

New Forest Roe Deer

John K Fawcett

The smallest and prettiest of our native deer, the roe is also the most elusive and hard to study. This dainty woodland creature is one of the most widespread of the deer species found in Britain today. However, in contrast to prolific and expanding roe deer populations elsewhere in England, in the New Forest pressures on the species are intense.

This fascinating book is the result of intensive research extending for over a decade by the author, John Fawcett, a well respected expert on the subject. This new publication provides an intimate portrait of the lives of a particular population of roe deer, which is exceptionally in need of special care. It will be valuable to scientifically oriented readers as well as those with wider interests.

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New Forest Roe Deer

A report, including detailed
studies since 1989

John K Fawcett

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From the mid-1960s I collaborated closely with the late Dr Donald Chapman and Norma Armstrong, who soon became Mrs Chapman, occasionally on wild fallow in Essex but more continuously on the large populations of fallow and red deer ranging Richmond Park. For over a decade we caught and tagged hundreds of fawns and calves for individual identification and study, one of the products being the comprehensive textbook on fallow deer published in 1975 and still not superseded, with which I was proud to be associated. Norma, like Donald until his tragic death in 1982, has remained a close family friend constantly supporting my interest in roe.

Above all, my wife Jeanne, whose contributions with those of our then young sons were acknowledged in *Fallow Deer*, has been my unflinching mainstay for half a century. Always facilitating my daily timetable and habits peculiar to mammal watchers, she has also participated actively in the fieldwork. Consistently throughout my wildlife observations she has been a conscientious critic of my reports and writings, including the current work. My studies would have been impossible without her continuous backing.

From Arthur Cadman's days 40 years ago, the Forestry Commission has issued permission to conduct research and since 1989 provided its census figures and records of mortality. I am grateful for the willing co-operation of many retired and current keepers, and for their friendship and that of Chief Keeper Martin Noble. Those not mentioned by name will understand special acknowledgement of those with whom circumstances brought me in greatest contact: Ian Young, who is also a valued neighbour, Robert Colin-Stokes, John Frankcom, John Gulliver, Alan Hobbs, Andy Page, Maurice Holland, Howard Taylor, Jonathan Cook, Andy Shore and Matthew

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A pre-publication edition of this report appeared in *Deer*, Volume 12 Numbers 1 – 6. Michael Baxter Brown, its editor on behalf of the British Deer Society, suffered my many requests for corrections and changes. He has been a good friend since June 1970 when, as newly appointed Superintendent of Richmond Park, he chose not to sit in his office but instead to join Norma Chapman, her late husband Donald and me in our searches to ear-tag newborn red and fallow deer, to gain (literally) hands-on experience of deer management. Hospitality for our studies there continued for some twenty years during which management of the large deer herds was among his many successes.

John Fawcett

Contents



introduction:	The New Forest and its Deer	Page 2
chapter one:	Population Status and Dynamics	Page 5
chapter two:	Annual Cycles and Social Relations	Page 15
chapter three:	Ranging	Page 25
chapter four:	Social Relationships of Individuals	Page 34
chapter five:	Conclusions	Page 45
postscript:	Conservation and the New Forest's Deer	Page 54
	References	Page 61

THE NEW FOREST is a very special place with unique woodlands, wetlands and heathlands recognised by many conservation designations. The management objectives of this multi-purpose working forest are defined in priority order in the Minister's Mandate of 6 July 1999 as (i) conservation; (ii) community engagement in decision making, recreation and understanding; and (iii) insofar as is consistent with the first and second objectives, timber production.

This is the largest area of wild vegetation and ancient woodland in lowland Britain. Historically, soil conditions dictated low density of human population. The habitat boundary became even sharper 30 years ago, after being delineated by fencing and grids across roads. Within this fenced area, deer have to compete with the greater numbers and greater individual bulk of ponies, cattle and other stock owned by commoners but roaming free. So the demarcation is abrupt, contrasting with most national parks worldwide where the transition is gradual and the animals recognise no sudden boundaries.

Britain has only two native species of deer, of which European roe *Capreolus capreolus* are believed to have been present a million years ago and, following periods of glaciation, continuously for more than 9,000 (Lister, 1984; Prior, 1995). Man probably exterminated them around 1600AD in what had become designated the New Forest but they re-colonised very slowly after 1860 and were breeding by 1900, at least a dozen being resident. So this indigenous species has had continuity for over 9,000 years with a man-made hiatus of about 250 years.

The other natives are red deer. Unlike roe,

they hybridise with introduced species and in the New Forest they themselves have depended on repeated introductions, the current population deriving mostly from stock we viewed in pens about forty years ago. Fallow deer were brought to the New Forest probably under a thousand years ago and sika less than a hundred, while muntjac have intruded occasionally for some thirty years.

In contrast to prolific roe deer populations elsewhere, here pressure on the species is intense, not only from competing stock and other deer, but from all kinds of public disturbance. The most serious - as for other wildlife - is from walkers, riders and cyclists with unled dogs, but some conditioning to walkers without dogs and to forestry vehicles favours closer and longer observation of roe deer.

The author's project

Studying roe in an area as large as the New Forest depends on extensive observations supplemented by data from other sources. To balance this breadth with depth of study, much of my fieldwork was in a 200ha core area near the middle of the Forest with the highest central concentration of roe. To be certain of details of population, movements and behaviour, dawn hours on most (about 2,000) mornings for over a decade were devoted to their intensive study.

Ear-tagging and other means of identification enabled the histories of some individuals to be followed for many years. While humans recognise each other by general impression rather than analysed description and a stockman knows his animals individually, this study also applied the discipline of recording descriptions

at each observation and more substantially on camcorder film for confirmation immediately after each survey. Careful scrutiny from head to diminutive tail reveals characteristics identifiable sometimes throughout life but too often, unfortunately, only while observations are continual. Scores of roe were identified individually, but mostly for only months or very few years. Some, either ear-tagged or otherwise recognisable with certainty, were studied much longer and a few selected for this report in which their field identifications have been simplified to letters (e.g. Doe 9218, Doe 18's 1992 kid, is redesignated Doe D).

Methodology to collect data here was established in 1989 and then surveys throughout the 200ha study area were made for another eleven years, following substantially standardised transects by vehicle and on foot. An account of the core study area is in chapter 3 of this report, to which it is most relevant.

It was routine practice to note times, locations and descriptions of roe deer observed. Many map grid references were definable within 10m but sometimes potential errors of 20m had to be accepted. Nevertheless, as precision was much closer than 100m, eight figure map references ("fixes") were recorded.

Although 95% of the surveys started at dawn, a few were before dusk. For statistical analysis of day-to-day (not hour-to-hour) ranging behaviour, only the first sighting of an individual in each six hour period was used; so only 5% of these fixes were other than around sunrise. This limitation minimised distortion of results by human disturbance and also excluded autocorrelation (where fixes are not independent but influenced by the position of previous ones). Ten thousand such first fixes were used for analysis, from about 5,000 hours' observation in about 2,000 surveys.

The research project was designed to concentrate on details of annual cycles, ranging behaviour, social relationships and other



Doe A, Brick Kiln, 13 August 1996

ethological characteristics. Five years after starting the project in 1989, however, major changes in New Forest deer management forced their attention on me in relation to roe, and on other workers whose systematic and intensive studies of fallow and sika extended for over a quarter-century. These changes provided opportunities to enlarge our knowledge and I realised that data collected for other purposes were available to apply to population dynamics and to record with scientific objectivity, setting value judgements aside.

The report

This report on over a decade of concentrated study of roe deer, drafted in 2000-01, relates mostly to the behavioural topics that fascinated from the start. Nevertheless, despite the deterrent mathematical emphasis of population dynamics, it is logical to start with that subject at chapter 1.

What follows is more reader friendly. Annual cycles prompt enquiry about how they vary with location. So chapter 2 includes an attempt at more precise definitions of timing in the hope that comparative information will be

contributed from other locations. That section then concentrates on intra-specific social relationships, likely also to vary geographically.

Although reiterating some doubt (Fawcett, 1997) whether customary calculations of home ranges are the most useful ways to represent ranging behaviour, chapter 3 offers my data, including those on individuals each observed during most of over ten years' study. In particular, it draws attention to "oscillation" as a subject of biological interest and of management importance in the contexts of census duplication and local migrations.

Vast records on identified deer collected during this study would occupy volumes, so instead chapter 4 focuses on very few of the individuals each observed over many years, selected because of interactions and movements interesting in their own right but also generally illustrating roe deer life style in this environment.

Chapter 5 is where an author would be expected to summarise discoveries in pushing forward the frontiers of knowledge and to announce momentous conclusions. But this report does not pretend to more than infilling and consolidation, drawing attention to features of roe deer ethology having received insufficient attention and others where variation is at least geographical and often fascinatingly individual. An example is the described departure from the norm of rutting behaviour.

The requirement for New Forest management to consult locally has figured conspicuously in government instructions, reiterated in the over-riding Minister's Mandate of July 1999, and therefore in local officers' statements of intent. The need for management to utilise locally-based knowledge of New Forest deer ethology was underlined by the foot and mouth epidemic. Thus, any management activity provoking ungulate migration from outside the Forest, mingling inside with thousands of free-roaming cattle and ponies, could have disastrous

consequences for commoners as well as wildlife.

Sensible deer management requires knowledge and understanding not only of population dynamics, but also of social and ranging behaviours.

THIS CHAPTER relates the interesting changes in New Forest roe population occurring spontaneously in the 1970s and 1980s, when culling was minimal, and the results in the 1990s following major swing of management policy.

Numbers and changes

New Forest counts of roe deer initiated in the 1960s may have been questionable until 1970. It is uncertain whether the census of over 600 then represented a peak or the end of a plateau during the previous decade. For most of the next 20 years few were shot, usually well under 5% of the population, yet by 1983 numbers had fallen below 300 (Forestry Commission office records; Tubbs, 1986; Putman & Sharma, 1987). The decline may have been even greater because undercounting was less likely during later years, accuracy (even as a percentage) being facilitated by smaller numbers and visibility enhanced by vegetation changes.

Putman (1986) reported that roe numbers were "extremely low (estimated by the Forestry Commission as 264 in 1984), and breeding performance of those animals which do remain is noticeably poorer than average for the species: New Forest roe does never conceive before their second year and usually have only a single offspring".

A population of about 300 represents a density of one per 100ha across the Forest. Most roe are within the forestry inclosures but certainly not confined to them: if one supposed they were, their density would equate to three per 100ha. Avoiding these outside figures, it is

therefore most valid to compare a density of around two per 100ha (Fawcett, 1998a; Fawcett, 1999) with the 10-25 accepted for woodland generally in southern England (Harris *et al.*, 1995). If that density applied to the New Forest, its roe population would be about 3,000, five times the highest recorded and ten times that of the 1990s.

In current research (Fawcett, 1997 updated) the productivity of individually identified does throughout five consecutive seasons varied widely from none to five kids surviving at one year old, though substantial mortality continues longer. A long-lived but otherwise more typical doe reared two kids to that age in nine potential reproductive years (Table 1.1).

Roe adapted to the New Forest by low population density, low productivity and probably high mortality (Sharma, 1994; Fawcett, 1995; Fawcett, 1998a). The sharp disparity with roe just outside the periphery is apparent even to the casual observer, for example, from contrasting frequencies of seeing twin kids. Within the Forest a detailed study in 1995 (Fawcett 1998a) showed that 64% of the roe were under 2km from the perimeter whereas most of the remaining third were spread very thinly.

In the unique conditions of the New Forest, its sparse roe deer population is regulated by such natural limiting factors as resources, intra-specific and inter-specific competition, and climate. Planned shooting represents predation and for practical purposes it may be more convenient to classify less deliberate human mechanisms - such as road traffic accidents, disturbance and habitat distortion - with more natural causes.

Table 1.1. Reproductive History of Doe A

Doe A was observed from summer 1989 and detailed records were maintained until her death in July 1997. As she had a kid in 1989, she was born no later than 1987 but her age could not be determined precisely. This is her known reproductive history:

1989	Female kid survived at least a year
1990	Male kid found dead 15 April 1991
1991	Pregnant but no kid ever found
1992	Unsexed kid disappeared, presumably dead, autumn 1992
1993	Dead male kid, probably stillborn, found 22 May
1994	Unsexed kid disappeared, presumably dead, autumn 1994
1995	Pregnant but no kid ever found
1996	Female kid survived over a year
1997	Pregnant but no kid ever found

Doe A's reproductive performance from 1989 to 1997, during which two kids survived to a year old, appears average for the study area. Other does were either less successful (e.g. Doe B, with no kids surviving to a year in five reproductive years) or more (e.g. Doe D, with four – potentially five – survivors in five reproductive years). Contribution to the population requires survival to at least two-and-a-half years, the minimum for a doe to rear a kid or a buck to have realistic opportunity to mate. If Doe A's 1989 and 1996 kids lived to that age, this fits the scenario of a self-regulating population in which each female leaves two successors.

Obvious explanations for the New Forest roe density having been only one-tenth of that otherwise predictable include the unproductive habitat, whose unfavourable geology contributed to its historical abandonment to hunting rather than human development, and removal of their forage by much larger and more numerous other herbivores, accounting for the sharp population difference at the Forest boundary.

New Forest herbivores

The New Forest's distinguished ecologist wrote extensively (Tubbs, 1986) about the habitat transformation following the incursion of ponies into the inclosures after 1969, identifying it as the cause of losses of precious flora and dependent invertebrates, and probably the decline of roe. While statistical correlations of roe and stock populations have varied between probabilities both above 98% and below 95%

(Putman & Sharma, 1987; Sharma, 1994), Tubbs' diagnosis remains well founded (Fawcett, 1995).

Commenting more recently on the negligible impact of deer on the Forest compared with domestic herbivores, the late Colin Tubbs (1997) pointed out that long-term effects of pastoralism had been to impoverish both shrub and herb layers without compensatory gains. For example, there had been a crash in many butterfly populations coinciding with the increasing numbers of stock depastured since the 1950s, ponies proliferating from about 1,700 in 1960 to 3,500-4,000 in the 1990s. Small mammals and consequently their avian and mammalian predators were suppressed.

Over 3,500 ponies and 2,000 cattle comprise more than 90% of

the biomass of large mammals in the New Forest; around 1,500 fallow constitute some 6%, 100 red deer under 1%, and 100 sika, and 300 roe deer even less. The combined offtake of forage by all deer species is only about 4% of that by stock (Putman & Langbein, 1999). Without distraction from this valid general picture by nitpicking precise numbers, such figures should be the starting point for comparisons of impact on the habitat, though other effects include trampling by large hooves, closer cropping by a pony's two sets of incisors rather than a deer's one, and bulk versus selective feeding.

Even if grasses could be dismissed as ecologically unimportant, just non-graminoid offtake by stock greatly exceeds that by deer. Misinterpretation of "concentrate selectors" to conjure an image of deer wasting time to search for precious botanical rarities represents fanciful foraging economics in this depleted habitat.

Indeed grasses constitute 17% of roe diet here from June to October (Sharma 1994). "An unselective mowing machine like a pony, simply because it is unselective, removes just as much biomass of 'sensitive' and 'vulnerable' plant species overall as do the deer" (Putman & Langbein, 1999).

Repeated censuses of all large herbivores in my core research area permitted calculation of their forage intake. Ponies invading the inclosures in 1991-96 took about four times as much even non-graminoid offtake as the combined offtake by fallow, red and roe deer despite the density of each being above the Forest average. When ponies in the inclosures were reduced by 73% in 1997, just those remaining removed as much as all deer species combined.

Where one species dominates another in numbers and size, the other is disadvantaged even if the species differ in emphasis between grazing and browsing. Similarly ponies, while not seeking nectar, remove such resources from butterflies that do.

The 1990s

The Forestry Commission has recorded known annual mortality of roe from causes other than shooting to be 30-45 (around 10-15%) and estimated unrecorded mortality after age ten months to be at least another 40 (15%). This estimate, used by the Commission, approximates closely to those derived in several different ways (Fawcett, 1998b; Putman & Langbein, 1999). While unrecorded mortality, by definition, can be only an estimate, 10-20% are the limits of informed credibility. These annual losses, totalling around 80 (25-30%) without shooting, account for much of the observed "natural" regulation peculiar to New Forest roe.

Table 1.2 reports the Forestry Commission

roe spring censuses for 1991, when it had changed the form for completion by keepers, until 2000. The potential for accuracy is exceptionally good in the New Forest with this species, and independent assessments elucidated reasons for this being achieved for total counts. I found minor errors largely self-cancelling (Fawcett, 1995; Fawcett, 1998b) although there was possible slight over counting of does and under counting of bucks. Putman and Langbein (1999) reported that their calculations suggested a population throughout 1989-98 just 1.05 times that censused.

Realistically for New Forest roe, the Commission intended not to distinguish true



Pony browsing in Hursthill Inclosure, 28 April 1990

yearlings (12-24 months and therefore about 22 months at the census) from older bucks and does.

For most of the decade, however, forms and instructions issued to keepers confused the categorisation of age groups within the totals: for each sex the headings were "yearlings" and "mature"; kids (properly defined as under 12 months and therefore about 10 months at the spring census) were directed to be classed as "yearlings". Although attention was drawn to this confusion repeatedly and even formally (Fawcett, 1995), the Commission reiterated assurances that "yearlings" in its collated data could be interpreted reliably as kids and did not include true yearlings, which management

Table 1.2. Forestry Commission Spring Censuses
(For 1999 the parenthetic figures are considered more probable: see text)

Year	Buck adults	Buck kids	Total bucks	Doe adults	Doe kids	Total does	Total roe	Total kids	Kids/doe adults
1991	103	41	144	130	77	207	351	118	0.91
1992	105	59	164	135	70	205	369	129	0.96
1993	104	44	148	139	64	203	351	108	0.78
1994	97	35	132	118	55	173	305	90	0.76
1995	104	43	147	129	64	193	340	107	0.83
1996	94	35	129	121	59	180	309	94	0.78
1997	73	32	105	104	56	160	265	88	0.85
1998	71	32	103	106	56	162	265	88	0.83
1999	97 (83)	16 (30)	113	139 (122)	31 (48)	170	283	47 (78)	0.34 (0.64)
2000	98	29	127	146	41	187	314	70	0.48

intended to be incorporated with “mature”. Nevertheless some perceived yearlings were found classified literally, alongside kids, rather than as “mature” according to the confused intention.

Estimating age, even of male deer from their antler development, is often too influenced by other factors to be consistently reliable (Fawcett, 1974a; Chapman & Chapman, 1975; Ratcliffe & Mayle, 1992). Specifically, studies of known-age roe in the New Forest demonstrate that even yearling bucks are not distinguishable by their antlers from older bucks: for example, chapter 2 reports on a yearling with five points and an older buck with only four points throughout at least four years.

Before 1991 there was obvious age misclassification. From then until 1999 the Forestry Commission, although confusing

terminology, correctly avoided purporting to distinguish at the census between yearlings and older adults. That year, age groups were re-designated on data collection forms, without informing those working on population dynamics. Nor was there accompanying explanation to keepers that they had to change to correct terminology from the misleading designations they had been required to use throughout the previous eight years. Also they were expected to identify and count yearlings reliably at 22 months. Keepers’ detailed returns in 1999 revealed that some kids were classified correctly but others were listed still as “yearlings”, consistency and comparability of data thus being destroyed. So Table 1.2 is generally reliable except for the separate age classes in 1999. Keepers’ returns for that year were perused to infer intention: the adjusted

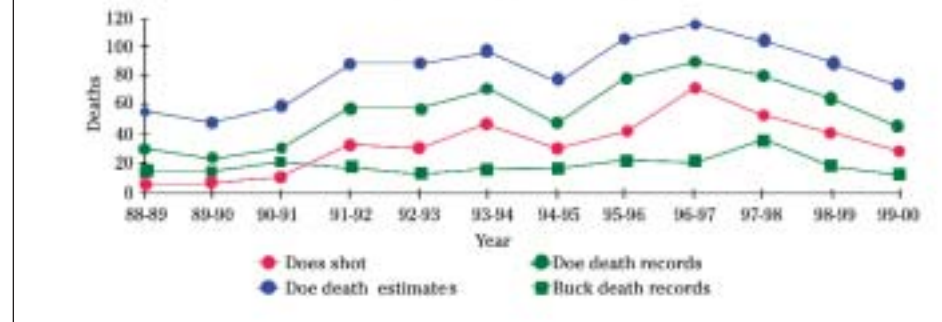
figures in parenthesis are considered more probable than those unadjusted, but can be only speculative. Instructions to keepers were improved in 2000.

Table 1.2 indicates that annually around 100 kids survived to ten months, subsequently reduced by spring mortality. In realistically not claiming until 1999 to distinguish three age classes, the Commission included true yearlings with adults. Although the kid/doe ratio therefore consistently under-estimates the



Doe A's 1990 kid, Hursthill Inclosure, 23 March 1991

Figure 1.1
Doe (and buck) mortality



productivity of just those does capable of having kids, it follows convention and ensures comparability. However, if the Commission were wrong in assuming its errors of classification to be negligible, the numbers of kids (which it called “yearlings”) would have been inflated by true yearlings, making the mean kid/doe ratio of 0.8 (already only half that typical for roe elsewhere) falsely high.

Figure 1.1 shows the escalation of numbers of does shot, above the negligible level over more than the previous decade, with the corresponding rises in the Forestry Commission’s overall recorded doe mortality and total estimates that include unrecorded mortality. In 1991, does shot annually rose from no more than ten (adults and kids) to a mean of 37 for 1991–96. Seventy-two does were shot in 1996–97 and 54 in 1997–98, before return to the still high 1991–96 level. Buck numbers remained stable while only one buck (range 0–2) was shot annually until 1996. Then nine bucks were shot in 1996–97 and 17 in 1997–98, before return to the previous negligible culls. Total recorded mortality of bucks is included in Figure 1.1 for comparison.

Table 1.2 demonstrates that, despite there being fewer kids, the first drastic increase in shooting, after 1991, had little immediate effect on the population, which dropped only following the even greater shooting from 1996. Productivity, of which the kid/doe ratio is an indicator, did not increase following heavier shooting after 1991 because it is other herbivores that remove roe resources. Indeed, after shooting increased, kid/doe ratios never achieved those in the springs following 1990 and 1991 births. It is noteworthy that February 1990 to April 1992 was the driest two and a quarter year period since the 1850s: kid mortality in the New Forest appears less related to winter temperature than to precipitation, particularly in December–February.



Doe A's 1990 kid, 15 April 1991

The Forestry Commission Bulletin on *Roe Deer Biology and Management* (Ratcliffe & Mayle, 1992) demonstrated that roe deer populations anywhere could seldom sustain culls of 35–40% of the spring census and that populations with low productivity, as in the New Forest, would stabilise with only 10% mortality. Table 1.2 shows that, even when recorded doe mortality was increased in 1996–97 to 91 (51%) and estimated total mortality to 115 (64%), the doe population decline was not commensurate and requires explanation.

Difference between New Forest management of bucks and does permits comparison, particularly informative in the knowledge that bucks migrate more readily and further than does. Yet (accepting that Forestry Commission censuses for this species were not colossal and inconsistently haywire: Fawcett, 1998b; Putman & Langbein, 1999) the scant fall in doe numbers despite enormously inflated mortality and fewer kids could be explained only by massive immigration, not shared by the lightly culled bucks. While this result of soaring doe shooting is obvious from even casual inspection of the census and mortality data, numerical evidence is available both across the Forest (Fawcett, 1998a & b) and within individual beats. For example, a keeper's census of 18 roe (including only four kids) in a peripheral group of inclosures in 1998 remained unchanged in 1999 despite shooting 17. Observations here contrast sharply with experience under normal management, where generally migration plays only a minor role in roe population dynamics (Ratcliffe & Mayle, 1992).

Immigration

As falls in doe populations by no means corresponded to the vast increases in shooting, it is desirable to quantify the immigration needed to compensate. Net immigration is

calculable (Fawcett, 1997; Fawcett, 1998b; Fawcett, 1999) from the basic equation:

$$\text{Population increase} = \text{births} - \text{deaths} + \text{net immigration}$$

(decrease if negative) (emigration if negative)

However, because total births and deaths cannot be ascertained, one must use the available data most closely related, including annual censuses and records of known mortality. In Britain about half of kids born die within their first year (Ratcliffe & Mayle, 1992) and New Forest mortality is known to extend beyond the spring census. Nevertheless, kids counted in March/April are potential input to the adult population. So, for this purpose only, they can be treated as if they were “births” into the adult population, ignoring prior kid mortality as irrelevant to subsequent calculation. There is a sense in which regarding kids dying before ten months as if they were never born is well justified because, until they reach even 30 months, does will not have independent kids and bucks are unlikely to have had the chance to mate.

The following derived equation (which also makes allowance for the 15% unrecorded mortality) can be applied to the data available at annual start dates (e.g. census dates) in any year or period of years:

$$\begin{aligned} \text{Adult population increase} &= \text{sum of kid censuses at annual start dates} \\ &- \text{recorded adult mortality} \\ &- 15\% \text{ adult + kid censuses at annual start dates} \\ &+ \text{net immigration} \end{aligned}$$

This can be rearranged to estimate net immigration over that period, thus:

$$\begin{aligned} \text{Immigration} &= \text{adult population increase} \\ &- \text{sum of kid censuses at annual start dates} \\ &+ \text{recorded adult mortality} \\ &+ 15\% \text{ censuses at annual start dates} \end{aligned}$$

Forestry Commission changes in recording kids, noted previously, made breakdown of their counts before 1991 and after 1998 the least comparable of the variables in this equation, although calculations before 1991 indicated migration around zero. Table 1.3 reports the net immigration figures derived for both sexes during the decade 1991–2000. Because of misclassification, in 1999 the figures reported for both sexes were falsely low for kids and correspondingly high for adults, so the parenthetic figures in Tables 1.2 and 1.3, based on interpretation of keepers' returns, may correspond more closely to the correct ones. Insofar as misclassification of kids in 1999 was cancelled by reducing the perceived adult population increase in the following year by the same amount, the equation is not invalidated for 1999–2000 like that for 1998–99.

The simple algebraic equation to calculate immigration can be refined by taking into account additional factors tending to increase or decrease, but they require assumptions and their effects are small and approximately self-cancelling. Particularly as the exercise is largely for comparison, minor adjustments are best avoided.

Population dynamics can be represented as balance sheets. Data for the first and last years of the Commission's consistent census recording convey a generally valid picture not dependent on precision. Table 1.4 shows adult (over one-year-old) numbers for 1991–92 and,

Table 1.3. Estimated Net Adult Immigration (For 1998–99 the parenthetic figures are considered more probable: see text)

Year	Bucks	Does
1991–92	-1	6
1992–93	-23	15
1993–94	-15	-4
1994–95	7	18
1995–96	-16	20
1996–97	-20	16
1997–98	15	37
1998–99	20 (6)	49 (35)
1999–2000	12	39

following increased shooting of bucks and of yet more does, 1997–98. Figures are those reported, except the italicised calculated estimates.

Precision in Tables 1.3 and 1.4 is not required to recognise that buck emigration from the Forest switched abruptly and substantially to immigration following the 1997 increase in bucks shot. For does, net immigration grew to around 18 annually between 1994 and 1997, and to nearly 40 in subsequent years. These rises followed increased doe shooting above the trivial pre-1991 culls, by about 30 annually from 1991 and by about 60 in 1996.

While calculations cannot be precise, particularly with some yearling misclassification, they show that replacement of doe deaths became almost as much by immigration as from births. In contrast, although bucks migrate more readily than does, there was no evidence of their net immigration until 1997, after they too were shot.

Table 1.4. Adult Population Changes (Italicised entries are those calculated)

	Bucks				Does			
	1991–92		1997–98		1991–92		1997–98	
Initial adult census		103		73		130		104
Shot as adults	1		16		24		42	
Other recorded deaths	16		17		23		25	
Unrecorded deaths	22		16		31		24	
Total subtractions		39		49		78		91
Kids	41		32		77		56	
Immigration	0		15		6		37	
Total additions		41		47		83		93
Final adult census		105		71		135		106

The New Forest is surrounded by woodland areas where forage is much better, with no competition from stock and less from other deer species. Outside much of the periphery, roe population density and productivity (including twin kids as the norm) are higher than in the Forest. So, despite massive mortality inside the periphery in the 1990s, immigration prevented the population falling below about 250, however many roe were shot. Although resources are poorer inside the boundary, it is the ratio of roe numbers to resources that determines the balance.

The core area

Population dynamics calculations for individual beats are fraught with hazards but they indicate that central areas, with low kid productivity, depended on recruitment from peripheral beats. The three most central beats contained only

around 15% of the New Forest's roe. Doe numbers here appeared reliant on immigration rippling from the periphery (Fawcett, 1998b), where productivity was above the New Forest average. The introduction of this report referred to the core study area and methodology applied within it. Table 1.5 summarises the reliable population data for this core area, based on censuses centred on 31 March and 4 August each year. Right-hand columns show the numbers of does with nil, one or twin kids respectively, and the ratio of kids to does.

Great precision was achieved by concentrating study on a small area in which all roe were known individually, at least over the census period. Nevertheless Table 1.5 reflects only twice-yearly snapshots; also, differences of only one unit in any column correspond to large percentages. Helpfully, another indicator (though not a measure) of population numbers was available, less affected by these limitations. Insofar

as data collection methodology was standard throughout the decade, the hourly rates of seeing different individuals of each sex and age class each year were indicators of their numbers. These frequencies are shown in Figure 1.2.

Whereas Table 1.5 reports changes in direct though discontinuous censuses, Figure 1.2 illustrates indicators that are indirect but derived from much larger numbers, hence showing smoother changes. These direct and indirect methods of representing populations both demonstrate the same declines to a third or less throughout the decade. This was despite habitat and other conditions becoming more rather than less favourable and exemption of this research area from culling within (but not around) it in most years. Nevertheless, Table 1.5 and Figure 1.2 concur on particularly sharp falls of bucks and does after 1996, the second intensification of Forest-wide shooting. Even more conspicuously than in Table 1.2 for the whole Forest, 1989–91 encompassed good years for kid births here, after which birth and survival rates both deteriorated. For reasons already noted, reducing numbers did not enhance productivity.

Numerical data for the whole Forest are heavily influenced by the periphery, where most of the roe are and where migration

compensates readily. So my interim quinquennial report to the Forestry Commission (Fawcett, 1995) showed that the central study area "provided a sensitive indicator of changes throughout the Forest". Variations of mortality and natality data for the whole Forest discernible in Table 1.2, but diluted by migration, are revealed much more clearly by the close and accurate observations near the core. Both show the decline of bucks and does particularly after 1996; and decline of kids after 1991 births (counted in spring 1992), measured as totals or as kid/doe ratios. So this core area representing some 1% of the New Forest, containing at the beginning of the decade about 8%, 6% and 5% of its bucks, does and kids respectively, ten years later contained only 4%, 3% and 2% of a population that was itself reduced.

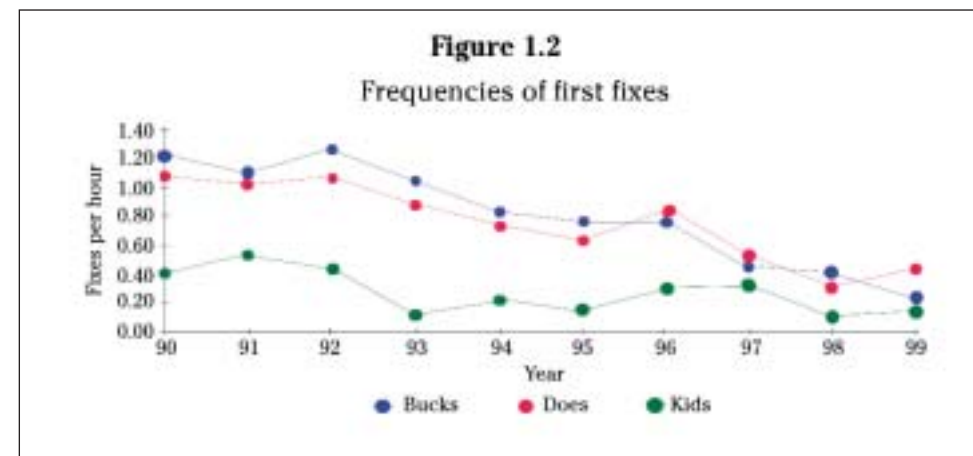
Conclusions

The following summary, applicable to roe deer only in the peculiar circumstances of the New Forest, incorporates explanations lodged in reports to the Forestry Commission, 1995–99.

Irrespective of numbers shot, the population remains within a range between a "floor" and "ceiling", both being influenced by the relationship between the ratios of roe densities

Table 1.5. Censuses in the Core Area

Month and year	Bucks	Does	Kids	Buck kids	Doe kids	Total	K = 0	K = 1	K = 2	K/D
August 1989	9	6	7			22	0	5	1	1.2
March 1990	7	7		2	3	19	2	5	0	0.7
August 1990	9	6	7			22	0	5	1	1.2
March 1991	7	9		3	4	23	3	5	1	0.8
August 1991	8	6	7			21	0	5	1	1.2
March 1992	8	8		2	4	22	3	4	1	0.8
August 1992	8	5	3			16	2	3	0	0.6
March 1993	7	6		1	1	15	4	2	0	0.3
August 1993	8	5	1			14	4	1	0	0.2
March 1994	9	6		0	0	15	6	0	0	0
August 1994	8	5	4			17	1	4	0	0.8
March 1995	9	8		1	1	19	6	2	0	0.3
August 1995	8	7	2			17	5	2	0	0.3
March 1996	8	6		1	1	16	4	2	0	0.3
August 1996	5	5	2			12	3	2	0	0.4
March 1997	4	4		3	2	12	0	3	1	1.7
August 1997	4	3	3			10	1	1	1	1.0
March 1998	3	3		1	1	8	2	0	1	0.7
August 1998	3	2	0			5	2	0	0	0
March 1999	2	3		0	1	6	2	1	0	0.3
August 1999	2	3	2			7	1	2	0	0.7
March 2000	1	3		1	1	6	1	2	0	0.7
August 2000	2	3	1			6	2	1	0	0.3
August mean	6.2	4.6	3.3			14.1	1.7	2.6	0.3	0.7
March mean	5.9	5.7		1.4	1.7	14.6	3	2.4	0.4	0.6



to resources inside and outside the boundary.

The ceiling, higher than the current population, is imposed by limited resources and competition (removal of forage by bigger and more numerous other herbivores).

A floor below which the population does not drop is less obviously predictable. A very experienced former superintendent of a royal park, managing about 1,000 deer, when shown the Commission's census and "cull" figures in the mid-1990s, foresaw extermination of New Forest roe in five years. This was a reasonable prediction for a closed population: there was no way in which New Forest roe could reproduce to replace the 40% doe cull instructed every year (the actual recorded deaths being even higher because of repeated failures in foreseeing other mortality).

However, far from being a closed population, New Forest roe are surrounded by others where forage is much better, with no competition from stock and less from other deer species. Outside much of the periphery, population density and productivity (including twin kids being the norm) are far higher than in the Forest. So massive mortality inside the periphery in the mid-1990s was replaced by immigration as much as by births. This prevented the population dropping below about 250, however many roe were shot.

But it is not quite so simple. There is some annual variation of the ceiling (depending on factors including weather): so a population self-regulated at 400 one year may rise to 450 the next but fall back to 400 the next without deliberate intervention. Other factors may cause annual variations too in the population floor. So the ceiling and floor are each represented by a band rather than a rigid line.

Deer management always requires assessment of the level likely to establish if the population is not controlled. Forestry Commission records show that in recent decades this dropped to around 300 but there is speculation about

possible favourable and unfavourable effects of predicted changes in habitat. If the population could be restored to that before ponies invaded the inclosures (depleting the understorey to the detriment of a wide range of wildlife), it would still be only a fifth of that typical of southern woodland, including that maintained by the Forestry Commission for commercial forestry.

A major unknown factor relates to the roe population in fertile and stock-free woodlands surrounding the Forest, shown to exert such substantial influence on that inside. The tendency to equilibrate is not to equalise population densities, but to equalise, on each side of the boundary, the ratio of roe density to roe resources. We have seen that heavier shooting inside the boundary than outside it results in massive replacement. If there is return to the sensitive management policy before 1992, population will stabilise but its level will depend on densities in the surrounding countryside and the control exercised by neighbours.

With population dynamics as the essential basis of sensible deer management, social and ranging behaviours also play their parts, as well as being of great intrinsic interest. Their intensive study for over a decade in this research area is reported in chapters 2–4 before further discussion of population dynamics.

ROE are sometimes depicted as "solitary", in contrast to most other British deer. Roe herds, observed elsewhere in Europe (Danilkin, 1996), are not typical here. Even congregation in fields for the early bite in April is perceived as merely to share a common resource (Fawcett, 1974b) and disturbance results in dispersal.

Nevertheless, exceptions to solitary life are obvious when does are accompanied by surviving kids throughout most of their first year, or relate with bucks during the rut. Furthermore, mutual avoidance declines in the winter and companionships are detectable irrespective of sex. The interesting social calendar of roe deer associations in the New Forest, analysed in depth, links with annual cycles of other events (reproduction, moults, antler changes) which are therefore best reviewed first, including some detail seldom published.

Annual cycles

Seasonal activities are often illustrated pictorially as cycles of concentric rings, preferably with a warning that dates vary with locations, for each of which they should be established (Fawcett, 1997). Data collected for New Forest roe deer in a central study area for over a decade led to the following summary.

Reproduction

Rut-chasing started fairly abruptly close to 21 July but faded less definitely after 10 August, with

some erratic activity up to three weeks later.

Although few kids were found when age could be estimated within a day or two, the peak of births appeared to be around 24 May with distribution skewed unusually for British deer, births occurring up to three weeks earlier but seldom more than two weeks later.

Moults

Winter coat growing through the summer one was usually visible around the second week of September but a few roe were still in full summer pelage at the end of that month. First the head and neck became duller and greyer; then rough or blotchy patches appeared on the lower chest. The transition was generally from the front backwards and ventral surface upwards. Dates varied but, two weeks after a typical start in mid-September, the neck, apron and ventral area were blotchy grey. At three weeks the winter coat was complete except for some dappling on the rump and perhaps sides,



Buck P and Doe A, Hursthill Inclosure, 27 February 1991

which disappeared in another week, in mid-October.

The spring moult on head and neck was typically throughout April, apparently unrelated to that on the torso and legs, the start of which varied from about 22 April to 21 May, so that roe at this time presented disparate appearances. Thus, in late April, some had shoulders in summer coat while the neck still showed winter; in contrast and more commonly, other roe had a sharp demarcation between the shoulders still in shaggy grey winter coat and the neck in short summer pelage.

Variation in timing was greater between years (and evidence supported the expectation of earlier moulting correlating with higher air temperature and sunshine records in March and April) than between individuals (although one doe consistently moulted late while appearing in splendid condition throughout her life despite the belief that roe in poor condition moult later). Examining dates either for each individual in successive years or for different individuals within years disclosed no evidence of correlation with age.

An average date for first detectable moult on the torso was about 7 May but with individual variation some two weeks either way. Summer coat showed on the ventral surface, rump and forelegs at one week and the torso was one-third moulted at about two weeks and almost two-thirds at three. At four weeks there were just flecks of winter coat on chest and thighs, which were gone by five weeks. But this summary reflects only averages.

Antlers

Antlers were dropped usually both on the same day but exceptionally with an interval of five. This occurred later in the New Forest than elsewhere, mostly between mid-November and mid-December, rarely as soon as 12 October or as late as 27 December. The trend for older bucks to cast earlier was perceptible but very

inconsistent, partly because of overall annual variation. Unlike fallow and red deer, roe here rarely showed new antler growth until a fortnight after casting.

Antler cleaning started slightly more often on the front than the top and back tines; generally the beams, below the lower bifurcations, were cleaned last. The start and finish were more protracted than the middle stages: sometimes a little premature scraping of velvet occurred a week before its removal; more often, some dried velvet adhered or hung weeks after most had gone. So, although occasionally cleaning was completed in twelve hours, usually it extended much longer.

The mid-stage when antlers were half clean was mostly between 7 and 17 April except for first antlers, on which velvet was retained sometimes even into July. Because the period within which different bucks cleaned was more compressed than that of casting, the evidence (from examining dates for either each individual in successive years or different individuals within years) of an earlier trend with increasing age, although discernible, was even less consistent than with casting. There was overall variation between years: cleaning appeared earlier when February temperature and rainfall were higher, presumably providing better forage.

Individual variation is the main conclusion to be drawn from Table 2.1 which shows, for four of the bucks studied over several years, the dates (when these were known or could be closely approximated) on which they cleaned (mid-point) and cast antlers, and the lengths of their tines (each the mean of numerous estimates). Buck P was chosen because of the many years of observations, and Bucks Q, S and T because they could be described in unscientific deer jargon as having respectively poor, average and good heads for the New Forest.

Buck P was born in 1990 but the others were of uncertain age, although circumstantial evidence suggested that Buck Q was born in

1989. Studies of known-age deer (Fawcett, 1974a; Chapman & Chapman, 1975; Ratcliffe & Mayle, 1992) demonstrate that age prediction from appearance rarely justifies confidence with which it is sometimes expressed. In this study there was only limited correlation with customary descriptions of annual increase in size of antlers followed by "going-back". As in examples illustrated here, yearlings (22 months at the spring census) sometimes had more than four points whereas older bucks (34 months or older at the census) often had only four. More subtle signs like thickness of coronet were not reliable determinants in the field.

Buck P's first antlers (1991) were spikes, long by local standards, but in each of the next three years (1992-94) there were only five points. In



Buck P's recovered cast antlers: 1994 right antler, from which top was broken; 1995 left antler.

Table 2.1. Antlers

Lengths of tines estimated in cm

(x = absent; o = offer only) and shown separately as left-right

M = main tine, above lower bifurcation

F = front tine, from main tine, i.e. above lower bifurcation

R = rear tine (and distance from tip of main tine)

Buck	Year	Cleaned	Cast	M	F	R	
P	1991	28 June	19 Dec	11-8 Total, unbifurcated			
	1992	19 April	23 Dec	13 - 12	8 - 8	x - o	
	1993	17 April	30 Nov	10 - 9	6 - 6	1(3) - x	
	1994	13 April	07 Dec	10 - *	2* - 6	1(2) - x	
	*Right main tine broken off; left front tine broken						
	1995	09 April	14 Dec	11 - 10	9 - 9	1(4) - 3(4)	
	1996	12 April	20 & 28 Dec	11 - 10	8 - 8	2(2) - 2(2)	
	1997	05 April	12 & 17 Oct	13 - 13	9 - 9	3(5) - 3(4)	
	1998	05 May		9 - 8	6 - 5	x - x	
Q	1991			9 - 8	2 - 2	x - x	
	1992			12 - 12	6 - 6	o - o	
	1993			7 - 8	2 - 3	x - x	
	1994			8 - 8	2 - 3	x - x	
	1995			10 - 10	2 - 3	x - x	
	1996			9 - 9	2 - 2	x - x	
S	1992	09 April		12 - 12	6 - 7	o(5) - x	
	1993	14 April		10 - 9	5 - 6	1(2) - x	
	1994	14 April		8 - 8	6 - 6	1(2) - 1(2)	
	1995	09 April		10 - 11	6 - 6	2(3) - 2(3)	
T	1993			10 - 10	7 - 6	1(3) - x	
	1994			12 - 12	7 - 6	2(4) - 3(4)	
	1995			13 - 13	6 - 6	5(4) - 3(4)	
	1996	29 March		13 - 13	8 - 7	4(4) - 4(4)	
	1997	12 April		14 - 14	8 - 9	5(6) - 5(6)	

the next three years (1995-97), the antlers became bigger, with six points, until reverting to four short points in the year (1998) of his presumed death at age eight. In most years the left main tine was longer than the right and the front tines were consistently incurving.

Buck Q was noticeably small throughout six years he was studied. So were his antlers: after reaching their maximum in 1992, the only year in which there were significant front tines and token rear tines, they were the smallest of adults in the study area for the next three years. Although spindly, the antlers were consistently very wide and divergent. Information on dates of cleaning and casting was insufficient for valid comparisons.

Buck S had antlers that might be described as of classic New Forest shape, divergent at the base but the main tines then appearing parallel from the front.

Buck T's antlers were of similar shape, but the biggest normal ones in the area throughout 1994–97 (excluding Buck U, abnormally with a seventh tine in two consecutive years). Unlike Buck S's, Buck T's antlers grew larger each year.

Johnson (1982) reported dates at Chedington in Dorset when antlers were fully clean, found here to be less precisely definable than middle stages through which cleaning passed quickly. His dates averaged around the end of April at age one, and mid to late March at ages three to six, substantially earlier than in the New Forest. Data here, however, fully support Johnson's conclusion that, while there is an inconsistent trend for cleaning to become earlier with increasing age up to six years, correlation is insufficient for practical usefulness. His tentative opinion that bucks seven or more years old cleaned later than those in their prime is also supported, though observations at both locations were scanty.

Data collection on social relations

Basic methodology to collect data on associations (social groups) and for other purposes was described in the introduction of this report.

As noted in chapter 1, twin kid observations were mostly following births before 1992 and were particularly rare following those in 1992–95. There were 98 first fixes of twins with mothers and 39 of unaccompanied twins, representing under 11% of all kid sightings. Statistics generally did not differentiate twins from singletons.

Ninety-eight per cent of observations were of a single animal or a doe with either kid or buck. So these were categorised in this way statistically: solitary buck, solitary doe, solitary kid (or two unaccompanied kids), doe with buck, doe with kid(s). The remaining 2% were considered separately as less frequent associations. In conformity with previous work

(Johnson, 1982), subjective judgement was preferred to define whether roe were truly associating as a group, being aware of each other and apparently favouring company (e.g. converging while feeding) rather than antagonistic: so, during the rut, a buck and doe together would be designated as a group but two bucks in view generally would not.

Year-to-year changes

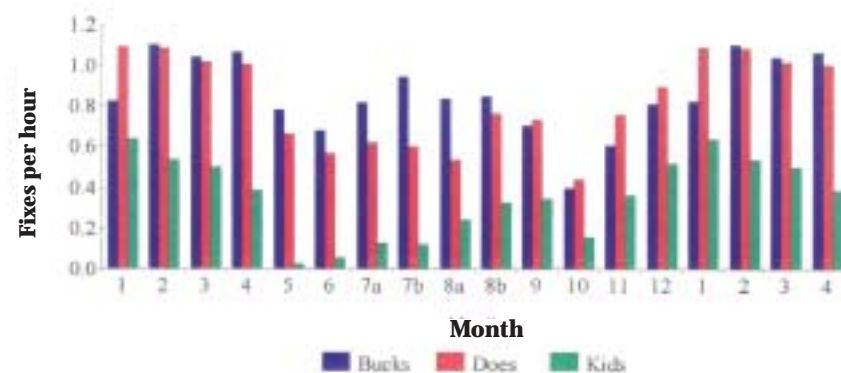
As noted in chapter 1, frequencies of sightings (Figure 1.2) varied with year-to-year changes in the census (Table 1.2), roe deer population declining greatly during the decade. In France, Vincent *et al.* (1995) had reported alterations in winter grouping when roe density increased to 25 per 100ha from 5–7 per 100ha, identified as “relatively low density” although much higher than that in the New Forest. So ratios of different groupings here were examined for any changes related to density dropping to a very low level. Because falls were most marked in 1992–93 and 1996–97, ratios were calculated separately for the inclusive periods 1990–92, 1993–96 and 1997–99; where appropriate, they were perused further on a monthly basis.

The only substantial changes in ratios entailed kids. As the decade progressed, kids were slightly more often alone (rising from 16% to 24% of all kid sightings), the change being most marked from mid-August to December. The smaller proportion of does giving birth in 1992–95 was reflected in the lower percentage of doe sightings in which kids were found with them (20% against 28% in other years), particularly in January to March.

Month-to-month changes

As most derived values for year-to-year changes were slight and/or predictable, monthly data in all ten years were combined for analysis to maximise sample sizes.

Figure 2.1
Frequency of first fixes



Frequencies of sightings

Figures 2.1–2.4 portray variations through the calendar year starting in January (Month 1). However, as May (5) is when kids of the previous year separate from their mothers and when most kids are born, the sequence of months in the figures continues through December (12) to the following April (4), thus repeating four months so that the May to April cycle can be visualised. As results differed far more between the two halves of each of the months embracing the rut, July and August, than between contiguous months (even between June and early July or late August and September), the halves of both months were analysed in the same way as full months for the rest of the year. Sample sizes were still large when each of the two halves of both July (7a and 7b) and August (8a and 8b) were treated as separate “months”.

Hourly frequencies of first-sightings of bucks, does and kids in each of the 14 “months” are shown in Figure 2.1. As several artefacts, including seasonal changes in obscuring vegetation, influence frequencies they have less significance biologically than the less affected ratios of different associations but are useful to

census-takers and other deer observers.

Frequencies of finding roe were lowest in October (0.4 per hour each for bucks and does, and 0.2 for kids), an observation familiar to roe deer watchers and sometimes explained by seasonal inappetence and by less need for daytime feeding when acorns are plentiful. From May to September inclusive, frequencies averaged around 0.8 bucks, 0.6 does and 0.2 kids per hour and, from December to April, 1.0 each for bucks and does, and 0.5 kids per hour.

The figures quantify the reduced visibility of roe deer in summer and autumn. Frequencies were at their peak (1.1) from February to April for bucks and January to April for does. So these data confirm that an annual census is best when vegetation is low and feeding intensive, at the end of March, which is also when individual identification is facilitated by antler growth and coat irregularities. A later census would be complicated by reduced social stability but would take into account the substantial mortality in April following winter inclemency, not all kids counted in March surviving to become yearlings.

Frequencies of observing bucks and does

were generally similar but bucks were seen more often than does from July to mid-August. This was foreseeable as a buck seeks to rut throughout three weeks a year but a doe has only some three days of oestrus. Bucks were less visible than does from November to January, during antler casting and growth.

Kid sightings per hour rose only slowly from May until August (0.2) but more quickly from October to January (0.6), then falling until April (0.4). Each May, kids of the previous year became yearlings but were classified with adults because certainty of identification and dependable age classification then became impracticable.

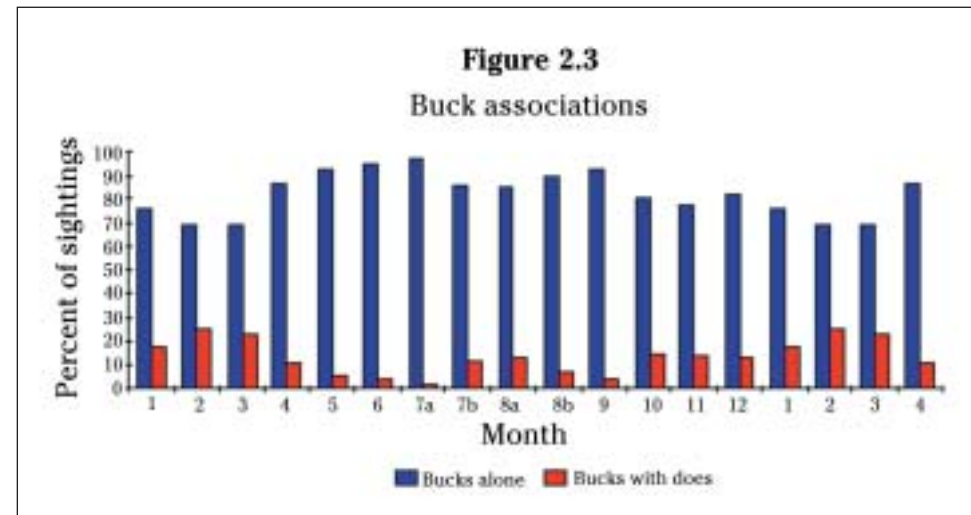
Ratios of associations

Figure 2.2 shows the proportions of does observed that were respectively alone, with one or more kids or with a buck, quantifying the qualitatively predictable variations throughout the year. The most rapid seasonal changes in doe sociability were from mid-July to mid-August (because 19% of doe sightings during the rut were with bucks) and around April (as does became more solitary). Over 80% of the does seen from May to mid-July were alone, as kids lay hidden much of the time, though the few does

accompanied by kids gradually increased. The proportion of does accompanied by kids rose in August to remain fairly constant above 30% until January, when a decline, gradual at first, reached below 20% in April. Meanwhile the proportion associating with bucks had been fairly constant above 10% from October to April except for a peak over 20% in February and March. After April the proportion with bucks declined. Of the does found in May, 3% were accompanied by yearling daughters, although none by their sons.

Setting aside for later consideration the bucks in less usual associations, Figure 2.3 shows the proportions seen either alone or with does. Companionship with does rose in autumn and winter to a peak in February and March, exceeding that in the rut. Over 90% of bucks were solitary from May to mid-July, despite many does being without kids, and most became solitary again in mid-August after the rut. Then some bucks appeared still territorial but, in contrast, a few became tolerant even in the second half of August.

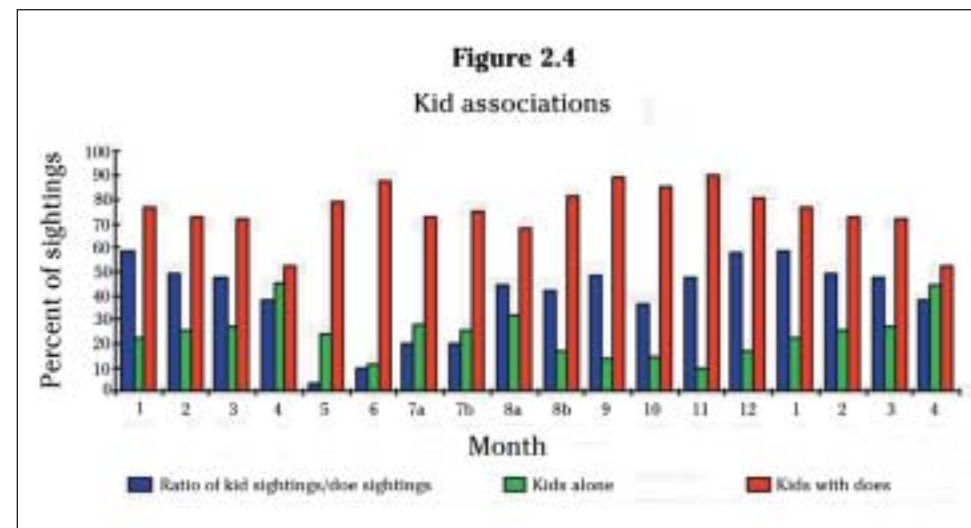
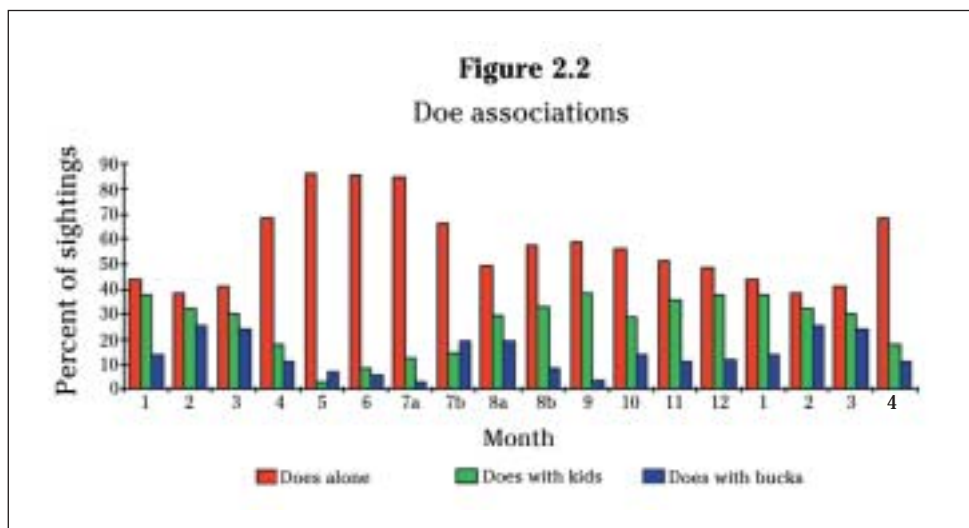
The association of does with kids shown in Figure 2.2 reflected the proportion of does that became mothers as well as the extent to which mothers and offspring remained together. As



there were only half as many kids as does, the proportion of kids with does was correspondingly higher than that of does with kids. Figure 2.4 therefore includes the ratio of kid to doe sightings, below 50% for much of the year. The ratio was lower before August, when kids were less visible, and slightly higher in December and January, when they were conspicuous.

Figure 2.4 shows also the proportions of kids

found either alone (or, rarely in the New Forest, with twin siblings) or with does. In May, searching for kids influenced the proportions found with or without mothers. In the rut, although sometimes kids became involved, generally they were left apart. From mid-August more accompanied their mothers, reversing after November, especially in April. Whereas 20–30% of kids were alone until March, nearly 50% were in April, when all roe became more solitary.



The few differences from Johnson's (1982) findings on associations seem due to the much lower population density here, the lower proportion of does with kids, and greater visibility in the Forest because of removal of understorey by ponies. However, although Johnson found that at Chedington there was no difference between dates on which buck and doe kids left their mothers, the data here support Kurt's (1968) finding that sons left earlier than daughters.

Less frequent associations

Figures 2.2–2.4 summarise 98% of observations, where the "group" constituted a single animal (or occasionally twin kids) or a doe with either a buck or kid (or twin kids). The remaining 2% of some 10,000 sightings comprised 205 as follows:

63 groups of two bucks together. These associations were rare after 1996 as the population decreased. 55 were in November–May; of the seven in May, at least one of each couple was one year old.

49 of two does together. 37 of these were in December–May; all of the 14 in May (representing 3% of doe sightings that month) were of a year-old doe with mother.

47 groups of buck, doe and kid (twin kids in one instance and, uniquely, two bucks, two does and a kid in another). 33 of these were in December–April and 12 during the rut.

19 groups of a buck (two bucks in one instance) *with a kid away from its mother.* Only three of these associations were after 1993, when kid numbers decreased. Only one was outside the months December–April. Of the other 18, seven sightings were in April, of buck kids about to become yearlings.

19 groups of two does and a buck. All but three sightings were in February–May, 1993 and 1994.

8 groups of two bucks and a doe. Three sightings were in March 1992.

The 63 couples of bucks and 49 of does compared with 470 sightings of buck-doe pairs.

Tolerance by bucks decreased with age. Does with kids participated in adult associations less often than those without.

Winter associations of two adult does might be attributed to mother-daughter kinship but there is no evidence in support. Chapter 4 describes a February–March companionship, recurring over four years, between Doe A born in 1987 or earlier and Doe B. Although Doe A had a doe kid in 1989, there was no evidence to identify it as Doe B: they had never been seen together between May 1990 and March 1992.

Most associations started to break up in April although a few, particularly of young roe, continued into May.

Doe-kid associations

Table 2.2 shows the percentages of sightings in which mother and kid were found together within specified periods. The second and third columns record Doe A respectively with her 1990 buck kid and with her 1996 doe kid. The next column records Doe C (shot on 17 February 1993) with her 1992 doe kid, and the next two record that daughter (Doe D) with her own doe kids in 1995 and 1996. In 1997 Doe D had twin kids (doe and buck) and her associations with them are shown in the last two columns.

The variation is remarkable, particularly as these records concentrate on few mothers. Doe A was seen much more frequently with her 1996 doe kid (surviving in 1998) than with her 1990 buck kid (dying in April 1991). Doe D was often with her 1995 kid until February but the association weakened early whereas, in contrast, next year she and her 1996 kid were less often together until February but then more so into April: both these doe kids survived to at least a year. Doe D's 1997 twin kids – especially the buck from January onwards – were seen frequently away from her but often they were with each other; they, too, survived to at least a year.

In the New Forest generally, the progressive

Table 2.2. Percentages of Sightings of Mother (Doe A, C, or D) and Kid Together (Numbers of sightings in parenthesis)

Mother/kid	A/b904	A/d964	C/d9218	D/d9518	D/d9618	D/d9718	D/b9718
Before 16 August	40 (10)	66 (29)	50 (4)	67 (6)	50 (8)	22 (9)	22 (9)
16 Aug – 31 Oct	82 (11)	100 (29)	83 (6)	83 (6)	50 (10)	33 (6)	50 (6)
1 Nov – 31 Dec	- (0)	100 (12)	63 (8)	100 (2)	25 (8)	58 (7)	43 (7)
1 Jan – 28/29 Feb	50 (6)	75 (16)	33 (3)	67 (3)	50 (6)	33 (12)	17 (12)
1 – 31 March	17 (6)	55 (11)		20 (5)	33 (6)	25 (8)	0 (8)
1 – 30 April	13 (8)	79 (14)		0 (8)	71 (7)	33 (6)	17 (6)
1 – 31 May		32 (22)		0 (9)	0 (14)	0 (5)	0 (5)

separation of kids and their mothers towards April appeared initiated by kids more than their mothers, and there was little evidence of mothers driving them away.

Buck kids separated more readily than doe kids and mothers were seen sometimes with their grown daughters (even grooming them), but not sons (which occasionally sought male company), until a few days before they gave birth again.

Injuries and deaths

Not all social relationships have benign consequences although Johnson (1982) believed that fights between bucks rarely led to serious injury. Throughout the current study just one such incident was known to result in fatality and another was suspected. Nevertheless lameness appeared more frequent than I have witnessed elsewhere and occurred mostly around May and during the rut.

One instance was observed during a fight and there is strong presumption of that being when such injuries happen, not from opponents' antlers but from stumbling. One can only speculate on what predisposes to injury in this environment: uneven ground, wire fences, brash or even mineral-deficient diet.

Known injuries are recapitulated for just those bucks most reported here.

Buck P hurt his front right leg in early June 1992, taking a month to recover; and his rear

right leg in August 1993, taking probably longer. In February 1994 his velvet-covered growing right antler was broken off immediately above the front tine and the tip of the front tine of the left antler was also broken: circumstantial evidence incriminated an aggressive neighbouring buck, chasing Buck P also in subsequent months.

Buck S injured his front right leg between 2 and 5 August 1993, taking one or two months to recover. From 29 July 1995 he limped on his front left leg and was never seen again after 14 August, when he was still lame and very lethargic.

Buck T fought Buck U on 2 May 1995. Although seeming the stronger, Buck T stumbled and retreated limping on his front left leg, which appeared recovered next day.

Buck U limped on his front left leg from early April to early June 1996.

McDiarmid (1974) noted that dead deer were rarely discovered and that there must be considerable mortality, particularly of roe in early summer, from dogs allowed to run loose in forest areas. A large proportion of known deaths in the study area were attributable directly to dogs; indirectly, deflection from feeding in an unrewarding environment contributes to deaths by malnutrition. Much mortality of roe deer goes unreported because of their small size and the habitat they occupy.

Inter-relating inter-relations

Social relations among roe deer influence their movements and are influenced by them: so ranging behaviour (chapter 3) too is of practical importance as well as interest. This current work reaffirms experience that roe deer are conspicuously individual in their activities (Prior, 1995; Fawcett, 1997), an observation expanded (chapter 4) in reports on ear-tagged or otherwise identified individuals observed intensively, some for most of their lives.

BEHAVIOUR of individual roe deer, each studied throughout many years, led to original observations, including some on seasonal and non-seasonal oscillation between locations.

Intensive study area

Figure 3.1 (overleaf) shows a 200ha area near the centre of the New Forest chosen for intensive research for over a decade, encompassing more than 5,000 hours of fieldwork.

Hursthill Inclosure and New Park Plantation were enclosed (stock-fenced to exclude ponies and cattle, with only partial success) but Brick Kiln had been thrown open in 1982. The rest of the study site other than Queen's Meadow (accessible to deer) was open but there was deer fencing at the northeast edge of Brick Kiln and at the northern part of the boundary with New Park Farm.

The vegetation conformed to published general descriptions of the New Forest (Tubbs,

1986; Putman, 1986), mostly close cropped and browsed to the height (1.8m) a pony can reach. Much of the area was modified mature oak woodland planted in 1800–20. While many oak were retained, over half Hursthill Inclosure had been replanted in 1950 with conifers (mostly Douglas fir and Corsican pine, some of which had been felled before 1989). Since 1969 the only forestry planting was of 7ha of Corsican pine in 1991 in Hursthill around the 860555 grid reference in Figure 3.1. In New Park Plantation only small blocks of conifers (mostly Douglas fir planted in 1965) had been added to the oak, with various scattered conifers (including Scots pine) and broadleaves (including sweet chestnut). Among the older trees in Brick Kiln were small patches of younger oak and other broadleaves planted in 1932, western hemlock in 1965, and Corsican pine in 1969.

Most of this study area contained small holly bushes and much bracken, particularly in and adjoining Hursthill Inclosure and New Park Plantation. The open forest around the inclosures was largely pasture woodland, with humid heath at Butts and Hursthill Lawns and Poundhill Heath. Ground cover was sparse, with grasses, ivy and herbaceous flora including bluebells and foxgloves. With stock periodically in the inclosures as well as outside, little bramble remained but some strips survived in the north and centre of Brick Kiln, with a patch of dog-rose, and more widely scattered in New Park Plantation, particularly the south.



Buck R, Hursthill Inclosure, 2 February 1991

Data collection

One of the frustrations in projects like this results from collecting countless records on animals whose future could not be predicted: a kid ear-tagged after many hours of searching may be either never seen again or observed throughout the next eight years; and a familiar buck with distinctively mutilated ears may be shot.

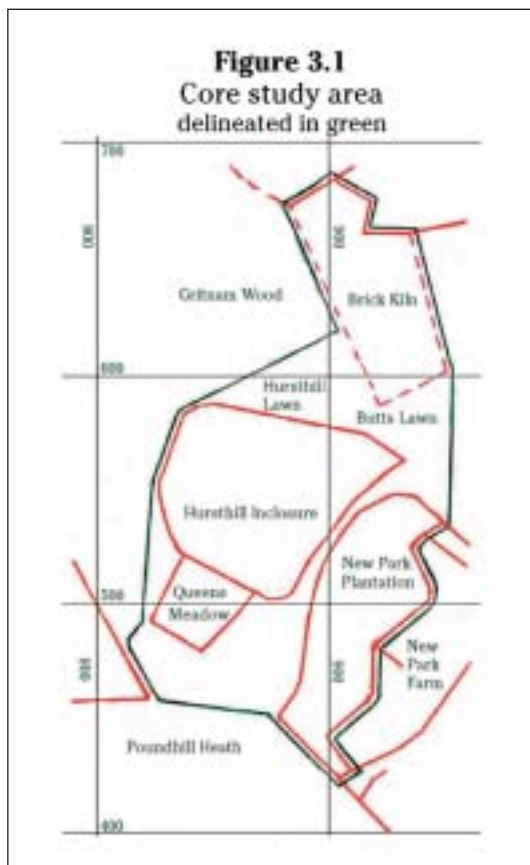
Such risks were among the problems weighed when radio-tracking was considered here to enhance opportunity to find individuals in every survey. Harris *et al.* (1990) pointed out that radio-tracking was not always best methodology and that accuracy of radio-fixes varied with habitat type. Indeed even global positioning system technology may achieve only 80% success in seeking fixes (Sibbald, 2001).

Catching animals to radio-collar is time-consuming and stressful, not only for the animals. Invasive trauma may change the behaviour being studied, in this case in a roe population conditioned to accept the researcher's close observation, tolerated often well within 30m. Our experience of ear-tagging hundreds of newborn red and fallow deer as well as roe, and observing them for many years, indicated that subsequent behaviour was not distorted; but catching adults is a different matter. In any case, netting adult roe is particularly unrewarding where their density is low, as in the New Forest.

The introduction of this report referred to methodology for collecting data, including locations of ear-tagged or otherwise individually identified deer.

Roe deer have distinct diurnal and nocturnal range shifts (Harris *et al.*, 1990) and, even with modern imagery

equipment, it is not practicable to determine nocturnal locations without radio-tracking. Daytime human disturbance moves deer in the New Forest to places they would not have chosen otherwise but fortunately this is minimal in the hours immediately after dawn and, though less consistently, before dusk. It was concluded that fixes recorded at such times would be most meaningful in interpreting where the deer chose to be when not influenced by disturbance. With the added problem of auto-correlation, it was decided for this exercise to use only first fixes (i.e. first sightings of an individual at dawn or, for under 5% of the total, before dusk), thus excluding those during continuing movement and subsequent sightings of individuals noted



within six hours of the first.

Many map grid references were definable within 10m but sometimes potential errors of 20m had to be accepted. Nevertheless, as precision was much closer than 100m, eight-figure map references ("fixes") were recorded. For convenience in the limited study area, the constant first digit of each ordinate (respectively 2 and 0 within the SU grid) was omitted from records (e.g. so that 28600555 was reported as 860555), as in Figures 3.1–3.4.

Figures have not been manipulated to separate superimposed points and so concentrations of fixes amalgamate.

Ranging behaviour

The ranging characteristics of roe deer in this area were illustrated clearly by Doe A, observed on some 500 days over eight years. Figure 3.2 (with map grid references relatable to Figure 3.1) shows that her time was divided between two locations, in Hursthill Inclosure and Brick Kiln. In each period most fixes were within 250m of their current centre (mean fix) but sometimes she made longer trips, not all of which were to the alternative location.

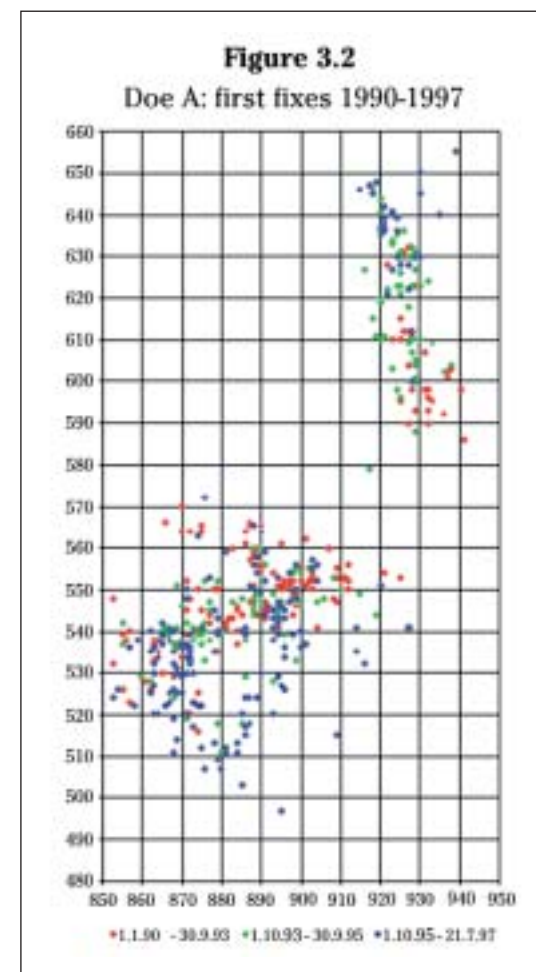
Many of some 20 oscillations between locations were seasonally related. However, four consecutive ones, all in different months, are illustrated in Figure 3.3.

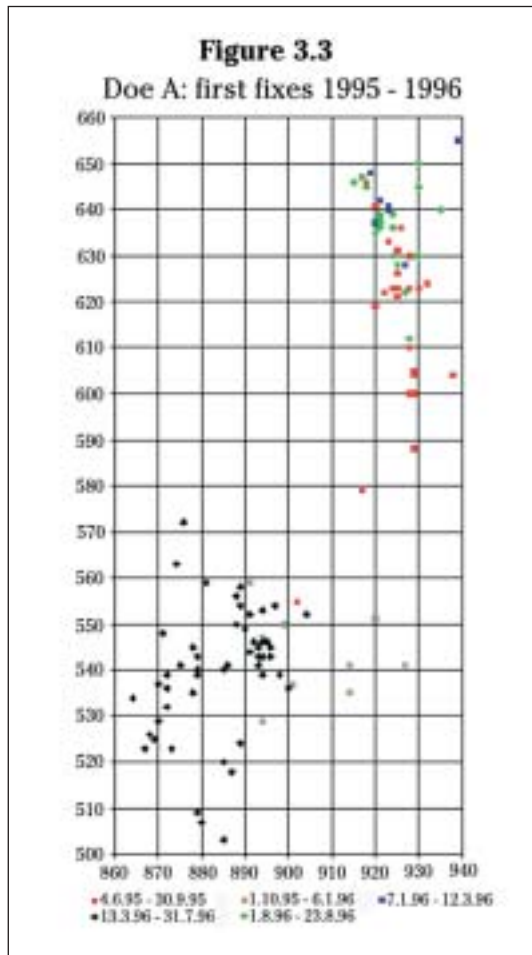
Difficulty in finding Doe A some autumns may have merely reflected the elusive habits of the species at that season but the possibility cannot be excluded that she visited a third location, undiscovered despite searches outside as well as inside the study area.

Figure 3.2 shows that, although the roe population of the study area fell from about 22 to 10 between 1990 and 1997,

the only changes in Doe A's locations throughout eight years were that in Hursthill drifting under 200m south and that in Brick Kiln under 400m north, the distance between their centres increasing from 600m to 1100m.

Buck P was studied on more than 500 days in seven and a half years. He too favoured a location in Hursthill Inclosure, being resident there each year from October to June and remaining throughout the summer in 1993, 1996 and 1998. But in the other five years (1991, 1992, 1994, 1995 and 1997) he made nine seasonally





“Home” ranges

Harris *et al.* (1990) presented a major review of problems and methodology of home range analysis, showing that insufficient attention was given to data collection and appropriate analytical techniques. They described methods of home range analysis, of which drawing the minimum convex polygon (i.e. joining the outside fixes) was by far the most often used. As the range boundary encompasses all fixes, including some well beyond the main area of activity, range size is strongly influenced by peripheral fixes and may include large areas never visited.

This drawback is conspicuous in Figures 3.2–3.4, where joining all the peripheral points would include many places an individual avoided; sometimes the apparent home range would be double the area actually occupied. Where the shape of a range is relatively simple, the error from including exploratory trips can be reduced by excluding a proportion (say 5, 20 or 33%) of the outside fixes; but greater sophistication is required where, as in these Figures, there are gaps between core areas.

Almost the only advantage of the minimum convex polygon technique is that, as the one most frequently used, it offers greatest possibilities for comparing results from different workers. Potentially the most valid is the harmonic mean method, perhaps using the 80% isopleth (i.e. excluding the 20% most peripheral fixes), but it is difficult to compare harmonic mean ranges between studies since each computer program may use a different set of algorithms and grid cell size. This method was tried here but not adopted.

There are other difficulties with home range

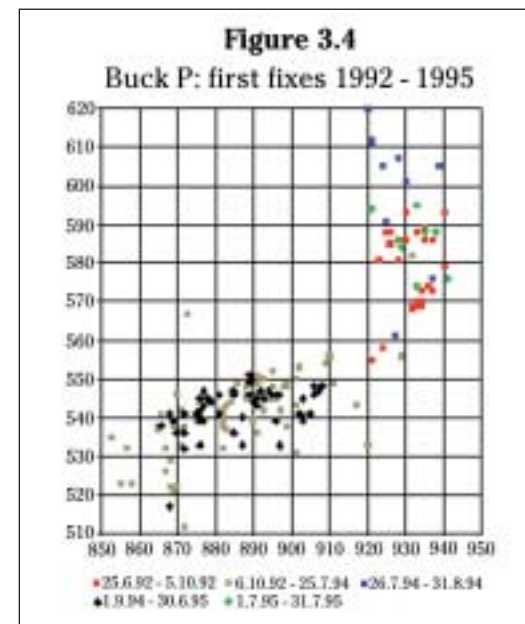
analysis, more fundamental though perhaps having attracted less attention. At times when an animal cannot be found, its location may be more important than the sightings in familiar places. Yet home ranges have been reported on the basis of opportunistic data collection, noting locations every time the individual is seen, whereas there may be other occasions and places unidentified whose inclusion would alter the picture significantly. Such ranges derived from data gathered opportunistically can be useful despite not being home ranges. Provided that the fixes are collected by consistent methodology, even without 100% success in always locating subjects, they may have validity for such purposes as comparing ranges between sexes or seasons (e.g. N. Rand in Putman, 1986). In such exercises, however, home range is a misnomer, as it would be for results reported here, which nevertheless also have alternative validity because consistent methodology conveys meaningful comparisons and changes.

Pointing out that the period over which a

home range is measured is one of the parameters essential to report, Harris *et al.* (1990) added “It is important to use seasonal divisions that reflect real aspects of the animal’s ecology, rather than any arbitrary division . . . which may obscure important changes of behaviour”. With this in mind, when Forde (1989) radiotracked seven roe deer each for at least a year (three for more than two years), he calculated bi-monthly changes rather than those over longer periods. San Jose & Lovari (1998), noting that no detailed reports had been published on individual variation in doe home ranges, studied a population with a density of 37 per 100ha. They too analysed bi-monthly changes in home range size of seven does for one year, imposing similar pre-selection of paired calendar months (January–February etc). However, Figures 3.3 and 3.4 show that such pre-selecting would still encompass unpredictable moves between locations, with consequent inconsistent exaggeration of ranges occupied in those periods.

As postulated earlier (Fawcett, 1997), Harris’s principle quoted in the previous paragraph therefore seems to require periods to be defined by the animals’ own movements. This was relatively easy for most individuals in this study. A consequent problem, however, is that shorter periods may not provide enough data for statistical analysis: Forde (1989) set a lower limit of 25 fixes below which a home range size was not calculated. However, constraint by inadequate data seems preferable to deriving results lacking validity.

What proportion of fixes should a range be defined to include? Putman (1986) reported figures for roe as well as fallow deer, indicating that 80% of fixes were within only some 44% of the total range sizes. Forde (1989) found that, for his roe, the 80% harmonic mean isopleth



included roughly 60% of the total home range. Corresponding figures here from convex polygon results lie between 50% and 60%. As total “ranges” are not so much ranges as areas linking radial trips, 80% ranges are preferred and have the additional advantage of not being critical: in most cases 75% or 85% ranges differ little from 80%, compared with bigger differences between, for example, 100% and 95% ranges.

Ranges of first fixes

The results shown and described here must be interpreted in the context of the limitations recognised in previous paragraphs.

Table 3.1 lists periods when Doe A occupied successive locations, the mean grid reference during each period, the distance moved from the previous centre, the number of first fixes and the number of trips more than 250m from the current centre. Dates quoted for each period are for the first and last sightings. Only periods in which observations were dependable are included; so five autumnal gaps show where data were judged inadequate for reliable analysis. Table 3.2 presents similar information on Buck P.

Such data are used below to describe the ranging behaviour of these two and six other roe throughout the years each was studied. As the constraints already discussed make precision unrealistic, figures are rounded to give only valid general descriptions. There was great individual variation in mobility within periods at each location and consequently in distances to be regarded as significant for each animal. As a guideline in observations that follow, a move between locations was judged significant if the

Table 3.1 Doe A locations

Period (Year/Month/Date)	Centre	Move (m)	Fixes	Trips
90/02/25–90/04/25	892556		7	2
90/05/01–90/05/18	925608	620	4	0
90/05/20–90/07/22	898556	580	6	1
90/07/28–90/08/08	935596	550	4	0
90/08/14–90/10/20	901562	480	11	2
91/01/03–91/07/09	878545		24	6
91/07/23–91/08/01	930605	760	3	0
91/08/21–91/09/08	899555	590	4	0
91/12/01–92/07/22	877542		30	2
92/07/28–92/08/05	937602	850	3	0
92/08/12–93/06/17	887548	740	54	7
93/06/28–93/09/04	923602	650	19	6
93/11/20–94/07/14	883544		41	5
94/07/19–94/09/27	924616	820	19	1
94/12/04–95/01/02	887544		10	0
95/01/08–95/01/14	922623	860	2	0
95/01/22–95/04/25	874537	980	27	1
95/04/27–95/05/03	929630	1080	3	0
95/05/15–95/06/01	899541	940	5	1
95/06/04–95/09/03	925616	790	27	5
95/11/14–96/01/06	905544		10	0
96/01/11–96/03/07	925642	1000	7	0
96/03/19–96/07/31	884540	1100	52	2
96/08/01–96/08/21	924636	1040	20	0
96/08/25–97/06/06	878532	1130	92	14
97/07/06–97/07/21	923624	1020	2	0

Table 3.2 Buck P locations

Period (Year/Month/Date)	Centre	Move (m)	Fixes	Trips
91/05/13–91/09/07	925577		41	6
91/09/08–92/06/22	904556	290	41	4
92/06/25–92/10/01	933583	390	25	1
92/10/09–94/07/23	886542	620	71	11
94/07/28–94/08/22	927600	710	11	2
94/09/27–95/06/14	887542	710	54	1
95/07/21–95/07/30	932586	620	8	0
95/08/01–97/06/13	893546	550	187	14
97/07/06–97/08/07	907583	410	26	5
97/08/14–98/08/29	887538	490	74	12

distance between their centres (mean fixes for each period) was at least three times the standard deviations for fixes within the periods.

Does

In each location 80% of Doe A's first fixes were within 200m of the current centre (mean first fix for each period) and 89% were within 250m, 11% therefore being trips (43 of 373 in Hursthill Inclosure and 12 of 113 in Brick Kiln). Her moves were defined as significant if over 400m but in practice all but two exceeded even 550m.

Her two to four moves a year averaged 830m. They included relocations annually (in 1989 as well as the following eight better-recorded years) from Hursthill to Brick Kiln for several weeks encompassing but extending substantially beyond the rut period; others were in April–May 1990 and 1995, January 1995, and January–March 1996. The mean of her 14 centres in Hursthill was 889547, all being within 200m. The mean of her 12 centres in Brick Kiln was 927616, all being within 250m.

Ranges derivable are not home ranges but demonstrate general limitations in interpreting them. Doe A's eight-year range, joining all the peripheral first fixes, covered some 90ha (reduced to about 50ha for an 80% range excluding the peripheral 20%). Measuring her two locations separately, however, that in Hursthill Inclosure occupied about 40ha (20ha for 80% of fixes) and that in Brick Kiln 20ha (10ha for 80%). Most of her annual ranges approached the size of the eight-year range but the area of each separate location recorded annually was only about 25ha (15ha for 80%) in Hursthill and 10ha (6ha for 80%) in Brick Kiln. Which of these various figures would be really informative even if it measured home range?

For Doe B, 80% of fixes were within 170m of centres and 95% were within 250m, only 5% (10 of 193) being trips. In 19 months, 5 November 1992 to 2 June 1994, only two of 60 fixes were more than 250m from her current centre and in



Buck P, Hursthill Inclosure, 27 February 1994

ten months, 22 September 1994 to 13 July 1995, only one of 60 was. So, in comparison, her 1km translocation from Hursthill to Brick Kiln during January–March 1996 was exceptionally significant and even six others of about 350m were significant in the context of such little movement within periods.

In great contrast, although Doe D's centres (but not individual fixes) were all within New Park Plantation where she was born in 1992, until autumn 1998 she wandered widely around central, southern and northern centres. To include 80% of fixes required 350m radii around them; only 62% (127 of 205) were within 250m of those centres. Her six significant moves (defined, because of this mobility within periods, as over 600m) were in August and November 1993, July and August 1997, and July and September/October 1998. Four others of 370–510m were in July and October 1996, and June and September 1997. She was unusual in that relocations encompassing the rut period were to the extreme south of the study area.

Bucks

Of Buck P's 538 first fixes, 80% were within 180m of current centres, and 89% were within 250m. When based in Hursthill Inclosure 10% (42 of 427) were trips (more than 250m from the

current centre), and when located to the northeast 13% (14 of 111) were. The mean grid reference of his five centres in Hursthill was 891545 (only 30m from Doe A's), the first being 170m away but the later four within 80m. In seven-and-a-half years Buck P made eight moves over 380m and averaging 560m. They were in June and October 1992, July and September 1994, July and August 1995, and June and August 1997.

Of Buck S's first fixes, 80% were within 190m of centres and 85% were within 250m, 15% of his fixes (40 of 264) being trips. Six moves between locations averaged 375m (310–470m), some of marginal significance in relation to movements within them. They were in June and September 1992, June and September 1993, and July and August 1994.

Buck Q's range drifted slowly eastward from 1991 to 1996, eventually out of the study area. Eighty percent of fixes were within 180m of centres and 89% were within 250m, only 11% (21 of 183) being trips. His eight moves between locations averaged 370m (310–520m), some of marginal significance. Moves were in November 1991, July and August 1992, August and September/October 1993, August 1994 (in both directions) and June 1995.

Buck V made no moves during two-and-a-half-years' continuous study. Of his 155 fixes, 80% were within 125m of his single centre and 97% within 250m. The equivalent for him of Tables 3.1 and 3.2 for Doe A and Buck P is a single line of figures:

Period	Centre	Move (m)	Fixes	Trips
89/07/13–91/12/28	931598	None	155	5

In huge contrast, during Buck T's four-and-a-half-year study, inclusion of 80% of fixes required encompassing those 330m from four distinct centres, from which only 69% (113 of 165) were within 250m. Nevertheless, despite greater movement within periods, his three 1km August

moves in 1994 and (in both directions) 1997 were very significant, and three of about 700m in September 1994, and June and August/September 1995 still significant (defined as over 600m). Directions of movement were inconsistent from year to year.

Summary of observations

Typically, 80% of fixes were within 170–210m of a current centre (closer for Buck V and further for Doe D and Buck T) and 10–20% were trips over 250m (substantially fewer for Doe B and Buck V and more for Doe D and Buck T).

Buck relocations appeared seasonal, before and after the rut, but individual differences were great, including those among the five bucks with most data, reported here. Oscillation between centres did not occur for all bucks, occurred only sometimes for others, and on only a small scale for yet others. For does, most but not all movements appeared similarly seasonal.

In four years (1991, 1993, 1995, 1997) when Doe A had no kid she moved to Brick Kiln between 2 June and 16 July (median 24 June); in four years (1990, 1992, 1994, 1996) when she had a kid her moves appeared between 16 and 31 July (median 25 July). These observations suggest a consistent movement by 16 July when without a kid but afterwards when with one. Doe B, however, in 1994, with a kid, shifted to her summer area before 12 June whereas in 1995, without a kid, she shifted about 17 July. Evidence from other does also confirmed individual differences.

There was little correlation of dates of return from Brick Kiln to Hursthill. Without a kid, Doe A's return was about 11 August in 1991 but not until September in 1993 and 1995. Her return with her kid in 1990 was close to 11 August, not until late September in 1994, and on 23 August 1996. Her 1992 kid was last seen on 22 July and she returned about 9 August. In 1997 she died in July, a week following attack by dog. Doe B

returned in early September 1994 and on 21 August 1995.

Buck movements to summer areas sometimes preceded does' but usually followed them when there had been winter associations. Thus, in 1994 Buck P relocated about 25 July (over a week after Doe A) and returned early September (probably a month before her), and in 1995 after 14 June (whereas she had moved by 4 June) and returned on 31 July (whereas she moved after 3 September). In 1994 Buck S moved on 21 July (over a month after Doe B) and returned about 21 August (three weeks before her); in 1995 his movements were less definable.

The recurring feature is individuality, not conformity to generalisations. More interesting examples of individualistic behaviour are reported in chapter 4.

ROE DEER are recognised as idiosyncratic (e.g. Prior, 1995; Fawcett, 1997); yet little detail has been published on wild individuals studied intensively over periods of many years. Behavioural differences became obvious in chapters 2 and 3 of this report.

Attachments between mother and kid, companionships between adults of the same or different sex, and movements within and between locations all varied so much among individuals that they frustrate attempts to generalise but fascinate ethologically, demanding closer perusal.

Although some generalisations can be derived from data collected here on social relations and ranging behaviour, deeper understanding depends on assimilating more biographical accounts and episodes of behaviour from individual histories. Drawing from the vast accumulation of such observations throughout over a decade, some topics are selected for description here partly in their own right and

partly to illustrate what can be gained from recording details daily for many years.

This chapter focuses on interactions among known roe and illustrates some day-by-day habits of this species. The first example is of companionship that sometimes develops between bucks, occasionally extending to some tolerance even during the rut.

The second portrays seasonal association of two adult does that started hesitantly early in 1992, consolidated next winter and lasted until 1996; also they demonstrated the contrast between positive association and merely sharing a range. More generally, the departure here from usual patterns of territory holding and rutting behaviour is reported. For one of the bucks and one of the does each studied for about eight years, the circumstances of their eventual loss are described.

Finally, a buck and doe sharing an area for several years illustrate apparent lack of affinity, in sharp contrast to frequent descriptions elsewhere of 'family groups'.



Buck R, Hursthill Inclosure, 3 September 1991

Dates and locations are detailed for those wishing to peruse them but even a fairly cursory scan conveys a general picture of events. Map grid references reporting locations or centres of ranges relate to Figure 3.1 in chapter 3, where the central study area is described. As explained there, although appearing to be of only six figures, they are more precise eight-figure references from which the constant first digit of each ordinate has been omitted.

Relationships of Buck P and Buck Q

Buck P was born in 1990 in Brick Kiln. In 1991 he had spikes longer than average for New Forest yearlings but subsequent antlers were below average (Table 2.1 in chapter 2). Buck Q had four-point antlers and was small-bodied throughout the six years he was studied; he was believed probably only one year older than Buck P. Buck Q was not seen to rut in 1991 but Buck R, thought most likely to be one year older still, rutted in Hursthill Lawn. Unsurprisingly for a yearling, Buck P's experience of this rut was mostly in being chased by Buck R and more often by another buck sharing the same ground.

Abstracted field observations show the association developing between Buck P and Buck Q, and their relationships with Buck R and other neighbours.

1991

In mid-August, Buck R and Buck Q moved southwestward into Hursthill Inclosure. They shared a range (centred 885561) but were not seen closer to each other than 150m.

23 August Buck P started exploring the same area.

27 & 28 August (876578). Buck P and Buck Q were first seen feeding together, following each other in turn.

29 August (927572). Buck P returned eastward to his previous area, now accompanied by Buck Q.

7 September (933585). Buck P was ignored when he fed towards Buck R, then on a "trip" (defined in chapter 3) outside the northeast boundary of Hursthill.

8 September (892555). Buck P and Buck Q

17 October had moved some 400m southwest again. (890555). Buck Q approached Buck R but was chased away. (923562). Buck P was found alone but 150 minutes later was with Buck Q and a doe nearly 300m southwest (899546).

14 November (928576). Periodically Buck P and Buck Q gently engaged antlers while feeding with the previous doe. (919556). Buck Q browsed 350m east of Buck P (886562).

16 November (922557). On another trip, Buck R, despite antlers cast, chased Buck Q, which then fed only 1m from Buck P. (925560). After they rubbed foreheads together, Buck P gently scratched Buck Q's throat with an antler and was chased a little; both then joined a doe. (880549). Buck R chased still-antlered Buck Q. (925557). Buck P too retained antlers. (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

23 November (925560). After they rubbed foreheads together, Buck P gently scratched Buck Q's throat with an antler and was chased a little; both then joined a doe. (880549). Buck R chased still-antlered Buck Q. (925557). Buck P too retained antlers. (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

28 November (925560). After they rubbed foreheads together, Buck P gently scratched Buck Q's throat with an antler and was chased a little; both then joined a doe. (880549). Buck R chased still-antlered Buck Q. (925557). Buck P too retained antlers. (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

30 November (925560). After they rubbed foreheads together, Buck P gently scratched Buck Q's throat with an antler and was chased a little; both then joined a doe. (880549). Buck R chased still-antlered Buck Q. (925557). Buck P too retained antlers. (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

7 December (880549). Buck R chased still-antlered Buck Q. (925557). Buck P too retained antlers. (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

14 December (925557). Buck P too retained antlers. (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

24 December (930565). Buck P and Buck Q, both now cast, fed together, each following the other in turn; meanwhile Buck R was with a doe only 50m away (926562).

1992
Buck P and Buck Q continued to associate that winter, drifting together a little westward; meanwhile Buck R and Doe B were often together until March 1992.

1 March (890557). Buck P and Buck Q fed with Doe B. (890560). Buck P and Buck Q

fed with another doe for at least two hours while Buck R fed with Doe B over 300m south-west (866537).

As Buck R's condition visibly deteriorated through the winter and his hitherto regular sightings suddenly ceased after 9 March (892552), he was believed to have died.

10 August

scrub repeatedly and scraped. An hour later they fed in Butts Lawn only 70m apart, Buck P occasionally looking towards Buck Q.

Buck P and Buck Q were again in Butts Lawn, wandering tolerantly and feeding 40m apart. About 16 August Buck Q moved over 300m south into New Park Plantation. He and Buck P were never again seen associating during the next four years.

Figure 4.1 illustrates, with first fixes (around dawn), how three bucks shared a range in the six months, 16 October 1991 to 15 April 1992. The centres of the usual locations of Bucks P, Q and R were within about 100m of Doe B's (891553). Doe A's (877542) was 150m to the southwest; unlike Doe B, she was seen this winter with none of those three bucks but with Buck V, whose centre was 120m still further southwest.

Figure 4.2 shows how Buck P, Buck Q and Buck S (at least as old as Buck Q) shared the same small range in the rut, all fixes but one being within 8ha. This reflects departure from usual descriptions of the roe rut, discussed later.

Figures 4.1 to 4.6 have not been manipulated to separate superimposed points for the same individuals and so they appear under-recorded.

Relationships of Doe A and Doe B

Doe A, first recorded as an adult with kid in summer 1989, and Doe B, an adult first firmly identified in 1991, associated each late winter from 1992 to 1996. Although the possibility that Doe B was Doe A's 1989 kid cannot be excluded, there is no positive evidence and Doe A was never found with any doe between May 1990 and

19 March (893545). Buck P and Buck Q fed with Doe B. Until the end of March Buck P and Buck Q remained usually together (893558), both still in velvet.

From 7 April all individuals were generally alone except that on 11 April (891561) mature Buck S, despite having cleaned antlers three days previously, joined Buck P.

20 April (892543). Buck P had freshly cleaned but bloodstained antlers.

21 to 27 April Buck P wandered widely and was not seen again until 27 May when he settled near the middle of his winter range (904556).

25 June The centre of Buck P's range shifted nearly 400m northeast into Butts Lawn (933583). Buck Q wandered but settled there by 27 July.

5 August (925588). Buck Q was briefly chased southward in Butts Lawn by Buck P but then chased him back into Brick Kiln. Buck Q promptly returned, thrashed birch

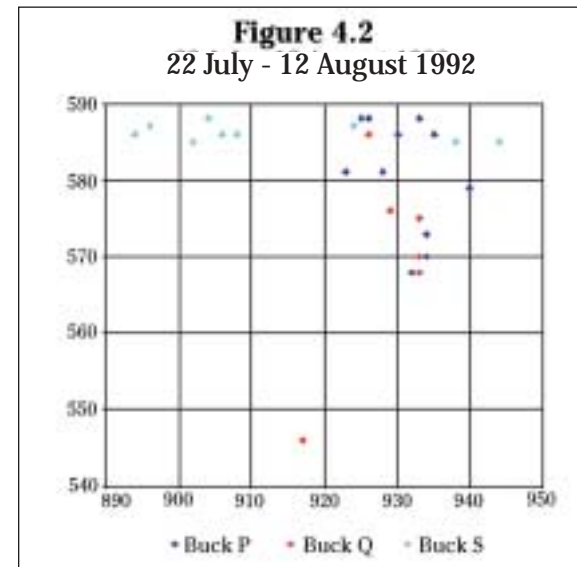
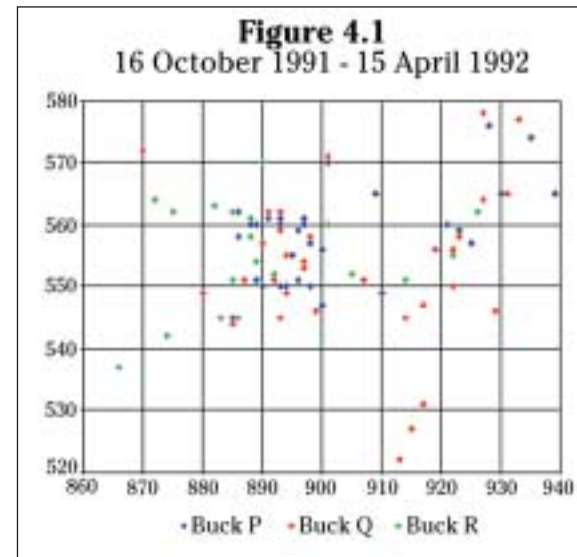


Table 4.1 Centres of ranges of first fixes in Hursthill Inclosure of four roe from 1 December to 15 April in six consecutive years

	Doe A	Doe B	Buck P	Buck S
1991-92	877542	891553	904556	895560
1992-93	887548	895553	886542	897557
1993-94	880543	882544	878538	900551
1994-95	878540	883545	887542	898559
1995-96	894544	894549	894545	
1996-97	878532		893546	

March 1992. Their continuing relationship was influenced by other roe, including their surviving kids, and Buck P and Buck S.

Table 4.1 reports centres (mean first fixes) of the ranges of the two does and two bucks in up to six winter periods, 1 December to 15 April, from 1991 to 1997. As these are based on eight-figure grid references, one unit in each ordinate represents only 10m. For each individual, range centres in successive years averaged 80m from their mean. In each season from 1992 to 1996, the range centres of the does and Buck P were all within 80m of their mean, virtually coinciding. Buck S averaged 200m distant, which was sufficient to avoid overlap of his and Buck P's ranges after 1992.

Ranges in four of the years are illustrated in Figures 4.3 to 4.6 but detailed study revealed how individuals might or might not be associating irrespective of the concurrence of their ranges.

1989-92

Doe A associated in winter 1989-90 with only her doe kid and in 1990-91 with only her buck kid. In winter 1991-92, without a kid, she sometimes accompanied Buck V, while Doe B that season related preferentially but not exclusively with Buck R. He disappeared after 9 March 1992 and the following other associations were recorded that month:

1 & 19 March (888558 & 893560). Doe B fed with Buck P and Buck Q.

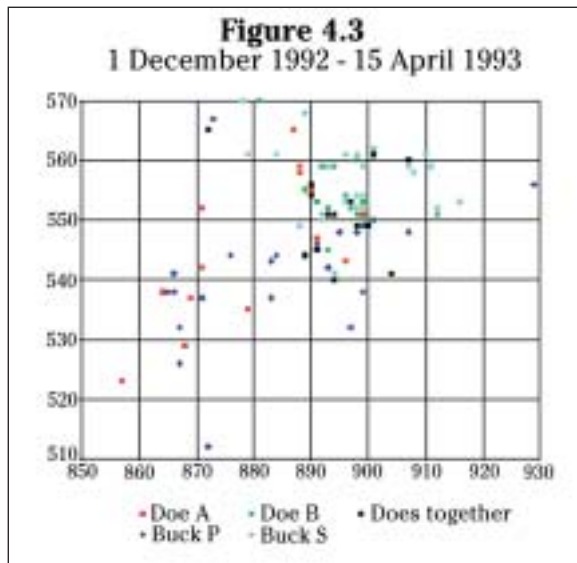


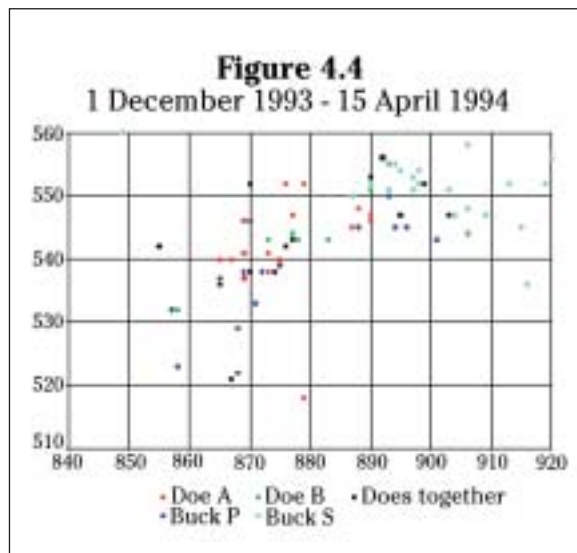
Figure 4.3 shows first fixes of Doe A, Doe B, Buck P and Buck S over the winter period 1 December 1992 to 15 April 1993. Doe B's centre when alone (895555) was only 40m north of that when the does were together (894551) and Doe A's when alone (880545) was nearly 200m southwest. Her wandering southwest brought her range into close concurrence with Buck P's, while Doe B's almost coincided with Buck S's. This nevertheless contrasts with the does associating more often with each other than with either buck. Sharing a range and close association were separate characteristics.

- 26 March (891547). Doe B fed with Doe A and Buck V, intermittent companions for the past month.
- 28 March (857540). Doe A was with Buck S.
- 30 March (884537). Doe A, Doe B and Buck S fed together.

On 16 April (910548) Doe A was alone when approached by Doe B, with which she was seen feeding for the last time before the body of Doe A's newborn, or probably stillborn, male kid was found on 22 May. Between 17 and 28 June 1993 she moved 600m north from Hursthill to Brick Kiln (887548 to 923602).

1992-93

Each doe had a kid in 1992 but lost it within a few months. The does were found associating again on 5 December. From 1 December until 15 April 1993 Doe A and Doe B were observed together on 17 of the 28 days each was found. Until Buck P cleaned velvet on 17 April he was seen with the does four times (once with each and twice with both) compared with 17 times alone. Until Buck S cleaned velvet on 14 April he was with the does ten times (five times with Doe B and five with both) compared with ten times alone.



1993-94

Each of the two does and two bucks associating in the spring was often solitary early next winter. Doe A was not seen with Buck P until 18 December 1993 (893528) or with Doe B until 6 January 1994 (904547).

Between 1 December 1993 and 15 April 1994 Doe A was found on 31 days, Doe B on 21 and Buck P on 14. All three were together on three mornings, the does together on eight, and Doe A with Buck P on four. Buck S was with one or both does in only four of his 19 sightings in that period. The last time Buck P was found near the does was on 14 April (872538) when his antlers were freshly clean. The two does were last seen together that season on 15 April (877543).

Figure 4.4 shows first fixes over the winter period 1 December 1993 to 15 April 1994. Doe B's centre when alone (882544) was identical to that when the does were together and this year Doe A's when alone (876542) was only 70m southwest. Buck P's centre (876538) was only 50m to her south. While these three ranges could be regarded as coinciding, Buck S's this year scarcely overlapped.

1994-95

Next winter differed from the two previous in that Doe B had a kid surviving until March. This did not affect her choice of range still shared with Doe A and Buck P but she was never seen with either during the period before 16 February, when she was usually accompanied by her kid. Thereafter they were seen always apart and the kid was found on 20 March recently dead, weighing under 7kg and apparently killed by a dog.

Meanwhile Doe A and Buck P had re-established their own companionship, witnessed from 4 December 1994 (876540) and more consistently from 2 February 1995 (872532). From 1 December to 15 April 1995 Doe A and Buck P were together 19 mornings out of the 35 Doe A and 33 Buck P were seen. Doe A



Buck S, Hursthill Inclosure, 17 June 1994

relocated in Brick Kiln for two weeks in January.

Despite sharing Doe A's range, Doe B's 31 first sightings between 1 December 1994 and 15 April 1995 were 30m or more from her or any other adult except on the following occasions after her kid left her. She fed 15m from Doe A on 23 February (856536) and was lying with Doe A and Buck P on 16 (874540) and 20 March (869536).

Then Doe B was found always alone until with Buck S on 3 (890559), 4 (892560), 6 (897554) and, at a distance, 9 April (907546), when both bucks were cleaning antlers. Except on these four dates, all of Buck S's 26 first sightings between 1 December and 15 April were of him alone, including those when he made trips northeast.

Figure 4.5 shows 1994-95 winter ranges in Hursthill Inclosure of Doe A, Doe B and Buck P all centred within 100m while Buck S's was over 200m northeast, though lapping that of Doe B.

No associations were seen after 9 April 1995. Before the end of the month, both does appeared pregnant but no kid was ever found. Doe A visited Brick Kiln for a fortnight in late April and early May. In June both moved northeast from Hursthill Inclosure but on 21 August Doe B went back (908584 to 898550) and a month later Doe A returned nearly 800m from Brick Kiln (925616 to 905544).

1995–96

Buck P was seen twice with Doe A and once with Doe B in November 1995 and then especially with Doe A from 2 December. The does were found together only after 6 January 1996, despite sharing a range and neither having a surviving kid. From 1 December 1995 to 15 April 1996 Buck P was seen 49 times, including three with both does, nine with Doe A and three with Doe B. Doe A and Doe B were together ten times (including the three also with Buck P) out of the total of 31 first sightings of Doe A and

23 of Doe B. Five of these ten were in Brick Kiln, to which Doe A moved over 1km from about 8 January to 15 March, and Doe B from 12 January to 23 March. All three were together in Hursthill on 27 and 28 March.

Buck P cleaned antlers on 12 April 1996 but remained with Doe A until 15 April. On 24 April (878546) they lay together while Doe B was over 300m to their east (914552). This was the last certain identification of Doe B although there was a possible observation in early June.

Buck S had been missing after September 1995 but Figure 4.6 shows that Buck P and the does again shared an identical Hursthill range in winter 1995–96.

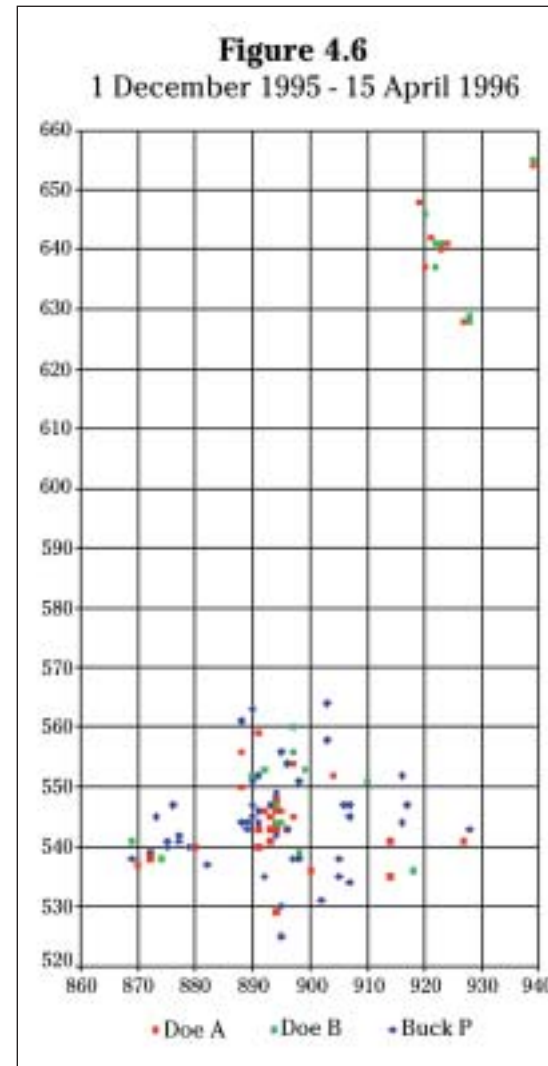
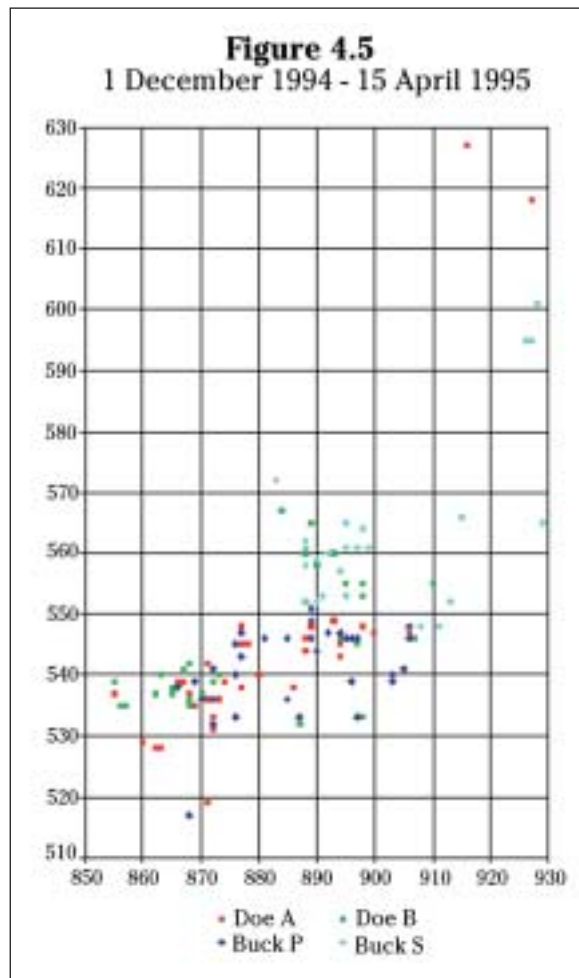
Throughout the next year outside the rut, Doe A was not found with any roe except her 1996 doe kid, with which she associated constantly.

Pairing in the rut

As noted in chapter 3, roe in the study area often relocated for periods around July and August. Sometimes bucks and does sharing ranges in the winter and spring moved to a new woodland location and re-constituted their companionships there. Often Butts and Hursthill Lawns were treated as rutting grounds in a way more characteristic of red or fallow deer, does and bucks gathering from Hursthill Inclosure, north Brick Kiln, Gritnam Wood and New Park Plantation. Different rutting behaviours are illustrated by three does.

Doe A

Doe A, despite spending most of each year in Hursthill Inclosure, in eight consecutive years always rutted a kilometre away in Brick Kiln. In 1989,



The circumstances in 1996 merit fuller description, particularly in the context of Lambert's (2000) reminder that the female roe deer has a pre-oestrous signal some 7–10 days before ovulation, thought to be a means of attracting a male and during which apparent matings occur.

- 19 July (873523). In Hursthill Inclosure Buck P rut-chased Doe A, with her kid.
- 26 July (892546). Buck P and Doe A appeared to ignore each other, 50m apart.
- 27 & 28 July (889554 & 894539). Buck P and Doe A, with her kid, fed within 6m.
- 29 July (893543). Buck P was found alone.
- 30 July (889558). Doe A and her kid were alone.
- 31 July (875541). Doe A fed with her kid while Buck P (874542) wandered more widely.
- 1 August Doe A had moved 1km northeast to Brick Kiln (884540 to 924636) whereas Buck P remained in Hursthill, seen with another doe on 2 (888560) and 3 August (891540) but alone on 4 August (895535) and thereafter.
- 6 August (930630). Doe A was rut-chased by Buck W and was with him on 7 August (930645).

1990 and 1991 this was with Buck N (933600) but, although she visited there in the winter, they were not found associating then. Following his disappearance, her liaison in 1992 was uncertain. In 1993, although briefly followed on 20 July by Buck S, she rutted with Buck W (927632) and in 1994 with Buck P (925608). She rutted with Buck W again in 1995 (927628) and 1996 (930635).

Doe B

Doe B was firmly identified rutting only in 1994 and 1995, both years in Hursthill Lawn with Buck S with which she had shared winter ranges. He, like other bucks, had rutted with several does around the same location (904585) in 1992 and 1993, when she could not be recognised with certainty.

Doe D

Doe D was found only 16 times in six successive ruts (1993–98). She was always alone, except for her kids, other than on 6 August 1993 and 30 July 1996, both times with Buck T. Generally these residents of New Park Plantation seemed to avoid each other.

Evidence of correlation between winter associations and pairing in the rut thus varied among individuals. If Doe A's frequent winter consort, Buck P, induced ovulation in 1996, the beneficiary appeared to be Buck W, her mate also in 1993 and 1995. Doe B and Buck S moved apparently independently from their shared winter ground to their shared summer ground in both recorded years, as did Doe A and Buck P in 1994. Because on these occasions the does rutted with their earlier companions, their moves might not appear searches for different mates; but perhaps a better suitor was sought in vain and so the available one was accepted in those years.

Last months of Doe A and Buck P

In winter 1996–97 neither Doe A, with a surviving doe kid, nor Buck P was seen associating with any other roe. Her range (878532) was now centred 200m southwest of his (893546) and they were never found closer than 50m, except on 13 March (896534) when he followed her briefly.

Doe A appeared pregnant by 21 April 1997, when she and her 1996 kid groomed each other's necks. Until even 22 May half their sightings were of mother and daughter together but from 25 May the daughter shifted northwest, though still in Hursthill Inclosure. Doe A looked pregnant until then but no evidence of a kid was seen. Around the end of June she moved 1km north from south Hursthill Inclosure to Brick Kiln (878532 to 923624) but was not found from 6 until 21 July, when she lay in a sunny ride

(922621 at 0742h), conspicuously ill. Five hours later she had moved 40m west, lying on her side with head stretched back and only just breathing. She died at 1330hr, before a humane killer arrived, and her abdomen was found ripped open and heavily infested with maggots, the biological evidence indicating attack by dog about a week earlier. Foliage of foxglove *Digitalis purpurea* was found in her mouth, an observation inviting a variety of speculation.

Buck P had shifted 400m to the northeast of Hursthill Inclosure by 6 July 1997 (893546 to 907583) where on 20, 21 and 23 July he fed while following a doe, rut-chasing her when she trotted away. He was seen every day from 26 to 30 July mostly alone, often patrolling and once chasing another buck. On 31 July and 1 August he pursued a yearling buck before returning to feed near a doe and later rut-chase her. On 4 August he pursued a doe intermittently but was hounded by Buck T that evening and those of 5 and 7 August. About 10 August Buck P moved 500m southwest into Hursthill (887538).

In December 1997 Buck P's ribs were prominent and in January 1998 his haunches were thin and flanks sunken. Though having cast antlers in October 1997, two months earlier even than in the previous year, his pedicles were still incompletely healed on 13 January 1998 and growth was not visible until 27 January. On that date in the previous year, despite casting having been much later, his 6–7cm antlers were already about to bifurcate; this was a stage not reached in 1998 until 20 February. Antlers were not cleaned until 5 May although growth had appeared complete for several weeks; even on 29 May the top of the left main tine and both coronets retained velvet. On 24 and 26 July he fed intently, now appearing plump and in good condition, but he could not be found after 29 August (880530).

Since mid-December 1997 Buck P had drifted in Hursthill Inclosure around 887538. Before he disappeared he seemed completely recovered

from poor condition the previous winter and was not injured in the rut. Intra-specific competition can be excluded as the cause of disappearance because the roe population had been reduced so far that, between 1 May and 1 November 1998, there were only three other roe sightings within 300m of his centre: Doe D on 25 May (885517), and her yearling daughter on 1 June (867522) and 29 August (894524). An eight-year-old buck adhering so closely to a limited home range is unlikely to have moved spontaneously outside the study area and his death was presumed.

Relationships of Doe D and Buck T

The roe occupying New Park Plantation most consistently in the 1990s were Doe D (1992–98) and Buck T (1993–97) but their relationship seemed to be generally of mutual avoidance. Others present in some years included Buck Q and Buck U.

Doe D was ear-tagged newborn on 29 May 1992 at 903499. For the next six and a half years her ranges were around 905500, 895452 and 920527, although she was found sometimes in Hursthill Inclosure (885515) from May 1998, ten months after the death of neighbour Doe A. Her first kid was born in 1994 at 895498 and in 1995–97 her locations near the time of giving birth were respectively around 907493, 910495 and 907501. She inherited the range of her mother, shot on 17 February 1993, and remarkably close philopatry was apparent, with her offspring born very near her own birthplace.

After her mother was shot, Doe D was the only doe to rear kids in New Park Plantation, although others were present temporarily. Usually having at least one offspring, her brief



Doe D, ear-tagged on 29 May 1992

winter associations with bucks were much delayed, in 1996 starting only from 29 March (with Buck U) and in 1997 from 10 March (with Buck T).

Early in 1995 Buck T occupied a large range (centred 910512) partly overlapping that of Buck U (917540), which had big seven-point antlers: the seventh 9cm tine rose from just inside the pedicle of the left antler; the front tines were about 2cm long on the left and 7cm on the right; the bottom bifurcation was 1cm lower on the left than on the right. His antlers were clean on 2 May (915540) when he fought Buck T, whose own large (by New Forest standards) six-point antlers still had residual velvet. Buck T appeared slightly the stronger but after a second joust he backed, limping on his front left leg. However, Buck U withdrew slowly and Buck T barked several times. Next day he no longer limped and, while barking, chased an unidentified roe. Until the end of May his range and Buck U's continued to overlap but they were never seen closer than 100m. Between 30 May and 14 June Buck T moved 700m south within New Park Plantation (910512 to 894445), presumably displaced eventually by Buck U, which remained until September except when visiting over 600m northeast to Butts Lawn (941580) from 25 July

to 7 August. Buck U was not seen in 1995 after September, when Buck T returned to his previous range some 700m north (916510).

From the start of 1996 Doe D and her doe kid wandered extensively (around 915500) and until 5 March Buck T roamed a similar range (916510). Two days later he seemed to have been displaced by a buck with abnormal seven-point antlers: the extra 5cm tine rose from the base of the right pedicle and, although not on the side of the previous year's abnormality, he was thought to be Buck U. Buck T roamed fairly extensively until the beginning of August. Doe D was not seen with either buck except on 29 and 30 March and 6 April, when (presumed) Buck U followed her. After 30 March the 1995 doe kid was never found with her mother, which wandered very widely from 18 April onwards. The kid was with Buck U on 7 and 15 April. Extended cleaning of Buck U's abnormal antlers started on 9 April; from then to early June, when he still had dangling velvet, he limped on the left foreleg. On 7 June Buck U was with Doe D, which had given birth at the end of May, but he was never seen after 9 July. Between 19 June and 19 July Doe D moved 350m southwest (907495 to 896463), where Buck T rut-chased her on 30 July.

In 1997, although the ranges of Doe D with her doe kid (906504) and Buck T (916510) overlapped, neither was seen associating with any roe until 10 March, when all three were together (909478). On 11 April Buck T fed within 7m of Doe D and her kid; his right antler was almost clean while the left was in velvet. On 14 and 28 April he followed and fed with the kid, her mother out of sight, although this year mother and daughter remained companionable and were together on 8 May when Buck T chased conspicuously pregnant Doe D. On 20 May she moved away when Buck T displayed flehmen. Between 23 June and 4 July she took her 1997 twin kids 500m south in New Park Plantation (906504 to 898456).

Doe D was not found with any buck during the 1997 rut. Around 22 July she moved 650m

north in New Park Plantation but, despite her proximity, on about 31 July Buck T moved nearly 1km further north to Butts and Hursthill Lawns (916510 to 921588). He chased Buck P on the evenings of 4, 5 and 7 August. About 11 August he returned, some 1.3km, to the south in New Park Plantation (921588 to 907462) where he was last observed on 6 October.

In 1998 Doe D had an unsexed kid but neither mother nor kid could be found after 17 November. Routine Forestry Commission reports eventually disclosed that on 14 February 1999 the remains of a doe had been found against a deer fence (947507); she was thought killed by a dog. Only two other does had been seen meanwhile within 600m of where the carcass had been found and, as both still survived, the dead doe was most likely Doe D; unfortunately the report was discovered too late to locate her ear-tag.

Much had been learnt from Bucks P, Q, S and T, Does A, B and D, the other half dozen roe identified in this report and many others studied for shorter periods. It remains to consider conclusions to be drawn and the care that should be applied to the management of this special roe deer population in what is recognised as a very special place, the New Forest.

THIS REPORT presents numerous observations and results, sometimes avoiding obvious interpretations so that readers can draw independent conclusions. It also discerns questions that fascinatingly demand elucidation.

It would be arrogant for our species to suppose that individuality is unique to us. Idiosyncratic behaviour that evolved in other life forms is demonstrated repeatedly by roe deer in this report. Humans share with other animals more than a common history, more even than close genetic identity with other species. So anthropocentricity may be as unwise as anthropomorphism.

Roe deer in the New Forest differ from those elsewhere, dramatically in their population dynamics, for example. But even more remarkable is variation among individuals, whether in prosaic features like moulting or antler growth or in more sophisticated ethology exemplified in social relations and ranging behaviour.



Doe A, Brick Kiln, 28 April 1990

This report presents data particularly on those roe deer best documented during more than a decade. They represent a fraction of the many more recorded less extensively because they disappeared or lost identification marks. Generalisations, where they are possible, are based on the few documented in great detail plus all those providing confirmatory observations over shorter periods.

An early lesson

My intensive concentration for over a decade on roe deer in the core area described in chapter 3 followed much longer experience of identifying and recording them individually elsewhere. They fitted the description of a sedentary species whose home range in the New Forest would be expected to have a radius of some 200m. In 1989 there was a doe retaining an apparently unique pattern of exceptionally long hair in her ears. Unfortunately this ease of identification was blighted by another doe a kilometre away with the same 'unique' pattern, attributed to probable kinship. I confess it was months before the penny dropped: does watched a kilometre apart shared additional less obvious characteristics; and they were never seen on the same day.

This was the start of my eight-year familiarity with Doe A – and the same Doe A! – and all that she and others taught about oscillation.

So roe deer here not only make trips from a current range but oscillate between locations, not necessarily on tidy dates in a human calendar.

This observation has great practical

importance, for example in relation to the census. Stalkers re-visited by the ghosts of their trophies are familiar with the problem of look-alikes; census-takers are accordingly careful not to under-count. Having told the 1989 story against myself, it is no disrespect to keepers in widely scattered parts of the Forest, whose conversations will not be divulged, to say that I know of over-counting through similar causes. Also it should not be assumed that roe seen weeks before the census are still there then.

As explained earlier, the potential for accurate census of this species is exceptionally good in the New Forest and errors of total counts are not great. A keeper knows his beat, usually holding just a score of roe, and my evidence is that, overall, sources of slight under- and over-counting roughly balance, a conclusion shared (Putman & Langbein, 1999). I believe that bucks may have been slightly under-counted and does over-counted, though not enough to invalidate the observed unusual bias of sexes in the Forest.

Statistics

This report makes many numerical data available to readers and includes mathematical treatment where necessary, but standard statistical methodology used is only occasionally mentioned. Statistical analysis should be neither worshipped nor derided: it has an important role if conducted and interpreted with caution, and without obsession that one has proved something if probability (of chance correlation) = 0.049 or, worse, proved the opposite if probability = 0.051. In 1987 a contributor declared to a scientific symposium "You can't expect biological systems to provide the same levels of statistical significance as physical systems, so I shall invent the term biological significance". Many lay people have too little respect for validly applied statistics whereas some scientists have too much ("paralysis by analysis"). Reproductive potential and success can be expressed in mathematical forms as in Tables 1.2

and 1.5 but biographical detail like that in Table 1.1 is needed not only for ready assimilation but for more complete scientific understanding. Table 1.1 contrasts, incidentally, with the 'obvious' assumption that a doe rears kids most successfully in her middle years.

In population dynamics, errors that are relatively small and consistent do not invalidate general conclusions whose overall reliability does not depend on precision. Although not ideal when validity of the bottom line results from mutual cancellation of errors, it is acceptable in relation to what can be expected from a census, particularly where those errors are minor and predictably consistent.

With total counts of roe deer here unusually dependable, even slight uncertainty about age classification was particularly regrettable because unnecessarily introduced by insistent managerial misuse of terminology.

Generalisations

There are geographical, annual and individual variations in the timing of episodes like moulting and antler cycle, and perhaps their sequential details. Attempts have been made (e.g. Staines & Ratcliffe, 1991; Fawcett, 1997) to generalise about the roe calendar but comparison of reports, like those in chapter 2, between different locations could be more instructive. Even moulting patterns are valuable in facilitating identification, which is important in conducting a census, in turn essential for deer management.

Although differences in behaviour between individual roe were great, some general conclusions are possible by drawing together findings reported in earlier chapters and comparing them with previous publications.

Despite great differences in habitat, inter-specific competition and roe population density, there was remarkable similarity on most topics between Johnson's (1982) findings at Chedington and mine in the New Forest, especially qualitatively and

comparatively (e.g. variation over periods). Whilst some quantitative differences were predictable from those of population density, others are of particular interest.

Johnson's tentative summary of buck territoriality conformed to much published over many years. Adult buck territories were clearly defined from about mid-April to November and were derived from annual home ranges. But in the current study, territoriality and rutting complied less with such usual descriptions for roe, in which resident bucks defend adjacent non-overlapping territories, than with the habits of different deer species, drawn to traditional areas where there is competition throughout the rutting period. Other behaviour, however, should be reviewed first.

Ranges

Chapter 3 posed questions about the most meaningful way to represent ranging behaviour; it did not postulate ideal answers. Conventional geometrical representation by polygons has obvious uses, whether or not the methodology justifies designation as home ranges; but it provokes further questions. If a range is defined to encompass all the peripheral sightings of an animal, how should one deal with incorporated areas where it is never seen? What alternative definition is preferable?

It could be argued that a scatter diagram showing where fixes were concentrated or dispersed is more meaningful. Even so, Figures 4.3–4.6, for example, could have misled that there was greater association between Doe A and Buck P, and Doe B and Buck S, than between Doe A and Doe B. Anecdotal observations are needed to correct misinterpretation.

It may appear very proper to pre-determine objectively, before seeing one's results, how one will divide the year into periods for analysis. Yet chapter 3 demonstrated how the perspective from supposed high ground of scientific integrity could negate understanding of what each individual was

really doing. This became apparent from retrospective inspection of the data and exercising judgement to define periods. For the animals most reported here, with many fixes, much of that judgement would not be debatable; but alternative delimitation of periods could be argued for the many individuals providing fewer data yet fitting the same patterns of behaviour.

Winter associations

In winter, bucks frequently shared ranges but generally avoided each other within them instead of feeding together, tolerance decreasing with age. The few buck associations usually included at least one yearling, as initially in the companionship of Buck P and Buck Q described in chapter 4.

Does with kids appeared content to share winter ranges with adults of either sex but not to associate with them, avoidance within a range seeming mutual.

Does without kids, or after kids had died or left them, associated more frequently, apparently regardless of sex: the companionship of Doe A and Doe B from 1992 to 1996 was described in chapter 4. Doe A related also with Buck P; Doe B's brief association with him was never as close as hers with Buck R before or Buck S afterwards.

Around April, when ties with their mothers had loosened, kid bucks sometimes seemed fascinated by adult bucks, particularly when cleaning antlers. The adults reacted with varying levels of tolerance, generally decreasing as the weeks passed. A few months later, bucks becoming yearlings sometimes associated together, usually amicably but occasionally with apparently playful jousts during the rut.

Territoriality, migration and oscillation

Prior (1995) concluded that, if both food and cover continued to be available, roe remained within the same boundaries throughout the year: where

habitat was ideal, adult bucks and does were faithful to their territories winter and summer; territoriality had little to do with selecting a mate but ensured freedom from competition. Before stock depleted the inclosures in the early 1970s and roe numbers dived further, those in the New Forest conformed to this pattern: Jackson (1977) reported on his earlier experience that "Once the roe bucks have established their territories, they normally live entirely within them for the duration of the summer".

Danilkin (1996) drew attention to great variation in ranging habits, including seasonal migration, more common in eastern Europe though occurring also in Scotland between hill and low ground. Cumming (1966) had reported there was sometimes in Britain a shift between summer and winter home ranges and Johnson (1982) deployed evidence of this by some does at Chedington. Are periodic oscillations (Fawcett, 1997) like those reported here in southern England related to the rut or prompted by differences in resources, including food, shelter, sun (obviously valued by roe) and freedom from disturbance?

Oscillation here seemed mostly seasonal, particularly for bucks. Relocation in the summer generally correlated more with the rut than with availability of resources. Although the ratio of deciduous to coniferous forage was lower in Hursthill Inclosure than in areas to which roe moved, differential availability could not readily account for translocation often limited to July and August. Indeed, other resources such as access to sunshine and relief from disturbance might well have dictated seasonal translocation in directions opposite to those observed. As exodus of most roe from Hursthill was to places where there were more roe, intra-specific competition can be excluded as the cause. Despite other, less predictable, movements in the winter and spring, there seem good grounds for relating most to reproductive motivation, possibly because of population sparsity.

Atypical rut behaviour

In different years a few local pairs in home ranges near 900500, 925525 and 930610 (map grid references defined in chapter 3) complied with familiar descriptions of roe rutting behaviour: both sexes remained in bucks' territories and does' home ranges from which other roe, particularly bucks, were excluded. But here this was the exception, untrue of most individuals in most years. Around June or July some bucks and does migrated separately a kilometre or more to rut in a different woodland location, such as Brick Kiln. More often they shifted to Butts and Hursthill Lawns, their behaviour being more evocative of other species that move annually to traditional rutting grounds where males compete for dominance and females make themselves available. Where population density is low, such convergence reinforces the effect of the doe pheeeping while rutting, attracting any stronger buck within earshot.

Some animals converging to this area were well known, others reliably identifiable only for that year, and others appearing for the rut period but at no other time. In many years until 1996 at least five bucks and three does rutted there although, after the population was depleted further, from 1998 there were often no more than one buck and two does.

This scenario contrasted with the norm for higher roe densities in coniferous forest (e.g. Chapman *et al.*, 1993) where does shared buck territories in spring and summer but in winter the territorial system broke down, with the deer ranging wider and exploiting nearby agricultural habitat. The familiar spring sightings elsewhere of roe gorging in pasture on the early bite of new growth were surprisingly rare in fields around the study area.

Friends and mates

Poutsma (1987) observed roe social preferences in a 67ha parkland estate in 1978–83, following three

bucks for five years. He found that winter groups of bucks and does remained within the summer territories of the bucks. He believed that does associating were usually related but there was "continuously aggressive behaviour between adult does", certainly not a feature of the New Forest study. He thought that each buck preferred one particular doe but that nevertheless long-term pair bonds were not favoured by roe deer.

Prior (1995) suggested that roe show "a distinct partiality for the company of this individual rather than that one. . . they are attracted to each other, even outside the rut". I believe that such attraction stems mainly from reassurance resulting from familiarity; but in the summer a doe's instinct to



Buck Z, Brick Kiln, 25 April 1990

advertise the approach of oestrus prevails. So the presence of a winter partner is no disincentive to translocation.

In this study, correlation between winter associations and pairing in the rut varied among individuals. Sometimes doe and buck moved separately to the same area and rutted with their winter companions. Usually the female made the move first, presumably to seek an alternative mate. This was often successful but, where it was not, she accepted her winter companion if he too had moved to the summer location.

Translocation

If the only oscillations were around July and August my inclination, perhaps conditioned by familiarity with other deer species, would have been to relate them to the rut; but some does studied (including Doe A and Doe B reported here) moved also at other times.

While this question could be dismissed as of just academic interest, nevertheless for deer management it seems more important to comprehend, for example, implications of trips and oscillation than to quote precise figures for so-called home ranges.

In any case, scatter charts like those in chapters 3 and 4 may convey more than measurements in hectares or maps depicting straight-sided polygons. Information is even greater when scatter charts can inter-relate the ranging behaviour of different individuals, as in chapter 4, though we have noted that even this needs amplification from detailed observation if it is not to mislead about individual preferences of company, distinct from location.

Apparently conflicting conclusions in scientific literature about distances roe translocate (particularly males and mainly around the unstable exploratory yearling stage) mostly reflect differences in geographical circumstances. Immigration following exceptionally heavy shooting, reported in chapter 1, is likely to have resulted, not from migrations of several kilometres, but from two other phenomena described in chapter 3 and, with individual detail, chapter 4: exploratory trips and oscillation.

In dynamic equilibrium the ratio of roe population to resources can be expected to equalise on each side of the Forest boundary, following lower roe/resource ratios being discovered in trips. Similarly, a deer oscillating

between locations on each side of the boundary can be expected to spend more time where the ratio is lower (i.e. roe even more depleted than their resources), therefore attracting more deer, potentially including sympatric muntjac. Deer drawn into the Forest are not to anticipate increased likelihood of being shot in their new environment, which makes the ratio even more attractive to yet more immigrants.

Interactions

Statements about interaction of roe and stock are often dogmatic. Frequent clichés like “roe and sheep don’t mix” may be countered by “the presumptions that deer do not mix with livestock and that they do not range far are nonsense” (Ward, 2002). The New Forest provides plentiful opportunity to observe inter-specific relations among roe and larger herbivores. Roe, particularly in the rut, appear sometimes teased by fallow or even pony foals.

Occasionally male fallow form brief associations with male roe or red deer but generally the different species ignore each other. Nevertheless the observer is often left with the strong impression that roe, in particular, would prefer the bigger herbivores not to be there, but only because their disturbance interferes with their own monitoring for predators, dogs or other sources of trouble.

Does with kids occasionally challenge the assumption that they are non-territorial: they hint that a conspecific is unwelcome nearby, by deliberate stare with ears pricked forward or with muzzle raised and ears laid back. But otherwise the ‘solitary’ roe sometimes favours companionship of its own species, preferably with an established friend apparently remembered from year to year. This study shows they do so particularly in late winter, paradoxically when competition for forage is greatest.

Zoological explanations of herding usually focus on (a) joint vigilance for predators or

(b) enhancing chances to discover a food source sufficiently abundant locally to be shared. The second seems particularly inappropriate for roe: a selective browser familiar with its own patch has a distinct advantage in keeping its knowledge private. In relation to the first explanation, one could argue there is comfort in having alert and friendly noses, ears and eyes around at the season when feeding must be most intense and single-minded. Does the particularly open habitat in February and March increase the need to enhance vigilance; or does it increase its longer-range effectiveness?

If this report suggests we might have been too dismissive of springtime field-feeding roe as merely sharing a common resource (e.g. Fawcett, 1997), nevertheless the frequent description of winter family groups is scarcely justified. A gathering of buck, doe and kid(s) does not establish the paternity of the offspring – current or future. This study showed also that does with kids were less likely than those without them to associate with bucks.

If randomised, buck-doe associations would occur twice as frequently as homogeneous ones of either sex but, although heterosexual associations were more common in this study, nevertheless buck-buck and doe-doe associations were much more frequent than just the examples detailed in chapter 4. It is scarcely surprising that buck-buck associations were often more edgy, given their weapons and the use to which they were put much of the year. In mixed partnerships, subtle signs suggested the does were the main decision-makers.

Female importance

Human choices of trophy concentrate on male deer, whether it is a head or a photograph we hang on the wall. Authors, editors and publishers lean the same way, my own work being no exception. A talented photographer knew he was unusual when he wrote “I do not go out on a

glorious buck hunt, as I am just as happy watching the does and fawns” (Rouse, 2001) and illustrated his success; but his recognition by judges of the Wildlife Photographer of the Year Competition was for one of his bucks. Many who just watch deer concentrate on males too, partly because they are easier to identify individually. Most watchers are male and it is relevant that the decisive role of females in (non-human!) primate society was understood only when the preponderance of primatologists swung from men to women.

The greater importance of the female in controlling numbers is recognised even for allegedly monogamous roe deer, notwithstanding the sex ratio of people studying them. Thus Donald Chapman (1974) pointed out “It is the fertility and fecundity of the female, rather than the male, that affects the rate of increase and the number of female deer that affects the size of the population. . . it is the proportion of the female fawns that survive from birth until they themselves produce fawns that is relevant, not the proportion of female fawns born. . . The size of the population and its rate of increase is affected by the fertility and fecundity of the female and, in general, not that of the male.”

In applying population dynamics of deer to management or other purposes, one must concentrate on females and calculate separately for males. Yet in 1998 bizarre calculations were deployed in the New Forest to derive a total figure for roe to be shot, after which numbers were allocated casually between the sexes as an unexplained afterthought. That followed computations depending on assumptions (a) that kids as well as adult does gave birth two months after the census and (b) that doe immigration would be greater rather than less if more does were already present. However, most responsible deer managers understand that kid-bearing females hold the key to population control.

Despite look-alikes, deer watchers can often identify males at least throughout a season. By

making reckless assumptions about bucks’ annual replication of antler shape, sometimes they are identified from one year to another. Often one does not need to be reckless, as males more frequently damage their ears in identifiable ways. Females – especially of our two native deer – present greater challenge, which partly accounts for their being studied less. Yet the work reported here indicates that females merit more study than males in contexts not only of population dynamics but of ethological characteristics including social associations and ranging practices.

Immediate examination and comparison of recent camcorder film is an enormous aid to confirming identification but ear tags should be used whenever newborn kids can be found, even though observing their numbers and colours has its own limitations (Blakeley *et al.*, 1997). However, other people may need convincing that you recognise neighbour Joe Bloggs when you see him, even without providing a formal police description. Where you observe individuals frequently, some marks on coats that last only weeks can help continuity of identification: they can be as important for cast bucks as for does. But it is the does we should study more, as the work here on social relations and ranging illustrates.

Kids

Kids as well as does have individuality. Chapter 2 showed that doe kids reared in successive years by the same mother demonstrated contrasting degrees of association with her during their first year. Nevertheless one can generalise that doe kids associated more closely than buck kids with their mothers, possibly enhancing survival. This difference was apparent almost from birth but more conspicuously as a kid approached one year old. While mutual affection was sometimes displayed between doe kids and their mothers until just before the latter gave birth again, buck kids were more intrigued by adult males, whose

company they might seek. In this study there was little evidence of mothers driving their previous year's kids away before giving birth and, at least with bucks, it seemed the kids that chose independence.

A frequent observation, not limited to the reported cases of Doe A and Doe B, was of does in April appearing conspicuously pregnant, even with visible "kicking" familiar to human parents-to-be. The does' shape was regained, significantly without udder development, sometimes early in May. Resorption may occur in New Forest roe when resources are depleted in April: if males were resorbed more readily than females, this would help explain the unusually low ratio here of bucks to does.

Throughout the study, only once was a stillborn found. And only once was there a kid limb, either scavenged or predated, among many items examined at fox earths. Foxes here share low population density and the few in the study area were observed usually taking squirrels and rabbits to their cubs, although previously there had been an historical anecdote of many kid remains at one fox earth in a prolific roe year.

Dogs

Natural predation is slight but in the New Forest domestic dogs create problems difficult to quantify. Anyone spending hours in cryptic wildlife observation at ground level or from a high seat is well placed to witness the frequent and serious intervention by dogs. It seems senseless policy to augment facilities for dog-running visitors in deer-sensitive areas.

However, many guilty dogs are those of New Forest residents, albeit often incomers lacking understanding of wildlife or even of their dogs' behaviour when out of sight. Instances are common like one in April (a month of particular vulnerability for most species) when a rampaging dog first chased a group of fallow, switched to a red hind, and then harassed a roe doe with her kid.

The handlers ignored it despite one of the Forest's too rare "All dogs on leads please" notices. Habitual offenders react with stubborn truculence in places, like Hursthill Inclosure, with such notices and even signs identifying special conservation areas.

Readers of this report will have noted the deaths from dogs, including those of Doe A and Doe D, both exceptionally valuable as research subjects, irrespective of whether a scientist can eschew sentiment in relation to an animal whose good and ill fortunes he has followed for most of a decade. Only a few of such attacks and harassments are recorded and most deer deaths are undetected, particularly of roe and the young of other species.

More harm results less directly. A dog briefly chased Doe D one morning in the year she had twin kids but its owner quickly brought it back to heel, understandably believing harm had been minimal. He should have joined me, unseen while watching her for the next two hours during which she did nothing but patrol alertly in extreme anxiety, neither feeding nor ruminating, a continuous need in this impoverished habitat. If her kids had been among those dying of malnutrition, what responsibility would be accepted for repeated incidents like this?

Putman & Langbein (1999) reported keepers' suggestions that disturbance and killing of kids by dogs might increasingly contribute to decline of roe even where potentially very suitable habitat was available. More dogs exercise in the Forest now than when distinguished veterinarian McDiarmid (1974) pointed out "We must also remember the dogs allowed to run loose in forest areas by ignorant owners – we will never know the precise mortality caused by these animals, particularly in early summer after the young are born, but it must be considerable, and with more and more public access being granted to the countryside this mortality will increase in the future". Fawcett (1999) drew attention also to welfare issues and, noting that regulations that

dogs must be "under control" are unenforceable and a code of conduct would be ineffective, reiterated previous reminders that the only objective criterion of control depended on dogs being on leads.

New Forest managers before 1992 were moving towards a requirement that dogs be on leads, at least in specified seasons and/or places. Now a vociferous well-regimented dog lobby seeks to impose management by decibel but is unrepresentative of responsible owners willing to learn how dogs impinge on wildlife, which properly retains priority over those of us privileged to live here with our pets.

A dog owner most of my life, a former breeder and trainer of gundog and pet breeds, my personal choice was not to replace dogs that died.

Threatened roe deer

Roe deer, whose importance and benefits in the New Forest have been neglected, need urgent conservation here. They have to contend with a habitat with poor forage, massive competition from other herbivores both more numerous and individually far bigger, road traffic accidents of which an average of 26 roe are victims a year, and dogs. The facts reported in chapter 1 need little interpretation to identify the extent to which this exceptional population has suffered from uncomprehending management since 1992, which official data show to be continuing, with words and deeds irreconcilable. New Forest roe deer should be cherished as an essential element of this unique area in which managers are required by the Minister's Mandate to give over-riding priority to its natural heritage.

Conservation and the New Forest's Deer

THE NEW FOREST is intimately linked with its deer, even in public perception. Red deer and European roe are the only species native to Britain. Fallow, however, are by far the most numerous in the New Forest and, although introduced by man, could claim credit for its designation nearly a thousand years ago for hunting them. Sika, imported only a century past, are less welcome in Britain but their preservation on an adjacent stalking estate would thwart removal from the Forest, which in any case could be said to have a museum responsibility for their observation. New Forest sika are thought to be among the genetically purest in Britain but do threaten further hybridisation of the local red deer. It is generally agreed that alien muntjac, reported in the Forest periodically over the past thirty years, should not be tolerated, for reasons additional to their displacing our native roe deer (Chapman *et al*, 1993). Muntjac invasion of the ecological niche our indigenous roe must defend against them is more likely when the natural equilibrium of our native species is disturbed by unreasonable shooting generating a vacuum.

The proper management of each species requires thorough comprehension of their fundamentally different biology, status and population dynamics.

Of the two indigenous species, red deer, unlike roe, hybridise, and in the New Forest they have depended on repeated introductions: the current population, considered genetically impure, is derived mostly from park stock released from pens where I viewed them nearly forty years ago. This may not greatly detract because most of Britain's native mammals – like many valued birds, reptiles and amphibians too – experience periods of local extermination and reintroduction.

The two indigenous deer species and two established introductions are important historically, scientifically, and recreationally for residents and visitors to the Forest. None of the four has greater claim to conservation than the native species-pure European roe.

Status of New Forest roe deer

European roe *Capreolus capreolus* were present in Britain a million years ago. After the last glaciation they were among the mammals soon re-occupying across the continental land bridge and so have been resident continuously for more than nine thousand years (Lister, 1984; Prior, 1995).

In what had become designated the New Forest, man interrupted this continuity with a hiatus of under 300 years but there is no doubt of the species-purity of the roe that re-colonised.

In contrast to prolific roe deer populations elsewhere, here pressure on the species is intense, not only from stock and other deer competing for meagre forage, but from all kinds of public disturbance. Even when the population was about twice its current level, density was only a fifth of the norm for southern English woodland, including that managed by the Forestry Commission. Productivity is under half the norm.

As noted in chapter 5, in the New Forest, roe have to contend with a habitat with poor resources, massive competition from other herbivores both more numerous and individually far bigger, road traffic accidents of which an average of 26 roe are victims each year, proliferating loose dogs and, since 1992, shooting that rocketed even just recorded doe mortality to up to half the spring census. They should be

cherished as an essential element of this area designated by the Minister's Mandate to give over-riding priority to its natural heritage. Their importance and benefits to the New Forest have been neglected and their need for conservation is urgent.

Conservation

Maroo and Yalden (2000) published estimates of mammalian populations in Britain 7000 years ago, following post-glacial re-occupation. Since then, roe deer are believed to have decreased from over 800 000 to 500 000, man to have increased from 2500 to over 43 000 000, and his domestic animals from a negligible number to 26 000 000. It tells us much about ourselves that it is roe deer, numbering only 1% of our species, that have been described as having a population explosion.

Nevertheless, nationally roe deer are surviving massive human competition far better than much wildlife now properly given conservation protection.

But the New Forest is frequently and correctly recognised as a very special place. The inapplicability to it of many generalisations extends particularly to roe deer, whose management requires ability in fresh and flexible thinking, not prejudice.

Although commercial forestry is now only a minor function of the New Forest, browsing and fraying damage may nevertheless sometimes suggest, as in the 1970s and 1980s, shooting individual deer in specific circumstances. Critical verification is essential, however, because sometimes misdiagnosis of damage attributed to roe (e.g. fresh fraying in February, and over a metre above ground) has been ludicrous. Even when roe have been genuinely

responsible in a limited area, concern has been allayed by inspection of the plantation ten years later, emphasising the lesson in forestry that what is important is not the number of young trees damaged (or even lost through poor husbandry), but the number surviving. But forestry is now subordinated, under the Minister's Mandate for management of the New Forest, to wildlife conservation and public amenity, requiring sufficient deer to enable residents and visitors to observe each species. There is not now reasonable opportunity in the case of roe.

Ministerial instructions to give conservation top priority take account of a species' local as well as national status. Roe are unique among British deer in being species-pure natives, thus fulfilling two key criteria for conservation. In turn, the New Forest seems unique in Britain in having a roe deer population regulating without intervention, as demonstrated by the Forestry Commission's good management in the 1970s and 1980s, at a density trivial in comparison with that of other southern woodland managed by the Commission. Unplanned mortality (some



Doe A, Hursthill Inclosure, 24 February 1991

25% annually) is exceptionally great here and productivity exceptionally low (the kid/doe ratio being under half the norm for southern England). Conservation of this indigenous species surviving at low density should be high on management's agenda.

Deer and larger herbivores

Even some who recognise commoners' stock as "architects of the New Forest", controlling invasive trees and scrub, find nothing incompatible in denigrating deer as ecologically inimical for their minor contribution. Unlike stock, deer lack a powerful lobby or even one concerned to represent all wildlife alongside ponies and cattle. Not only is the ecological contribution of deer to maintaining the forest profile unappreciated but so too is their amenity value, except where it can be exploited for public relations.

Ponies and roe deer both graze and browse. Differences of emphasis between grazing and browsing are overwhelmed in the New Forest by a biomass of ponies two hundred times greater than that of roe deer. In comparison, the ecological impact of roe is minimal. 'Selective feeding' is misinterpreted sometimes as if roe could afford to devote time to seeking botanical rarities among the limited forage available. Similarly it is overlooked that ponies, simply because they are unselective mowing machines requiring to bulk feed (Putman & Langbein, 1999), remove just as much precious flora as roe alleged to indulge in the luxury of searching.

Several influences inhibit assimilation of the relative "contributions"/"impact" (depending on whether it suits to depict as good or bad) of commoners' stock and the much fewer and very much smaller mass of deer.

Within the Forestry Commission inclosures there should be a light foraging regime determined by the relatively delicate impact of deer without the intrusion of the larger stock

animals. Since 1970, however, stock have not been excluded effectively from the inclosures and periodically renewed management declarations of intent have been followed by only limited success. Chapter 1 explained that roe took only 1% of just the non-graminoid offtake (and much less of the grasses) eaten by invading ponies in central inclosures throughout most of the 1990s, and still only a tiny percentage when ponies were reduced in 1997 to 27% of previous numbers. Compared with consistent exclusion of stock in accordance with the inclosures' purpose, there would be trifling effect on forage offtake if half the deer of all species were shot – a reduction greater than even managers most prejudiced against deer have postulated publicly.

Ecological management and diversity

Sadly the ecological importance of the forestry inclosures is still insufficiently recognised. The facts were demonstrated in the comprehensive analysis by the Forest's distinguished ecologist, Colin Tubbs (1986). His latest paper published posthumously (Tubbs, 1997) updated the responsibility since 1969 of ponies in inclosures, not deer, for removing shrubs and climbers and reducing rides to bald close-bitten turf: he demonstrated how entry of stock after 1969 removed nectar sources and food plants so that butterflies and moths declined alarmingly. Management propagandists in the mid-1990s misrepresented the facts but Tubbs' work should have been adequate evidence for those with the motivation to read and the comprehension to assimilate. It should be superfluous also to invoke other data collated for different purposes, such as Sharma's thesis, *The decline of the Roe Deer in the New Forest, Hampshire*, and chapter 1 of this report.

The assumption by management in the mid-1990s that inclosures were exclusively for

commercial forestry has been replaced by assumptions that they should be either (a) thrown open for additional heathland at the expense of woodland, or (b) exploited for recreation.

Assumption (a) is promoted with great enthusiasm because it is in fashion and can be "sold" to the public more readily than wetland restoration, for which the ecological case in the New Forest is far stronger. The consequent loss of potentially stock-excluded woodland is regrettable, as illustrated in studies of invertebrate ecology, for example by Pinchen and Ward (2002) reporting that all modern records of New Forest cicada come from largely ungrazed forestry inclosures. "Recent proposals for the 'improvement' of the New Forest have included removing a number of forestry Inclosure fences. The resulting loss of lightly grazed scrub . . . needs more conservation attention, as this will have a further negative effect on the cicada and on many other invertebrates in the New Forest." In contrast to where stock had access, they found in an eight-week experiment that no pre-emergence



Buck P, Hursthill Inclosure, 4 September 1996

turrets were damaged in a forestry inclosure where only deer had free entry. Pinchen (2000) had already pointed out Tubbs' (1986) observation that some 50% of the New Forest area is already open whereas inclosures occupy only some 25%.

Assumption (b) increases disturbance, emphasising the illogicality of, for example, encouraging tourist wagon rides round an inclosure specifically and justifiably designated and signposted as a "Conservation Area".

Of course, promoting the case for preserving inclosures specifically as a stock-free habitat leads to accusations of seeking a haven for deer. But that habitat has great importance for rare flora, insectivora (particularly lepidoptera) and, because of ground cover not available in the open forest, small mammals and the raptors and other predators depending on them. Indeed, despite a minority of obvious exceptions, it is in the interest of most invertebrate (Pinchen, 2000) and vertebrate fauna for inclosures to be retained (and improved) instead of thrown open just to add to the grazed heathland, particularly bearing in mind that a 10% "gain" represents a 20% loss of inclosure habitat.

Roe Deer Management: some general principles

Roe are a species particularly adaptable in adjusting their own populations. In favourable situations they proliferate because, exceptionally for deer in Britain, outwith the New Forest they habitually have twins. In unfavourable conditions like those in the Forest they adapt by reducing productivity and population.

Sensible deer management is impossible unless based on knowledge of population dynamics, a subject applied in depth to New Forest roe in chapter 1. But management is handicapped without also understanding deer biology, including ethological characteristics like those reported on social relations and ranging habits among roe at different seasons, described in chapters 2, 3 and 4.

Over thirty years ago, when employed by the Forestry Commission to manage deer, Richard Prior wrote *“The obvious does not always apply in questions of animal behaviour, and ill-conceived attempts at control which are not based on a general understanding of the behaviour and population dynamics of roe often prove expensive and ineffective”* (Prior, 1968).

Contrasts in management

When official New Forest roe deer censuses became reasonably reliable, around 1969–70, numbers were about 600. The population fell (Insley, 1979) when annual culling was under 20% and continued to fall when reduced in the 1970s and 1980s even below 5%.

Numbers had declined naturally to around 300 for a decade when, from 1992, numerical doe “culls” were introduced arbitrarily, shooting 15–40% of the census every year instead of a maximum of 5%, so that total recorded mortality rocketed to 50%. The onslaught on the sparse roe population depleted the middle of the Forest but failed to reduce total numbers

correspondingly; instead it destabilised the resident deer and created a vacuum drawing in many does from the prolific surroundings, as reported in chapter 1.

The disparity between falling numbers following negligible culling in the 1970s and 1980s, and the failure of excessive shooting in the 1990s to effect commensurate reduction is a consequence of population changes in the neighbouring countryside. Carne’s (2000) description of the Hampshire scenario a half century ago when “most parts of the county outside the New Forest were virtually devoid of roe” remained substantially applicable in 1970. He went on to report the complete reversal now “the New Forest’s roe population represents only a fraction of that in Hampshire as a whole”. This inversion of the relationship of densities inside and outside the boundary explains the contrast in population response, decreasing far more with negligible culling than with excessive slaughter.

1995 and 1998 recommendations

Where there is a simple balance between a species and its resources, reduction in numbers is expected to lead to those retained being better nourished and reproducing more prolifically. This principle is applicable to roe deer in most situations. In contrast, because roe resources in the New Forest continue to be removed by other herbivores present in much greater numbers and bulk, thus submerging differences in dietary emphasis, shooting roe has no beneficial effect on their survivors. This was explained in January 1995 in a quinquennial report to the Forestry Commission on the New Forest’s roe deer population dynamics (Fawcett, 1995).

That report to the Forestry Commission after

it abandoned in the 1990s its sensitive culling practice of the 1970s and 1980s had included “Practical Considerations” with discreet recommendations to assist management. It had proposed avoidance of errors from misclassification of kids/yearlings and from failure to standardise dates for the census across different beats. With the Commission’s own evidence that the local population regulated, without intervention, at a density a fraction of that generally in southern woodland, the report noted that shooting “is not justified for population control”, as distinct from limited selective culling for specified other reasons.

That report and an update (Fawcett, 1998b) recommended that there should be a presumption against culling where population densities, kid numbers or kid/doe ratios were low. Culling should be considered where substantial damage was attributable unequivocally to identified roe and would be remedied by their removal; but such consideration should be based on realistic estimation of damage and any eventual economic consequences, as well as on the tolerance to be exercised because of objectives different in the New Forest from those of commercial forestry elsewhere. The 1995 report concluded that, because of high natural mortality, beat keepers should make any decisions on culling, subject to management review, as close as possible to the time of implementation, taking account of numbers of adults and kids then surviving.

In 1998 an unpublished Forestry Commission brief with limited circulation anticipated a changed aim, “to maintain the maximum number of fallow, red and roe deer consistent with the other objectives”, apparently to conform to government policy that conservation was to have first priority in the New Forest, public amenity second and forestry third. Fawcett (1998b, 1999) pointed out that, to fulfil management’s conservation responsibilities, the

health of the species in the New Forest necessitated a spring census never below 300 roe, still representing a density only one-tenth of that reported by the Commission to be the norm in southern managed woodland. To fulfil amenity requirements, residents and visitors should be able to observe roe, as well as other deer, reasonably readily. Individuals might need to be culled selectively for specific reasons but a numerical cull, based on a percentage of the spring census, was unnecessary and improper for this species in this location.

Management in practice

The enormous increase in shooting does in the 1990s not only was wrong but failed to commensurately reduce the population, particularly near the periphery of the Forest. Even without taking into account the exceptionally low production of kids here, it requires no mathematical skill to recognise that this failure can be explained only by massive immigration. The calculations in chapter 1 are merely an attempt to quantify what is obvious qualitatively: great precision is neither claimed nor necessary to demonstrate the general picture of events.

The Forestry Commission’s contribution to roe deer research was unintended. Application of disparate practices to bucks and does could scarcely have been better designed for controlled scientific experiment. As detailed in chapter 1, the Commission applied to does such excessive shooting (28–72 annually over nine years) that total recorded mortality soared to 50% of the spring census. It was obvious that this would have been unsustainable even for roe of average productivity and that the Forest population must either approach extermination or depend on enormous immigration. In contrast, until 2000 the annual number of bucks shot exceeded the negligible range 0–2 only twice, thus providing a fortuitous control group.

As bucks are well known to move more

readily and further than does, their insignificant net migration here corroborated that the simultaneous large immigration of does correlated just with heavy shooting. What management achieved by its blitz on does was depletion of roe near the centre of the Forest and huge disturbance near the boundary (with predictable hazards to forestry as well as deer management), sucking in scores from adjacent estates so that the partial replacement of the Forest's depleted does was as much by immigration as by the fewer Forest-bred kids the surviving does could rear. All this was deplorable in terms of roe biology, management and forestry practice. Furthermore, pulling in animals to replace excessive numbers of shot residents could have catastrophic consequences from spread of disease among wildlife and the thousands of free-roaming commoners' stock, as might have materialised disastrously if the foot-and-mouth epidemic had neared the Forest.

Numbers of roe does shot annually escalated from below 10 throughout many years before 1992 to a mean of 37, rising in 1996 to 72. For eight years the Forestry Commission imposed total doe recorded mortality of 27–51% of the previous spring census, reducing the adult doe population almost to 100, which could produce annually only some 80 surviving offspring of both sexes.

Following local criticism of deer management generally, the Commission contracted with consultants away from the New Forest to collate a detailed report and recommendations on managing deer here, which required little interpretation to recognise recent policies were discredited. Yet managers still failed to return to their predecessors' successful practices for roe in previous decades, when less than ten were shot annually – after establishing the unavoidable need in each case, a requirement the consultants said should be restored.

A report on roe deer ethology is not the best place for an account of human behaviour,

fascinating though that is, but well-documented examples of conspicuous biological (and biomathematical) incomprehension, mismanagement and broken promises are available. Personal experience in relation to roe is paralleled by that of specialists in other deer species suffering similar frustration in seeking the application of knowledge and reason, including Stephen Smith, expert on the New Forest's sika and fallow deer (Smith, 1984; Smith, 1995; Smith, 1996). Scientific study is concerned with what happens in practice, not with declarations. So we learnt to disregard what was said, other than what had to be revealed retrospectively as facts and figures about what was done.

The Commission's 2001–02 data for roe deer show that the number shot (41) was the sixth highest for nearly thirty years, with bucks shot (10) and total recorded buck deaths (26) the second highest. Combining both sexes, shooting and other recorded mortality amounted to 76. The Commission's own formula – with which, based on different reasoning, Fawcett (1998b) and Putman & Langbein (1999) both agreed – adds some 55–60 unrecorded deaths, making 130–135 in total. It reported only 84 kids of both sexes born in 2001 surviving to age 10 months (beyond which we have found still substantial losses). Not surprisingly, the Commission's figures show that the roe population, which had been expected to rise substantially, fell by 12%.

The scale of continued shooting, in senseless conflict with all the damning evidence and the strong recommendations of experts, including those whom the Commission paid to advise, leads to an assessment of management deeds, distinct from words, on which readers can make their own judgements.

Recent staff appointments raise the possibility of greater regard for knowledge and reason.

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About Mammals Trust UK

Mammals Trust UK is a dynamic new charitable organisation set up to highlight the many problems British mammals face, and to take really effective action to solve them. We seek to fund both the basic scientific research required and the practical work that can make all the difference, including habitat enhancement and the breeding and reintroduction of animals whose numbers are so low that they can no longer breed themselves out of trouble. We have brought together voluntary organisations, government agencies and eminent scientists to form an Advisory Group, which carefully considers the allocation of funds twice a year.

We purchase reserves to ensure their long-term protection and for educational purposes. Each year we offer our supporters opportunities to observe and enjoy native mammals in their natural habitats and to meet the scientists and others at work. We are taking an active role in helping to set up national monitoring schemes for all British mammals and encouraging everyone to collect relevant information by joining in innovative, exciting surveys. Our lively conferences and publications help spread the word and provide practical, useful advice.

About the Author

John Fawcett developed natural history enthusiasm as a boy in the early 1940s. An initial scientific career, with a score of research papers published by 1962 in eminent and discriminating scientific journals, led to his appointment as chief executive of a large national scientific institute. Soon after, he joined the Mammal Society and, a year after its inauguration, the British Deer Society. To relate zoological knowledge to public interest, in the 1970s he contributed features to such publications as *Country Life* and, under its earlier titles, *BBC Wildlife*.

Retirement in 1988 enabled the equivalent of half time employment to be devoted to applying earlier professional research experience to mammalian interests, but now unremunerated. Though publications had associated the author more with badgers, foxes and red and fallow deer, roe had always been his favourite, studied in agricultural Surrey, highland Scotland and, whenever possible throughout half a century, New Forest woodlands. That was where he and his wife each planted one foot in 1952 and both feet by 1989 as residents of Brockenhurst.

About this Book

In 1997 the author was commissioned by the Mammal Society and the British Deer Society to write a monograph on *Roe Deer* for naturalists and diverse other readers. Copies are obtainable from the Mammal Society www.mammal.org.uk, price £3.50. While the subject matter of *New Forest Roe Deer* is specialised, in location as well as species, it is a logical extension of that more generalised study of roe deer.