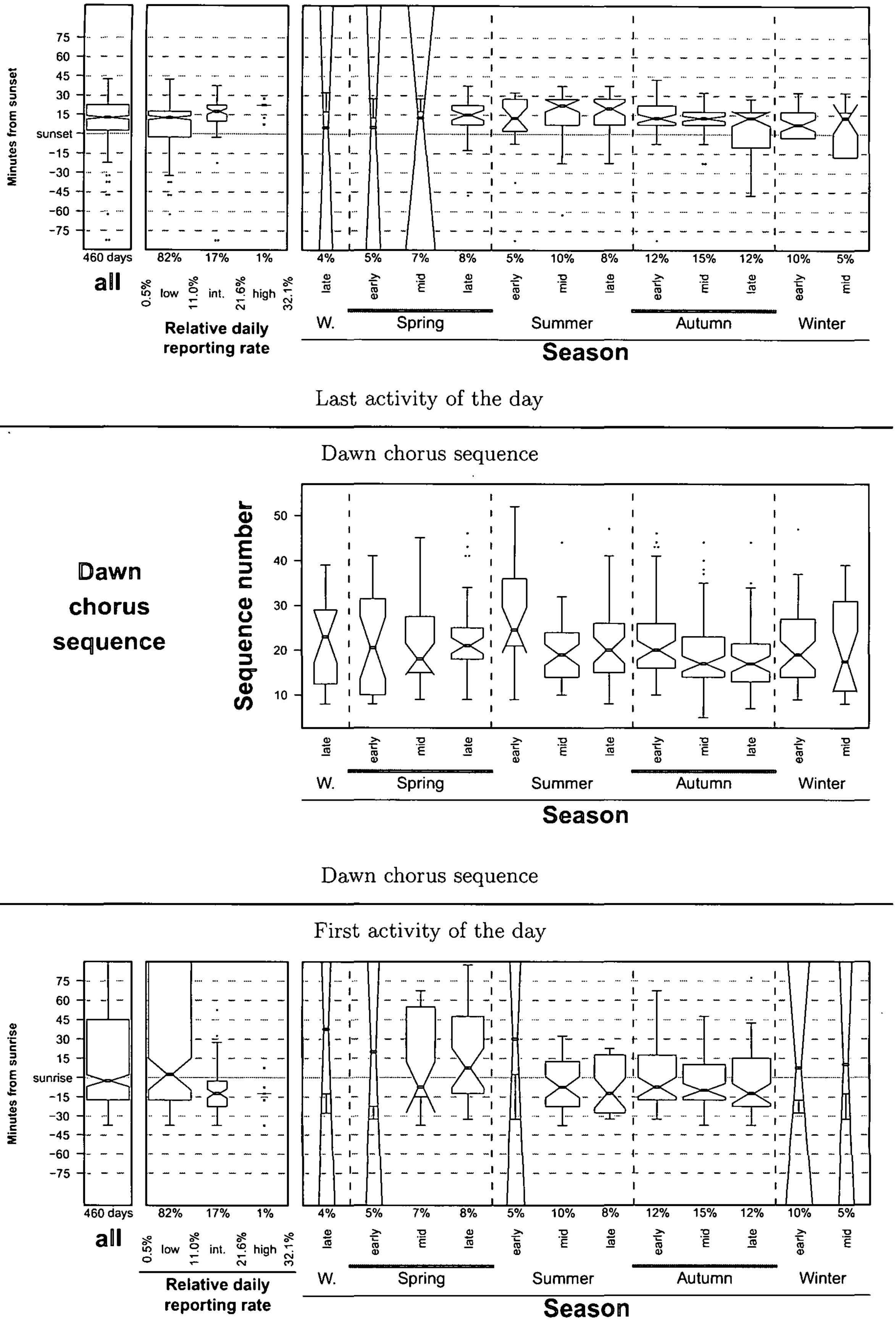


Figure 4.102: R199 Swainson's Spurfowl — birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

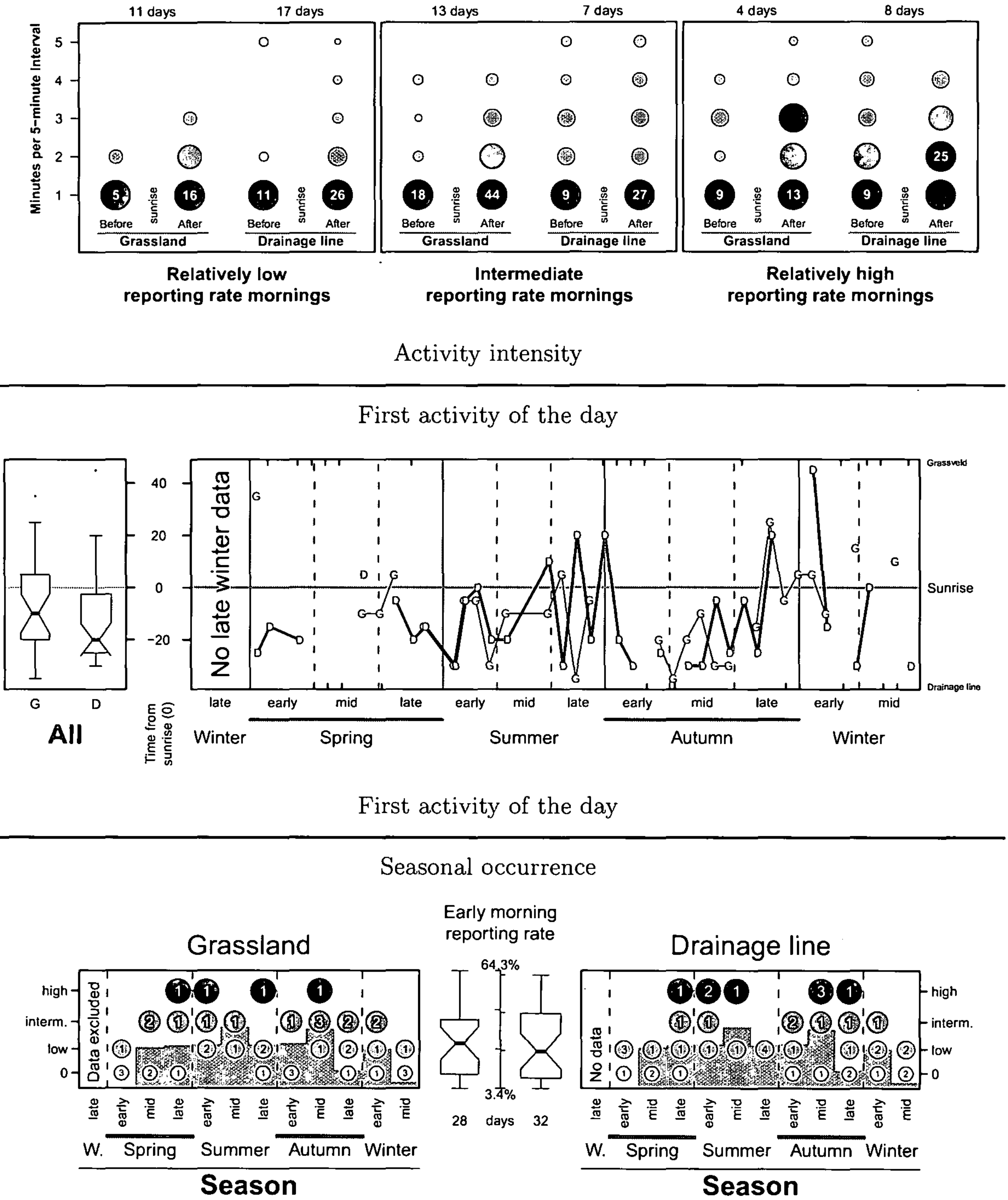


Figure 4.103: R199 Swainson's Spurfowl — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

but apparently not trans-equatorial (Cramp 1998). In southern Africa, Little & Allan (1997b) noted that the interpretation of the SABAP1 data — that shows a peak from about November to March [summer to mid-autumn] — is "bedevilled by the fact that most atlas records were probably of birds heard calling, rather than seen, and calling is linked to the breeding season." They continue by suggesting that the marked drop in reporting rates in South Africa may represent less calling, rather than movement (Little & Allan 1997b). Indeed, the reporting rate models and seasonal maps indicate that birds are present in South Africa throughout the year (Little & Allan 1997b). In addition, the SABAP1 data also lends support to the idea that South African birds move further north into Namibia, Angola and western Zambia and southern Zaire during the cooler seasons (Little & Allan 1997b).

The birds at Glen

In the grassland, 93.7% of the 5-minute checklists on which the Common Quail appears involved male advertising calls (Table 4.20a). These calls are described by Taylor (2005) as a high-pitched, ventriloquial, trisyllabic *whIT whit-whIT* (often rendered *wet-my-lips*) repeated up to 10 times and is audible up to 400 m. The remaining 6.3% of the grassland 5-minute checklists (Table 4.20a) was of birds flushed underfoot. This data is not analysed specifically, but is used to assess the overall occurrence of the birds at Glen. Of the 47 instances where the birds were counted, 68.1% involved single birds, 29.8% two birds and only once (2.1%) was three birds flushed. Data were collected for each minute since early summer 2001/2 (Table 4.21). Figures start on page 284.

Table 4.20: R200 Common Quail: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.937	1 125	114 612	1.0	advertisement calls	12.7	656	83	14
0.063	76	114 612	0.1	birds flushed	8.4	656	55	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	9	1 190	0.8	advertisement calls	11.6	43	5	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.800	16	1 188	1.3	advertisement calls	16.3	43	7	2
0.200	4	1 188	0.3	birds flushed	9.3	43	4	1

Table 4.21: R200 Common Quail: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
advertisement calls	early summer 2001/2	2 030	332 190	0.6

Annual occurrence of advertisement calls in the grassland: Recorded on 12.7% of the days with an activity index of 14 (Table 4.20a). Heard during 1–5 seasons each year, except in 1998/9 when it was not recorded (Fig. 4.104; Fig. 4.105). Daily reporting rates ranged from 0.5 to 56.1% with 86.7% of the days attaining low reporting rates (Fig. 4.104). The year 2001/2 was exceptional as its daily reporting rates were much higher than that of other years (Fig. 4.104). Its annual frequency index and activity intensity were highest of all years (Fig. 4.104; Note: activity intensity was measured since 2001/2 only, Table 4.21).

Seasonal occurrence of advertising calls in the grassland: Based on the number of years as well as the seasonal frequency index, activity became more frequent from spring onward, peaking in autumn (no winter records; Fig. 4.104). However, high reporting rate days were limited to early and mid-summer (Fig. 4.104; Fig. 4.105). The latter two seasons also showed higher activity intensities compared to other seasons (Fig. 4.104).

Daily occurrence of advertising calls in the grassland: Overall, activity occurred most frequently before sunrise and was very infrequent from mid-morning onwards (Fig. 4.104). The pattern varied seasonally with activity occurring at high levels throughout the day during mid-summer (Fig. 4.106). The two bird-segment combinations occurring during more than five bird-days involved single segments S0 and S1, collectively accounting for nearly half of all bird-days (Fig. 4.107). Both combinations were particularly frequent during autumn (Fig. 4.107).

The first activity of the day usually occurred more than 20 minutes before sunrise and showed only slight inter-seasonal variation (Fig. 4.106; Fig. 4.108). This corresponds to the dawn chorus sequence that remained reasonably stable (Fig. 4.108). Note that advertising calls did not occur during winter (Fig. 4.104) — the winter data points in the dawn chorus data refers to flushed birds.

The occurrence of the last activity of the day was more variable, occurring either in the early morning (frequently before sunrise) or in the afternoon (Fig. 4.106).

Activity intensity was highest after sunset (Fig. 4.104). Daily segment reporting rates ranged from 5.9 to 100% with values overlapping extensively (Fig. 4.104).

Early morning occurrence of advertising calls during 2007/8: Activity occurred slightly more frequently in the grassland than in the drainage line and the activity index was the same for both habitats (Table 4.20b & c).

Combined data (advertising calls plus birds flushed underfoot): Recorded during all years, being particularly frequent during 2001/2 and 2007/8 when recorded during 7–8 seasons compared to the 1–5 seasons of other years (Fig. 4.109). Found during all seasons except late winter, with the number of years during which the birds were recorded increasing from spring through summer, peaking during autumn (Fig. 4.109).

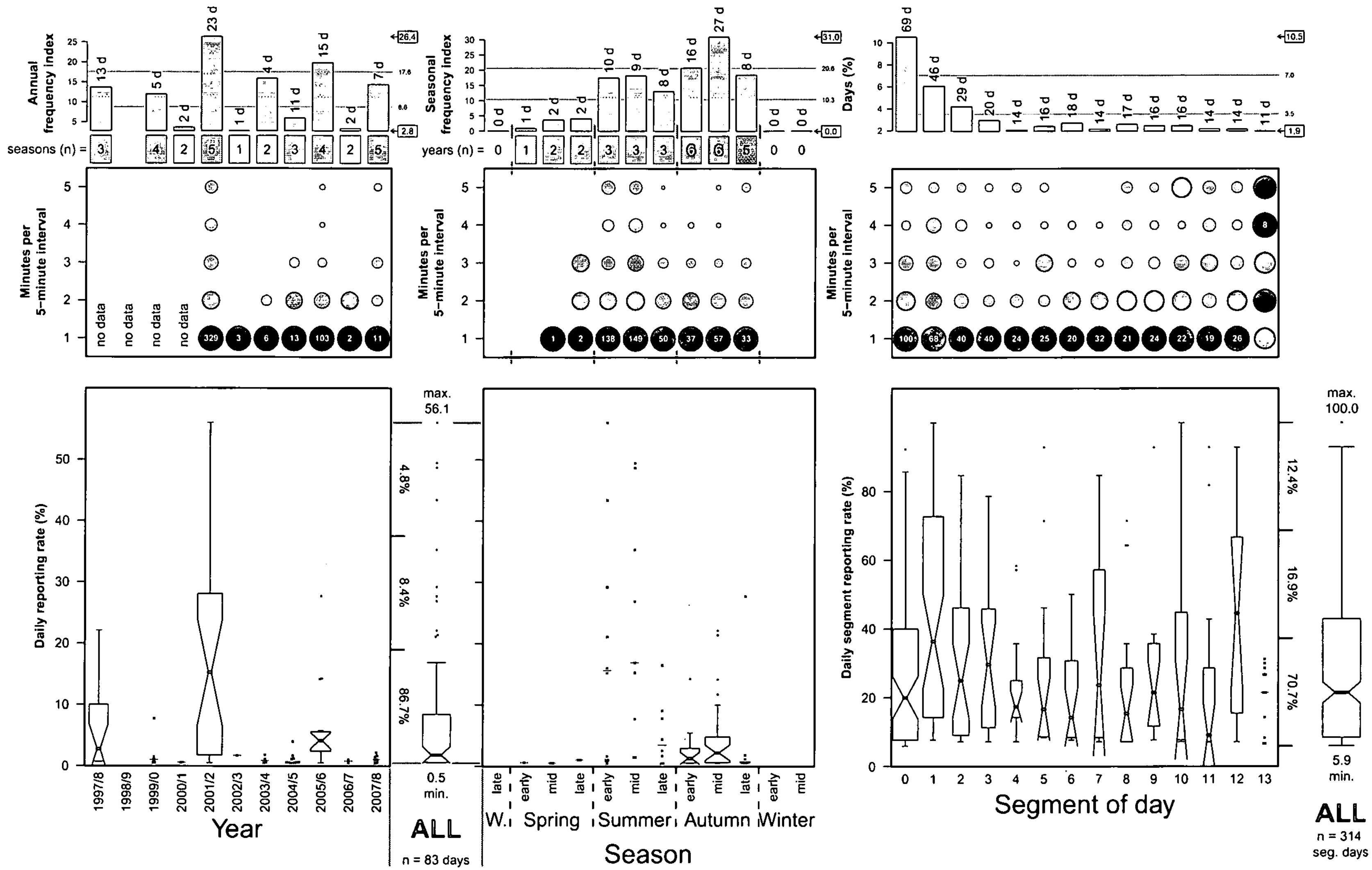


Figure 4.104: R200 Common Quail — advertisement calls: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

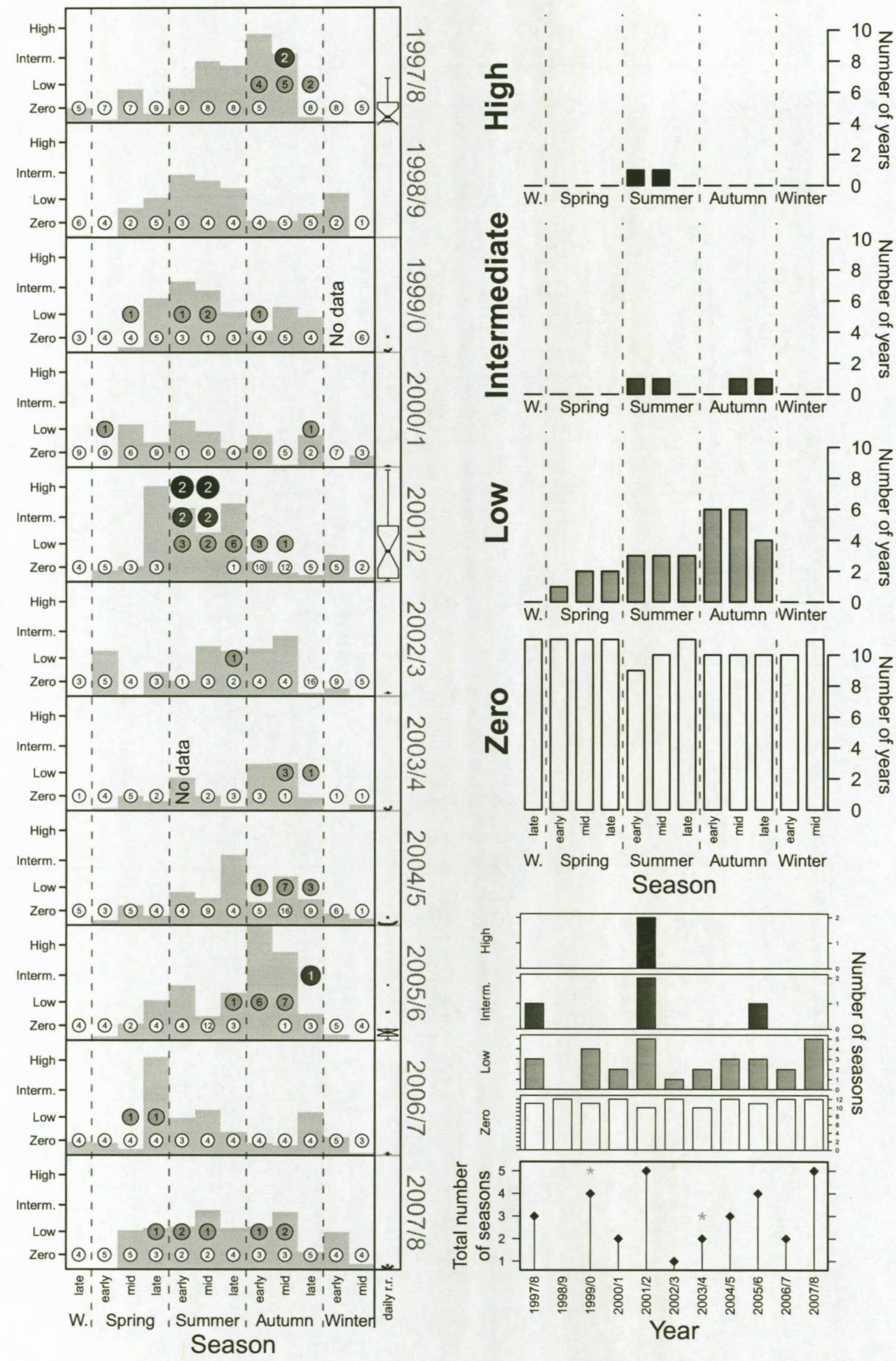


Figure 4.105: R200 Common Quail — advertisement calls: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

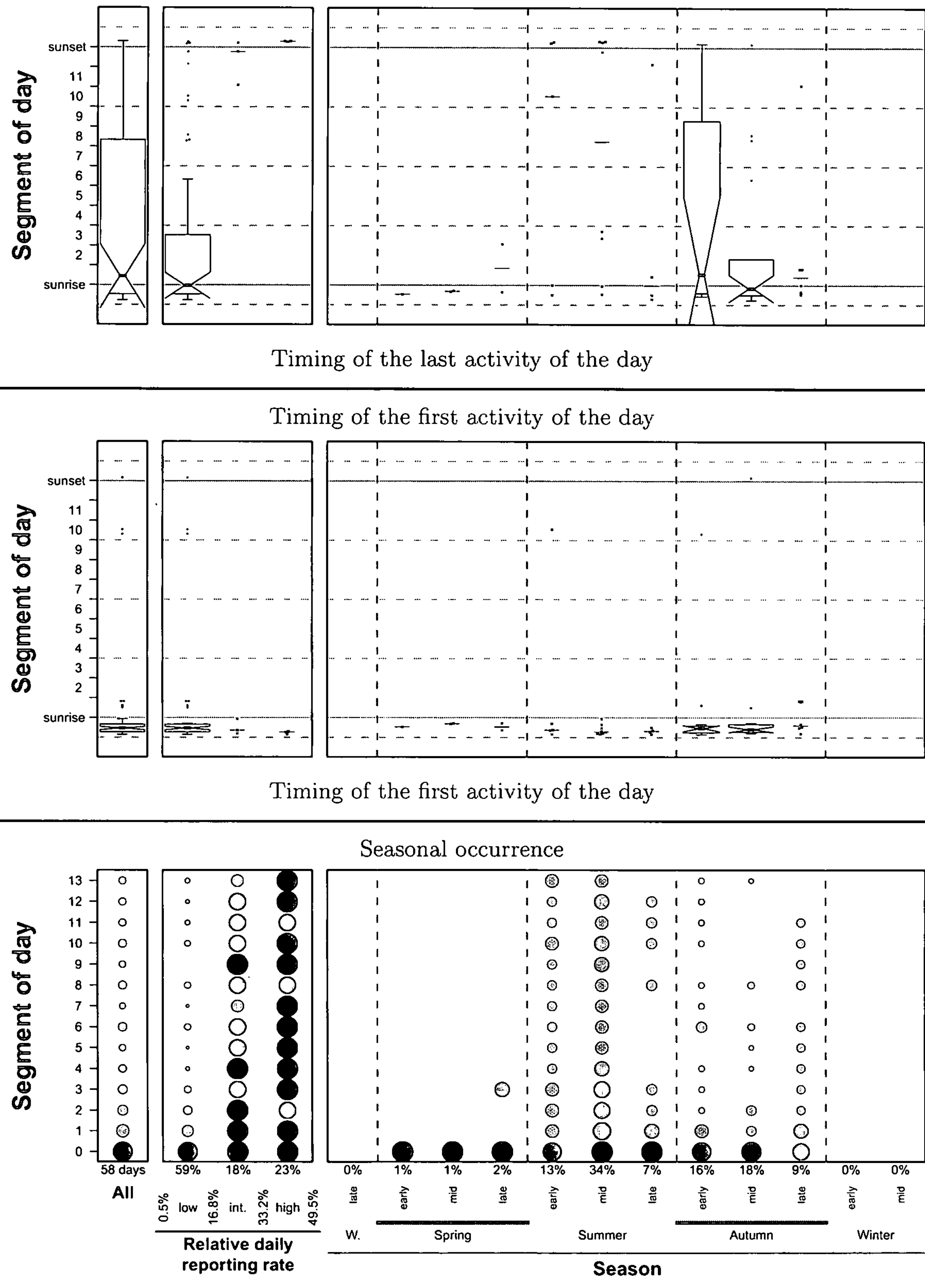


Figure 4.106: R200 Common Quail — advertisement calls: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

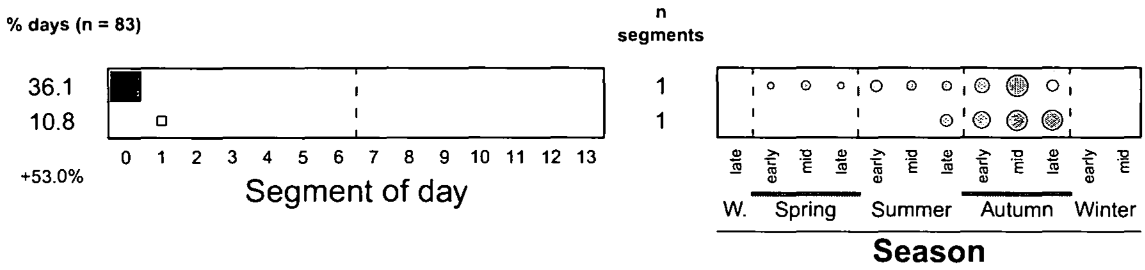


Figure 4.107: R200 Common Quail — advertisement calls: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

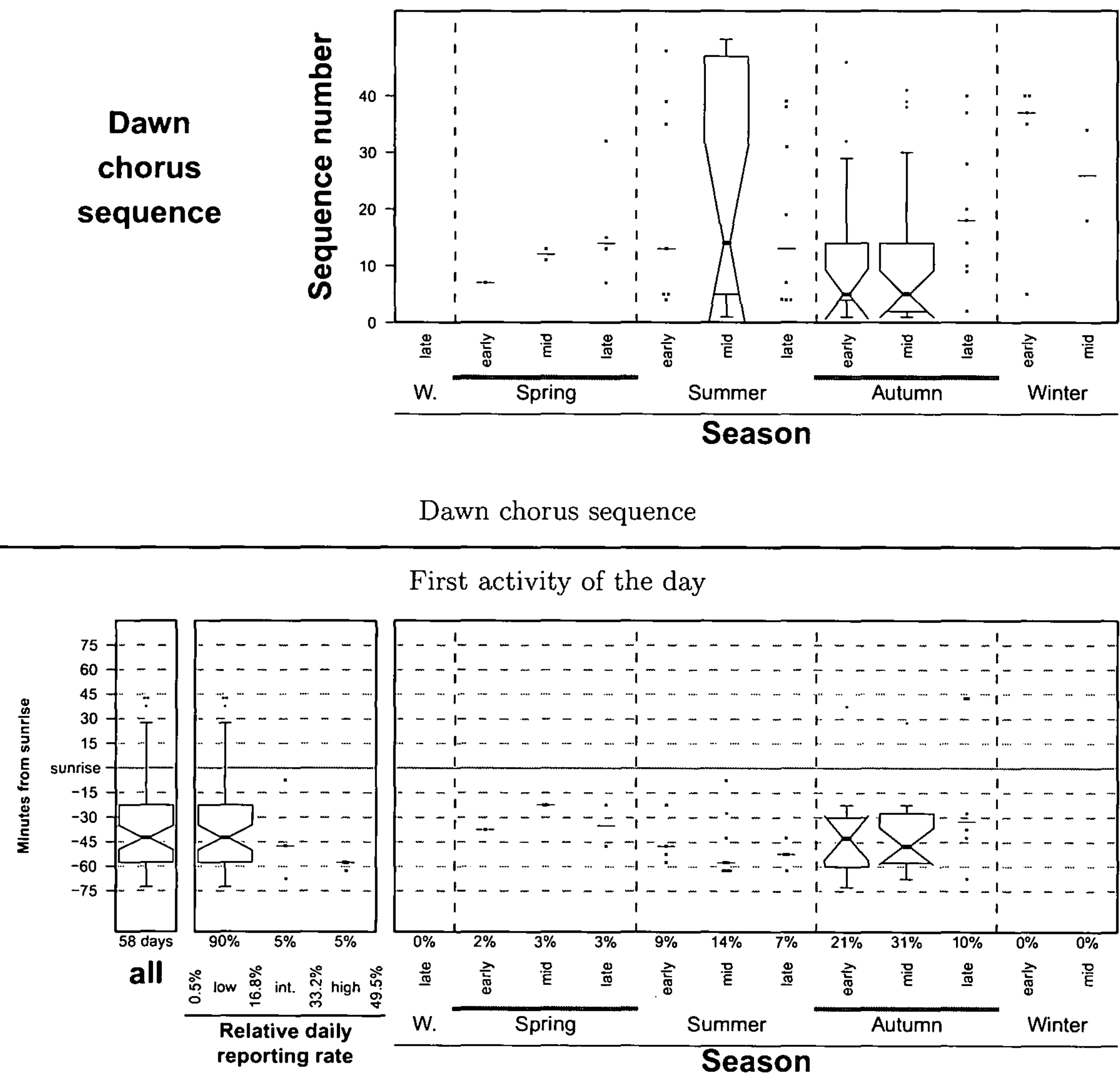


Figure 4.108: R200 Common Quail — advertisement calls: Details on the daily occurrence of the first activity of the day (bottom) and the dawn chorus sequence (top) in the grassland at Glen. See page 136 for more information on this detailed first/last activity figure.

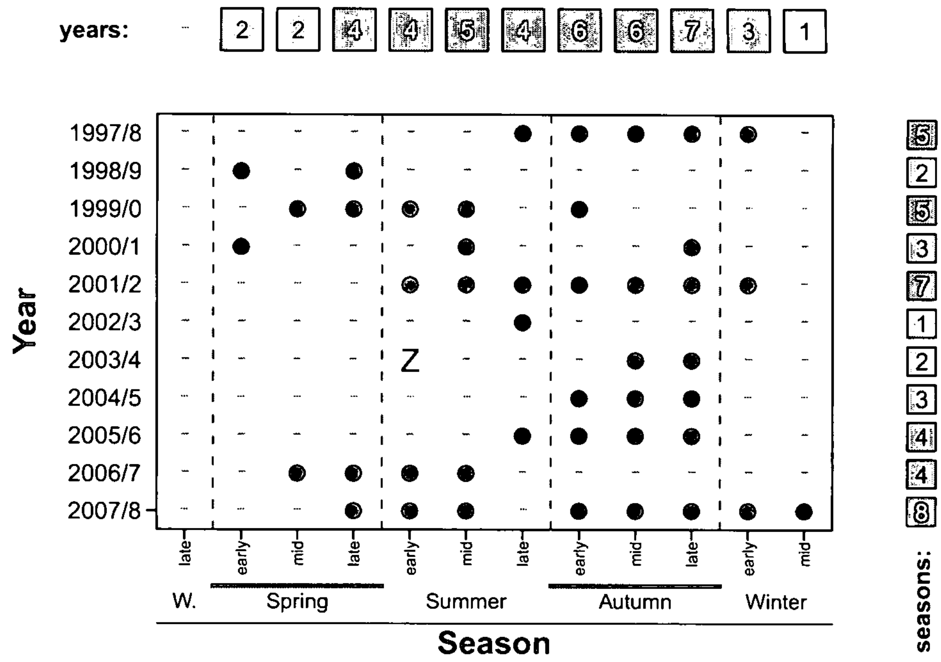


Figure 4.109: R200 Common Quail: Annual and seasonal occurrence at Glen when all data are combined. See page 137 for more information on this combined figure.

Discussion

According to Taylor (2005), the advertising calls of male Common Quails are "most often given at dawn and dusk." Maclean (1985) stated: "Calls mainly morning and evening; also at night." At Glen, activity was frequent during the early mornings only (Fig. 4.104).

In central Africa the Common Quail appears after the onset of rains, breeds and then departs but may not return in comparable numbers for several years, suggesting that irregular movements occur in response to rainfall patterns (Taylor 2005). Rainfall may also influence the extent of seasonal influxes in southern Africa (Little & Allan 1997b). The data from Glen gives fairly direct evidence that activity is indeed influenced by rainfall.

The occurrence of days with intermediate and high advertising call reporting rates, which was limited to 1997/8, 2001/2 and 2005/6, always followed after one or two seasons with relatively high rainfall (Fig. 4.105). More specifically, high reporting rate days occurred only during 2001/2, following good rains in late spring (Fig. 4.105). By contrast, generally lower daily reporting rates were attained during 1997/8 and 2005/6 (Fig. 4.104) with the few intermediate reporting rate days occurring in mid- and late autumn after good rains earlier in autumn (Fig. 4.105). This implies that activity was not only influenced by good rains, but also by the timing thereof. It is assumed that most primary moult occurs in wintering areas (Taylor 2005).

4.15 Numididae: Guineafowls

The natural distribution of the six species is thought to be limited to Africa only (Cramp 1998; Hockey *et al.* 2005). Helmeted Guineafowl populations in Madagascar were probably introduced there and those in south-west Arabia possibly also (Cramp 1998). Two of the six species occur in southern Africa (Hockey *et al.* 2005). Only the Helmeted Guineafowl R203 occurs in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a).

R203 Helmeted Guineafowl . . . . *Numida meleagris*

The Helmeted Guineafowl is probably Africa's most widespread gamebird (Little 1997c). It is widespread all over southern Africa, except in the dry western areas, and may be found in many different habitat types (Little 1997c). They are largely resident with one study showing long-term stability of flock membership (Little 1997c). The latter author attributed seasonal patterns in SABAP1 reporting rates — which in SABAP1 Zone 7 peaked from September to December [mid-spring to mid-summer] — to "seasonal changes in conspicuousness linked to their raucous calling early in the breeding season." However, Little (1997c) continued by suggesting that some mobility must be assumed as the relatively stable flocks that formed during the non-breeding season break up as the breeding season approaches (see also Marx & Stoltz 1988; Van Niekerk 1979), with the first few days of heavy rainfall stimulating pairing (Little *et al.* 2000; Van Niekerk 1979). The timing of breeding is apparently more reliant on and responsive to rainfall than in francolins and spurfowls (Little 1997c).

The birds at Glen

Helmeted Guineafowl was seldom seen in the grassland. However, vocalisations of birds in the drainage line (mainly) were much more common. Since late summer 1997/8 distinction was made between the female's double note *buck-wheat* call, as rendered by Little *et al.* (2000), versus all other vocalisations. Because this distinction was not made for the greater part of 1997/8, that year is excluded from the analysis. Data was collected separately for each minute since early spring 2001/2 for the *buck-wheat* calls and since early summer 2001/2 for other vocalisations (Table 4.22). Figures start on page 294.

Table 4.22: R203 Helmeted Guineafowl: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
buck-wheat calls	early spring 2001/2	12 996	340 525	3.8
other vocalisations	early summer 2001/2	6 712	333 130	2.0

Annual occurrence of* buck-wheat *calls in the grassland: Heard on 67.7% of the days with an activity index of 19 (Table 4.23a). Recorded during 11–12 seasons every year, except 2003/4 and 2006/7 when recorded during 8–9 seasons (Fig. 4.110; Fig. 4.111). Daily reporting rates ranged from 0.5 to 82.7% with 87.6% of all bird-days attaining low values (Fig. 4.110). Apart form the relatively low daily reporting rates attained during 2001/2, the values for all other years overlapped extensively (Fig. 4.110). Activity intensity was slightly higher in 2001/2 and 2007/8 compared to other years (Fig. 4.110).

Table 4.23: R203 Helmeted Guineafowl: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.635	8 635	114 612	7.5	*buck-wheat* calls	67.7	656	444	19
0.362	4 921	114 612	4.3	other vocalisations	72.0	656	472	10
0.003	47	114 612	0.0	seen only	5.3	656	35	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.389	95	1 190	8.0	*buck-wheat* calls	48.8	43	21	5
0.594	145	1 190	12.2	other vocalisations	58.1	43	25	6
0.016	4	1 190	0.3	seen only	4.7	43	2	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.565	113	1 188	9.5	*buck-wheat* calls	55.8	43	24	5
0.430	86	1 188	7.2	other vocalisations	58.1	43	25	3
0.005	1	1 188	0.1	seen only	2.3	43	1	1

Seasonal occurrence of* buck-wheat *calls in the grassland: Heard during 9–10 years in spring, summer and autumn, and during 6–7 years in winter, with the seasonal frequency index following a similar trend (Fig. 4.110). Median daily reporting rates peaked in mid- and late spring, and were very low during autumn and winter (Fig. 4.110). This pattern corresponds with the occurrence of high reporting rate days that were limited to mid- and late spring and intermediate reporting rate days that peaked during the same period. In addition, days with zero records were most frequent from mid-autumn to late winter (Fig. 4.111). Activity intensity was also higher from mid-spring to early summer, particularly during mid-spring (Fig. 4.110).

Daily occurrence of* buck-wheat *calls in the grassland: Overall, activity occurred most frequently during the two segments around sunrise and sunset respectively (Fig. 4.110). This general pattern largely reflects the situation for low reporting rate days, with activity occurring on more than 75% bird-days during all segments of the day when intermediate and high reporting rate days are considered (Fig. 4.112). Seasonally, this latter pattern is approached most closely by mid-spring, late spring and early summer, while the day-frequency pattern for other seasons was more like that of low reporting rate days (Fig. 4.113). No bird-segment combinations occurred during more than 5% bird-days.

Activity usually started earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.113). The occurrence of the first activity of the day also varied seasonally, occurring mostly before or just after sunrise from mid-spring to late summer and typically after sunrise at other times of the year (Fig. 4.113; Fig. 4.114). The seasonal pattern shown by the dawn chorus sequence is very similar to that of the first activity of the day (Fig. 4.114).

Whereas the last activity of the day typically occurred well after sunset on intermediate and high reporting rate days (often during the last 5-minute interval of the day), it frequently occurred before sunset on low reporting rate days (Fig. 4.113; Fig. 4.114). There is also a well-defined seasonal pattern with the last activity of the day typically recorded well after sunset during late spring and early summer and usually some time before sunset in autumn and winter (Fig. 4.113; Fig. 4.114).

Overall, activity intensity showed only minor fluctuations through the day, being slightly higher after sunset (Fig. 4.110). This general pattern mostly reflects the situation for low reporting rate days, because on intermediate reporting rate days the activity intensity becomes markedly higher in the early morning and late afternoon and on high reporting rate days it was high throughout most of the day (Fig. 4.112).

Overall, daily segment reporting rates ranged from 5.3 to 100% with 71.3% of the values relatively low (Fig. 4.110). For low reporting rate days, median daily segment reporting rates were only slightly higher during the early morning after sunrise and towards the end of the day (Fig. 4.112). This is in contrast to the situation on intermediate reporting rates days when values were much higher at these times (Fig. 4.112). For high reporting rate days, the median daily segment reporting rates for almost all segments were generally high (>50%) (Fig. 4.112). Seasonal variation in daily segment reporting rates is shown in Figure 4.115.

Early morning occurrence of **buck-wheat** ***calls during 2007/8:*** Activity was only slightly more frequent in the grassland than in the drainage line (Table 4.23b & c), and median early morning reporting rates as well as the seasonal occurrence of high reporting rate mornings (*i.e.* during mid- and late spring) were similar for the two habitats (Fig. 4.116). The timing of the first activity of the day was variable and did not show any consistent seasonal trend (Fig. 4.116). Activity intensities were comparable before and after sunrise (Fig. 4.116).

Annual occurrence of other vocalisations in the grassland: Heard on 72.0% of the days, and an activity index of ten (Table 4.23a). Activity was recorded during 10–12 seasons each year (Fig. 4.117; Fig. 4.118). Daily reporting rates ranged from 0.5 to 31.8% with 83.1% bird-days attaining low values and six years attaining high reporting rate days (Fig. 4.117). Activity intensity was slightly higher during 2001/2 than in other years (Fig. 4.117; Only measured since 2001/2, Table 4.22).

Seasonal occurrence of other vocalisations in the grassland: Activity was noted during 9–10 years in each season, except early spring when noted during eight seasons (Fig. 4.117; Fig. 4.118). Median daily reporting rates follow a clear seasonal pattern with a peak centred on early summer and relatively low values during autumn, winter and early spring (Fig. 4.117). The occurrence of days with zero records were relatively frequent from mid-autumn to mid-spring, occurring during more than five years (Fig. 4.118). Activity intensity was slightly higher during summer, early and mid-autumn (Fig. 4.117).

Daily occurrence of other vocalisations in the grassland: Overall, activity was most frequent during the two segments around sunrise and sunset respectively (Fig. 4.117). This overall pattern is very similar to that shown when only low and intermediate reporting rate days are considered, although in the latter case activity was relatively frequent during S2 and S11 too (Fig. 4.119). On high reporting rate days activity was relatively frequent throughout the day (Fig. 4.119). There are also notable seasonal differences in the day-frequency pattern (Fig. 4.120). During late spring and summer activity was particularly frequent during the early morning and late afternoon, in contrast to other seasons when activity also peaked at these times, but at lower levels (Fig. 4.120). No segment combinations occurred on more than 5% bird-days.

The first activity of the day typically occurred earlier (usually before or shortly after sunrise) on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.120; Fig. 4.121). In addition, median values suggest a seasonal pattern in the timing of the first activity of the day with earliest times recorded in mid-summer (usually before sunrise) and the latest times during winter and early spring (Fig. 4.120; Fig. 4.121). This pattern corresponds only partially with that of the dawn chorus sequence (Fig. 4.121).

The last activity of the day typically occurred after sunset on intermediate and high reporting rate days compared to low reporting rate days when it occurred most frequently some time before sunset (Fig. 4.120; Fig. 4.121). Seasonally, the last activity of the day typically occurred after sunset during late spring and summer (frequently during the late 5-minute interval) in contrast to that of other seasons when activity normally ceased earlier in the day (Fig. 4.120; Fig. 4.121).

Activity intensity was higher during the early morning and in the late afternoon for low and intermediate reporting rate days, which is in contrast to high reporting rate days when the activity intensity were relatively low during the early morning (Fig. 4.119).

Overall, daily segment reporting rates ranged from 4.8 to 100% (Fig. 4.117). Whereas the median daily segment reporting rates showed only slight differences on low and high reporting rate days, the median daily segment reporting rates of S1 and particularly S13 were notably higher than those of other segments for intermediate reporting rate days (Fig. 4.119).

Early morning occurrence of other vocalisations during 2007/8: Activity occurred on exactly the same number of mornings (n = 25) in the grassland and in the drainage line. However, the activity index for the drainage line was double that of the grassland (6 vs. 3; Table 4.23b & c). Median early morning reporting rates, seasonal occurrence of high reporting rate days (early and mid-summer) as well as the absence of zero record days (at least during late spring, early and mid summer) were similar in both habitats (Fig. 4.122). There was, however, also an high reporting rate day during early autumn in the grassland (Fig. 4.122). The timing of the first activity of the day was variable, but often occurred before sunrise in both habitats (Fig. 4.122). Activity intensities tended to be higher in the drainage line, and on high reporting rate mornings they were higher before than after sunrise (Fig. 4.122).

Birds seen in the grassland: Encounters with birds in the grassland were typically of short duration as the birds would quickly take evasive actions once the presence of the observer was detected. Seen during nine years with records mostly limited to late winter, spring and summer

(Fig. 4.123). Most encounters occurred in the early morning and in the late afternoon (Fig. 4.123).

Discussion

According to Little *et al.* (2000), the first few days of heavy rainfall stimulate pairing in the Helmeted Guineafowl, while the female is said to give her *buck-wheat* call during the breeding season. These calls were heard throughout the year at Glen, but showed a well-defined seasonal peak centred on late spring (Fig. 4.110■; Fig. 4.111), which also represents the start of the main rain period. This peak in *buck-wheat* calls is followed by a peak in the occurrence of other vocalisations during early summer, which is followed in turn by relatively low daily reporting rates and a high incidence of zero record days during autumn, particularly mid-autumn (Fig. 4.117■; Fig. 4.118). This latter decrease in activity probably coincides with moulting. Adults have a complete post-breeding moult with peak moult — which is dependant on the timing of breeding/rainfall — in one study occurring during March [mid-autumn] (Ratcliffe 2005; Skead 1962).

4.16 Turnicidae: Buttonquails

The 17 small, quail-like buttonquail species of the world occur in subtropical and tropical Palearctic, Africa, Madagascar, Philippines and Australasia, with three species occurring in southern Africa (Hockey *et al.* 2005). Only the Kurrichane Buttonquail R205 occurs in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a).

R205 Kurrichane Buttonquail .... *Turnix sylvaticus*

Nine Kurrichane Buttonquail subspecies occur from the southern Iberian Peninsula south to South Africa and from Pakistan to Vietnam (Dean 2005b). In southern Africa, *T. s. lepurana* is rather sparsely distributed in Namibia, Botswana, Zimbabwe, Swaziland and South Africa from the Free State northwards (Colahan 1997a) and in southern Mozambique (Parker 1999). It occurs in open grassy areas within savanna habitats (Colahan 1997a; Dean 2005b). No regular movements occur in southern Africa, it being generally nomadic and irruptive, common in some years and not in others (Colahan 1997a; Dean 2005b).

The birds at Glen

The inconspicuous Kurrichane Buttonquail were recorded at Glen only when single birds were flushed in the grassland. Recorded on 28 days with records limited to 1997/8–2000/1 and 2004/5–2005/6 (Fig. 4.124, page 308). Most frequently recorded from mid-summer to mid-autumn and seldom recorded during winter and spring (Fig. 4.124). Recorded throughout the day (Fig. 4.124).

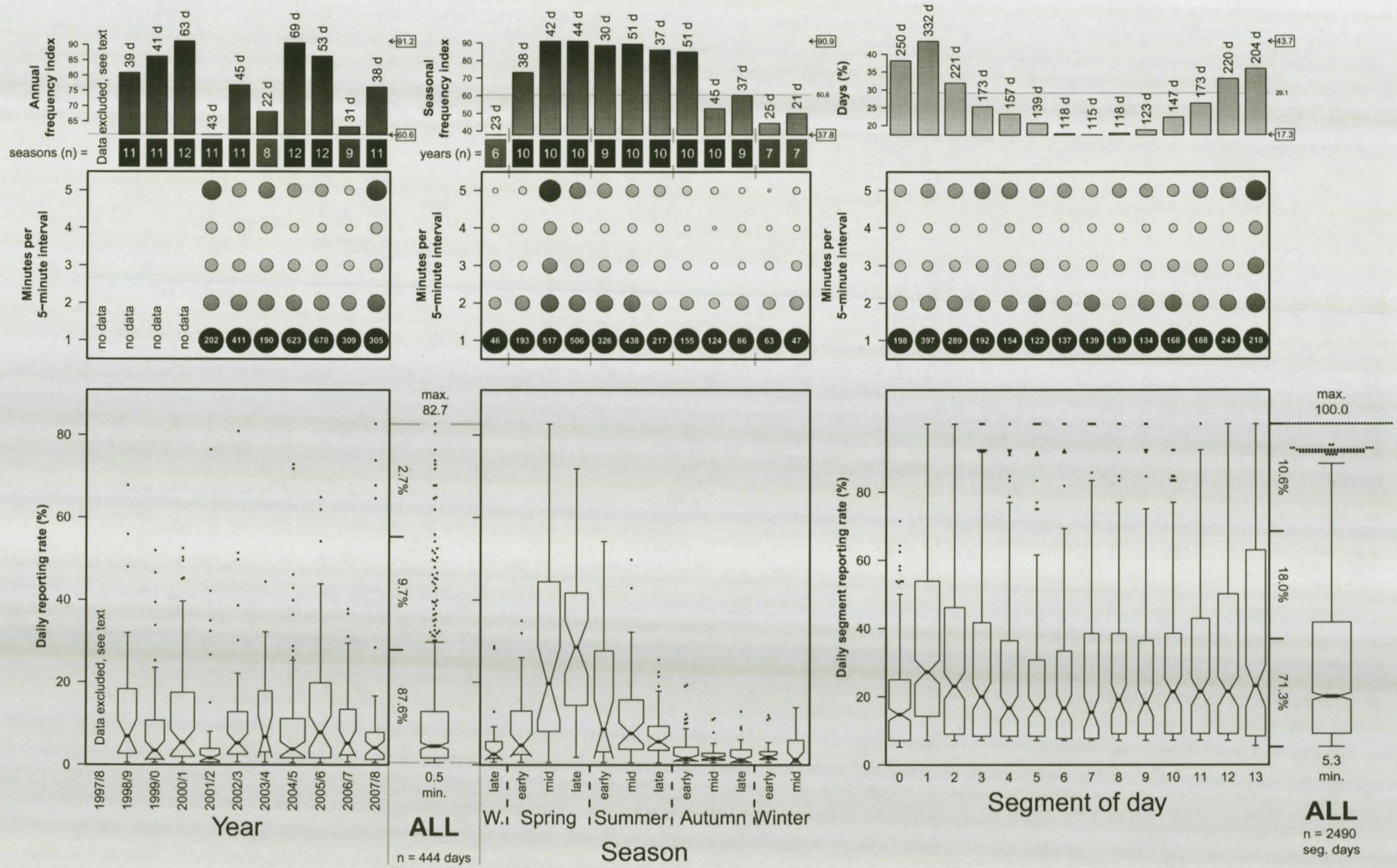


Figure 4.110: R203 Helmeted Guineafowl — *buck-wheat* calls: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

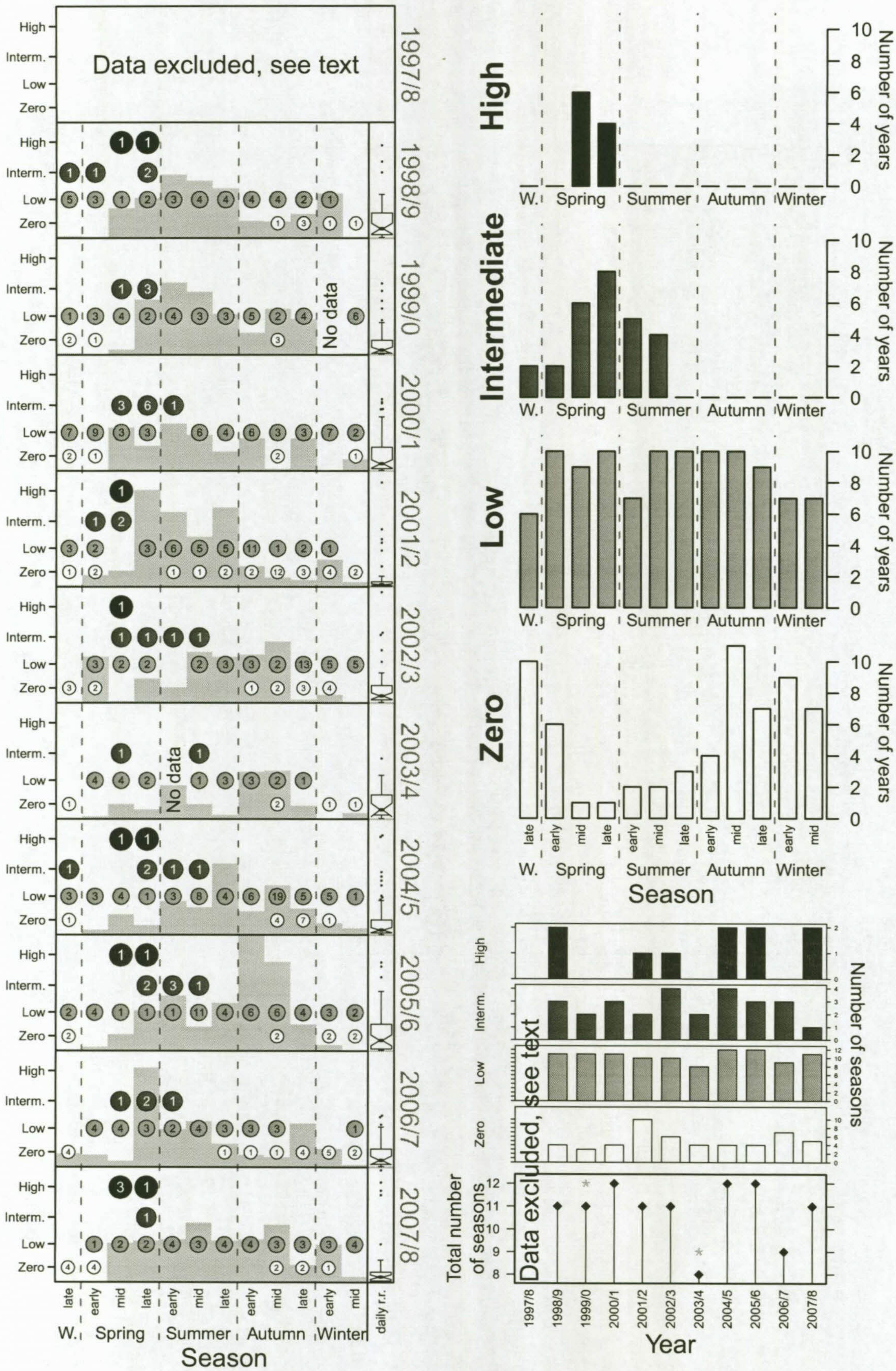


Figure 4.111: R203 Helmeted Guineafowl — *buck-wheat* calls: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

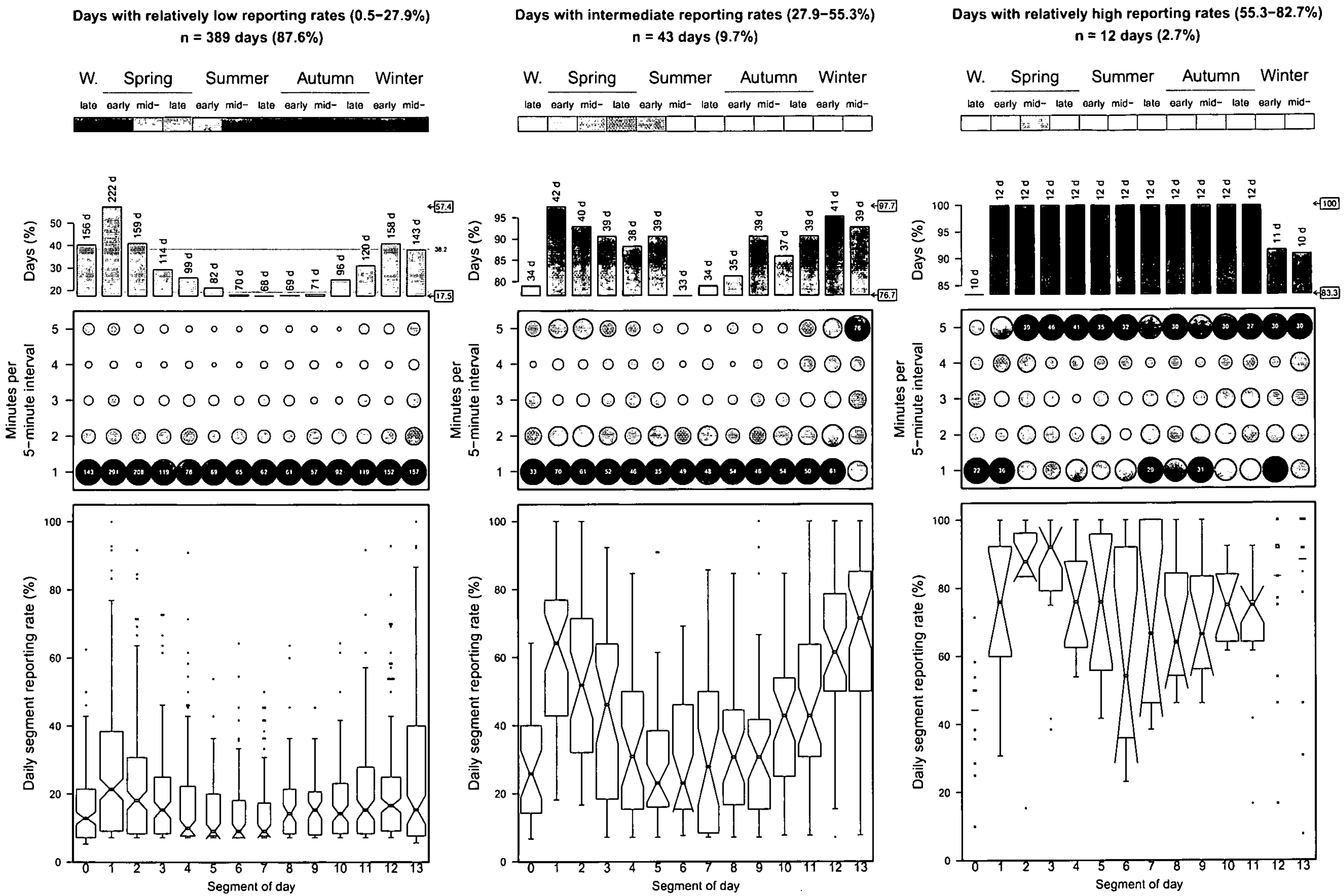


Figure 4.112: R203 Helmeted Guineafowl — *buck-wheat* calls: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LJH figure.

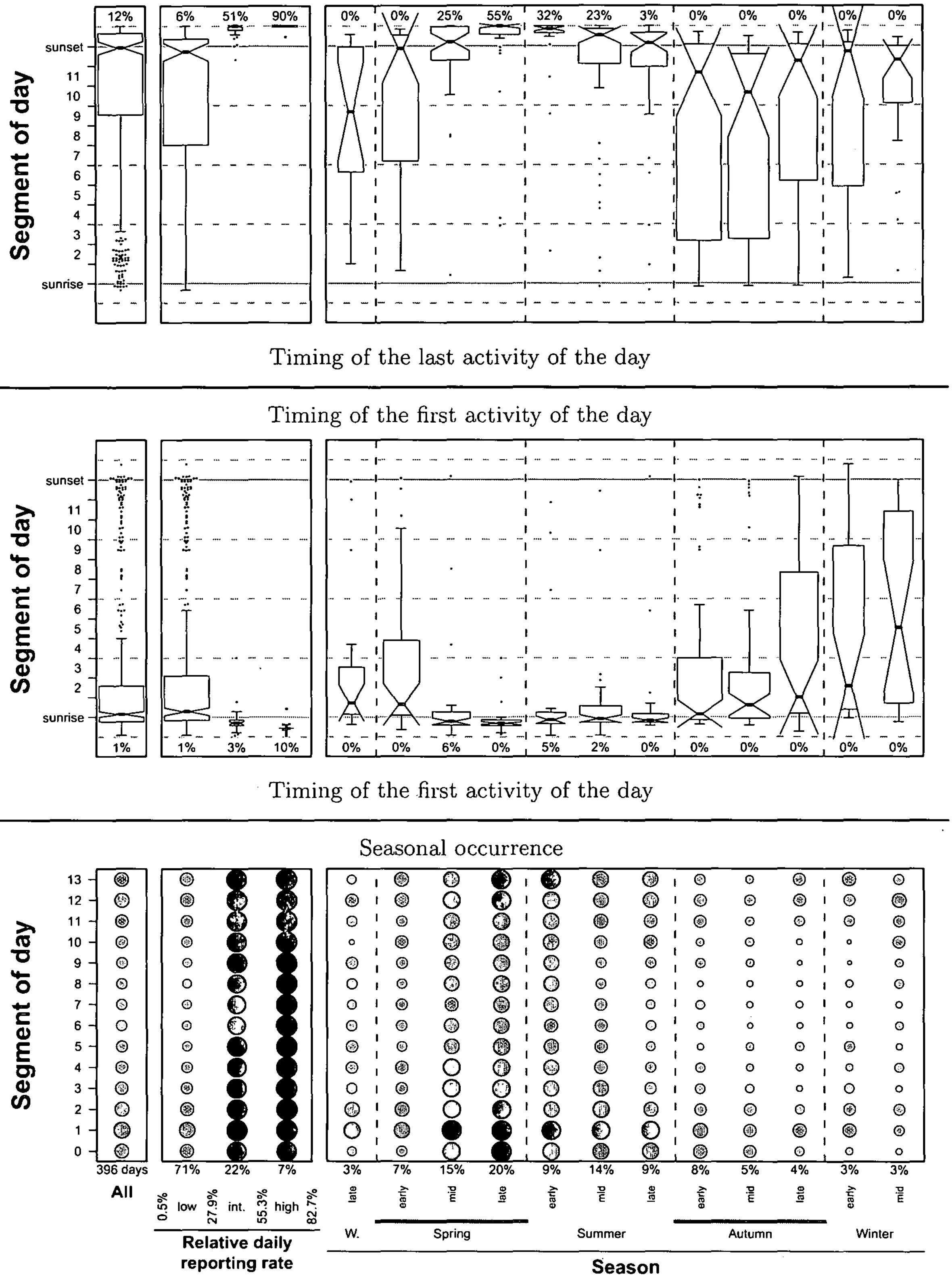
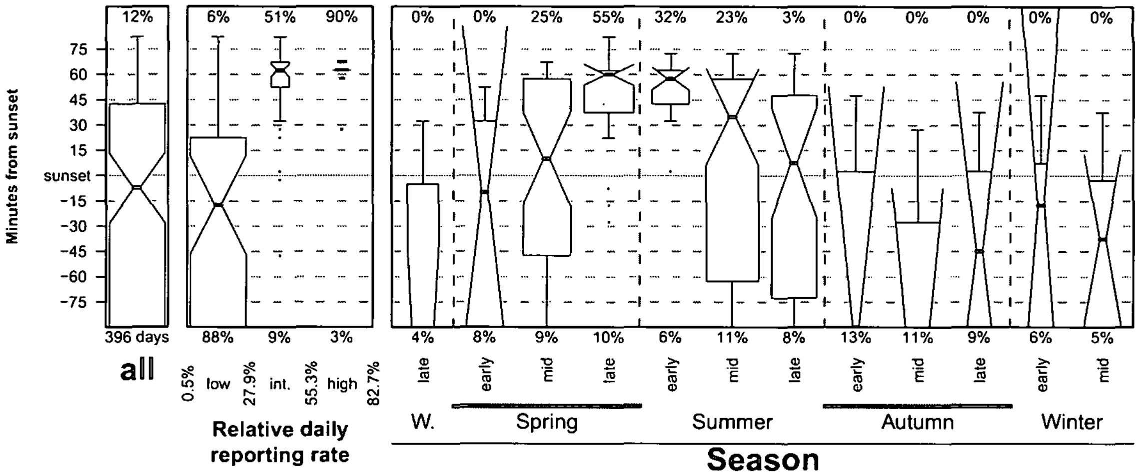
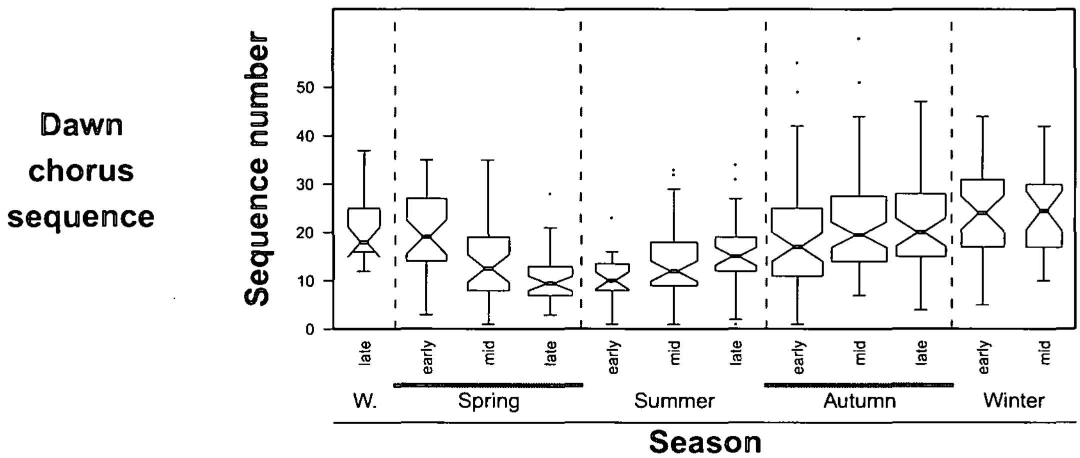


Figure 4.113: R203 Helmeted Guineafowl — *buck-wheat* calls: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

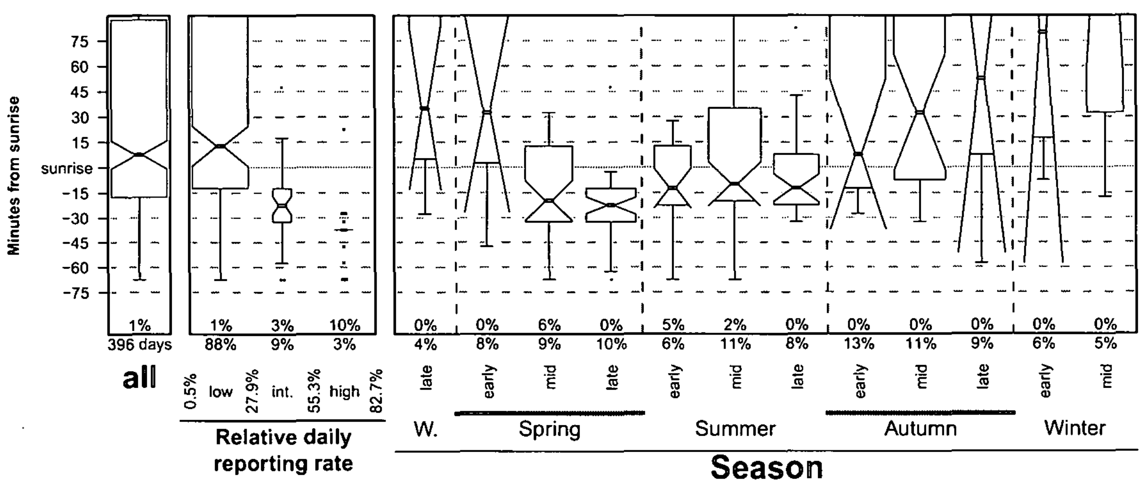


Figure 4.114: R203 Helmeted Guineafowl — *buck-wheat* calls: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

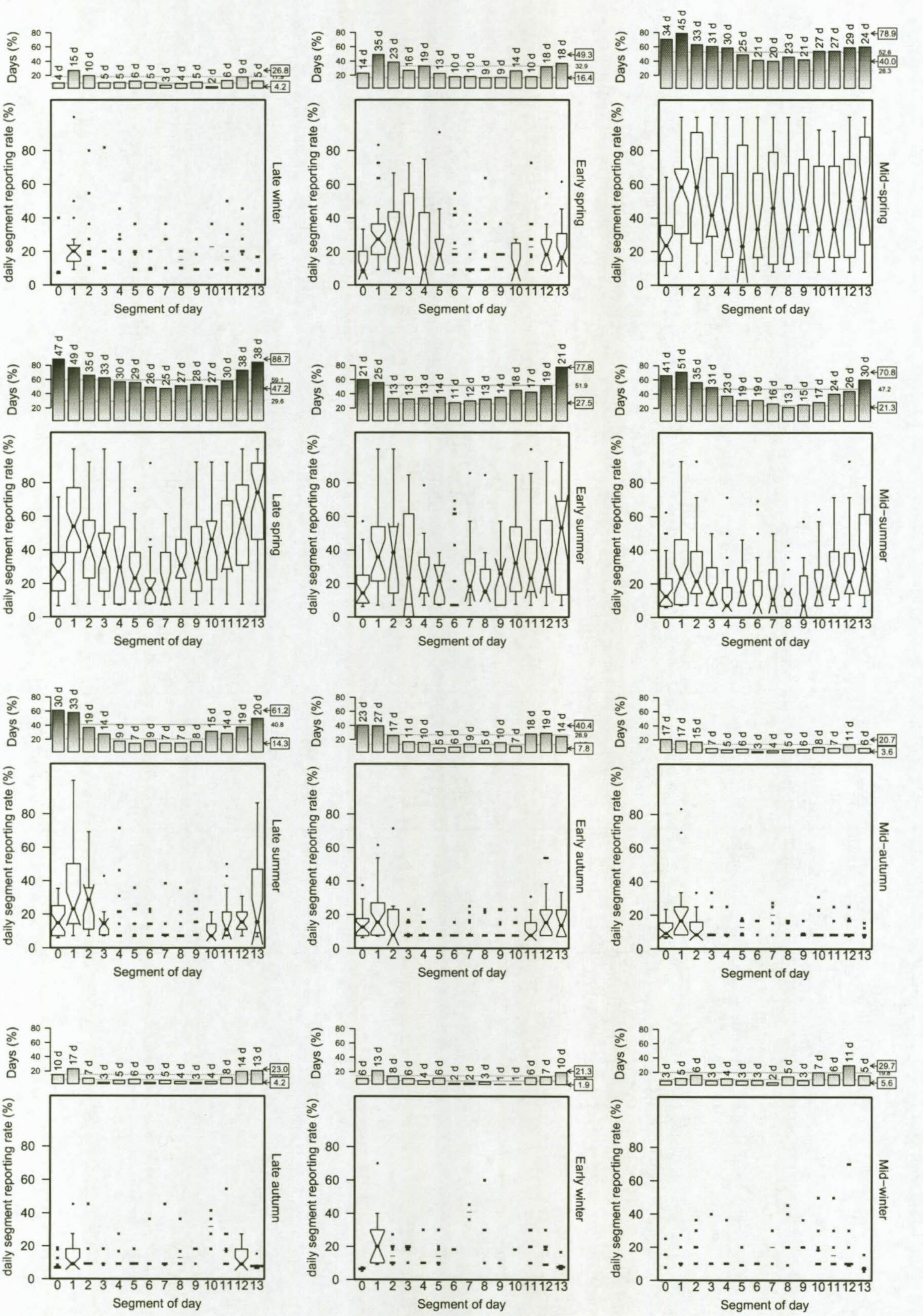
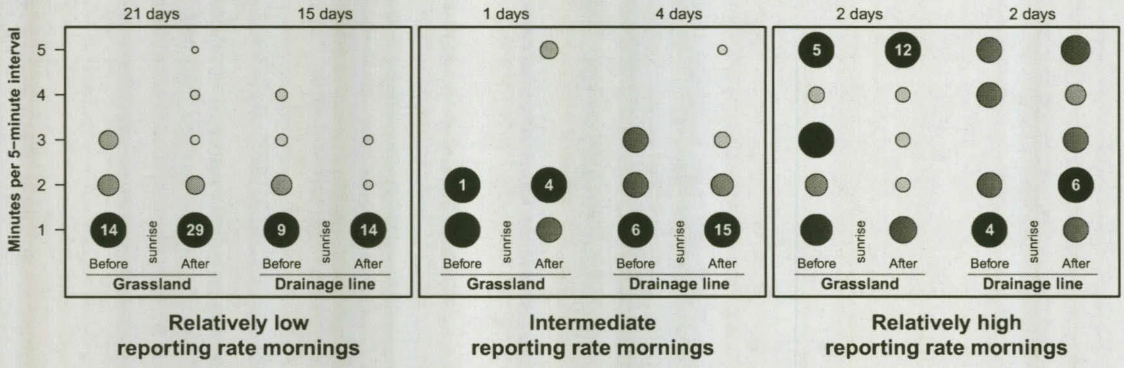
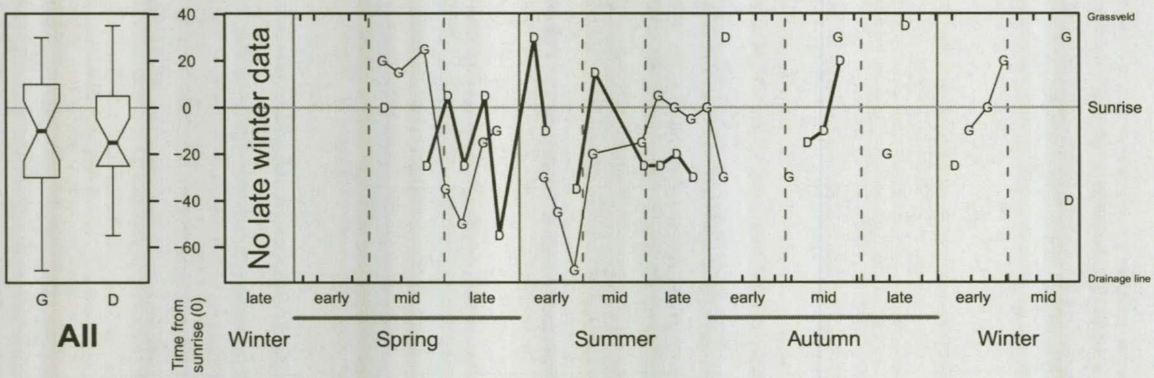


Figure 4.115: R203 Helmeted Guineafowl — *buck-wheat* calls: Seasonal fluctuations in daily occurrence in the grassland at Glen. See page 136 for more information on this seasonal detail figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

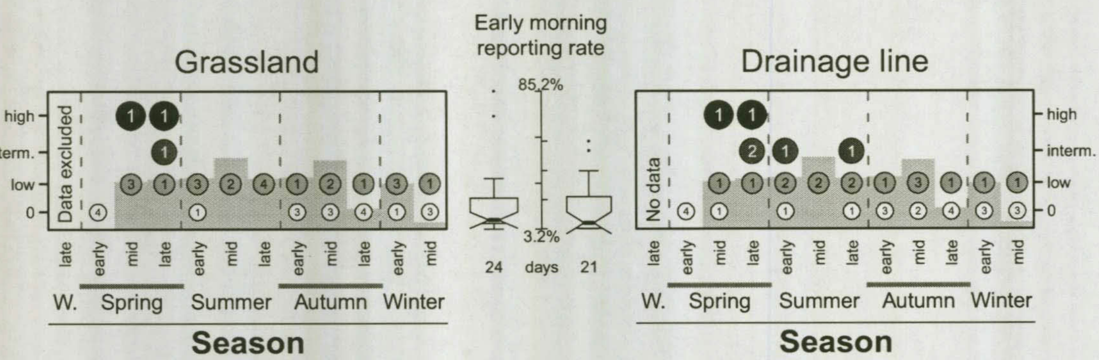


Figure 4.116: R203 Helmeted Guineafowl — *buck-wheat* calls: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

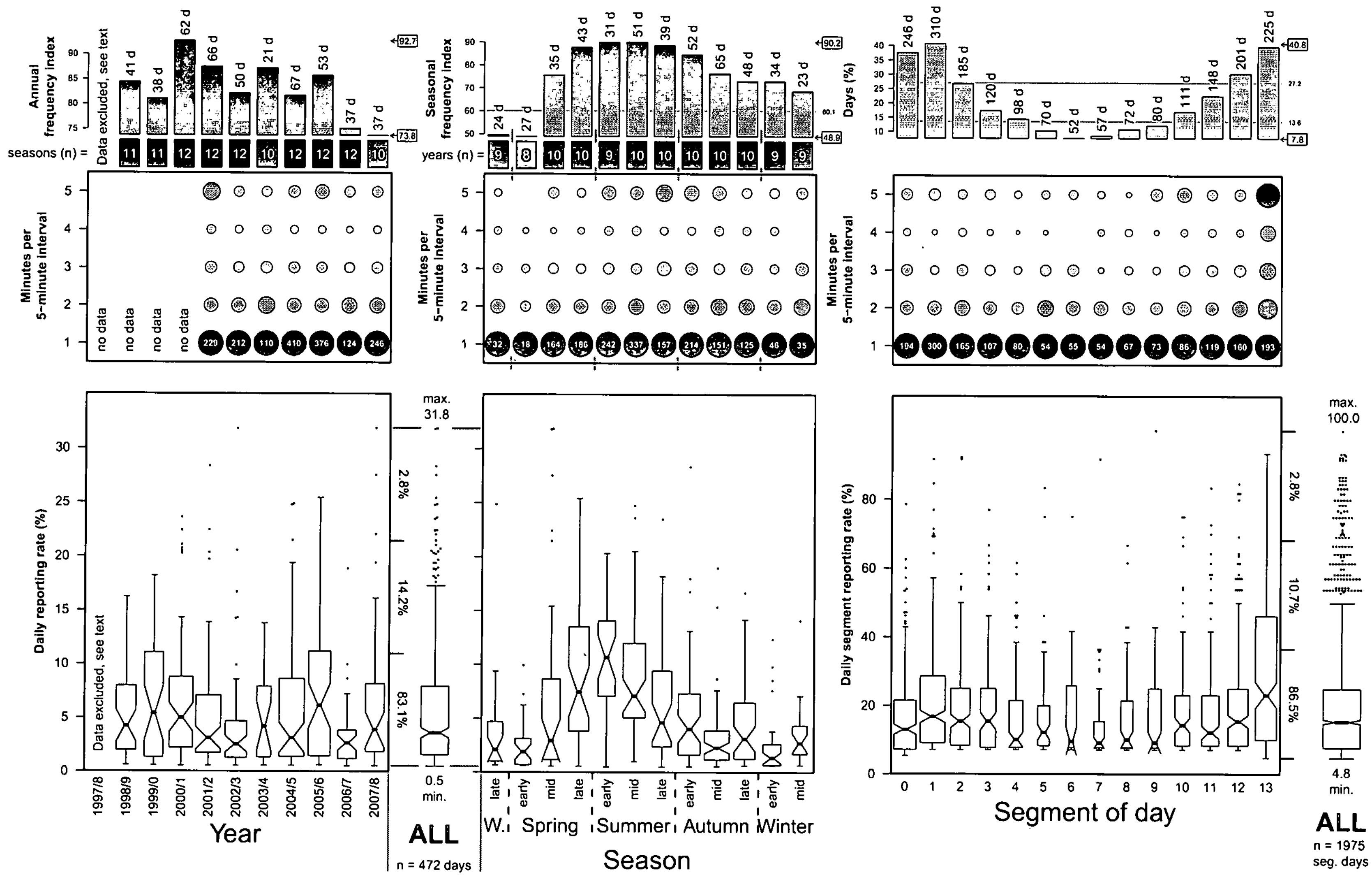


Figure 4.117: R203 Helmeted Guineafowl — other vocalisations: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

Figure 4.118: R203 Helmeted Guineafowl — other vocalisations: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

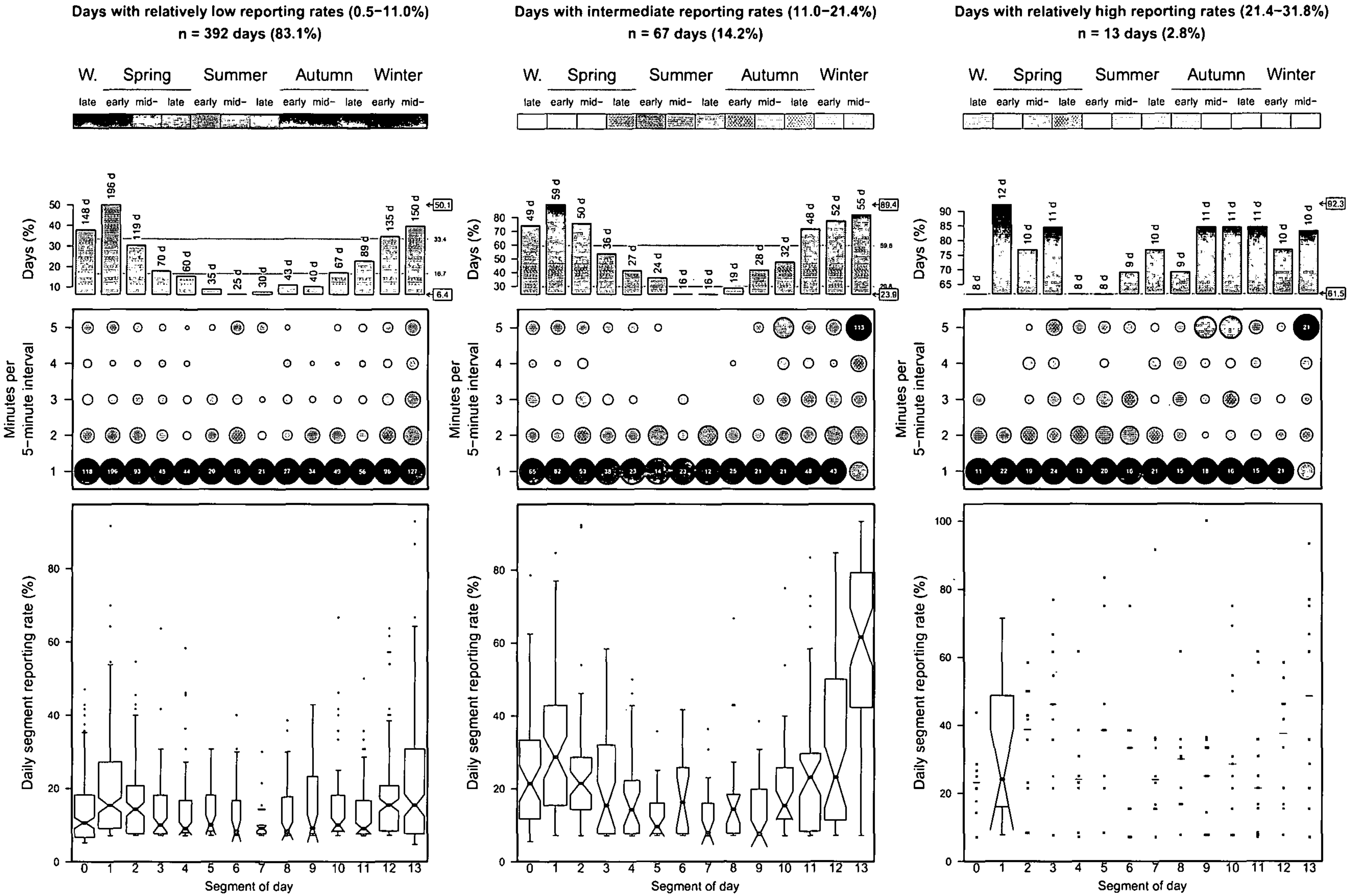


Figure 4.119: R203 Helmeted Guineafowl — other vocalisations: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

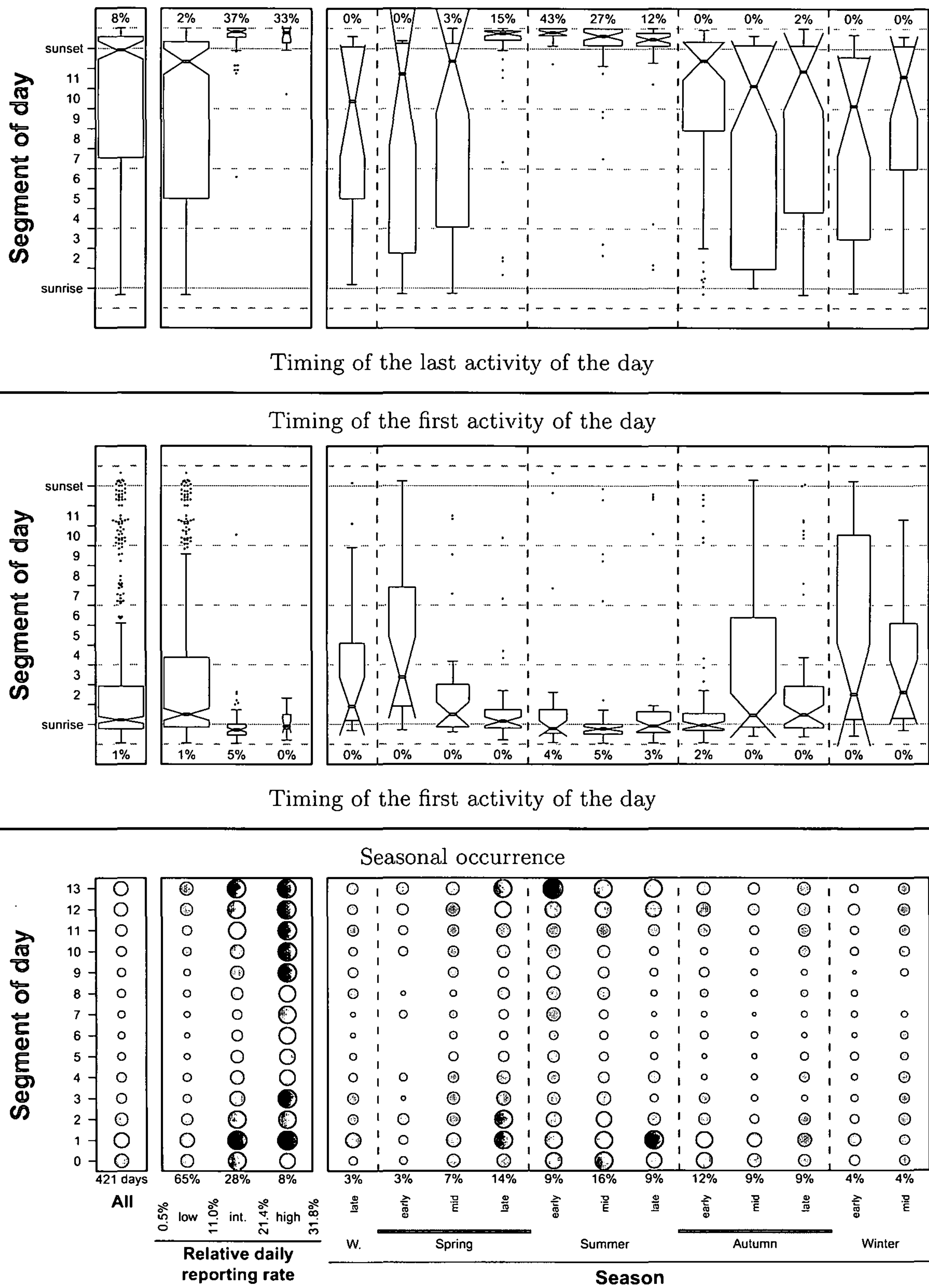
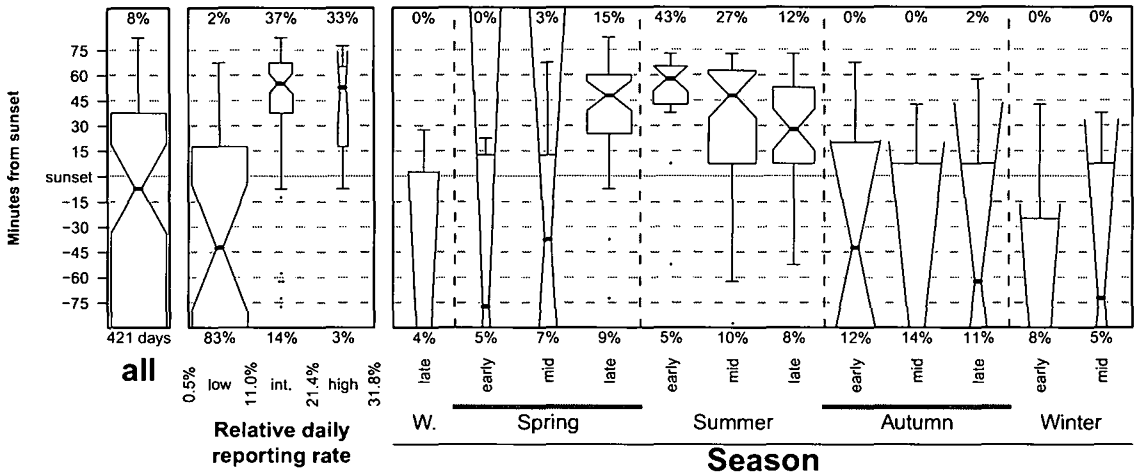
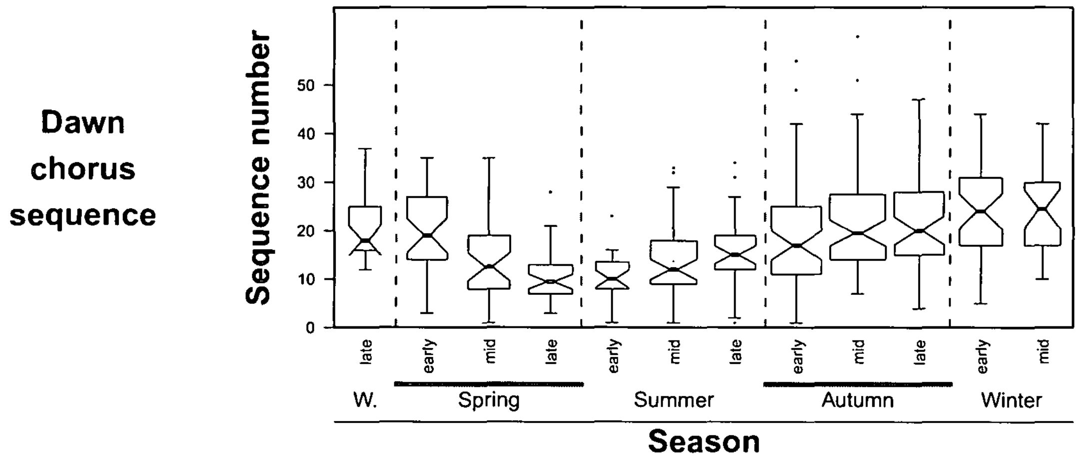


Figure 4.120: R203 Helmeted Guineafowl — other vocalisations: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

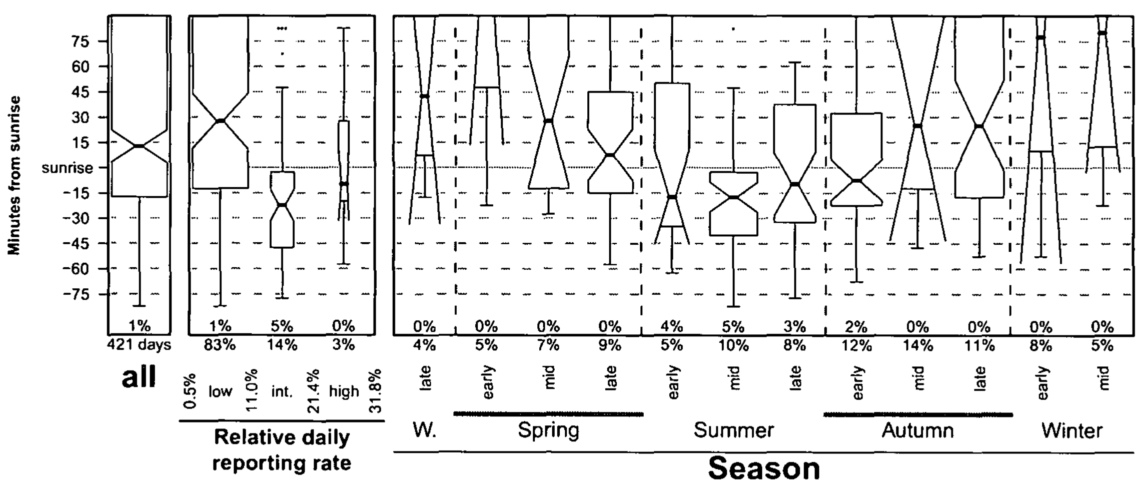
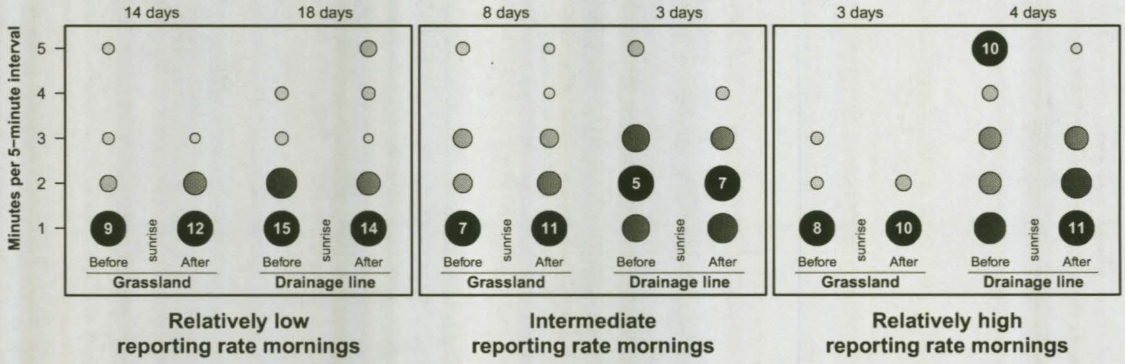
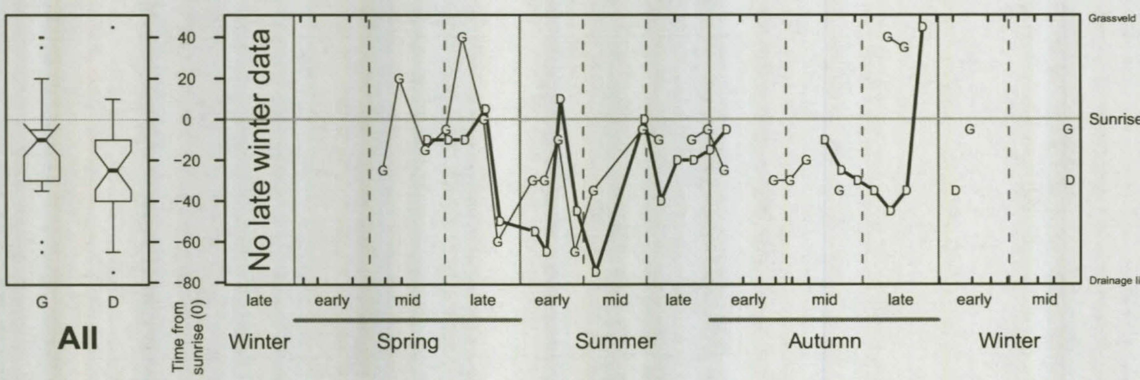


Figure 4.121: R203 Helmeted Guineafowl — other vocalisations: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

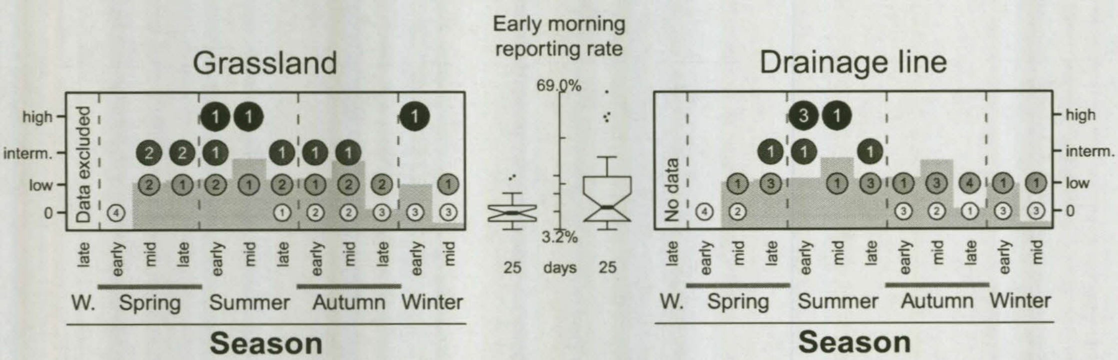


Figure 4.122: R203 Helmeted Guineafowl — other vocalisations: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

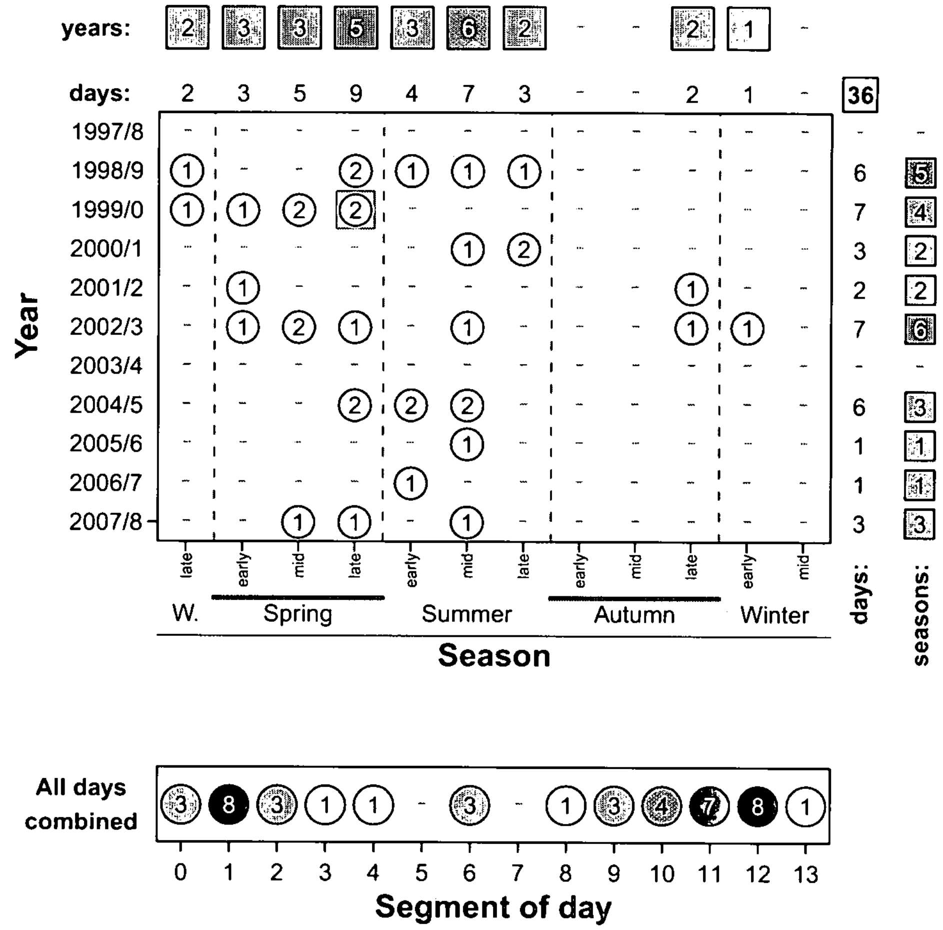


Figure 4.123: R203 Helmeted Guineafowl — seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Discussion

Since the Kurrichane Buttonquail data is limited to birds flushed, it is bound to be biased to an unknown extent as the 'search effort' was not constant.

4.17 Gruidae: Cranes

Fifteen crane species are found in North America, Eurasia, Africa and Australia with three species occurring in southern Africa (Hockey *et al.* 2005). All three species occur in the Free State, but it is only the Blue Crane R208 that is reasonably widespread in the province (Earlé & Grobler 1987; Harrison *et al.* 1997a), and the only species recorded at Glen.

R208 Blue Crane . . . . *Anthropoides paradiseus*

As the world's most range restricted crane, the Blue Crane is endemic to southern Africa where its distribution is largely limited to South Africa (Allan 1997c, 2005c). It occurs throughout most of the Free State where it is relatively scarce in the central parts (Allan 1997c; Shaw 2003).

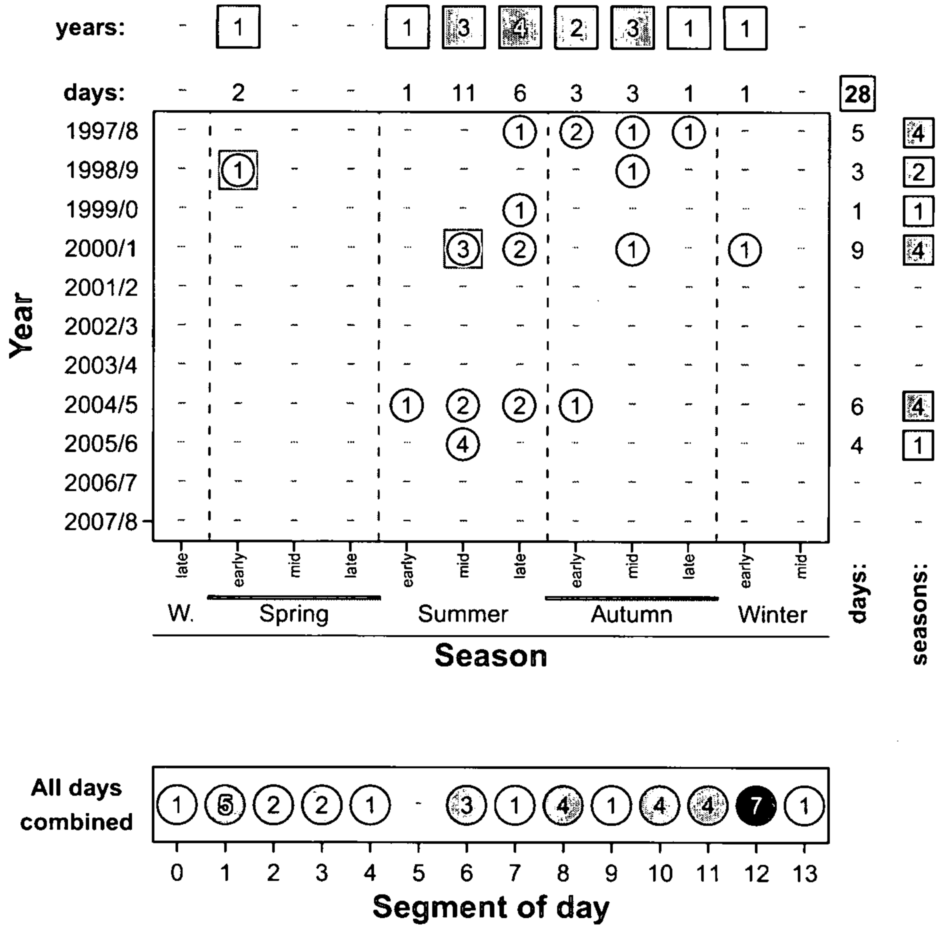


Figure 4.124: R205 Kurrichane Buttonquail — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

It shows a preference for a variety of habitats with short vegetation, including grassland and agricultural fields (Allan 1997c, 2005c; Maclean 1985; Shaw 2003; Van Niekerk 2007). In the Free State it is a resident and sometimes locally nomadic (Geldenhuys 1984). The Blue Crane is considered to be facing a high risk of extinction in the wild (McCann 2000).

The birds at Glen

Flocks of 5–7 Blue Cranes were seen and heard in soaring flight on three days only during late summer 1999/0, early autumn 2001/2 and mid-winter 1999/0 respectively. All records occurred during the early afternoon.

Discussion

The fact that the Blue Cranes were found during the early afternoon is most probably due to them utilising thermals. Unless they are calling, soaring birds are easily overlooked.

4.18 Rallidae: Flufftails, Rails, Crakes, Gallinules, Swamphens, Moorhens, Coots

The 143 rallid species occur worldwide except in the polar regions, with 18 species occurring in southern Africa (Hockey *et al.* 2005). Eight species have been recorded in the Free State with only two species common in the central parts of the province; both species are closely associated with water (Earlé & Grobler 1987; Harrison *et al.* 1997a). At Glen, the farm dam in the drainage line is unsuitable for the Common Moorhen *Gallinula chloropus* and only the Red-knobbed Coot R228 was recorded.

R228 Red-knobbed Coot .... *Fulica cristata*

The Red-knobbed Coot occurs in Africa and Madagascar, with a small population also in southern Spain (Cramp 1998; Dean 2005h; Keith 1986). It is the most numerous and frequently reported rallid in southern Africa, and particularly common in South Africa where the grassland biome forms part of its core distribution (Taylor 1997). As an obligate waterbird it is found on almost any inland waters, especially those with aquatic vegetation on which it feeds (Dean 2005h; Maclean 1985). While the existence of movements is evident from large fluctuations in numbers present at individual wetlands, the pattern and extent of these movements are unclear and perhaps best described as nomadic and opportunistic (Dean 2005h; Taylor 1997; Underhill *et al.* 1999).

The birds at Glen

Records of the Red-knobbed Coot in the grassland were limited to the vocalisations of adult birds on the farm dam in the drainage line, where breeding was recorded. Not recorded during the early mornings of 2007/8 (Table 4.24b & c). Figures start on page 311.

Table 4.24: R228 Red-knobbed Coot: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	1 135	114 612	1.0	birds heard	13.9	656	91	12
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–

Annual occurrence of farm dam birds heard in the grassland: Activity was noted on 13.9% of the days with an activity index of 12 (Table 4.24a). Recorded during six years, mostly during 1–4 seasons, but during eight seasons in 2001/2, which also showed the highest annual frequency index (Fig. 4.125). Daily reporting rates ranged from 0.5 to 51.1% with 87.9% bird-days attaining low reporting rates (Fig. 4.125). The median daily reporting rate of 2001/2 was higher than that of the other years and it also represented the only year with intermediate and high reporting rate days (Fig. 4.125; Fig. 4.126).

Seasonal occurrence of farm dam birds heard in the grassland: Activity was noted during almost all seasons with a distinct peak in occurrence centred on mid-autumn (Fig. 4.125). Median daily reporting rates peaked in early autumn, but was also relatively high during mid-autumn, the two seasons being the only ones with intermediate and high reporting rates (Fig. 4.125; 4.126).

Daily occurrence of farm dam birds heard in the grassland: Overall, activity occurred most frequently before sunrise and after sunset (Fig. 4.125). Activity was largely limited to the early morning or late afternoon during all seasons, except in autumn when it also occurred relatively frequently during other segments (Fig. 4.127). Bird-segment combinations occurring during more than five bird-days were limited to combinations involving S0 and S13, collectively accounting for almost a quarter of all bird-days (Fig. 4.128).

The first activity of the day commonly occurred before, or soon after, sunrise, particularly from mid-summer to early winter (Fig. 4.127; Fig. 4.129). The dawn chorus sequence followed a similar pattern (Fig. 4.129). The last activity of the day typically occurred after sunset, especially from mid-summer to mid-autumn (Fig. 4.127; Fig. 4.129).

Daily segment reporting rates ranged from 5.0 to 86.7% with values tending to be higher in the early morning and late afternoon than during other parts of the day (Fig. 4.125).

Discussion

In SABAP1 Zone 7, Red-knobbed Coot breeding was recorded throughout the year (Taylor 1997), and at Barberspan flightless moult was recorded year-round and lasted nearly two months (Dean & Skead 1979). The seasonal pattern at Glen appears to point to a breeding peak centred on mid-autumn (Fig. 4.125; Fig. 4.126), which is when the dam in the drainage line is most likely to have water. However, the presence of water does not automatically mean that the coots will be present, and even if present their presence may go undetected in the grassland if the birds are not vocal. In 2006/7, for example, there was a pair on the dam but no vocal activity was noted in the grassland during that year (Fig. 4.126). Yet the birds were relatively frequently recorded during 2001/2, mid-autumn and in the early morning and late afternoon (Fig. 4.125; Fig. 4.126). It is suggested that the vocalisations associated with breeding are more readily detectable in the grassland, particularly when there is more than one pair on the dam as was the case during 2001/2 when the dam filled relatively early in the year. Unfortunately, the significance and function of many of the Red-knobbed Coot calls are largely unknown (Keith 1986). It is furthermore suggested that the birds move to permanent water bodies after breeding for their protracted flightless moult (see also Dean & Skead 1979).

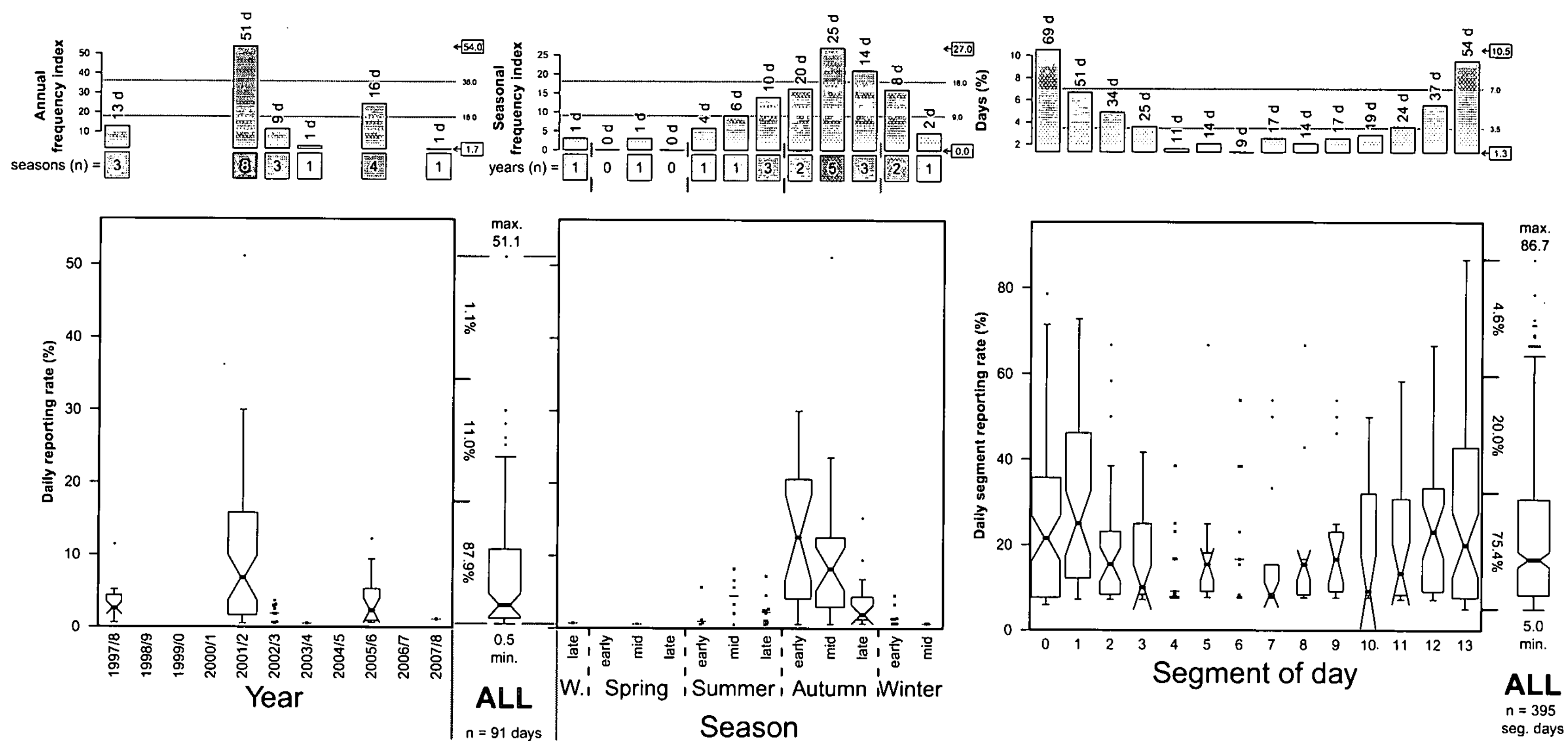


Figure 4.125: R228 Red-knobbed Coot — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

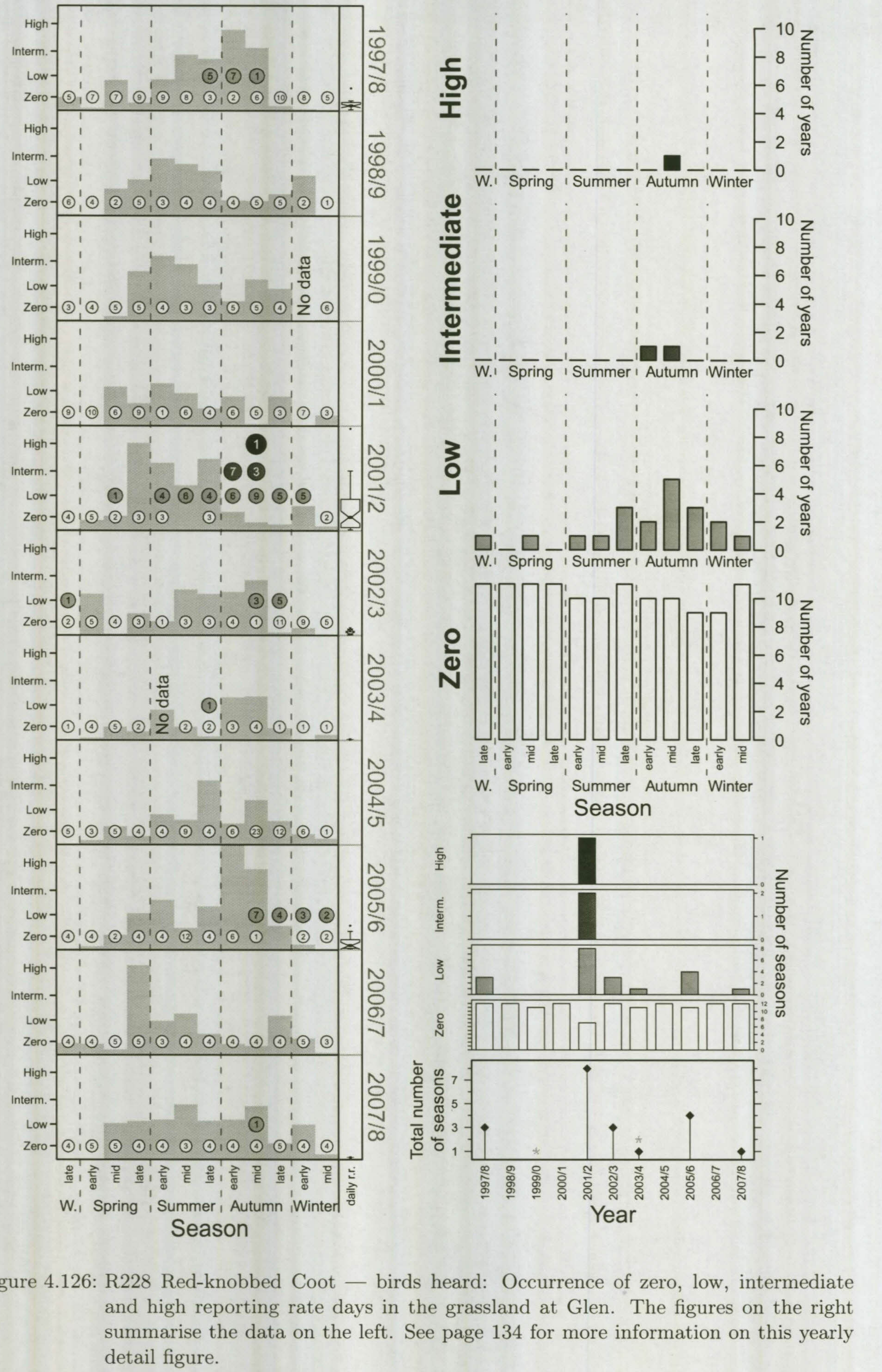


Figure 4.126: R228 Red-knobbed Coot — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

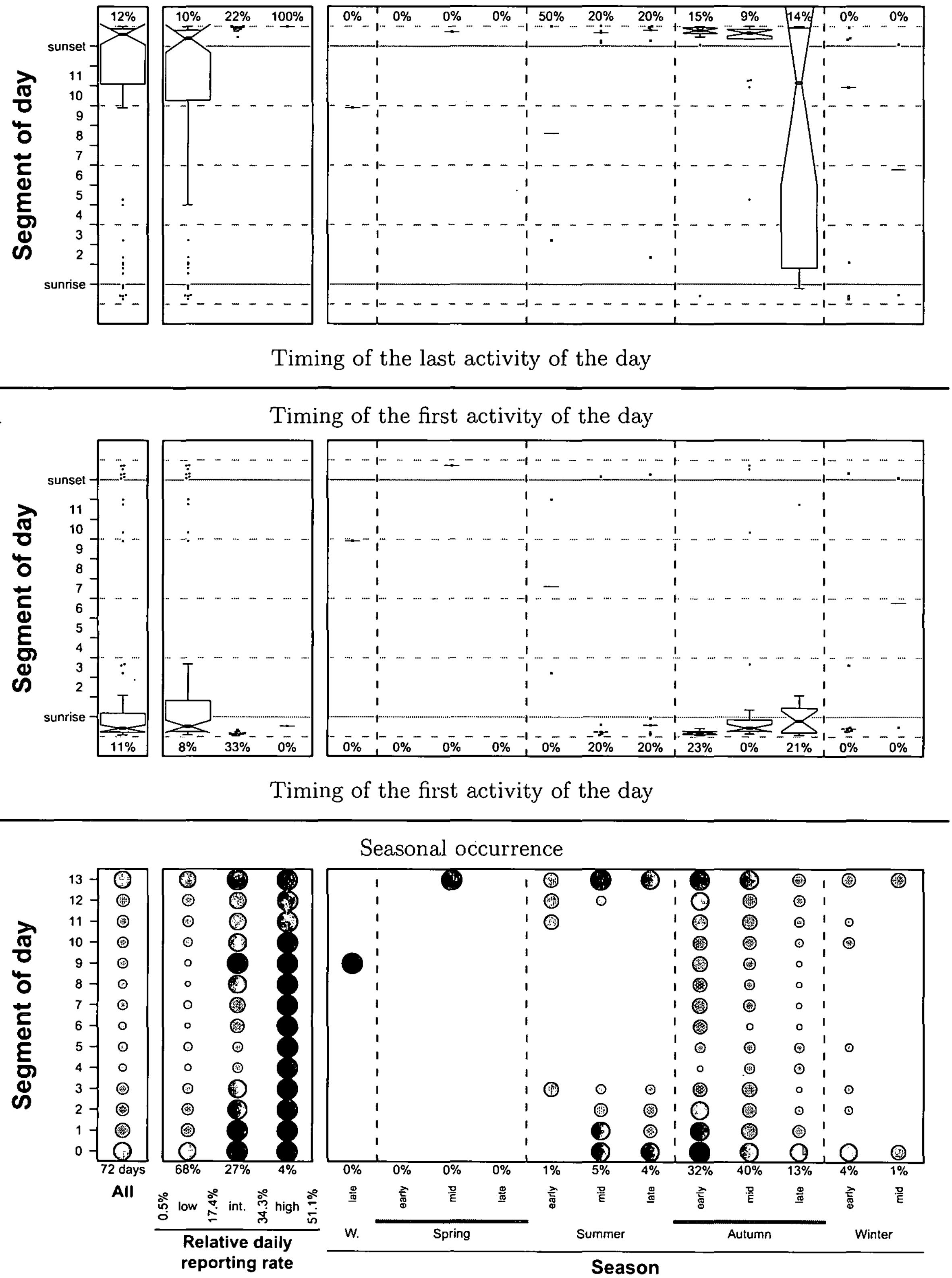


Figure 4.127: R228 Red-knobbed Coot — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

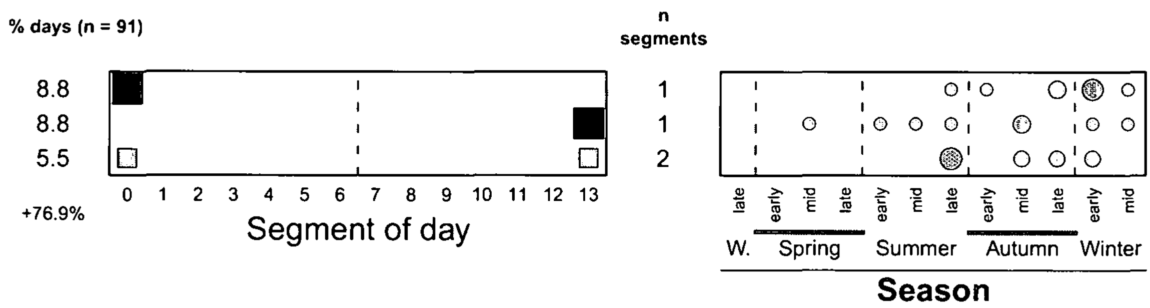


Figure 4.128: R228 Red-knobbed Coot — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

4.19 Otididae: Bustards

Bustards include medium-sized to very large terrestrial birds with fairly long necks and legs, and no preen gland (Hockey *et al.* 2005). There are approximately 25 species that occur in Africa, Eurasia and Australia with 11 species occurring in southern Africa (Hockey *et al.* 2005). Eight species occur in the Free State, but only two, the Blue Korhaan R234 and the Northern Black Korhaan R239, are widespread in the central parts of the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). In addition to these two species, the Ludwig's Bustard R232 was also recorded at Glen.

R232 Ludwig's Bustard .... *Neotis ludwigii*

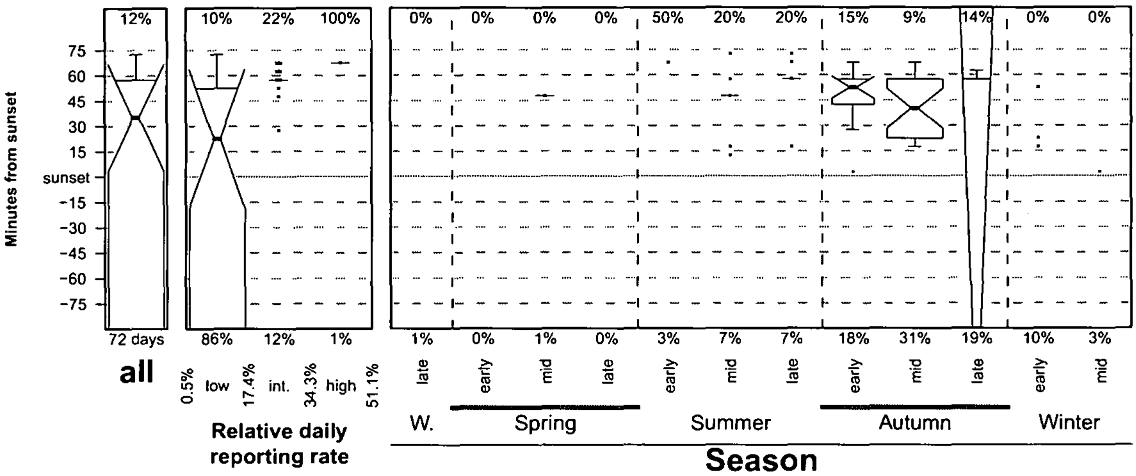
Ludwig's Bustard occurs from south-western Angola (Dean 2000) southwards through the western parts of Namibia into South Africa where its distribution extends as far east as the western and southern parts of the Free State (Allan 1997d; Anderson 2003). The study area at Glen is situated at the north-eastern edge of its distribution. It occurs in a variety of open habitats ranging from desert to grassland (Allan 1997d; Earlé & Grobler 1987; Maclean 1985). In the Free State and elsewhere, they may be locally common after rain (Allan 1994; Anderson 2003; Earlé & Grobler 1987; Herholdt 1988). The Ludwig's Bustard is considered to be facing a high risk of extinction in the wild (Anderson 2000b).

The birds at Glen

Single Ludwig's Bustards were seen in flight during early morning (S0, S1 and S3) in late spring, early summer and mid-summer on four occasions (1997/8, 2000/1, 2002/3 and 2005/6).

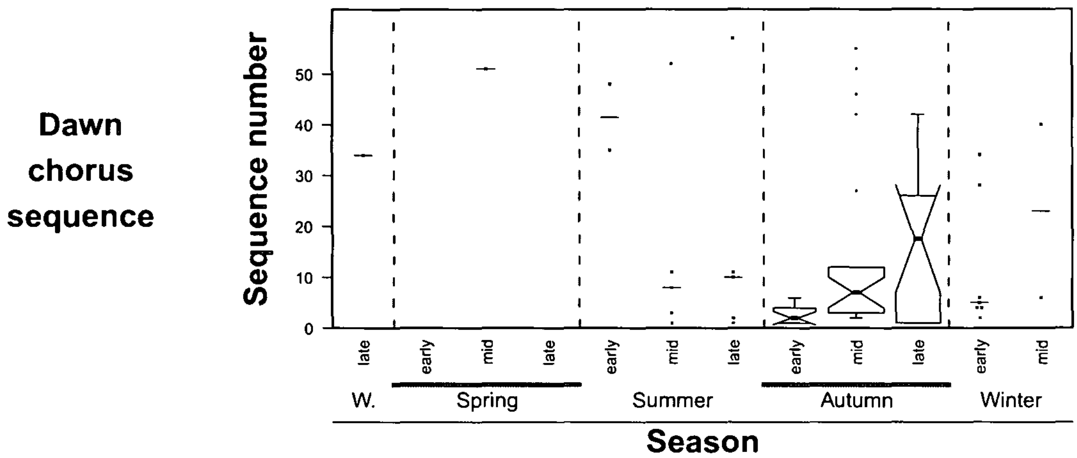
R234 Blue Korhaan .... *Eupodotis caerulescens*

The Blue Korhaan is endemic to South Africa and Lesotho with its distribution centred on the Free State (Allan 1997f; Colahan 2003a). It inhabits open grassland, karoo scrub and cultivated fields and is a sedentary resident (Allan 1997f, 2005b; Maclean 1985). The Blue Korhaan is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Barnes 2000f).



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

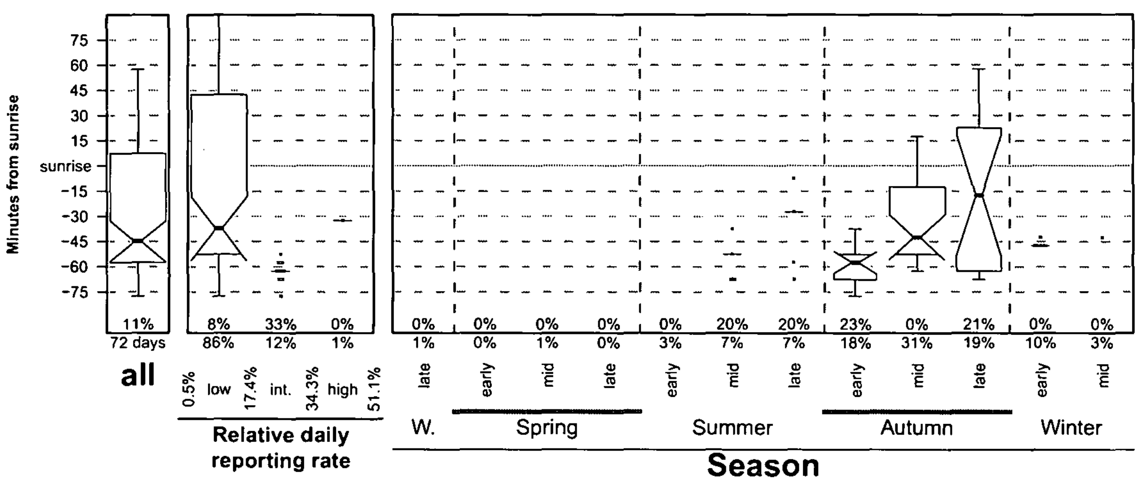


Figure 4.129: R228 Red-knobbed Coot — birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

The birds at Glen

The Blue Korhaan was rarely seen. Most of the records were of birds heard calling from somewhere beyond the drainage line towards the south and south-west. Data was collected separately for each minutes since 2002/3 (Table 4.25). Figures start on page 318.

Table 4.25: R234 Blue Korhaan: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
birds heard only	late winter 2002/3	169	282 355	0.1

Annual occurrence of calls heard in the grassland: Recorded on 39.8% of the days with an activity index of two (Table 4.26a). Heard during 9–12 seasons from 1997/8 to 2004/5 and during 4–6 seasons from 2005/6 to 2007/8 (Fig. 4.130; Fig. 4.131). The annual frequency index as well as daily reporting rates were relatively low during the latter three years (Fig. 4.130; Fig. 4.131). Daily reporting rates ranged from 0.5 to 8.0% with 90.8% bird-days attaining low values (Fig. 4.130). Activity intensity was largely similar for all years since it was measured in 2002/3 (Fig. 4.130; Table 4.25).

Table 4.26: R234 Blue Korhaan: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.990	578	114 612	0.5	birds heard only	39.8	656	261	2
0.010	6	114 612	0.0	birds seen	0.9	656	6	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	8	1 190	0.7	birds heard only	11.6	43	5	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.667	2	1 188	0.2	birds heard only	4.7	43	2	1
0.333	1	1 188	0.1	birds seen	2.3	43	1	1

Seasonal occurrence of calls heard in the grassland: Heard during 5–10 years per season with no clear seasonal trend (Fig. 4.130). Activity intensity was similar for all seasons (Fig. 4.130). All median daily reporting rates were less than 2% and tended to be slightly higher during autumn, winter and early and mid-spring (Fig. 4.130). While the two high reporting rate days were limited to early autumn and late winter, intermediate reporting rates occurred during most seasons with no prominent seasonal trend (Fig. 4.131).

Daily occurrence of calls heard in the grassland: Overall, activity occurred most frequently during the two segments around sunrise with a lesser peak in the late afternoon before sunset and infrequently at other times of the day (Fig. 4.130). This pattern was similar for low and intermediate reporting rate days (Fig. 4.132). Seasonally, activity was most frequent in the early morning during all seasons, and from mid-summer to early winter also during the late afternoon (Fig. 4.133). The four bird-segment combinations that occurred on more than 5% bird-days were limited to combinations involving the two segments around sunrise and S12 (Fig. 4.134). Collectively these combinations account for nearly half all bird-days (Fig. 4.134).

The first activity of the day frequently occurred in the early morning, often before sunrise, especially on intermediate and high reporting rate days (Fig. 4.133; Fig. 4.135). The median dawn chorus sequence followed a pattern very similar to that of the first activity of the day (Fig. 4.135). The timing of the last activity of the day was variable (Fig. 4.133; Fig. 4.135).

Activity intensities were similar for the respective segments of the day (Fig. 4.130; Fig. 4.132; Note: the data point for S7 was ignored because of the small sample size).

Overall, daily segment reporting rates ranged from 5.9 to 40.0% with 89.3% of the values relatively low (Fig. 4.130). Median daily segment reporting rates were slightly higher during S1 for intermediate reporting rate days (Fig. 4.132).

Early morning occurrence of vocalisations during 2007/8: Activity was noted on five mornings in the drainage line compared to only two mornings in the grassland (Table 4.26b & c).

Birds seen in the grassland: Single Blue Korhaans were seen on six occasions (Fig. 4.136). The first three sightings occurred during 2001/2, followed by one sighting each in the two subsequent years with the final sighting at the end of 2007/8 (Fig. 4.136). The sightings occurred during different seasons and at various times of the day (Fig. 4.136).

Discussion

The Blue Korhaan breeds mainly from October to November [late spring to early summer]; nothing is apparently known about moult (Allan 2005b). At Glen this breeding period coincided with relatively low daily reporting rates that were preceded by slightly higher values from late winter to mid-spring (Fig. 4.130).

Is not known why the Blue Korhaan was heard relatively less often during the last three years.

R239 Northern Black Korhaan .... *Afrotis afraoides*

The Northern Black Korhaan is endemic to southern Africa, and is widespread in Namibia, Botswana and South Africa where the Free State represents the south-eastern limit of its range (Allan 1997e). It is found in a variety of habitats, including grassland (Allan 2005a; Colahan 2003b; Earlé & Grobler 1987; Maclean 1985). Generally considered to be a resident (Earlé & Grobler 1987; Maclean 1985), with Allan (1997e) attributing seasonal variations in SABAP1 reporting rates to the enhanced conspicuousness of males during the breeding season. However, Allan (1997e) pointed out that local abundance can quickly change if suitable habitat becomes available. Commenting on this, Colahan (2003b) suggested that "these movements are likely to be only local, from adjacent occupied areas."

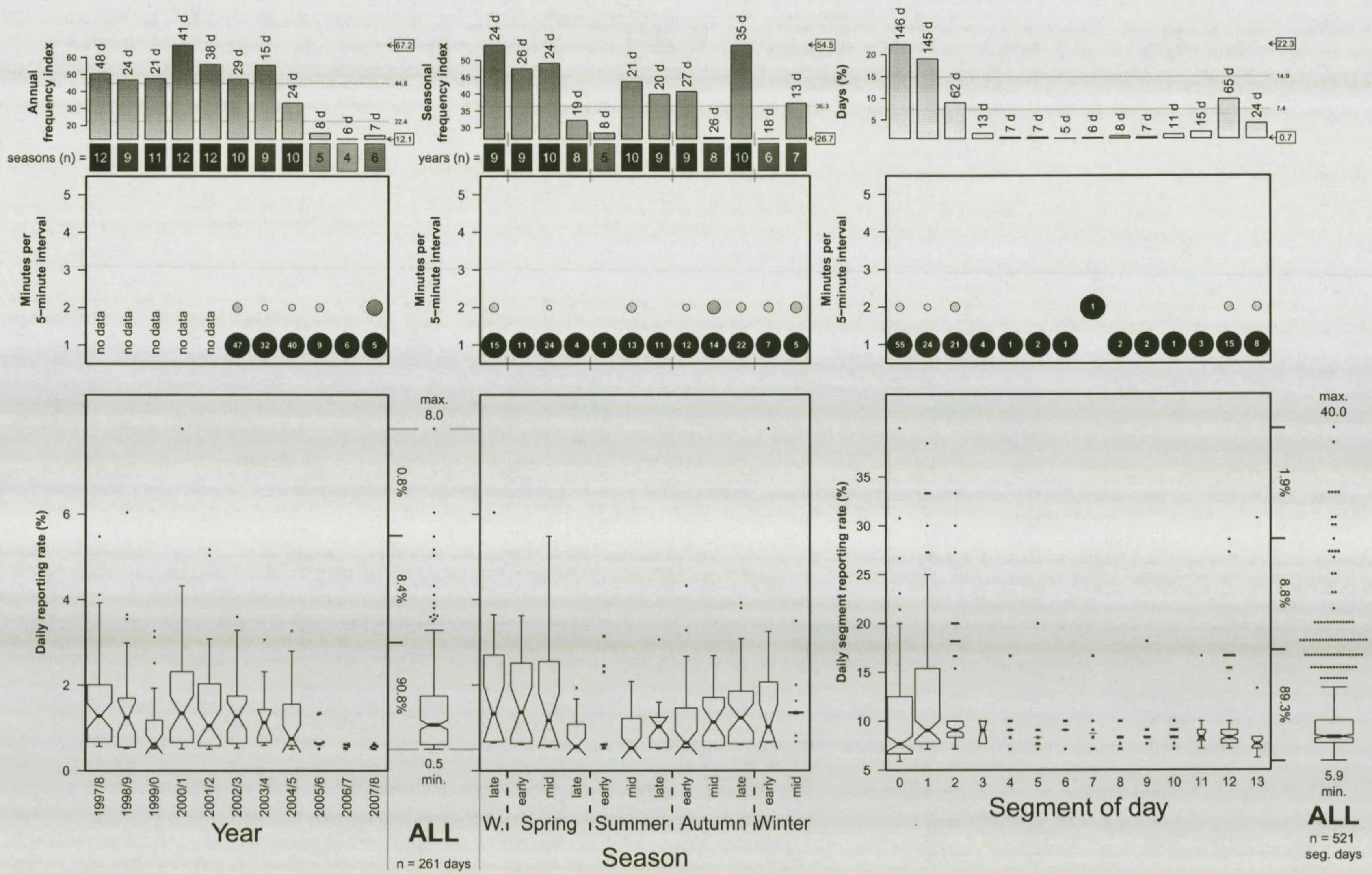


Figure 4.130: R234 Blue Korhaan — birds heard only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

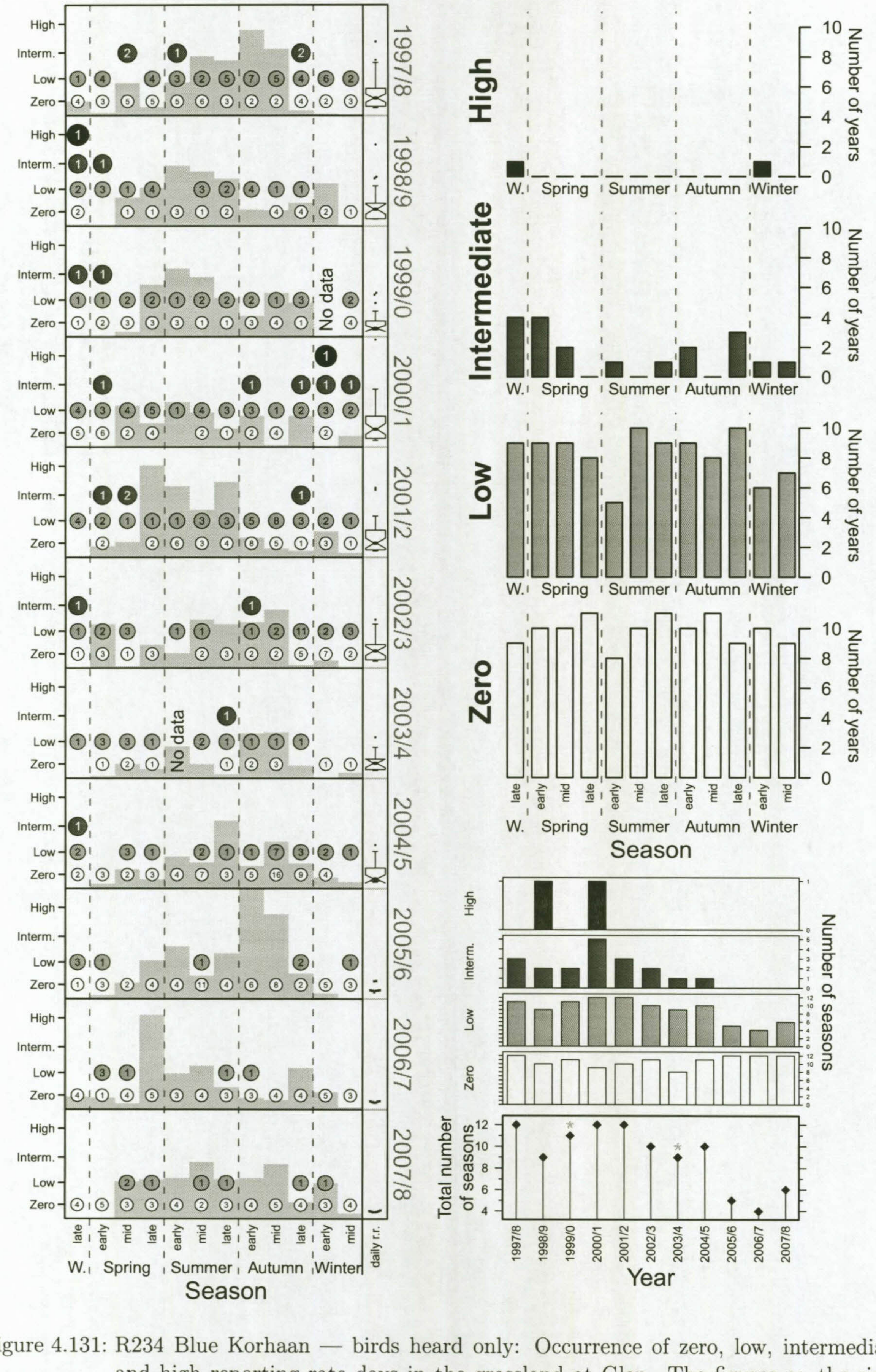


Figure 4.131: R234 Blue Korhaan — birds heard only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

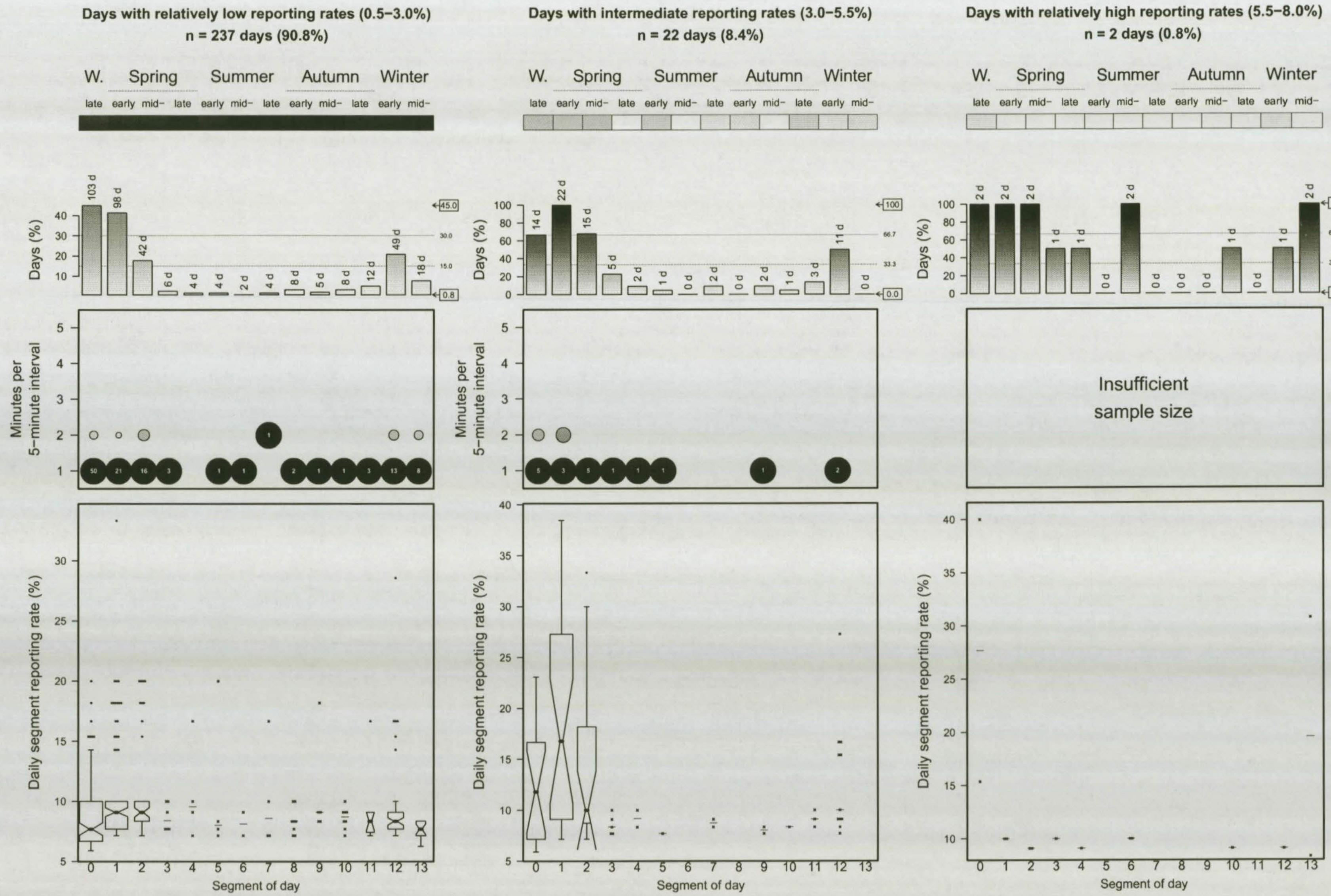
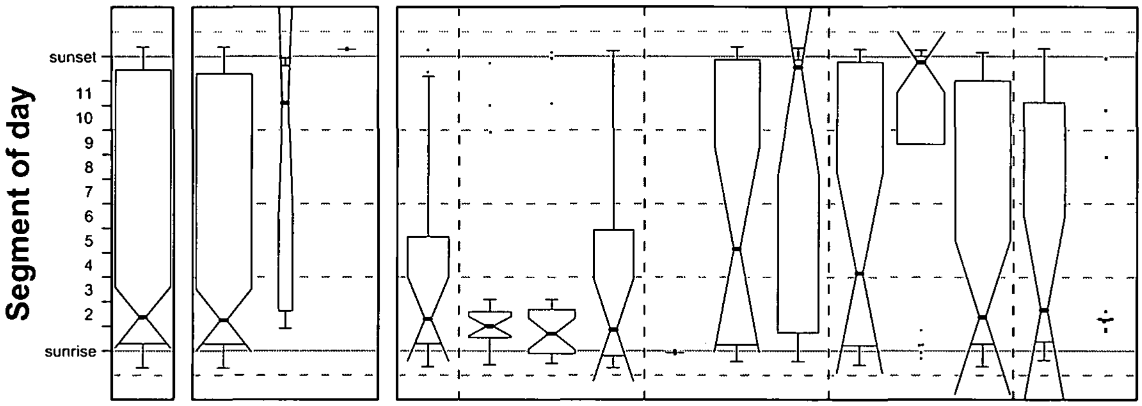
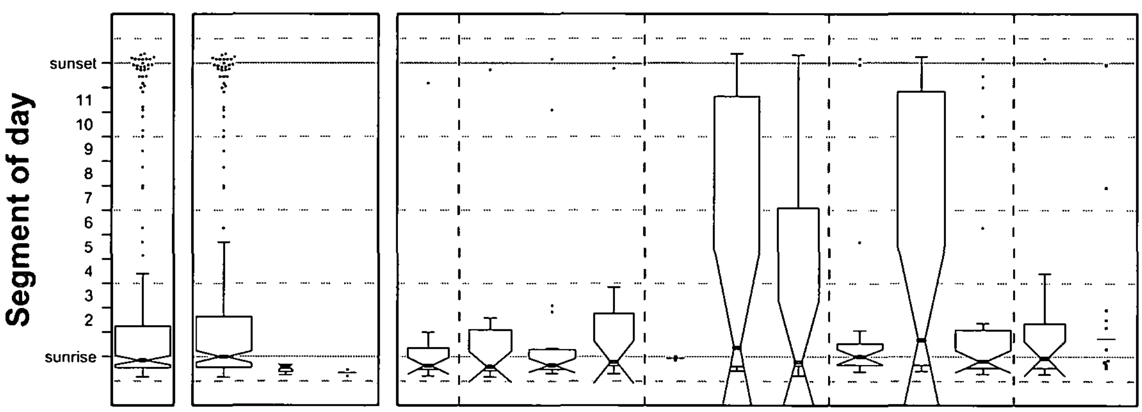


Figure 4.132: R234 Blue Korhaan — birds heard only: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.





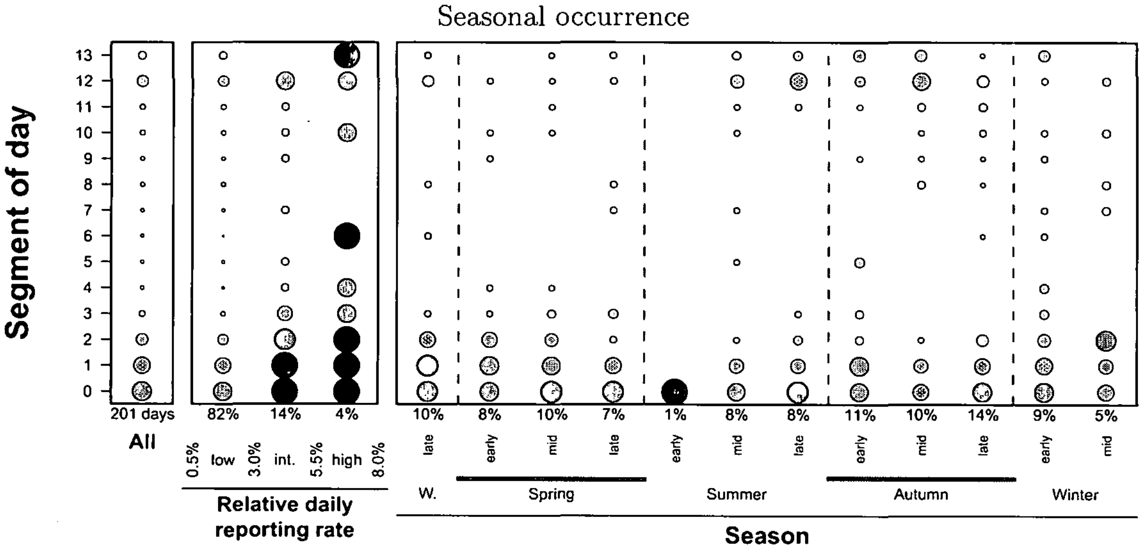


Figure 4.133: R234 Blue Korhaan — birds heard only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

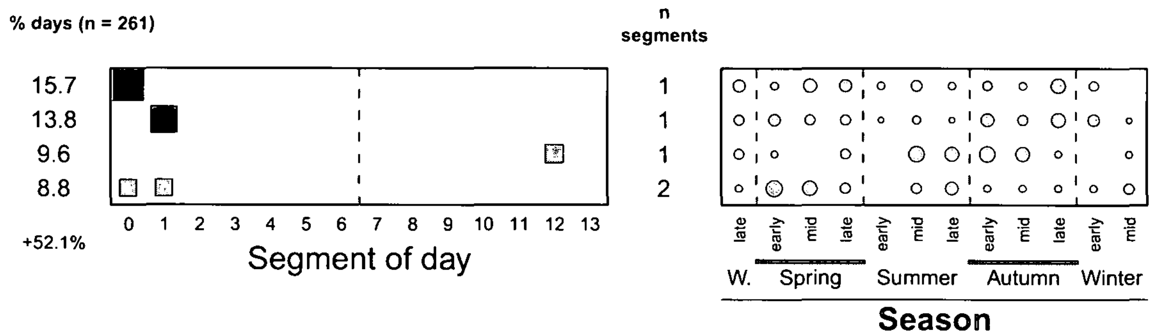


Figure 4.134: R234 Blue Korhaan — birds heard only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

The birds at Glen

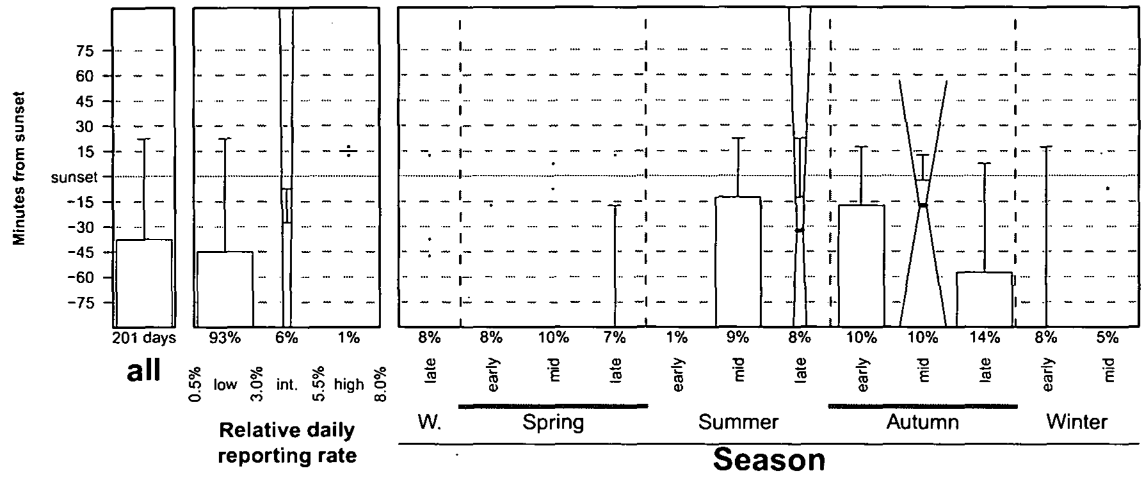
Distinction was made between terrestrial and aerial vocalisations of the Northern Black Korhaan. In addition to the obvious differences implied by these terms, the two vocalisation types can be readily distinguished by ear alone. Terrestrial vocalisations emanate from a bird on the ground or atop a termite mound and consist of a repeated, raucous sound which Maclean (1985) renders "*kraaak-kraaak*". As the name implies, aerial vocalisations comprise all sounds made by a bird or birds in flight and include birds involved in chasing as well as the so-called display flight (see Kemp & Tarboton 1976). A male engaging in either one of the two vocalisation modes may cause other birds to join in. These vocalisations are not restricted to normal daylight hours as they may also occur at any time of the night, especially around full moon. Breeding was recorded in the grassland.

No distinction was made between the two vocalisation types prior to spring 2000/1. Therefore, the data is analysed as follows: all vocalisations (1997/8–2007/8); terrestrial vocalisations (2000/1–2007/8); aerial vocalisations (2000/1–2007/8). Data was collected for each minute since 2001/2 (Table 4.27). Figures start on page 328.

Table 4.27: R239 Northern Black Korhaan: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

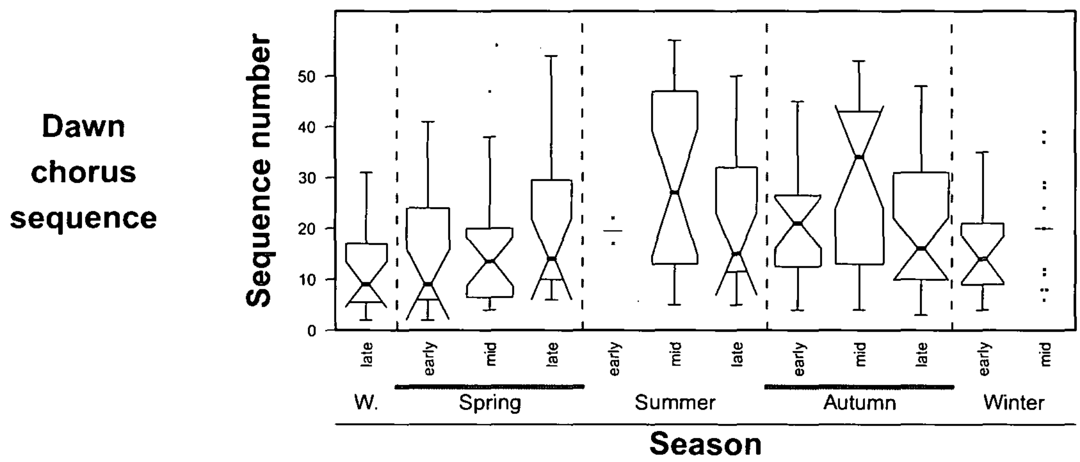
Activity	Recorded since...	n	Total	%
all vocalisations	late winter 2001/2	147 634	345 105	42.8
terrestrial vocalisations	late winter 2001/2	145 672	345 105	42.2
aerial vocalisations	late winter 2001/2	7 398	345 105	2.1

Annual occurrence of all vocalisations in the grassland: Heard on all days with an activity index of 111 (Table 4.28a). Daily reporting rates ranged from 0.8 to 100% with more than half of the bird-days attaining relatively high reporting rates (Fig. 4.137). Median daily reporting rates varied from year to year, being highest in 1999/0, 2000/1 and 2005/6, with 1999/0 and 2000/1 also being the only years without low reporting rate days (Fig. 4.137; Fig. 4.138). 2001/2 was an unusual year as its median daily reporting rate was exceptionally low



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

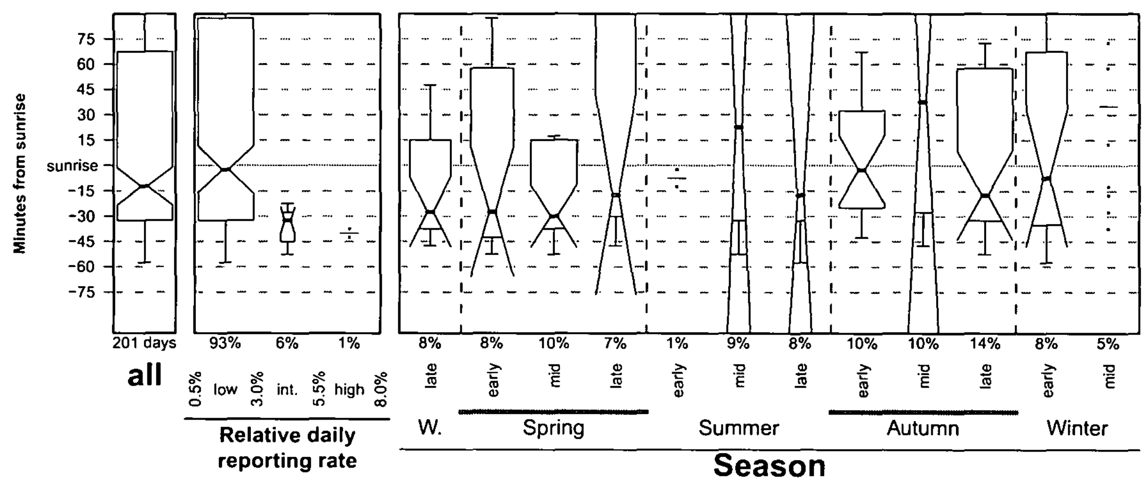


Figure 4.135: R234 Blue Korhaan — birds heard only: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

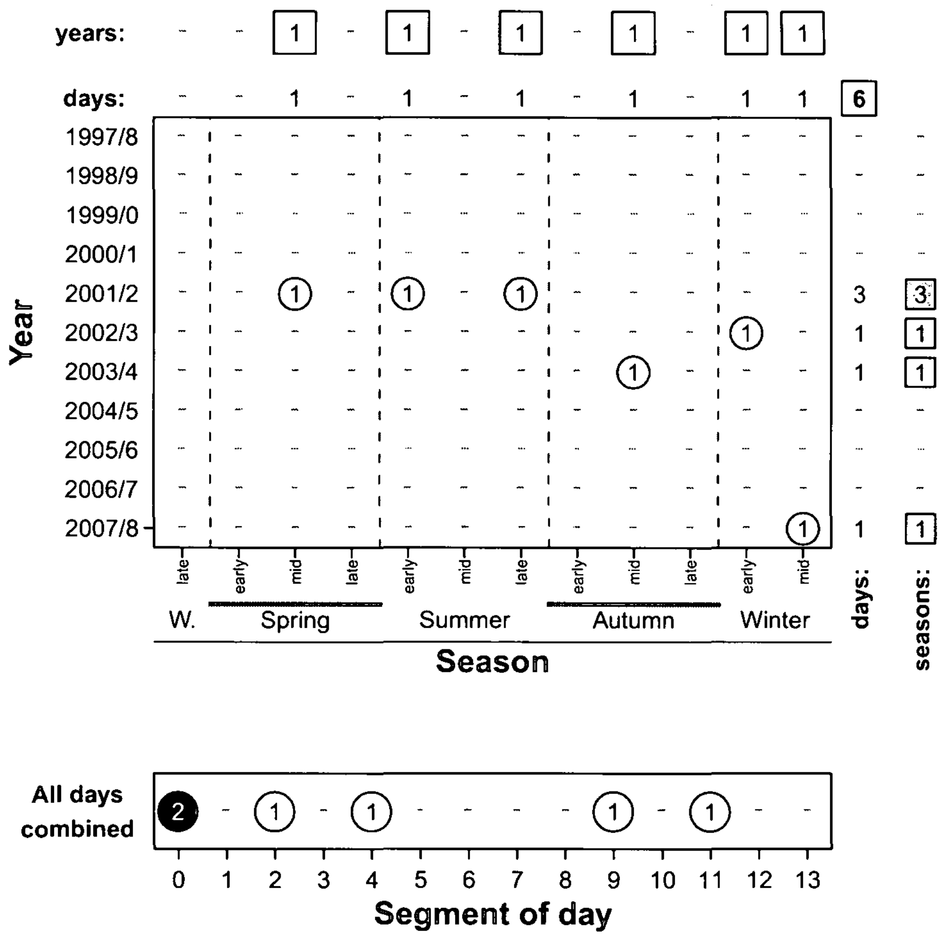


Figure 4.136: R234 Blue Korhaan — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

(Fig. 4.137). Figure 4.138 reveals that high reporting rate days ceased abruptly after early summer in that year. Since recorded in 2001/2 (Table 4.27), activity intensities were similar for all years (Fig. 4.137).

Seasonal occurrence of all vocalisations in the grassland: Median daily reporting rates followed a well-defined seasonal pattern with highest values from mid-spring to late summer and lowest values during winter (Fig. 4.137; Fig. 4.138). Activity intensities were also lowest during winter (Fig. 4.137).

Daily occurrence of all vocalisations in the grassland: Profound differences exist in the daily occurrence of vocalisations between low, intermediate and high reporting rate days respectively (Fig. 4.139). For low reporting rate days (day-frequency range 47.9–91.7%) vocalisations tend to occur more frequently in the late afternoon (Fig. 4.139). This is in contrast to those of intermediate reporting rate days (day-frequency range 84.8–98.8%) and especially high reporting rate days (day-frequency range 88.6–100%) during which vocalisations were approximately equally frequent during all segments of the day (Fig. 4.139). Seasonally, activity was almost

Table 4.28: R239 Northern Black Korhaan: Numerical data summary of 5-minute checklists compiled in the study area at Glen. voc. = vocalisations

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.552	72 797	114 612	63.5	all voc.	100.0	656	656	111
0.396	52 230	79 333	65.8	terrestrial voc.	100.0	463	463	113
0.051	6 738	79 333	8.5	aerial voc.	99.1	463	459	15
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.462	942	1 190	79.2	all voc.	100.0	43	43	22
0.461	940	79 333	1.2	terrestrial voc.	9.3	463	43	22
0.078	159	79 333	0.2	aerial voc.	8.0	463	37	4
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.472	976	1 188	82.2	all voc.	97.7	43	42	23
0.470	972	79 333	1.2	terrestrial voc.	9.1	463	42	23
0.058	119	79 333	0.2	aerial voc.	6.9	463	32	4

equally frequent throughout the day during all seasons (Fig. 4.140). This concurs with the occurrence of activity during all 14 segments during 60.2% bird-days, spread throughout the year (Fig. 4.141). The only other combination of segments to occur on more than 5% bird-days involved activity between sunrise and sunset (S1–S12) that was restricted to spring, summer and early and mid-autumn (Fig. 4.141).

The first activity of the day was often recorded more than 45 minutes before sunrise (Fig. 4.140; Fig. 4.142). In fact, on approximately a third of the days activity was already noted at the start of the observations (Fig. 4.140), implying that activity could have started even earlier. Compared to low reporting rate days, the first activity of the day was typically recorded earlier on intermediate, and earlier still on high reporting rate days (Fig. 4.140; Fig. 4.142). A seasonal pattern is also discernible with the first activity of the day occurring earliest from mid-spring to mid-summer and latest in early and mid-winter (Fig. 4.140; Fig. 4.142). A similar seasonal trend is reflected by the dawn chorus sequence (Fig. 4.142).

The last activity of the day was often recorded more than 30 minutes after sunset, and even later on high reporting rate days compared to either low or intermediate reporting rate days (Fig. 4.140; Fig. 4.142). The seasonal pattern is also distinct with activity occurring later during spring and summer than during late autumn and early or mid-winter (Fig. 4.140; Fig. 4.142).

Activity intensity changes from being most frequently one minute per 5-minute interval throughout the day for low reporting rate days, to being more frequent at higher intensities in the early morning and late evening on intermediate reporting rate days and most frequently (five minutes per 5-minute interval) throughout the day on high reporting rate days (Fig. 4.139). In the latter case the incidence of lower activity intensities are also relatively frequent around midday (Fig. 4.139).

Overall, daily segment reporting rates ranged from 5.9 to 100% with nearly two-thirds of the values relatively high (Fig. 4.137). For low reporting rate days, the median daily segment reporting rate of S12 was particularly high (Fig. 4.139). The same is true for intermediate reporting rate days. In addition to having generally higher daily segment reporting rates, the median daily segment reporting rate of S1 is also higher than that of most other segments (Fig. 4.139). Considering the high reporting rate days, the median daily segment reporting rates of all segments are greater than 80% compared to the intermediate reporting rate days where the late morning and early afternoon segments all showed median daily segment reporting rates of approximately 50% (Fig. 4.139). Seasonally, the daily segment reporting rate patterns for mid- and late spring, and early and mid-summer most closely resemble the pattern shown for high reporting rate days, while the pattern for early autumn lie somewhere between that of the low and intermediate reporting rate days (*cf.* Figs. 4.139 & 4.143).

Early morning occurrence of birds heard during 2007/8: All aspects of activity in the grassland and the drainage line were similar (Table 4.28b & c; Fig. 4.144).

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Terrestrial vocalisations: The figures for terrestrial vocalisations are so similar to those already discussed above that it would be superfluous to repeat it all here again. This similarity is here demonstrated only in Table 4.28a, were the degree of similarity can be judged from the 5-minute checklist reporting rate (63.5% vs. 65.8%), day reporting rate (both 100%) as well as the activity indices (111 vs. 112).

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Annual occurrence of aerial vocalisations in the grassland: Heard on 99.1% of the days with an activity index of 15 (Table 4.28a). Daily reporting rates ranged from 0.5 to 32.2% with 76.9% bird-days attaining relatively low reporting rates (Fig. 4.145). Median daily reporting rates was similar for all years with no high reporting rate days occurring from 2004/6 to 2006/7 (Fig. 4.145; Fig. 4.146). Activity intensities for which data was collected since 2001/2 only (Table 4.27) were similar for the respective years (Fig. 4.145).

Seasonal occurrence of aerial vocalisations in the grassland: Median daily reporting rates followed a well-defined seasonal pattern with a peak in late spring and early summer and relatively low values from late summer to late winter (Fig. 4.145). This coincided with the occurrence of high and especially intermediate reporting rate days that peaked from mid-spring to mid-summer (Fig. 4.145; Fig. 4.146). Activity intensities were similar for all seasons (Fig. 4.145).

Daily occurrence of aerial vocalisations in the grassland: Overall, activity was most frequent during the late afternoon with activity otherwise also relatively frequent, occurring during at least 22.9% of the days (Fig. 4.145). This general pattern is largely a reflection of the situation for low reporting rate days. For intermediate and high reporting rate days activity was frequent throughout the day, occurring on more than half the days involved (Fig. 4.147). This pattern closely resembles that of late spring, while the pattern for winter is most like that for low reporting rate days (Fig. 4.148). No segment combinations occurred during more than 5% bird-days.

The first activity of the day frequently occurred during the first half of the morning, and earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.148; Fig. 4.149). The timing of the first activity of the day show a well-defined seasonal pattern, being largely confined to the period before sunrise from mid-spring to late summer and occurring well after sunrise during winter (Fig. 4.148; Fig. 4.149). This seasonal trend does not match the dawn chorus sequence (Fig. 4.142) very well.

The last activity of the day was typically recorded after sunset, tending to be later on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.148; Fig. 4.149). Except for mid-winter when the last activity of the day was frequently recorded before sunset, it was typically recorded there after during all other seasons (Fig. 4.148; Fig. 4.149).

Activity intensities were the same for all parts of the day; most frequently one minute per 5-minute interval (Fig. 4.147).

Overall, daily segment reporting rates ranged from 4.8 to 78.6% with 87.3% of the values relatively low (Fig. 4.145). Median daily segment reporting rates were consistently higher in the late afternoon before sunset (S12; Fig. 4.147; Fig. 4.150).

Early morning occurrence of aerial vocalisations during 2007/8: Nearly all aspects of activity in the grassland and the drainage line were similar (Table 4.28b & c; Fig. 4.151).

Discussion

At Barberspan, Farkas (1962) noted that Northern Black Korhaans are heard throughout the year and that their "call is especially prominent just before and after rain in the daytime as well as at night." He also described fights between 4–6 males in "early spring" that may end with the group scattering with "a loud commotion", presumably referring to birds in flight. Allan (2005a), referring to unpublished data of W. R. Tarboton at Nylsvley in Limpopo Province, stated that the birds call throughout the year, least often during the non-breeding season. Breeding is recorded throughout the year with a peak from September to March [mid-spring to mid-autumn] (Allan 2005a). At Glen both terrestrial and aerial vocalisations was recorded throughout the year and peaked during late spring and early summer (Fig. 4.137; Fig. 4.145).

The unusually low terrestrial vocalisation reporting rates during 2001/2 (Fig. 4.137) is the result of a sudden decrease in daily reporting rates in mid-summer following the exceptionally good rains of late spring and early summer (Fig. 4.138). It is unclear, however, why this happened.

The data from Glen supports the idea — first suggested by Allan (1997e) in his assessment of the SABAP1 data and later also by Colahan (2003b) in his interpretation of greater mean summer densities shown by CAR[2] data from the southern and north-western Free State — that Northern Black Korhaan male conspicuousness affect the detectability of the species.

[2]CAR: Coordinated Avifaunal Roadcounts. See Young *et al.* (2003).

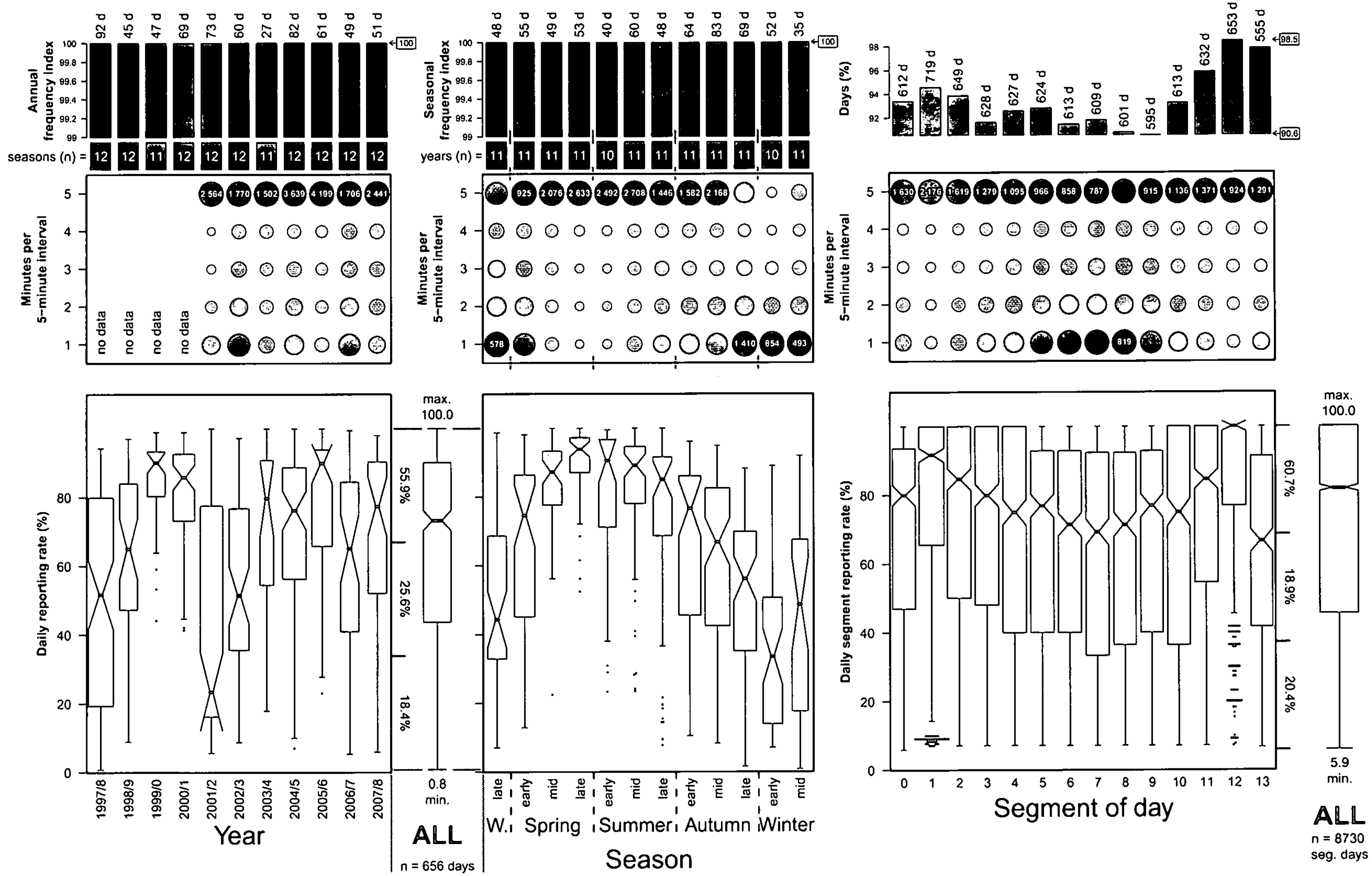


Figure 4.137: R239 Northern Black Korhaan — all vocalisations: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

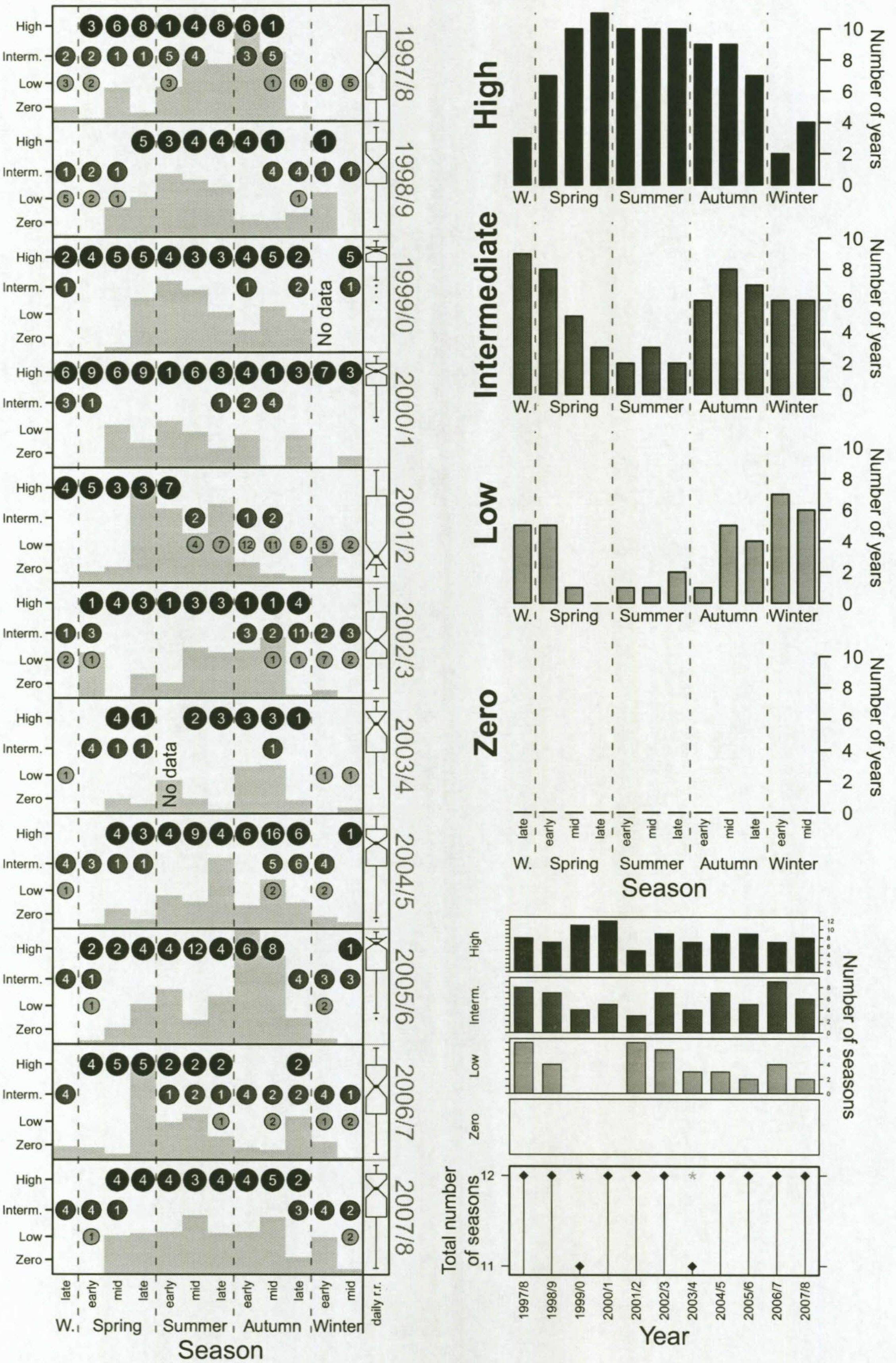


Figure 4.138: R239 Northern Black Korhaan — all vocalisations: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

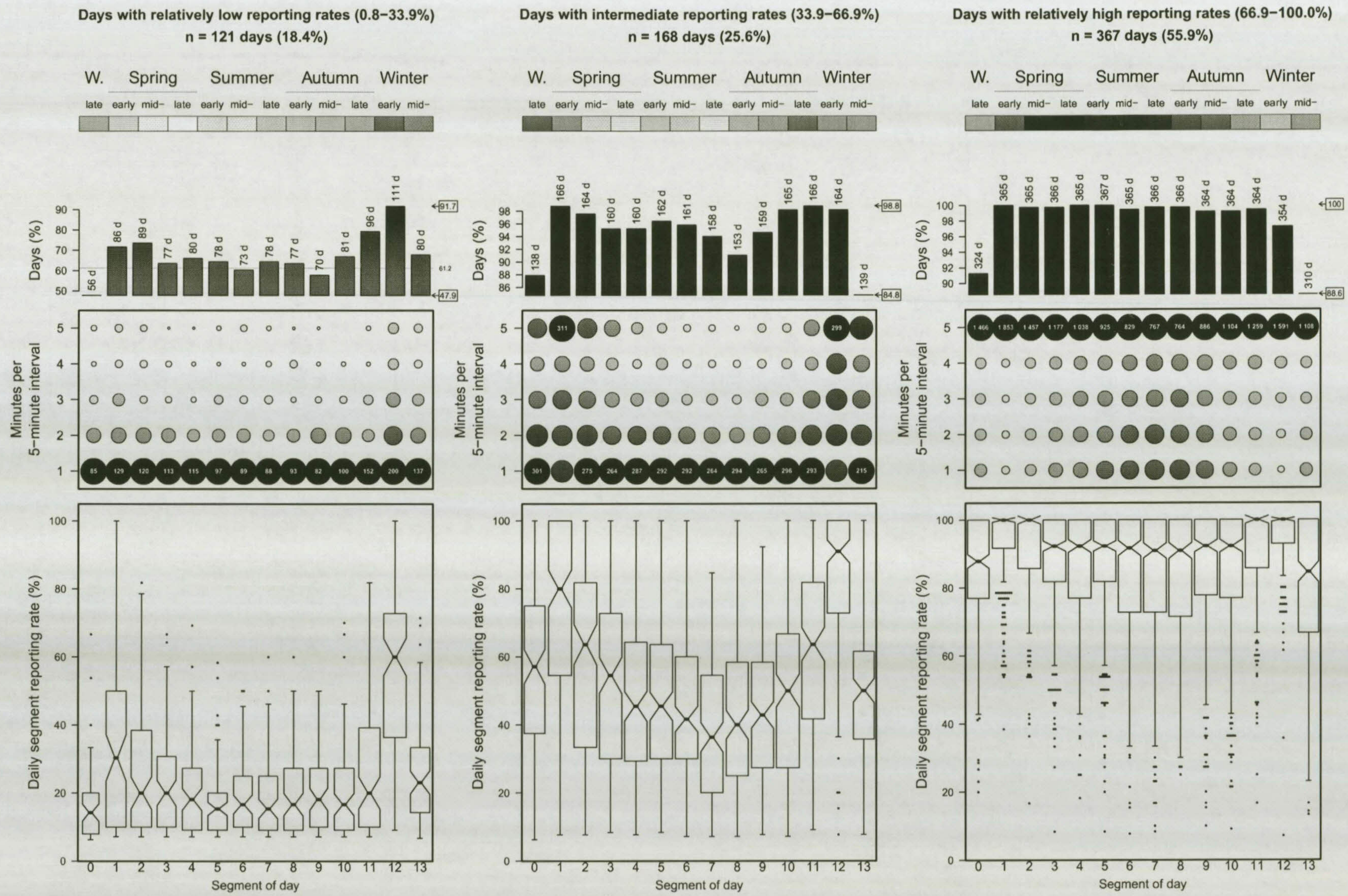


Figure 4.139: R239 Northern Black Korhaan — all vocalisations: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

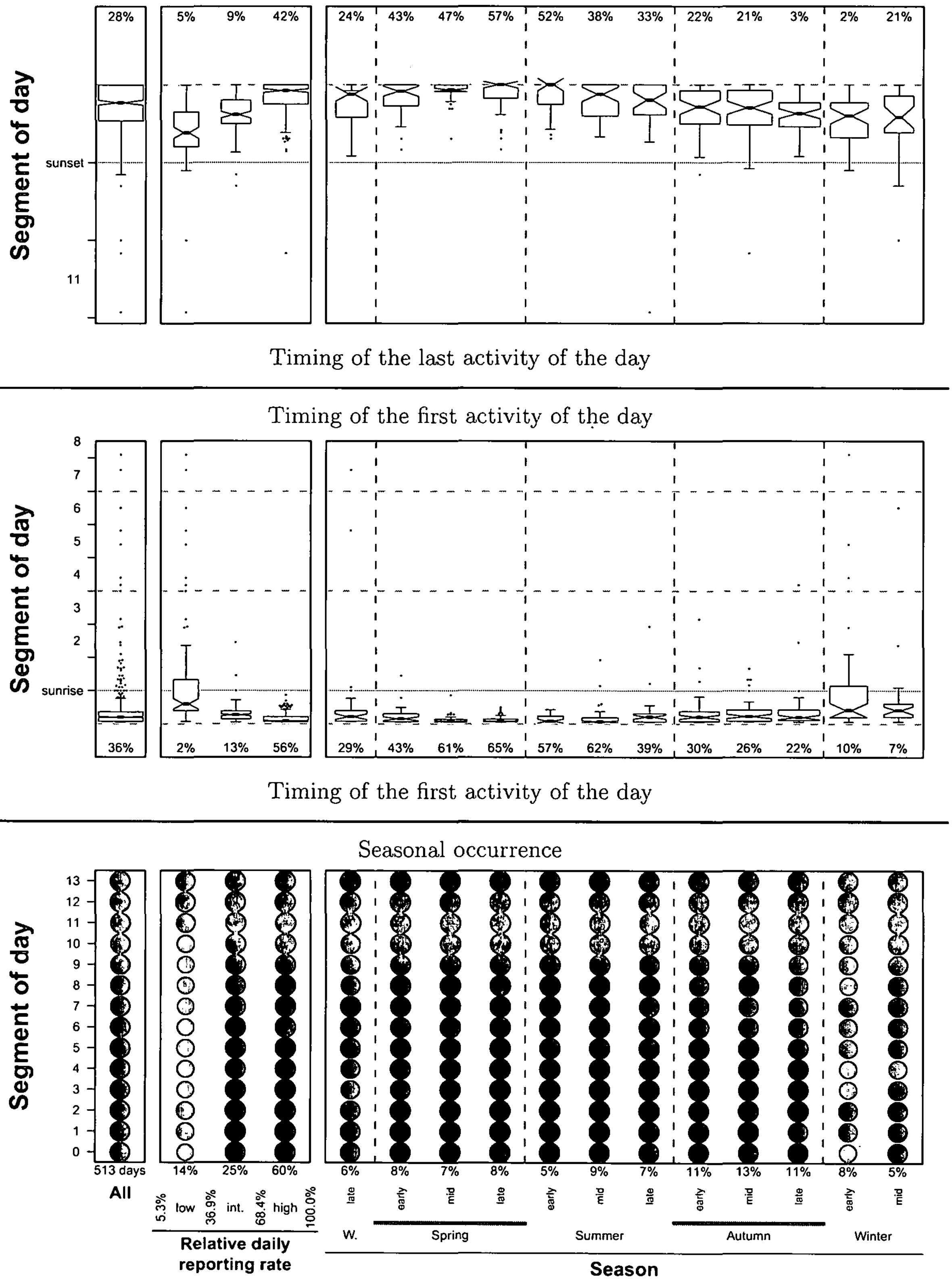


Figure 4.140: R239 Northern Black Korhaan — all vocalisations: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

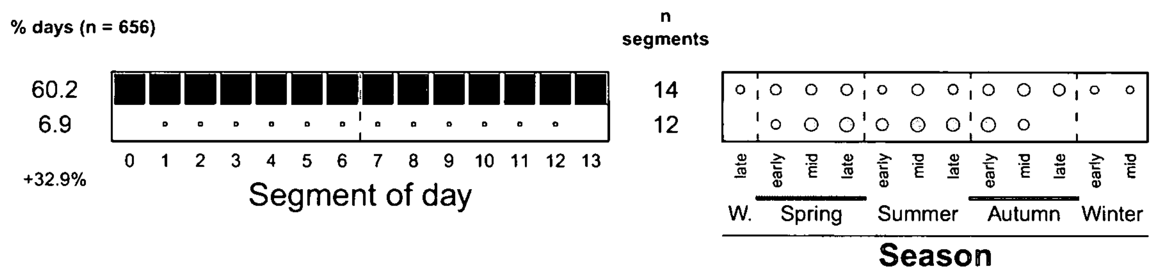


Figure 4.141: R239 Northern Black Korhaan — all vocalisations: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

4.20 Charadriidae: Plovers, Lapwings

Plovers and lapwings, of which there are 67 species, have a worldwide distribution with 21 species occurring in southern Africa (Hockey *et al.* 2005). Nine of these occur in the Free State of which four are scarce or localised, one occurs in the eastern parts and four others are widespread in the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). The latter group includes the Three-banded Plover R249, Crowned Lapwing R255, Blacksmith Lapwing R258 and Kittlitz's Plover *Charadrius pecuarius*. Only the latter species was not recorded at Glen.

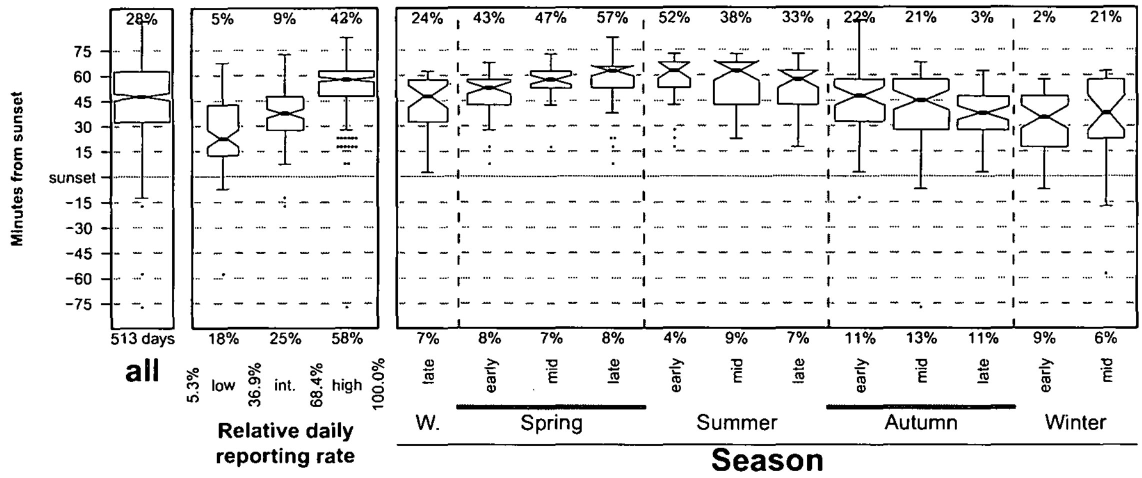
R249 Three-banded Plover .... *Charadrius tricollaris*

The Three-banded Plover occurs in Africa and Madagascar (Maclean 1985). In southern Africa it is particularly widespread in Zimbabwe, Swaziland, Lesotho and South Africa, occurring in the widest range of aquatic habitats of any wader in southern Africa (Tree 1997a). Its movements are complex with populations consisting of a mixture of resident, migratory and nomadic elements (Maclean 1985; Taylor *et al.* 1999; Tree 1997a, 2003; Underhill *et al.* 1999). Based on ringing studies and other observations in Zimbabwe and elsewhere in southern Africa, including the Free State, Tree (2003) suggested that widespread movements occur from April to August [mid-autumn to early spring].

The birds at Glen

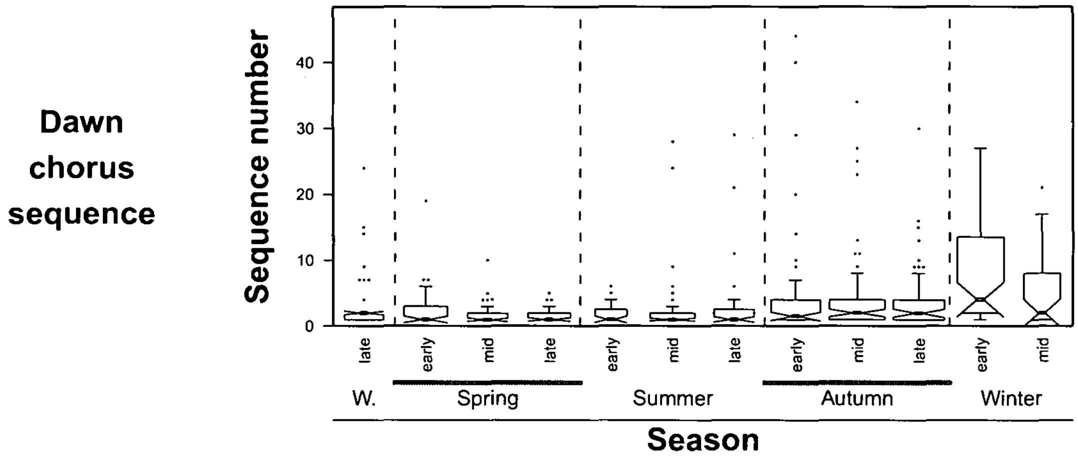
The Three-banded Plover was only recorded as birds heard in flight during four days in the grassland and on two days in the drainage line as follows:

Habitat	Year	Season	Segment
Grassland	1997/8	late autumn	2
Grassland	1998/9	mid-spring	3
Drainage line	2000/1	late autumn	11
Grassland	2002/3	late autumn	2
Grassland	2002/3	late autumn	2
Drainage line	2007/8	mid-autumn	0



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

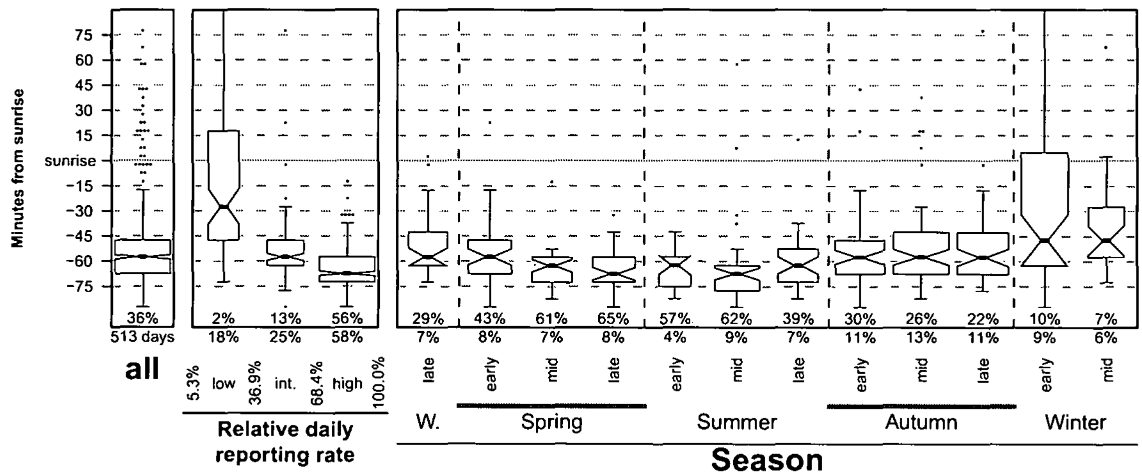


Figure 4.142: R239 Northern Black Korhaan — all vocalisations: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

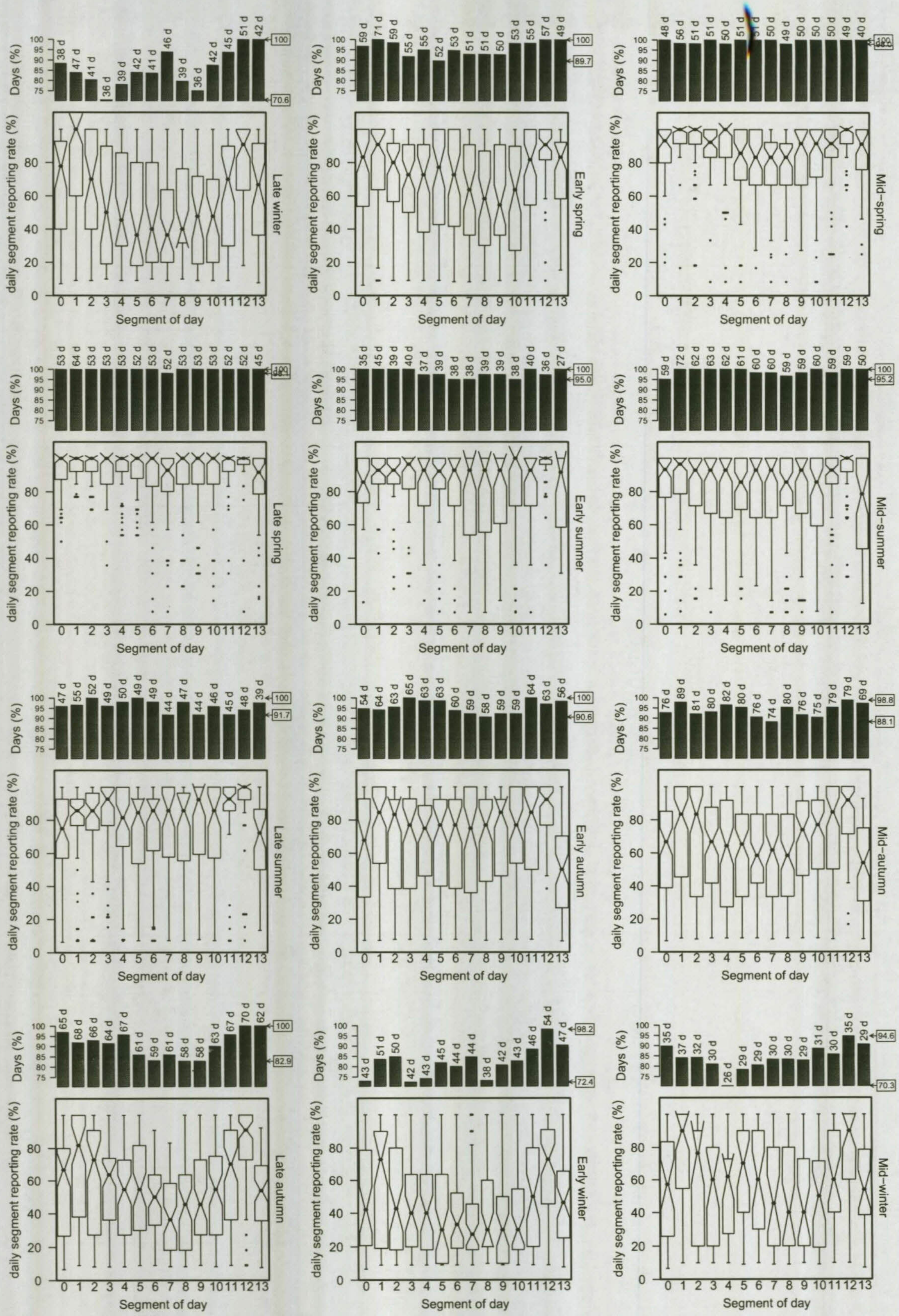
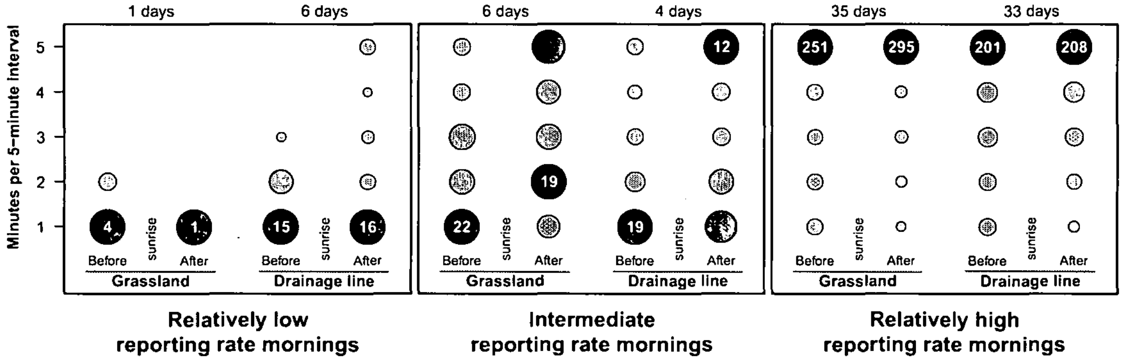
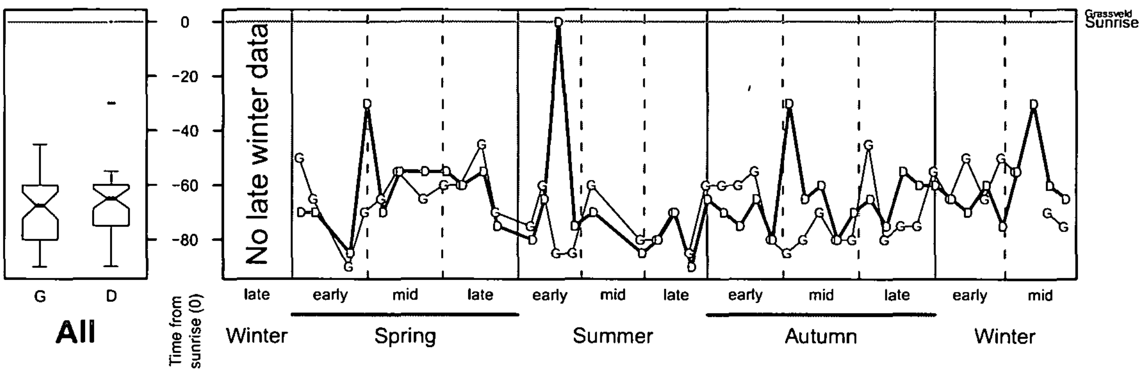


Figure 4.143: R239 Northern Black Korhaan — all vocalisations: Seasonal fluctuations in daily occurrence in the grassland at Glen. See page 136 for more information on this seasonal detail figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

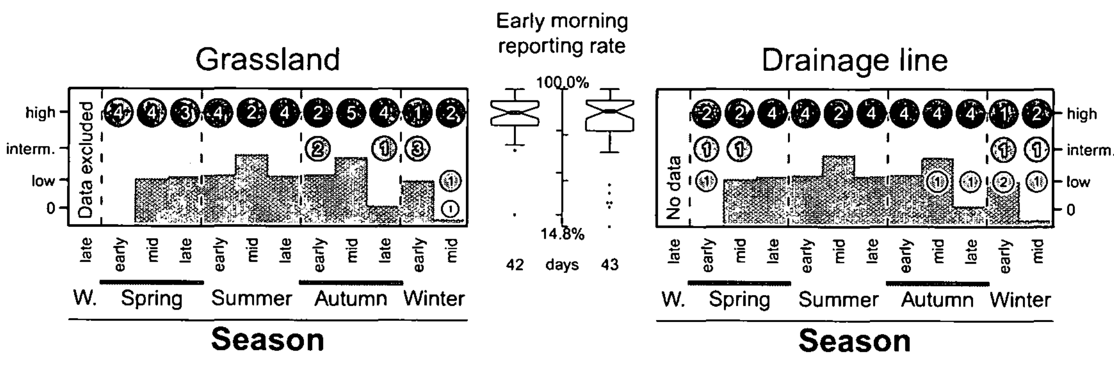


Figure 4.144: R239 Northern Black Korhaan — all vocalisations: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

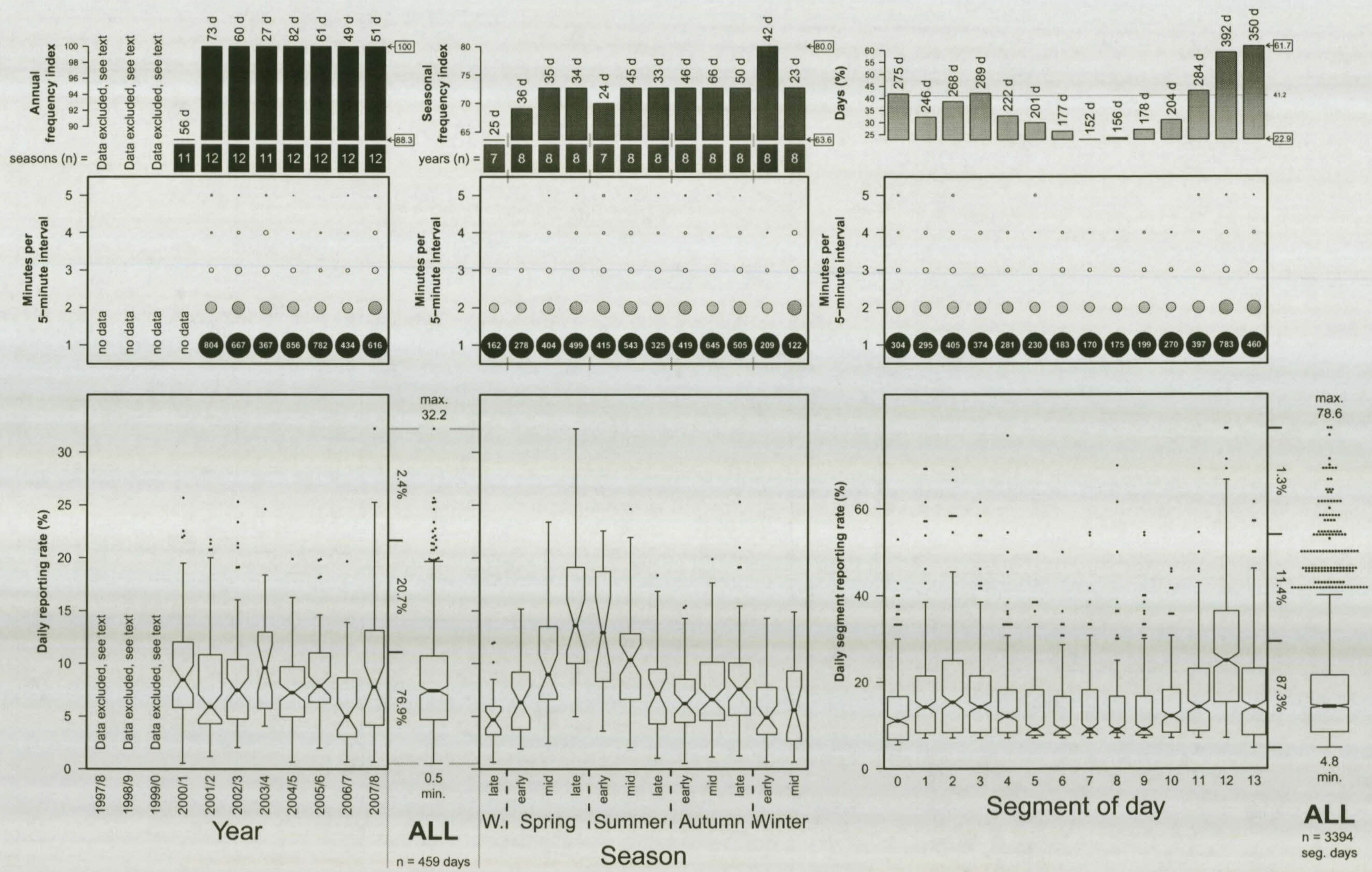


Figure 4.145: R239 Northern Black Korhaan — aerial vocalisations: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

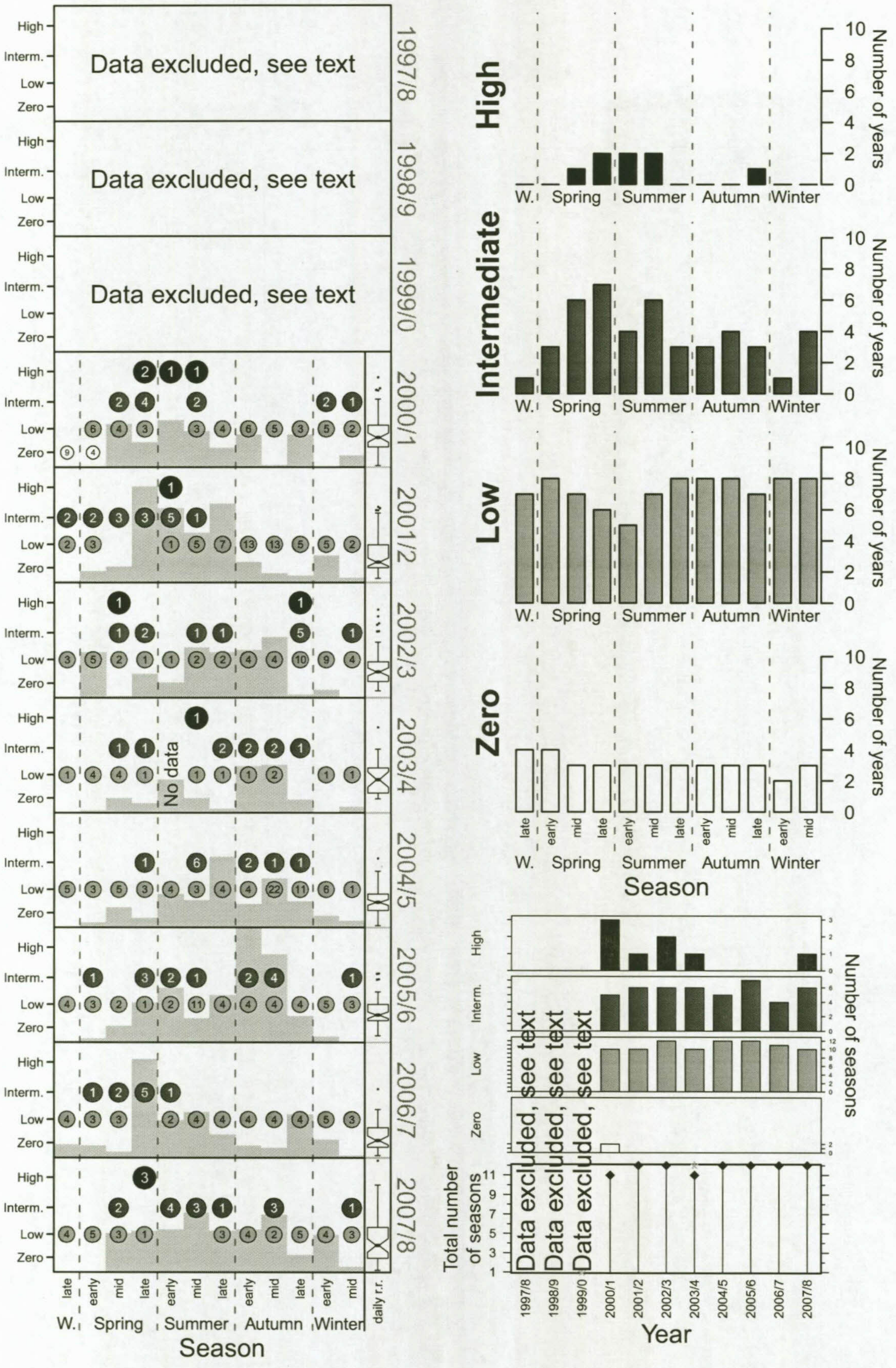


Figure 4.146: R239 Northern Black Korhaan — aerial vocalisations: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

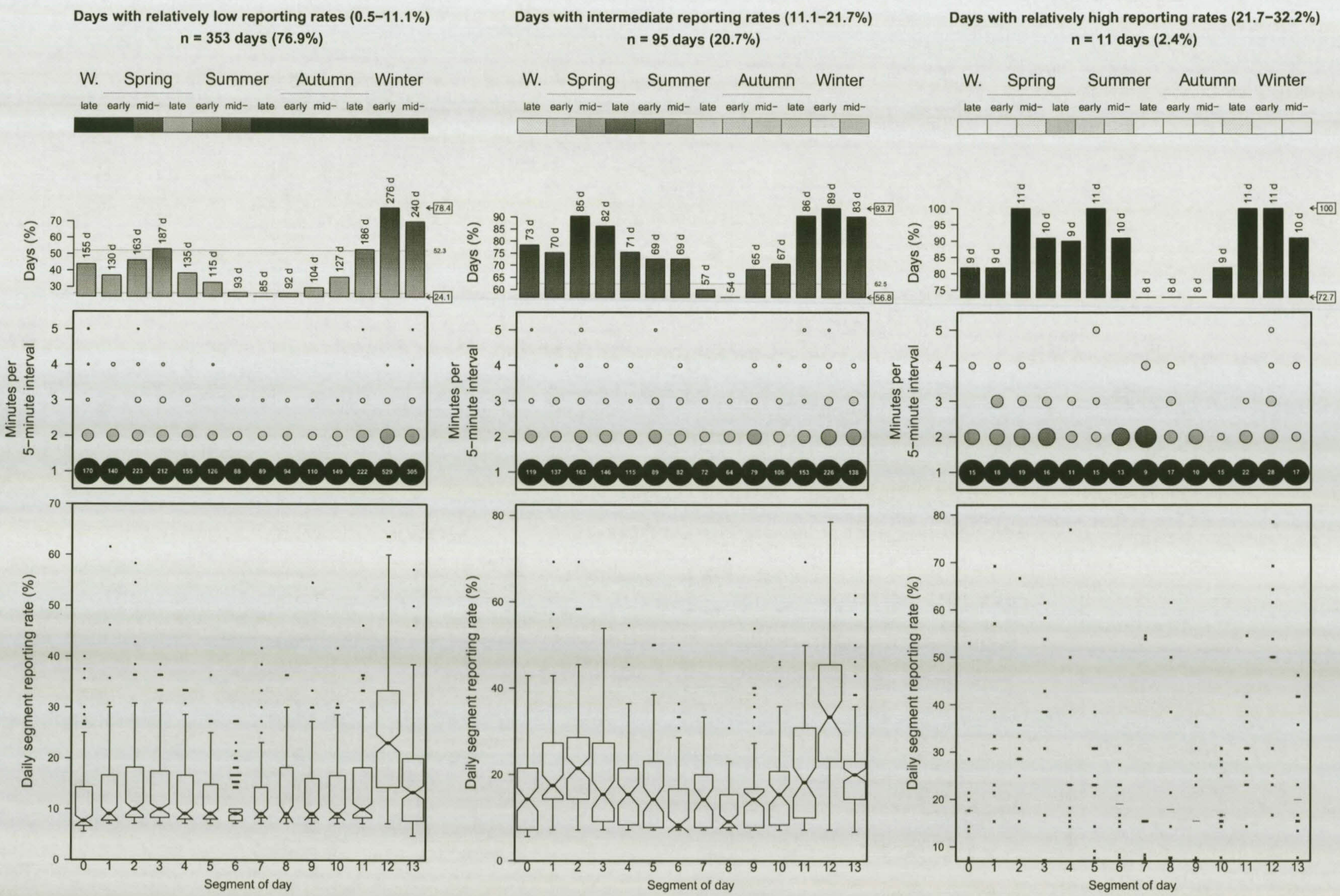


Figure 4.147: R239 Northern Black Korhaan — aerial vocalisations: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

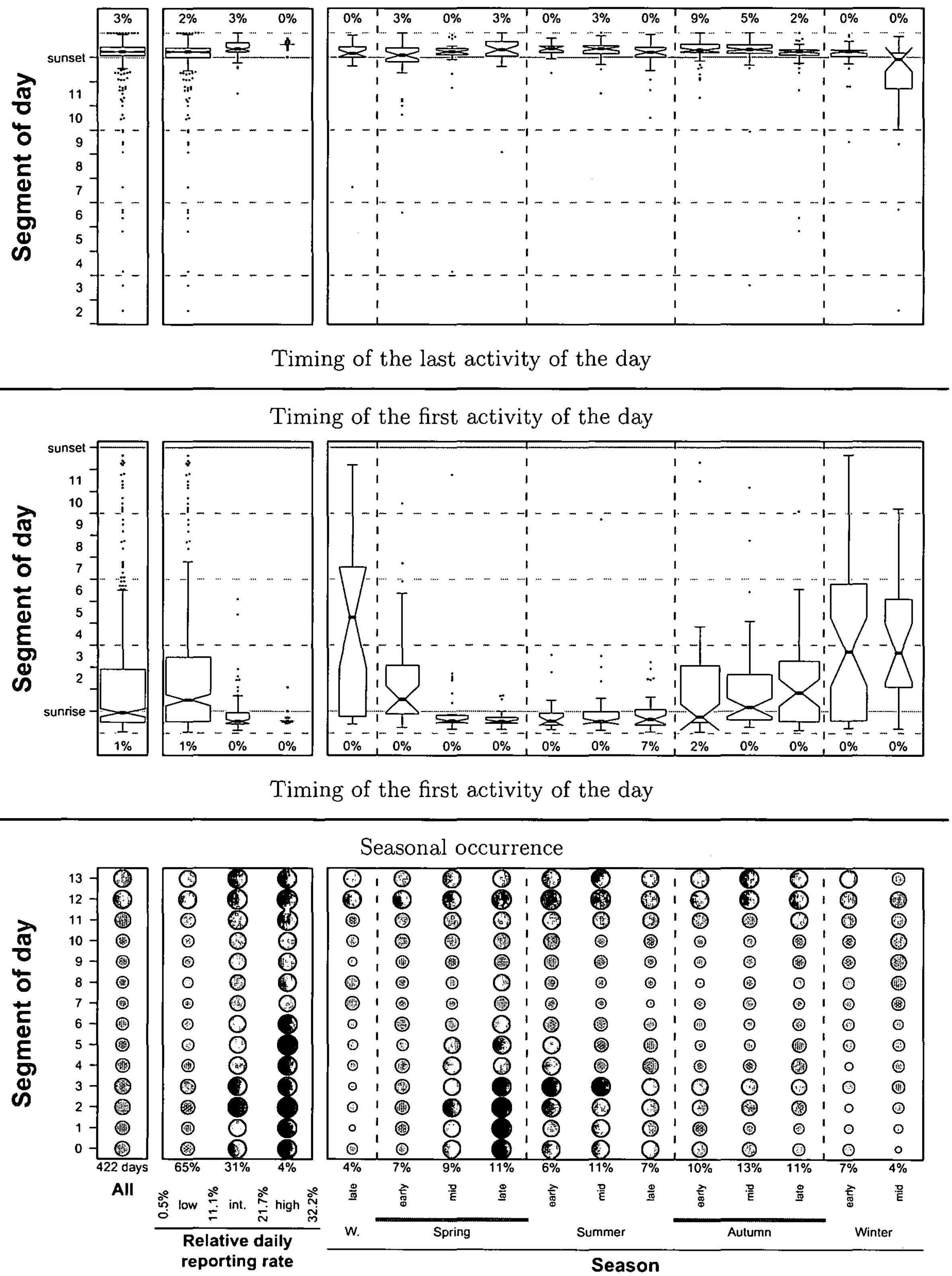
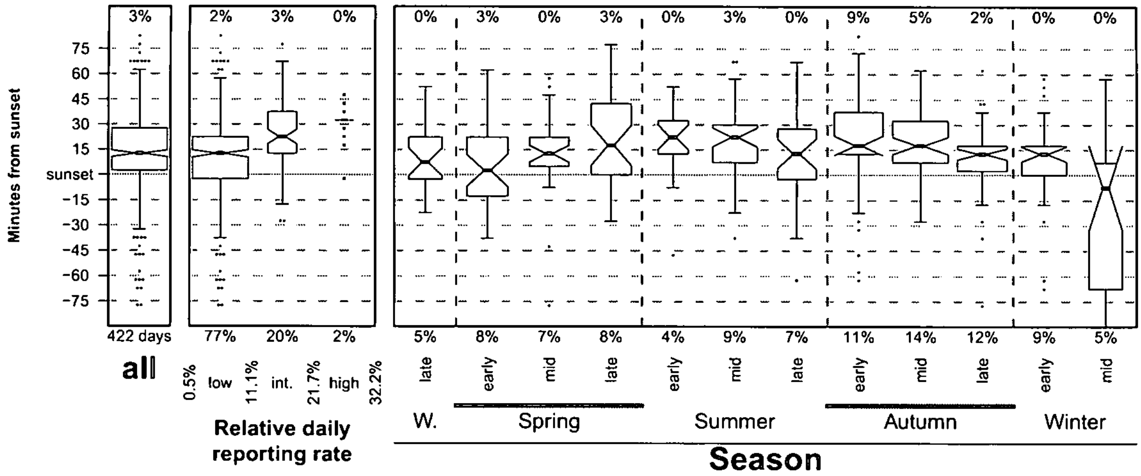


Figure 4.148: R239 Northern Black Korhaan — aerial vocalisations: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.



Last activity of the day

First activity of the day

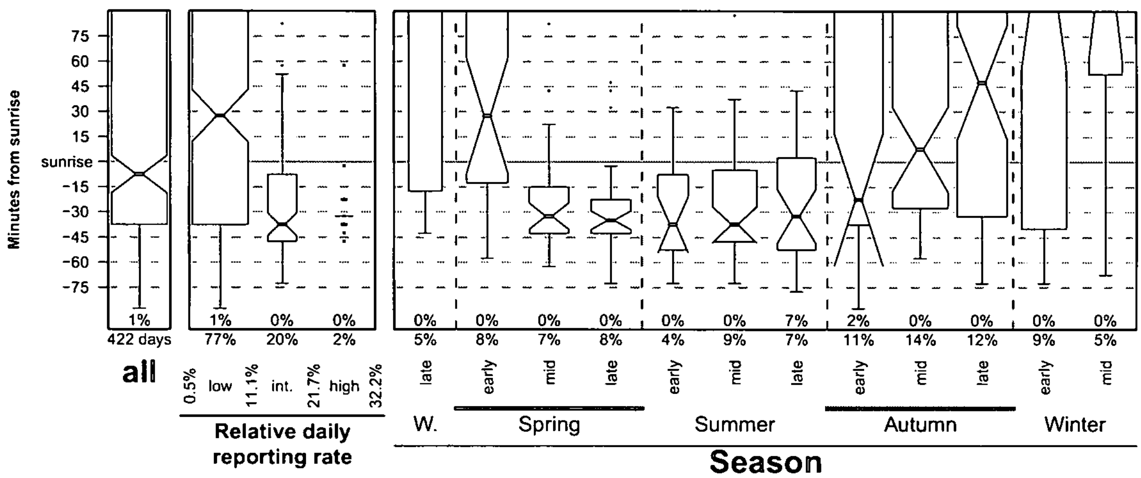


Figure 4.149: R239 Northern Black Korhaan — aerial vocalisations: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. See page 136 for more information on this detailed first/last activity figure.

Discussion

The concentration of Three-banded Plover records during mid- and particularly late autumn, which translates to March and April, appears to be more than coincidental. It is suggested that this involves birds on passage and lends further support to Tree's (2003) concept of widespread movements from April to August.

R255 Crowned Lapwing .... *Vanellus coronatus*

The Crowned Lapwing is endemic to Africa (Maclean 1985). It is widespread over much of southern Africa with the Free State forming part of its core distribution (Ward 1997). It favours habitats with short grass (Maclean 1985; Ward 1997). In South Africa it is considered to be resident subject to local movements in response to changing conditions (Underhill *et al.* 1999; Ward 1997).

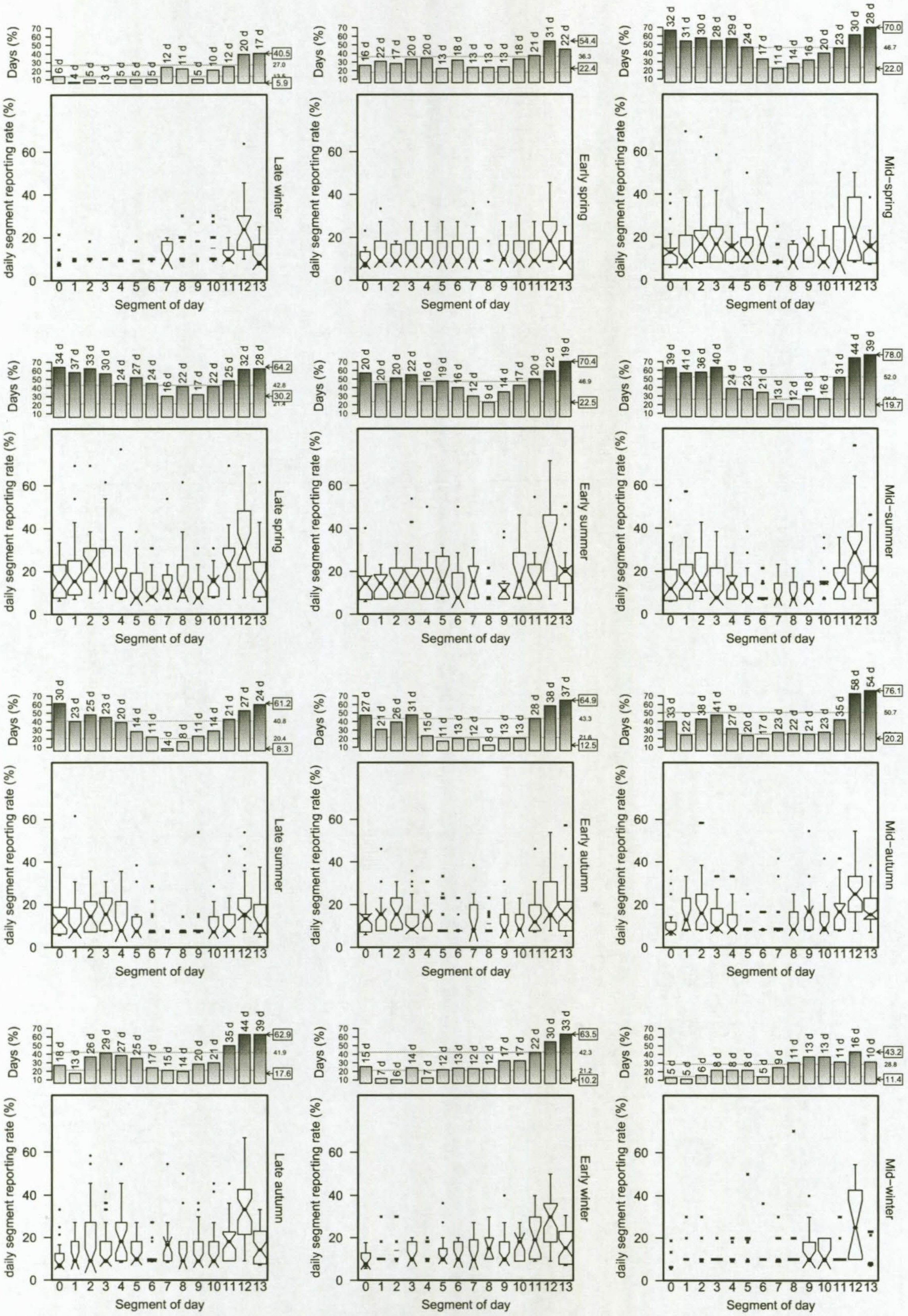
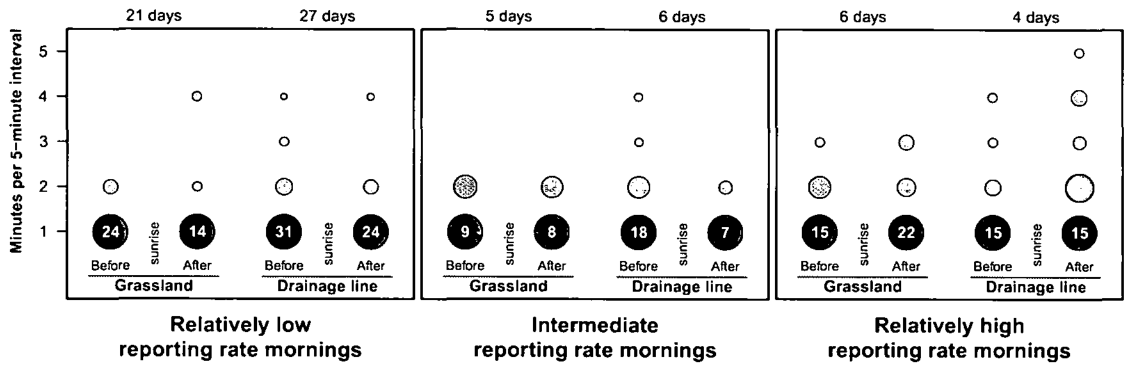
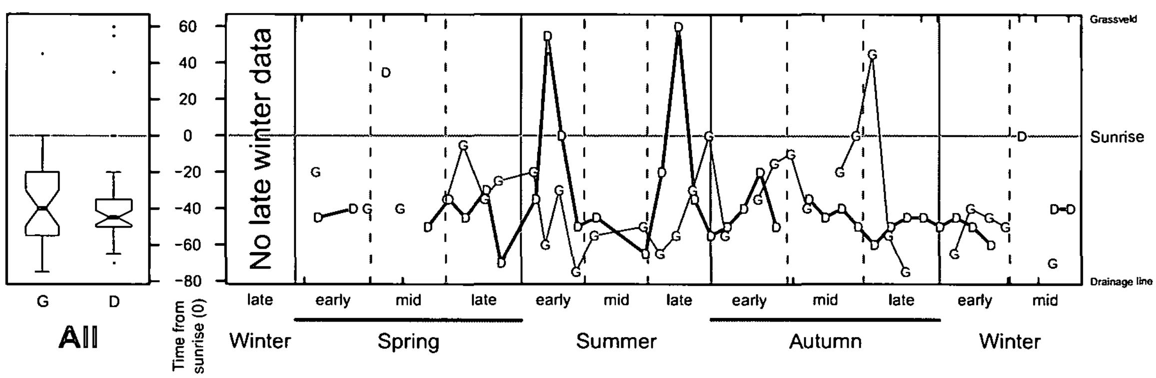


Figure 4.150: R239 Northern Black Korhaan — aerial vocalisations: Seasonal fluctuations in daily occurrence in the grassland at Glen. See page 136 for more information on this seasonal detail figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

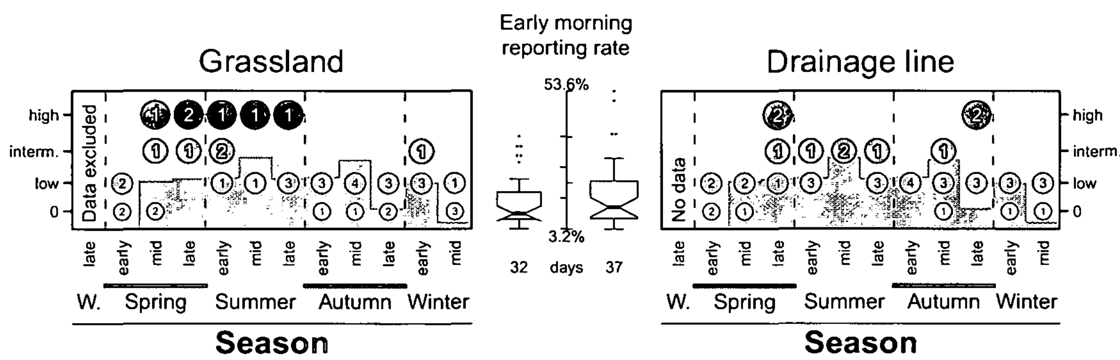


Figure 4.151: R239 Northern Black Korhaan — aerial vocalisations: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

The birds at Glen

The Crowned Lapwing is closely associated with the trampled areas around watering points or licks in the grassland, reflecting their preference of short grass habitats. Breeding has been recorded in these habitats, including those in the study area. They usually occur in small flocks of two to five birds, but as many as seven birds were recorded. They are very noisy birds, even at night. Only data on vocal birds are presented here. An unknown number of incidents involved birds that reacted to the observer's presence, thus introducing a degree of bias in the data. Figures start on page 345.

Annual occurrence of vocal birds in the grassland: Heard on 91.9% of the days with an activity index of 14 (Table 4.29a). Recorded during all seasons each year, except 2003/4 when recorded from only eight seasons (Fig. 4.152). Compared to other years, the occurrence of days with zero records were exceptionally frequent during 1997/8 (Fig. 4.153). This is probably because limited observations were made during S0 in that year (Fig. 3.4; Fig. 3.5), *i.e.* the time of day when the birds are most frequently recorded (see below). Daily reporting rates ranged from 0.5 to 36.4% with three quarters of the day attaining low values (Fig. 4.152). The median daily reporting rates of 1998/9, 2000/1, 2002/3 and 2006/7 were higher than that of 2007/8 (Fig. 4.152).

Table 4.29: R255 Crowned Lapwing: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	8 707	114 612	7.6	birds heard	91.9	656	603	14
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	68	1 190	5.7	birds heard	62.8	43	27	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	96	1 188	8.1	birds heard	65.1	43	28	3

Seasonal occurrence of vocal birds in the grassland: Recorded during 9–11 years each season (Fig. 4.152). Median daily reporting rates and particularly the upper quartile were slightly higher during spring and late autumn than during other seasons (Fig. 4.152). High reporting rate days were particularly frequent in early spring and again in late autumn while intermediate reporting rate days peaked in mid- and late spring as well as in mid- and late autumn (Fig. 4.153). The occurrence of days with no records were slightly more frequent during winter than during other seasons (Fig. 4.153).

Daily occurrence of vocal birds in the grassland: Overall, activity occurred most frequently in the early morning and late afternoon (Fig. 4.152). This trend was similar for low and intermediate reporting rate days, and also partially matched the pattern of high reporting rate days during which activity was relatively frequent throughout the day (Fig. 4.154). Each season generally showed patterns similar to that of low reporting rate days (Fig. 4.155). No segment combinations occurred on more than 5% bird-days.

The first activity of the day frequently occurred before sunrise, in general starting earlier during summer, early and mid-autumn than during other times of the year (Fig. 4.155; Fig. 4.156). In addition, the timing of the first activity of the day was more variable during late autumn, winter and spring than during summer, early and mid-autumn (Fig. 4.155; Fig. 4.156). The overall seasonal pattern is similar to that shown by the dawn chorus sequence (Fig. 4.156).

The timing of the last activity of the day was typically after sunset, and frequently later on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.155; Fig. 4.156). Seasonally the timing was most variable and earliest during winter and least variable and latest during summer (Fig. 4.155; Fig. 4.156).

Overall, daily segment reporting rates ranged from 5.3 to 100% with 86.1% of the values relatively low (Fig. 4.152). Median daily reporting rates were higher in the early morning and late afternoon than during the middle part of the day, a trend which is more evident for intermediate and high reporting rate days than for low reporting rate days (Fig. 4.154).

Early morning occurrence of vocal birds during 2007/8: Recorded equally frequently from the drainage line and the grassland (Table 4.29b & c). The median early morning reporting rate as well as the seasonal occurrence of high and intermediate reporting rate days are also similar (Fig. 4.157). The timing of the first activity of the day was similar too (Fig. 4.157). The activity intensity in the drainage line (no data collected in the grassland) was slightly higher before sunrise than after sunrise on intermediate reporting rate mornings (Fig. 4.157).

Discussion

Breeding in the Crowned Lapwing is recorded throughout the year with a peak from August to December [early spring to mid-summer] (Turpie & Ryan 2005). Adult birds presumably undergo a complete moult annually which may overlap with breeding (Turpie & Ryan 2005). A study in the Free State shown that primary moult occurs mainly from December to March [mid-summer to mid-autumn] (Anderson 1988). At Glen fighting between pairs was particularly frequent during early spring. Activity patterns suggest four periods in the annual cycle demarcated by two episodes during which daily reporting rates tended to be higher: spring and mid- to late autumn (Fig. 4.152; Fig. 4.153). This may be a reflection of breeding in spring, moult in summer and early autumn, post-moult activity later in autumn and a relatively quite period during winter before breeding.

In 2003/4 the Crowned Lapwing was recorded during eight seasons only, compared to other years when recorded during all seasons (Fig. 4.153). After 1997/8, that was the year with the highest number of seasons (n = 4) with zero record days (Fig. 4.153). Their absence during 2003/4 occurred after mid-autumn (Fig. 4.153), presumably after moult. The relative scarcity of the birds is possibly related to the dry conditions that prevailed during that year (see Fig. 2.13).

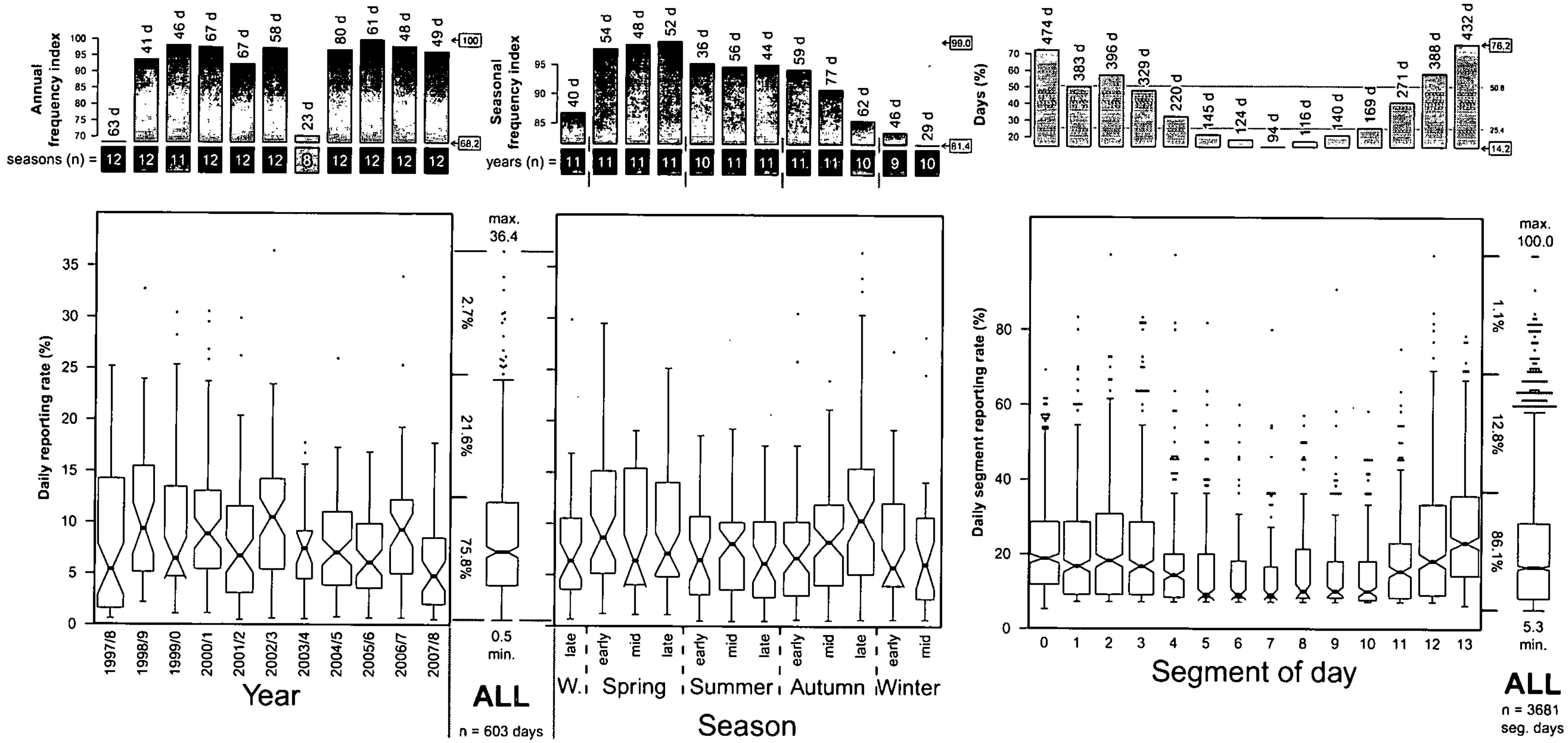


Figure 4.152: R255 Crowned Lapwing — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

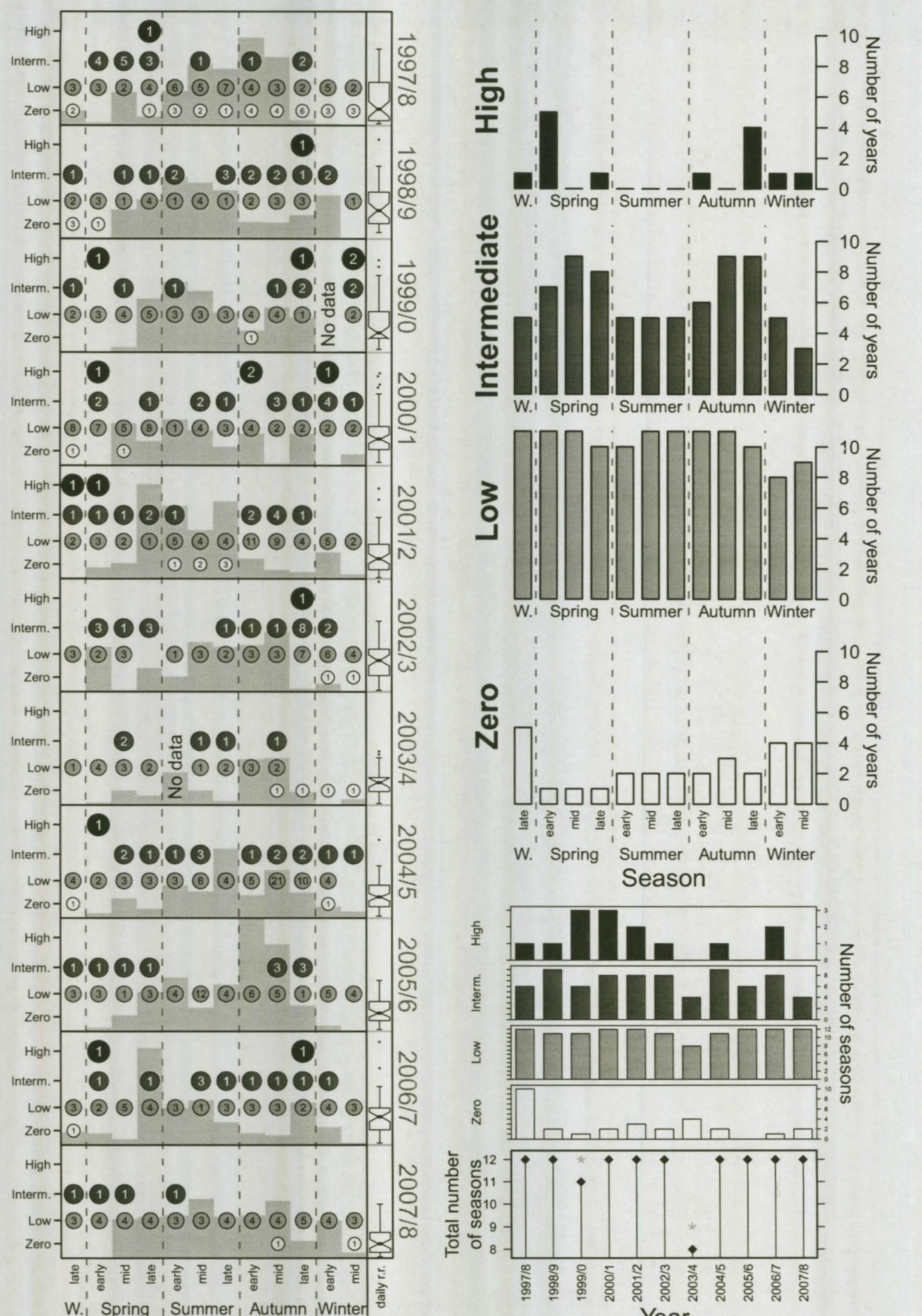


Figure 4.153: R255 Crowned Lapwing — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

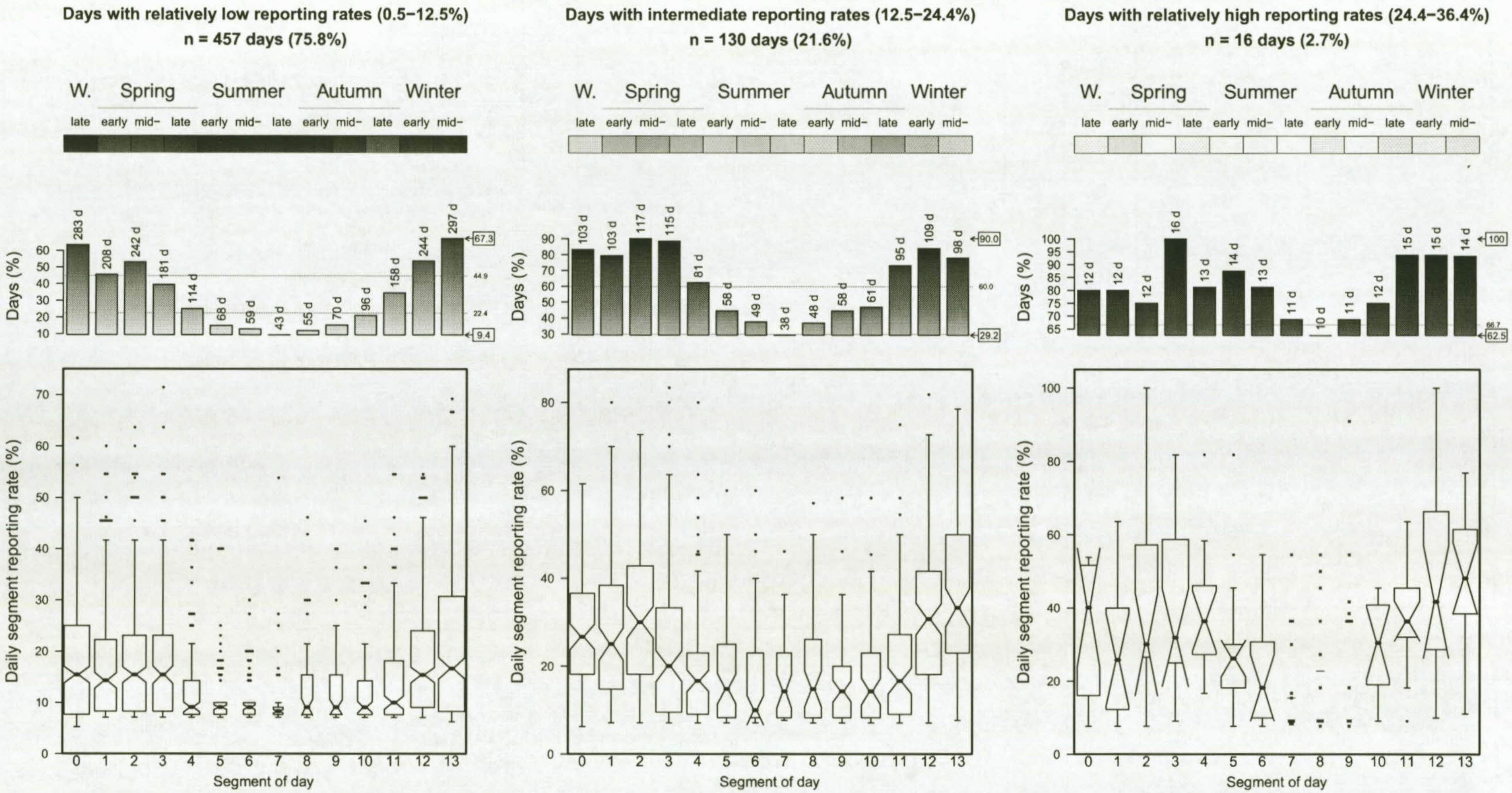


Figure 4.154: R255 Crowned Lapwing — birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

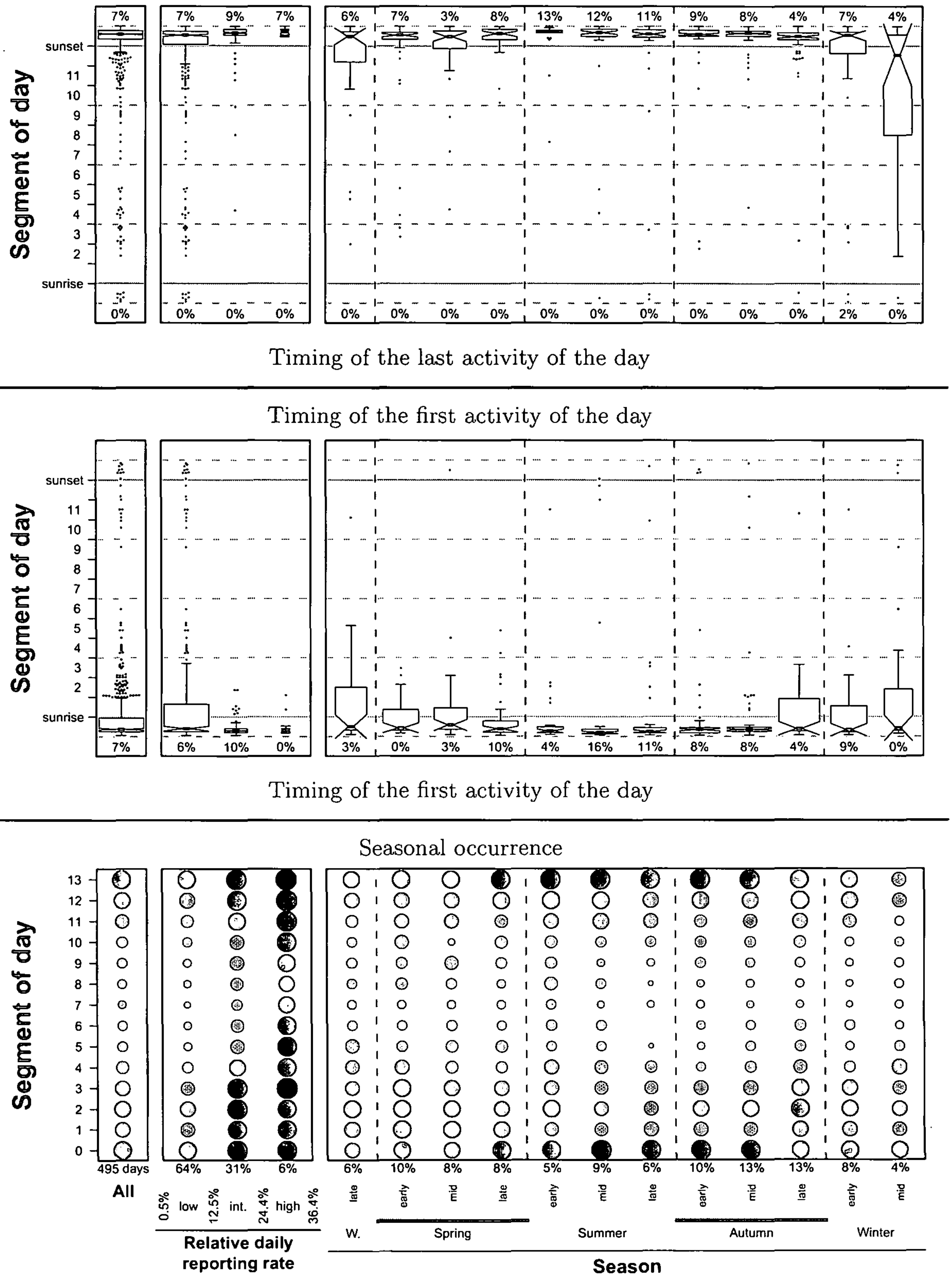
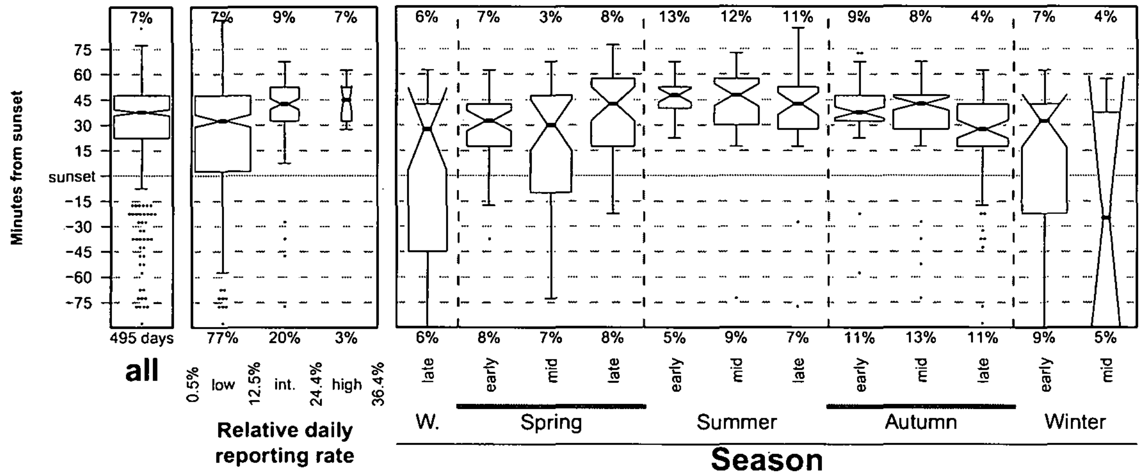
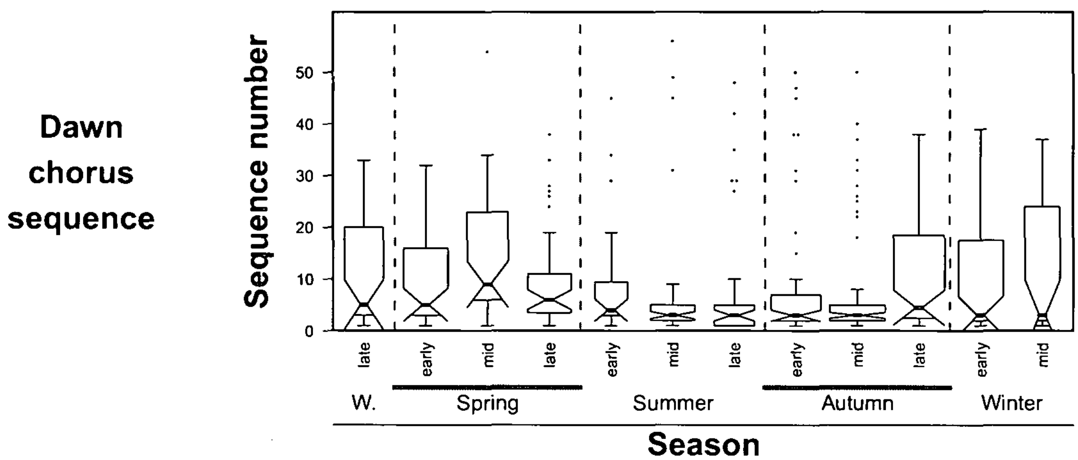


Figure 4.155: R255 Crowned Lapwing — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

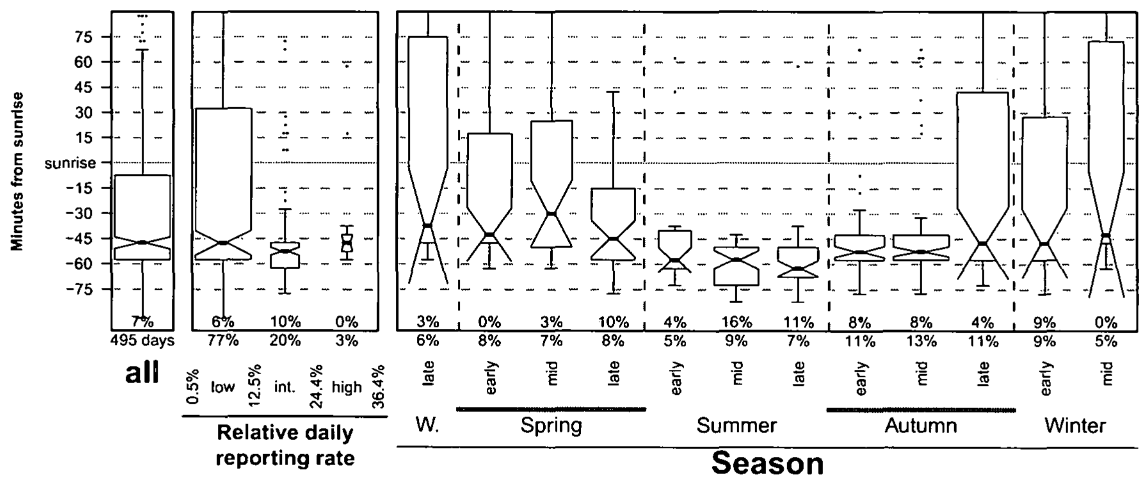
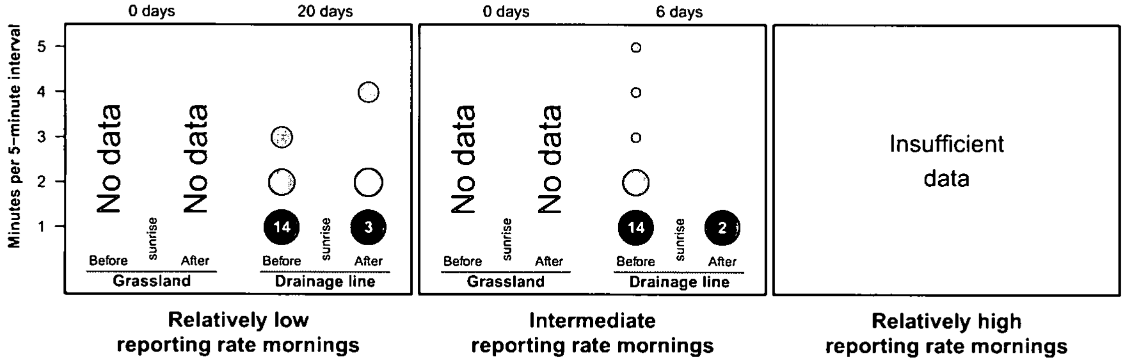
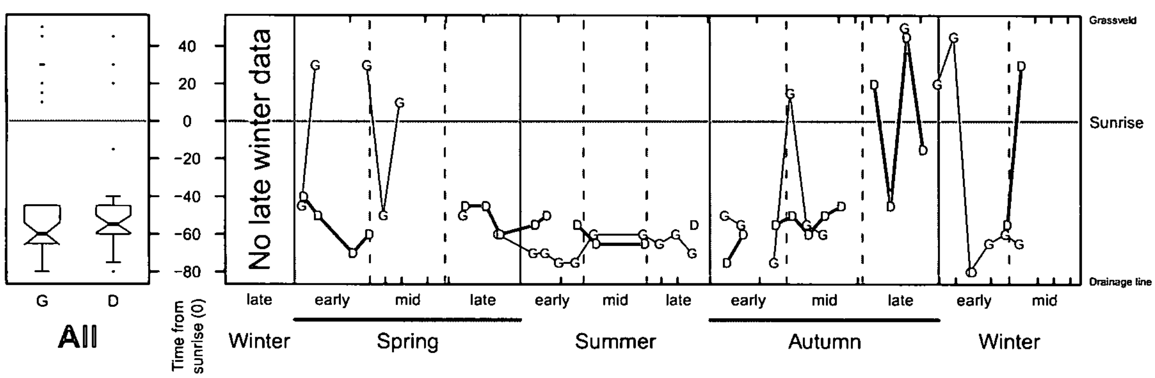


Figure 4.156: R255 Crowned Lapwing — birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

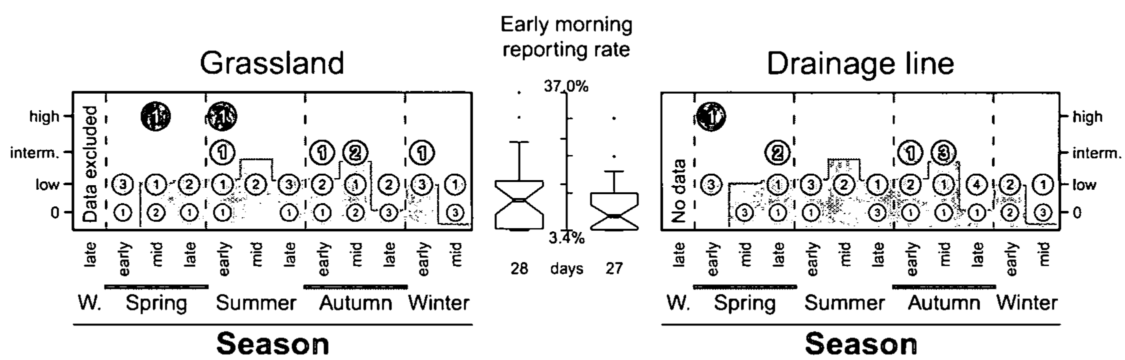


Figure 4.157: R255 Crowned Lapwing — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

R258 Blacksmith Lapwing . . . . *Vanellus armatus*

The Blacksmith Lapwing is endemic to Africa (Maclean 1985). Widespread over most of southern Africa, the Free State forming part of its core distribution (Ward *et al.* 1997). It inhabits moist, short grasslands and mudflats on the edge of wetlands (Ward *et al.* 1997). Nomadic movements are related to rainfall and the availability of suitable habitat (Turpie *et al.* 2005; Underhill *et al.* 1999; Ward *et al.* 1997).

The birds at Glen

The main attraction for Blacksmith Lapwings at the study site is the farm dam in the drainage line where there usually is at least one resident breeding pair if the dam has not dried up. Records of them in the grassland mostly (92.8%; Table 4.30a) refers to the calls of birds at the farm dam. They do visit the grassland at times, especially the trampled area where as many as five birds were recorded once. The data is analysed separately for birds heard only (*i.e.* mostly birds calling at the farm dam) and for birds seen (and heard) in the grassland. Figures start on page 354.

Table 4.30: R258 Blacksmith Lapwing: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.928	1 695	114 612	1.5	drainage line birds heard	54.0	656	354	5
0.072	131	114 612	0.1	birds seen in the grassland	7.2	656	47	3
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	257	1 190	21.6	drainage line birds heard	74.4	43	32	8
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	42	1 188	3.5	drainage line birds heard	51.2	43	22	2

Annual occurrence in the grassland of birds calling at the farm dam: Heard on 54.0% of the days with an activity index of five (Table 4.30a). Recorded during 9–11 seasons per year (Fig. 4.158; Fig. 4.159). Daily reporting rates ranged from 0.5 to 29.0% with 94.9% bird-days attaining low values (Fig. 4.158). High reporting rate days were limited to 2001/2 and intermediate reporting rate days to 2001/2, 2002/3 and 2005/6 (Fig. 4.158; Fig. 4.159). The median daily reporting rates of the latter three years, particularly 2001/2, were also higher than those of other years (Fig. 4.158).

Seasonal occurrence in the grassland of birds calling at the farm dam: Activity was noted during 10–11 years in spring, mid-summer, late summer and autumn, but only during 6–8 years in winter and early summer (Fig. 4.158). The seasonal frequency index shows a peak centred on late autumn (Fig. 4.158), coinciding with the relatively infrequent occurrence of days with zero records during late autumn and early winter (Fig. 4.159). Median daily reporting rates were also relatively high from mid-autumn to early winter (Fig. 4.158).

Daily occurrence in the grassland of birds calling at the farm dam: Overall, activity was most frequently recorded before sunrise and after sunset, with activity during the remainder of the day relatively infrequent, particularly from mid-morning to mid-afternoon (Fig. 4.158). This general pattern largely reflect the situation for low reporting rate days (Fig. 4.160). On intermediate reporting rate days, activity also occurred frequently for the first two segments after sunrise and in the late afternoon before sunset (Fig. 4.160). Seasonally, activity occurred most frequently in the early morning and after sunset in most seasons (Fig. 4.161). During autumn, activity was recorded during all or nearly all segments of the day, albeit infrequently during most segments (Fig. 4.161). Bird-segment combinations occurring on more than 5% bird-days were limited to three combinations involving S0 and S13, collectively accounting for approximately one third of all bird-days (Fig. 4.162).

The first activity of the day usually occurred in the early morning, often before sunset (Fig. 4.161; Fig. 4.163). The occurrence of the first activity of the day showed least variation during late summer and autumn when it typically occurred before sunrise (Fig. 4.161; Fig. 4.163). The seasonal pattern suggested by median values were similar for the first activity of the day and the dawn chorus sequences (Fig. 4.163).

The timing of the last activity of the day was most variable and occurred at any time of the day, except on intermediate and high reporting rate days when it occurred after sunset (Fig. 4.161; Fig. 4.163). Nonetheless, whereas the medians of other seasons were situated at or close to sunset, it was situated much closer to sunrise during winter (Fig. 4.161; Fig. 4.163).

Overall, daily segment reporting rates ranged from 5.0 to 92.9% with 91.6% of the values relatively low (Fig. 4.158). For intermediate and high reporting rate days, the median daily segment reporting rate was higher in the early morning than in the late morning and early afternoon segments (Fig. 4.160).

Birds calling at the farm dam in the early mornings of 2007/8: Activity was recorded on more mornings (74.4% vs. 51.2%) and more frequently per morning (activity index 8 vs 2) in the drainage line than in the grassland (Table 4.30b & c). The median early morning reporting rate was also much higher in the drainage line (Fig. 4.164). However, the seasonal pattern of occurrence was similar with high reporting rate mornings in late spring and in mid- and late autumn (Fig. 4.164). The first activity of the day often occurred later in grassland (Fig. 4.164). Activity intensity in the drainage (no data for the grassland) was slightly higher before sunrise (Fig. 4.164).

Birds seen in the grassland: Seen on 7.2% of the days with an activity index of three (Table 4.30a). Recorded during all years except 2005/6 and 2006/7, and was most frequently seen in 2001/2 when recorded during ten seasons compared to the 1–3 seasons of the other years (Fig. 4.165). Seen during all seasons except mid- and late winter, and was particularly frequent during mid-spring when recorded during five years compared to the 1–3 years in the other seasons (Fig. 4.165). Most sightings occurred in the early morning after sunrise (S1–S2) and particularly in the later afternoon (Fig. 4.165).

Discussion

Blacksmith Lapwing data from the early mornings in 2007/8 (Fig. 4.164) suggests that the vocal behaviour in the drainage line was slightly underestimated in the grassland, but that it was heard often enough to get a reasonable accurate picture of seasonal trends.

Blacksmith Lapwings breed mainly from July to October [late winter and spring] followed by a complete post-breeding moult that lasts approximately four months (Turpie *et al.* 2005). In other words, moult would normally finish by March [mid-autumn]. This is confirmed by data from the central Free State (DJvN unpublished data). At Glen, the relatively high daily reporting rates from mid-autumn to early winter (Fig. 4.158■) probably represent post-moult activity. Daily reporting rates were otherwise relatively low, except for early spring when it was slightly higher (Fig. 4.158■), possibly because of breeding activities.

The peak in activity in 2001/2 (Fig. 4.159; Fig. 4.165) is probably due to the good rains during that year.

4.21 Scolopacidae: Snipes, Godwits, Curlews and Whimbrels, 'Shanks', Stints, Sandpipers, Ruff, Turnstones, Phalaropes

This diverse family of shorebirds occur worldwide (88 species in total), with 36 species occurring in southern Africa (Hockey *et al.* 2005). Less than half of these species was recorded in the Free State with seven scarce and eight more common species found in the central parts of the province (Earlé & Grobler 1987; Harrison *et al.* 1997a). Only the Wood Sandpiper R266 and Common Greenshank R270 were recorded at Glen.

R266 Wood Sandpiper . . . . *Tringa glareola*

The Wood Sandpiper breeds in the Palearctic and spends the non-breeding season in Africa, southern Asia and Australia (Cramp 1998). Widespread throughout southern Africa where suitable habitat is available (Underhill 1997a). The birds arrive in southern Africa mainly from August to September [early to mid-spring] and depart mainly from March to April [mid- to late autumn], some birds overwintering (Underhill 1997a). They occurs along marshy shorelines, preferring emergent or floating vegetation as feeding habitats (Maclean 1985; Underhill 1997a).

The birds at Glen

There is only one Wood Sandpiper record, involving a bird that flew over the study area in early autumn 2001/2 (S8).

Discussion

The Wood Sandpiper at Glen possibly represent a bird on passage.

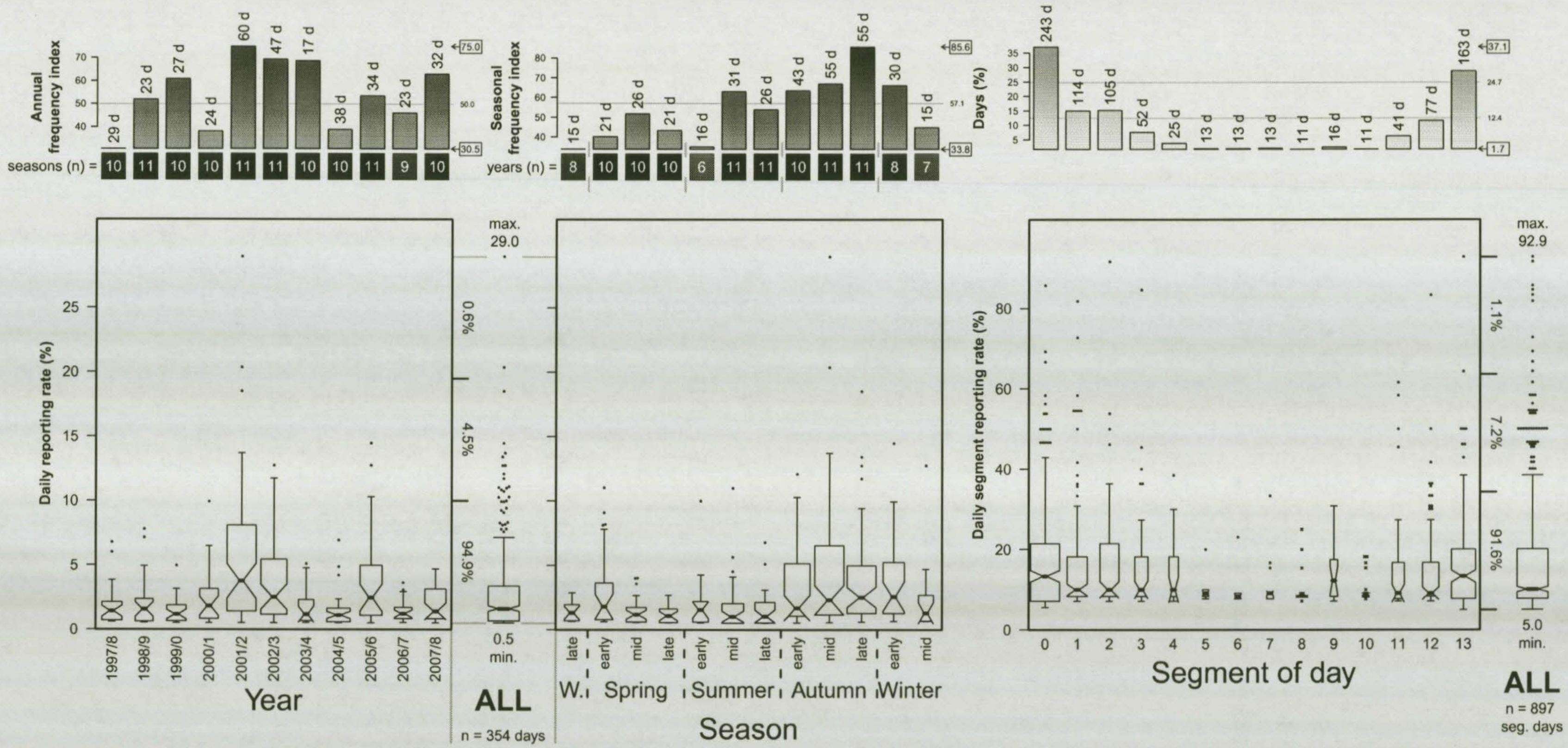


Figure 4.158: R258 Blacksmith Lapwing — drainage line birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

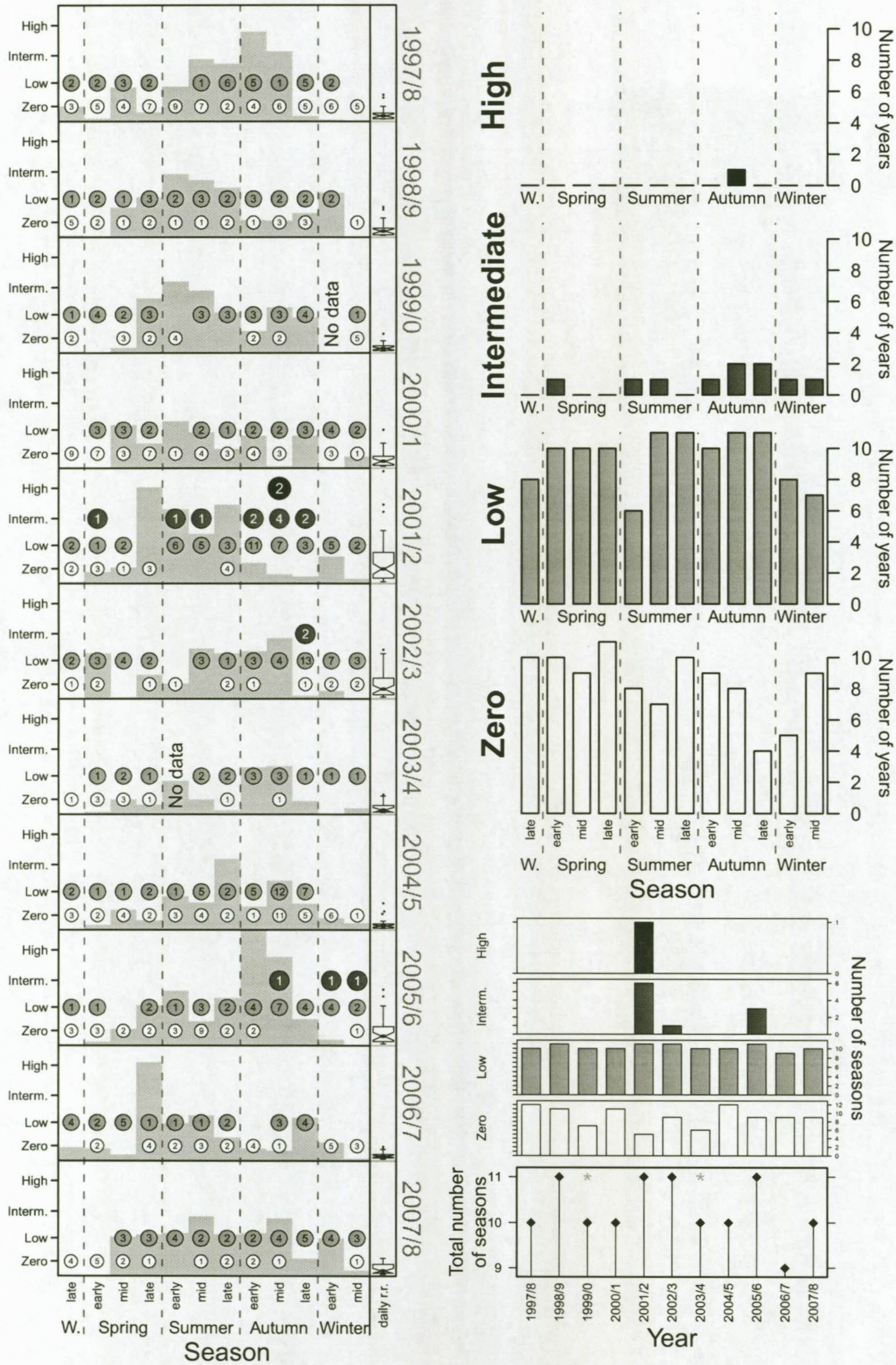


Figure 4.159: R258 Blacksmith Lapwing — drainage line birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

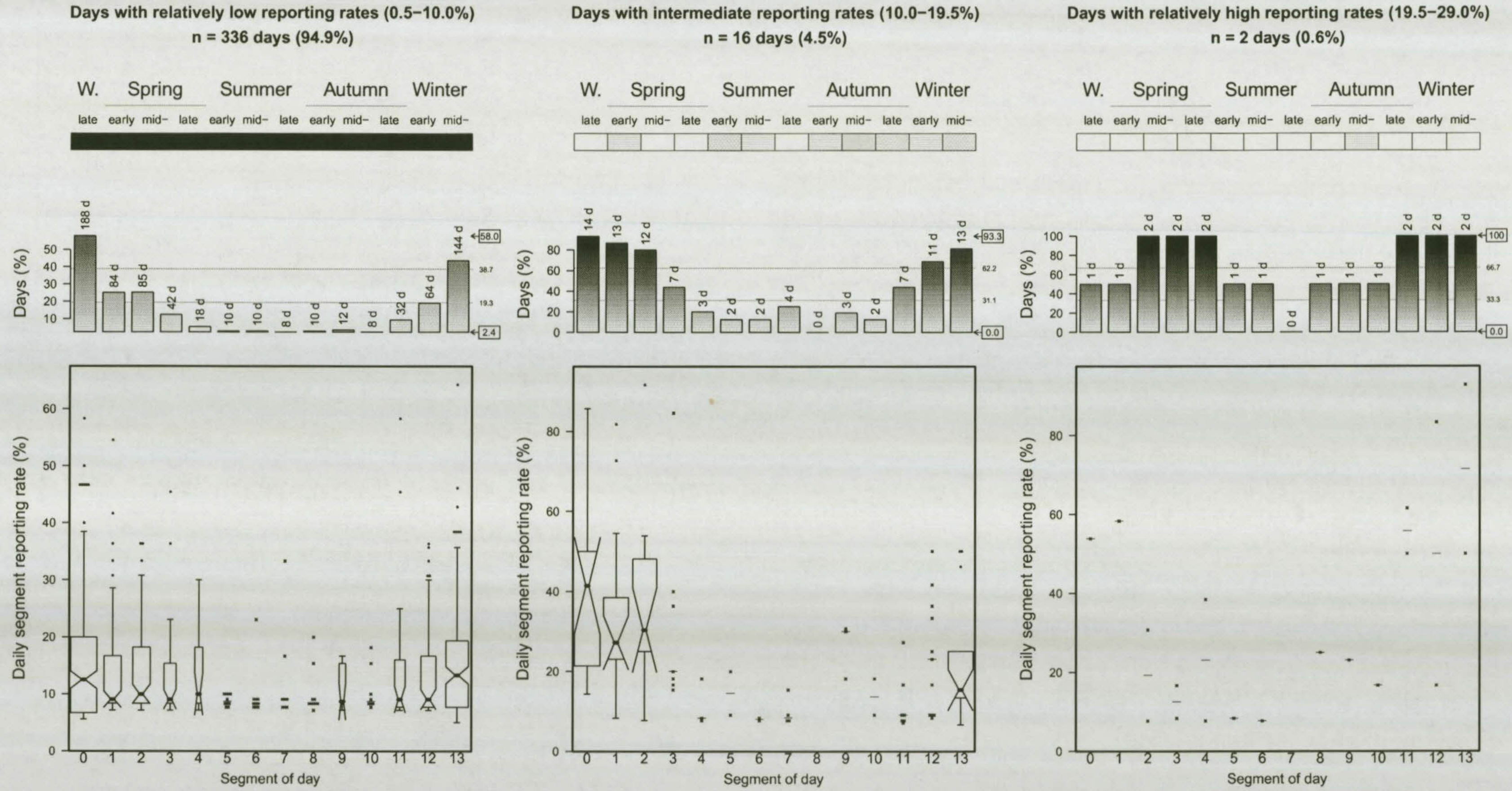


Figure 4.160: R258 Blacksmith Lapwing — drainage line birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

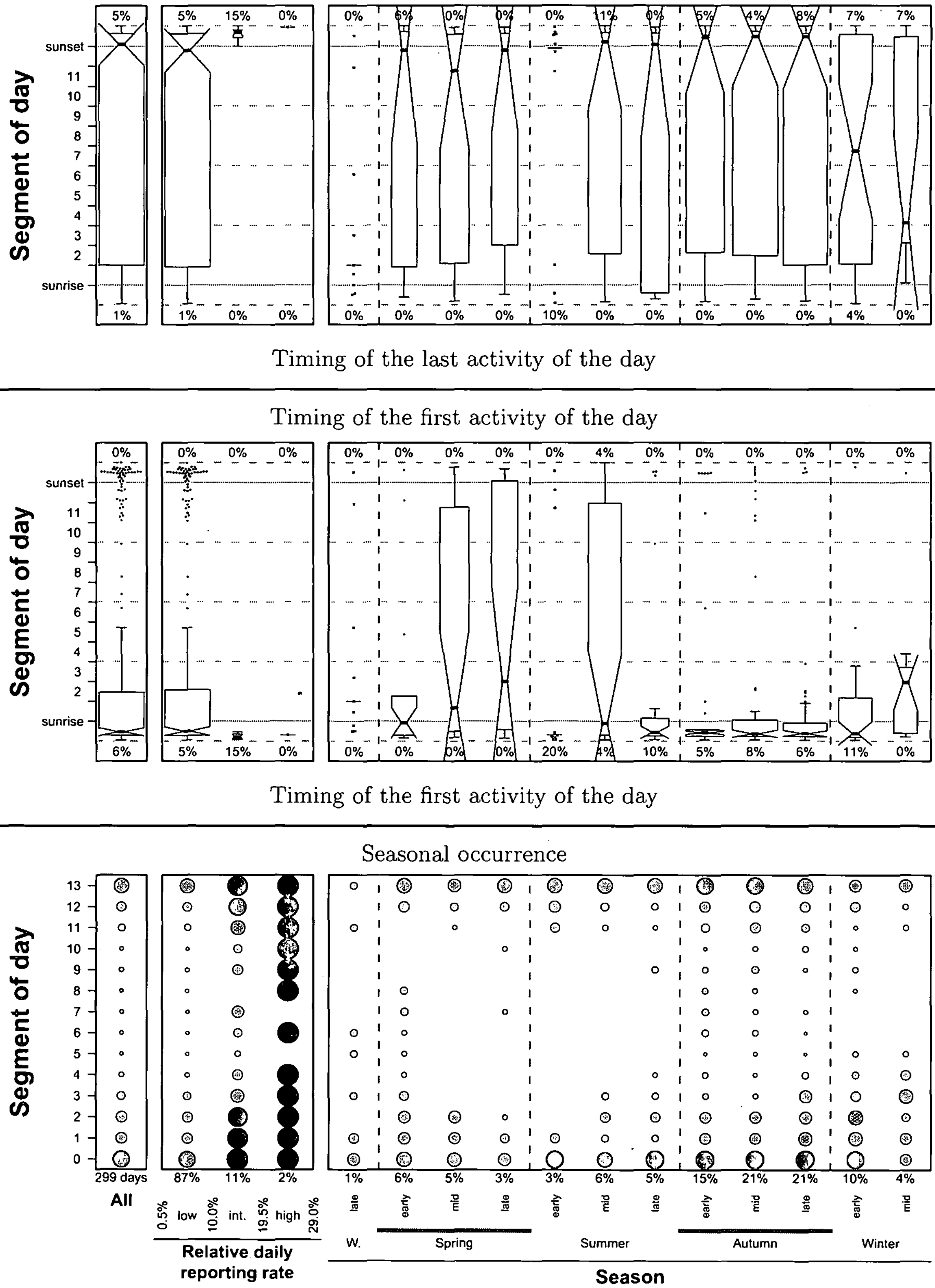


Figure 4.161: R258 Blacksmith Lapwing — drainage line birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

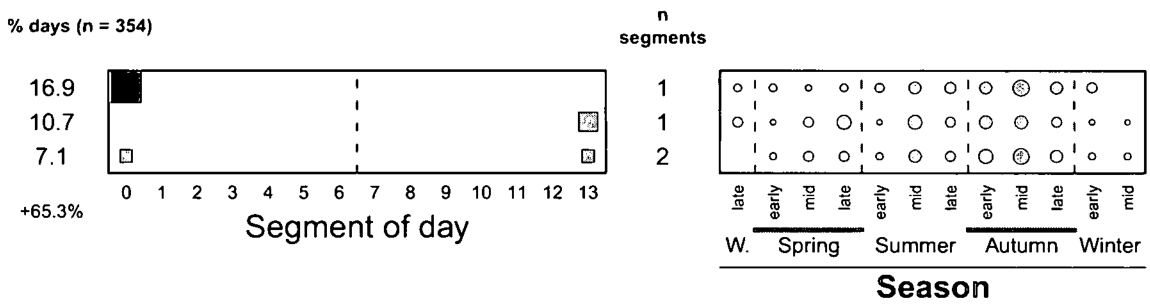


Figure 4.162: R258 Blacksmith Lapwing — drainage line birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

R270 Common Greenshank .... *Tringa nebularia*

Common Greenshanks breed in the Palearctic and spend the non-breeding season in the Palearctic, Africa, southern Asia and Australia (Cramp 1998). Widespread throughout southern Africa where suitable habitat is available (Underhill 1997a). They arrive in southern Africa mainly from August to September [early to mid-spring] and depart mainly from March to April [mid- to late autumn]; some birds may overwinter (Underhill 1997a). It utilises aquatic habitats with shallow margins (Underhill 1997a).

The birds at Glen

The three Common Greenshank records involved birds heard in flight during early autumn 1997/8 (S13) and mid-autumn 2004/5 (S6; S13; two separate days).

Discussion

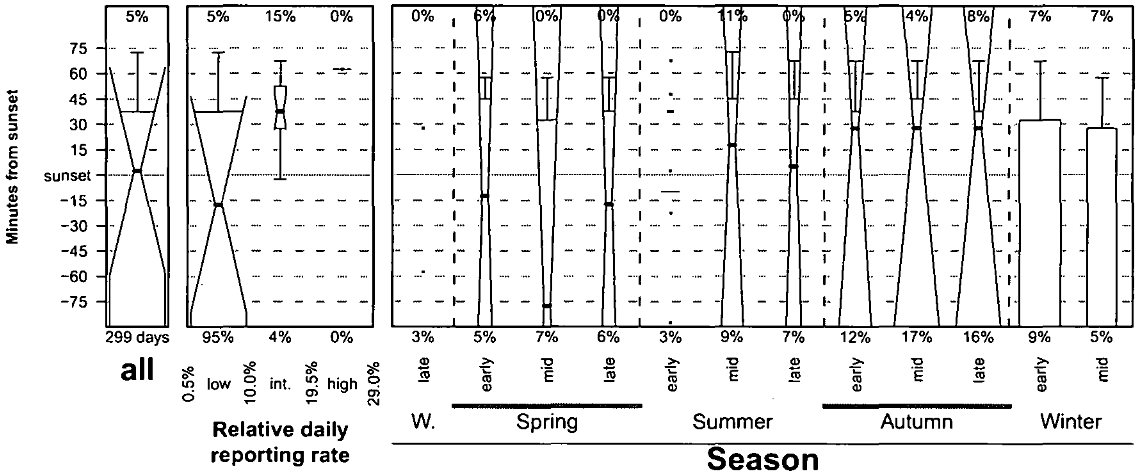
The Common Greenshank records at Glen probably represent birds on passage.

4.22 Recurvirostridae: Stilts, Avocets

Eleven avocet and stilt species occur worldwide except in polar regions, with two species occurring in southern Africa (Hockey *et al.* 2005). Both species have a widespread distribution in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a). Only the Black-winged Stilt R295 was recorded at Glen.

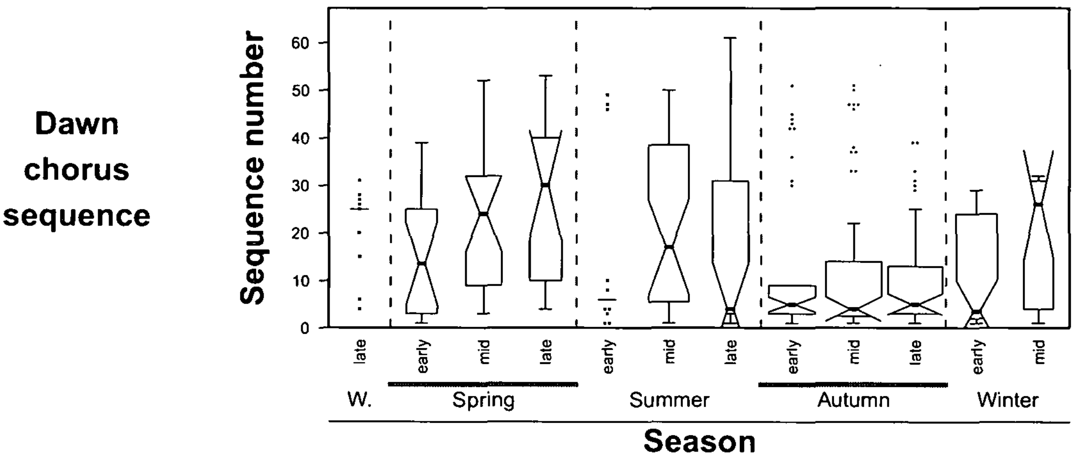
R295 Black-winged Stilt .... *Himantopus himantopus*

The Black-winged Stilt has an extensive worldwide distribution between approximately 50°N and 40°S (Hockey 2005b). Widespread in southern Africa with the Free State forming part of its main range in South Africa (Tree 1997b). It is dependant on extensive open, shallow waters (Tree 1997b) and is locally common, but highly nomadic (Maclean 1985).



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

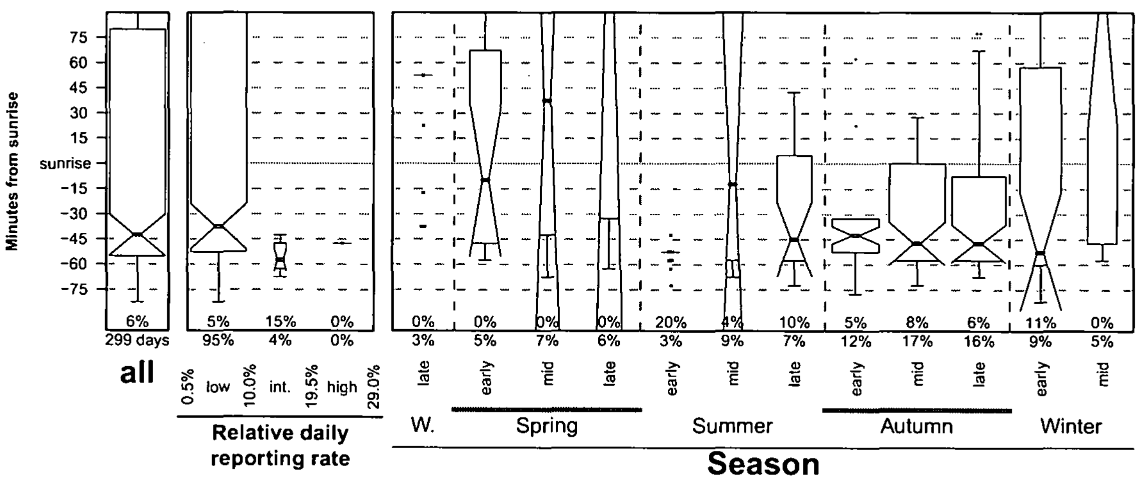


Figure 4.163: R258 Blacksmith Lapwing — drainage line birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

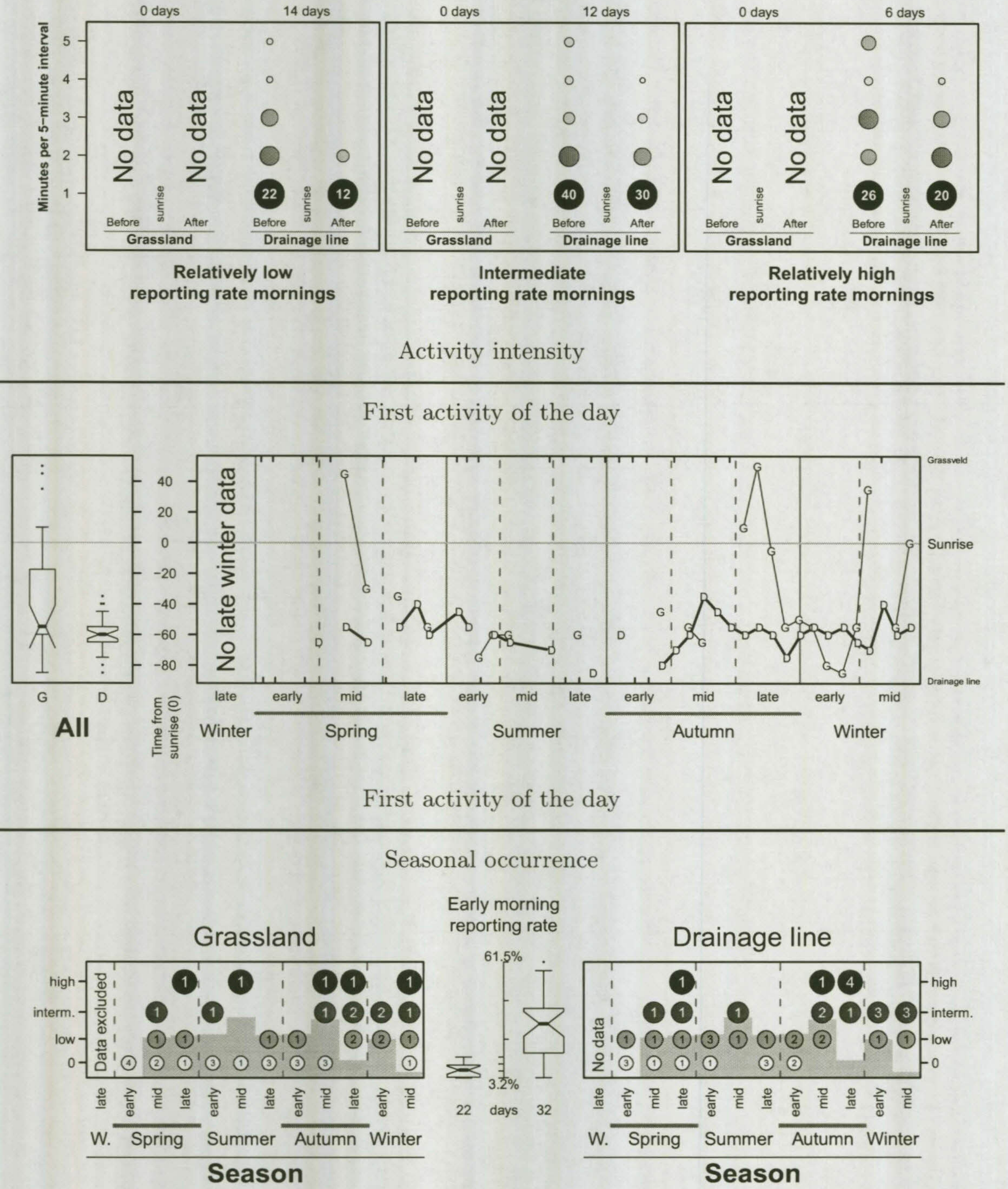


Figure 4.164: R258 Blacksmith Lapwing — drainage line birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

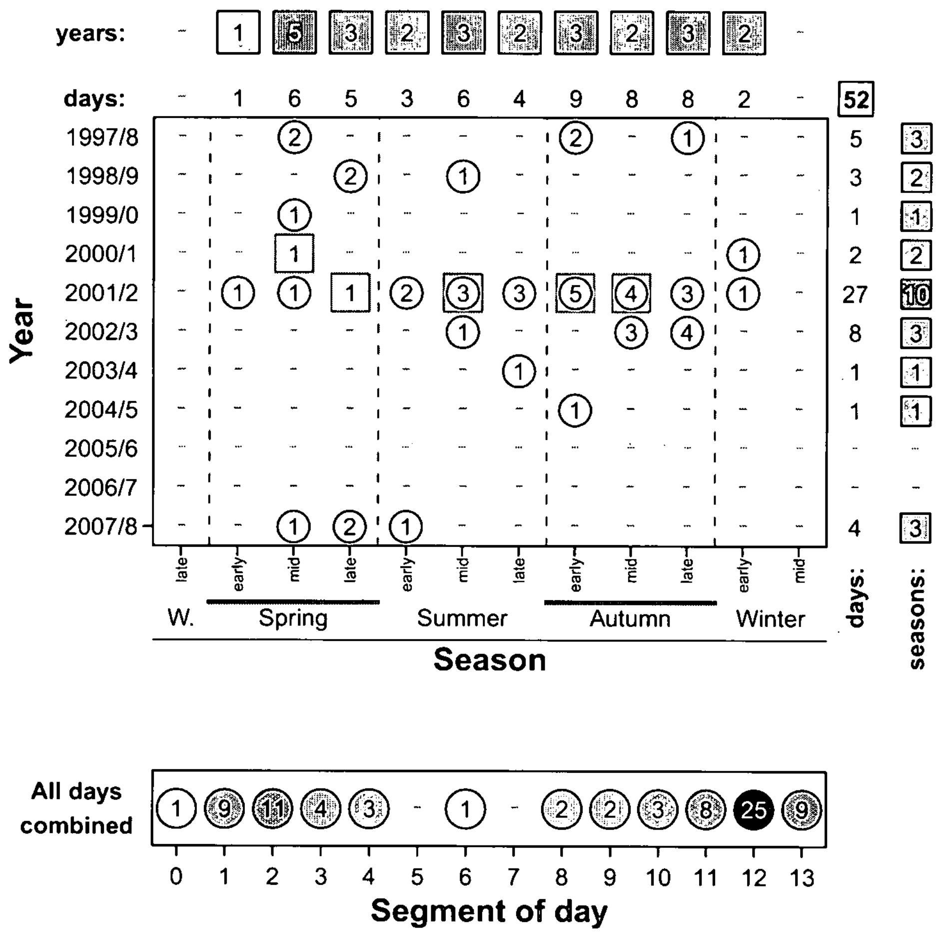


Figure 4.165: R258 Blacksmith Lapwing — birds seen in the grassland: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

The birds at Glen

The Black-winged Stilt was heard/seen on four days in early summer 1998/9 (S13), early autumn 1997/8 (S13), late autumn 2005/6 (S3) and early winter 2005/6 (S6).

4.23 Burhinidae: Thick-knees

Nine thick-knee species occur in the tropics and subtropics of Eurasia, Africa, Australasia and South America, with two species occurring in southern Africa (Hockey *et al.* 2005). Only the Spotted Thick-knee R297 occurs in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a).

R297 Spotted Thick-knee.................................*Burhinus capensis*

The Spotted Thick-knee occurs in sub-Saharan Africa with isolated populations also found in the Arabian Peninsula (Maclean 1997g). It has a widespread distribution in southern Africa and is a common breeding resident in the Free State (Earlé & Grobler 1987; Maclean 1997g). Its occurs in a wide range of habitats, including open grassland near trees or bushes (Maclean 1985, 1997g).

Mostly crepuscular and nocturnal, but also active on overcast days, especially after rains (Maclean 198

The birds at Glen

Almost all Spotted Thick-knee records in the grassland (99.4%; Table 4.31a) involved birds that was heard only. The few sightings were (presumably) largely limited to individuals from the drainage line arriving in the trampled area some time after sunset. Records for each minute were noted since early summer 2006/7 (Table 4.32).

Adult birds have a complete post-breeding moult (Hockey 2005a). Based on the data from five adult birds checked for moult during ringing operations at Glen in 2001/2 and the beginning of 2002/3, it appears that wing moult commences in early summer. Figures start on page 365.

Table 4.31: R297 Spotted Thick-knee: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.994	5 280	114 612	4.6	birds heard only	79.3	656	520	10
0.006	32	114 612	0.0	birds seen	4.1	656	27	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.991	218	1 190	18.3	birds heard only	90.7	43	39	6
0.009	2	1 190	0.2	birds seen	4.7	43	2	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	141	1 188	11.9	birds heard only	76.7	43	33	4

Table 4.32: R297 Spotted Thick-knee: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
birds heard only	early summer 2006/7	1 329	71 250	1.9

Annual occurrence of calls heard in the grassland: Heard on 79.3% of the days with an activity index of ten (Table 4.31a). Recorded during 10–12 seasons each year, except 1997/8 when recorded during only eight seasons (Fig. 4.166; Fig. 4.167). Compared to other years, 1997/8 also had an exceptionally high number of seasons with zero records (n = 12; Fig. 4.167). This is because pre-sunrise data, when the birds are most frequently recorded (see below), was not collected for most of that year (Fig. 3.4; Fig. 3.5). Daily reporting rates ranged from 0.5 to 36.2% with 90.0% bird-days attaining low reporting rates (Fig. 4.166). Activity intensity was comparable between 2006/7 and 2007/8 (Fig. 4.166), *i.e.* the only two years for which data is available (Table 4.32).

Seasonal occurrence of calls heard in the grassland: Heard during 10–11 years each season, except during early and mid-winter when heard during nine and seven years respectively (Fig. 4.166; Fig. 4.167). The seasonal frequency index was also at its lowest in winter (Fig. 4.166). Median daily reporting rates show a well-defined seasonal trend with values increasing during spring and peaking from late spring to mid-summer after which it decrease with minimum values recorded during late autumn and winter (Fig. 4.166). This corresponds with the occurrence of intermediate reporting rate days which occurred mainly during spring and summer, as well as the occurrence of days with zero records which was most frequent during winter (Fig. 4.167). Activity intensities were similar for the respective seasons (Fig. 4.166).

Daily occurrence of calls heard in the grassland: Overall, activity was most frequent before sunrise and after sunset (Fig. 4.166). However, for intermediate reporting rate days the occurrence of activity after sunrise and before sunset are also frequent, the three high reporting rate days suggesting a similar trend (Fig. 4.168). Seasonally the occurrence of activity after sunrise and before sunset is particularly frequent from mid-spring to late summer (Fig. 4.169). Bird-segment combinations occurring on more than 5% bird-days were limited to combinations involving S0, S12 and S13, which collectively account for more than half of all bird-days (Fig. 4.170). These combinations were particularly frequent during autumn (Fig. 4.170).

The first activity of the day typically occurred before sunrise, often during the first five minute interval of the day (Fig. 4.169; Fig. 4.171), implying that activity could have started earlier. Activity started earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.169; Fig. 4.171). Seasonally activity started earlier from mid-spring to mid-summer than during autumn and winter (Fig. 4.169; Fig. 4.171). This pattern is similar to that shown by the dawn chorus sequence (Fig. 4.171).

The last activity of the day typically occurred after sunset, and later on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.169; Fig. 4.171). Seasonally the last activity of the day occurred later (often recorded during the last 5-minute interval) during late spring, early and mid-summer than during other seasons (Fig. 4.169; Fig. 4.171). The timing of the last activity of the day was particularly variable during winter and early spring (Fig. 4.169; Fig. 4.171).

Activity intensity was highest before sunrise and after sunset (Fig. 4.166; Fig. 4.168).

Overall, daily segment reporting rates ranged from 5.3 to 100.0% with 75.7% of the values relatively low (Fig. 4.166). The median daily segment reporting rates of S1 and S13 were higher than those of other segments, a pattern which is particularly obvious for intermediate and high reporting rate days (Fig. 4.168).

Early morning occurrence of calls during 2007/8: More frequently recorded in the drainage line than in the grassland (Table 4.31b & c). The median early morning reporting rate in the drainage line is also slightly higher than that recorded in the grassland (Fig. 4.172). Nonetheless, the seasonal pattern is similar with high reporting rate days occurring during late spring and early summer in both habitats (Fig. 4.172). The timing of the first activity of the day is also very similar in the two habitats (Fig. 4.172). Further agreement is to be seen in the activity intensities which show similar patterns with intensities higher before sunrise (Fig. 4.172).

Birds seen in the grassland: Seen on 30 days spread over eight years (Fig. 4.173). Occurred most frequently during 2000/1 when recorded during six seasons compared to the 1–3 seasons of other years (Fig. 4.173). Most records were during mid-spring and from mid-summer to mid-autumn, with most sightings occurring after sunset (Fig. 4.173).

Discussion

The seasonal occurrence patterns during the early mornings of 2007/8 was similar in the grassland and the drainage line (Fig. 4.172), indicating that the grassland data-set is representative of activity occurring in the drainage line.

According to Tarboton (2001), egg-laying in the Spotted Thick-knee occurs mainly from September to October [spring], with the incubation and nestling/fledgling periods collectively amounting to approximately three months (Hockey 2005a; Tarboton 2001). Assuming that it represents a typical breeding cycle of the birds at Glen, it would encompass spring and summer, which coincides with increased activity levels (Fig. 4.166; Fig. 4.167; Fig. 4.169). Adults have a complete post-breeding moult, approximately from November to April [late spring, summer and autumn] (Hockey 2005a; DJvN unpublished data). This overlaps extensively with the period of peak activity at Glen (Fig. 4.166).

4.24 Glareolidae: Coursers, Pratincoles

This morphologically diverse family consists of two main groups, namely the terrestrial coursers and the more aerial pratincoles (Hockey *et al.* 2005). Seventeen species occur in Eurasia, Africa and Australia with eight species occurring in southern Africa (Hockey *et al.* 2005). Four species are generally recognised as occurring in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a). A fifth species, the Bronze-winged Courser R303, is seldom recorded in the province. All five species were recorded at Glen.

R299 Burchell's Courser .... *Cursorius rufus*

From south-western Angola (Dean 2000), the distribution of Burchell's Courser extents southwards into Namibia and South Africa where it occurs as far east as the eastern Free State (Maclean & Herremans 1997a). It favours sparsely vegetated areas including open short grassland and overgrazed veld (Maclean 1985; Maclean & Herremans 1997a). Little is known about its movements, with populations consisting of resident, migratory as well as nomadic components (Hockey 2005c; Maclean & Herremans 1997a).

The birds at Glen

There are two records of Burchell's Coursers at Glen. On 10 July 2007 (late winter 2007/8) two birds alighted in the grassland area during late morning (S5) and flew again after approximately 10 minutes. The second record was of birds heard on 9 April 2008 (late autumn 2007/8) during late morning (S6).

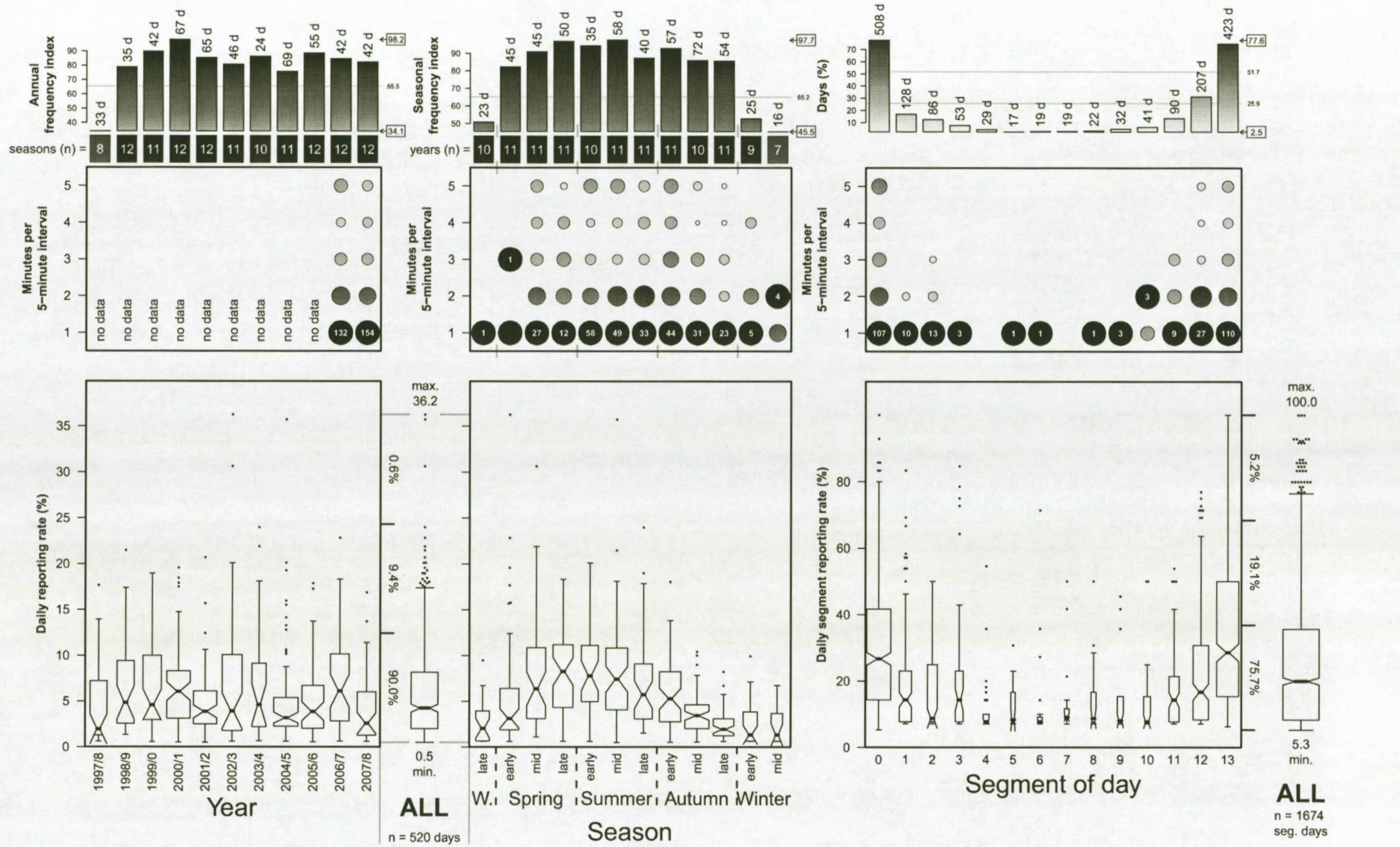


Figure 4.166: R297 Spotted Thick-knee — birds heard only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

Figure 4.167: R297 Spotted Thick-knee — birds heard only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

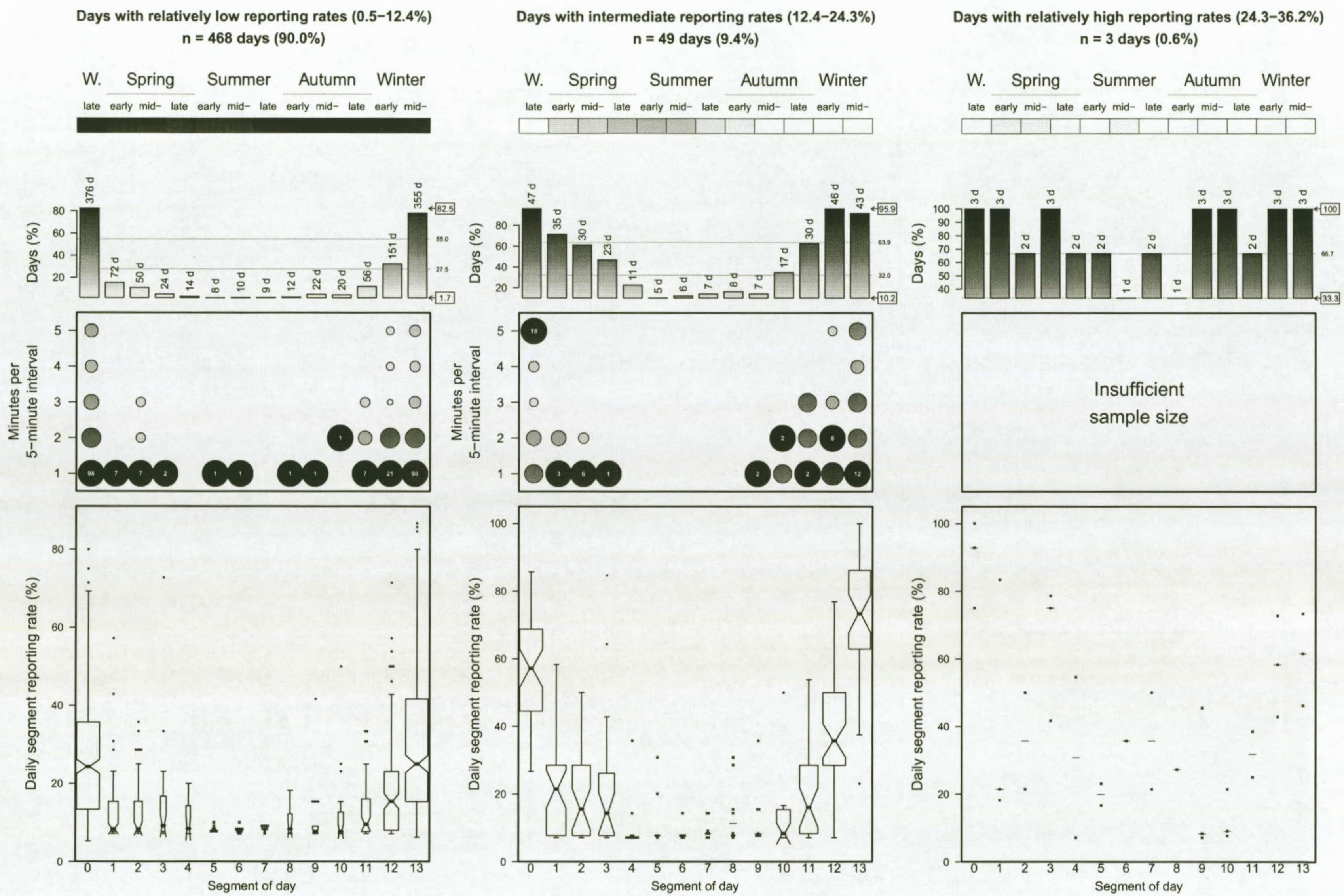


Figure 4.168: R297 Spotted Thick-knee — birds heard only: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

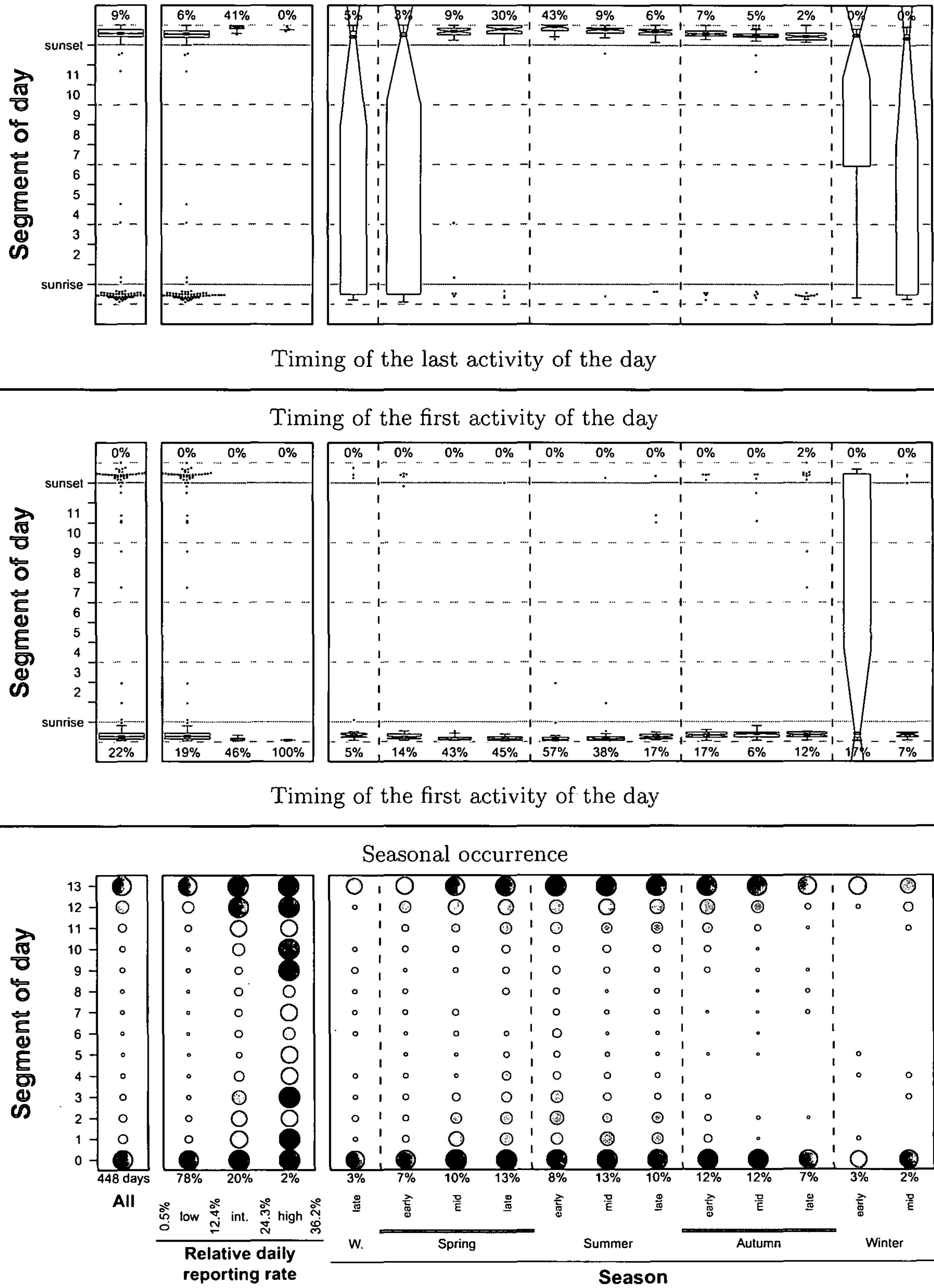


Figure 4.169: R297 Spotted Thick-knee — birds heard only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

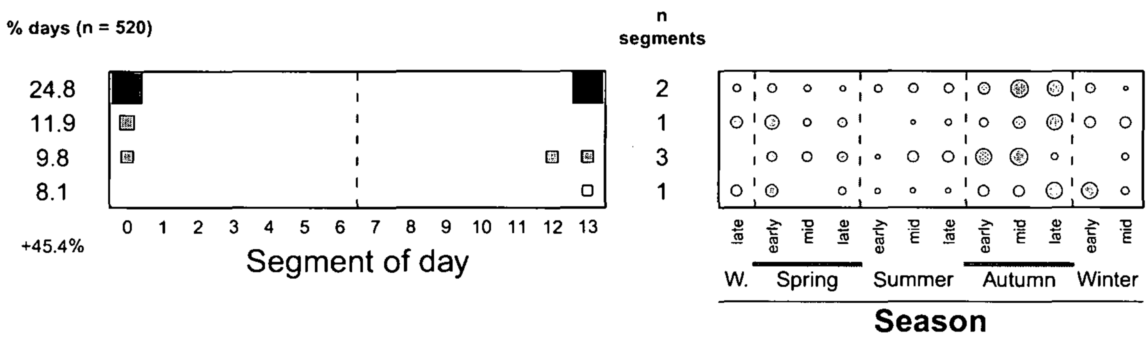


Figure 4.170: R297 Spotted Thick-knee — birds heard only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

R300 Temminck's Courser .... *Cursorius temminckii*

Temminck's Coursers are endemic to Africa (Maclean 1985). In southern Africa they are widespread in the northern half of Namibia, Botswana, Zimbabwe and South Africa where the Free State represents the southern limit of their main distribution (Maclean & Herremans 1997b). They prefer open, sparsely vegetated habitats (Maclean 1985). The movements of the three subspecies are complex and not fully understood, and include residents, partial migrants, nomads and intra-African migrants (Hockey 2005d).

The birds at Glen

Temminck's Coursers were recorded on eight days in total (Fig. 4.174, page 373). As many as six birds were present on five days during early and mid-autumn of 2000/1. Also heard during late summer 2001/2 and early autumn 2007/8, with two birds subsequently seen during the latter season. Recorded throughout the day between sunrise and sunset (Fig. 4.174).

Discussion

The concentration of records in late summer, early and mid-autumn (Fig. 4.174) suggests that the Temminck's Coursers occurring at Glen may be involved in regular seasonal movements. One can only speculate as to their origin and destination. Observations in recently planted maize fields in the central and southern Free State during summer showed that the birds are fairly common there; breeding was also noted (Van Niekerk 2007). These observations suggest that agricultural fields may be important to these birds in this part of their range. Since the observations were restricted to summer, however, it is not known if the birds vacate the area after breeding. If they do, it could explain their strong seasonality at Glen.

R301 Double-banded Courser .... *Rhinoptilus africanus*

The Double-banded Courser is endemic to Africa where three disjunct populations occur in southern Africa (plus south-western Angola, Dean 2000), eastern and north-eastern Africa (Maclean 1985). In southern Africa they are widespread in Namibia, Botswana and South Africa as far east as

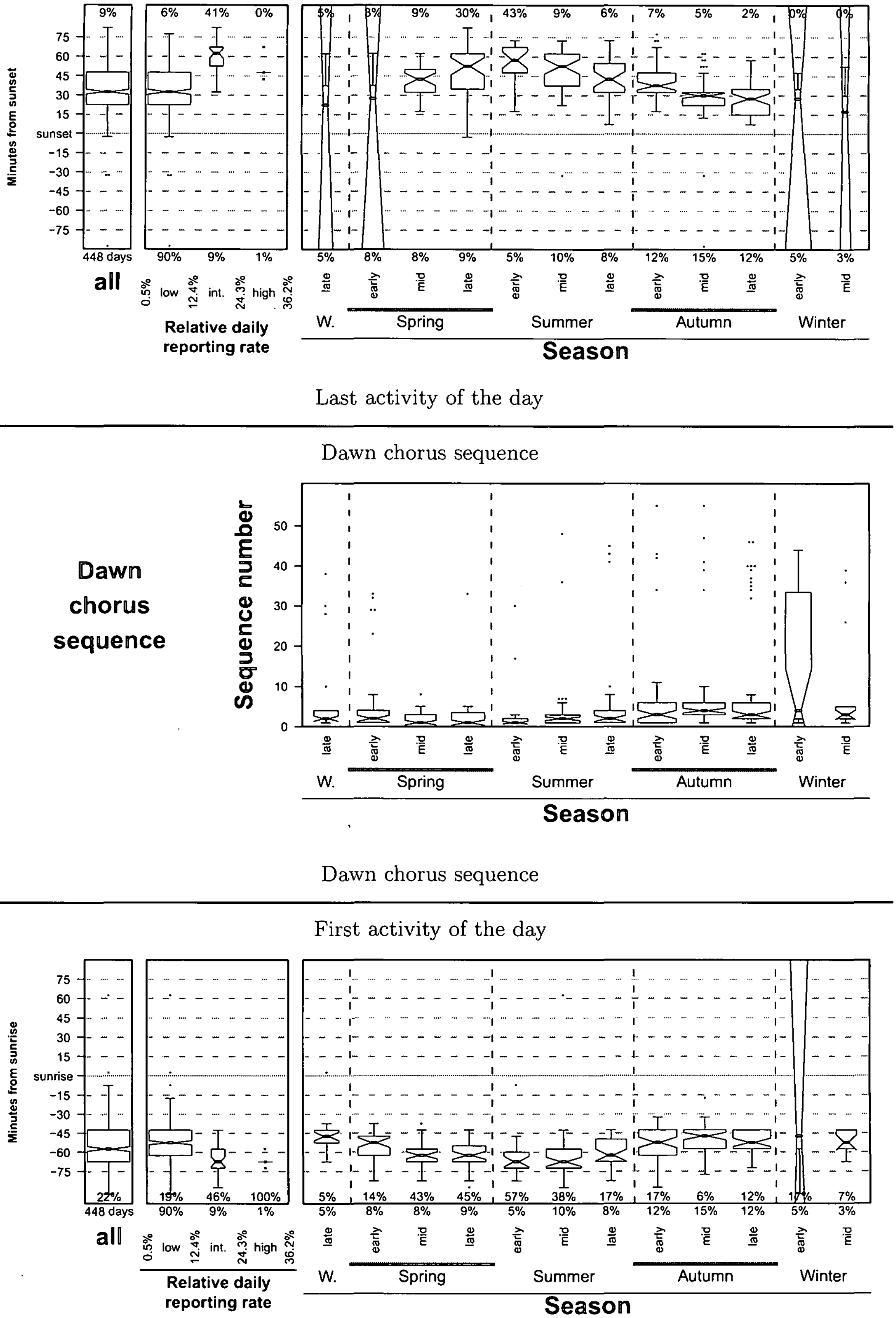
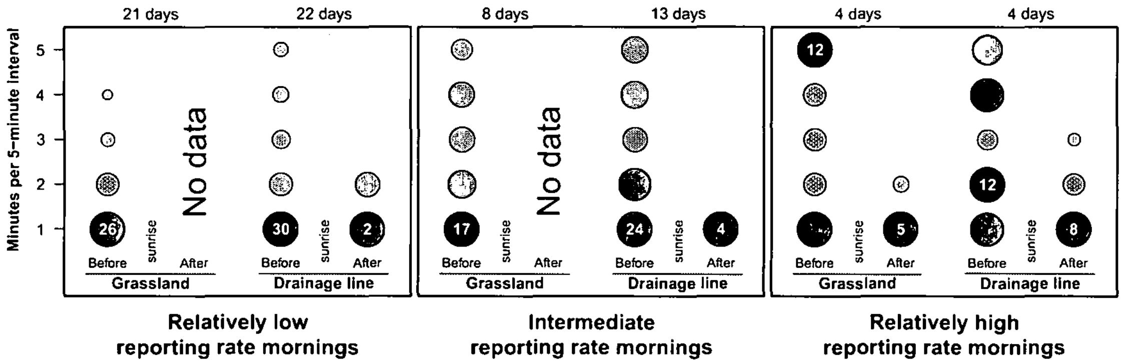
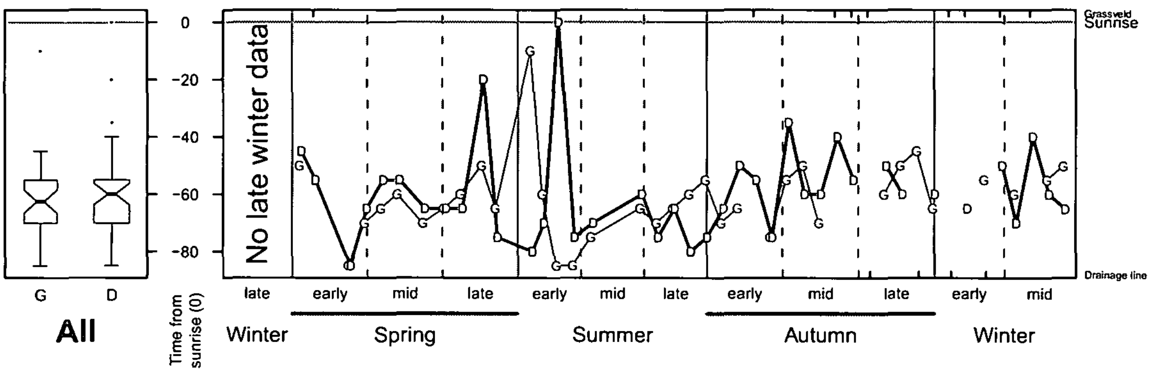


Figure 4.171: R297 Spotted Thick-knee — birds heard only: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

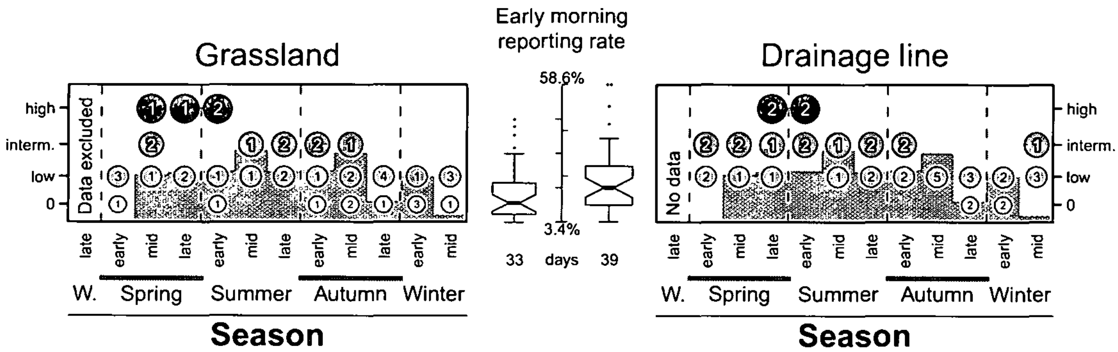


Figure 4.172: R297 Spotted Thick-knee — birds heard only: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

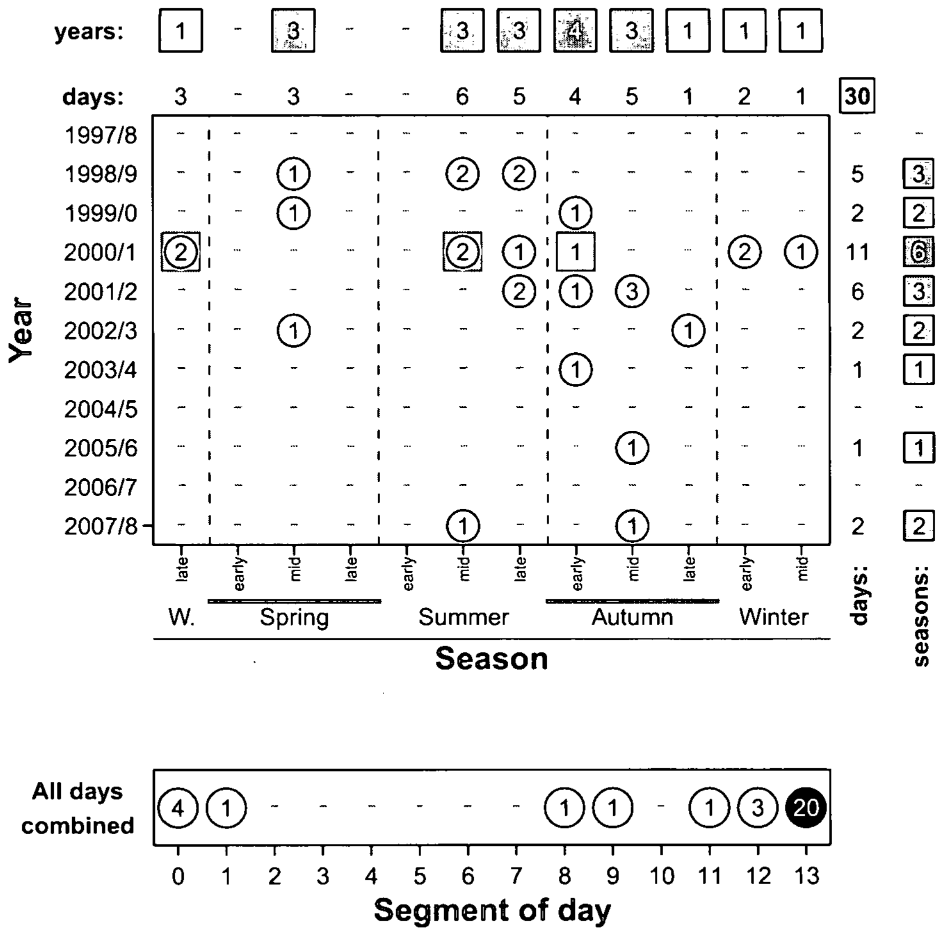


Figure 4.173: R297 Spotted Thick-knee — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

the eastern Free State (Maclean & Herremans 1997b). Habitat requirements include bare ground or short grass interspersed with sparse taller vegetation (Maclean 1997h; Penry 1994). It is a resident in the Free State, subject to local movements dictated by the availability of suitable habitats (De Swardt 2000; Earlé & Grobler 1987; Farkas 1988).

The birds at Glen

A Double-banded Courser 'nest' with one egg was found just outside the study area in early summer 1995/6, *i.e.* nearly two years before commencement of the present study. During the present study it was seen on five days only with the observations restricted to 1999, 2000 and 2001, and seasonally to mid- and late winter and late spring (Fig. 4.175). Only recorded in the late morning and in the afternoon (Fig. 4.175). Two birds were feeding on *Trinervitermes* termites during mid-winter 1999/0 on two consecutive days.

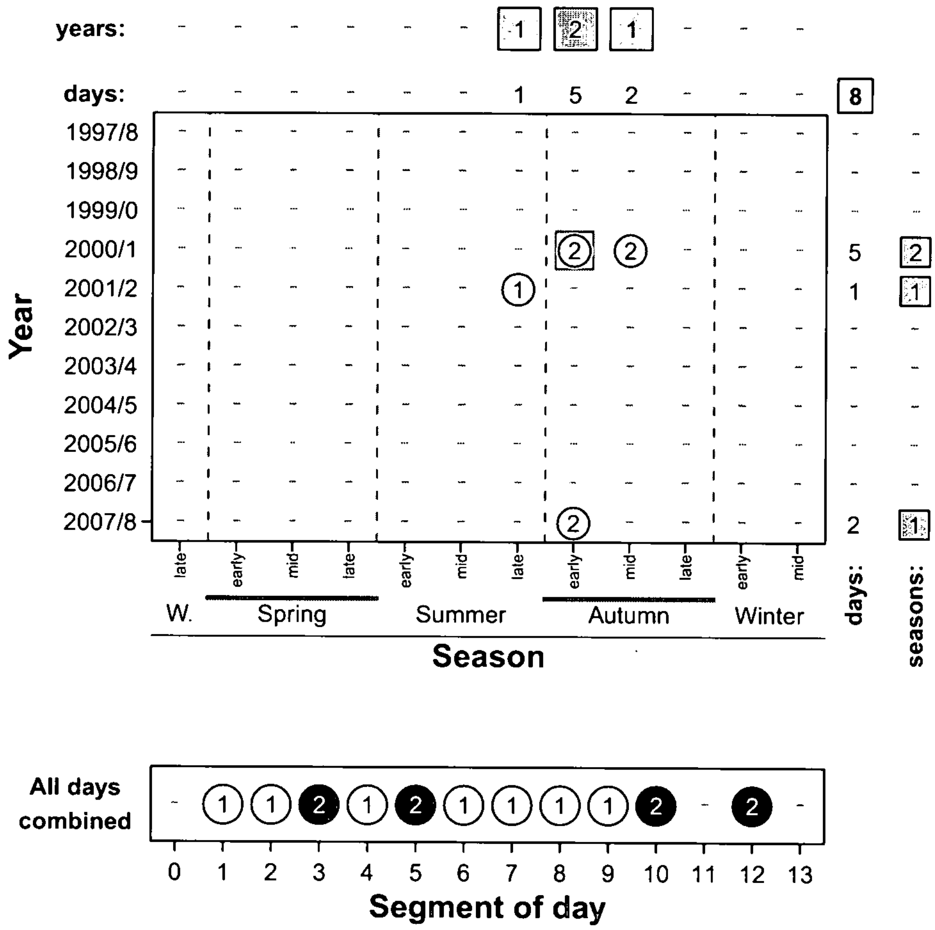


Figure 4.174: R300 Temminck's Courser — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R303 Bronze-winged Courser .... *Rhinoptilus chalcopterus*

The Bronze-winged Courser is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa it is recorded rather sparsely, mainly from the northern half of Namibia and in Botswana, Zimbabwe, southern Mozambique and South Africa north of 26°S (Parker 1999; Tree 1997c). Free State records are exceptional with records limited to single localities along the Vaal River (Tree 1997c; DJvN personal observations) and at Soetdoring Nature Reserve (R. J. Nuttall, personal communication). It is associated with woodlands, but moves into open grassland, roads and clearings at night (Maclean 1985; Tree 1997c). It appears that the apparently resident southern African population is supplemented by non-breeding birds from the north during the period November to May [late spring to early autumn] (Tree 1997c).

The birds at Glen

Single Bronze-winged Coursers were flushed during transects in the drainage line in late autumn 2000/1 and late spring 2001/2. In the grassland, heard for the first and only time in early autumn 2007/8, between 20 and 35 minutes after sunset on two days.

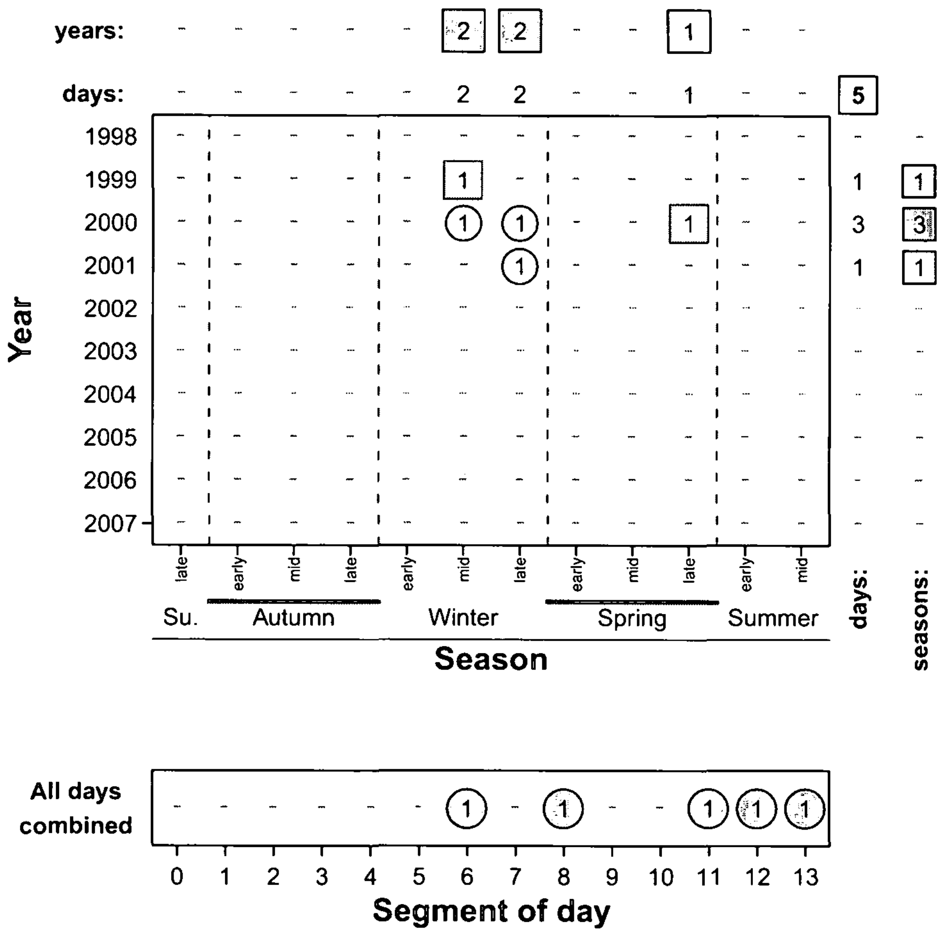


Figure 4.175: R301 Double-banded Courser — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

There were additional records of birds seen in the dirt road leading to the study area in previous years. However, the data await computerisation and I have to rely on memory here. There were only one or two sightings per year, usually in summer and autumn but they were more frequently encountered in 2007/8.

Discussion

It appears that the Bronze-winged Courser is a regular seasonal visitor at Glen. This is somewhat of a mystery, because they are not recorded anywhere else in the Free State with any degree of regularity. To be sure, they are by no means common at Glen, but they do occur nonetheless.

Bronze-winged Coursers are nocturnal and this, coupled with their relatively silent custom, no doubt makes them more difficult to study than most other species (Tree 1997c). They are also localised wherever they do occur, and they are secretive when breeding (Tree 1997c). Furthermore, they are superficially similar to the Crowned Lapwing R255, a common bird that, like the Bronze-winged Courser, also occurs on dirt roads close to woodland at night (Tree 1997c; DJvN personal observations). At Glen, the coursers were most frequently encountered on a dirt road that is patrolled once a week at night. The regularity — and timing, of course — of these visits is surely part of the reason why these birds are seen at Glen.

In conclusion, it is suggested that the Bronze-winged Courser may be more common in the Free State than the current records, or rather lack of records, seem to imply. Their apparent scarcity is being influenced by behaviour, bird behaviour on the one hand and birder behaviour on the other.

R305 Black-winged Pratincole .... *Glareola nordmanni*

The Black-winged Pratincole breeds in the Palearctic and spends the non-breeding season within the Afrotropics, mostly south of the equator (Cramp 1998). In southern Africa they occur mainly in the Okavango region of Botswana, as well as in South Africa where thy occur mainly from the northern Free State north to approximately 26°S (Maclean & Herremans 1997c). They are infrequent further south in the Free State (De Swardt 2000; Earlé & Grobler 1987; Maclean & Herremans 1997c). Its preferred habitat is open grassland and the edges of pans and cultivated fields (Maclean & Herremans 1997c). In SABAP1 Zone 7 they are present mainly from November to March (Maclean & Herremans 1997c) [late spring to mid-autumn]. They are highly gregarious, hawking insects in the early morning and evening or foraging on the ground (Maclean 1985). The Black-winged Pratincole is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Barnes 2000g).

The birds at Glen

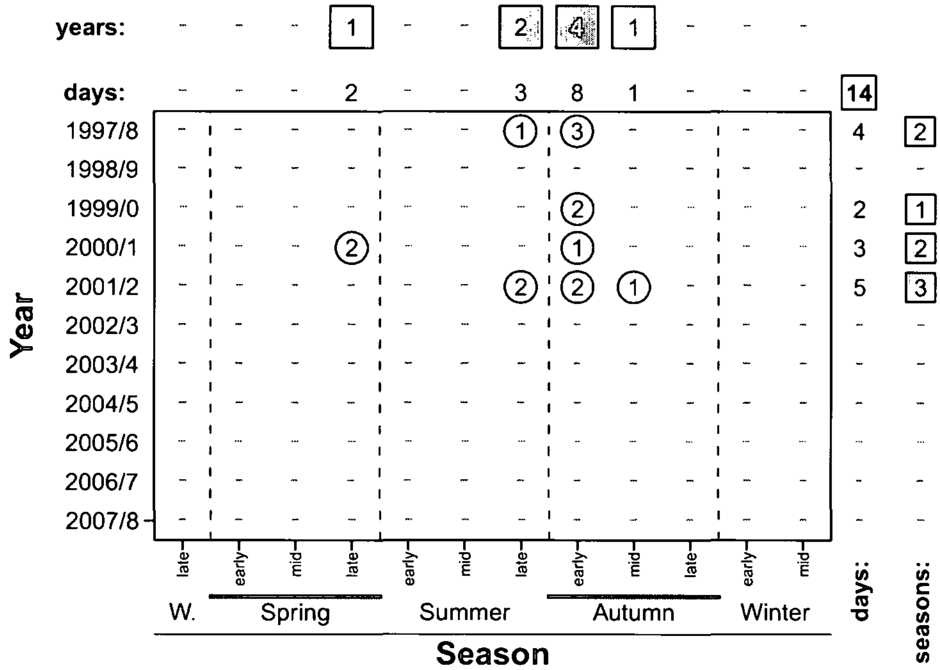
Black-winged Pratincoles were seen on 14 days with flock sizes varying from one to approximately 250 birds. Recorded during almost all years prior to 2002/3, but no records since then (Fig. 4.176). Seasonally, the earliest records were in late spring. However, all the rest of the records are limited to late summer, early and mid-autumn, being particularly frequent in early autumn (Fig. 4.176). Activity was recorded throughout most of the day (Fig. 4.176).

Discussion

It is well known that the Black-winged Pratincole remains nomadic in response to local rainfall throughout its stay in southern Africa; it rarely stays in one place for long (Earlé & Grobler 1987; Maclean & Herremans 1997c). In addition, in the former Transvaal, where they occur every year, their numbers are higher during wetter years (Tarboton *et al.* 1987). This association with rain is related to food as they exploit insect gluts after storms as well as swarms of grasshoppers and alate termites (Maclean & Herremans 1997c), often on the wing (Moreau 1972).

At Glen the two years during which they occurred in consecutive seasons (1997/8 and 2001/2; Fig. 4.176) were also years with above average rainfall (Fig. 2.13). In both years the birds arrived in late summer, with the last birds recorded in early autumn in 1997/8 and in mid-autumn in 2001/2. What is puzzling, though, is that they were not recorded at all in two subsequent high rainfall years, 2005/6 and 2007/8 (Fig. 4.176; Fig. 4.176). The key to this puzzle may lay in the timing of the rainfall in each year.

When the birds arrived at Glen in late summer 1997/8, 52 mm rain had already fallen in early summer and 94 mm in mid-summer (Fig. 2.16). In late summer another 87 mm fell and in early



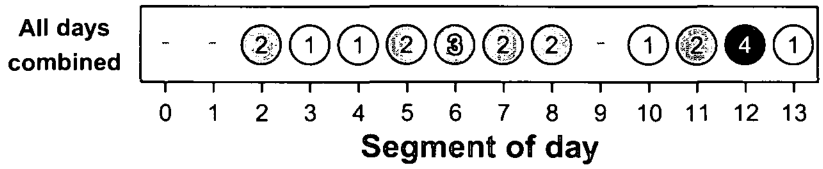


Figure 4.176: R305 Black-winged Pratincole — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

autumn 135 mm (Fig. 2.16). Note that in this case the birds were already there when the 'big' rain came in early autumn. This is perhaps more than a coincidence. It is suggested that the birds followed the rain fronts which were perhaps part of a larger system that eventually caused the high rainfall in 1997/8.

Compared to 1997/8, high rainfall occurred earlier in 2001/2 (Fig. 2.16). In the seasons before the pratincoles arrived in late summer, exceptionally good rains were experienced in late spring (147 mm) and early summer (113 mm) with 76 mm in mid-summer (Fig. 2.16). Then during late summer when the birds arrived (Fig. 4.176) 121 mm fell (Fig. 2.16). Here, too, it is possible that the birds followed rain fronts which were part of a larger system that led to high rainfall for that year. However, very little rain fell in early and mid-autumn when the birds were present (Fig. 4.176; Fig. 2.16). It is suggested that the good rains of the preceding seasons were sufficient to maintain good stores of prey for the birds.

The rainfall patterns of the remaining two high rainfall years were very different from that of 1997/8 and 2001/2 (Fig. 2.16). More specifically, it was mainly rain in early and late autumn that boosted the total rainfall for 2005/6, while the high rainfall figure of 2007/8 was the result of a reasonably constant amount of rainfall spread over eight seasons (Fig. 2.16). Possible reasons for the pratincoles' absence during these years include the fact that the 'big' rain came too late in 2005/6, and that there was no single seasons with particularly high rainfall in 2007/8.

4.25 Laridae: Skuas, Jaegers, Gulls, Skimmers, Terns, Noddies

This diverse family, mostly seabirds, consists of four groups which are often treated as families of their own, namely the Laridae (gulls; 50 spp.), Rhynchopidae (skimmers; 3 spp.), Stercorariidae (skuas and jaegers; 7 spp.) and the Sternidae (terns; 44 spp) (Hockey *et al.* 2005). Only five species occur regularly on inland waters (see Earlé & Grobler 1987; Harrison *et al.* 1997a). In southern African the African Skimmer *Rynchops flavirostris* is mainly restricted to the northern parts of the region and very scarce in South Africa, in contrast to the Grey-head Gull *Larus cirrocephalus* that is widespread in the Free State and elsewhere in the country (Earlé & Grobler 1987; Harrison *et al.* 1997a). However, only the Caspian Tern R322, Whiskered Tern R338/White-winged Tern R339 were recorded at Glen.

R322 Caspian Tern .... *Sterna caspia*

The Caspian Tern occurs worldwide except in South America and Antarctica (Cooper *et al.* 1992). In southern Africa it is found all around the coast as well as at a few large inland dams and pans, some of which are located in the Free State (Colahan 2008; Maclean 1985; Tree 1997d). There is currently no evidence to suggest the presence of northern hemisphere birds in southern Africa (Underhill *et al.* 1999). Erratic inland movements are presumably in response to high water levels (Tree 2005a). The Caspian Tern is close to qualifying for or is likely to be become vulnerable to extinction in the wild in the near future (Underhill 2000).

The birds at Glen

Soetdoring Nature Reserve (De Swardt 2000) is the nearest locality to Glen where the Caspian Tern is resident. One individual flew over the study area during the early morning (S2) in mid-spring 2007/8.

R338 Whiskered Tern .... *Chlidonias hybrida*

The Whiskered Tern occurs in the Palearctic and India (*C. h. hybridus*), southern and East Africa and Madagascar (*C. h. sclateri*), and Australia (*C. h. javanicus*) (Cramp 1998). In southern Africa it occur in various areas in all seven countries and are widespread in the Free State (Hockey 2005e). It occurs at a variety of inland wetlands (Maclean 1985). Palearctic birds migrate to Africa, but apparently do not reach southern Africa (Cramp 1998). The southern African birds include residents, nomads and partial intra-African migrants (Hockey 2005e). In the Free State they are resident subject to movements dependant on local conditions (De Swardt 2000; Earlé & Grobler 1987).

The birds at Glen

Owing to insufficient views, it was difficult to distinguish between the Whiskered Tern and the similar looking White-winged Tern R339. A small flocks was seen in flight on two occasions, four individuals during mid-summer 2001/2 and three in late spring 2002/3.

R339 White-winged Tern .... *Chlidonias leucopterus*

The White-winged Tern breeds in the Palearctic and migrates mainly to sub-Saharan Africa, Asia and Australia to spend the non-breeding season there (Cramp 1998). In southern Africa it is recorded from all countries except Lesotho, and it is more concentrated in certain areas with the Free State forming part of its largest core area (Williams & Underhill 1997). Some birds overwinter in southern Africa, but most arrive from about September and depart in April [mid-spring to late autumn] (De Swardt 2000; Williams & Underhill 1997). It occurs on a variety of wetlands and may also forage over grassland and cultivated crops (Earlé & Grobler 1987; Hockey & Tree 2005).

The birds at Glen

See Whiskered Tern R338 above.

4.26 Pteroclidae: Sandgrouse

Sixteen sandgrouse species occur in Eurasia, Africa and Madagascar with four species found in southern Africa (Hockey *et al.* 2005). Only the Namaqua Sandgrouse occurs in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a).

R344 Namaqua Sandgrouse .... *Pterocles namaqua*

The Namaqua Sandgrouse occurs from south-western Angola (Dean 2000) south throughout most of Namibia and the western half of South Africa where it penetrates marginally into the central and eastern Free State (Earlé & Grobler 1987; Little 1997d). Also recorded from scattered localities in Botswana (Little 1997d). Part of the population is nomadic, and southern populations partially migratory (Maclean 1985; Malan & Little 1994). In the Free State, its habitat includes arid and semi-arid grassland and karoo (Earlé & Grobler 1987).

The birds at Glen

Always located by their call as birds flew overhead. Birds alighted in the trampled area of the study area on two occasions. Recorded on a total of 24 days spread over seven years (Fig. 4.177). Most frequently recorded during 1998/9 when found in six seasons compared to the 0–3 seasons of other years (Fig. 4.177). Seasonally recorded for 0 to 3 years in all seasons except early spring when recorded during five years (Fig. 4.177). Records were limited to the morning (S1-S5) and late afternoon (S11-S12) with the majority of the records during mid-morning (Fig. 4.177). On the few occasions when birds were seen they numbered 1 (n = 1), 2 (n = 3) and 3 (n = 1) individuals.

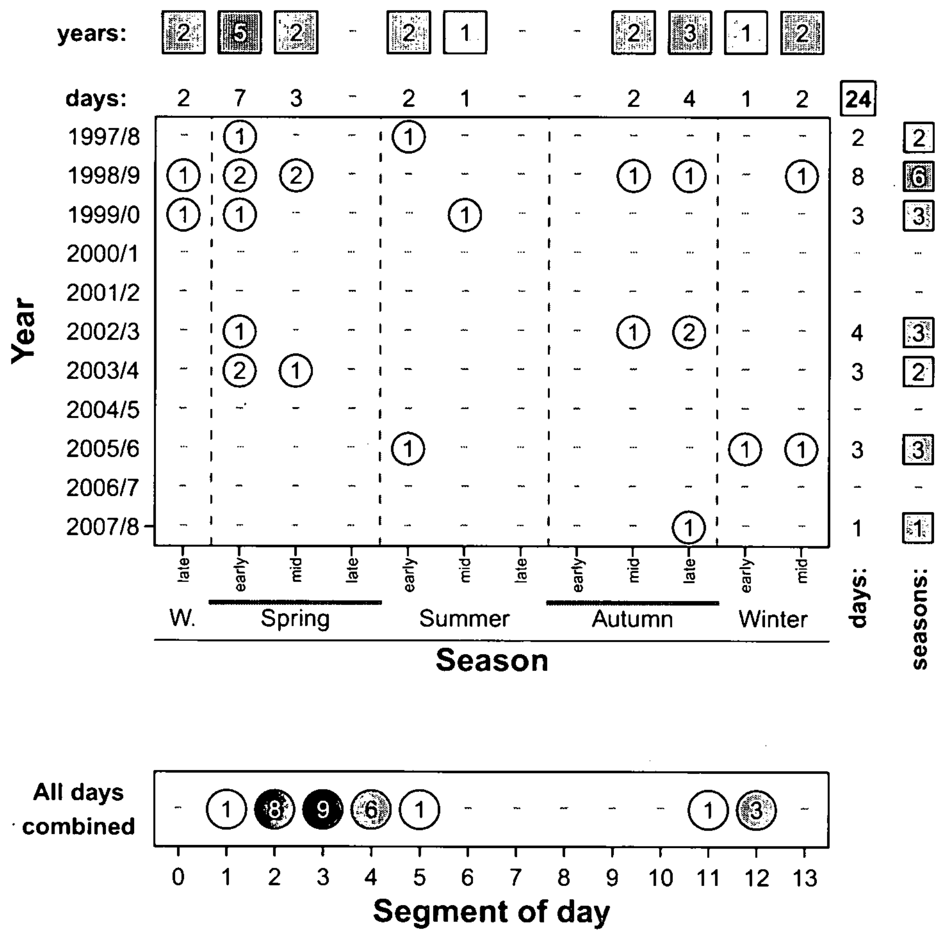


Figure 4.177: R344 Namaqua Sandgrouse — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Discussion

It is known that flocks of Namaque Sandgrouse may fly up to 60 km or more to drink water, typically one to three hours after sunrise (Lloyd *et al.* 2000; Maclean 1985). Individual birds may drink only every three to five days, and some individuals drink again in the evening (Lloyd *et al.* 2000; Maclean 1985). This drinking routine is the most likely explanation for the well-defined activity pattern observed at Glen (Fig. 4.177). However, the start and end points of their journey is unknown.

In a study on South African birds, Malan & Little (1994) found that the majority of sandgrouse are concentrated in Bushmanland in the Northern Cape from December to March [summer to mid-autumn]. From April to July [late autumn and winter] the birds move north and east of Bushmanland and apparently return to Bushmanland from August to November [spring to early summer] (Malan & Little 1994). This probably explains why the birds were mainly found from mid-autumn to mid-spring at Glen (Fig. 4.177).

4.27 Columbidae: Pigeons, Doves

The approximately 310 columbid species occur worldwide except in the polar regions, with 15 species occurring in southern Africa (Hockey *et al.* 2005). Six species show a widespread distribution in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a) and all six were recorded at Glen. Additional species not recorded at Glen but occurring in the Free State include the highly localised African Olive-Pigeon *Columba arquatrix* (Earlé & Grobler 1987; Oatley 1997a) and the Emerald-spotted Wood-Dove *Turtur chalcospilos* which is a vagrant to the province (Earlé & Grobler 1987).

R348 Rock Dove .... *Columba livia*

Due to a long history of domestication by man, the original distribution of the Rock Dove is obscure (Cramp 1998). According to Maclean (1985), they originally occurred in south-eastern Europe, south-western Asia, India, Arabia, North Africa and the British Isle, but has since been introduced worldwide. The birds in South Africa derived from escaped domestic stock first brought from the Netherlands in 1652 and later from elsewhere in Europe. However, it is unknown when the birds first became feral (Brooke 1997a; Maclean 1985). In South Africa their current distribution is mainly concentrated in urban areas (Brooke 1997a).

The bird at Glen

All, or at least the vast majority, 'Rock Doves' recorded at Glen actually refer to racing pigeons overflying the study area, usually from a south-westerly to a north-easterly direction. Flock size varied from one to approximately a 1 000 birds. Recorded only since 2001, and only seen in the grassland. The data analysis is based on a year starting in late summer.

Recorded on 37 days in all years since 2001, being particularly frequent in 2002 when recorded during eight seasons compared to the 1–5 seasons of other years (Fig. 4.178). All except one of the records — involving a single bird in early autumn — were during late autumn, winter and spring (Fig. 4.178). Most of the records were of birds seen in the morning (Fig. 4.178).

Discussion

Both the seasonal and the daily pattern reflect the times when pigeon racing occur.

R349 Speckled Pigeon .... *Columba guinea*

The Speckled Pigeon is endemic to sub-Saharan Africa, with *C. g. guinea* occurring north of 9°S, and *C. g. phaeonotus* (including *C. g. bradfieldi*) south of 16°S (Dean 2005d; Rowan 1983). More specifically, the distribution of *C. g. phaeonotus* extends from south-western Angola (Dean 2000) south into Namibia and from there into South Africa, Lesotho, Swaziland, eastern Botswana and certain parts of Zimbabwe (Colahan 1997b). Cliffs and buildings count amongst their favourite roosting and breeding sites, and from these they travel to foraging areas such as agricultural fields, which may be more than 20 km away (Rowan 1983). It is mainly a resident (Dean 2005d; Maclean 1985; Rowan 1983).

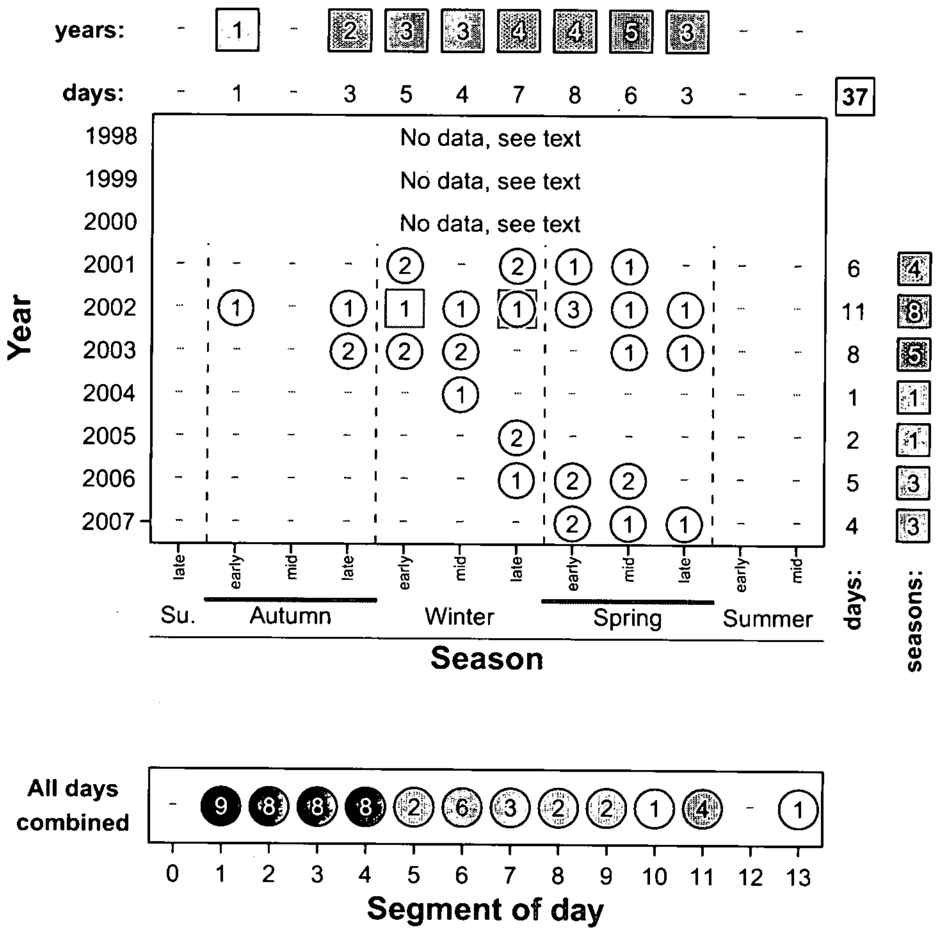


Figure 4.178: R348 Rock Dove — birds seen only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

The birds at Glen

Records of Speckled Pigeons at Glen were virtually limited to birds seen in flight, often one or two individuals, but flocks of up to approximately a 100 birds have been recorded (Fig. 4.179). In addition, single birds flushed from the veld at dawn (n = 7 days) present clear evidence that birds sometimes roost on the ground in the grassland. On occasion, a bird was also found roosting in the middle of a gravel road near the study area. These observations confirm the suggestion of Kok (1987) that some birds may roost away from their usual sites at times. The few vocal records are ignored in the analysis. Figures start on page 383.

Annual occurrence of birds seen in flight: Seen on 37.0% of the days with an activity index of two (Table 4.33a). Recorded for 5–11 seasons per year, most frequently (n = 10–11 seasons) in 2001/2, 2002/3, 2004/5 and 2007/8 (Fig. 4.180; Fig. 4.181). The annual frequency index was relatively high in 2003/4, 2004/5 and 2007/8 (Fig. 4.180). Daily reporting rates ranged from 0.5 to 9.1% with 96.7% of the values relatively low and with no meaningful differences in median daily reporting rates (Fig. 4.180).

Table 4.33: R349 Speckled Pigeon: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists n	5-minute checklists Total	5-minute checklists %	Activity	Days %	Days Total	Days n	Activity index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	483	114 612	0.4	seen in flight	37.0	656	243	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	4	1 190	0.3	seen in flight	9.3	43	4	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	11	1 188	0.9	seen in flight	23.3	43	10	1

Seasonal occurrence of birds seen in flight: No clear seasonal pattern is discernible. Seen during 6–10 years each season (Fig. 4.180). Median daily reporting rates for all seasons were less than 2% (Fig. 4.180).

Daily occurrence of birds seen in flight: Overall, activity occurred most frequently in the early morning after sunrise (Fig. 4.180). This pattern is particularly prominent in spring, summer and early autumn, in contrast to the remainder of autumn and winter when activity tend to be frequent in the late morning and / or early afternoon too (Fig. 4.182). Bird-segment combinations occurring on more than 5% bird-days were limited to four single segments in the early morning and mid-afternoon, collectively accounting for more than a third of all bird-days (Fig. 4.183).

The first activity of the day usually occurred sometime during the morning, with the median time variable amongst the seasons (Fig. 4.182). Timing of the last activity if the day was even more variable, occurring at any time between sunrise and sunset (Fig. 4.182).

Daily segment reporting rates ranged from 5.6 to 42.9% with 92.3% of all values relatively low and medians less than 10%, equivalent to activity during only two 5-minute checklists per day (Fig. 4.180).

Early morning occurrence of birds seen in flight during 2007/8. Recorded on ten mornings in the grassland and on only four in the drainage line (Table 4.33b & c), with the observations in the grassland occurring during most seasons while those in the drainage line were limited to four seasons only (Fig. 4.184). However, the activity index (Table 4.33b & c) and the median early morning reporting rates (Fig. 4.184) are basically the same. Activity tended to start earlier in the grassland (Fig. 4.184).

Discussion

Given the fact that records of Speckled Pigeons at Glen were mainly limited to birds in flight, it is likely that an unknown number of pigeons flew past unnoticed. This complicates the interpretation of the data. It is, nonetheless, of interest to note the seasonal change in the daily pattern with activity more frequent in the late morning and early afternoon during most of autumn and

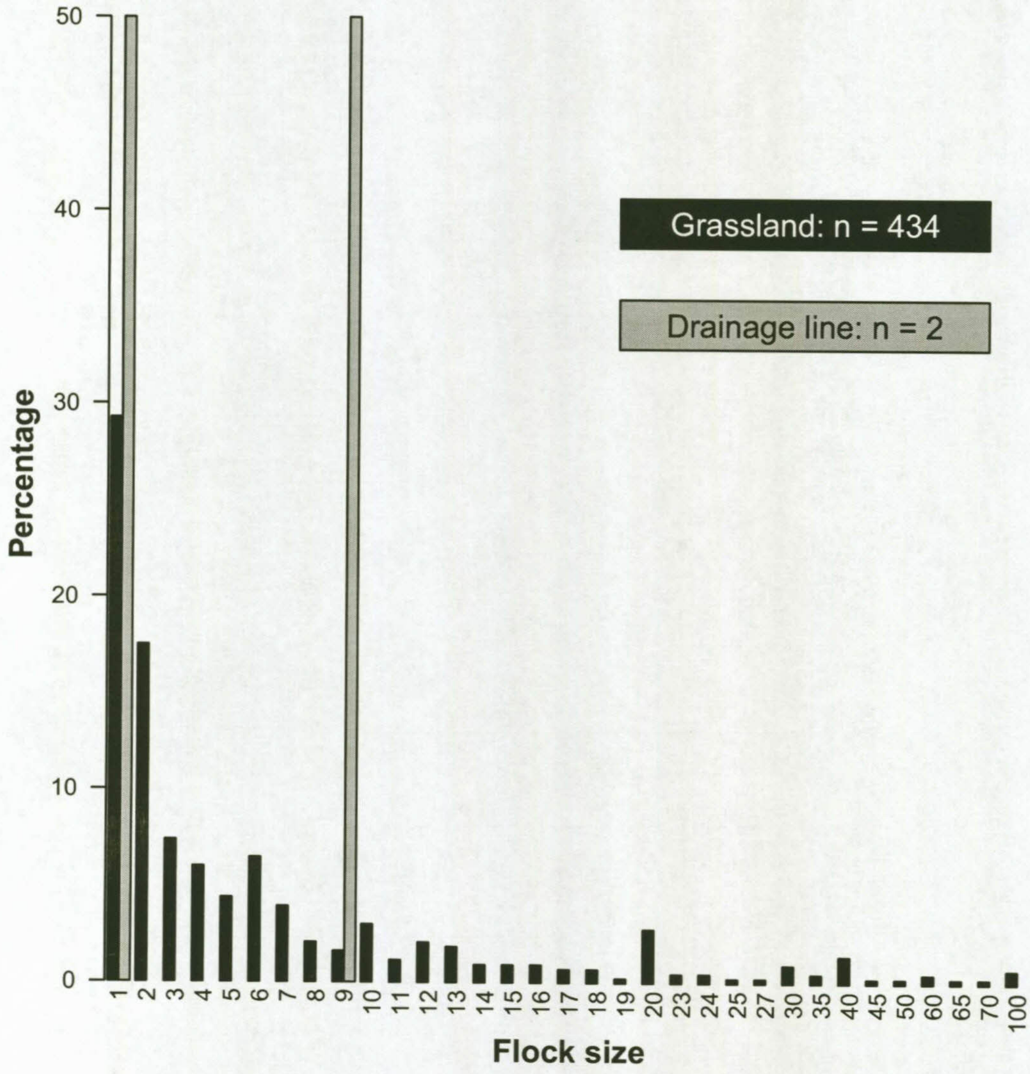


Figure 4.179: R349 Speckled Pigeon: Flock size of birds seen in the study area at Glen.

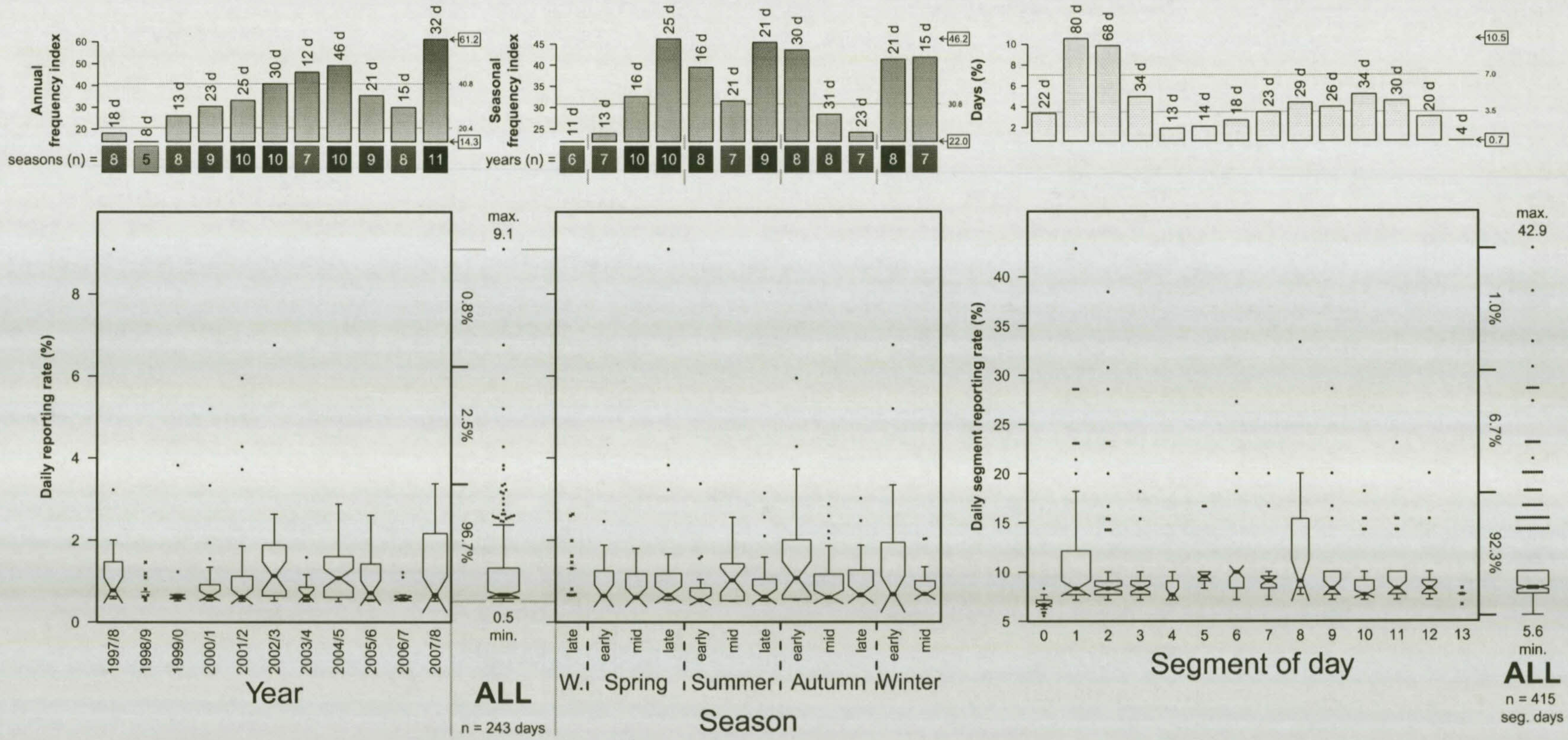


Figure 4.180: R349 Speckled Pigeon — seen in flight: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

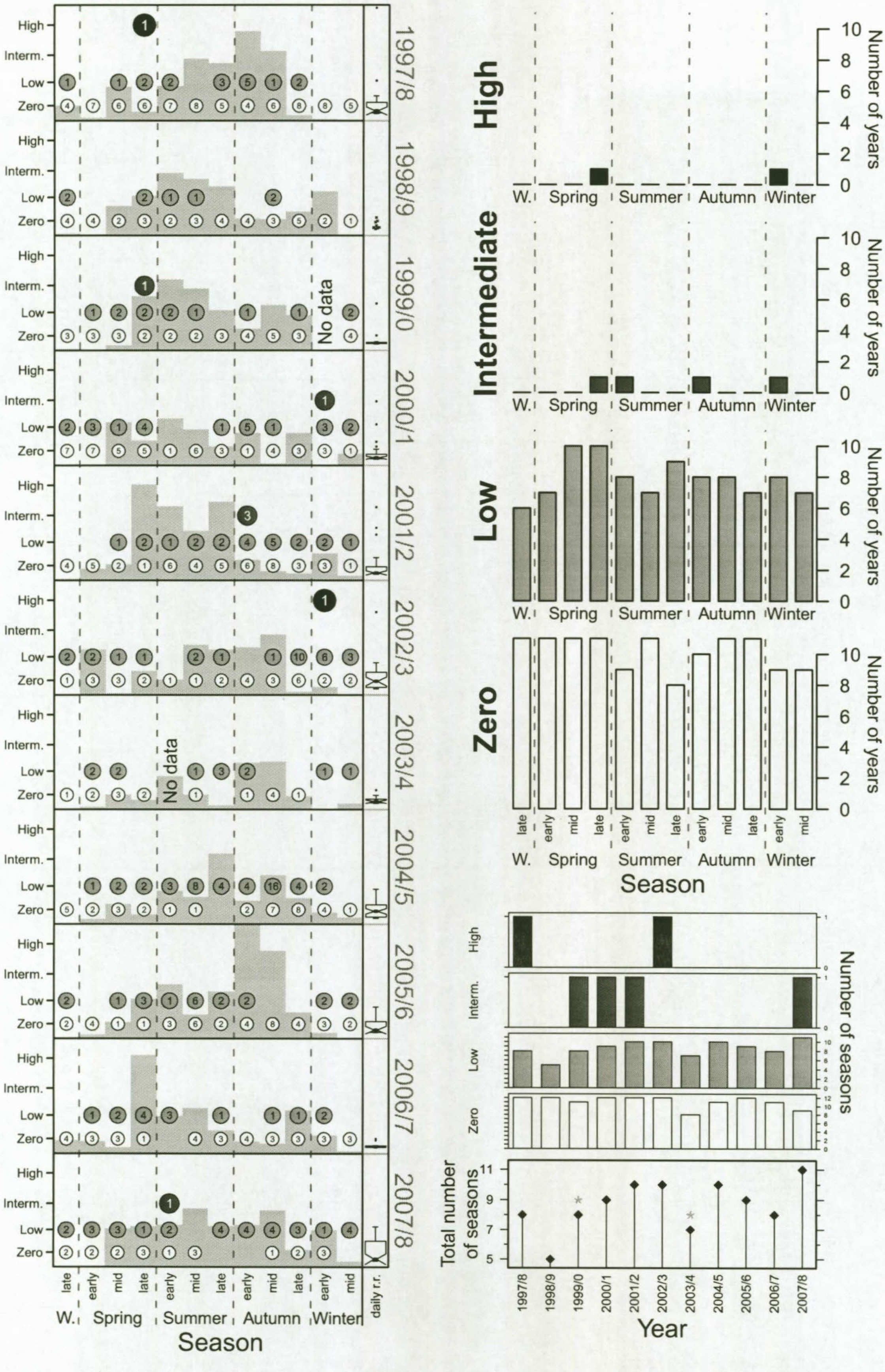


Figure 4.181: R349 Speckled Pigeon — seen in flight: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

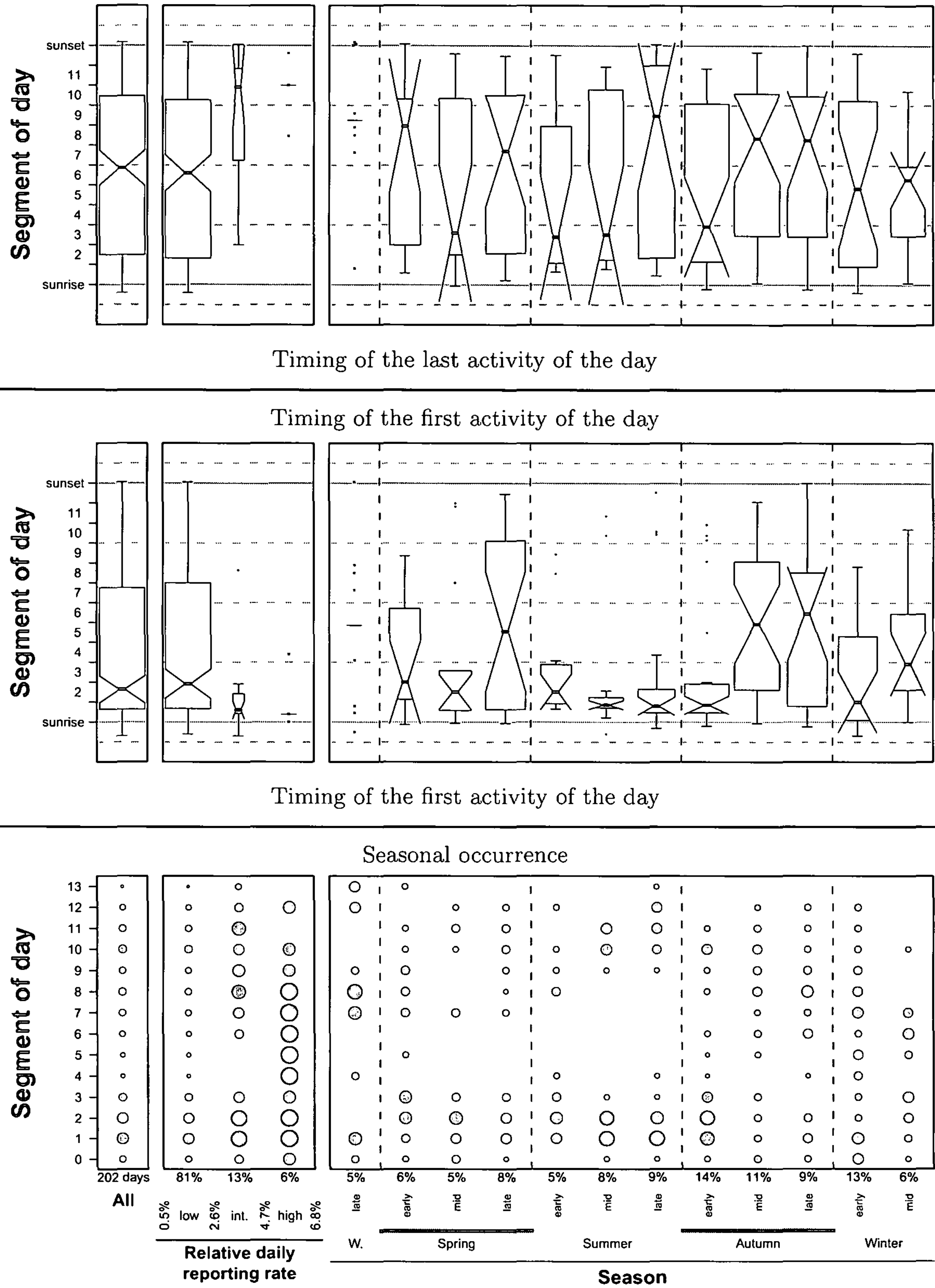


Figure 4.182: R349 Speckled Pigeon — seen in flight: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

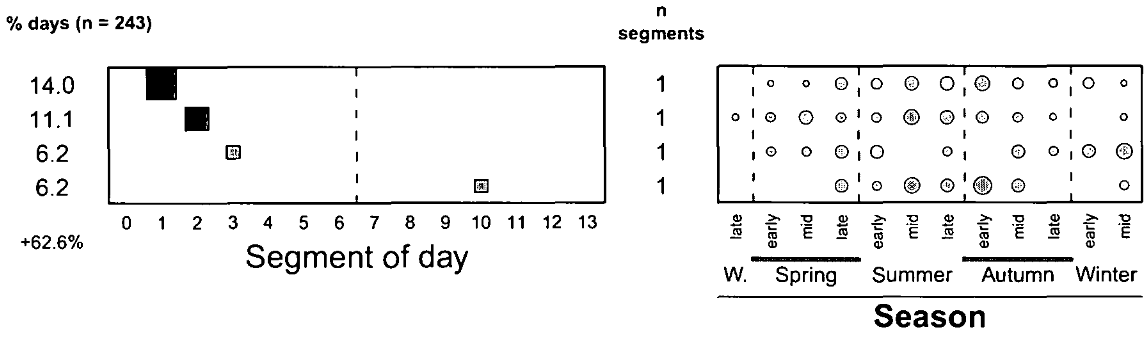


Figure 4.183: R349 Speckled Pigeon — seen in flight: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

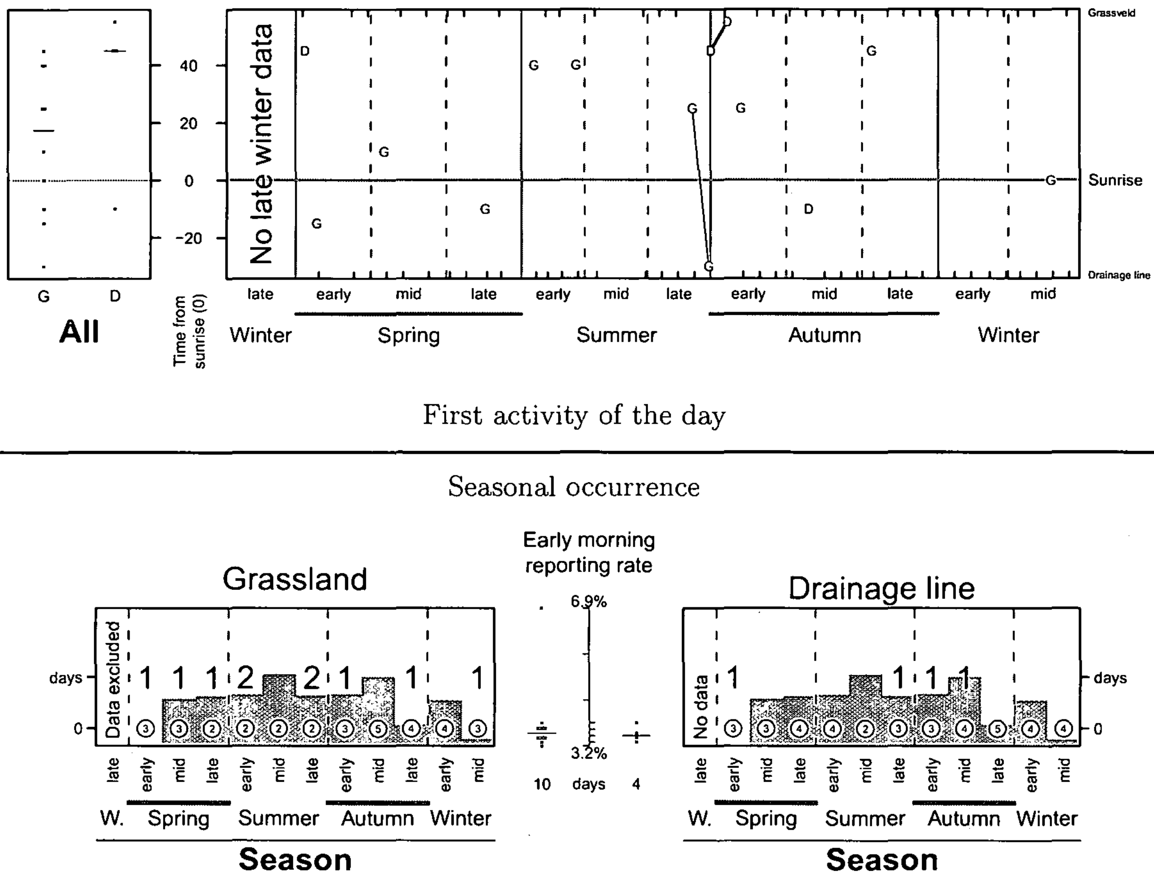


Figure 4.184: R349 Speckled Pigeon — seen in flight: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Top: Occurrence of the first activity of the day. See page 136 for more information on this early morning figure.

winter compared to spring and summer (Fig. 4.182). This may be related to feeding in recently harvested maize and sunflower fields at this time of the year (see Kok 1987).

R352 Red-eyed Dove .... *Streptopelia semitorquata*

The Red-eyed Dove occur throughout sub-Saharan Africa and is also found on east African islets and in south-west Arabia (Rowan 1983). It is widespread in southern Africa but absent or scarce in Namibia, central and southern Botswana and the drier western parts of South Africa (Colahan 1997c). Tall trees close to water appear to be an essential habitat requirement for this species (Rowan 1983). A certain fraction of the population appears to be resident while others are involved in seasonal influxes (Colahan 1997c; Rowan 1983).

The birds at Glen

The majority of Red-eyed Dove records in the grassland (85.7%) involved birds heard only, while the remainder were of birds seen in flight (Table 4.34a). The two sections of the data-set were analysed separately. The analyses are based on a year starting in late summer.

Table 4.34: R352 Red-eyed Dove: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.857	90	114 612	0.1	heard only	7.9	656	52	2
0.143	15	114 612	0.0	seen in flight	2.1	656	14	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.947	18	1 190	1.5	heard only	16.3	43	7	3
0.053	1	1 190	0.1	seen in flight	2.3	43	1	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	2	1 188	0.2	heard only	4.7	43	2	1

Birds heard only: Heard on 7.9% of the days with an activity index of two (Table 4.34a). Activity was recorded during 5–6 seasons in 1998, 2002, 2005 and 2006 compared to only 0–3 seasons in the remaining years (Fig. 4.185). Not recorded during early summer, but otherwise recorded for 2–3 years in all seasons except early and mid-spring when recorded during 4–5 years (Fig. 4.185). Activity was recorded throughout the day, but it was most frequent in the late afternoon before sunset (Fig. 4.185).

During the early mornings (S0 and S1) of 2007/8, heard on seven days in the drainage line compared to only two in grassland with activity indices of three and one respectively (Table 4.34b & c).

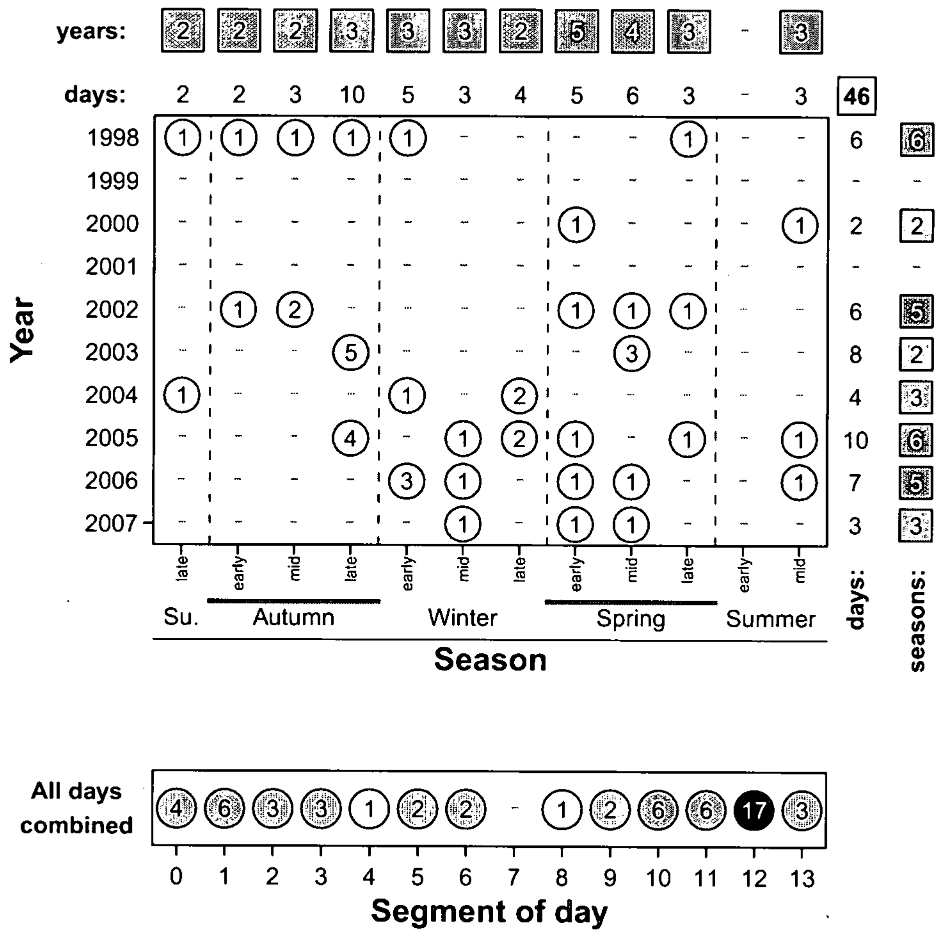


Figure 4.185: R352 Red-eyed Dove — heard only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Birds seen in flight: Seen on 16 days with records in 2000 and 2002–2006 (Fig. 4.186). Seasonally, records were limited to two distinct periods: 1) mid-spring–late spring, and 2) late summer–early winter, with records during two years each season (Fig. 4.186). Seen during the early morning and late afternoon only (Fig. 4.186).

Discussion

According to Tarboton (2001) breeding in the Red-eyed Dove occurs throughout the year but is probably most frequent from August to October [spring]. At Glen, vocalisations occurred most frequently during this period (Fig. 4.185). The concentration of sight records around early morning and late afternoon (Fig. 4.186) probably represent birds commuting between the drainage line where they roost and feeding grounds elsewhere.

R354 Cape Turtle-Dove . . . . *Streptopelia capicola*

The Cape Turtle-Dove is endemic to sub-Saharan Africa (Rowan 1983) and the most widespread of all southern Africa birds (Colahan & Harrison 1997a). It occurs in any woodland and is ap-

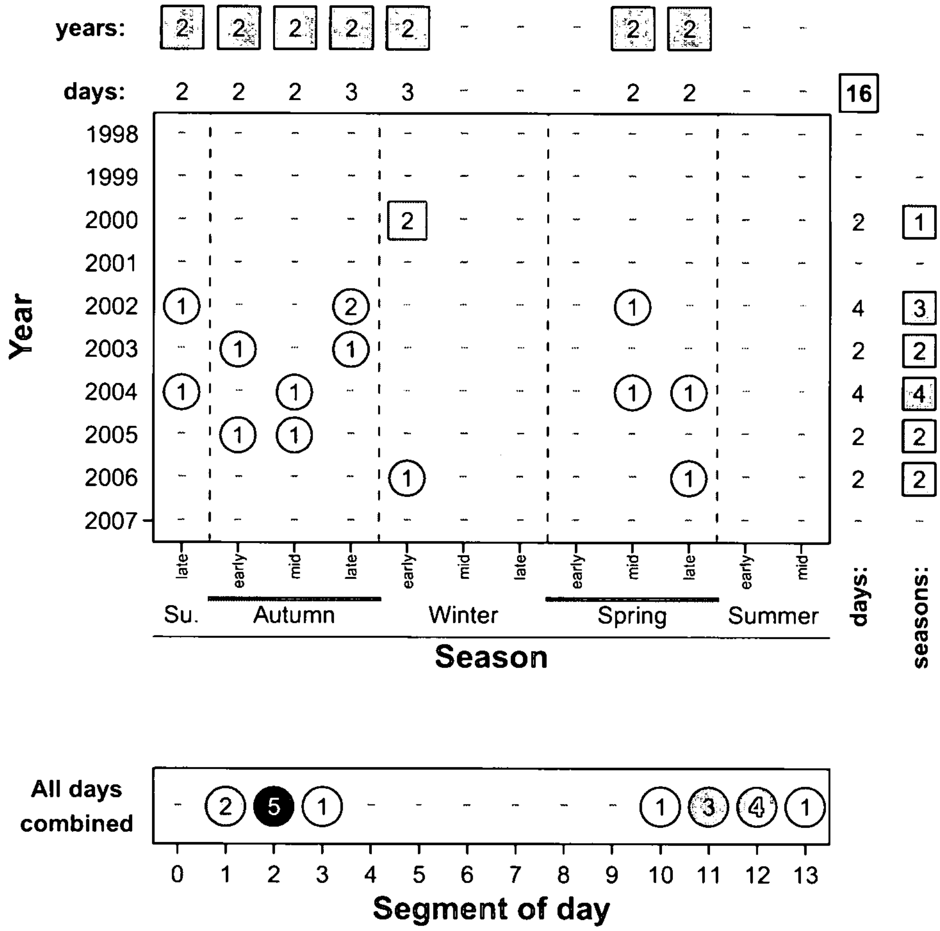


Figure 4.186: R352 Red-eyed Dove — seen in flight: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

parently sedentary in mesic areas such as the Free State (Colahan & Harrison 1997a; Dean 2005f; Rowan 1983).

The birds at Glen

The Cape Turtle-Dove was the most frequently recorded species at Glen, being recorded on 62.9% of all five minute intervals in the grassland (Table 4.35a). The vast majority of records in the grassland (97.7%; Table 4.35a) involved the so-called 'advertising calls' which could be rendered 'work hárder'. In most cases the calls originated from birds calling from the drainage line. The rest of the records involved birds seen (Table 4.35a), usually single birds or pairs in transit, but also in the trampled area where they often drank water. The analysis is based on a year starting with late summer. Figures start on page 394.

Annual occurrence of drainage line birds heard in the grassland: Heard on 99.8% of the days with an activity index of 110 (Table 4.35a). Daily reporting rates ranged from 2.1 to 100% with only 15.1% of all bird-days attaining relatively low values (Fig. 4.187). The median daily reporting rates increased from approximately 50% in 1998 to values greater than 85% since 2002,

Table 4.35: R354 Cape Turtle-Dove: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.977	72 087	114 612	62.9	birds heard	99.8	656	655	110
0.023	1 660	114 612	1.4	birds seen	68.3	656	448	4
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	975	1 190	81.9	birds heard	100.0	43	43	23
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.988	951	1 188	80.1	birds heard	100.0	43	43	22
0.012	12	1 188	1.0	birds seen	23.3	43	10	1

except for 2004 when the median daily reporting rate was 69.3% (Fig. 4.187). Furthermore, the incidence of days with high reporting rates increased gradually from occurring during only four seasons in 1998 to all 12 seasons in 2006 and 2007 (Fig. 4.188). This was accompanied by a complementary decrease in both intermediate and particularly low reporting rate days (Fig. 4.188).

Seasonal occurrence of drainage line birds heard in the grassland: The median daily reporting rates show a prominent seasonal pattern with lowest values attained during late spring and summer and highest values from mid-autumn to early winter (Fig. 4.187). High reporting rate days were most prevalent in autumn, winter and early and mid-spring, while low reporting rate days were most frequent in late spring and summer (Fig. 4.188).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity was very frequent, occurring on at least 88.2% of the days during all segments (Fig. 4.187). For low reporting rate days, activity tended to be more frequent in the early morning after sunrise and in the late afternoon before sunset and was least frequent (*i.e.* occurring on a minimum of 40.9% bird-days) around midday (Fig. 4.189). Although the data for intermediate reporting rate days show a similar pattern, activity levels were high for all segments of the day, occurring during at least 85.2% bird-days (Fig. 4.189). Activity was very frequent (>96%) for all segments of high reporting rate days (Fig. 4.189).

Activity tended to be slightly less frequent during the middle of the day in mid- and particularly late summer (Fig. 4.190). Activity during all 14 segments was the the only bird-segment combination occurring on more than 5% bird-days (64.6%) (Fig. 4.191).

The first activity of the day typically occurred some time before sunrise, and earlier on high than on intermediate or low reporting rate days (Fig. 4.190; Fig. 4.192). During autumn, winter and spring activity was noted on approximately one third of all bird-days during the first 5-minute interval of the day (Fig. 4.190; Fig. 4.192), suggesting that activity could have started earlier. During summer this value was down to approximately 5% of the days (Fig. 4.190;

Fig. 4.192). In addition, the median starting time was later in early and late summer than during late autumn (Fig. 4.190; Fig. 4.192). The dawn chorus sequence (Fig. 4.192) followed a seasonal pattern similar to that shown by the timing of the first activity of the day .

The last activity of the day typically occurred after sunset, and later on high than on intermediate or low reporting rate days (Fig. 4.190; Fig. 4.192). Although no seasonal differences occurred, the timing was least variable in mid- and late autumn and most variable in late spring, summer and early autumn (Fig. 4.190; Fig. 4.192).

Overall, daily segment reporting rates ranged from 5.0 to 100% with two-thirds of the values relatively high (Fig. 4.187). Median daily segment reporting rates were highest in the early morning after sunrise and again in the late afternoon before sunset, and lowest from late morning till early afternoon (Figs. 4.187). This general pattern holds for low, intermediate as well as high reporting rate days, differing mainly in the magnitude of their respective absolute values (Fig. 4.189). Seasonal variation in these patterns are illustrated in Figure 4.193.

Early morning occurrence of birds heard during 2007/8: Activity was equally frequent in the drainage line and in the grassland, being recorded on all mornings in both habitats and with similar activity indices (Table 4.35b & c). In addition, the median early morning reporting rate was also similar for both habitats, as was the seasonal pattern of occurrence (Fig. 4.194). The timing of the first activity of the day was similar too (Fig. 4.194). Activity intensity was assessed in the drainage line only, where it was similar before and after sunrise (Fig. 4.194).

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Annual occurrence of birds seen in the grassland: Seen on 68.3% of the days with an activity index of four (Table 4.35a). Recorded during 10–12 seasons each year, except 2006 when recorded during seven seasons only (Fig. 4.195). Daily reporting rates ranged from 0.5 to 14.2% with 90.3% bird-days attaining relatively low values (Fig. 4.195). Median daily reporting rates were relatively high in 1998, 1999, 2003 and 2007 (Fig. 4.195), these also being the only years with high reporting rates (Fig. 4.196). The median daily reporting rates of 2000, 2001, 2005 and 2006 were relatively low (Fig. 4.195), with the occurrence of zero record days particularly frequent during these years (Fig. 4.196).

Seasonal occurrence of birds seen in the grassland: Recorded for 8–10 years in each season (Fig. 4.195). Median daily reporting rates tend to be higher from late autumn to mid-spring than from late spring to mid-autumn (Fig. 4.195). Relatively few instances of high or intermediate reporting rate days occur, with the occurrence of zero record days being particularly frequent in late summer, and early and mid-autumn (Fig. 4.196).

Daily occurrence of birds seen in the grassland: Overall, activity was most frequent before mid-morning and again in the late afternoon before sunset (Fig. 4.195). This general pattern is most prominent for intermediate and least prominent for high reporting rate days (Fig. 4.197). All seasons showed a similar pattern (Fig. 4.198). The only bird-segment combinations occurring on more than 5% bird-days was activity during S11 alone and activity during S12 alone, collectively accounting for only 15.9% bird-days (Fig. 4.199). These two combinations occurred most frequently in late spring and early autumn respectively (Fig. 4.199).

The occurrence of the first activity of the day was variable and showed no prominent seasonal pattern with the median values of most seasons in the early morning (Fig. 4.198). The last activity was less variable and tended to be in the late afternoon during most seasons (Fig. 4.198).

Overall, daily segment reporting rates ranged from 5.9 to 54.5% with 90.5% of the values relatively low (Fig. 4.195). The upper quartile of S2, S3, S10, S11 and S12 was particularly high (Fig. 4.195), and for intermediate as well as high reporting rate days the medians of these segments were also relatively high (Fig. 4.197).

Discussion

In most cases vocal activity involved birds calling in the drainage line. The fact that vocal activity was similar in the drainage line and the grassland (Fig. 4.194) indicates that the vocalisations measured in the grassland is representative of that occurring in the drainage line.

The advertising call of the Cape Turtle Dove is said to be one of the most characteristic sounds of the southern African veld (Rowan 1983). Rowan (1983) continues: "They are to be heard all day long and often at night at all seasons of the year." The Glen data attest to these facts, and add much more besides. According to Rowan (1983), the "Cape Turtle Dove starts calling at sunrise or as much as an hour earlier." At Glen, however, the first activity of the day *typically* occurred more than 45 minutes before sunrise and frequently more than an hour before sunrise (Fig. 4.190; Fig. 4.192). The observations at Glen do agree partially with Rowan's (1983) statement that the "Cape Turtle Dove retires fairly early to roost, usually before sunset." Note in particular how the peak in occurrence of birds seen before sunset — usually involving birds returning to the drainage line — contrasts with the few observations after sunset (Fig. 4.195; Fig. 4.197).

But, adds Rowan (1983), "the resting birds are easily disturbed any time till dark, and night-calling is frequent." In context, this seems to imply that the birds are not normally vocally active after sunset. However, later in her text for the Laughing Dove R355 she noted that Cape Turtle Doves are "slightly more crepuscular" than the Laughing Dove (Rowan 1983). She continues: "Nevertheless birds [Laughing Doves] start calling an hour or more before sunrise [reference deleted] and continue for as much as an hour after sunset [reference deleted]" (Rowan 1983). Nevertheless, the observations at Glen clearly indicate that activity *typically* ceased between 30 and 60 minutes *after* sunset (Fig. 4.190; Fig. 4.192).

Although not specifically quantified, bush encroachment occurred in the drainage line since the start of the study. It is suggested that the general increase in vocal activity over the years (Fig. 4.187) could be related to this. It is not known to what extent the birds forage in the drainage line itself, but it is well known that they commonly forage on the ground, taking a variety of food items including seeds and insects (Rowan 1983). In addition, Rowan (1983) noted that there are two main feeding periods, one in the early morning and the other in the late afternoon. At Glen, birds were most often seen in the grassland at these times (Fig. 4.195; Fig. 4.197; Fig. 4.198), and in most cases this involved birds in transit, presumably commuting to and from feeding areas further afield. But note that vocal activity continues throughout

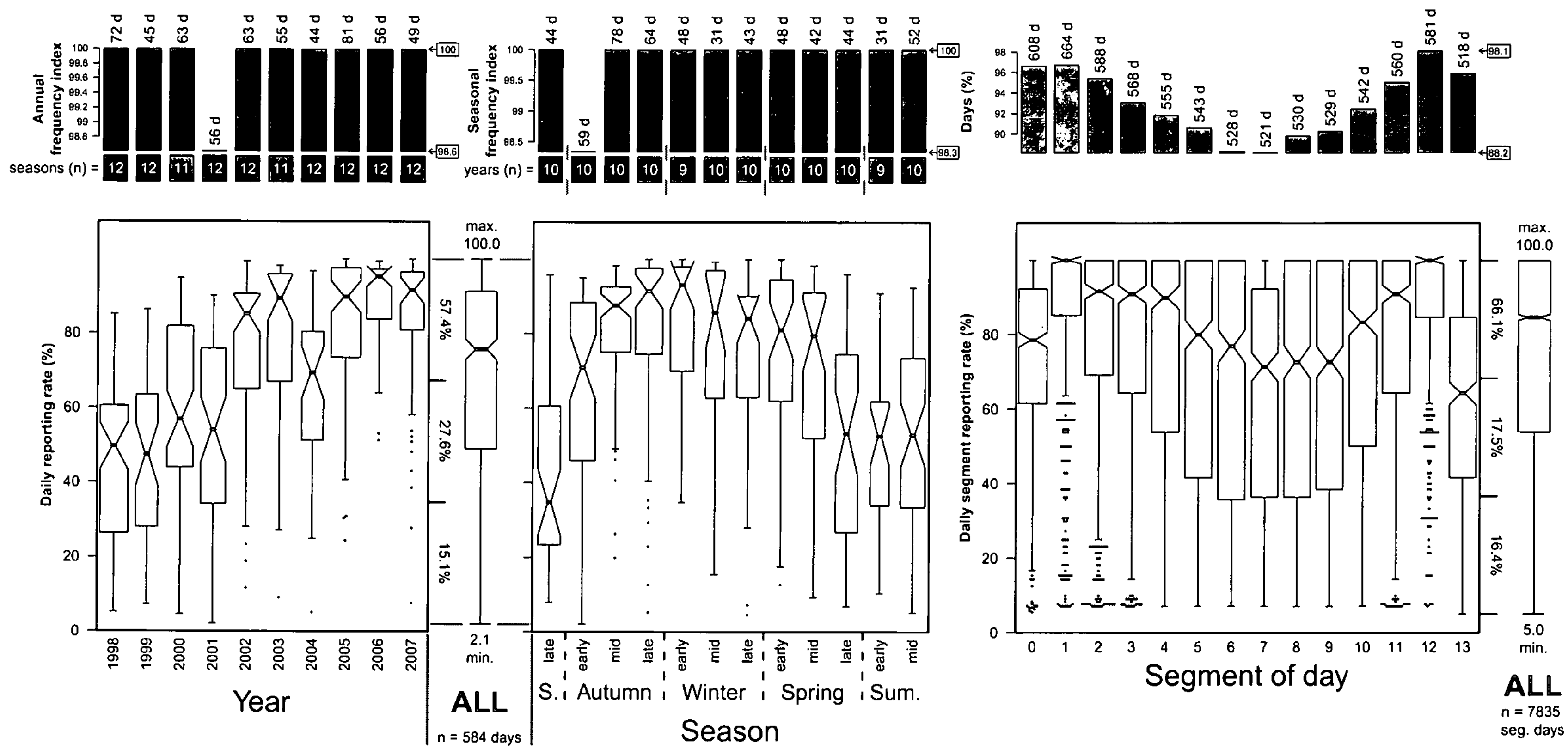


Figure 4.187: R354 Cape Turtle-Dove — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

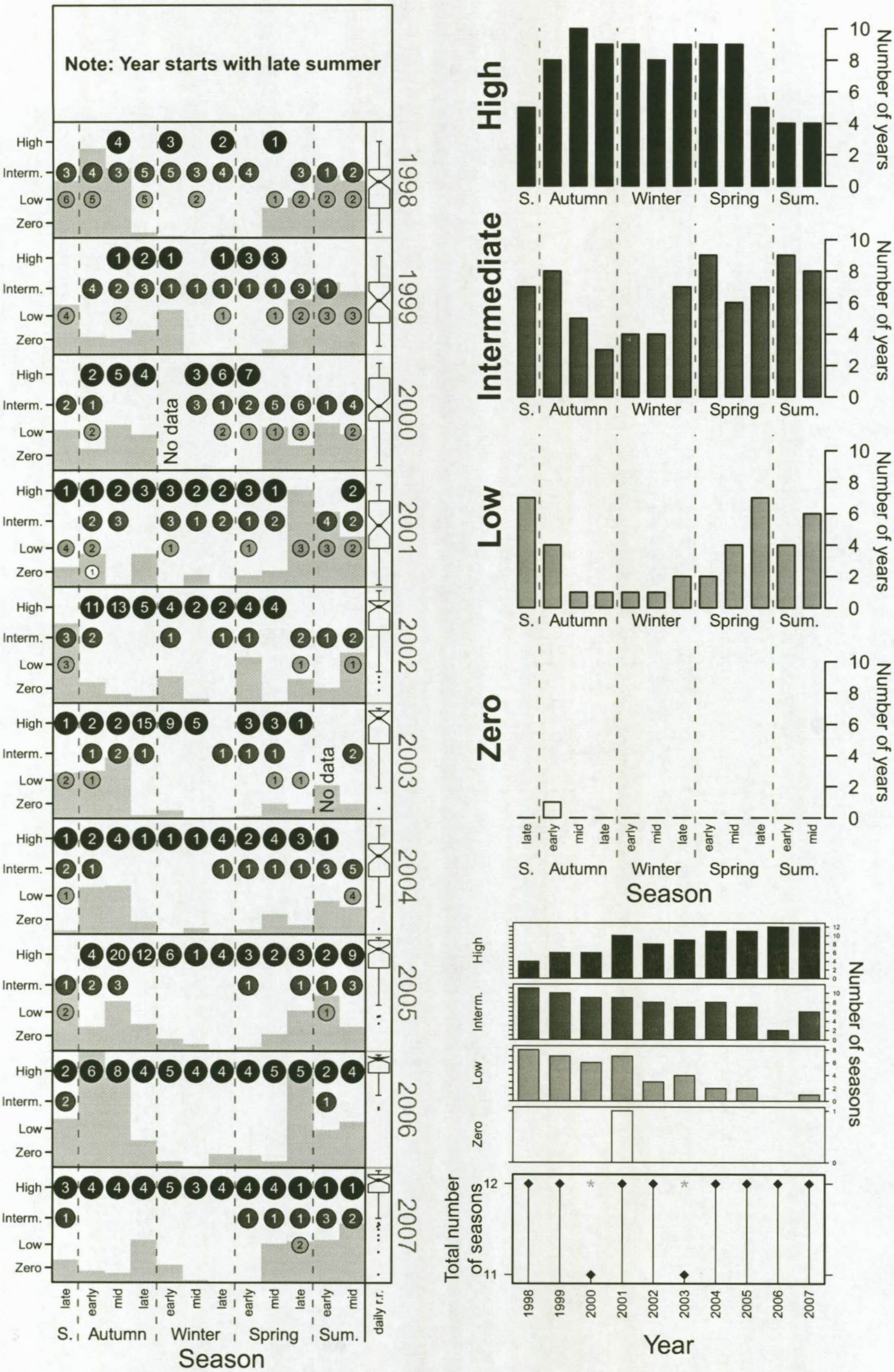


Figure 4.188: R354 Cape Turtle-Dove — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

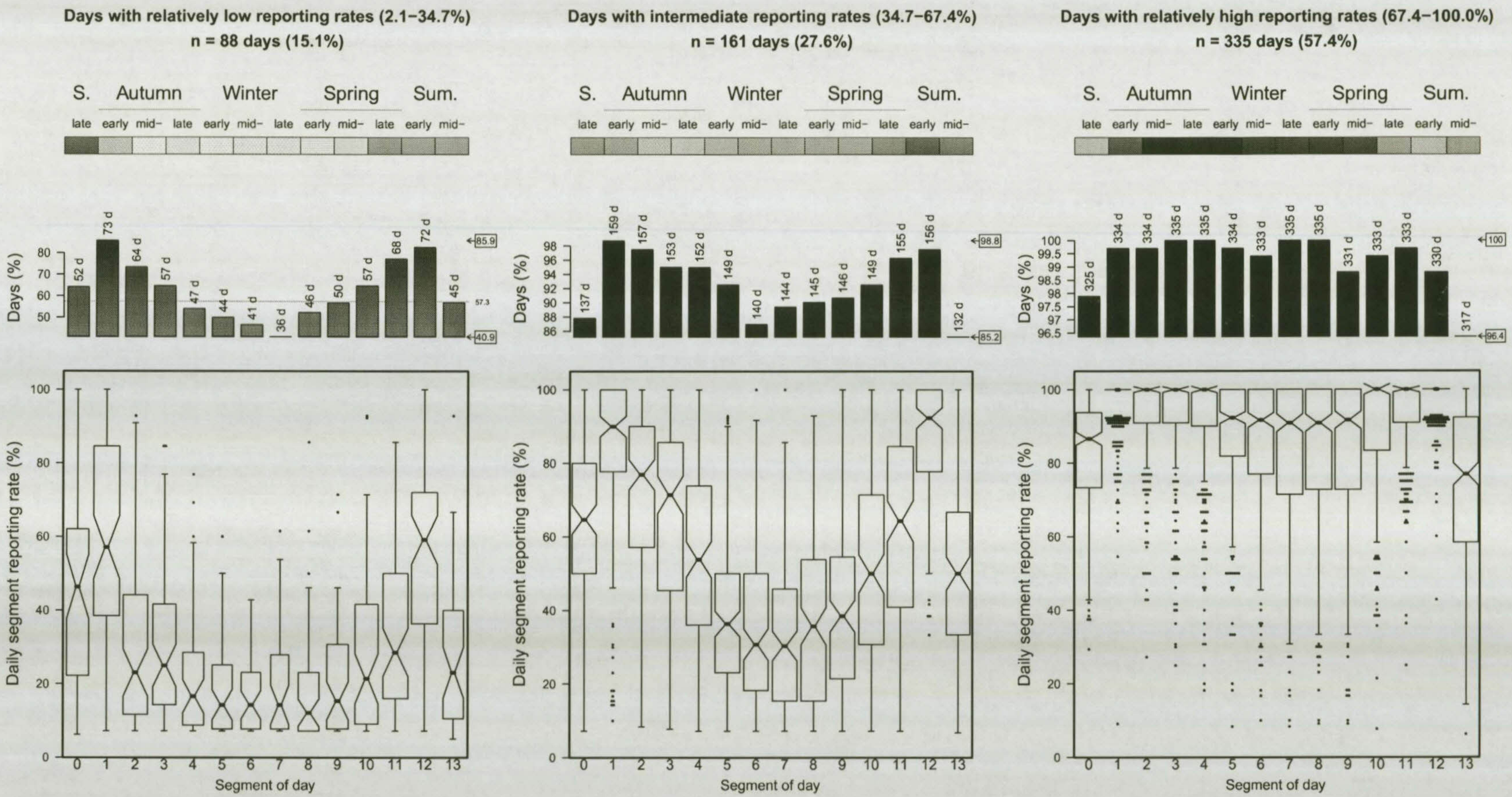


Figure 4.189: R354 Cape Turtle-Dove — birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

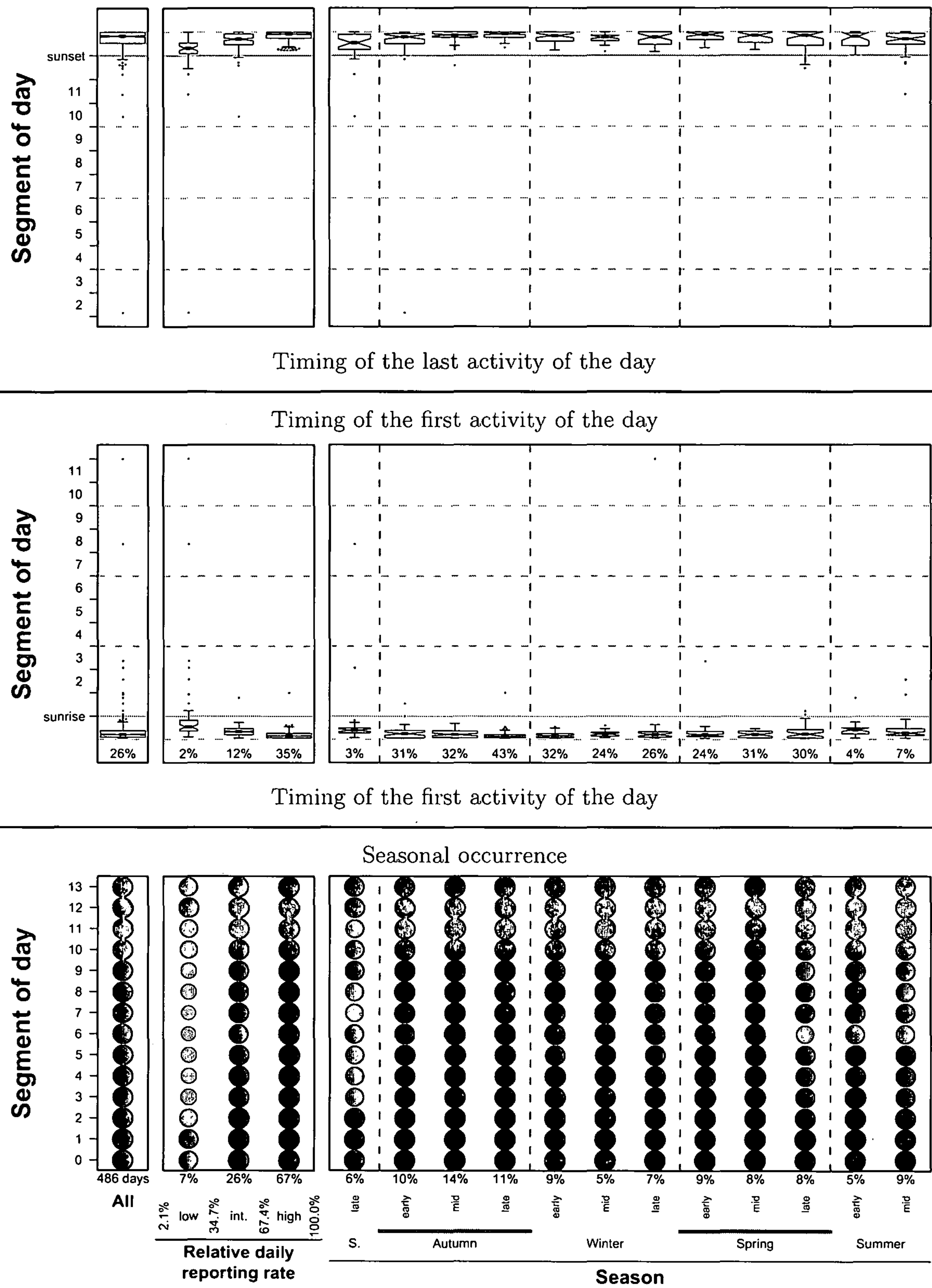


Figure 4.190: R354 Cape Turtle-Dove — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

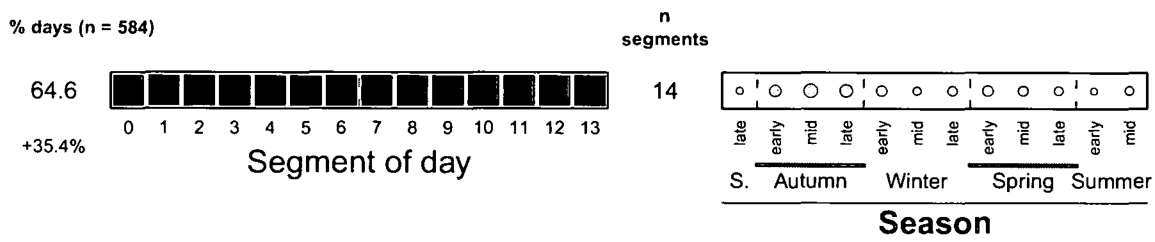


Figure 4.191: R354 Cape Turtle-Dove — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

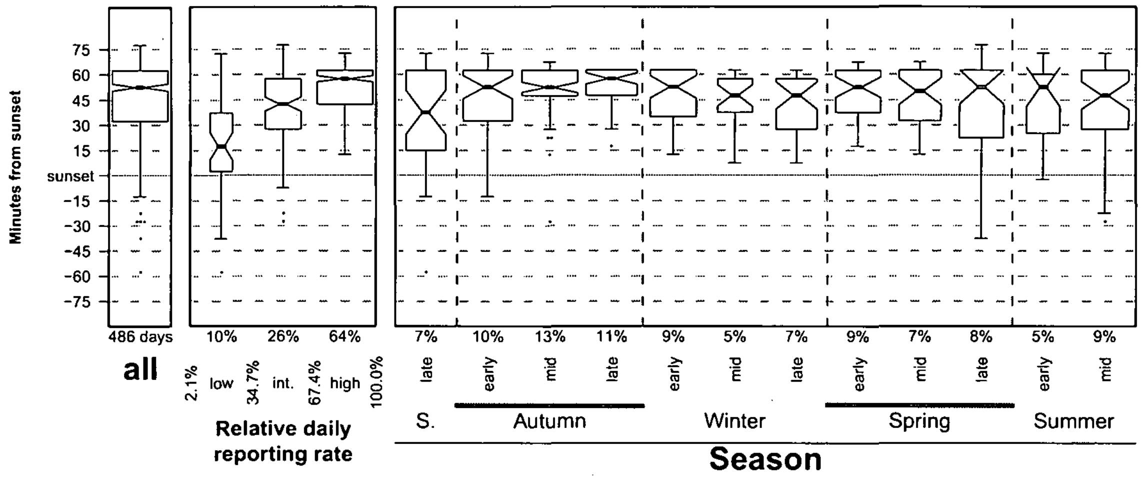
the day, particularly on high reporting rate days (Fig. 4.190), indicating that the birds (not necessarily the same individuals) remain in the drainage line throughout the day. Thus, although it is clear that at least some of the birds leave the drainage line to forage elsewhere during the day, others remain behind and probably forage in the drainage line too. In fact, it is possible that bush encroachment has lead to a greater availability of food, thereby increasing the carrying capacity of the habitat which, in turn, could result in more individuals and, by extension, vocal activity.

In addition to providing more food, bush encroachment probably also leads to more nesting opportunities for the doves. According to Rowan (1983), the Cape Turtle Dove is monogamous with the male defending an area around its nest. Consequently, nests are solitary and well spaced (Rowan 1983). At Glen, nests have been found in trees and shrubs in the drainage line, confirming that the birds are indeed breeding there. It is suggested that bush encroachment created new nesting habitats that enabled more birds to establish territories.

While on the topic of nests, breeding in the south-west Cape — a winter rainfall area — shows some correlations with rainfall. This is how Rowan (1983) describes it:

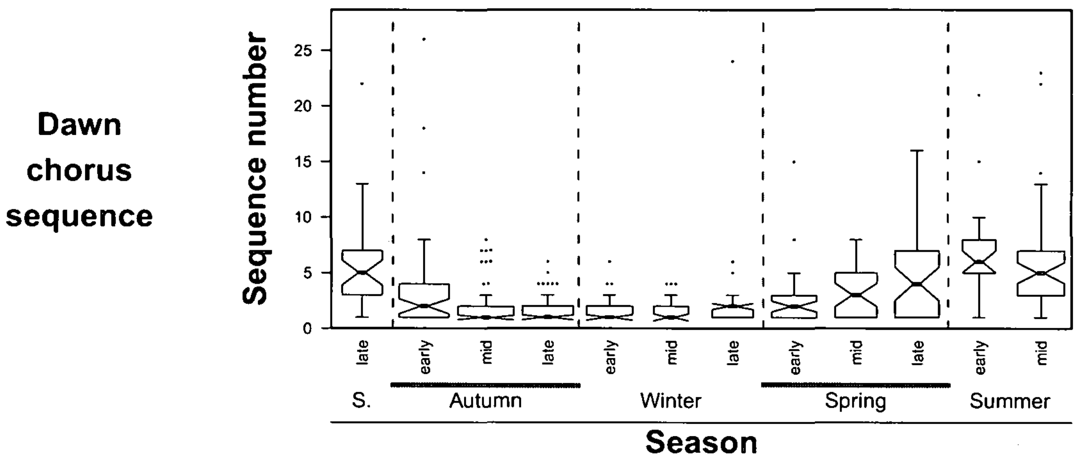
> "Following a winter of average rainfall, breeding tends to rise to a fairly sharp peak in October or November. If July and August have been wetter than usual the peak may be delayed to December, or if they have been drier it may arrive earlier, in September. If the summer is very dry, breeding may terminate abruptly towards the end of the calendar year; but if November and December are wetter than normal, breeding tends to continue at a fairly high level for a longer period, producing a broader flattened peak."

It seems, therefore, that in the winter rainfall region the main breeding season follows some time after the rains in most cases. At Glen — which falls in a summer rainfall region — observations on breeding in the drainage line were not systematic enough to afford a meaningful analysis of seasonality in breeding. However, if it is assumed that advertising calls give an indication of breeding activity, it is noted that from 1998 to 2001 the occurrence of days with high advertising call reporting rates ceased with the onset of rains in spring. This change was most dramatic in 2001 (Fig. 4.188). Subsequent to 2001 this pattern becomes blurred and since 2005 days with high reporting rates occurred throughout the year (Fig. 4.188). What is interesting here is that 2001/2 was a year with above average rainfall, and so too 2005/6 (and 2007/8) (Fig. 2.13). Note



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

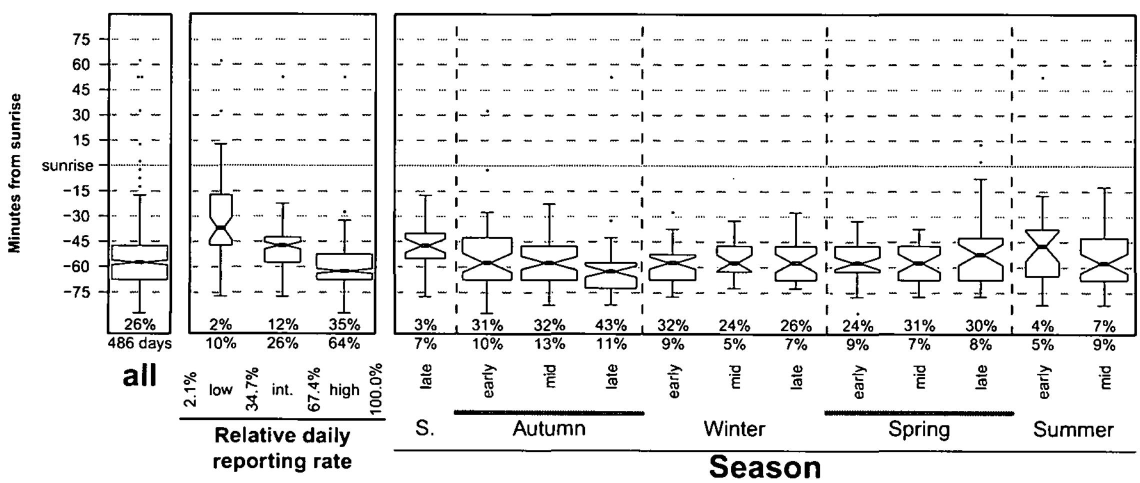


Figure 4.192: R354 Cape Turtle-Dove — birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

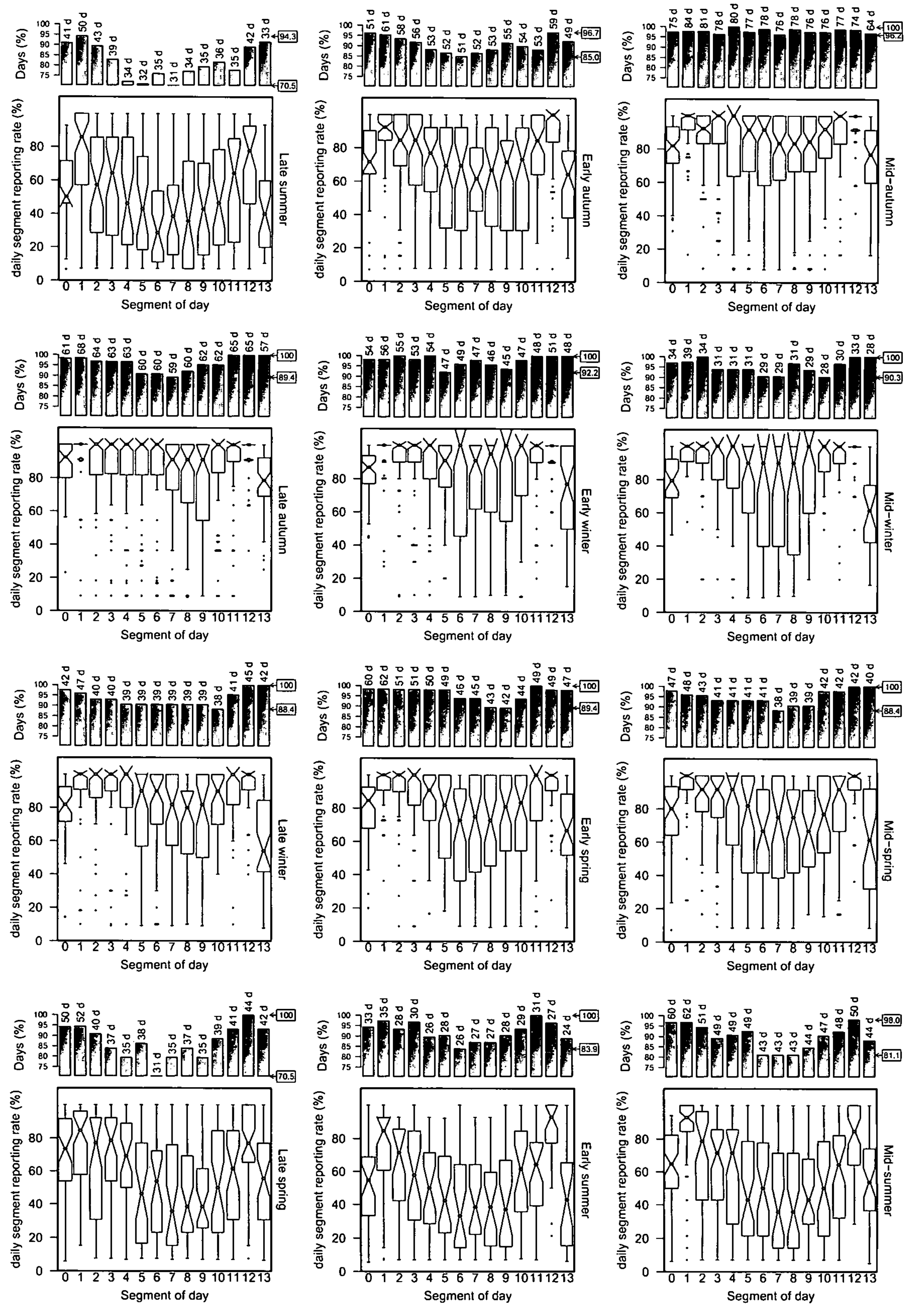
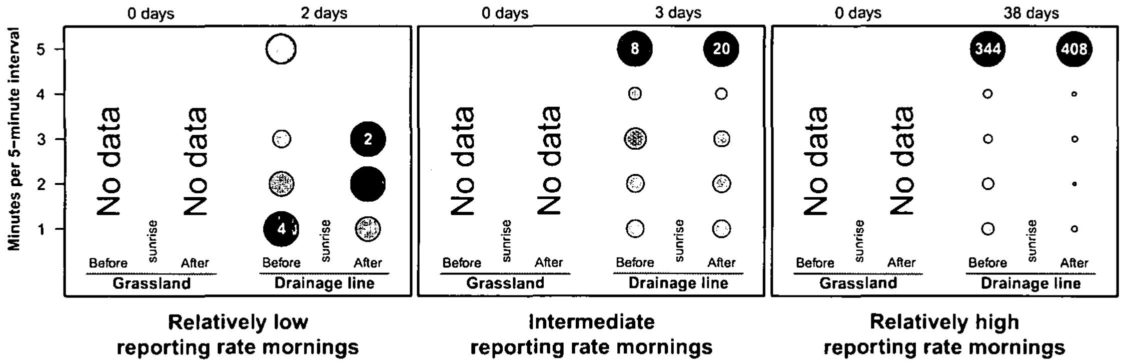
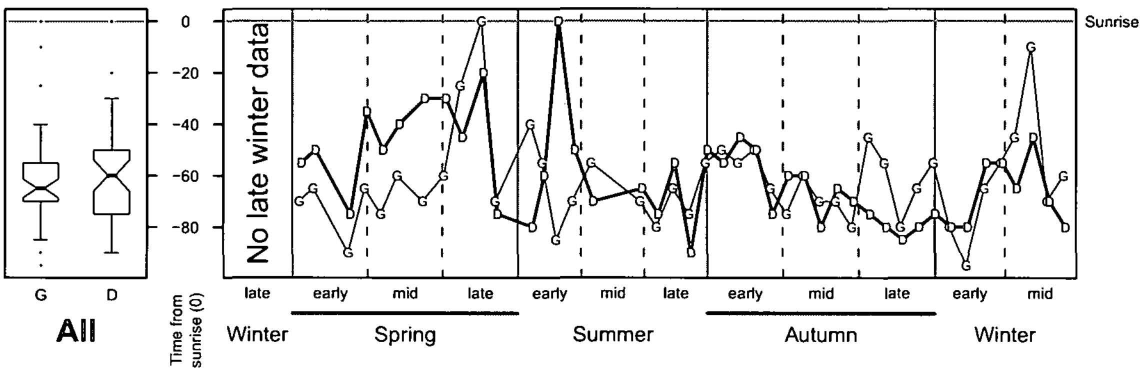


Figure 4.193: R354 Cape Turtle-Dove — birds heard: Seasonal fluctuations in daily occurrence in the grassland at Glen. See page 136 for more information on this seasonal detail figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

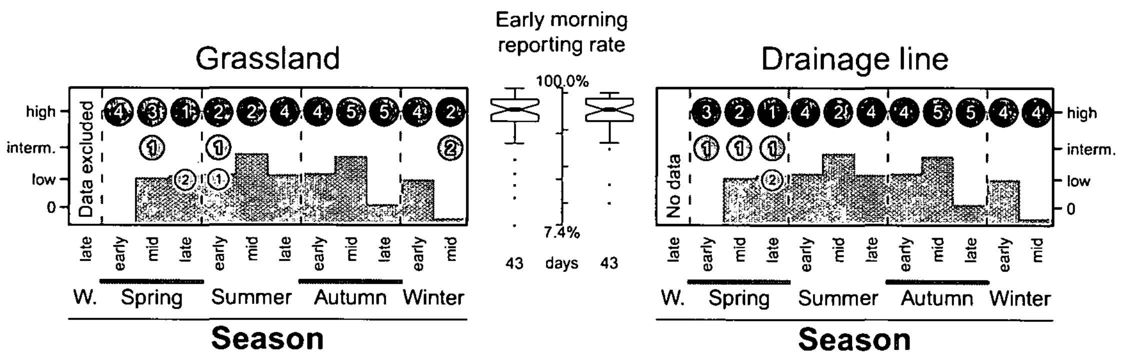


Figure 4.194: R354 Cape Turtle-Dove — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

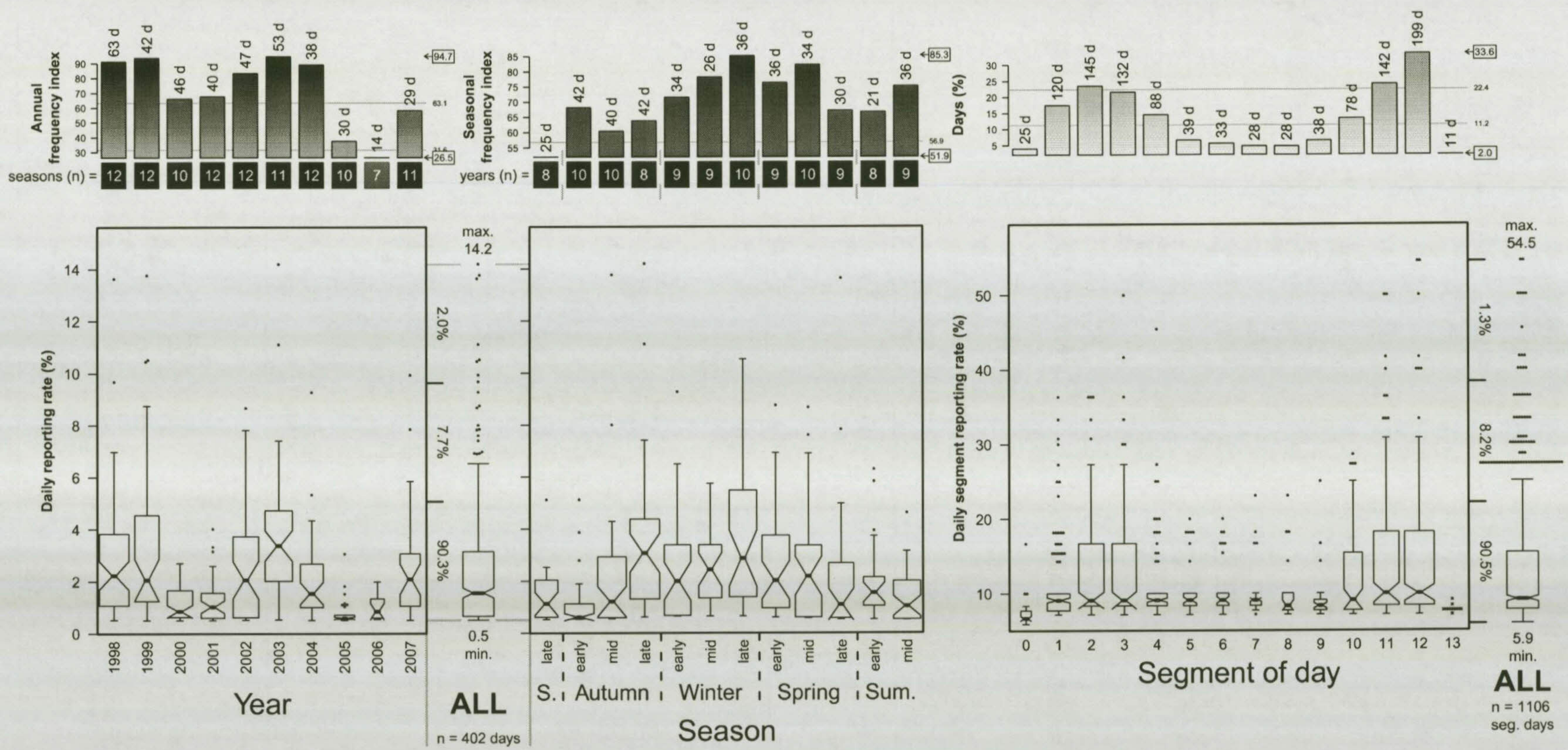


Figure 4.195: R354 Cape Turtle-Dove — birds seen: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

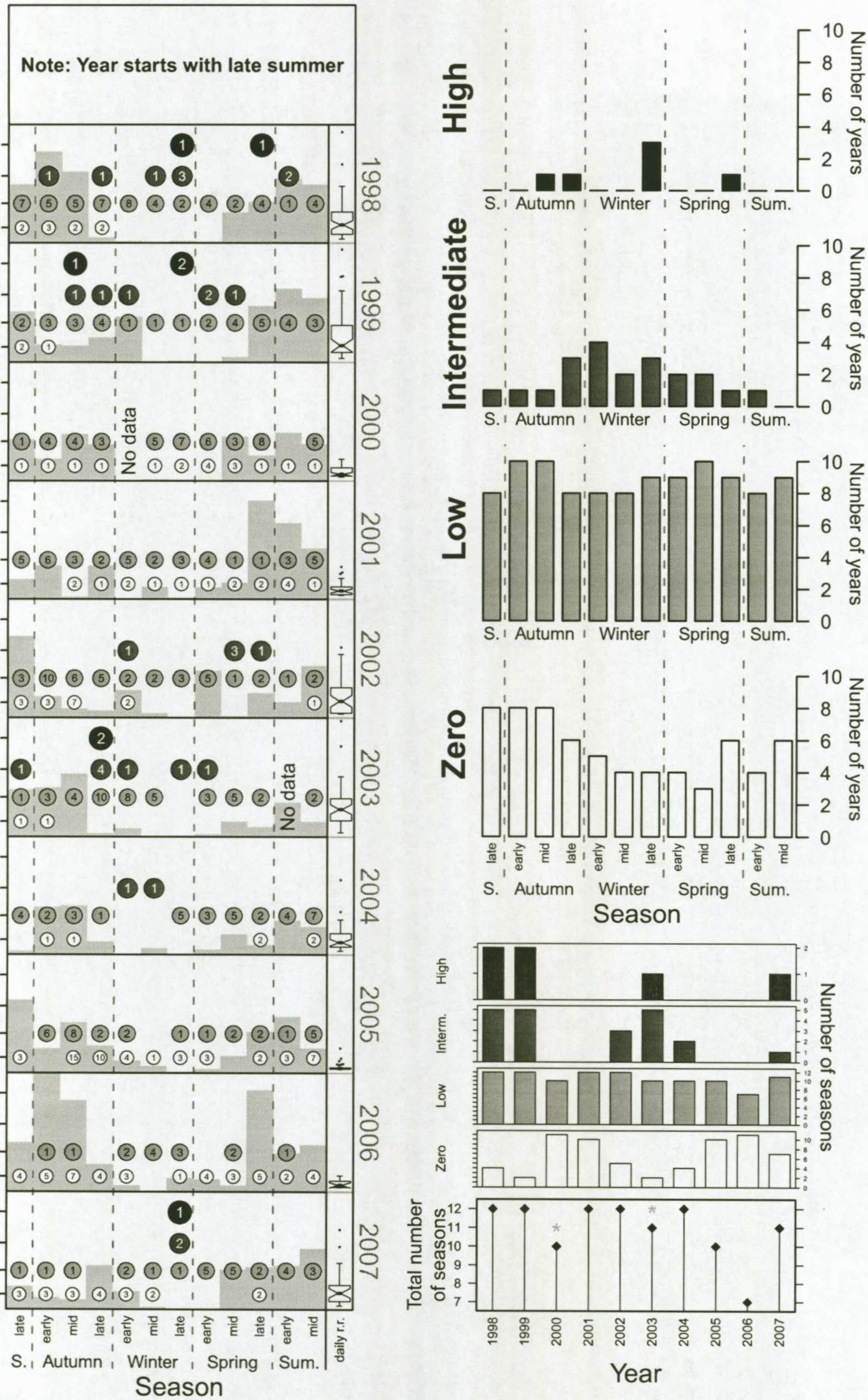


Figure 4.196: R354 Cape Turtle-Dove — birds seen: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

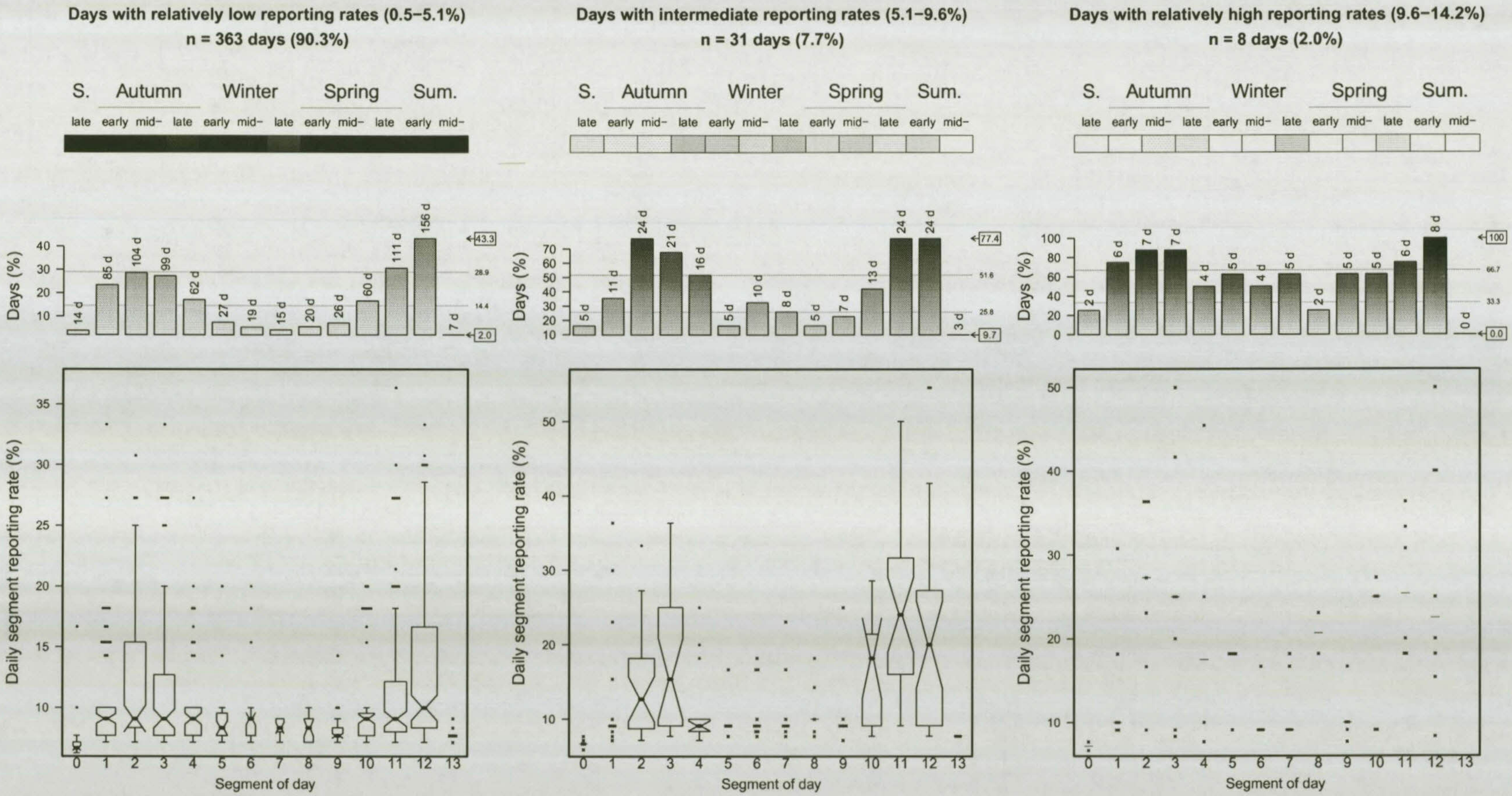


Figure 4.197: R354 Cape Turtle-Dove — birds seen: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

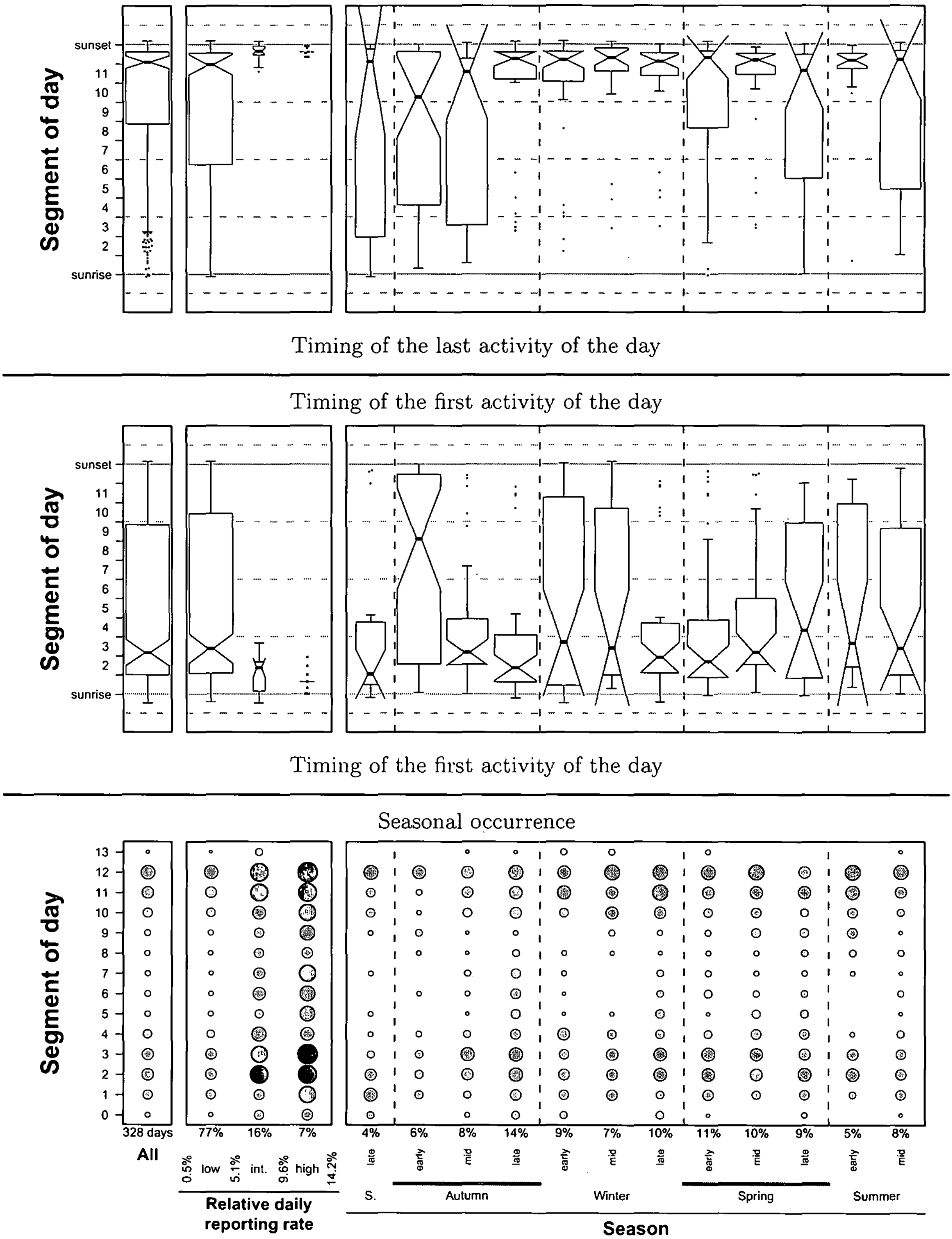


Figure 4.198: R354 Cape Turtle-Dove — birds seen: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

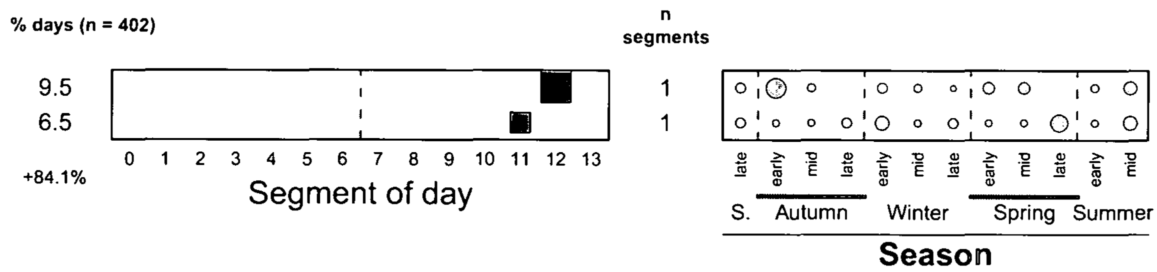


Figure 4.199: R354 Cape Turtle-Dove — birds seen: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

in the quote from Rowan (1983) above that the only time when breeding "tends to continue at a fairly high level for a longer period..." was when abnormal out of season rain occurred. At Glen it seems that it is not so much out of season rainfall, but above average rainfall that causes high advertising call reporting rates and by extension breeding.

That rain can have an influence on the activity of the birds is further illustrated by the dip in the general magnitude of daily reporting rates in 2004 (Fig. 4.187). That year followed on the 2003/4 rain year during which only 308 mm was recorded, the lowest annual rainfall since 1972/3 (Fig. 2.13).

With these facts in hand the following scenario is suggested. The conditions during 2001/2 stimulated bush encroachment that was further encouraged during subsequent years. Initially it resulted in a greater availability of food that attracted more birds to the area. This would explain the sudden increase in median daily reporting rates from 2001 (54.0%) to 2002 (85.1%) (Fig. 4.187). New nesting habitat only became available in later years as the bushes and trees became older and more suitable for breeding.

The literature on the breeding season of the Cape Turtle Dove in the summer rainfall regions of southern Africa is confusing. Steyn (1996) noted that for pigeons and doves in general "It is difficult to define the breeding seasons of most species, and nests may be found in all months." There may be a number of reasons for this. Rowan (1983) cited a study where a succession of ringed birds (three males and four females) bred continuously for decades, regularly starting new nestings before the young of the previous brood have departed. Steyn (1996) also noted that a pair's breeding might extend over several months as they often raise multiple broods. The observations at Glen indicate an additional reason: local change in habitat. If the advertising calls are assumed to be an index of breeding activity, then it appears that breeding at Glen changed from being seasonal to aseasonal (Fig. 4.188).

The timing of moult seems to vary from one region to the next (see Dean 2005f), and it is uncertain whether it overlaps with breeding (Siegfried 1971). At Glen, generally lower daily reporting rates in vocal activity (Fig. 4.187; Fig. 4.188; Fig. 4.193) and birds seen (Fig. 4.195; Fig. 4.196) from late-spring to late summer / early autumn (*ca.* October to January/February) (Fig. 4.187; Fig. 4.188; Fig. 4.193) is suggestive of an approximately five month long moulting period. Given an average duration of nearly six months in individuals (Siegfried 1971), this would suggest that moult is well synchronised within the population at Glen. Its slightly shorter duration (*ca.* 5 vs. 6 months) is possibly due to the more rapid rate of moult and growth of individual feathers at the start than later in the feather replacement sequence (see Siegfried 1971). It is suggested that vocal activity is least affected during the latter part of moult.

R355 Laughing Dove .... *Streptopelia senegalensis*

The Laughing Dove occurs in Africa, Arabia, Turkmenistan, Afghanistan and India, with introduced populations elsewhere (Rowan 1983). It is the second most widespread species of all birds in southern Africa (Colahan & Harrison 1997a), and a very common breeding resident throughout the Free State (Colahan & Harrison 1997b; Earlé & Grobler 1987; Rowan 1983). Its habitat preferences include a variety of woodland types, including those associated with drainage lines (Dean 2005e).

The birds at Glen

The Laughing Dove occurs mainly in the drainage line with most of the records in the grassland (96.0%; Table 4.35a) involving drainage line birds uttering their so-called 'advertising coo'. This is the call described by Maclean (1985) as a "Bubbling phrase of 6-8 notes, *koo koo kuRUkuto-koo*, individually variable, but always with gentle laughing quality." The whole call, writes Rowan (1983), is muted, murmuring and unobtrusive. Birds were also seen in the grassland either as birds in flight (usually singles or pairs) or as birds visiting the trampled area to feed and especially to drink water. The analysis is based on a year starting in late summer. Figures start on page 410.

Annual occurrence of drainage line birds heard in the grassland: Heard during 90.1% of the days with an activity index of 27 (Table 4.36a). Recorded during 10–12 seasons each year (Fig. 4.200; Fig. 4.201). Daily reporting rates ranged from 0.5 to 88.4% with 79.9% bird-days attaining low values (Fig. 4.200). There was a general increase in activity through the years. This can be seen in the increase in annual frequency index (>81% for all years; Fig. 4.200), median daily reporting rates (Fig. 4.200), high reporting rate days which were recorded only since 2003, intermediate reporting rate days which increased since the start of the study and the incidence of days with zero records which have also become less frequent (Fig. 4.201).

Seasonal occurrence of drainage line birds heard in the grassland: Heard during 9–10 years in each season, except early summer when heard during only seven years, also representing the season with the lowest seasonal frequency index (Fig. 4.200). The median daily reporting rates followed a well-defined seasonal pattern with highest values from late autumn to early spring and lowest values during summer (Fig. 4.200). The data were, however, variable during the peak seasons (Fig. 4.200). High reporting rate days were limited to late autumn and winter while intermediate reporting rate days occurred mainly from mid-autumn to mid-spring (Fig. 4.200; Fig. 4.201). Days with zero records were most frequent during summer (Fig. 4.201).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity occurred most frequently in the early morning and again in the late afternoon before sunset (Fig. 4.200).

Table 4.36: R355 Laughing Dove: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.960	16 248	114 612	14.2	birds heard	90.1	656	591	27
0.040	669	114 612	0.6	birds seen	40.7	656	267	3
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	786	1 190	66.1	birds heard	97.7	43	42	19
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.982	437	1 188	36.8	birds heard	83.7	43	36	12
0.018	8	1 188	0.7	birds seen	16.3	43	7	1

This pattern is most prominent for low reporting rate days (Fig. 4.202). On intermediate reporting rate days activity were very frequent during all segments, occurring during at least 82.0% bird-days, and on high reporting rate days it was recorded during almost all segments of each day (Fig. 4.202). All seasons showed peaks in the early morning and late afternoon, with the incidence of activity during the rest of the day frequent from mid-autumn to late spring too (Fig. 4.203). Activity during all 14 segments was the only bird-segment combination occurring during more than 5% bird-days (8.1%) and was particularly frequent in early winter (Fig. 4.204).

The first activity of the day typically occurred before or just after sunrise, earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.203; Fig. 4.205). There was no clear seasonal pattern with the timing of the first activity of the day, being more variable in early and late summer than during other seasons (Fig. 4.203; Fig. 4.205). Yet the median values of the dawn chorus sequence (Fig. 4.205) do trace the subtle changes in the median timing of the first activity of the day (Fig. 4.205).

The last activity of the day typically occurred around sunset, later on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.203; Fig. 4.205). The timing of the last activity of the day was more variable during late spring and mid- and late summer than during other seasons (Fig. 4.203; Fig. 4.205).

Overall, daily segment reporting rates ranged from 5.6 to 100% (Fig. 4.200). Median daily segment reporting rates were highest in the early morning after sunrise and again in the late afternoon before sunset, however, the data is very variable (Fig. 4.200). The pattern of higher median daily segment reporting rates in the early morning and in the late afternoon is better defined when the magnitude of the daily reporting rate is taken into consideration (Fig. 4.202). Apart from increased absolute values, the general pattern was similar for low, intermediate and high reporting rate days with median daily segment reporting rates peaking in the early morning after sunrise and in the late afternoon before sunset (Fig. 4.202). A similar pattern is seen in all seasons (Fig. 4.206). However, the daily segment reporting rates are very variable in late autumn and during winter (Fig. 4.206).

Early morning occurrence of drainage line birds heard during 2007/8: Activity was slightly less frequent in the grassland than in the drainage line (Table 4.36b & c). This coincided with the median early morning reporting rate that was lower in the grassland than in the drainage line (Fig. 4.207). Furthermore, whereas low, intermediate and high reporting rate mornings showed a well-defined seasonal pattern in the drainage line, this was not the case in the grassland (Fig. 4.207). However, the timing of the first activity of the day was often similar between the two habitats, and if different it usually started later in the grassland than in the drainage line (Fig. 4.207). Activity intensity, assessed in the drainage line only, showed no differences before or after sunrise (Fig. 4.200).

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Annual occurrence of birds seen in the grassland: Seen on 40.7% of the days with an activity index of three (Table 4.36a). Activity was usually recorded during 8–12 seasons each year, but during only 2–4 seasons in 2005 and 2006 which two years also had the lowest annual frequency indices (Fig. 4.208). Daily reporting rates ranged from 0.5 to 12.5% with 94.6% bird-days attaining low values (Fig. 4.208). High reporting rate days were limited to 1998 and 1999 with intermediate reporting rate days occurring during 2007 too (Fig. 4.208; Fig. 4.209).

Seasonal occurrence of birds seen in the grassland: Activity was noted during 5–9 years each season with the number of years as well as the seasonal frequency index showing a peak centred on early spring (Fig. 4.208). Median daily reporting rates were similar for all seasons (Fig. 4.208). Only a few intermediate and high reporting rate days occurred (Fig. 4.208; Fig. 4.209). The incidence of days with zero records were only marginally more frequent from mid-summer to mid-autumn (Fig. 4.209).

Daily occurrence of birds seen in the grassland: Overall, activity was most frequent in the early morning from after sunrise until mid-morning and again in the late afternoon before sunset (Fig. 4.208). This general pattern holds for both low and intermediate reporting rate days (Fig. 4.210). Most seasons showed a pattern similar to the general overall pattern (Fig. 4.211). Four bird-segment combinations occurred during more than 5% bird-days and were restricted to single segments S1, S2, S3 and S12, collectively accounting for nearly a third of all bird-days (Fig. 4.212).

The timing of the first activity of the day was variable, but often occurred during the morning (Fig. 4.211). The timing of the last activity of the day was even more variable and occurred throughout the day (Fig. 4.211).

Overall, daily segment reporting rates ranged from 6.7 to 40.0% with 88.8% of the values relatively low and all median daily segment reporting rates similar, except S0 which had a relatively low value (Fig. 4.208).

Discussion

In most cases the advertising coo emanated from birds in the drainage line. The data collected in the early mornings of 2007/8 (Fig. 4.207) suggest that the data collected in the grassland

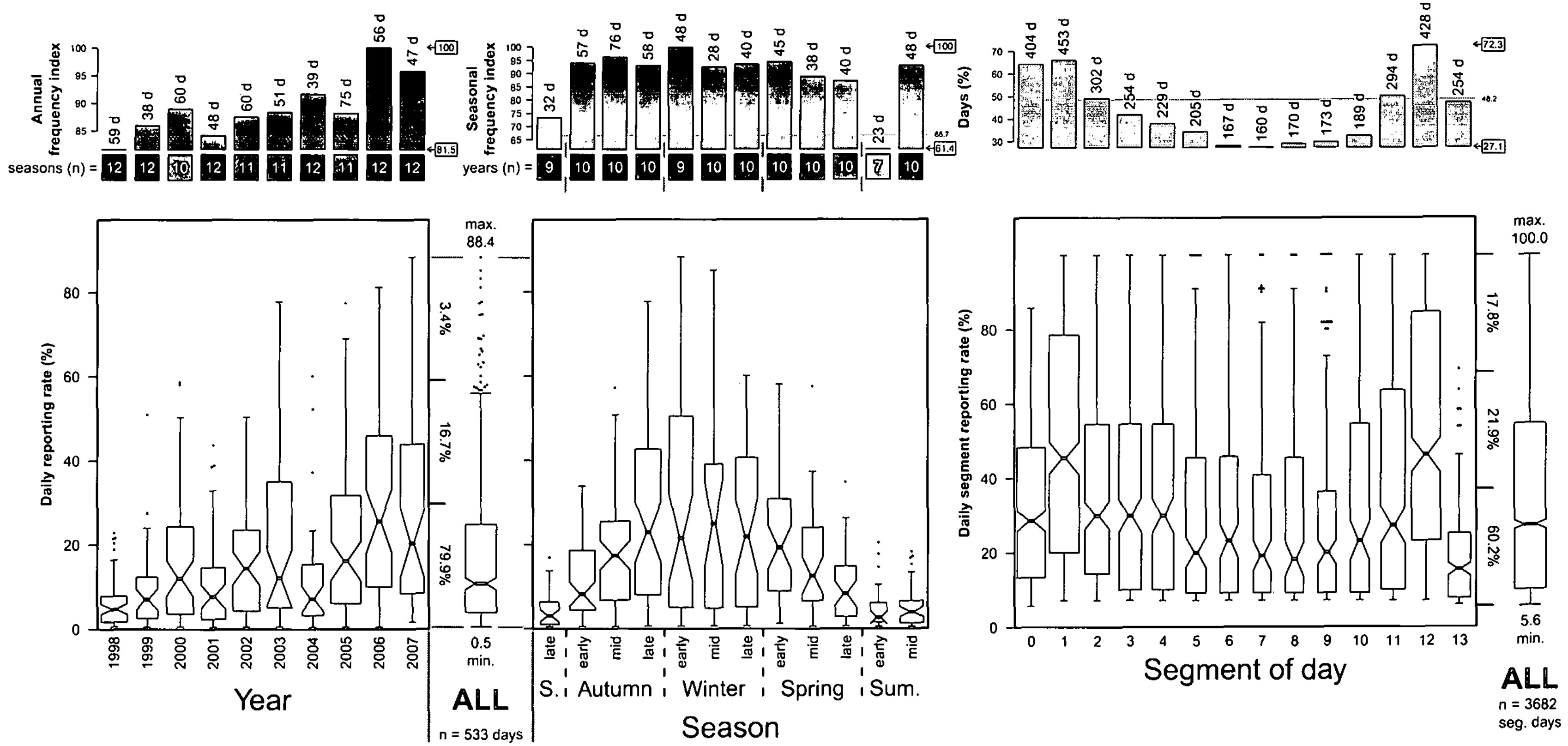


Figure 4.200: R355 Laughing Dove — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

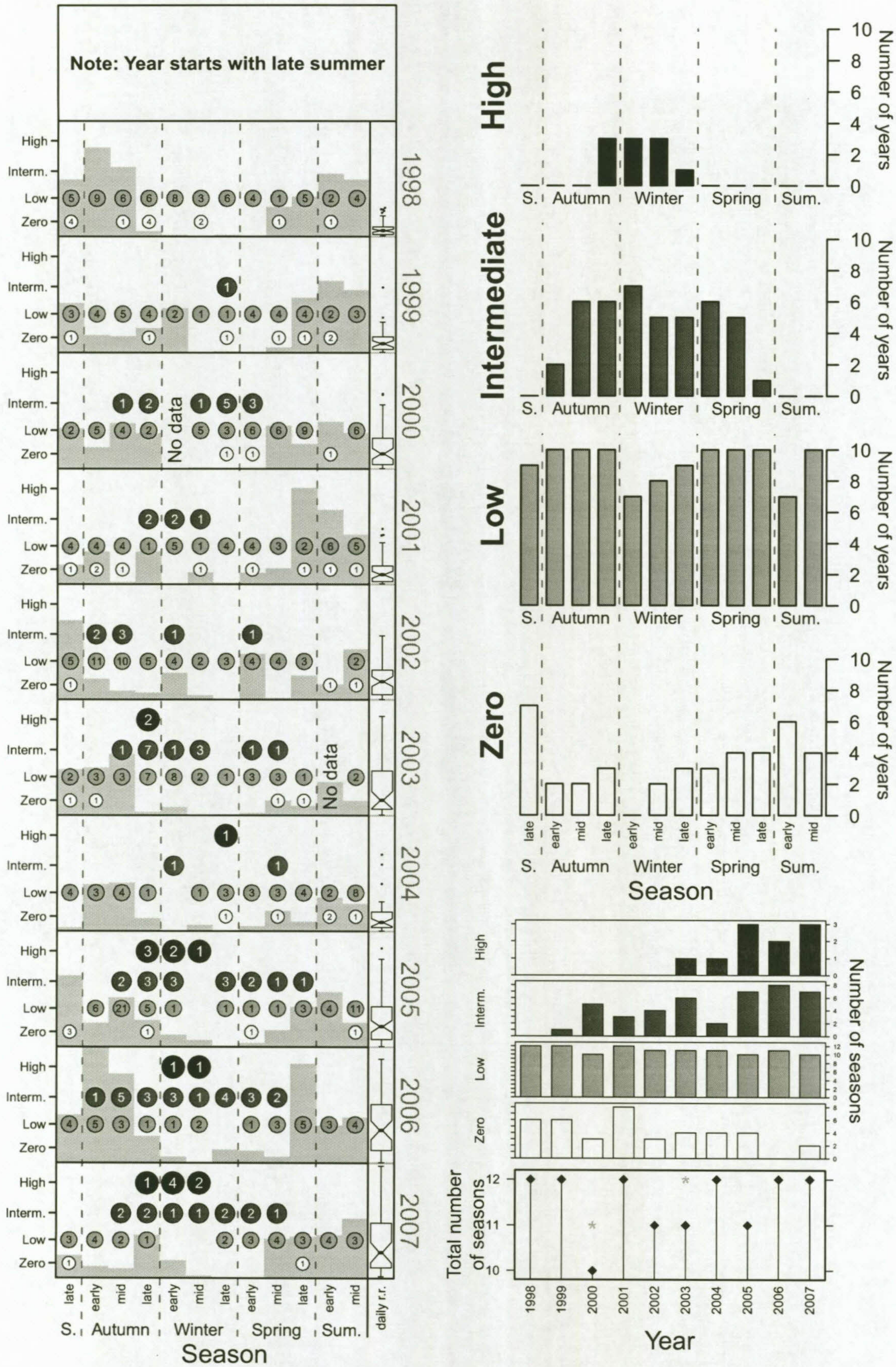


Figure 4.201: R355 Laughing Dove — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

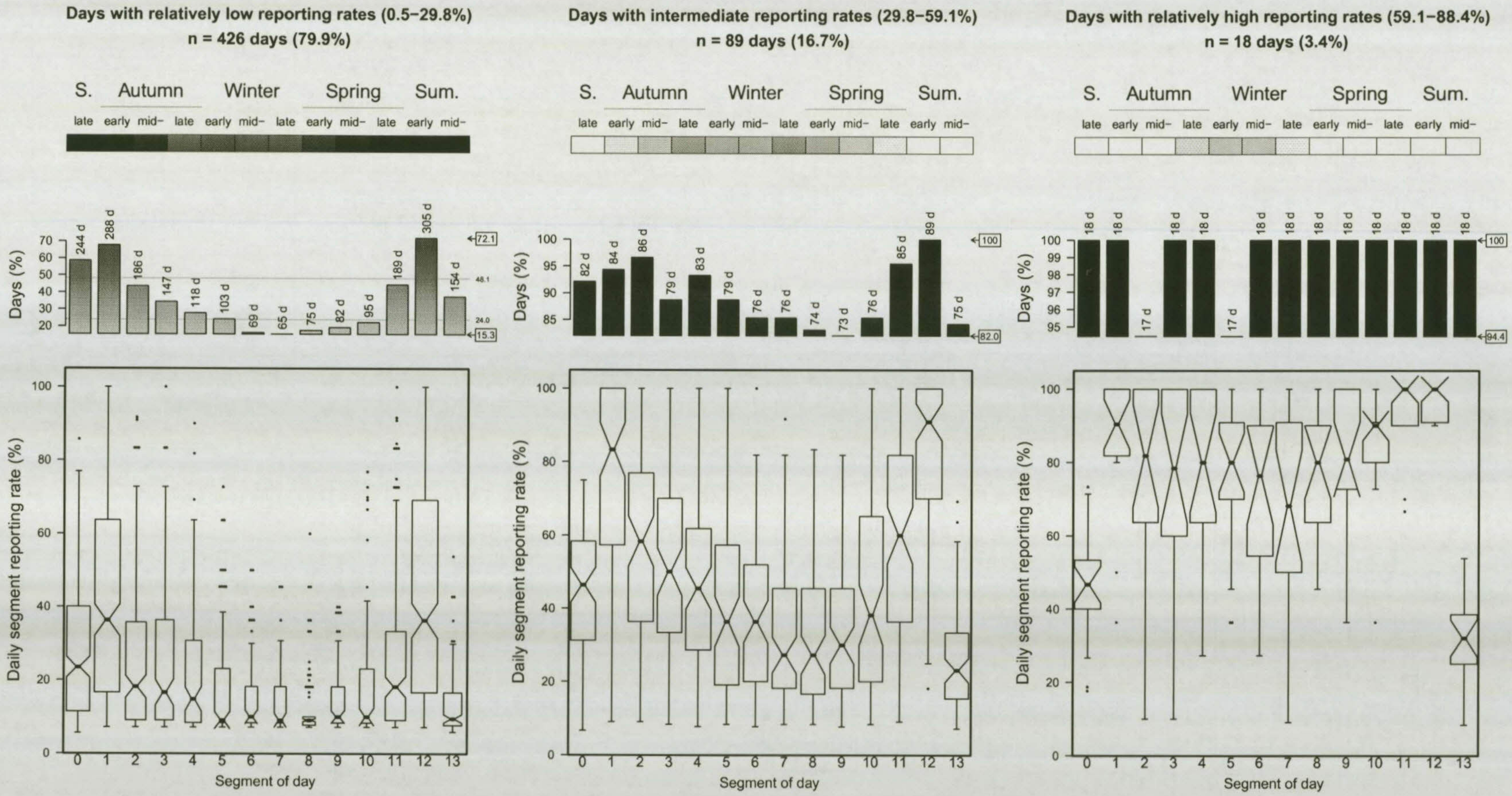


Figure 4.202: R355 Laughing Dove — birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

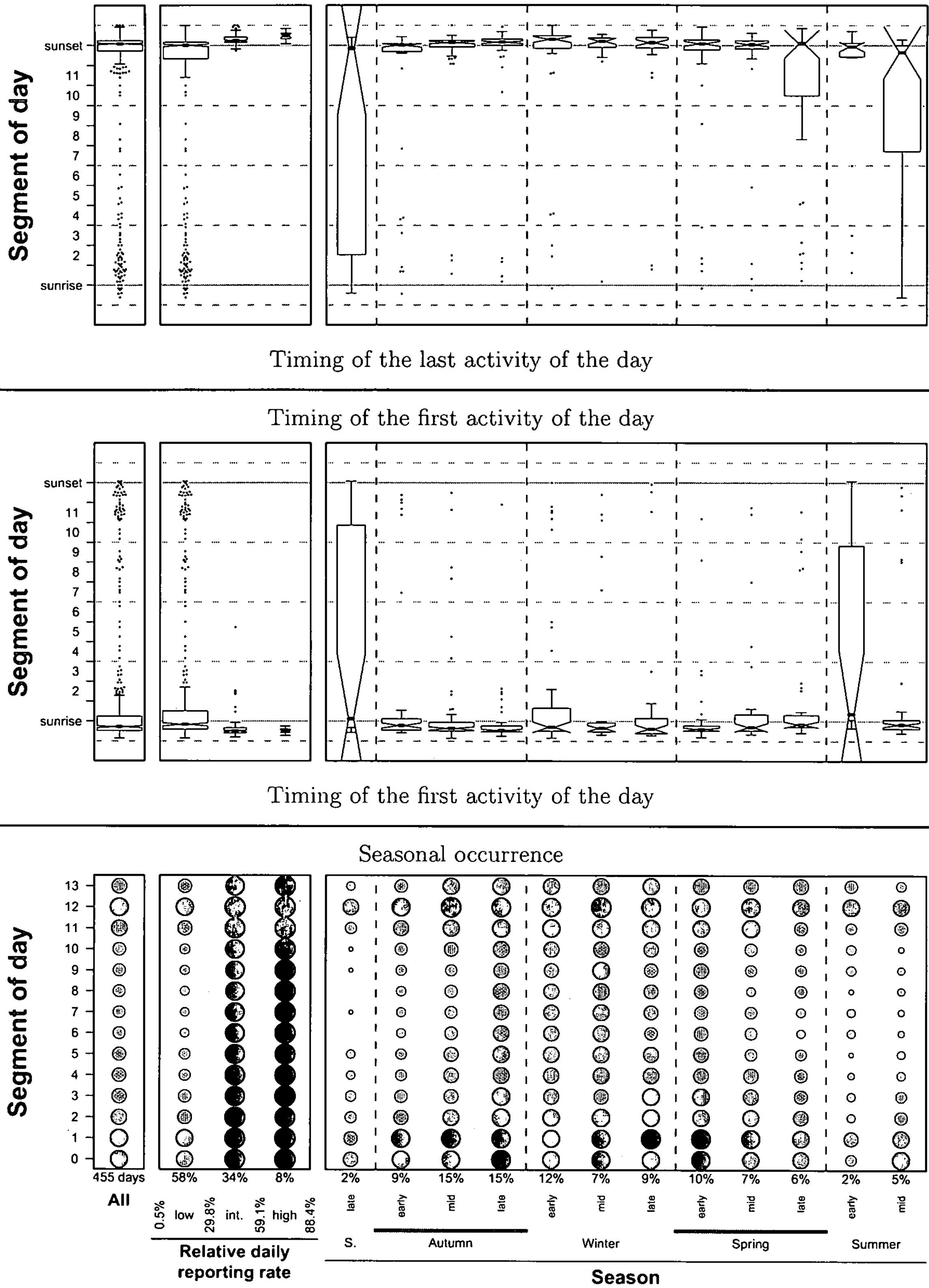


Figure 4.203: R355 Laughing Dove — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

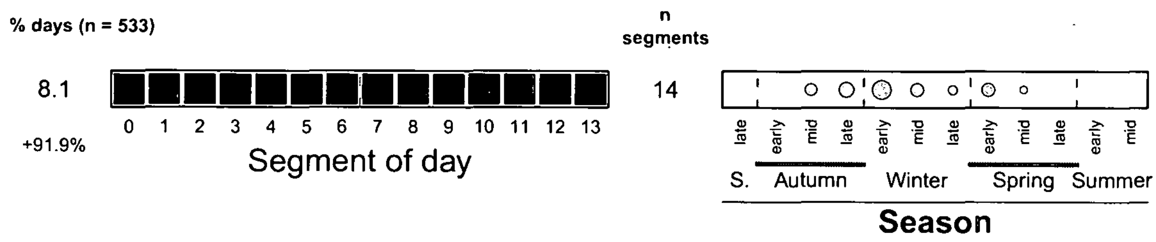


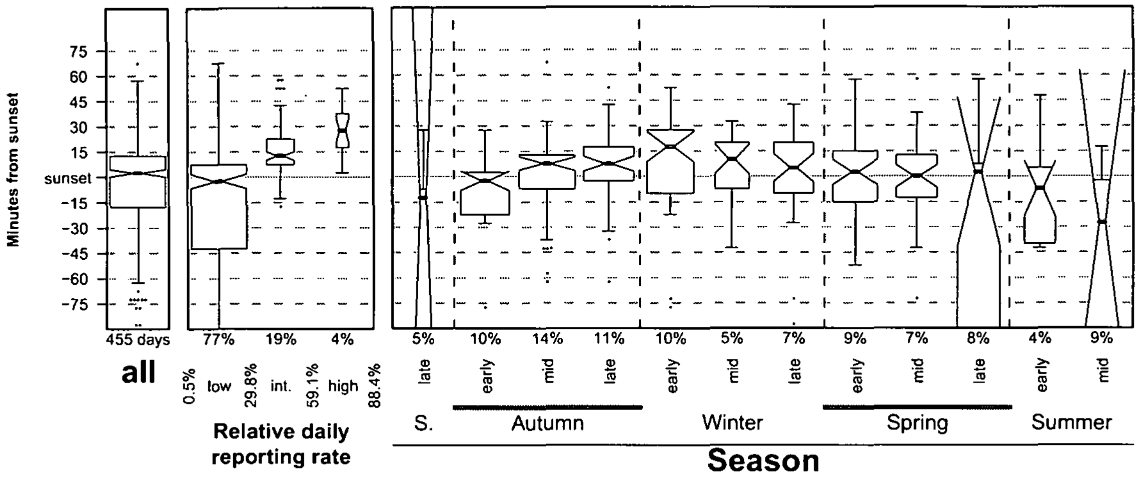
Figure 4.204: R355 Laughing Dove — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

probably underestimates the occurrence of these vocalisations. This is understandable given the unobtrusive quality of the call, and it is likely that wind, in addition to distance, influenced the results. It was assumed, however, that the degree of unobtrusiveness remained constant over time.

According to Rowan (1983) the general behaviour of the Laughing Dove resembles that of the Cape Turtle Dove R354, "with active periods in the morning and afternoon and an idle one in the middle of the day." This was also observed at Glen (*cf.* Figs. 4.189 & 4.202). "However," continues Rowan (1983), "the peak feeding and drinking hours for this species [the Laughing Dove] tend to occur a little later in the morning and a little earlier in the afternoon than in the slightly more crepuscular *S capicola* [Cape Turtle Dove]." This, too, appears to be the case at Glen, but the differences is "little" indeed (*cf.* Figs. 4.198 & 4.211).

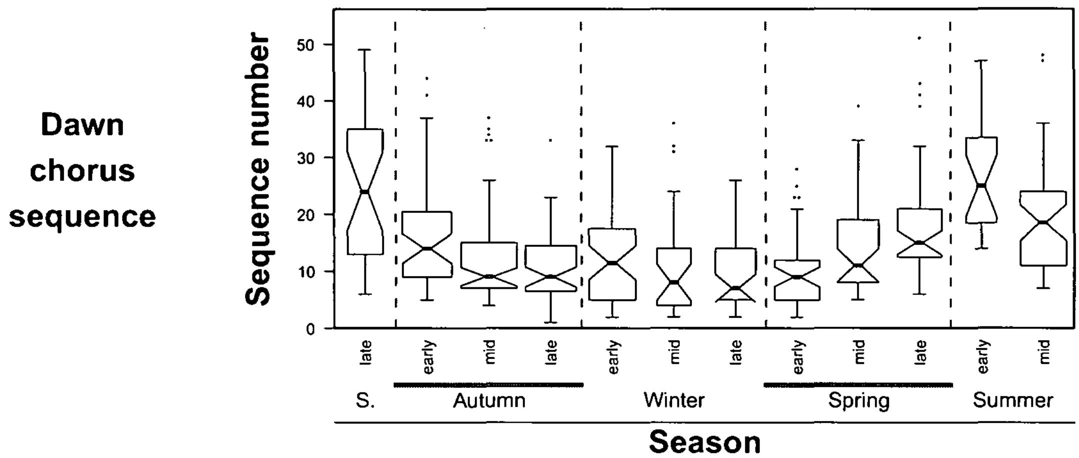
There has been a definite increase in the occurrence of the advertising coo over the years (Fig. 4.200; Fig. 4.201). While the degree of change might not have been as dramatic as that observed in the Cape Turtle Dove R354, the general pattern is similar between the two species. More specifically, compare the pattern followed by the median daily reporting rates in Figure 4.187 with that in Figure 4.200 and note how similar they are. The most obvious similarity is the relatively low daily reporting rates attained during 2004 compared to that attained during adjacent years. Given the similar ecology of the two species (see Rowan 1983), the explanations for these patterns are probably similar too. In brief, it is likely that rainfall patterns and ensuing bush encroachment lead to a greater availability of food and nesting habitat. A more detailed discussion is given in the text for the Cape Turtle Dove, starting on page 393.

In spite of nests being found, the observations in the drainage line were not systematic enough to enable a seasonal analysis of breeding. Assuming that the advertising coo is an index of breeding activity, it would suggest that breeding peaks from late autumn to early spring (Fig. 4.200). This is in agreement with the results of a study at Baberspan (Dean 1980), which also indicated extensive overlap between breeding and moulting schedules with moult peaking from September to February [mid-spring to early autumn] (Dean 1979). This moult peak coincides with relatively low activity levels at Glen (4.200; Fig. 4.201; Fig. 4.206).



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

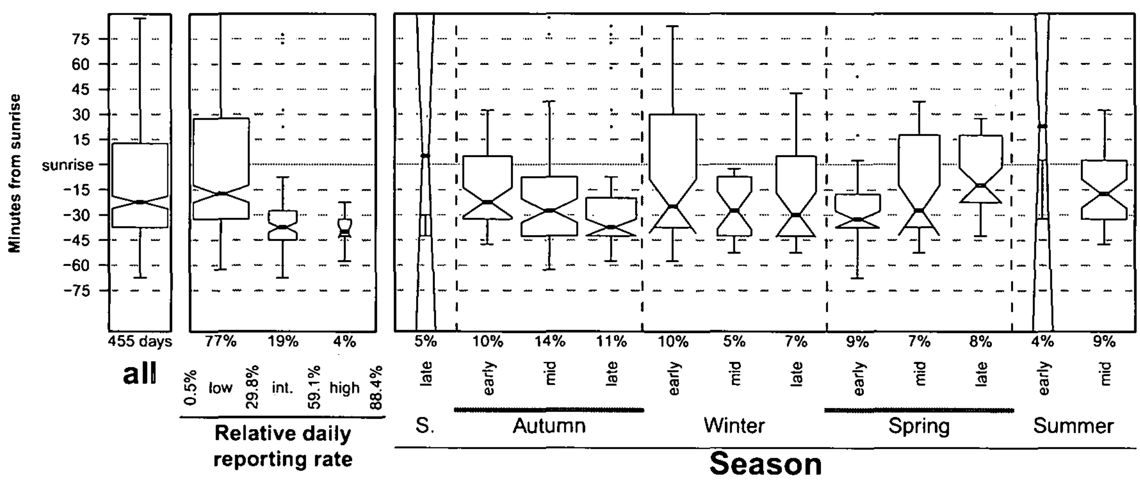


Figure 4.205: R355 Laughing Dove — birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

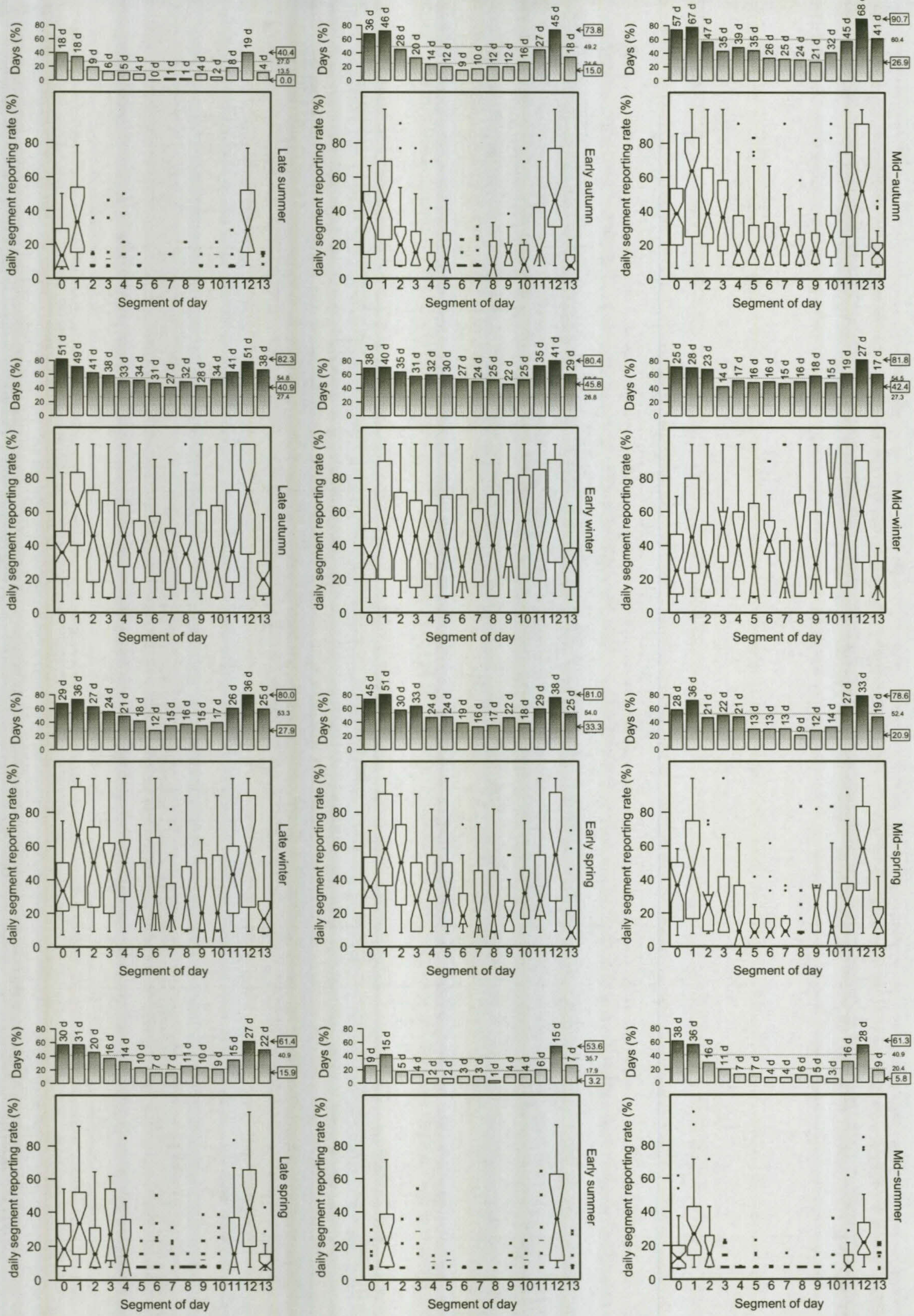


Figure 4.206: R355 Laughing Dove — birds heard: Seasonal fluctuations in daily occurrence in the grassland at Glen. See page 136 for more information on this seasonal detail figure.

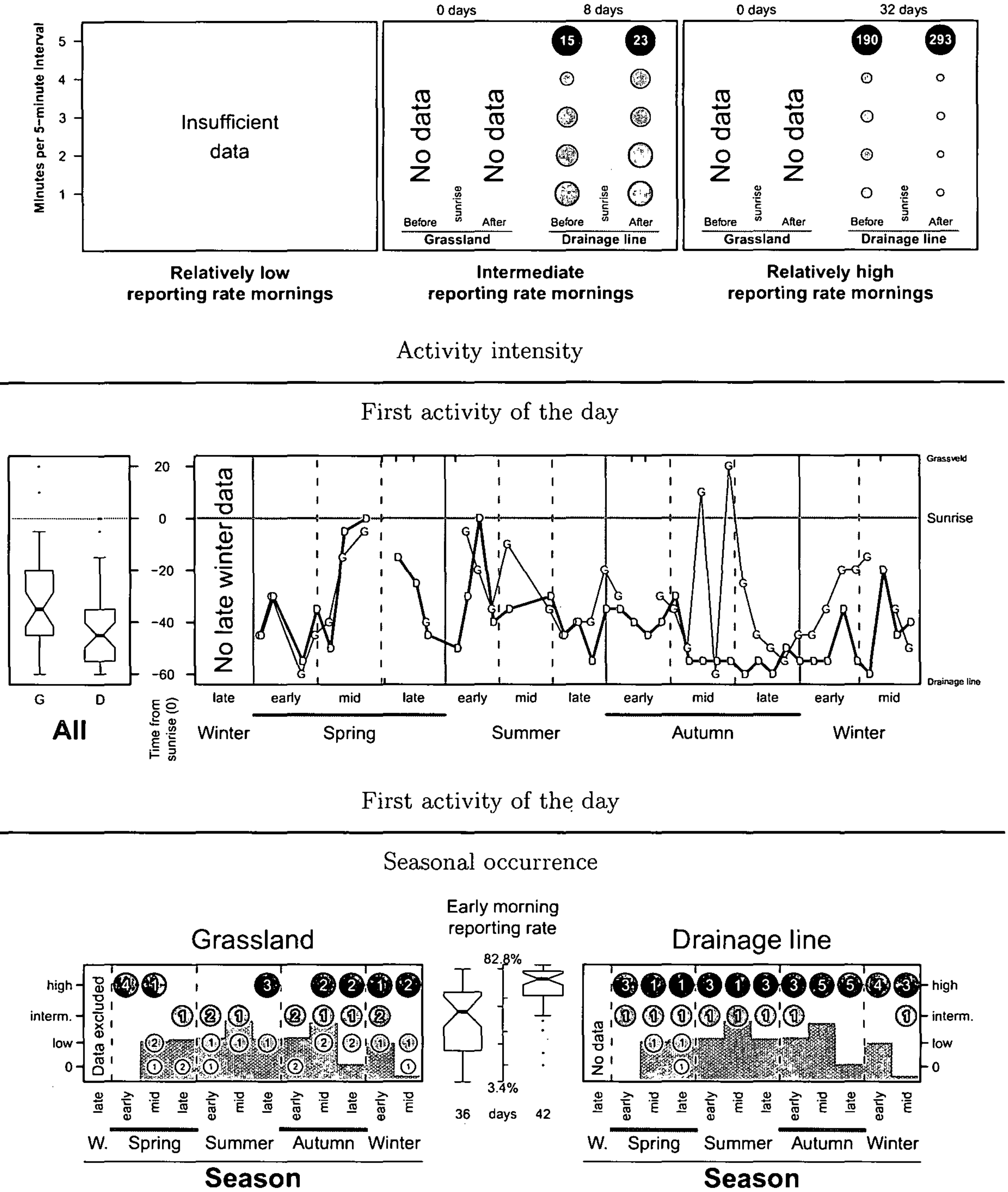


Figure 4.207: R355 Laughing Dove — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

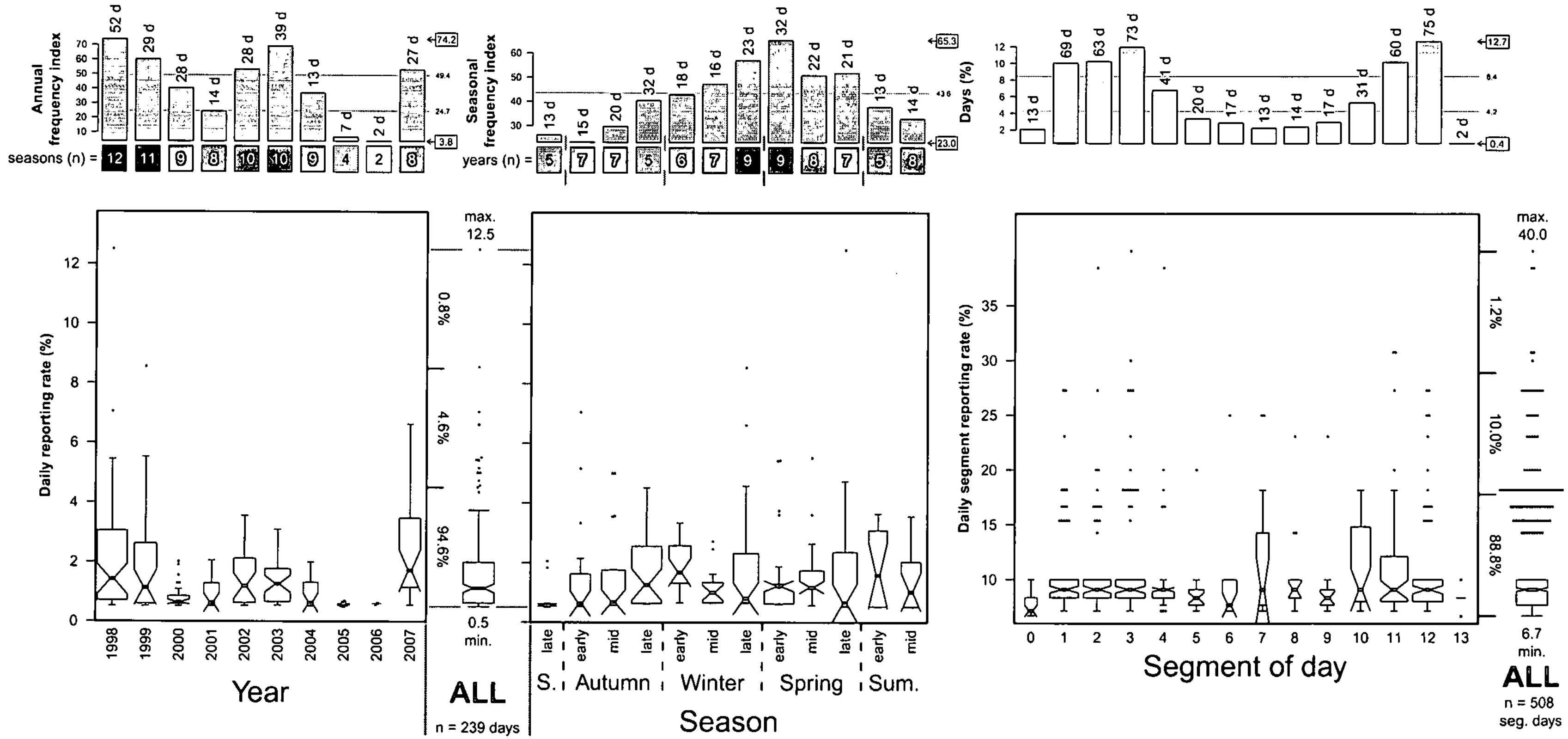


Figure 4.208: R355 Laughing Dove — birds seen: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

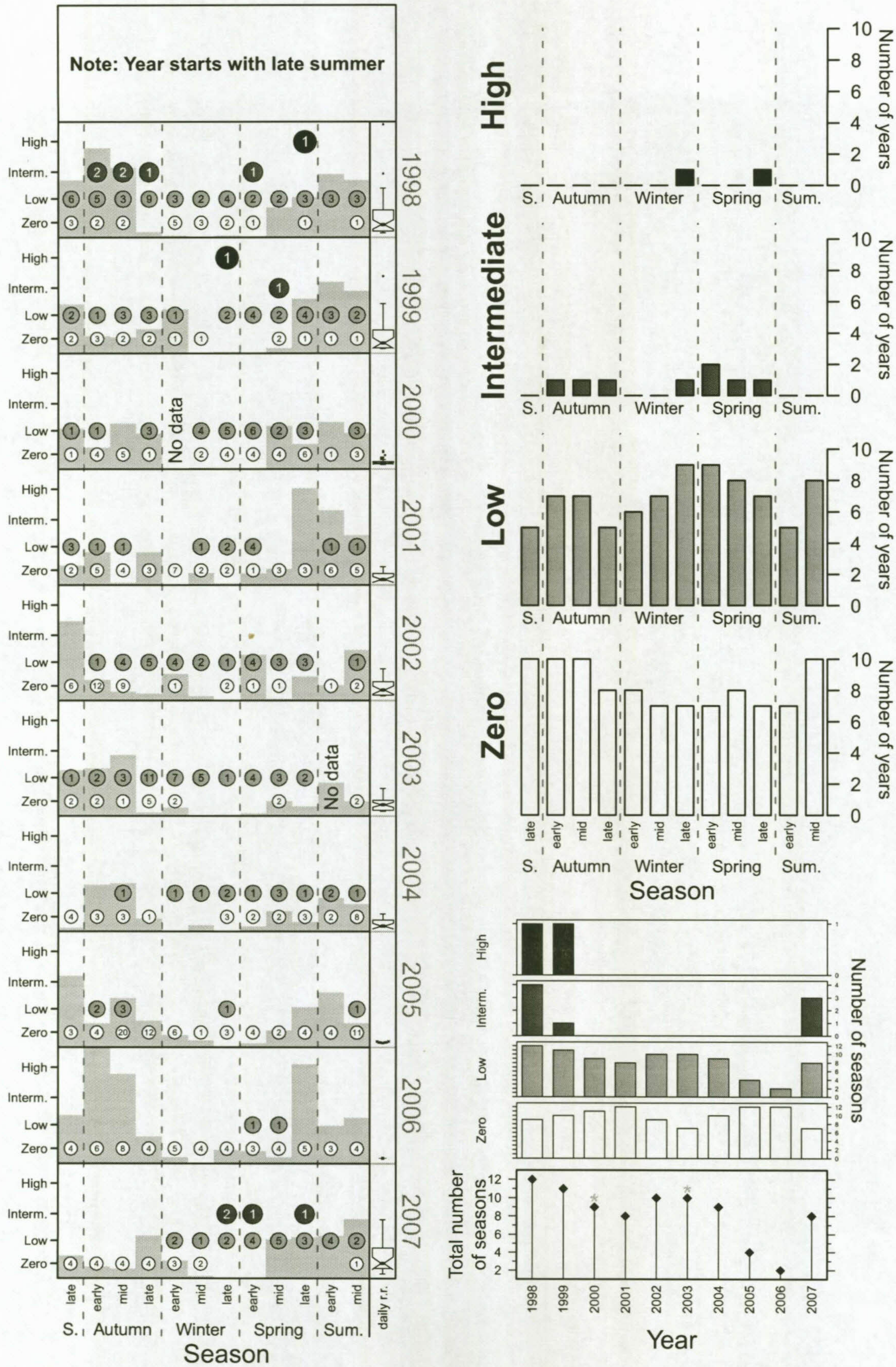


Figure 4.209: R355 Laughing Dove — birds seen: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

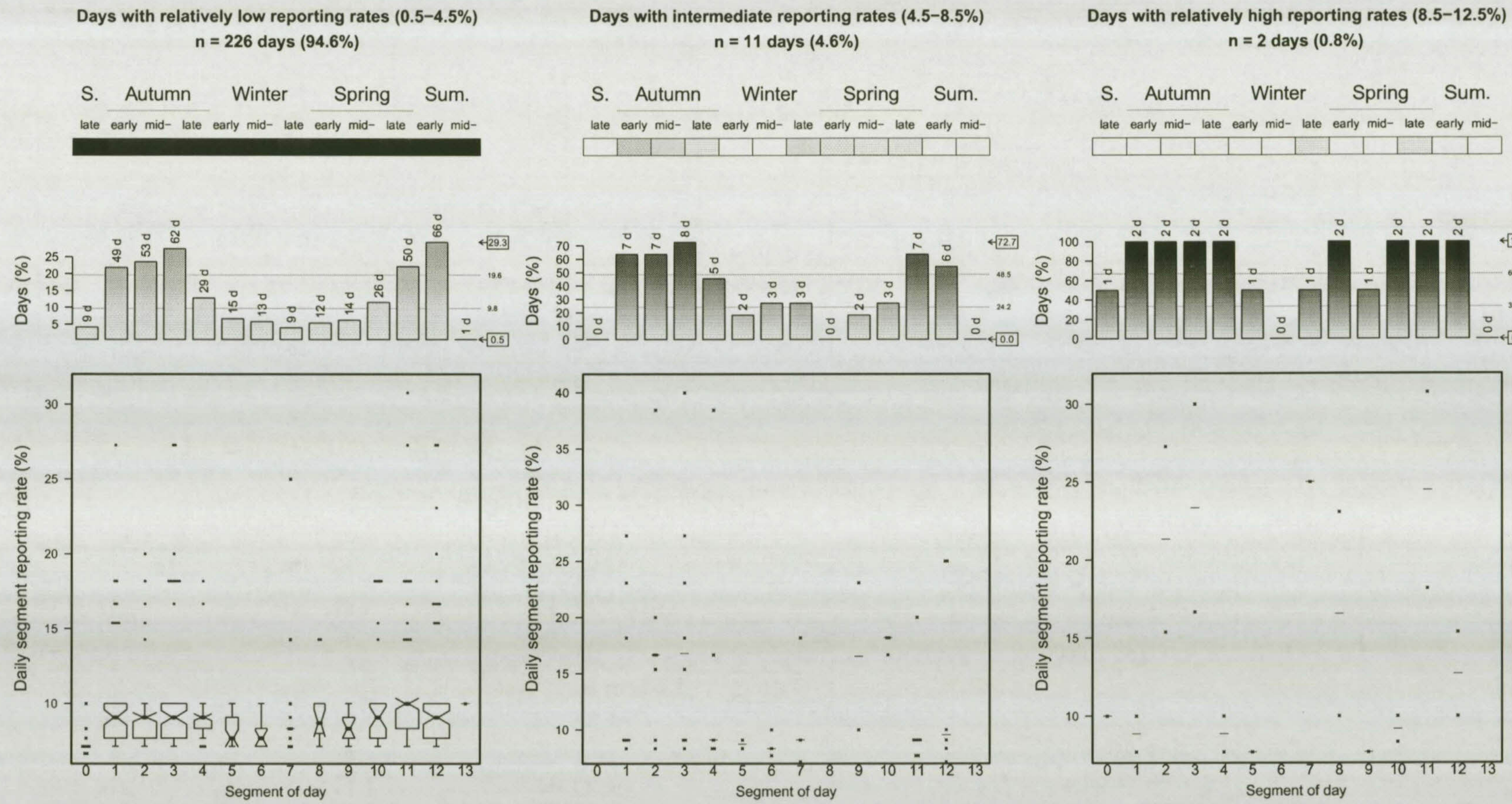


Figure 4.210: R355 Laughing Dove — birds seen: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

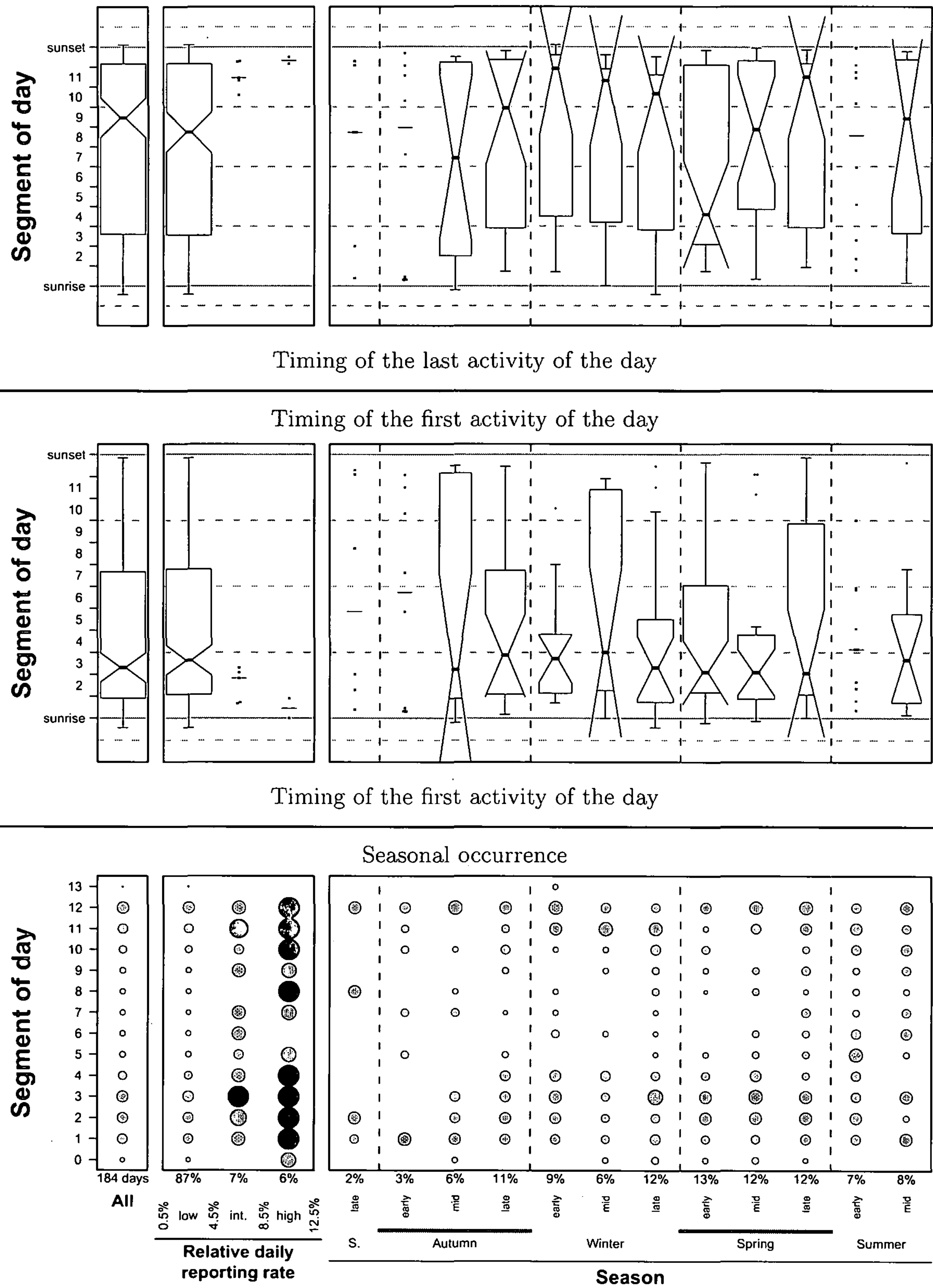


Figure 4.211: R355 Laughing Dove — birds seen: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

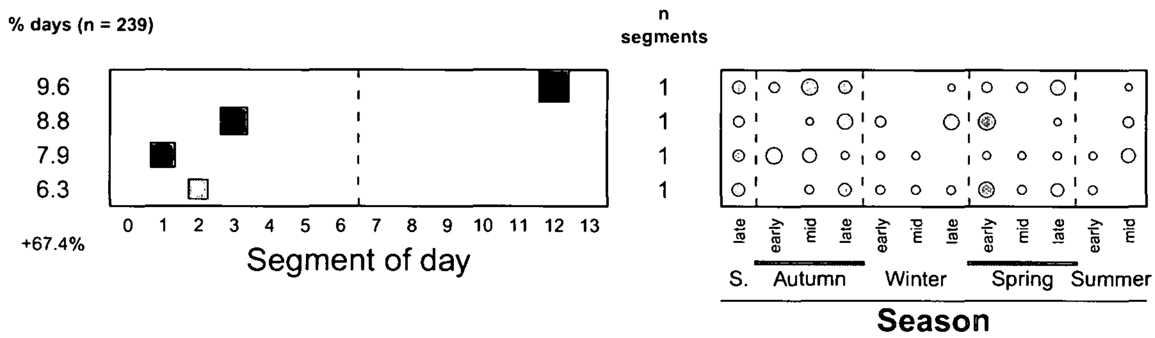


Figure 4.212: R355 Laughing Dove — birds seen: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

R356 Namaqua Dove .... *Oena capensis*

The Namaqua Dove occurs in sub-Saharan Africa, south-western Arabia, Socotra and Madagascar (Rowan 1983). It is the third most widespread species of all birds in southern Africa (Colahan & Harrison 1997c). It occurs in a wide variety of habitats, including grassland — where it prefers areas with reduced cover — usually with some *Acacia* trees (Earlé & Grobler 1987; Rowan 1983). Movements are complex and not fully understood, the population consisting of resident and nomadic components (Colahan & Harrison 1997c; Rowan 1983).

The birds at Glen

Rowan (1983) rightly noted that the calls of the Namaqua Dove are so soft and unobtrusive that they may easily pass unnoticed. All Namaqua Dove records in the grassland refer to birds actually present in the grassland, unlike species such as the Cape Turtle Dove R354 where birds calling in the drainage line were often heard in the grassland. In most cases birds were seen in grassland (81.8%; Table 4.37a), either as birds in flight or as birds in the trampled area, usually as singles or pairs. Calls were typically from birds in the trampled area. Breeding has been recorded in the area. Figures start on page 425.

Annual occurrence in the grassland of birds seen only: Seen on 40.1% of the days with an activity index of two (Table 4.37a). Recorded during between 9–12 seasons in seven years, and during 2–6 seasons from 1999/0 to 2001/2 and during 2006/7 (Fig. 4.213; Fig. 4.214). The annual frequency indices were relatively high in 1998/9, 2002/3, 2003/4 and 2007/8 (Fig. 4.213). Daily reporting rates ranged from 0.5 to 13.6% with 98.1% of the days attaining low reporting rates (Fig. 4.213).

Seasonal occurrence in the grassland of birds seen only: Seen during 7–9 years in spring, summer and autumn and during 4–6 years during winter (Fig. 4.213). The median daily reporting rates were similar for the respective seasons (Fig. 4.213).

Table 4.37: R356 Namaqua Dove: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.818	598	114 612	0.5	seen only	40.1	656	263	2
0.182	133	114 612	0.1	heard	11.0	656	72	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	130	1 190	10.9	heard	55.8	43	24	5
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.792	19	1 188	1.6	seen only	34.9	43	15	1
0.208	5	1 188	0.4	heard	7.0	43	3	2

Daily occurrence in the grassland of birds seen only: Activity was recorded during all segments of the day, but was relatively infrequent before sunrise and after sunset and otherwise slightly more frequent in the early morning (Fig. 4.213). The pattern was seasonally variable (Fig. 4.215). Bird-segment combinations occurring on more than 5% bird-days were limited to activity during four single morning segments (S1–S4), which collectively accounts for a quarter of all bird-days (Fig. 4.216).

The first activity of the day usually occurred during the course of the morning, with no clear seasonal pattern (Fig. 4.215). The timing of the last activity of the day was greatly variable (Fig. 4.215).

Daily segment reporting rates ranged from 6.2 to 54.5% with 97.9% of the values relatively low and median daily segment reporting rates similar for the respective segments (Fig. 4.213).

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Annual occurrence of birds calling in the grassland: Heard during 11.0% of the days with an activity index of two (Table 4.37a). Not recorded in 2000/1, and recorded during 3–7 seasons in other years (Fig. 4.217; Fig. 4.218). Daily reporting rates ranged from 0.5 to 5.7% with 90.3% bird-days attaining low values; The median daily reporting rates were comparable between the respective years (Fig. 4.217).

Seasonal occurrence of birds calling in the grassland: Recorded during 1–9 years in each season, being particularly frequent in autumn (Fig. 4.217). Median daily reporting rates were low for all season and representative of activity during one or rarely two 5-minute intervals per day per season (Fig. 4.217).

Daily occurrence of birds calling in the grassland: Overall, activity was most frequent in the early morning after sunrise and in the late afternoon before sunset (Fig. 4.217). Some seasonal variability is evident (Fig. 4.219). A total of five bird-segment combinations, all involving activity during single segments, occurred during more than 5 bird-days and collectively accounted for almost two-thirds of all bird-days (Fig. 4.220). The timing of both the first and the last activity of the day was variable (Fig. 4.219).

Daily segment reporting rates ranged from 5.9 to 83.3% with 95.7% of all values relatively low (Fig. 4.217). Median daily segment reporting rates were similar for the respective segments (Fig. 4.217).

Early morning occurrence of birds calling during 2007/8: Activity was much more frequent in the drainage line than in the grassland (Table 4.37b & c), coinciding with a higher median early morning reporting rate in the former habitat (Fig. 4.221). High reporting rate days occurred during early summer and during late autumn in the drainage line (Fig. 4.221). The first activity of the day normally occurred within the last 20 minutes before sunrise (Fig. 4.221). There were only some minor differences in activity intensity between pre- and post-sunrise segments (Fig. 4.221).

Discussion

The data of the Namaqua Dove is bound to be biased to some unknown extent because it is based on birds that are often found in the trampled area only. This complicates the interpretation of the data.

There is apparently no published data on moult in South Africa (Dean 2005g). Limited data from birds ringed at Glen suggests that moulting occurs during summer and autumn (November to April) (DJvN unpublished data). This seems to be similar to the situation in Malawi where many of the adults start moulting from September to November (Dean 2005g). Data from southern Zambia and Nigeria suggests that primary moult lasts 4.5–7 months (Dean 2005g).

4.28 Cuculidae: Old World Cuckoos, Malkohas

Primary moult is atypical in cuckoos. The feathers are not shed from the innermost to the outermost, but each growing feather (except the outermost one) is flanked on both sides by a full grown one; this is known as the 'transilient' moult (from the Latin *transilire*, to jump over) (Rowan 1983). The 79 species occur in Eurasia, Africa, Madagascar and Australasia, with 15 species occurring in southern Africa (Hockey *et al.* 2005). Most cuckoos are brood parasites (Hockey *et al.* 2005). A total of eight species have been recorded in the Free State to date (Earlé & Grobler 1987; Harrison *et al.* 1997a), of which the four most common ones were recorded at Glen.

R377 Red-chested Cuckoo .... *Cuculus solitarius*

The Red-chested Cuckoo is endemic to sub-Saharan Africa (Rowan 1983). In southern Africa it is widespread in southern Mozambique (Parker 1999), Zimbabwe, Swaziland and the eastern and far southern parts of South Africa (Vernon & Herremans 1997a), the present study area being situated towards the western edge of its distribution. It occurs in woodland where it prefers denser stands of trees, and enters other habitats such as grassland only where suitable habitats are available (Rowan 1983). Although its apparent seasonal presence in southern Africa [mid-spring to

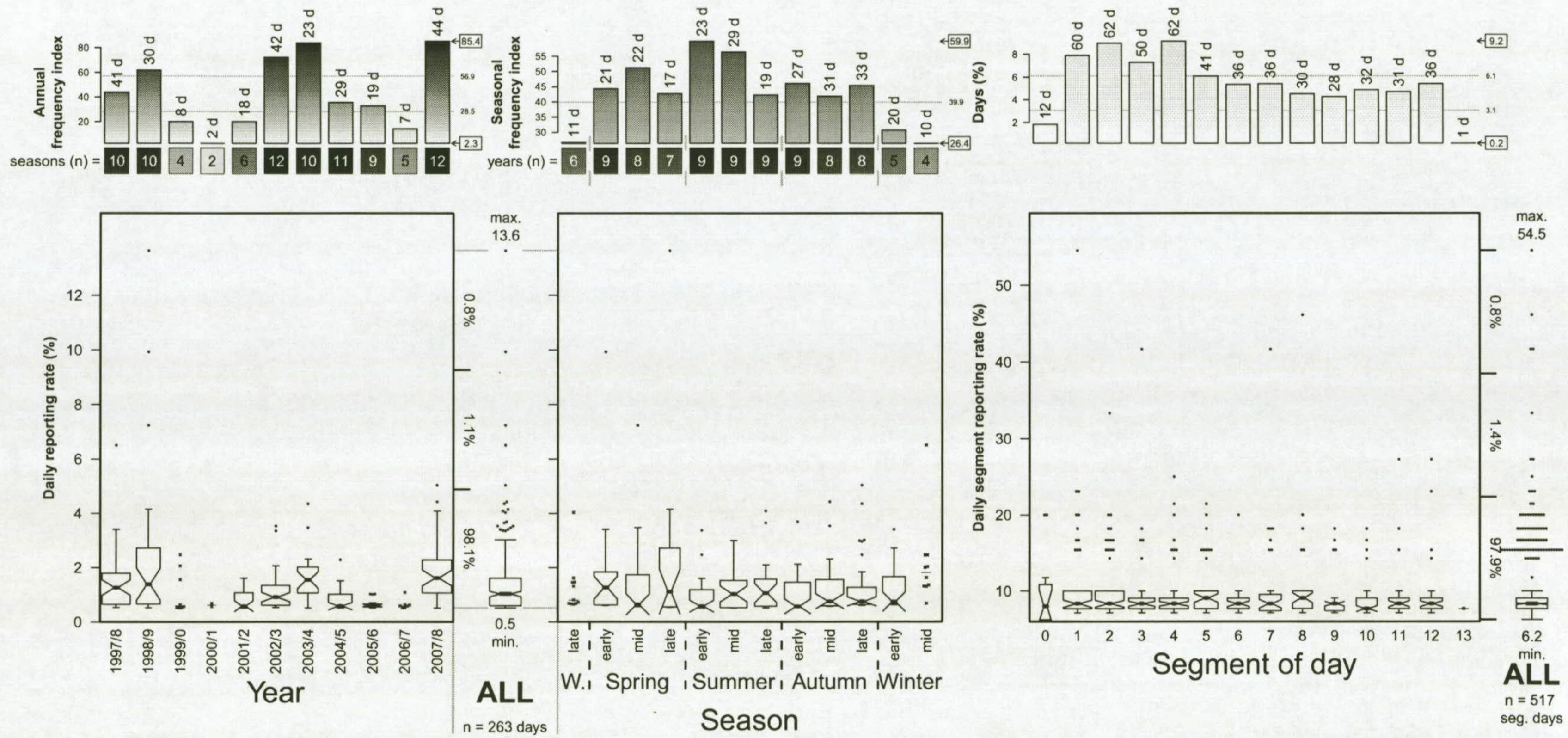


Figure 4.213: R356 Namaqua Dove — seen only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

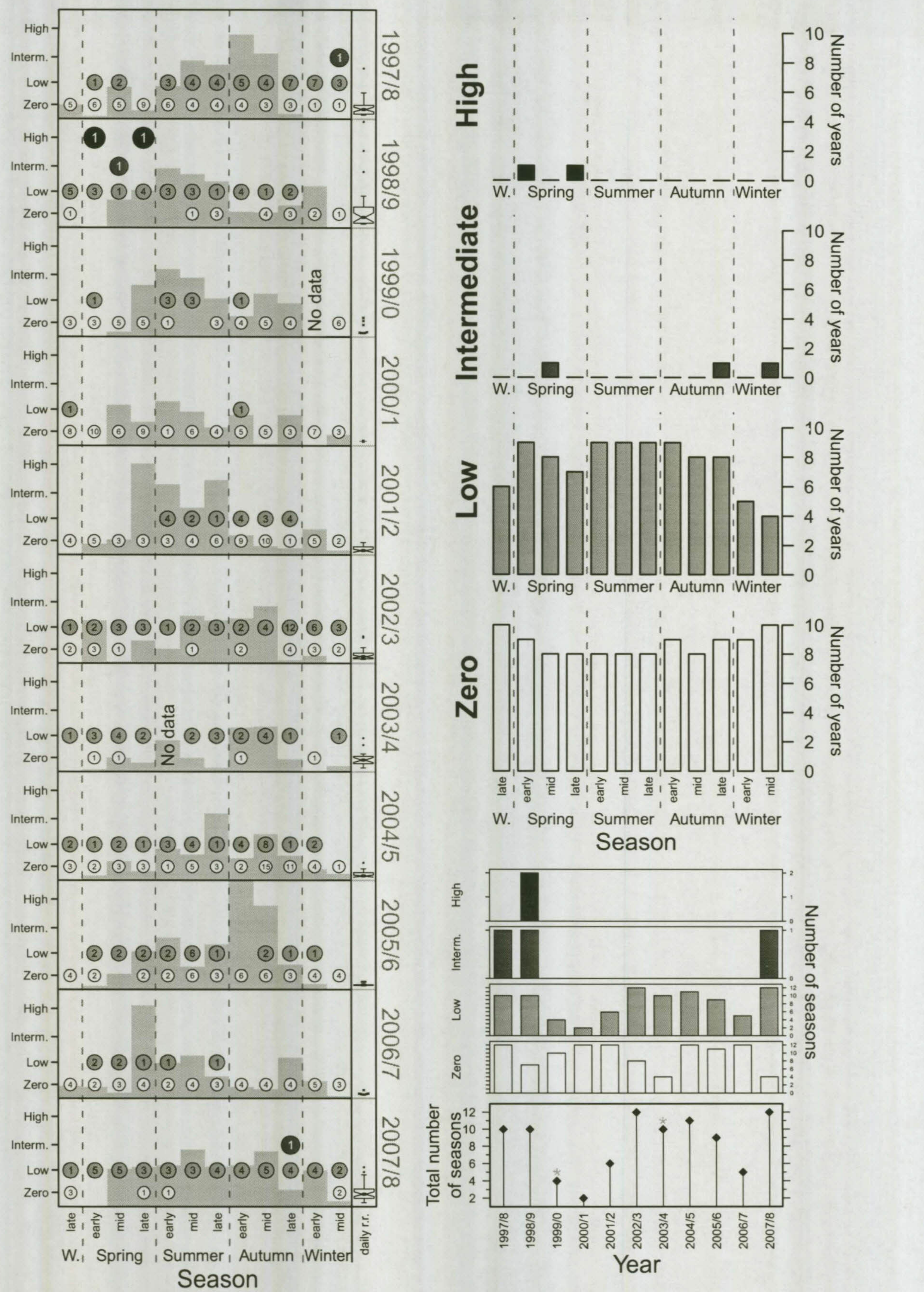


Figure 4.214: R356 Namaqua Dove — seen only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

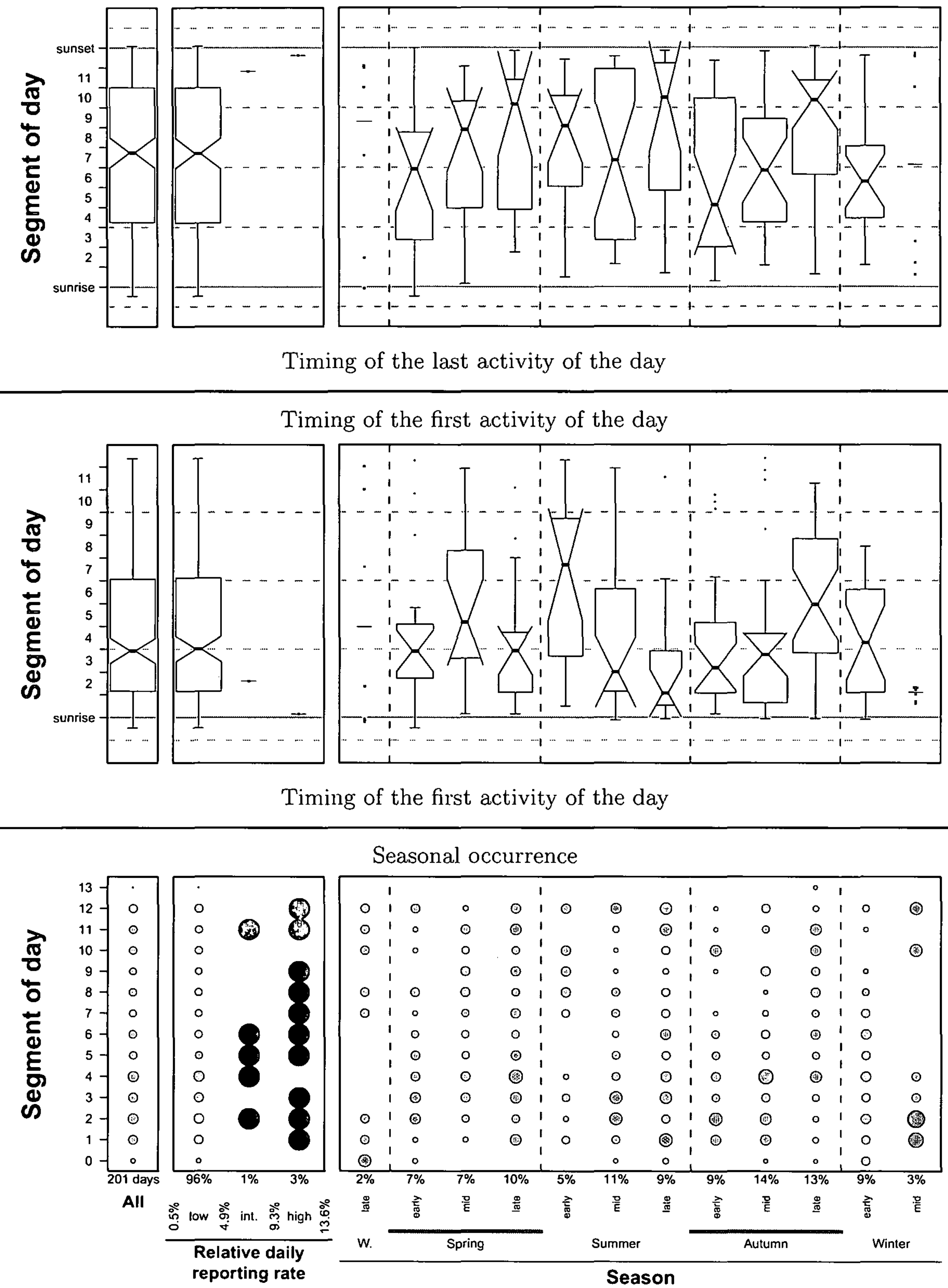


Figure 4.215: R356 Namaqua Dove — seen only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

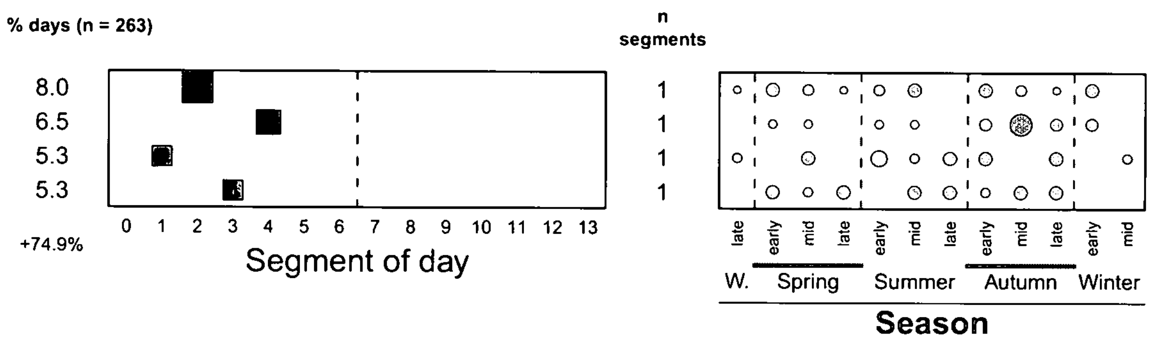


Figure 4.216: R356 Namaqua Dove — seen only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

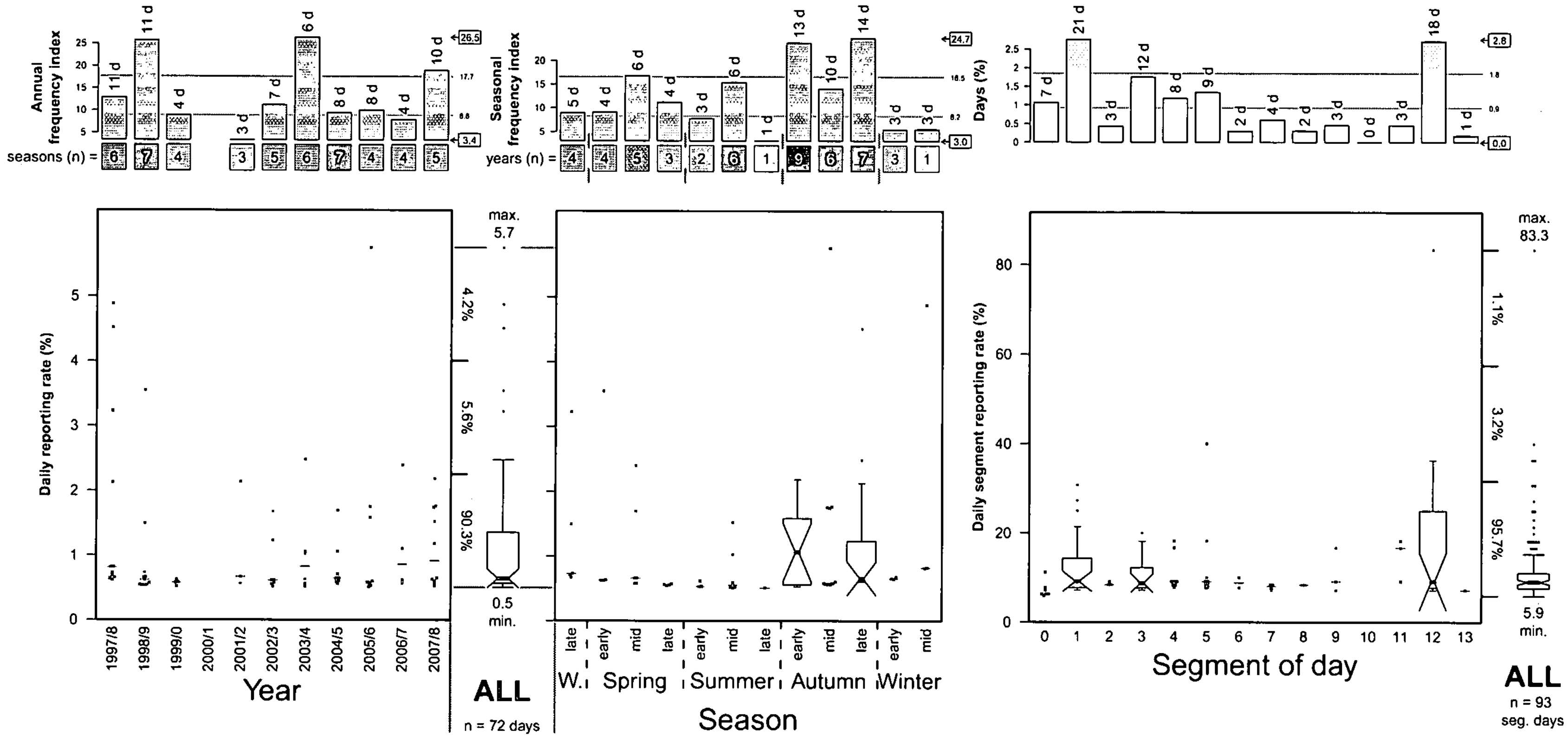


Figure 4.217: R356 Namaqua Dove — heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

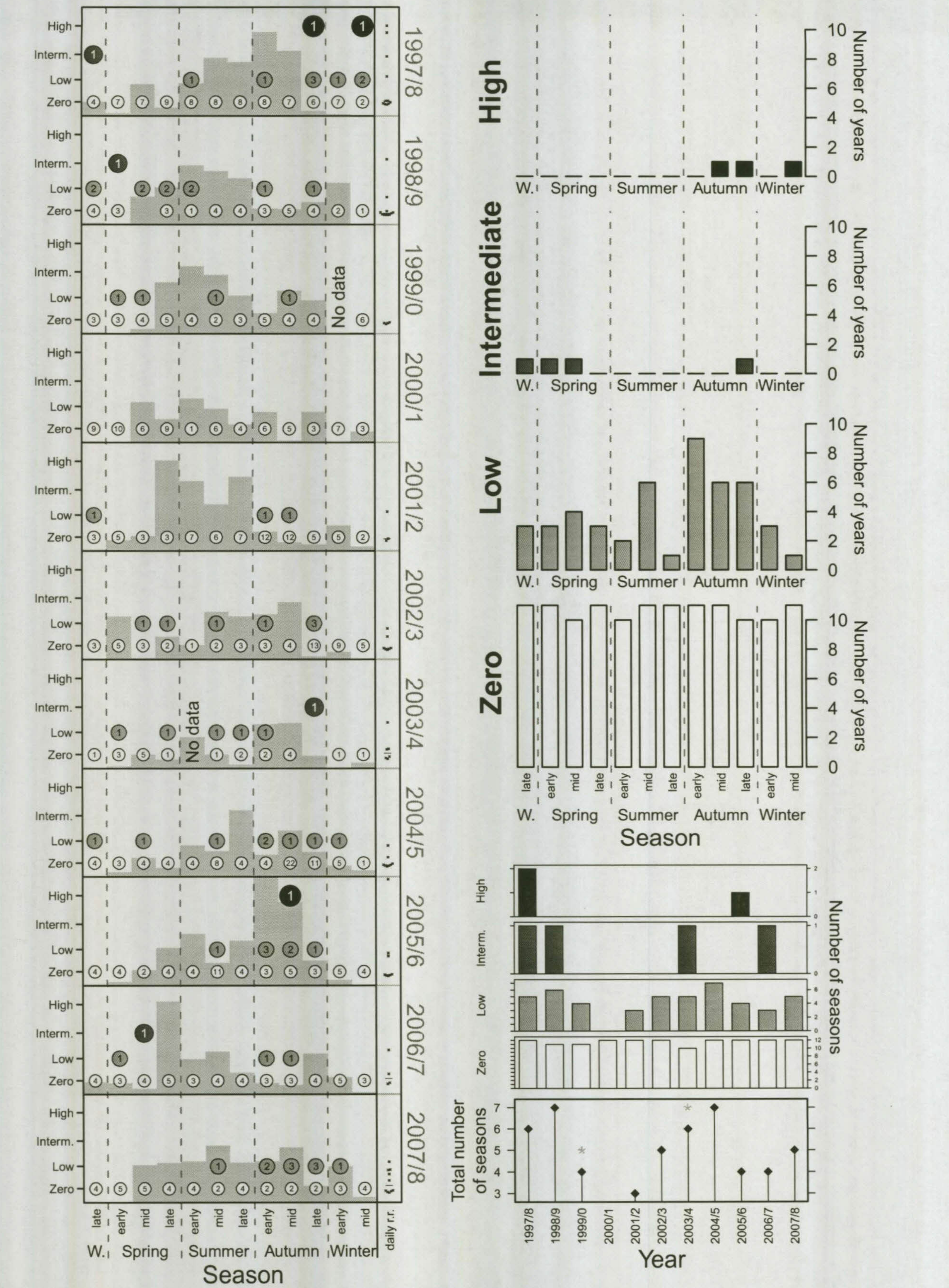


Figure 4.218: R356 Namaqua Dove — heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

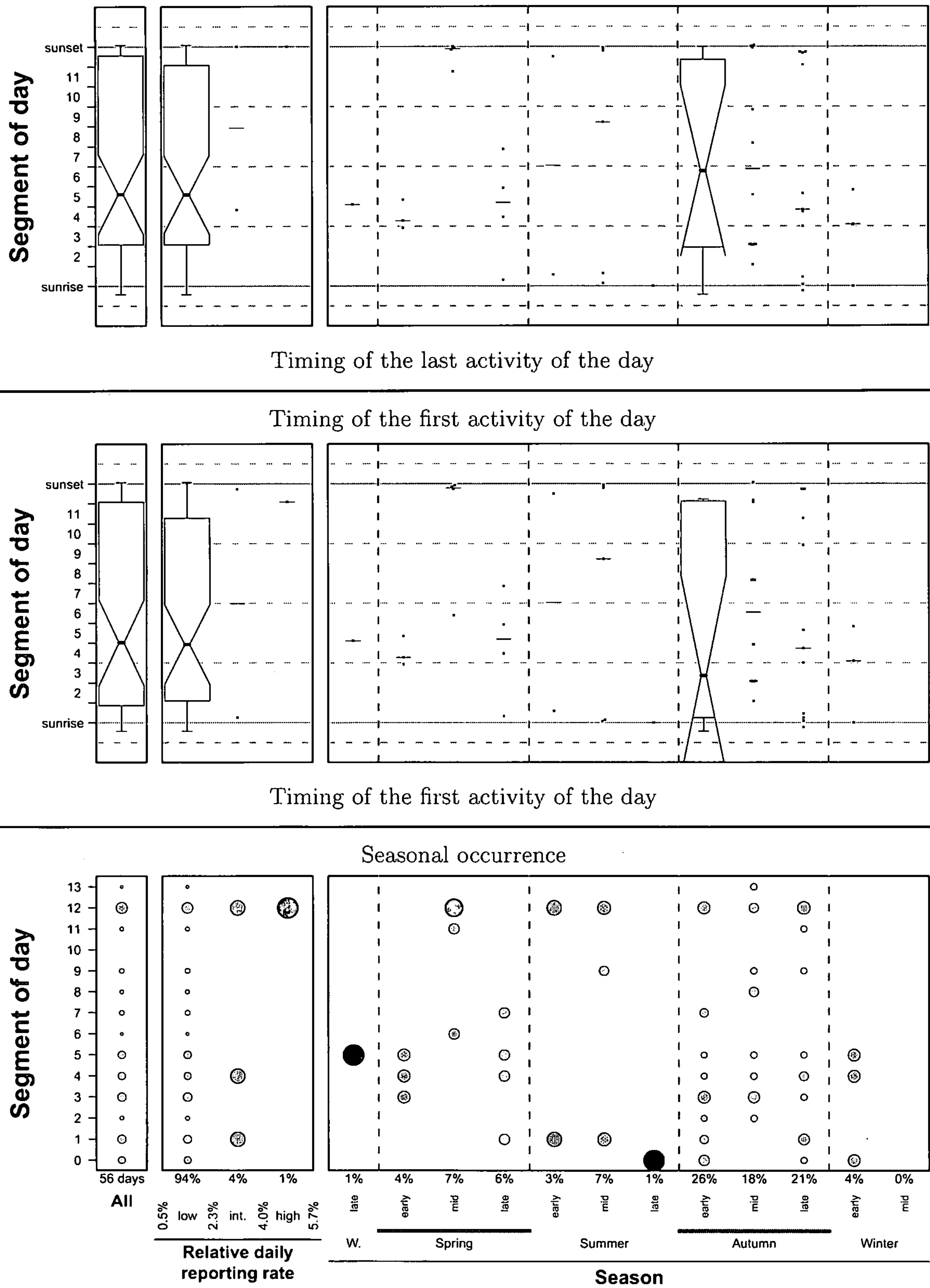


Figure 4.219: R356 Namaqua Dove — heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

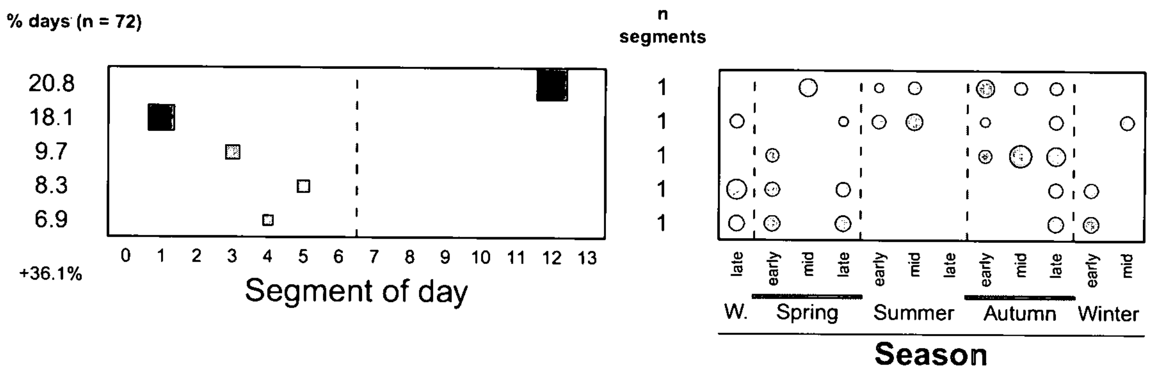
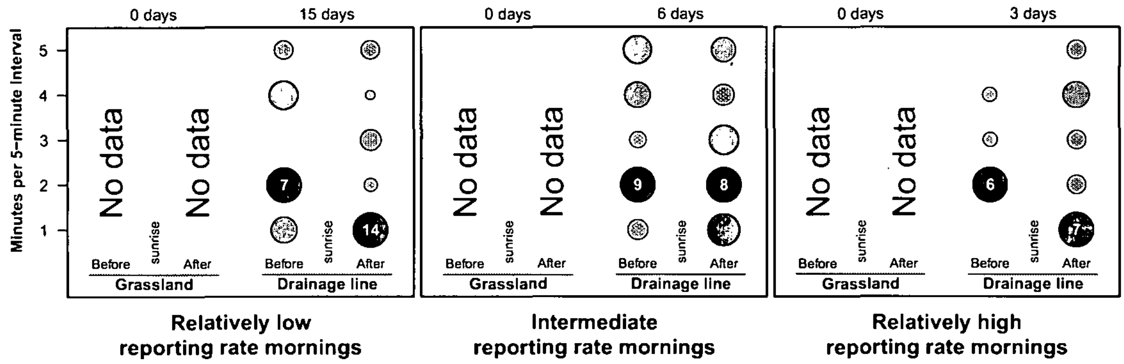
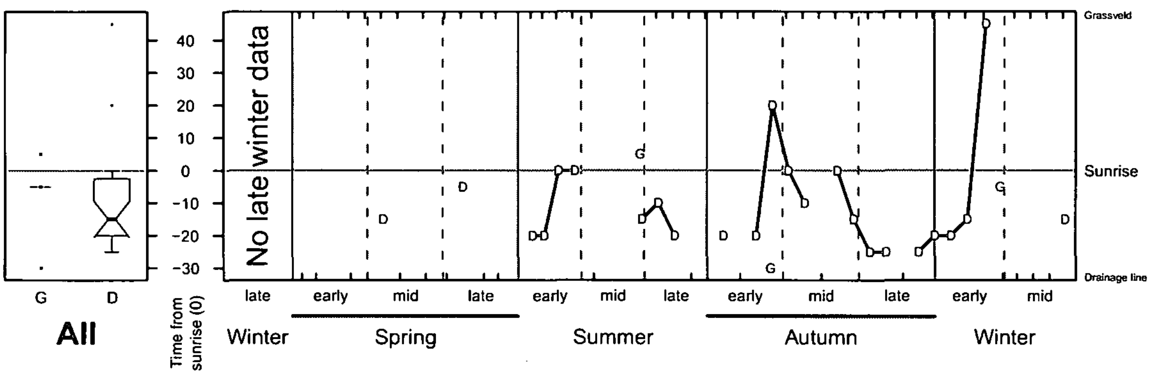


Figure 4.220: R356 Namaqua Dove — heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

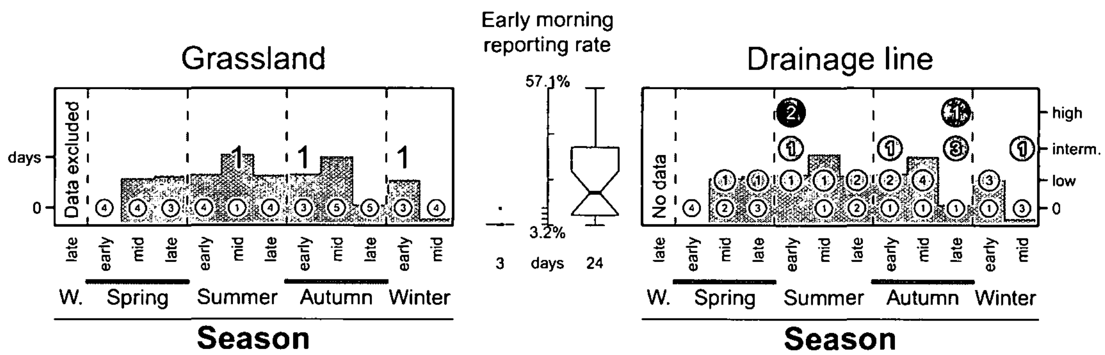


Figure 4.221: R356 Namaqua Dove — heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

mid-autumn] points to it being an intra-African breeding migrant (Vernon & Herremans 1997a), the origin of these southern African birds is still unknown (Dean & Payne 2005a; Rowan 1983). A complicating factor is that adult birds are only rarely seen, identification relying mostly on its persistent call. The problem is that the end of calling does not coincide with the departure of the adults (Vernon & Herremans 1997a). Nonetheless, the current consensus is that at least the bulk of the population move further north during the cooler seasons (Dean & Payne 2005a; Rowan 1983).

The birds at Glen

The loud advertising call (usually rendered *piet-my-vrou*) of the male Red-chested Cuckoo in the drainage line was the only evidence of their presence at Glen. The Karoo Thrush R577, Cape Robin-Chat R601 (main host) and Cape Wagtail R713 (Steyn 1996) count among their potential hosts at Glen.

In the grassland, heard on a total of 12 days spread over six years, usually on only one morning/day/season per year, but during two and three seasons in 2001/2 and 2007/8 respectively (Fig. 4.222). All records from late spring to mid-summer, and mostly in the early morning (Fig. 4.222).

During the early mornings of 2007/8 it was heard on only one morning each in the drainage line (late spring) and the grassland (early summer).

Discussion

2001/2 and 2007/8 was the only years with more than one Red-chested Cuckoo record (Fig. 4.222). They also experienced above average rainfall (Fig. 2.13), however no birds were recorded during the other two years with above average rainfall, 1997/8 and 2005/6 (Fig. 2.13; Fig. 4.222). It is, nonetheless, suggested that rainfall, and particularly the timing of the rain, influence the activity of the birds at Glen. In 2001/2 the 'big-rains' started in late spring before the arrival of the first cuckoo in early summer when further rain fell (Fig. 2.16; Fig. 4.222). The rainfall pattern of 2007/8 was characterised by a relatively constant amount of rain (58–91 mm) in eight seasons, starting in mid-spring with the cuckoo arriving in late spring (Fig. 2.16; Fig. 4.222). The rainfall patterns of 1997/8 and 2005/6 were different, with most rain falling only in early and mid-autumn (Fig. 2.16), presumably too late for the cuckoo's.

R382 Jacobin Cuckoo .... *Clamator jacobinus*

The Jacobin Cuckoo occurs in sub-Saharan Africa and in Asia (Rowan 1983). In southern Africa it is absent from large parts in the western half of the region (Herremans & Vernon 1997a), as well as southern Mozambique (Parker 1999). In the Free State it is largely confined to the central and northern parts of the province (Earlé & Grobler 1987; Herremans & Vernon 1997a). It occurs in a variety of woodland habitats, favouring those with *Acacia* trees (Herremans & Vernon 1997a; Rowan 1983).

Three subspecies migrate to southern Africa during the warmer seasons: *C. j. jacobinus* and *C. j. pica* are non-breeding migrants from Africa and Asia, and *C. j. serratus* is an intra-African breeding migrant (Rowan 1983; Vernon & Dean 2005d). Based on the information

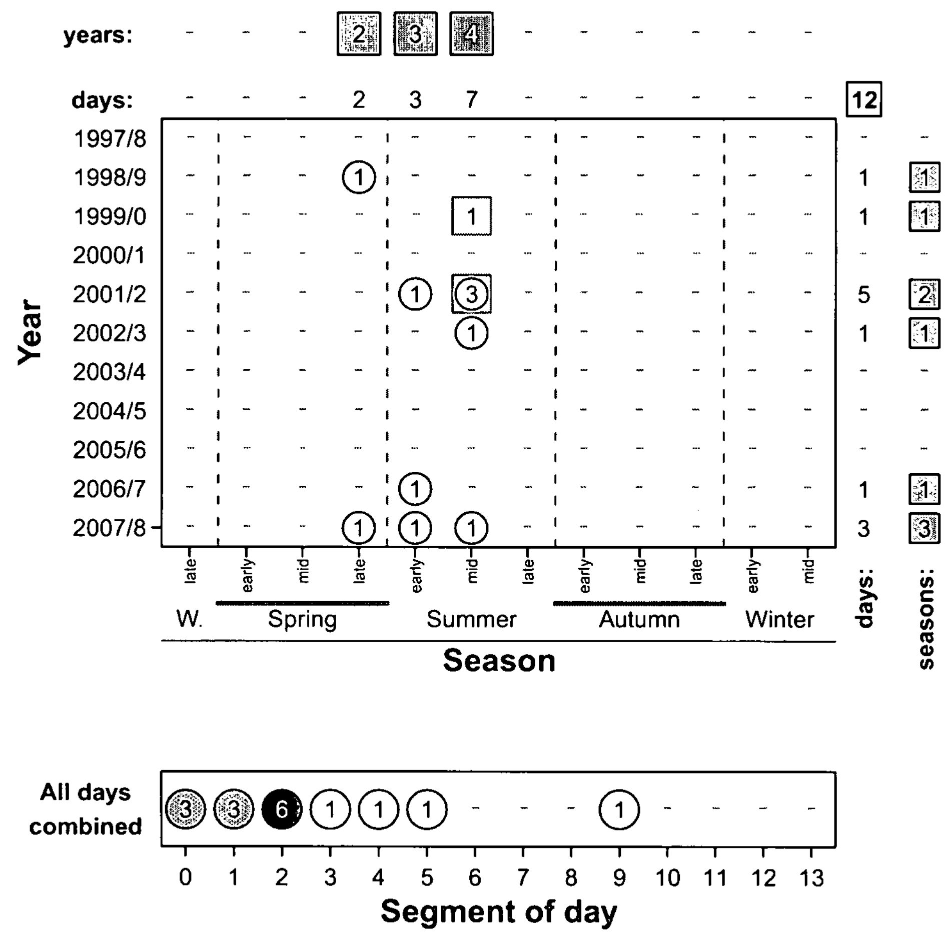


Figure 4.222: R377 Red-chested Cuckoo — birds heard only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

in Rowan (1983) (see also map in Vernon & Dean (2005d)) only *C. j. serratus* occurs in the Free State where it is present from October to April [late spring to late autumn] (Herremans & Vernon 1997a).

The birds at Glen

All Jacobin Cuckoo records in the grassland refer to birds calling in the drainage line, where both the pied and dark phase of *C. j. serratus* (Rowan 1983) occur. The African Red-eyed Bulbul R567 and Common Fiscal R732 (Steyn 1996) represent two of its host species that occur at Glen. Figures start on page 438.

Annual occurrence of drainage line birds heard in the grassland: Heard during 27.7% of the days with an activity index of four (Table 4.38a). Recorded during 4–6 seasons each year (Fig. 4.223; Fig. 4.224). Daily reporting rates ranged from 0.5 to 17.7% with 94.0% bird-days attaining low values (Fig. 4.223). Median daily reporting rates were largely similar for the respective years (Fig. 4.223).

Table 4.38: R382 Jacobin Cuckoo: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	789	114 612	0.7	birds heard only	27.7	656	182	4
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	76	1 190	6.4	birds heard only	44.2	43	19	4
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	17	1 188	1.4	birds heard only	23.3	43	10	2

Seasonal occurrence of drainage line birds heard in the grassland: The birds usually arrived during the latter part of late spring or the beginning of early summer with the median date being 5 November (Fig. 4.225; Note: there were no observations made during the arrival period in 2003/4). The last birds were recorded some time during autumn each year (median date: 16 March; Fig. 4.225). Records were thus limited to the period from late spring to late-autumn (Fig. 4.225), being notably less frequent during the beginning and end of this period (Fig. 4.223), with the incidence of days with zero records least frequent during mid-summer (Fig. 4.224). Median daily reporting rates were similar for all seasons (*ca.* 2%; Fig. 4.223).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity was most frequently recorded in the early morning and in the late afternoon before sunset (Fig. 4.223). A similar pattern was discernible for all seasons (Fig. 4.226). The two bird-segment combinations occurring during at least 5% bird-days involved single segments S1 and S12, occurring most frequently during early and mid-autumn and collectively accounting for 13.7% of all bird-days (Fig. 4.227).

The first activity of the day often occurred during the first half of the morning after sunrise, but this was more variable during early and late summer than during other seasons (Fig. 4.226). The timing of the last activity of the day was more variable, occurring during any time of the day and was least variable during early summer when it was often recorded in the late afternoon (Fig. 4.226).

Daily segment reporting rates ranged from 5.3 to 64.3% with 92.2% of the values relatively low (Fig. 4.223). Median daily segment reporting rates was similar for all segments (Fig. 4.223).

Early morning occurrence of drainage line birds heard during 2007/8: Activity was less frequently recorded in the grassland than in the drainage line (10 vs. 19 days; Table 4.38b & c), coinciding with a lower median early morning reporting rate in the grassland (Fig. 4.228). A further difference is that activity was recorded for a longer period in the drainage line (late spring to late autumn) than in the grassland (early summer to mid-autumn) (Fig. 4.228). However, only low reporting rate mornings occurred during the two extra drainage line seasons, late spring and late autumn (Fig. 4.228). In the drainage line, high reporting rate mornings were limited to early summer and mid-autumn with no zero records during summer (Fig. 4.228). Activity usually commenced approximately 20 minutes either side of sunrise (Fig. 4.228). In the drainage line, activity intensities were similar before and after sunrise (Fig. 4.228).

Discussion

The early morning data of 2007/8 (Table 4.38b & c; Fig. 4.228) indicate that the data collected in the grassland underestimates the occurrence of Jacobin Cuckoo calls in the drainage line. The least that can be said is that the Jacobin Cuckoo is a regular seasonal visitor at Glen (Fig. 4.224). One of the main effects of this presumed reduced detectability in the grassland is illustrated by the early morning data of 2007/8, which shows that the birds, or rather their calls, went undetected in the grassland during late spring and late autumn (Fig. 4.228). This could have been the result of the birds not calling on the specific mornings in the grassland. In addition, it is known that they are largely silent in windy weather conditions (Rowan 1983). Wind can also have a negative effect on detectability by presumably making it more difficult to hear birds calling in the drainage line from the grassland under such circumstances. A more detailed analysis in this regard is beyond the scope of the present investigation.

R385 Klaas's Cuckoo .... *Chrysococcyx klaas*

Klaas's Cuckoo occur in sub-Saharan Africa and southern Arabia (Maclean 1985). In southern Africa it is most widespread in South Africa in a broad strip from the Cape eastwards along the coast through Swaziland into the former Transvaal, southern Mozambique and Zimbabwe (Parker 1999; Vernon & Herremans 1997b). In the Free State it is recorded from a number of scattered localities in the eastern, central and northern parts of the province (Earlé & Grobler 1987; Vernon & Herremans 1997b). It occurs in a wide range of habitats with a well-wooded component (Rowan 1983). The birds are solitary and easily overlooked when not calling (Maclean 1985), thus making it difficult to determine when and if any seasonal movements take place (Rowan 1983). In southern Africa, the data at hand suggest that the population is partly resident and migratory (Rowan 1983; Vernon & Herremans 1997b).

The birds at Glen

The Long-billed Crombec R651, Yellow-bellied Eremomela R653, Neddicky R681 and Pririt Batis R703 (Steyn 1996) are Klaas's Cuckoo breeding hosts which occur at Glen. Not recorded in the grassland, being heard during five early mornings observations in the drainage line only: on four days (mid-spring and mid-summer 2001/2, mid-summer 2002/3 and late summer 2003/4) during transects and once in late summer 2007/8.

Discussion

The few records seem to suggest that Klaas's Cuckoo is a seasonal visitor at Glen from mid-spring to late summer. The years during which it was recorded reflect the times when observations were made in the drainage line. It may therefore, be more common than the current records suggest.

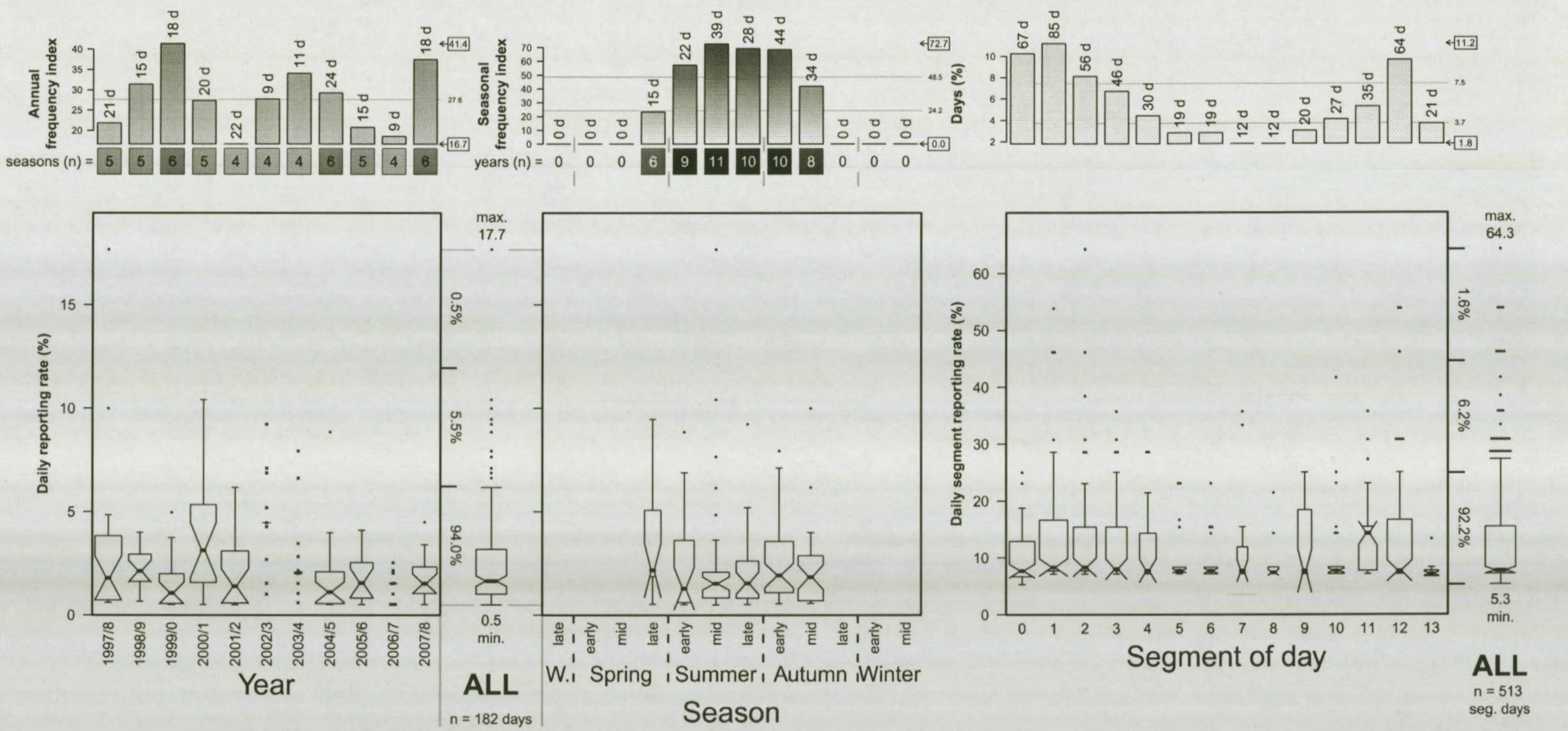


Figure 4.223: R382 Jacobin Cuckoo — birds heard only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

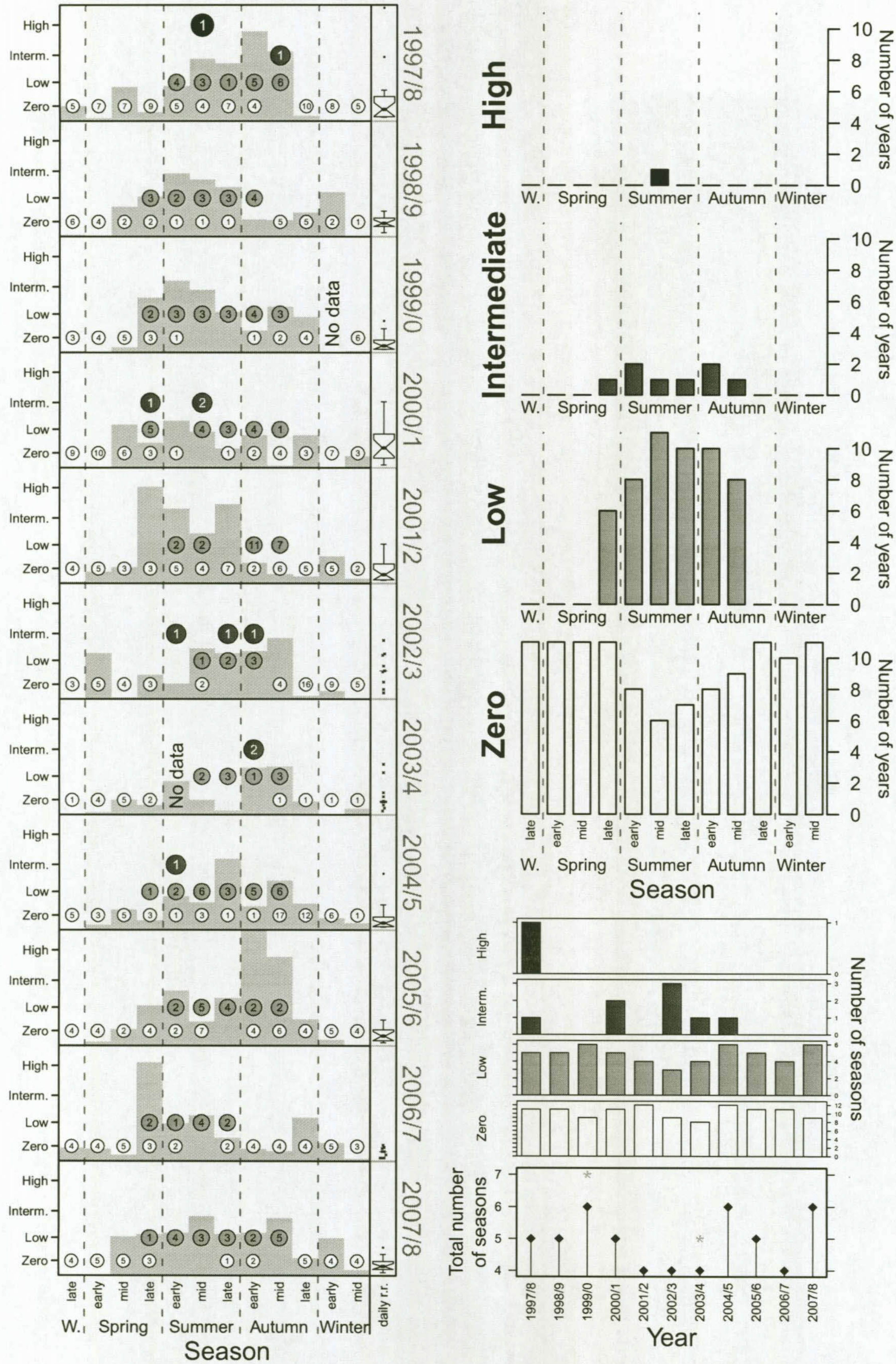


Figure 4.224: R382 Jacobin Cuckoo — birds heard only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

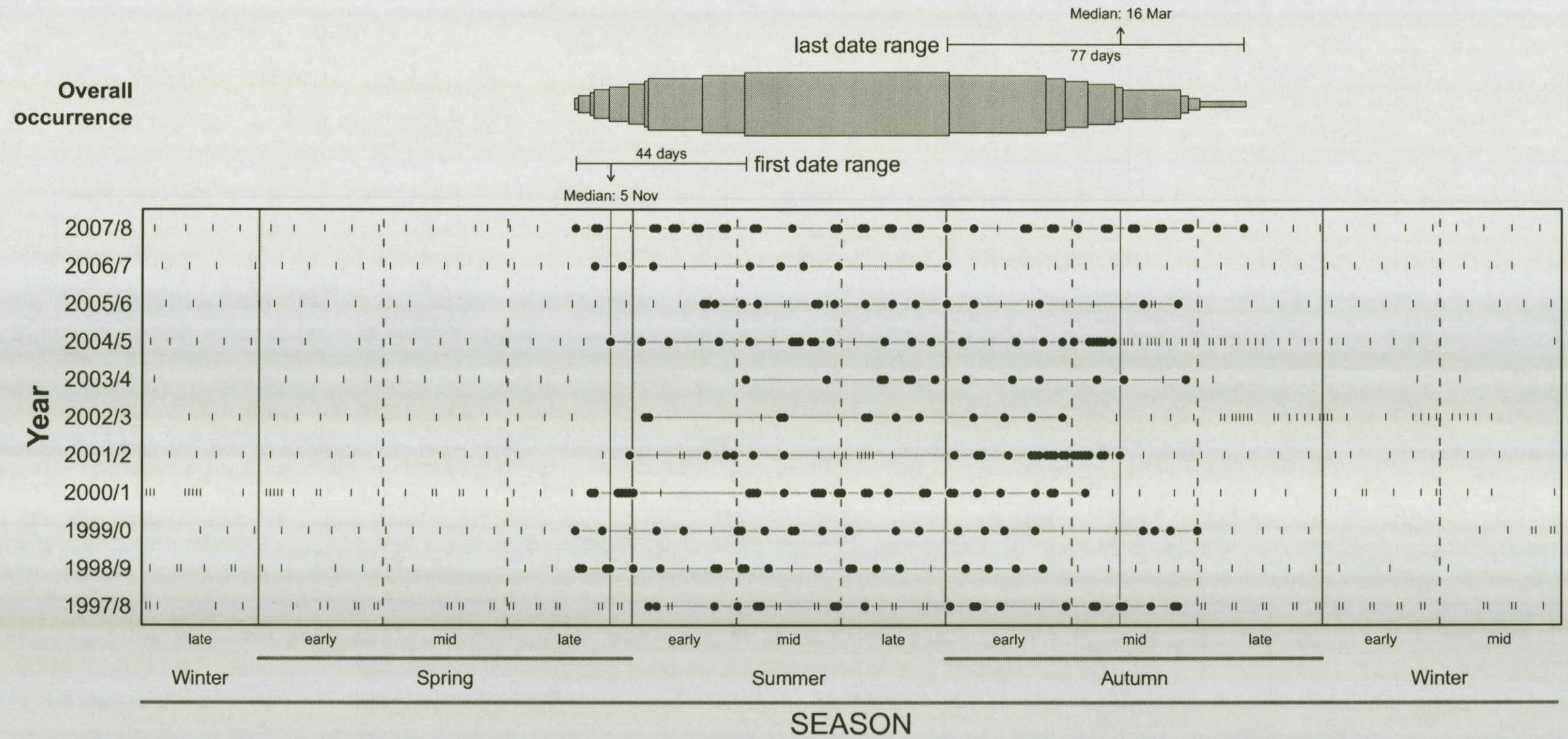


Figure 4.225: R382 Jacobin Cuckoo: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

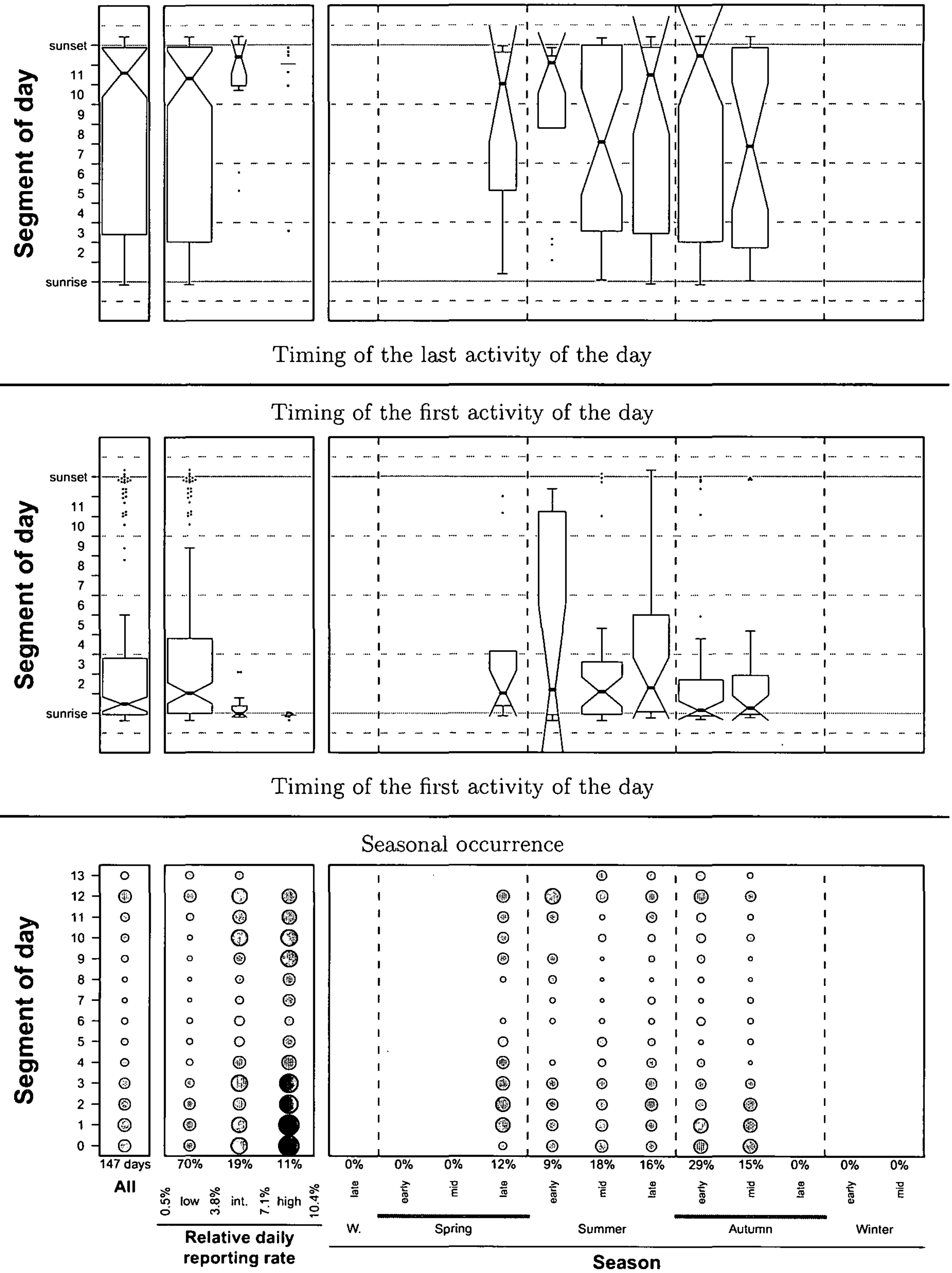


Figure 4.226: R382 Jacobin Cuckoo — birds heard only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

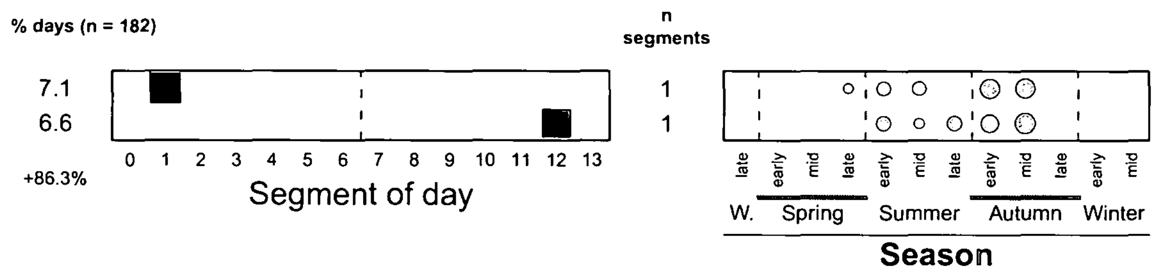


Figure 4.227: R382 Jacobin Cuckoo — birds heard only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

R386 Diderick Cuckoo . . . . *Chrysococcyx caprius*

The Diderick Cuckoo occurs in sub-Saharan Africa and in southern Arabia (Maclean 1985). It is widespread over much of southern Africa, but avoids the more arid western parts of the region (Vernon & Herremans 1997c). It is found in a wide range of woodland habitats, including tree-dotted grasslands and drainage line woodlands (Rowan 1983). It is an intra-African migrant, present in SABAP1 Zone 7 mainly from October to April [mid-spring to late autumn] (Vernon & Herremans 1997c).

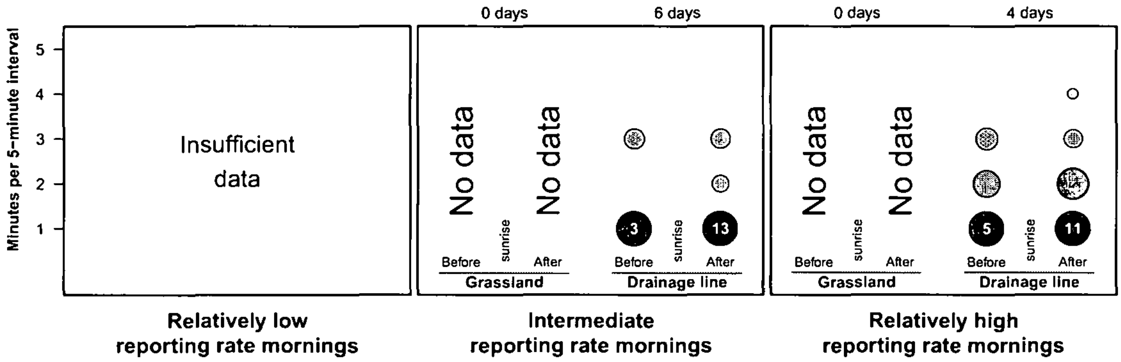
The birds at Glen

This cuckoo is known to parasitize more host species (at least 24) than any other cuckoo occurring in southern Africa (Steyn 1996). The species listed by Steyn (1996) include the following breeding species at Glen: Karoo Robin R614, Kalahari Robin R615, Chestnut-vented Tit-Babbler R621, Cape Wagtail R713, Cape Sparrow R803, Grey-headed Sparrow R804 and Southern Masked Weaver R814.

Most of the Diderick Cuckoo records in the grassland (95.5%; Table 4.39a) represent birds calling in the drainage line. The remainder of the grassland records involved birds seen in the grassland (Table 4.39a). Figures start on page 446.

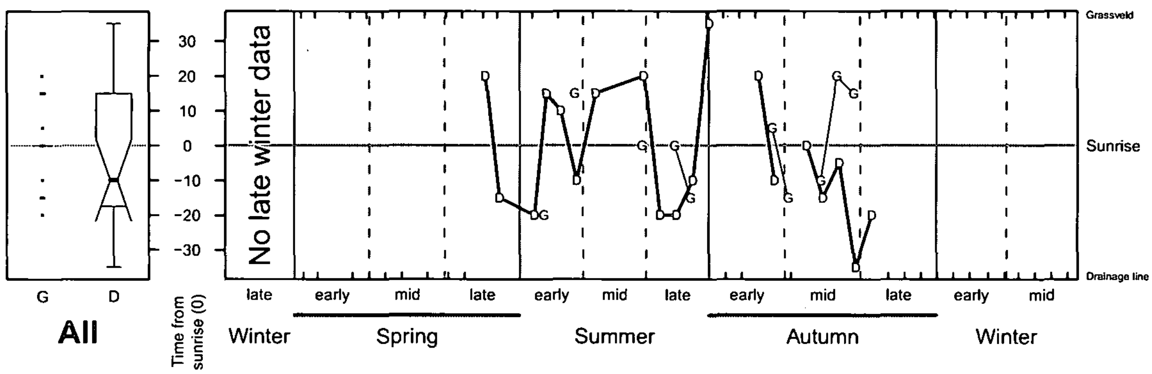
Table 4.39: R386 Diderick Cuckoo: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.955	834	114 612	0.7	birds heard	27.3	656	179	5
0.045	39	114 612	0.0	birds seen	3.4	656	22	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	99	1 190	8.3	birds heard	44.2	43	19	5
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	23	1 188	1.9	birds heard	20.9	43	9	3



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

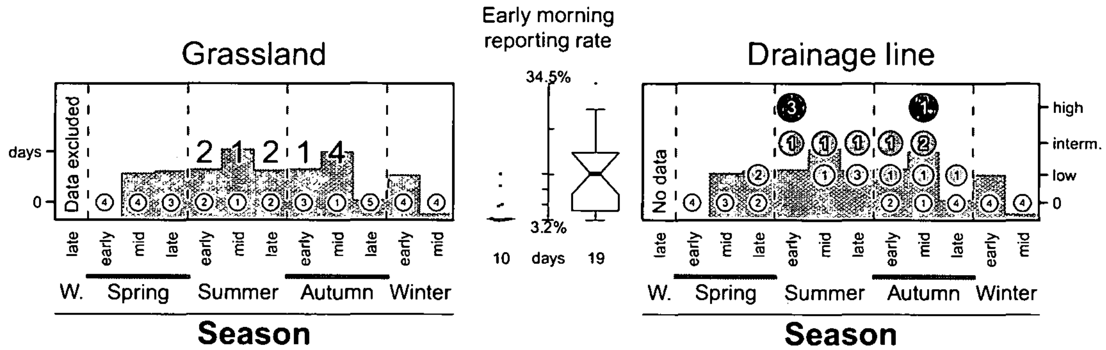


Figure 4.228: R382 Jacobin Cuckoo — birds heard only: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

Annual occurrence of drainage line birds heard in the grassland: Heard on 27.3% of the days with an activity index of five (Table 4.39a). Recorded for 3–6 seasons per year (Fig. 4.229). Daily reporting rates ranged from 0.5 to 20.8% with 95.5% of the values relatively low and median values similar for the respective years (Fig. 4.229). High reporting rate days were limited to 2001/2 with intermediate reporting rate days occurring in 1998/9, 2001/2 and 2007/8 (Fig. 4.229; Fig. 4.230).

Seasonal occurrence of drainage line birds heard in the grassland: The first birds were always recorded during late spring (median date: 28 October; Fig. 4.231; Note: there were no observations made during the arrival period in 2003/4). Departure dates were more variable and ranged from mid-summer (2000/1) to late autumn (1997/8 and 2001/2) (Fig. 4.231).

Vocal records were limited to the period from late spring to mid-autumn, being relatively infrequent during the last season (Fig. 4.229). Daily reporting rates tended to be higher during early summer than during other seasons, particularly mid-autumn which showed generally low values (Fig. 4.229). This concurs with the occurrence of zero record days that were least frequent in early summer, becoming progressively more frequent towards mid-autumn (Fig. 4.230).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity was least frequent before sunrise and after sunset, and otherwise was slightly more frequent in the early morning and late afternoon (Fig. 4.229). The pattern varied seasonally with activity occurring relatively frequently during other parts of the day too, especially during early summer (Fig. 4.232). The two bird-segment combinations occurring during more than 5% bird-days involved single segments S2 and S12, which collectively accounted for 12.3% of all bird-days (Fig. 4.233).

The first activity of the day usually occurred during the course of the morning with median values for most seasons in the first half of the morning (Fig. 4.232). Mid-autumn is an exception as its median time of first activity is near mid-afternoon (Fig. 4.232). The timing of the last activity of the day was generally variable, least during early summer (Fig. 4.232).

Daily segment reporting rates ranged from 5.3 to 53.8% with 89.3% of the values relatively low (Fig. 4.229). Median daily segment reporting rates were similar for the respective segments (Fig. 4.229).

Early morning occurrence of drainage line birds heard during 2007/8: Activity was noted on twice as many mornings in the drainage line than in the grassland (19 vs. 9 bird-mornings) with the activity index only slightly higher in the drainage line (5 vs. 3; Table 4.39b & c). The median early morning reporting rate was also marginally higher in the drainage line (Fig. 4.234). In addition, the last activity of the year was noted in early autumn in the grassland compared to mid-autumn in the drainage line (Fig. 4.234). In the drainage line, the only high reporting rate morning to occur was during late spring (Fig. 4.234). However, it appears that peak activity occurs during mid-summer when no zero record mornings or low reporting rate mornings occurred (Fig. 4.234).

In the drainage line, the timing of the first activity of the day was more variable during late spring and early summer than during other seasons (Fig. 4.234). Activity in the grassland often occurred later than in the drainage line (Fig. 4.234). Activity intensity was slightly higher before than after sunrise on low and intermediate reporting rate mornings, and on high reporting rate mornings it was higher after sunrise (Fig. 4.234).

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Birds seen in the grassland:

Birds were seen in the grassland on 22 days with an activity index of two (Table 4.39a). Not recorded during 2004/5, 2005/6 or 2006/7, and seen during 1–2 seasons in most other years, except 1997/8, 2001/2 and 2007/8 when recorded during 3–4 seasons (Fig. 4.235). Records are limited to late spring, summer and autumn with a distinct peak in occurrence during early autumn (Fig. 4.235). Seen during all segments between sunrise and sunset (Fig. 4.235).

Discussion

The occurrence of Diderick Cuckoo calls during the early mornings in 2007/8 (Table 4.39b & c; Fig. 4.234) suggests that vocal activity measured in the grassland underestimated activity in the drainage line. This is understandable given the distance between the observation point in the grassland and the drainage line where the birds were calling from. The lack of sight records during 2004/5, 2005/6 and 2006/7 (Fig 4.235) concurred with intensive observations on the Eastern Clapper Lark R495. When the cuckoos visited the grassland they were usually silent, and the observer, being preoccupied with the larks, could easily have missed such birds. In short, the data for those 3 years are biased as far as sight only records are concerned.

The narrow window of arrival during late spring (Fig. 4.231) suggests that change in day-length plays an important role in the timing of their migration.

It is interesting to note the seasonal occurrence of birds seen in the grassland, particularly during the years when they were recorded for more than two seasons, *i.e.* 1997/8, 2001/2 and 2007/8 (Fig. 4.235). These were the years with above average rainfall (Fig. 2.13). In 1997/8 early and mid-autumn were very wet seasons (Fig. 2.16), corresponding with the occurrence of the cuckoos in the grassland during the autumn of that year (Fig. 4.235). Similarly, in 2001/2 when late spring and summer represented wet seasons (Fig. 2.16) the cuckoos occurred from late spring (Fig. 4.235). The third year with above average rainfall was 2005/6 (Fig. 2.13), but as explained above, the absence of the cuckoos in the grassland during that year was possibly caused by the observer's preoccupation with larks. The fourth and final year with above average rainfall was 2007/8 (Fig. 2.13). During that year, eight seasons received 58–91 mm rain, starting in mid-spring (Fig. 2.16), with the cuckoos being seen in the grassland in early summer, late summer and early autumn (Fig. 4.235).

Food is the probable reason why the cuckoos visit the grassland at these times. According to Rowan (1983), hairy and smooth caterpillars feature prominently in the diet of these birds. In addition, it was observed at Glen that these prey items emerge in numbers after good rains, and Diderick Cuckoos were seen to eat them in the grassland. Perhaps this also explains the frequent occurrence of these birds in the grassland during early autumn (Fig. 4.235).

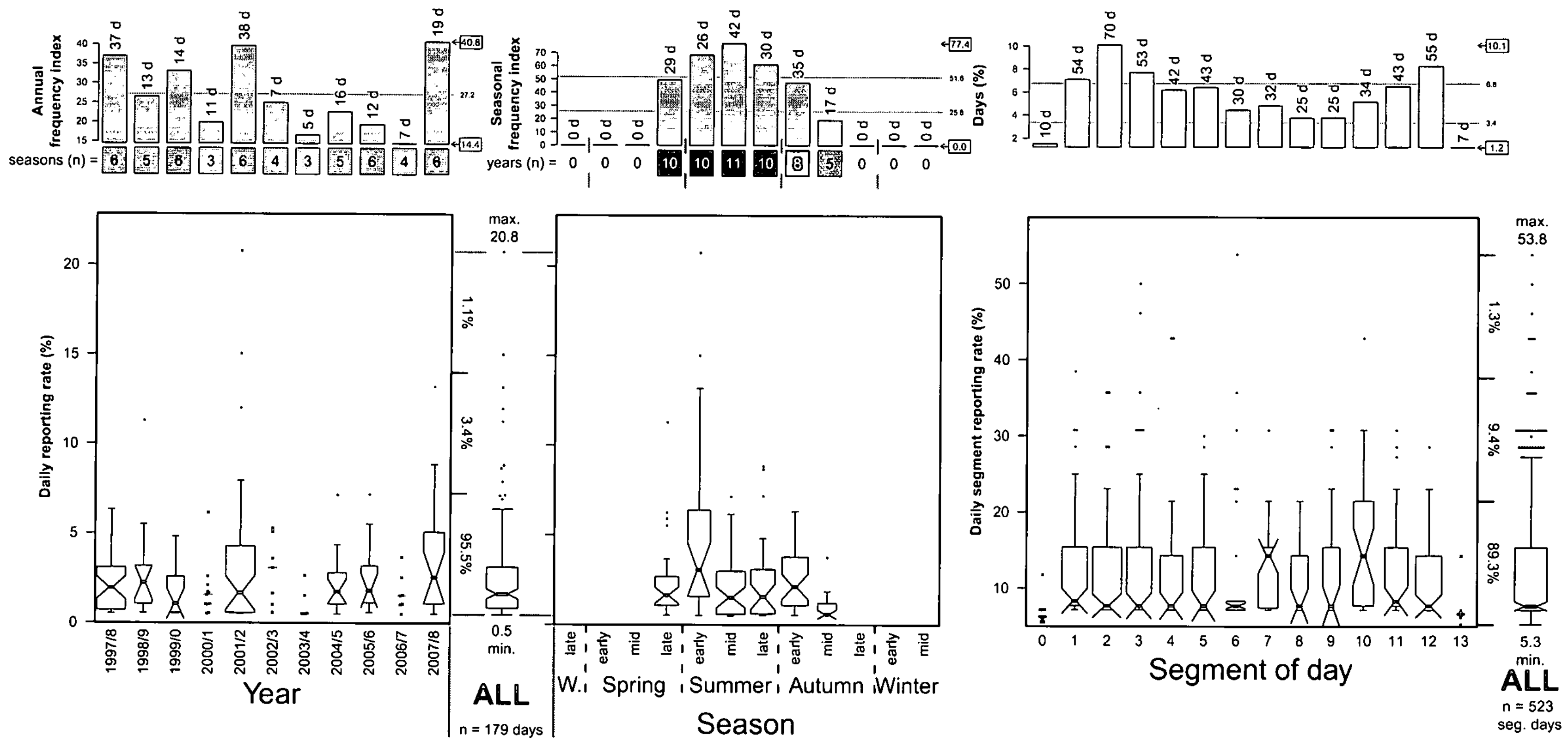


Figure 4.229: R386 Diderick Cuckoo — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

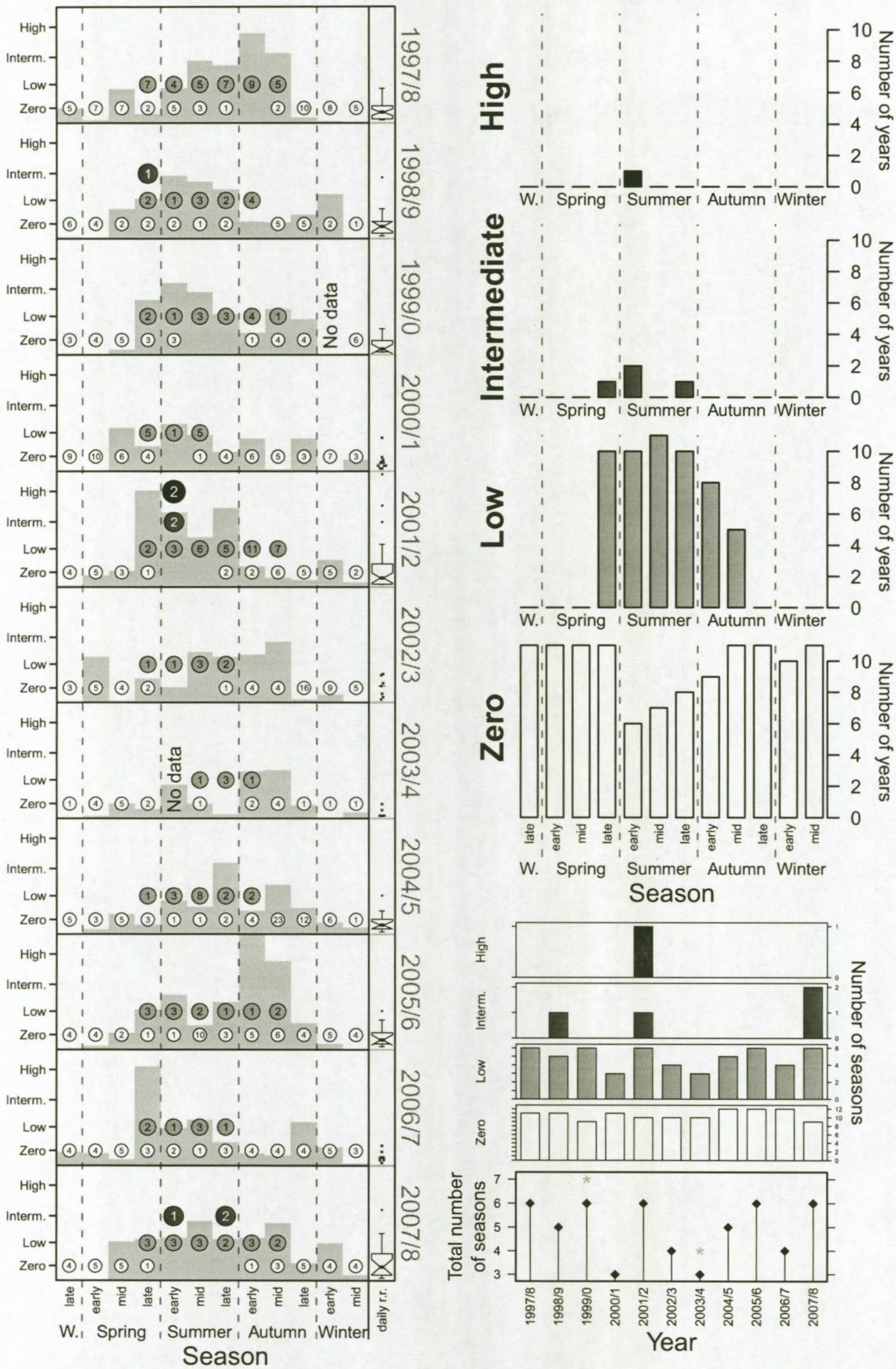


Figure 4.230: R386 Diderick Cuckoo — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

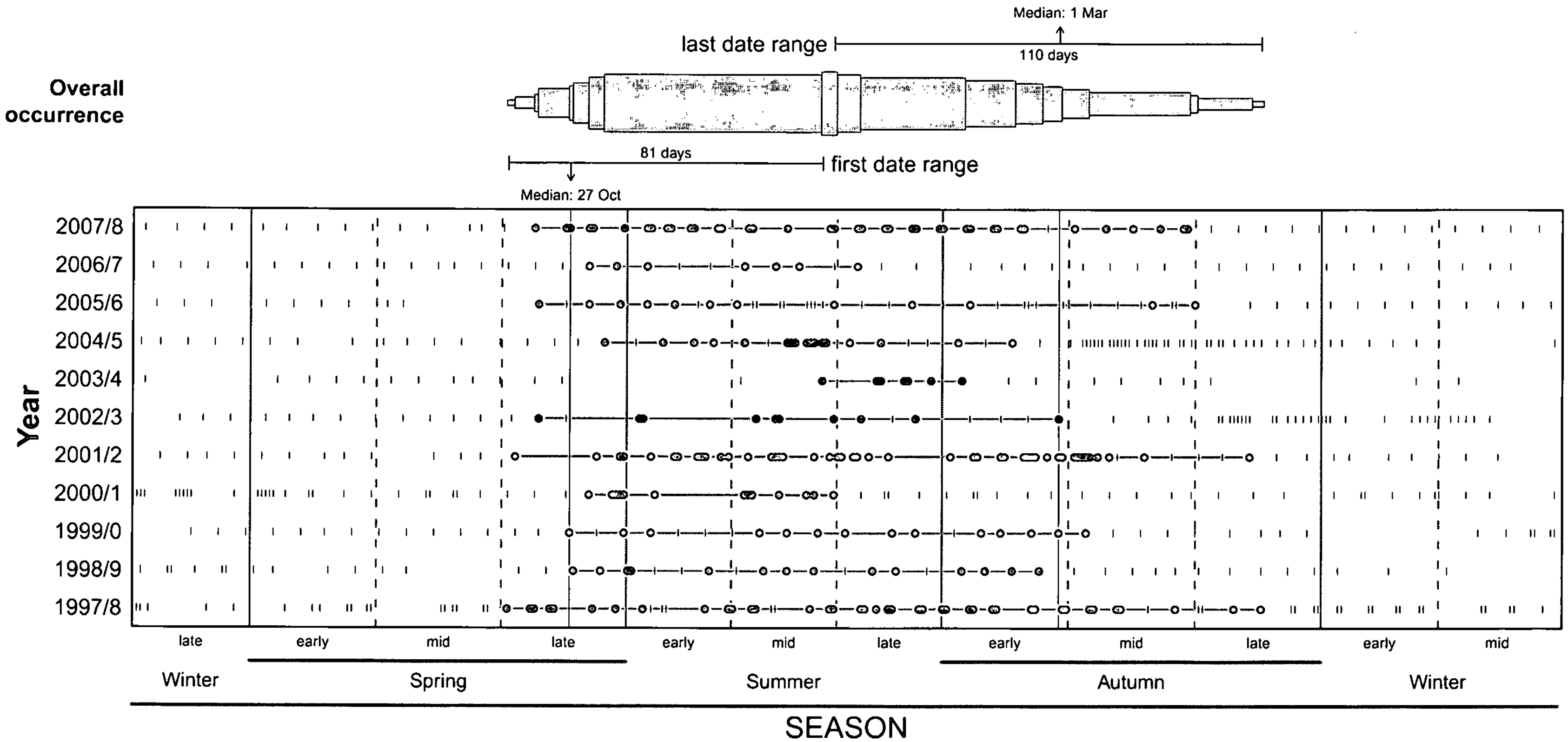


Figure 4.231: R386 Diderick Cuckoo: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

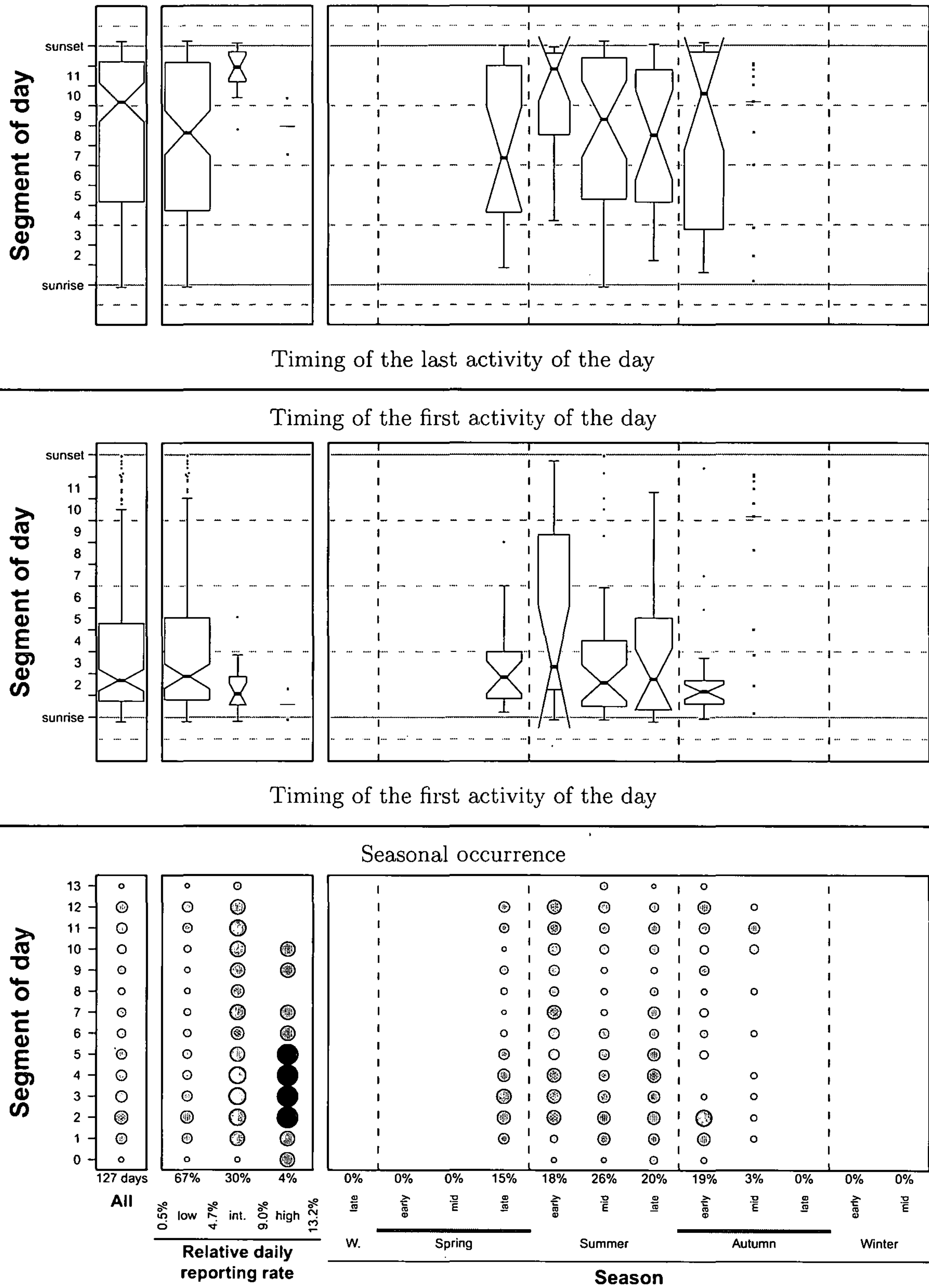


Figure 4.232: R386 Diderick Cuckoo — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

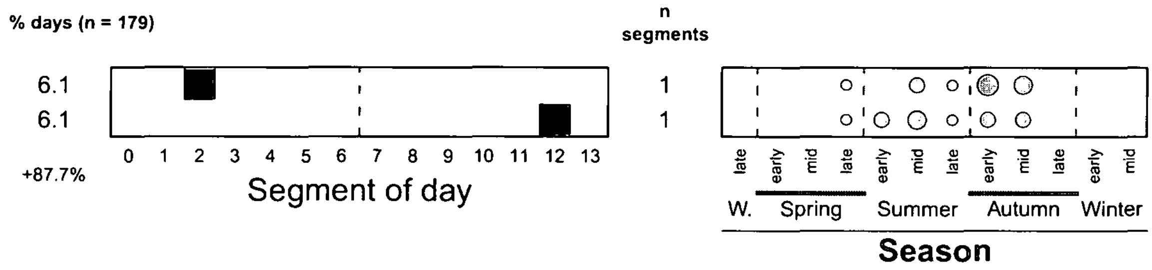


Figure 4.233: R386 Diderick Cuckoo — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

4.29 Centropodidae: Coucals

In coucals the primary feathers are not shed from the innermost to the outermost, but alternately beginning with P9 or P10 (Rowan 1983). The 30 species in this monogeneric family occur in Africa, southern Asia, the Philippines and Australasia with five species occurring in southern Africa (Hockey *et al.* 2005). Only Burchell's Coucal occurs in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a)

R391 Burchell's Coucal .... *Centropus burchellii*

Formerly considered a conspecific of the White-browed Coucal *C. superciliosus* (Rowan 1983), Burchell's Coucal is endemic to southern Africa where it occurs in a narrow band along the coast from the Cape eastwards through Swaziland into the former Transvaal (Herremans & Vernon 1997b). Also common in southern Mozambique (Parker 1999). Localised in the Free State, occurring along the Vaal River, Sand River and in the Bloemfontein area (Earlé & Grobler 1987; Herremans & Vernon 1997b). It inhabits rank and tangled growth, often near water (Rowan 1983). Although it may be overlooked when not calling, paired birds are probably highly sedentary (Rowan 1983).

The birds at Glen

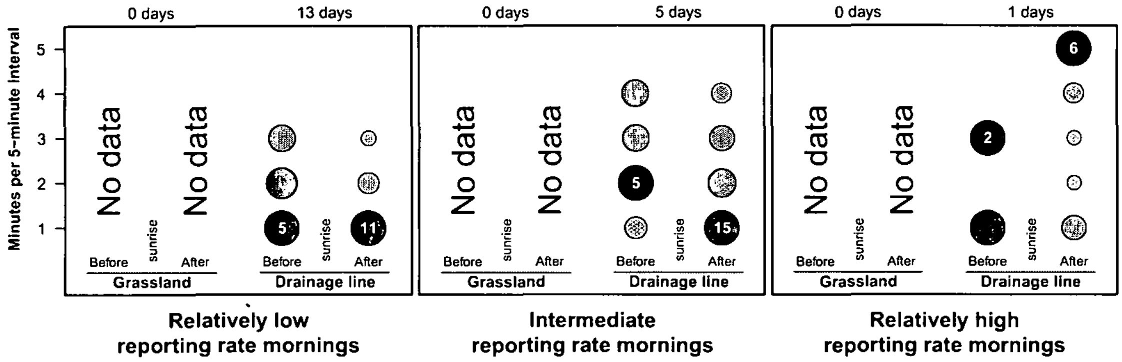
Burchell's Coucal was heard calling in the drainage line on two days: early summer 2001/2 (S1) and mid-autumn 2005/6 (S0). In addition, it was once seen during a transect in the drainage line in late winter 2002/3.

Discussion

The occurrence of vocalisations at Glen coincided with high rainfall years.

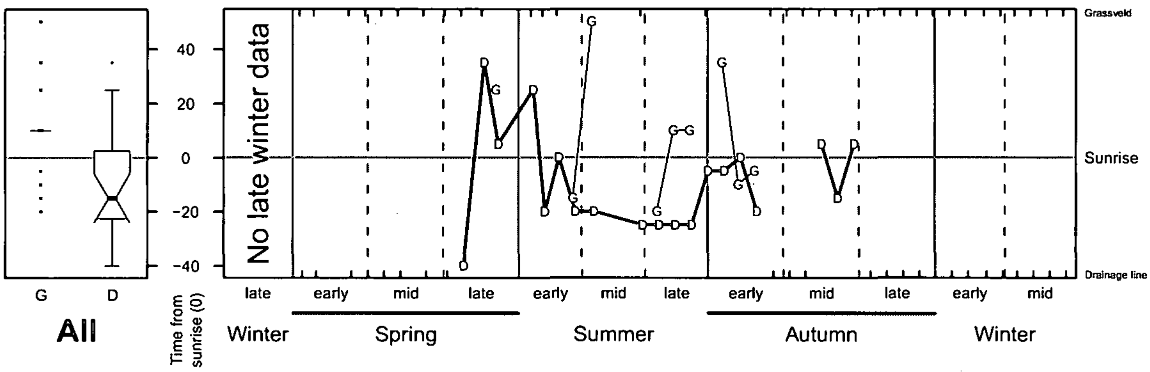
4.30 Tytonidae: Barns Owls, Grass Owls

Although most of the 18 species occur in Australasia, they have a virtually worldwide distribution, with two species occurring in southern Africa (Hockey *et al.* 2005). Both species occur in the Free State with the Barn Owl R392 being much more common than the African Grass



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

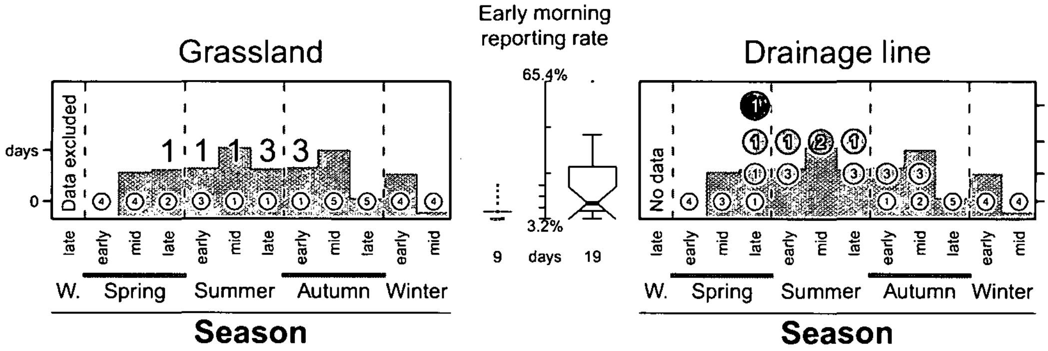


Figure 4.234: R386 Diderick Cuckoo — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

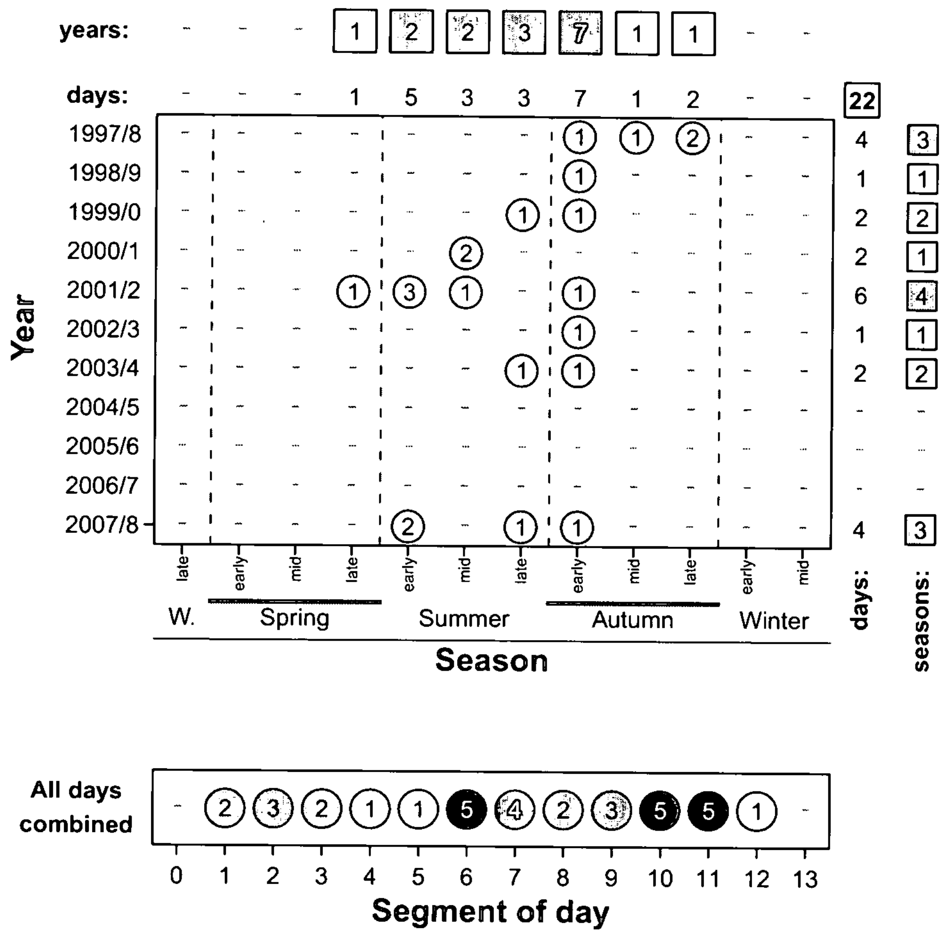


Figure 4.235: R386 Diderick Cuckoo — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Owl *Tyto capensis* (Earlé & Grobler 1987; Harrison *et al.* 1997a). Only the former species was recorded at Glen.

R392 Barn Owl .... *Tyto alba*

The Barn Owl has an almost cosmopolitan distribution (Taylor 1994), and is widespread in southern Africa (Mendelsohn 1997f; Steyn 1982). It occurs in a wide variety of habitats, but always near suitable roosting and nesting sites (Steyn 1982). Apparently resident and sedentary as long as food supplies hold (Mendelsohn 1997f; Steyn 1982).

The birds at Glen

It is known that the Barn Owl roosts in the drainage line.

All except one of the records were of birds heard. Recorded on 33 days and in nine of the 11 years (Fig. 4.236). Recorded during 1–2 seasons in most years, but during 4–5 seasons in 2000/1, 2001/2 and 2005/6 (Fig. 4.236). Activity was noted during all seasons except mid-winter, with no clear seasonal pattern (Fig. 4.236). Activity was restricted to the time (not later than 40 minutes) before sunrise and (no earlier than 30 minutes) after sunset (Fig. 4.236), and was only once recorded on the same day during the morning and the evening.

Discussion

The lack of records during 1997/8 (Fig. 4.236) can easily be explained by the fact that observations during that year started too late in the morning and ended too early in the evening to detect the presence of this nocturnal species. The dearth of records in 2003/4 is probably due to the relatively few observation days during that year (Fig. 3.6). The chance of hearing the owls is not very great and in some years with about 50 such days it was recorded only once. This complicates the interpretation of the data in general.

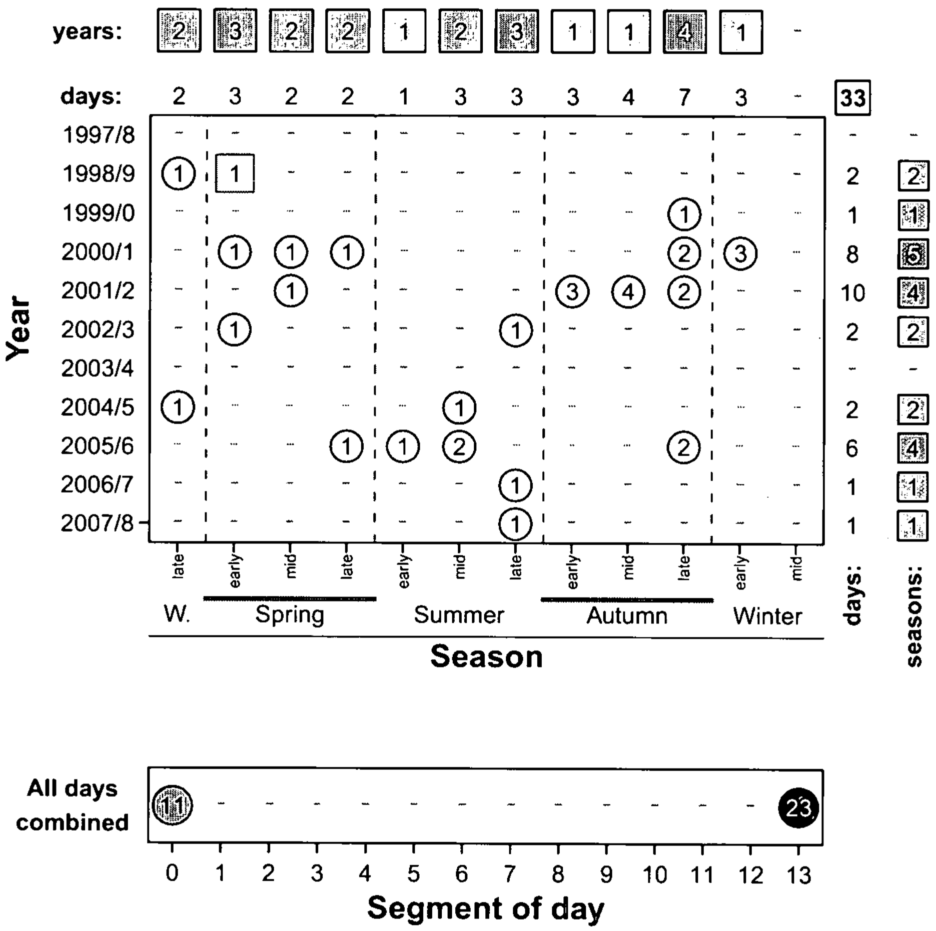


Figure 4.236: R392 Barn Owl — all displays: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

4.31 Strigidae: Typical Owls

The 182 typical owl species occurs worldwide with ten species occurring in southern Africa (Hockey *et al.* 2005). Six species occur in the Free State of which only the Marsh Owl R395 and Spotted Eagle-Owl R401 are widespread (Earlé & Grobler 1987; Harrison *et al.* 1997a). Only the latter two species were recorded at Glen.

R395 Marsh Owl .... *Asio capensis*

The Marsh Owl occurs in sub-Saharan Africa with isolated populations also in Morocco and Madagascar (Steyn 1982). It has a fragmented distribution in southern Africa, being recorded from isolated areas in Namibia, Botswana and Zimbabwe, with the largest concentrations found in South Africa where the central, northern and eastern parts of the Free State form part of its core distribution (Mendelsohn 1997g). The study area is close to the south-western limit of its South African range. It prefers grassland with tall grass, often near water (Steyn 1982). Movements are difficult to assess (Mendelsohn 1997g), but habitat destruction by fire and other causes no doubt cause a degree of nomadism (Steyn 1982).

The birds at Glen

The records are almost equally split between sight and sound records, with all the data pooled for the analysis, which is based on a year starting in late summer.

Recorded on a total of 42 days with no activity noted during 2004 (Fig. 4.237). In the remaining years it was mostly recorded for 1–3 seasons per year, but during 4–6 seasons in 1998, 2002 and 2003 (Fig. 4.237). Records limited to the period from mid-summer to early spring, being particularly frequent in early winter (Fig. 4.237). Activity was mostly restricted to the time before sunrise and after sunset, being recorded outside this period on three days only (Fig. 4.237). Ignoring these latter three days, the last activity before sunrise occurred 30 minutes before sunrise. This is in contrast to activity after sunset which was not too infrequent within the first 30 minutes after sunset.

Discussion

It is obvious from Figure 4.237 that the occurrence of the Marsh Owl at Glen is a seasonal phenomenon. It recalls the fluctuations in SABAP1 Zone 7 reporting rates illustrated in Mendelsohn (1997g), which show a well-defined seasonal pattern with a peak from about May to July [winter] and a low from about November to February [summer and early autumn]. With no complimentary patterns in other SABAP1 zones, Mendelsohn (1997g) ruled out migration to or from other areas within southern Africa and suggested two "equally plausible" explanations: 1) "movements into this part of southern Africa from outside the region or from Mozambique"; 2) "reporting rates reflect changes in crepuscular activity." (Mendelsohn 1997g).

As for his first suggestion, it is unlikely that the birds come from Mozambique where they are very rare and the few records limited to July and October (Parker 1999). However, Kemp (2005b) cited Smalley (1983) and noted that the Marsh Owl is a suspected intra-African migrant further north in Africa.

As support for his second explanation, Mendelsohn (1997g) noted that "Marsh Owls often hunt at dusk, or even during daylight, when they are much more likely to be seen and reported than at night." He then referred to his own observations on the Springbok Flats where the owls "appeared to hunt more often during daylight in the winter than at other times," implying

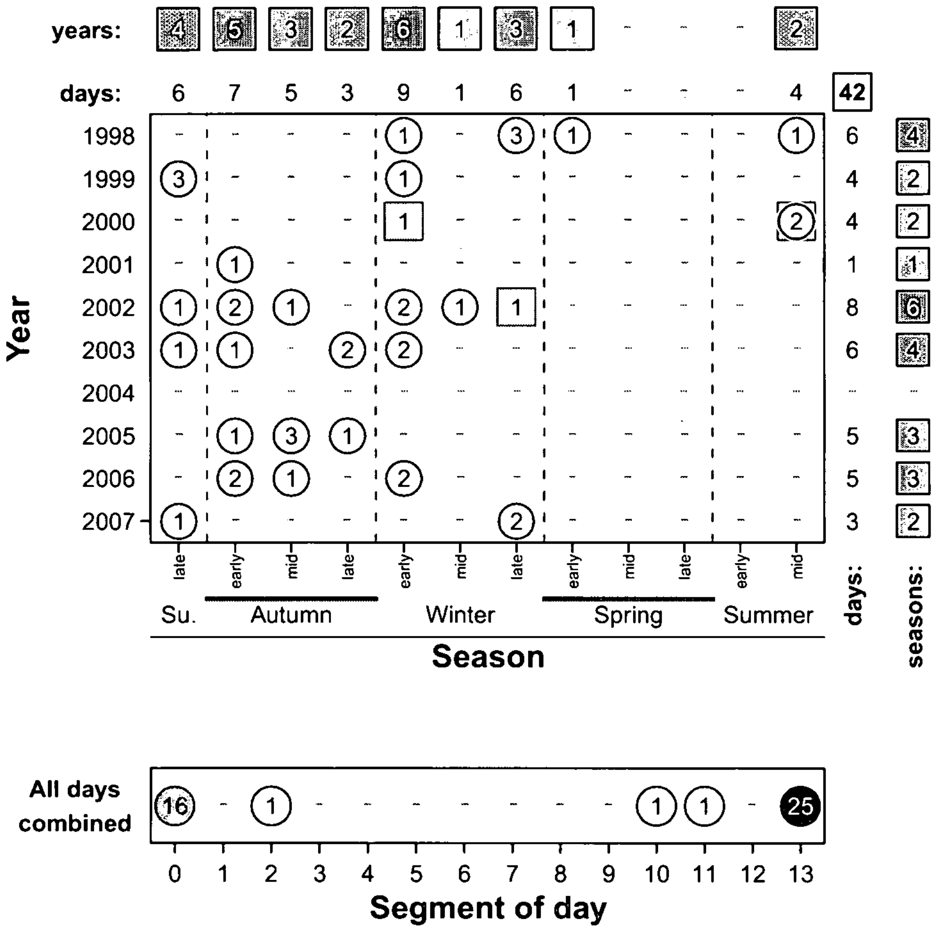


Figure 4.237: R395 Marsh Owl — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

that during other seasons the owls were seen less often. Importantly, Mendelsohn (1997g) gave no additional information as to indicate that the actual density of the owls remained constant throughout the year. As it stands, therefore, he simply indicated that he saw the owls more often during winter. In other words, his observations merely *confirms* the SABAP1 Zone 7 reporting rate pattern, it does not *explain* it. Kemp (2005b) was, therefore, mistaken when he cited, with approval, Mendelsohn's (1997g) idea of "diurnal recordability" as having anything to do with the difficulty to distinguish regional movements from local fluctuations.

To his credit, Mendelsohn (1997g) noted an obvious problem with his idea: "This, however, begs the question as to why the same pattern is not apparent in the other Zones." "Perhaps," Mendelsohn (1997g) suggested, "their prey have more diurnal movements in winter and this is peculiar to the central South African plateau." It is suggested, instead, that a more consistent explanation would be that the SABAP1 Zone 7 reporting rates represent real changes in abundance, indicative of migration of some sort. The observations at Glen (Fig. 4.237) would also be consistent with such a conclusion.

Did rainfall affect the owls at Glen? Fluctuations in Marsh Owl "numbers in response to droughts and pluvials have been observed in Zimbabwe" (Mendelsohn 1997g). At Glen, the birds were more common in certain years than in others (Fig. 4.237), and the data suggest that rainfall played a role in this. The mechanism by which this could occur is with high rainfall leading to improved habitat (tall grass) and presumably also prey increase — the prey of Marsh Owls consist mainly of small rodents and birds (Kemp 2005b; Steyn 1982).

Recall that the four years with above average rainfall at Glen were 1997/8, 2001/2, 2005/6 and 2007/8 (Fig. 2.13). In 1998 (Fig. 4.237) the owls were recorded after the end of the 1997/8 main rain period. Note, however, that most of the observations during the first half of 1998 commenced too late in the morning and terminated too early in the afternoon to enable detection of these owls. This methodological issue was resolved towards the end of 1997/8, *i.e.* towards the middle of 1998, hence the observations in early winter 1998 (Fig. 4.237). Note also that the records in late winter and early spring 1998 (Fig. 4.237) could represent an 'overflow' of 1997/8 activity. If true, it would suggest that activity was also high during 1997. Nevertheless, activity was much more concentrated in 2002 and 2003 with only one extra season splitting the bird-seasons in two periods in both years (Fig. 4.237).

No birds were recorded during 2004 (Fig. 4.237). In addition to being at the end of the driest year of the study (2003/4; Fig. 2.13), it was also a year with relatively few observation days (Fig. 3.6). In the following year, 2005, the birds were recorded once again in all three autumn seasons (Fig. 4.237) following good rains in late summer (109 mm; Fig. 2.16). The birds appeared again in early autumn of the next year, 2006 (Fig. 4.237), which was towards the end of the 2005/6 main rain period with more than 300 mm of rain falling in early and mid-autumn 2006 (Fig. 2.16). The birds were seen only sporadically subsequent to 2006 (Fig. 4.237). The relative infrequent occurrence during 2007 (Fig. 4.237) could be due to the rather unusual occurrence of the rain in that year with eight seasons receiving 58–91 mm rain per year (Fig. 2.16). Presumably this spread of rain was not conducive to stimulate prey fertility or suitable habitat.

R401 Spotted Eagle-Owl . . . . *Bubo africanus*

The Spotted Eagle-Owl is endemic to Africa south of the equator, being replaced north of the equator by the Vermiculated Eagle-Owl *B. cinerascens* (Kemp 2005a; Sinclair & Ryan 2003). It is the most widespread owl in southern Africa, having been recorded virtually throughout the region and occurring in a wide variety of habitats (Mendelsohn 1997h). Generally considered to be resident, but capable of exploiting areas with rodent plagues (Mendelsohn 1997h; Steyn 1982).

The birds at Glen

In the grassland, where recorded on ten days in total, Spotted Eagle-Owl records mostly refer to birds calling in the drainage line; seen in the grassland only once. Recorded every second year since 2001/2, with most of the records during 2001/2 and 2007/8 (Fig. 4.238). Only recorded from mid-spring to early autumn with most of the records in the early morning more than 35 minutes before sunrise, otherwise more than 20 minutes after sunset (Fig. 4.238).

During the early morning observations in the drainage line in 2007/8, birds were heard calling on four mornings, *i.e.* in mid-spring, late spring and early summer (n = 2 mornings). In addition, a Spotted Eagle-Owl was flushed during transects in the drainage line on two days: early autumn 2000/1 and early spring 2001/2.

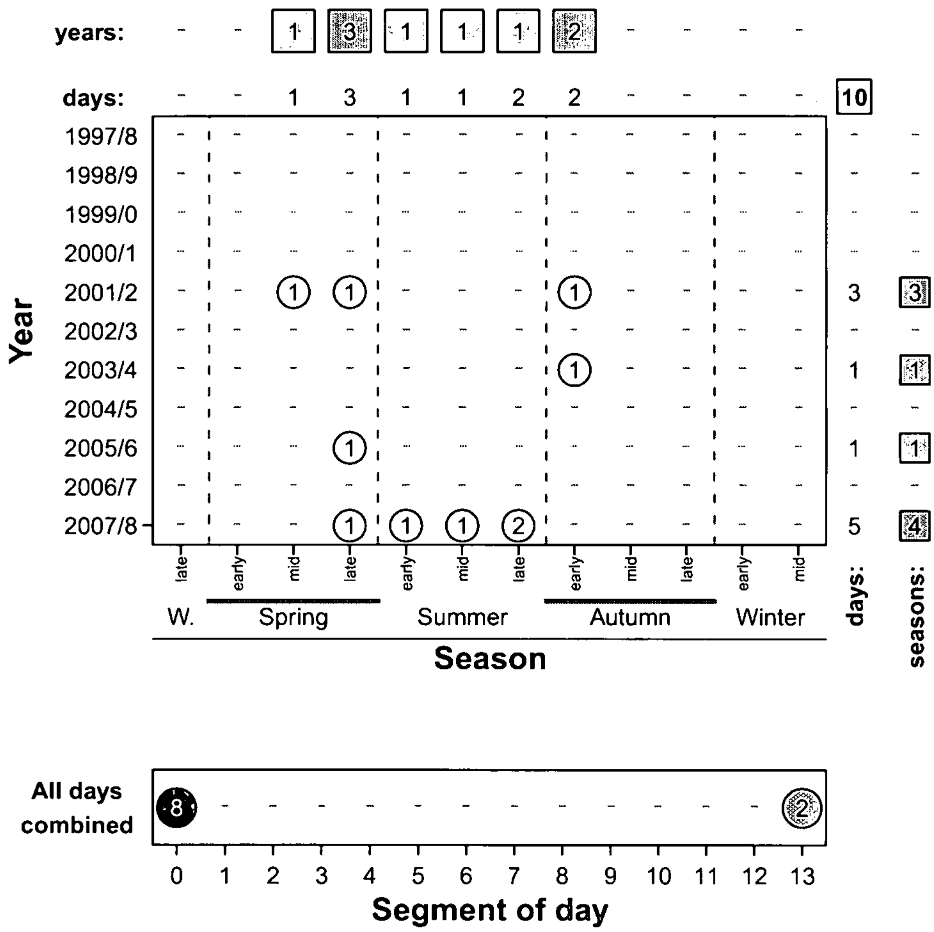


Figure 4.238: R401 Spotted Eagle-Owl — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Discussion

Spotted Eagle-Owls emerge from their roost at dusk (Steyn 1982). The male and female often engage in duetting, with the resulting vocalisations sounding like a single call (Steyn 1982). Both sexes may call throughout the night, with the male's peak calling times at dusk and dawn, and those of the female between 1h00 and 2h00 and at dawn (Steyn 1982). Although no distinction was made between the calls of the sexes at Glen, activity occurred most frequently at dawn (Fig. 4.238).

The two years when activity was noted during more than one season, 2001/2 and 2007/8 (Fig. 4.238), also involved years with above average rainfall (Fig. 2.13). However, the pattern of occurrence during these two years was fundamentally different, with the observations in 2001/2 interrupted by no records during summer in contrast to the situation in 2007/8 when the birds were recorded in late spring and throughout summer (Fig. 4.238). Furthermore, activity occurred relatively frequently in late spring (Fig. 4.238). These patterns may be related to breeding since egg-laying occur from August to October [spring] in South Africa (Kemp 2005a; Steyn 1982; Tarboton 2001).

4.32 Caprimulgidae: Nightjars

Nightjars are crepuscular and nocturnal aerial insectivores. The 76 species occur worldwide except in New Zealand and oceanic islands with seven species occurring in southern Africa (Hockey *et al.* 2005). Of the four species occurring in the Free State, the Rufous-cheeked Nightjar R406 is by far the most common (Harrison *et al.* 1997a), and also the only species recorded at Glen.

R406 Rufous-cheeked Nightjar .... *Caprimulgus rufigena*

The Rufous-cheeked Nightjar is endemic to sub-Saharan Africa (Fry & Harwin 1988). In southern Africa it is widespread in Namibia, Botswana, Zimbabwe and in South Africa where absent from the east (Maclean 1997i). In the Free State it is largely confined to the central and western parts of the province (Maclean 1997i). Usually associated with trees and bushes, even in otherwise open grassland (Maclean 1997i). It is an intra-African migrant that breeds in southern Africa where it is present in SABAP1 Zone 7 from September to the beginning of April [early spring to mid-autumn] (Maclean 1997i).

The birds at Glen

Rufous-cheeked Nightjar records in the grassland refer mainly (97.1%; Table 4.40a) to birds calling from within the drainage line. The remaining records were of birds seen in the grassland, usually foraging or drinking water from the zinc dam on the wing. Because observations during 1997/8 were largely limited to the period between sunrise and sunset, *i.e.* it did not encompass part of the activity period of these nocturnal birds, the data for that year is excluded from the analysis. Activity was recorded separately for each minute since 2001/2 (Table 4.41). Figures start on page 461.

Annual occurrence in the grassland of calling drainage line birds: Heard on 31.1% of the days with an activity index of eight (Table 4.40a). Recorded during 6–7 seasons each year (Fig. 4.239; Fig: 4.240). Daily reporting rates ranged from 0.5 to 12.1% with 54.9% of the bird-days attaining relatively low values and median daily reporting rates similar for all years (Fig. 4.239). Activity intensity was similar for all years in which it was measured (Fig. 4.239).

Seasonal occurrence in the grassland of calling drainage line birds: Arrival and departure is well synchronised with the first birds usually recorded at the beginning of mid-spring (median date: 13 September) and the last birds in mid-autumn (median date: 27 March; Fig. 4.241). Overall, activity was recorded during spring, summer and autumn, with a distinct peak from mid-spring to mid-summer; records in early spring and late autumn were rare (Fig. 4.239; Fig. 4.240).

Table 4.40: R406 Rufous-cheeked Nightjar: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.971	1 599	114 612	1.4	birds heard	31.1	656	204	8
0.029	48	114 612	0.0	birds seen	5.8	656	38	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.992	119	1 190	10.0	birds heard	37.2	43	16	7
0.008	1	1 190	0.1	birds seen	2.3	43	1	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.986	68	1 188	5.7	birds heard	30.2	43	13	5
0.014	1	1 188	0.1	birds seen	2.3	43	1	1

Table 4.41: R406 Rufous-cheeked Nightjar: Numerical data summary of 1-minute checklists compiled in the study area at Glen.

Activity	Recorded since...	n	Total	%
birds heard	late winter 2001/2	3 477	345 105	1.0

Daily occurrence in the grassland of calling drainage line birds: Activity was basically limited to the time before sunrise and after sunset; only on rare occasion did it occurs in the late afternoon before sunset (Fig. 4.239; Fig. 4.242; Fig. 4.243). Whereas activity peaked in the early morning as well as evening in mid-spring, late spring and summer, it peaked only after sunset during early spring and autumn (Fig. 4.243). Activity was recorded both before sunrise and after sunset on more than half of all bird-days, predominantly from mid-spring to mid-summer (Fig. 4.244). On 21.6% bird-days activity occurred after sunset only, least frequently during summer (Fig. 4.244). The incidence of activity recorded before sunset only (19.6% bird-days) occurred mainly during mid- and late summer (Fig. 4.244).

The first activity of the day typically occurred more than 30 minutes before sunrise, but on low reporting rate days it often occurred after sunset too (Fig. 4.243; Fig. 4.245). Seasonally, activity typically occurred long before sunrise during mid-spring, late spring and summer, but only after sunset in early spring and autumn (Fig. 4.243; Fig. 4.245). This trend is reflected by the dawn chorus sequence (Fig. 4.245).

The last activity of the day typically occurred more than 30 minutes after sunset, except on low reporting rate days when it often occurred before sunrise too (Fig. 4.243; Fig. 4.245). The median time for the last activity of the day was sightly later from mid-spring to mid-summer than during the other seasons (Fig. 4.243; Fig. 4.245).

Activity intensity becomes progressively higher from low to high reporting rate days (Fig. 4.242).

Overall, daily segment reporting rates ranged from 5.6 to 92.3% with only half of the values relatively low, and median values similar for S0 and S13 (Fig. 4.239). The only difference between low, intermediate and high reporting rate days is the increase in absolute values of the daily segment reporting rates (Fig. 4.242).

Early morning occurrence of calling drainage line birds during 2007/8: Activity was slightly more frequent in the drainage line than in the grassland (Table 4.40b & c), with the median early morning reporting rate also higher in the drainage line (Fig. 4.246). The overall seasonal pattern appears to be similar for the two habitats with high reporting rate days occurring in mid- and late spring and early summer (Fig. 4.246). However, activity was recorded until early autumn in the drainage line compared to the grassland where it ceased during late summer (Fig. 4.246). In both habitats the first activity of the day was recorded 45 minutes or more before sunrise (Fig. 4.246). Activity intensities were comparable between the two habitats (Fig. 4.246).

Birds seen in the grassland: Seen on 5.8% of the days with an activity index of one (Table 4.40a). Not recorded in 2002/3 but recorded during 1–3 seasons in most other years, the exceptions being 2004/5 and 2007/8 when recorded during five and four seasons respectively (Fig. 4.247). Seasonally, activity was recorded from mid-spring to late autumn with two fairly well-defined peaks centred on late spring and mid-autumn, respectively (Fig. 4.247). Activity was limited to the time before sunrise and after sunset, being particularly frequent after sunset (Fig. 4.247). Activity during S0 was limited to early and mid-autumn while activity during S13 always occurred between 15 and 45 minutes after sunset.

Discussion

The data collected in the grassland underestimated Rufous-cheeked Nightjar activity occurring in the drainage line slightly (Table 4.40b & c; Fig. 4.246). This is to be expected given the distance between the calling birds in the drainage line and the observer in the grassland. Nonetheless, Figure 4.246 suggests that the overall patterns — in the mornings at least — are very similar between the two habitats. It is assumed, therefore, that the data collected in the grassland offers a reasonably accurate picture of the activity of these birds.

According to Tarboton (2001), egg-laying occurs from August to January [spring & summer] with a peak from September to November [early/mid-spring to early summer]. The nightjars breed in the drainage line at Glen. Although no nests have been found to date (no specific effort was made to do so), the common occurrence of the highly distinctive song of the males and the presence of young birds in the dirt road later in the season are good evidence of breeding. In addition, a bird laid an egg while being ringed during mid-spring. It is thus likely that the high level of activity at their presumed arrival in mid-spring (approximately September) (Fig. 4.239; Fig. 4.240) is linked to breeding.

The extremely narrow window during which displays usually start in the beginning of mid-spring, as well as the narrow window of their departure in mid-autumn (Fig. 4.241), indicate that the timing of migration (and breeding) are tightly controlled by changes in day-length. It is likely that the peak in birds seen in the grassland after sunset during mid-autumn (Fig. 4.247) represent birds departing for their non-breeding grounds.

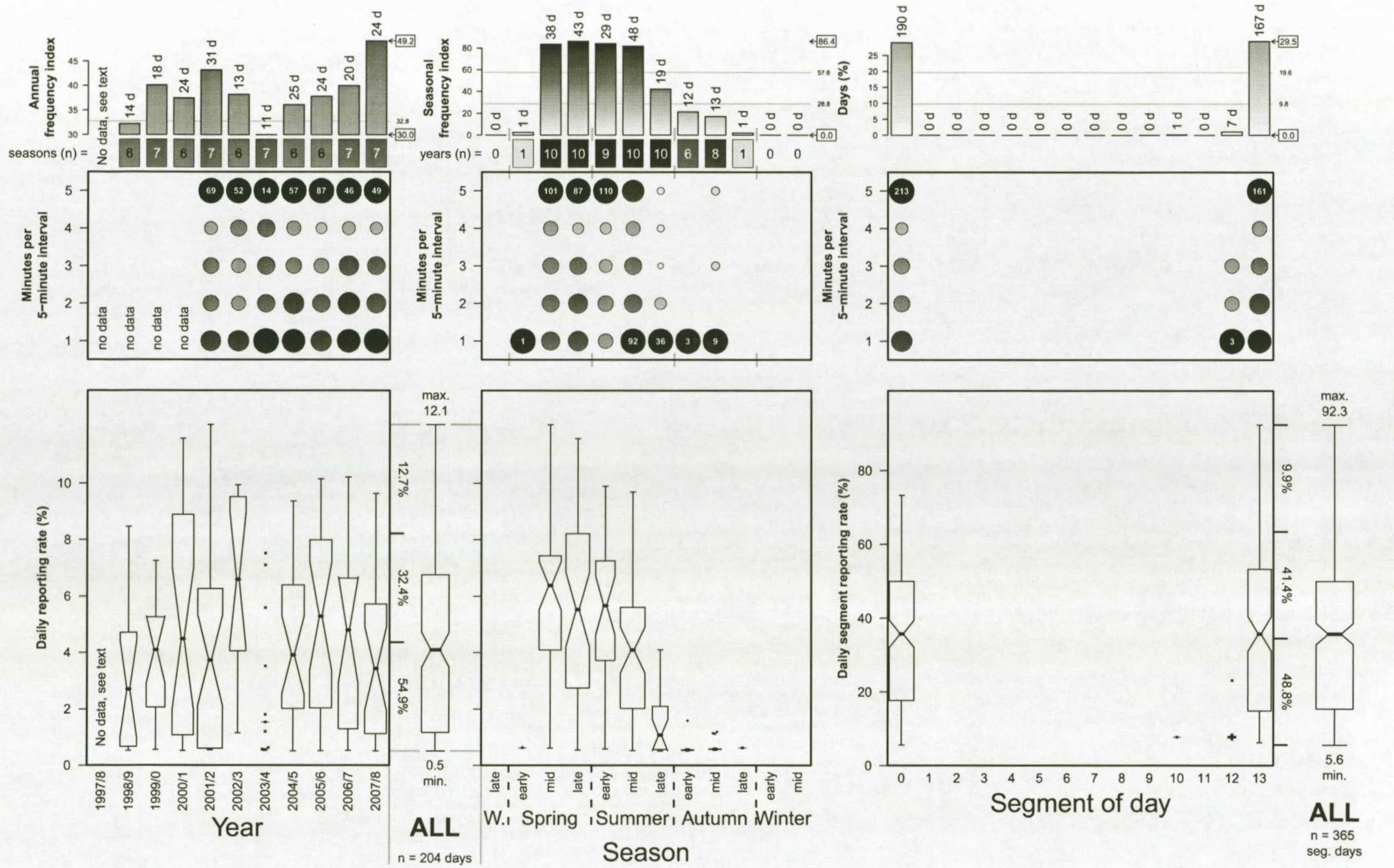


Figure 4.239: R406 Rufous-cheeked Nightjar — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

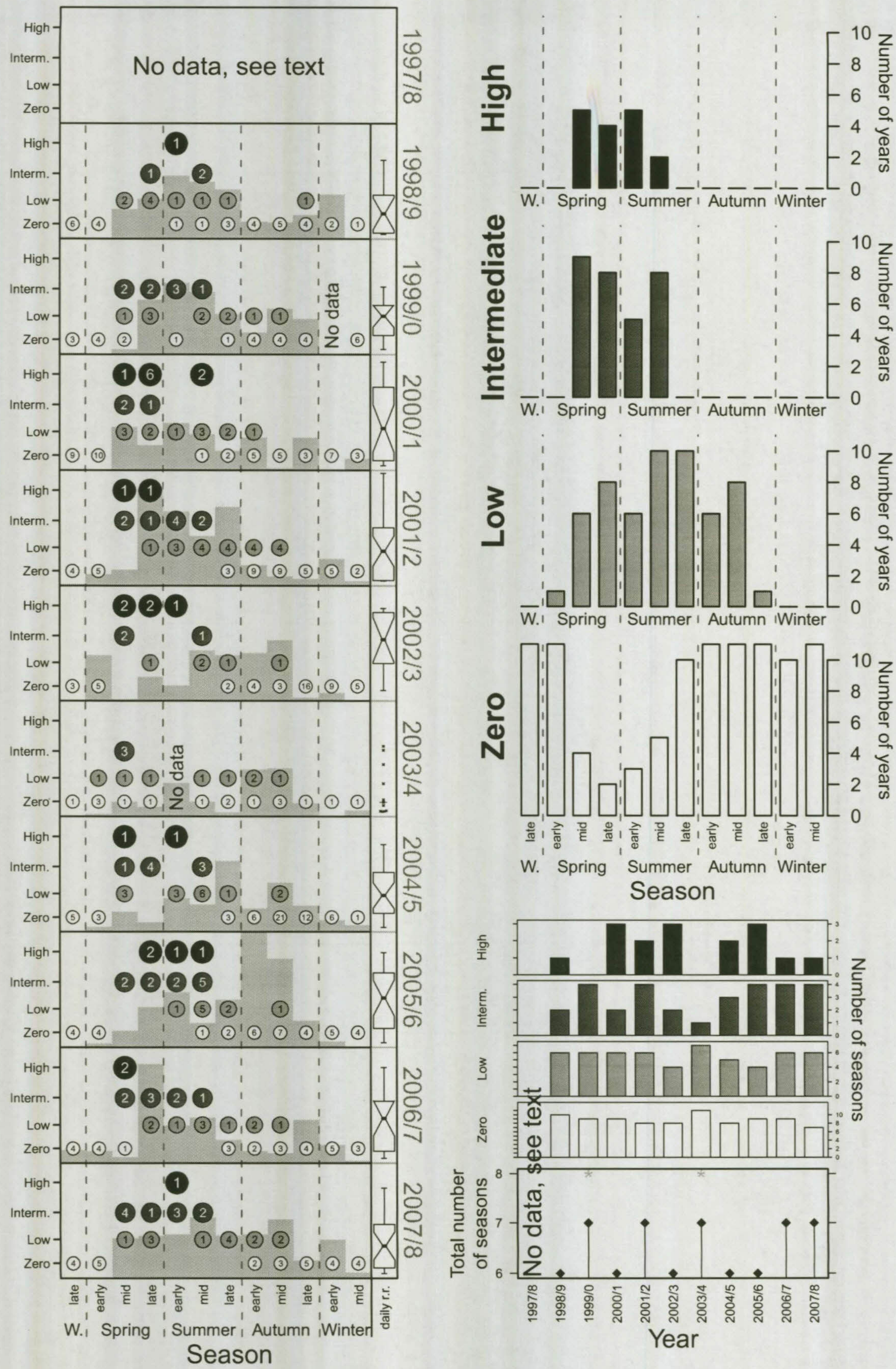


Figure 4.240: R406 Rufous-cheeked Nightjar — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

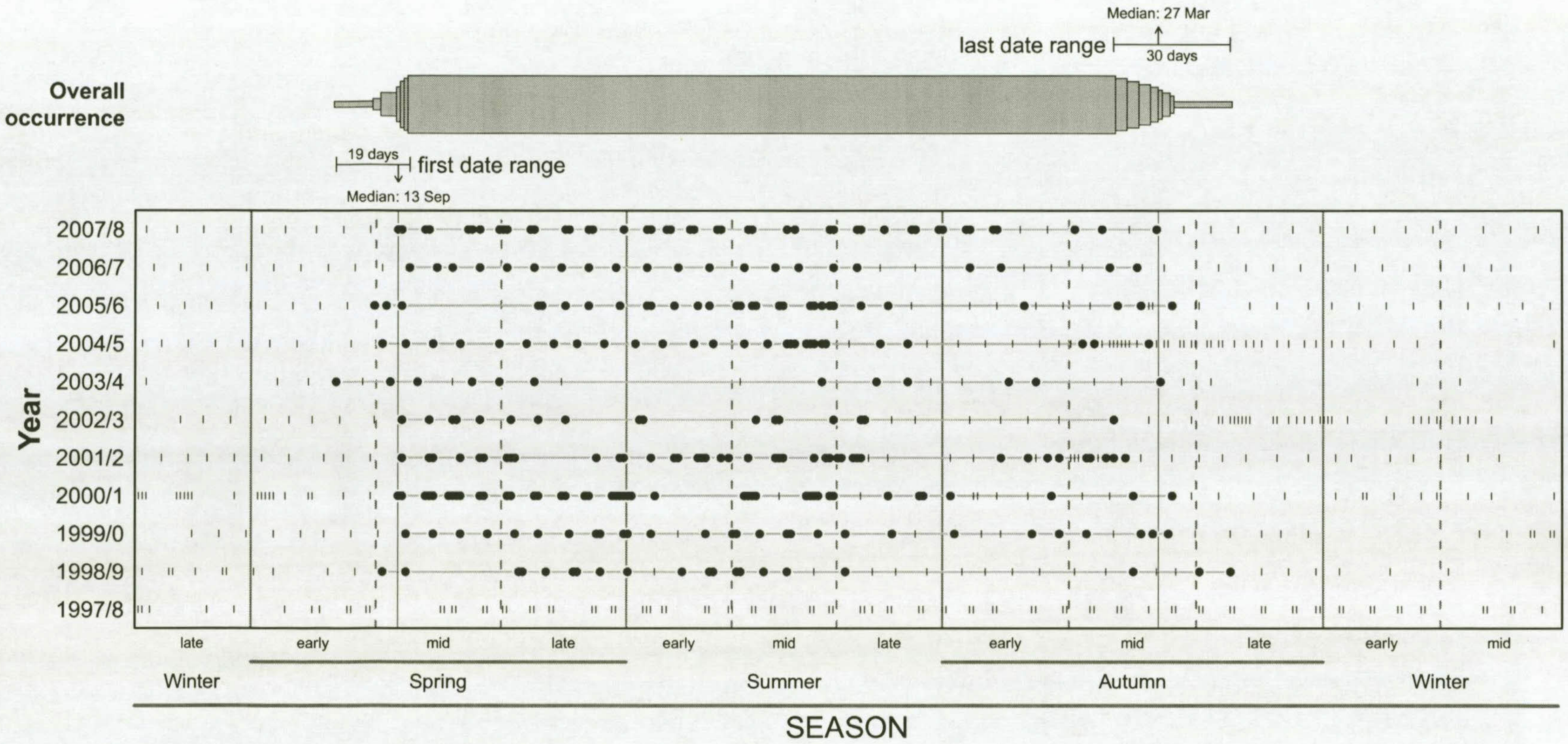


Figure 4.241: R406 Rufous-cheeked Nightjar: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

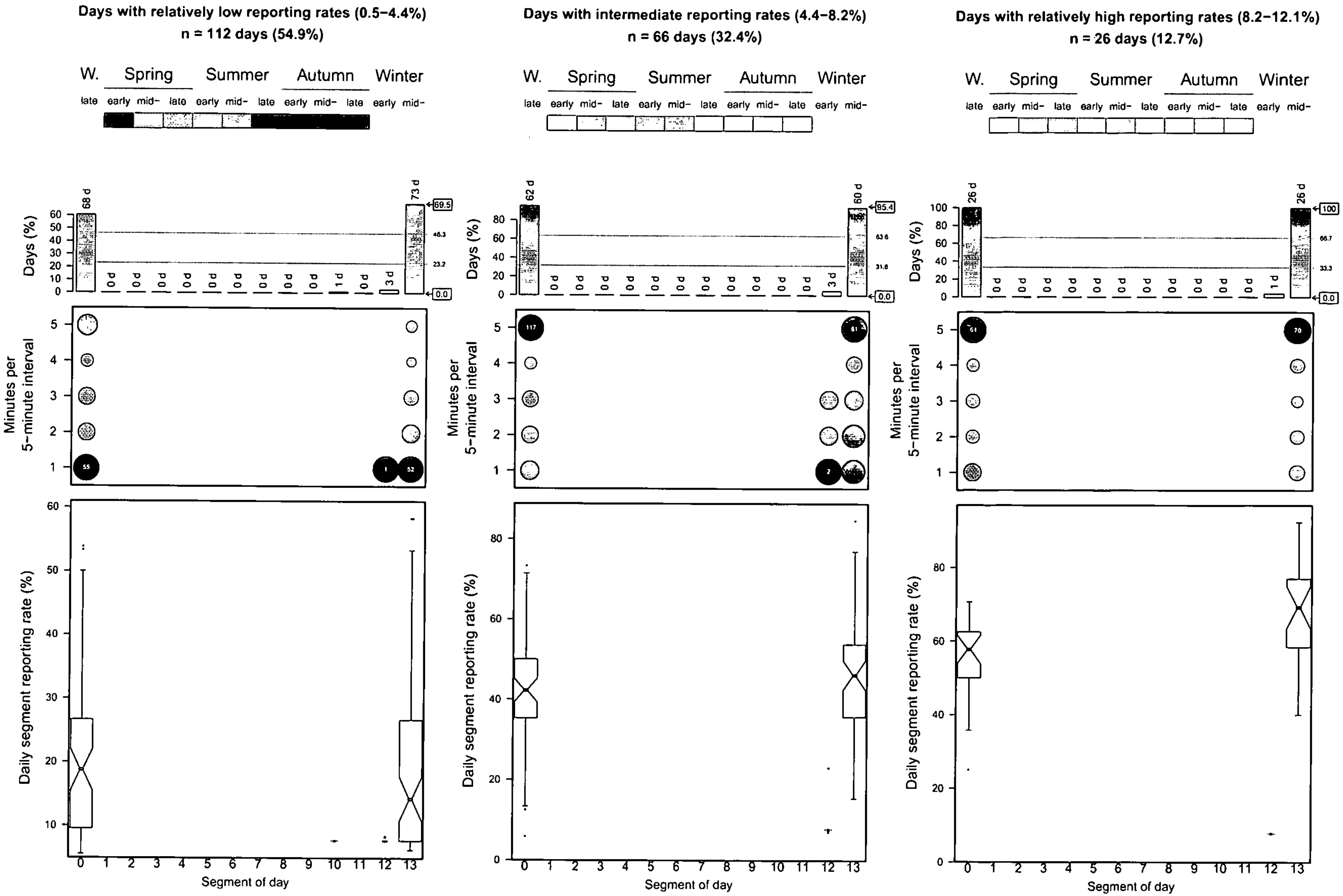


Figure 4.242: R406 Rufous-cheeked Nightjar — birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

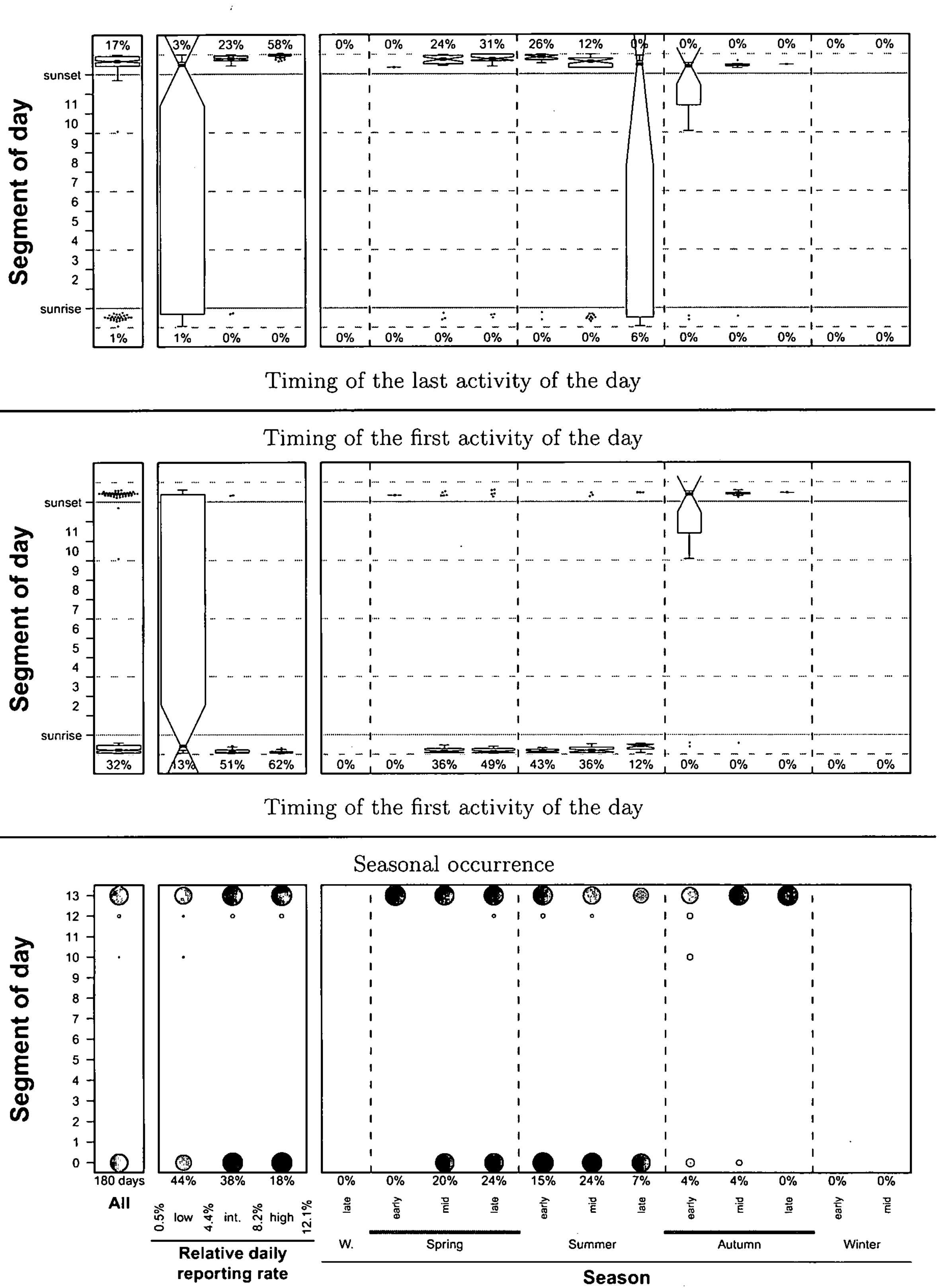


Figure 4.243: R406 Rufous-cheeked Nightjar — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

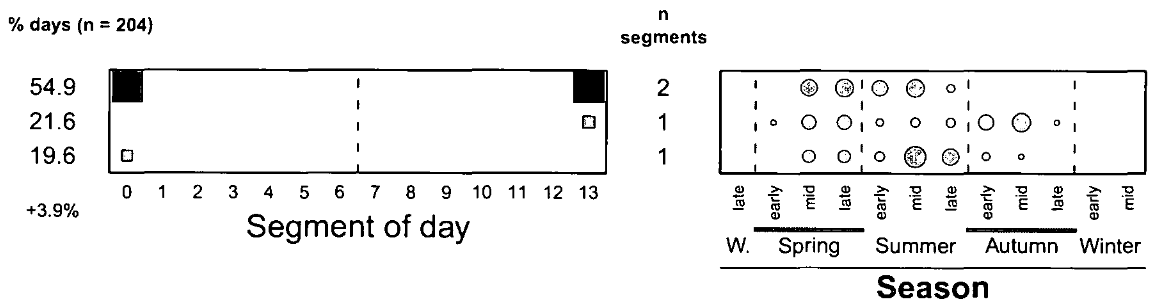


Figure 4.244: R406 Rufous-cheeked Nightjar — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

The total number of birds ringed to date approaches 100. The data still awaits analyses, but indicates that primary moult starts in mid-summer (December). This coincides with the end of the main activity period (Fig. 4.239; Fig. 4.240). Birds are still in active primary moult by the time they depart in mid-autumn (March). This compliments observations on their non-breeding grounds north of the Equator where the birds are found to be in the late stages of moult in June–July, suggesting that moult is suspended during migration (Spottiswoode & Jackson 2005).

4.33 Apodidae: Typical Swifts

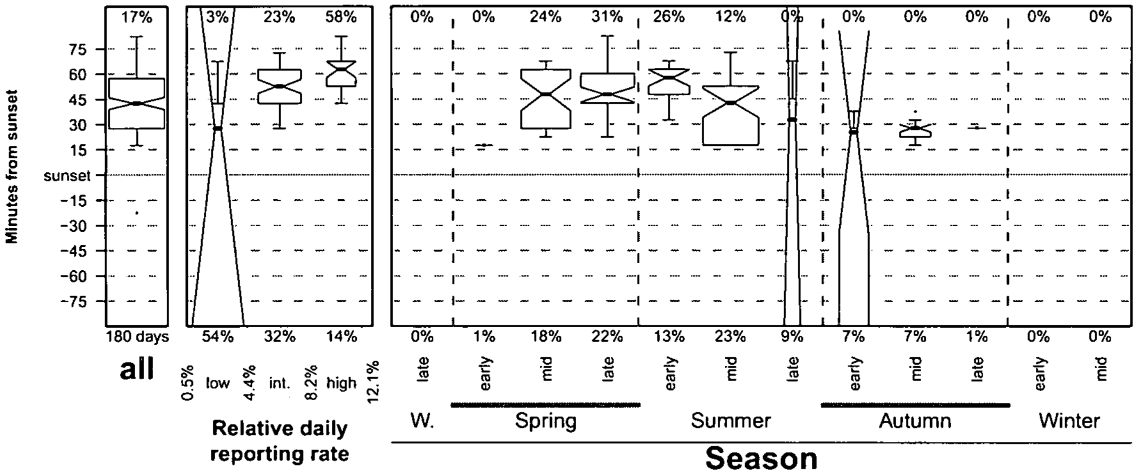
Swifts are highly specialised aerial insectivores, with the 99 species occurring worldwide except in polar regions and remote islands; 13 species occur in southern Africa (Hockey *et al.* 2005). All seven species found in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a) was recorded at Glen.

R411 Common Swift . . . . *Apus apus*

The Common Swift breeds in the Palearctic region with most birds spending the non-breeding season in sub-Saharan Africa, the remainder migrating to Arabia and northern India (Cramp 1998). Recorded in all seven southern African countries, but records rather scattered (Brooke 1997b). It roosts in flight (Cramp 1998; Lockley 1970) and is gregarious, foraging over open country (Brooke 1997b). Recorded from November to April [late spring to late autumn] in SABAP1 Zone 7 (Brooke 1997b).

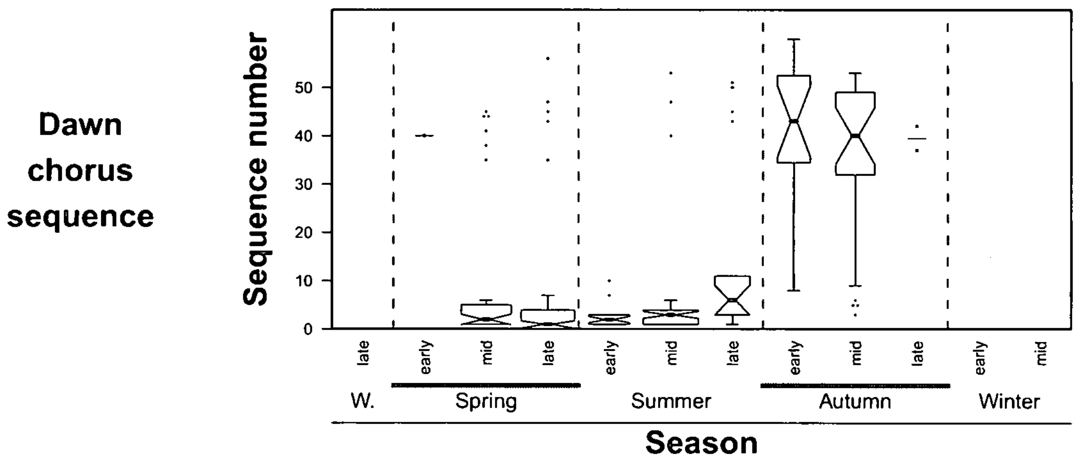
The birds at Glen

The Common Swift is very similar to the African Black Swift R412, Bradfield's Swift *Apus bradfieldi* and Pallid Swift *Apus pallidus*, and it is difficult to identify them in the field except under the most favourable circumstances (Brooke 1997b; Sinclair *et al.* 2002). However, based on current distribution maps (Brooke 1997b,c,d,j), it was assumed firstly that records of Bradfield's and Pallid Swifts in the study area would be exceptional, and secondly that the Common Swift and African Black Swift would be more likely to occur in the study area. It was under these



Last activity of the day

Dawn chorus sequence



Dawn chorus sequence

First activity of the day

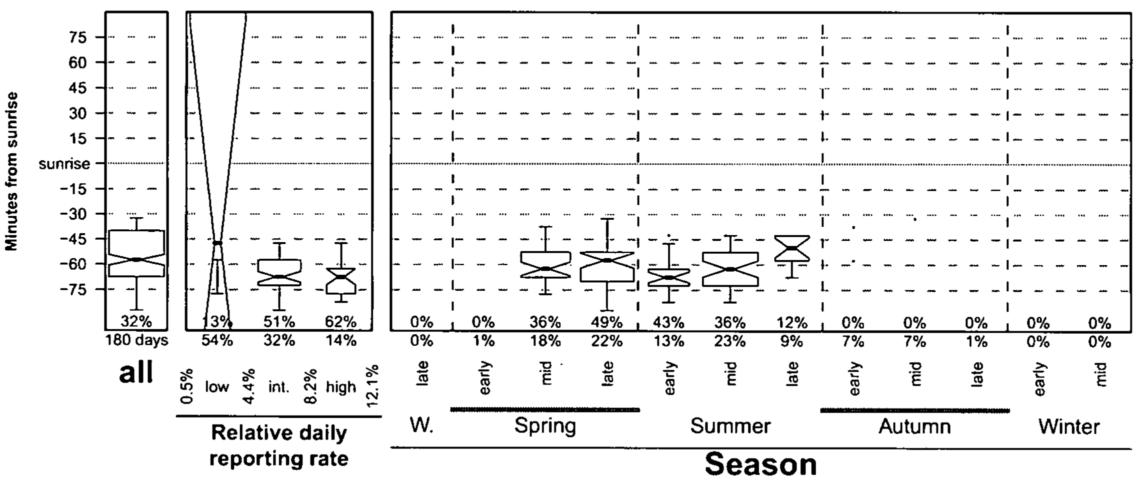


Figure 4.245: R406 Rufous-cheeked Nightjar — birds heard: Details on the daily occurrence of the first (bottom) and last (top) activity of the day in the grassland at Glen. The dawn chorus sequence is indicated in the centre. See page 136 for more information on this detailed first/last activity figure.

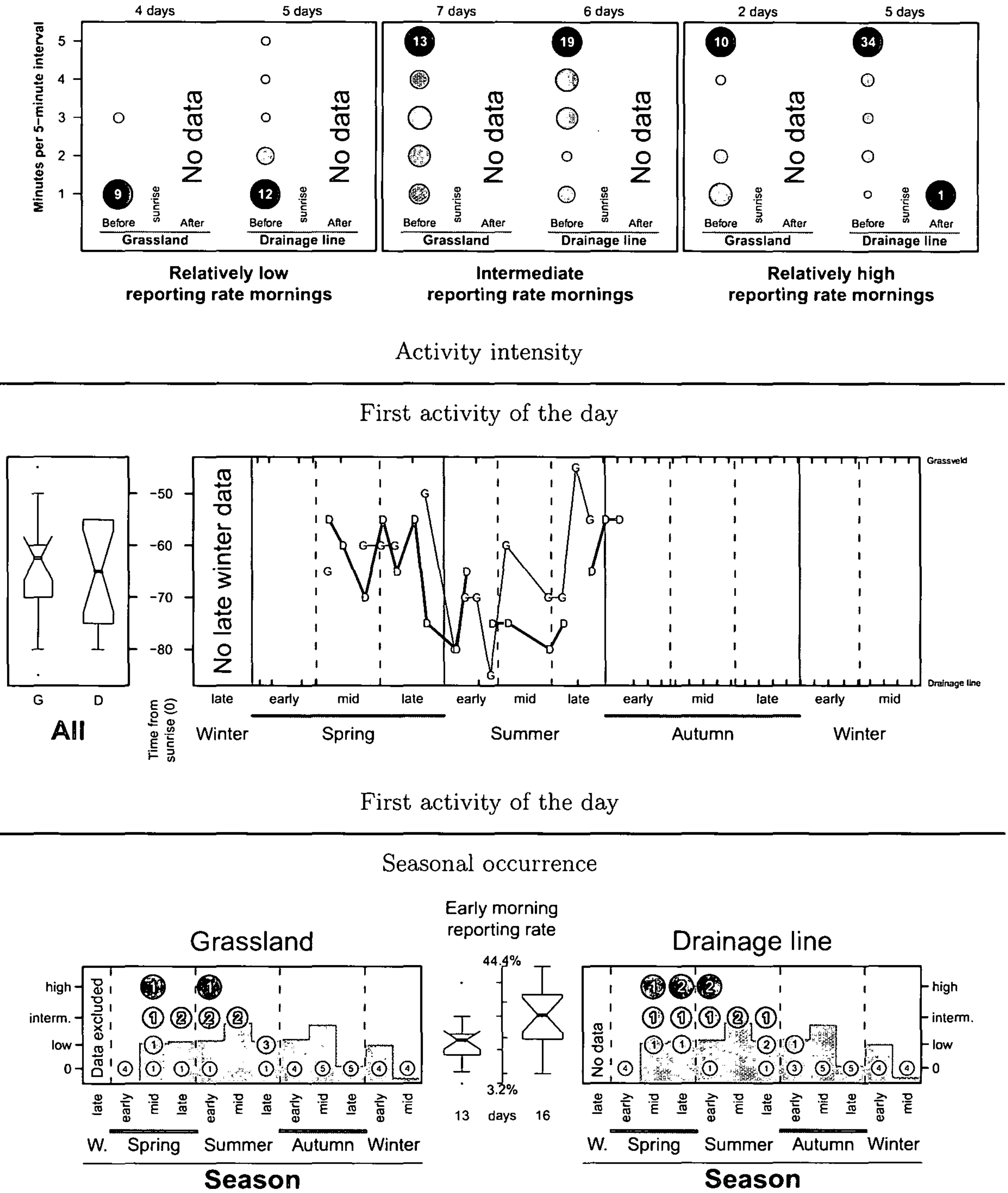


Figure 4.246: R406 Rufous-cheeked Nightjar — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

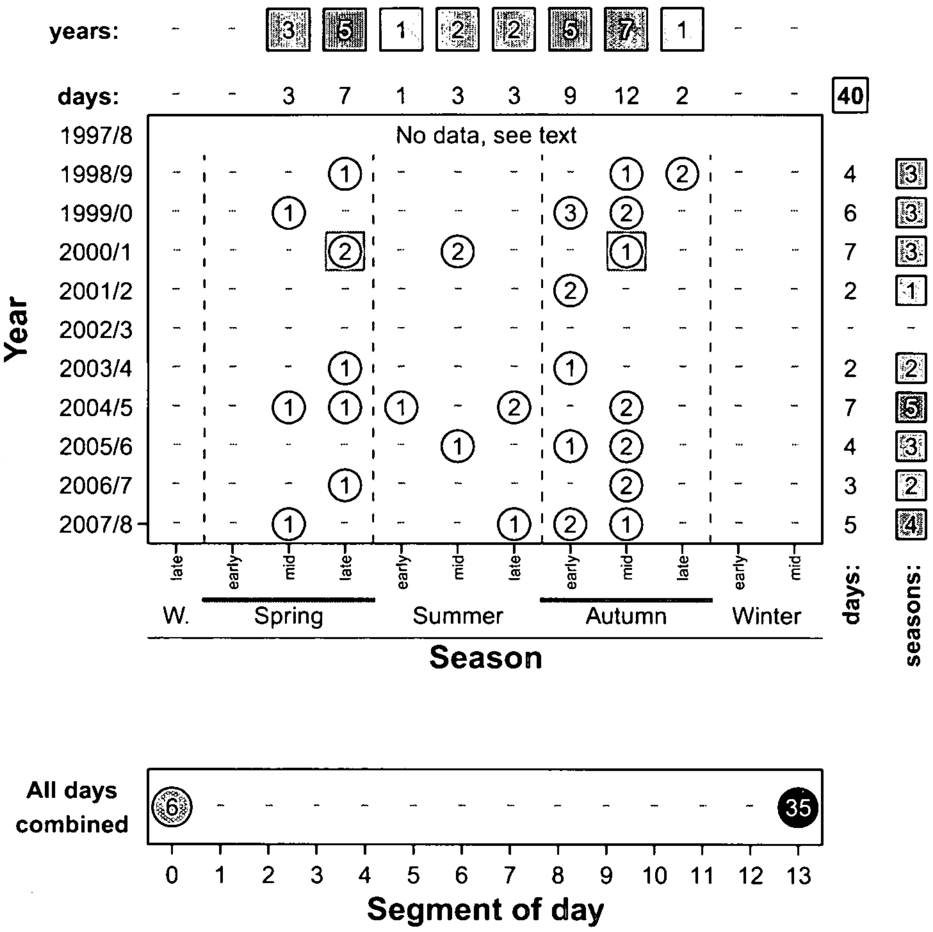


Figure 4.247: R406 Rufous-cheeked Nightjar — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

assumptions that distinction was made between the latter two species. When insufficient views of plain dark swifts precluded distinction it was noted as such — these records are analysed separately below.

Positively identified Common Swifts at Glen: Only recorded in the grassland where seen on 6.7% of the days with an activity index of 10 (Table 4.42a). Usually recorded during 2–3 seasons each year, but during only one season in 2007/8 and not at all in 1999/0 or 2006/7 (Fig. 4.248). Activity was restricted to the period from late spring to early autumn with a well-defined peak centred on late summer; Activity during late spring and early summer was rare (Fig. 4.248). The timing of the first and last sighting of each year was not well synchronised (Fig. 4.249). Recorded throughout the day with a distinct peak during the morning (S2–S5) (Fig. 4.248).

Table 4.42: R411 Common Swift: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists n	Total	%	Activity	Days %	Total	n	Activity index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	452	114 612	0.4	birds seen	6.7	656	44	10
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 188	0.1	birds seen	2.3	43	1	1

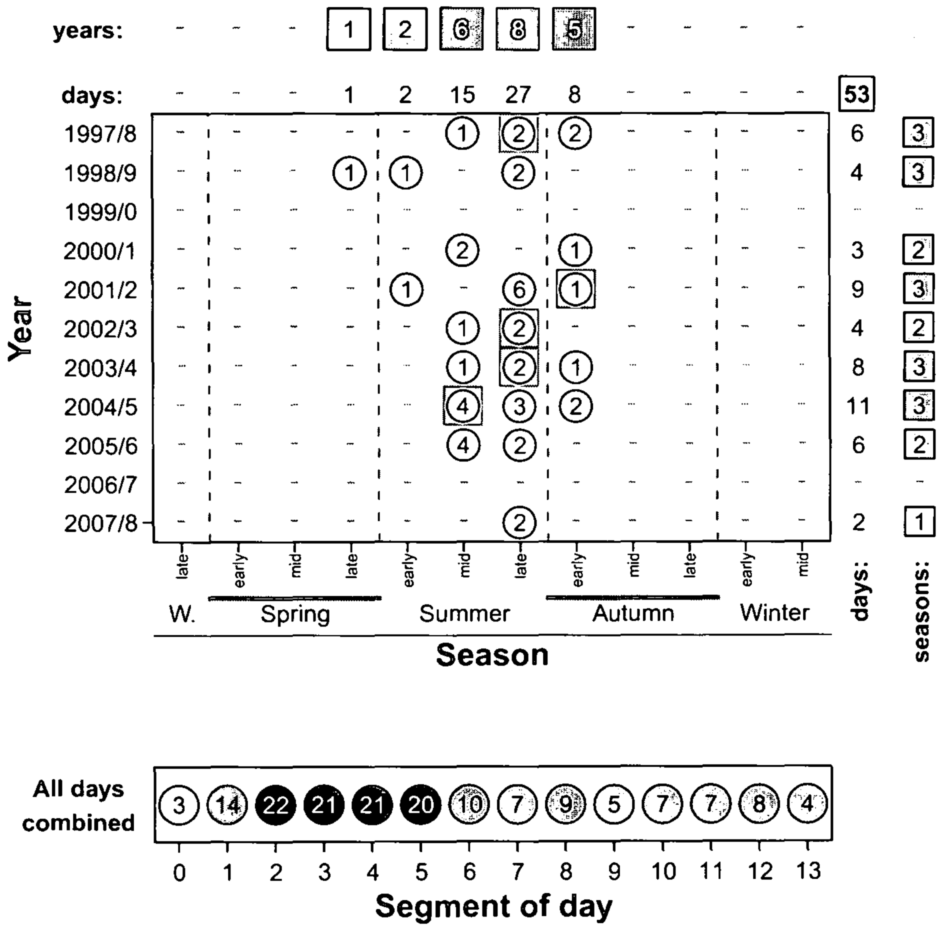


Figure 4.248: R411 Common Swift — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

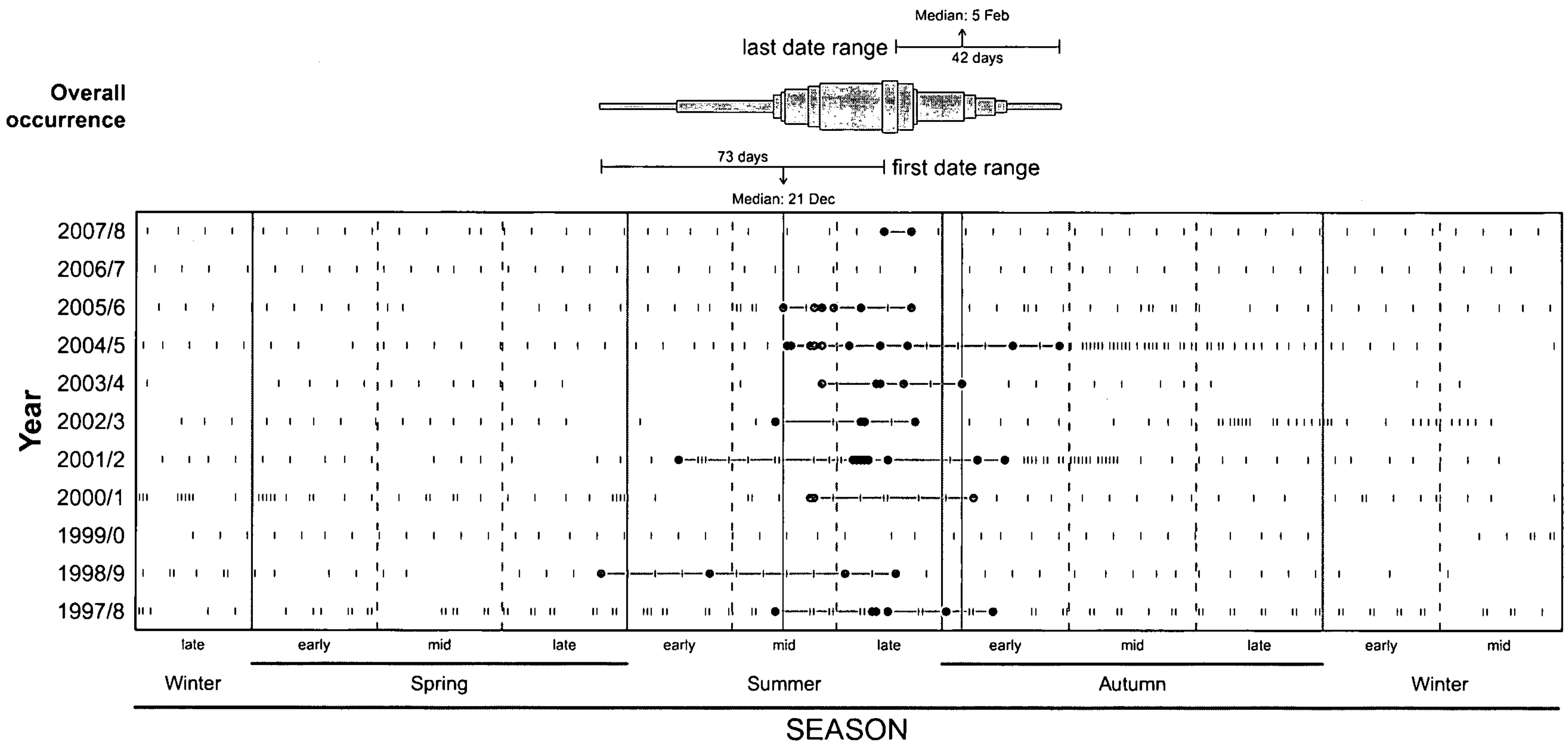


Figure 4.249: R411 Common Swift: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

Discussion

Brooke (1997b) noted that the Common Swift "is prone to under-recording because it flies at altitudes above the visibility limit." It is likely, therefore, that an unknown number of swifts were overlooked at Glen. The birds recorded at Glen typically involved those associated with rain and thunderstorm activity — this is typical for this species. As Moreau (1972) put it: "One observer in Africa after another has stressed that *A. apus* appear in disturbed weather." Indeed, several authors mention it, for example Brooke (1997b), Maclean (1985) and Penry (1994) (see Herremans & Herremans-Tonnoeyr (1994b) for an exception). The reason for this association, of course, is food — flying insects and airborne spiders to be more precise (Cramp 1998; Elkins 2004; Moreau 1972). For more information on the mechanics involved, see Elkins (2004).

R412 African Black Swift .... *Apus barbatus*

The African Black Swift occurs in sub-Saharan Africa, Madagascar and the Comoros (Maclean 1985). Due to identification problems (see Common Swift R411 above), there is uncertainty as to its exact distribution in southern Africa (Brooke 1997c). In the Free State, it is most commonly found around its breeding cliffs in the eastern parts, with scattered records elsewhere in the province (Brooke 1997c; Earlé & Grobler 1987). Although present in southern Africa throughout the year, there is a marked drop in SABAP1 reporting rates during the cooler times of the year (Brooke 1997c). A similar situation is evident in the Free State (Earlé & Grobler 1987). Most of the birds occurring in South Africa are apparently intra-African breeding migrants (Brooke 1972; Brooke 1997c).

The birds at Glen

African Black Swifts were often seen in the company of other swifts, particularly Common Swift. They were typically associated with rain and thunderstorms when they would fly low, enabling good views which facilitated identification. Large, plain, dark swifts which could not be identified — see discussion on identification problems on page 466 — often involved cases were the birds were flying at higher altitudes; these birds were recorded separately and their data is analysed below.

Sight records of positively identified African Black Swifts in the grassland: Recorded on 20 days with no records during 1997/8 or 2002/3 (Fig. 4.250). Whereas it was normally recorded during 1–2 seasons in most years, it occurred during 3–4 seasons in 2004/5 and 2007/8 (Fig. 4.250). Records were restricted to the period from mid-spring to mid-autumn, and most frequently recorded during summer and early autumn (Fig. 4.250). The timing of the first and last sighting each year was highly variable (Fig. 4.251). Mostly recorded during the morning (Fig. 4.250).

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Sight records of unidentified large plain dark swifts in the grassland: Seen on 9.3% of the days with an activity index of two (Table 4.43a). Recorded during a maximum of five seasons per year and not recorded in 2006/7 (Fig. 4.252). Activity was limited to the period from mid-spring to late autumn, with peak occurrence centred on mid-summer, late summer and early autumn (Fig. 4.252). Activity most frequently occurred between sunrise and mid-morning and in the late afternoon before sunset (Fig. 4.252).

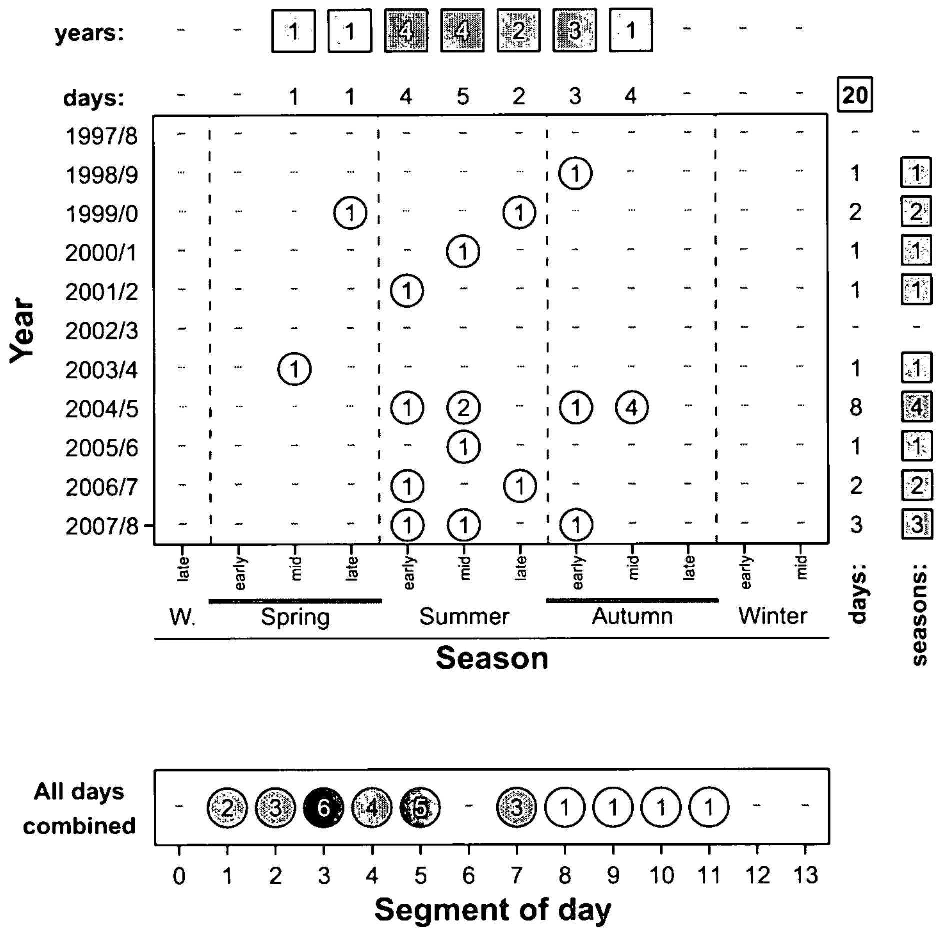


Figure 4.250: R412 African Black Swift — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Table 4.43: R411/2 Common/African Black Swift: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.500	127	114 612	0.1	birds seen	9.3	656	61	2
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.500	1	1 188	0.1	birds seen	2.3	43	1	1

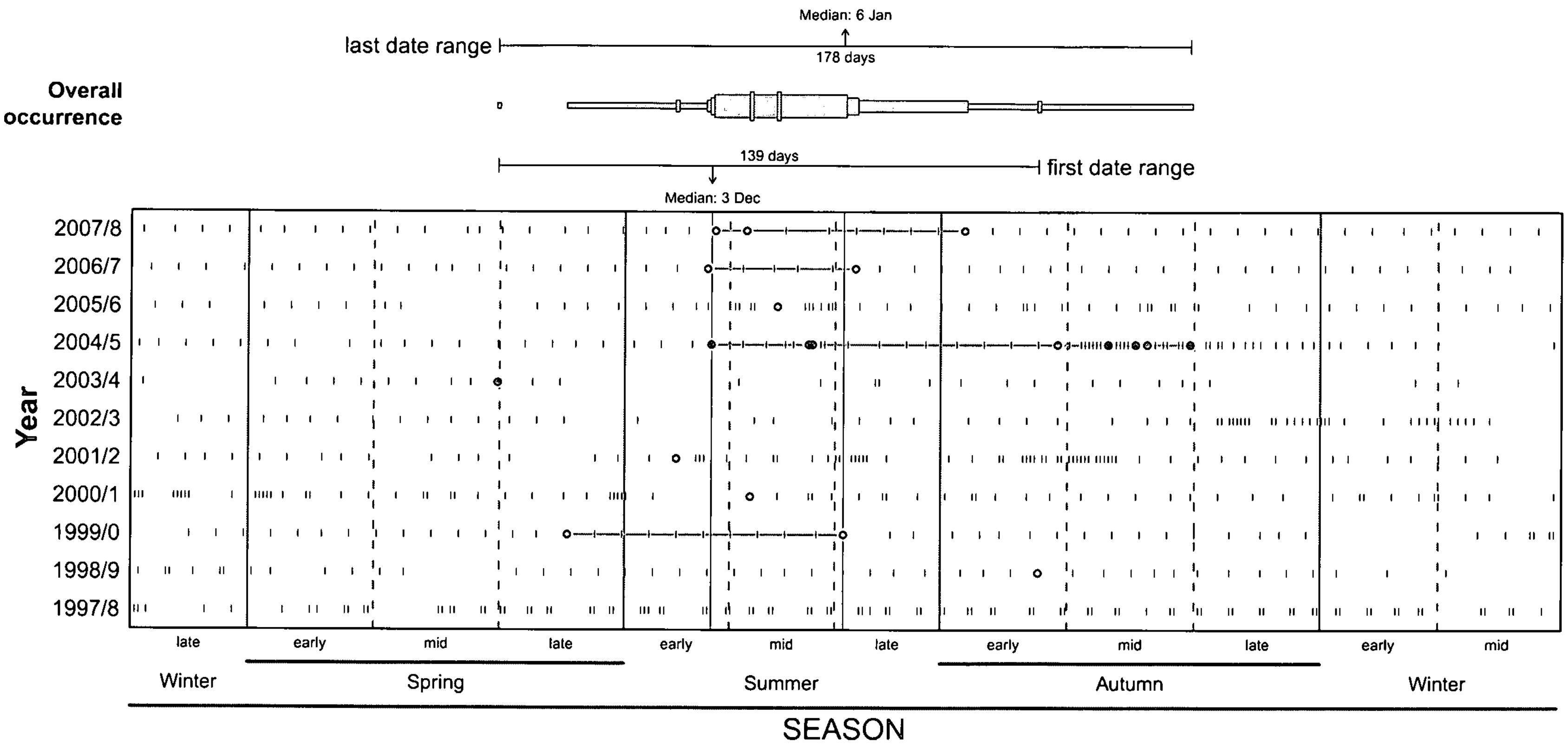


Figure 4.251: R412 African Black Swift: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

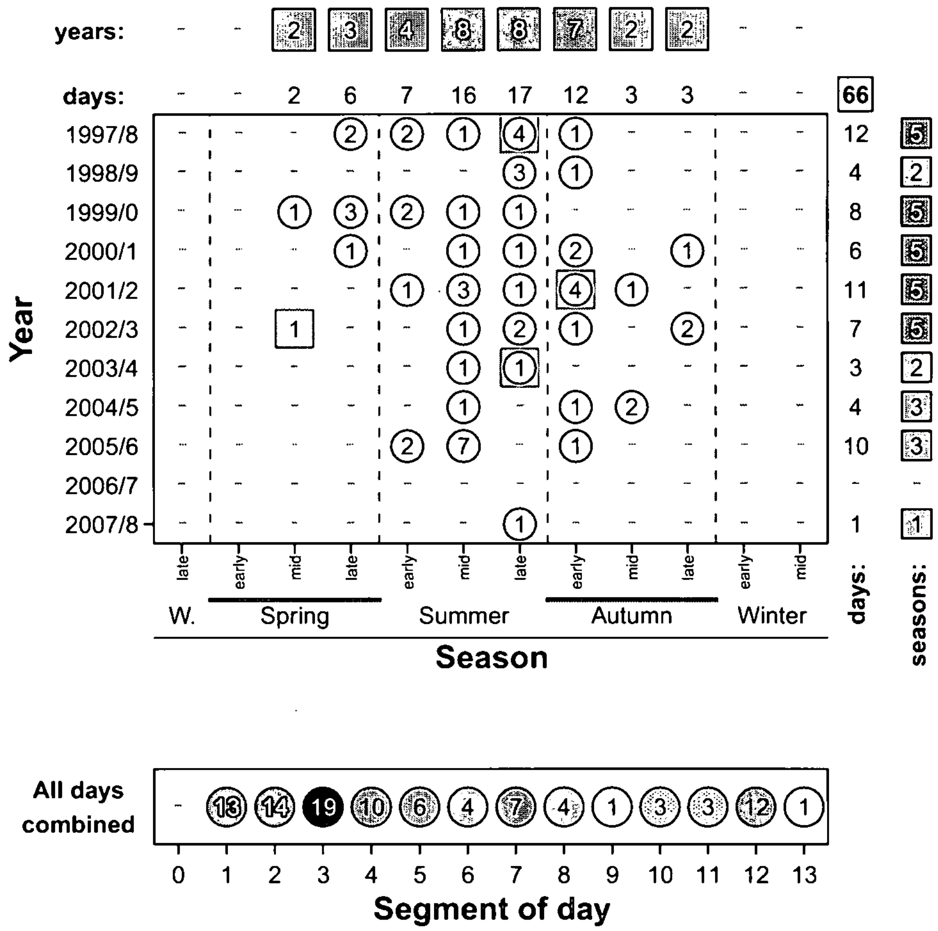


Figure 4.252: R411/2 Common/African Black Swift — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Discussion

The association of the African Black Swift with rain and thunderstorms is a common phenomenon (Fry 1988a), as it is also for the Common Swift — see the *Discussion* section of that species on page 472.

R415 White-rumped Swift . . . . *Apus caffer*

Both migratory and resident populations of the White-rumped Swift occur in sub-Saharan Africa, with a few birds also breeding in south-western Palearctic (Cramp 1998). In southern Africa, it is widespread in Zimbabwe, Swaziland, Lesotho and South Africa, with a more limited distribution in Namibia, Botswana and southern Mozambique (Brooke 1997e; Parker 1999). It breeds on buildings, cliffs and under bridges and forages over the surrounding area (Brooke 1997e; Earlé & Grobler 1987). It occurs mainly from September to May [mid-spring to early winter] as an intra-African migrant, with some birds overwintering (Brooke 1997e; Earlé & Grobler 1987).

The birds at Glen

The nearest breeding birds were at Glen village, with a number of breeding sites under bridges and on buildings occurring within a 30 km radius from the study site. Often seen together with other swallows and swifts, especially Little Swift R417. Records of birds in the grassland refer exclusively to birds seen in flight. Figures start on page 477.

Annual occurrence of birds seen in the grassland: Seen on 20.0% of the days with an activity index of four (Table 4.44a). Recorded during six seasons in most years (range 2–7 seasons; Fig. 4.253; Fig. 4.254). Median daily reporting rates ranged from 0.5 to 11.7% with 90.1% of the values relatively low, and all median daily reporting rates less than 2% (Fig. 4.253).

Table 4.44: R415 White-rumped Swift: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	467	114 612	0.4	seen only	20.0	656	131	4
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	1	1 190	0.1	seen only	2.3	43	1	1
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	4	1 188	0.3	seen only	4.7	43	2	2

Seasonal occurrence of birds seen in the grassland: The timing of the first and last sighting each year was variable (Fig. 4.255). Recorded from mid-spring to late autumn, most frequently during summer and early autumn with a peak in activity centred on mid-summer (Fig. 4.253). Although daily reporting rates tended to be higher during mid- and late summer, median daily reporting rates were similar for all seasons (Fig. 4.253; Fig. 4.254).

Daily occurrence of birds seen in the grassland: Most frequently recorded during mid-morning with a lesser peak in occurrence during the late afternoon before sunset (Fig. 4.253). Most seasons show a similar pattern, but activity in the late afternoon was lacking during mid- and late autumn (Fig. 4.256). Activity typically started during the course of the morning with the median times similar for most seasons (Fig. 4.256). The occurrence of the last activity of the day was more variable and occurred throughout the day (Fig. 4.256).

Daily segment reporting rates ranged from 5.6 to 76.9% with 88.5% of the values relatively low; median daily reporting rates were similar for the respective segments of the day (Fig. 4.253).

Discussion

In one study Brooke (1957) found that White-rumped Swifts roost on the nest or in crevices, settling 5–20 minutes after sunset and leaving the next morning 5–20 minutes before sunrise.

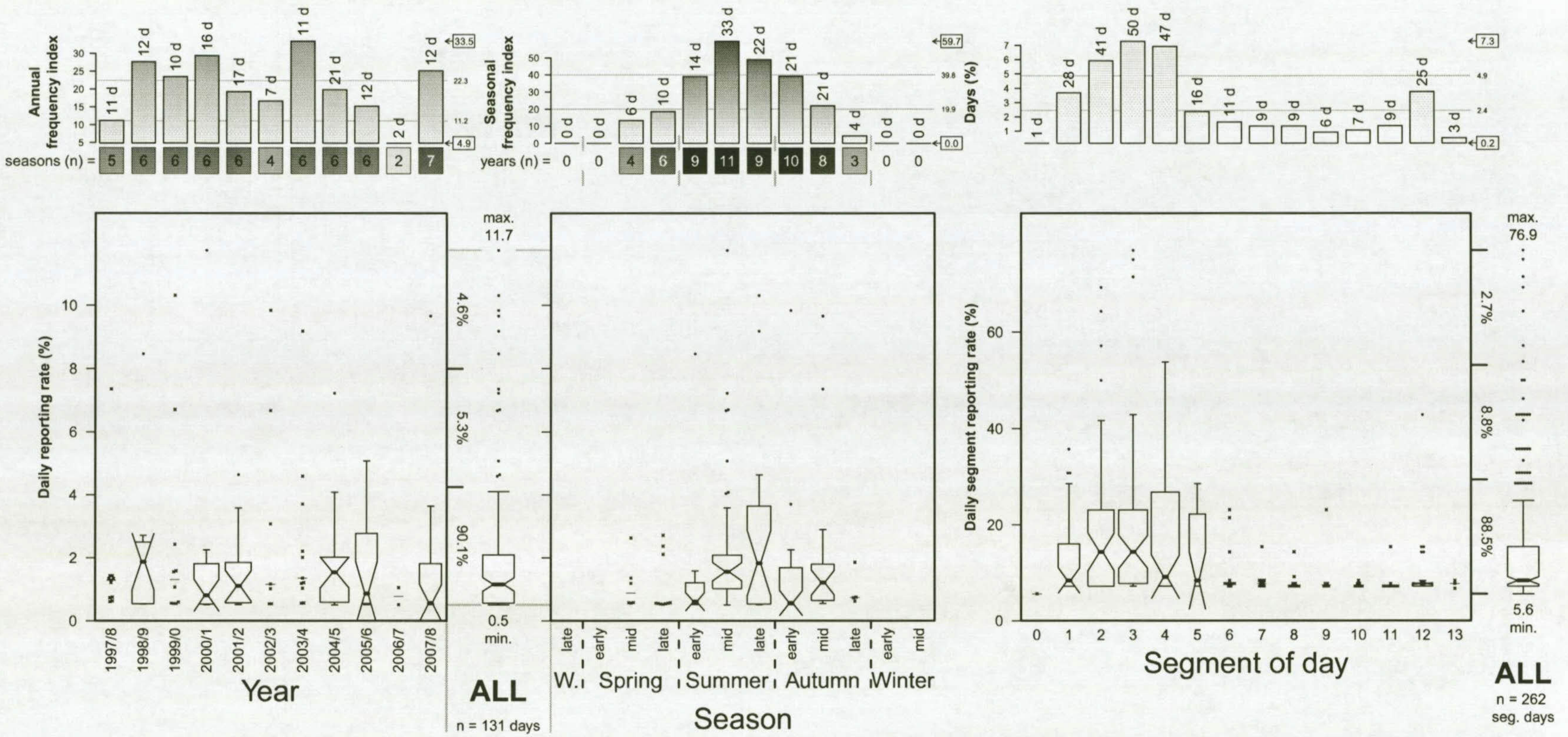


Figure 4.253: R415 White-rumped Swift — seen only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

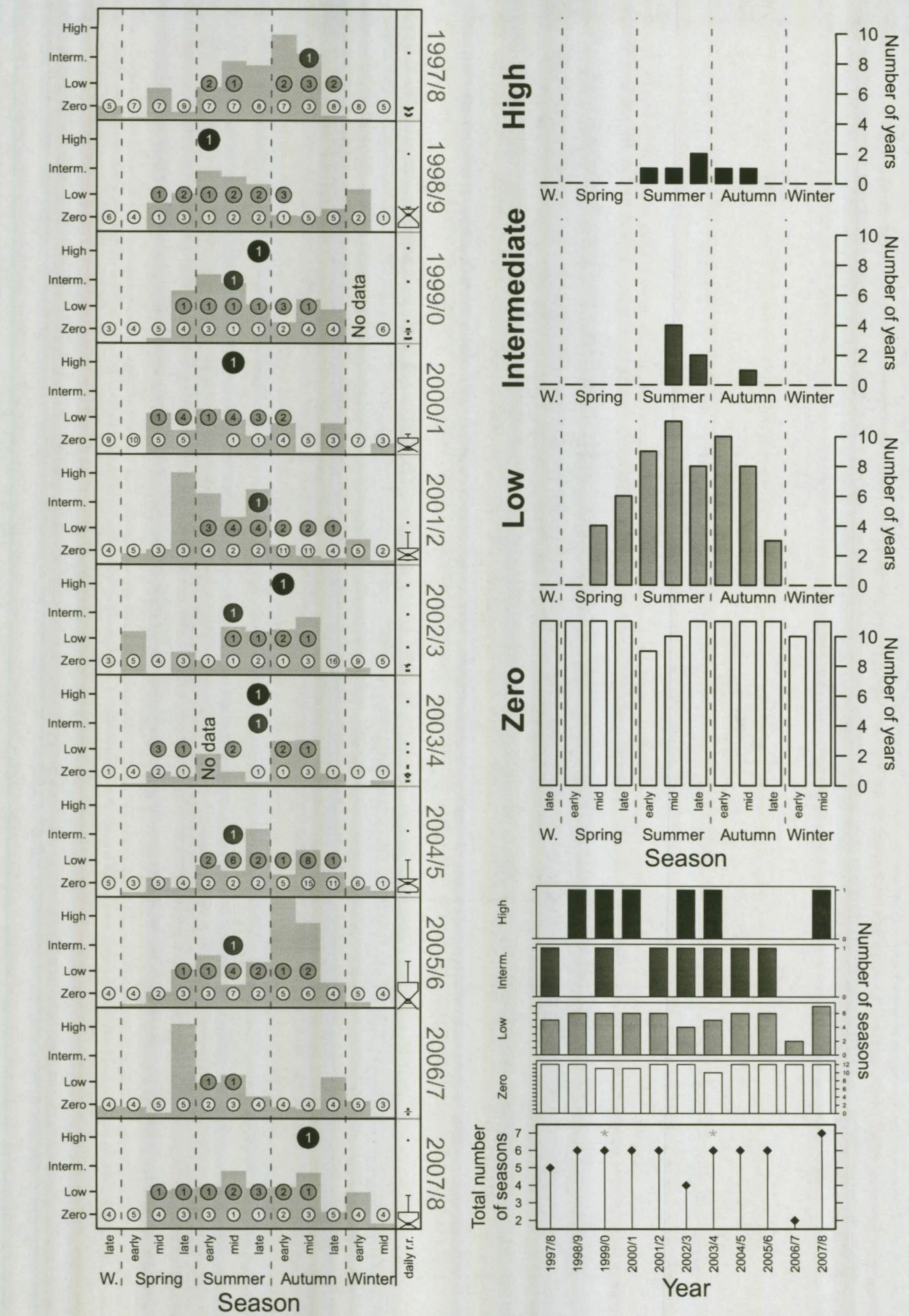


Figure 4.254: R415 White-rumped Swift — seen only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

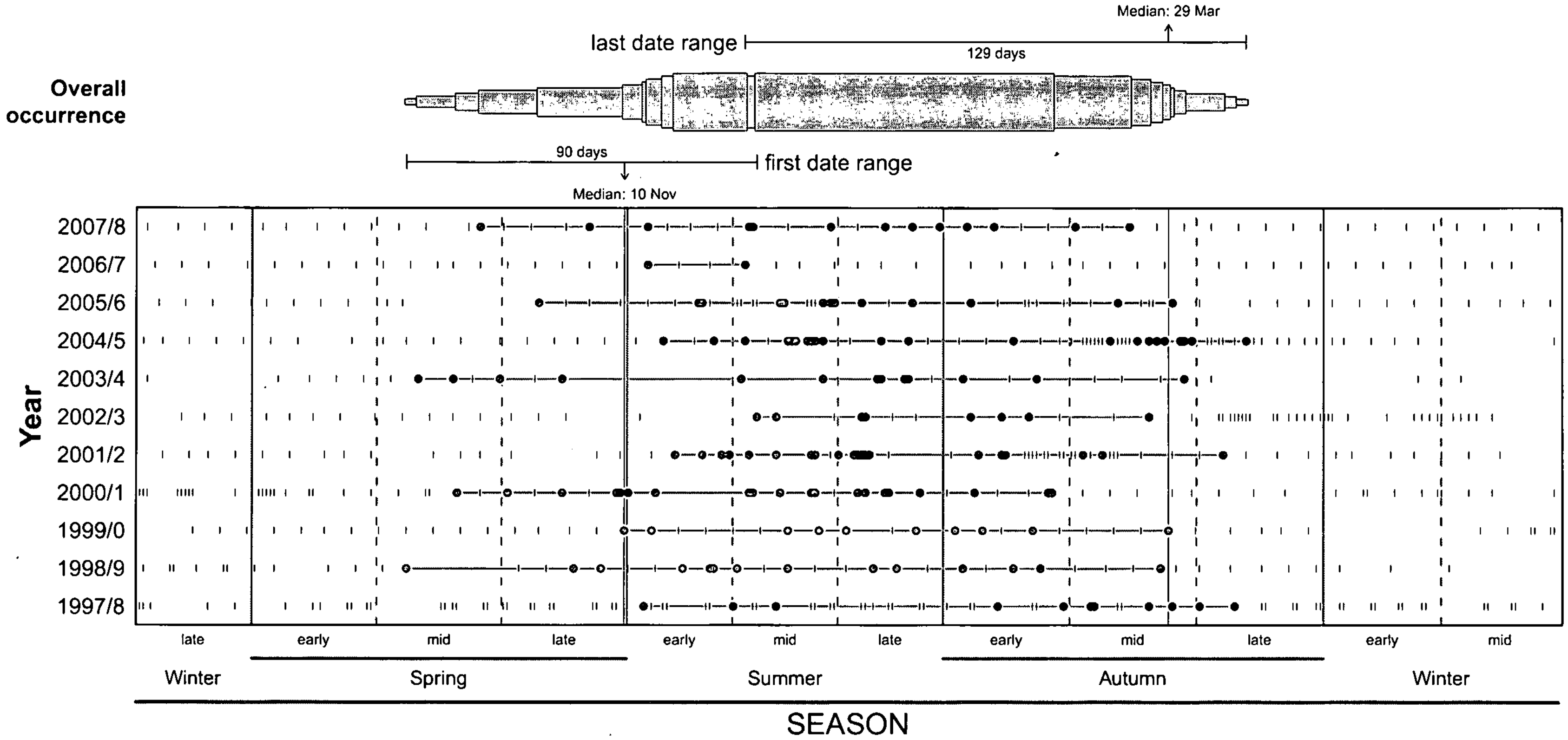
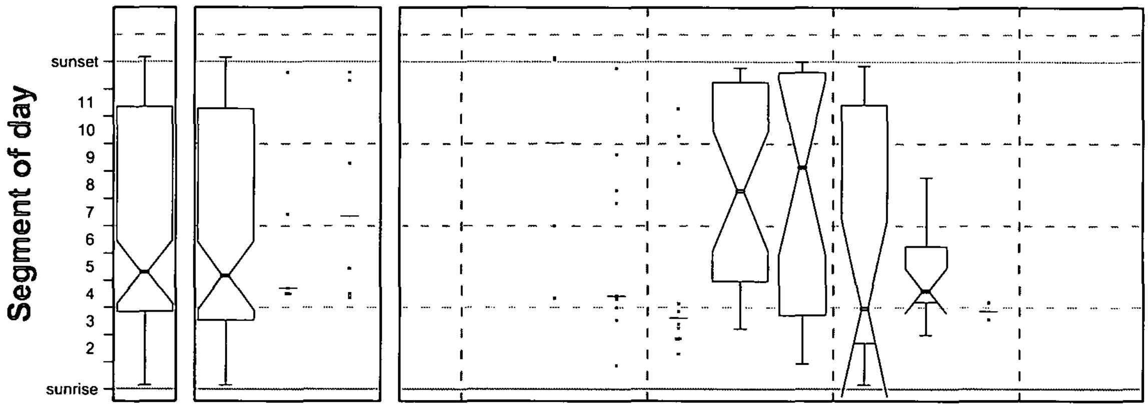
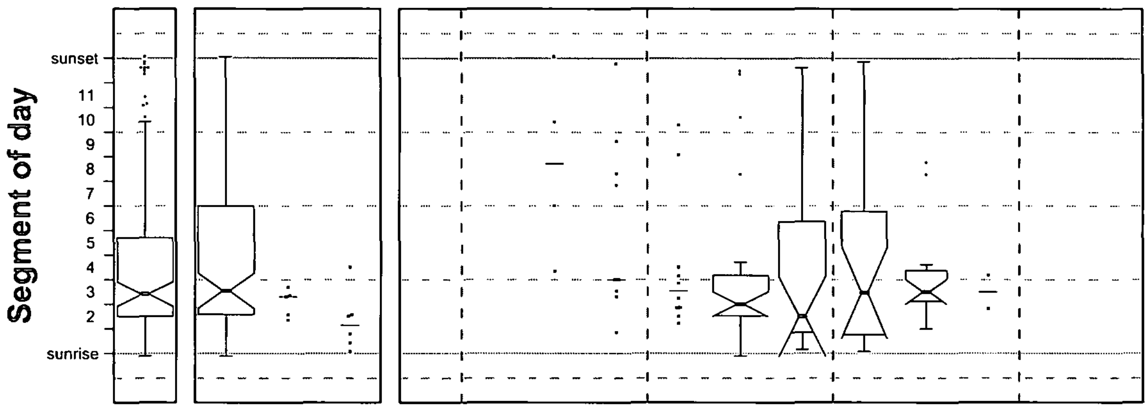


Figure 4.255: R415 White-rumped Swift: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.



Timing of the last activity of the day

Timing of the first activity of the day



Timing of the first activity of the day

Seasonal occurrence

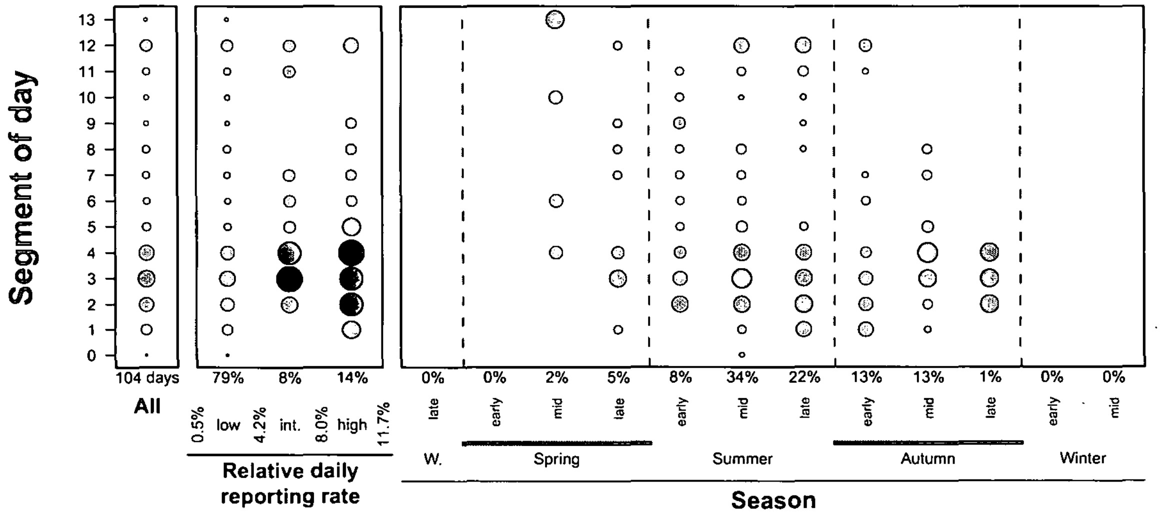


Figure 4.256: R415 White-rumped Swift — seen only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

In another study birds released 80 km from their nests generally returned within 5 days, but sometimes within hours (Louw 2005d). The pattern observed at Glen with peak activity around mid-morning and again in the late afternoon before sunset (Fig. 4.253) probably results form birds commuting between roosting and foraging areas.

R416 Horus Swift . . . . *Apus horus*

The Horus Swift is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa, it occurs mainly in Zimbabwe, Swaziland, Lesotho and South Africa where largely confined to the south and from the Free State eastwards (Brooke 1997f). It is not restricted to any particular habitat while foraging. However, it requires vertical surfaces such as along rivers and road cuttings for nesting holes (Brooke 1997f; Earlé & Grobler 1987; Maclean 1985). In the southerly parts of its range (including the Free State), it is mainly a breeding intra-African migrant present during the warmer months (Brooke 1972; Brooke 1997f; Earlé & Grobler 1987).

The birds at Glen

A breeding colony along the Modder River at Soetdoring Nature Reserve (De Swardt 2000), situated approximately 30 km north-west of the study area, is the nearest known breeding site to Glen. Records of birds in the grassland refer to birds seen in flight; it was heard (and seen) only once.

Seen in the grassland on 24 days in total with no records during 1999/0 or 2006/7 (Fig. 4.257). Recorded during 3–4 seasons in 2002/3 and 2003/4 and only 1–2 seasons in other years (Fig. 4.257). Seasonally, records were limited to the period from late spring to mid-autumn with a pronounced peak during late summer when recorded during seven years compared to the 0–3 years of other seasons (Fig. 4.257). The timing of the first and last sighting each year was variable (Fig. 4.258). Mostly seen around mid-morning with a lesser peak in the late afternoon before sunset (Fig. 4.257).

Discussion

The Horus Swift roosts in nesting or non-nesting burrows, settling to roost only when it is almost dark (Louw 2005c). The mid-morning peak at Glen (Fig. 4.257) probably represent birds arriving from such roosts while their presence in the late afternoon before sunset (Fig. 4.257) probably represents birds on their way to roost, in which case it may imply that their nests are not too far away.

In South Africa breeding occurs from January to March/April [late summer to late autumn] (Maclean 1985; Tarboton 2001). At Glen, activity peaked during late summer (Fig. 4.257), suggesting a possible link with breeding activity.

R417 Little Swift . . . . *Apus affinis*

The Little Swift occurs from Africa east to India (Brooke 1997g; Louw 2005b). In southern Africa it is most common in South Africa and Swaziland, but it is also widespread in other southern African countries (Brooke 1997g; Parker 1999). It forages over all vegetation types, but requires

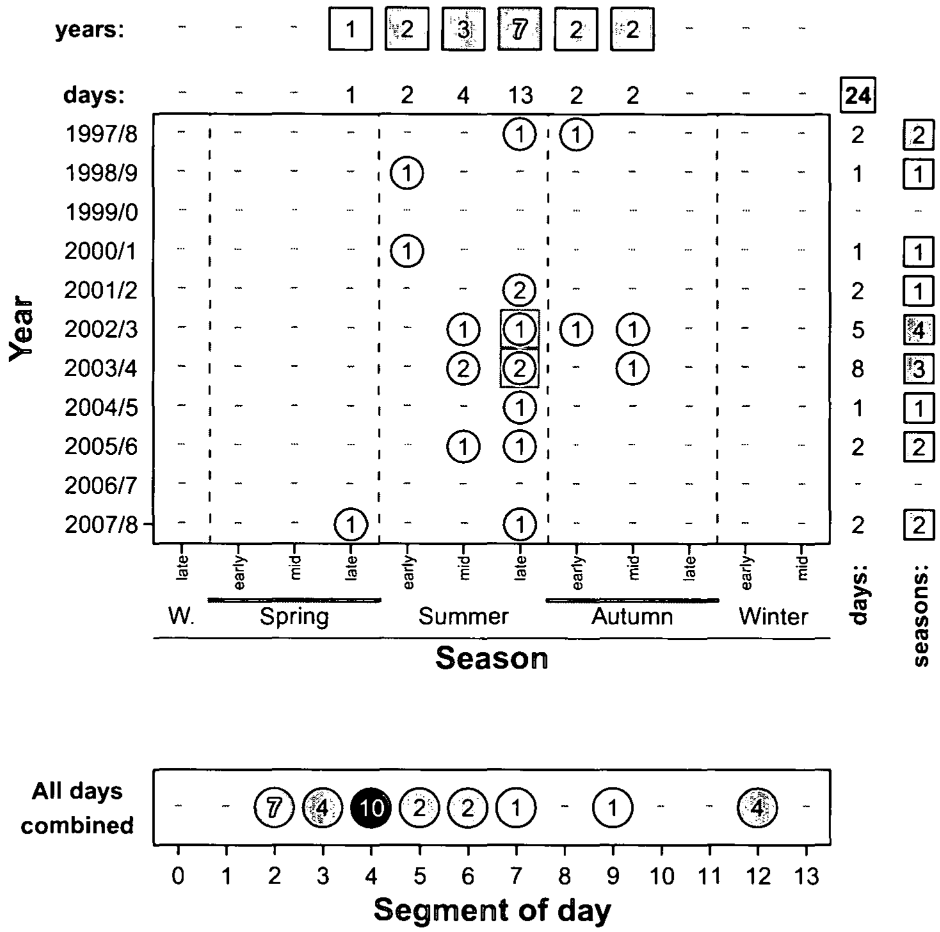


Figure 4.257: R416 Horus Swift — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

buildings and cliffs for breeding (Louw 2005b; Maclean 1985; Penry 1994). The population consists of migratory and resident components, but seasonal fluctuations in conspicuousness complicate the interpretation of the data (Brooke 1997g; Ferguson 1955; Parker 1984). The colonial Little Swift roost and breed on or under man-made structures and, occasionally, cliffs (Maclean 1985).

The birds at Glen

The closest Little Swift breeding colony to the study area is at Glen village, with a number of other colonies situated within a 30 km radius from the study site. Records in the grassland represent birds seen or heard (and seen), with the incidence of the former slightly higher than that of the latter (Table 4.45a). Figures start on page 486.

Annual occurrence in the grassland of birds seen only: Seen on 45.6% of the days with an activity index of six (Table 4.45a). Recorded during eight seasons in most years, but in seven during 1999/0 and in ten during 1997/8 and 2007/8 (Fig. 4.259; Fig. 4.260). Daily reporting rates ranged from 0.5 to 22.7% with 92.0% bird-days attaining relatively low reporting rates; the

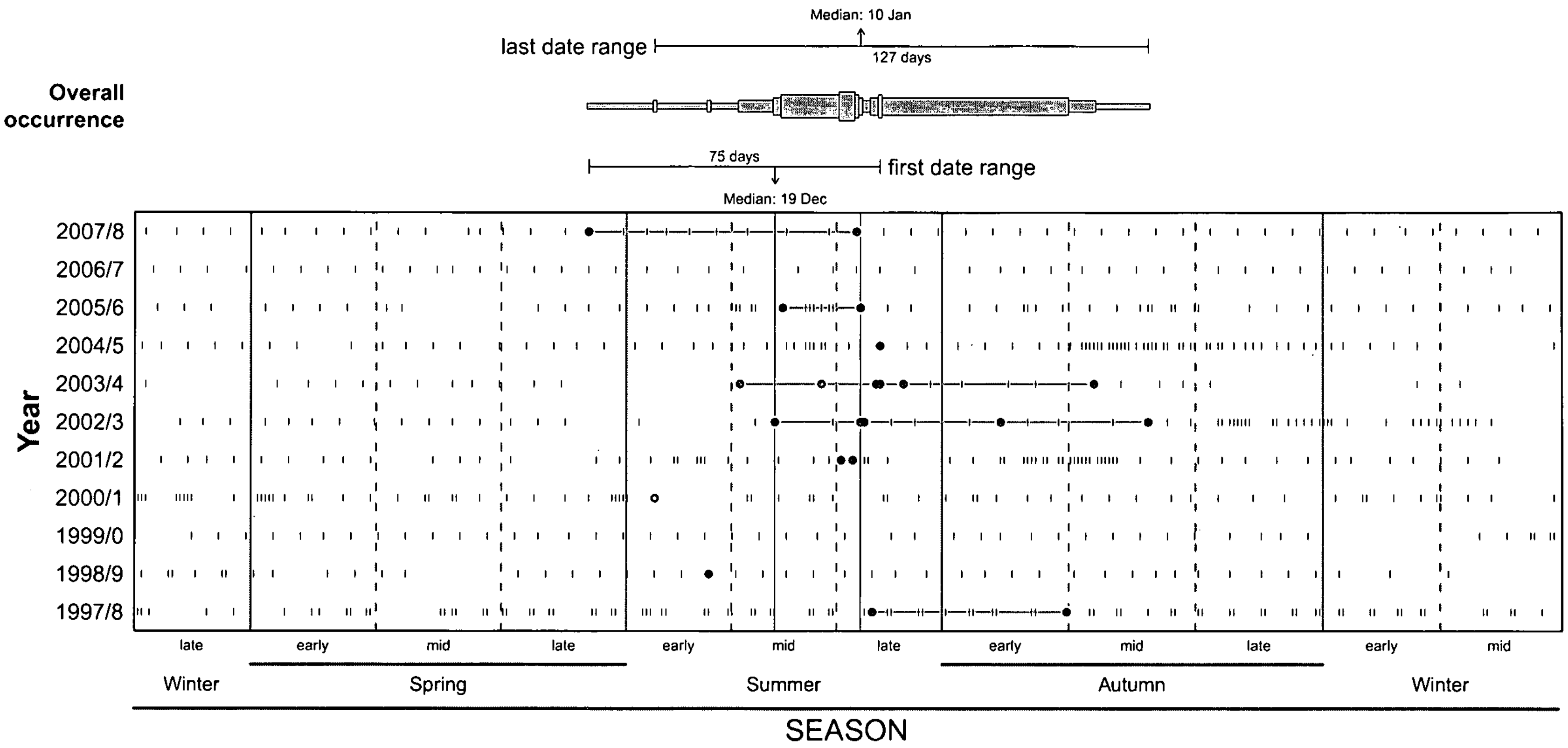


Figure 4.258: R416 Horus Swift: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

Table 4.45: R417 Little Swift: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.578	1 663	114 612	1.5	birds seen only	45.6	656	299	6
0.422	1 214	114 612	1.1	birds heard	39.5	656	259	5
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.571	4	1 190	0.3	birds heard	4.7	43	2	2
0.429	3	1 190	0.3	birds seen only	4.7	43	2	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	6	1 188	0.5	birds seen only	11.6	43	5	1

median daily reporting rates of the respective years were all similar (Fig. 4.259).

Seasonal occurrence in the grassland of birds seen only: The timing of the first record for each year was variable and spanned an 88-day period from late winter to mid-spring (Fig. 4.261). The last record for each year normally occurred during the latter part of mid-autumn or in late autumn (median date: 20 April; Fig. 4.261). Overall, recorded during all seasons, but winter records were exceptional (Fig. 4.259). The incidence of zero record days was particularly infrequent during summer, occurring during a maximum of four years compared to other seasons when it occurred during more than eight years (Fig. 4.260). This coincides with relatively high median daily reporting rates during summer, particularly mid-summer (Fig. 4.259). The seasonal frequency index in summer was also the highest (Fig. 4.259).

Daily occurrence in the grassland of birds seen only: Overall, activity occurred slightly more frequently during mid-morning than at other times, with activity before sunrise and after sunset exceptional (Fig. 4.259). This pattern mainly reflects the situation for low reporting rate days. Activity was markedly more frequent during mid-morning on intermediate reporting rate days (Fig. 4.262). The pattern was seasonally more variable (Fig. 4.263). Activity during S10 only was the only segment combination that occurred on at least 5% bird-days (Fig. 4.264).

The first activity of the day occurred most frequently during the mornings, generally earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.263). The median timing of the first activity remained reasonably constant throughout the year (Fig. 4.263).

The last activity of the day often occurred during the afternoon, and showed a seasonal trend with the last activity generally occurring later during late spring and summer than during other times of the year (Fig. 4.263).

Overall, daily segment reporting rates ranged from 5.6 to 91.7% with 91.4% of the values relatively low (Fig. 4.259). While the median daily segment reporting rates for low reporting rate days were only slightly higher during S3 than during most other segments, those for intermediate reporting rate days were exceptionally high during S2–S3 compared to those of most subsequent segments (Fig. 4.262).

Early morning occurrence during 2007/8 of birds seen only: Recorded during five mornings in the grassland compared to the two mornings in the drainage line (Table 4.45b & c).

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Annual occurrence in the grassland of birds heard: Heard on 39.5% of the days with an activity index of five (Table 4.45a). Recorded during 4–9 seasons each year, most frequently during 1997/8, 2004/5 and 2005/6 (Fig. 4.265; Fig. 4.266). Daily reporting rates ranged from 0.5 to 23.0% with 95.4% of the bird-days attaining low values (Fig. 4.265). Median daily reporting rates were similar for most years, but relatively low in 2004/5, particularly when compared to 1998/9 (Fig. 4.265).

Seasonal occurrence in the grassland of birds heard: Noted during all seasons except winter (Fig. 4.265). The incidence of days with zero records were least frequent during summer and early autumn, with intermediate reporting rate days occurring during the same period, in addition to mid-autumn (Fig. 4.266). Although the median daily reporting rates were similar for all seasons, the upper quartile was higher from mid-summer to early autumn than during other bird-seasons (Fig. 4.265).

Daily occurrence in the grassland of birds heard: Overall, activity was almost equally frequent from mid-morning to late afternoon, being infrequent in the early morning (not recorded before sunrise) and after sunset (Fig. 4.265). A similar pattern is evident for most seasons (Fig. 4.267). Activity during S3 only was the only segment combination occurring on more than 5% bird-days (5.4%), and it occurred most frequently during autumn (Fig. 4.268).

The first activity of the day often occurred during the morning and showed no clear seasonal trend (Fig. 4.267). The occurrence of the last activity of the day was typically later on intermediate (and the few high) reporting rate days than on low reporting rate days, and it tended to occur later from late spring to early autumn than during other seasons (Fig. 4.267).

Overall, daily segment reporting rates ranged from 7.1 to 69.2% with 93.4% of the values relatively low. The median daily segment reporting rates were similar for all segments (Fig. 4.265).

Early morning occurrence of birds heard during 2007/8. Recorded on two mornings in the drainage line only (Table 4.45b & c).

Discussion

The behaviour of the Little Swift of foraging high in the sky during the non-breeding season complicates the interpretation of the data (Brooke 1997g; Ferguson 1955; Parker 1984). It is consequently not known to what extent dips in reporting rates during the cooler part of the year (Brooke 1997g; Fig. 4.259; Fig. 4.265) represent migratory movements.

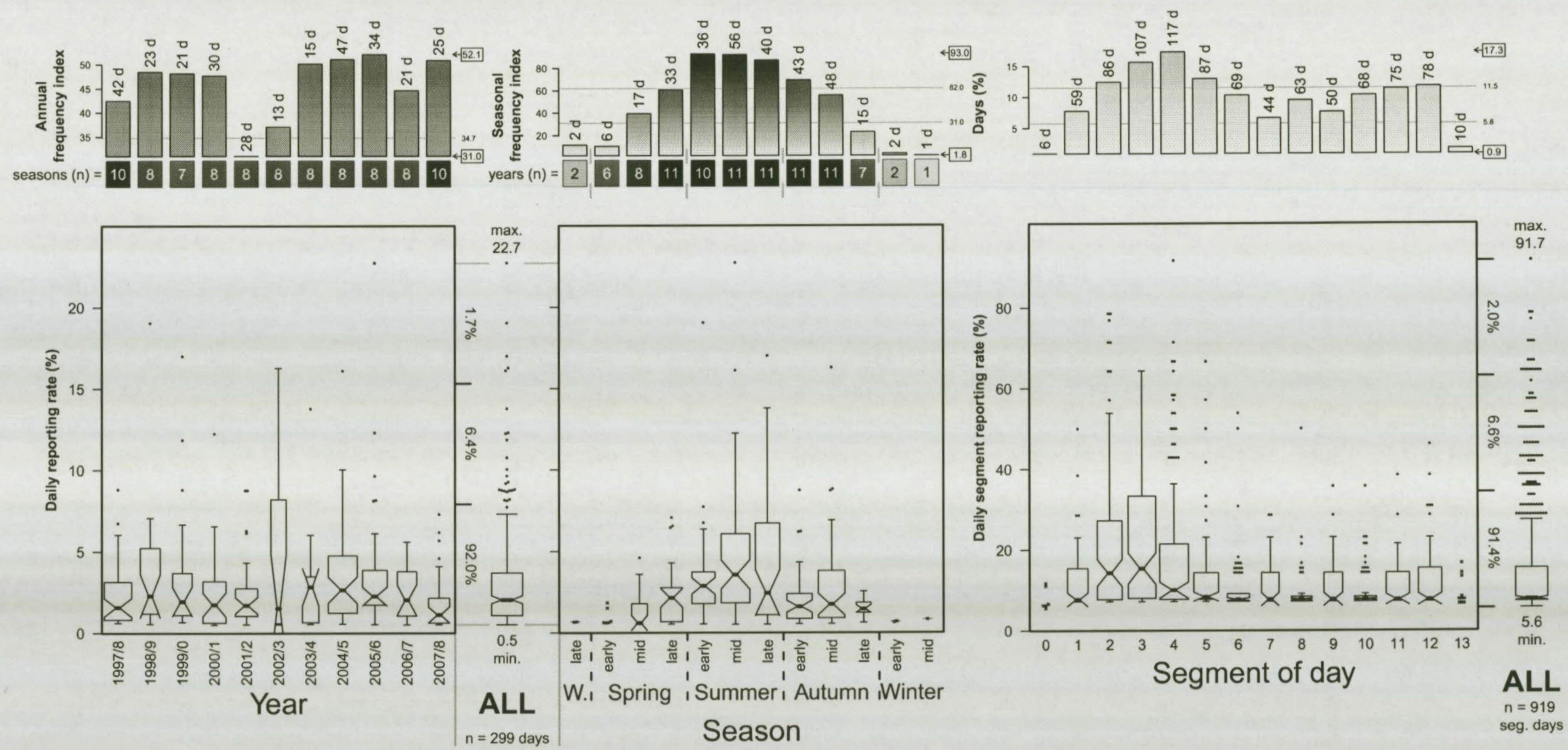


Figure 4.259: R417 Little Swift — birds seen only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

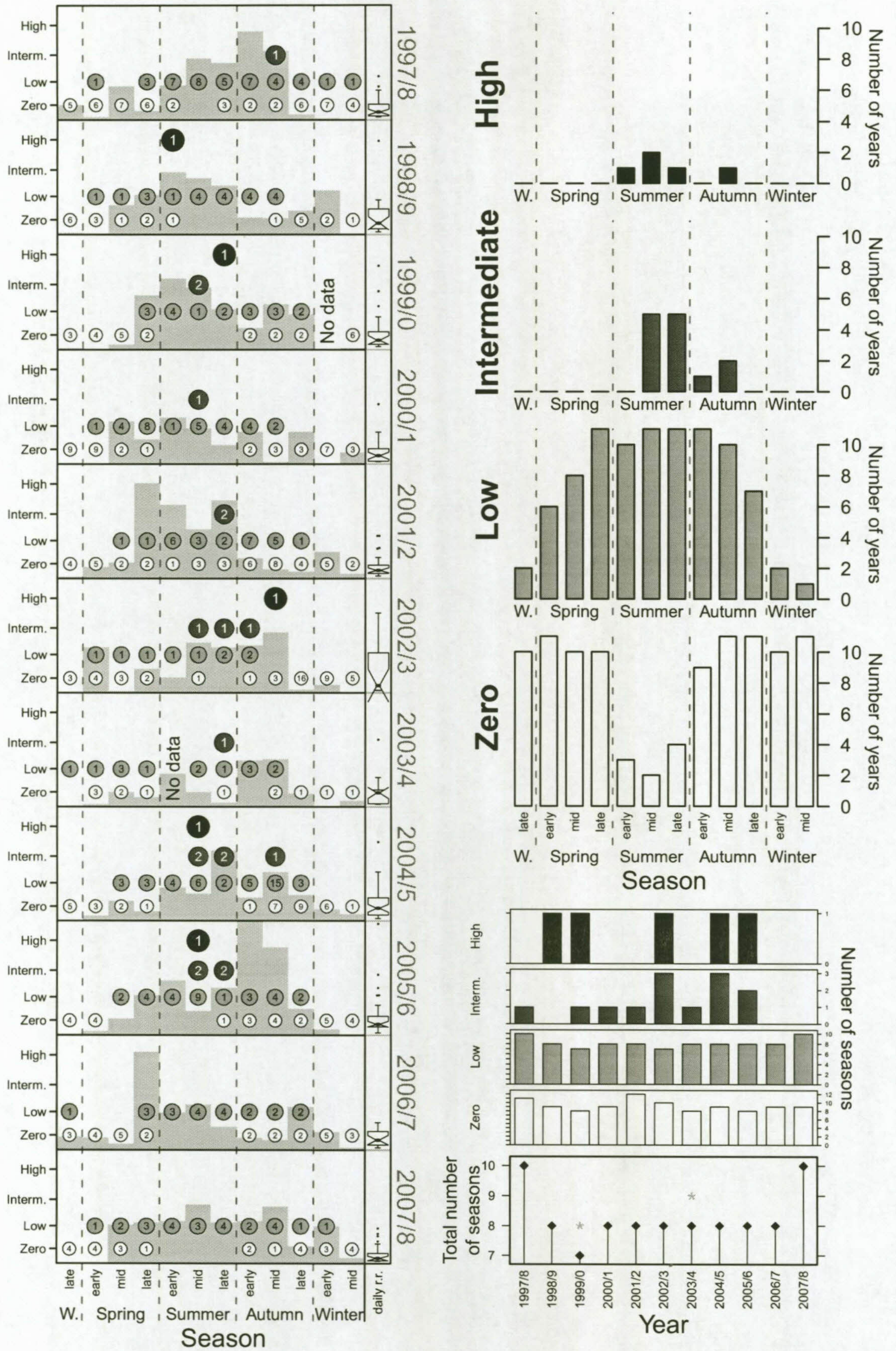


Figure 4.260: R417 Little Swift — birds seen only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

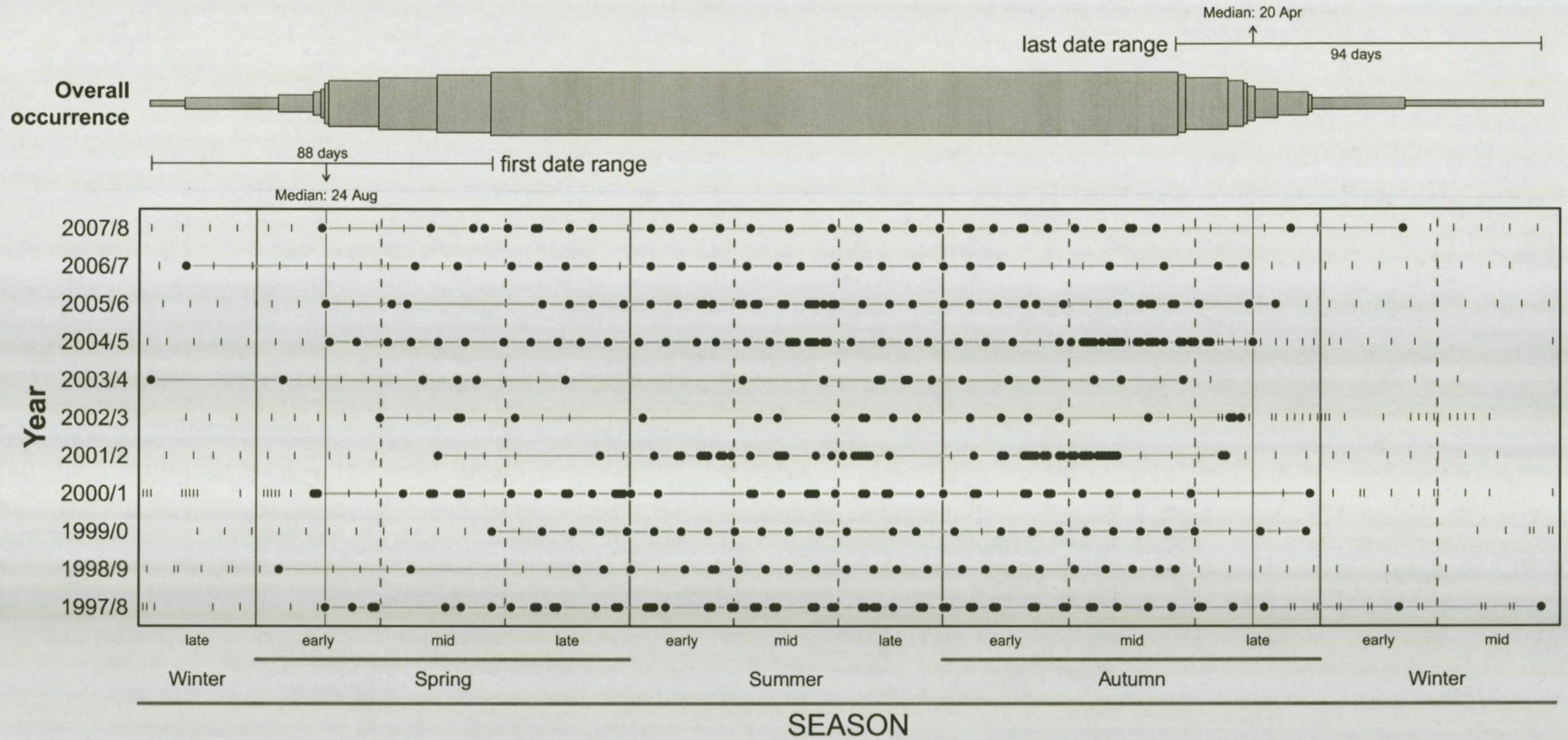


Figure 4.261: R417 Little Swift: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

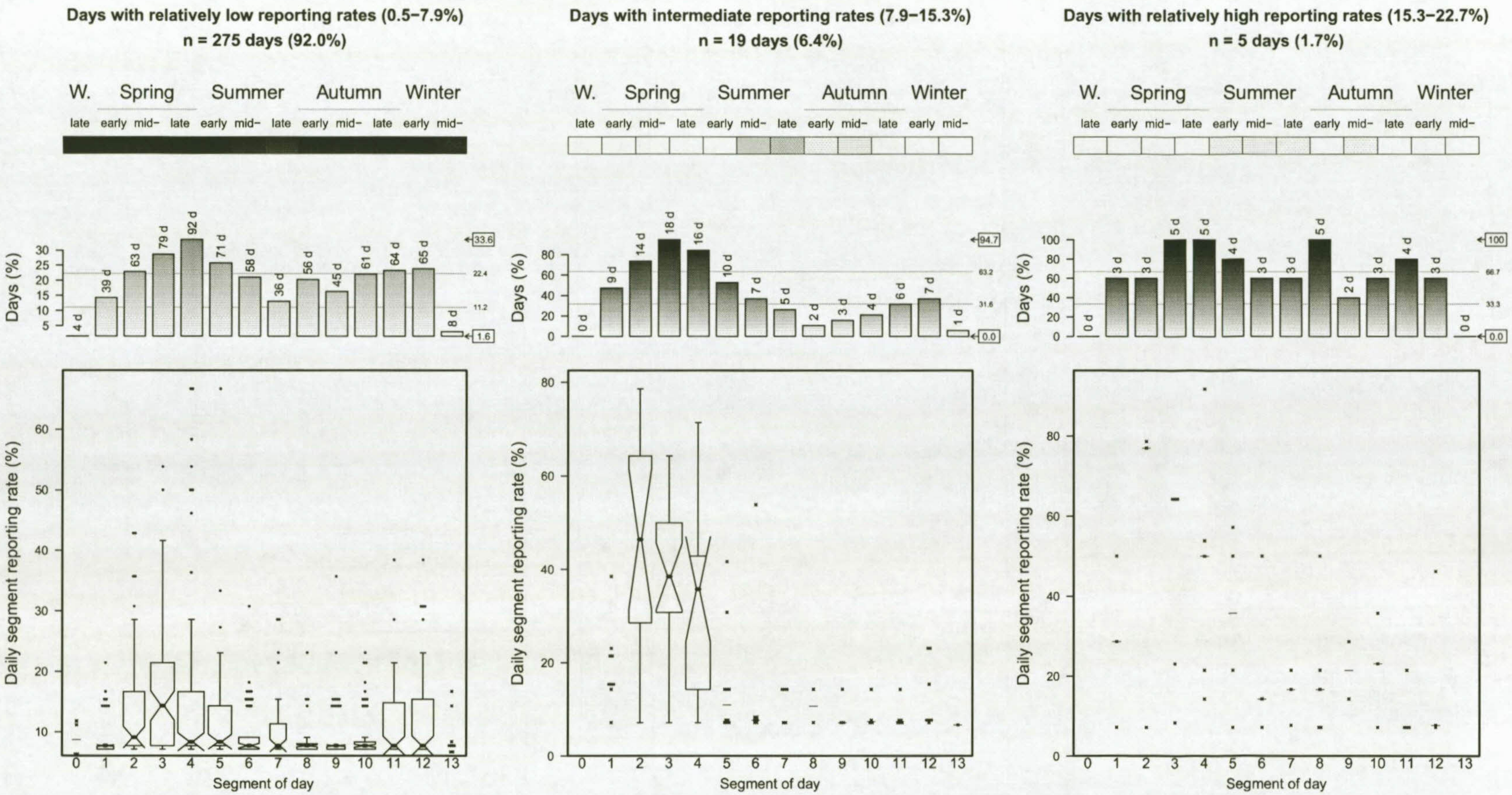


Figure 4.262: R417 Little Swift — birds seen only: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

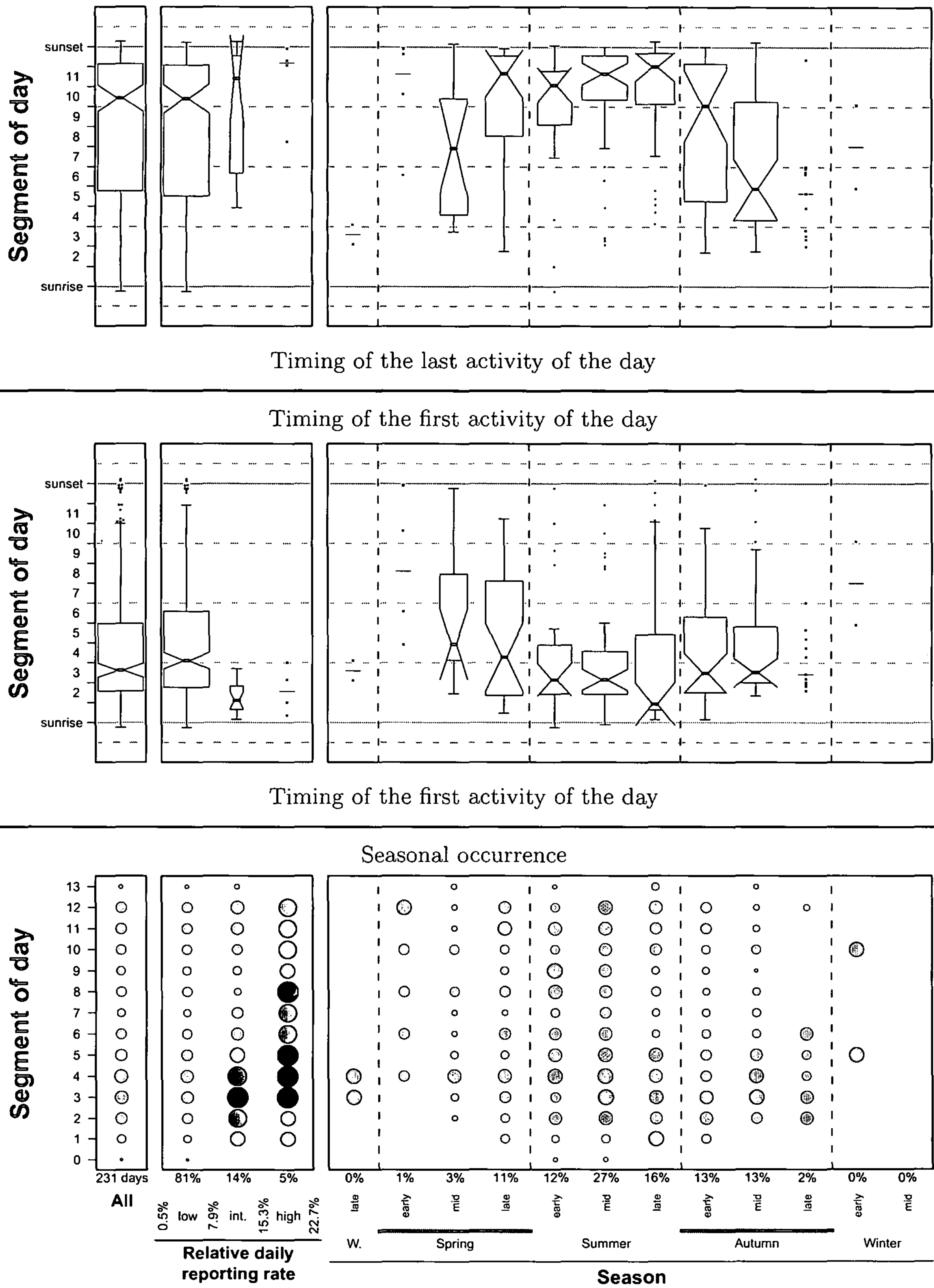


Figure 4.263: R417 Little Swift — birds seen only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

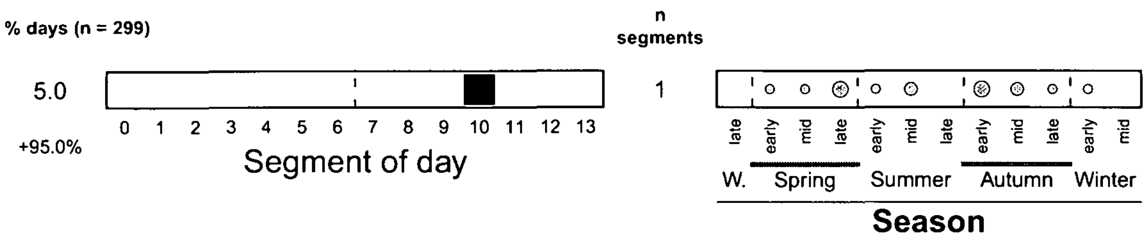


Figure 4.264: R417 Little Swift — birds seen only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

The birds usually leave their roost well after sunrise and fly back after sunset (Brooke & Vernon 1961). This explains the relative scarcity for records in the early mornings at Glen as well as the relative abrupt end of activity after sunset (Fig. 4.259; Fig. 4.262; Fig. 4.265). There are a number of colonies within a 30 km radius of the study site, but it is unknown from which of these the birds at Glen originate from. Brooke (1997g) stated that he "believe that breeding birds forage only within *c.* 20 km of a breeding site."

R418 Alpine Swift .... *Tachymarptis melba*

The Alpine Swift occurs in Africa, Madagascar and from the western Palearctic eastward to India and Sri Lanka (Brooke 1971a; Cramp 1998). In southern Africa, it is concentrated in the eastern third (*i.e.* east of the study area) and southern third of South Africa and in the western and central parts of Namibia; recorded from scattered localities in Botswana and Zimbabwe too (Brooke 1997h). It forages over any type of habitat, but is dependent on mountainous terrain — less often man-made structures — for breeding (Louw 2005a). Breeding intra-African migrants supplement the southern African population during the warmer times of the year, but the precise origin of these migrants is unknown; these migrant birds probably sleep on the wing high in the night sky (Brooke 1972; Brooke 1971a, 1997h).

The birds at Glen.

The Alpine Swift breeds on a building in Bloemfontein (Colahan *et al.* 1991). This is the nearest known breeding site. At Glen, recorded in the grassland only, with almost all the records involving birds seen; rarely heard.

Seen on 31 days in total with records during all years except 1998/9 (Fig. 4.269, page 495). Recorded in all seasons except early and mid-winter, and very frequently during mid-spring when found during eight years compared to the 1–3 years of other seasons (Fig. 4.269). Records spread throughout most of the day with a distinct peak in occurrence in the early afternoon (Fig. 4.269).

Discussion

The mainly incidental nature of Alpine Swift records at Glen (Fig. 4.269) is at least partially attributable to the habit of these birds to forage at high altitudes, a habit which, according to

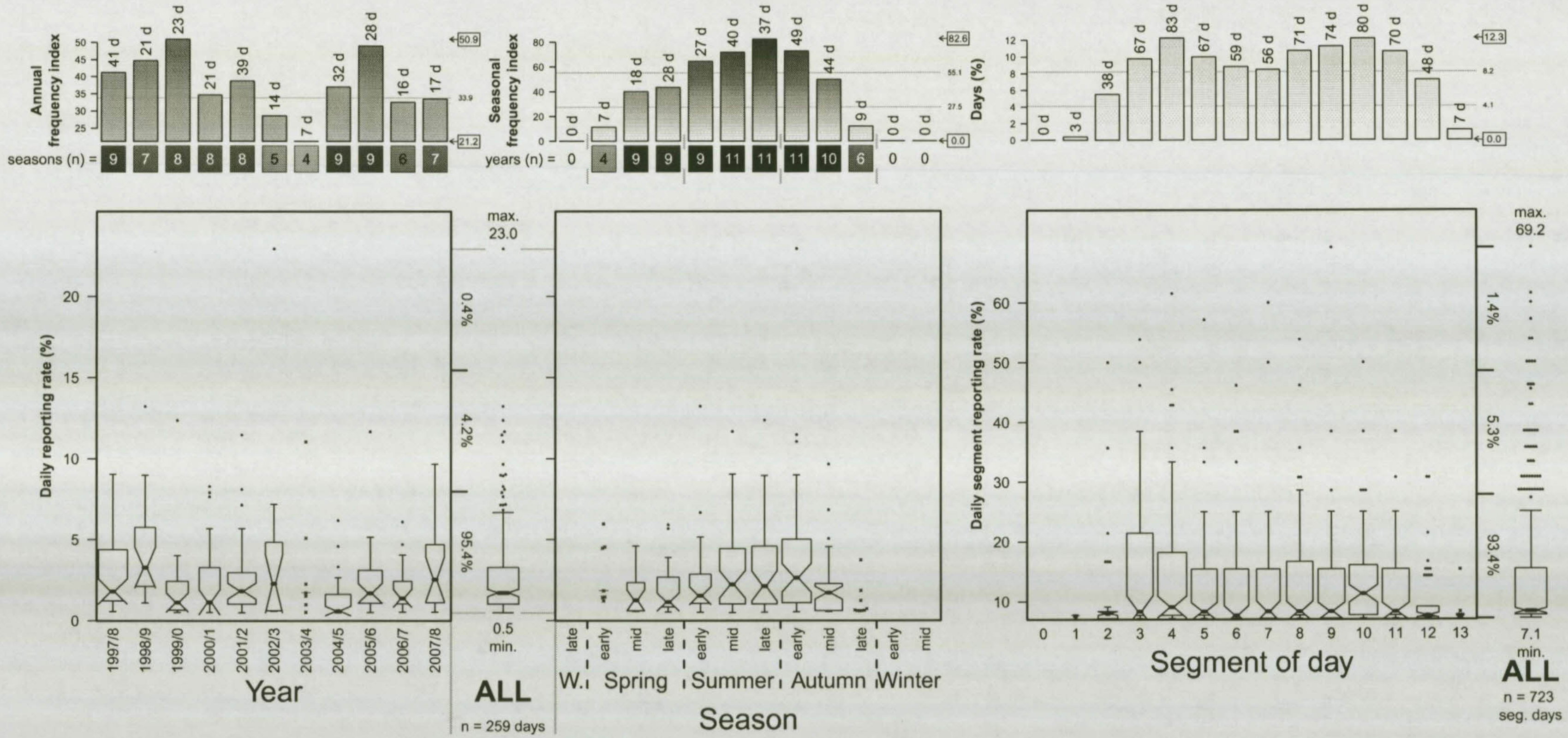


Figure 4.265: R417 Little Swift — birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

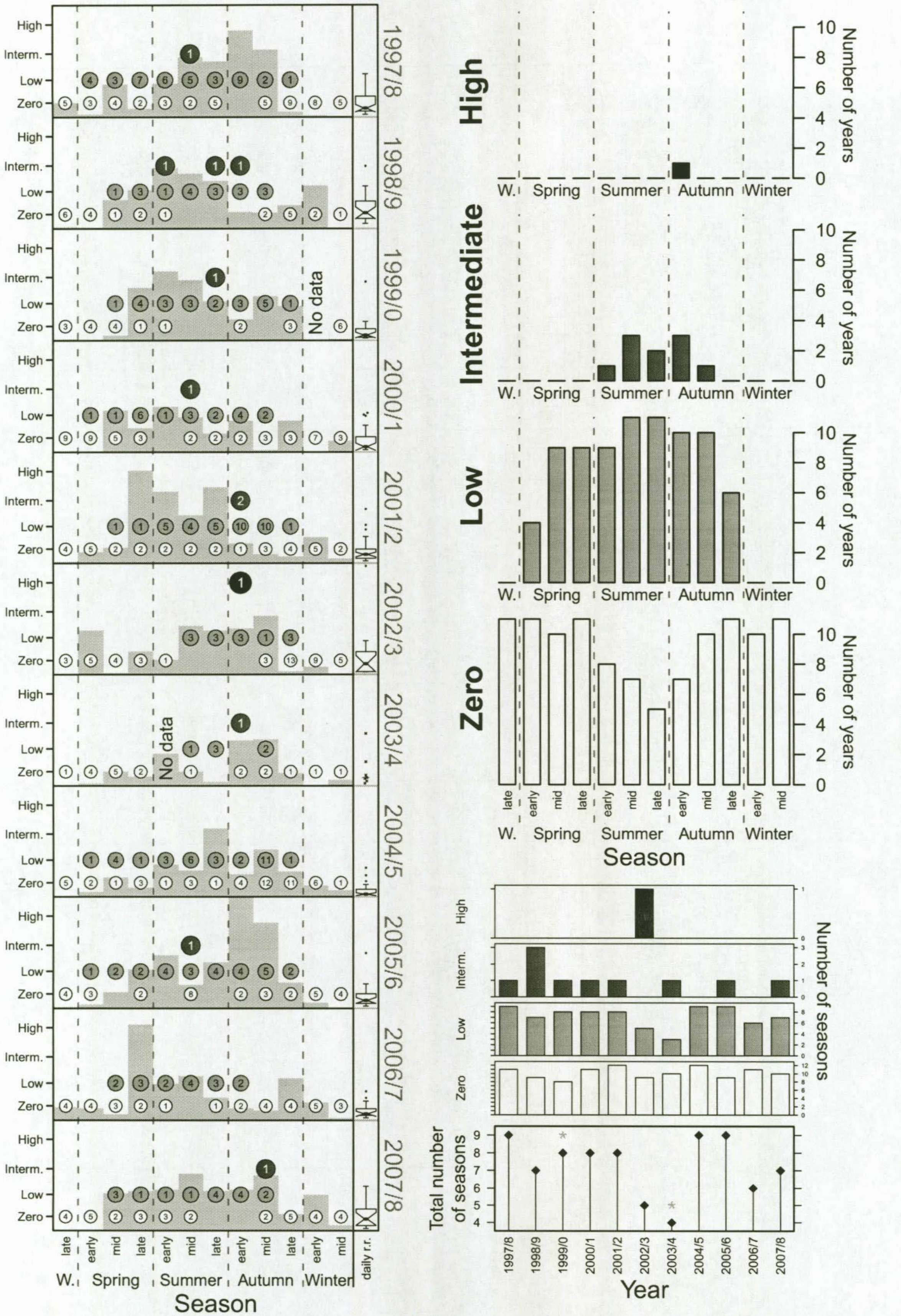


Figure 4.266: R417 Little Swift — birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

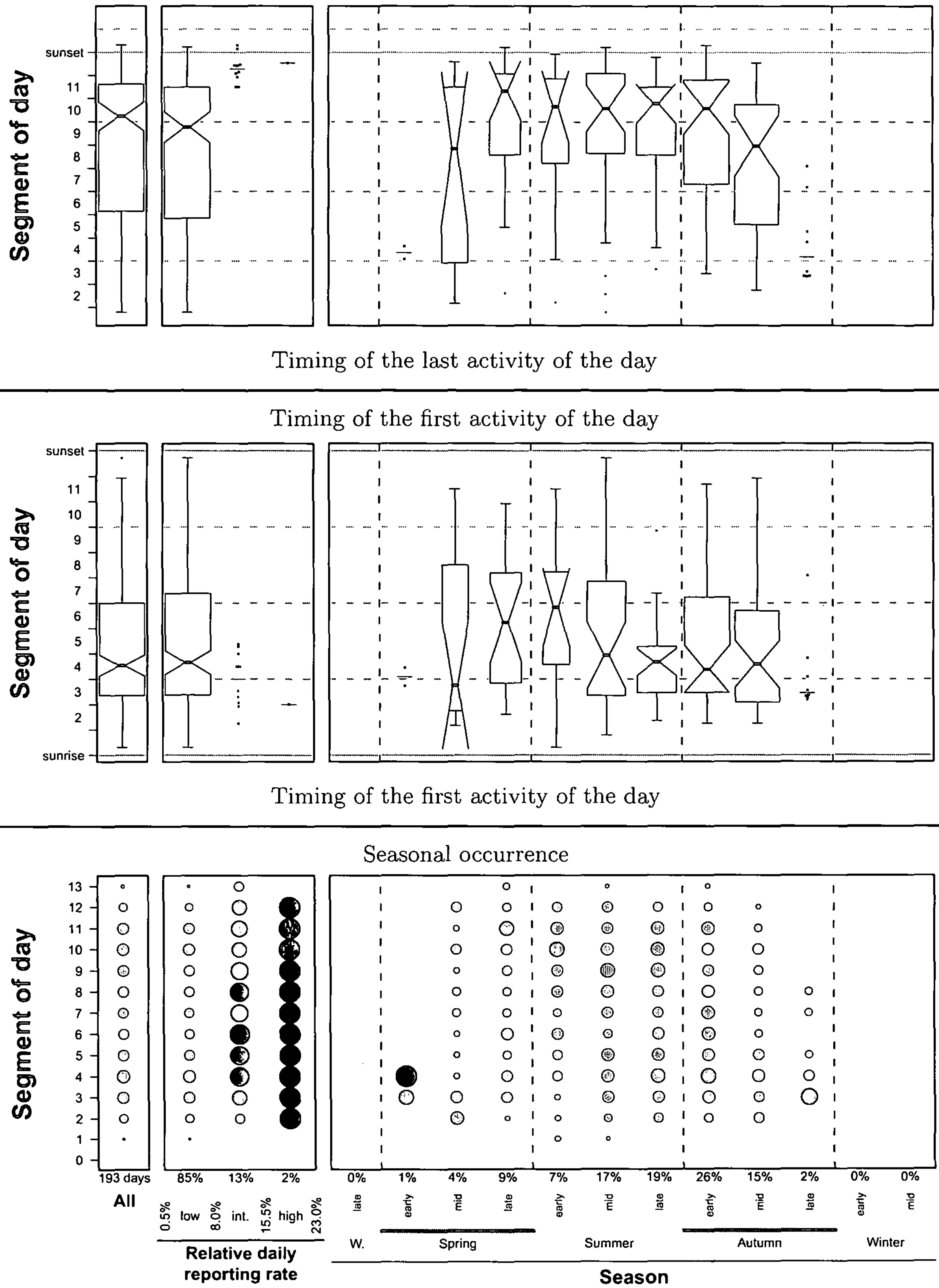


Figure 4.267: R417 Little Swift — birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

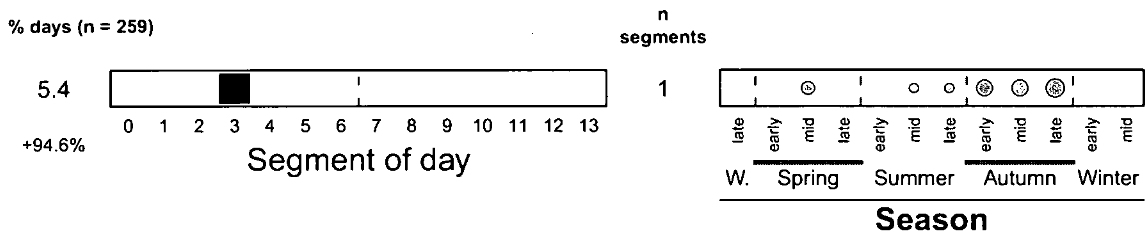


Figure 4.268: R417 Little Swift — birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

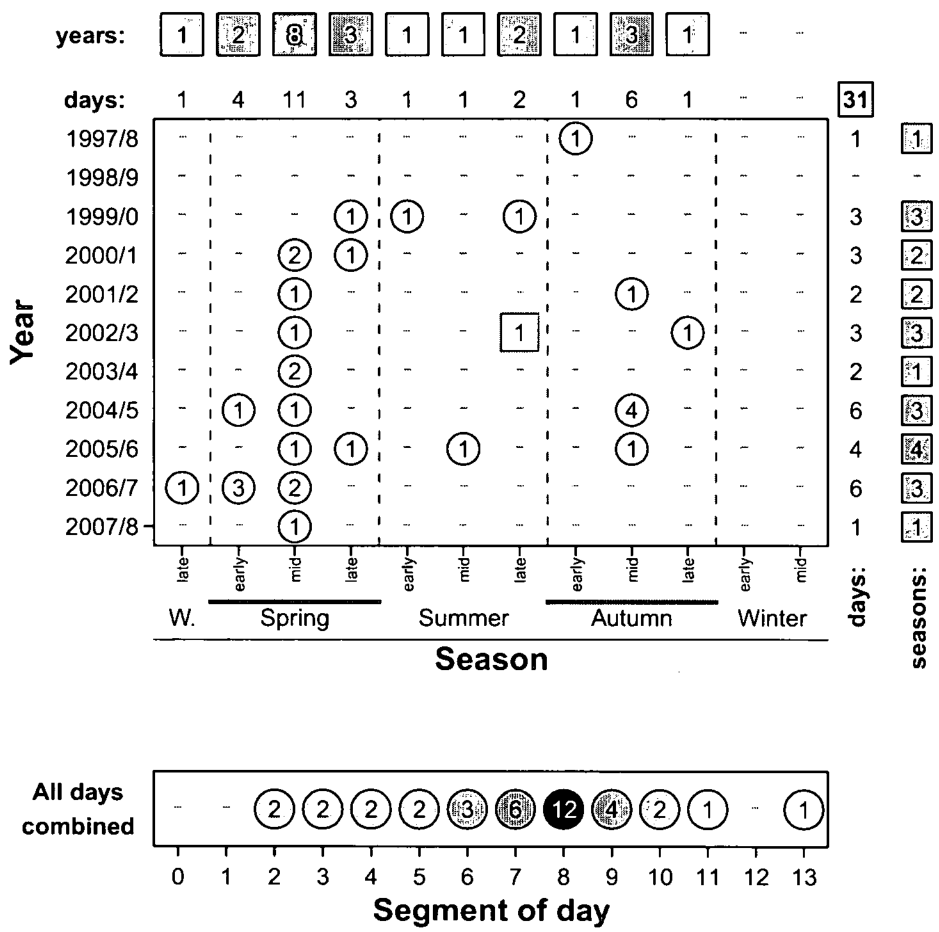


Figure 4.269: R418 Alpine Swift — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Brooke (1997h), occurs particularly during winter. Yet the prominent seasonal peak in mid-spring (Fig. 4.269) demands an explanation.

In Malawi, birds have been noted on southward passage from August to October [spring] and on northward passage from March to April [mid- to late autumn] (Medland 1993), with a similar pattern also observed in Zimbabwe (Brooke 1972; Irwin 1981). In Botswana, passage peaks during September [mid-spring] and, to a lesser extent, in April [late autumn] (Penry 1994). Thus, the well-defined peak at Glen during mid-spring (September) (Fig. 4.269) most probably relates to birds on southward passage. The consistency of their passage during mid-spring indicates that the timing of their migration is fairly tightly controlled by day-length. These passage migrants typically pass through the area in the early afternoon with the mid-spring records contributing half of the records in each of S7, S8 and S9 in Figure 4.269.

R421 African Palm-Swift .... *Cypsiurus parvus*

The African Palm-Swift occurs in Madagascar, sub-Saharan Africa and adjacent islands (Brooke 1971b). In southern Africa, it occurs in parts of northern and central Namibia, northern and eastern Botswana, Zimbabwe, southern Mozambique, Swaziland and in the northern and eastern parts of South Africa (Brooke 1997i; Parker 1999). It is closely associated with palm trees and has expanded its southern African range through using planted flabelliform palm trees and some man-made structures (Brooke 1997i). Normally resident, but Brooke (1997i) suggested that migratory behaviour might develop in response to food shortages at newly colonised areas with cold winters.

The birds at Glen

A scarce bird in the Free State (Earlé & Grobler 1987), the African Palm-Swift breeds in Bloemfontein. The birds seen at Glen almost certainly involve these birds, as it is the closest known breeding site.

Seen in the grassland on four days: mid-spring 2005/6, early summer 2004/5, mid-summer 2000/1 and mid-autumn 2007/8. These sightings occurred during the early morning (S2–S3) and mid-afternoon (S10).

Discussion

According to Vernon & Dean (2005e) African Palm-Swifts disperse from their roost sites by day to "forage over large area, returning to circle around roost at midday and dusk." Assuming that the birds at Glen originated from Bloemfontein, the data suggests a minimum foraging range of approximately 25 km.

4.34 Coliidae: Mousebirds

The order Coliiformes, to which the family Coliidae belongs, is one of only two bird orders endemic to Africa (Hockey *et al.* 2005; Maclean 1990). Three of the six species occur in southern Africa (Hockey *et al.* 2005; Rowan 1967). All three species occur in the Free State (Earlé &

Grobler 1987; Harrison *et al.* 1997a), but the study area is on the western edge of the Speckled Mousebird's *Colius striatus* Free State distribution and was not recorded at Glen.

R425 White-backed Mousebird .... *Colius colius*

The distribution of the White-backed Mousebird stretches from northern Namibia (and possibly bordering Angola, Dean 2000) south into South Africa where it occurs as far east as the east-central parts of the Free State (Dean 1997c). It is absent from the eastern quarter of the Free State, but common in the western and central parts of the province (Dean 1997c; Earlé & Grobler 1987). Associated with woodland habitats, including wooded drainage lines and suburban gardens (Dean 1997c; Earlé & Grobler 1987). Normally resident, but may be locally nomadic in response to food availability (Dean 1997c, 2005c).

The birds at Glen

The White-backed Mousebird is restricted to the drainage line where flocks of up to eight birds were found. The ten records in the grassland refer to birds heard only (Table 4.46a). All but one of these records were before 2002/3, with the records further limited to spring and autumn, and to the early morning and late afternoon (Fig. 4.270).

Table 4.46: R425 White-backed Mousebird: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	11	114 612	0.0	birds heard	1.5	656	10	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	79	1 190	6.6	birds heard	53.5	43	23	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
–	–	–	–	No Records	–	–	–	–

Early morning occurrence of birds heard in 2007/8: Recorded in the drainage line only (Table 4.46b & c). Not recorded during spring with the occurrence of high reporting rate days limited to late summer and those of intermediate reporting rate days to late summer, autumn and winter (Fig. 4.271). The first activity of the day usually occurred within 20 minutes either side of sunrise (Fig. 4.271). Activity intensities are similar before and after sunrise (Fig. 4.271).

Discussion

Subsequent observations during 2008/9 indicate that the White-backed Mousebird is present in the drainage line throughout the year, but that they are not vocally active at times. It follows that the data collected in the drainage line (Fig. 4.271) is representative of vocal activity only and does not necessarily relate to changes in abundance.

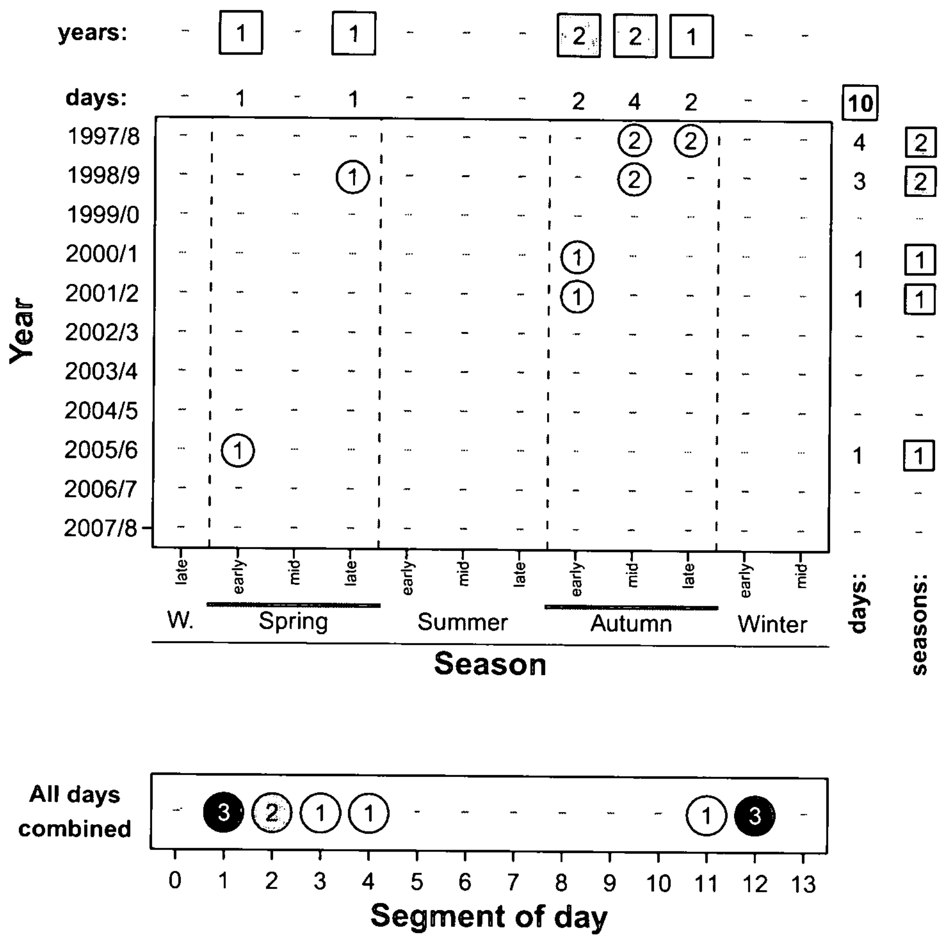
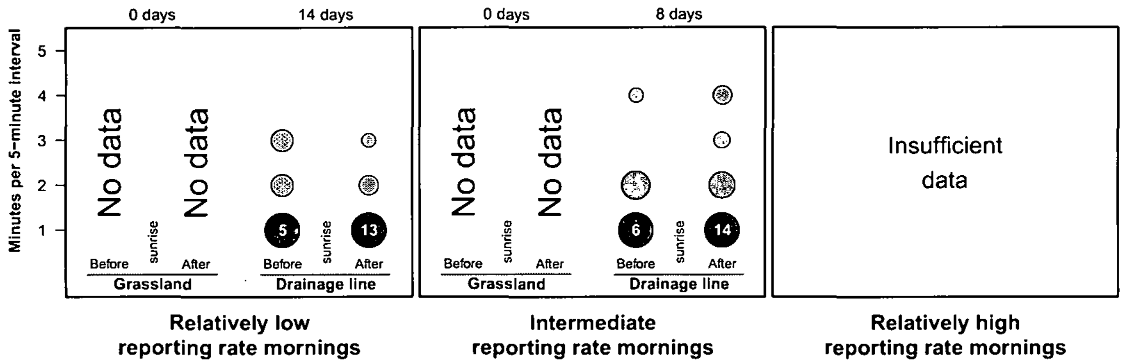


Figure 4.270: R425 White-backed Mousebird — birds heard: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Breeding occurs year-round with a peak from September to December [mid-spring to early summer] (Dean 2005c; Rowan 1967). Limited data suggests that flight feather moult occurs mainly from December to May [mid-summer to early winter] (Dean 2005c; Rowan 1967; DJvN unpublished data). Assuming these periods to be typical for the birds at Glen, it seems that activity in the drainage line (Fig. 4.271) was minimal during breeding and higher during moulting.

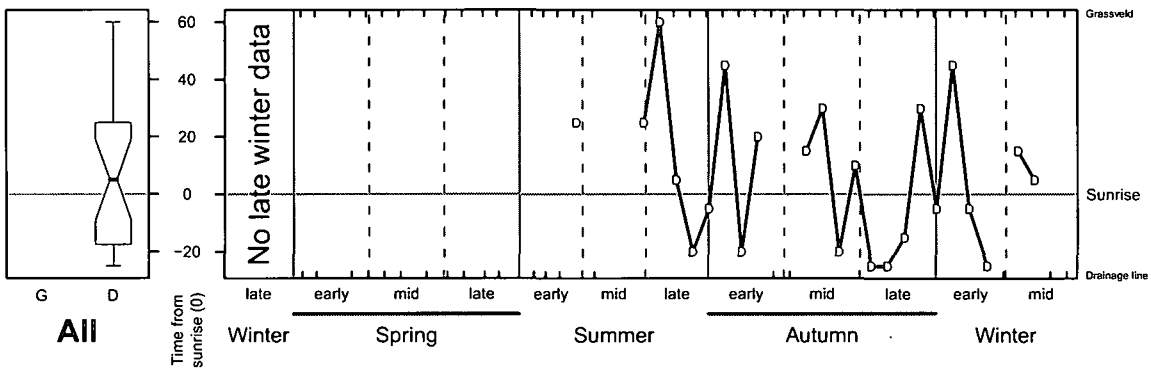
R426 Red-faced Mousebird .... *Urocolius indicus*

The Red-faced Mousebird is endemic to Africa south of the equator (Maclean 1985). It is widespread in all southern African countries, except Lesotho (Dean 1997c; Parker 1999). Found in woodland habitats, including drainage lines and suburban gardens (Maclean 1985). It is a common temporary resident in the Free State where suitable habitat and feeding areas occur (Earlé & Grobler 1987).



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

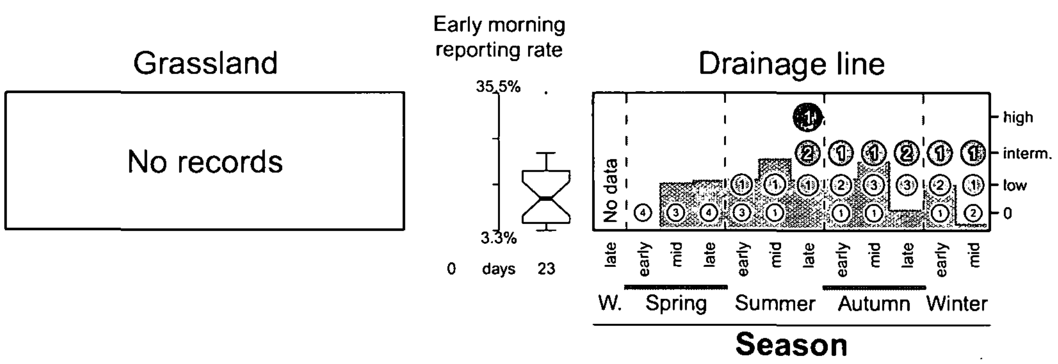


Figure 4.271: R425 White-backed Mousebird — birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

The birds at Glen

The Red-faced Mousebird is mainly associated with the drainage line. However, birds were also recorded in the grassland. Overall, flock size varied from one to 18 birds (Fig. 4.272). Almost all of the flocks seen in the drainage line during the early mornings of 2007/8 were flying south-west → north-east, obviously commuting between roosting area somewhere to the south-west and feeding areas eastward. Observations during 2008/9 showed that a fair proportion of the birds originate from somewhere more than 1 km south-west of the farm dam.

The grassland records were of two types: 1) birds heard and not seen; 2) birds seen and heard. While the first type presumably involves birds in the drainage line, the second type involved birds flying over the grassland. The two types are analysed separately. The incidence of birds heard only constituted the bulk of the grassland data-set (97.2%; Table 4.47a). The analysis is based on a year starting in late summer. Figures start on page 502.

Table 4.47: R426 Red-faced Mousebird: Numerical data summary of 5-minute checklists compiled in the study area at Glen (DL=drainage line).

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.972	1 365	114 612	1.2	DL birds heard	44.4	656	291	5
0.028	40	114 612	0.0	seen in grassland	5.0	656	33	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.786	224	1 190	18.8	DL birds heard	86.0	43	37	6
0.214	61	1 190	5.1	seen in grassland	44.2	43	19	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	38	1 188	3.2	DL birds heard	34.9	43	15	3

Annual occurrence in the grassland of birds heard only: Heard on 44.4% of the days with an activity index of five (Table 4.47a). Activity was recorded during only 5–6 seasons per year in 2000, 2002, and 2004, but in 9–12 seasons in other years (Fig. 4.273; Fig. 4.274), a contrast also discernible in the annual frequency indices which were lower during these three years (Fig. 4.273). Overall, daily reporting rates ranged from 0.5 to 16.9% with 86.4% of the bird-days attaining relatively low values (Fig. 4.273). The median daily reporting rates of most years were comparable, the exceptions being 2001 and particularly 2003 which had relatively higher values (Fig. 4.273). The latter two years together with 2006 were also the only years with high reporting rate days (Fig. 4.273; Fig. 4.274).

Seasonal occurrence in the grassland of birds heard only: Recorded during all seasons, normally during 7–8 years per season, but during only 5–6 years in early and mid-summer, and during 9–10 seasons in early and mid-autumn (Fig. 4.273). A similar trend is indicated by the seasonal frequency index (Fig. 4.273). Median daily reporting rates were particularly high in late autumn and early winter (Fig. 4.273), coinciding with the occurrence of high and intermediate reporting rate days which peaked during late autumn (Fig. 4.274). Late autumn also showed the lowest incidence of days with zero records (Fig. 4.274).

Daily occurrence in the grassland of birds heard only: Overall, most frequently recorded during the first half of the morning after sunrise and in the late afternoon before sunset (Fig. 4.273). A similar pattern is seen for low, intermediate as well as high reporting rate days (Fig. 4.275), and during most seasons, although the peak in the morning tends to dominate (Fig. 4.276). Segment combinations occurring on at least 5% bird-days were limited to activity during single morning segments (S1–S3) and S12; collectively, these combinations accounted for more than a quarter of all bird-days (Fig. 4.277).

The first activity of the day was usually sometime during the morning, frequently occurring earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.276). Seasonally, activity tended to start earlier during late autumn and early winter than during mid-winter, late spring and summer (Fig. 4.276).

The occurrence of the last activity of the day was more variable and occurred throughout the day, although it did tend to occur towards the end of the day on intermediate and especially high reporting rate days (Fig. 4.276). The pattern was also variable seasonally, tending to occur earlier in the day during winter, early and mid-spring than during other seasons (Fig. 4.276).

Overall, daily segment reporting rates ranged from 5.9 to 100% with 94.0% of the values relatively low (Fig. 4.273). Except for S0, which had a relatively low value, the median daily segment reporting rates of all other segments were similar to one another (Fig. 4.273). This pattern was the same regardless the magnitude of the daily reporting rate (Fig. 4.275).

Early morning occurrence during 2007/8 of drainage line birds heard: Activity occurred much more frequently in the drainage line (86.0% vs. 34.9% bird-mornings; Table 4.47b & c). Nonetheless, both habitats indicate a similar seasonal pattern with intermediate and high reporting rates restricted to the period from late autumn to early spring in the drainage line, and activity in the grassland restricted to a similar period (Fig. 4.278). The timing of the first activity of the day was often noted earlier in the drainage line than in the grassland, but nevertheless followed the same general trend with activity occurring earlier during the peak period than at other times (Fig. 4.278). In the drainage line, activity intensity tended to be slightly higher after sunrise (Fig. 4.278).

Birds seen (and heard) in the grassland. Seen on 5.0% of the days with an activity index of one (Table 4.47a). Recorded during all years except 2005 (Fig. 4.279). Seen on 1–2 days in 2000, 2002 and 2004 compared to the remainder of the years when seen during 4–5 days (Fig. 4.279). Seasonally, recorded during 0–2 years from early summer to mid-winter and during 3–4 years in late winter and spring (Fig. 4.279). Activity occurred mainly in the morning and late afternoon (Fig. 4.279).

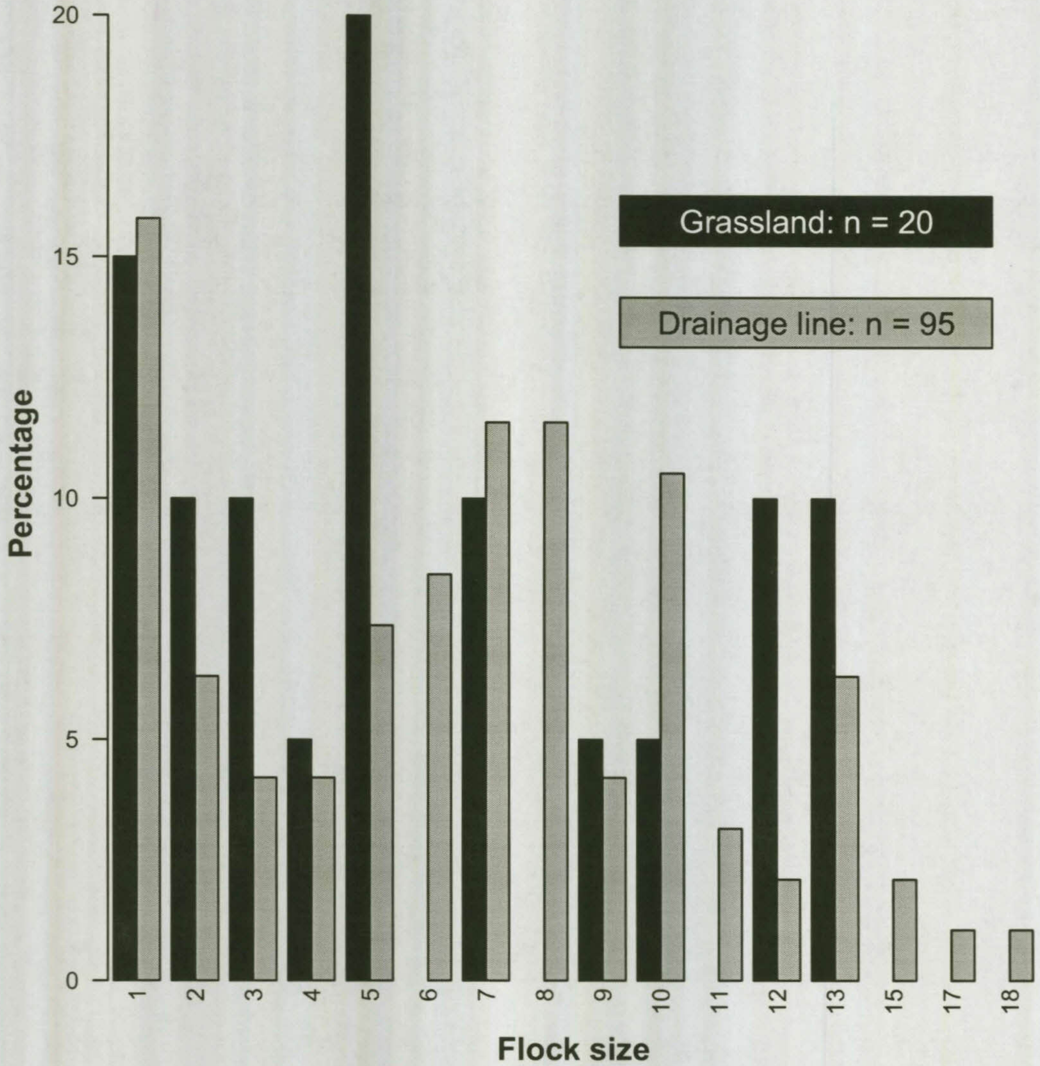


Figure 4.272: R426 Red-faced Mousebird: Flock size of birds seen in the study area at Glen.

Discussion

Although the grassland data-set underestimated the activity of the Red-faced Mousebirds in the drainage line (Table 4.47b & c), the data is apparently sufficient to assess seasonal trends (Fig. 4.278).

Breeding occurs mainly from September to January [mid-spring to late summer] followed by a complete moult from November to April [summer and autumn] (Rowan 1967). It seems, therefore, that the peak in activity during the transition form autumn to winter at Glen is associated with the end of moult, with a smaller peak associated with the beginning of breeding during spring, followed by a relatively quiet period in summer, presumably related to moult (Fig. 4.273; Fig. 4.274; Fig. 4.278).

Maclean (1985) stated that the Red-faced Mousebirds is a "Common resident; somewhat nomadic". Dean (1997d) similarly claimed that they are "locally nomadic". In the Free State, Earlé & Grobler (1987) summarised the situation thus:

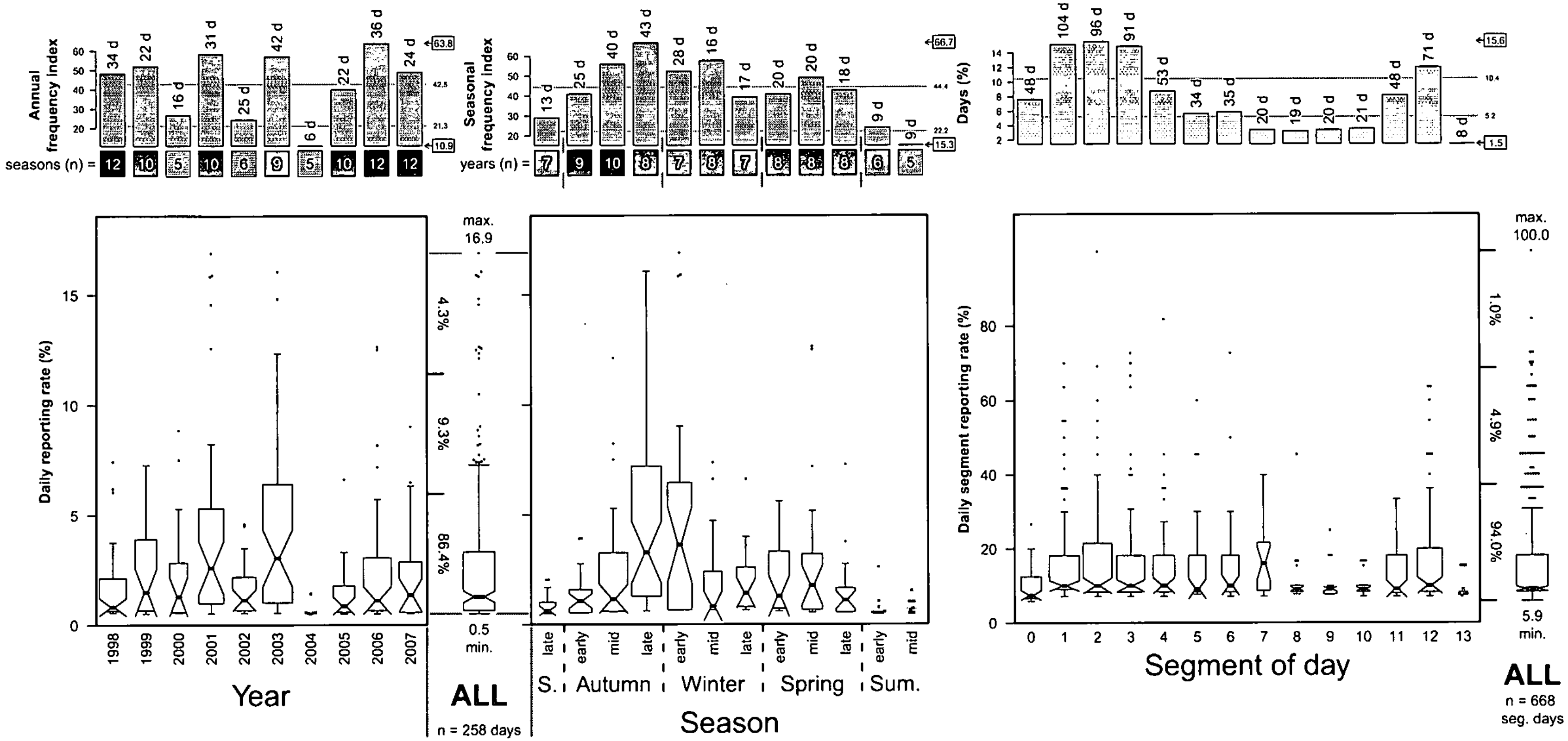


Figure 4.273: R426 Red-faced Mousebird — drainage line birds heard: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

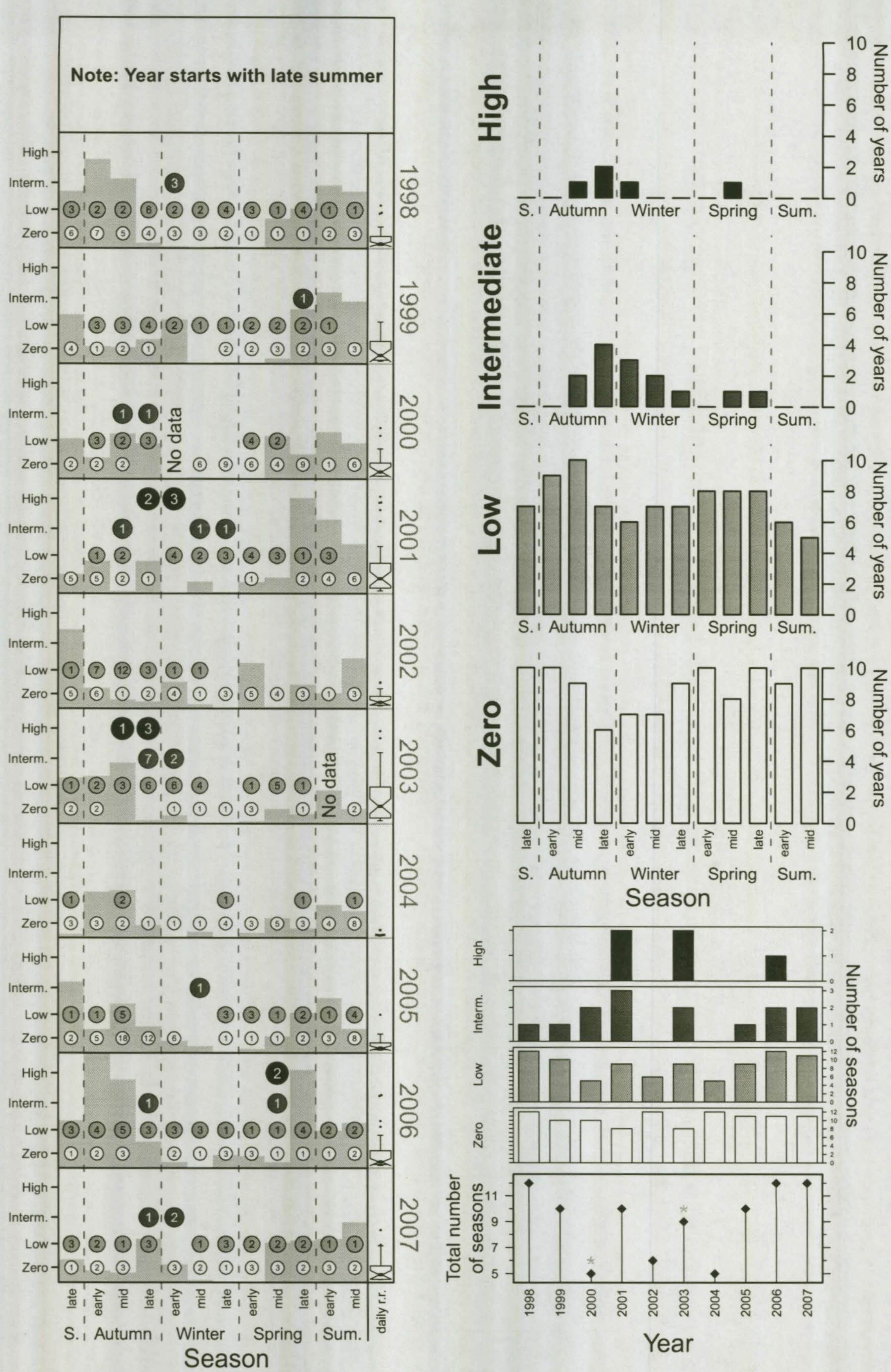


Figure 4.274: R426 Red-faced Mousebird — drainage line birds heard: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

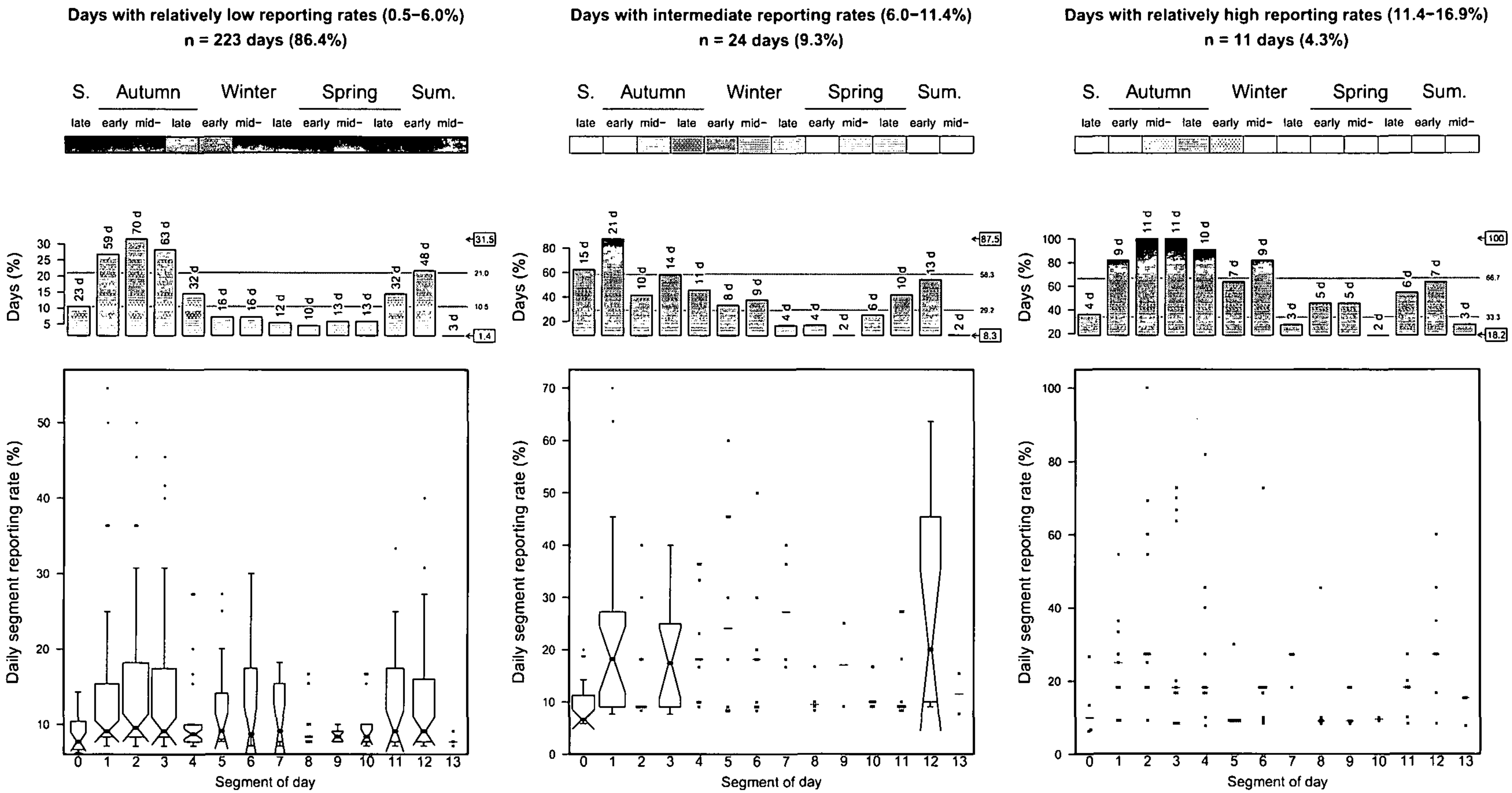


Figure 4.275: R426 Red-faced Mousebird — drainage line birds heard: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

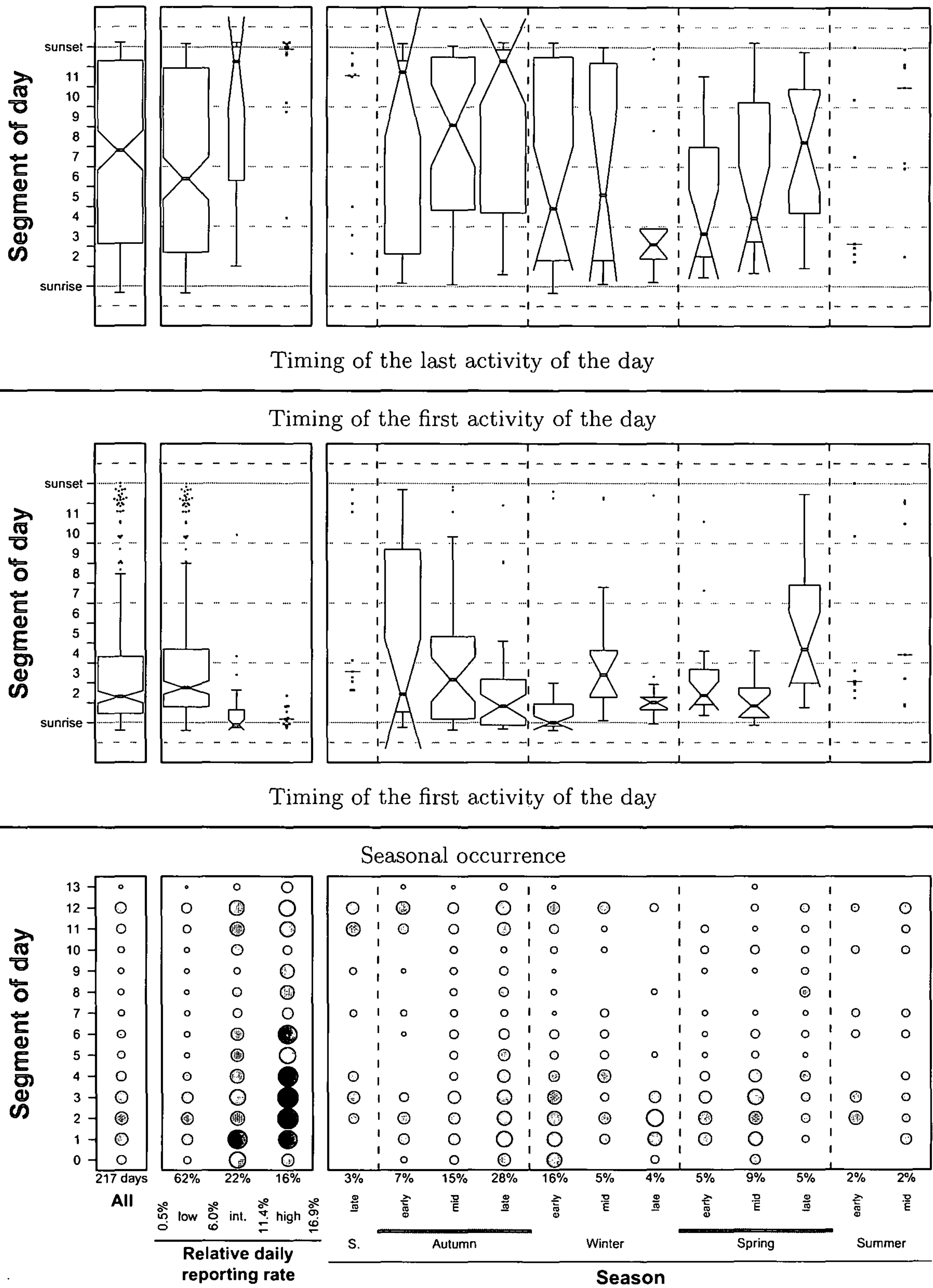


Figure 4.276: R426 Red-faced Mousebird — drainage line birds heard: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

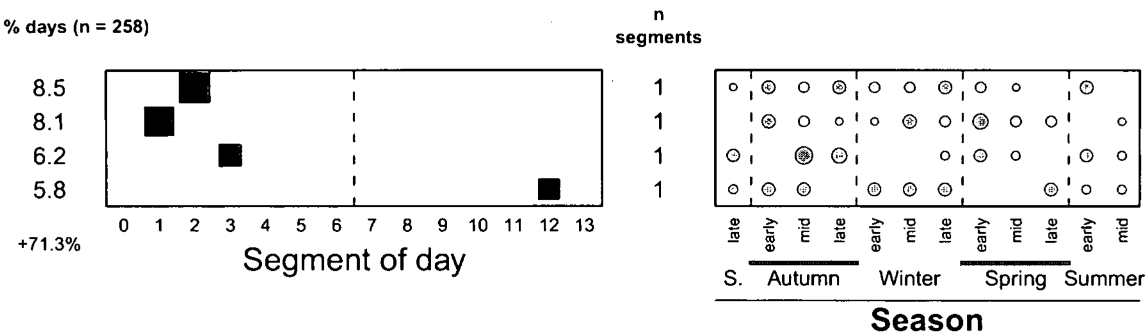


Figure 4.277: R426 Red-faced Mousebird — drainage line birds heard: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

> "A common resident over most of the Free State but absent from the open grassland of the Riemland area. Often nomadic, moving in flocks to suitable feeding sites where it will then be very common as long as conditions are favourable."

At Glen, the Red-faced Mousebird is a resident in the drainage line, with influxes in certain years from the latter part of autumn (Fig. 4.274; Fig. 4.278; Fig. 4.279), presumably representing post-moult dispersal.

4.35 Dacelonidae: Dacelonid Kingfishers

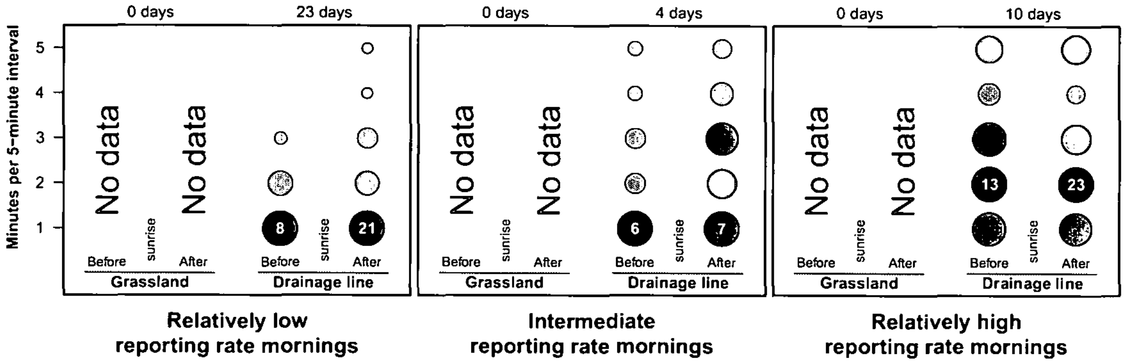
These medium-sized to large kingfishers occur in Africa, Asia, Australasia and Oceania, with five of the 61 species occurring in southern Africa (Hockey *et al.* 2005). The Brown-hooded Kingfisher is the only species that regularly occur in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a).

R435 Brown-hooded Kingfisher .... *Halcyon albiventris*

The Brown-hooded Kingfisher is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa it occurs in a broad band along the coast from the Cape eastward through Swaziland into the former Transvaal, Mozambique, Zimbabwe and the northern and eastern parts of Botswana, with an isolated population also in northern Namibia (Clancey 1997a). It also occurs in the northern, north-western and central parts of the Free State (Clancey 1997a), with Glen situated on the southern edge of its Free State distribution. It is associated with thickets in woodland type habitats where it hunts mostly terrestrial prey (Maclean 1985). The subspecies occurring in the Free State, *H. a. vociferans*, is probably resident (Clancey 1997a).

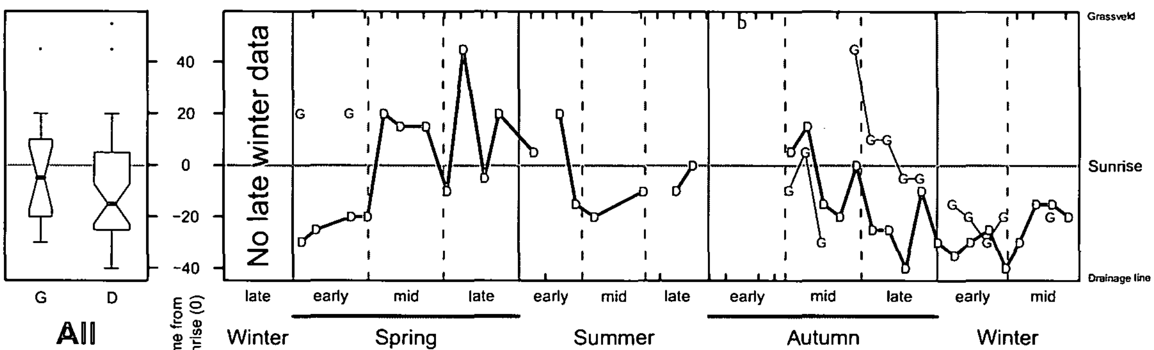
The birds at Glen

This species has been recorded along the Modder River (Clancey 1997a; De Swardt 2000), which at it closest approach is approximately 5 km south-west of the study area (Fig. 2.2). De Swardt (2000) has found them to be a common resident along this river in Soetdoring Nature Reserve, which is situated approximately 30 km west-north-west of the study area. They were



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

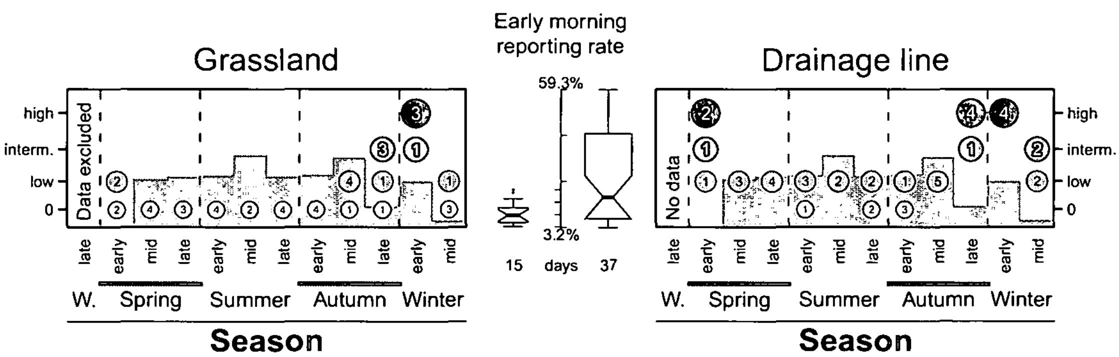


Figure 4.278: R426 Red-faced Mousebird — drainage line birds heard: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

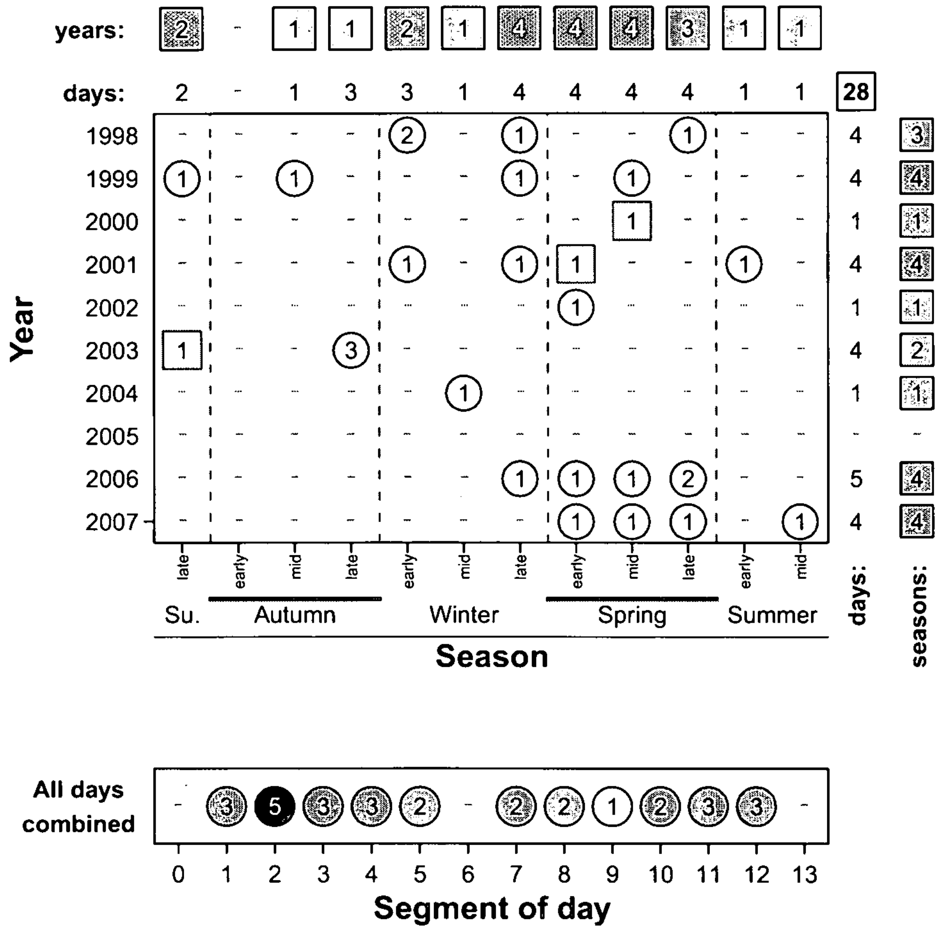


Figure 4.279: R426 Red-faced Mousebird — seen in grassland: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

recorded in Glen village recently (P. Goosen personal communication). At Glen an individual was heard calling from the drainage line once, in early spring 2006/7.

4.36 Meropidae: Bee-eaters

Bee-eaters specialise on flying venomous Hymenoptera (ant, bees, wasps) for food (Fry 1985). The 26 species occur in tropical and subtropical Eurasia, Africa and Australia, with nine species occurring in southern Africa (Hockey *et al.* 2005). Four species occur in the Free State (Harrison *et al.* 1997a) of which only the Blue-cheeked Bee-eater *Merops persicus* was not recorded at Glen. The Free State distribution of the Blue-cheeked Bee-eater is limited to localities along the Vaal River in the north-western parts of the province (Earlé & Grobler 1987; Harrison *et al.* 1997a).

R438 European Bee-eater .... *Merops apiaster*

The European Bee-eater occurs from the Palearctic to Pakistan and India, and in Africa (Cramp 1998; Grimmett *et al.* 1999). It is widespread in southern Africa but notably scarce or absent in certain western parts, Lesotho and South Africa from the eastern half of the Free State eastward

(Earlé & Grobler 1987; Parker 1999; Underhill 1997b). It occurs in a variety of woodland and shruby habitats (Maclean 1985). Two populations occur in southern Africa during the warmer parts of the year: non-breeding visitors from the Palearctic (most birds occurring in southern Africa are from there) and breeding intra-Africa migrants (Brooke & Herroelen 1988; Underhill 1990, 1997b). In SABAP1 Zone 7 they are present from September to April [mid-spring to late autumn] (Underhill 1997b).

The birds at Glen

Most European Bee-eater records at Glen refer to birds heard, often in high-flying flocks. The analysis combines all the data. Figures start on page 512.

Annual occurrence of birds in the grassland: Recorded on 35.1% of the days with an activity index of 12 (Table 4.48a). Usually recorded during 4–6 seasons each year, but during 7–8 seasons in 2000/1 and 2004/5–2005/6 (Fig. 4.280; Fig. 4.281). However, median daily reporting rates and especially the limits of the upper quartile were higher in 1997/8, 2001/2, 2002/3, 2006/7 and 2007/8 than during other years (Fig. 4.280); these were also the only years with high reporting rate days (Fig. 4.281).

Table 4.48: R438 European Bee-eater: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	2 712	114 612	2.4	birds present	35.1	656	230	12
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	20	1 190	1.7	birds present	18.6	43	8	2
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	29	1 188	2.4	birds present	20.9	43	9	3

Seasonal occurrence of birds in the grassland: The arrival of the first birds are very well synchronised, occurring in a 15 day period during the first part of mid-spring (median date: 15 September; Fig. 4.282). Departure dates was variable and spanned a 105 day period from late summer to late autumn (Fig. 4.282). Activity was thus restricted to the period from mid-spring to late autumn, with a definite peak in occurrence from mid-spring to late summer (Fig. 4.280; Fig. 4.281).

Daily occurrence of birds in the grassland: Overall, activity was relatively infrequent before sunrise and after sunset, with activity otherwise tending to be more frequent around mid-morning and in the late afternoon (Fig. 4.280). The pattern was similar for low and intermediate reporting rate days (Fig. 4.283), as well as for the respective seasons (Fig. 4.284). No segment combinations occurred during more than 5% bird-days.

The first activity of the day usually occurred during the morning, typically earlier on intermediate and high reporting rate days than on low reporting rate days (Fig. 4.284). The seasonal pattern suggests four periods with the timing relatively later during early summer and in autumn than in spring, mid- and late summer (Fig. 4.284).

The last activity of the day often occurred during the late afternoon, especially on intermediate and high reporting rate days (Fig. 4.284). There is also a well-defined seasonal pattern with the last activity of the day occurring mainly in the late afternoon during spring and summer, and earlier in the day during autumn (Fig. 4.284).

Overall, daily segment reporting rates ranged from 5.0 to 100% with 84.9% of the values relatively low and the median daily segment reporting rate of S12 slightly higher than that of other segments (Fig. 4.280). This general pattern most closely resembles the situation for low reporting rate days (Fig. 4.283). Intermediate reporting rate days also show a relatively high median daily segment reporting rate for S12, but additionally also have relatively high median daily segment reporting rates around mid-morning (Fig. 4.283).

Early morning occurrence of birds during 2007/8. Although activity was recorded on nearly the same number of days in the drainage line and the grassland (8 vs. 9 bird-days; Table 4.48b & c), and peaked during the same season (early summer; Fig. 4.285), there are nonetheless a few subtle differences. These include the activity index which was slightly higher in the grassland (3 vs. 2; Table 4.48b & c), and activity which was noted in the drainage line during three seasons compared to five in the grassland (Fig. 4.285). The first activity of the day typically occurred later in the drainage line than in the grassland (Fig. 4.285).

Discussion

The narrow window of arrival of the European Bee-eaters at the beginning of mid-spring (Fig. 4.282) indicates that it is tightly controlled by day-length.

Rainfall probably influenced the occurrence of the European Bee-eater at Glen. Note in particular that the daily reporting rates were generally higher during years with above average rainfall. However, this relationship is not as simple as it first appears.

In 1997/8, peak activity occurred during mid- and late spring, before the main rain of that year (Fig. 4.281). This peak in occurrence was possibly influenced by the exceptional rains of the previous year, 1996/7, which was the wettest year since 1988/9 (Fig. 2.13). The next peak in activity occurred during 2001/2 (Fig. 4.280), also an above average rainfall year (Fig. 2.13). In that year, the activity peaked during summer after good rains in late spring, which continued through summer (Fig. 4.281). The daily reporting rates of the following year, 2002/3, were also relatively high (Fig. 4.280), but only one day with a relatively high reporting rate occurred (Fig. 4.281).

The highest rainfall during the study period was recorded during 2005/6 (Fig. 2.13). However, its daily reporting rates were generally low compared to those of the years discussed above (Fig. 4.280). This is, perhaps, not surprising given the fact that: 1) the previous three years experienced below average rainfall (Fig. 2.13), and 2) the main rainfall events of 2005/6 occurred only during autumn (Fig. 4.281), presumably too late to be exploited by the bee-eaters. However,

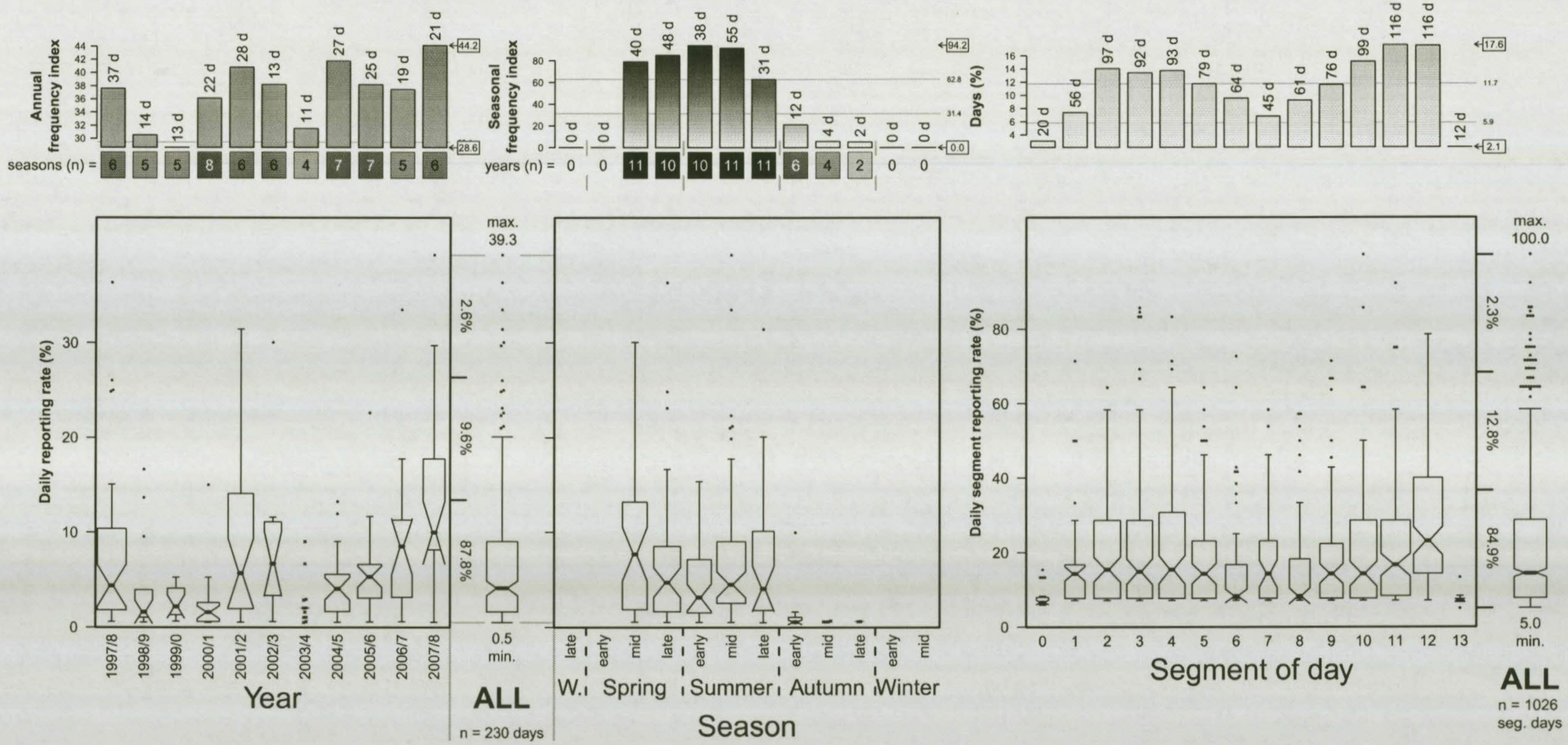


Figure 4.280: R438 European Bee-eater — birds present: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

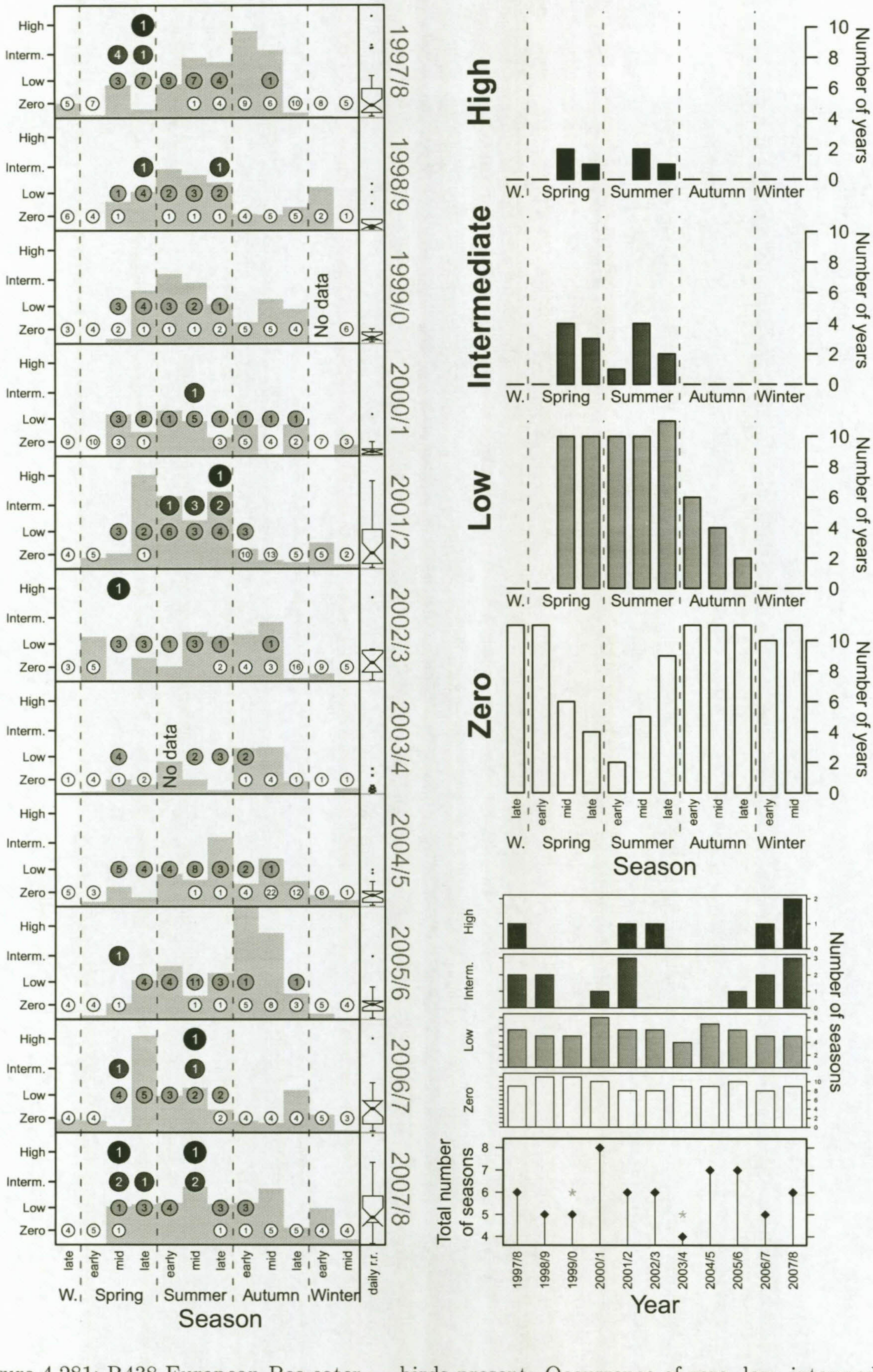


Figure 4.281: R438 European Bee-eater — birds present: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

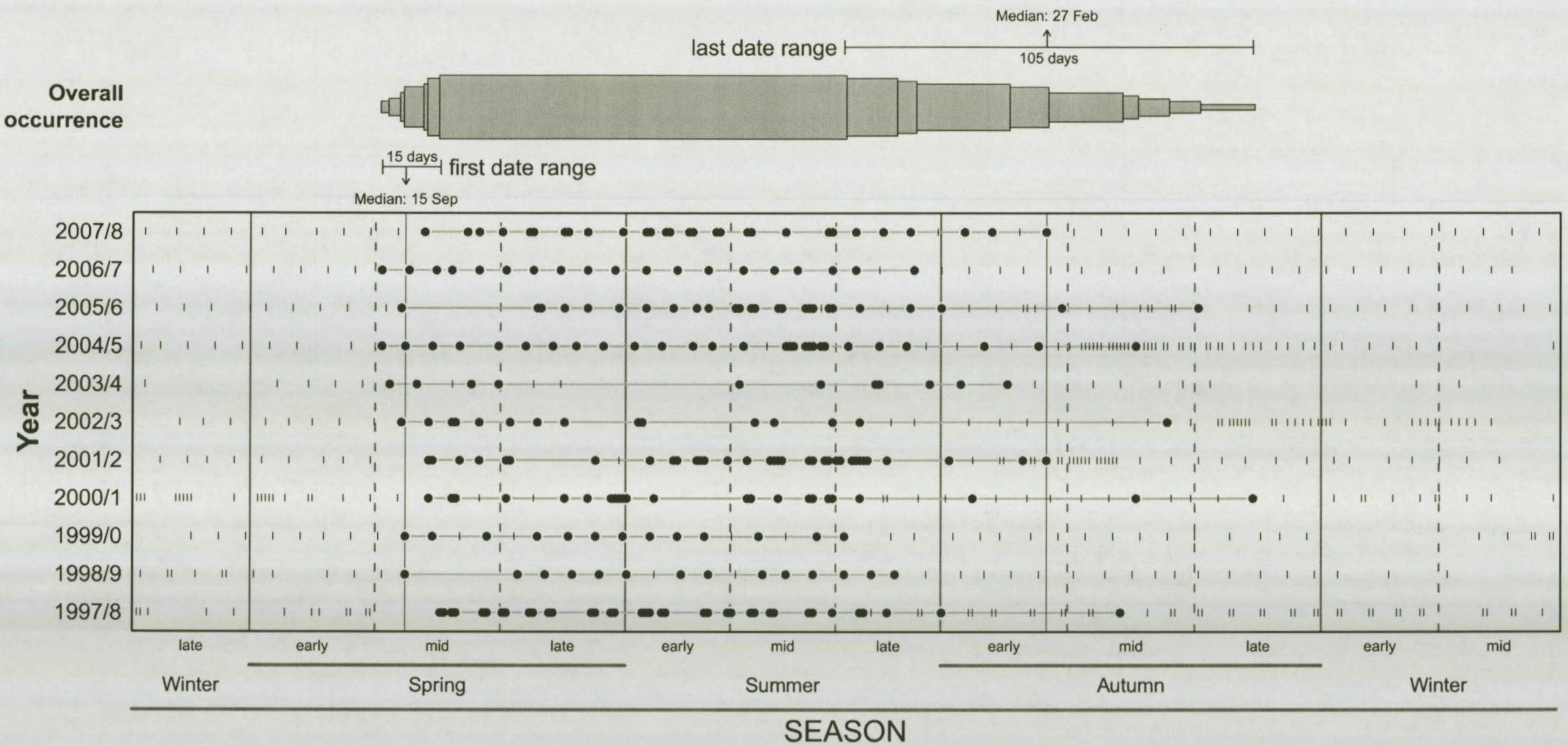


Figure 4.282: R438 European Bee-eater: Arrival and departure dates in the grassland at Glen. See page 134 for more information on this migration figure.

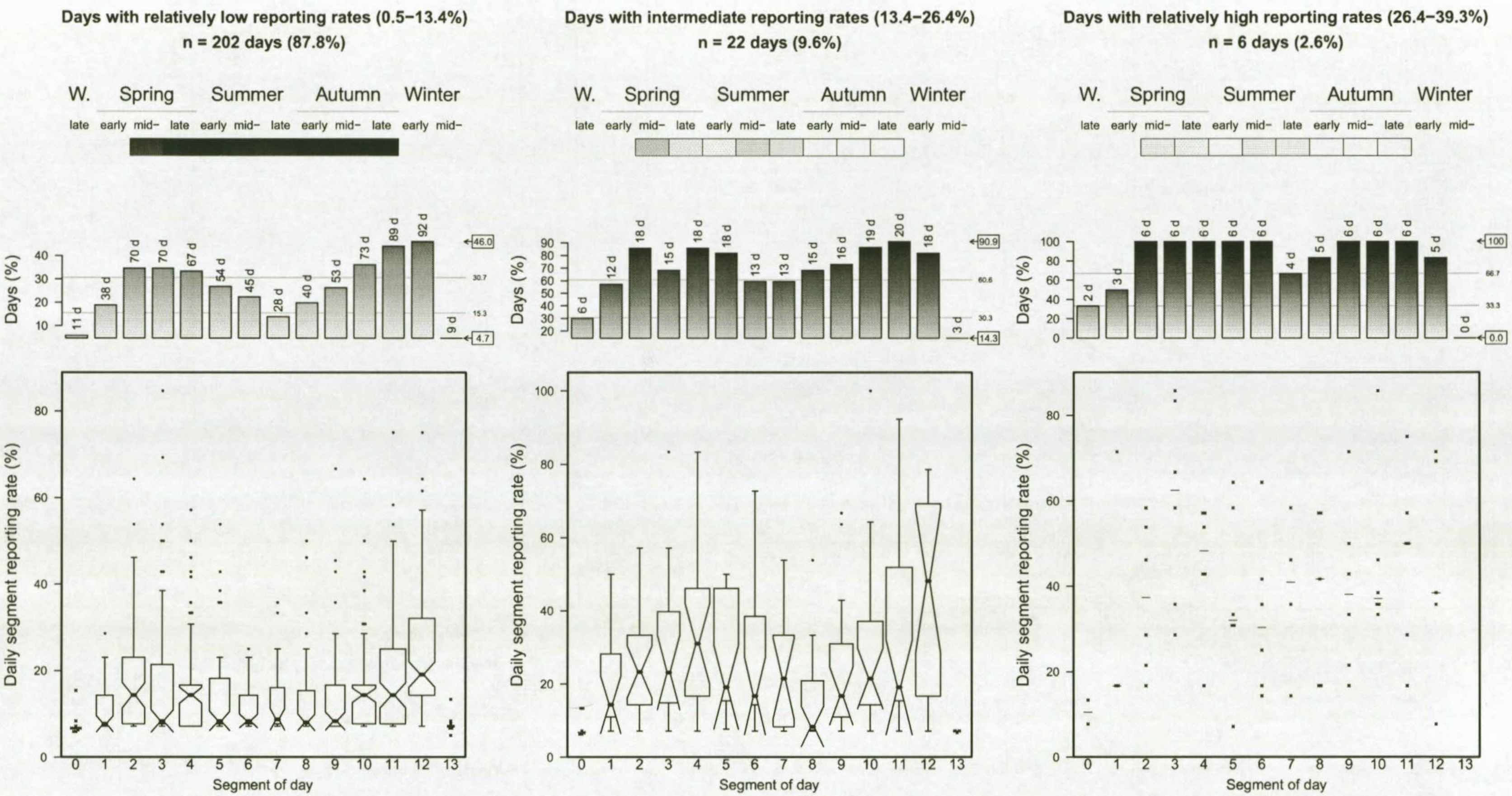


Figure 4.283: R438 European Bee-eater — birds present: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

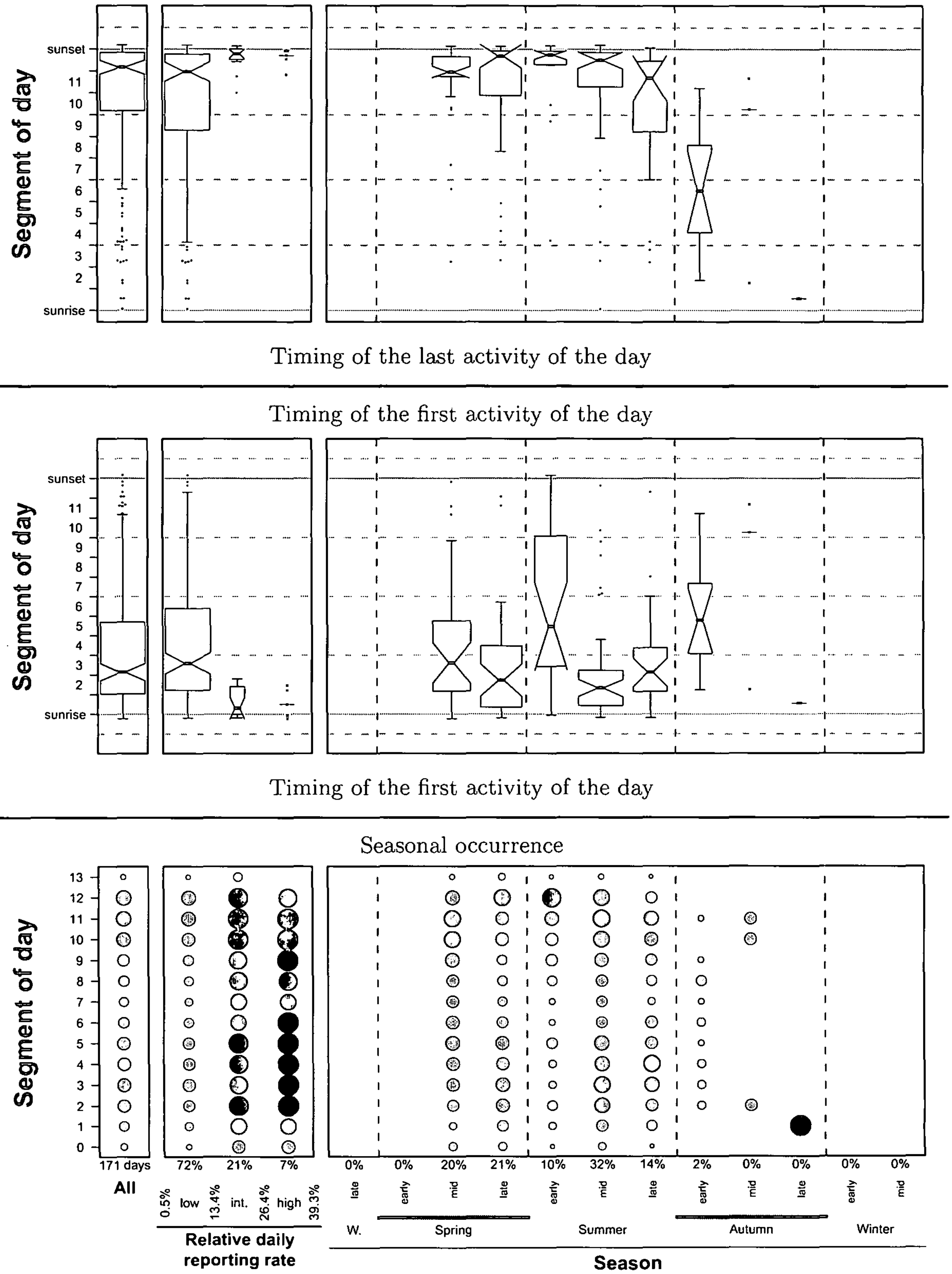


Figure 4.284: R438 European Bee-eater — birds present: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

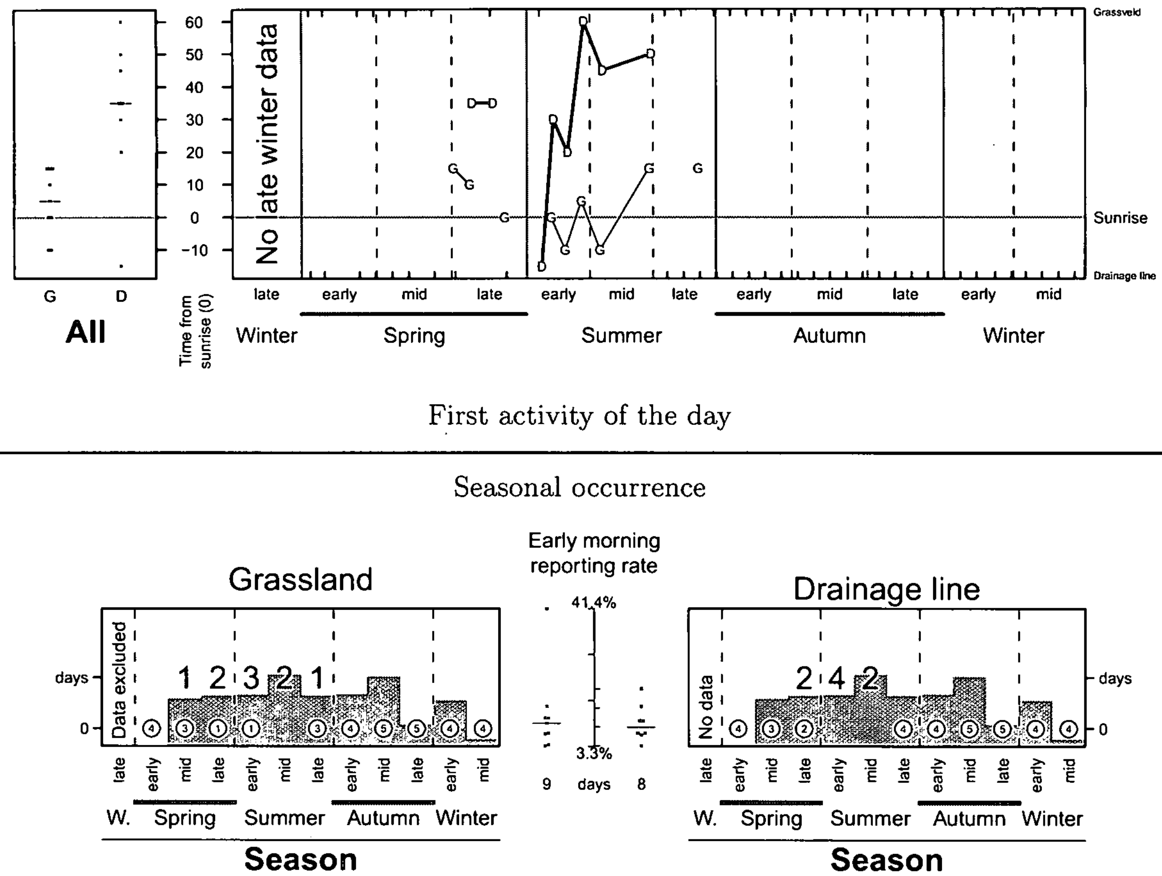


Figure 4.285: R438 European Bee-eater — birds present: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Top: Occurrence of the first activity of the day. See page 136 for more information on this early morning figure.

daily reporting rates were again relatively high in 2006/7, which year experienced good rains in early spring only (Fig. 4.281). As was the case in 1997/8, it is suggested that the 2006/7 peak was partially influenced by the good rains of the previous year. The rains of 2007/8 were exceptional in that no less than eight seasons received 58–91 mm rain (Fig. 2.18). It was also the year with the highest median daily reporting rate (Fig. 4.280).

R443 White-fronted Bee-eater .... *Merops bullockoides*

The White-fronted Bee-eater is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa, it occurs mainly in northern Botswana, Zimbabwe and Swaziland, and in South Africa mainly north of 26°S, in the northern parts of KwaZulu-Natal, and with a fairly isolated population along the Vaal, Riet, Modder and Vet river systems in central and north-western Free State (Barnes 1997). The present study area is situated on the southern limit of their distribution. It is typically found along woodland-fringed watercourses (Maclean 1985). The bee-eaters are sedentary with possible dispersion form breeding sites during the dry season (Barnes 1997).

The birds at Glen

The White-fronted Bee-eater occurs along the Modder River, with breeding recorded near Glen village (P. Goosen, personal communication). All records refer to birds seen and/or heard, with all the data combined for analysis. The analysis is based on a year starting in late summer.

It became more frequent since it was first recorded during 2003/4 (Fig. 4.286). All records are from mid-autumn to mid-spring, with a peak in occurrence during late winter and early spring (Fig. 4.286). Recorded only between mid-morning and late afternoon (Fig. 4.286).

Discussion

According to Barnes (2005), White-fronted Bee-eaters seldom wander more than 3–7 km from their breeding colony. The birds encountered at Glen most probably involve birds from the nearby Modder River. They are also known to be more frequent at Glen village during the cooler part of the year (P. Goosen, personal communication). Overall, the data suggests short distance post-breeding dispersal.

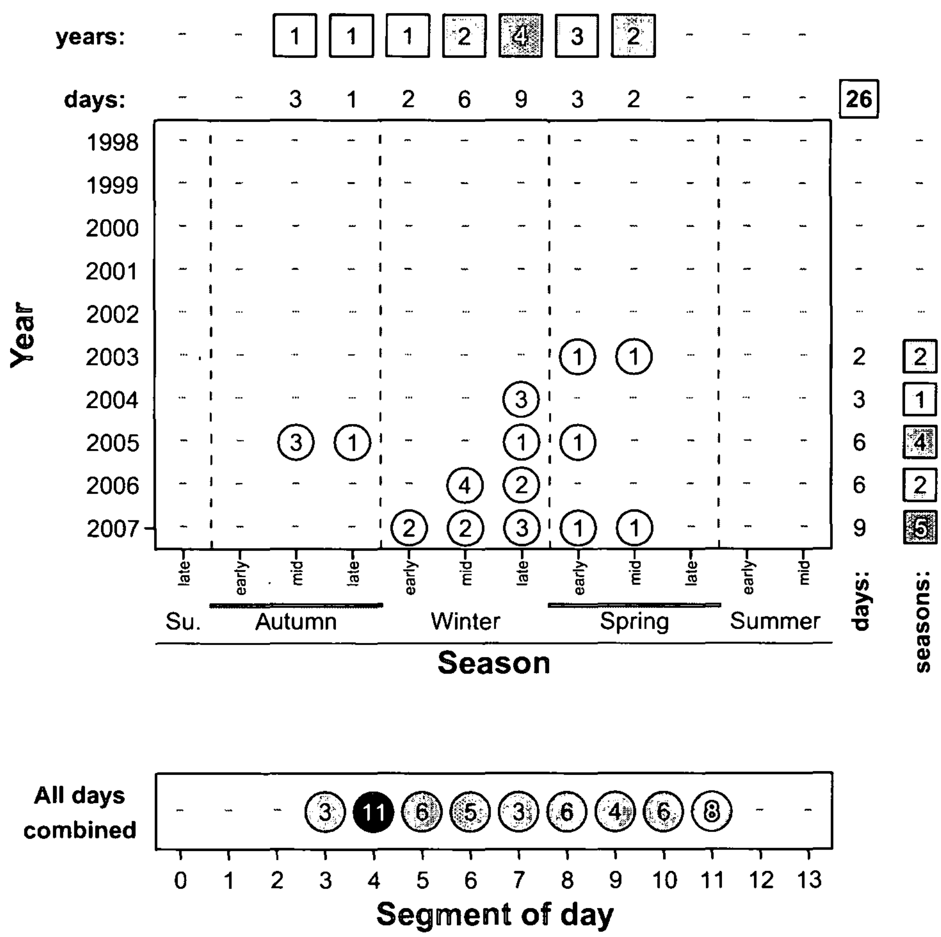


Figure 4.286: R443 White-fronted Bee-eater — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R445 Swallow-tailed Bee-eater .... *Merops hirundineus*

The Swallow-tailed Bee-eater is endemic to sub-Saharan Africa (Maclean 1985). The Orange River is basically the southern limit of its range, and in the Free State it is mainly associated with it and the Vaal River (Herremans & Barnes 1997). Records elsewhere in the Free State are rare, and typically during the cooler seasons (Earlé & Grobler 1987). This species is associated with woodland habitats (Maclean 1985).

The birds at Glen

Recorded once in late autumn 2001/2 during a transect in the drainage line.

4.37 Upupidae: Hoopoes

The taxonomy of this monogeneric family is problematic. It was formerly considered to be one species, *Upupa epops* (Clancey 1980; Cramp 1998; Fry 1988b; Maclean 1993), but Sibley & Monroe (1990) regarded birds breeding in Africa and Madagascar as a separate species, *U. africana*. While certain subsequent authors disagreed with this conclusion (*e.g.* Clements 2007), others including Hockey *et al.* (2005) and Sinclair & Ryan (2003) agree with Sibley & Monroe (1990). The taxonomy of Hockey *et al.* (2005) is followed in this thesis.

R451 African Hoopoe .... *Upupa africana*

The African Hoopoe is found in sub-Saharan Africa and Madagascar (Du Plessis 2005a). It occurs throughout most of southern Africa, but is absent or scarce in the more arid western regions and is largely absent from Lesotho (Harrison 1997a; Parker 1999). It is associated with woodland habitats where it feeds on bare ground or short grass (Harrison 1997a). The population consists of resident, migratory and nomadic components (Harrison 1997a).

The birds at Glen

The African Hoopoe derives its name from the male's advertisement call, described by Du Plessis (2005a) as "a soft, low, far-carrying *hoo-poo* or *hoo-poo-poo*." Records of birds in the grassland refer mostly to these calls emanating from calling birds in the drainage line. It was exceptional to see the African Hoopoe in the grassland. Figures start on page 521.

Annual occurrence of drainage line birds heard in the grassland: Recorded on 21.2% of the days with an activity index of six (Table 4.49a). Often recorded during 6–7 seasons each year, but during 2–4 seasons in 1997/8, 2002/3 and 2003/4, and 8–9 seasons in 1998/9 and 2006/7 (Fig. 4.287◰; Fig. 4.288). Daily reporting rates ranged from 0.5 to 24.5% with 92.1% of the bird-days attaining relatively low reporting rates, and median daily reporting rates similar for all years (Fig. 4.287◧). 2001/2 was the only year with high reporting rate days (Fig. 4.287◧; Fig. 4.288).

Table 4.49: R451 African Hoopoe: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.990	788	114 612	0.7	birds heard only	21.2	656	139	6
0.010	8	114 612	0.0	birds seen	0.9	656	6	1
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.903	28	1 190	2.4	birds heard only	20.9	43	9	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	20	1 188	1.7	birds heard only	18.6	43	8	2

Seasonal occurrence of drainage line birds heard in the grassland: Activity occurred during all seasons, but was very infrequent from late summer to mid-winter when daily reporting rates were also at a minimum (Fig. 4.287). Daily reporting rates were particularly high in late spring (Fig. 4.287), coinciding with the occurrence of days with zero records which were least frequent from late spring to early summer (Fig. 4.288). Intermediate and high reporting rate days were limited to spring and early summer (Fig. 4.287; Fig. 4.288).

Daily occurrence of drainage line birds heard in the grassland: Activity was most frequent in the early morning after sunrise and infrequent after mid-morning (Fig. 4.287), a pattern also evident for most seasons (Fig. 4.289). Segment combinations occurring during at least 5% bird-days were limited to combinations involving S1 and S2, which collectively accounted for a third of all bird-days (Fig. 4.290).

The first activity of the day typically occurred during S1 or S2 (Fig. 4.289). Seasonally the timing was least variable during late spring, which was also the only season during which activity started shortly before sunrise on a large proportion of bird-days (Fig. 4.289). The timing of the last activity of the day was variable (Fig. 4.289).

Daily segment reporting rates ranged from 5.6 to 100% with 86.9% of the values relatively low (Fig. 4.287). The median daily segment reporting rate of S1 was relatively higher than that of S0 as well as segments from mid-morning onward (Fig. 4.287).

Early morning occurrence of birds heard during 2007/8. Activity occurred slightly more frequently in the drainage line than in the grassland (Table 4.49b & c). Median early morning reporting rates were similar between the two habitats and in both most bird-mornings occurred during mid-spring and late spring (Fig. 4.291). The timing of the first activity of the day was variable (Fig. 4.291).

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Birds seen in the grassland: Seen on six days in four years (1998/9–2002/3) with records limited to early spring, mid-spring and early summer.

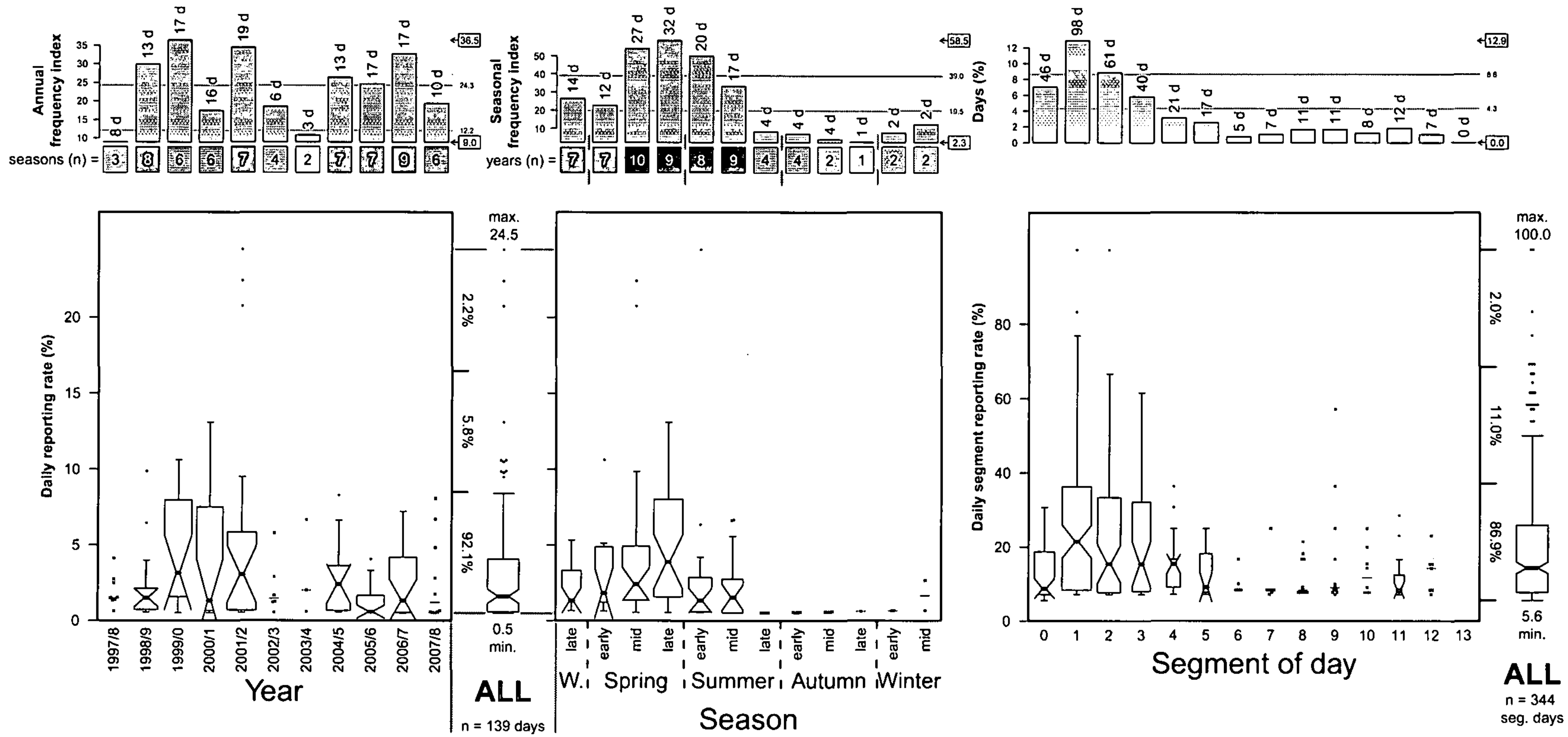


Figure 4.287: R451 African Hoopoe — birds heard only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

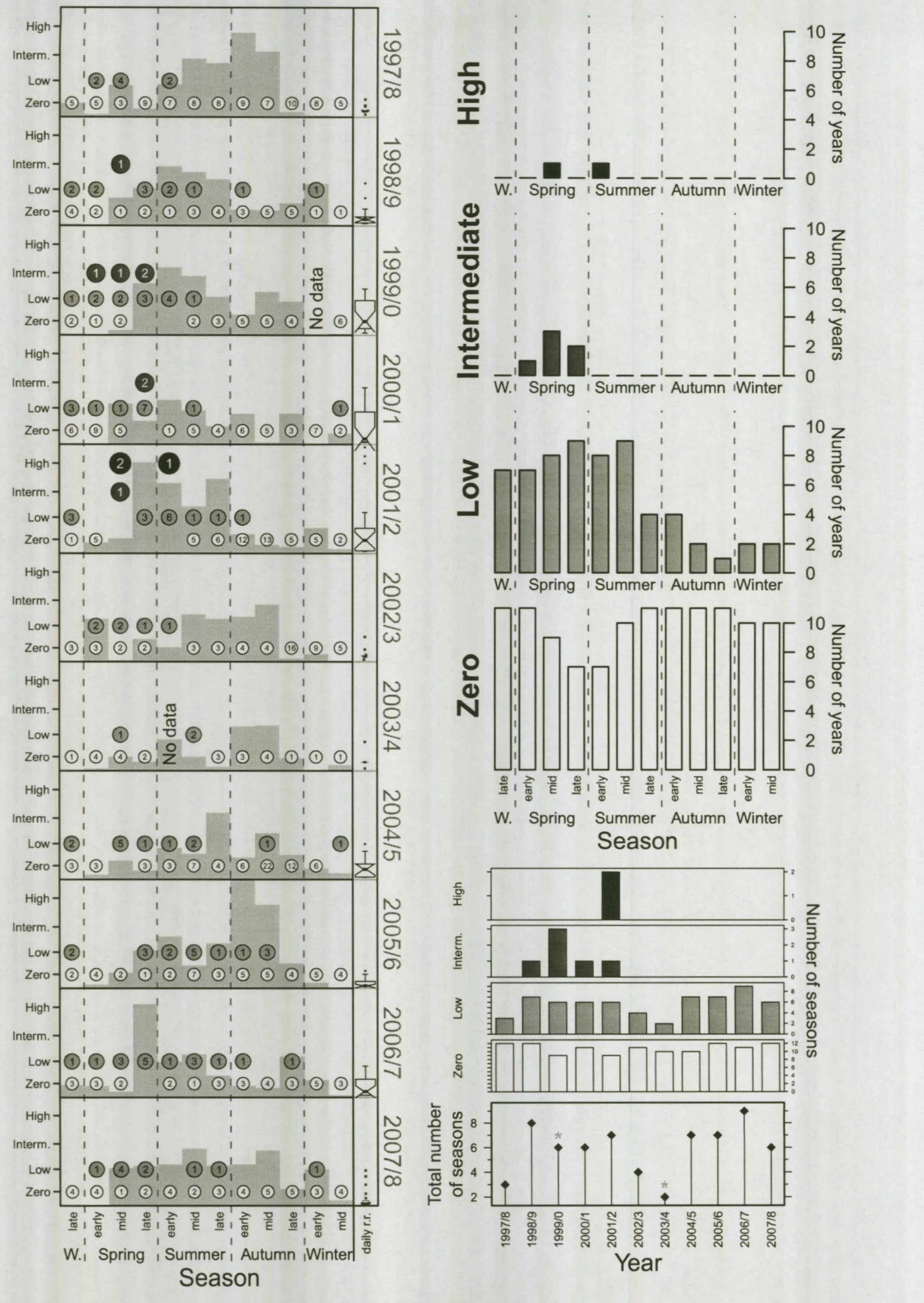
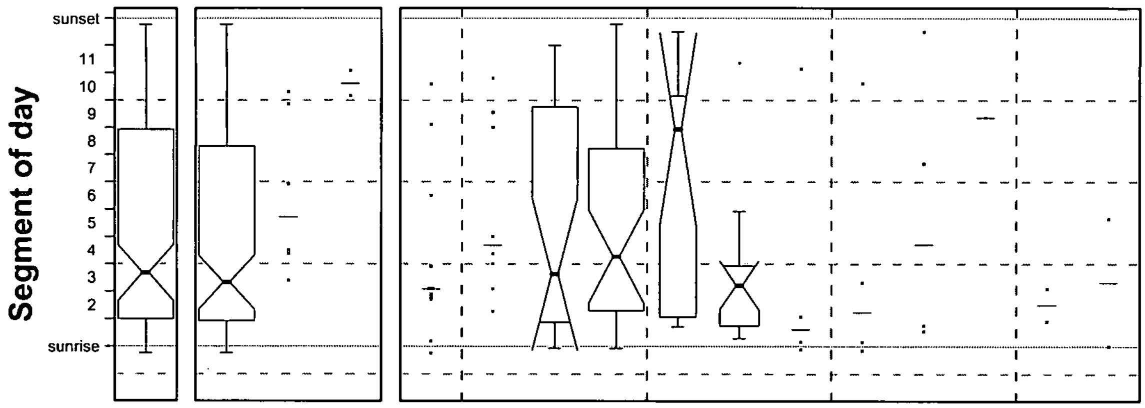
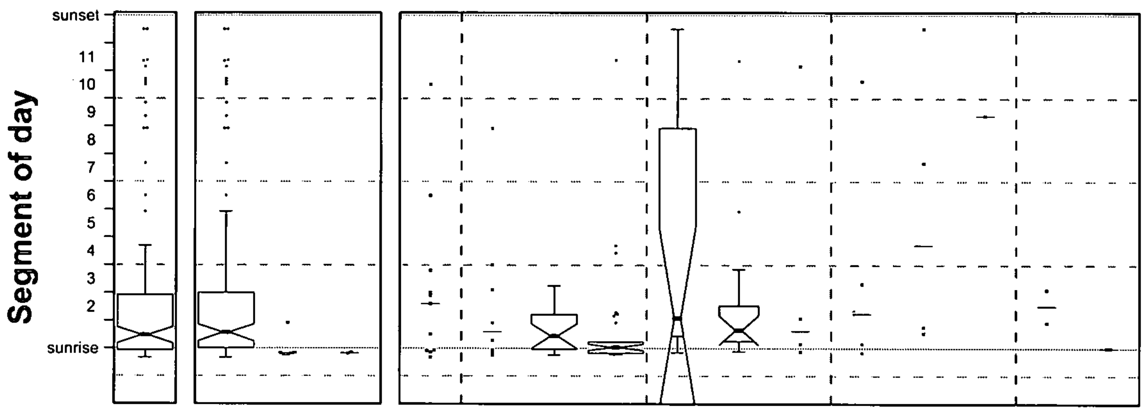


Figure 4.288: R451 African Hoopoe — birds heard only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.



Timing of the last activity of the day

Timing of the first activity of the day



Timing of the first activity of the day

Seasonal occurrence

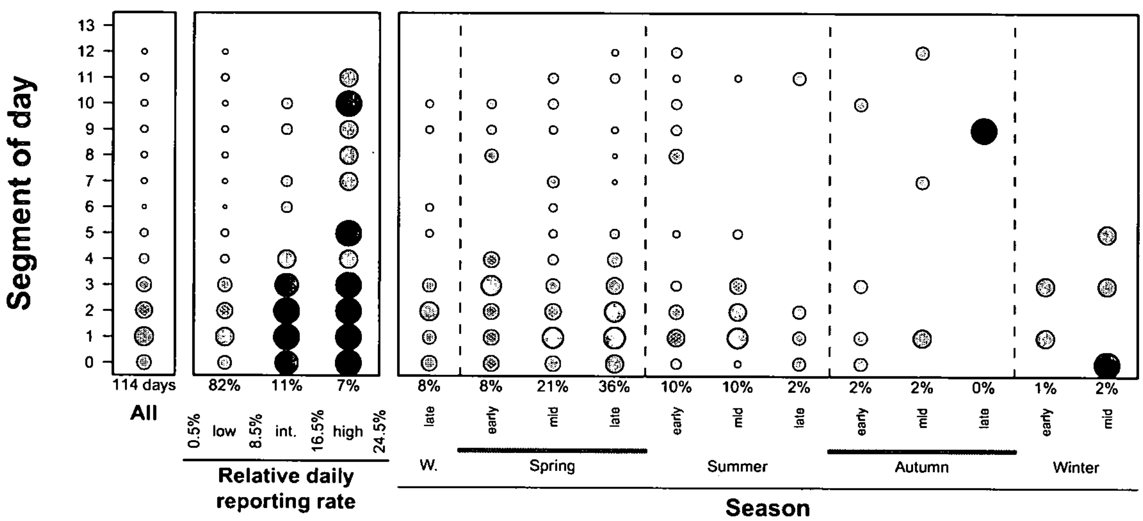


Figure 4.289: R451 African Hoopoe — birds heard only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

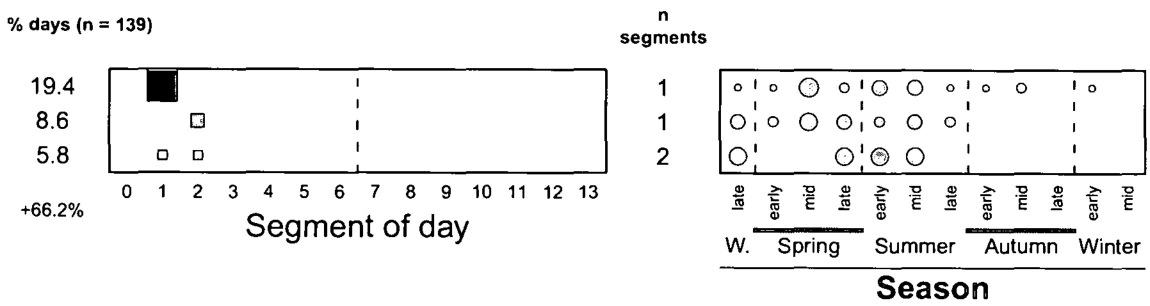


Figure 4.290: R451 African Hoopoe — birds heard only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

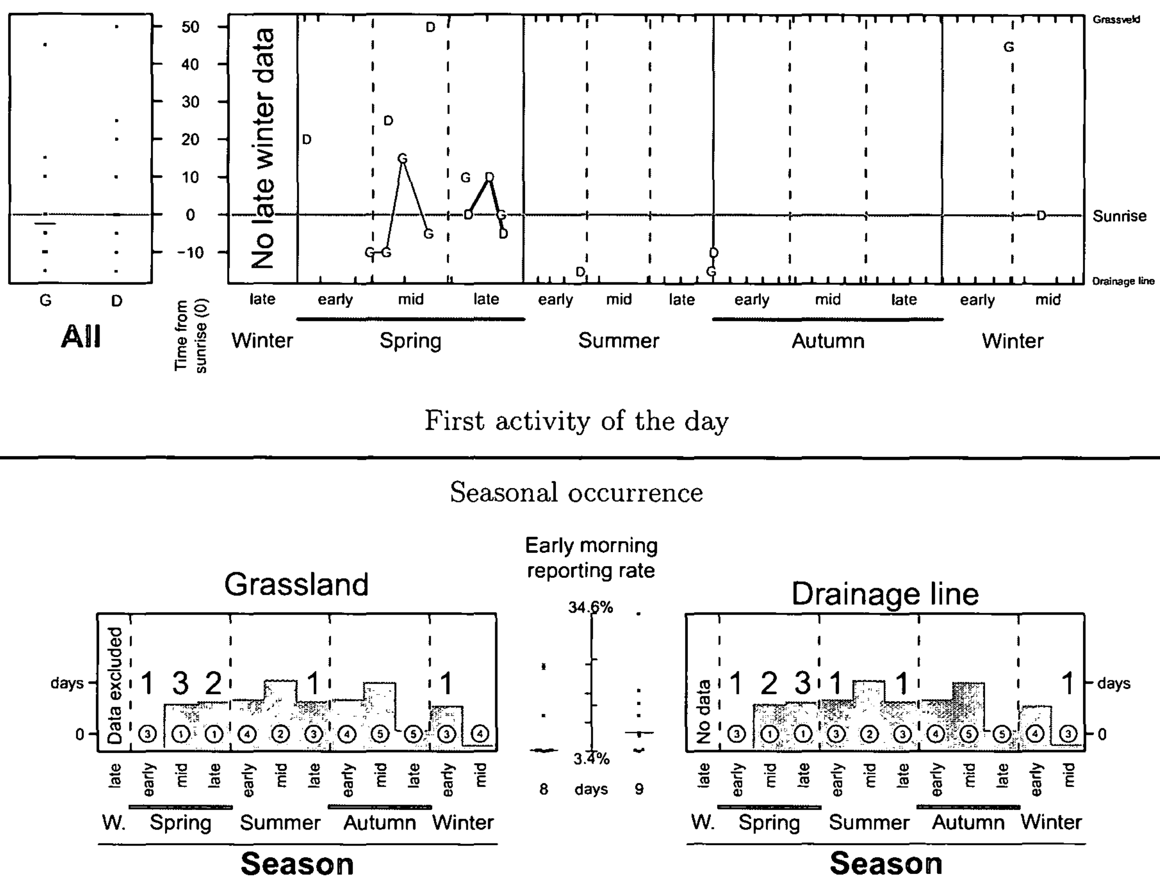


Figure 4.291: R451 African Hoopoe — birds heard only: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Top: Occurrence of the first activity of the day. See page 136 for more information on this early morning figure.

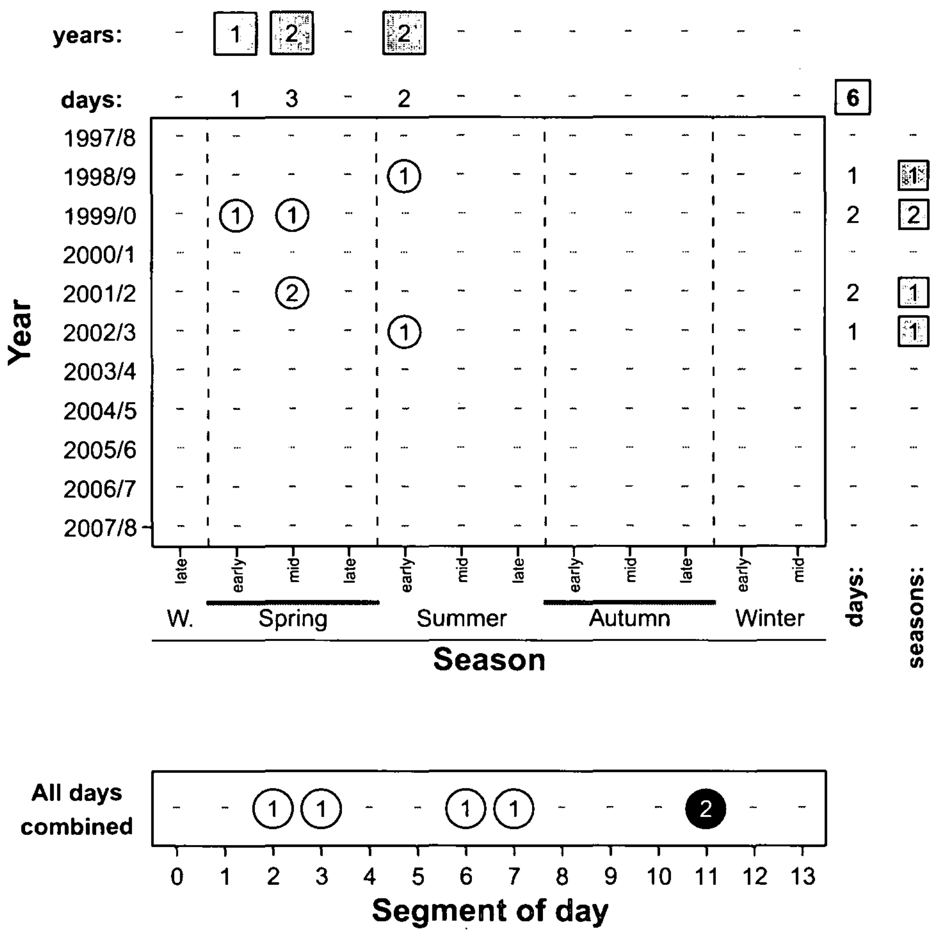


Figure 4.292: R451 African Hoopoe — birds seen: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Discussion

The early morning data of 2007/8 (Fig. 4.289) suggests that the data collected in the grassland is reasonably accurate, sufficient to establish seasonal trends at least.

According to Du Plessis (2005a), the African Hoopoe "Sings for hours on end for 60% of year, but mostly silent for the rest (E Cape Jan to mid Apr)." At Glen, calling occurred for about 50% of the year with the timing of the silent period from late summer to mid-winter (January to June) (Fig. 4.287). Activity was largely limited to the first half of the morning (Fig. 4.287).

Breeding occurs mainly from September to November [spring to early summer] according to Tarboton (2001). This interval is encompassed by the main activity period at Glen (late winter to mid-summer; Fig. 4.287) and indicates a direct relationship between these two activities.

The Eurasian Hoopoe *U. epops* is known to have a complete post-breeding moult (Cramp 1998). Limited data suggest that the African Hoopoe has a similar moult strategy. In northern Botswana an adult had started its moult early in February [early autumn] (Du Plessis 2005a). In the central Free State one adult male have not yet started moulting in mid-spring while another male examined in mid-autumn were growing primaries 1 and 2 and was in heavy body moult (DJvN unpublished data). It is concluded that moult occurs during at least part of the silent period.

4.38 Phoeniculidae: Wood-Hoopoes

This monogeneric family is endemic to sub-Saharan Africa where five species occur. Two species are found in southern Africa of which only the Green Wood-Hoopoe R452 occurs in South Africa (Hockey *et al.* 2005).

R452 Green Wood-Hoopoe .... *Phoeniculus purpureus*

In southern Africa, the Green Wood-Hoopoe is largely absent from the south-western quarter of the region as well as Lesotho (Du Plessis 1997a). It is relatively scarce in the Free State, being mainly associated with the Vaal and Modder Rivers where it is apparently resident (Du Plessis 1997a; Earlé & Grobler 1987). Associated with woodlands where groups of up to 12 individuals may be encountered (Du Plessis 1997a). It occupies these woodlands permanently only when suitable roosting sites in the form of holes in trees are available (Du Plessis 1997a).

The birds at Glen

Records in the grassland represent birds heard and, rarely, seen in the drainage line. Numbers noted include seven and eight birds seen during 2003/4 and 2004/5 respectively. In addition, during mid-winter 2006/7 two birds were seen and heard while they were flying high in the sky.

In the grassland, recorded on 21 days from 2002/3 to 2006/7 only, with a distinct peak in occurrence during 2004/5 (Fig. 4.293). Encountered during most seasons with records limited to the first half of the morning and the latter half of the afternoon (Fig. 4.293).

Discussion

Although the Green Wood-Hoopoe is generally resident, it is known to undertake exploratory movements along river systems in the Free State and into the Kalahari (De Swardt 1994a; Du Plessis 2005b). The birds recorded at Glen probably involve those occurring along the Modder River during such movements. What is interesting, however, is that they appeared only after 2001/2 — which was also a high rainfall year (Fig. 2.13) — when they became relatively frequent during 2004/5, after which they became less frequent with no records in 2007/8 (Fig. 4.293). The birds depend on tree cavities for roosting and breeding (Du Plessis 1989, 1992; Du Plessis & Williams 1994). It is suggested that the birds became temporarily established in the drainage line or close-by after a group found a suitable roosting site, and that their subsequent disappearance is possibly due to the lost of this site.

4.39 Rhinopomastidae: Scimitarbills

This monogeneric family is endemic to sub-Saharan Africa where three species occur; one species is found in southern Africa (Hockey *et al.* 2005).

R454 Common Scimitarbill .... *Rhinopomastus cyanomelas*

The Common Scimitarbill is endemic to southern and eastern Africa (Maclean 1985). In southern Africa it is widespread from the Orange River and KwaZulu-Natal northwards (absent from

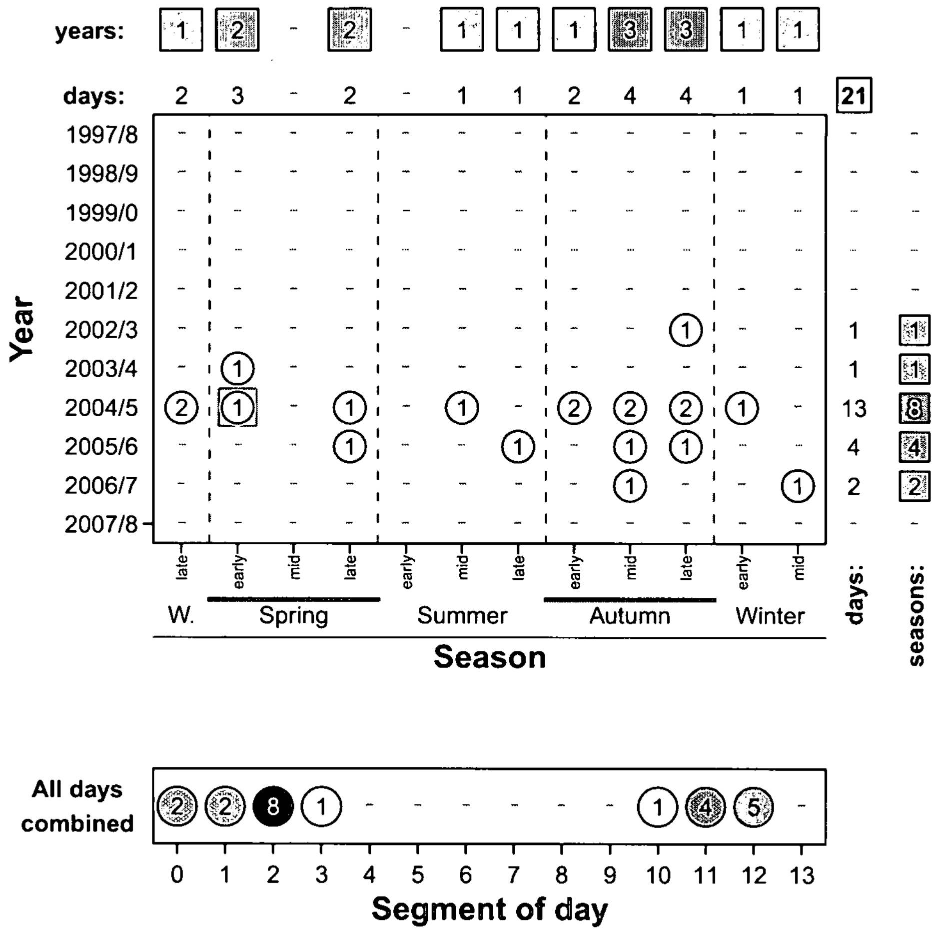


Figure 4.293: R452 Green Wood-Hoopoe — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Lesotho and the eastern half of the Free State) (Du Plessis 1997b). It is a resident species associated with woodland habitats (Du Plessis 1997b; Steyn 1999). The Common Scimitarbill frequently roosts out in the open by clinging to the bark of trees, and is thus not dependant on cavities for roosting as is the case with wood-hoopoes (Du Plessis 1997b; Steyn 1999). It needs holes to breed in, preferring those in trees (Steyn 1996).

The birds at Glen

Records of the Common Scimitarbill in the grassland refer to birds calling in the drainage line. It was typically the plaintive, ventriloquial *wheep-wheep-wheep* call, as Steyn (1999) describes it, which was heard. This call is given by a bird in flight or from a perch and, according to Steyn (1999), it carries over a considerable distance. Figures start on page 529.

Annual occurrence of drainage line birds heard in the grassland: Recorded on 28.8% of the days with an activity index of three (Table 4.50a). Usually heard during 7–12 seasons per year but during only 3–4 seasons in 1999/0, 2003/4 and 2006/7 (Fig. 4.294; Fig. 4.295). Daily reporting rates ranged from 0.5 to 7.6% with 85.2% bird-days attaining relatively low reporting rates; median daily reporting rates were similar for all years (Fig. 4.294).

Table 4.50: R454 Common Scimitarbill: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	554	114 612	0.5	birds heard only	28.8	656	189	3
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	47	1 190	3.9	birds heard only	37.2	43	16	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	6	1 188	0.5	birds heard only	9.3	43	4	2

Seasonal occurrence of drainage line birds heard in the grassland: Based on the number of bird season-years and the seasonal frequency index, there appear to be two seasonal peaks in activity, the first in mid-spring and the second centred on mid-autumn (Fig. 4.294). The few high reporting rate days similarly occurred during mid-spring and during late summer and autumn (Fig. 4.295). However, median daily reporting rates were similar for the respective seasons (Fig. 4.294).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity was most frequently recorded during the first half of the morning and never after sunset (Fig. 4.294). This general pattern remains similar regardless the relative magnitude of the daily reporting rate (Fig. 4.296) or season (Fig. 4.297). Segment combinations occurring during more than 5% bird-days were limited to combinations involving S1–S3, which collectively accounted for almost half of all bird-days (Fig. 4.298).

The first activity of the day usually occurred during the earlier part of the morning with no major differences amongst the seasons (Fig. 4.297). The last activity of the day often occurred during the morning (Fig. 4.297).

Overall, daily segment reporting rates ranged from 5.6 to 63.6% with 87.8% of the values relatively low (Fig. 4.294). The median daily segment reporting rates of S2 were slightly higher than those of most other segments (Fig. 4.296).

Early morning occurrence of drainage line birds heard during 2007/8: Activity was much more frequent in the drainage line than in the grassland (37.2% vs. 9.3% bird-days; Table 4.50b & c). The median early morning reporting rate was also higher in the drainage line, but there is no clear seasonal pattern in that habitat (Fig. 4.299). The timing of the first activity of the day was variable (Fig. 4.299) and the activity intensity in the drainage line tended to be higher after sunrise (Fig. 4.299).

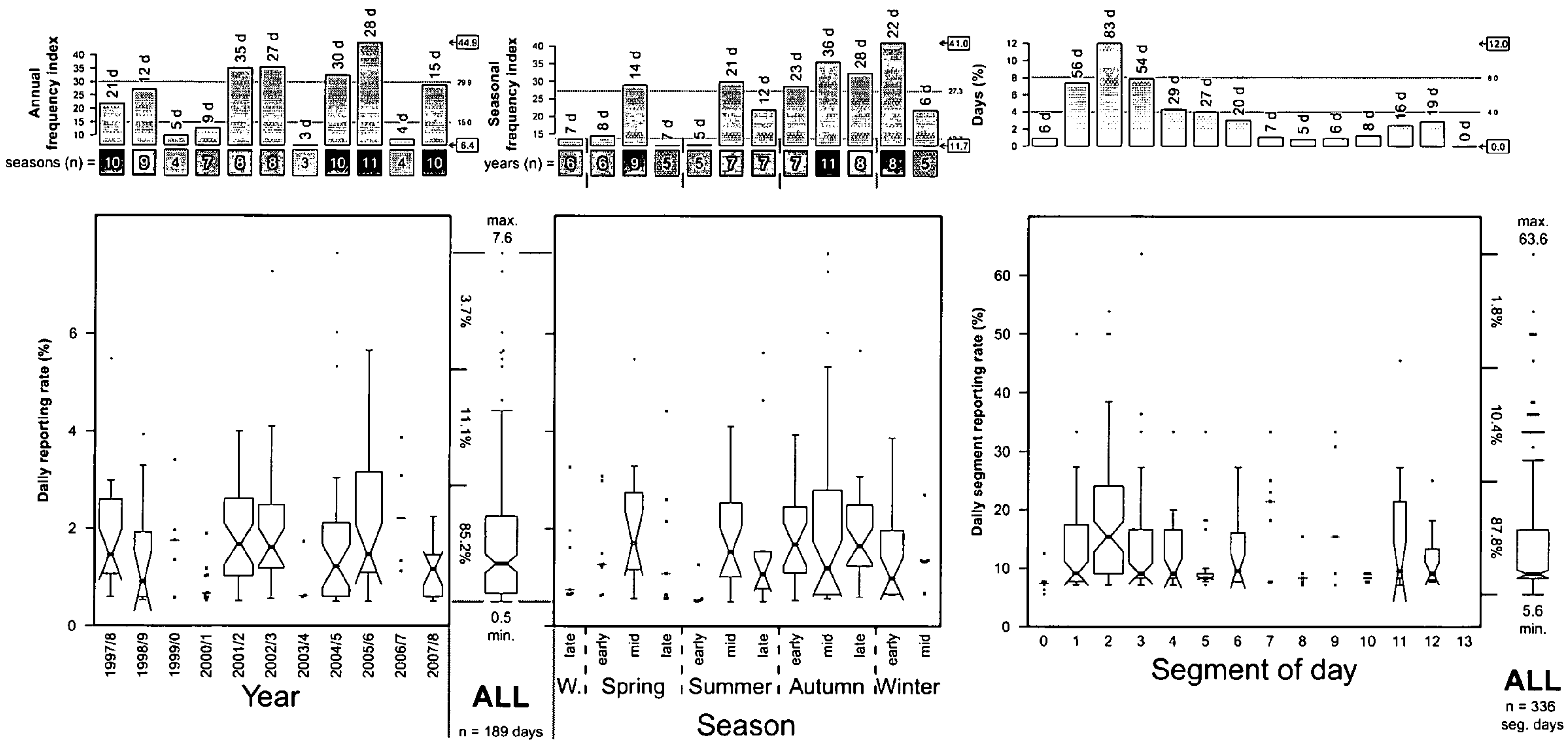


Figure 4.294: R454 Common Scimitarbill — birds heard only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

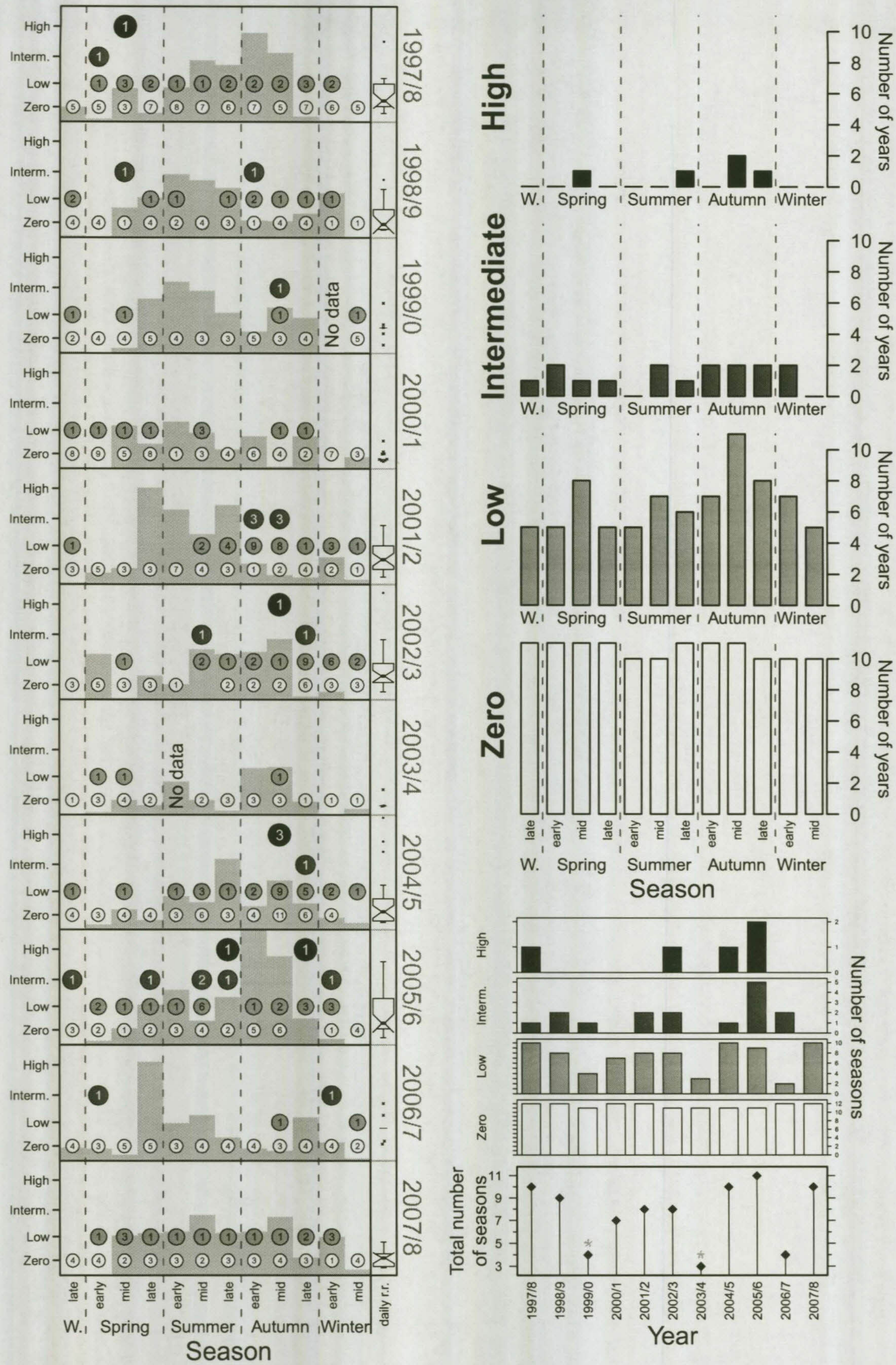


Figure 4.295: R454 Common Scimitarbill — birds heard only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

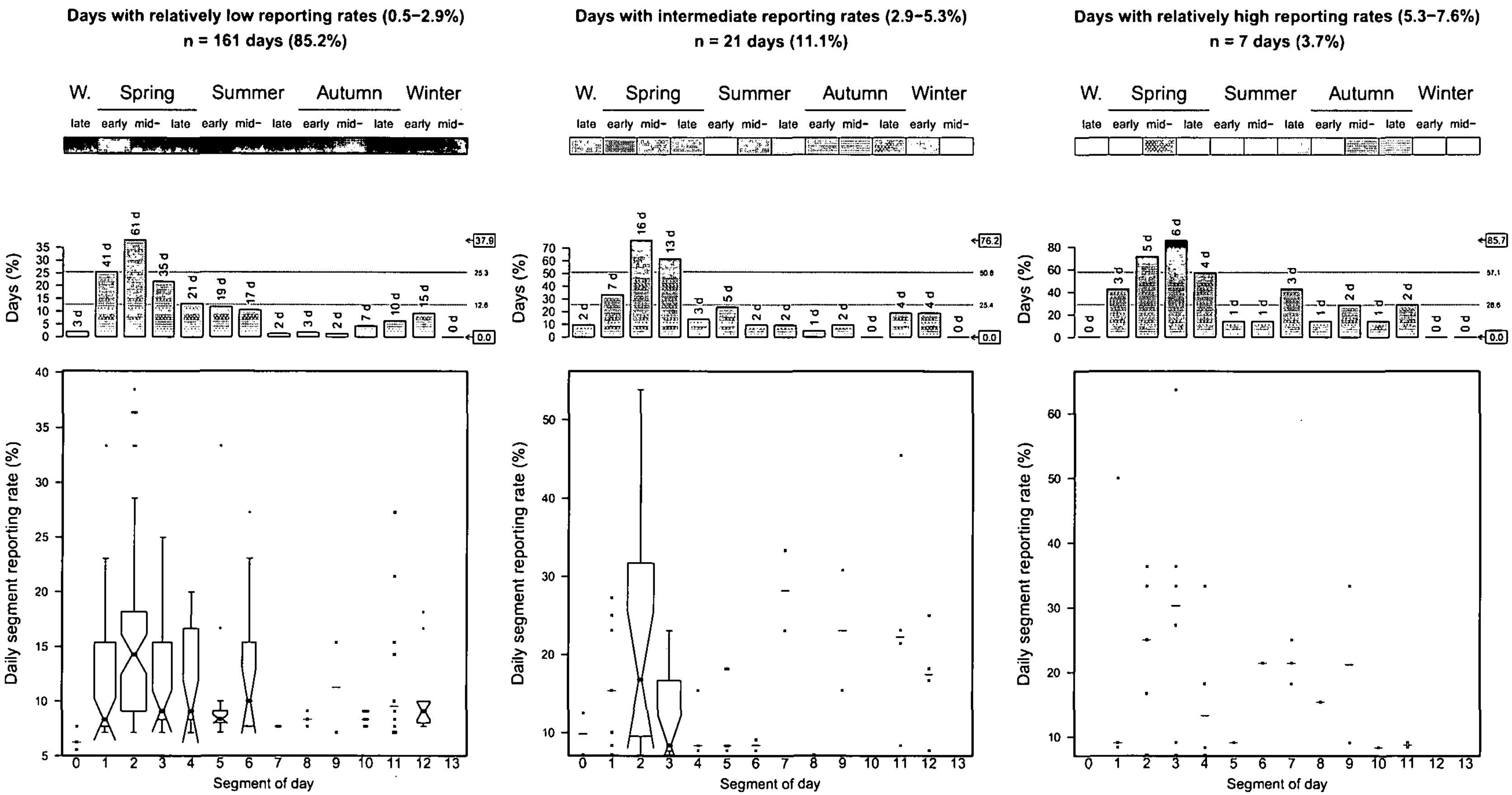


Figure 4.296: R454 Common Scimitarbill — birds heard only: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

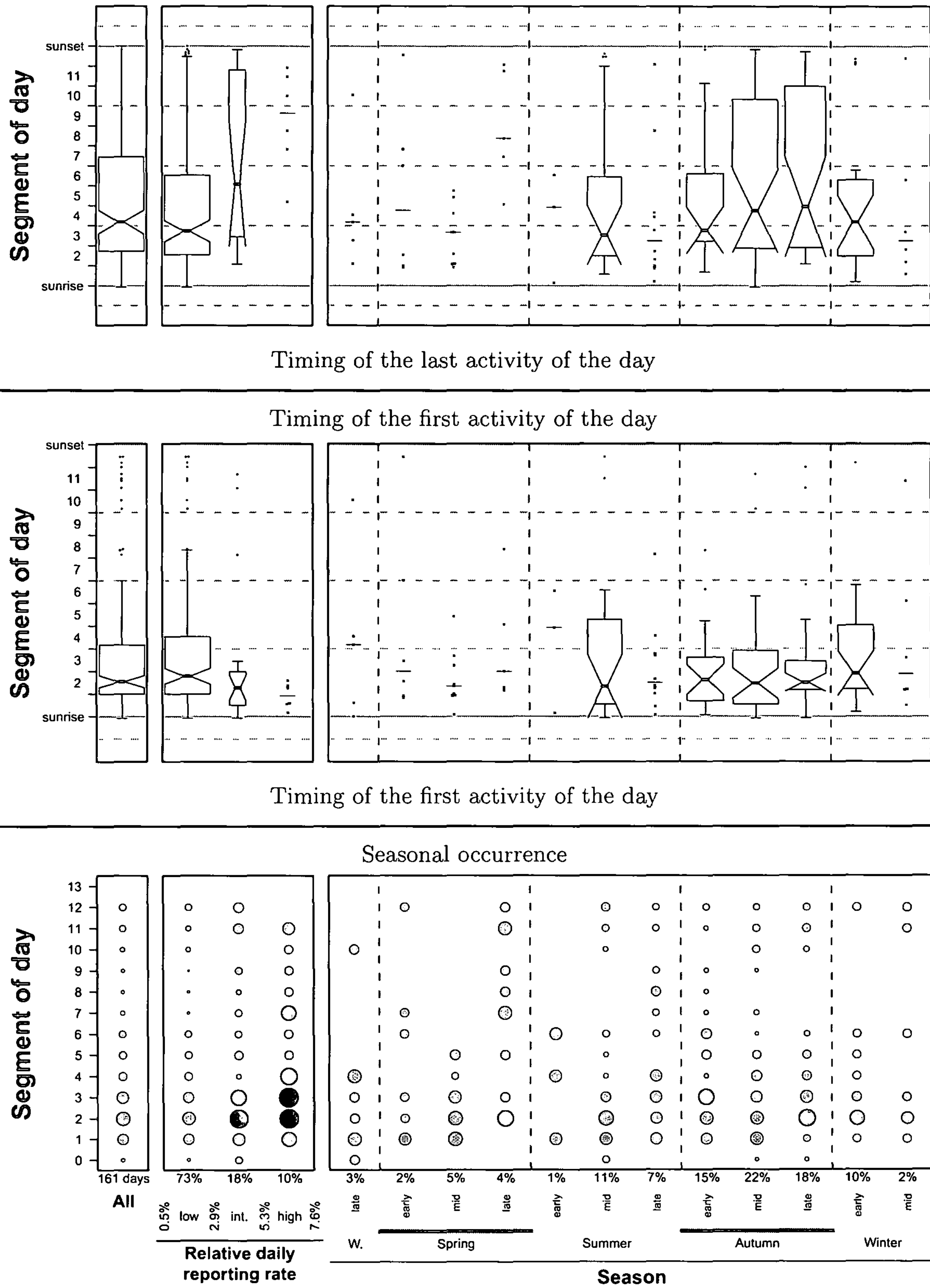


Figure 4.297: R454 Common Scimitarbill — birds heard only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

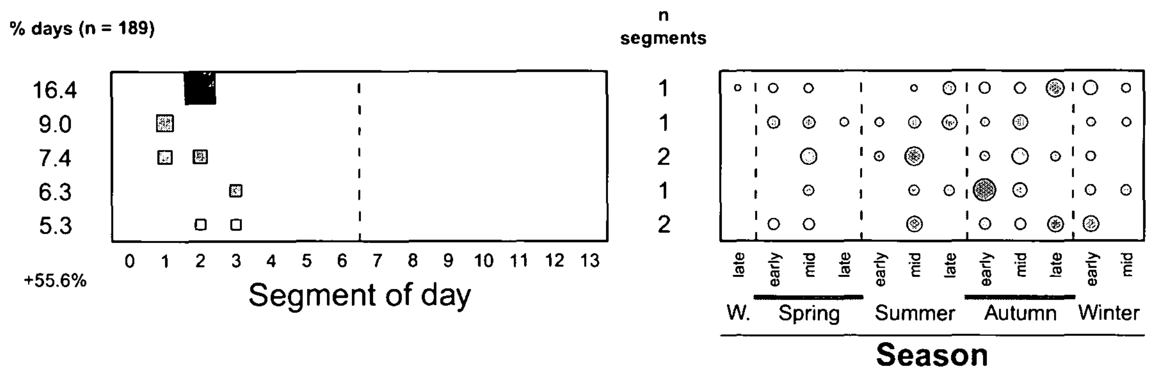


Figure 4.298: R454 Common Scimitarbill — birds heard only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

Discussion

The general lack of Common Scimitarbill records in the grassland during the early mornings (S0 and S1) of 2007/8 contrasts with the situation in the drainage line where activity was noted throughout the year (Fig. 4.299). The birds were, however, recorded for most of the year in the grassland too (Fig. 4.295), only later in the morning (*i.e.* after S1; see Fig. 4.294; Fig. 4.296; Fig. 4.297). This suggests that the birds are detected in the grassland only once they wander more widely from roosting areas.

Du Plessis (2005c) suggested that the function of the *wheep-wheep-wheep* calls — which are possibly given by the male only (Steyn 1999) — is probably territory advertisement (see also Steyn 1999). This is supported by the data from Glen where these calls were relatively frequently heard during mid-spring (Fig. 4.294), coinciding with the start of the breeding season, which, according to Tarboton (2001), is mainly from September to November [mid-spring to early summer].

The breeding cycle from egg-laying until the young fledge lasts approximately 5–6 weeks (Steyn 1999). After that family groups may remain together for as long as six months (Du Plessis 1997b). Interestingly, at Glen the mid-spring peak in activity is followed approximately six months later by another, more extensive, peak period centred on autumn (Fig. 4.294). The limited data available on moult indicates that it follows breeding (Du Plessis 2005c). The relatively frequent occurrence of activity around autumn (Fig. 4.294) may, therefore, represent post-moult activity.

4.40 Lybiidae: African Barbets, Tinkerbirds

The 42 species of this family is endemic to sub-Saharan Africa with ten species occurring in southern Africa (Hockey *et al.* 2005). All three species occurring in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a) were recorded at Glen.

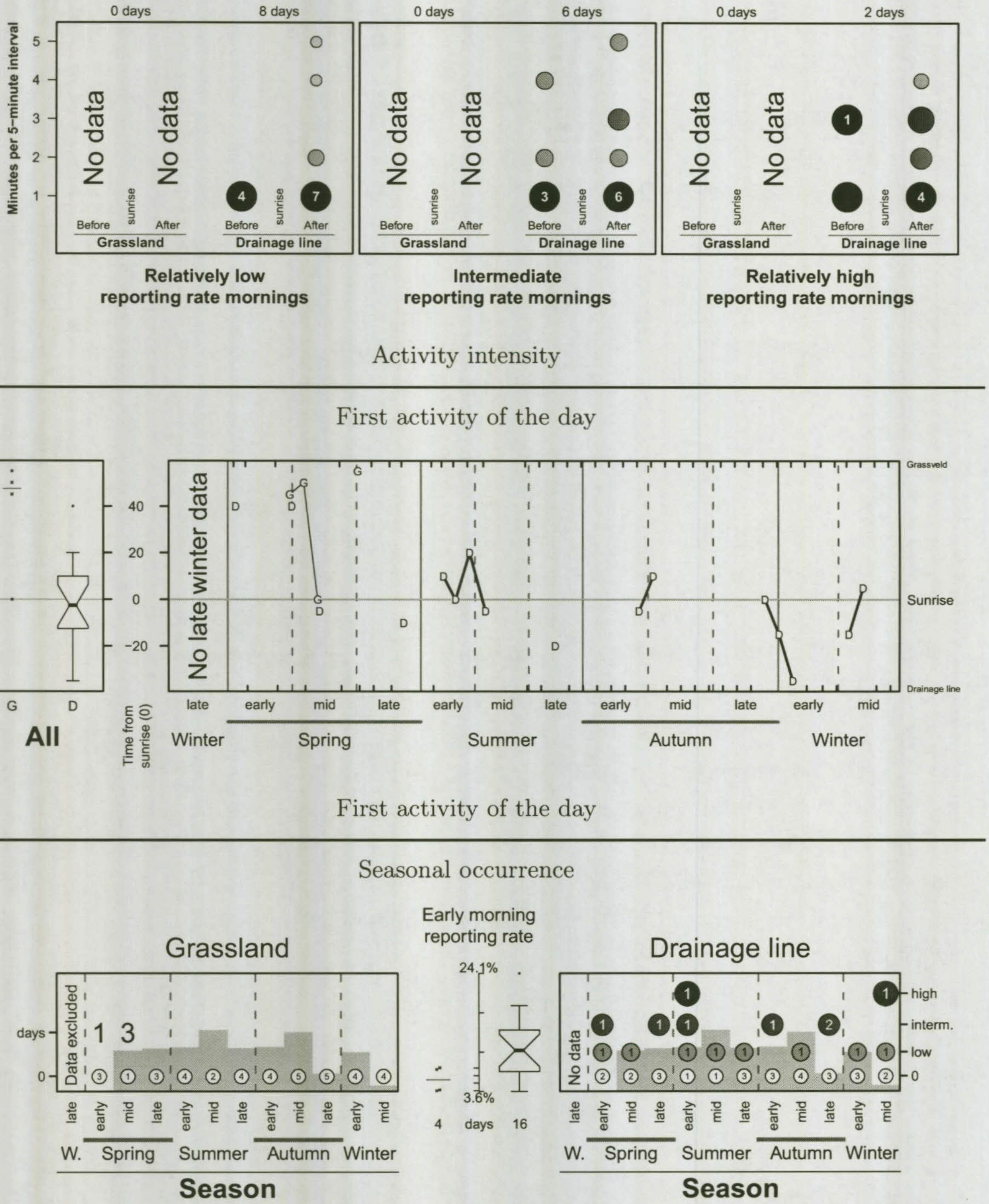


Figure 4.299: R454 Common Scimitarbill — birds heard only: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

R464 Black-collared Barbet .... *Lybius torquatus*

The Black-collared Barbet is endemic to Africa south of the equator (Maclean 1985). Its southern African distribution is largely limited to the eastern third of the region as well as areas to the north (Nuttall 1997a). It colonised Bloemfontein in recent years (DJvN personal observations). It is restricted to wooded habitats in the more mesic areas of southern Africa (Tarboton 2001) where it is a resident (Chittenden 2005b; Maclean 1985; Nuttall 1997a).

The birds at Glen

A bird was heard calling in the drainage line once in mid-spring 2003/4.

Discussion

Black-collared Barbets are highly vocal and it is unlikely to be overlooked (Nuttall 1997a). Records outside their normal range — *e.g.* in Lesotho (Ambrose 1998; Ambrose & Maphisa 1999; Bonde 1993; Jacot-Guillarmod 1963) and in parts of the central and southern Free State (Nuttall 1997a) — indicate that at least some birds may wander. The single record from Glen further proves that point.

R465 Acacia Pied Barbet .... *Tricholaema leucomelas*

The Acacia Pied Barbet is southern Africa's most widespread barbet species, occurring throughout most of the region (Nuttall 1997b; Parker 1999). Its distribution extends only marginally into Angola (Dean 2000) and south-western Zambia (Short & Horne 1988). It has a broad feeding niche and wide ecological tolerance (Macdonald 1986) and occurs in a wide range of habitats with woody stratum, including wooded drainage lines (Nuttall 1997a). Generally considered to be resident (Chittenden 2005a; Maclean 1985). However, Nuttall (1997b) suggested dispersal during summer, particularly over the more arid regions.

The birds at Glen

Records of the Acacia Pied Barbet in the grassland and drainage line refer exclusively to birds calling in the latter habitat. Distinction was made between two types of vocalisations: a) the repeated nasal *pehp, pehp, pehp* and b) the repeated hoopoelike *hoop, hoop, hoop*. According to Chittenden (2005a), the latter call occurs mostly during the breeding season. Figures start on page 539.

Annual occurrence of* pehp *vocalisations in the grassland: Recorded on 30.3% of the days with an activity index of four (Table 4.51a). Daily reporting rates ranged from 0.5 to 13.5% with 88.9% of the bird-days attaining relatively low values (Fig. 4.300■□). Based on the number of bird-seasons each year, as well as the annual frequency index, there appears to have been two peak periods: 2000/1–2002/3 and 2006/7–2007/8. During these years activity was noted during 8–10 seasons compared to the 1–7 seasons of other years (Fig. 4.300▀□; Fig. 4.301). However, the median daily reporting rates of 2000/1 and 2001/2 were slightly higher than those of 2006/7 and 2007/8 (Fig. 4.300) and no intermediate or high reporting rate days occurred subsequent to 2002/3 (Fig. 4.301).

Table 4.51: R465 Acacia Pied Barbet: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists			Activity	Days			Activity
	n	Total	%		%	Total	n	index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
0.707	728	114 612	0.6	*pehp* calls	30.3	656	199	4
0.293	302	114 612	0.3	*hoop* calls	14.6	656	96	3
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
0.800	180	1 190	15.1	*pehp* calls	95.3	43	41	4
0.200	45	1 190	3.8	*hoop* calls	39.5	43	17	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
0.833	5	1 188	0.4	*pehp* calls	11.6	43	5	1
0.167	1	1 188	0.1	*hoop* calls	2.3	43	1	1

Seasonal occurrence of* pehp *vocalisations in the grassland: Recorded during all seasons, most frequently from mid- to late autumn and least frequently during early summer and mid-winter (Fig. 4.300). The upper quartile of daily reporting rates were relatively high during early and mid-autumn (Fig. 4.300). The few high reporting rate days were limited to autumn and early winter and most of the intermediate reporting rate days occurred during autumn (Fig. 4.301).

Daily occurrence of* pehp *vocalisations in the grassland: Overall, activity was most frequent in the early morning after sunrise with a secondary peak in the later afternoon before sunset; not recorded after sunset (Fig. 4.300). This pattern is mainly a reflection of the situation for low reporting rate days (Fig. 4.302). For intermediate reporting rate days the morning activity peak extends past mid-morning and the late afternoon peak becomes more prominent (Fig. 4.302).

In contrast to autumn and early winter when activity was recorded during all segments between sunrise and sunset, activity was mostly limited to the earlier part of the morning and late afternoon during other seasons (Fig. 4.303). The three bird-segment combinations occurring on more than 5% bird-days were limited to single early morning segments S1, S2 and S3. Collectively these combinations accounted for more than a quarter of all bird-days (Fig. 4.304).

The first activity of the day occurred most often during the first half of the morning after sunrise, slightly earlier on intermediate and high reporting rate days than on low reporting rate days and with the median time similar for all seasons (Fig. 4.303). The occurrence of the last activity of the day was variable (Fig. 4.303).

Overall, daily segment reporting rates ranged from 5.3 to 60.0% with 91.3% of the values relatively low (Fig. 4.300). Apart from the low value of S0, the median daily segment reporting rates of other segments were alike (Fig. 4.300). This pattern was similar for low, intermediate and high reporting rate days (Fig. 4.302).

Early morning occurrence of* pehp *vocalisations during 2007/8: Activity was much more frequent in the drainage line, occurring on 95.3% mornings compared to the 11.6% of the grassland; its activity index was higher too (4 vs. 1; Table 4.51b & c). In addition, the median early morning reporting rate in the grassland was always at a minimum compared to that of the drainage line where it was much higher (Fig. 4.305). In the drainage line, activity peaked from late autumn to mid-winter (no data for late winter) with four of the five grassland records occurring from mid-autumn to early winter (Fig. 4.305). In the drainage line, the timing of the first activity of the day was least variable from mid-autumn onward when it typically occurred within the last 30 minutes before sunrise (Fig. 4.305). Activity intensity was similar before and after sunrise (Fig. 4.305).

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Annual occurrence of* hoop *vocalisations in the grassland: Recorded on 14.6% of the days with an activity index of three (Table 4.51a). Heard during 1–9 seasons per year with activity particularly frequent during 2000/1 (Fig. 4.306; Fig. 4.307). With the exception of one day in 2000/1 with a reporting rate of 19.2%, the overall maximum reporting rate of all other bird-days was only 6.6% (Fig. 4.306). The median daily reporting rate was similar for all years (Fig. 4.306).

Seasonal occurrence of* hoop *vocalisations in the grassland: Recorded during all seasons except late winter and otherwise infrequent during the rest of winter, early spring and early summer and most frequent from mid-summer to early autumn (Fig. 4.306). Median daily reporting rates were similar for the respective seasons (Fig. 4.306).

Daily occurrence of* hoop *vocalisations in the grassland: Activity was most frequent in the early morning after sunrise (S1) and was not recorded after sunset (Fig. 4.306). A similar pattern is evident for most seasons (Fig. 4.308). Bird-segment combinations occurring on more than five bird-days were limited to single segments S1, S2 and S12, collectively accounting for a third of all bird-days (Fig. 4.309).

The first activity of the day occurred most often sometime during the morning and varied from season to season (Fig. 4.308). The occurrence of the last activity of the day was even more variable (Fig. 4.308).

Overall, daily segment reporting rates ranged from 5.9 to 83.3% with 95.8% of the values relatively low (Fig. 4.306). Apart from the low value of S0, the median daily segment reporting rates of other segments were similar to one another (Fig. 4.306).

Early morning occurrence of* hoop *vocalisations during 2007/8: Activity was much more frequent in the drainage line, occurring on 17 mornings compared to the one morning in the grassland; the activity index was higher too (3 vs. 1; Table 4.51b & c). In addition, the median early morning reporting rate was higher in the drainage line (Fig. 4.310). In the drainage line, activity peaked during spring and early summer (Fig. 4.310). The first activity of the day most frequently occurred after sunrise (Fig. 4.310). Activity intensity tended to be higher after sunrise (Fig. 4.310).

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Combined data: The overall occurrence is shown in Figure 4.311. Relatively infrequently recorded during 1998/9 and 2003/4. Seasonally there appears to be two distinct periods marked by infrequent occurrence during early summer and mid-winter.

Discussion

The data collected in the grassland seriously underestimated Acacia Pied Barbet activity in the drainage line, at least during the early mornings (Table 4.51b & c; Fig. 4.305; Fig. 4.310). Nevertheless, note that the degree of underestimation is different for the two vocalisation types. In the case of *pehp* calls, the data collected in the grassland seem to represent — in part at least — the peak period of activity in the drainage line (Fig. 4.305). This was not the case for the *hoop* calls where the peak period in the drainage line went undetected in the grassland (Fig. 4.310). This is probably due to the subdued nature of the *hoop* calls which renders it less audible at a distance compared to the other call. Note also that compared to the early morning data (Fig. 4.305; Fig. 4.310), activity was more frequent when data for the whole day is considered (see 2007/8 in Figures 4.301 and 4.307). This is the result of birds being recorded later in the day (Fig. 4.300; Fig. 4.303; Fig. 4.306; Fig. 4.308), presumably representing birds roaming more widely in the drainage line at these times.

The breeding season, mainly from September to December [spring to mid-summer] (Tarboton 2001), coincides with the peak occurrence of *hoop* calls in the drainage line (Fig. 4.310). This agrees with Chittenden (2005a) according to whom these calls occur mostly during the breeding season.

Limited data from Botswana and the Northern Cape suggest a complete post-breeding moult from January to February [late summer to early autumn] in these regions (Chittenden 2005a). However, based on a few birds ringed at Glen and elsewhere in the Free State, moulting seems to start as early as early summer and continue into autumn (DJvN unpublished data). This may explain why activity was rarely recorded during early summer (Fig. 4.300; Fig. 4.305; Fig. 4.306; but note that *hoop* calls during the early mornings in the drainage line in 2007/8 ceased only in mid-summer, Fig. 4.310). This conclusion would imply that the beginning of moulting is highly synchronised in the population and that it has an adverse effect on vocalisations. Alternatively, the relatively strong wind that normally blows during early summer mornings (Fig. 2.40) caused this effect by making it less likely to hear drainage line birds in the grassland. A combination of these factors could also be involved.

Be that as it may, the occurrence of *hoop* calls in the grassland peaked from mid-summer to early autumn (Fig. 4.306), possibly overlapping partially with the latter part of moult. This is followed by a peak in *pehp* calls in the grassland (Fig. 4.300) and the drainage line (Fig. 4.305), which appear to follow moult.

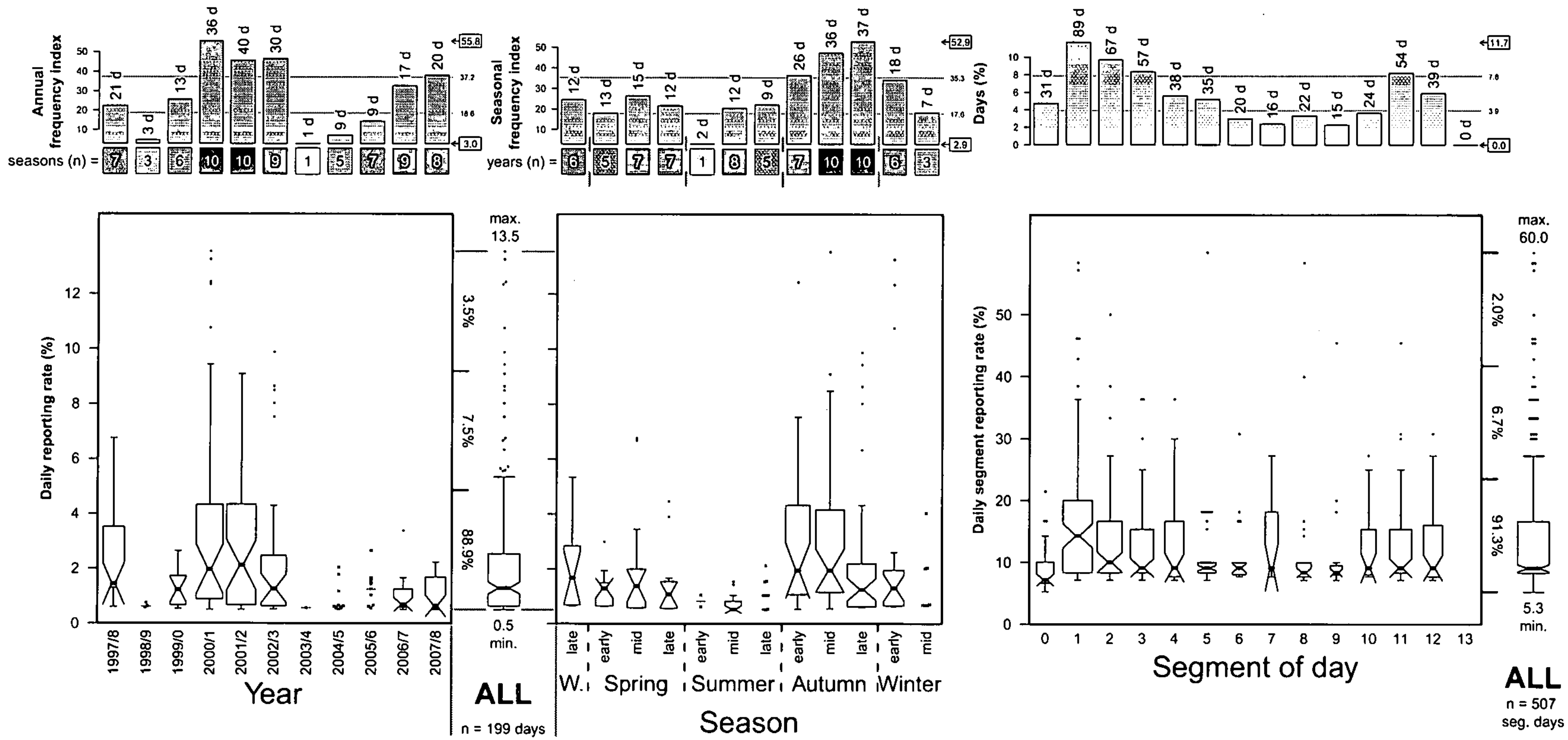


Figure 4.300: R465 Acacia Pied Barbet — *pehp* calls: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

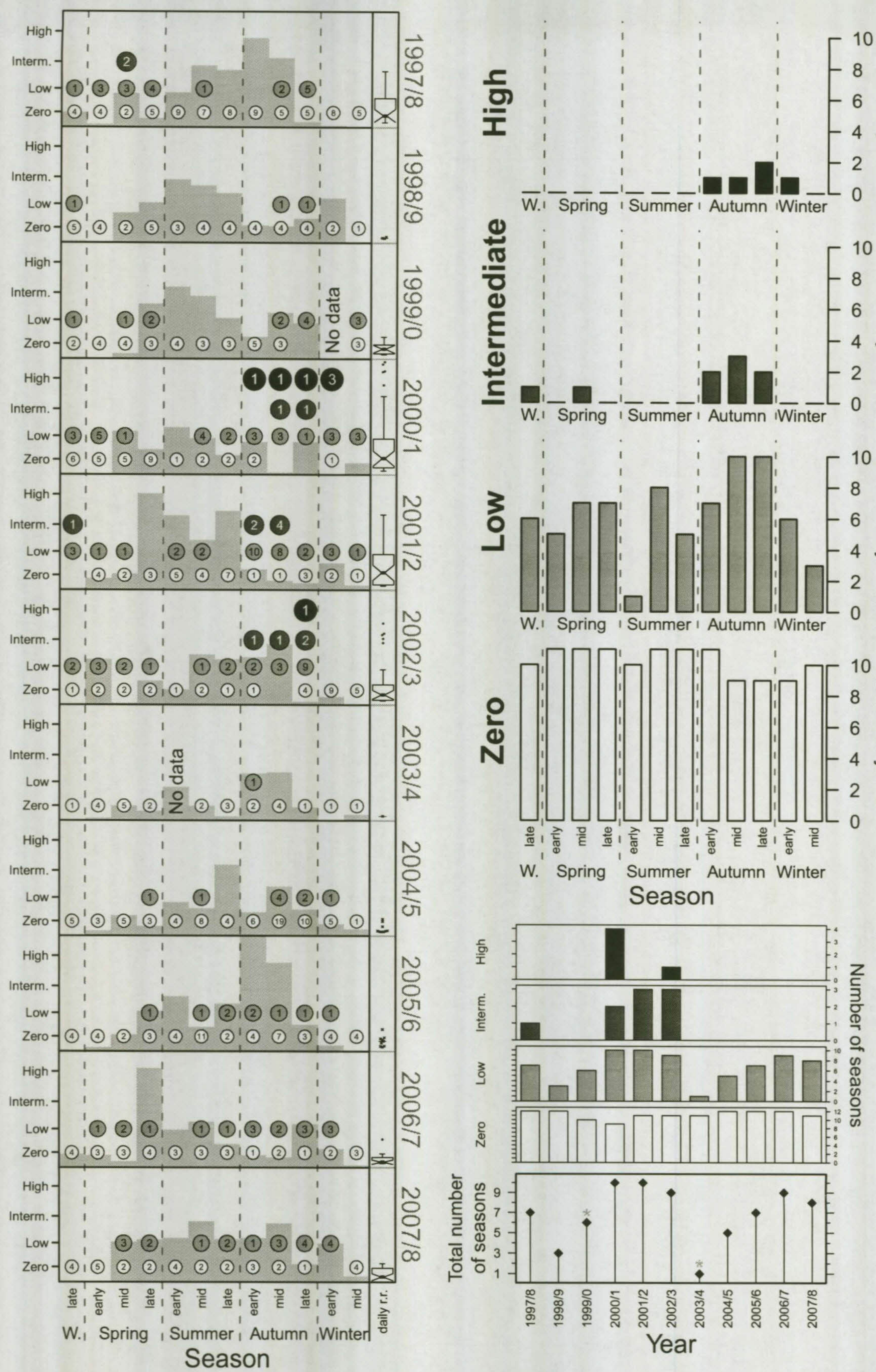


Figure 4.301: R465 Acacia Pied Barbet — *pehp* calls: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

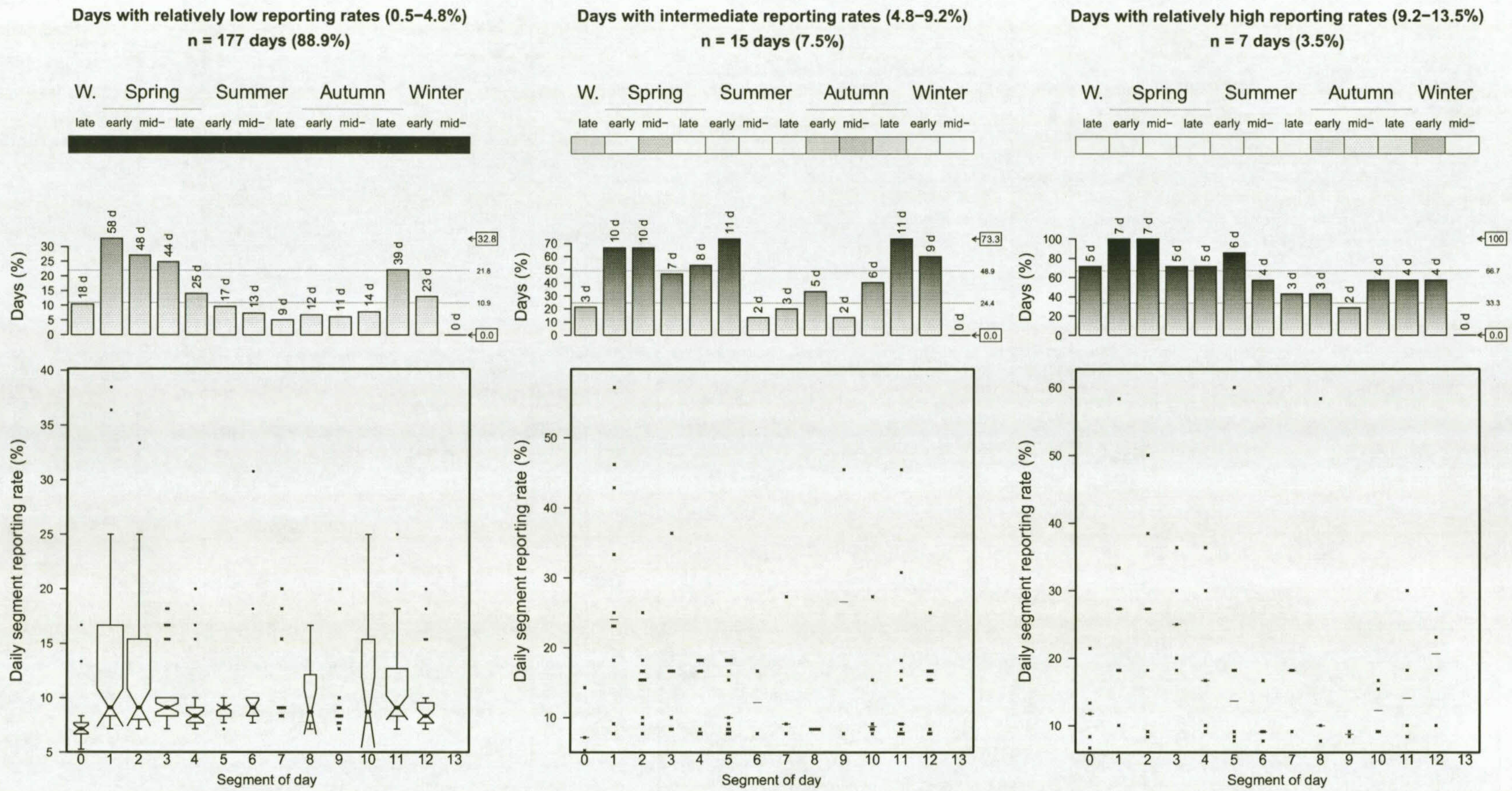


Figure 4.302: R465 Acacia Pied Barbet — *pehp* calls: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

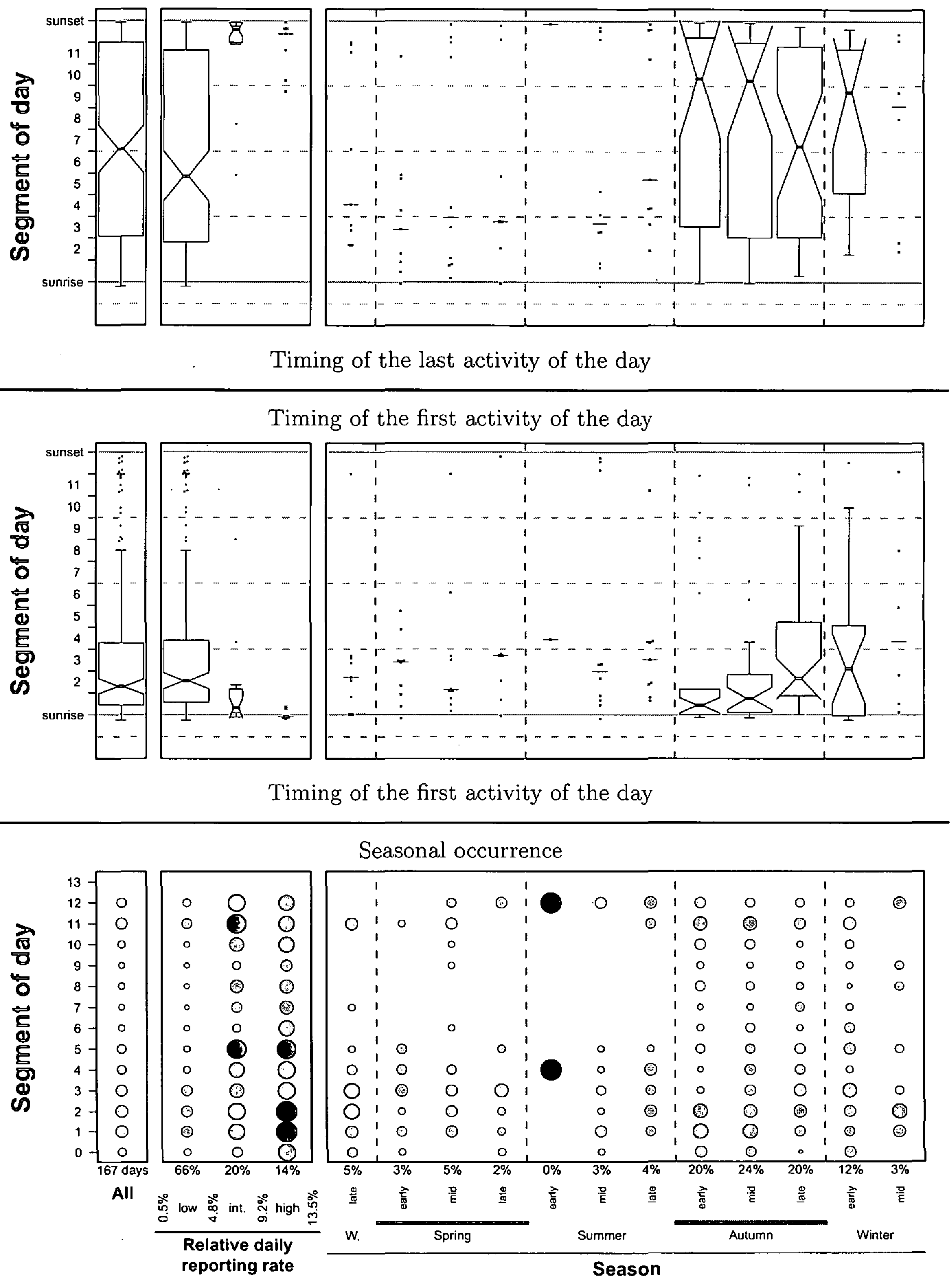


Figure 4.303: R465 Acacia Pied Barbet — *pehp* calls: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

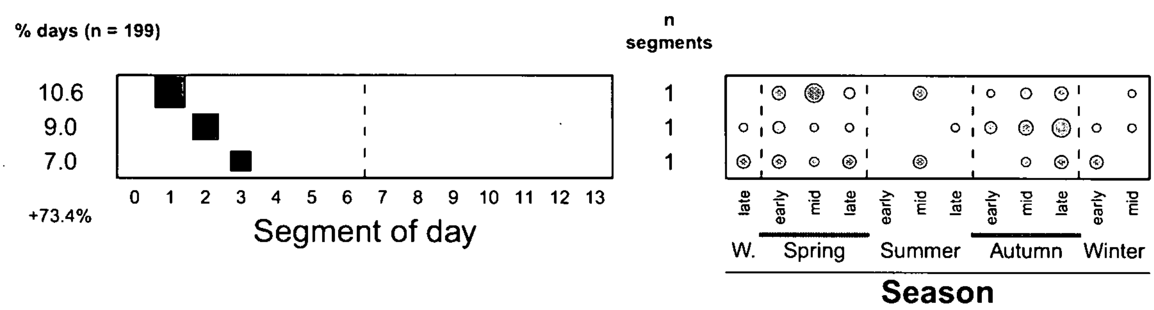


Figure 4.304: R465 Acacia Pied Barbet — *pehp* calls: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

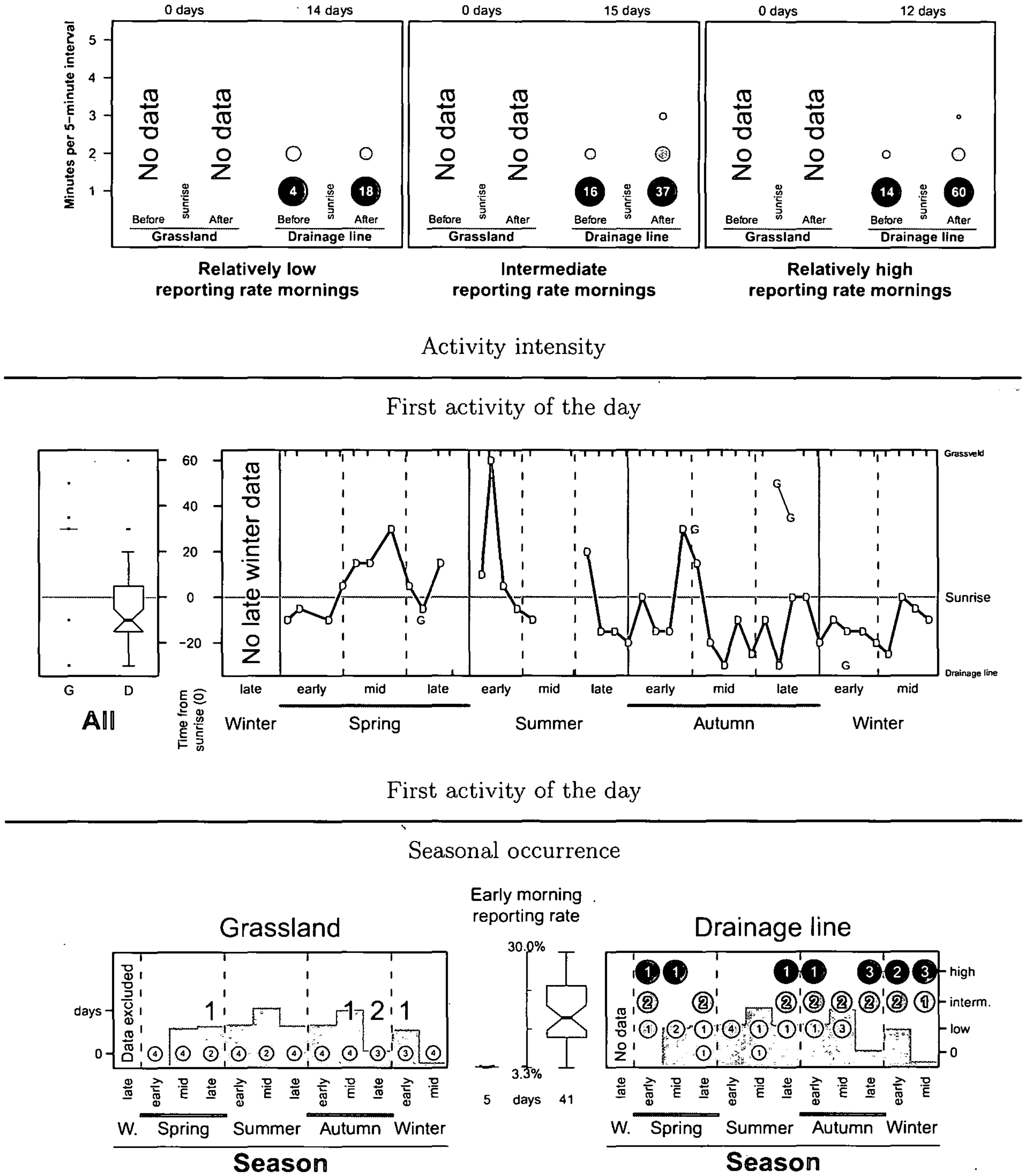


Figure 4.305: R465 Acacia Pied Barbet — *pehp* calls: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

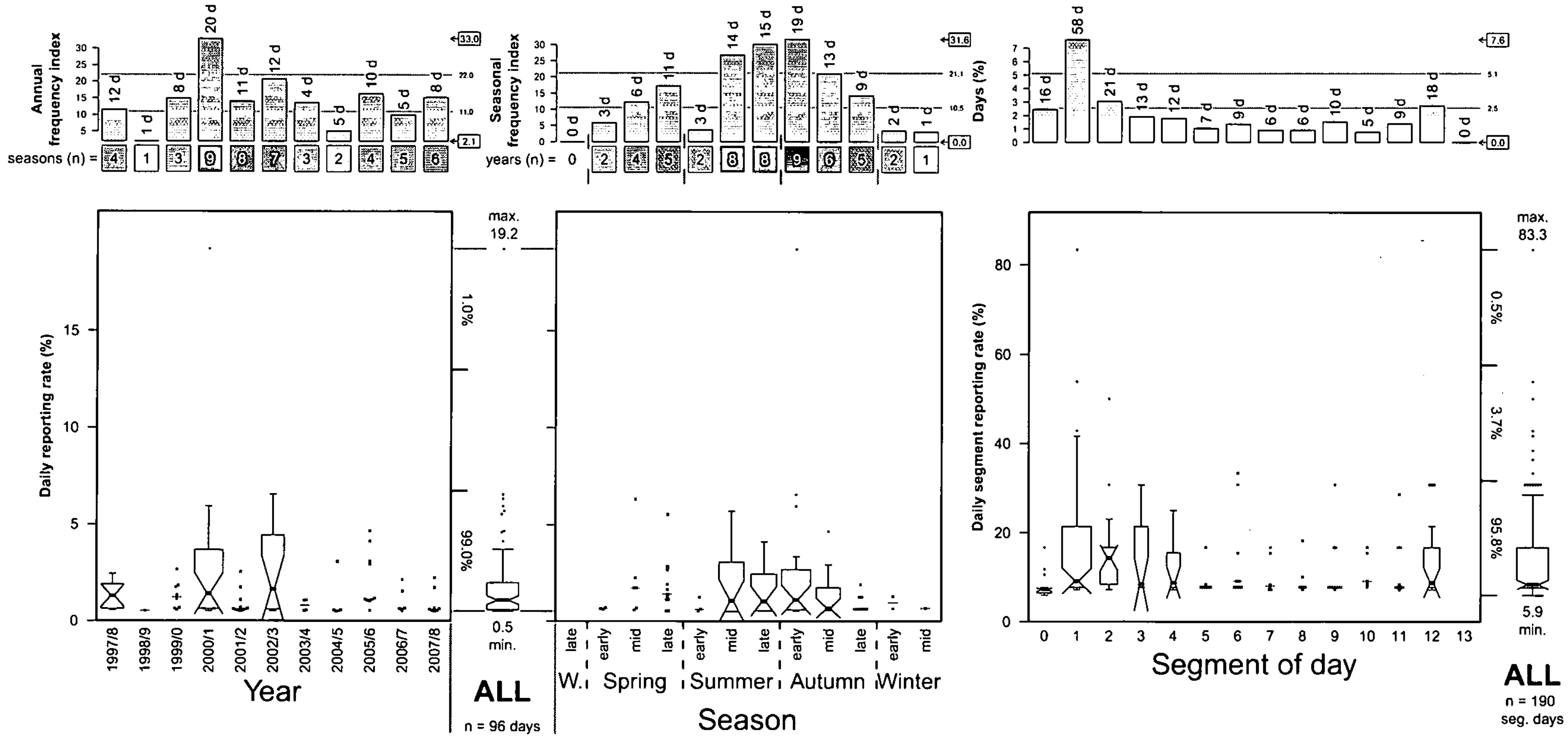


Figure 4.306: R465 Acacia Pied Barbet — *hoop* calls: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

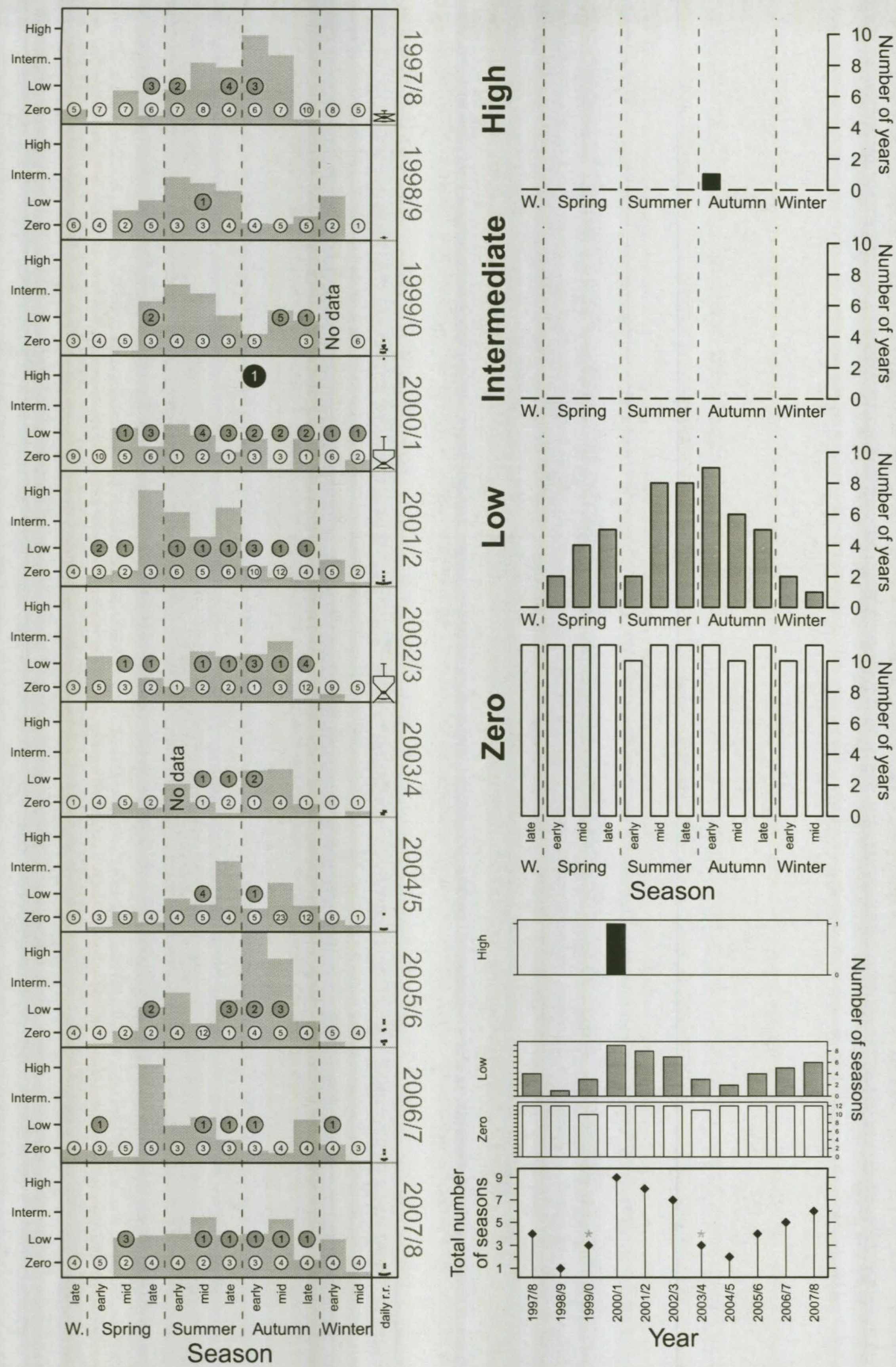


Figure 4.307: R465 Acacia Pied Barbet — *hoop* calls: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

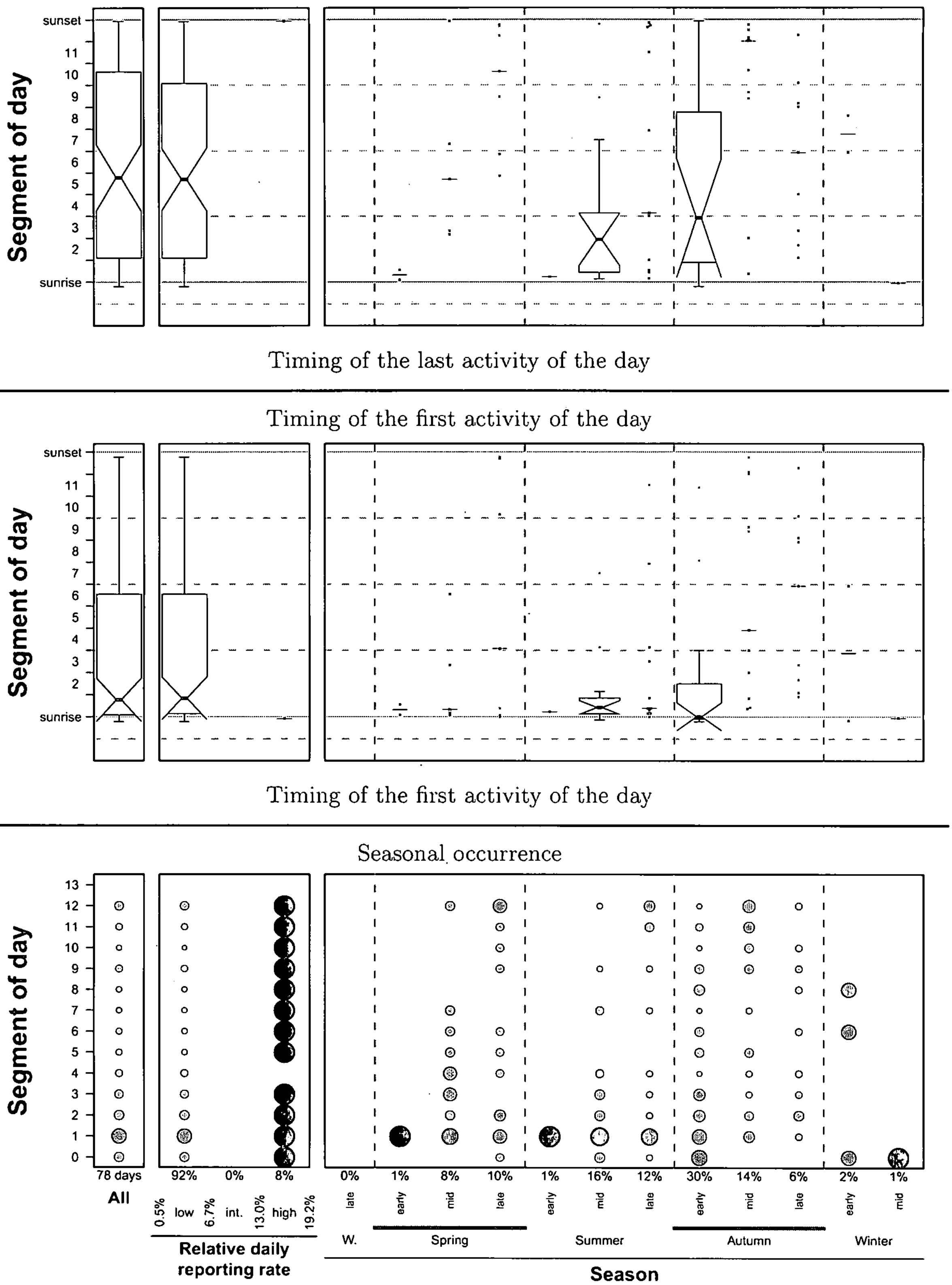


Figure 4.308: R465 Acacia Pied Barbet — *hoop* calls: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

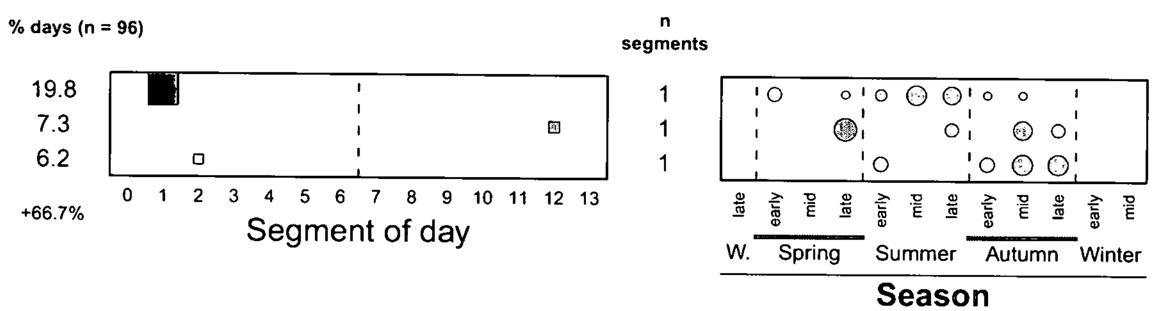


Figure 4.309: R465 Acacia Pied Barbet — *hoop* calls: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

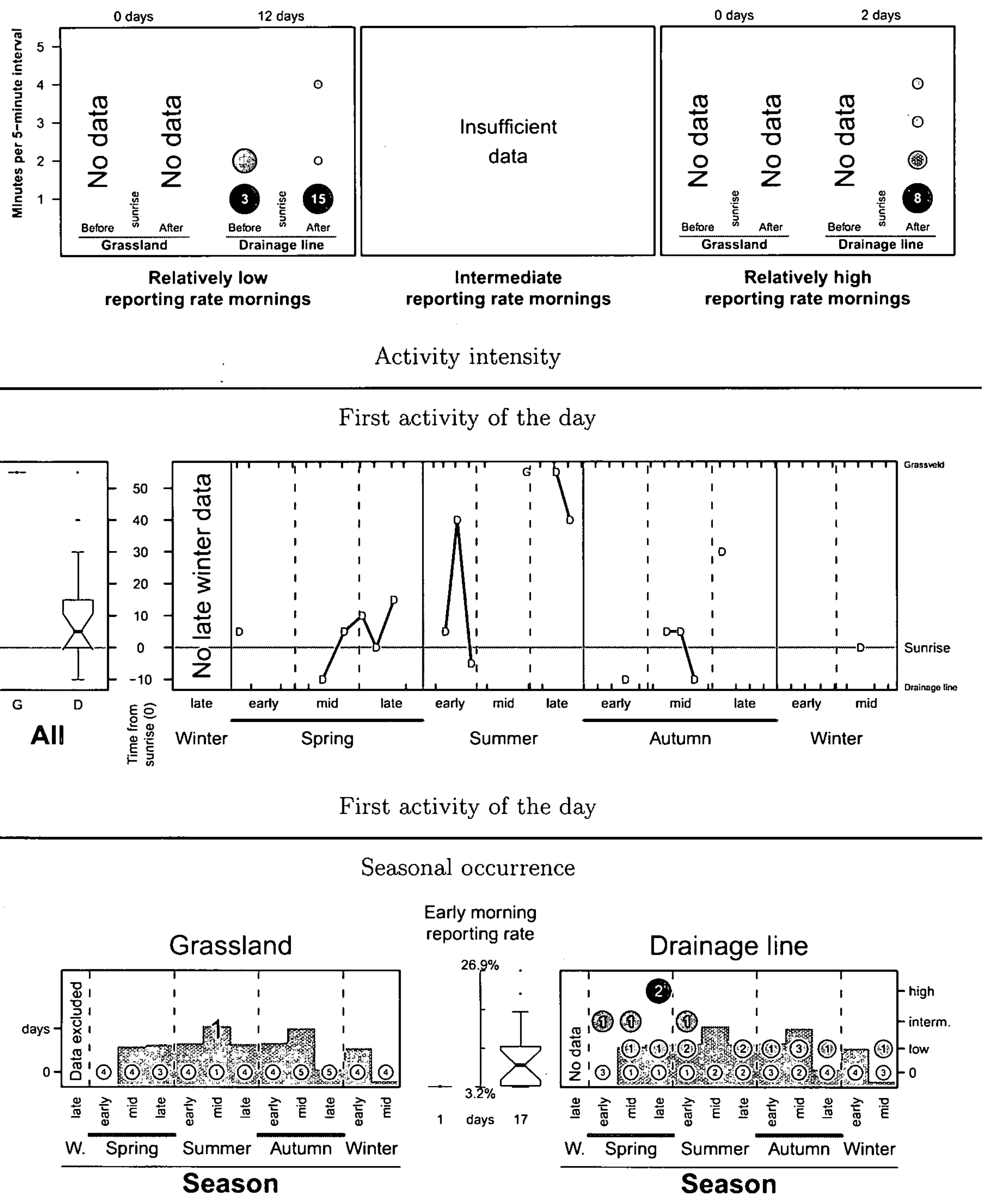


Figure 4.310: R465 Acacia Pied Barbet — *hoop* calls: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

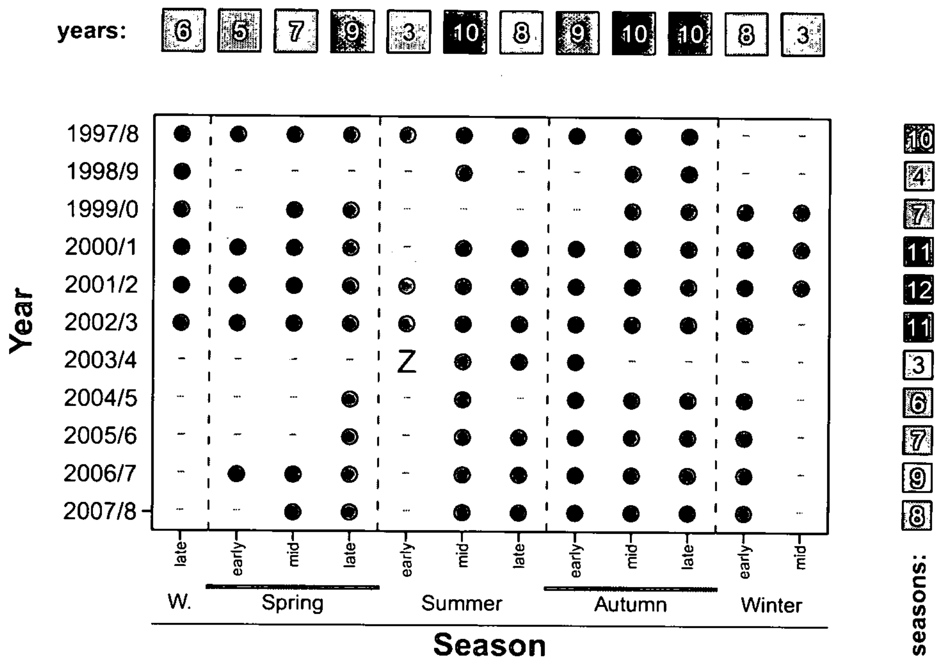


Figure 4.311: R465 Acacia Pied Barbet: Annual and seasonal occurrence at Glen when all data are combined. See page 137 for more information on this combined figure.

In explaining slight fluctuations in SABAP1 reporting rates (higher during the cooler seasons in Zone 7 and other zones), Nuttall (1997b) suggested that this may be caused by birds moving into habitats where they are more likely to be encountered during these seasons, in contrast to the warmer seasons when they are presumably more widespread. However, the SABAP1 data is also compatible with a resident population exhibiting rather complicated seasonal changes in detectability, as illustrated by the Glen data.

R473 Crested Barbet .... *Trachyphonus vaillantii*

The Crested Barbet is endemic to Africa south of the equator (Maclean 1985). In southern Africa it is widespread in the eastern half of the region from the Free State and KwaZulu-Natal northward (Nuttall 1997c; Parker 1999). Its spread south-westward into the Free State during the last few decades was probably via riparian vegetation (Earlé & Grobler 1987; Herholdt & Earlé 1987). Ringing data suggest that they are resident. However, the recent range expansion indicates that at least some individuals are liable to more extensive movements (Nuttall 1997c).

The birds at Glen

Crested Barbet records were limited to birds heard calling in the drainage line. Figures start on page 552.

Annual occurrence of drainage line birds heard in the grassland: Recorded on 46.5% of the days with an activity index of four (Table 4.52a). Activity was noted during 7–12 seasons per year (Fig. 4.312; Fig. 4.313). Daily reporting rates ranged from 0.5 to 19.4% with 93.8%

bird-days attaining relatively low reporting rates and the median daily reporting rates similar for all years (Fig. 4.312).

Table 4.52: R473 Crested Barbet: Numerical data summary of 5-minute checklists compiled in the study area at Glen.

Proportion	5-minute checklists n	5-minute checklists Total	5-minute checklists %	Activity	Days %	Days Total	Days n	Activity index
a) Grassland data-set for all 11 years (excl. days with <10 obs. segs.)								
1.000	1 298	114 612	1.1	birds heard only	46.5	656	305	4
b) Drainage line data-set for 2007/8 – segments 0 and 1 only:								
1.000	58	1 190	4.9	birds heard only	53.5	43	23	3
c) Grassland data-set for 2007/8 – segments 0 and 1 only:								
1.000	30	1 188	2.5	birds heard only	37.2	43	16	2

Seasonal occurrence of drainage line birds heard in the grassland: Recorded during all seasons, least frequently (4–6 years) in late winter, early spring and early summer (Fig. 4.312). Median daily reporting rates were similar for all seasons (Fig. 4.312).

Daily occurrence of drainage line birds heard in the grassland: Overall, activity was most frequent during the early morning after sunrise and infrequent after mid-morning (Fig. 4.312). This pattern was similar for low and intermediate reporting rate days (Fig. 4.314). All seasons, except early summer, showed a similar pattern (Fig. 4.315). Segment combinations occurring during more than 5% bird-days were limited to three combinations involving S1–S2, collectively accounting for nearly a third of all bird-days (Fig. 4.316).

The first activity of the day typically occurred in the early morning after sunrise with the median time of the respective seasons similar to one another (Fig. 4.315). The timing of the last activity of the day was variable (Fig. 4.315).

Overall, daily segment reporting rates ranged from 5.3 to 83.3% with 89.6% of the values relatively low (Fig. 4.312). The median daily segment reporting rate of S1 and S2 were higher than those of other segments (Fig. 4.312), particularly on intermediate reporting rate days (Fig. 4.314).

Early morning occurrence of birds heard in 2007/8: Activity was slightly more frequent in the drainage line, occurring on 53.5% of the mornings compared to 37.2% in the grassland (activity index 3 vs. 2; Table 4.52b & c). The median early morning reporting rate of the drainage line was also marginally higher (Fig. 4.317). Nonetheless, both habitats showed only one high reporting rate morning, and in both cases it occurred during mid-spring (Fig. 4.317). The timing of the first activity of the day was variable (Fig. 4.317). Activity intensity was sometimes slightly higher after sunrise (Fig. 4.317).

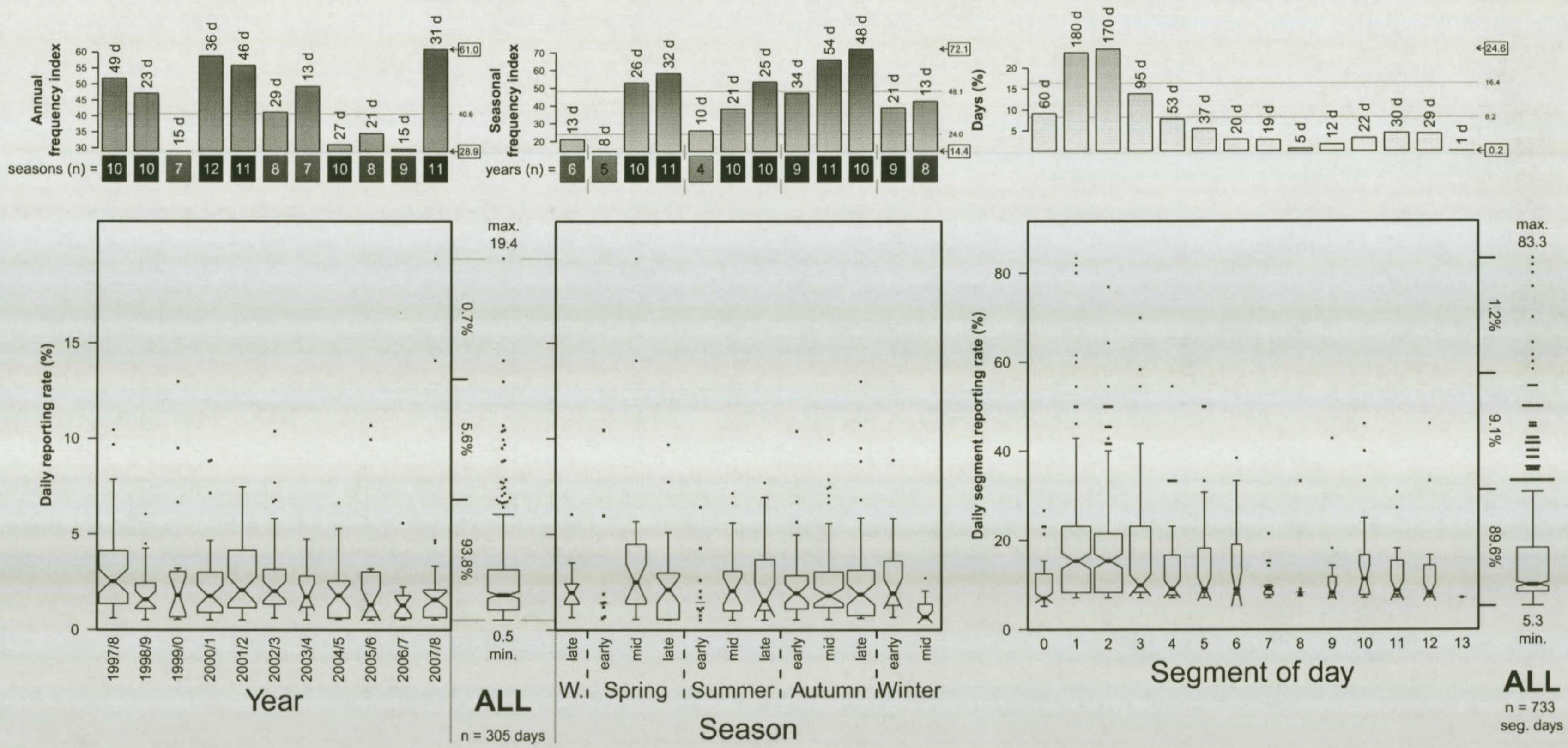


Figure 4.312: R473 Crested Barbet — birds heard only: Annual (left), seasonal (middle) and daily (right) occurrence in the grassland at Glen. See page 132 for more information on this general summary figure.

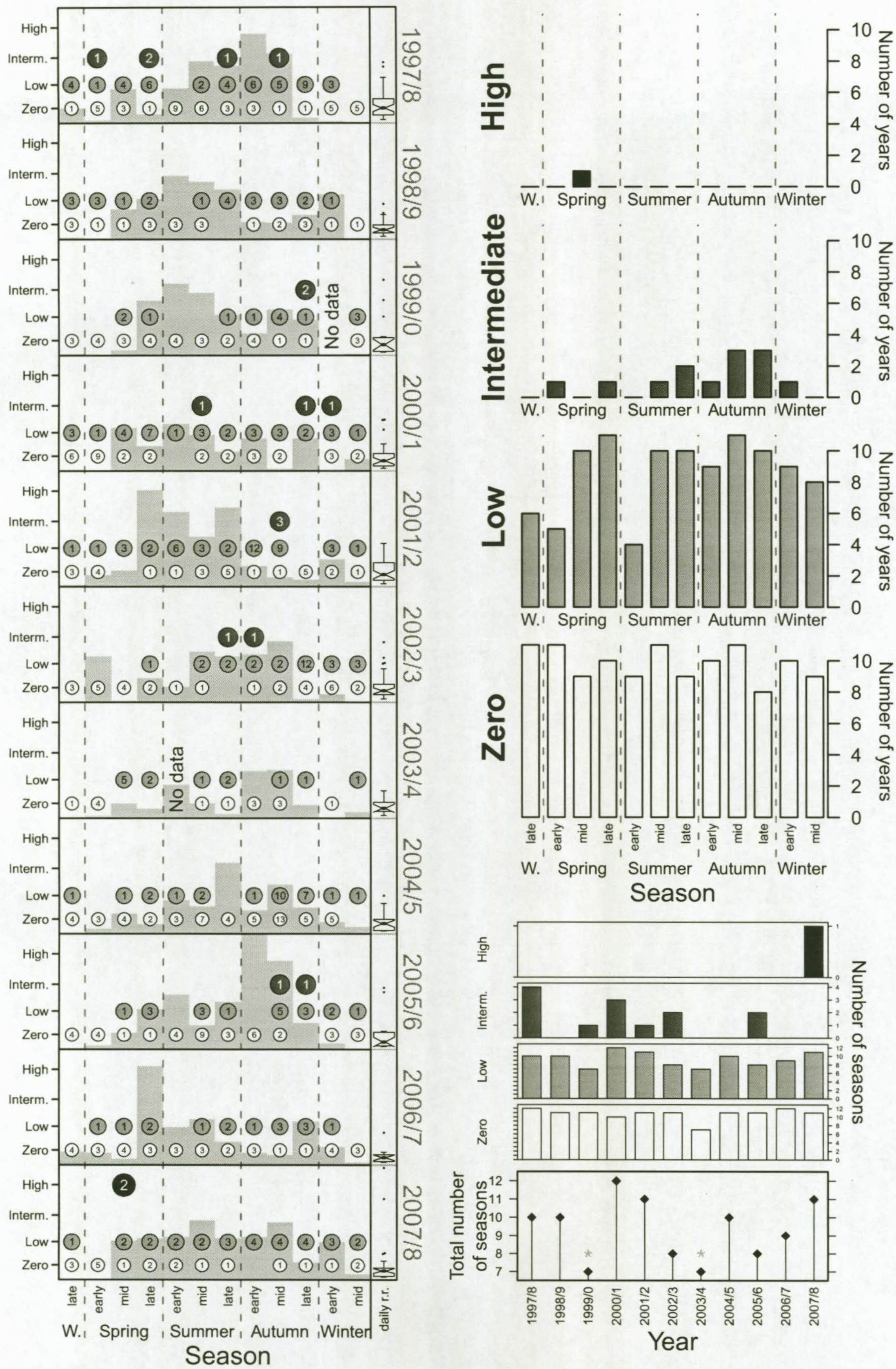


Figure 4.313: R473 Crested Barbet — birds heard only: Occurrence of zero, low, intermediate and high reporting rate days in the grassland at Glen. The figures on the right summarise the data on the left. See page 134 for more information on this yearly detail figure.

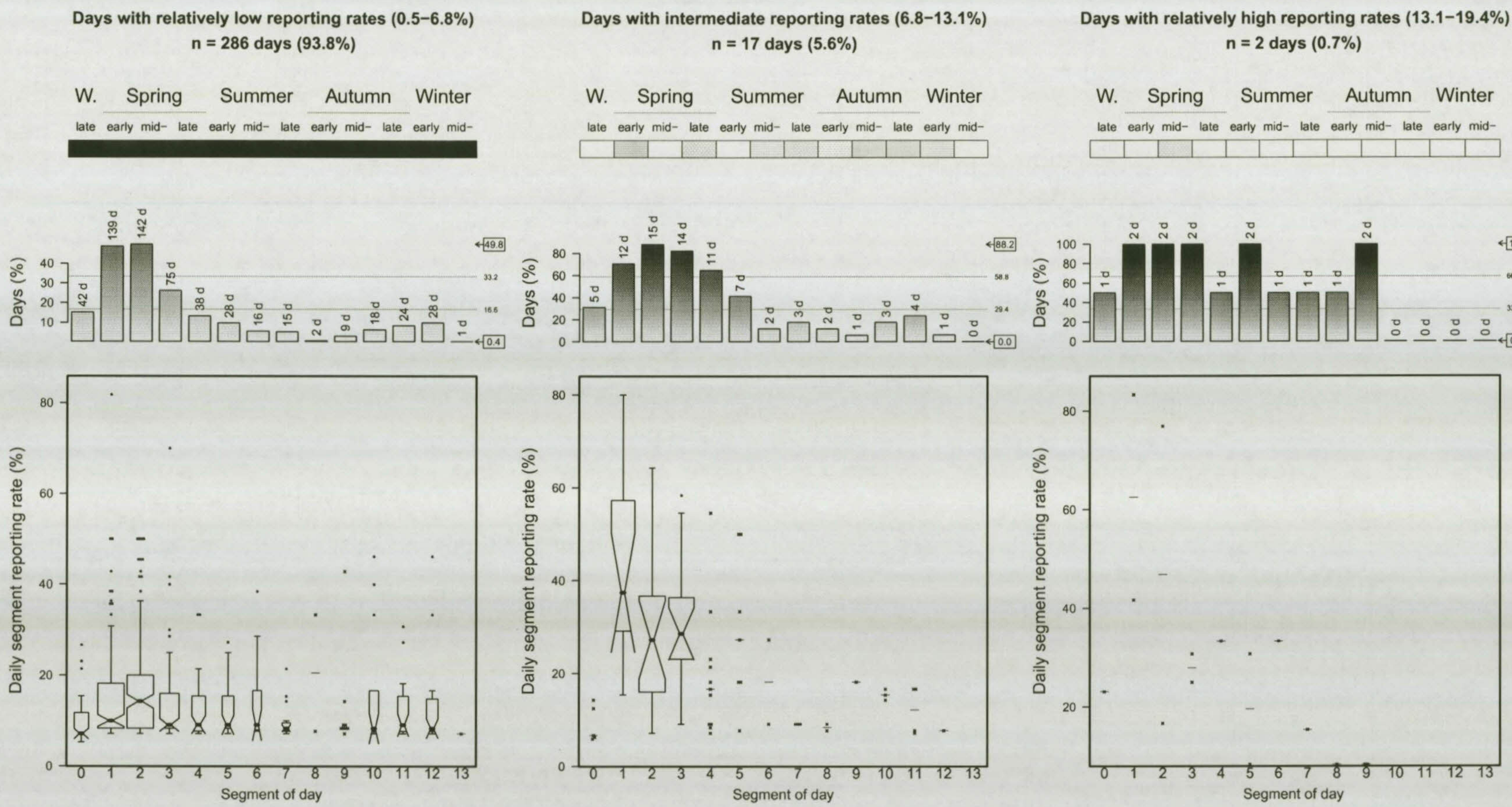


Figure 4.314: R473 Crested Barbet — birds heard only: Details on the daily occurrence during low (left), intermediate (middle) and high (right) reporting rate days in the grassland at Glen. See page 134 for more information on this LIH figure.

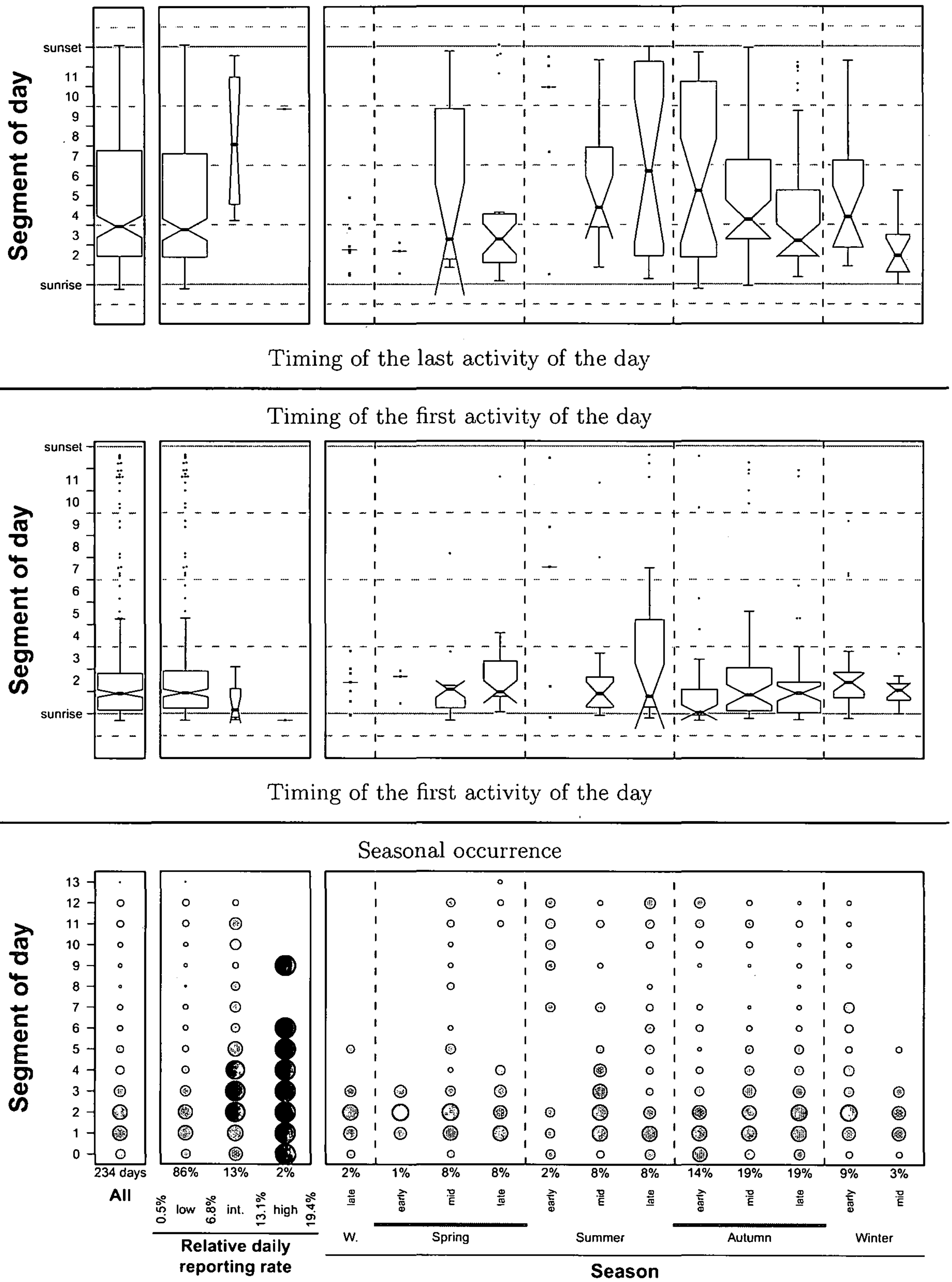


Figure 4.315: R473 Crested Barbet — birds heard only: Details on daily occurrence in the grassland at Glen. See page 135 for more information on this daily activity figure.

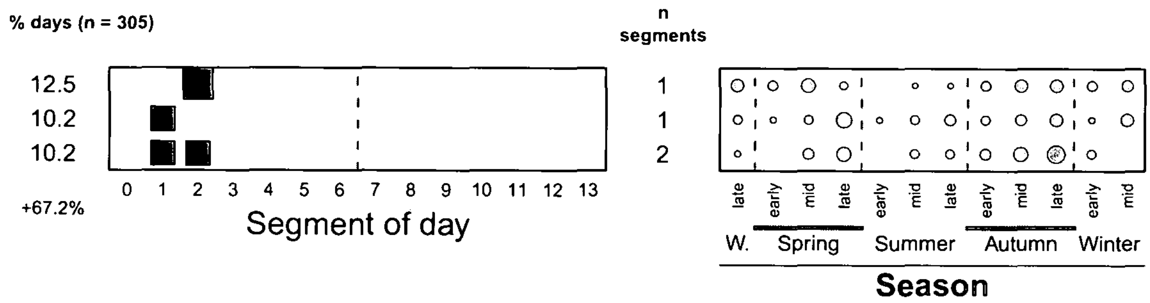


Figure 4.316: R473 Crested Barbet — birds heard only: Daily occurrence of activity during segment combinations in the grassland at Glen. See page 135 for more information on this bird-segment combination figure.

Discussion

The data collected in the early mornings of 2007/8 suggests that the Crested Barbet activity recorded in the grassland slightly underestimated the activity of these birds in the drainage line (Table 4.52b & c; Fig. 4.317). Fortunately, however, it appears that the grassland data-set is accurate enough for the determination of peak activity (Fig. 4.317).

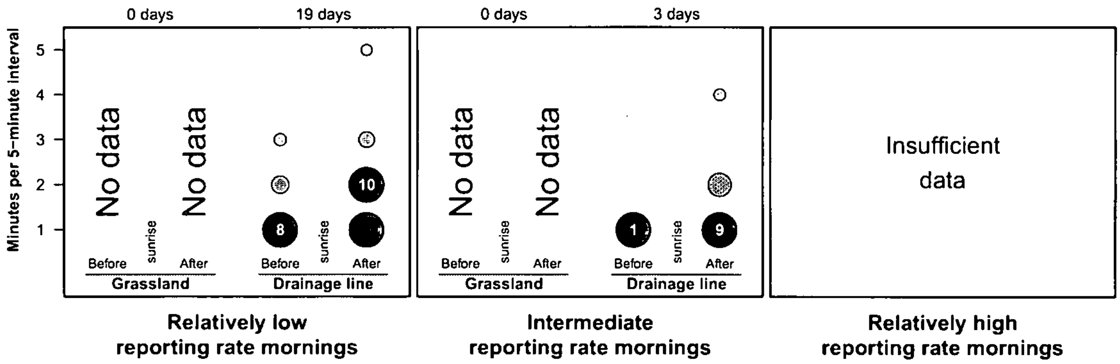
The seasonal pattern of Crested Barbet activity in the grassland is similar to that shown by the Acacia Pied Barbet R465 *pehp* calls (*cf.* Figs. 4.300 & 4.312). Given that the breeding season are similar for both species (mainly September to December [spring to mid-summer], Tarboton 2001), it is suggested that the explanation for the observed similarity in activity patterns is also similar. Briefly, it entails a post-breeding moult that is followed by more vocalisations; see Discussion on page 538. However, more study is needed because the moult strategy of the Crested Barbet is not yet clear (Chittenden 2005c; DJvN unpublished data).

4.41 Indicatoridae: Honeyguides

Seventeen honeyguide species occur in Asia and in Africa with six species found in southern Africa (Hockey *et al.* 2005). They are all brood parasites of a variety of bird species (Hockey *et al.* 2005). Three species occur in the Free State with the distribution of the Brown-backed Honeyguide (formerly Sharp-billed Honeyguide) *Prodotiscus regulus* limited to certain peripheral areas of the province (Earlé & Grobler 1987; Harrison *et al.* 1997a) [Note that the map in Earlé & Grobler (1987) is in error; see Colahan 1994]; It was the only species not recorded at Glen.

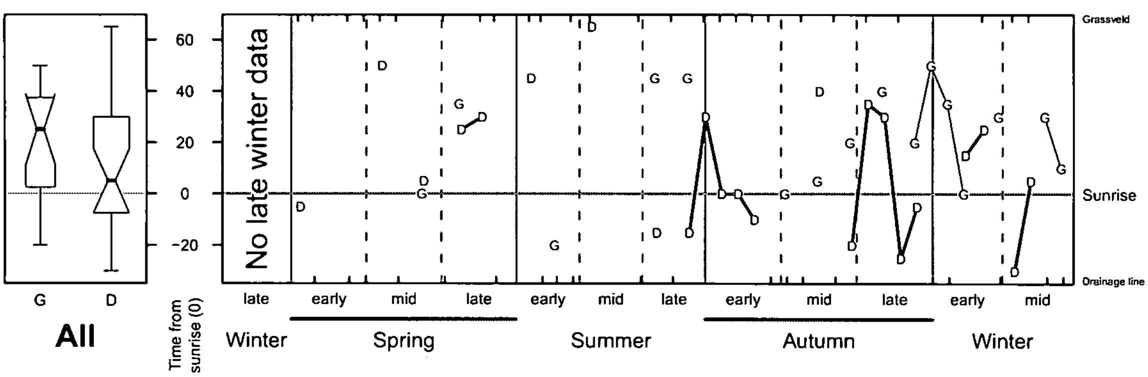
R474 Greater Honeyguide . . . . *Indicator indicator*

The Greater Honeyguide is endemic to sub-Saharan Africa (Maclean 1985). In southern Africa its distribution is mainly limited to the eastern half and the far south of the region (Parker 1999; Vernon & Underhill 1997a). It is a rare bird in the Free State (Earlé & Grobler 1987; Vernon & Underhill 1997a). Found in a wide range of woodland habitats (Maclean 1985). The population consists of resident as well as nomadic elements (Vernon & Dean 2005b; Vernon & Underhill 1997a).



Activity intensity

First activity of the day



First activity of the day

Seasonal occurrence

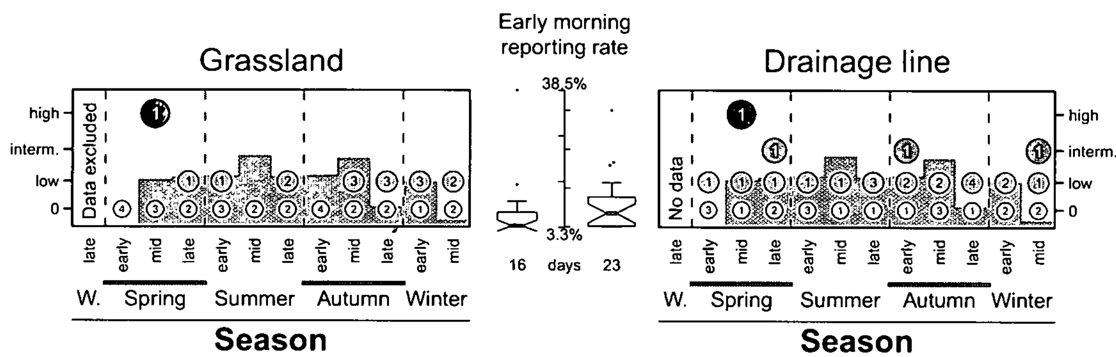


Figure 4.317: R473 Crested Barbet — birds heard only: Summary of data collected during 2007/8 in S0 – S1 at Glen, first in the grassland and the following morning in the drainage line. Bottom: Seasonal occurrence of days with zero, low, intermediate and high early morning reporting rates; Middle: Occurrence of the first activity of the day; Top: Activity intensities before and after sunrise on low (left), intermediate (middle) and high (right) reporting rate mornings. See page 136 for more information on this early morning figure.

The birds at Glen

According to Steyn (1996), the Greater Honeyguide parasitize more than 30 bird species. The following species are breeding or probably breeding within the study area and are therefore potential hosts for the honeyguide: African Hoopoe R451, Common Scimitarbill R454, Pied Barbet R465, Crested Barbet R473, Ant-eating Chat R595, Glossy Starling R764 and Southern Grey-headed Sparrow R804.

Records in the grassland refer to immature birds seen (and heard) in the grassland or the trampled area, as well as adults heard calling in the drainage line.

Encountered on a total of 12 days with no records from 1999/0 to 2002/3 (Fig. 4.318). Recorded in seven seasons from late winter to mid-autumn with most records occurring prior to mid-morning (Fig. 4.318).

Discussion

The status of the Greater Honeyguide at Glen is perhaps best described in the words of Skead (1951): Nomadic birds "appeared quite unexpectedly at any time and seemed to roam about the veld without any fixed intentions."

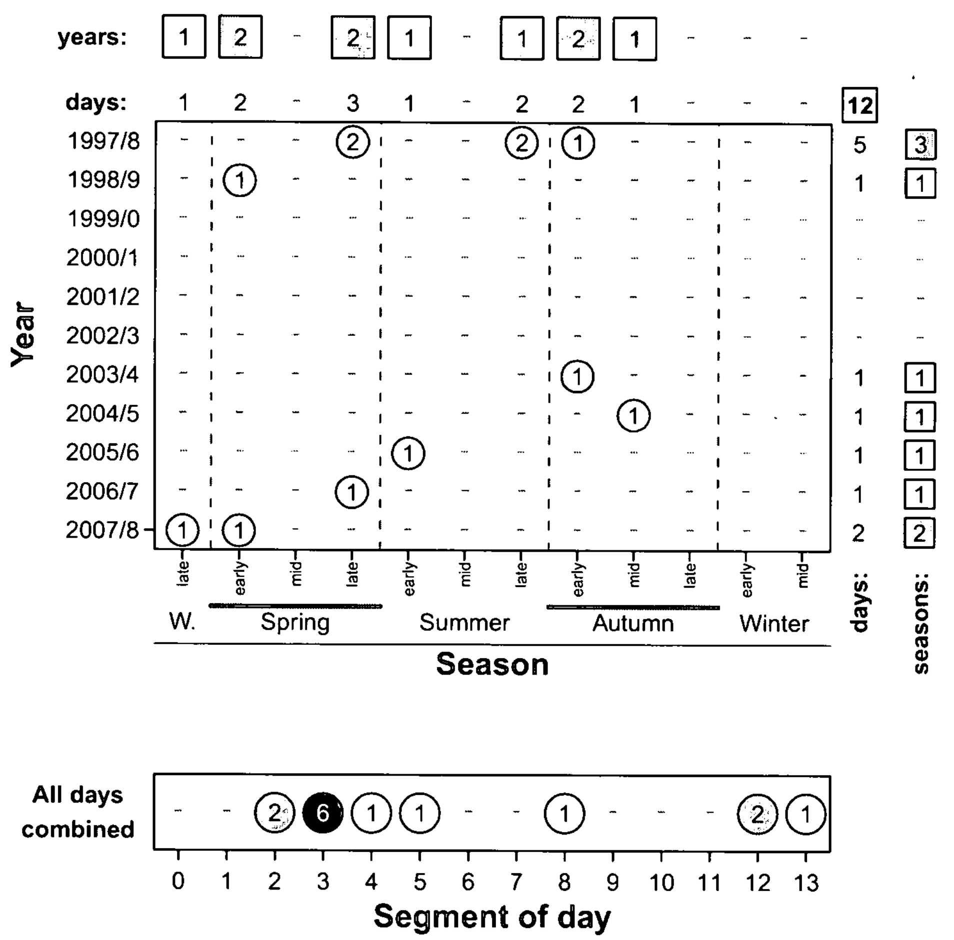


Figure 4.318: R474 Greater Honeyguide — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

R476 Lesser Honeyguide . . . . *Indicator minor*

The Lesser Honeyguide is endemic to sub-Saharan Africa (Maclean 1985). Its southern African distribution is similar to that of the Greater Honeyguide R474, except that it is recorded from more Namibian localities (Parker 1999; Vernon & Underhill 1997b). Recorded from a number of localities in the Free State (Earlé & Grobler 1987; Vernon & Underhill 1997b). It occurs in a variety of woodland habitats and is easily overlooked unless it is calling (Vernon & Underhill 1997b). The population consists of resident and nomadic elements (Vernon & Dean 2005c; Vernon & Underhill 1997b).

The birds at Glen

The Lesser Honeyguide is known to parasitize a number of host species (Steyn 1996), which include the following breeding species at Glen: Pied Barbet R465, Crested Barbet R473 and Glossy Starling R764.

Recorded on four days only. It was seen in the grassland on two days in early spring 2003/4 and heard twice during mid-summer (1997/8 and 2000/1).

Discussion

The few Lesser Honeyguide records at Glen are suggestive of nomadic movements, although they are easily overlooked when not calling.

4.42 Picidae: Woodpeckers, Wrynecks

A total of 216 species occur worldwide, with ten species — *i.e.* nine woodpeckers and a wryneck — occurring in southern Africa (Hockey *et al.* 2005). The wryneck and five woodpecker species occur in the Free State (Earlé & Grobler 1987; Harrison *et al.* 1997a). The Golden-tailed Woodpecker *Campethera abingoni* and the Bearded Woodpecker *Dendropicos namaquus* are rare vagrants to the province, and the Olive Woodpecker *Dendropicos griseocephalus* is restricted to the evergreen montane forests of the eastern Free State. The Ground Woodpecker *Geocolaptes olivaceus* is more common, but largely restricted to the mountainous terrain of the eastern, south-eastern and southern parts of the province. Only the Cardinal Woodpecker R486, which is more widespread in the province, and the Red-throated Wryneck R489, also widespread, were recorded at Glen.

R486 Cardinal Woodpecker . . . . *Dendropicos fuscescens*

The Cardinal Woodpecker is endemic to sub-Saharan Africa (Maclean 1993), and the most widespread woodpecker in southern Africa, being absent only from treeless areas (Tarboton 1997a). It is resident and sedentary (Tarboton 1997a).

The birds at Glen

All records of the Cardinal Woodpecker in the grassland actually refer to birds calling in the drainage line.

In the grassland, recorded on nine days spread over seven (non-consecutive) years (Fig. 4.319). These records occurred during six seasons from mid-spring to early winter, with most of the records during the morning (Fig. 4.319).

In the drainage line, recorded four times during the early mornings of 2007/8 (no records during the same period in the grassland), and on a total of nine days during transects. Collectively, these drainage line records occurred during eight seasons.

Discussion

The data collected in the grassland is probably not representative of the Cardinal Woodpecker's activity in the drainage line. In fact, Tarboton (1997a) — referring to SABAP1 data — noted that "it was probably under-recorded on account of its relative inconspicuousness." According to Tarboton (2005b), pairs remain together and are territorial year-round. Breeding occurs mainly from August to October [spring] (Tarboton 2001).

R489 Red-throated Wryneck .... *Jynx ruficollis*

The Red-throated Wryneck is endemic to sub-Saharan Africa (Maclean 1985). Its southern African distribution is basically limited to Swaziland and South Africa where it occurs from Port Elizabeth in the Eastern Cape to Louis Trichardt in Limpopo Province, including the eastern half of the Free State (Earlé & Grobler 1987; Tarboton 1997b, 2005a). Glen is situated at the western limit of its range. It is found in grassland with sparse trees where it is resident (Earlé & Grobler 1987; Tarboton 1997b, 2005a).

The birds at Glen

All Red-throated Wryneck records involved individuals calling from within the drainage line in the south, or trees along the railway line in the north-east. Heard on six days during mid-spring, late summer and early winter (2002/3, 2003/4 and 2007/8) in the grassland, mostly between sunrise and mid-morning (Fig. 4.320).

Encountered during the early mornings of 2007/8 in the drainage line only, where it was heard on eight days during early spring (n = 4 mornings; two birds seen during one morning), mid-spring, early and mid-summer and mid-winter.

Discussion

The Red-throated Wryneck appears to be an irregular visitor in the drainage line.

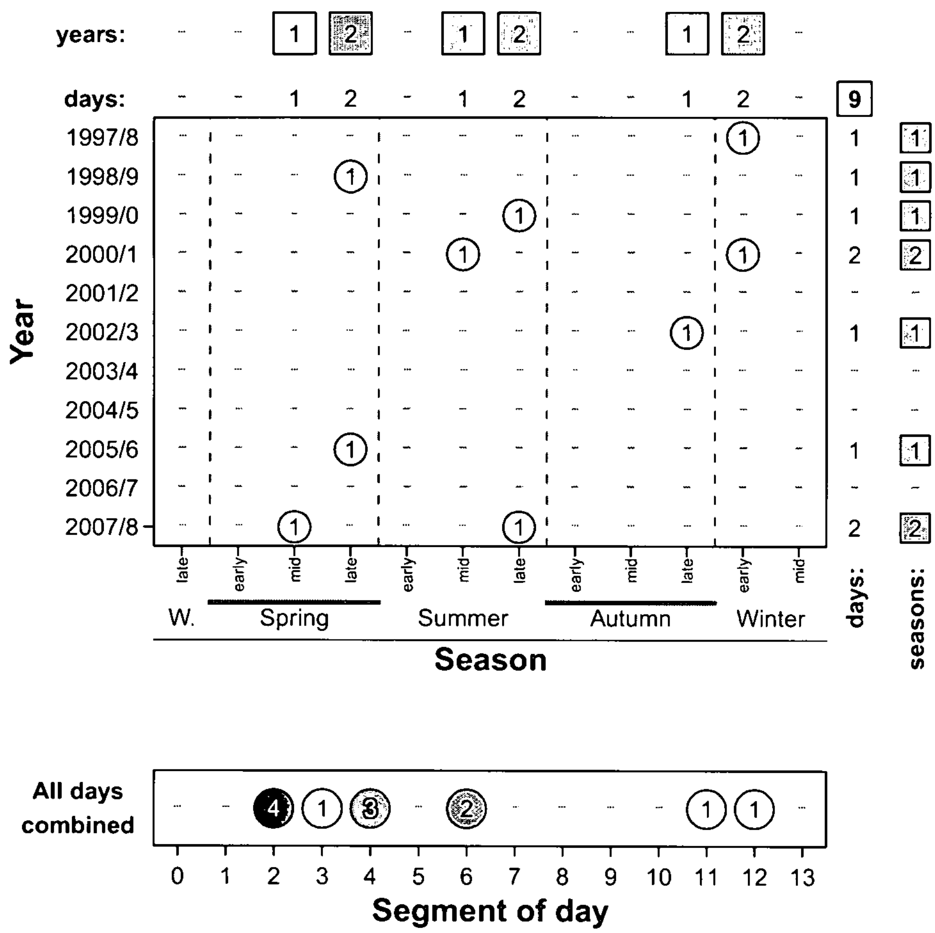


Figure 4.319: R486 Cardinal Woodpecker — birds present: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

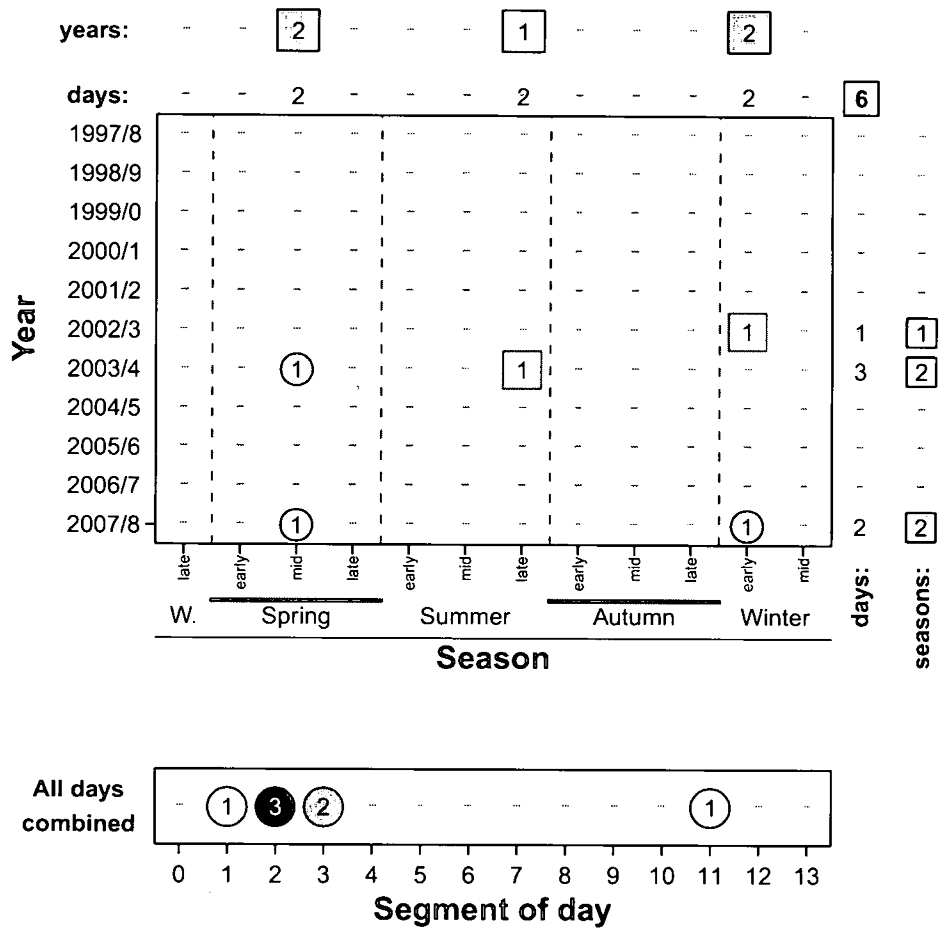


Figure 4.320: R489 Red-throated Wryneck — birds heard only: Annual, seasonal (top) and daily (bottom) occurrence in the grassland at Glen. See page 138 for more information on this 'few records figure'.

Continued in Volume II ...