A DEMOGRAPHIC AND EPIDEMIOLOGICAL STUDY OF THE EQUINE POPULATION OF SCOTLAND AND NORTHERN ENGLAND

by

Dominic J. Mellor BVMS MRCVS

Thesis submitted for the Degree of Doctor of Philosophy in the Faculty of Veterinary Medicine, University of Glasgow.

Veterinary Informatics and Epidemiology
Department of Veterinary Clinical Studies
University of Glasgow.

May 1997

This thesis is dedicated to my family and friends.

ABSTRACT

The aim of this study was to estimate the total size, composition and geographical distribution of the equine population of Scotland and Northern England, and to record information on the management, level of activity and disease prevalence of this population in order to make recommendations for the prioritisation of future research in equine health and welfare.

The study was conducted by means of a series of four mailed questionnaire surveys of a specifically recruited network of sentinel first opinion veterinary practices, recording data from both veterinary surgeons and also horse owners registered with the practices. Both group data, at the level of the veterinary practice or of the holding where horses were kept, and individual animal data were recorded. Extensive use was made of proprietary computer word processing, database, spreadsheet and Geographical Information System (GIS) software in the production of questionnaires and survey materials and in the storage, collation, analysis and presentation of survey data.

The total size of the equine population of Scotland and Northern England was estimated to be 96,622 animals kept by 26,114 horse owners. The mean ± SD age of the population was 11.0 ± 7.5 years with 50% of animals male and 50% female. Thoroughbred or Thoroughbred cross were the commonest breeds comprising 30% of the total population. Overall 50% of owners kept their horses on private premises and 50% kept them on shared premises. Despite the large proportion of animals kept on private premises, animals from all types of premises mixed at shows or competitions approximately once a month. In terms of management, 69% of horses grazed for at least half of their time with 10% always grazed. Twenty nine per cent of horses were stabled for most of the time and a further 2% were permanently stabled and never grazed. Rates of vaccination and worming of horses reported by horse owners fell below recommended rates. The most popular equestrian activity was hacking, involving 24% of horses kept by respondent owners, closely followed by breeding and riding/pony club events involving 20% and 18% of horses respectively. Endurance riding and point-to-point appeared to be the least popular activities, each involving only 2% of horses kept by respondent owners. The top five categories of equine disease problem diagnosed, in descending order were: musculoskeletal, minor injuries, dermatological, gastrointestinal and respiratory, though the most common reason for veterinary attention to a horse was for a routine procedure such as vaccination. A Geographical Information System, holding all data generated by the study linked to maps of the study area, was created to allow intuitive interrogation of information relating to equine welfare. In addition, this system has the potential to become a powerful management tool for contingency planning in the face of new diseases.

It was concluded that sentinel practice based research provided a successful means of gathering demographic and epidemiological information about populations of animals at the macro level. The findings of the study suggested that future research should focus on: musculoskeletal disease, in particular laminitis and joint, tendon and ligament problems; gastrointestinal disease, particularly colic, and especially in eastern areas; dermatological disease and respiratory disease, particularly COPD and upper respiratory tract infections especially in the central areas where a greater proportion of horses are kept in shared premises. Timely dissemination of information generated by this and other studies, in an intuitive manner, was considered to be of paramount importance to ensure maximum impact by improving animal health and welfare.

LIST OF CONTENTS

	PAGE
ABSTRACT	**1**
LIST OF CONTENTS	**2**
LIST OF TABLES	**9**
LIST OF FIGURES	**16**
ACKNOWLEDGEMENTS	**19**
AUTHOR'S DECLARATAION	**21**
LIST OF ACRONYMS	**22**
CHAPTER 1: INTRODUCTION AND REVIEW OF THE LITERATURE	**23**
1.1. GENERAL INTRODUCTION	**23**
1.2. HISTORICAL INFLUENCES ON THE NATURE AND SIZE OF THE BRITISH EQUINE POPULATION	**24**
1.2.1. Introduction	**24**
1.2.2. Earliest Records	**25**
1.2.3. Early Britain	**25**
1.2.4. The Middle Ages	**26**
1.2.5. The Early Modern Period	**28**
1.2.6. Ministry of Agriculture Records	**31**
1.2.7. Agricultural Atlases	**37**
1.2.8. Studies in Foreign Countries	**38**
1.3. RECORDS OF EQUINE DISEASE	**39**
1.4. DEMOGRAPHY, CENSUS AND EPIDEMIOLOGY	**41**
1.4.1. Demography and Census Taking	**41**
1.4.2. Epidemiology	**43**
1.4.2.1. Cohort studies	**44**
1.4.2.2. Case-control studies	**45**
1.4.2.3. Cross-sectional studies	**45**
1.5. QUESTIONNAIRE SURVEYS	**46**
1.5.1. Mailed Questionnaire Study Design	**47**
1.6. SAMPLING	**48**

1.7. PRACTICE-BASED RESEARCH NETWORKS 49

1.8. GEOGRAPHICAL INFORMATION SYSTEMS 52

1.9. INTEGRATED SYSTEMS FOR INFORMATION DELIVERY 55

1.10. SUMMARY 57

CHAPTER 2: GENERAL MATERIALS AND METHODS 59

2.1. INTRODUCTION 59

2.2. THE HOME OF REST FOR HORSES STUDY OF EQUINE WELFARE 61

2.2.1. The Home of Rest for Horses 61
2.2.2. General Study Design 62
2.2.3. Recruitment of Veterinary Practices 64

2.3. HARDWARE AND SOFTWARE 64

2.4. GENERAL QUESTIONNAIRE DESIGN AND IMPLEMENTATION 67

2.4.1. Introduction 67
2.4.2. Format 67
2.4.3. Questions 69
2.4.4. Accompanying Letters 69
2.4.5. Mailing 70

2.5. DATABASE DESIGN 71

2.6. STATISTICAL METHODS 72

2.7. MAPPING 73

CHAPTER 3: FIRST SURVEY OF VETERINARY PRACTICES 75

3.1. INTRODUCTION 75

3.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION 76

3.2.1. Considerations 76
3.2.2. Questionnaire Design 76
3.2.3. The Accompanying Letter 79
3.2.4. Implementation 79
3.2.5. Data Storage and Analysis 80

3.3. RESULTS - PHASE Ia SURVEY OF VETERINARY PRACTICES	**81**
3.3.1. Response	**81**
3.3.2. Survey Data	**81**
3.4. PHASE Ib SURVEY OF ALL VETERINARY PRACTICES	**90**
3.4.1. Introduction	**90**
3.4.2. The Study Population	**91**
3.4.3. Questionnaire Design	**91**
3.4.4. Implementation	**92**
3.4.5. Data Storage and Analysis	**92**
3.5. RESULTS - PHASE Ib SURVEY OF ALL VETERINARY PRACTICES	**92**
3.5.1. Response	**92**
3.5.2. Survey Data	**93**
3.6. SUMMARY OF RESULTS FROM PHASES Ia AND Ib	**95**
3.7. DISCUSSION	**99**
3.7.1. Response	**99**
3.7.2. Population	**99**
3.7.3. Disease and Health Maintenance	**99**
3.7.4. Conclusions	**100**
CHAPTER 4: PHASE II SURVEY OF HORSE OWNERS	**101**
4.1. INTRODUCTION	**101**
4.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION	**103**
4.2.1. Considerations	**103**
4.2.2. Questionnaire Design	**104**
4.2.3. The Accompanying Letter	**107**
4.2.4. Implementation	**107**
4.2.5. Data Storage and Analysis	**110**
4.2.5.1. Data reliability	**111**
4.2.5.2. Geocoding	**111**
4.3. RESULTS	**112**
4.3.1. Response	**112**
4.3.2. Survey Data	**116**
4.3.3. Analyses	**125**
4.3.4. Summary	**126**
4.4. DISCUSSION AND COMPARISON WITH PREVIOUS PHASES OF THE STUDY	**133**
4.4.1. Response	**133**
4.4.2. Population	**135**

4.4.3. Conclusions 139

CHAPTER 5: PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES 140

5.1. INTRODUCTION 140

5.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION 141
5.2.1. Considerations 141
5.2.2. Recruitment 142
5.2.3. Questionnaire Design 143
5.2.4. The Accompanying Letter 146
5.2.5. Implementation 146
5.2.6. Data Storage and Analysis 147

5.3. RESULTS 149
5.3.1. Response 149
5.3.2. Survey Data 150
5.3.2.1. Demographic data 150
5.3.2.2. Disease data 153
5.3.2.2.1. Routine cases 156
5.3.2.2.2. Musculoskeletal cases 158
5.3.2.2.3. Injuries 160
5.3.2.2.4. Dermatological cases 160
5.3.2.2.5. Gastrointestinal cases 161
5.3.2.2.6. Respiratory cases 163
5.3.2.2.7. Reproductive cases 164
5.3.2.2.8. Metabolic cases 165
5.3.2.2.9. Neoplastic cases 166
5.3.2.2.10. Miscellaneous cases 166
5.3.2.2.11. No abnormality detected 168
5.3.3. Summary 168

5.4. DISCUSSION AND COMPARISON WITH PREVIOUS PHASES OF THE STUDY 173
5.4.1. Response 173
5.4.2. Diseases - Phase Ia and Phase III 174
5.4.3. Diseases - Phase III and Other Studies 175
5.4.4. Conclusions 176

CHAPTER 6: PHASE IV IN DEPTH SURVEY OF HORSE OWNERS 178

6.1. INTRODUCTION 178

6.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION 179
6.2.1. Considerations 179
6.2.2. The Study Population 180

6.2.3. Questionnaire Design 184
6.2.4. The Accompanying Letter 186
6.2.5. Implementation 186
6.2.6. Data Storage and Analysis 187

6.3. RESULTS 189
6.3.1. Response 189
6.3.2. Survey Data 191
6.3.2.1. Questionnaire data 191
6.3.2.2. Fact sheet data 196
6.3.2.2.1. Demographic data 196
6.3.2.2.2. Grazing and stabling 201
6.3.2.2.3. Feeding details 204
6.3.2.2.4. Activity grouping data 207
6.3.2.2.5. Health maintenance data 208
6.3.2.2.5. Insurance data 214
6.3.3. Summary 214

6.4. DISCUSSION AND COMPARISON WITH PREVIOUS PHASES OF THE STUDY 215
6.4.1. Response 215
6.4.2. Population 219
6.4.3. Health Maintenance 219
6.4.4. Disease 220
6.4.5. Conclusions 222

CHAPTER 7: CONCLUSIONS AND GENERAL DISCUSSION 223

APPENDIX 1: INITIAL CONTACT LETTER TO VETERINARY PRACTICES 232

APPENDIX 2: PHASE Ia SURVEY OF VETERINARY PRACTICES - ACCOMPANYING LETTER 233

APPENDIX 3: PHASE Ia SURVEY OF VETERINARY PRACTICES - QUESTIONNAIRE 235

APPENDIX 4: A SURVEY OF CHARGES FOR VETERINARY SERVICES - QUESTIONNAIRE 236

APPENDIX 5: PHASE Ia SURVEY OF VETERINARY PRACTICES - DATA ENTRY FORM 237

APPENDIX 6: PHASE Ib SURVEY OF ALL VETERINARY PRACTICES - LETTER / QUESTIONNAIRE 238

APPENDIX 7:	PHASE Ib SURVEY OF ALL VETERINARY PRACTICES - DATA ENTRY FORM	239
APPENDIX 8:	PHASE II SURVEY OF HORSE OWNERS - ACCOMPANYING LETTER	240
APPENDIX 9:	PHASE II SURVEY OF HORSE OWNERS - QUESTIONNAIRE	241
APPENDIX 10:	PHASE II SURVEY OF HORSE OWNERS - DATA ENTRY FORM	242
APPENDIX 11:	PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - INITIAL CONTACT LETTER	243
APPENDIX 12:	SUMMARY REPORT OF RESULTS OF PHASE Ia FOR VETERINARY PRACTICES	244
APPENDIX 13:	PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - ACCOMPANYING LETTER	245
APPENDIX 14:	PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - CASE SHEET	246
APPENDIX 15:	PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - REMINDER LETTER	247
APPENDIX 16:	PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - DATA ENTRY FORM	248
APPENDIX 17:	PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - ACCOMPANYING LETTER	249
APPENDIX 18:	PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - QUESTIONNAIRE	250
APPENDIX 19:	PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - FACT SHEET	251
APPENDIX 20:	PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - QUESTIONNAIRE DATA ENTRY FORM	252
APPENDIX 21:	PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - FACT SHEET DATA ENTRY FORM	253

APPENDIX 22: **PHASE II SURVEY OF HORSE OWNERS - SUMMARY STATISTICS BY PRACTICE AFFILIATION** **254**

APPENDIX 23: **PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - SUMMARY STATISTICS BY PRACTICE AFFILIATION** **263**

APPENDIX 24: **PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - SUMMARY STATISTICS BY ACTIVITY GROUPING** **272**

APPENDIX 25: **LIST OF SUPPLIERS** **279**

REFERENCES **280**

LIST OF TABLES

		PAGE
Table 1.	Estimated numbers of horses imported to and home-bred horses exported from Britain in sample years (from Chivers, 1983).	**30**
Table 2.	Estimated numbers of horses (x 10^3) in the UK in the 19^{th} and early 20^{th} Centuries (Thomson, 1983).	**31**
Table 3.	Annual returns for numbers of horses (x 10^3) kept in Great Britain for selected years between 1880 and 1965 (Ministry of Agriculture Fisheries and Food & Department of Agriculture and Fisheries for Scotland, 1968).	**32**
Table 4.	1994 returns for horses kept in England and Wales (Ministry of Agriculture Fisheries and Food, 1996).	**33**
Table 5.	Agricultural returns for horses kept in Scotland for 1991 - 1995 (The Scottish Office Agriculture, Environment and Fisheries Department, 1996a).	**34**
Table 6.	Results of the British Horse Society survey of horse numbers in Scotland in the early 1990s (British Horse Society, 1996).	**36**
Table 7.	Numbers of horses imported to and exported from Britain 1988-1995 (Ministry of Agriculture Fisheries and Food, The Scottish Office Agriculture, Environment and Fisheries Department and Welsh Office Agricultural Department, 1991-1995).	**37**
Table 8.	Equine population distribution by region in Scotland 1870 (Coppock, 1976b).	**37**
Table 9.	Summary results from the 'Equus' survey of horse owners' opinions of the most important equine diseases (Underhill and Showalter, 1989).	**40**
Table 10.	The top five adult equine medical problems as ranked by members of the American Association of Equine Practitioners (Traub-Dargatz *et al.*, 1991).	**41**
Table 11.	The commonest diseases affecting different body systems as specified by members of the American Association of Equine Practitioners (Traub-Dargatz *et al.*, 1991).	**41**
Table 12.	Effects of inclusion of different types of return envelope on mailed survey response rates (Choi *et al.*, 1990).	**47**

Table 13.	UK situation pertaining to the exotic equine diseases in 1994 (Ministry of Agriculture Fisheries and Food, Scottish Office Agriculture, Environment and Fisheries Department, Welsh Office Agricultural Department 1995).	**60**
Table 14 a.	Phase Ia Survey of veterinary practices - results.	**82**
Table 14 b.	Phase Ia Survey of veterinary practices - the frequency with which diagnoses are made within disease categories.	**83**
Table 14 c.	Phase Ia Survey of veterinary practices - the most important equine diseases encountered in each practice.	**84**
Table 15.	Phase Ia Survey of veterinary practices - descriptive statistics of results.	**85**
Table 16.	Phase Ia Survey of veterinary practices - descriptive statistics of results.	**86**
Table 17.	Phase Ia Survey of veterinary practices - summary of responses to question 7.	**87**
Table 18.	Phase Ia Survey of veterinary Practices - frequency of diagnosis of categories of disease.	**89**
Table 19.	Phase Ia Survey of Veterinary Practices - the most important with regard to equine welfare.	**90**
Table 20.	Phase Ib Survey of all veterinary practices - response rates to the original mailing and the two follow-up mailings.	**93**
Table 21.	Phase Ib Survey of all veterinary practices - summary statistics of responses to the questionnaire.	**93**
Table 22.	Summary statistics of the combined results of phases Ia and Ib.	**94**
Table 23.	Phase II Survey of horse owners - summary of implementation.	**109**
Table 24.	Phase II Survey of horse owners - summary of the response grouped by practice affiliation.	**113**
Table 25.	Phase II Survey of horse owners - equine population change over time among repeat responders.	**114**
Table 26.	Phase II Survey of horse owners - numbers, percentage and response rate by practice affiliation of respondents using their own stamps on FREEPOST return envelopes.	**115**

Table 27.	Phase II Survey of horse owners - effects of different types of return envelopes on response rate and on the percentage of respondents using their own stamps on FREEPOST return envelopes.	**116**
Table 28.	Phase II Survey of horse owners - responses by practice affiliation - premises.	**117**
Table 29.	Phase II Survey of horse owners - responses by practice affiliation - management.	**118**
Table 30 a.	Phase II Survey of horse owners - responses by practice affiliation - activities.	**119**
Table 30 b.	Phase II Survey of horse owners - responses by practice affiliation - activities (continued).	**120**
Table 30 c.	Phase II Survey of horse owners - responses by practice affiliation - activities (continued).	**121**
Table 31.	Phase II Survey of horse owners - premises.	**122**
Table 32.	Phase II Survey of horse owners - management.	**123**
Table 33.	Phase II Survey of horse owners - activities.	**124**
Table 34.	Phase II Survey of horse owners - summary statistics (2,632 owners, 9,830 animals).	**125**
Table 35.	Phase II Survey of horse owners - numbers of animals kept.	**126**
Table 36.	Comparison of population data from phases Ia and II from The Home of Rest for Horses Study of Equine Welfare.	**136**
Table 37.	Corrected figures, by region, for the number of horse owners and horses in Scotland and Northern England.	**137**
Table 38.	Phase III Cross-sectional case study of veterinary practices - details of response to each mailing of case sheets.	**151**
Table 39.	Phase III Cross-sectional case study of veterinary practices - distribution of breed or type of animal seen.	**152**
Table 40.	Phase III Cross-sectional case study of veterinary practices - distribution of gender of animal seen.	**153**
Table 41.	Phase III Cross-sectional case study of veterinary practices - distribution of coat colour of animal seen.	**153**

Table 42.	Phase III Cross-sectional case study of veterinary practices - percentage of cases seen in each category summarised for the whole year and broken down by season of the year.	**154**
Table 43.	Phase III Cross-sectional case study of veterinary practices - percentage of cases seen in each category summarised by veterinary practice.	**155**
Table 44.	Phase III Cross-sectional case study of veterinary practices - the reasons for routine consultation.	**156**
Table 45.	Phase III Cross-sectional case study of veterinary practices - musculoskeletal conditions.	**158**
Table 46.	Phase III Cross-sectional case study of veterinary practices - dermatological conditions.	**161**
Table 47.	Phase III Cross-sectional case study of veterinary practices - gastrointestinal conditions.	**162**
Table 48.	Phase III Cross-sectional case study of veterinary practices - respiratory conditions.	**163**
Table 49.	Phase III Cross-sectional case study of veterinary practices - reproductive conditions.	**165**
Table 50.	Phase III Cross-sectional case study of veterinary practices - metabolic conditions.	**165**
Table 51.	Phase III Cross-sectional case study of veterinary practices - miscellaneous conditions.	**167**
Table 52.	Phase III Cross-sectional case study of veterinary practices - percentage of cases seen in each category excluding routine consultations and those in which no abnormal clinical findings were made.	**169**
Table 53.	Comparison of the ranking of the disease categories between phases Ia and III of The Home of Rest for Horses Study of Equine Welfare.	**175**
Table 54.	Phase III Cross-sectional case study of veterinary practices - ranking of individual diseases diagnosed.	**176**
Table 55.	Comparison of the percentage composition of the respondents to phase II and the sample of owners surveyed in phase VI in terms of practice affiliation.	**183**

Table 56.	Comparison of the percentage composition of the respondents to phase II and the sample of owners surveyed in phase VI in terms of activity groupings in which horses were involved.	**183**
Table 57.	Phase IV In depth survey of horse owners - summary of response from owners by practice affiliation.	**190**
Table 58.	Phase IV In depth survey of horse owners - summary statistics.	**193**
Table 59.	Phase IV In depth survey of horse owners - the number, and percentage in parentheses, of owners keeping their animals and of animals kept either at home or at other premises or a combination of these.	**193**
Table 60.	Phase IV In depth survey of horse owners - summary statistics for the distance from home of the premises where animals are kept and the frequency with which these animals are checked for animals not kept at home.	**194**
Table 61.	Phase IV In depth survey of horse owners - the number, and percentage in parentheses, of owners keeping their own animals and of animals kept either by themselves or sharing with animals belonging to other people or a combination of these.	**195**
Table 62.	Phase IV In depth survey of horse owners - the top fifteen most important equine diseases as ranked by horse owners.	**195**
Table 63.	Phase IV In depth survey of horse owners - the most important categories of disease affecting horses as ranked by horse owners.	**196**
Table 64.	Phase IV In depth survey of horse owners - summary statistics of age and length of ownership of animals.	**197**
Table 65.	Phase IV In depth survey of horse owners - summary statistics of age stratified by practice affiliation.	**198**
Table 66.	Phase IV In depth survey of horse owners - summary statistics of age stratified by activity grouping.	**199**
Table 67.	Phase IV In depth survey of horse owners - distribution of animals by gender.	**199**
Table 68.	Phase IV In depth survey of horse owners - distribution of animals by breed or type.	**201**
Table 69.	Phase IV In depth survey of horse owners - distribution of animals by coat colour.	**201**
Table 70.	Phase IV In depth survey of horse owners - summer grazing.	**202**

Table 71.	Phase IV In depth survey of horse owners - winter grazing.	**202**
Table 72.	Phase IV In depth survey of horse owners - percentage of the study population which graze alone or with other equine animals.	**202**
Table 73.	Phase IV In depth survey of horse owners - summer stabling.	**202**
Table 74.	Phase IV In depth survey of horse owners - winter stabling.	**203**
Table 75.	Phase IV In depth survey of horse owners - type of bedding used for horses which are stabled.	**203**
Table 76.	Phase IV In depth survey of horse owners - details of feeding by practice affiliation.	**205**
Table 77.	Phase IV In depth survey of horse owners - details of feeding by activity grouping.	**206**
Table 78.	Phase IV In depth survey of horse owners - summary of the percentage of horses receiving different feeds.	**204**
Table 79.	Phase IV In depth survey of horse owners - summary of the percentage of horses receiving different feeds appearing in the 'other' category of the feeding section of fact sheets.	**207**
Table 80.	Phase IV In depth survey of horse owners - summary of the percentage of horses involved in different activities.	**208**
Table 81.	Phase IV In depth survey of horse owners - summary statistics of shoeing, vaccination, worming and the length of time since last attended by a veterinary surgeon (for any reason).	**209**
Table 82.	Phase IV In depth survey of horse owners - percentage of horses in the study population suffering from permanent or recurrent disease problems.	**211**
Table 83.	Phase IV In depth survey of horse owners - percentage of horses in the study population suffering from permanent or recurrent disease problems collapsed into categories of disease.	**212**
Table 84.	Phase IV In depth survey of horse owners - percentage of horses attended by a veterinary surgeon for different reasons.	**213**
Table 85.	Phase IV In depth survey of horse owners - percentage of horses attended by a veterinary surgeon for different reasons collapsed into categories of consultation.	**214**
Table 86.	Phase IV In depth survey of horse owners - details of insurance cover on horses.	**214**

Table 87.	Phase IV In depth survey of horse owners - a comparison of the profiles of responders and non-responders to phase IV in terms of their response to phase II.	**216**
Table 88.	Phase IV In depth survey of horse owners - details of the time elapsed and the change in number of animals kept between phases II and IV.	**218**
Table 89.	Phase IV In depth study of horse owners - incidence of new cases of disease expressed as the percentage of the population affected per year.	**221**

LIST OF FIGURES

		PAGE
Figure 1.	The equine population density of Britain according to agricultural returns for 1994 (Ministry of Agriculture, Fisheries and Food, 1996; The Scottish Office Agriculture, Environment and Fisheries Department, 1996a).	**54**
Figure 2.	Phase Ia Survey of veterinary practices - question 7 from the first version of the questionnaire. Some respondents just ticked the 'Commonest' boxes.	**78**
Figure 3.	Phase Ia Survey of veterinary practices - question 7 from the final version of the questionnaire. The heavy double border separates the "Commonest" box from the rest of the table.	**78**
Figure 4.	Map showing the distribution of practices involved in Phases Ia and Ib of The Home of Rest for Horses Study of Equine Welfare.	**96**
Figure 5.	Map showing the equine population density of Scotland and Northern England from Phases Ia and Ib of The Home of Rest for Horses Study of Equine Welfare.	**97**
Figure 6.	Map showing the equine population density of Scotland and Northern England from returns to the annual agricultural census conducted by the Ministry of Agriculture, Fisheries and Food in 1994.	**98**
Figure 7.	Phase II Survey of horse owners - question 4 from the first version of the questionnaire.	**105**
Figure 8.	Phase II Survey of horse owners - question 4 from the final version of the questionnaire.	**106**
Figure 9.	Two designs for FREEPOST labels for return envelopes, the initial design on the left, and the final design on the right.	**109**
Figure 10.	Map showing the distribution of respondents, colour coded by practice affiliation, to Phase II Survey of horse owners.	**127**
Figure 11.	Map showing the relative proportions of horse owners using private and shared premises for their animals from Phase II Survey of horse owners.	**128**
Figure 12.	Map showing the relative proportions of horses experiencing different management regimens from Phase II Survey of horse owners.	**130**

Figure 13.	Map showing the relative proportions of horses involved in different activities from Phase II Survey of horse owners.	**131**
Figure 14.	Map showing the relative proportions of horse owners who keep different numbers of animals from Phase II Survey of horse owners.	**132**
Figure 15.	Map showing the equine population density of Scotland and Northern England from Phase II Survey of horse owners.	**138**
Figure 16.	Phase III Cross-sectional case study of veterinary practices - outline of final table design of the survey form.	**145**
Figure 17.	Phase III Cross-sectional case study of veterinary practices - list table for coat colour form The Home of Rest for Horses Study of Equine Welfare database.	**148**
Figure 18.	Phase III Cross-sectional case study of veterinary practices - list table for categories form The Home of Rest for Horses Study of Equine Welfare database.	**149**
Figure 19.	Map showing the proportion of cases in different categories seen by each practice from Phase III Cross-sectional case study of veterinary practices.	**170**
Figure 20.	Map showing the proportion of the five most frequent disease categories diagnosed in each practice from Phase III Cross-sectional case study of veterinary practices.	**171**
Figure 21.	Map zoomed in on the area where respiratory disorders appear to be most prevalent from Phase III Cross-sectional case study of veterinary practices.	**172**
Figure 22.	Phase IV In depth survey of horse owners - outline of table design of the survey form.	**185**
Figure 23.	Phase IV In depth survey of horse owners - list tables for time and day/night options from The Home of Rest for Horses Study of Equine Welfare database.	**188**
Figure 24.	Phase IV In depth survey of horse owners - list table for bedding type from The Home of Rest for Horses Study of Equine Welfare database.	**188**
Figure 25.	Map showing the distribution of respondents, colour coded by practice affiliation, to Phase IV In depth survey of horse owners.	**192**
Figure 26.	Phase IV In depth survey of horse owners - population pyramid demonstrating the age/sex structure of the population.	**200**

Figure 27. Map showing the potential application of Geographical Information Systems in outbreaks of infectious disease. Buffer zone of 5 miles radius around a premises where horses are kept. **229**

ACKNOWLEDGEMENTS

The work submitted in this thesis would not have been possible without the vision and financial support of The Home of Rest for Horses. In his role as a trustee of The Home of Rest for Horses, Professor Derek Tavernor has been instrumental in the continued success of the project of which this study forms a part, and his sage advice has been much appreciated. In the course of conducting this investigation, I have been very fortunate to work in a friendly and supportive department and with a great many helpful and enthusiastic people from both within and outside the department, without whom this work could not have been completed.

First, I owe a great many thanks to all those veterinary surgeons who gave of their time and expertise to take part in this study along with all the horse owners who responded to the questionnaires they were sent. A list of the veterinary practices that participated in this study is not included in this thesis for reasons of confidentiality.

Tom Irwin taught me how to use a computer and, along with the other occupants of the Veterinary Informatics and Epidemiology 'laboratory', David Irvine, Colin Naismith and Vicki Dale, showed tremendous patience in suffering my initial computer illiteracy. In addition, these people were forced to tolerate seeing their office periodically submerged beneath a mountain of folded paper and envelopes, as mailings of questionnaires were prepared. In addition, members of the Veterinary Informatics and Epidemiology group based in the Department of Statistics and Modelling Science at the University of Strathclyde have been both helpful and supportive. I am indebted to Sharon Casey, who typed all the 2,300 address labels for the survey of horse owners registered with practice 25, and to Ed Bulman, who assisted in the preparation of survey materials and in the computer data entry for the second horse owner survey. Barbara Gillies and Linda Braida also provided invaluable secretarial assistance. Brian Wright, in his role as senior administrator of the Department of Veterinary Clinical Studies, was unstinting in his efforts to make life easy for me; ordering computer hardware and software and stationery, and organising the FREEPOST address.

Since my appointment as lecturer in the Division of Farm Animal Medicine and Production in October 1995, I have been very lucky to work with some excellent people who have endured my occasional lapses into insanity in trying to come to terms with writing a thesis at the same time as starting a new job. In this respect I am especially indebted to Julie Fitzpatrick who has always been supportive, sympathetic and encouraging, and together with David Barrett, who has been unfortunate enough to share an office with me for the last two years, has shouldered the extra burden of many of my teaching commitments to allow me time to write this thesis. Professor Jim Parkins has also endeavoured to arrange a busy teaching timetable around my need to have time free in which to write. In addition, I owe many thanks to Rose Goulding, Keith Chandler, Mandy Dale and Maureen Milne for the cheerful and tolerant way in which they have worked with me in the farm animal clinics over the last two years.

In the design of each phase of this study I have been very fortunate to have had the advice and guidance of Dr Mat Reeves and of Professor George Gettinby who has also provided invaluable expert statistical advice in the analysis of data from this study. Katie Knox has also given greatly of her time and patience to help me with some of the statistical analyses. In addition, Carol Dickson, Arthur Kidd, Angela McGill and Ian Price were painstaking in their pretesting veterinary questionnaires and case sheets for me. Similarly, Dr Marion Carter, Mrs Beth Jones and Jill Underwood gave of their time and knowledge to pretest horse owner questionnaires and fact sheets.

My family have, as ever, been tremendously supportive and encouraging in my endeavours to complete this research, start a new job and write this thesis. Heather Richards has lived with me for the last two years, both through my transition from postgraduate student to lecturer, and throughout the writing of this thesis. I will never forget the selfless and understanding way in which she supported me through these trying times, and I am very appreciative of her company and her capacity to make me laugh, even at the worst times.

I am deeply indebted to Professor Max Murray for awakening, encouraging and developing my interest in research from the outset of this study. I shall never be able to repay my supervisors, Professor Sandy Love and Professor Stuart Reid, for their efforts on my behalf in terms of both this project and in the development of my career in general. Sandy has provided the clinical expertise and reputation around which this project was built, without which there would have been no project. In addition, he has endured the invariably missed deadlines for chapters with considerable patience and has provided invaluable advice in the writing of this thesis, not the least in matters grammatical, for which I owe many thanks. Stuart has been a source of inspiration and has provided tremendous encouragement from even before the beginning of this study, and without his friendly advice and careful guidance, especially in epidemiological and statistical matters, I could not have managed. In addition, throughout all he has been a great friend, and for this, as much as anything else, I am deeply grateful.

There are many others, colleagues and friends, who have provided advice, assistance, encouragement, inspiration and solace, for which I owe them all many thanks.

AUTHOR'S DECLARATION

The work presented in this thesis was performed solely by the author except where the assistance of others has been acknowledged. It has not been submitted in any form for another degree or professional qualification.

Dominic J. Mellor

Some of the work presented in this thesis has been the subject of the following publications:

Mellor, D.J., Reid, S.W.J., Irwin, T. and Gettinby, G. (1993) The Development of a Computer Knowledge Base for the Management of Equine Health. *Proceedings: Mathematical and Information Models for Veterinary Science*, 37-39.

Mellor, D.J., Reid, S.W.J., Irwin, T., Love, S. and Gettinby, G. (1994) The development of EQWISE - Equine Welfare Information System / Expert. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine, Belfast*, 148-154.

Reid, S.W.J., Mellor, D.J., Irwin, T., Love, S. and Gettinby, G. (1996) A hypertext knowledge base medium for the delivery of epidemiological models and expert systems. *Preventive Veterinary Medicine*, **26**:97-105.

and presentations:

Mellor, D.J., Reid, S.W.J., Love, S., Reeves, M. (1994) Demographics of the Equine Population of Scotland and Northern England:- Practitioner Opinions. *33rd British Equine Veterinary Association Congress, Dublin.*

Mellor, D.J., Reid, S.W.J., Reeves, M.J. and Love, S. (1996) The Demographic Census. *Workshop on Equine Epidemiology - The Horserace Betting Levy Board Veterinary Advisory Committee.*

Mellor, D.J., Reid, S.W.J., Reeves, M.J. and Love, S. (1997) A demographic and epidemiological study of the equine population of Scotland and Northern England through sentinel practices. *Association of Veterinary Teachers and Research Workers.*

In addition, the following paper has been accepted for presentation and publication in the proceedings of the VIIIth Symposium of the International Society for Veterinary Epidemiology and Economics, to be held in Paris, France in July 1997:

Mellor, D.J., Love, S., Reeves, M.J., Gettinby, G. and Reid, S.W.J. A demographic approach to equine disease in the northern UK through a sentinel practice network.

LIST OF ACRONYMS

AD	Anno domini
ANOVA	Analysis of variance
BC	Before Christ
BHS	British Horse Society
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
EER	Equine exertional rhabdomyolysis
EQWISE	EQuine Welfare Information System and Expert
EVA	Equine viral arteritis
GIS	Geographical Information System
NSAIDs	Non-steroidal anti-inflammatory drugs
MAFF	Ministry of Agriculture, Fisheries and Food
ODBC	Object database connectivity
PML	Pharmacy and Merchant's List
PMSG	Pregnant mare serum gonadotrophin
SD	Standard deviation
SIQ	Semi-interquartile range
SQL	Standard query language
TRH	Thyrotropin releasing hormone
UK	United Kingdom
US / USA	United States of America

CHAPTER 1

INTRODUCTION AND REVIEW OF THE LITERATURE

1.1. GENERAL INTRODUCTION

The last census of horses in the UK was taken in 1934 (Urquhart, 1983), since when only Ministry of Agriculture Fisheries and Food (MAFF) have maintained any records of numbers of horses kept. Though there has been much research investigating individual equine diseases or syndromes affecting groups of animals, there is no information concerning the relative importance of equine diseases as they affect the general population (Traub-Dargatz *et al.*, 1991).

Animal disease surveillance programmes have been a prominent feature of British agricultural policy since the Diseases of Animals Act of 1950. These programmes have been devised to record the occurrence of diseases of particular significance to animal health and welfare. Stringent efforts are made to control and prevent these diseases, not only for reasons of production economics, but also for reasons of public health where zoonotic diseases are concerned. Routine screening of cattle for brucellosis and tuberculosis are good examples of such programmes (The Scottish Office Agriculture, Environment and Fisheries Department, 1997).

In the UK, due to the traditional British reluctance to eat horse flesh, the horse has no significant role as a production animal in comparison to cattle, sheep, pigs and poultry. Although some exotic diseases of horses remain notifiable, and records of numbers of horses kept on agricultural land are still maintained, relatively little effort is made by the authorities in monitoring equine health and welfare. However, even if the role of the horse in modern society is almost exclusively that of leisure, there is a large industry involved in the production, housing, feeding, health, training and equiping of horses. In addition, any animal population, and in particular a large, domesticated animal population with close human contact, represents a potential reservoir of diseases that may affect both man and other domestic species. An outbreak of acute equine respiratory disease in Queensland, Australia in 1994, caused by a previously unrecognised morbillivirus which is also believed to have been responsible for the development of influenza-like illness, in one case fatal, in two men caring for the affected horses provides evidence for this (Cordes and Hooper, 1995). Therefore, there is a strong case for expanding and maintaining knowledge of horses, not only from the point of view of equine health but also because of the potential zoonotic implications.

Surveillance programmes are expensive in terms of both human and financial resources. An alternative to extensive, continuous disease surveillance is to have detailed knowledge of the population: - its numbers, distribution, age structure, breed and sex characteristics, management experience, and to undertake periodic point prevalence studies to record the changing health status of the population (Davies, 1983).

1.2. HISTORICAL INFLUENCES ON THE NATURE AND SIZE OF THE BRITISH EQUINE POPULATION

1.2.1. Introduction

Although one of the last animals to be domesticated approximately 6,000 years ago (Clutton-Brock, 1992), the horse has had a greater effect on the development of human civilisation than any other (Urquhart, 1983). Prior to their domestication, horses had been hunted for meat and hides to such an extent that, 10,000 years ago, they were extinct from the North American continent and in Europe and Asia they were to be found only in small numbers in remote areas (Clutton-Brock, 1992). Following domestication, the horse, in carrying man fast and far into battle, in hauling goods to supply armies and settlers, in providing nearly all the power for early industry and in conveying news and information, enabled the conquest of new lands and the development of the modern material world (Urquhart, 1983). By the beginning of the 20th Century, despite the advent of steam locomotives, there were greater numbers of carefully bred, efficiently used horses than ever before or since (Barker, 1983).

1.2.2. Earliest Records

The earliest use (3,000 BC) of horses and mules was as pack animals (Urquhart, 1983; Clutton-Brock, 1992). By 2000 BC light chariots with spoked wheels had been developed to carry men into war (Dunlop and Williams, 1996). At this stage horses were unable to draw heavy carts due to limitations of harness (Urquhart, 1983). The Chinese introduced shafts by the 4th Century BC, but it was not until the development of the rigid collar and traces around 700 AD that horses could be harnessed to wagons (Urquhart, 1983; Dunlop and Williams, 1996). Men took to riding horses around 1100 BC, and by the 4th Century BC Alexander the Great was able to conquer 2,000,000 square miles of the ancient world riding on his great horse Bucephalus (Clutton-Brock, 1992). Progressive cultures at this time developed systems of dispatch riders to hasten communication (Dunlop and Williams, 1996).

1.2.3. Early Britain

The earliest accurate reference to domesticated horses in Britain refers to the Roman invasion in 55 AD, when Caesar's army was strongly opposed by the Britons (Wortley-Axe, 1908). The British King, Cassivellaunus, retained 4,000 chariots to harry the Romans, but the Roman cavalry, equipped with superior horses, eventually subdued all England (Urquhart, 1983). When the Romans finally left Britain, they left behind their excellent horses, which, being much larger than the native animals, began to produce fresh crosses of greater quality and size. Subsequent invasions by the Saxons and the Danes led to the introduction of more foreign horses and laid the foundations for the further improvement of the small native breeds (Wortley-Axe, 1908).

In the 9th Century AD, Alfred the Great, having acquired a great deal of knowledge about horsemanship in Rome, inaugurated a system of horse breeding in Britain. In addition, he imported large numbers of good quality continental horses and imposed laws calculated to improve the indigenous breeds of horse. Athelstane, who succeeded him to the throne in 925 AD, continued to import large numbers of foreign horses but also prohibited the export of British horses (Wortley-Axe, 1908). It is evident, even at this early stage, that intelligent measures had been put in place to ensure the propagation, improvement and multiplication of horses in Britain.

In 1066 William the Conqueror invaded Britain bringing with him an army of 12,000 men, roughly half of whom were mounted (Urquhart, 1983). The Bayeux Tapestry depicts all of the boats of the invading army to be full of horses (Wortley-Axe, 1908). The horses of William and his barons had been drawn from all over Europe and remained permanently in Britain, not only increasing numbers but also leading to further improvement of native stock (Urquhart, 1983).

The Domesday Book, compiled in the reign of William, mentions horses and categorises them in various ways (Chapter 1.4.2.). Pack animals are recorded, though no manor had any appreciable number of them. Mention is made of forest and unbroken horses in the eastern counties and in the south west. Numbers of these are given for some manors: Brendon had 104 and Lynton 72. Occasional references are made to donkeys, asses and mules and rarely to foals (Finn, 1963).

William and his barons bred horses for specific purposes: the largest and heaviest were kept as war-horses, used only in battle and public displays, medium sized horses were bred for the chase, or hunting, from which the earliest racehorses descended, and only the smallest were retained on farms as pack animals (Urquhart, 1983).

1.2.4. The Middle Ages

In about 1200 AD, King John imported 100 huge stallions from Flanders, Holland and the Elbe with which to improve native stock (Urquhart, 1983). After 1300, armour made from sheets of iron began to replace chain-mail and ever stronger and larger horses were required to bear the weight. Edward I imported horses to equip his army to fight the Scots, and later, in the reign of Edward II, Scottish stocks were greatly boosted by English horses captured at the Battle of Bannockburn in 1314. After Bannockburn, Edward II banned the exportation of English horses to Scotland under heavy penalties (Urquhart, 1983).

As a result of these policies, the English war-horse became, for a time, superior to any in Europe. However, the Wars of the Roses put an end to this state of affairs: all strong horses were seized and used in the battles of the time, and those that were not were smuggled abroad by people who saw little point in breeding horses for Yorkists or Lancastrians to waste (Urquhart, 1983). In the reign of Richard III, in 1483, first reference was made to the use of post horses and stages in Britain (Wortley-Axe, 1908). By the time Henry VII was crowned King after the Battle of Bosworth Field in 1485, the British Isles were left with a small, poor collection of horses (Urquhart, 1983).

Responding quickly to this situation, Henry VII again enacted laws prohibiting the export of horses (Urquhart, 1983). He also put an end to the, until then, usual practice of grazing entire horses on common lands which had led to much in-breeding and the propagation of inferior animals (Wortley-Axe, 1908). Despite maintaining these laws throughout his reign, Henry VIII was notable for causing the wastage of England's and Europe's stock of horses (Thirsk, 1978). Having declared war on France in 1512, Henry sent his officials to scour the English countryside to buy horses for cart and carriage to supply the troops, and 2,566 horses were purchased in the counties lying between Lincolnshire and Kent (Thirsk, 1978). Twenty eight years later, in 1540, there was a serious shortage of horses for war service, a time Henry chose to wage concurrent wars on France and Scotland. Musters had been carried out in 1535, and yielded a very thorough census of horses for war service in every county, parish and gentleman's stable - Southern England could offer many foot soldiers, but had practically no serviceable horses (Thirsk, 1978). Musters were repeated in 1544, and in addition Henry, taking for granted the support of his allies, ordered 4,100 draught horses from the Queen of Hungary for the French campaign. One month later he requested a further 7,200 animals from her. The low counties of England supplied 5,226 horsemen for an army of 40,000 and another 10,500 horses to pull 1,500 supply wagons (Thirsk, 1978). The wars in the north were no less costly: attacks on Haddington and Hawick involved 4,000 and 3,000 horsemen, and prior to a planned attack on Edinburgh, five northern counties were ordered to supply 2,500 horsemen (Thirsk, 1978). At this time, a constructive policy for improving the quality and increasing the number of English horses emerged and prohibition of export was more rigorously enforced (Thirsk, 1978).

Henrician policies were maintained by the government for the remainder of the 16th Century. In the reign of Edward VI a new muster book was compiled and gentlemens' incomes were reassessed, based on which they were ordered to furnish a number of horses each. In 1565 Queen Elizabeth I announced her intention to take six-monthly musters of horses until the nation was sufficiently stocked. Although never as frequently as every six months, muster returns were compiled regularly in the 1570s and 80s. In 1580, the Queen set up a high powered 'Special Commission for the Increase and Breed of Horses' when war with Spain was rumoured. Laws were passed to ensure that all common lands had a good quality stallion to produce progeny of good size (Thirsk, 1978).

With the discovery of gunpowder and the development of firearms, the heavy armour worn by warriors became redundant. Military demands changed for lighter, swifter horses to carry cavalry. In 1580 the Earl of Arundel introduced carriages and they were swiftly adopted by Elizabeth I. Carriages became so popular so quickly that every heavy horse no longer required by the army was rapidly bought up for draught purposes (Urquhart, 1983).

Books on horsemanship started to appear in 1560 and their number grew rapidly as the breeding and training of magnificent horses became a major pastime among the nobility. By 1600 regular government musters and the fast growing literature were raising standards of training and significantly increasing the size and number of serviceable horses in Britain (Thirsk, 1978).

1.2.5. The Early Modern Period

After the end of the English Civil War in 1647, large numbers of heavy horses flooded from the armies into civil life and from there to agriculture. The Stuart kings had all been great supporters of racing, but Oliver Cromwell banned the sport when he was in power (Wortley-Axe, 1908). However, when Charles II was restored to the throne in 1660, racing became more popular than ever before (Urquhart, 1983).

Throughout the 17th Century, breeders turned their attention to producing better horses. The British human population, which had grown from 2,250,000 in 1500 to 5,500,000 in

1700, demanded an ever increasing number of horses. Animals were now required for: pack animals, pulling carts, wagons and carriages on the roads and on the farms, pulling loads from quarries and mines to river ports, to pull canal barges, plough teams and every day riding horses (Thirsk, 1978). Blood of great cart horse breeds was disseminated as widely as possible by practices such as groups of farmers collectively hiring the services of a stallion for a season. At this time, travelling stallions also started to appear. Notices would be displayed throughout an area advertising the whereabouts of the stallion on different days, so that farm mares could be taken to him with minimum disruption to their work schedule (Thirsk, 1978). One of the most famous, and one of the last, travelling stallions was a Clydesdale called Baron of Buchlyvie who was, at the turn of the 20th Century, the top breeding horse in Scotland and the sire of many champion Clydesdales (Hart, 1986).

Throughout the 18th Century, horses continued to become increasingly necessary for the conduct of every day life. However, many communities remained practically isolated and cut off from communications due to the appalling state of the roads, many of which were still completely impassable to wheeled vehicles. The work of Macadam (1756 - 1836) in developing level and durable road surfaces meant that by the end of the 18th Century long distance travel in carriages could be considered a serious proposition (Urquhart, 1983). However, local travel in rural areas continued to be horse dependent until the Second World War (Dunlop and Williams 1996).

During the early part of the 19th Century, and especially after 1809 when export duty on horses was abolished, many mares and stallions were sold to the continent to meet the shortages there caused by the Napoleonic Wars (1803-15). During these wars both sides experienced serious problems of providing sufficient fodder for cavalry horses and many starved (Dunlop and Williams 1996).

By 1800, the practice of mating horses in hand, a novelty 100 years previously, had become commonplace (Chivers, 1983) and, at the same time a custom of holding spring shows for stallions began. Usually organised by groups of mare owners, a generous prize was offered on the condition that, for the coming season, the members could have the services of the winning stallion at a reduced rate (Chivers, 1983). In 1863 the Royal Agricultural Society Show identified breeds for the first time (Dunlop and Williams 1996). The Shire Society held a show in London each February, at which the most rigorous veterinary tests were applied with a view of eliminating hereditary defects and diseases of wind and limb (Chivers, 1983). Throughout the 19^{th} Century numerous repositories for the selling of farm bred horses sprang up. In such repositories, thousands of horses each year would change hands; Manley's, just one of two large repositories in Crewe, a busy railway junction, sold 8,000 heavy horses each year (Chivers, 1983).

Due to the huge increase in demand for horses at this time, it was necessary to import large numbers. Many came from Ireland, then wholly within the UK, but no records were kept until the Veterinary Department of the Privy Council added horses to its count of livestock in 1878 (Chivers, 1983). Statistics of horses imported from outwith the UK began in 1853 with the 'Annual Statement of the Trade and Navigation of the United Kingdom with Foreign Countries and British Possessions' (Chivers, 1983). The vast majority of imported horses were 5 to 6 year-olds of either sex for town work. Exports, on the other hand, at least until 1880, were nearly all breeding stock - Thoroughbreds and heavy draught horses to developing countries. After 1890, a new, and soon even bigger, export market developed - large numbers of worn out horses were sold to Belgium and Holland for the meat trade (Chivers, 1983). Estimated numbers of British horses imported and exported during the 19^{th} and early 20^{th} centuries are shown in Table 1 (form Chivers, 1983).

	1853	**1860**	**1870**	**1880**	**1890**	**1900**	**1910**
horses imported	6819	1761	2387	9264	19286	51768	14674
home-bred horses exported	1902	3199	7202	5128	12916	30038	59149

Table 1. Estimated numbers of horses imported to, and home-bred horses exported from, Britain in sample years (from Chivers, 1983).

At the end of the 19^{th} Century, there were more horses in Britain than ever before or since. The London Post Office alone employed 6,000, The Great Western Railway 2,234 and the South Wales coal mining industry had 17,000 pit ponies. At this time the army had 17,250 horses with an annual replacement rate of 2,500 (Chivers, 1983). Thomson (1983) attempted to estimate the total British equine population throughout the 19^{th} and early 20^{th} centuries (Table 2).

	1811	1851	1871	1881	1891	1901	1911
horses on farms	800	?	1254	1428	1481	1511	1495
'commercial' horses	251	264	444	?	858	1166	995
private or pleasure horses	236	277	414	585	500	600	537
Total	**1287**	**?**	**2112**	**?**	**2839**	**3277**	**3027**

Table 2. Estimated numbers of horses (x 10^3) in the UK in the 19th and early 20th Centuries (Thomson, 1983).

In 1911, a government scheme for subsidising heavy horse breeding was started - comparable schemes had been in place in most continental European countries for as long as 20 years prior to this (Chivers, 1983). On the first day of World War I, the British Army owned 25,000 horses (Chivers, 1983). In just 12 days in 1914, 140,000 were compulsorily purchased and by the end of the war one third of all the horses in Britain had left for service in the army (Urquhart, 1983). A total of 1,212,000 horses, though not all of them from Britain, were purchased by the British army for World War I and of these, 500,000 died in the battles of the Marne, Mons, Ypres, Vimy Ridge and Passchendale alone (Urquhart, 1983).

The first census of horses was held in 1917, and in 1920 stallions were, at last, required to have licences (Chivers, 1983). The development of the internal combustion engine rapidly began to displace horses after World War I. Despite this there were still 237,000 horse drawn vehicles in Britain at the end of 1922, but this figure had fallen to 66,000 by 1929 and to 12,000 by 1937 (Barker, 1983). On farms, the decline was slower: a peak number of 1,137,000 horses were employed in 1910 which fell to 960,000 after World War I and 650,000 by 1939. Most farmers retained a horse for occasional carting duties until after World War 2, but by 1965 there were only 21,000 working horses left on farms in Britain (Barker, 1983). The last census of horses in Britain was taken in 1934 when the estimated total number was 1,278,341 (Urquhart, 1983).

1.2.6. Ministry of Agriculture Records

In 1866, The Ministry of Agriculture began an annual census of farming and livestock kept in the UK (Ministry of Agriculture Fisheries and Food & Department of Agriculture and

Fisheries for Scotland, 1968). Horses were not included in the annual returns until four years later, though they have been ever since (Britton, 1989). Since the last census of horses in 1934 (Chapter 1.2.5.) the annual returns have been the only published records of horse numbers. Table 3 shows the annual returns for horses for selected years between 1880 and 1965.

Year	England and Wales		Scotland		Great Britain		
	non-agri	agri	non-agri.	agri.	non-agri.	agri.	Total
1880	388	839	53	141	441	980	**1021**
1890	351	892	43	147	394	1039	**1433**
1900	381	925	41	153	422	1078	**1500**
1910	361	981	47	156	408	1137	**1545**
1920	577	789	76	138	653	927	**1580**
1930	279	683	36	120	315	803	**1123**
1940	278	541	39	101	317	642	**959**
1950	128	289	19	58	147	347	**494**
1955	100	134	13	26	113	160	**273**
1958	95	72	10	12	104	84	**188**
1960	93	46	10	8	103	64	**167**
1965	115	19	10	2	125	21	**146**

Table 3. Annual returns for numbers of horses (x 10^3) kept in Great Britain for selected years between 1880 and 1965 (Ministry of Agriculture Fisheries and & Department of Agriculture and Fisheries for Scotland, 1968).
non agri. - horses for non-agricultural use.
agri. - horses for agricultural use.

These figures concern only horses kept on agricultural land, and therefore are an underestimate of the total equine population as many horses are kept on land which is not used for commercial agricultural purposes. Table 4 shows the 1994 returns for horses kept in England and Wales (Ministry of Agriculture Fisheries and Food, 1996). The change in these figures over time may reflect real trends in the total equine population. As can be seen from Table 5, the Scottish equine population appears to have been growing steadily at a mean rate of approximately 8% since 1992 (The Scottish Office Agriculture, Environment and Fisheries Department, 1996a).

County	Holdings	Animals	County	Holdings	Animals
Cleveland	138	1019	Shropshire	916	4931
Cumbria	954	3978	Staffordshire	957	5689
Durham	535	2912	Warwickshire	595	3759
Northumberland	613	2820	West Midlands	148	1120
Tyne and Wear	101	979	Cheshire	934	4624
Humberside	637	2789	Greater Manchester	518	3958
N/Yorks (N'Allerton)	1590	7466	Lancashire	905	4279
N/Yorks (Beverly)	174	886	Merseyside	101	1137
South Yorkshire	361	2014	Clwyd	636	3158
West Yorkshire	869	4751	Dyfed	2063	9961
Derbyshire	829	4139	Gwent	559	2879
Leicestershire	703	4388	Gwynedd	648	3338
Lincolnshire	722	3146	Mid Glamorgan	373	1959
Northamptonshire	523	3291	Powys	1059	4939
Nottinghamshire	455	2672	South Glamorgan	149	933
Cambridgeshire	456	3720	West Glamorgan	287	1588
Norfolk	862	4501			
Suffolk	651	4289	**Total**	**38995**	**225987**
Bedfordshire	264	1619			
Berkshire	296	2672			
Buckinghamshire	586	4946			
East Sussex	626	3930			
Essex	856	5863			
Greater London (E)	53	742			
Greater London (SE)	92	1358			
Hampshire	1036	9394			
Hertfordshire	446	4184			
Isle of Wight	156	828			
Kent	906	5299			
Oxfordshire	634	4778			
Surrey	634	5259			
West Sussex	665	5770			
Avon	517	2609			
Cornwall & Scilly Isles	1437	6649			
Devon	2566	12602			
Dorset	772	4576			
Gloucestershire	929	5979			
Somerset	1230	5993			
Wiltshire	835	5489			
Hereford & Worcester	1438	7436			

Table 4. 1994 returns for horses kept in England and Wales (Ministry of Agriculture Fisheries and Food, 1996).

Region	Holdings 1991	Horses 1991	Holdings 1992	Horses 1992	Holdings 1993	Horses 1993	Holdings 1994	Horses 1994	Holdings 1995	Horses 1995
Shetland	100	450	105	486	97	562	93	539	98	625
Orkney	116	385	113	404	115	434	115	449	116	419
Western Isles	25	52	26	56	28	55	28	66	29	71
Highland	386	1295	400	1532	401	1444	434	1551	458	1782
Grampian	688	3844	734	3501	779	4130	844	4299	880	4465
Tayside	351	1689	350	1911	362	2053	398	2194	410	2299
Fife	140	695	144	807	159	945	174	1018	183	1135
Lothian	174	828	172	904	167	948	189	1020	191	1005
Borders	338	1390	377	1610	368	1768	410	1886	412	1943
Central	158	835	153	965	157	939	185	960	195	1625
Strathclyde	702	2903	687	2841	707	3003	748	3256	769	3561
Dumfries & Galloway	371	1193	387	1241	406	1360	435	1474	448	1474
Total	**3549**	**15959**	**3648**	**16258**	**3746**	**17641**	**4053**	**18719**	**4189**	**20404**

Table 5. Agricultural returns for horses kept in Scotland for 1991 - 1995 (The Scottish Office Agriculture, Environment and Fisheries Department, 1996a).

Combining the totals for England, Wales and Scotland for 1994 gives a total British equine population of 244,699 animals kept on 43,048 holdings. This gives a mean of nearly six horses per holding. Chivers (1983) writes:

> In the 1980s, although there is a return of horses on farms, the picture it presents is so imperfect that the most informed members of the British Horse Society are able to discuss whether there are a quarter, or a half, or a whole million of horses in Britain.

In the early 1990s the British Horse Society attempted to enumerate the equine population of Scotland (excluding the Highland region, Orkney, Shetland and the Western Isles) in order to give weight to their lobbying of local councils to provide more facilities for equestrianism. Members of the society were allocated areas in which they were to count the number of horses in fields in their area. These figures were then summed to give totals for each region. The results are shown in Table 6:

Area	Number of horses
Aberdeen City	777
Aberdeenshire	2563
Angus	986
East Ayrshire	575
North Ayrshire	873
South Ayrshire	859
Argyll and Bute	2068
Scottish Borders	5304
Clackmannanshire	689
Dumfries and Galloway	3168
East Dunbartonshire	645
West Dunbartonshire	448
Dundee City	65
City of Edinburgh	849
Falkirk	1577
Fife	2635
City of Glasgow	272
Inverclyde	434
North Lanarkshire	959
South Lanarkshire	2239
East Lothian	1231
Midlothian	1214
West Lothian	1704
Moray	1767
Perth and Kinross	3812
East Renfrewshire	858
Renfrewshire	553
Stirling	1948
Total	**41072**

Table 6. Results of the British Horse Society survey of horse numbers in Scotland in the early 1990s (British Horse Society, 1996).

The Ministry of Agriculture also monitors international movements of horses, and figures for the numbers exported from Britain between 1986 and 1994 are summarised in Table 7:

Year	Imports	Exports	Net effect on UK numbers
1988	8854	7204	+1650
1989	10917	7399	+3518
1990	10418	7483	+2935
1991	8088	8545	-457
1992	11462	9147	+2315
1993	1772	3228	-1456
1994	2323	3712	-1389
1995	2317	4531	-2214

Table 7. Numbers of horses imported to and exported from Britain 1988-1995 (Ministry of Agriculture Fisheries and Food, The Scottish Office Agriculture, Environment and Fisheries Department and Welsh Office Agricultural Department, 1991-1995).

The reasons for the fluctuations in the net movement of animals are not clear from the data in Table 7. However, since 1992 there has been a marked reduction in the total numbers imported and exported.

1.2.7. Agricultural Atlases

'An Agricultural Atlas of Scotland' (Coppock, 1976b) shows a map of the equine population density of Scotland in 1870. At the time there were 172,871 horses with widespread distribution in the lowlands and sparse population in the uplands. Table 8 shows the population distribution by region:

Region	Horses
Highland	27939
North East	50639
East Central	33177
South East	20954
South West	40162
Scotland	**172871**

Table 8. Equine population distribution by region in Scotland 1870 (Coppock, 1976b).

'Agricultural Atlas of England and Wales' (Pryse Howell, 1925) presents a map showing the distribution of 2,739,000 horses in these countries in 1918. In 1954, 'The Agricultural

Resources of the World' (Van Royen) stated that the total world population of horses was over 60,000,000 (excluding mules and asses) and used population density maps to depict their distribution. In 'An Agricultural Atlas of England and Wales' (Coppock, 1964), 167,022 horses were kept on agricultural holdings of which 43% were used for agricultural purposes. Of these, the highest numbers were to be found in the Fenland and West Cornwall, where horses were still used for horticulture. Of horses kept for non-agricultural purposes, the highest concentrations were to be found in Greater London, Newmarket, the New Forest, Dartmoor, Exmoor and South Wales. The second edition of this atlas, published in 1976, makes no mention of horses (Coppock, 1976a).

1.2.8. Studies in Foreign Countries

In 1983 and again in 1987, the American Veterinary Medical Association sponsored studies on animal ownership and the use of veterinary services by US households (Charles, Charles and Associates, 1983; Charles, Charles Research Group, 1988a and 1988b). Mailed questionnaires were used to gather data from sample US households to determine the numbers of dogs, cats, horses, pet birds and exotic species kept. The use of, and expenditure on, veterinary services for different pets in each household were also recorded. These data were then extrapolated to give national estimates of pet populations, and usage and expenditure on veterinary services. Comparison of the two studies allowed the authors to comment on the trends in these data. In 1987, 2,600,000 (2.8%) US households owned one or more horses. The mean number of horses kept in each of these households was 2.6, reduced from 3.0 in 1983. The estimated total size of the US equine population in 1987 was 6,600,000 animals. Forty seven per cent of horse owners obtained veterinary care for one or more of their horses during that year with a mean annual number of veterinary visits per horse of 0.33.

A study in Japan estimated the equine population to be 120,244 in 1991 (Hata, 1993). Of these, 60% were racehorses, 25% were farm horses, 7% were registered riding horses, 3% were native breeds and 5% were fattening meat horses.

1.3. RECORDS OF EQUINE DISEASE

Many studies have been conducted to determine the prevalence of single diseases, or diseases of common presenting signs, and risk factors associated with them (Barrowman and Van Vuurnen, 1976; Reif, 1979; Rossdale *et al.*, 1985; Reeves *et al.*, 1990; Hunt, 1993; Reid *et al.*, 1994), but very limited data exist concerning the comparative importance of equine diseases (Traub-Dargatz *et al.*, 1991).

In Britain in 1851, The Epidemiological Society began to seek veterinary co-operation in studying epidemic diseases. The veterinary schools of the time focused attention on the preservation of horse health and the therapy of ill or injured horses when they were often worked beyond the limits of their endurance in both war and peace (Dunlop and Williams, 1996). 'The Illustrated Horse Doctor' (Mayhew, 1881) originally published in 1860, contains over 400 pictures showing features of diseases of horses and describes diagnosis and treatment methods of the time. Causal factors believed to be associated with some diseases are also described. According to Mayhew, the following were common occurrences: migraine, ophthalmia, colds, vascular nasal polyps, sore throat, laryngitis, coughing, choke, bronchitis, heaves, pneumonia and pleurisy followed by hydrothorax, influenza, bots, abdominal injuries, urinary tract disease, mange, stocking and water farcy (hindlimb swellings below the hock), diseases of the locomotor system, trauma to the feet, laminitis and strangles. Strangles, and glanders and farcy, were especially serious infectious diseases which affected many horses of the time. Cardiac disease and cystitis were considered to be less common ailments, whilst purpura haemorrhagica and hepatitis were poorly understood.

More recently, in 1989, the American magazine 'Equus' carried out a survey among horse owners in the US in an attempt to discover which were the most important equine diseases (Underhill and Showalter, 1989). The findings of this study are summarised in Table 9:

Rank order	Condition
1	subtle lameness
2	colic
3	wounds requiring sutures
4	puncture wounds
5	breeding/foaling matters
6	incapacitating lameness
7=	respiratory diseases
7=	eye injuries
9	skin diseases
10	allergies

Table 9. Summary results from the 'Equus' survey of horse owners' opinions of the most important equine diseases (Underhill and Showalter, 1989).

There were major discrepancies between this list and the top ten ranking equine research areas. The top two research areas in terms of funding were immunology and pharmacology, with colic research receiving only 10% of the total research fund. In addition, a poll of veterinarians showed that almost 50% of the calls they received were for injuries requiring immediate attention, with one in five calls for colic problems and nearly one third of their time was spent dealing with subtle lameness. Veterinarians reported a high level of owner misinformation and ignorance of the general principles of good equine management. In particular, there was a lack or regular parasite control, and inappropriate feeding, especially overfeeding, was a commonly reported problem. The findings concerning lack of owner education relating to parasite control, are supported by three independent studies involving nearly 800 horse owners in the UK commissioned by Hoechst Animal Health (Baker, 1994).

Between September 1989 and February 1990, Traub-Dargatz *et al.* (1991) conducted a survey of members of the American Association of Equine Practitioners to determine the most prevalent medical problems that affected adult equine animals. The study did not consider surgical or lameness problems, or problems affecting foals. Practitioners were asked to rank the top five medical problems in their practice from 36 possible conditions listed on a mailed questionnaire. The results are summarised in Table 10:

Rank order	Condition
1	colic
2	viral respiratory disease
3	endometritis
4	dermatitis
5	parasitism

Table 10. The top five adult equine medical problems as ranked by members of the American Association of Equine Practitioners (Traub-Dargatz *et al.*, 1991).

Some regional variation was observed among conditions ranked 3, 4 and 5, with conditions such as COPD, pulmonary haemorrhage and dental problems mentioned in some areas. The commonest diseases affecting different body systems, as specified by 276 veterinarians in the study, are shown in Table 11:

Body system	Commonest disease
digestive	colic
respiratory	viral respiratory disease
musculoskeletal	myositis
cardiovascular	jugular vein thrombosis
ocular	corneal ulcers
urinary	urinary infections
reproductive	endometritis
miscellaneous	dermatitis

Table 11. The commonest diseases affecting different body systems as specified by members of the American Association of Equine Practitioners (Traub-Dargatz *et al.*, 1991).

Hata (1993) reported that among Japanese horses, reproductive disorders comprised 35% of veterinary cases, gastrointestinal disease 16%, trauma and accidents 15%, respiratory disease 14%, locomotor disorders 11%, infectious and parasitic diseases 3% and others 6%.

1.4. DEMOGRAPHY, CENSUS AND EPIDEMIOLOGY

1.4.1. Demography and Census Taking

Demography, an interdisciplinary field involving statistics, biology, medicine, economics, history, and geography, is the scientific study of the size, distribution and composition of populations (Hollingsworth, 1969; Keyfitz and Beekman, 1984). Demography uses birth, death and migration rates, and related statistics to determine the characteristics of populations, their patterns of change over time, and the determinants and consequences of such changes. Demographers have often used so-called population pyramids to describe graphically the age and sex structure of populations (Hollingsworth, 1969). Population studies yield knowledge important for planning, particularly by governments, in fields such as health, education, housing, social security, employment, and environmental preservation (Keyfitz and Beekman, 1984; Pol and Thomas, 1992).

In addition to data from birth, death and migration records, demographers make much use of census data. A census is an official count, at a particular time, of people, houses, socio-economic status and other items of interest (Alterman, 1969). The earliest records of census-taking date back to 3800 BC when the Babylonians developed a system of revenue control that involved enumeration of the tax-paying segment of the population. Fifteen hundred years later each district of the kingdom was able to calculate their own returns. These data were kept on clay tablets and contained inventories of farm animals and farm animal products as well as counts of the number of households within districts (Alterman, 1969). The building of pyramids began around 2900 BC. Such huge projects required organisation and control, as well as the precise timing of the activities of an enormous workforce required to build and supply materials. By 2300 BC maps of the country had been drawn with statistical material relating to the areas they described (Alterman, 1969). At the same time, the Chinese were also beginning to take a form of census (Hollingsworth, 1969). The first Roman census under the supervision of official censors was taken in 435 BC. The fundamental objectives of their census were an objective system of taxation and an estimation of military resources. The scope of the Roman census, i.e. the number and type of questions it asked, was greater than any taken until the 19th Century (Alterman, 1969; Hollingsworth, 1969). It was a Roman census for which, according to Christian belief, Joseph and Mary travelled to Bethlehem, in compliance with an imperial decree. In the Roman Empire, census taking came to an end in the 1st Century AD (Alterman, 1969; Hollingsworth, 1969). There followed a period of more than a thousand years during which, mainly due to social and political upheaval in Europe, almost no census activity was undertaken. In Britain, however, there was one outstanding exception to this rule: The Domesday Book, compiled for William the Conqueror in 1086 and referred to as "the description of England" (Finn, 1963). This book contains detailed "descriptions" for each county, including the holders of any land, the numbers of tenants as well as the numbers of serfs and servants. There are also occasional entries in the Domesday Book which make reference to horses (Chapter 1.2.3). During the next seven hundred years, census taking in Britain was at best sporadic.

The Census Bill was introduced in Britain in 1800 by Charles Abbot who was influenced by the writings of Rickman (1796) and Malthus (Flew, 1970). The first full census was undertaken in 1801, since when censuses have been taken every ten years with the exception of 1941 (Dewdney, 1984). The first four censuses (1801 - 1831) recorded only numbers of male and females and a simple breakdown of occupation. The most recent British census (1991) recorded, as well as these basic numbers, a broad range of diverse information such as age, car ownership and household amenities. The results of the 1991 British Census are available on CD-ROM (1991 Census on CD-ROM).

1.4.2. Epidemiology

Epidemiology can be defined as the application of hypotheses to *populations* concerning the relationships between causes and effects in terms of disease (Rothman, 1986; Dargatz and Salman, 1993). Such hypotheses are derived from observations made on a sample of a population (Chapter 1.6). The process of generalising beyond these observations requires informed judgement about which features of the observations may be extrapolated. Such judgements require an understanding of the *conditions* relevant to the generalisation (Rothman, 1986).

Data analysis in epidemiology is based upon hypothesis testing whereby it is assumed that exposure has no effect on outcome (i.e. absolute effect = 0, or relative effect = 1) (Rothman, 1986; Thrusfield, 1995). The data generated by a particular study are then analysed to determine whether or not they support this 'null' hypothesis on the basis of a statistical decision rule - the level of statistical significance. When the null hypothesis is rejected at a particular level of significance, then the alternative hypothesis - that the data are consistent with the exposure having an effect - is adopted. The magnitude of the observed effect can then be estimated with confidence intervals (Rothman, 1986; Levy and

Lemeshow, 1991). This describes most appropriately the effect of a given exposure on outcome.

Stratified analysis can be used once a crude estimate of effect has been made. The objectives of stratified analysis are to evaluate and control confounding, to describe effect measure modification and, in some cases, to standardise the results of different studies (Rothman, 1986).

There are several types of observational epidemiological study design which have been used to investigate diseases affecting man and animals including cohort studies, case-control studies and cross-sectional studies (Kelsey *et al.*, 1986; Rothman, 1986; Lilienfeld and Stolley, 1994; Thrusfield, 1995).

1.4.2.1. Cohort studies

In a cohort study concerned with the aetiology of a particular disease, an investigator begins with a group of individuals apparently free from the disease of interest (Kelsey *et al.*, 1986). The group of individuals is divided into two or more *cohorts* according to the level of their exposure to some hypothesised risk factor for the disease, and are followed through time to compare the incidence of the disease between cohorts (Kelsey *et al.*, 1986; Rothman, 1986). A good example of a cohort study is Snow's famous observations of the relatively higher rates of mortality from cholera among households supplied with drinking water by the Southwark and Vauxhall company than those supplied by the Lambeth company (Snow, 1855). In a retrospective cohort study, the investigator identifies a cohort of individuals based upon their attributes in the past and follows their disease experience, using existing data, until some point in the more recent past or up to the present time (Kelsey *et al.*, 1986).

Cohort studies are sometimes impossible to conduct because it is difficult to identify a cohort. They are typically expensive as they usually require the collection of large volumes of data prospectively over a long period of time (Thrusfield, 1995).

1.4.2.2. Case-control studies

In a case-control study, a group of diseased individuals (cases) is compared with a group of non-diseased individuals (controls) with respect to their exposure to some hypothesised risk factor (Thrusfield, 1995). Where differences exist between groups in terms of exposure to a risk factor, the ratio of risk is termed the odds ratio, or relative risk for exposure to that particular factor. Reid *et al.*, (1994) described a case-control study to identify risk factors for the development of sarcoid tumours among a closed population of donkeys. Cases were defined as animals developing a sarcoid six or more months after entering the population. Controls were animals which did not develop sarcoids. Case and control groups were then compared in terms of their exposure to potential risk factors for sarcoids.

Case control studies are often cheaper and easier to conduct than cohort studies, but do not give absolute measures of disease occurrence.

1.4.2.3. Cross-sectional studies

Cross-sectional studies, or prevalence surveys, record the frequency of disease in a population (Lilienfeld and Stolley, 1994). Cross-sectional studies involve taking a sample of individuals from a population and, at the same point in time, determining the presence or absence of disease and hypothesised risk factors simultaneously, and therefore provide no information about disease dynamics. However, if such studies are repeated at intervals they can highlight trends in disease prevalence among a population over time (Rothman, 1986). Sischo *et al.* (1993) described the use of a cross-sectional study to determine the prevalence of the major contagious pathogens of bovine mastitis, and the use of common mastitis control measures. In this study, mastitis control data were collected using a questionnaire mailed to a sample of dairy herd owners within the study area.

Under some circumstances, cross-sectional studies can be conceptualised as case-control studies where cases can be defined as individuals with disease at the time of the study and the controls are the remainder of the population (Rothman, 1986). Similarly, a study that begins with a cohort of healthy individuals, and then at some future point in time ascertains the disease status of the entire cohort, may also be considered a cross-sectional study (Rothman, 1986).

1.5. QUESTIONNAIRE SURVEYS

A questionnaire is a set of questions on a form, submitted to a number of people in order to collect statistical information (Collins English Dictionary and Thesaurus, 1993). Questionnaires are the main instrument for data collection in censuses and are used widely in epidemiological studies (Vaillancourt *et al.*, 1991; Bourque and Fielder, 1995). There are three broad types of questionnaire study relating to the way in which they are administered: Personal Interview (Collaborative Group for the Study of Stroke in Young Women, 1975; Baltazar *et al.*, 1988; Wells *et al.*, 1995), Telephone (Reeves *et al.*, 1991) and Mail (Spicer *et al.*, 1994; Singleton and Dobson, 1995; McGreevy *et al.*, 1995b). The personal interview was for a long time thought to be the only reliable method of collecting data using a questionnaire (Siemiatycki *et al.*, 1984). Telephone surveys were criticised because, until recently, many people did not have telephones, and those that did tended to have higher than average incomes and education (Dillman, 1978). Mailed questionnaire surveys have also been criticised because response rates tend to be low (Dillman, 1978,), and indeed, Bourque and Fielder (1995) state that an investigator using a single mailing with no incentives given to subjects to respond can expect no better than a 20% response rate. Again, until relatively recently, illiteracy among lower income bracket groups biased results obtained from mail surveys. These arguments against mail and telephone surveys are no longer valid, in this country at least, since 91% of households in Britain have a telephone (Central Statistical Office, 1995), and 92% of the adult population of Britain are literate (Central Statistical Office, 1995). In comparison to personal interviews, both mail and telephone surveys are very much cheaper to administer to the same number of subjects (Siemiatycki, 1979). Mail surveys have the added advantage that they allow study subjects to take their own time to consider answers to questions in the questionnaire. The objectives of any questionnaire study must be to collect sufficient quantities of relevant, reliable data as efficiently as possible (Dillman, 1978; Vaillancourt *et al.*, 1991).

1.5.1. Mailed Questionnaire Study Design

Careful selection and wording of questions is very important in questionnaire design. Open ended questions allow the user freedom of response and are good for recording continuous variables (Bourque and Fielder, 1995). However, coding of responses to open ended questions can be difficult for the purposes of data analysis (Dillman, 1978; Vaillancourt *et al.*, 1991). Closed ended questions are easier to code and are generally used where the response of the subjects can be anticipated. Closed ended questions can also act as prompts to study subjects where some of the options available may have been forgotten. Semi-open ended questions commonly offer a number of choices and leave the last choice as "Other, please specify". Ordering of questions, paper size and colour, format and length of questionnaire can all affect response rate (Dillman 1978). Childers and Ferrell (1979) showed a statistically significant increase in response rate in the USA when 8.5 × 11" paper was used in preference to 11 × 14" paper.

Response rates are thought be increased if questionnaires are presented in booklet form (Dillman, 1978; Vaillancourt *et al.*, 1991), and by the inclusion of a covering letter explaining the aims of the study, especially if the letter is hand signed. Questionnaires should be pretested on a group of individuals who are comparable to the target population, but ideally who are not part of the population themselves. The purpose of this is to evaluate the questionnaire in terms of the degree of understanding of each question and in the information it provides. Pretesting is an iterative process and many modifications to the original design may be necessary before a definitive version is agreed upon (Dillman, 1978). In addition, the inclusion of a return envelope with the questionnaire has been shown in studies in the USA to increase response rates (Table 12) (Choi *et al.*, 1990).

Inclusion in survey Mailing	Response rate
no return envelope	lowest
unpaid return envelope	
prepaid FREEPOST return envelope	↓
stamp on return envelope	
commemorative stamp on return envelope	highest

Table 12. Effects of inclusion of different types of return envelope on mailed survey response rates (Choi *et al.*, 1990).

Siemiatycki (1979) compared the effects on survey response of several follow-up strategies. It is generally accepted that response rates to questionnaire surveys are improved by up to eight follow-ups, after which the gains in response are negligibly small. Siemiatycki (1979) showed that high response rates to mailed questionnaires were achievable with careful questionnaire design and a structured follow-up combining mail and telephone reminders. Mailed questionnaires, as compared to telephone and personal interview, achieved the greatest validity of response.

1.6. SAMPLING

An important application of surveys in epidemiology is to estimate the prevalence of disease among a population by inference from observations made in a sample taken from the population (Cannon and Roe, 1982; Thrusfield, 1995). Censuses, which count all members of a population and give the exact distribution of variables within that population, are often prohibitively expensive or impossible to conduct (Thrusfield, 1995). Sample surveys are designed to make an estimate, to a desired degree of accuracy, of a variable within a population by looking at a representative subset of the population (Levy and Lemeshow, 1991).

Sampling strategy, the size of sample and the method by which it is taken, depends upon the expected size of the population and the expected prevalence of the variable(s) of interest (Macro International Inc., 1996). In addition, the desired accuracy of the estimate and the desired confidence in that estimate will both influence sample size (Canon and Roe, 1982; Levy and Lemeshow, 1991). The aim is to collect as representative as possible a sample of the total population. This may involve simple random sampling, where study units are selected from the population purely at random. Alternatively, varying levels of stratification on known variables in the population may be employed to ensure representation from all strata within the population (Cannon and Roe, 1982; Thrusfield, 1995). This is often the case where the stratifying variable is thought to influence the variable(s) of interest to the study. Again the selection of study subjects within strata may also vary depending on the aims of the study (Canon and Roe, 1982; Levy and Lemeshow, 1991). Proportional allocation selects study subjects from strata in proportion to the overall size of the stratum in relation to the total population. Allocation to strata may also be based upon formulae which calculate, for a given sample size, the optimal numbers in each stratum to give an estimated total, mean or proportion with the lowest variance (Levy and Lemeshow, 1991).

1.7. PRACTICE-BASED RESEARCH NETWORKS

Practice-Based Research Networks, or Sentinel Practice Research Networks or General Practitioner Spotter Practice Schemes, are groups of practices organised to collect data about problems in clinical practice (Nutting and Green, 1994). Initially launched in human medicine in the 1970s, such networks evolved in an attempt to reunite clinical medical practice with academic research (Bartelds, 1993; Nutting and Green, 1994).

There are many motivations, to both academic researchers and practising clinicians, for conducting practice based research. In the case of the academic researcher, hospital-based or referral centre-based studies suffer from Berkson's bias, i.e. mild cases of disease rarely reach these institutions (Senturia *et al.*, 1994). In the case of veterinary science in the UK, and in particular equine veterinary science, this bias is accentuated by financial considerations associated with referral to secondary or tertiary health care centres. Practising veterinarians represent a major source of data regarding the incidence of diseases among horses and can be used to determine the most prevalent and serious of these (Traub-Dargatz *et al.*, 1991). In the case of the practitioner, motivation comes from a desire to be involved in research while continuing to practice, but being unable to do so alone because of time constraints and lacking study design and data analysis skills (Niebauer and Nutting, 1994; Jones, 1995). Nutting and Green (1994) and Green *et al.* (1994) identify two problems relating to the relationship between academic institutions and general medical practice:

1) The belief that general primary care practice is best taught by a series of specialists giving a summary of the 'basics' of their speciality.

2) The belief that specialist research is broadly applicable to primary care practice.

In addition, they cite a somewhat dismissive attitude towards general practice within academic institutions. Therefore, practitioners view practice-based research not only as an opportunity to be involved in the process of data collection, but also to influence the subject of investigation. In so doing, they gain insight into problems which confront them most frequently (Niebauer and Nutting, 1994).

Most practice-based research networks exist as formally recognised groups of practices affiliated to some academic institution. Generally, studies are designed by academics in consultation with practice-based clinicians. Data are then collected by practice-based clinicians, managed and analysed by academics and subsequently discussed and published by both groups (Senturia *et al.*, 1994). There are many examples in human medicine including: The Ambulatory Sentinel Practice Network (Green *et al.*, 1994) involving 72 practices in 32 US states and 4 Canadian provinces; the Paediatric Practice Research Group (Senturia *et al.*, 1994) involving 35 Chicago area practices; The Dutch Sentinel Practice Network (Bartelds, 1993); General Practitioner Spotter Practice Schemes in the UK (Chakraverty, 1994; Salmon, 1997) and other examples in Australia (Del-Mar and Pincus, 1995) and Germany (Schlaud *et al.*, 1995). Founded in 1978, The Ambulatory Sentinel Practice Network, had conducted 29 studies by 1994 into such problems as headache, spontaneous abortion, chest pain and HIV (Green *et al.*, 1994).

Senturia *et al.* (1994) discuss sampling issues in practice-based research networks, stating that practice-based research has the potential to be applicable to all practices and even the entire population. This, however, is dependent on adopting sampling strategies that recruit patients to studies in as unbiased a fashion as possible within the constraints of funding, necessary patient flow and staff co-operation in the practices involved. The importance of questionnaire design and pretesting and of taking geographically and seasonally representative samples is emphasised. Response rates from patients are greatly improved where time is spent in maximising practitioner enthusiasm, and orientating practice staff to the subject and goals of the study. Where funding is available, further improvements in response rates can be achieved by financial compensation of patients for time invested in the study, and by the deployment of specialist research assistants in practices to co-ordinate data collection.

In order to evaluate how representative of typical practice, practice-based research networks were, Green *et al.* (1993) replicated the 1990 National Ambulatory Medical

Care Survey in the Ambulatory Sentinel Practice Network. The results showed that the two samples differed only slightly and the authors concluded that practice-based research networks were sufficiently representative to serve as reference groups for the investigation of primary medical care practice.

In veterinary medicine, many practitioners will, at some stage, have taken part in new product trials. This might be termed a form of practice-based research where new products, in their final stages of testing, are supplied to practices free of charge or at reduced rates in exchange for information concerning their ease of use and efficacy (Jones, 1995). There are several examples of studies in which data has been, at least in part, collected from practitioners (Kornblatt and Schantz, 1980; Hoffsis *et al.*, 1983; Barrett *et al.*, 1992, Moll *et al.*, 1995; Vaughan and Mullville, 1995; Haws and Anthony, 1996). However, these studies have all relied on a one-off survey of practitioners rather than recruiting a group of practices to supply data at regular intervals over a period of time. Reports of formally established groups of veterinary practices supplying data related to animal diseases continually or regularly in a study are scarce. Edney and Smith (1986) recruited eleven veterinary practices to complete survey forms in a study of obesity for each dog seen over a period of six months. Cohen (1994) and Cohen *et al.*, (1995) established extensive networks of members of the American Association of Equine Practitioners to conduct successful studies into farm management factors associated with death and disease in foals (1994) and management factors associated with the development of colic in horses (1995). Johnston (1994) and Johnston *et al.*, (1995) described 'The Confidential Enquiry into Perioperative Equine Fatalities' in which sixty two equine veterinary clinics in the UK were recruited to supply data continually on all equine anaesthetics - this study has been very successful has subsequently been extended. Nevertheless, there is still very little veterinary literature on practice-based research. Slater and Boothe (1995) advocate continuing education of academics, practising clinicians and research funding bodies to emphasise the scope and importance of practice-based research.

1.8. GEOGRAPHICAL INFORMATION SYSTEMS

Haviland (1892) in his work 'The Geographical Distribution of Disease in Great Britain' wrote the following short list of points which underline the importance of mapping in the understanding of disease:

> 1) To ascertain the geographical distribution of a disease is the first step towards a knowledge of its natural history, as it is in that of the fauna and flora of a district, a continent, or of the world.
>
> 2) Thus to discover where diseases prevail, and where they do not thrive.
>
> 3) To search for, in those localities, the causes of prevalence, or absence, or scarcity, whether they reside in their local airs or waters, or are due to local climates, geological structure, physical configuration, or social surroundings.

A Geographical Information System (GIS) is a computer system that stores, manages and displays spatially referenced data (Paterson, 1995). A GIS can generate two- or three-dimensional images of an area on the computer screen, showing natural and artificial features. Geographical information is usually stored and displayed in layers of similar type, for example, coastline and regional boundaries may be stored in one layer, waterways in another layer and roads and railways in yet another layer (Paterson, 1995; Clifton-Hadley, 1995). The GIS is able to display many layers superimposed on one another. In order to do this, the GIS stores all geographical data as digital code so as to be able to represent accurately the spatial relationship between objects, within and between layers. Using specialised hardware and software, geographical data from a variety of sources, including maps, satellite images and aerial photographs can be digitised or scanned to be used by GIS. Data can be stored in two digital formats, raster or vector (Clifton-Hadley, 1995). In raster format, a grid is superimposed on a geographical area and the resolution is determined by the cell size of the grid. This is the usual format for photographic and satellite data. Vector format stores information as points, which can be joined to create lines and polygons, and resolution is determined by the number of points digitised to represent a feature. Geographical data in digital form are readily available, though expensive especially if high detail and resolution are required. Field data can be stored and displayed by GIS if they are spatially referenced. Where observations are made at farm, building or holding level the postcode or zip code can be geocoded to grid references which can then be used by GIS to display the data. Alternatively, remote sensing, making use of satellites and global positioning systems to locate points of interest accurately on the earth's surface, may be employed to generate digital data for GIS display and analysis (Hugh-Jones, 1991). There are several proprietary GIS software packages available and they are becoming increasingly sophisticated (Pfeiffer *et al.*, 1994).

Although still lacking features for advanced spatial analysis (Paterson, 1995), there are many features visualising and analysing data (Pfeiffer *et al.*, 1994). Tools allow zooming to show data in ranges of detail, buffering to create artificial boundaries around objects, and the creation of various types of thematic map (Dent, 1985). The International Cartographic Association defines thematic maps as "Maps designed to show special features". This involves the mapping of physical and cultural features, such as shading areas according to population density so that differences between areas, difficult to interpret in a table or graph, can easily be seen. Figure 1 depicts data from Tables 4 and 5 showing the overall equine population density of Britain according to Ministry of Agriculture and Scottish Office returns for 1994. Measurements to calculate the distance between objects, the length of lines and the area of objects can be performed within and between layers (Pfeiffer *et al.*, 1994). GIS have been widely used in many areas for a number of years. Marketing has for a long time made use of GIS for defining market areas, sales territories and assessing catchment areas (Lilly, 1995). Major oil companies make extensive use of GIS to map oil fields and drilling sites (Wilson, 1995). Cornelius (1992) and Zisman (1992) describe applications in environmental management and conservation monitoring. In addition, the police have made use of GIS as a management tool for the most efficient deployment of forces within areas (Campbell, 1992).

In human medicine, GIS has been used in mapping and planning the distribution of health care resources in relation to demographic characteristics (Lovett, 1992; Paage, 1995). Jones and Bentham (1995) describe the use of GIS to analyse the effect of time taken by ambulances to reach road traffic victims and convey them to hospitals on patient mortality. Other studies have used GIS as an epidemiological tool to investigate associations between asthma and factory emissions (Dunn *et al.*, 1995) and for measles surveillance among children (Solarsh and Dammann, 1992). In 1996, Colledge *et al.* gave an account of the

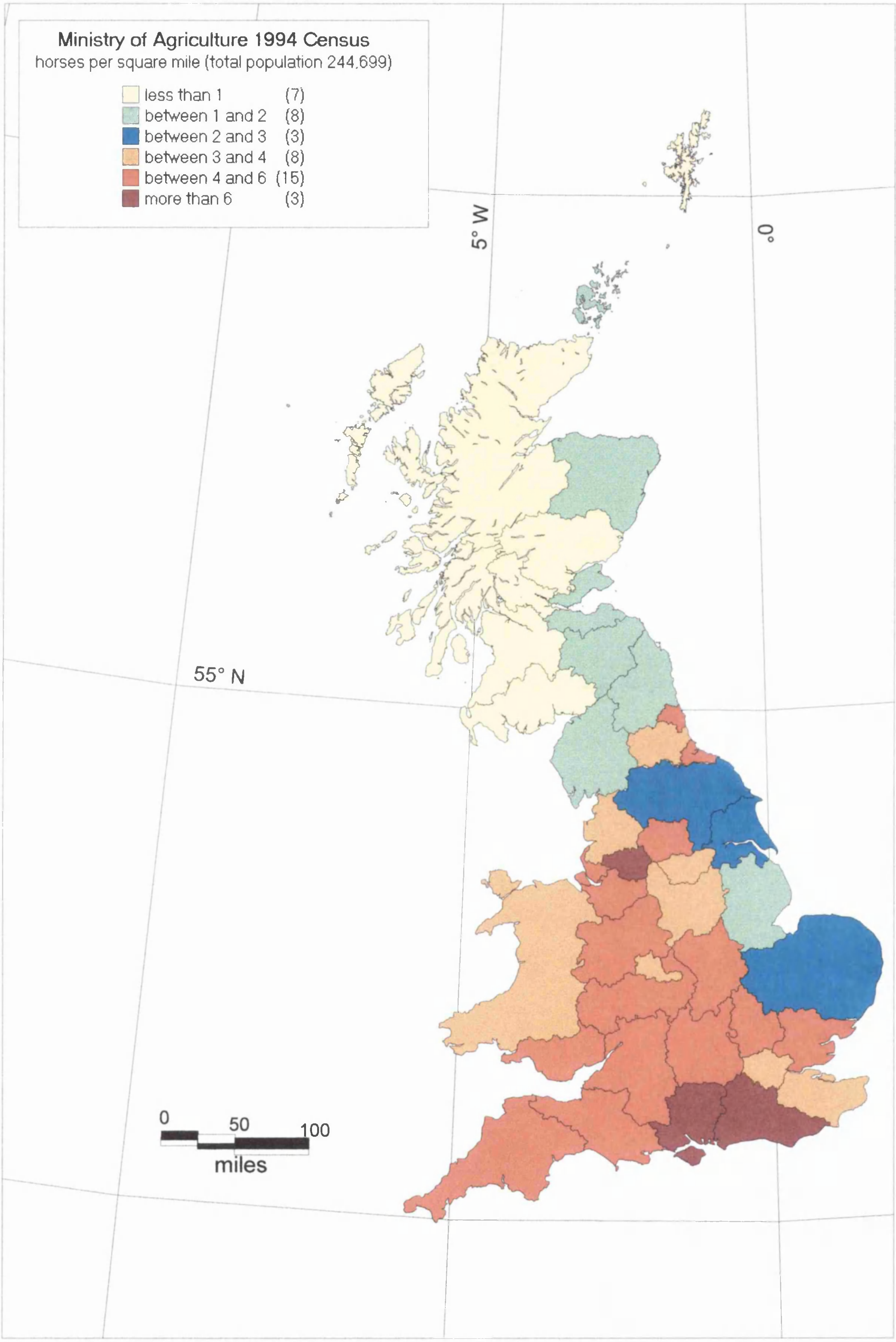


Figure 1. The equine population density of Britain according to agricultural returns for 1994 (Ministry of Agriculture, Fisheries and Food, 1996; The Scottish Office Agriculture, Environment and Fisheries Department, 1996a).

development of the use of GIS in general medical practice as a tool for clinical and resource decision making.

In veterinary medicine, Marsh *et al.* (1991) described the use of GIS to study the spread of Aujeszsky's disease virus among swine herds across Minnesota. Lessard *et al.* (1990) used GIS to study the distributions of cattle and tick populations of Africa in investigating the epidemiology of cattle diseases caused by *Theileria parva*, and the same authors discuss the use of GIS in combination with other data as a means of decision support for controlling *Theileria parva* associated disease. The work described by Sanson *et al.* (1991) and Morris *et al.* (1993) of the development of EpiMAN, a system combining a database management system, a GIS, a simulation model and an expert system for the management of a foot-and-mouth disease outbreak is an excellent example of the integrated application of GIS and information technology to the control of animal disease. This system integrates large volumes of data from different sources, and maps an epidemic of foot and mouth disease as it occurs. The effects of various control measures can be simulated, so that the most effective can be implemented in any given situation.

1.9. INTEGRATED SYSTEMS FOR INFORMATION DELIVERY

The combination of a database management system, a GIS, a simulation model and an expert system (*vide supra*, Chapter 1.8) constitutes an integrated approach to the delivery of epidemiological information (Sanson *et al.*, 1991; Morris *et al.*, 1993). Also within the context of infectious disease, Forsyth *et al.* (1992) described the development of a 'hybrid information system' integrating hypertext (Nielsen, 1990; Woodhead, 1991) and an expert system (Turban, 1993) with the intended function of providing an intelligent library containing computer-based, easily accessible information on animal trypanosomiasis. Revie *et al.* (1996) went on to describe hybrid information systems as computer based systems for decision support combining different types of information model. In veterinary medicine, the models of interest are generally those for the prediction and management of disease (Michael, 1993). For the clinician, these models can provide quantitative assessments of associations between perceived risks and outcomes, and are usually based upon censored data relating to health and disease in large groups of individuals (Cecile and McCleish, 1990). Models based purely on opinion are often referred to as expert systems (Turban, 1993). Heuristics, derived from the balance of 'expert opinion' in a given domain or field of knowledge, generally form the inferential structure of these models. The heuristics may exist as a series of simple production rules, or as a more complex system which takes into account interaction between parameters, subjective weighting and probabilities. In some instances a combination of these model types may be encountered.

Disease modelling can have several aims, for example: to improve understanding of disease transmission (Anderson, 1988; Anderson, 1989), to plan disease control strategies (Gettinby *et al.*, 1989), to quantify risk factors for disease (Reeves and Smith, 1995; Reid *et al.*, 1995); and, ultimately, to improve the efficiency of diagnosis, management, treatment and prevention of disease. Expert systems aid clinicians in reaching diagnoses, and in making decisions concerning management, treatment and prevention of particular diseases (Pople, 1982; Miller and Masserie, 1989; Weiding *et al.*, 1990; Lemeshow *et al.*, 1994). In the veterinary domain, the majority of mathematical and statistical models developed hitherto are concerned with parasitic disease (Smith and Grenfell, 1994), whilst expert systems have more frequently been developed to provide guidance in production animal economics (Schmisseur *et al.* 1989, Vos *et al.*, 1990, Domecq *et al.* 1991), rather than to support specific disease diagnosis/management decisions, although some examples exist such as Associate (Carter-Melloy Corporation, P.O. Box 9219, College Station, Texas. 77842) and BOVID (Blood, 1991).

EQWISE, Equine Welfare Information System and Expert (Mellor *et al.*, 1994), was developed as an integrated Microsoft Windows environment combining an electronic library, a rudimentary GIS and an equine cough consultation system (Revie *et al.*, 1994). Mellor *et al.* (1995) and Reid *et al.* (1996) described the further development of EQWISE as a knowledge-based medium for the delivery of different types of disease model and associated information. The motivation for this was to increase the utility and success of disease models; a model that is not used is redundant. In order to achieve this, a 'unifying medium', in this case hypertext, was used to link the component parts and produce a seamlessly integrated system (Mellor *et al.*, 1995; Reid *et al.*, 1996).

1.10. SUMMARY

For any particular species the focus of research and teaching should be orientated toward the most common disease problems (Traub-Dargatz *et al.*, 1991). In the case of equine diseases in the UK, there is a paucity of data relating to their comparative prevalence and importance. It is insufficient to describe the importance of these diseases purely in relative terms. Quantitative assessment of disease prevalence and impact are essential for health monitoring, preventive medical strategy and contingency planning. Up until the end of the 19th Century, accurate records of the equine population were kept because horses were essential for the conduction of every day life. However, the last census of horses in the UK was taken in 1934 (Urquhart, 1983), since when the only existing records of the equine population been derived from agricultural returns. These figures however, are by no means true representations of the equine population as many horses are kept on land which is not used for commercial agricultural purposes. This is evidenced by the discrepancies between the agricultural returns for horses kept in Scotland for 1994 (Table 5), which stated that there were 18,719 horses in Scotland, and the British Horse Society survey of horse numbers in Scotland in the early 1990s (Table 6) which stated that there were 41,072 horses in Scotland excluding the Highland region, Orkney, Shetland and the Western Isles.

Green *et al.* (1994) have shown that large quantities of data relating to diseases among populations can be collected by organising general practitioners into research networks. The success of such ventures depends upon very careful study design. Sampling methods must be used to select a representative sample, so that findings may be extrapolated to apply to the whole population. Painstaking attention must be paid to issues of questionnaire design and implementation to ensure good response rates and data validity.

Geographical Information Systems represent a powerful epidemiological tool for the visualisation and analysis of spatially referenced data (Clifton-Hadley, 1995). They provide a means of study for the spatial associations between disease occurrence and geographically variable factors (Pfeiffer *et al.*, 1994). If studies of this nature are to achieve their stated aims: to direct research funding to the most important disease problems, careful attention must be paid to the delivery and dissemination of results and conclusions (Reid *et al.*, 1996). The development of widely available, intuitive, integrated information systems combining knowledge and data from diverse sources will maximise the impact of these studies.

It is against this background that the current study was performed with the aims of:

1) By means of a series of mailed questionnaire studies of veterinarians and horse owners to collect data to:

i) estimate and describe the size and geographical distribution of the equine population of Scotland and Northern England

ii) estimate and describe the use and management experience of this population

iii) estimate and describe the disease experience of this population

2) By the use of computer software (database, spreadsheet and Geographic Information System) examine, analyse and present these data in such a way as to be suitable for integration with electronic reference material and decision support modules to engender a seamless environment for the interrogation of knowledge relating to equine health and welfare, thereby to identify the most significant factors influencing the well-being of horses and make recommendations for the future use of research resources.

CHAPTER 2

GENERAL MATERIALS AND METHODS

2.1. INTRODUCTION

Agricultural returns from the Ministry of Agriculture Fisheries and Food and from the Scottish Office Agriculture, Environment and Fisheries Department today provide the only published statistics of horses kept in the UK. Only animals kept on commercial agricultural premises are recorded, and therefore these figures cannot be regarded as being an accurate estimate of the total equine population because many horses are kept on land which is not used for commercial agricultural purposes. However, inspection of the figures for Scotland for the last 5 years suggests an annual increase in the equine population of approximately 8%, despite the fact that horses are now used almost entirely for recreation. The last census of horses in the UK, taken in 1934 when there were considered to be 1,278,341 animals (Urquhart, 1983), represents the most up to date estimate of the total equine population.

Traub-Dargatz *et al.* (1991) reported the results of a study conducted in the USA among equine practitioners to record the relative prevalence of medical diseases affecting adult horses. A previous study had recorded the opinions of American horse owners as to which were the most important equine diseases (Underhill and Showalter, 1989). No such comparative studies have been undertaken in the UK.

Disease surveillance consumes vast resources both financially and in terms of staff time (Davies, 1983). The state veterinary service monitors the notifiable equine diseases which are: African horse sickness, anthrax, Aujeszky's disease, contagious equine metritis, dourine, epizootic lymphangitis, equine infectious anaemia, equine viral encephalomyelitis, glanders and farcy, rabies, vesicular stomatitis and warble fly. 'Animal Health 1994, The Report of the Chief Veterinary Officer' contained information on the status of recorded equine diseases which are presented in Table 13. Since these data were published, there have been several cases of contagious equine metritis in the UK.

Disease	History
African horse sickness*	never recorded
Anthrax*	last recorded in horses in 1986
Aujeszky's disease*	never recorded
Contagious equine metritis*	last isolation 1986 (Thoroughbreds), 1990 (non-Thoroughbreds)
Dourine*	never recorded
Epizootic lymphangitis*	last recorded in 1906
Equine viral encephalomyelitis* (includes Venezuelan equine encephalomyelitis)	never recorded
Equine herpes virus	sporadic incidence
Equine infectious anaemia*	last recorded in 1976
Equine influenza	sporadic incidence
Equine mange	last recorded in 1977
Equine piroplasmosis (*Babesia caballi and Babesia equi*)	never recorded
Equine viral arteritis	sporadic incidence
Getah*	never recorded
Glanders (including farcy)*	last recorded in 1928
Japanese B encephalitis*	never recorded
Rabies*	last recorded in horses in 1921
Salmonella equine abortus	never recorded
Surra	never recorded
Vesicular stomatitis*	never recorded

Table 13. UK situation pertaining to the exotic equine diseases in 1994 (Ministry of Agriculture Fisheries and Food, Scottish Office Agriculture, Environment and Fisheries Department, Welsh Office Agricultural Department 1995).
* notifiable disease.

Although there is an international reporting system for equine infectious diseases operated from a centre in Suffolk, England, other diseases are not recorded at all. An alternative to surveillance is to mount point prevalence studies at specific intervals in time to monitor the disease situation (Davies, 1983). However, without a knowledge of the denominator i.e. the total number of animals in the population, it is impossible to assess both the animal health significance and economic implications of diseases. Resources can then be focused on those diseases most worthy of attention.

Green *et al.* (1993, 1994) have shown that sentinel practice based research can provide useful, representative information about disease in the general population. In this setting, carefully designed and administered questionnaires are a prerequisite for achieving high response rates and good quality data. In comparison to personal interview and telephone strategies, the mail method of questionnaire administration has been shown to produce cheaper and more valid responses (Siemiatycki, 1979; Siemiatycki *et al.*, 1984).

2.2. THE HOME OF REST FOR HORSES STUDY OF EQUINE WELFARE

2.2.1. The Home of Rest for Horses

The Home of Rest for Horses is a charitable organisation concerned with equine welfare. Originally founded in 1886, The Home of Rest for Horses began making equine welfare grants in the 1960s. Initially, these grants were made for the building of loose boxes at The Animal Health Trust and The Royal Veterinary College for the pre- and post-operative care of horses. Subsequently, support was provided for The British Horse Society and other organisations concerned with the interests of horses and ponies in the UK. From 1982 onwards, The Home of Rest for Horses has made grants to veterinary establishments to allow specific work to be undertaken. The terms of such grants were that such work should benefit the welfare of all types of horses. In addition, surgical and invasive procedures were not permitted under the terms of such grants. Still more recently, large sums have been provided for the upgrading and building of equine medical and surgical facilities in veterinary institutions of excellence.

Funding from The Home of Rest for Horses has in the past supported many investigative studies of various equine diseases. Areas of particular interest have been: lameness, especially laminitis, navicular disease and tendon injury; respiratory disease, especially chronic obstructive pulmonary disease (COPD); grass sickness, alimentary disease, cauda equina neuritis, rhabdomyolysis, strangles and valvular heart disease. All these studies were conducted in university veterinary institutions or at The Animal Health Trust. In 1992, motivated by the need to target funding to benefit the welfare of all types of horses, The Home of Rest for Horses supported the current study to establish the most important diseases affecting the British equine population.

2.2.2. General Study Design

A study was planned to investigate the disease status of the equine population of Scotland and Northern England. It was decided that the study should be carried out through both veterinary practitioners and horse owners and should estimate the size and geographical distribution of the population. In addition, data on management practices, feeding and levels of activity should be collected and records made of the frequency with which different categories of disease were diagnosed. The overall aim of the study should be to collate and analyse this information in order to establish the most important diseases affecting the equine population. Factors associated with management, feeding, level of activity and geographical location affecting disease prevalence should also be identified.

The initial plan of investigation was to recruit a number of veterinary practices with which the University of Glasgow Veterinary School had close relations. These practices would be organised to establish a sentinel practice based research network (Chapter 1.7). Each practice would supply information concerning the nature and quantity of equine veterinary work undertaken. In addition, each practice would be asked to select a random sample of horse owners registered with them on the basis of level of activity of their horses. These owners would be solicited to supply information on management and feeding practices as well as disease occurrence among their animals.

In response to concerns about bias which might arise from: 1) involving only practices with which the University of Glasgow Veterinary School had close relations and, 2) allowing practitioners to be responsible for the selection of horse owning clients registered with them, the initial plan of investigation was refined and practices were selected at random. An initial, short questionnaire, mailed to all horse owners registered with each practice was used to provide a large volume of general information and act as a recruitment exercise for participants in a more detailed second study. Participants in the second study were selected on the basis of general information already supplied. In this way, high response rates to the second study could be expected as the subjects had already indicated their willingness to take part.

The final study design was organised to be implemented sequentially in phases and is summarised below (each phase is discussed in detail in Chapters 3, 4, 5 and 6):

Phase Ia Survey of veterinary practices. A sample of veterinary practices providing care for horses in Scotland and Northern England was selected randomly to participate in the study. They were asked to complete a short questionnaire concerning quantity and nature of equine work undertaken in their practice. In addition, they were asked to supply a list of the names and addresses of all horse-owning clients registered with their practice.

Phase Ib Survey of all veterinary practices. As a follow-up to phase Ia, in order to make as accurate as possible an estimate of the total equine population of the area, all veterinary practices providing care for horses in Scotland and Northern England were surveyed. Practitioners were asked only three questions: How many horse-owning clients were registered with the practice?, How many horses the practice provided care for? and, How large a geographical area was covered by the practice?

Phase II Survey of horse owners. A simple, short questionnaire concerning numbers, management and use of horses was mailed to every horse-owner registered with a practice which had responded to phase Ia of the study. Participants were asked to indicate on their questionnaire whether they were prepared to take part in a second, more detailed, study at a later date.

Phase III Cross-sectional case study of veterinary practices. Practices responding to phase Ia were asked to complete four sets of ten case sheets, one set each quarter, over a period of one year. Sets of case sheets were mailed to each participating practice in autumn, winter, spring and summer. One case sheet was completed for each of the first ten horses seen, for whatever reason, after the set of case sheets arrived in the mail.

Phase IV In depth survey of horse owners. A stratified random sample of horse owners, who indicated in phase II their willingness to participate further in the study, was selected for phase IV. These owners were asked to complete one general questionnaire concerning management of all their horses and one fact sheet for each horse owned.

2.2.3. Recruitment of Veterinary Practices

'The Directory of Veterinary Practices 1992' (Hall, 1991) is a listing of all veterinary practices in the UK. Each entry consists of the practice address and telephone number and the names of the veterinary surgeons in the practice. A table is used to indicate the nature of work undertaken by the practice - there is a separate column for horse work. The list is broken down into geographical areas: England by county and some major towns; Scotland by region, Edinburgh and Glasgow; Wales and Northern Ireland by county. The study population was defined as those practices which indicated that they undertook equine work, listed within Cleveland, Cumbria, Durham, Northumberland, Tyne and Wear and all of Scotland. There were 188 practices which met these criteria. These practices were each assigned a code number from 1 - 188. Twenty five practices were selected, using a random number generator in Microsoft Excel (Microsoft Corporation), to provide a ten per cent sample of the total population, allowing for non-response and unusable replies. Initial contact with these practices was by letter explaining the background, aims and expected benefits of the study (Appendix 1). The letter was addressed from Professor Love, the head of the equine clinical group at the University of Glasgow Veterinary School, to the principal of each practice. The use of a well-known name on the contact letter was considered likely to have a positive effect on participation rate. A follow-up telephone call to each practice was made within two weeks of mailing the letter, again by Professor Love. All practices asserted their willingness to participate in the study at this stage.

2.3. HARDWARE AND SOFTWARE

The study began in October 1992. At this stage, it was considered possible that some data would be collected in the field. The requirements were: 1) to develop and produce questionnaires, letters and mailing labels and 2) to store and analyse data. With this in mind a Compaq LTE LITE/25 laptop computer with desktop expansion base (Compaq Corporation) and external Panasonic PanSync C1381 14" VGA colour monitor was purchased. This machine was supplied with 25 MHz 386 processor, 4 Mb RAM, 500 Kb video memory, 84 Mb hard disk and 1.44 Mb floppy disk drive. MS-DOS 5.0 (disk operating system), Microsoft Windows 3.0 and Microsoft Word for Windows 2.0 (word processing software) were pre-installed on this computer (Microsoft Corporation).

Microsoft Excel 4.0 (spreadsheet software) was installed and used for random number generation. In January 1993, the operating system was upgraded to Windows for Workgroups 3.11 (Microsoft Corporation), to allow printer and file sharing with other members of the research group. A Hewlett-Packard ScanJet IIC flatbed scanner (Hewlett-Packard Company) connected to an Elonex PC 450 personal computer (486DX 66 MHz, 8 Mb RAM, 200 Mb hard disk) (Elonex plc) running Deskscan II software (Hewlett-Packard Company) was used to scan images from letterheads for incorporation into questionnaires. Questionnaires, letterheads, accompanying letters and mailing labels were written and developed in Microsoft Word for Windows 2.0 (Microsoft Corporation). A Hewlett-Packard LaserJet III laser printer (Hewlett-Packard Company) was used for all printing of questionnaires, letters and labels.

A4 (210 × 297 mm), 90 GM^2, Logic Premier super white copier/laser paper (Neat Ideas) was used for printing questionnaires and accompanying letters. A4 (210 × 297 mm) sheets (16 labels per sheet) of self adhesive laser labels (The Stampiton group of Companies Ltd.) were used to print return address labels. Prestige high white self-seal envelopes (162 × 229 mm) (Neat Ideas) were used for mailing questionnaires to veterinarians and horse owners. Merlin white opaqued fastseal envelopes (110 × 220 mm) (Neat Ideas) were enclosed with questionnaire mailings as self-addressed, pre-paid return envelopes.

In April 1993 Microsoft Access 1.0 (relational database management software) (Microsoft Corporation) was installed to store and analyse data generated by the study. Microsoft Access allows the creation of multiple tables linked by common fields, development of forms for data entry and analysis, graphical query design, and output in the form of graphs and reports.

Due to constraints of hard disk space and technological advances, the Compaq laptop computer was replaced in May 1994. The replacement system was a Genie Medium Tower Pentium PCI P5/90 Personal Computer (Viglen Ltd.). The specifications for this system were 90 MHz Pentium processor, 32 Mb RAM, 1 Mb video memory, 1 Gb hard disk, 1.44 Mb floppy disk drive, CD-ROM drive and Envy 15P (15") Super VGA colour monitor. The system ran MS-DOS 6.2 and Windows 3.1 (Microsoft Corporation). A 3Com Ethernet card and Novell Netware software were installed to provide connection to local area networks and the Internet.

MapInfo 3.0 for Windows (desktop mapping software) (MapInfo Corporation) was installed in September 1994. Digitised boundary data of Scotland at regional level and of Cleveland, Cumbria, Durham, Northumberland and Tyne and Wear (100m resolution) were ordered from Graphical Data Capture Ltd. at the same time and were received during February 1995. MapInfo is a Geographical Information System (GIS) in which maps can be created to present and analyse spatially referenced data (Chapter 1.8.). Postcodes of veterinary practices and horse owners were converted into grid references (geocoded) by Graphical Data Capture Ltd. Survey data were then displayed and analysed over background maps of Scottish regions and northern English counties.

In January 1995 upgrades to MapInfo 3.02 (MapInfo Corporation), Microsoft Excel 5.0 and Microsoft Access 2.0 (Microsoft Corporation) were made. At this stage, data stored in Microsoft Access were most easily transferred to be displayed in maps in MapInfo by first converting tables to Microsoft Excel spreadsheets. The installation of MapInfo SQL DataLink 1.2 for Windows (MapInfo Corporation) in July 1995 allowed direct connection between MapInfo and Microsoft Access.

In January 1996 Microsoft Windows 3.1 was upgraded to Windows 95 (Microsoft Corporation). Existing Microsoft software packages were upgraded to Microsoft Office Professional for Windows 95 (comprising Microsoft Word 7.0, Microsoft Excel 7.0, Microsoft Access 7.0, Microsoft Powerpoint 7.0 and Microsoft Schedule+ 7.0). MapInfo 3.02 was upgraded to MapInfo Professional 4.0 for Windows 95 (MapInfo Corporation) which came with an object database connectivity (ODBC) feature allowing even closer links with Microsoft Access databases. These programmes formed an integrated system with each component part able to link directly to any other, thus greatly enhancing the storage, manipulation, presentation and analysis of data.

2.4. GENERAL QUESTIONNAIRE DESIGN AND IMPLEMENTATION

2.4.1. Introduction

As a result of the limited availability of personnel, the design, production and implementation of questionnaires were carried out solely by the author. The issues relating to the design of questionnaires for each phase of the study will be discussed in detail at the beginning of Chapters 3, 4, 5 and 6. Questionnaires were developed following, as closely as possible, standard guidelines (Dillman, 1978; Vaillancourt *et al.*, 1991) designed to maximise response rates. In brief, the general recommendations are:

1) Response rates to short questionnaires are likely to be higher than to long questionnaires because study subjects perceive a lower required time commitment in responding.
2) Questionnaires in booklet form have been shown to produce higher response rates than sheets of paper simply stapled together.
3) A twelve page questionnaire booklet, if it is printed on paper slightly lighter than the standard 75 GM^2, with an accompanying letter and return envelope, can still be mailed at the standard letter rate, thus minimising postal charges which are always the biggest costs in a mail survey.
4) Questionnaires with horizontal and vertical continuity in the spacing of question numbers and spaces for responses are believed to create a more professional impression and may increase response rates.
5) Hand signing and hand addressing letters to study subjects is believed to convey an impression of individual attention and may increase response rates.

2.4.2. Format

All questionnaires were designed using Microsoft Word 2.0 (Microsoft Corporation) word processing software. Questionnaires were printed on both sides of standard A4 (210 × 297 mm) paper. In order to increase response, and obviate the need for time consuming stapling, each questionnaire was limited to 2 sides (one sheet) of paper. With the exception of case sheets in phase III and fact sheets in phase IV, questionnaires were printed landscape and designed to be folded down the middle in booklet form (148 × 210 mm).

The one page questionnaires used for The Home of Rest for Horses study were produced on heavier, 90 GM^2 white paper, intended to give an impression of higher quality. A one page questionnaire in booklet form, a folded accompanying letter on the same 90 GM^2 paper and a 110 × 220 mm return envelope fitted easily into a 162 × 229 mm envelope and could still be mailed at the minimum letter rate.

Case sheets for phase III and fact sheets for phase IV were printed portrait. In both studies the same set of questions was printed on each sheet of paper to record details about different individual animals, and the most intuitive format was a simple case or fact sheet. In these instances, multiple copies, using the same 90 GM^2 paper, were mailed to veterinarians (ten case sheets each mailing) and horse owners (one fact sheet for each horse owned - taken from their response to phase II), even though the use of lighter paper might have slightly reduced mailing costs.

The title of 'The Home of Rest for Horses Study of Equine Welfare' was agreed. An electronic version of The Home of Rest for Horses logo was produced by scanning the image from a letterhead using a Hewlett-Packard ScanJet IIC flatbed scanner (Hewlett-Packard Company). The image was edited in Paintbrush, a graphics package forming part of the Microsoft Windows (Microsoft Corporation) system. The front page of each booklet questionnaire bore The Home of Rest for Horses logo above the study title above the University of Glasgow logo (available in electronic format from the University of Glasgow) above the departmental address (Appendices 3, 9 and 18). Due to space constraints, only The Home of Rest for Horses logo and the study title appeared on individual case and fact sheets in phases III and IV (Appendices 14 and 19).

A unique identification number was assigned to each veterinary practice in the study area, and both questionnaires and case sheets were marked with this identification number prior to mailing. Horse owners were identified with a unique six digit number, derived in part from the practice with which they were registered. The first two digits of the owner number were the same as the practice number, the remaining four digits identified each owner within that practice. Owner numbers were marked on all questionnaires and fact sheets prior to mailing.

2.4.3. Questions

In order to enable accurate coding and analysis of responses, the type of questions used varied according to the anticipated response. Where a numerical response was expected, an open ended question was used, for example: *How many horses, ponies and donkeys do you own?* Semi-open ended questions were used for information about management, feeding and level of activity of horses. These questions offered a series of choices with one choice being: '*Other (please specify)*'. In general questions were ordered so that those about attributes of animals such as number owned or treated, age and sex, preceded questions concerning 'behaviour' such as treatment or feeding practices. It was considered that this would establish a logical flow of questioning in which the early, easy to answer, factual questions would prompt study subjects to think about the more subjective questions that followed.

All questions were typed in Times New Roman font, 12 point characters. Questions were spaced evenly on each page with spaces for responses. In each questionnaire, care was taken to establish vertical continuity in the alignment of question numbers, questions and response categories to reduce the risk of inadvertent omission of questions by study subjects.

All questionnaires, case sheets and fact sheets were pretested among groups of veterinarians and horse owners as appropriate, who would not themselves be involved in the full study. Questions were reordered and reworded in response to comments from these groups. In the development of case sheets and fact sheets particularly, several iterations were necessary before a final design was agreed.

2.4.4. Accompanying Letters

A separate letter, explaining the aims and expected benefits of the investigation, was written for each phase of the study and was enclosed with every questionnaire. All letters were produced using Microsoft Word 2.0 (Microsoft Corporation) word processing software. Each letter was headed with The Home of Rest for Horses logo in the top left corner, the University of Glasgow logo in the top right corner and the title 'A Study of Equine Welfare' centred in between (Appendices 2, 6, 8, 11, 13, 15 and 17). The names of the principal investigators appeared just below the title, and the departmental address and telephone number appeared at the foot of the page.

The specific wording and addressing of different letters will be discussed in detail at the beginning of Chapters 3, 4, 5 and 6. All letters were printed on A4 (210 × 297 mm) 90 GM^2 paper and hand signed.

2.4.5. Mailing

With the exception of phase Ib, questionnaires were mailed in 162 × 229 mm envelopes. Each envelope contained a prepaid, self-addressed return envelope placed inside the folded questionnaire, which was in turn placed inside the folded accompanying letter. All folding of letters, questionnaires, case sheets and fact sheets was done by hand. Self addressed labels were designed in Microsoft Word 2.0 (Microsoft Corporation) and printed onto self-adhesive laser labels. Return envelopes were white, 110 × 220 mm with a self-addressed label and second class postage stamp affixed. Later, when the number of questionnaires being mailed increased dramatically, postage stamps and address labels were replaced by a FREEPOST address label.

With few exceptions, all outgoing mail to horse owners and veterinarians was hand addressed. In phases Ia and III of the study, there were only 25 study subjects so the task was not large, and was worth the extra time. In phases II and IV, each subject was contacted only once, and the time saving in typing and printing address labels would have been minimal. In addition, in the interests of confidentiality, no computer databases of information that could be used to identify horse owners were created or maintained. In phase Ib, despite there being 188 study subjects, the higher response rate from hand addressing envelopes reduced the number of follow-up mailings required. These issues are discussed more fully in Chapters 3, 4, 5 and 6. All outgoing mail was franked second class letter rate.

2.5. DATABASE DESIGN

In order to meet the objectives of the study, a system was required for the storage, collation and analysis of data gathered by the separate questionnaire surveys. Further requirements were for easy data entry, analyses of data across different phases of the study, flexibility and compatibility with other computer software.

Microsoft Access (Microsoft Corporation) is a relational database management system that allows the storage of data in related tables. A **table** is designed by naming and specifying the properties of *fields* (columns) which usually relate to one question on a questionnaire such as the number of horses owned. Field properties relate to the format of data held in the field such as number, text or date. Properties can be specified that limit the permissible entries in a field, which can be a useful way of reducing errors in data entry. Each questionnaire or *record* occupies a single row of the table with an entry in all appropriate columns. A *key field* (or fields) may be defined to uniquely identify each record for the purposes of indexing. Examples of such fields might be practice number or owner number or a combination of these (Chapter 2.4.2). Fields common to two tables may be used to *relate* these tables for the purposes of **querying** across multiple tables. Single or multiple tables can be queried by specifying *criteria* and writing *functions* to limit and aggregate the data in any desired way. A **form** shows one complete record on screen at a time. As they can be made to correspond roughly to the appearance of a questionnaire, forms are a useful medium for data entry.

Data from each phase of the study were maintained in separate tables. Each table was indexed using a key field consisting of some combination of practice number, owner number and animal number. In this way, linking between tables was possible to allow comparison and analyses of data across different phases of the study. Data were entered using forms corresponding to the appearance of questionnaires (Appendices 5, 7, 10, 16, 20 and 21). Wherever possible, responses were coded to avoid time consuming typing and reduce data entry errors. Spell checking and querying were also employed to detect and correct errors made in data entry (Chapter 4.2.5.1). Simple descriptive data analysis was carried out by means of queries. In order to produce maps of data to investigate geographical distribution of variables, tables and queries had to be exported from Microsoft Access to MapInfo (MapInfo Corporation).

2.6. STATISTICAL METHODS

Where appropriate, the χ^2 test was used to test the statistical significance of differences in estimates of proportions, and the paired or two sample t test were used to test the statistical significance of observed differences between groups (Clarke and Cooke, 1992). Ninety five per cent confidence intervals for estimates of population size were calculated using the following formula after Levy and Lemeshow (1991):

$$95\%\ \text{CI for } x',\ \pm\ 1.96\left(\frac{N}{\sqrt{n}}\right) \times \sigma_x$$

where: x' = estimate of total population

N = total number of sampling units (in this instance veterinary practices)

n = number of sampling units sampled (sample size)

σ_x = standard deviation of x, the mean population across n sampling units

Ninety five per cent confidence intervals for estimates of population proportions were calculated using the following formula for an infinite population after Clarke and Cooke (1992):

$$95\%\ \text{CI for } p,\ \pm\ 1.96\sqrt{\frac{p\,(1-p)}{n}}$$

where: p = proportion of population

However, where the size of the population from which the sample is taken is known, a finite population correction (fpc) is applied to the above equations which is given by the following formula (Levy and Lemeshow, 1991):

$$\text{fpc} = \sqrt{\frac{N-n}{N-1}}$$

It can be seen that if the size of the sample is small in relation to the size of the population, the finite correction factor will be close to 1. The formulae used for the calculation of 95% confidence intervals in the current study were:

$$95\% \text{ CI for } x', \pm 1.96 \left(\frac{N}{\sqrt{n}}\right)(\sigma_x)\sqrt{\frac{N-n}{N-1}}$$

$$95\% \text{ CI for } p, \pm 1.96\sqrt{\frac{p\,(1-p)}{n}}\ \sqrt{\frac{N-n}{N-1}}$$

2.7. MAPPING

MapInfo (MapInfo Corporation), a geographical information system, can be used to present and analyse spatially referenced data (Paterson, 1995; Chapter 1.8). Spatially referenced data are points that can be located precisely in space such as grid references. Postcodes correspond to grid references and can be used to locate data points precisely on a map. Postcode data were stored for all respondents to questionnaires in The Home of Rest for Horses Survey of Equine Welfare. A dataset of practice and owner numbers with corresponding postcodes was produced by querying tables in Microsoft Access (Microsoft Corporation). These data were saved onto 3.5" 1.44 Mb floppy diskette and mailed to Graphical Data Capture Ltd. for geocoding. Geocoding refers to converting postcode or zip code information to grid references. Geocoded data from 3.5" 1.44 Mb floppy diskette, received by return of post from Graphical Data Capture Ltd., were imported into MapInfo. Further data from tables and queries in Microsoft Access were imported into MapInfo, initially via Microsoft Excel spreadsheets but latterly using direct links designed for this purpose.

The geographical distribution of any variable recorded in the study could then be displayed by querying in order to link data with geocoded points. Maps showing the distribution of variables were created by overlaying points on background digitised boundary files for Scottish regions and Northern English counties (Chapter 2.3). Thematic maps, which aggregate data over a pre-defined area were used to display and compare population density

(Dent, 1985; Chapter 1.8). Pie charts and bar charts were used to compare disease prevalence in different areas at different times of the year.

CHAPTER 3

FIRST SURVEY OF VETERINARY PRACTICES

3.1. INTRODUCTION

The use of sentinel primary health care practices to gather demographic and epidemiologic data in the general population has been termed practice-based research (Chackraverty, 1994; Green *et al.*, 1994). In the domain of human medicine, formally established networks of such practices have been in existence since the 1970s (Bartelds, 1993; Nutting and Green, 1994). Since their inception, they have contributed important, representative information to the primary health care knowledge base (Nutting, 1996).

In the domain of equine veterinary medicine in the UK, no such primary care knowledge base exists (Chapter 2.1). Indeed, despite annual returns on numbers of horses kept on agricultural land, no accurate estimate of the total equine population of the UK is available. In the USA in 1991, a survey of members of the American Association of Equine Practitioners ranked the medical problems of adult horses in order of importance on a subjective scale (Traub-Dargatz *et al.*, 1991; Chapter 1.3). These data were not related to population figures to give prevalence estimates for different diseases. A Japanese study assigned percentage values to the number of cases of different types diagnosed by equine practitioners (Hata, 1993; Chapter 1.3).

In 1991, motivated by the need to target funding to benefit the welfare of all types of horses, The Home of Rest for Horses supported the current study to establish the most important diseases affecting the British equine population. Initially, due to constraints of time and finance, the study was confined to Scotland and Northern England. Phase Ia of this study involved a mailed questionnaire survey of a sample of veterinary practitioners involved in equine work.

3.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION

3.2.1. Considerations

The aims of this study were to recruit a sample of the total number of veterinary practices undertaking horse work to form a sentinel network supplying information about the equine population in the study area. This information would be gathered from the practices themselves and also from owners of horses under the care of these practices (Chapter 2.2.2). The recruitment of practices is discussed in detail in Chapter 2.2.3.

Twenty five of 188 practices were selected at random to be involved in the study. After initial mail contact followed up by a telephone call, all 25 practices agreed to take part. However, despite this and the busy nature of veterinary practice, it was considered that participation rate would decrease if a questionnaire was used that was difficult or time consuming to complete. Furthermore, all other phases of the study (Chapter 2.2.2) would rely on the continued co-operation of these practices. Balanced against this was the need to collect, and to be seen by practitioners to be collecting, accurate and useful information. The objective was to produce a questionnaire which conveyed the impression of collecting the most useful information with the least perceived time commitment by the respondent.

During initial telephone contacts, several practitioners indicated their interest in a confidential survey of charges made for equine veterinary services. A question was included on the back page of the questionnaire asking whether participants would be interested in a survey of this kind. A statement of willingness to collect and analyse confidential data on charges made for equine services was included, and was intended as an added incentive for practitioners to complete the questionnaire.

3.2.2. Questionnaire Design

The physical design of the questionnaire has been described previously (Chapter 2.4.2, Chapter 3.2.1). The aims of the questionnaire were:

1) to determine how many horse owners were registered with each practice, and how many horses were in the care of each practice.

2) to record the quantity and nature of equine work undertaken by each practice, and the quantity of vaccine and anthelmintic administered annually.

3) to make a subjective assessment, later to be validated in a cross-sectional study, of the frequency with which different equine diseases were diagnosed in different practices.

Questions were ordered in a logical fashion, the more general factual questions coming first, followed by questions requiring subjective judgements.

Devising a way to ask questions about disease prevalence posed a number of problems. A series of questions of the type: *How many times a year do you diagnose COPD?* for all possible equine diseases would have been inappropriate. First, the questionnaire would have been so long that response rates would have suffered (Chapter 2.4.1, Chapter 3.2.1). Secondly, for many diseases there would be difficulties in standardisation of terminology, and in confirmation of diagnosis. Thirdly, this level of detail extended beyond the scope of the study. Therefore questions were limited to categories of disease. After pretesting among veterinarians who were not to be involved in the full study, it was concluded that the most intuitive and efficient way to collect this information was in a table, where respondents simply had to tick the appropriate boxes (Appendix 3). The frequency of diagnosis was stratified into three categories: rare, occasional and frequent. Numerical ranges were not used because it would have been impossible to standardise these so as to be applicable to practices with such widely varying workloads. This variation was accounted for in the analysis by weighting results according to the number of horses under the care of a particular practice. A fourth column was included in the table to allow practitioners to indicate which was the commonest individual disease diagnosed within each category. In initial designs this caused some confusion, a number of pretesters also just ticking boxes in this column. This was overcome by separating the 'Commonest' column from the rest of the table as shown in Figures 2 and 3.

Q7. Please indicate the frequency with which the following disease classes are diagnosed in your practice (please tick the appropriate column for each disease class), and the most common disease entity within each disease class.

	Rare	Occasional	Frequent	Commonest
Acute respiratory				
Chronic respiratory				
Acute GI				
Chronic GI				
Acute musculoskeletal				
Chronic				
Minor injuries				
Metabolic				
Reproductive				
Dermatological				
Neoplastic				
Miscellaneous				

Figure 2. Phase Ia Survey of veterinary practices - question 7 from the first version of the questionnaire. Some respondents just ticked the 'Commonest' boxes.

Q7. Please indicate the frequency with which the following disease classes are diagnosed in your practice (please tick the appropriate column for each disease class), and the most common disease entity within each disease class.

	Rare	Occasional	Frequent	Commonest
Acute respiratory				
Chronic respiratory				
Acute GI				
Chronic GI				
Acute musculoskeletal				
Chronic				
Minor injuries				
Metabolic				
Reproductive				
Dermatological				
Neoplastic				
Miscellaneous				

Figure 3. Phase Ia Survey of veterinary practices - question 7 from the final version of the questionnaire. The heavy double border separates the "Commonest" box from the rest of the table. After this change the questionnaire performed as it was designed to.

Pretesting was undertaken among a group of non-participating veterinary surgeons, and comments were discussed and addressed by a committee involving the author, Professor S.W.J. Reid, Professor S. Love with advice from Dr M.J. Reeves. Apart from the tables in Figures 2 and 3, minor changes to the wording of some of the questions were the only alterations that were made. On the back page of the questionnaire, respondents were asked if they would be interested in a survey of charges made for equine veterinary services.

3.2.3. The Accompanying Letter

Initial contact with veterinary practitioners was made by letter (Appendix 1), and followed up by a telephone call within two weeks of the letter's arrival (Chapter 2.2.3). These contacts served to explain the aims and objectives of the study, and to obtain a verbal commitment to participate. The letter which accompanied the questionnaire in the first mailing to veterinarians (Appendix 2) had four purposes:

1) to reassert the aims and objectives of the study.
2) to request completion of the questionnaire.
3) to explain the general format of the follow-up cross-sectional study, phase III (Chapter 2.2.2, Chapter 5).
4) to request a list of names and addresses of horse owning clients registered with each practice.

A specimen questionnaire to horse owners for phase II of the study was enclosed in this mailing to veterinarians (Chapter 2.2.2, Chapter 4, Appendix 9). This enabled practitioners to raise any objections they might have to the questionnaire, and also to make constructive criticism where they felt necessary.

The general physical appearance of the letter is discussed in Chapter 2.4.4. The practice address and salutation were hand written in ink at the top left of each individual letter. All letters were hand signed in ink.

3.2.4. Implementation

The mailing package contained the questionnaire, the accompanying letter, a clearly marked specimen questionnaire for horse owners and a self addressed return envelope (size 110 × 220 mm) with second class postage stamp affixed. An envelope (size 162 × 229 mm) was hand addressed to each practice, with the open end of the envelope on the right as the address was written. Dillman (1978) asserts that the arrangement of the contents of the outgoing mailing is important. Folding all the various documents together and carelessly inserting them haphazardly into the envelope conveys the impression of mass mailing and can discourage response because subjects perceive a lack of individual attention. With this in mind, the accompanying letter was folded in half with the address on the outside top left.

The questionnaire was placed inside this with the title page uppermost, inside which were the specimen owner's questionnaire and the return envelope. The whole package was placed into the envelope with the practice address on the letter and that on the envelope orientated to each other.

The first mailing took place on 26/01/93. A telephone call follow-up was made to non-respondents after three weeks. Replacement questionnaires were mailed to five practices that had lost the original. Subsequent follow-ups were made by telephone at approximately monthly intervals. Eighteen further replacement questionnaires were mailed, one practice losing three before returning a completed questionnaire. The last completed questionnaire was returned on 05/10/93.

3.2.5. Data Storage and Analysis

A Microsoft Access (Microsoft Corporation) database table was designed to store data from this phase of the study (Chapter 2.5). All data were stored in a single table, with one database field corresponding to each question, and a form was created to correspond to the format of the questionnaire in order to facilitate data entry (Appendix 5). The practice number was used as the primary key field to link data form this phase of the study with those gathered in subsequent phases. Simple analyses and transformation of data were carried out in Microsoft Access using specifically designed queries. Further analyses were carried out making use of data analysis tools in Microsoft Excel (Microsoft Corporation, Chapter 2.3) after data had been imported from the Microsoft Access database. The formula given in Chapter 2.6 was used for the calculation of 95% confidence intervals for estimates of population size. Postcode data from respondent practices were geocoded as described in Chapter 2.7 in order to create maps of data from this phase of the study.

3.3. RESULTS - PHASE Ia SURVEY OF VETERINARY PRACTICES

3.3.1. Response

Twenty two out of twenty five practices completed the questionnaire (88% response rate). Of the three non-respondents, one practice wrote to declare that they no longer wished to take part in the study, despite requesting two replacement questionnaires previously. The remaining two non-respondents were not followed-up beyond October 1993.

Fourteen of the twenty two practices supplied lists of names and addresses of horse owning clients. A further three practices indicated their willingness to mail questionnaires to their clients provided that their costs were covered. In addition, practice 10, which did not respond to the questionnaire, did supply a list of names and addresses of horse owning clients. Some practices, having completed and returned the phase Ia questionnaire, took several months to compile and send a list of names and addresses. The overall response to this part of the study was 72%.

3.3.2. Survey Data

The response to questionnaires is shown in Tables 14a, 14b and 14c. Summary statistics of these responses are given in Table 15:

Practice number	Number of owners	Number of horses	%Workload	% Routine	Vaccination (doses administered / year)	Anthelmintics (doses sold / year)
1	100	180	8	50	150	300
2	190	600	20	50	530	162
3	200	700	25	50	600	1100
4	200	800	18	50	450	500
5	50	100	10	50	30	50
6	1000	1500	80	30	1250	815
7	250	750	15	35	700	750
8	500	1350	8	5	-	-
9	68	100	15	30	165	348
11	1000	2100	20	45	1766	2584
12	680	1700	15	20	380	650
13	500	1000	30	15	-	200
15	40	122	5	40	100	150
16	235	270	8	75	220	234
17	150	225	15	40	230	615
18	950	1200	20	20	832	1327
19	160	360	15	70	130	500
20	80	100	8	60	150	368
21	150	340	10	40	300	250
22	65	200	10	90	230	422
24	300	1000	10	50	500	1000
25	1988	3000	30	40	850	750

Table 14a. Phase Ia Survey of veterinary practices - results.
%Workload - percentage of the total practice workload which is comprised of equine work.
%Routine - percentage of equine work which is comprised of routine procedures such as vaccination.

Practice number	acute resp.	chronic resp.	acute GI	chronic GI	acute MS	chronic MS	minor injuries	metabolic	repro.	derm.	neoplastic	misc.
1	o	f	o	r	f	f	f	o	r	f	o	f
2	o	o	o	r	f	o	f	r	r	o	r	r
3	o	f	o	o	f	f	f	f	f	f	o	-
4	o	f	o	f	f	f	f	o	f	o	o	-
5	r	o	o	r	f	f	f	r	f	o	o	o
6	o	f	o	r	f	f	f	o	f	o	r	o
7	f	f	o	o	f	f	f	o	f	o	o	-
8	o	f	f	o	f	f	f	o	o	f	o	-
9	f	o	o	r	o	f	f	o	r	o	o	f
11	f	f	o	r	f	f	f	o	f	o	r	-
12	o	f	o	f	o	o	o	o	r	o	o	o
13	o	f	o	f	o	o	f	f	o	o	o	f
15	o	f	f	r	f	f	f	r	r	f	r	r
16	o	f	r	r	f	f	f	r	o	f	o	-
17	r	f	o	r	f	f	f	r	r	f	o	f
18	o	f	o	r	f	f	f	o	f	o	r	-
19	o	f	o	o	f	o	f	o	r	o	r	o
20	o	o	f	r	f	o	f	r	o	f	r	o
21	o	f	f	r	o	r	f	f	o	f	f	-
22	r	f	o	o	f	f	o	r	r	f	o	r
24	o	f	r	r	f	f	f	o	f	f	f	-
25	f	f	o	o	f	f	f	o	f	o	o	-

Table 14b. Phase Ia Survey of veterinary practices - the frequency with which diagnoses are made within disease categories.
resp. - respiratory, GI - gastrointestinal, MS - musculoskeletal, repro. - reproductive, derm. - dermatological, misc. - miscellaneous.
r - rare, o - occasional, f - frequent.

Practice number	Most important disease
1	laminitis / colic / acute & chronic injuries
2	flu / strangles
3	laminitis
4	hoof problems
5	lameness
6	lameness
7	teeth problems / grass sickness / COPD† / mismanagement
8	-
9	laminitis / helminthiasis
11	low fore limb lameness / COPD† / hind limb lameness
12	endo/ecto parasites
13	lameness and management
15	chronic musculoskeletal - feet
16	bad feet / chronic laminitis
17	chronic osteoarthritis / mud fever
18	laminitis
19	laminitis / grass sickness
20	malnutrition associated with poor grazing
21	COPD†
22	laminitis / COPD†
24	laminitis / parasitism
25	lameness (lower forelimb), cyathostomes

Table 14c. Phase Ia Survey of veterinary practices - the most important equine diseases encountered in each practice.
†COPD - chronic obstructive pulmonary disease.

	Owners	Animals	Animals / owner	Workload (%)	Routine work (%)
mean	403	804	2.3	18	43
standard deviation	472	760	0.83	16	20
standard error	101	162	0.17	3.3	4.2
median	200	650	2.2	15	43
range	1948	2900	2.9	75	85
minimum	40	100	1.1	5	5
25th percentile	100	200	1.5	30	10
75th percentile	500	1200	3.0	50	20
maximum	1988	3000	4.0	80	90
mode	200	100	1.5	15	50
sum	8856	17697	-	-	-

Table 15. Phase Ia Survey of veterinary practices - descriptive statistics of results.
Workload (%) - percentage of the total practice workload which is comprised of equine work.
Routine work (%) - percentage of equine work which is comprised of routine procedures such as vaccination.
Animals/owner - number of animals cared for by each practice divided by the number of horse owning clients registered with each practice.

The 22 veterinary practices provided veterinary care to a total of 17,697 equine animals belonging to 8,856 horse owners. There was wide variation among practices ranging from practice 15 with only 40 horse owning clients and 122 animals comprising 5% of the total practice workload, to practice 6 with 1,000 horse owning clients and 1500 animals comprising 80% of the total practice workload. The largest practice, practice 25, provided care to 3,000 animals belonging to 1,988 owners, though this comprised only 30% of the total practice workload. The estimated total number of horse owners and horses in the study area, with 95% confidence intervals (Chapter 2.6), are given below:

$$\text{total number of horse owners: } \frac{188}{22} \times 8,856 = 75,679 \pm 34,797$$

$$\text{total number of horses: } \frac{188}{22} \times 17,697 = 151,228 \pm 56,252$$

The median ± SIQ number of horse owning clients per practice was 200 ± 200. The median ± SIQ number of horses cared for per practice was 650 ± 500. The mean ± SD number of animals per owner was 2.3 ± 0.83. The mean ± SD percentage of the total practice workload comprised of equine work was 18% ± 16%. The mean ± SD percentage of equine work which comprised of routine procedures was 43% ± 20%.

Interpretation of the figures for the number of doses of flu and/or tetanus vaccine administered and the number of doses of anthelmintic sold by each practice each year is related to the number of animals under the care of each practice. Summary statistics are presented in Table 16:

	Vaccines / animal / year	**Anthelmintics / animal / year**
mean	0.80	1.3
standard deviation	0.37	1.0
standard error	0.08	0.22
median	0.83	1.0
range	1.4	3.5
minimum	0.22	0.20
25th percentile	0.50	0.44
75th percentile	0.93	1.6
maximum	1.7	3.7
mode	0.83	1.0
total animals	17697	17697

Table 16. Phase Ia Survey of veterinary practices - descriptive statistics of results.
Vaccines (flu, tetanus and flu/tetanus combined)/animal/year - doses of vaccines administered each year by each practice divided by the number of animals cared for by each practice.
Anthelmintics/animal/year - doses of anthelmintic sold each year by each practice divided by the number of animals cared for by each practice.

The mean ± SD vaccine (flu, tetanus and flu/tetanus combined) administration rate was 0.80 ± 0.37 doses of vaccine/horse/year. The mean ± SD anthelmintic sales rate was 1.3 ± 1.0 doses/horse/year.

A summary of the responses to question 7 on the questionnaire (Appendix 3), presented in Table 14b, showing the frequency with which diagnoses were made in each practice and the most common disease in each category is presented in Table 17.

Disease category	Rare (%)	Occasional (%)	Frequent (%)	Commonest conditions in each category * (the number in parentheses is the number of practices citing the condition)
acute respiratory	14	**68**	18	viral (7), acute allergic bronchospasm (1)
chronic respiratory	0	18	**82**	COPD† (9)
acute gastrointestinal	9	**73**	18	spasmodic colic (6), endoparasites (1), **grass sickness (1)**
chronic gastrointestinal	**59**	27	14	idiopathic diarrhoea (3), impaction (2), dental problems (1), **grass sickness (1)**
acute musculoskeletal	0	18	**82**	foot sepsis (3), tendonitis (2), **EER‡ (1)**, fractures (1), injuries (1), **laminitis (1)**
chronic musculoskeletal	4	23	**73**	osteoarthritis (3), **laminitis (2)**, DJD (1), **lameness (1)**, navicular disease (1)
minor injuries	0	9	**91**	skin lacerations (8), kicks (1)
metabolic	32	**54**	14	**EER‡ (3), laminitis (1)**
reproductive	36	23	**41**	infertility (3), endometritis (1), foaling (1)
dermatological	0	**54**	46	dermatophilosis (4), ringworm (4), ectoparasites (2), **sarcoids (1)**
neoplastic	36	**55**	9	melanoma (5), **sarcoids (5)**, papilloma (1)
miscellaneous **	9	23	18	ocular problems (1), **lameness (1), laminitis (1)**, strangles (1)

Table 17. Phase Ia Survey of veterinary practices - summary of responses to question 7.
rare (%), occasional (%), frequent (%) - the percentage of practices responding in grouping (rare, occasional, frequent) - numbers in bold type are the largest percentage in each disease category.
* conditions in bold are cited in more than one disease category.
** only 12 practices completed the miscellaneous category.
†COPD - chronic obstructive pulmonary disease.
‡EER - equine exertional rhabdomyolysis.

It can be seen that in a high percentage of practices chronic respiratory problems (82%), acute and chronic musculoskeletal problems (82% and 73% respectively) and minor injuries (91%) were frequently diagnosed. Acute respiratory problems and acute gastrointestinal problems were occasional diagnoses in 68% and 73% of practices respectively. Chronic gastrointestinal problems were classified as rare diagnoses in 59% of practices. Metabolic problems were classified as rare or occasional diagnoses by 86% of practices. Dermatological problems were classified as occasional or frequent diagnoses by 100% of practices. Neoplastic problems were classified as rare or occasional diagnoses by 91% of practices. There was no consensus about the frequency with which reproductive problems were diagnosed with 36% of practices stating they were rare, 23% occasional and 41% frequent. The responses in the miscellaneous category are difficult to interpret, as only 12 of the 22 participating practices completed this part of the questionnaire.

The commonest conditions diagnosed in each disease category are shown in the right hand column of Table 17. Many practices did not complete this part of the questionnaire at all, or just made entries for some of the categories. All practices that did complete this part of the questionnaire stated that COPD was the commonest cause of chronic respiratory problems. Eight of nine practices that completed the appropriate part of the questionnaire stated that skin lacerations were the commonest cause of minor injuries. Seven of eight practices that completed the appropriate part of the questionnaire stated that the commonest causes acute respiratory problems were viral. Six of eight practices that completed the appropriate part of the questionnaire stated that spasmodic colic was the commonest cause of acute gastrointestinal problems.

There was obvious difficulty in categorising some disease conditions. Laminitis was categorised as acute musculoskeletal (1 practice), chronic musculoskeletal (2 practices), metabolic (1 practice) and miscellaneous (1 practice). Equine exertional rhabdomyolysis (EER) was categorised as acute musculoskeletal (1 practice) and metabolic (3 practices). Grass sickness was categorised as acute and chronic gastrointestinal (1 practice in each category). Sarcoids were categorised as dermatological (1 practice) and neoplastic (5 practices), though melanomas (5 practices) and papillomas (1 practice) only appeared in the neoplastic category despite both being tumours that affect the skin.

In order to take into account the wide variation in the size of the veterinary practices the results for the frequency of diagnosis of different categories of disease were weighted according to the number of animals registered with each practice. The classifications 'rare', 'occasional' and 'frequent' were allocated numerical scores of 1, 2, and 3 respectively, and then for each practice multiplied by the number of horses under the care of each practice. The resulting numbers were summed for each disease category and the percentage contribution of each category to the total diagnosed equine disease was calculated. The results are shown in Table 18:

Disease category	Percentage of total equine disease diagnosed
acute respiratory	8
chronic respiratory	11
acute gastrointestinal	8
chronic gastrointestinal	7
acute musculoskeletal	10
chronic musculoskeletal	10
minor injuries	11
metabolic	8
reproductive	9
dermatological	9
neoplastic	7
miscellaneous	3

Table 18. Phase Ia Survey of veterinary practitioners - frequency of diagnosis of categories of disease.

This approach is imperfect because it assumes that 'frequent' is only 3 times more frequent than 'rare', and only 1.5 times more frequent than 'occasional'. However, it does give an indication of which are the most prevalent problems and which are less so. Thus minor injuries, chronic respiratory disease and musculoskeletal disease would appear to constitute the most important equine problems in veterinary practice. Chronic gastrointestinal disease and neoplastic disease appear to be relatively rare.

Practitioners' responses to question 8 (Appendix 3) *Which disease(s) do you consider to be most important with regard to equine welfare?* are shown in Table 14c. A summary of these results is given below in Table 19:

Disease condition	Number of times cited
laminitis	7
lameness (including arthritis)	6
hoof/foot problems	4
COPD†	4
parasitism	4
mismanagement	3
grass sickness	2
colic	1
flu	1
injuries	1
strangles	1
teeth problems	1

Table 19. Phase Ia Survey of veterinary practitioners - the most important with regard to equine welfare.
†COPD - chronic obstructive pulmonary disease.

Laminitis was considered to be the most important disease condition with regard to equine welfare. 'Lameness' appears as the second most important condition but lameness is not a specific diagnosis. Both laminitis and the equal third most important condition cited here, hoof/foot problems, cause lameness. If all the conditions causing lameness are added together, the total is 17, which may give a more realistic perspective on what the practices in this study considered to be the most important equine diseases.

3.4. PHASE Ib SURVEY OF ALL VETERINARY PRACTICES

3.4.1. Introduction

Following the completion of phase Ia of the study, and after the beginning of phase II (Chapter 2.2.2, Chapter 4), a simple census of all veterinary practices in Scotland and Northern England providing care to equine animals was undertaken. The purpose of this extension to the original study design was to validate population estimates made from the results of the previous and ongoing phases of the study. In addition, this census would raise the general awareness of the study and its aims among the veterinary profession which would be beneficial for future collaboration on this or similar studies.

3.4.2. The Study Population

Using 'The Directory of Veterinary Practices 1992' (Hall, 1991), 188 practices were identified that indicated that they provided care for horses (Chapter 2.2.3). Of these practices, 25 had already been included in phase Ia of this study. All remaining 163 practices made up the study population for Phase Ib Survey of all veterinary practices. A table was created in Microsoft Word (Microsoft Corporation) containing the names and addresses of all practices to be included in the survey (Chapter 2.5).

3.4.3. Questionnaire Design

The main aim of this phase of the study was to canvass as many practices as possible in order to make an accurate estimate of the true size of the equine population of Scotland and Northern England. Only three questions were asked:

1) How many clients (including farm clients) registered with your practice own horses?

2) Approximately how many equine animals are under the care of your practice?

3) Approximately how big an area does your practice cover?

As a result, there was no need for a separate questionnaire, and these questions were appended to the bottom of the accompanying letter (Appendix 6). The letter was designed as a form letter, which is a template which can be linked electronically to a table of addresses and printed, so that one copy of the letter bearing each address in the table is produced automatically. The letter was linked to the table of practice addresses described above (Chapter 3.4.2) to produce individually addressed letters. The salutation and signature on each letter were hand written in ink. The letter explained the background to the study and the expected benefits to be gained from it. Practitioners were requested to complete and return the questionnaire, even if they no longer treated horses, as this information was important in order to estimate the population size.

3.4.4. Implementation

The mailing package contained the questionnaire/letter and a return envelope (size 110 × 220 mm) with a FREEPOST self addressed label affixed to it. An envelope (size 110 × 220 mm) was hand addressed to each practice.

The first mailing took place on 19/01/95. A second questionnaire was mailed to non-respondents on 01/02/95. A third, and final, mailing to non-respondents took place on 20/02/95.

3.4.5. Data Storage and Analysis

A Microsoft Access (Microsoft Corporation, Chapter 2.5) database table was designed to store data from this phase of the study. All data were stored in a single table with one database field corresponding to each question. A form was created to correspond to the format of the questionnaire and facilitate data entry (Appendix 7). The practice number was used as the primary key field. Simple analyses and transformation of data were carried out in Microsoft Access using specifically designed queries. Further analyses were carried out making use of data analysis tools in Microsoft Excel (Microsoft Corporation, Chapter 2.3) after data had been imported from the Microsoft Access database. The formula given in Chapter 2.6 was used for the calculation of 95% confidence intervals for estimates of population size. Postcode data from respondent practices were geocoded as described in Chapter 2.7 in order to create maps of data from this phase of the study.

3.5. RESULTS - PHASE Ib SURVEY OF ALL VETERINARY PRACTICES

3.5.1. Response

In total 152 of the 163 practices surveyed responded to the questionnaire (93% response). Of these respondents, 8 had ceased to trade or had merged with other practices within the study area. A further 7 practices stated that they were no longer involved in equine work. Two practices were referral practices, seeing only second opinion cases and were not included in the study. Two practices supplied incomplete, unusable questionnaires.

Therefore, 133 usable questionnaires were returned (91% of eligible practices). Table 20 shows the overall response rates to the original and two follow-up mailings in this study.

	Percentage of total study population responding
original mailing	63
first follow-up	20
second follow-up	8

Table 20. Phase Ib Survey of all veterinary practices - response rates to the original mailing and the two follow-up mailings.

3.5.2. Survey Data

Summary statistics of responses to phase Ib are shown in Table 21:

	Owners	Animals	Animals / owner	Area (square miles)
mean	162	402	2.9	679
standard error	42	100	0.37	81
median	50	125	2	380
mode	50	100	2	310
standard deviation	480	1152	4.3	936
range	4997	10993	49	6350
minimum	3	7	1	10
25th percentile	30	60	1.5	150
75th percentile	120	250	3.1	710
maximum	5000	11000	50	6360
sum	21492	53501	-	-

Table 21. Phase Ib Survey of all veterinary practices - summary statistics of responses to the questionnaire.

The 133 practices provided veterinary care to a total of 53,501 equine animals belonging to 21,492 horse owners. Again, there was wide variation among practices ranging between 3 and 5,000 horse owning clients registered and providing care to between 7 and 11,000 animals. The median ± SIQ number of horse owning clients per practice was 50 ± 45. The median ± SIQ number of horses cared for per practice was 125 ± 145. The median ± SIQ number of horses per owner was 2.0 ± 0.8. The median ± SIQ area covered by each practice was 380 ± 280 square miles.

Adding the relevant results from phase Ia to phase Ib, gives data from 155 of 188 practices in Scotland and Northern England. However, 17 practices (8 no longer trading, 7 no longer undertaking equine veterinary work, and 2 second opinion only) can be excluded from the calculations. Therefore the overall response rate was 91% ([155/171] x 100). Summary statistics from combined results of phases Ia and Ib are shown in Table 22:

	Owners	Animals	Animals / owner
mean	196	459	2.8
standard error	39	89	0.32
median	60	160	2.0
mode	50	100	2.0
standard deviation	485	1112	4.0
range	4997	10993	49
minimum	3	7	1
25th percentile	35	70	1.5
75th percentile	150	383	3.0
maximum	5000	11000	50
sum	30348	71198	-

Table 22. Summary statistics of the combined results of phases Ia and Ib.

In total, 155 practices provided veterinary care to 71,198 equine animals belonging to 30,348 horse owners. The estimated total number of horse owners and horses in the study area, with 95% confidence intervals (Chapter 2.6), are given below:

$$\text{total number of horse owners: } \frac{171}{155} \times 30{,}348 = 33{,}480 \pm 4{,}006$$

$$\text{total number of horses: } \frac{171}{155} \times 71{,}198 = 78{,}547 \pm 9{,}183$$

The median ± SIQ number of horse owning clients per practice was 60 ± 58. The median ± SIQ number of horses cared for per practice was 160 ± 157. The median ± SIQ number of horses per owner was 2.0 ± 0.8.

3.6. SUMMARY OF RESULTS FROM PHASES Ia AND Ib

The geographical distribution of veterinary practices involved in the study is shown in Figure 4. Practices tend to be concentrated in Cumbria and in the central belt and Grampian region of Scotland. These 155 practices represent 91% of all practices that care for horses in Scotland and Northern England. The estimated total equine population from these figures was 78,547 animals kept by 33,480 owners (*vide supra*).

Figures 5 and 6 compare the geographical distribution of the equine population and the population density according to the figures from this survey and those from the Ministry of Agriculture Fisheries and Food annual agricultural census returns for 1994 (Ministry of Agriculture Fisheries and Food, 1996; Chapter 1.2.6). The figures from this survey suggest that there are more than twice as many horses (78,547 / 30,427 = 2.58) than the official MAFF figures record. On a regional basis, there appears to be a greater density of horses in Tayside, Central, Fife, Lothian and Strathclyde regions and in the counties of Cumbria, County Durham, Teesside and Tyne & Wear. In other parts of the study area there is general agreement in terms of population density between ministry figures and the results of this survey, suggesting that in these regions more horses are kept on commercial agricultural land.

Considering Scotland alone, 113 of 125 (90% response) practices responded to the survey. These practices provided veterinary care to 34,328 horses belonging to 16,148 horse owners. The projected equine population of Scotland is 37,973 animals belonging to 17,862 horse owners. These figures are slightly less than the 41,072 for Scotland, excluding Highland region, Orkney, Shetland and the Western Isles, estimated by the British Horse Society (British Horse Society, 1996; Chapter 1.2.6).

The median ± SIQ number of horses per owner was 2.0 ± 0.8. The mean ± SD vaccine administration rate was 0.80 ± 0.37 doses of vaccine/horse/year. The mean ± SD anthelmintic sales rate was 1.3 ± 1.0 doses/horse/year. The most prevalent equine disease problems appear to have been acute and chronic lamenesses, in particular caused by laminitis. Minor injuries, in particular skin lacerations, and COPD were also prevalent

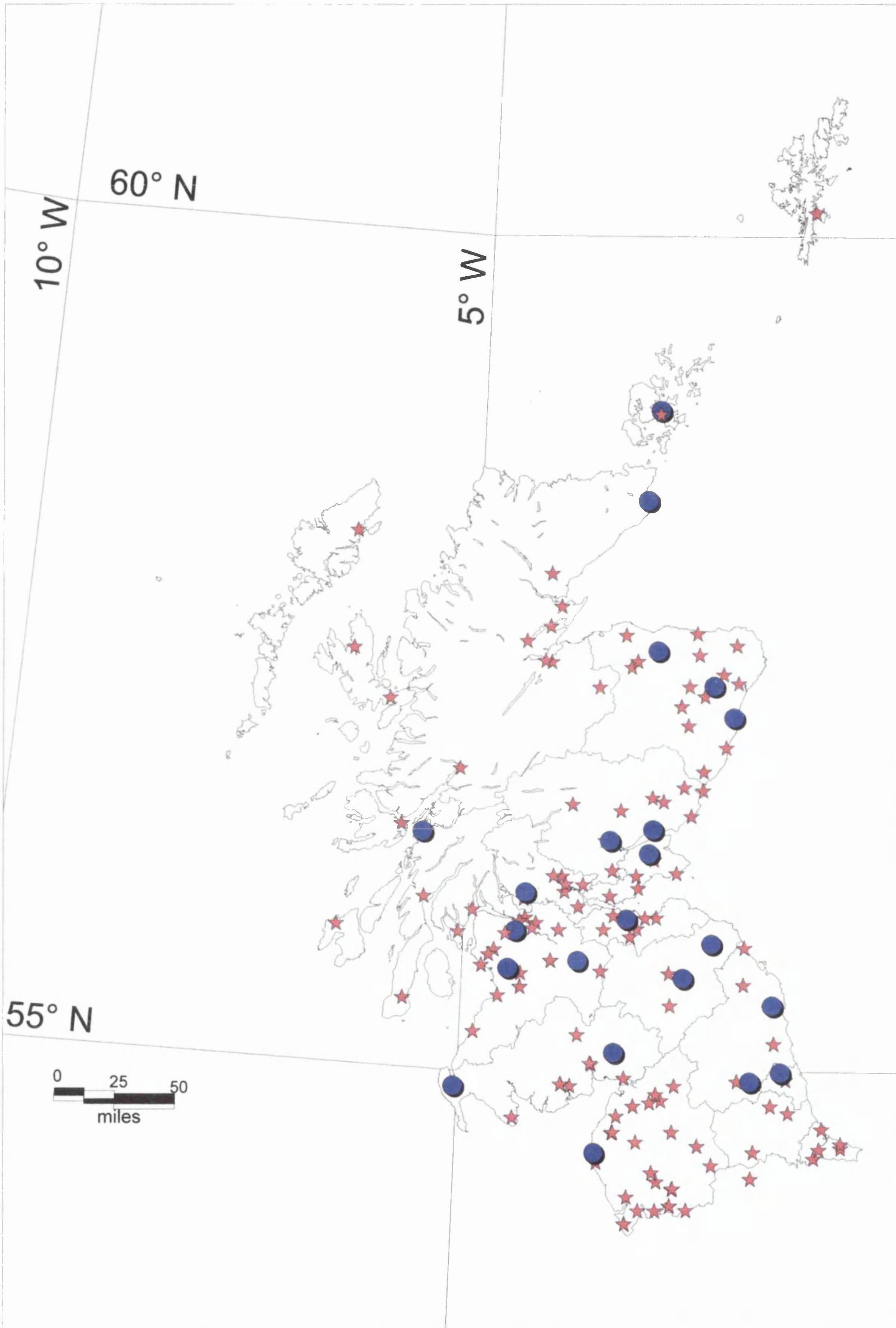


Figure 4. Map showing the distribution of practices involved in phases Ia and Ib of The Home of Rest for Horses Study of Equine Welfare.
Phase Ia practices are represented by a blue dot.
Phase Ib practices are represented by a red star.

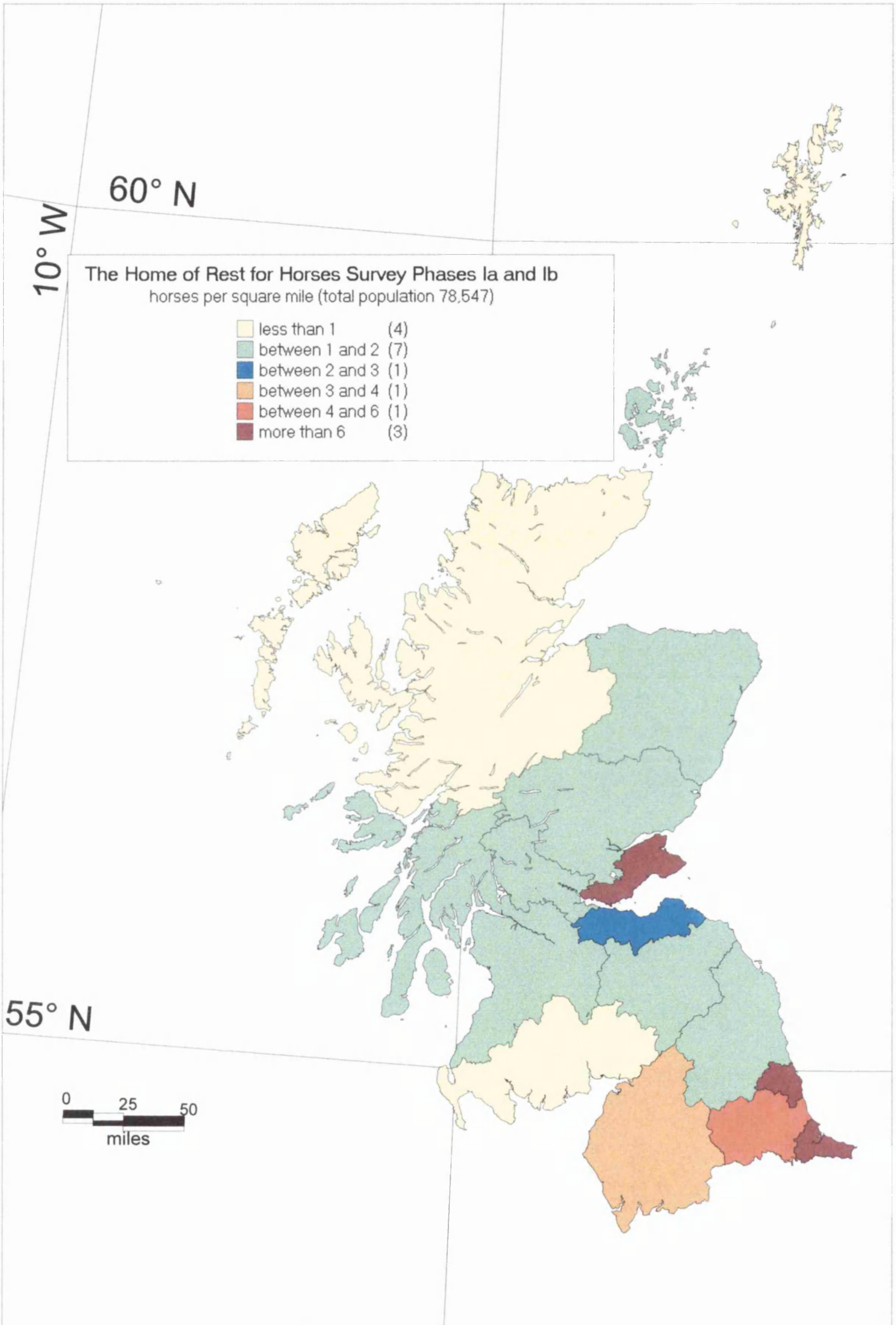


Figure 5. Map showing the equine population density of Scotland and Northern England from Phases Ia and Ib of The Home of Rest for Horses Study of Equine Welfare.

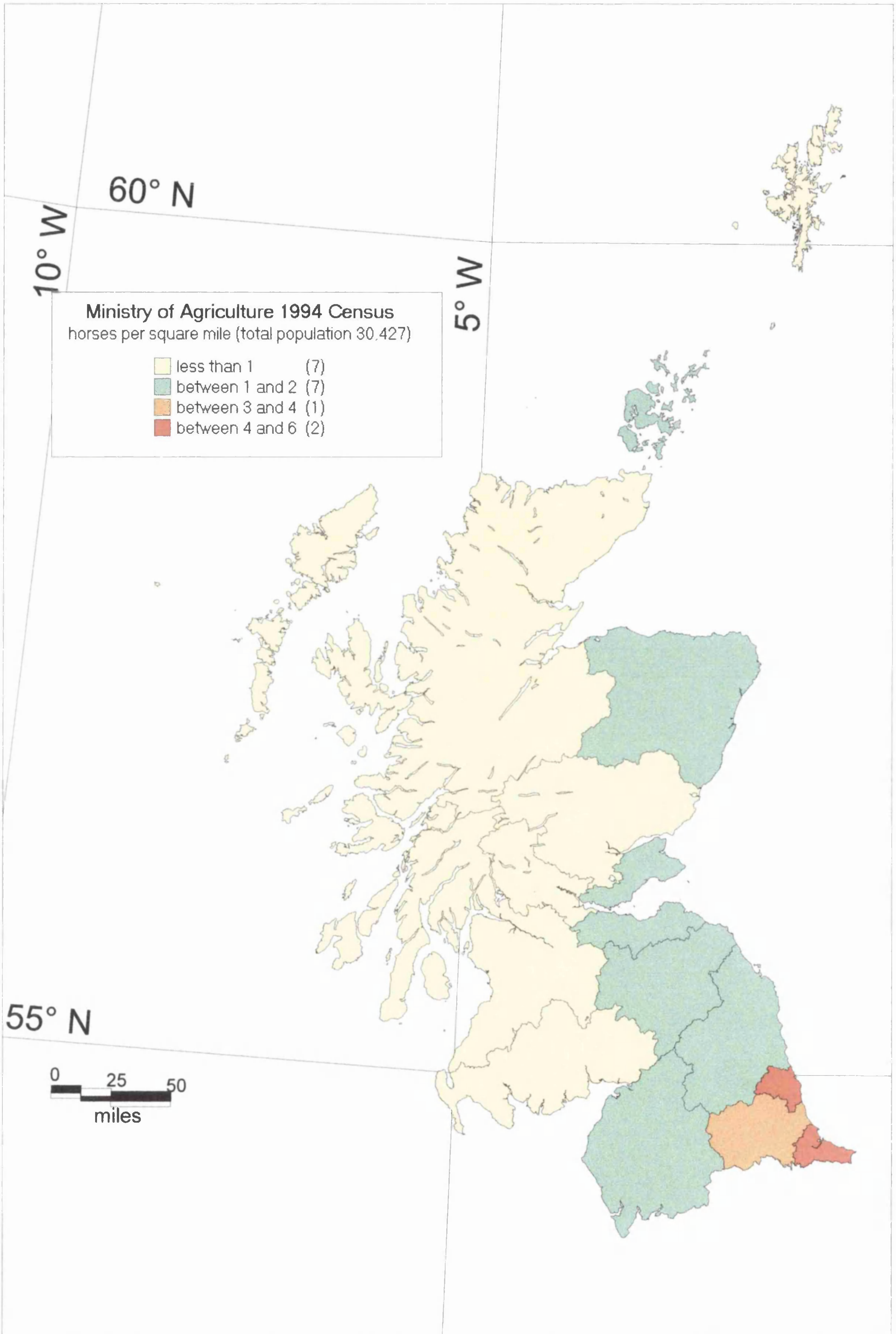


Figure 6. Map showing the equine population density of Scotland and Northern England from returns to the annual agricultural census conducted by the Ministry of Agriculture, Fisheries and Food in 1994.

equine problems. Chronic gastrointestinal disease and neoplastic conditions were uncommon.

3.7. DISCUSSION

3.7.1. Response

The response rate to phase Ia of the current study was 88%, which was considered an excellent level of positive interaction, and compares favourably with those quoted in some other studies involving equine practitioners (Traub-Dargatz *et al.*, 1991; Cohen *et al.*, 1995; Slater *et al.*, 1995, Shuster *et al.*, 1997). Nevertheless, all 25 practices had agreed to participate in the study after the first contact by telephone (Chapter 3.2.1). It is not known why the three non-participating practices failed to make any response to repeated mailings of questionnaires, but, had they indicated their unwillingness to be involved at the outset, they would have been replaced by more supportive practices. The overall response rate to phase Ib was 91% and the benefits of just two follow-up mailings, which increased the response rate by 28%, are in agreement with the findings of Siemiatycki (1979).

3.7.2. Population

Using summary data from phase Ia of the study to estimate the population size gave high total figures with very wide confidence intervals (Chapter 3.3.3). This reflects the very wide variation in the number of horse owners and horses registered with each practice. Even with a 91% response to phase Ib, the width of 95% confidence band for the total equine population from the combined results of phases Ia and Ib is 18,366 horses which is greater than the total number recorded in phase Ia. Again, this is due to the wide variation in the numbers of horses under the care of different veterinary practices which ranged from 7 to 11,000 animals (Table 22).

3.7.3. Disease and Health Maintenance

The overall rates of vaccination reported in phase Ia are less than the recommended vaccination rate of one dose every year (for equine influenza), following an initial course of

3 doses within a year. This suggests that many horses may be inadequately vaccinated. In addition, the worming rate recorded is also considerably less than the recommended frequency of anthelmintic treatment of every 6 to 8 weeks (approximately 7 treatments per year depending on the product used). However, as anthelmintics are PML drugs, they can be purchased from sources other than veterinary practices, and this figure cannot be interpreted as the true treatment rate. However, the findings are in general agreement with a study on worming practices in the UK by Baker (1994), and a detailed study in Michigan, USA, investigating patterns of equine health maintenance (Kaneene *et al.*, 1996). Both of these studies surveyed persons responsible for keeping horses to collect data about preventive medical practices and this was part of the focus of phase IV of the current study described in Chapter 6.

It is difficult to compare the results of this study with those of previous studies in the USA reported by Underhill and Showalter (1989) and Traub-Dargatz *et al.* (1991) as these studies ranked the most common disease entities, whereas the current study has so far recorded categories of disease. Chapter 5 describes phase III of the current study which was a cross-sectional case study of the practitioners responding to phase Ia described above and provided more detailed information about the disease status of the equine population of Scotland and Northern England.

3.7.4. Conclusions

Phases Ia and Ib provided an estimate of the total size and geographical distribution of the equine population of Scotland and Northern England which represented the basis of a demographic description. In order to supplement this description, data on age, breed, sex, management, feeding and level of activity of animals comprising the population were required. These data were considered to be most readily available from people keeping horses, and a preliminary study of horse owners, concentrating on some of the characteristics listed above, is described in Chapter 4.

CHAPTER 4

PHASE II SURVEY OF HORSE OWNERS

4.1. INTRODUCTION

Animal owners have been the focus of numerous questionnaire surveys in the domain of veterinary research. Such surveys begin with varying aims and objectives, which often affect both the selection of the study population and the method by which the questionnaire is administered. Questionnaire surveys are often used in 'follow-up' to monitor progress of animals after surgical and/or medical treatment once they have been discharged from hospital care. Henney and Gambardella (1989) used a personal interview questionnaire to gather follow-up information from dog owners on the success of surgery for premature closure of the ulnar physis in their animals. Similarly, Lumsden *et al.* (1994) used a combination of race records and the results of a telephone survey of owners to evaluate the outcome after treatment of 51 horses undergoing various surgical procedures for the treatment of epiglottic entrapment. In both these examples the study populations were defined simply by selecting medical records of animals presenting with a particular disease. Questionnaire studies of animal owners may also be used to gather information in relation to specific diseases or syndromes under investigation. Reeves *et al.* (1996) report the use of a telephone questionnaire survey of horse owners, trainers and caretakers in a case-control study to identify risk factors for equine colic. In this study both cases and controls were selected from medical of records of animals presenting at referral hospitals.

Other studies, particularly those investigating associations between farm management practices and disease in production animal species, make use of the membership of registered societies or co-operatives to identify the target population. Cowen *et al.* (1989) conducted a mailed census of all dairy producers listed by the Tulare County Co-operative Extension in California to investigate the association between particular reproductive management practices and production indices. In another study, investigating management factors associated with calf mortality in South Carolina dairy herds, self administered questionnaire forms were distributed among, and later collected from, Dairy Herd Improvement (DHI) members (Jenny *et al.*, 1981). McGreevy *et al.* (1995a) used a mailed questionnaire followed-up by telephone or a second mailing to racehorse trainers listed in a publication entitled 'Horses in Training 1992' to investigate management factors associated with stereotypic behaviour in the Thoroughbred horse.

An annual census, conducted by the Ministry of Agriculture Fisheries and Food, the Scottish Office Department of Agriculture and Fisheries and the Welsh Office Agricultural Department, records the numbers of all production animal species in various management groups, as well as agricultural land use and crop yields, for the purpose of monitoring and regulating the food industry from the points of view of both economics and public health. Since the beginning of the BSE crisis, there have been even more rigorous controls imposed upon the cattle industry with the banning of all exports, and the legal requirement for the accurate identification and passport documentation of all bovine animals (The Scottish Office Department of Agriculture, Environment and Fisheries, 1996b). Although horses are included in the agricultural census, only the number of holdings where horses are kept, and the number of horses kept are recorded. These figures are inaccurate estimates of the total equine population as many horses are kept on land which is not used for commercial agricultural purposes (Chapter 1.2.6). Questionnaire studies involving animal owners have also been used to gather demographic data about pet populations. Edney and Smith (1986) in a study of canine obesity, collected demographic and clinical data about dogs attending 11 veterinary clinics in the UK using record sheets completed by owners and veterinarians during a consultation. Thrusfield (1989) used these data in combination with data from the Edinburgh Small Animal Practice Teaching Unit clinical database and from Kennel Club registrations to describe the demographic characteristics of the UK canine and feline populations in 1986.

In 1988, in the USA, a report on the veterinary services market for companion animals was based on the results of a mailed questionnaire survey of a nationally representative sample of 40,000 households and estimated the total equine population to be 6.6 million animals (Charles, Charles and Associates, 1983; Charles, Charles Research Group, 1988a and b).

Phase II of the current study was conducted through a large number of horse owners who were registered with veterinary practices that participated in phase Ia (Chapter 3). The aims of the horse owner survey were to gather data about management and level of activity of horses under the care of the veterinary practices involved in phase Ia of the study as well as to validate population estimates made in phase Ib (Chapter 3). Furthermore, phase II provided a pool of compliant horse owners who were sampled to provide more detailed data on management, feeding, level of activity, health and disease of horses in phase IV (Chapter 6).

4.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION

4.2.1. Considerations

Initially, this part of the study was designed such that each veterinary practice involved in phase Ia (Chapter 3) should select, for inclusion in the study, a sample of their horse-owning clients to represent a range of different equine management systems and activity levels. In light of concerns about possible bias attributable to practitioner selection of study subjects and achieving adequate response with this structure, the study design was changed and, in the first instance, all horse owning clients registered with phase Ia veterinary practices received a letter explaining the aims of the study together with a short questionnaire concerning the management and use of their horses. Respondents to this questionnaire were asked to indicate their willingness to complete a second, more detailed questionnaire at a later date, concerning the housing, grazing, feeding, level of activity, health and disease of their horses. A random sample of respondents to the first questionnaire, stratified by location and activity levels of their horses, were selected to complete the second questionnaire. This design was thought likely to provide a high response to the second questionnaire from a representative sample of horse owners.

In the mailing to veterinary practices involved in phase Ia of the study (Chapter 3), the accompanying letter (Appendix 2) explained the need to collect data from owners as well as veterinarians, and requested that each practice supply a list of the names and addresses of all horse owning clients registered (Chapter 3.2.3). A specimen of the proposed questionnaire and letter to horse owners were enclosed for the perusal and comment of the veterinary practices involved. In situations where practices were unwilling to disclose client names and addresses, they were asked to undertake the mailing of questionnaires from the practice and were later reimbursed for all costs incurred. In the interest of practice/client relations a single mailing was planned and records were only kept of the addresses of those clients who responded to the first owner questionnaire and indicated their willingness complete the second questionnaire.

The questionnaire was designed to be completed by horse owners and related only to animals that they owned. The length of the questionnaire was again limited to one sheet of A4 (210 × 297 mm) paper to convey the impression of being easy and quick to complete, as well as obviating the need to staple sheets together and reducing mailing costs (Chapter 2.4.2). Each sheet was printed landscape on both sides and folded in half (210 × 144 mm) to form a booklet. The front page was a title page, leaving three pages for the printing of questions (Appendix 9).

4.2.2. Questionnaire Design

The physical design of the questionnaire has been described previously (Chapter 2.4.2, Chapter 4.2.1). Instructions for completion of the questionnaire were printed at the top of the first page and owners were asked to include all horses, ponies and donkeys which belonged to them (Appendix 9). Questions were asked concerning: 1) The number of animals owned; 2) Whether the premises where animals were kept were used solely by the animals of the respondent or were shared by animals belonging to different people; 3) The housing and grazing arrangements for the animals; 4) The level of activity in which the animals were involved. Question 4, concerning levels of activity was originally worded as shown in Figure 7:

Q4 Please state how many animals you own in each of the following categories:

1 Advanced competition. (racing, BHS, BSJA, p-to-p) ____

2 Endurance competition. (endurance riding, driving) ____

3 Mid-level competition. (dressage, showjumping) ____

4 Amateur competition. (riding/pony club events) ____

5 Leisure. (hacking) ____

6 Purely companion. ____

7 Breeding. ____

Figure 7. Phase II Survey of horse owners - question 4 from the first version of the questionnaire.

However, after pretesting among a group of horse owners who would not be involved in the full study, it became clear that some owners could become confused or even offended at the suggestion that some activities such as showjumping or riding/pony club events were considered to be only mid-level or amateur competition. These concerns were addressed by a committee involving the author, Professor S.W.J. Reid, Professor S. Love and Dr M.J. Reeves, and the question was changed to the format shown in Figure 8:

Q4. Please state how many animals you own in each of the following activity groupings:

a. Racing _____

b. Horse trials/ Eventing _____

c. Showjumping _____

d. Point - to - Point _____

e. Endurance Riding _____

f. Driving _____

g. Showing _____

h. Hunting _____

i. Riding/Pony Club events _____

j. Hacking _____

k. Purely Companion _____

l. Breeding _____

m. Other _____

Figure 8. Phase II Survey of horse owners - question 4 from the final version of the questionnaire (Appendix 9).

The result of this change was that the questionnaire included most of the common equestrian activities in the UK and made no presumption of different the levels of exertion or seriousness between different activities.

In the space on the back page of the questionnaire for the address, a separate, labelled space was deliberately included for the postcode as this would be used to geocode the location of respondents for the purposes of mapping using Geographical Information System software (Chapter 1.8, Chapter 2.7).

Horse-owners were identified with a unique six digit number derived in part from the practice with which they were registered. The first two digits of the owner number were the same as the practice number, the remaining four digits identified each owner within that practice. Owner numbers were marked on all questionnaires and fact sheets prior to mailing.

4.2.3. The Accompanying Letter

The general physical characteristics of the accompanying letter have been described in Chapter 2.4.4. This letter would be the first and only contact with owners, as no follow-up was intended (Chapter 4.2.1), and therefore the wording was very carefully considered (Appendix 8). As several of the practices participating in phase Ia of the study had indicated their intention to mail owner questionnaires from the practice, it was impossible to address letters to horse owners individually. As a result, the letters were all addressed: 'Dear Horse Owner,'. The letter gave some general background information and explained the reasons for the inception of this study. Owners were encouraged to respond on the basis that only they could supply the important information on which the study depended, and that this would in turn bring benefit to their own animals. The letter mentioned that veterinary practices were also involved in the study, but did not suggest that owners' names and addresses had been taken from veterinary practice records. The letter assured respondents of complete confidentiality, stating that the identification number with which each questionnaire was marked was for postal purposes only (Chapter 2.4.2, Chapter 4.2.4). It was explained that summary results of the study would made available to organisations and parties with an interest in equine health and welfare. Respondents were invited to make use of a FREEPOST envelope to return their completed questionnaire. All letters to horse owners were hand signed in ink.

4.2.4. Implementation

Fourteen of the twenty two practices which responded to phase Ia of the study supplied lists of names and addresses of horse owning clients. A further three practices indicated their willingness to mail questionnaires to their clients provided that their costs were covered. In addition, practice 10, which did not respond to the phase Ia questionnaire, did supply a list of names and addresses of horse owning clients. Some practices, having completed and returned the phase Ia questionnaire, took several months to compile and send a list of names and addresses (Chapter 3.3.1).

The mailing package contained the questionnaire, the accompanying letter and a self addressed return envelope (size 110 × 220 mm) within an envelope (size 162 × 229 mm). The accompanying letter was folded in half with the salutation on the outside top left. The questionnaire was placed inside this with the title page uppermost, inside which was the return envelope. The whole package was placed into the envelope with the salutation on the letter and the address on the envelope orientated to each other (Chapter 3.2.4).

Questionnaires were mailed in batches, usually including all the owners registered with one or more practices in each batch. Where questionnaires were mailed by the author, envelopes were hand addressed, with the exception of those to the 2335 owners registered with practice 25 where secretarial assistance was enlisted to type self adhesive address labels. Where questionnaires were mailed to owners by the practices themselves, practice produced self adhesive address labels were used. The self-addressed return envelope was initially produced with a second class postage stamp affixed, and these were used for the owners registered with practices 17, 20, 21 and 22. However, with the large numbers of owners registered with some practices who were surveyed subsequently, it became impractical to affix postage stamps to all return envelopes and a FREEPOST address was established. After this, all return envelopes bore self adhesive labels with this address printed upon it (Chapter1.3.1, Chapter 2.4.5). The first FREEPOST address labels were printed in standard 12 point text. The 'FREEPOST' line was later changed to 16 point bold text, after a number of owners returned the original FREEPOST envelopes with their own postage stamps affixed (Figure 9).

Veterinary Informatics & Health Unit
FREEPOST GW 7431
Bearsden
Glasgow
G61 1BR

Veterinary Informatics & Health Unit
FREEPOST GW 7431
Bearsden
Glasgow
G61 1BR

Figure 9. Two designs for FREEPOST labels for return envelopes, the initial design on the left, and the final design on the right.

The implementation of this phase of the study is summarised in Table 23:

Practice number	Administration of questionnaires[‡]	Questionnaires sent	Date sent	Return envelopes - small text, large text or stamp[+]
2	DJM	196	26/10/93	small
3	practice	250[¢]	04/08/94	large
4	DJM	343	15/02/94	large
6	DJM	436	11/02/94	large
8	practice	450[¢]	07/02/95	large
9	DJM	80	23/03/94	large
10	DJM	26	19/05/93	small
11	DJM	993	28/10/93	large
12	DJM	662	02/07/93	small
16	DJM	237	15/12/94	large
17	DJM	106	10/05/93	2nd class stamp
18	practice	500[¢]	05/09/94	large
19	DJM	123	02/07/93	small
20	DJM	30	19/05/93	2nd class stamp
21	DJM	131	15/07/93	2nd class stamp
22	DJM	63	19/05/93	2nd class stamp
24	DJM	245	19/09/93	small
25	DJM	2335	15/08/95	large

Table 23. Phase II Survey of horse owners - summary of implementation.
[‡] questionnaires were mailed either by the author (DJM) or by the practice to horse owners.
[¢] these were the numbers of questionnaires that were requested by practices who wanted to undertake the mailing to owners themselves.
[+] refers to the return envelope: 2nd class stamp or FREEPOST with small text or large text (Figure 9).

All outgoing questionnaire mail to horse owners were franked second class letter rate. In the instances of practices 3, 8 and 18, who mailed their own questionnaires, each was supplied with the requested number questionnaire filled envelopes ready for mailing. These were addressed and mailed by the practices.

4.2.5. Data Storage and Analysis

A Microsoft Access table was designed, within The Home of Rest for Horses Study of Equine Welfare database, to hold all data from this phase of the study (Chapter 2.5). Data were entered using a form, linked to the table, corresponding to the design of the questionnaire (Appendix 10). A field for practice number was included for the purposes of analysing owner response by practice affiliation, and linking to practice data from phases Ia and III. The owner number, unique to each record in the database, was used as a primary key field to index the table (Chapter 2.5). Owner postcodes were recorded (not complete addresses) and used later to geocode records for mapping purposes (Chapter 2.7). Where owners completed the questionnaire, but stated that they were unwilling to complete the second questionnaire, the address space was not filled in and no postcode was recorded. Thus only those owners who had entries in the postcode field of this table in the database were eligible for inclusion in phase IV of the study (Chapter 6). The rest of the table was organised so that one field in the database corresponded to one option on the questionnaire. A number coding (1 = yes, 0 = no) was used for responses to question 2 to facilitate calculations in later analyses (Appendix 9). In all the remaining fields covering management and activity groupings, the number of animals listed against each option were recorded in the database. Two further fields, calculated by the author at the time of data entry, were added (Appendix 10): 1) 'number of use categories' stored a count of the total number of activity groupings in which a particular owner's animals were involved, and 2) 'total number of entries in use categories' stored a sum of the entries across all use categories for each owner record. These two fields were used in analysis and in checking for errors in data entry.

Ninety five per cent confidence intervals for estimates of proportions of horse owners and horses were calculated using the formula presented in Chapter 2.6.

4.2.5.1. Data reliability

Several procedures were employed to avoid inaccuracies in the database as a result of errors made during data entry. In Microsoft Access (Microsoft Corporation), properties can be set for each individual field to specify not only the format of the data stored such as text, number, date/time, but also to limit the permissible values within a particular field with specified data format (Chapter 2.5). As far as was possible, strict properties were set for each field in the table so that gross errors in data entry were prevented. In addition to this, querying within the table was used to identify and correct errors once the table was complete. Querying to find postcodes with more than one owner number, identified owners who, through being registered with more than one practice, had received two questionnaires and responded twice. This required careful sifting through individual questionnaires as postcodes are not specific to individual houses and many respondents with identical postcodes were different people living in the same street or village. This analysis was very useful, as it gave some idea of the proportion of horse owners who were registered with more than one practice (Chapter 4.3.1). The responses to question 2 (Appendix 9) were mutually exclusive and errors were prevented by setting appropriate field properties. Errors in data entry for question 3 (Appendix 9) were identified by summing the responses to the five options and comparing this figure to the 'number of animals owned' field (Appendix 10). Instances where these figures were not equal, since the five options to question 3 were mutually exclusive, identified records with an error in data entry for this question. These errors were corrected after checking the original questionnaire returned from owners who were identified by the query. In a similar way, errors in data entry for question 4 (Appendix 9) were identified and corrected, this time summing the response to the thirteen activity level options and comparing this figure to the 'total number of entries in use categories' field (Chapter 4.2.5) rather than the 'number of animals owned' as the options for question 4 were not mutually exclusive (one horse could be involved in more than one activity).

4.2.5.2. Geocoding

Geocoding has already been described as the process by which spatially referenced data, in this case by postcodes, are converted to grid references which can be read by Geographical Information System (GIS) software (Chapter 1.8, Chapter 2.7). A dataset of owner numbers with corresponding postcodes was produced by querying the database table in Microsoft Access (Microsoft Corporation). These data were saved onto 3.5" 1.44 Mb floppy diskettes and mailed to Graphical Data Capture Ltd. for geocoding. Geocoded data received by return of post from Graphical Data Capture Ltd. were imported into MapInfo (GIS) software (MapInfo Corporation). Data from the original table in Microsoft Access were imported into MapInfo, initially via Microsoft Excel (Microsoft Corporation) spreadsheets but latterly using direct links designed for this purpose (Chapter 2.3). Using customised standard query language (SQL) functions in MapInfo data from the original table were linked to geocoded points so that any feature of the survey of horse owners could be represented in map form (Chapter 1.8).

4.3. RESULTS

4.3.1. Response

The response to Phase II A Survey of Horse Owners, grouped by practice affiliation, is summarised in Table 24. As a result of the unforeseen categories of respondent shown in Table 24, rather than simply dividing the number of questionnaires returned by the number of questionnaires sent, response rates were calculated using the following equation relating to column headings from Table 24:

$$\left[\frac{\begin{array}{c}([\text{no horses owned}] + [\text{duplicates / double response}] \\ + [\text{repeat responders}] + [\text{positive responses}])\end{array}}{([\text{questionnaires sent}] - [\text{not known at address}])}\right] \times 100$$

A total of 7,206 questionnaires were sent to horse owners either by the author or, in case of practices 3, 8 and 18, by the veterinary practice on behalf of the author. Three hundred and twenty seven questionnaires were returned where the addressee was unknown or had moved away. Seventy nine questionnaires were returned by owners who stated that they no longer owned any horses. Using the database querying methods mentioned in Chapter 4.2.5.1, several respondents were identified who had completed the questionnaire twice. Eight of these responded twice to the questionnaire from the same individual practice

Practice number	Questionnaires sent	Not known at address‡	Questionnaires reaching owners	No horses owned¢	Duplicates / double response+	Repeat responders†	Positive responses°	Overall response rate (%)
2	196	0	196	4	0	1	110	59
3*	250	0	250	0	1	0	105	42
4	343	31	312	8	2	21	114	46
6	436	8	428	5	0	0	223	53
8*	450	0	450	0	0	0	92	20
9	80	1	79	1	0	0	44	57
10	26	0	26	0	0	0	17	65
11	993	68	925	19	1	0	393	45
12	662	63	599	0	0	0	220	37
16	237	6	230	4	0	0	74	34
17	106	2	104	0	0	0	79	76
18*	500	0	500	7	1	3	214	45
19	123	2	121	1	0	0	69	58
20	30	0	30	0	0	0	23	77
21	131	2	129	1	0	0	67	53
22	63	1	62	0	0	0	32	52
24	245	0	245	0	2	0	125	52
25	2335	143	2292	29	1	57	631	31
count	**total**	**total**	**total**	**total**	**total**	**total**	**total**	**overall**
18	7206	327	6978	79	8	82	2632	40

Table 24. Phase II Survey of horse owners - summary of the response grouped by practice affiliation.
* practices 3, 8 and 18 mailed questionnaires to horse owners from the practice.
‡ the number of questionnaires returned where the addressee was not known at the address or gone away.
¢ the number of owners responding stating that they no longer owned any horses.
+ the number of owners responding twice to the questionnaire within the same practice list (twice to the same mailing).
† the number of owners responding twice to the questionnaire mailed to different practice lists (different mailings).
° the number of owners responding after correcting for all the above factors.

address list. In these instances, owners had been entered twice on the address list supplied by the practices, received two identical questionnaires in the post on the same day (because questionnaires were mailed in batches including all owners registered with a particular practice (Chapter 4.2.4)), and responded to both of them. These eight 'double responders' came from six different practices. A further 82 owners responded twice as a result of being entered on the address list of more than one practice. In these instances, the time elapsing between mailings varied depending upon on which practice address lists owners appeared. These data were useful not only as a guide of what proportion of horse owners were registered with more than one practice, but also as an indicator of repeatability of the questionnaire and stability of the population. Changes in equine population data among repeat responders are summarised in Table 25:

First practice number‡	Second practice number¢	Number of owners	Months between mailings	Total horses at first response	Total horses at second response	Change in number over time
2	18	3	10	23	25	2
2	25	3	22	13	17	2
4	25	2	18	5	5	0
6	25	2	18	14	12	-2
9	25	3	17	6	4	-2
11	4	18	4	104	108	4
11	25	3	22	24	16	-8
12	2	1	3	2	2	0
12	25	25	25	125	131	6
17	25	1	27	1	1	0
18	25	3	11	23	27	4
19	4	3	9	8	8	0
21	25	11	25	51	54	3
22	25	1	27	2	1	-1
24	25	3	23	10	8	-2
		total	average	total	total	total
		82	17	411	419	8

Table 25. Phase II Survey of horse owners - equine population change over time among repeat responders.

‡ the number of the practice from whose list owners were mailed first.

¢ the number of the practice from whose list owners were mailed second.

Over a mean ± SD period of 17 ± 8 months the total number of horses kept by 82 horse owners increased from 411 to 419 (2%) though this was not statistically significant (p = 0.6). Over the same period there were minimal changes reported in management practices and activities in which animals belonging to these respondents were involved, and the majority of these appeared to be attributable to small changes in numbers of animals belonging to individual respondents. Repeat responders were entered into the database table only once, and in all cases were left affiliated (in terms of practice number and owner number) to the practice surveyed first. The major reason for this was that many of those that responded a second time did so as clients of practice 25, which was known to be involved in second opinion work throughout the study area. It was decided therefore, that clients were more likely to receive regular veterinary care from their local practice.

The effects on the number of respondents using their own postage stamps on return envelopes, and on response rate, of using a 2nd class stamp, small text FREEPOST label or large text FREEPOST label (Chapter 4.2.4) are summarised in Tables 26 and 27:

Practice number	Return envelopes - small text, large text or stamp	Number of self stamped return envelopes used	Percentage of respondents using self stamped return envelopes	Overall response rate (%)
2	small	2	2	59
3	large	9	8	42
4	large	4	3	46
6	large	6	3	53
8	large	2	2	20
9	large	0	0	57
10	small	1	6	65
11	large	23	6	45
12	small	45	20	37
16	large	1	1	34
17	2nd class stamp	0	0	76
18	large	8	4	45
19	small	14	20	58
20	2nd class stamp	0	0	77
21	2nd class stamp	0	0	53
22	2nd class stamp	0	0	52
24	small	17	13	52
25	large	21	3	31

Table 26. Phase II Survey of horse owners - numbers, percentage and response rate by practice affiliation of respondents using their own stamps on FREEPOST return envelopes.

Return envelopes - small text, large text or stamp	Number of self stamped envelopes returned	Percentage of return envelopes self stamped*	Overall response rate (%)
2nd class stamp	0	0	62
large	74	4	38
small	79	14	46

Table 27. Phase II Survey of horse owners - effects of different types of return envelopes on response rate and on the percentage of respondents using their own stamps on FREEPOST return envelopes.
* the percentage of respondents using their own stamps on return envelopes.

There was a marked, statistically significant ($p<0.001$) reduction (14 - 4%) in the percentage of respondents who used their own stamps on FREEPOST envelopes as a result of changing the FREEPOST line from standard 12 point text to bold 16 point text (Chapter 4.2.4). Despite this, there was a reduction in response rate following the change, though this may have been due in part to the fact that 16 point FREEPOST return envelopes were used for practices 3, 8 and 18 which mailed questionnaires to horse owners themselves, all giving very low response rates. Response rates were highest when a 2nd class stamp was used on return envelopes rather than a FREEPOST address.

4.3.2. Survey Data

The results of Phase II Survey of horse owners are presented in Tables 28, 29 and 30 a, b and c. After removing repeat responders (Chapter 4.3.1), a total of 2,632 horse owners registered with 18 veterinary practices provided information about 9,830 equine animals. The results are summarised in Tables 31, 32 and 33:

Practice number	Number of respondents	Number of animals owned	Owners keeping animals on private premises		Owners keeping animals on shared premises		Animals kept on private premises		Animals kept on shared premises	
			number	%	number	%	number	%	number	%
2	110	467	73	**65**	40	**35**	382	**82**	85	**18**
3	105	442	55	**52**	51	**48**	226	**51**	216	**49**
4	114	412	72	**63**	43	**37**	302	**73**	110	**27**
6	223	828	97	**43**	128	**57**	427	**52**	401	**48**
8	92	322	49	**53**	43	**47**	185	**57**	137	**43**
9	44	125	17	**39**	27	**61**	66	**53**	59	**47**
10	17	77	11	**65**	6	**35**	60	**78**	17	**22**
11	393	1419	157	**40**	237	**60**	817	**58**	602	**42**
12	220	628	80	**36**	143	**64**	269	**43**	359	**57**
16	74	243	41	**55**	33	**45**	146	**60**	97	**40**
17	79	184	14	**18**	65	**82**	51	**28**	133	**72**
18	214	959	136	**62**	82	**38**	663	**69**	296	**31**
19	69	380	46	**64**	26	**36**	256	**67**	124	**33**
20	23	77	19	**83**	4	**17**	67	**87**	10	**13**
21	67	267	36	**53**	32	**47**	159	**60**	108	**40**
22	32	135	20	**63**	12	**37**	88	**65**	47	**35**
24	125	512	97	**78**	28	**22**	414	**81**	98	**19**
25	631	2353	297	**47**	339	**53**	1296	**55**	1057	**45**
count	**total**	**total**	**total**		**total**		**total**		**total**	
18	2632	9830	1317	**50**	1339	**50**	5874	**60**	3956	**40**

Table 28. Phase II Survey of horse owners - responses by practice affiliation - premises.
The figure on the right side of each column is the percentage of the population affiliated to each practice kept in each type of premises.
The shaded cells highlight the practice with the highest (dark) and lowest (light) percentage of the owners or animals using each type of premises.
The sum of numbers in columns ‘respondents keeping animals on private premises’ and ‘respondents keeping animals on shared premises’ is, in some practices, greater than the total number of respondents - this is because some owners keep some of their animals on private premises and others on shared premises, therefore appearing in both columns of the table.

Practice number	Number of respondents	Number of animals owned	Animals mostly stabled		Animals mostly grazed		Animals half stabled / half grazed		Animals always stabled		Animals always grazed	
			number	%	number	%	number	%	number	%	number	%
2	110	467	83	**18**	232	**50**	95	**20**	0	**0**	57	**12**
3	105	442	86	**19**	251	**57**	56	**13**	17	**4**	32	**7**
4	114	412	109	**65**	133	**32**	52	**13**	8	**2**	110	**27**
6	223	828	400	**48**	215	**26**	185	**22**	7	**1**	21	**3**
8	92	322	67	**21**	145	**45**	76	**24**	1	**0**	33	**10**
9	44	125	21	**17**	66	**53**	27	**22**	0	**0**	11	**9**
10	17	77	21	**27**	36	**47**	7	**9**	1	**1**	12	**16**
11	393	1419	267	**19**	706	**50**	225	**16**	36	**3**	185	**13**
12	220	628	271	**43**	168	**27**	148	**24**	13	**2**	28	**4**
16	74	243	60	**25**	128	**53**	40	**16**	6	**2**	9	**4**
17	79	184	73	**40**	55	**30**	29	**16**	1	**1**	26	**14**
18	214	959	199	**21**	458	**48**	184	**19**	34	**4**	84	**9**
19	69	380	38	**10**	150	**39**	32	**8**	13	**3**	147	**39**
20	23	77	27	**35**	37	**48**	13	**17**	0	**0**	0	**0**
21	67	267	103	**39**	88	**33**	69	**26**	1	**0**	6	**2**
22	32	135	6	**4**	75	**56**	7	**5**	14	**10**	33	**24**
24	125	512	147	**29**	240	**47**	73	**14**	1	**0**	51	**10**
25	631	2353	855	**36**	884	**38**	451	**19**	74	**3**	89	**4**
count	**total**	**total**	**total**		**total**		**total**		**total**		**total**	
18	2632	9830	2833	**29**	4067	**41**	1769	**18**	227	**2**	934	**10**

Table 29. Phase II Survey of horse owners - responses by practice affiliation - management.

The figure on the right side of each column is the percentage of the equine population affiliated to each practice experiencing each type of management.

The shaded cells highlight the practice with the highest (dark) and lowest (light) percentage of the equine population experiencing each type of management - where there are two or more practices the same, the practice with largest number of horses affiliated to it is highlighted.

Practice number	Number of respondents	Number of animals owned	Animals involved in **racing** number	%	Animals involved in **horse trials / eventing** number	%	Animals involved in **showjumping** number	%	Animals involved in **point-to-point** number	%	Animals involved in **endurance riding** number	%
2	110	467	16	**3**	34	**7**	5	**1**	13	**3**	9	**2**
3	105	442	16	**4**	48	**11**	18	**4**	11	**2**	3	**1**
4	114	412	0	**0**	41	**10**	40	**10**	0	**0**	14	**3**
6	223	828	31	**4**	82	**10**	95	**11**	19	**2**	14	**2**
8	92	322	22	**7**	18	**6**	24	**7**	12	**4**	4	**1**
9	44	125	1	**1**	7	**6**	11	**9**	0	**0**	0	**0**
10	17	77	5	**6**	3	**4**	2	**3**	0	**0**	2	**3**
11	393	1419	0	**0**	127	**9**	166	**12**	3	**0**	36	**3**
12	220	628	5	**1**	42	**7**	99	**16**	12	**2**	2	**0**
16	74	243	6	**2**	19	**8**	18	**7**	0	**0**	3	**1**
17	79	184	0	**0**	17	**9**	24	**13**	0	**0**	6	**3**
18	214	959	111	**12**	84	**9**	33	**3**	42	**4**	23	**2**
19	69	380	0	**0**	8	**2**	17	**4**	0	**0**	1	**0**
20	23	77	0	**0**	4	**5**	4	**5**	0	**0**	0	**0**
21	67	267	12	**4**	6	**2**	13	**5**	2	**1**	1	**0**
22	32	135	0	**0**	1	**1**	2	**1**	0	**0**	18	**13**
24	125	512	81	**16**	20	**4**	35	**7**	22	**4**	2	**0**
25	631	2353	106	**5**	179	**8**	330	**14**	19	**1**	13	**1**
count	**total**	**total**	**total**		**total**		**total**		**total**		**total**	
18	2632	9830	412	**4**	740	**8**	936	**10**	155	**2**	151	**2**

Table 30a. Phase II Survey of horse owners - responses by practice affiliation - activities.
The figure on the right side of each column is the percentage of the equine population affiliated to each practice involved in each activity grouping.
The shaded cells highlight the practice with the highest (dark) and lowest (light) percentage of the population involved in each type of activity - where there are two or more practices the same, the practice with largest number of horses affiliated to it is highlighted.
The sum of numbers and percentages across all activity grouping columns (Tables 30a, b and c) add to greater than the 'number of animals owned' column and 100% respectively - this is because many horses are involved in more than one activity.

Practice number	Number of respondents	Number of animals owned	Animals involved in **driving**		Animals involved in **showing**		Animals involved in **hunting**		Animals involved in **riding / pony club events**		Animals involved in **hacking**	
			number	%	number	%	number	%	number	%	number	%
2	110	467	17	**4**	78	**17**	65	**14**	81	**17**	66	**14**
3	105	442	4	**1**	28	**6**	95	**21**	67	**15**	124	**28**
4	114	412	7	**2**	95	**23**	9	**2**	94	**23**	99	**24**
6	223	828	46	**6**	108	**13**	135	**16**	198	**24**	253	**31**
8	92	322	15	**5**	41	**13**	38	**12**	59	**18**	85	**26**
9	44	125	1	**1**	12	**10**	3	**2**	25	**20**	47	**38**
10	17	77	4	**5**	6	**8**	3	**4**	16	**21**	30	**39**
11	393	1419	38	**3**	182	**13**	15	**1**	261	**18**	430	**30**
12	220	628	15	**2**	90	**14**	49	**8**	122	**20**	161	**26**
16	74	243	11	**5**	52	**21**	5	**2**	45	**19**	92	**38**
17	79	184	7	**4**	18	**10**	5	**3**	41	**22**	58	**31**
18	214	959	19	**2**	125	**13**	130	**14**	185	**20**	222	**23**
19	69	380	8	**2**	82	**22**	0	**0**	68	**18**	61	**16**
20	23	77	7	**9**	9	**12**	0	**0**	28	**36**	11	**14**
21	67	267	2	**1**	53	**20**	3	**1**	46	**17**	64	**24**
22	32	135	2	**1**	4	**3**	0	**0**	34	**25**	22	**16**
24	125	512	15	**3**	49	**10**	39	**8**	69	**13**	90	**18**
25	631	2353	35	**1**	296	**13**	119	**5**	350	**15**	451	**19**
count	**total**	**total**	**total**		**total**		**total**		**total**		**total**	
18	2632	9830	253	3	1328	**14**	713	7	1789	**18**	2366	**24**

Table 30b. Phase II Survey of horse owners - responses by practice affiliation - activities (continued).
The figure on the right side of each column is the percentage of the equine population affiliated to each practice involved in each activity grouping.
The shaded cells highlight the practice with the highest (dark) and lowest (light) percentage of the population involved in each type of activity - where there are two or more practices the same, the practice with largest number of horses affiliated to it is highlighted.
The sum of numbers and percentages across all activity grouping columns (Tables 30a, b and c) add to greater than the 'number of animals owned' column and 100% respectively - this is because many horses are involved in more than one activity.

Practice number	Number of respondents	Number of animals owned	Animals involved in purely companion		Animals involved in breeding		Animals involved in other	
			number	%	number	%	number	%
2	110	467	21	**5**	119	**25**	87	**19**
3	105	442	22	**5**	93	**21**	66	**15**
4	114	412	51	**12**	106	**26**	66	**16**
6	223	828	79	**10**	134	**16**	98	**12**
8	92	322	34	**11**	59	**18**	38	**12**
9	44	125	15	**12**	10	**8**	11	**9**
10	17	77	1	**1**	12	**16**	3	**4**
11	393	1419	118	**8**	240	**17**	344	**24**
12	220	628	66	**11**	59	**9**	134	**21**
16	74	243	14	**6**	47	**19**	33	**14**
17	79	184	14	**8**	13	**7**	56	**30**
18	214	959	62	**6**	199	**21**	131	**14**
19	69	380	28	**7**	124	**33**	50	**13**
20	23	77	7	**9**	15	**19**	13	**17**
21	67	267	16	**6**	73	**27**	37	**14**
22	32	135	13	**10**	26	**19**	38	**28**
24	125	512	33	**6**	121	**24**	62	**12**
25	631	2353	179	**8**	472	**20**	420	**18**
count	**total**	**total**	**total**		**total**		**total**	
18	2632	9830	773	**8**	1922	**20**	1887	**17**

Table 30c. Phase II Survey of horse owners - responses by practice affiliation - activities (continued).
The figure on the right side of each column is the percentage of the equine population affiliated to each practice involved in each activity grouping.
The shaded cells highlight the practice with the highest (dark) and lowest (light) percentage of the population involved in each type of activity - where there are two or more practices the same, the practice with largest number of horses affiliated to it is highlighted.
The sum of numbers and percentages across all activity grouping columns (Tables 30a, b and c) add to greater than the 'number of animals owned' column and 100% respectively - this is because many horses are involved in more than one activity.

Premises	Percentage of owners keeping horses	Range (%, by practice) of owners keeping horses
private	50	18 practice 17 (Lothian) 83 practice 20 (Orkney)
shared	50	17 practice 20 (Orkney) 82 practice 17 (Lothian)
	Percentage of equine population	**Range (%, by practice) of equine population**
private	60	28 practice 17 (Lothian) 87 practice 20 (Orkney)
shared	40	13 practice 20 (Orkney) 72 practice 17 (Lothian)

Table 31. Phase II Survey of horse owners - premises.

Overall, 50% of owners kept their animals on private premises used only for the horses of one owner, and 50% kept their animals on premises shared by horses belonging to more than one owner. Ninety five per cent confidence intervals for these proportions are given by the following (Chapter 2.6):

$$\pm 1.96\sqrt{\frac{0.5(1-0.5)}{2{,}632}} \times \sqrt{\frac{33{,}480-2{,}632}{33{,}480-1}} = 0.018$$

where 33,480 is the estimated total number of horse owners in the study area (Chapter 3.5.2). Therefore, the 95% confidence band for the percentage of horse owners keeping their animals on private or shared premises is 48 - 52%. In terms of the proportion of the equine population however, 60% of animals were kept on private premises and only 40% of animals were kept on shared premises. This suggests that horse owners who share premises tend to own fewer animals than people who keep horses on their own private premises. Ninety five per cent confidence intervals for these proportions are given by the following (Chapter 2.6):

$$\pm 1.96\sqrt{\frac{0.6(1-0.6)}{9{,}830}} \times \sqrt{\frac{78{,}547-9{,}830}{78{,}547-1}} = 0.009$$

where 78,547 is the estimated total number of horses in the study area (Chapter 3.5.2). Therefore, the 95% confidence band for the percentage of horses kept on private premises is 59 - 61%, and on shared premises is 39 - 41%. In the following tables, confidence intervals are not quoted as they are all less than ± 1%.

Management	**Percentage of the population involved**	**Range (%, by practice) of population involved**
mostly grazed	**41**	26 practice 6 (Tyne & Wear) 57 practice 3 (Northumberland)
mostly stabled	**29**	4 practice 22 (Strathclyde) 65 practice 24 (Grampian)
half stabled/half grazed	**18**	5 practice 22 (Strathclyde) 26 practice 21 (Strathclyde)
always grazed	**10**	0 practice 20 (Orkney) 39 practice 19 (Grampian)
always stabled	**2**	0 practice 2 (Borders) 10 practice 22 (Borders)

Table 32. Phase II Survey of horse owners - management.

Overall, 29% of horses spent the majority of their time stabled. Only 2% of the population were permanently stabled. Horses which spent roughly half their time stabled and half grazing comprised a further 18% of the population. Overall 41% of horses spent the majority of their time grazing, and a further 10% were permanently grazed.

Activity	Percentage of the population involved	Range (%, by practice) of population involved
hacking	24	14 practice 2 (Borders) 39 practice 10 (Dumfries & Galloway)
breeding	20	7 practice 17 (Lothian) 33 practice 19 (Grampian)
riding/pony club events	18	13 practice 24 (Dumfries & Galloway) 36 practice 20 (Orkney)
showing	14	3 practice 22 (Strathclyde) 22 practice 19 (Grampian)
showjumping	10	1 practice 2 (Borders) 16 practice 12 (Strathclyde)
horse trials/eventing	8	1 practice 22 (Strathclyde) 11 practice 3 (Northumberland)
purely companion	8	1 practice 10 (Dumfries & Galloway) 12 practice 4 (Grampian)
hunting	7	0 practice 19 (Grampian) 21 practice 3 (Northumberland)
racing	4	0 practice 11 (Grampian) 16 practice 24 (Dumfries & Galloway)
driving	3	1 practice 25 (Strathclyde) 9 practice 20 (Orkney)
point-to-point	2	0 practice 19 (Grampian) 4 practice 18 (Borders)
endurance riding	2	0 practice 9 (Central) 13 practice 22 (Strathclyde)
other (youngstock, trekking, riding schools	17	4 practice 10 (Dumfries & Galloway) 30 practice 17 (Lothian)

Table 33. Phase II Survey of horse owners - activities.

As can be seen from Table 33, many horses were used for more than one activity. Hacking, breeding and riding/pony club events were the single activities which involved the greatest proportion of the equine population. Racing, driving, point-to-point and endurance riding combined, involved only 11% of the total equine population. Horses involved in ‘miscellaneous’ activities such as pony trekking and riding schools as well as young horses not yet involved in any activity, made up 17% of the total equine population.

Of 2,632 respondents, only 101 (4%) stated that they would be unwilling to complete a second questionnaire in the future and did not supply an address or postcode. A further 40 (1%) respondents, though willing to complete a second questionnaire, supplied an address with no postcode. Postcodes, which were later geocoded to locate horse owner records in the Geographical Information System (Chapter 1.8, Chapter 2.7, Chapter 4.2.5.2) were supplied by 95% of respondents.

4.3.3. Analyses

Summary statistics from analysis of the results of Phase II Survey of horse owners are presented in Table 34. Tables showing these data stratified by practice affiliation are presented in Appendix 22.

	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.7	2.5	1.6	1.5
standard deviation	5.1	1.5	2.2	0.9
standard error	0.10	0.03	0.04	0.02
median	2	2	1.0	1.0
range	59	9	57.9	6.5
minimum	1	1	0.1	1
25th percentile	1	1	1	1
75th percentile	4	3	2	1.7
maximum	60	10	58	7.5
semi-interquartile range	1.5	1	0.50	0.35
mode	1	1	1.0	1.0

Table 34. Phase II Survey of horse owners - summary statistics (2,632 owners, 9,830 animals).
activities/owner - the number of activities in which an owner's animals were involved.
animals/activity - the number of animals involved in each activity.
activities/animal - the number of activities in which each animal was involved.

The mean ± SD number of animals per owner was 3.7 ± 5.1, with a range from 1 to 60. The mean ± SD number of activities in which each owner was involved was 2.5 ± 1.5. A mean ± SD of 1.5 ± 2.2 animals owned were involved in each activity and the mean ± SD number of activities in which an animal was involved was 1.6 ± 0.9.

Table 35 summarises the results of Phase II Survey of horse owners in terms of the proportion of horse owners keeping different numbers of animals and proportion of the population kept in different sized groups.

Number of animals owned	Percentage of animals	Percentage of owners	Range (%, by practice) of owners
one	9	32	18 practice 10 (Dumfries & Galloway) 58 practice 17 (Lothian)
two	13	24	19 practice 17 (Lothian) 33 practice 4 (Grampian)
three	11	14	7 practice 9 (Central) 26 practice 20 (Orkney)
four	9	8	4 practice 17 (Lothian) 13 practice 21 (Strathclyde)
five	7	5	0 practice 9 (Central) 12 practice 10 (Dumfries & Galloway)
six - ten	20	10	3 practice 22 (Strathclyde) 17 practice 2 (Borders)
eleven - twenty	15	4	0 practice 17 (Lothian) 12 practice 10 (Dumfries & Galloway)
more than twenty	16	2	0 practice 21 (Strathclyde) 7 practice 19 (Grampian)

Table 35. Phase II Survey of horse owners - numbers of animals kept.

Thirty two percent of horse owners kept just one equine animal and of these 195 owners (7% of the total number of respondents) kept a single animal on private premises (combining results from Tables 31 and 35), meaning that 2% of the total equine population were kept in solitude. A further 24% of owners kept two animals, meaning that 56% of horse owners kept one or two animals, although 51% of the equine study population were kept by people who own more than five animals.

4.3.4. Summary

In phase II of the study a total of 2,632 horse owners provided information about 9,830 equine animals giving an average of nearly 4 animals per owner. Ninety five percent of these owners provided postcodes, so that a map showing their distribution throughout the study area could be created using Geographical Information System software (Figure 10). Overall 50% of owners kept their horses on private premises and 50% kept them on shared premises, but there was significant ($p<0.001$) variation in this ratio across owners registered with different veterinary practices (Figure 11). It can be seen that, with the exception of practices 6 and 11, the greatest percentage of owners using shared premises is concentrated

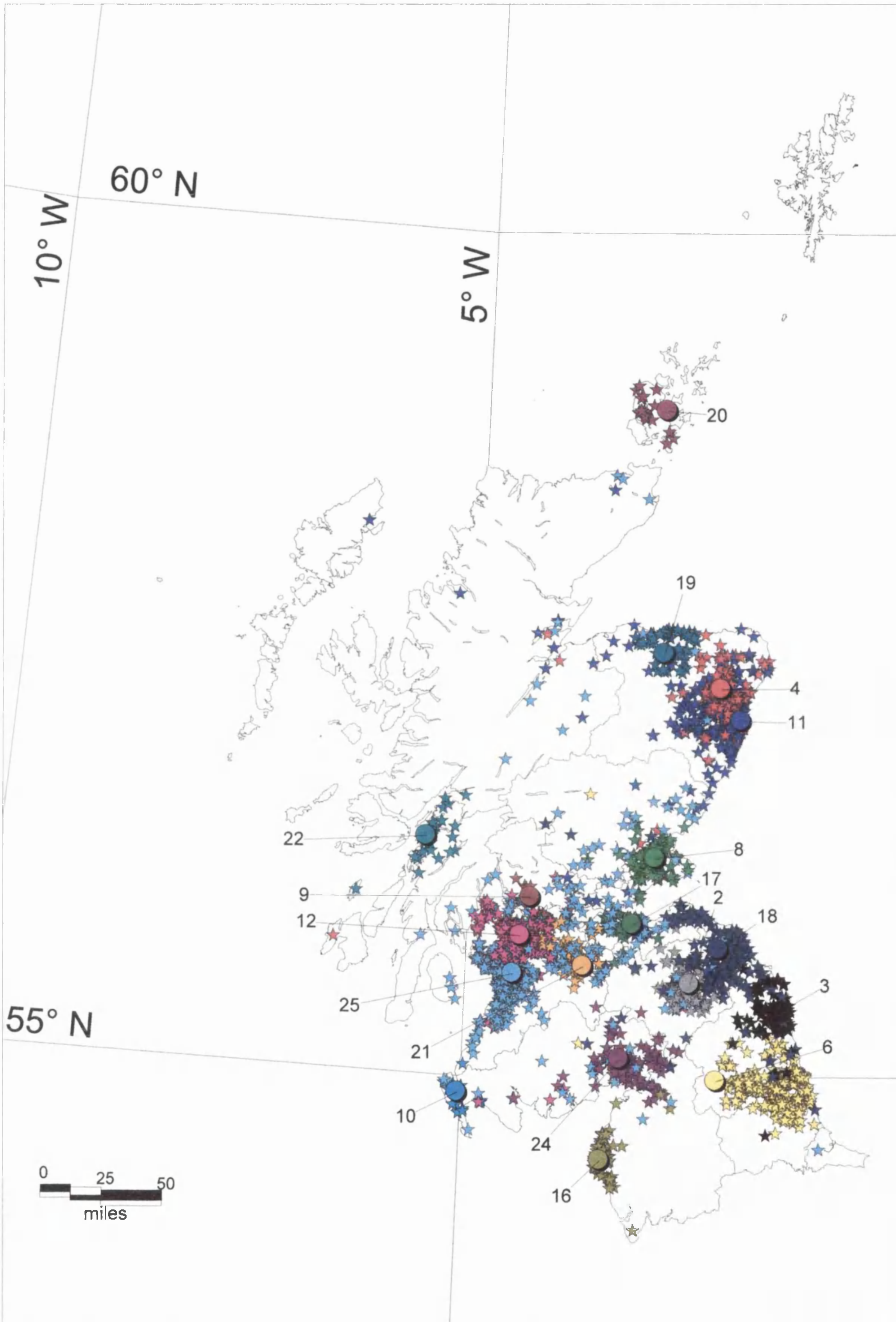


Figure10. Map showing the distribution of respondents, colour coded by practice affiliation, to Phase II Survey of horse owners.
Practices are represented by a dot and a practice identification number.
Horse owners are represented by a star.

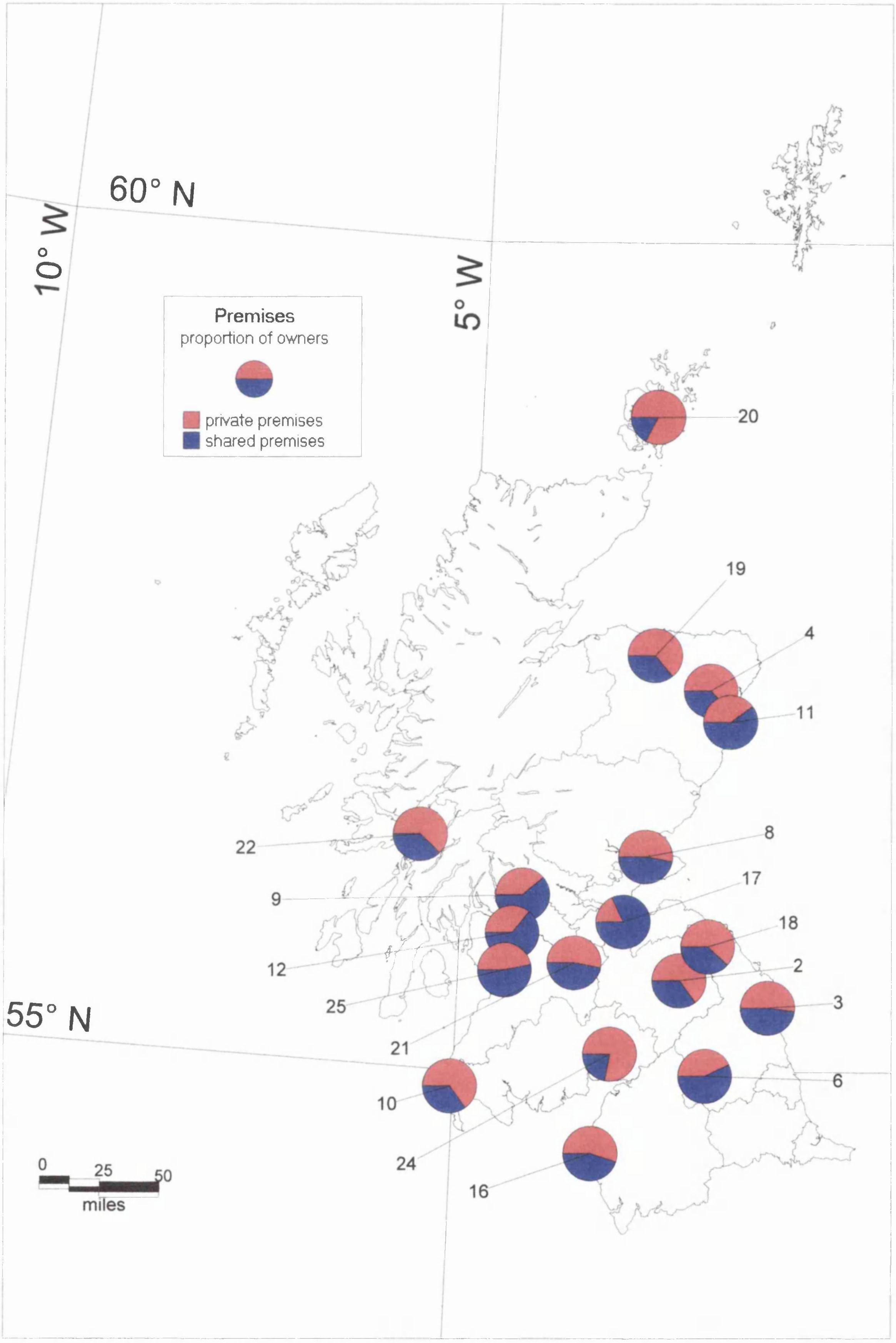


Figure 11. Map showing the relative proportions of horse owners using private and shared premises for their animals from Phase II Survey of horse owners.
The numbers are practice identification numbers.

in the central belt of Scotland where the human population is densest and where people tend to own fewer horses (Table 31, Figure 14). The most popular system of management appeared to be to allow horses to graze for most of the time with 41% of animals experiencing this and, interestingly, only 2% of horses never grazed. Figure 12 shows the relative proportions of horses kept by owners registered with each veterinary practice experiencing different management systems. There appears to be a higher percentage of animals kept mostly stabled in the same central belt of Scotland where a higher percentage of owners use shared premises.

The most popular equestrian activity appeared to be hacking, involving 24% of horses kept by respondent owners, closely followed by breeding and riding/pony club events involving 20% and 18% of horses respectively. Endurance riding and point-to-point appeared to be the least popular activities, each involving only 2% of horses kept by respondent owners. Figure 13 shows the relative proportions of horses kept by owners registered with each veterinary practice involved in different activities. Each horse was involved in an average of 1.6 activities. There appear to be no owners with racehorses or point-to-pointers north of practice 8, but this area has a higher percentage of horses used for endurance riding and trekking ('other' category) especially in practices 19 and 22. Practices 19 and 22 also have the highest percentage of owners keeping more than 20 horses (Figure 14). Hunting appears to be most popular in the Borders and Northumberland with over 10% of the horses belonging to owners registered with practices 2, 3, 6 and 18 involved. The other activities are distributed relatively evenly throughout the study area, though it is interesting that the two practices with the lowest percentage of horses used for breeding purposes are located in Edinburgh and Glasgow (practices 9, 12 and 17).

It was commonest for horse owners to keep small numbers of animals, with 70% keeping three or less, though these owners accounted for only one third of all the animals owned. Figure 14 shows the relative proportions of owners registered with each practice keeping different numbers of animals.

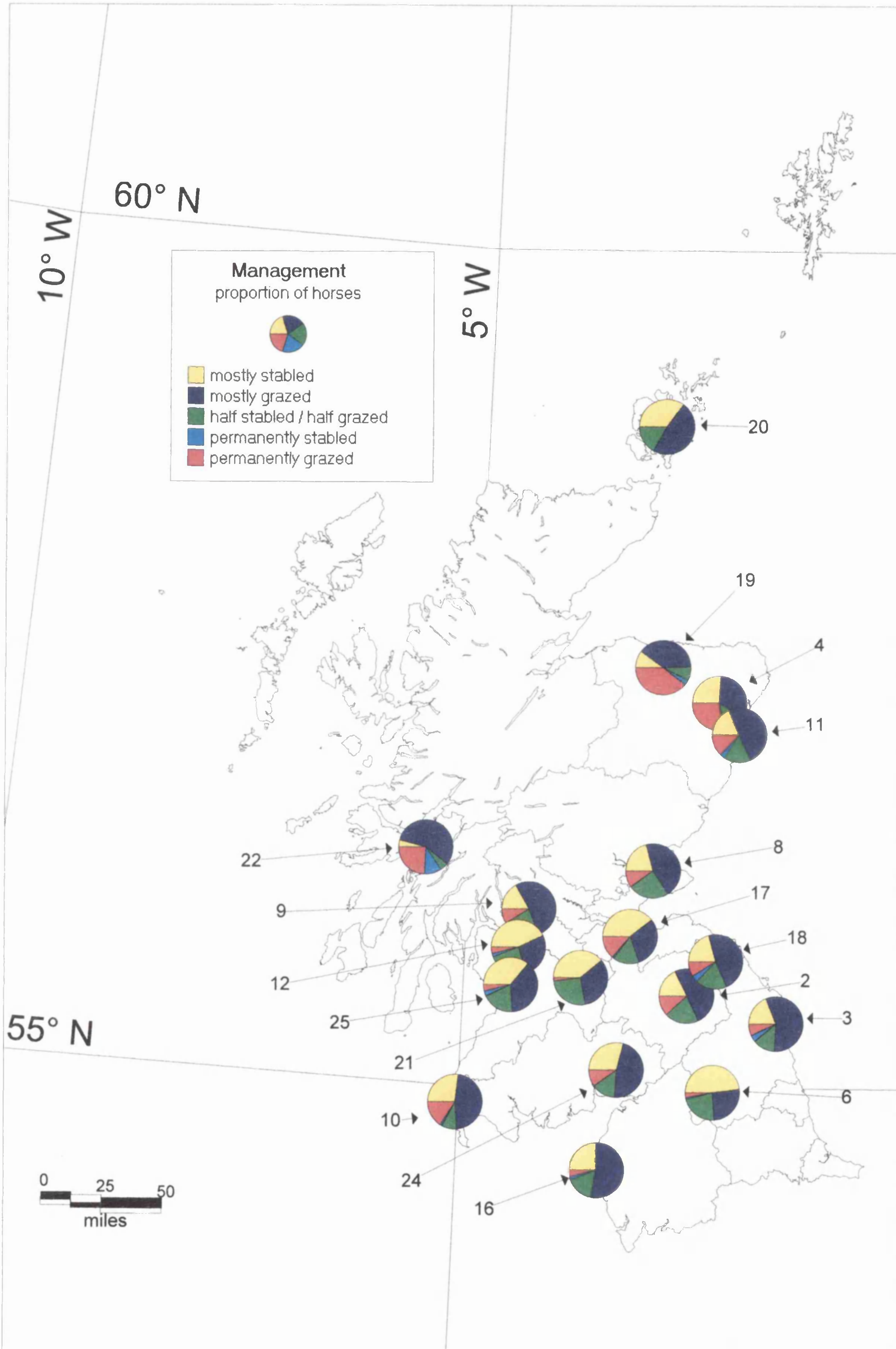


Figure 12. Map showing the relative proportions of horses experiencing different management regimens from Phase II Survey of horse owners.
The numbers are practice identification numbers.

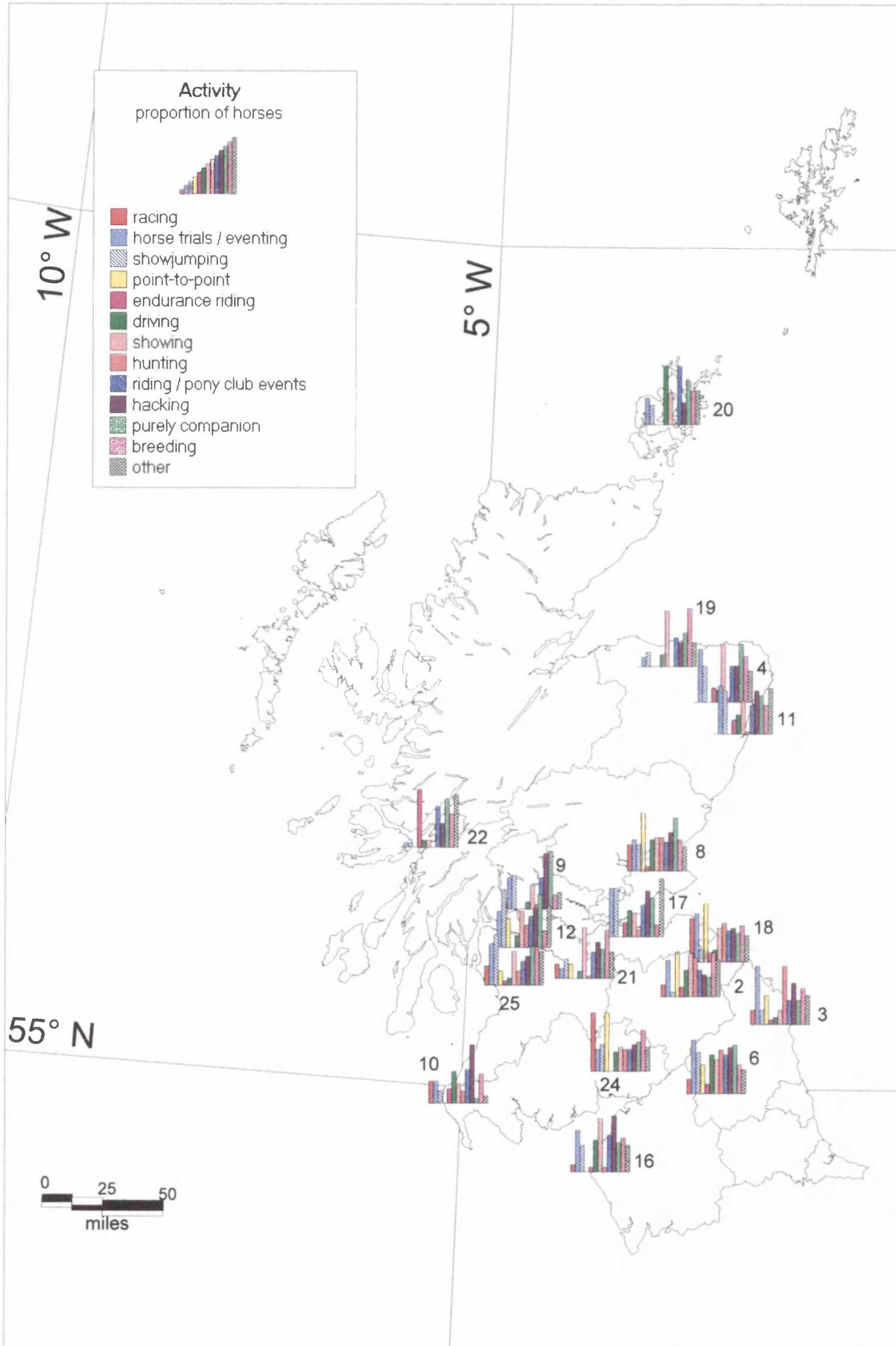


Figure 13. Map showing the relative proportions of horses involved in different activities from Phase II Survey of horse owners.
The numbers are practice identification numbers.

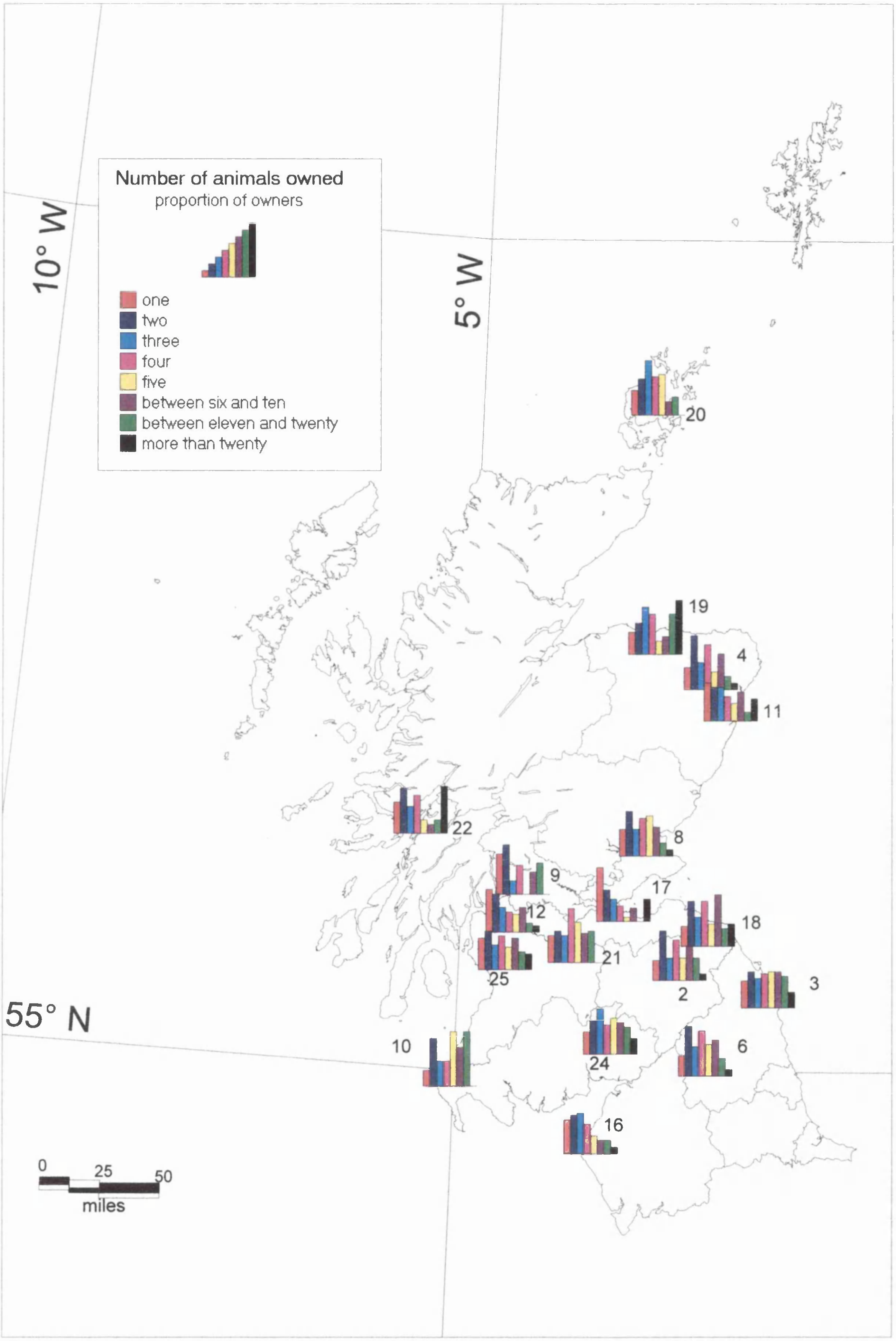


Figure 14. Map showing the relative proportions of horse owners who keep different numbers of animals from Phase II Survey of horse owners.
The numbers are practice identification numbers.

4.4. DISCUSSION AND COMPARISON WITH PREVIOUS PHASES OF THE STUDY

4.4.1. Response

The overall response rate for this phase of the study was 40% (Chapter 4.3.1). Similar studies using single contact (no follow-up) questionnaires to gather general information from animal owners have achieved comparable response rates (Nassar *et al.*, 1984; Blackshaw and Day, 1994). Response rates in questionnaire surveys vary widely depending on how the target population is selected, the method used to administer the questionnaire and the topic of interest (Dillman, 1978; Chapter 4.1). Considering postal surveys of animal owners, Partlow *et al.* (1993) reported receiving only 428 usable questionnaires from 4,400 which were sent to pig farms in Ontario. Kent *et al.* (1996) reported a 28% response from cattle farmers when they used a postal questionnaire to survey methods used for castrating calves. In contrast, French *et al.* (1992) used a postal questionnaire to collect data from sheep farmers concerning blowfly strike and reported a 74% response.

In the current study, there was considerable variation (20% - 77%) in response across groups of owners registered with different practices. Commenting on response rates overall, there are a number of factors which may have artificially reduced the response rate. First, even though 327 questionnaires returned as 'not known at address' or 'addressee gone away' were not included in the response rate calculation (Table 4.3.1.1), many others may not have been returned by the new occupants of the address and simply thrown away. Secondly, 79 questionnaires were returned stating that the respondents no longer owned horses, but many others who also no longer owned horses may just have thrown the questionnaire away. Response to a questionnaire about animal ownership is, perhaps, likely to be less from subjects that are no longer animal owners than from those who are. Considering the different practices, it can be seen that some, in particular practices 4, 11, 12 and 25, supplied address lists where a significant percentage of horse owning clients were either not known at the address or had moved away. This may suggest that some practices do not update their records on a regular basis. It is impossible to be sure of the exact response rates in practices 3, 8 and 18, where questionnaires were mailed by the practice, as it is not known how many of the questionnaires supplied were actually mailed. Certainly, practice 8 had the lowest response, and those for practices 3 and 18 fell within the bottom third of all response rates. The response rate for practice 25 was also low at 31%. Practice 25 was the only practice included in the study that was known to undertake a significant quantity of second opinion work. From the entry in the 'repeat responders' column in Table 24, it can be seen that by far the largest number of people who responded to a second identical questionnaire, by virtue of being on the mailing list of a second practice, appeared on the list supplied by practice 25. It is a matter of conjecture to speculate on how many owners who received the questionnaire previously from a different practice list, received it again from the list supplied by practice 25, and did not return it a second time; but this may be partly responsible for the low response rate from owners registered with practice 25.

The positive effect on response rate of using a stamped return envelope as opposed to a FREEPOST envelope was obvious (Table 4.3.1.4) and agrees with the findings of Choi *et al.* (1990) which are discussed in Chapter 1.5.1. The effect of increasing the size and emboldening the text of the FREEPOST line on the return envelope was positive in the fact that the number of respondents using their own stamps on the return envelopes was greatly reduced, but was apparently negative in terms of response rate. This is the opposite to what would be expected, in that if subjects perceive a financial cost (a postage stamp) in responding they will be less likely to do so. However, the fact that the owners of practices 3, 8, 18 and 25, which may have had lower response rates as a result of other factors (*vide supra*), were all sent questionnaires with large text return envelopes may artificially reduce the response rates seen with this type of envelope. When the owners of these practices are removed from the analysis, the response rate with large, emboldened text FREEPOST envelopes is 46% - the same as that for small, standard text FREEPOST envelopes.

The data presented in Table 25, concerning owners who responded twice from address lists of different practices, suggest that the repeatability of questionnaires was good and that the equine population remains relatively stable over time. It is difficult to determine, from these data, the proportion of horse owners who make use of the services of more than one veterinary practice for the reasons described above with reference to practice 25. As practice 25 undertakes second opinion work, and the owners registered with this practice were surveyed last, it is not surprising that the majority of subjects who responded twice did so from this mailing. The degree of 'overlap' between practice 25 and others cannot be considered representative of that between other practices because of the second opinion work undertaken by practice 25. Considering the other practices in Table 25, it can be seen that twenty five owners responded twice. In all instances but one, these owners were located within twenty five miles of both practices. Obviously, proximity is one factor that will influence which practices 'overlap' in terms of horse owner registrations. In the practices discussed here, the owners registered with two practices comprised approximately 5% of respondents. These owners, and others, could of course also be registered with other practices whose lists of owner addresses were not included in this phase of the study. However, taking into account the varying distances of horse owners from veterinary practices within the study area, an overall figure of 5% of horse owners who use the services of more than one veterinary practice may be a reasonable estimate.

4.4.2. Population

Comparing the combined results of phases Ia and Ib of the study with those from phase II, in particular between Tables 15 and 28, it can be seen that the mean number of animals per owner is 1.6 times greater in phase II. This may suggest veterinary practice records of horse numbers consistently underestimate the population, or that some horses never receive veterinary care. In either case, this finding means that the estimate of the total equine population for the study area at 78,547 (Chapter 3.6) is probably too low. Several factors from phase II need to be taken into account before a corrected estimate of the size of the population can be made. In Table 36 some of the results from phases Ia and II are compared:

Practice number	Owners registered in phase Ia+	Questionnaires sent†	Discrepancy*	Animals / owner (phase Ia)	Animals / owner (phase II)
2	190	196	-6	3.2	4.3
3	200	250	-50	3.5	4.2
4	200	343	-143	4	3.6
6	1000	436	564	1.5	3.7
8	500	450	50	2.7	3.5
9	68	80	-12	1.5	2.8
11	1000	993	7	2.1	3.6
12	680	662	18	2.5	2.9
16	235	237	-2	1.1	3.3
17	150	106	44	1.5	2.3
18	950	500	450	1.3	4.5
19	160	123	37	2.3	5.5
20	80	30	50	1.3	3.4
21	150	131	19	2.3	4
22	65	63	2	3.1	4.2
24	300	245	55	3.3	4.1
25	1988	2335	-347	1.5	3.7
count	**total**	**total**	**overall**	**overall**	**overall**
17	7916	7180	736	2.3	3.7

Table 36. Comparison of population data from phases Ia and II from The Home of Rest for Horses Study of Equine Welfare. Practice 10 is not included because it did not take part in phase Ia.

+ the number of owners registered with each practice in veterinary practice response to phase Ia.

† the number of horse owner addresses supplied by each practice in phase II (the number of questionnaires requested for mailing to owners in practices 3, 8 and 18).

* [owners registered in phase Ia] - [questionnaires sent].

It can be seen that, on an individual practice level, in some cases there is a significant discrepancy between the number of horse owners that practices claimed were registered with them and the number of addresses they supplied. Overall, addresses were supplied for 91% of the number of owners claimed in phase Ia. This suggests that practices overestimated the number of horse owners registered by 9%. In addition, from Table 24 it can be seen that 5% of questionnaires were returned as 'not known at address', and a further 3% of respondents no longer owned horses. The estimate for the number of horses registered with more than one practice was 5% (Chapter 4.4.1). Therefore the corrected estimate for the number of horse owners in the study area is:

$$33{,}480 \times [1 - (0.09 + 0.05 + 0.03 + 0.05)] = 33{,}480 \times 0.78 = \mathbf{26{,}114}$$

Correcting for the number of animals owned, using a mean number of 3.7 rather than 2.3 (Chapter 3.2.2), the estimated total equine population for Scotland and Northern England is:

$$26{,}114 \times 3.7 = \mathbf{96{,}622}$$

These data are presented in Table 37 broken down by region and displayed in Figure 15.

Region	Number of owners	Number of animals
Scotland		
Borders	1299	3583
Central	436	1395
Dumfries and Galloway	698	3082
Fife	1129	4339
Grampian	2298	8951
Highland	560	2215
Lothian	1022	3084
Orkney Islands	127	475
Shetland Islands	38	117
Strathclyde	5298	14712
Tayside	971	4610
Western Isles	60	142
Total	**13936**	**46705**
Northern England		
Cleveland	4788	16838
Cumbria	2165	13994
Durham	2386	10119
Northumberland	1832	6294
Tyne and Wear	1007	2672
Total	**12178**	**49917**
Overall	**26013**	**96248**

Table 37. Corrected figures, by region, for the number of horse owners and horses in Scotland and Northern England.

The corrected estimate for the population of Scotland, excluding Highland region, the Western Isles, Orkney and Shetland, of 43,756 is slightly higher than the 41,072 estimated

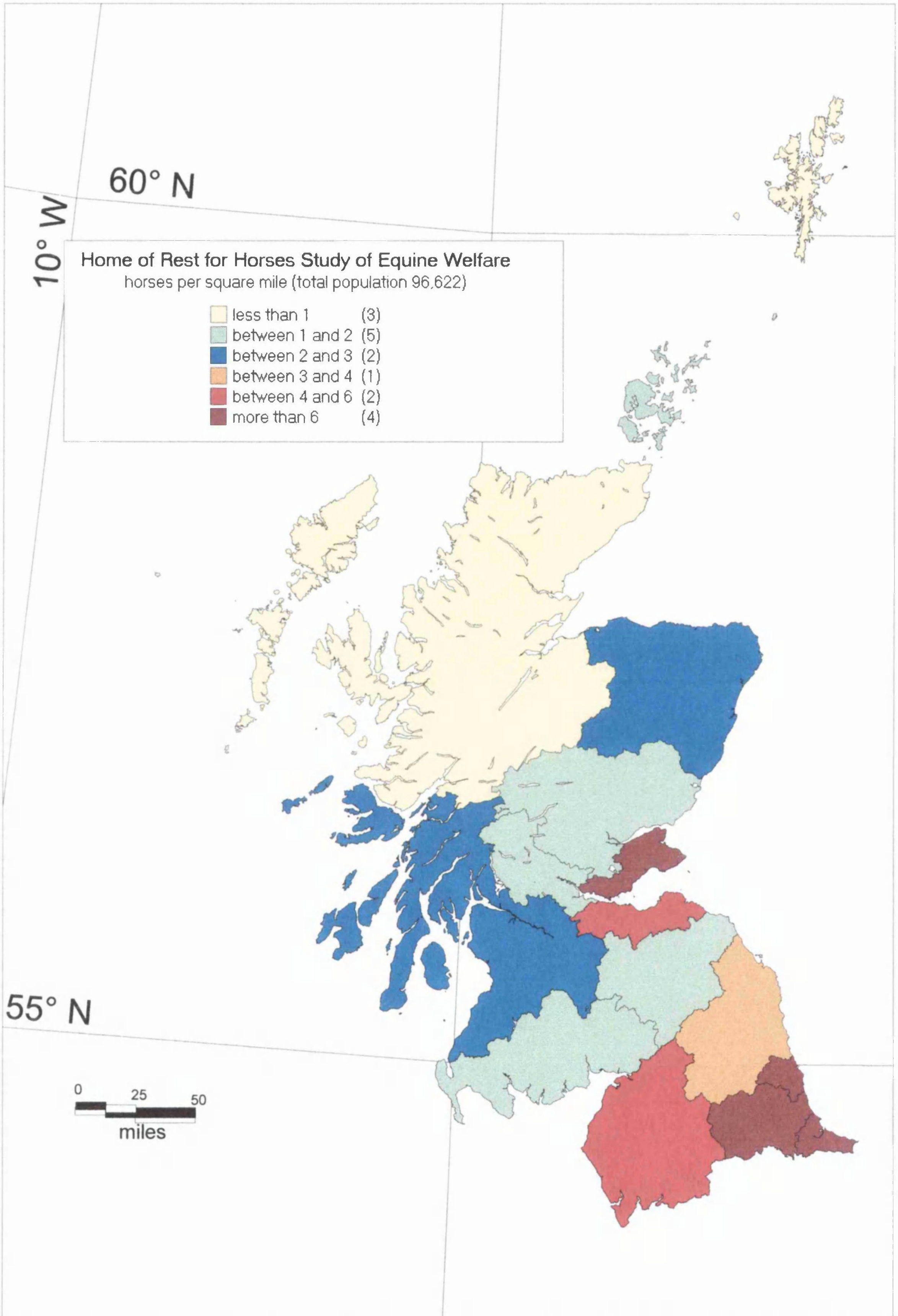


Figure 15. Map showing the equine population density of Scotland and Northern England from Phase II Survey of horse owners.

by the unpublished British Horse Society survey for the same area (British Horse Society, 1996; Chapter 1.2.6).

The corrections made for the number of horse owners responding twice and for those responding who no longer own horses, may be underestimates as these groups may be unevenly distributed among responders and non-responders. As they would be more likely to be non-responders, the above figures for the population are possibly slight overestimates. However, in this study it was not possible to account for those horses which are not under the care of any veterinary practice.

4.4.3. Conclusions

Phase II of The Home of Rest for Horses Study of Equine Welfare collected a large volume of basic data relating to the management and activity level of equine animals in Scotland and Northern England. In addition, a corrected estimate of the population size and distribution was made which suggested that there were more than three times as many equine animals as recorded in the MAFF census for the same area at the same time (Ministry of Agriculture, Fisheries and Food, 1996; The Scottish Office, Environment and Fisheries Department, 1996a). A large pool of compliant horse owners was provided, who were sampled to provide more detailed data on management, feeding, level of activity, health and disease of horses in phase IV (Chapter 6). Phase III, a cross-sectional case study of equine disease, conducted through veterinary practices in follow-up to phase Ia, was carried out to provide more detailed information on the equine diseases diagnosed in the study area. The design, implementation, results and conclusions of phase III are presented and discussed in Chapter 5.

CHAPTER 5

PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES

5.1. INTRODUCTION

A cross-sectional study of disease involves the selection of a sample of subjects from a population and their contemporaneous classification with respect to both exposure and disease (Rothman, 1986; Thrusfield, 1995; Chapter 1.4.2.3). Cross-sectional studies, also known as prevalence surveys, provide information about the frequency of disease in a population (Lilienfeld and Stolley, 1994). Such studies have been used widely in human and veterinary medicine to establish disease prevalence and investigate associations between risk factors and disease. Piga *et al.* (1988) conducted a cross-sectional study to investigate risk factors for Paget's disease of bone. Another study, making use of mailed questionnaires to gather data from dairy herd owners, was conducted to investigate the prevalence of contagious pathogens of bovine mastitis (Sischo *et al.*, 1993). Cross-sectional studies may involve analysis of hospital based data, such as a study conducted by Kiper *et al.* (1990) comparing cases of gastric rupture in horses with all other equine cases on record for exposure to various risk factors. Alternatively, field data may be collected specifically for the purposes of estimating the prevalence of a disease and investigating risk factors associated with it (Barrett *et al.*, 1992; Frankena et al, 1992). Further studies have combined cross-sectional and longitudinal data in the study of a particular disease such as that by Lindblom *et al.* (1986) which investigated the time at which young chicks became colonised with *Campylobacter jejuni.*

Networks of sentinel practices, so-called practice-based research networks (Green *et al.*, 1994), have been used successfully to gather epidemiological data about diseases (Chapter 1.7, Chapter 2.1). Examples of the use of such networks in equine veterinary research in the USA are provided by: Cohen *et al.* (1995), who recruited 82 veterinary practices to collect data on a monthly basis for a case-control study of the association between various management factors and the development of colic in horses and, Slater *et al.* (1995) who used data provided by 7 private veterinary practices to describe epidemiological factors associated with the development of equine laminitis. In the UK, Proudman (1991) collected data in a single veterinary practice over a two year period in a study of equine colic, and 'The Confidential Enquiry of Perioperative Equine Fatalities' (Johnston, 1994; Johnston *et al.*, 1995), which relied on data supplied continually by 62 equine veterinary clinics to investigate the risk factors associated with death during or within 7 days of anaesthesia, represents an excellent example of the use of a sentinel practice based research network.

Despite numerous epidemiological studies investigating many equine diseases, very few have reported the relative prevalence of different diseases (Traub-Dargatz *et al.*, 1991). A Japanese study assigned percentage values to the number of cases of different types diagnosed by equine practitioners (Hata, 1993). In the USA in 1991, a survey of members of the American Association of Equine Practitioners ranked the medical problems of adult horses in order of importance on a subjective scale (Traub-Dargatz *et al.*, 1991). However, these data were not related to population figures to give prevalence estimates for different diseases. In the UK, there are no data comparing the relative prevalence of equine diseases.

In phase III of The Home of Rest for Horses Study of Equine Welfare, a cross-sectional case study of veterinary practices which responded to phase Ia (Chapter 3) was carried out to estimate the relative prevalence of equine diseases in the study area. The study was repeated four times at intervals of three months to assess seasonal variation in disease prevalence, and therefore may also be considered to be a prospective cohort study of veterinary practices with four points of disease ascertainment (Rothman, 1986; Chapter 1.4.2.3).

5.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION

5.2.1. Considerations

The aims of this phase of the study were to collect data relating to disease occurrence among individual equine animals under the care of an attending veterinary surgeon. In addition, the study would gather further data about the nature of equine veterinary practice in the Northern UK and record seasonal and geographical trends. The study population was pre-determined as those veterinary practices which had already been involved in phase Ia of the study, which supplied baseline data about the equine population of Scotland and

Northern England and provided subjective estimates of the frequency with which different equine diseases were diagnosed (Chapter 2.2.2, Chapter 3). The intention to conduct a second survey, collecting data from individual equine cases, was mentioned in the letter which accompanied the phase Ia questionnaire to veterinary practices (Appendix 2, Chapter 3.2.3). In order to add useful information to the study, data from phase III needed to be more detailed and precise than the data gathered in phase Ia. In surveying the same veterinary practices for a second time, results from the two surveys could be compared to evaluate the reliability of general, subjective data collected in phase Ia. Furthermore, these data would also relate to the population of horses studied through horse owners in phases II and IV.

The same considerations expressed in Chapter 3.2.1, in terms of both intuitiveness and the length of time required by busy practitioners to complete survey forms, again applied in this phase of the study. Set against this was the need to collect sufficient, detailed information which could readily be coded to facilitate computer data entry and analysis. It was considered unlikely that most practitioners would be prepared to complete survey forms for more than 10 cases at a time. In order to take into account seasonal variation, it was decided to request that practitioners complete one set of 10 case sheets in each of autumn, winter, spring and summer, each practice therefore supplying data for a total of 40 cases. As the study was to investigate the general nature of equine veterinary practice, it was decided not to confine data recording to non-routine cases, but rather to include equine consultations for any reason including routine procedures such as vaccination and certification. As a result, participating practitioners were asked to complete one case sheet for each of the first 10 horses seen after receiving their allocation of forms in the mail.

5.2.2. Recruitment

As mentioned above, the veterinary practices involved in this phase of the study were the same as those in phase Ia. As a prelude to mailing case sheets to veterinary practitioners it was considered important to contact them, reiterate the aims of the study, thank them for their previous responses and solicit their continued participation in the study. Initially this was done by means of a letter, hand addressed and signed, which was mailed to each practitioner on July 20th 1994 (Appendix 11). It was also important, at the same time as requesting more input from practitioners, to provide some feedback from the information they had already supplied. A one-page A4 summary sheet of results from phase Ia of the study was prepared for inclusion with the letter (Appendix 12). In addition, in response to the unanimous interest in a survey of charges made for equine veterinary services among participating practices (mentioned on the back page of the phase Ia questionnaire (Appendix 3, Chapter 3.2.2)), a survey form itemising charges for these services and a FREEPOST return envelope were also included in this mailing*. Allowing time for the letter to reach the practices involved, but within two weeks of mailing, each practitioner was contacted by telephone and asked to take part in this phase of the study.

5.2.3. Questionnaire Design

Once again, for the reasons discussed above and in Chapter 2.4.2, survey forms were limited to a single sheet of A4 (210 × 297 mm) paper, and for this phase of the survey all the questions were printed on one side. As practitioners would receive sets of 10 identical survey forms every three months, the printing was orientated portrait, which was intended to give the more intuitive impression of a group of report forms rather than 10 individual questionnaires. It was envisaged that veterinary practitioners would be more likely to complete the survey at the practice during 'spare moments', or at home after work, rather than to complete them in the company of the horse owner during the consultation. It was considered that a requirement to complete the forms with the owner present would greatly reduce participation rates, as practitioners would be unlikely to allow extra time on busy rounds for this purpose. Therefore, the type of information requested was restricted to that which could be ascertained by the veterinary surgeon, and could not relate to factors that only the owners would know in all cases such as management and level of activity. It was decided to record the age, breed, coat colour and sex of the patient; the distance from the main practice building where the animal was kept; the owner's complaint or reason for the consultation; a summary of any relevant history; the clinical findings; the nature and results (where available) of any investigative procedures; the diagnosis on the basis of clinical findings and available results of investigative procedures; a summary of the treatment and

---

* this has not been included as it is not part of the welfare study

management protocol; an assessment of the prognosis for the animal; and a statement of when, if at all, a revisit was planned for the animal in question.

The initial design of survey forms was based on a table template and, after many refinements in consultation with Professor S.W.J. Reid, Professor S. Love and Dr M.J. Reeves a final form was agreed and pretested among a group of veterinary practitioners who would not be involved in the full study (Figure 16).

Age in years	
Sex (Male, Female, Gelding)	
Breed or Type	
Coat colour	
Distance from practice	
Reason you were called (owner's complaint)	
Relevant history	
Clinical findings	
Investigations undertaken (including results if applicable)	
Details of treatment / management protocol	
Prognosis	
When will you revisit this animal? (days)	

Figure 16. Phase III Cross-sectional case study of veterinary practices - outline of final table design of the survey form.

The form was completed correctly by all pretesters and detailed information was supplied in all cases where it was used. There were no criticisms about the design of the form but, almost all the answers were open ended, requiring a lot of writing on the part of the respondent veterinary surgeon. There was concern that the same level and quality of response would be difficult to maintain over 40 cases in one year. In addition, many of the open ended answers would have been difficult to code for the purposes of data entry and analysis. Furthermore, from an aesthetic point of view, the plain table left no room for the title of the study and was visually unattractive. As a result, the survey form was completely redesigned, retaining the general sense of the table format but providing more structure to the sections on clinical findings and further investigations, as well as expanding the section on prognosis. A title was added to each sheet (Chapter 2.4.2) and where possible, tick boxes were used for categorical responses to reduce the quantity of writing required to complete the form (Appendix 14).

5.2.4. The Accompanying Letter

Prior to receipt of their first instalment of 10 case sheets, each practitioner who had agreed to be involved in the study had been contacted by telephone to explain how the case sheets were to be completed and to solicit his or her participation. The letter that accompanied the case sheets was therefore brief, giving instructions for completion of one case sheet for each of the first 10 horses seen, for whatever reason, after the case sheets arrived in the mail (Appendix 13). The letter also informed practices that further sets of case sheets would be mailed to them in 3, 6 and 9 months time. The letters which accompanied these subsequent mailings were identical, except for an amendment to the number and timing of future mailings as the year progressed. All letters were hand addressed and hand signed in ink.

5.2.5. Implementation

The mailing package contained 10 case sheets, the accompanying letter and a self addressed return envelope (size 162 × 229 mm) with a large text FREEPOST address label affixed (Chapter 2.4.5). An envelope (size 162 × 229 mm) was hand addressed to each practice, with the open end of the envelope on the right as the address was written. Case sheets were marked in the top right hand corner with the practice identification number and folded in half with the printed side on the outside. The accompanying letter was also folded in half with the printed side on the outside and placed outside the 10 case sheets with the folded return envelope inside them. The whole package was placed into the envelope with the practice address on the letter orientated to that on the envelope. All outgoing mail was franked first class which, because of the number of sheets of paper enclosed, was one price banding above the standard UK letter rate.

Sets of 10 case sheets were mailed to veterinary practitioners who had agreed to participate, on the following dates, in order to broadly represent the seasons, as shown:

10th August	1994	autumn
10th November	1994	winter
10th February	1995	spring
10th May	1995	summer

A reminder letter, offering to replace any lost case sheets, was mailed to non-responding practitioners 6 weeks after the original case sheets had been sent (Appendix 15). Only one practice ever requested a replacement set of case sheets, having lost the originals.

5.2.6. Data Storage and Analysis

A Microsoft Access table was designed, within The Home of Rest for Horses Study of Equine Welfare database, to hold all data from this phase of the study (Chapter 2.3, Chapter 2.5). Data were entered using a form, linked to the table, corresponding to the design of the case sheet (Appendix 16). Each case sheet returned was numbered sequentially 1, 2, 3... and so on, and a combination of the practice number and this record number were used as a primary key field to index the database table (Chapter 2.5). Additional fields were created to record the season of the year during which the case sheets were completed, a judgement, made by the author from the information given on the form, of the duration of illness, and a classification of the case in terms of the body system affected. In order to speed data entry, eliminate errors and facilitate data analysis, sub-tables were designed containing number coded lists of options for categorical response fields wherever possible and embedded in the data entry form. Number coded list tables were created for breed or type of horse, coat colour, gender, clinical findings, body system affected, prognosis, classification, season and duration. The list table for coat colour is shown in Figure 17 by means of an example.

code	coat colour
0	not recorded
1	Bay
2	Black
3	Brown
4	Chestnut
5	Dun
6	Grey
7	Palomino
8	Piebald
9	Roan
10	Skewbald
11	Appaloosa

Figure 17. Phase III Cross-sectional case study of veterinary practices - list table for coat colour from The Home of Rest for Horses Study of Equine Welfare database.

The table shown in Figure 17 was embedded in the form in the position of the 'coat colour' field such that, for example, typing the number 4 would enter "Chestnut" in the database table. In situations where the number coding for the desired option was not known, an arrow, located at the right hand end of the field in the database form, could be clicked using the mouse to pull down the list, scroll through and select. As can be seen, there were 11 options in the list table for coat colour. A list of 49 different breeds or types of horse, pony or donkey including options for "other" and "not recorded" was compiled for the 'Breed or type' field. Lists of 333 clinical findings and 58 body system classifications were modified from those used in the hospital case recording database at the University of Glasgow Veterinary Hospital. The same clinical findings list table was embedded in each of the four clinical findings fields on the form (Appendices 14 and 16). Two fields extra fields were created to allow specification by the author of up to two body systems affected, and made use of the same body system classifications list table. There were 3 options for gender: mare, gelding, stallion, where 'stallion' referred to an entire male animal of any age; 4 options for season: autumn, winter, spring, summer; 4 options for duration: not applicable, acute, chronic, indeterminate; and 5 options for prognosis corresponding to those on the case sheet: unknown, good, fair, guarded, poor. When data entry for the whole study was completed, the records were classified by the author into categories of disease diagnosed, corresponding to those used in phase Ia of the study (Chapter 3.2.2) so that results from the two surveys could be compared. Another list table in the data entry form was used for this purpose and this is shown in Figure 18:

code	category
1	dermatological
2	gastrointestinal
3	injuries
4	metabolic
5	miscellaneous
6	musculoskeletal
7	nad*
8	neoplastic
9	reproductive
10	respiratory
11	routine

Figure 18. Phase III Cross-sectional case study of veterinary practices - list table for categories from The Home of Rest for Horses Study of Equine Welfare database.
* no abnormality detected - where a horse was examined by a veterinary practitioner and no abnormal clinical findings were made.

As can be seen from Figure 18, option 11 was 'routine', and this was used to categorise all consultations for routine procedures on non-diseased animals. Consultations for vaccination, certification, pregnancy diagnosis (by whatever method), castration, and routine rasping of teeth were grouped into the 'routine' category.

Data were queried directly from the MapInfo Geographical Information System (MapInfo Corporation) and linked to the previously geocoded practice locations to produce maps of the results from this phase of the study. Ninety five per cent confidence intervals for estimates of proportions of horse owners and horses were calculated using the formula presented in Chapter 2.6.

5.3. RESULTS

5.3.1. Response

After discussing the study over the telephone, nineteen of the twenty two practices that took part in phase Ia agreed to complete case sheets for the cross-sectional study. Practices 7 and 13 were not willing to participate, and the practitioner who had previously been involved from practice 4, left the practice between the two surveys and none of the remaining members of the practice were willing to take on the task of completing the case sheets. Of the nineteen practices that agreed to participate, three (practices 5, 9 and 15) failed to return any case sheets, despite being mailed ten sheets every three months, and receiving the reminder letters. Therefore, case sheets were supplied by sixteen practices. Practices 16 and 21 completed only the first two sets of ten case sheets for autumn and winter, supplying a total of 20 case sheets each and, practice 8 returned ten case sheets to all except the winter mailing, when none were returned. Practice 3 returned case sheets to winter, spring and summer mailings, but only five, seven and nine sheets respectively to each mailing. All the remaining twelve practices returned the full compliment of forty case sheets, but at both the spring and summer mailings practice 11 returned one case sheet which was only partially completed and unusable. Practices 11 and 17 also returned one uncompleted case sheet each, to the spring and winter mailings respectively. A total of $19 \times 40 = 760$ case sheets were supplied to practitioners, of which 571 were returned, giving an overall response rate of 75%. Of the case sheets returned, four were either blank or unusable giving a total of 567 records from individual equine consultations for analysis. The response to this phase of the study is summarised in Table 38. The overall mean ± SD time elapsing between mailing case sheets to practitioners and receiving them back in the post was 37 ± 26 days. On average, it took practitioners more than a month to document 10 equine consultations and return the case sheets. In three instances the elapsed time was greater than 90 days, which meant that the subsequent set of case sheets would have arrived before the current set were returned. In one of these instances, the autumn mailing to practice 21, the original set of case sheets were lost and a replacement set was only mailed after the reminder at 6 weeks after the original mailing. It is not clear how much of the time was taken to undertake 10 equine consultations and how much was taken to complete and return the case sheets.

5.3.2. Survey Data

5.3.2.1. Demographic data

Of the 567 case sheets returned, 20 were from animals that were seen and reported more than once by a practitioner in the same set of 10 case sheets. There were four instances of

Practice number	Total case sheets returned	Time* (days) autumn	Case sheets returned autumn	Time* (days) winter	Case sheets returned winter	Time* (days) spring	Case sheets returned spring	Time* (days) summer	Case sheets returned summer
1	40	11	10	92	10	6	10	54	10
2	40	9	10	11	10	6	10	6	10
3	21	-	-	57	5	52	7	65	9
6	40	58	10	18	10	10	10	15	10
8	30	99	10	-	-	54	10	75	10
11	37	33	10	56	10	46	8	57	9
12	40	71	10	13	10	26	10	22	10
16	20	61	10	56	10	-	-	-	-
17	39	6	10	18	9	12	10	58	10
18	40	6	10	8	10	33	10	17	10
19	40	41	10	56	10	40	10	54	10
20	40	23	10	25	10	61	10	16	10
21	20	103	10	56	10	-	-	-	-
22	40	33	10	56	10	45	10	55	10
24	40	26	10	14	10	53	10	20	10
25	40	19	10	8	10	17	10	5	10
count	**total**	**mean ± SD**	**total**	**mean ± SD**	**total**	**mean ± SD**	**total**	**mean ± SD**	**total**
16	567	40 ± 32	150	36 ± 26	144	33 ± 20	135	37 ± 24	138

Table 38. Phase III Cross-sectional case study of veterinary practices - details of response to each mailing of case sheets.
* the time elapsing between mailing case sheets and their return in the mail.

one animal being seen three times within the first 10 cases after the case sheets arrived with the practice, and twelve instances of an animal being seen twice. There was no way of knowing whether the cases reported in different sets of case sheets, in other words from different seasons, from the same practice, were the same. Only the first consultation with each case was considered in descriptive analysis of the group, and in estimation of disease prevalence.

The overall mean ± SD age of animals seen was 9.3 ± 6.4 years (range 1 day - 37 years). The mean ± SD distance of an animal from the veterinary practice premises was 11 ± 9 miles (range 1 - 101 miles). Seventeen animals (3%) were transported to the practice premises for consultation. The distributions of breed or type, gender and coat colour of horses seen are summarised in Tables 39, 40 and 41:

Breed or type	Percentage of horses seen (± 95% CI)
Thoroughbred or Thoroughbred X	34 (± 4)
Pony	12 (± 3)
Hunter	8 (± 2)
Welsh or Welsh X	7 (± 2)
Part-bred	6 (± 2)
Cob	5 (± 2)
Warmblood or Warmblood X	3 (± 1)
Arab or Arab X	3 (± 1)
Irish Draught or Irish X	3 (± 1)
Highland or Highland X	3 (± 1)
Shetland or Shetland X	3 (± 1)
Connemara or Connemara X	3 (± 1)
Clydesdale or Clydesdale X	2 (± 1)
Fell	1 (± 1)
Donkey	1 (± 1)
other breeds and types	5 (± 2)
not recorded	1 (± 1)

Table 39. Phase III Cross-sectional case study of veterinary practices - distribution of breed or type of animal seen.

Obviously, with categories such as 'Hunter' and 'Part-bred', there will be some overlap between the different breeds and types, but this is how they were reported by veterinary practitioners.

Gender	Percentage of horses seen (± 95% CI)
gelding	46 (± 4)
mare	45 (± 4)
stallion	9 (± 1)

Table 40. Phase III Cross-sectional case study of veterinary practices - distribution of gender of animal seen.

There appear to be quite a high proportion of entire male animals at 9% (47 animals), but only one third of these (16 animals, 3% of all animals seen) were older than three years of age.

Coat colour	Percentage of horses seen (± 95% CI)
Bay	42 (± 4)
Chestnut	18 (± 3)
Grey	17 (± 3)
Brown	7 (± 2)
Black	4 (± 2)
Dun	3 (± 1)
Roan	2 (± 1)
Palomino	2 (± 1)
Skewbald	2 (± 1)
Piebald	2 (± 1)
not recorded	1 (± 1)

Table 41. Phase III Cross-sectional case study of veterinary practices - distribution of coat colour of animal seen.

5.3.2.2. Disease data

Data from Phase III Cross-sectional case study of veterinary practices broken down by category (Chapter 5.2.6) and by season of the year are presented in Table 42:

Classification	Overall % of cases seen (± 95% CI)		Cases seen in autumn (%)	Cases seen in winter (%)	Cases seen in spring (%)	Cases seen in summer (%)
routine	**33**	(± 4)	28	28	36	39
musculoskeletal	**28**	(± 4)	35	34	23	19
injuries	**10**	(± 3)	8	8	10	11
dermatological	**6**	(± 2)	4	7	7	6
gastrointestinal	**6**	(± 2)	6	10	6	3
respiratory	**5**	(± 2)	3	7	5	4
reproductive	**3**	(± 1)	1	2	3	6
metabolic	**3**	(± 1)	3	7	1	2
neoplastic	**0**	-	1	1	0	0
miscellaneous	**5**	(± 2)	7	5	4	4
nad	**1**	(± 1)	3	0	1	1

Table 42. Phase III Cross-sectional case study of veterinary practices - percentage of cases seen in each category summarised for the whole year and broken down by season of the year.

Routine consultations comprised the most frequently reported category of work undertaken by practitioners, with one third of all consultations being for routine procedures. A higher proportion of routine work was undertaken in spring and summer than in autumn and winter. Musculoskeletal disorders were the most frequently reported category of disease, with 28% of all animals seen suffering from some musculoskeletal problem. Musculoskeletal problems appeared to be more prevalent in autumn and winter, when they comprised an even greater proportion of cases than routine consultations, compared with the situation in spring and summer. Minor injuries, the third most prevalent category, seemed to be more common in spring and summer, which perhaps reflects when the greatest proportion of horses are likely to be involved in the most popular activities of hacking and riding/pony club events (Chapter 4.3.2). Gastrointestinal, respiratory and metabolic problems all appeared to be most prevalent in winter, coinciding with the period when most animals are receiving supplementary feeding and/or are housed for at least some of the day. Reproductive problems seemed to be most prevalent in the summer coinciding with the middle of the breeding season.

The same data, this time summarised by practice number, are presented in Table 43. There was variation between practices in the relative percentage of different categories of case seen. No single practice reported cases in every category, but it should be remembered that

Classification	Overall % of cases seen	Percentage of cases seen by practices															
		1	2	3	6	8	11	12	16	17	18	19	20	21	22	24	25
routine	**33**	44	72	14	25	41	19	42	13	24	36	37	19	30	18	33	33
musculoskeletal	**28**	25	10	29	42	10	38	25	44	26	28	26	33	30	32	15	35
injuries	**10**	8	5	14	10	7	14	15	19	13	5	0	14	5	18	7	5
dermatological	**6**	6	0	5	0	3	8	5	0	13	3	5	3	5	13	15	7
gastrointestinal	**6**	6	3	14	7	10	3	3	0	3	5	13	8	5	13	3	3
respiratory	**5**	8	0	10	3	10	3	0	6	11	10	0	6	15	0	3	5
reproductive	**3**	0	0	10	0	0	5	3	0	0	3	11	6	0	0	10	3
metabolic	**3**	0	3	0	5	3	3	3	13	11	0	0	6	0	0	3	5
neoplastic	**0**	0	0	5	0	0	3	0	0	0	0	0	0	0	0	0	0
miscellaneous	**5**	0	5	0	5	7	5	5	6	0	5	8	6	10	5	13	3
nad	**1**	3	3	0	3	7	0	0	0	0	5	0	0	0	0	0	3

Table 43. Phase III Cross-sectional case study of veterinary practices - percentage of cases seen in each category summarised by veterinary practice.

The grey shading highlights the practice with the highest (dark) and lowest (light) percentage of cases in each category. Where two practices have the same percentage of cases in a category, the practice supplying the greatest number of responses is highlighted.

these data are summarised from as few as sixteen case sheets from practice 16, and only twenty from practices 3 and 21. In general however, the overall trend in the relative frequency of cases is maintained in each practice with the top three categories remaining routine, musculoskeletal and minor injuries in all but four practices. Practices 17 (Lothian), 22 (Strathclyde) and 24 (Dumfries & Galloway) reported a higher percentage dermatological disorders than the remaining practices. Practices 3 (Northumberland), 8 (Fife) and 19 (Grampian) saw a higher percentage of gastrointestinal disorders than the remaining practices. Practices 3 (Northumberland), 8 (Fife), 17 (Lothian), 18 (Borders) and 21 (Strathclyde) reported a higher percentage of respiratory disorders than the remaining practices. Practices 3 (Northumberland), 19 (Grampian) and 24 (Dumfries & Galloway) reported a higher percentage of reproductive disorders than the remaining practices. Practices 16 (Cumbria) and 17 (Lothian) reported a higher percentage of metabolic disorders than the remaining practices.

5.3.2.2.1. Routine cases

Overall, there were 178 case sheets returned in which routine procedures were undertaken. The mean ± SD age of these animals was 8.5 ± 6.0 years (range 1 day - 37 years). The reasons for consultation in this category are summarised in Table 44:

Reason for consultation	**Number of cases**	**Percentage of routine cases**	**Percentage of all cases seen (± 95% CI)**	
vaccination (flu + tetanus)	91	**51**	17	(± 3)
vaccination (tetanus only)	8	**5**	1	(± 1)
vaccination (flu only)	3	**2**	1	(± 1)
vaccination (EVA)	1	**1**	0	-
pregnancy diagnosis	22	**13**	4	(± 2)
pre-purchase examination	19	**11**	3	(± 1)
castration	11	**6**	2	(± 1)
certification (height, identification)	8	**5**	1	(± 1)
routine teeth rasping/wolf teeth removal	7	**4**	1	(± 1)
sedation for clipping or shoeing	6	**3**	1	(± 1)

Table 44. Phase III Cross-sectional case study of veterinary practices - the reasons for routine consultation.

There were a total of 103 vaccinations accounting for 59% of all routine consultations (19% of all consultations, 95% CI: ± 3%). On a seasonal basis, 15% of vaccinations took place in autumn, 26% in winter, 32% in spring and 27% in summer. The mean ± SD age of animals that were vaccinated was 8.9 ± 6.5 years (range 5 months - 37 years).

Twenty two mares (13% of all routine consultations) were submitted for pregnancy diagnosis, of which twelve (55%) were Thoroughbred or Thoroughbred X. Of these, 64% were in the autumn, 9% in the spring and 27% in the summer. In 68%, a combination of rectal examination and transrectal ultrasound were used to make the diagnosis, in a further 27% of cases rectal examination alone was used, and in 5% (1 case) a blood sample was analysed to determine the concentration of pregnant mare serum gonadotrophin (PMSG). Seventeen mares (77%) were diagnosed pregnant, but two of these were found to have twins and were both injected with prostaglandin to terminate the pregnancy. Five mares (23%) were diagnosed as non-pregnant, but only one was injected with prostaglandin with a view to re-mating her. The mean ± SD age of mares submitted for pregnancy diagnosis was 10.0 ± 4.7 years (range 3 - 20 years).

Nineteen animals (11% of all routine consultations) underwent a pre-purchase examination. In eleven instances (58%), including one in which survey radiographs of all four feet were taken before a decision was made, the animal was considered suitable for the purpose intended by the purchaser. Nine animals (42%) failed the pre-purchase examination. The mean ± SD age of animals undergoing a pre-purchase examination was 8.4 ± 4.1 years (range 2 - 18 years).

Eleven colts (6% of all routine consultations) were attended in order to perform castration. Of these, 82% were done in the summer, 9% in the autumn and 9% in the spring. In five cases (45%), the colt was castrated standing sedated (in three instances using a combination of detomidine and butorphanol and in two instances using a combination of romifidine and butorphanol), and in five cases (45%) the colt was castrated under general anaesthesia (in one instance using a combination of detomidine and ketamine and in four instances using a combination of romifidine and ketamine). The method of restraint and castration was not specified in one case. The mean ± SD age of colts that were castrated was 3.0 ± 2.1 years (range 1 - 8 years). At the top end of this age range, there was only one 8 year old animal castrated, which had previously been at stud but had been replaced by another stallion.

5.3.2.2.2. Musculoskeletal cases

Overall, there were 151 case sheets returned in which musculoskeletal disorders were diagnosed. The mean ± SD age of these animals was 10.0 ± 5.7 years (range 1 day - 26 years). The conditions diagnosed in this category are summarised in Table 45:

Reason for consultation	Number of cases	Percentage of musculoskeletal cases	Percentage of all cases seen (± 95% CI)	
foot abscess	30	**20**	5	(± 2)
joint disorders and arthritis	21	**14**	4	(± 2)
laminitis	20	**13**	4	(± 2)
tendon/ligament problems	19	**13**	3	(± 1)
non-specific foot lameness (not abscess)	14	**10**	3	(± 1)
fractures	7	**5**	1	(± 1)
back/sacroiliac problems	6	**4**	1	(± 1)
conformational defects (valgus, varus)	5	**3**	1	(± 1)
bursitis	4	**3**	1	(± 1)
navicular disease	3	**2**	1	(± 1)
upward fixation of the patella	2	**1**	0	-
other	10	**6**	2	(± 1)
undiagnosed/non-specific	11	**6**	2	(± 1)

Table 45. Phase III Cross-sectional case study of veterinary practices - musculoskeletal conditions.

Thirty animals (20% of all musculoskeletal conditions) were diagnosed with foot abscesses. Of these, 27% were in the autumn, 42% in the winter, 27% in the spring and 4% in the summer. In all instances, the owner's complaint had been that the animal was lame, though two cases had been seen previously by the practitioner for this condition. The clinical signs recorded were consistently of lameness, foot pain and localised heat. Twenty cases (65%) were reported of short duration and ten cases (35%) were chronic. In one case the veterinary practitioner reported using nerve blocks to investigate the lameness. In the management of foot abscess cases, foot paring was used in 23% of cases and poulticing in 50% of cases. Antibiotics were administered in 42% of cases and tetanus toxoid (vaccine) was administered in 8% of cases. The prognosis for survival was good in 92% of cases, fair in 4% and guarded in 4%. The prognosis for return to work was good in 85% of cases, fair in 8%, poor in 4% and unknown in 3%. In twelve cases in which the practitioner reported planning to revisit the animal, the timing of the revisit was specified at a mean ± SD of 5 ± 3 days. The mean ± SD age of animals diagnosed with foot abscesses was 10.1 ± 6.0 years (range 1 - 25 years).

Twenty animals (13% of all musculoskeletal conditions) were diagnosed with laminitis. Of these, 25% were in the autumn, 35% in the winter, 35% in the spring and 5% in the summer. In twelve cases (60%), the owner's complaint had been that the animal was lame, in two cases the animal was recumbent and in another two the animal was described as 'stiff'. Five cases (25%) had been seen previously by the practitioner for this condition, three of which had been diagnosed with Cushing's disease. Four cases had a history of being overweight and three were presented because of sudden onset stiffness. The clinical signs recorded were that in fifteen cases (75%) increased digital pulsation was detected, in thirteen cases (65%) there was foot pain and in six cases (29%) there was lameness. Ten cases (50%) were reported of short duration and eight cases (40%) were chronic. In two cases x-rays of the feet were taken and in another case a thyrotropin releasing hormone (TRH) stimulation test was performed to confirm the diagnosis of Cushing's disease. In the management of laminitis cases, three animals (15%), one of which had Cushing's disease, were given euthanasia. Non-steroidal anti-inflammatory drugs (NSAIDs) were administered in 80% of cases, a restricted diet was prescribed in 50% of cases, foot trimming by a blacksmith was prescribed in 35% of cases and bandaging, providing frog support, was used in 30% of cases. The prognosis for survival was good in 45% of cases, fair in 30% and guarded in 10%; 15% of cases were given euthanasia. The prognosis for return to work was good in 20% of cases, fair in 35%, guarded in 10% and poor in 20%. In eight cases in which the practitioner reported planning to revisit the animal, the timing of the revisit was specified at a mean ± SD of 5 ± 2 days. The mean ± SD age of animals diagnosed with laminitis was 12.9 ± 5.3 years (range 2 - 21 years).

The groupings for 'joint disorders and arthritis' and 'tendon/ligament problems' contained too many diverse diagnoses to merit detailed description.

Seven animals sustained fractures, three of which were severe enough to require the animals to be given euthanasia. The euthanased horses had sustained fractures of the tibia (one horse), the third metatarsal (cannon) bone (one horse) and the radius & ulna (one horse). The remaining four horses had chip fractures of carpal bones (two horses), fractured pedal bone (one horse) and a fractured second metacarpal (splint) bone (one horse).

5.3.2.2.3. Injuries

Fifty three cases were reported where animals had sustained minor injuries, which were of a diverse nature. Thirty nine (74%) were new cases being seen for the first time and 14 (26%) were rechecks on cases that had previously received veterinary attention. In eleven cases (21%), there was a history of being kicked by another horse, and in a further eight cases (15%), barbed wire was implicated as the cause of injury. Five cases (9%) sustained injuries whilst hunting and three cases (6%) were injured in transit. Forty cases (75%) had sustained skin lacerations or abrasions, fourteen (26%) were lame and in twelve (23%) there was localised soft tissue swelling. In terms of management of injuries, debridement of the wound was reported in 17% of cases, lavage of the wound in 9% of cases and sutures were used in 17% of cases. Antibiotics were administered in 68% of cases, non-steroidal anti-inflammatory drugs (NSAIDs) in 25% of cases and tetanus toxoid (vaccine) in 17% of cases. Dressings and bandages were applied in 23% of cases. The prognosis for survival was good in 98% of cases and fair in 2%. The prognosis for return to work was good in 72% of cases, fair in 13%, guarded in 6%, poor in 2% and unknown in 7%. In twenty seven cases in which the practitioner reported planning to revisit the animal, the timing of the revisit was specified at a mean ± SD of 9 ± 9 days. The mean ± SD age of animals diagnosed with injuries was 8.0 ± 6.1 years (range 5 days - 25 years).

5.3.2.2.4. Dermatological cases

Overall, there were 33 case sheets returned in which dermatological disorders were diagnosed. The mean ± SD age of these animals was 9.0 ± 6.7 years (range 9 months - 27 years). The conditions diagnosed in this category are summarised in Table 46:

Reason for consultation	Number of cases	Percentage of dermatological cases	Percentage of all cases seen (± 95% CI)
sarcoids	11	**33**	2 (± 1)
exuberant granulation tissue	4	**12**	1 (± 1)
abscesses	4	**12**	1 (± 1)
non-specific urticaria	3	**10**	1 (± 1)
dermatomycosis (ringworm)	2	**6**	0 -
dermatophilosis	2	**6**	0 -
melanoma	1	**3**	0 -
other	6	**18**	1 (± 1)

Table 46. Phase III Cross-sectional case study of veterinary practices - dermatological conditions.

Eleven animals (33% of all dermatological conditions) were diagnosed with sarcoids, of which 54 % were bay and 27% were grey. Of these, 9% were in the autumn, 27% in the winter, 27% in the spring and 37% in the summer. Four cases (36%) were new, the remaining seven cases (64%) had been seen at least once previously by the practitioner for this condition. All cases were reported to be chronic in duration. In one case, the veterinary practitioner reported taking samples from lesions for histopathology to confirm the diagnosis. In the management of sarcoids, a topical cytotoxic cream prepared at the University of Liverpool Veterinary School was used in 54% of cases. In a further 36% of cases, surgical excision of the lesions was reported, in one instance of which cryosurgery was the reported method of choice. The prognosis for survival was good in 91% of cases and fair in 9%. The prognosis for return to work was good in 82% of cases, fair in 9% and guarded in 9%. In nine cases in which the practitioner reported planning to revisit the animal, the timing of a revisit was specified at a mean ± SD of 35 ± 54 days. The mean ± SD age of animals diagnosed with sarcoids was 6.4 ± 2.7 years (range 4 - 13 years).

5.3.2.2.5. Gastrointestinal cases

Overall, there were 33 case sheets returned in which gastrointestinal disorders were diagnosed. The mean ± SD age of these animals was 9.0 ± 6.7 years (range 9 months - 27 years). The conditions diagnosed in this category are summarised in Table 47:

Reason for consultation	Number of cases	Percentage of gastrointestinal cases	Percentage of all cases seen (± 95% CI)
spasmodic/non-specific colic	14	**42**	3 (± 1)
large intestinal impaction colic	6	**18**	1 (± 1)
grass sickness	4	**12**	1 (± 1)
small intestinal obstruction/strangulation	3	**10**	1 (± 1)
retained meconium	2	**6**	0 -
other	4	**12**	1 (± 1)

Table 47. Phase III Cross-sectional case study of veterinary practices - gastrointestinal conditions.

Fourteen animals (42% of all gastrointestinal conditions) were diagnosed with spasmodic colic. Of these, 36% were in the autumn, 57% in the winter and 7% in the summer. In all cases, the owner's complaint was that the animal showed signs of abdominal pain, and in five cases (36%) there was a history of a recent change in the diet. The clinical signs reported were of abdominal pain in 71% of cases, increased gut sounds on auscultation of the abdomen in 50% of cases and tachycardia in 36% of cases. Thirteen cases (93%) were reported of short duration and only one case (7%) was chronic. In investigating the causes of colic, in five cases (36%) the veterinary practitioner reported conducting a rectal examination, and in one case a stomach tube was passed. In one case a blood sample was taken to measure biochemical parameters associated with liver function, and in another case a faeces sample was taken for examination for the presence of parasite eggs. In the management of spasmodic colic, spasmolytic drugs were administered in 86% of cases, non-steroidal anti-inflammatory drugs (NSAIDs) were administered in 36% of cases and an anthelmintic preparation (ivermectin) was administered in 14% of cases. The prognosis for survival was good in 64% of cases, fair in 22%, guarded in 7% and poor in 7% (1 case), and indeed this case was reported to have died later. The prognosis for return to work was good in 64% of cases, fair in 8%, guarded in 14% and poor in 14%. In four cases in which the practitioner reported planning to revisit the animal, the timing of a revisit was specified at within 12 hours. The mean ± SD age of animals diagnosed with spasmodic colic was 11.5 ± 7.5 years (range 1 - 21 years).

There were four cases of grass sickness reported with a mean ± SD age of 3.3 ± 1.5 years (range 1 - 4 years). One case was in autumn, two in spring and one in summer. Two cases were from Northumberland, one from Lothian and one from Orkney. In only one case, the one from Orkney, was a previous history of grass sickness cases on the same premises reported. Three cases were given euthanasia and the remaining case was given a poor prognosis for survival.

5.3.2.2.6. Respiratory cases

Overall, there were 27 case sheets returned in which respiratory disorders were diagnosed. The mean ± SD age of these animals was 9.6 ± 7.6 years (range 3 weeks - 26 years). The conditions diagnosed in this category are summarised in Table 48:

Reason for consultation	Number of cases	Percentage of respiratory cases	Percentage of all cases seen (± 95% CI)
COPD[†]	9	**33**	2 (± 1)
viral upper respiratory tract disease	9	**33**	2 (± 1)
pneumonia	4	**15**	1 (± 1)
strangles	3	**11**	1 (± 1)
idiopathic laryngeal hemiplegia	1	**4**	0 -
maxillary sinusitis	1	**4**	0 -

Table 48. Phase III Cross-sectional case study of veterinary practices - respiratory conditions.
[†]COPD - chronic obstructive pulmonary disease.

Nine animals (33% of all respiratory conditions) were diagnosed with chronic obstructive pulmonary disease (COPD). Of these, 22% were in the autumn, 11% in the winter, 45% in spring and 22% in the summer. In seven cases (78%), the owner's complaint was that the animal was coughing and in the remaining two cases (22%) there was a nasal discharge. One case had been seen once previously by the practitioner for the current episode of COPD and a further three cases (33%) had a previous history of COPD. Four cases (44%) had recently been housed and changed onto a diet which included hay. The clinical signs reported were of coughing in 67% of cases, nasal discharge in 44% of cases and adventitious sounds on auscultation of the chest in 33% of cases. Five cases (56%) were reported of short duration (acute onset COPD) and four cases (44%) were chronic. In the management of COPD, bronchodilators were prescribed in 56% of cases (the five acute onset cases). In 56% of cases, advice was given on the creation and maintenance of an environment with minimal dust contamination, and in 67% of cases it was advised to either soak hay before feeding or change to another 'wet' type of conserved grass. The prognosis for survival and return to work was good in all cases. The mean ± SD age of animals diagnosed with COPD was 15.8 ± 5.6 years (range 8 - 26 years).

Nine animals (33% of all respiratory conditions) were diagnosed with viral upper respiratory tract disease. Of these, 23% were in the autumn, 33% in the winter, 33% in spring and 11% in the summer. In four cases (44%), the owner's complaint was that the animal was coughing and in two cases (22%) that the animal was dull and inappetent. One case had been seen once previously by the practitioner for this complaint. Three cases (33%) had been transported within the previous seven days. The clinical signs reported were of nasal discharge in 67% of cases, coughing in 56% of cases, pyrexia in 44% of cases and lymphadenopathy in 44% of cases. Seven cases (78%) were reported of short duration and two cases (22%) were chronic. In the management of viral upper respiratory tract disease, antibiotics were administered in 78% of cases and non-steroidal anti-inflammatory drugs (NSAIDs) were administered in 22% of cases. The prognosis for survival and return to work was good in all cases. The mean ± SD age of animals diagnosed with diagnosed viral upper respiratory tract disease was 4.9 ± 3.6 years (range 5 months - 10 years).

5.3.2.2.7. Reproductive cases

Overall, there were 17 case sheets returned in which reproductive disorders were diagnosed. The mean ± SD age of these animals was 10.1 ± 5.6 years (range 3 weeks - 26 years). The conditions diagnosed in this category are summarised in Table 49:

Reason for consultation	Number of cases	Percentage of reproductive cases	Percentage of all cases seen (± 95% CI)
cryptorchid	4	**24**	1 (± 1)
endometritis	3	**18**	1 (± 1)
dystocia	2	**12**	0 -
granulosa cell tumour	1	**6**	0 -
other	7	**40**	1 (± 1)

Table 49. Phase III Cross-sectional case study of veterinary practices - reproductive conditions.

All four cases of cryptorchidism underwent successful surgery to remove the retained testicles. In all three cases of endometritis, daily uterine lavage and intrauterine antibiotics were prescribed and all were given a poor prognosis for breeding in the future. In both cases of dystocia, a live foal was delivered following the application of manual traction. The seven cases grouped as 'other', all had vague or uncertain diagnoses.

5.3.2.2.8. Metabolic cases

Overall there were 19 case sheets returned in which metabolic disorders were diagnosed. The mean ± SD age of these animals was 14.4 ± 7.8 years (range 3 - 30 years). The conditions diagnosed in this category are summarised in Table 50:

Reason for consultation	Number of cases	Percentage of metabolic cases	Percentage of all cases seen (± 95% CI)
sporadic lymphangitis	5	**26**	1 (± 1)
malnutrition	5	**26**	1 (± 1)
Cushing's disease	4	**21**	1 (± 1)
liver failure	2	**11**	0 -
EER*	2	**11**	0 -
hyperlipaemia	1	**5**	0 -

Table 50. Phase III Cross-sectional case study of veterinary practices - metabolic conditions.
*EER - equine exertional rhabdomyolysis

Five animals (26% of all metabolic conditions) were diagnosed with sporadic lymphangitis. Of these, 80% were in the winter and 20% in the summer. All cases had a history of a previous skin wound which was healing badly, and in all cases the clinical signs reported were of soft tissue swelling. In the management of sporadic lymphangitis, antibiotics were administered in all cases and non-steroidal anti-inflammatory drugs (NSAIDs) were administered in 80% of cases. In 80% of cases walking in hand exercise was advised. The prognosis for survival was good in all cases, and for return to work it was fair in all cases. The mean ± SD age of animals diagnosed with sporadic lymphangitis was 10.2 ± 5.4 years (range 3 - 18 years).

Four cases were diagnosed with Cushing's disease, three of which presented with laminitis (Chapter 5.3.2.2.2). In all cases a poor prognosis for survival was given and one case was given euthanasia.

5.3.2.2.9. Neoplastic cases

There were only two cases grouped in the neoplastic category, both of which involved ocular structures. One case was a nine year old pony mare and the other a ten year old pony gelding. Both were presented because of ocular discharge, and a visible nodule on the eyelid in the mare and the third eyelid in the gelding. After histopathology, both structures were diagnosed as squamous cell carcinomas and were surgically removed under heavy sedation and local anaesthesia. A fair prognosis for non-recurrence was given in both cases.

In addition there were eleven cases diagnosed with sarcoids and one with melanoma: These could also be considered neoplastic conditions, but have been described within the dermatological cases section (Chapter 5.3.2.2.4).

5.3.2.2.10. Miscellaneous cases

Overall there were 28 case sheets returned in which miscellaneous disorders were diagnosed. The mean ± SD age of these animals was 14.4 ± 7.8 years (range 3 - 30 years). The conditions diagnosed in this category are summarised in Table 51:

Reason for consultation	Number of cases	Percentage of miscellaneous cases	Percentage of all cases seen (± 95% CI)	
dental problems	6	**21**	1	(± 1)
ocular problems	5	**18**	1	(± 1)
umbilical hernia	3	**11**	1	(± 1)
tetanus	2	**7**	0	-
neonatal problems	2	**7**	0	-
stable vices	2	**7**	0	-
mastitis	1	**4**	0	-
bee sting	1	**4**	0	-
other	6	**21**	1	(± 1)

Table 51. Phase III Cross-sectional case study of veterinary practices - miscellaneous conditions.

There were six animals (21% of all miscellaneous cases) diagnosed with dental problems. In three cases (50%), there was a history of dysphagia and dropping food, in a further two cases (34%) there was a history of mouth discomfort, especially when inserting the bit, and in one case (17%) there was a history of loss of condition. In all cases, sharp points on the teeth were detected on clinical examination and in all cases the teeth were rasped. In all cases the prognosis for survival and return to work were good. No revisits were planned. The mean ± SD age of animals diagnosed with dental problems was 14.3 ± 9.2 years (range 5 - 30 years).

There were five instances of ocular problems which were diagnosed as one case of each of the following: entropion, anterior uveitis, bilateral cataracts, corneal ulcer and dacryocystitis.

Two umbilical hernias were treated by the placement of a rubber castration ring around the neck of the hernia sac and the third case was treated surgically. The prognosis in all cases was good.

5.3.2.2.11. No abnormality detected

In eight consultations, a horse was examined by a veterinary practitioner and no abnormal clinical findings were made. In three of these instances the owner's complaint was of an animal with a nasal discharge, in one instance choke was suspected and in another an abnormal respiratory noise was heard when the animal galloped. Three cases were check-ups on cases that had been treated previously and were now fully recovered.

5.3.3. Summary

In phase III of the study, sixteen veterinary practices provided detailed data form 547 equine consultations spread over the four seasons of one year (Chapter 5.3.2). The most frequent consultations were for routine procedures comprising 33% of all consultations. The most common reasons for routine consultations were vaccination (59%), pregnancy diagnosis (13%) pre-purchase examination (11%) and castration (6%) (Chapter 5.3.2.2.1). Musculoskeletal disorders were the most frequent category of disease diagnosed, comprising 28% of all consultations. The most common diagnoses within the musculoskeletal category were of foot abscess (20%), non-specific joint disorders and arthritis (14%), laminitis (13%), non-specific tendon and ligament problems (13%) and non-specific foot lameness, excluding foot abscesses, (10%) (Chapter 5.3.2.2.2). Minor injuries comprised 10% of all consultations, and 75% of these cases involved skin lacerations or abrasions (Chapter 5.3.2.2.3). Dermatological conditions comprised 6% of all consultations, with 33% of these cases diagnosed as sarcoids (Chapter 5.3.2.2.4). Gastrointestinal disorders also comprised 6% of all consultations, with 60% of these cases diagnosed as spasmodic or large intestinal impaction colic (Chapter 5.3.2.2.5). Respiratory disorders comprised 5% of all consultations, with 33% of these cases diagnosed as COPD and 33% diagnosed as viral upper respiratory tract disease (Chapter 5.3.2.2.6). Reproductive and metabolic disorders each comprised 3% of all consultations, and neoplastic conditions overall comprised <1%, though if sarcoids and melanomas were categorised as neoplastic as well as dermatological, then neoplastic conditions would comprise 3% of all consultations with sarcoids being diagnosed in 79% of cases (Chapters 5.3.2.2.4, 5.3.2.2.7, 5.3.2.2.8, 5.3.2.2.9). Miscellaneous conditions comprised 5% of all consultations, with dental problems, ocular problems and umbilical hernias making up 59% of these cases. In 1% of cases no abnormal clinical findings were made.

The relative percentages of the different categories of disease diagnosed, discounting routine consultations and those in which no abnormal clinical findings were made, are summarised in Table 52:

Classification	Overall % of cases seen
musculoskeletal	42
injuries	15
dermatological	9
gastrointestinal	9
respiratory	7
reproductive	5
metabolic	5
neoplastic	1
miscellaneous	7

Table 52. Phase III Cross-sectional case study of veterinary practices - percentage of cases seen in each category excluding routine consultations and those in which no abnormal clinical findings were made.

The data from Table 40 which shows the percentage of each category of disease, including routine consultations and those in which no abnormal clinical findings were made, diagnosed in each practice are presented in Figure 19.

Figure 20 shows the relative proportions of the five most frequently diagnosed categories of disease within each practice. Although the proportion of musculoskeletal disease varies from practice to practice, it is difficult to see any regional differences in its distribution. Subjectively, dermatological disease appears to comprise a slightly larger proportion of cases in western and central Scotland, whereas gastrointestinal disease appears to be proportionally more frequent in eastern practices though there was no statistically significant difference in the proportion of these cases seen by veterinary surgeons in these different regions ($p = 0.22$). Respiratory disease appears to comprise a relatively larger proportion of diagnoses in a belt extending across the study area from the Scottish/English border in the south to Fife in the north. Making use of the zoom features of MapInfo GIS (MapInfo Corporation), Figure 21 shows the area where respiratory disorders appear to be

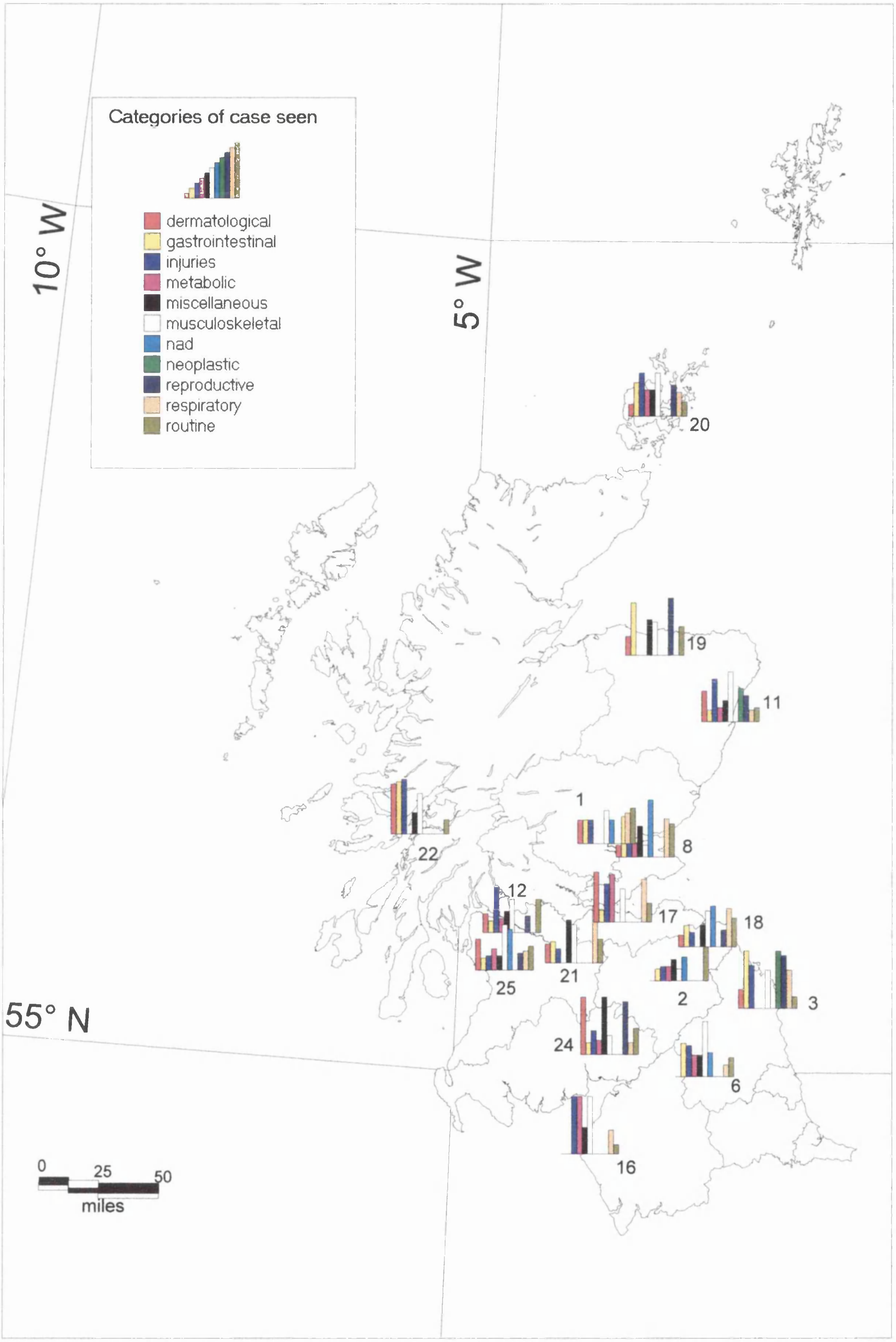


Figure 19. Map showing the proportion of cases in different categories seen by each practice from Phase III Cross-sectional case study of veterinary practices.
The numbers are practice identification numbers.

Figure 20. Map showing the proportion of the five most frequent disease categories diagnosed in each practice from Phase III Cross-sectional case study of veterinary practices. The numbers are practice identification numbers.

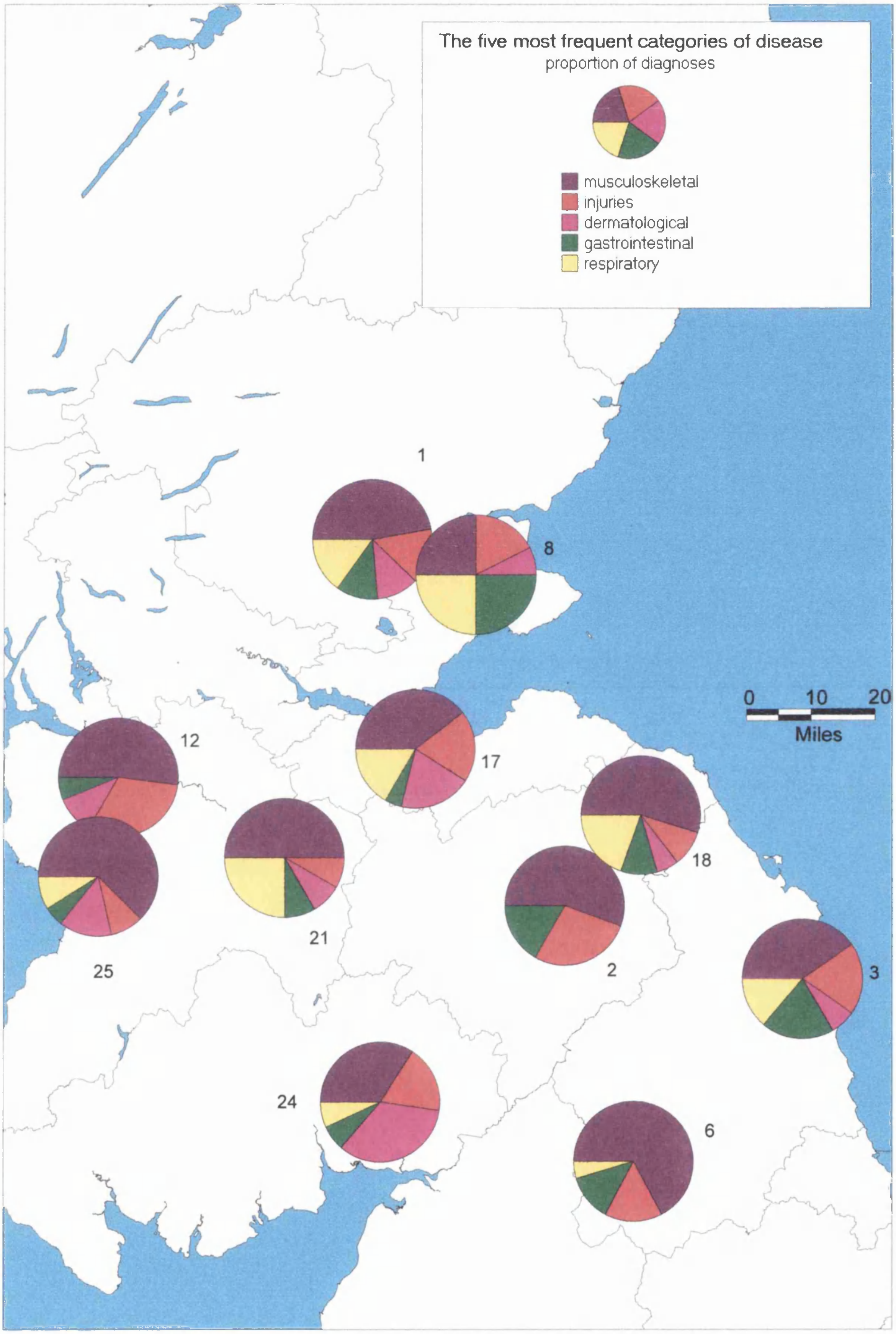


Figure 21. Map zoomed in on the area where respiratory disorders appear to be most prevalent from Phase III Cross-sectional case study of veterinary practices.
The numbers are practice identification numbers.

most prevalent. If practices 2, 3, 8, 12, 17, 18, 21 and 25 are denoted as being located in the central belt and compared to the remaining practices either to the north or south of this belt, a veterinary surgeon from one of the central practices would be 3.8 times more likely than a veterinary surgeon in one of the other practices to see a case of respiratory disease ($p = 0.02$).

5.4. DISCUSSION AND COMPARISON WITH PREVIOUS PHASES OF THE STUDY

5.4.1. Response

The overall response rate in this phase of the study was 75% (Chapter 5.3.1). Broken down on a seasonal basis, there was a 79% response to the autumn mailing, a 72% response to the winter mailing, a 74% response to the spring mailing and a 76% response to the summer mailing suggesting that there was no serious waning of interest and motivation among participants over the course of the study. The response rate compares favourably with other studies which have relied on surveying veterinary practitioners. Hoffsis *et al.* (1983) reported a response rate of 29% in a mailed questionnaire survey of bovine practitioners investigating the incidence and geographical distribution of Johne's disease in the USA. In another survey of practitioners concerned with bovine caesarean sections in Ireland, Vaughan and Mulville (1995) reported a response rate of 34.3%. Considering studies focusing on equine disease, Traub-Dargatz *et al.* (1991), in their study ranking the medical problems of adult horses from a survey of members of the American Association of Equine Practitioners, reported a response rate of 39.1%. Another study, using a mailed questionnaire survey of equine clinicians in the USA to investigate clinical aspects and treatment of endotoxaemia in horses, reported a 30% response rate (Shuster *et al.*, 1997).

Considering studies where data were collected over a period of time, Slater *et al.* (1995) recruited nine veterinary practices to supply data about cases of equine laminitis, of which seven practices (78%) participated in the study, which is comparable to sixteen (84%) out of the original nineteen practices recruited in this study. Cohen *et al.* (1995) reported a 77.4% participation rate in a study investigating associations between management factors and colic where practitioners were asked to supply data for one case and one control horse each month, which is again comparable to the response obtained in this study.

5.4.2. Diseases - Phase Ia and Phase III

Comparing the overall results between phases Ia and III, it can be seen that in phase Ia the mean ± SD percentage of equine work comprised of routine procedures was 43% ± 20% (Chapter 3.3.3) whereas in phase III of the study the percentage of cases seen for routine procedures was 33% (95% CI: ± 4%). Whilst this figure does fall within one standard deviation of the figure from phase Ia, it is still a discrepancy. There are two factors which may go some way toward explaining this difference. First, routine procedures, especially vaccinations, are often performed as a 'job lot' on premises where several animals are kept, and instances where this occurred when veterinary practitioners were recording the first ten animals seen would tend to over report these procedures. This occurred twice with practice 2, which supplied six and nine case sheets in the winter and spring mailings respectively, that were all vaccinations on the same premises in each instance. However, with just ten consultations reported, if these were all for non-routine reasons, this would tend to under report routine procedures. In retrospect, it might have been a better study design to request one case sheet be completed for the first horse seen on each of the first ten premises visited. However, this would still tend to underestimate the importance of routine procedures and may have led to difficulties where practitioners saw more than one horse at a particular premises and had to chose which to report. More importantly, the categorisation into 'routine' in phase III was done by the author and the criteria used may have been different from that used by practitioners in phase Ia.

Table 53 compares the ranking of the disease categories between phases Ia and III:

Classification	Ranking in phase Ia	Ranking in phase III
musculoskeletal	2	1
injuries	1	2
dermatological	4=	3
gastrointestinal	7	4
miscellaneous	9	5
respiratory	3	6
reproductive	4=	7
metabolic	6	8
neoplastic	8	9

Table 53. Comparison of the ranking of the disease categories between phases I and III of The Home of Rest for Horses Study of Equine Welfare. The rankings for gastrointestinal, musculoskeletal and respiratory from phase Ia were calculated by taking the mean of the value of acute and chronic shown in Table 18.

There was no statistically significant association between the ranking of categories of disease between phases Ia and III ($p = 0.1$). Taking the data from phase III, which was recorded from individual cases, to be more accurate than the subjective data collected in phase Ia, it can be seen that in phase Ia the importance of respiratory disease appears to have been overestimated while the importance of gastrointestinal disease and miscellaneous disease appear to have been underestimated. However, as a cross-sectional study, phase III cannot take into account disease chronicity, which may have been taken into account by practitioners making subjective assessments of disease prevalence in phase Ia. If castrations and pregnancy diagnoses had been categorised as reproductive rather than routine in phase III, reproductive procedures would have been ranked fourth in both phases Ia and III.

5.4.3. Diseases - Phase III and Other Studies

Hata (1993) reported that among Japanese horses reproductive disorders comprised 35% of veterinary cases, gastrointestinal disease 16%, trauma and accidents 15%, respiratory disease 14%, locomotor disorders 11%, infectious and parasitic diseases 3% and others 6% (Chapter 1.3). Except for trauma and accidents, the findings of the Japanese study disagree totally with those of phase III of the current study. This perhaps reflects different patterns of equine management and activity level between Northern Britain and Japan.

Considering the diagnosis of discrete disease entities, the cases from phase III can be ranked as shown in Table 54:

Rank	Disease
1	foot abscess
2	laminitis
3	spasmodic/non-specific colic
4	sarcoids
5 =	COPD†
5 =	viral upper respiratory tract disease
7 =	large intestinal impaction colic
7 =	dental problems
9	sporadic lymphangitis

Table 54. Phase III Cross-sectional case study of veterinary practices - ranking of individual diseases diagnosed.
†COPD - chronic obstructive pulmonary disease.

In comparison, a survey, conducted among members of the American Association of Equine Practitioners, to determine the most prevalent medical problems among adult equine animals ranked the five commonest diseases in descending order as: colic, viral respiratory disease, endometritis, dermatitis and parasitism (Traub-Dargatz *et al.*, 1991; Chapter 1.3). The American study only considered diseases of adult horses and took no account of lameness and surgical conditions and, if these conditions are excluded from the results of the current study, and all colic cases are considered together, then the top five conditions in descending order would be: colic, sarcoids, COPD, viral upper respiratory tract disease, dental problems. There is close agreement between the studies in some respects in that both report colic and viral upper respiratory tract disease, but it is perhaps surprising that sarcoids seem to be so prevalent in The Home of Rest for Horses Study when they are not mentioned at all in the American study.

5.4.4. Conclusions

In Phase III of The Home of Rest for Horses Study of Equine Welfare a large volume of data was collected regarding the nature of first opinion equine veterinary practice and the relative frequency of occurrence of equine disease in the northern UK. These data supplemented the findings of phase Ia of the study (Chapter 3) in providing more detailed information about individual equine animals attended by a veterinary surgeon. The data collected in phase II of the study provided a general idea of the management and level of activity of equine animals comprising the study population (Chapter 4), but more detailed information, at the individual animal level, was needed to complete the demographic description and relate the disease data collected in phase III to the general population. The design, implementation, results and conclusions of phase IV, a detailed survey of a stratified random sample of horse owners to collect detailed data on the age, breed, sex, management, feeding and health maintenance of individual equine animals are presented and discussed in Chapter 6.

CHAPTER 6

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS

6.1. INTRODUCTION

Factors associated with animal management, involving environmental management and housing (Webster *et al.*, 1987; Clarke, 1989a), nutrition (Gilmour and Jolly, 1974; Clarke, 1989b), use or level of activity (Estberg *et al.*, 1995) and routine preventive health care practices (Reid *et al.*, 1995), have often been implicated as risks for the development of disease. A great deal of epidemiological research has been conducted in an attempt to identify, describe and, more recently, to quantify associations between management factors and disease occurrence.

Logically, as animal owners usually control the management of their own animals, many of these epidemiological studies have involved, at least in part, surveys of owners to gather information about animal management and demographics. In equine veterinary science, studies of this nature have tended to focus on a single disease entity or syndrome (Traub-Dargatz *et al.*, 1991): Gilmour and Jolly (1974) and later Doxey *et al.* (1991) and Wood *et al.* (1994) conducted mailed questionnaire surveys of horse owners to investigate associations between management factors and the occurrence of equine grass sickness; in their study of management factors associated with stereotypic behaviour in Thoroughbred horses, McGreevy *et al.* (1995a) distributed a mailed questionnaire among trainers; Reinemeyer and Rohrbach (1990) used a telephone questionnaire to collect information relating to equine parasite control practices employed among Tennessee horse owners; Reeves *et al.* (1996) used an extensive telephone questionnaire to collect management information from the person responsible for the day-to-day care of individual horses in investigating and quantifying risk factors for equine colic.

Studies which have recruited animal owners to record the relative frequency with which different specific diseases occur have been reported infrequently, and have tended to concentrate on production animal species, presumably because of the numbers of animals per owner. Dohoo *et al.* (1985) used a combination of three questionnaires mailed to sheep producers to collect demographic and management data, and to record the occurrence of diseases affecting ewes and lambs. These data were combined with data from diagnostic laboratories to estimate the prevalence of ovine diseases and the aetiological agents associated with them. Underhill and Showalter (1989) reported the findings of a survey of horse owners in the USA in which the equine diseases most frequently requiring veterinary attention were recorded (Table 9).

Phase IV of The Home of Rest for Horses Study of Equine Welfare was conducted among a sample of horse owners in Scotland and Northern England to solicit horse owner opinions about the most important equine diseases and to collect data relating to management and disease occurrence in individual animals.

6.2. QUESTIONNAIRE DESIGN AND IMPLEMENTATION

6.2.1. Considerations

1) The aims of phase IV of the study were to collect more detailed data than was provided in phase II, from a representative sample of horse owners on the general management of all their animals and precise details of the management of individual animals. Of particular interest were the age, breed and sex of animals, arrangements for grazing and housing, feeding, activities in which animals were involved, rates of routine hoof care, worming and vaccination and short term veterinary history.

2) On the basis that the target population of horse owners for phase IV of the study had already indicated their willingness to participate in their responses to phase II (Chapter 4.3.2), the necessity to produce a short questionnaire, with a small perceived time commitment for completion, was reduced.

3) Once again, in accordance with the wishes of veterinary practices with whom these horse owners were registered, no follow-up with reminders or repeat mailings of questionnaires were planned, except in instances where the originals had been lost and replacements were requested.

4) The size and composition of the sample had to be carefully chosen to allow meaningful conclusions to be drawn for the entire equine population of the study area.

6.2.2. The Study Population

The required sample size was calculated using sampling theory designed to estimate the prevalence of a variable within a population at a desired level of accuracy with a desired measure of confidence. An expression for the estimation of the prevalence of a variable in a large, theoretically infinite, population, in this case with a 95% confidence interval, is given below after Cannon and Roe (1982), and Thrusfield (1995):

$$n = \frac{1.96^2 \, P_{exp}(1 - P_{exp})}{d^2}$$

where: n = required sample size

P_{exp} = expected prevalence

d = desired absolute precision

As can be seen, decisions had to be made about the desired precision and width of confidence interval, and some estimate of the expected prevalence of the variable of interest also had to be made. Where the expected prevalence of the variable of interest is unknown, the worst case scenario of a prevalence of 50% may be assumed, which gives the largest sample size and therefore allows more accuracy in estimating the prevalence of variables above and below 50%.

In the current study, the desired precision was decided at within 5% of the true value with the confidence interval at 95%. As the aim of the study was to record data relating to many variables, the prevalence of most of which were unknown, a prevalence of 50% was assumed. The calculation for the required sample size n, is given below:

$$n = \frac{3.84\,(0.5 \times 0.5)}{(0.05)^2} = \frac{0.96}{0.0025} = \mathbf{384}$$

Despite the fact that all horse owners eligible for inclusion had agreed to participate in this phase of the study in their responses to the questionnaire in phase II (Chapter 4.3.2), it was anticipated that the response would be less than 100%, especially as no follow-up was planned (Chapter 6.2.1). The expected response rate was estimated at 70%, which meant that the original 384 was multiplied by a factor of 1.43 to give a final sample size of 550 horse owners. If the assumptions were correct, this would provide data on approximately 3.7* × 384 = 1420 horses, ponies and donkeys, which would be more than adequate to estimate the prevalence of variables within the population at the desired precision with the desired level of confidence.

At the outset of the study, it was intended to investigate how disease prevalence varied with geographical location and with level of activity of animal. It was decided therefore, to employ a stratified random sampling plan to ensure representation of all groups within the study population (Levy and Lemeshow, 1991). Using the data from phase II (Chapter 4), practice affiliation acted as a convenient indicator variable for geographical location, but data on level of activity of individual equine animals were not available. Furthermore, animals could be involved in more than one of the activity groupings reported by horse owners, making this unsuitable as a stratifying variable. Therefore, a stratified random sample of horse owners was taken in order to be representative of all veterinary practices and therefore all geographical areas. Owners were allocated to strata in the same proportions in terms of practice affiliation. This is termed stratified random sampling with proportional allocation and is explained by the following formula after Levy and Lemeshow (1991):

$$n_h = N_h \times \frac{n}{N}$$

where: n_h = the number of elements taken from stratum h

N_h = the total number of elements in stratum h

n = the sample size

N = the total population

---

* 3.7 is the mean number of animals per owner from phase II of the study (Chapter 4.3.3)

Under these conditions, the formula for the construction of 95% confidence intervals for estimates of p, the proportion of the population is after Levy and Lemeshow (1991):

$$95\%\ \text{CI for}\ p,\ \pm\ 1.96\left\{\frac{1}{N^2}\sum_{h=1}^{L}\left(N_h^2\right)\left[\frac{P_h\,(1-P_h)}{n_h}\right]\left(\frac{N_h-n_h}{N_h-1}\right)\right\}^{1/2}$$

where: L = the number of strata

P_h = the proportion within stratum h

However, this is only correct if the sum of the elements of all L strata, $\sum_{h=1}^{L}\left(N_h\right)$, is equal to N, the total population size. As the sample for the current phase of The Home of Rest for Horses Study of Equine Welfare was drawn from the respondents to phase II, who in themselves represented a sample of veterinary practices, the above formula is inapplicable and 95% confidence limits were calculated using the general formulae given in Chapter 2.6

Microsoft Excel (Microsoft Corporation) software was used to select the required number of owner numbers within each stratum. The composition of the sample compared with that of the respondents to phase II, in terms of practice affiliation, can be seen in Table 55. Table 56 shows a comparison of the composition of the sample taken for phase IV, with the overall response to phase II, in terms of the activity groupings in which horse owners stated their animals were involved.

Practice number	Percentage of all owners in phase II	Percentage of all owners in phase IV
2	4	5
3	4	5
4	4	5
6	8	10
8	3	3
9	2	1
10	1	1
11	15	14
12	8	9
16	3	3
17	3	3
18	8	8
19	3	2
20	1	1
21	3	4
22	1	1
24	5	5
25	24	19

Table 55. Comparison of the percentage composition of the respondents to phase II and the sample of owners surveyed in phase VI in terms of practice affiliation.

Activity in which horses were involved	Percentage of phase II study population involved	Percentage of phase IV study population involved
hacking	24	28
breeding	20	19
riding/pony club events	18	23
showing	14	16
showjumping	10	13
horse trials/eventing	8	10
purely companion	8	9
hunting	7	10
racing	4	3
driving	3	4
point-to-point	2	2
endurance riding	2	2
other	17	16

Table 56. Comparison of the percentage composition of the respondents to phase II and the sample of owners surveyed in phase VI in terms of activity groupings in which horses were involved.

6.2.3. Questionnaire Design

The physical design of the questionnaire has been described previously (Chapter 2.4.2). Considering point 1) in Chapter 6.2.1, it was decided that the questionnaire for this phase of the study would be in two parts; a single questionnaire concerning the general management of all animals belonging to an owner, and one separate fact sheet each for the detailed management of each individual animal. Both the questionnaire and the fact sheets were limited to one sheet of A4 (210 × 297 mm) paper printed on both sides.

The questionnaire was printed landscape and folded into booklet form as described in Chapter 2.4.2. The questions were designed to record how frequently any of an owner's animals required veterinary attention for non-routine procedures during a year, where animals were kept in relation to the owner's home and how often they were checked if kept away from home, details of pasture availability and mixing of animals at pasture and at equine events such as shows and competitions. Finally, owners were asked to list what they considered to be the three most important disease or health problems of horses (Appendix 18).

Fact sheets, for the same reasons outlined in Chapter 5.2.3 for case sheets, were printed landscape to give the more intuitive impression of a series of identical report forms, one to be completed for each animal owned. Again, as with the case sheets (Chapter 5.2.3), the initial design of fact sheets was based on a table design as can be seen in Figure 22:

Name of horse pony or donkey	
Age in years	
Sex (Male, Female, Gelding)	
Breed or type	
Coat colour	
Brief description of management (when grazed, when stabled, type of bedding used)	
Principal use(s)	
Brief details of supplementary feeding (i.e. hay, hay and coarse mix etc.)	
How often is this animal shod?	
How often is this animal vaccinated against equine flu/tetanus?	
How often is this animal wormed?	
Does this animal have any permanent or recurrent disease problems?	
What was the reason for the vet's last visit to this animal (including vaccination)?	
What is this animal insured against?	

Figure 22. Phase IV In depth survey of horse owners - outline of table design of the survey form.

Again, refinements were made in consultation with Professor S.W.J. Reid, Professor S. Love and Dr M.J. Reeves. Generally speaking, the tabular design provided no structure to the potential answers of the respondent, meaning that many of the open ended type of answers would have been difficult to code for the purposes of data entry and analysis. Furthermore, from an aesthetic point of view, the plain table left no room for the title of the study and was visually unattractive. As a result, the survey form was completely redesigned, retaining the general sense of the table format but providing more structure to almost all sections, and at the same time expanding some of them. Wherever possible, respondents were asked to fill in a single word or number in spaces provided, or to tick a box or boxes where a number of options were offered. This, and the addition to a title heading for each sheet, necessitated expanding the questions over both sides of the paper. Careful attention was taken to avoid crowding the paper and maintain a 'vertical flow' throughout the form (Chapter 2.4.3). In this way, the form was made more simple for respondents to complete, and the answers easier to code for the purposes of data entry and analysis with no apparent loss in the quality of information. The final design of the fact sheet can be seen in Appendix 19.

The questionnaire and fact sheet were pretested among a small number of horse owners who would not participate in the full study, and all of the returns to both questionnaire and fact sheet were considered to be of good quality. Only minor adjustments to the designs of the questionnaire and fact sheet were made after the pretesting. Each questionnaire and fact sheet was marked in the top right hand corner with the unique identifying owner number of the intended recipient from phase II of the study (Chapter 4.2.2).

6.2.4. The Accompanying Letter

The accompanying letter began by thanking study subjects for their participation in phase II of the study and for indicating their willingness to complete the current second part of the owner study (Appendix 17). The letter provided instructions for the completion of questionnaire and fact sheets, urging owners who owned more horses than they had when they had responded to the first part of the owner survey, to telephone or write and ask for supplementary fact sheets to be mailed to them. Respondents were assured that all information supplied would be treated in the strictest confidence. All accompanying letters were hand addressed and hand signed in ink.

6.2.5. Implementation

The mailing package contained the questionnaire, the requisite number of fact sheets - taken from the owner's response in phase II, the accompanying letter and a self addressed return envelope (size 162 × 229 mm) with a large text FREEPOST address label affixed. An envelope (size 162 × 229 mm) was hand addressed to each owner, with the open end of the envelope on the right as the address was written. The fact sheets were folded in half with the top of the front page uppermost, and placed inside the questionnaire booklet. The folded return envelope was placed inside the fact sheets and the accompanying letter, also folded in half with the owner's address uppermost, was placed outside the questionnaire. The whole package was placed into the envelope with the owner's address on the letter orientated to that on the envelope. All outgoing mail was franked second class, which, depending on the number of fact sheets enclosed, fell either within, or within one or two price bandings above, the standard UK letter rate. Mailing took place on 2nd October 1995.

6.2.6. Data Storage and Analysis

Separate tables, one for questionnaire data and one for fact sheet data, were designed within The Home of Rest for Horses Study of Equine Welfare database, to hold all data from phase IV of the study (Chapter 2.3, Chapter 2.5). Data were entered using forms, linked to the tables, corresponding to the design of the questionnaire or fact sheet (Appendices 20 and 21).

In the questionnaire database table, an extra field was added for the number of horses owned which was calculated simply from the number of fact sheets returned. This figure was compared with the figure quoted for number of horses owned in phase II (Chapter 4) and used to assess change in the numbers of animals owned over time (see also Chapter 4.3.1). Responses to question 2: *Where are your animals kept?* were coded: 1 = at home, 2 = at other premises, 3 = combination. Responses to question 4: *Do your animals live by themselves or share premises with horses, ponies and/or donkeys belonging to other people?* were similarly coded: 1 = by themselves, 2 = with animals belonging to other people, 3 = combination. In this table, the 'owner number' field was designated the primary key field and was also used to link data between phases II and IV (Chapter 2.5).

Fact sheets from each owner were numbered sequentially 1, 2, 3 … and so on, as they were entered into the fact sheet database table, and extra 'record number' field was added to store this number. A combination of the owner number and record number were designated as the primary key for this table and were used to identify each animal uniquely within the database (Chapter 2.5). The 'owner number' field was used to link data from this table with those in the questionnaire tables from both the current phase and phase II of The Home of Rest for Horses Study of Equine Welfare. Once again, in order to speed data entry, eliminate errors and facilitate data analysis, sub-tables were designed containing number coded lists of options for categorical response fields and embedded in the data entry form wherever possible (Chapter 5.2.6). Identical number coded list tables as described in Chapter 5.2.6, were used for breed or type of horse, coat colour, and gender. In addition, list tables were created for all the time period and day/night options in questions 1 and 2 (Appendix 19) concerning the length of time and the time of day spent by an animal grazing and stabled at different times of the year (Figure 23).

code	time
1	always
2	never
3	sometimes
4	not

code	day / night
1	day
2	night
3	both
4	neither

Figure 23. Phase IV In depth survey of horse owners - list tables for time and day/night options from The Home of Rest for Horses Study of Equine Welfare database.

A list table for the type of bedding used in an animal's stable, the answer to question 3 on the fact sheet (Appendix 19), was also created (Figure 24).

code	bedding
1	straw
2	shavings
3	peat
4	sawdust
5	paper
6	rubber
7	other
8	combination
9	not

Figure 24. Phase IV In depth survey of horse owners - list table for bedding type from The Home of Rest for Horses Study of Equine Welfare database.

List tables were also created for question 1b: *Does this animal graze alone or with other horses?* where there were three options: 1= alone, 2 = with other horses and, 3 = either; and for question 11: *Is this animal insured?* where there were just two options: 1 = yes, 2 = no.

Separate fields were created for all tick box options in the feeding and activity sections (Appendix 19 - questions 4 and 5). In addition, a further three text fields were created for the 'other' options in feeding, and one for the 'other' option in activity. Responses to questions 6, 7 and 8 on the frequency of shoeing, vaccination and worming were all entered as a yearly rate for the purposes of comparison. Again, for the purposes of analysis and comparison between animals, the date of the last veterinary visit was converted into a number by calculating the number of days that had elapsed between the date quoted and the date of the postmark on the return envelope. The categories of insurance were all entered in one field called 'insurance details' and abbreviated as follows: t = theft, d = death, l = loss of use, v = veterinary fees and o = other.

As only owners who had supplied a postcode were selected for this phase of the study, their locations were already geocoded within the MapInfo Geographical Information System (MapInfo Corporation). Data from this phase of the study were queried within the Microsoft Access (Microsoft Corporation) database from MapInfo using object database connectivity (ODBC) software to link the two programmes and produce maps from the results of this phase of the study (Chapter 2.3). The statistical methods used in the analysis of data from phase IV of the study have been described in Chapters 2.6 and 6.2.2.

6.3. RESULTS

6.3.1. Response

Of the 550 sets of survey forms sent, 14 were returned marked 'addressee gone away', in which instances it can only be assumed that the study subject had moved house in the time between the two phases of the owner study. Three were returned from people who stated that they no longer wished to take part in the study, and twelve more from people who no longer owned horses. In total, 365 returns were made from people who still owned horses, though one person returned the questionnaire but no fact sheets, and six people returned fact sheets but no questionnaire. A total of 1,264 fact sheets were returned. Details of the response to phase IV of the study are presented in Table 57. Once again, as a result of the unforeseen categories of respondent shown in Table 57, rather than simply dividing the

Practice number	Number mailed	Addressee moved	Unwilling to participate	No longer own any animals	Questionnaire but no fact sheets	Fact sheets but no questionnaire	Questionnaire and fact sheets	Overall response rate (%)
2	29	1	0	0	0	1	17	64
3	25	0	0	0	0	1	18	76
4	27	1	0	2	1	1	16	77
6	56	3	1	2	0	1	33	70
8	17	0	0	0	0	0	13	76
9	8	0	0	0	0	0	5	63
10	3	1	0	0	0	0	2	100
11	79	4	0	2	0	0	51	71
12	49	1	1	2	0	1	28	67
16	15	0	0	0	0	0	9	60
17	16	0	0	1	0	0	6	44
18	46	0	0	0	0	0	25	54
19	13	2	0	1	0	0	10	100
20	7	0	0	0	0	0	4	57
21	21	0	0	0	0	0	11	52
22	6	0	0	0	0	0	5	83
24	28	0	0	0	0	0	21	75
25	105	1	1	2	0	1	84	85
count	total	total	total	total	total	total	total	overall
18	550	14	3	12	1	6	358	71

Table 57. Phase IV In depth survey of horse owners - summary of response from owners by practice affiliation.

number of questionnaires returned by the number of questionnaires sent, response rates were calculated using the following equation relating to column headings from Table 57:

$$\left[\frac{\begin{array}{c}\text{([unwilling to participate] + [no longer own any animals]}\\ \text{+ [questionnaire but no fact sheets] + [fact sheets but no questionnaire]}\\ \text{+ [questionnaire and fact sheets])}\end{array}}{\text{([number mailed] - [addressee moved])}}\right] \times 100$$

As can be seen from Table 57 the overall response rate was 71%, agreeing well with the expected response rate of 70% stated in Chapter 6.2.2. However, due mainly to the number of horse owners moving house or no longer owning any animals, the number of responses, 359 questionnaires and 366 owners supplying 1,264 fact sheets, fell slightly short of the desired 384 (Chapter 6.2.2). However, the detailed data from 1,264 horses was more than adequate to estimate the prevalence of management variables within the equine population of the study area with the desired precision and within the desired confidence limits. The geographical distribution of respondents to phase IV of The Home of Rest for Horses Study of Equine Welfare is shown in Figure 25.

6.3.2. Survey Data

6.3.2.1. Questionnaire data

A total of 359 questionnaires were returned from horse owners who kept a total of 1,233 animals. Data from this phase of the study are summarised in Tables 58, 59, 60 and 61:

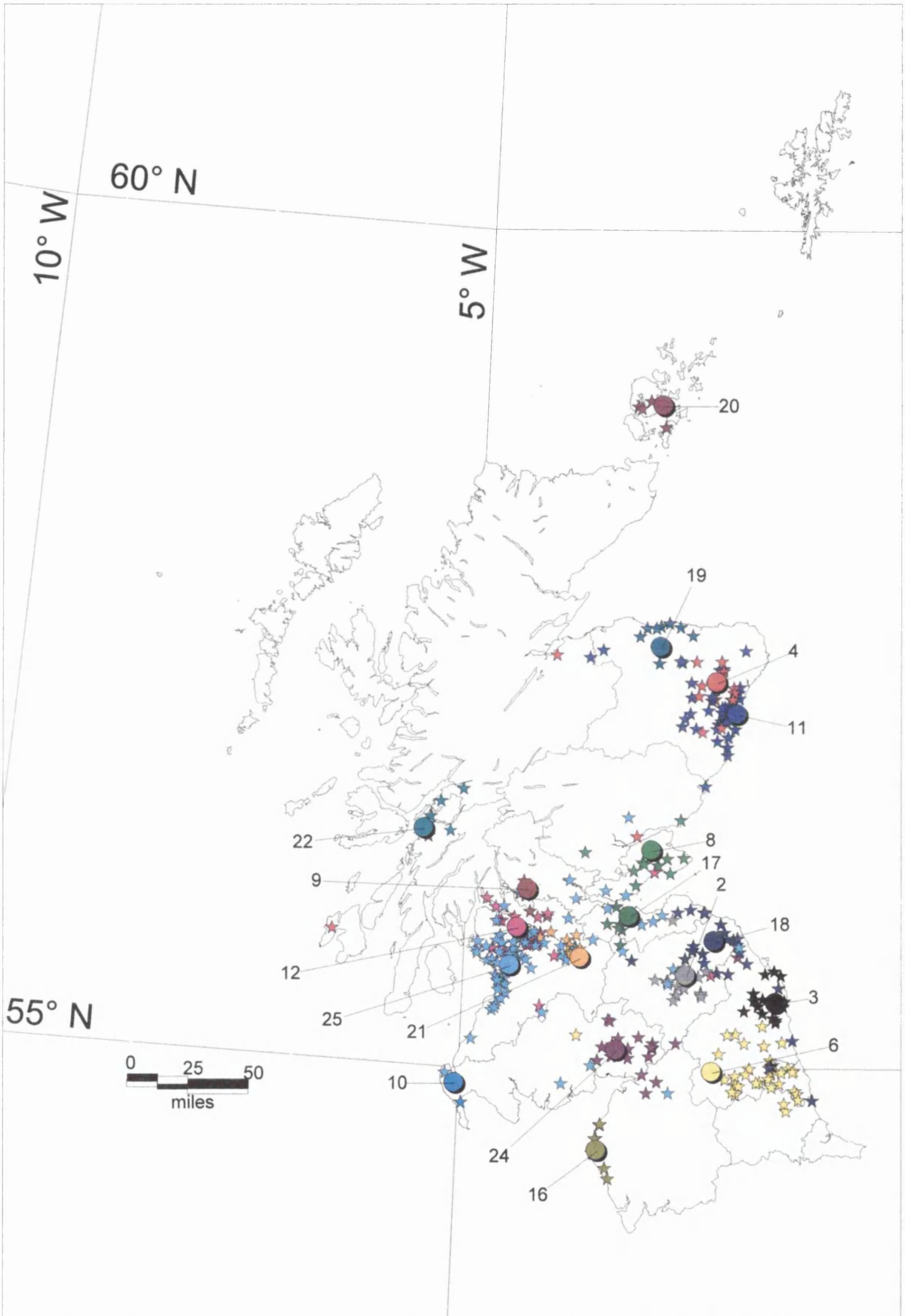


Figure 25. Map showing the distribution of respondents, colour coded by practice affiliation, to Phase IV In depth survey of horse owners.
Practices are represented by a dot and a practice identification number.
Horse owners are represented by a star.

	Animals / owner	Veterinary visits / horse owned / year	Fields or pastures / horse	Mix with other horses / year
mean	3.4	0.88	1.1	17.5
standard deviation	3.5	1.1	0.91	17.3
standard error	0.19	0.06	0.05	0.91
median	2	0.5	1	12
range	37	8	0.96	125
minimum	1	0	0.04	0
25th percentile	1	0.25	0.45	4
75th percentile	4	1	1.36	25
maximum	38	8	10	125
semi-interquartile range	1.5	0.38	0.46	11
mode	1	1	1	0

Table 58. Phase IV In depth survey of horse owners - summary statistics.
animals/owner - the number of animals owned.
veterinary visits/year - the number of non-routine veterinary visits per horse owned per year.
fields or pastures/horse - the number of fields or pastures available per horse.
mix with other horses/year - the number of times a year any of an owner's animals leave the premises where they are kept and mix with other animals at an event or show.

The median ± SIQ number of animals per owner was 2.0 ± 1.5, as it was in phases I (a and b) and II, and the mean ± SD was 3.4 ± 3.5 animals per owner. The median ± SIQ of non-routine veterinary visits per owner per year was 1.0 ± 0.5, but this would be expected to vary according to the number of horses kept, thus Table 58 shows the veterinary visits per horse kept per year of which the median ± SIQ was 0.50 ± 0.38. There was a median ± SIQ stocking rate of 1.0 ± 0.46 horses per field or pasture. The median ± SIQ number of times per year that any of an owner's animals left the premises and mixed with other animals was 12 ± 11 times.

Premises	Owners		Animals	
	number	percent (± 95% CI)	number	percent (± 95% CI)
home	206	57 (± 5)	833	68 (± 3)
other premises	138	39 (± 5)	300	24 (± 2)
combination	15	4 (± 2)	100	8 (± 1)

Table 59. Phase IV In depth survey of horse owners - the number, and percentage in parentheses, of owners keeping their animals and of animals kept either at home or at other premises or a combination of these.

From Table 59 it can be seen that 57% of respondents kept their animals at home and that these animals comprised 68% of horses included in the study. A further 39% of respondents kept their animals in premises away from home but these animals comprised only 24% of all horses included in the study. Where animals were kept in premises away form home they were a median ± SIQ of 3 ± 2 miles away and checked a median ± SIQ of 2 ± 1 times a day by the owner or a representative of the owner (Table 60):

	Distance from home (miles)	Frequency of checking (/ day)
mean	5.2	2.2
standard deviation	8.9	1.2
standard error	0.71	0.10
median	3	2
range	100	7
minimum	0	0
25^{th} percentile	2	1
75^{th} percentile	6	3
maximum	100	7
semi-interquartile range	2	1
mode	2	2

Table 60. Phase IV In depth survey of horse owners - summary statistics for the distance from home of the premises where animals are kept and the frequency with which these animals are checked for animals not kept at home.

In Table 61 it can be seen that 55% of respondents kept their animals on premises that were not shared with animals belonging to other people and that these animals comprised 63% of horses included in the study. A further 44% of respondents kept their animals in premises shared with animals belonging to other people; 35% of all horses included in the study were kept on this type of premises.

Animals are kept	Owners		Animals	
	number	percent (± 95% CI)	number	percent (± 95% CI)
by themselves	197	55 (± 5)	781	63 (± 3)
sharing with others	158	44 (± 5)	435	35 (± 3)
combination	4	1 (± 1)	17	2 (± 1)

Table 61. Phase IV In depth survey of horse owners - the number, and percentage in parentheses, of owners keeping their own animals and of animals kept either by themselves or sharing with animals belonging to other people or a combination of these.

The responses to question 7 on the questionnaire (Appendix 18), where owners were asked to list up to three diseases of horses that they felt were most important, were analysed by assigning a score of 3 to the disease listed first, 2 to the disease listed second and 1 to the disease listed third. The total numerical scores for each disease entity were summed to give a rank order of the equine diseases which horse owners felt were most important. The top 15 diseases are presented in Table 62:

Rank	Disease
1	grass sickness
2	laminitis
3	colic
4	worms
5	equine influenza
6	strangles
7	navicular disease
8	respiratory problems
9	lameness
10	foot problems
11	COPD†
12	coughing
13	tetanus
14	sweet itch
15	joint problems

Table 62. Phase IV In depth survey of horse owners - the top fifteen most important equine diseases as ranked by horse owners.
†COPD - chronic obstructive pulmonary disease.

Obviously, from a veterinary point of view, 'respiratory problems', 'lameness', 'foot problems', 'coughing' and 'joint problems' are too non-specific to constitute single diseases. Therefore, the data have been summarised in Table 63 in the same categories as were used to group veterinary practitioner diagnoses from phase III (Chapter 5.2.6).

Rank	Disease category
1	gastrointestinal
2	musculoskeletal
3	respiratory
4	miscellaneous
5	metabolic
6	dermatological
7	injuries
8	neoplastic

Table 63. Phase IV In depth survey of horse owners - the most important categories of disease affecting horses as ranked by horse owners.

6.3.2.2. Fact sheet data

6.3.2.2.1. Demographic data

A total of 1,264 fact sheets, providing detailed information about the management of individual animals, were returned from 366 horse owners. Summary statistics for the age and length of ownership of these animals are presented in Table 64:

	Age of animal (years)	Length of ownership (years)
mean	11.0	5.6
standard deviation	7.5	5.2
standard error	0.21	0.15
median	10	4
range	36.9	31.7
minimum	0.1	0.01
25th percentile	5	2
75th percentile	16	8
maximum	37	31.7
semi-interquartile range	5.5	3
mode	5	3
count of animals+	1260	1219

Table 64. Phase IV In depth survey of horse owners - summary statistics of age and length of ownership of animals.
+ the number of animals for which there was an entry in this category on the fact sheet

The mean ± SD age of animals was 11.0 ± 7.5 years (range 1 month - 37 years) and the mean ± SD length of ownership was 5.6 ± 5.2 years (range 1 week - 32 years). Summary statistics of age and length of ownership, stratified by practice number (geographical location) and activity grouping are presented in Appendices 23 and 24 and the age data are summarised in Tables 65 and 66:

Practice number	Region	Mean ± SD age (years)
2	Borders	12.1 ± 8.2
3	Northumberland	10.1 ± 7.1
4	Grampian	12.6 ± 7.5
6	Durham	12.7 ± 7.6
8	Fife	11.8 ± 7.3
9	Strathclyde	10.7 ± 5.9
11	Grampian	9.5 ± 6.9
12	Strathclyde	12.0 ± 7.5
16	Cumbria	7.0 ± 6.0
17	Lothian	14.5 ± 7.0
18	Borders	11.4 ± 7.8
19	Grampian	10.7 ± 6.8
20	Orkney	11.2 ± 8.7
21	Strathclyde	13.7 ± 6.6
22	Strathclyde	11.2 ± 6.1
24	Dumfries & Galloway	12.1 ± 7.5
25	Strathclyde	10.1 ± 7.8

Table 65. Phase IV In depth survey of horse owners - summary statistics of age stratified by practice affiliation.

The highest mean age, 14.5 years, was found in horses affiliated to practice 17 (Lothian), whilst the lowest, 7.0 years, was found in horses affiliated to practice 16 (Cumbria). The difference between the mean ages of animals affiliated with each practice was tested using a one way ANOVA test (Clarke and Cooke, 1992) followed by a Newman-Keuls multiple range test (Winer *et al.*, 1991). Only the mean ages of horses registered with practices 16 and 17 were significantly different ($p<0.001$).

Activity grouping	Mean ± SD age (years)
breeding	11.0 ± 6.1
companion/retired	18.3 ± 8.4
dressage	10.2 ± 5.0
driving	9.5 ± 5.4
endurance riding	12.0 ± 4.8
hacking	12.6 ± 6.1
horse trials/eventing	10.9 ± 5.2
hunting	11.2 ± 4.1
point-to-point	8.1 ± 2.8
racing	7.2 ± 3.9
riding/pony club events	12.0 ± 5.8
show jumping	11.6 ± 5.6
showing	7.6 ± 5.7

Table 66. Phase IV In depth survey of horse owners - summary statistics of age stratified by activity grouping.

The oldest mean age of horses was found, not surprisingly, in companion/retired animals followed by those used for hacking. The youngest mean age of horses was found among those animals involved in racing, showing and point-to-pointing. It was not possible to test the statistical significance of these observed differences, as the categories for level of activity are not mutually exclusive.

The distribution of animals by gender is presented in Table 67:

Gender	Percentage of horses kept (± 95% CI)
gelding	46 (± 3)
mare	50 (± 3)
stallion	4 (± 1)

Table 67. Phase IV In depth survey of horse owners - distribution of animals by gender.

Of a total of 51 entire male animals, only 14 (1% of the total population) were over 3 years of age. Figure 26 shows a population pyramid which demonstrates the age/sex structure of the population of animals involved in phase IV of the study.

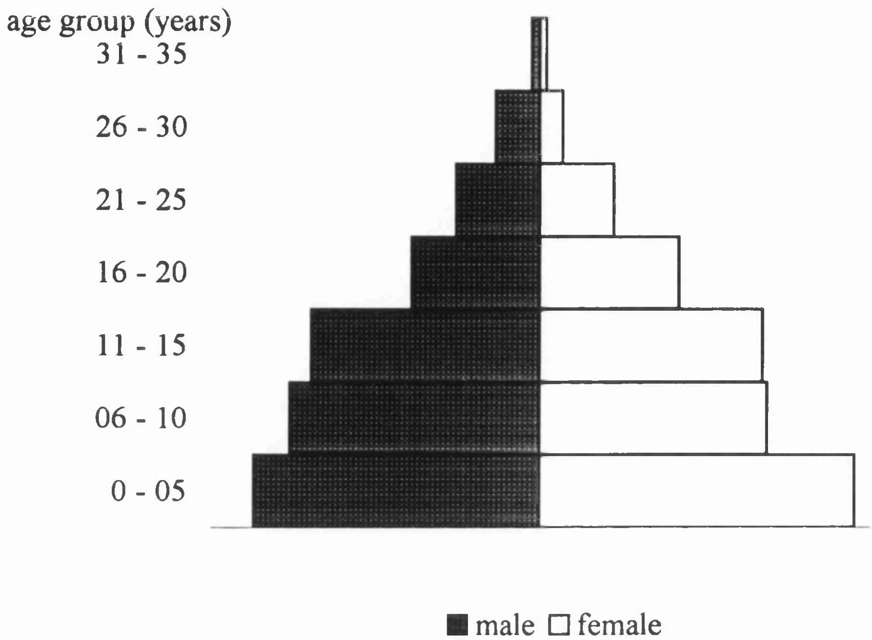


Figure 26. Phase IV In depth survey of horse owners - population pyramid demonstrating the age/sex structure of the population.

Subjectively, there appears to be a marked reduction in the female population between the 0 - 5 years and the 6 - 10 years age groups, and in the population overall between 11 - 15 and 16 - 20 years. The size of the population appears very stable between 6 and 15 years of age with very little apparent change in numbers. There appear to be more male than female animals older than 26 years of age. There was no statistically significant difference between the mean age of male and female animals ($p = 0.32$), or between the proportion of male and female animals in each age group presented in Figure 26 ($p = 0.32$).

The composition of the study population in terms of in terms of breed or type and coat colour are summarised in Tables 68 and 69:

Breed or type	Percentage of horses kept (± 95% CI)
Thoroughbred or Thoroughbred X	30 (± 3)
Welsh or Welsh X	12 (± 2)
Irish Draught or Irish X	6 (± 1)
Arab or Arab X	6 (± 1)
Shetland or Shetland X	6 (± 1)
Cob or Cob X	5 (± 1)
Connemara or Connemara X	4 (± 1)
Highland or Highland X	4 (± 1)
Pony	4 (± 1)
Hunter	3 (± 1)
Warmblood or Warmblood X	3 (± 1)
Clydesdale or Clydesdale X	2 (± 1)
Hanoverian or Hanoverian X	2 (± 1)
Part-bred	2 (± 1)
Dartmoor	1 (± 1)
Fell	1 (± 1)
Quarter Horse	1 (± 1)
Donkey	1 (± 1)
Cleveland Bay	1 (± 1)
other breeds and types	6 (± 1)

Table 68. Phase IV In depth survey of horse owners - distribution of animals by breed or type.

Coat colour	Percentage of horses kept(± 95% CI)
Bay	38 (± 3)
Chestnut	19 (± 2)
Grey	16 (± 2)
Black	5 (± 1)
Brown	5 (± 1)
Dun	5 (± 1)
Roan	3 (± 1)
Skewbald	2 (± 1)
Palomino	2 (± 1)
Piebald	2 (± 1)
Appaloosa	1 (± 1)
not recorded	2 (± 1)

Table 69. Phase IV In depth survey of horse owners - distribution of animals by coat colour.

6.3.2.2.2. Grazing and stabling

Details of grazing and stabling management are summarised in Tables 70 to 75:

Grazing April - September	Night / day	Mean time grazing (hrs)	SD time grazing (hrs)	Percentage of animals (± 95% CI)
always	both	24		**61** (± 3)
sometimes	day	9.1	3.9	**26** (± 2)
sometimes	night	13.6	3.7	**11** (± 2)
never	neither	0		**1** (± 1)

Table 70. Phase IV In depth survey of horse owners - summer grazing.

Grazing October - March	Night / day	Mean time grazing (hrs)	SD time grazing (hrs)	Percentage of animals (± 95% CI)
always	both	24		**25** (± 2)
sometimes	day	6.9	2.8	**68** (± 3)
sometimes	night	11.1	2.7	**3** (± 1)
never	neither	0		**4** (± 1)

Table 71. Phase IV In depth survey of horse owners - winter grazing.

Graze alone / with other animals	Percentage of animals (± 95% CI)
alone	**6** (± 1)
either	**1** (± 1)
others	**93** (± 1)

Table 72. Phase IV In depth survey of horse owners - percentage of the study population which graze alone or with other equine animals.

Overall, 306 animals (24% of the study population) were always grazed in both winter and summer, and only 6 animals (<1% of the study population) were never grazed.

Stabling April - September	Night / day	Mean time stabled (hrs)	SD time stabled (hrs)	Percentage of animals (± 95% CI)
always	both	24		**5** (± 1)
sometimes	day	7.3	3.9	**20** (± 2)
sometimes	night	14.7	3.2	**26** (± 2)
never	neither	0		**49** (± 3)

Table 73. Phase IV In depth survey of horse owners - summer stabling.

Stabling October - March	Night / day	Mean time stabled (hrs)	SD time stabled (hrs)	Percentage of animals (± 95% CI)
always	both	24		**10** (± 2)
sometimes	day	11.1	5.5	**4** (± 1)
sometimes	night	16.2	6.3	**64** (± 3)
never	neither	0		**22** (± 2)

Table 74. Phase IV In depth survey of horse owners - winter stabling.

Overall, 53 animals (4% of the study population) were always stabled in both winter and summer, and 245 animals (19% of the study population) were never stabled. The type of bedding material used for those 1,019 horses (81% of the study population) that were stabled, is summarised in Table 75:

Bedding type	Percentage of animals which are stabled (± 95% CI)
straw	**50** (± 3)
shavings	**34** (± 3)
combination	**6** (± 1)
sawdust	**4** (± 1)
paper	**4** (± 1)
rubber matting	**1** (± 1)
peat	**<1** -
other	**1** (± 1)

Table 75. Phase IV In depth survey of horse owners - type of bedding used for horses which are stabled.

The discrepancy between <1% of the study population being never grazed and 4% of the study population being always stabled is explained by the fact that some owners occasionally turn an animal out for 'a couple of hours on sunny days'. Similarly, the discrepancy between 30% of the study population which are always grazed and 19% which are never stabled is explained by the fact that some owners occasionally stable an animal, usually for the night before a show or competition.

6.3.2.2.3. Feeding details

Details of the feeding of animals in the study population are presented in Table 76 broken down by practice affiliation and in Table 77 broken down by activity grouping. These results are summarised in Table 78:

Feed	Overall percentage of animals receiving feed (± 95% CI)	Range (by practice) of the percentage of animals receiving feed		Range (by activity grouping) of the percentage of animals receiving feed	
hay	**87** (± 2)	33	practice 9 (Strathclyde)	78	point-to-point
		100	practice 21 (Strathclyde)	96	showjumping
haylage/ silage	**18** (± 2)	0	practice 9 (Strathclyde)	12	showjumping
		50	practice 22 (Strathclyde)	46	driving
bran	**18** (± 2)	0	practice 17 (Lothian)	9	driving
		45	practice 21 (Strathclyde)	50	racing
nuts (any brand)	**42** (± 3)	6	practice 8 (Fife)	11	driving
		88	practice 9 (Strathclyde)	63	racing
sugar beet pulp	**64** (± 3)	29	practice 9 (Strathclyde)	22	point-to-point
		100	practice 17 (Lothian)	78	dressage
coarse mix	**60** (± 3)	13	practice 9 (Strathclyde)	43	driving
		100	practice 22 (Strathclyde)	83	endurance riding
oats	**24** (± 2)	0	practice 17 (Lothian)	17	hacking
		42	practice 3 (Northumberland)	94	point-to-point

Table 78. Phase IV In depth survey of horse owners - summary of the percentage of horses receiving different feeds.

It can be seen from Table 77 that a higher percentage of horses involved in more strenuous activities such as racing and point-to-point receive energy dense feeds such as oats and that a lower percentage of animals involved in these activities are fed lower energy content feeds such as hay or haylage/silage. Entries in the three 'other' categories from the feeding section of the fact sheet (Appendix 19) are summarised in Table 79:

Practice number	Number of animals	Percentage of animals fed hay	Percentage of animals fed haylage / silage	Percentage of animals fed bran	Percentage of animals fed nuts	Percentage of animals fed sugar beet pulp	Percentage of animals fed coarse mix	Percentage of animals fed oats
2	68	97	21	22	54	54	78	32
3	78	90	12	23	31	64	59	42
4	46	80	22	2	30	78	72	7
6	145	89	21	23	54	61	65	24
8	31	94	19	13	6	48	68	16
9	24	33	0	13	88	29	13	0
11	171	82	26	24	15	73	72	20
12	90	84	13	24	52	54	59	28
16	36	94	6	6	14	94	83	8
17	14	100	29	0	7	100	71	7
18	83	92	14	24	45	46	84	34
19	43	95	5	28	44	56	42	19
20	13	62	23	0	54	69	46	0
21	22	100	14	45	55	68	68	18
22	6	67	50	0	33	100	100	0
24	89	99	7	16	58	65	39	15
25	303	85	20	10	49	68	45	29
count	overall	overall	overall	overall	overall	overall	overall	overall
17	1264	87	18	18	42	64	60	24

Table 76. Phase IV In depth survey of horse owners - details of feeding by practice affiliation.
The shaded cells highlight the practice with the highest (dark) and lowest (light) percentage of the study population receiving each type of feed - where there are two or more practices the same, the practice with largest number of horses affiliated to it is highlighted.

Activity grouping	Number of animals	Percentage of animals fed hay	Percentage of animals fed haylage/silage	Percentage of animals fed bran	Percentage of animals fed nuts	Percentage of animals fed sugar beet pulp	Percentage of animals fed coarse mix	Percentage of animals fed oats
breeding	208	81	22	16	35	67	63	30
companion/retired	195	87	18	27	42	60	59	19
dressage	166	95	21	17	37	78	73	29
driving	35	94	46	9	11	54	43	37
endurance riding	34	88	21	24	38	68	88	32
hacking	576	91	16	16	46	69	64	17
horse trials/eventing	132	93	17	17	40	72	80	32
hunting	118	91	24	27	52	53	59	53
point-to-point	18	78	44	22	50	22	44	94
racing	30	87	30	50	63	50	57	87
riding/pony club events	306	92	20	17	40	66	65	18
showing	238	90	17	15	45	65	70	19
showjumping	209	96	12	18	40	75	73	22
count	**overall**	**overall**	**overall**	**overall**	**overall**	**overall**	**overall**	**overall**
13	**1264**	**87**	**18**	**18**	**42**	**64**	**60**	**24**

Table 77. Phase IV In depth survey of horse owners - details of feeding by activity grouping.
The shaded cells highlight the activity grouping with the highest (dark) and lowest (light) percentage of the study population receiving each type of feed - where there are two or more practices the same, the practice with largest number of horses affiliated to it is highlighted.

Feed type	Percentage of animals receiving feed type on a regular basis (± 95% CI)
chaff/mollassed chaff/fibre preparations	**38** (± 3)
barley preparations	**18** (± 2)
vitamin/mineral supplements	**12** (± 2)
garlic	**5** (± 1)
carrots	**3** (± 1)
miscellaneous mixes	**3** (± 1)
maize preparations	**3** (± 1)
grass nuts and other conserved forage	**2** (± 1)
young animal preparations	**2** (± 1)
stud/breeding mixes	**2** (± 1)
succulents (turnips and swedes)	**2** (± 1)
seaweed	**2** (± 1)
apples	**1** (± 1)
other	**4** (± 1)

Table 79. Phase IV In depth survey of horse owners - summary of the percentage of horses receiving different feeds appearing in the 'other' category of the feeding section of fact sheets.

6.3.2.2.4. Activity grouping data

The percentage of the study population involved in each of the activity groupings listed in question 5 of the fact sheet (Appendix 19) are presented in Table 80:

Activity grouping	Percentage of animals involved (± 95% CI)
hacking	46 (± 3)
riding/pony club events	24 (± 2)
showing	19 (± 2)
showjumping	17 (± 2)
breeding	16 (± 2)
companion/retired	15 (± 2)
dressage	13 (± 2)
horse trials/eventing	10 (± 2)
hunting	9 (± 2)
driving	3 (± 1)
endurance riding	3 (± 1)
racing	2 (± 1)
point-to-point	1 (± 1)

Table 80. Phase IV In depth survey of horse owners - summary of the percentage of horses involved in different activities.

Hacking was the most popular activity with 46% of the study population involved, followed by riding/pony club events, showing and showjumping.

There were 258 entries in the 'other' category for question 5 on the fact sheet (Appendix 19). One hundred and fifty four animals (12% of the study population) were recorded as youngstock, and 64 animals (5% of the study population) were used in riding schools or for teaching people to ride. All of the remaining activities cited involved fewer than 5 animals.

6.3.2.2.5. Health maintenance data

Summary statistics for shoeing, vaccination, worming and the length of time since last attended by a veterinary surgeon (for any reason) for all animals are presented in Table 81:

	Shoeing rate (times / year)	Vaccination rate (times / year)	Worming rate (times / year)	Last seen by a veterinary surgeon (days ago)
mean	5.0	0.80	6.3	186
standard deviation	6.0	0.41	2.4	235
standard error	0.13	0.01	0.07	7.1
median	7	1	7	124
range	52	3	13	2552
minimum	0	0	0	3
25^{th} percentile	0	1	4	62
75^{th} percentile	9	1	8	240
maximum	52	3	13	2555
semi-interquartile range	4.5	0	2	89
mode	0	1	7	124
count of animals^{+}	1256	1258	1260	1081

Table 81. Phase IV In depth survey of horse owners - summary statistics of shoeing, vaccination, worming and the length of time since last attended by a veterinary surgeon (for any reason).

$^{+}$ the number of animals for which there was an entry in this category on the fact sheet

Summary statistics of shoeing, vaccination, worming and the length of time since last attended by a veterinary surgeon, stratified by practice number (geographical location) and activity grouping, are presented in Appendices 23 and 24.

The overall mean ± SD shoeing rate was 5.0 ± 6.0 times a year with 40% of all animals in the study reported not to be shod at all. The highest mean ± SD shoeing rates were: 9.8 ± 1.7 times/year, found among animals registered with practice 22 (Strathclyde) and, 9.4 ± 2.0 times/year among animals involved in point-to-pointing. In contrast the lowest mean ± SD shoeing rates were: 2.5 ± 4.1 times/year, found among animals registered with practice 9 (Strathclyde) and, 1.9 ± 3.3 times/year among companion/retired animals.

The overall mean ± SD vaccination rate was 0.80 ± 0.41 times a year with 17% of all animals in the study reported not to be vaccinated at all. The highest mean ± SD vaccination rates were: 0.97 ± 0.28 times/year, found among animals registered with practice 3 (Northumberland) and, 1.0 ± 0.26 times/year among animals involved in endurance riding, point-to-pointing and racing. In contrast the lowest mean ± SD vaccination rates were: 0.29 ± 0.62 times/year, found among animals registered with practice 9 (Strathclyde) and, 0.64 ± 0.48 times/year among companion/retired animals.

The overall mean ± SD worming rate was 6.3 ± 2.4 times a year with only 1% of all animals in the study reported not to be wormed at all. The highest mean ± SD worming rates were: 8.3 ± 1.4 times/year, found among animals registered with practice 9 (Strathclyde) and, 6.9 ± 2.2 times/year among animals involved in showing. In contrast the lowest mean ± SD worming rates were: 5.1 ± 2.4 times/year, found among animals registered with practices 8 (Fife) and 24 (Dumfries & Galloway) and, 4.4 ± 2.9 times/year among animals involved in point-to-pointing.

Three hundred and sixty six animals (29% of the total study population) were reported to suffer from permanent or recurrent disease problems and of these, 79 animals (6% of the total study population) were reported to suffer from more than one problem. The percentage of the study population suffering from different permanent or recurrent disease problems is presented in Table 82:

Condition	Overall percentage of animals (± 95% CI)
joint problems	6 (± 1)
laminitis	5 (± 1)
COPD†	4 (± 1)
non-specific foot problems	3 (± 1)
non-specific skin problems	2 (± 1)
sweet itch	2 (± 1)
non-specific respiratory problems	2 (± 1)
navicular disease	2 (± 1)
back problems	1 (± 1)
tendon/ligament problems	1 (± 1)
ocular problems	1 (± 1)
non-specific musculoskeletal problems	1 (± 1)
miscellaneous diseases/problems	1 (± 1)
colic	<1 -
non-specific gastrointestinal problems	<1 -
non-specific metabolic problems	<1 -
stable vices	<1 -
melanomas	<1 -
mud fever	<1 -
Cushing's disease	<1 -
heart murmur	<1 -
sarcoids	<1 -
EER*	<1 -
dental problems	<1 -
infertility	<1 -

Table 82. Phase IV In depth survey of horse owners - percentage of horses in the study population suffering from permanent or recurrent disease problems.
†COPD - chronic obstructive pulmonary disease.
*EER - equine exertional rhabdomyolysis

The data from Table 82 have been collapsed into categories of disease, as used in phase III, for the purposes of comparison of results between different phases of the study and are presented in Table 83:

Category	Overall percentage of animals (± 95% CI)
musculoskeletal	**19** (± 2)
respiratory	**6** (± 1)
dermatological	**5** (± 1)
miscellaneous	**3** (± 1)
gastrointestinal	**1** (± 1)
metabolic	**1** (± 1)
reproductive	**<1** -

Table 83. Phase IV In depth survey of horse owners - percentage of horses in the study population suffering from permanent or recurrent disease problems collapsed into categories of disease.

Of the total 1,264 animals involved in the current study, 173 (14%) were reported never to have been seen by a veterinary surgeon whilst in the possession of the current owner (mean ± SD = 5.6 ± 6.0 years). Summary statistics for the length of time in days since last attended by a veterinary surgeon are presented in Table 81, and also by practice affiliation and activity grouping in Appendices 23 and 24. The overall mean ± SD length of time since last attended by a veterinary surgeon was 186 ± 235 days. The longest mean times since last attended by a veterinary surgeon were, 249 ± 281 days, found among animals registered with practice 2 (Borders) and, 372 ± 551 days among animals involved in driving. In contrast, the shortest mean times since last attended by a veterinary surgeon, 100 ± 64 days, found among animals registered with practice 17 (Lothian) and, 133 ± 175 days among animals involved in point-to-pointing. The percentage of those animals that were attended by veterinary surgeon for different reasons are presented in Table 84 and summarised by disease category in Table 85:

Reason last seen by a veterinary surgeon	Percentage of animals attended (± 95% CI)
vaccination	46 (± 3)
routine teeth rasping	9 (± 2)
traumatic injuries	7 (± 1)
non-specific musculoskeletal problems	4 (± 1)
pregnancy diagnosis	3 (± 1)
post foaling check	3 (± 1)
non-specific respiratory problems	3 (± 1)
non-specific skin problems	2 (± 1)
laminitis	2 (± 1)
colic	2 (± 1)
foaling	2 (± 1)
non-specific reproductive problems	2 (± 1)
tendon/ligament problems	2 (± 1)
miscellaneous diseases/problems	2 (± 1)
foot abscess	1 (± 1)
routine certification	1 (± 1)
castration	1 (± 1)
joint problems	1 (± 1)
routine reproductive procedures	1 (± 1)
non-specific foot problems	1 (± 1)
routine health checks	<1 -
ocular problems	<1 -
non-specific gastrointestinal problems	<1 -
routine pre-purchase examination	<1 -
non-specific metabolic problems	<1 -
dental problems	<1 -
back problems	<1 -

Table 84. Phase IV In depth survey of horse owners - percentage of horses attended by a veterinary surgeon for different reasons.

Category	Percentage of animals attended (± 95% CI)
routine	63 (± 3)
musculoskeletal	12 (± 2)
traumatic injuries	7 (± 1)
reproductive	6 (± 1)
miscellaneous	3 (± 1)
gastrointestinal	3 (± 1)
respiratory	3 (± 1)
dermatological	2 (± 1)
metabolic	1 (± 1)

Table 85. Phase IV In depth survey of horse owners - percentage of horses attended by a veterinary surgeon for different reasons collapsed into categories of consultation.

6.3.2.2.5. Insurance data

Data from the current study showed that 70% of horse owners insured one or more of their animals. A total of 488 animals (39% of the study population) were insured. Details of the insurance cover for these animals are presented in Table 86:

Insurance cover	Overall percentage of the study population covered (± 95% CI)
death	34 (± 3)
theft	33 (± 3)
vets fees	22 (± 2)
loss of use	15 (± 2)
third party	10 (± 2)

Table 86. Phase IV In depth survey of horse owners - details of insurance cover on horses.

6.3.3. Summary

Respondents to this phase of the study kept a mean ± SD of 3.4 ± 3.5 animals. The mean ± SD age of these animals was 11.0 ± 7.5 years, with Thoroughbred or Thoroughbred X breed type being the most common comprising 30% of the study population. Fifty seven per cent of owners, owning 68% of animals in the study population, kept their animals at home. Twenty four percent of animals, owned by 39% of owners were kept at premises a mean ± SD distance of 5.2 ± 8.9 miles from home. Fifty five per cent of owners, owning

63% of animals in the study population, kept their animals on private premises whereas 35% of animals belonging to 44% of owners were kept on premises shared with animals belonging to other people. Less than 1% of the study population were never grazed, and 93% of the population usually grazed with other animals. The majority of animals spent more than half their time grazing. When animals were stabled, most commonly at night in the winter months, straw was used as bedding for 50% of animals and shavings for another 34%. Hay was the commonest supplementary feed used, which was regularly fed to 87% of animals in the study population. Subjectively, a higher percentage of animals involved in more strenuous activities were fed more energy dense feeds such as oats. The mean ± SD shoeing rate was 5.0 ± 6.0 times per year. The mean ± SD vaccination rate was 0.80 ± 0.41 times per year. The mean ± SD worming rate was 6.3 ± 2.4 times per year. The mean ± SD time elapsed since an animal was last attended by a veterinary surgeon was 186 ± 235 days, and in 46 % of cases this was for vaccination. Twenty nine per cent of the study population were reported to suffer from permanent or recurrent disease problems of which 66% were musculoskeletal. Despite this, horse owners ranked gastrointestinal problems above musculoskeletal and respiratory problems as the most important causes of equine disease. Thirty nine per cent of animals were covered by some form of insurance.

6.4. DISCUSSION AND COMPARISON WITH PREVIOUS PHASES OF THE STUDY

6.4.1. Response

The response to phase IV of The Home of Rest for Horses Study of Equine Welfare was 71%, which was as anticipated in the design of the study (Chapter 6.2.2). This meant that a total of 156 horse owners did not respond, despite having indicated their willingness to do so in their responses to phase II of the study. Table 87 compares the profile of responders and non-responders to phase IV in terms of their responses to phase II:

		Responders	Non-responders
	mean ± SD animals/owner	3.7 ± 3.3	4.2 ± 4.0
% owners keeping their animals in:	private premises	54	57
	shared premises	46	43
% animals kept:	mostly stabled	24	36
	mostly grazed	46	41
	half stabled/half grazed	20	16
	always stabled	1	1
	always grazed	8	6
% animals involved in:	racing	2	5
	horse trials/eventing	9	10
	showjumping	12	14
	point-to-pointing	1	3
	endurance riding	2	1
	driving	4	3
	showing	17	13
	hunting	11	9
	riding/pony club events	24	21
	hacking	31	22
	companion/retired	10	8
	breeding	18	21
	other	17	14

Table 87. Phase IV In depth survey of horse owners - a comparison of the profiles of responders and non-responders to phase IV in terms of their response to phase II.

It can be seen from Table 87 that the mean number of animals per owner was slightly higher among non-responders, though this is not a statistically significant difference (p = 0.12). Owners who kept larger numbers of animals would have been required to complete more fact sheets, and this may have discouraged some from responding. However, one respondent completed fact sheets for 39 animals, and several others for around 20 animals, so that the extra perceived time commitment cannot have been sufficient to discourage all owners of large numbers of animals. In terms of management, owners who kept their animals mostly stabled appear to have been less likely to respond, though it is impossible to suggest an explanation for this. Generally, there is close agreement between the activity grouping profiles of animals belonging to responders and non-responders, though subjectively, owners with animals involved in racing appear to have been less likely to respond, whereas owners of animals involved in hacking appear to have been more likely to respond. A possible explanation for this could be that, as racing is a seriously competitive sport, owners of racehorses may be less willing to disclose precise details of the feeding and management of their animals. Furthermore, racing animals represent a business investment for many people and racehorse owners and trainers may have been too busy to complete questionnaires and fact sheets.

The length of time elapsing between phases II and IV, and the change in the number of animals kept over that time are presented in Table 88. The mean ± SD elapsed time between phases II and IV was 623 ± 251 days (20 ± 8 months). Over this time there was a statistically significant ($p = 0.003$) apparent 4% reduction in the total number of animals kept, which is contrary to the apparent 8% annual increase suggested from inspection of figures from the MAFF annual census (The Scottish Office Agriculture, Environment and Fisheries Department, 1996a; Chapter 1.5.6). The apparent 4% reduction seen in the current study is likely to be erroneous, as study subjects involved in phase IV were only mailed as many fact sheets as the number of horses they said they owned in their responses to phase II. Owners who kept more horses at the time of phase IV than phase II, would have had to request that extra fact sheets be mailed to them, and then spend extra time completing them. Given these circumstances, it would have been unlikely for owners to report that they kept more horses in phase IV and indeed, only one owner requested extra fact sheets though a small number of others did photocopy their own sheets to provide the extra required. Furthermore, the shape of the population pyramid (Figure 26) resembles what would be expected for the human population of a developing country and suggests a growing population.

The author is aware of only one published study of this nature involving horses, but response rates were not given (Underhill and Showalter, 1989). Dohoo *et al.* (1985) conducted a similar study among sheep farmers and reported a 74.4% response rate, though only 38.5% of study subjects returned all the survey forms. Response rates to questionnaire surveys of animal owners have been discussed in detail in Chapter 4.4.1.

Practice number	Responding owners (phase IV)	Animals owned (phase II)	Time delay phases II to IV (days)	Animals owned (phase IV)	Change in no. of animals phases II to IV	Percentage change in number of animals / year	Overall response rate phase IV, (%)
2	18	67	706	59	-8	-6	64
3	19	94	424	74	-20	-18	76
4	18	41	594	38	-3	-7	77
6	34	168	598	138	-30	-18	72
8	13	33	237	31	-2	-6	82
9	5	22	558	24	2	9	63
10	2	2	866	2	0	0	100
11	51	166	704	172	6	4	71
12	29	92	822	93	1	0	67
16	9	37	291	36	-1	-3	60
17	6	17	875	12	-5	-30	44
18	25	92	392	83	-9	-10	54
19	10	50	822	43	-7	-14	100
20	4	13	866	13	0	0	57
21	11	22	809	22	0	0	52
22	5	10	866	6	-4	-40	83
24	21	98	743	89	-9	-9	75
25	85	305	48	296	-9	-22	85
count	**sum**	**sum**	**mean ± SD**	**sum**	**overall**	**overall**	**overall**
18	365	1329	623 ± 251	1231	-98	-4	71

Table 88. Phase IV In depth survey of horse owners - details of the time elapsed and the change in number of animals kept between phases II and IV.

6.4.2. Population

Comparison of data from phases III and IV, shows that the mean ± SD age of the general equine population (11.0 ± 7.5 years) was significantly greater ($p<0.001$) than that of animals attended by a veterinary surgeon (9.3 ± 6.4 years). Comparison on the basis of breed or type, gender and coat colour between phases III and IV suggests little or no difference in the distribution of these variables throughout the general population and those animals attended by a veterinary surgeon (Tables 39, 40, 41, 67, 68 and 69).

6.4.3. Health Maintenance

An overall mean ± SD shoeing rate of 5.0 ± 6.0 times per year would approximate to an animal being shod every ten weeks, which would generally be considered too long an interval. However, since 40% of animals in the study were reported not to be shod at all, the true rate among animals which were shod would approximate to once every six weeks which would be a more acceptable figure. This does not take into account lower rates of shoeing which may have been reported in animals which were only shod during part of the year. In retrospect, it would have been better to have asked a question about the frequency of shoeing and/or foot trimming. Kaneene *et al.* (1996) reported a mean rate of farrier work, including both shoeing and trimming, of 3.2 times per year in Michigan operations. In the American study, trimming was found to be more common than shoeing, though even the combined rate quoted above is considerably less than that found in the current study.

The apparent mean ± SD vaccination rate of 0.80 ± 0.41 times per year agrees well with that (0.80 ± 0.37 doses per animal year) reported by veterinary practices in phase Ia (Chapter 3.6). This rate could be considered to be too low, as an annual booster against influenza would be the minimum recommendation in the majority of cases. However, since 17% of animals were reported not to be vaccinated at all, the true rate among animals which were vaccinated would approximate to one dose per animal per year. Therefore, it appears as though those horse owners that do vaccinate their animals, do so at, or close to, the recommended frequency. The reasons for an owner choosing not to vaccinate an animal are not recorded by this study. Comparison with the American study by Kaneene *et al.* (1996), is less straightforward, as vaccinations against Potomac Horse Fever, encephalitis and rabies are reported in addition to vaccinations against respiratory disease and tetanus, and there are different recommendations for the frequency of vaccination in the USA.

The apparent mean ± SD worming rate of 6.3 ± 2.4 doses would approximate to one dose every eight weeks. This is markedly higher than the rate of 1.3 ± 1.0 doses per animal per year quoted by veterinary practitioners in phase Ia (Chapter 3.6), and appears to support the argument that the majority of anthelmintic preparations for use in horses are purchased from non-veterinary practice suppliers (Chapter 3.6). Since only 1% of animals were reported not to be wormed at all, the rate quoted above is likely to be a good estimate of the true rate. Though the current study does not examine worming practice in detail, and in particular does not record the different anthelmintic preparations used, which can influence the recommended frequency of treatment, a rate of one treatment every eight weeks would generally be considered too low. This finding is in keeping with those reported by Baker (1994) from three independent surveys of horse worming practices involving nearly 800 horse owners, which found that 63% of owners wormed every 6 to 8 weeks, 7% at 10 week intervals, 20% every three months and 10% varying widely between more frequently than every 6 weeks to less frequently than every three months to not at all. Kaneene *et al.* (1996) reported a mean annual worming rate of 2.6 treatments per animal compared with an absolute minimum recommendation of 3 treatments per animal per year in the USA, again suggesting that equine animals receive anthelmintic treatments at below recommended rates.

6.4.4. Disease

The mean ± SD number of non-routine veterinary visits per horse kept per year was 0.88 ± 1.1. In other words, on average, a horse would be attended by a veterinary surgeon for a non-routine consultation approximately once every fourteen months. Combining this rate with data from phase III for discrete disease entities, the annual incidence in terms of the percentage of the population diagnosed as new cases per year, excluding revisits, can be estimated and is presented in Table 89:

Disease	**Incidence (percentage of the population affected per year)**
foot abscess	4.8
laminitis	2.5
sporadic/non-specific colic	2.1
viral upper respiratory tract disease	1.4
COPD†	0.9
large intestinal impaction colic	0.9
dental problems	0.9
sporadic lymphangitis	0.9
sarcoids	0.7

Table 89. Phase IV In depth study of horse owners - incidence of new cases of disease expressed as the percentage of the population affected per year.
†COPD - chronic obstructive pulmonary disease.

The mean ± SD time elapsing since the last veterinary visit to any animal for any reason was 186 ± 235 days, and 63% of these visits were reported to be for routine procedures. The reason reported for the last veterinary visit, may have been affected by recall bias which might have been expected to overestimate more dramatic disease incidents and underestimate routine procedures. However, since vaccination certificates are maintained for equine animals, vaccination may have been over represented as an accurate timing could be given.

There was close agreement between the ranking of the top three reasons for consultation reported in phase III and the ranking of the top three reasons for the last veterinary visit in phase IV (Tables 42 and 85). The differences between the percentage of animals attended for vaccination in these tables may be partially explained by the fact that animals which were seen by a veterinary surgeon for any reason were vaccinated approximately once per year, whereas animals were seen for non-routine consultations approximately once every fourteen months. Reproductive problems constituted a greater than expected percentage of the reasons of the last veterinary visit, and this may have been partially a seasonal effect as phase IV of the study was implemented at the end of the breeding season.

Approximately one third of the study population were reported to be affected with permanent or recurrent disease problems. The differences between the ranking of categories of diseases seen by a veterinary surgeon in phase III (Table 43) and categories of permanent or recurrent disease reported in phase IV (Table 83) may be partially explained by the chronic and/or recurrent nature of some disease problems, notably COPD, sweet itch, melanomas and sarcoids. Again, sweet itch may also be over reported in phase IV an effect of the season of the year in which this phase of the study was implemented.

Owner opinions as to the most important equine diseases (Tables 61 and 62) differ noticeably form those listed as the most common by veterinary surgeons in phase III (Chapter 6.3). The word 'important' in question 7 of the questionnaire (Appendix 18) was used deliberately rather than 'common' or 'frequent' since an owner would not be expected to have any knowledge of the relative frequency of diseases affecting horses. The appearance of grass sickness and colic as the first and third most important equine diseases, suggests that horse owners consider diseases with uncertain or unexplained aetiology and epidemiology, that often have a fatal outcome, to be the most important. Comparison of these results from the current study in Table 61 and the American study in Table 9 (Underhill and Showalter, 1989) shows good general agreement in the opinions of horse owners as to the most important equine diseases.

6.4.5. Conclusions

The results of this final phase of The Home of Rest for Horses Study of Equine Welfare have consolidated those from the previous three phases presented and discussed in Chapters 3, 4 and 5. Together, these surveys have provided a validated, comprehensive overview of the size, distribution and nature of the equine population of Scotland and Northern England and of the diseases from which its members suffer.

CHAPTER 7

CONCLUSIONS AND GENERAL DISCUSSION

A knowledge of the population size is essential for epidemiological studies in order to provide a denominator for the quantification of disease rates. Furthermore, when considering diseases, especially infectious diseases, among specific groups of animals of the same and other species, knowledge of the size and proximity of reservoir populations is essential for assessments of disease transmission and persistence. In this study, through a series of mailed questionnaire studies of veterinarians and horse owners, the equine population of Scotland and Northern England was estimated at 96,622 animals kept by 26,114 owners. In addition, the geographical distribution of this population, by region (Scotland) and county (Northern England), was established. Since the last UK census of horses taken in 1934 (Urquhart, 1983), the annual agricultural census conducted by the Ministry of Agriculture, Fisheries and Food (MAFF) has provided the only published figures for the numbers of horses kept in Britain. However, these figures have inevitably been inaccurate estimates of the total equine population, as many horses are kept on land which is not used for commercial agricultural purposes. The current study has shown that, for the area covered at the time of the study, there appear to be more than three times the number of horses recorded in the MAFF census. The population estimate made in the current study is in general agreement with that of a survey conducted by the British Horse Society in the early 1990s (unpublished) in Scotland excluding the Highland region, Orkney, Shetland and the Western Isles.

Ministry figures have suggested an annual increase in the equine population size of approximately 8%, which is supported by some of the results of the present study, particularly when analysed as a population pyramid. The age, breed and sex distributions of the general equine population within any region of the UK, to the knowledge of the author, have not been previously reported.

The accuracy of the population estimate made in the present study may have been affected by various factors: First, although there was a 91% response to the census of veterinary practices, it remains unknown whether the practices sampled thereafter were representative of all practices in the region; secondly, in this study it was not possible to account for those animals belonging to people who were themselves not registered with any veterinary practice. The number of questionnaires returned marked 'addressee gone away' and from people who no longer owned horses, suggests that many practices do not delete old records from their client databases very often or at all, such that it would seem reasonable to assume that the great majority of horse owners had at some time been registered with a veterinary practice. If this was the case, then the proportion of the population missed by the study is likely to be small as all horse owners registered with participating practices were surveyed. In future, studies of this type might also take into account the records of farriers, as it may be argued that in the short term a greater proportion of horses will require the services of a farrier than of a veterinarian.

It is well recognised that management factors can affect the occurrence of disease (Gilmour and Jolly, 1974; Webster *et al.*, 1987; Clarke, 1989a, 1989b; Estberg *et al.*, 1995; Reid *et al.*, 1995; Reeves *et al.*, 1996). In this study, the percentages of the equine population experiencing different management practices and involved in different activities have been documented, and these novel data constitute baseline reference information which may be used in any future studies investigating the association of management factors with equine disease. The results show that the majority of equine animals are kept in groups, and that even where the animals belonging to one owner are kept on private premises, there is frequent mixing of animals, on average approximately once a month, at shows and competitions. These findings suggest that infectious and contagious diseases of horses, and control measures taken against them, will continue to be important. Rates of vaccination and worming recorded in the study would appear to be lower than recommended rates, and there may be a need to increase owner awareness of adequate equine preventive medicine practice.

By investigating the disease experience of the study population it was possible to identify the most important diseases which affected equine animals within the study area. These findings provided an overview of first opinion equine veterinary practice and reflected the relative importance of different categories of disease from which members of the study population suffered. Within the design of the current study, where the aims were to collect general information about all diseases, precise diagnoses were often not recorded so that the conclusions which could be drawn about the relative importance of specific diseases were limited. However, where diagnoses of discrete disease entities were reported, estimates of the percentage of the study population affected annually were made.

A drawback of the current study was that management data for individual animals provided by horse owners could not be related directly to disease data for individual animals provided by veterinary practitioners. As a result, it was not possible to investigate the effects of management practices on individual disease problems with a veterinary diagnosis. Ideally, veterinary practitioners, for each of a number of separate equine consultations, would have completed a case sheet and, at the same time, supplied the owner with a questionnaire and fact sheets indicating which fact sheet was to be completed for the case animal. Thus, clinical and management data would have been provided for the case animal and management data could also have been provided for premises matched control animals, except in rare circumstances where the veterinarian attended a single animal kept alone. However, this would have required much closer collaboration with veterinary practices involved in the study and participation rates may have suffered as a result of the extra commitment required. The level of detail that could be provided by such a design would go beyond the requirements of the current study, but would be appropriate for more precise epidemiological investigations, concentrated on specific disease syndromes in particular geographical areas. Such focused studies could be based on the major findings of the current study which were:

i) musculoskeletal disease was the most prevalent category of equine disease comprising 28% of all consultations, in particular caused by foot abscesses, laminitis, joint, tendon and ligament problems;

ii) minor injuries were the second most common reason for non-routine veterinary attention to horses, comprising 10% of all consultations

iii) gastrointestinal disease (particularly colic), dermatological disease and respiratory disease (particularly COPD and upper respiratory tract infections especially in the central areas where a greater proportion of horses are kept in shared premises) were equally the third most prevalent categories of equine disease, each comprising approximately 6% of all consultations.

In general, the methods by which the results of this study were obtained can be said to have been successful. The response rates to all phases were comparable to, or better than, those reported in the majority of similar studies. Considerable planning of questionnaire design, presentation and distribution was undertaken and the attention to practical details of stationery, materials and printing style advocated from previous work appears to be justified (Dillman, 1978; Siemiatycki, 1979; Choi *et al.*, 1990; Vaillancourt *et al.* 1991; Bourque and Fielder, 1995). However, whilst the first owner survey served its purpose in gathering a large quantity of general information and recruiting a population of reliable responders to be sampled in a later phase of the study, an overall response rate of 40% was disappointing. The negative effect on response of changing from a stamped to a FREEPOST return envelope is in agreement with the findings of Choi *et al.* (1990). It is well known that response rates to mailed questionnaires can be improved by follow-up reminders either by mail or telephone (Dillman, 1978; Siemiatycki, 1979; Bourque and Fielder, 1995). This fact was demonstrated in the survey of all veterinary practices, when two follow-up mailings increased the overall response rate by 28%. In the interests of practice/client relations only one mailing was made to horse owners, but if follow-up mailings had been conducted response rates may have been higher.

Consideration must be given to the fact that there may have been a degree of information bias in the responses to questionnaires in this study, in that for example, veterinary practitioners may have reported diagnoses of which they could not be absolutely certain, or that horse owners reported higher rates of vaccination or worming than were actually practised. Within the scope of the current study however, it was impossible to control or account for these potential sources of error. Analysis and comparison of data from horse owners who responded twice to the first survey suggests that the results have a good level of repeatability. Taking this into account, and given the care with which samples were randomly chosen to be representative, it would appear to be reasonable to extrapolate the findings of this study to apply to the general equine population of the study area. Comparing responses by practitioners between veterinary practice surveys, and by horse owners between the first and second survey, there appears to be good overall agreement, but the time lag between phases makes interpretation of repeatability between phases difficult. Without data from other studies with which to compare, it is impossible to assess the accuracy and validity of the results of the current study.

Unreliability of data, in particular diagnostic data, and poor participation rates have been cited as major drawbacks of sentinel practice based research (Slater and Boothe, 1995). Nevertheless, there are many advantages, the most important of which is that practising veterinarians have the greatest knowledge of disease occurrence in the general population, and only animal owners know how their animals are managed. The success of studies such as those reported by Proudman (1991), Barrett *et al.* (1992), Cohen, (1994), Cohen *et al.* (1995), Johnston *et al.* (1995), McGreevy et al, (1995a, 1995b), Slater *et al.* (1995) and Reeves *et al.* (1996) is evidence of the utility of this approach in the investigation of equine disease. However, it has been suggested that field veterinarians view themselves as data users rather than data gatherers (Kelton and Lissemore, 1997), and many look upon epidemiological research as esoteric and irrelevant to the practice situation (Green, 1997). However, amid increasing opposition to experimental studies from the animal welfare lobby, and the realisation that it may be impossible to extrapolate the findings of hospital based studies to the general population, the so-called Berkson's bias (Senturia *et al.*, 1994), research mediated through general practice must have an increasing role to play. If this is to be the case, there needs to be a closer relationship between academics and practitioners than has existed in the past. Academics in universities and research institutions have a duty to concentrate their investigations on the problems faced by those in veterinary practice. In turn, those in veterinary practice should realise that there is a price to pay for practical solutions to their problems and that they could collaborate closely with their academic colleagues in order to supply much needed, conscientiously collected information on a regular basis. Sentinel practice based research has been shown to be successful in human medicine and to achieve completeness and data accuracy at least as good as in other types of study (Green *et al.*, 1994). The current study is testament to the fact that the majority of veterinary practitioners, judging by the response rates, are interested and willing to take part in this type of research with no more incentive than a summary of the results at the end of the study. However, there is considerable room for improvement which might be achieved by introducing the concepts and merits of sentinel practice based research to veterinary students at the undergraduate level. Furthermore, as the Royal College of Veterinary Surgeons has recommended a minimum participation in formal continuing professional development for all practising veterinarians (Royal College of Veterinary Surgeons / British Veterinary Association, 1994), involvement in sentinel practice based research projects might be considered as part of this requirement.

In order to ensure maximum impact of sentinel practice based studies, the method and the medium by which information is fed back to practitioners is very important and must be provided in a timely manner in an appropriate, intuitive format to allow full utilisation in the busy environment of veterinary practice. For example, the results presented in this thesis are probably easiest to visualise and digest in a series of 'intelligent' maps in a computer programme where the reader or user can mouse click to zoom in on a point or region of interest and to reveal more detailed tabular or textual information. All of these features are available within the GIS that was used to produce the maps presented as figures in this thesis. In addition, there are other useful features such as the ability to zoom in and draw buffer zones of any size or shape around points or regions displayed in the map. A potential application for this feature would be in a situation where a new or exotic disease was identified on a premises and there was a need to undertake testing and restrict movements of animals within a certain radius. Such a situation, using data from the current study is presented in Figure 27. The user would be able to draw the buffer zone rapidly, in this hypothetical instance with a radius of five miles, identify from the database the premises involved and the number of animals kept on each. Of course, such a system would be much more useful if records for all premises where equine animals were kept were held in the database, rather than the sample that have been involved in the current study. The success of a similar approach combining GIS with expert systems and mathematical models dealing with foot and mouth disease outbreaks has been shown by Morris *et al.* (1993) and Nielen *et al.* (1996). Commercially available GIS are currently limited by the lack of embedded robust analytical statistical techniques to quantify time/space clustering of disease occurrence (Paterson, 1995). However, it could not be argued that veterinary practices required the full functionality of GIS: on the contrary this would be more likely to hinder the flow of information as the software is complex and requires specialist skills to operate. Nonetheless, the findings of the current study presented as 'intelligent' maps with additional, supplementary information would be useful to practitioners as evidenced by the positive response to the 'UK Disease Profiles' presented monthly in UK Vet magazine. The seamless combination, using hypertext as the unifying medium, of data from this study in the form of maps with electronic reference information, expert systems and mathematical models to assist in the diagnosis of disease and decision support modules to create EQuine Welfare Information System and Expert (EQWISE) has been described (Mellor *et al.*, 1994; Revie *et al.*, 1994; Mellor *et al.*, 1995; Reid *et al.*, 1996).

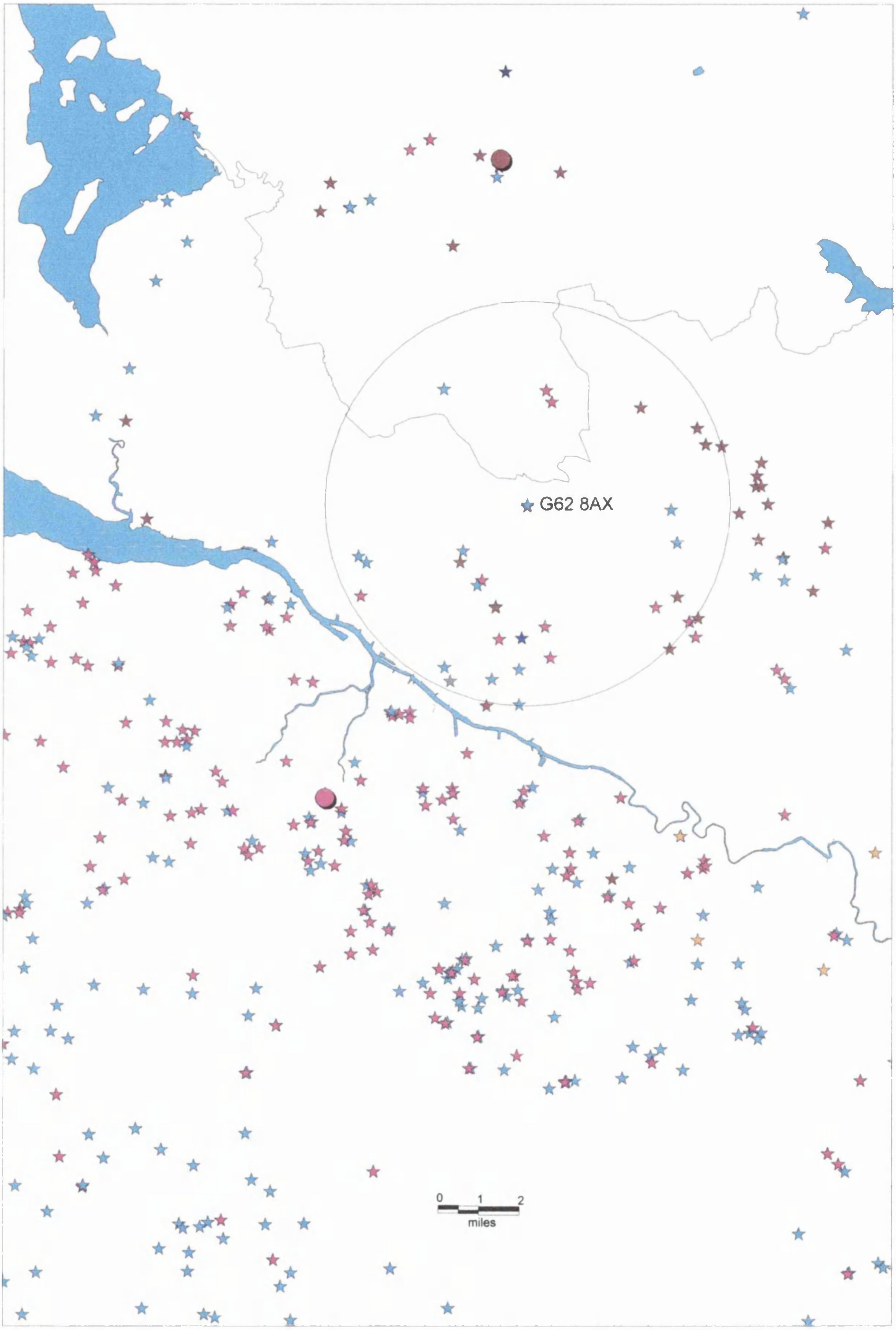


Figure 27. Map showing the potential application of Geographical Information Systems in outbreaks of infectious disease. Buffer zone of 5 miles radius around a premises where horses are kept.

The increasing number of veterinary practices which are equipped with computer facilities has been documented by Gerrard and Little (1994). Interrogation of EQWISE from a practice computer through, for example the Internet, would give a user access to a wide range of up-to-date information about equine disease including the latest research findings. With the increased computerisation of veterinary practice, recording of animals disease occurrence in the field using computerised survey forms, much like the paper forms used in the current study, feeding into a centrally maintained database could also be achieved via the Internet. In human medicine, reporting of laboratory isolates is already electronic in many instances through EPINET (the UK public health network) using a laboratory database system developed by the Public Health Laboratory Service (Salmon, 1997).

The current study, using the same methods, is already being extended to Northern Ireland, Wales and the rest of England. With the completion of the extended study there will exist a much more comprehensive database of information relating to the general British equine population than has ever been previously available. However, even this database will have some shortcomings as a result of the extended total time period of six years during which the information will have been collected. Although the current study showed good overall repeatability of results obtained approximately 18 months apart, there are likely to be changes in numbers of animals kept by individual horse owners over a six year period. Furthermore, and more importantly, patterns of disease may also change. Davies (1983) proposed that the conduct of repeated prevalence surveys was a cheaper method than continual surveillance for monitoring disease patterns in a population. By this argument, the current study, in some form, should be repeated at some time in the future. Comparison of the results of these and future studies will only then begin to suggest how, and perhaps why, both the equine population and also the pattern of equine diseases change over time. In the meantime, the results of the current study justify more precise, detailed studies on the epidemiology of laminitis, joint, tendon and ligament problems, colic, COPD and upper respiratory tract infectious disease (*vide supra*). In addition, consideration should be given to programmes designed to educate people responsible for horses in 'good management' and adequate equine preventive medical practises as it would appear that, despite heavy commercial advertising on aspects such as parasite prophylaxis and influenza vaccination, owners may not perform these tasks adequately. Eventually, it may be possible to provide improved information on such issues via the Internet with the increasing number of UK households having access to a home computer. In the meantime, popular equine journals and newsletters and meetings of equine societies, as well as continued advertising represent the best method of disseminating this information among horse owners

The future need for sentinel practice based research will almost certainly increase, and it seems likely that greater demand will be placed upon veterinary practitioners to complete survey forms and supply data to researchers. Under these circumstances, there are arguments for the creation of a single, creditable agency to regulate all research carried out through veterinary practitioners. The role of such an agency would be to screen proposed studies and match them to suitable practices, and to protect busy practices from the currently unregulated bombardment with questionnaires. If practices were protected in this way and given official credit for participating in such studies, rates of compliance and data quality would improve. In studies designed to investigate specific disease entities, additional consideration would need to be given to the issues of providing standard case definitions and financial support for laboratory diagnosis.

In the fullness of time, a situation may be imagined where all veterinary practices and diagnostic laboratories are fully computerised. Information from every case seen could be fed automatically into a central database, matched against existing records and feedback returned to the practitioner in the consulting room. Within the area in which this study was conducted, there are a total of 304 veterinary practices and at an estimated cost price of approximately £1,000 per practice to install the necessary computer hardware and software, the entire network could be set up for an initial cost of approximately £300,000.

The current study represents the first step towards a closer awareness of the British equine population as a whole. Knowledge generated by this and future studies of the same nature will increase understanding of all equine diseases leading to more accurate and efficient diagnosis, treatment and control, and continually improving standards of equine health and welfare.

APPENDIX 1

INITIAL CONTACT LETTER TO VETERINARY PRACTICES

<<name>>
<<practice name>>
<<address 1>>
<<address 2>>
<<town>>
<<county>>
<<postcode>>

UNIVERSITY
of
GLASGOW

<<date>>

Dear

Equine Informatics: A feasibility study

On behalf of The Home of Rest for Horses, we are undertaking an epidemiological study of equine diseases and disorders. One component of this project is a demographic census of horses, ponies and donkeys in Scotland and Northern England.

I write to ask for your help in this project. It is intended to perform a cross-sectional study of the equine population by questionnaire. In order to obtain a representative sample, I am contacting a number of practices which I hope can supply a list of clients who might be prepared to provide information on aspects of management and health of their animals. Also, some general information and your own opinions on relevant areas such as the prevalence of equine diseases or those conditions which have particular importance in relation to welfare would be appreciated.

The purpose of this study is to provide The Home of Rest for Horses with basic information on the relative importance of equine diseases as they occur in the UK with a view to assist them in directing their future research. Further, it will provide fundamental information for population health studies.

If, in principle, you are willing to participate in this project I will be pleased to provide details of the specific information we hope to collect and by what means the study will be conducted. At this stage I wish to emphasise that, at all times, professional confidentiality will be maintained.

I will contact you by telephone within a few days to get your views.

With kind regards,

Yours sincerely,

<u>SANDY LOVE</u>

Equine Informatics Group -
Professor M. Murray, Dr S.W.J. Reid, Professor G. Gettinby (University of Strathclyde), Dr S. Love, Dr M.J. Reeves (University of Pennsylvania), D.J. Mellor, T. Irwin.

DEPARTMENT OF VETERINARY MEDICINE
University of Glasgow Veterinary School, Bearsden Road, Bearsden, Glasgow G61 1QH
Telephone: 0141-330-5700 *Ext* 5742 *Fax:* 0141-942-7215

APPENDIX 2

PHASE Ia SURVEY OF VETERINARY PRACTICES - ACCOMPANYING LETTER

HOME OF REST FOR HORSES

UNIVERSITY
of
GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<date>>

Dear

On behalf of The Home of Rest for Horses and the University of Glasgow Veterinary School, we thank you for agreeing to co-operate in the equine welfare study. It has been decided that the best way for us to collect the kind of data we want is to write to as many horse owners as possible with a very simple preliminary questionnaire concerning the numbers of horses kept and type of use to which these horses are put. (Please find enclosed a sample copy of this questionnaire and the letter we propose to send to the owners.) We then intend to select from the respondents to this preliminary questionnaire a number of owners and send to them a second, more detailed questionnaire concerning management practices and disease/illness/injury prevalence among their animals. The combination of these questionnaires would give us valuable information about the total number and type of horses in Scotland and Northern England as well as more specific information about the most important diseases in the field. To enable us to do this we hope that you will supply us with a list of names and addresses of all your horse clients - obviously excluding any that you would not wish us to contact for any reason. (Please note that in our letter to owners there is no mention that their names and addresses were supplied by their veterinary practitioners.)

As an integral part of the study we feel it is of vital importance to look at equine welfare from the point of view of the veterinary practitioner. This we would propose to do in two ways; first by asking you to complete a general questionnaire concerning the work in your practice (see enclosed)*, and

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY MEDICINE
Glasgow University Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 6615 *Fax:* 0141-942 7215

secondly by asking you to fill in a number of individual case questionnaires every three months - for the first 10 equine cases seen after receiving the questionnaires each time. Every three months for one calendar year we would send you 10 questionnaires to be filled in for the first 10 equine cases visited - regardless of the reason for the visit - after the date you received the questionnaires. This would then give more information about the seasonality of equine diseases as well as continually updating our database.

From the results of this survey it is hoped to be able to establish which equine diseases are the most important and so direct future research funding to these areas. Hopefully there will be more immediate benefits for all veterinary practitioners in assisting them to target areas of greater importance in disease control programmes for their equine clientele. The results of the study will be made available to all participating veterinary surgeons and owners.

We look forward to receiving your list of equine clients and completed questionnaire, please use the S.A.E. provided.

We will be happy to answer any questions you may have, by fax, letter or telephone. The telephone number is 041 -330 5700 (Ext. 5741), fax number 041 -942 7215.

Yours sincerely,

S.LOVE **D.J.MELLOR** **S.W.J.REID**

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY MEDICINE
Glasgow University Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 6615 *Fax:* 0141-942 7215

APPENDIX 3

PHASE Ia SURVEY OF VETERINARY PRACTICES - QUESTIONNAIRE

Please answer the following questions.

Q1. How many clients registered with your practice own horses?

____

Q2. Approximately what is the total number of equine animals under the care of your practice?

____

Q3. What percentage of the total work-load of your practice is made up by equine work?

____

Q4. *Of this work*, what percentage is made up by routine work such as: vaccinations, registration / certification, teeth rasping?

____

Q5. How many flu and/or tetanus vaccine doses are administered per year in your practice?

____

Q6. How many equine anthelmintic doses are sold per year in your practice?

____

Q7. Please indicate the frequency with which the following disease classes are diagnosed in your practice (please tick the appropriate column for each disease class), and the most common disease entity within each disease class.

	Rare	Occasional	Frequent	Commonest
Acute respiratory				
Chronic respiratory				
Acute GI				
Chronic GI				
Acute musculoskeletal				
Chronic musculoskeletal				
Minor injuries				
Metabolic				
Reproductive				
Dermatological				
Neoplastic				
Miscellaneous				

Q8. Which disease(s) do you consider to be the most important with regard to equine welfare?

____

P.T.O.

Some of the participating practitioners have suggested that a survey of charges made for equine services should be included in the study. We are happy to provide this service. Information will be collated, analysed and the results circulated to respondents. This component of the study would be optional and all information would be treated with the strictest confidence.

Would you be willing to complete a short questionnaire concerning charges made for equine services?

1. yes
2. no

Thank you for your co-operation

HOME OF REST FOR HORSES

A Study of Equine Welfare

UNIVERSITY *of* GLASGOW

Veterinary Informatics and Health Group
Department of Veterinary Medicine
University of Glasgow Veterinary School
Bearsden Road
Glasgow
G61 1QH

APPENDIX 4

A SURVEY OF CHARGES FOR VETERINARY SERVICES - QUESTIONNAIRE

A Survey of Charges for Equine Services

What charge (or range of charges), **including VAT**, is made by your practice for the following services to equine patients? (In the questionnaire it is assumed that a separate charge is made for a visit. If, however, this is included in the charge for a particular service, please specify below. Also for those procedures requiring sedation / general anaesthetic please exclude this from the price quoted for that procedure.)

Visit		£_______
	- revisit	£_______
	- part visit	£_______
Full clinical examination		£_______
Charge for equine work per hour		£_______
Vaccination against equine influenza		£_______
Combined tetanus and flu vaccination		£_______
Examination of an animal on behalf of a purchaser		£_______
Rasping teeth		£_______
Sedation		£_______
General anaesthetic		£_______
Minor wound clean / stitch-up / care (per hour)		£_______
Check up & dressing change		£_______
Castration		£_______
Clitoral swab for CEM		£_______
Internal (rectal) examination		£_______
Pregnancy diagnosis	- rectal palpation	£_______
	- blood sample	£_______
	- ultrasound	£_______
Exploration of foot		£_______
Nerve block (per block)		£_______
Full lameness examination		£_______
Radiography (per plate)		£_______
Any others:	________________________	£_______
	________________________	£_______

Thank you for your co-operation

APPENDIX 5

PHASE Ia SURVEY OF VETERINARY PRACTICES - DATA ENTRY FORM

Phase Ia Survey of veterinary practices

Practice number: 1

Practice postcode: PH2 8HQ

Number of horse-owning clients:	100
Number of horses cared for:	180
Equine work as % of total practice workload:	8
% of equine work which is routine procedures:	50
Doses of flu/tetanus vaccine sold per year:	150
Doses of anthelmintic sold per year:	300

Frequency of disease diagnosis

acute respiratory:	o
chronic respiratory:	f
acute gastrointestinal:	o
chronic gastrointestinal:	r
acute musculoskeletal:	f
chronic musculoskeletal:	f
minor injuries:	f
metabolic:	o
reproductive:	r
dermatological:	r
neoplastic:	o
miscellaneous:	f

Most importantequine disease: laminitis / colic / acute + chronic injuries

APPENDIX 6

PHASE Ib SURVEY OF ALL VETERINARY PRACTICES - LETTER / QUESTIONNAIRE

HOME OF REST FOR HORSES

UNIVERSITY
of
GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<name>>
<<practice name>>
<<address>>
<<town>>
<<area>> <<postcode>>

<<date>>

Dear

A study, funded by The Home of Rest for Horses, is being conducted in order to establish the size, distribution, disease and welfare problems of the equine population of Scotland and Northern England. The data gathered from the study will be analysed and disseminated among veterinarians, teaching, research and welfare organisations to increase awareness of equine diseases. Future research funding may then be directed at the most significant diseases, and more efficient measures devised for the prevention and control of these diseases.

This study is being conducted by the Veterinary Informatics and Epidemiology Group, a joint research group involving personnel from the Department of Veterinary Medicine, University of Glasgow and the Department of Statistics and Modelling Science, University of Strathclyde. Practising veterinarians can contribute essential information to this study, because only they have an accurate, up to date knowledge of the animal populations they are dealing with on a daily basis. I write to ask you to complete the three short questions at the end of this letter and return it to me in the **FREEPOST** envelope enclosed. (If you very rarely, or never see any equine animals, please write 'NONE' in answer to question 1. and return this letter anyway). If you have any comments or queries please write them on the back of this letter, or telephone me on the number given below. **All information provided will be treated in strictest confidence.**

Yours sincerely,

Dominic J. Mellor BVMS MRCVS

Q1. How many clients (including farm clients) registered with your practice own horses?

____

Q2. Approximately how many equine animals are under the care of your practice?

____

Q3. Approximately how big an area does your practice cover?

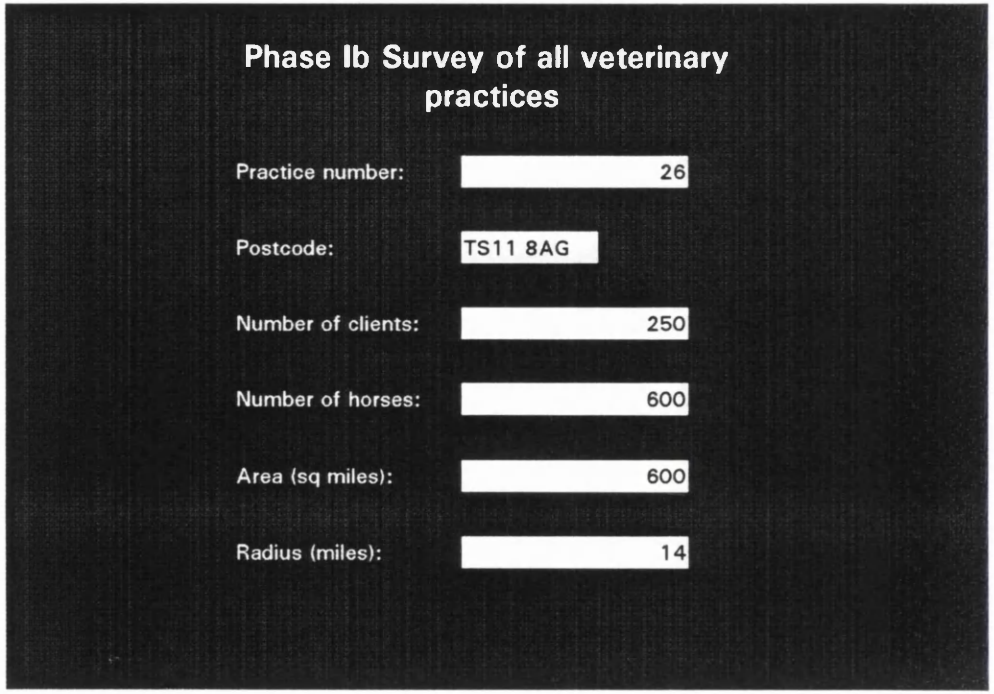
____

Thank you for your co-operation

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY CLINICAL STUDIES
University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 5742 *Fax:* 0141-942 7215 *Email:* gvma09@udcf.gla.ac.uk

APPENDIX 7

PHASE Ib SURVEY OF ALL VETERINARY PRACTICES - DATA ENTRY FORM



Phase Ib Survey of all veterinary practices

Practice number:	26
Postcode:	TS11 8AG
Number of clients:	250
Number of horses:	600
Area (sq miles):	600
Radius (miles):	14

APPENDIX 8

PHASE II SURVEY OF HORSE OWNERS - ACCOMPANYING LETTER

HOME OF REST FOR HORSES

UNIVERSITY *of* GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<date>>

Dear Horse Owner,

Significant advances have been made in recent years in the understanding, investigation and treatment of many of the diseases which affect horses and ponies. However, little is known regarding the relative importance of these diseases. The Home of Rest for Horses and University of Glasgow Veterinary School are interested in improving equine welfare by identifying the diseases which are the most prevalent and have the largest impact on the equine population. In the first instance, the number and type of horses, ponies and donkeys in Scotland and northern England will be identified and classified according to their use by asking horse owners to complete a short questionnaire (see enclosed). When this information has been collected horse owners will be (randomly) selected and asked to complete a second, and more detailed questionnaire, concerning the diseases and welfare of their animals. Coupled with a survey of veterinary practices throughout the same geographical region this study will be able to identify which diseases are most important in the field.

As a horse owner, only you can supply detailed and accurate information about the horses and ponies in this area. It is important that information about all horses, ponies and donkeys; in all types of use and management; is included, in order to fully understand the factors affecting disease and welfare.

You may be assured of complete confidentiality. The questionnaire has an identification number for postal purposes only.

The results of this study will be made available to equine welfare organisations, animal charities, veterinary practitioners, veterinary schools and all parties interested in the care, management and welfare of horses, ponies and donkeys in the UK.

I will be happy to answer any questions you might have. Please write or telephone. The telephone number is 0141 330 5700, Ext.6615. I look forward to receiving your completed questionnaire soon (please use the **FREEPOST** envelope enclosed). Thank you for your assistance.

Yours faithfully,

Dominic J. Mellor BVMS MRCVS

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY MEDICINE
Glasgow University Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 6615 *Fax:* 0141-942 7215

APPENDIX 9

PHASE II SURVEY OF HORSE OWNERS - QUESTIONNAIRE

Please answer the following questions.

Please specify horses, ponies and donkeys in your answers. In questions where you are given a choice, please circle the number adjacent to the most appropriate answer.

Q1. How many equine animals do you own?

______

Q2. Are the premises where your animals are kept :

1. used solely for your own animals?
2. shared with animals belonging to other people?

Q3. Which of the following best describes how your animals are kept?

1. predominantly stabled
2. predominantly grazed
3. roughly half stabled / half grazed
4. always stabled
5. always grazed

Q4. Please state how many animals you own in each of the following activity groupings:

a. Racing _____

b. Horse trials/ Eventing _____

c. Showjumping _____

d. Point - to - Point _____

e. Endurance Riding _____

f. Driving _____

g. Showing _____

h. Hunting _____

i. Riding/ Pony Club events _____

j. Hacking _____

k. Purely Companion _____

l. Breeding _____

m. Other _____

P.T.O.

Q5. Would you be willing to complete a supplementary questionnaire concerning the management and welfare of your horses?

1. yes
2. no

If your answer to Q5 was 'yes' please fill in your name and address in the space provided below so that a supplementary questionnaire can be mailed to you.
(This information will be treated with strictest confidentiality.)

Name ....

Address ....

....

....

Postcode ....

Thank you for your co-operation.

HOME OF REST FOR HORSES

A Study of Equine Welfare

UNIVERSITY
of
GLASGOW

Veterinary Informatics and Health Group
Department of Veterinary Medicine
University of Glasgow Veterinary School
Bearsden Road
Glasgow
G61 1QH

APPENDIX 10

PHASE II SURVEY OF HORSE OWNERS - DATA ENTRY FORM

Phase II Survey of horse owners

Practice number: 2 Owner number: 20005

Postcode: TD6 9JU Number of animals owned: 7

Premises

Exclusive premises: 1

Shared premises: 0

Management

Predominantly stabled: 3

Predominantly grazed: 4

Half in/Half out: 0

Always stabled: 0

Always grazed: 0

Uses

Racing (a): 0

Horse trials/Eventing (b): 0

Showjumping (c): 0

Point-to-Point (d): 0

Endurance riding (e): 0

Driving (f): 0

Showing (g): 0

Hunting (h): 1

Riding/Pony club events (i): 3

Hacking (j): 0

Purely companion (k): 1

Breeding (l): 2

Other (m): 0

Number of use categories: 4

Total number of entries in use categories: 7

APPENDIX 11

PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - INITIAL CONTACT LETTER

HOME OF REST FOR HORSES

UNIVERSITY
of
GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<date>>

Dear

Thank you for taking part in the first phase of The Home of Rest for Horses' study of equine welfare. The information you have supplied has been most useful and I have enclosed a summary of the results obtained from the survey of veterinary practitioners throughout Scotland and Northern England. The first part of the survey of horse-owners is well under way and I will let you have a summary of the results of this survey when it is complete.

In the second phase of the study I am interested in information concerning equine animals that you go to visit for any reason at all. This information would be gathered by asking you to complete a short information sheet for the first ten animals you see (for whatever reason) after you receive these sheets in the mail. I would hope to mail you ten sheets every third month for the next year. I will telephone within the next two weeks to discuss this further with you.

All the practitioners who responded to the survey expressed an interest in participating in an anonymous survey of charges made for veterinary services. This component was originally requested by some of the practitioners who agreed to take part in the study of equine welfare. Enclosed is a questionnaire concerning the charges made for equine services in your practice and a **FREEPOST** envelope for its return. This information will be treated with strictest confidence and practices wishing to take part will be provided with a summary of the results of the survey. I look forward to hearing from you in the near future.

Yours sincerely,

Dominic J. Mellor BVMS MRCVS

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY CLINICAL STUDIES
University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 6615 *Fax:* 0141-942 7215

APPENDIX 12

SUMMARY REPORT OF RESULTS OF PHASE Ia FOR VETERINARY PRACTICES

The Home of Rest for Horses Study of Equine Welfare

SUMMARY OF SURVEY OF VETERINARY PRACTICES

22 of **25** practices completed the questionnaire.

Total number of horse owning clients in all practices	**8856**
Average number of horse owning clients per practice	**403** (± 472) range 40 -1988
Total number of horses in the care of all practices	**17697**
Average number of horses per practice	**704** (± 760) range 100 - 3000
Average number of horses per owner	**2.3** (± 0.8) range 1.1 - 4.0
Average number of doses of vaccine (flu, flu/tet or tet) per horse per year	**0.5** (± 0.4) range 0.2 - 1.5
Average number of doses of anthelmintic per horse per year	**0.7** (±1.0) range 0.2 - 3.5
Equine workload as percentage of total practice workload	**18%** (± 16%) range 5 - 80%
Percentage of equine work which is routine	**43%** (± 20%) range 5 - 90%

The following classes of disease occur frequently

Minor Injuries	Traumatic cuts and wounds
Acute Musculoskeletal	Foot abscess, tendon injury, laminitis
Chronic Respiratory	COPD
Chronic Musculoskeletal	Osteoarthritis, laminitis

The following classes of disease occur less frequently

Dermatological	Ringworm, ectoparasites, dermatophilosis
Acute Gastrointestinal	Spasmodic colic, parasites, grass sickness
Acute Respiratory	Respiratory viruses
Reproductive	Infertility, endometritis
Metabolic	Rhabdomyolysis
Neoplastic	Sarcoid, melanoma

The following classes of disease occur rarely

Chronic Gastrointestinal	Diarrhoea, teeth
Miscellaneous	Ocular

APPENDIX 13

PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - ACCOMPANYING LETTER

HOME OF REST FOR HORSES

UNIVERSITY
of
GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<date>>

Further to our telephone conversation of earlier today please find enclosed the first ten case sheets we discussed. Please complete the relevant parts of one case sheet for each of the first ten horses seen by you or other members of you practice. This should include animals seen for revisits and check ups and for routine procedures such as annual vaccinations or certification. When all ten sheets have been completed please return them to me using the **FREEPOST** envelope provided. A second set of ten sheets will be mailed to you in three months time, and again in six and nine months time in order to detect seasonal variations in the nature of equine health and welfare problems.

Thank you for your continued support of our study. A full summary of findings will be made available to you when the study is completed. If you have any questions I will be happy to answer them and can be reached at the address and telephone number below.

Yours sincerely,

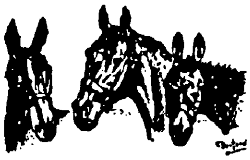
Dominic J. Mellor BVMS MRCVS

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY MEDICINE
Glasgow University Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 041-330 5700 / 041-339 8855 *Ext.* 6615 *Fax:* 041-942 7215

APPENDIX 14

PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - CASE SHEET

The Home of Rest for Horses Study of Equine Welfare



CASE SHEET

Where there is a choice of answers, please tick the appropriate box(es).

Age (years)_____ Breed or Type _______________ Mare ☐

Coat Colour _______________ Sex: Gelding ☐

Stallion ☐

Distance of premises where this animal is kept from your practice _______________

What was the reason for your visit / revisit to this animal (owner's complaint)?

____

Summary of any relevant history

____

____

Summary of clinical findings (list up to four in order of importance)

1.______________ 2.______________

3.______________ 4.______________

Further investigations undertaken (e.g. blood sample, x-ray, ultrasound, endoscopy, peritoneal tap etc.)

____

Provisional Diagnosis _______________

Summary of treatment/management protocol

____

____

Prognosis: (please tick the appropriate box)

for survival:			for return to work:		
	Good	☐		Good	☐
	Fair	☐		Fair	☐
	Guarded	☐		Guarded	☐
	Poor	☐		Poor	☐
	Unknown	☐		Unknown	☐

When, if at all, will you revisit this animal? _______________

APPENDIX 15

PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - REMINDER LETTER

HOME OF REST FOR HORSES

UNIVERSITY
of
GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<date>>

Approximately six weeks ago ten case sheets were mailed to you. Thank you for agreeing to complete these sheets and continue to support this study. The majority of case sheets have now been returned supplying important and interesting information. Yours is one of only twenty practices which have been chosen to represent equine veterinary work throughout Scotland and Northern England. It is therefore very important that your case sheets are included for the results of the study to be accurate and meaningful. These were the last set of case sheets to be mailed to you, after which my study will be complete. A full copy of my findings will be made available to you as soon as they are available.

If you have already completed these case sheets and returned them to me, please accept my sincere thanks. If by some chance you did not receive any case sheets, or they have been misplaced, please contact me on 0141 339 8855 ext. 6615 and I will mail replacement sheets to you immediately.

If you have any questions or problems please contact me at the number given above. Thank you for your co-operation.

Yours sincerely,

Dominic J. Mellor BVMS MRCVS

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY MEDICINE
Glasgow University Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 6615 *Fax:* 0141-942 7215

APPENDIX 16

PHASE III CROSS-SECTIONAL CASE STUDY OF VETERINARY PRACTICES - DATA ENTRY FORM

Phase III Cross-sectional case study of veterinary practices

Practice number: 1 Record number: 1 Classification: 6

Animal age (years): 12 Breed or type: 35 Coat colour: 1 Gender: 2

Distance from practice (miles): 2 Season: 1

Reason for visit: lameness

History: sudden onset lameness and swelling lateral aspect mid cannon RF (see also records 0107 and 0110)

Clinical finding 1: 26

Clinical finding 2: 18

Clinical finding 3: 218

Clinical finding 4:

Body system affected 1: 54 Duration: 1

Body system affected 2:

Investigations: advise X-ray pending progress

Provisional diagnosis: traumatic injury to cannon

Management: NSAIDs (ketofen, i/v, 3 days) walking in hand (15 mins several times a day)

Prognosis (survival): 1 Prognosis (return to work): 2 Revisit (days): 1

APPENDIX 17

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - ACCOMPANYING LETTER

HOME OF REST FOR HORSES

UNIVERSITY
of
GLASGOW

A Study of Equine Welfare

S. Love, D.J. Mellor, S.W.J. Reid

<<date>>

Thank you for completing Part 1 of 'A Study of Equine Welfare', and for agreeing to complete a more detailed questionnaire. The response to our study by horse owners has been excellent and a great deal of useful information has been gathered. If our study is to reach its goal of identifying the most significant equine health and welfare problems, it is essential that further, more detailed, information is collected.

In order to gather this information I would like to ask you to complete a further short questionnaire entitled 'A Study of Equine Welfare Part 2' (enclosed), and one 'Fact Sheet' (enclosed) for each horse, pony or donkey that you **own**. The number of fact sheets enclosed is based on the number of animals that you said you owned in Part 1 of the study. If you now own more animals, please contact me at the telephone number below and I will supply additional fact sheets. I would be grateful if you would inform me if you no longer wish to take part in the study.

All information supplied will be treated in strictest confidence; numbers appear on the top right of questionnaires and fact sheets only to link information between Parts 1 and 2 of the study. The results of the study will be available when the data have been analysed.

Please return your completed questionnaire and fact sheets to me making use of the **FREEPOST** envelope enclosed. If you have any questions, please do not hesitate to telephone me on 0141 330 6615 or write to me at the address below.

Thank you for taking part in this study.

Yours sincerely,

Dominic J. Mellor BVMS MRCVS

Veterinary Informatics and Epidemiology
DEPARTMENT OF VETERINARY CLINICAL STUDIES
University of Glasgow Veterinary School, Bearsden Road, Glasgow G61 1QH
Telephone: 0141-330 5700 / 0141-339 8855 *Ext.* 6615 *Fax:* 0141-942 7215

APPENDIX 18

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - QUESTIONNAIRE

Thank you for completing part one of 'A Study of Equine Welfare' and agreeing to continue to participate in the second phase of our study. You have been chosen from the large number of respondents to the first part of the study. We would now like to request more detailed information concerning the management and welfare of your horses, ponies and donkeys. Please complete the following short questionnaire, **AND** one fact sheet (enclosed) for each of the animals that you own.

Q1. On average how many times a year does one of your equine animal(s) require veterinary attention for something other than a routine procedure such as vaccination or teeth rasping?

________times / year

Q2. Where are your animal(s) kept? (please tick the appropriate box)

At home ☐ (please go straight to **Question 3**)

At other premises ☐ (please go on to **Questions 2b & c**)

Q2b) How far from your home are these premises? ______ miles

Q2c) How often are your animal(s) checked on by you or a representative?

____

please go on to **Question 3**

Q3. Do your animal(s) live by themselves or share premises with horses, ponies and donkeys belonging to other people? (please tick the appropriate box)

By themselves ☐

With animals belonging to other people ☐

Q4. How many pastures / fields are available to your horses, ponies or donkeys?

____

Q5. In total how many horses, ponies and donkeys usually share these pastures?

____

Q6. On average about how many <u>times a year</u> do any of your animals leave the premises, and mix with other equine animals at, for example, a show?

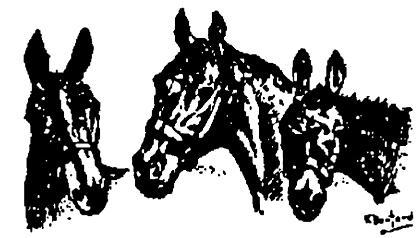
________times / year

Q7. Of all the conditions and diseases that affect horses, ponies and donkeys, list up to three that you feel are most important.

1. ______________
2. ______________
3. ______________

Thank you for your co-operation

HOME OF REST FOR HORSES



A Study of Equine Welfare
Part 2

UNIVERSITY
of
GLASGOW

Veterinary Informatics and Health Group
Department of Veterinary Medicine
University of Glasgow Veterinary School
Bearsden Road
Glasgow
G61 1QH

APPENDIX 19

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - FACT SHEET

The Home of Rest for Horses Study of Equine Welfare

FACT SHEET

Please complete one fact sheet for each horse, pony and donkey that you own.
Where there is a choice of answers, please tick the appropriate box(es).

Animal Details

Name of horse, pony or donkey: ______________________________

Age (years)_____ Breed or Type ______________ Sex: Mare ☐

Coat Colour ______________ Gelding ☐

How long have you owned this animal? _________ Stallion ☐

Management

Q1a. During the spring and summer months (April-Sept), when is this animal usually turned out?

Always ☐ Never ☐ Some of the time ☐ (please specify below)

On average how many hours a day? ____________

Is this typically at night or during the day? (please tick) Day ☐ Night ☐

During the autumn and winter months (Oct-March), when is this animal usually turned out?

Always ☐ Never ☐ Some of the time ☐ (please specify below)

On average how many hours a day? ____________

Is this typically at night or during the day? (please tick) Day ☐ Night ☐

Q1b. Does this animal usually graze alone or with other horses? Alone ☐

With other horses ☐

Q2. During the spring and summer months (April-Sept), when is this animal usually stabled?

Always ☐ Never ☐ Some of the time ☐ (please specify below)

On average how many hours a day? ____________

Is this typically at night or during the day? (please tick) Day ☐ Night ☐

During the autumn and winter months (Oct-March), when is this animal usually stabled?

Always ☐ Never ☐ Some of the time ☐ (please specify below)

On average how many hours a day? ____________

Is this typically at night or during the day? (please tick) Day ☐ Night ☐

Q3. What type of bedding is used in this animal's stable? ____________

P.T.O.

Feeding

Q4. Which of the following are **usually** fed to this animal? (please tick those boxes that apply)

Hay	☐	Sugar Beet Pulp	☐	Other (please specify below)
Haylage / Silage	☐	Coarse Mix	☐	______________________
Bran	☐	Oats	☐	______________________
Nuts (any commercial brand)	☐			______________________

Activity

Q5. Which activities does this animal **usually** take part in? (please tick those boxes that apply)

Breeding	☐	Hacking	☐	Riding/Pony Club events	☐
Companion/Retired	☐	Horse Trials/Eventing	☐	Show Jumping	☐
Dressage	☐	Hunting	☐	Showing	☐
Driving	☐	Point-to-Point	☐	Other (please specify below)	
Endurance Riding	☐	Racing	☐	______________________	

Health

Q6. How often is this animal shod? ______________________

Q7. How often is this animal vaccinated against equine flu / tetanus? ______________________

Q8. How often is this animal wormed? ______________________

Q9. Does this animal have any permanent / recurrent conditions or disease problems? (please specify below)

1. ______________________
2. ______________________

Q10. When, and for what reason, did a vet last see this animal (including routine procedures such as vaccination or teeth rasping)?

Date __________ Reason ______________________

____

Q11. Is this animal insured? Yes ☐ No ☐

If 'Yes', against what?

Theft ☐

Death ☐

Loss of use ☐

Vets fees ☐

Other (please specify below)

____

Thank you for your co-operation

APPENDIX 20

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - QUESTIONNAIRE DATA ENTRY FORM

Phase IV In depth study of horse owners

Owner number: 20012 Record number: 1

Animal Details

Age (years):	20	Breed or type:	25	Gender:	1
Coat colour:	6	Ownership (years):	10		

Management

Summer grazing:	1	Time (hrs) - summer grazing:	24	Day/night summer grazing:	3	Graze alone/others:	2
Winter grazing:	3	Time (hrs) - winter grazing:	10	Day/night winter grazing:	1		
Summer stabling:	2	Time (hrs) - summer stabling:	0	Day/night summer stabling:	4	Bedding:	1
Winter stabling:	3	Time (hrs) - winter stabling:	14	Day/night winter stabling:	2		

Feeding

Hay:	1	Sugar beet pulp:	1	Other 1:	bruised barley
Haylage/silage:	0	Coarse mix:	1	Other 2:	
Bran:	0	Oats:	0	Other 3:	
Nuts:	0				

Activity

Breeding:	0	Hacking:	0	Riding/Pony Club Events:	1
Companion/retired:	0	Horse trials/Eventing:	0	Showjumping:	0
Dressage:	0	Hunting:	0	Showing:	0
Driving:	0	Point-to-Point:	0	Other:	
Endurance riding:	0	Racing:	0		

Health

Shoeing rate (times / year):	9	Vaccination rate (times / year):	1	Worming rate (times / year):	9
Disease problem 1:		Disease problem 2:			
Last vet visit (days):	180	Vet visit reason:	tendon problems (RH)		
Insured ?:	2	Insurance details:			

APPENDIX 21

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - FACT SHEET DATA ENTRY FORM

Phase IV In depth study of horse owners

Owner number: 20012 Record number: 1

Animal Details

Age (years): 20 Breed or type: 25 Gender: 1

Coat colour: 6 Ownership (years): 10

Management

Summer grazing:	1	Time (hrs) - summer grazing:	24	Day/night summer grazing:	3	Graze alone/others:	2
Winter grazing:	3	Time (hrs) - winter grazing:	10	Day/night winter grazing:	1		
Summer stabling:	2	Time (hrs) - summer stabling:	0	Day/night summer stabling:	4	Bedding:	1
Winter stabling:	3	Time (hrs) - winter stabling:	14	Day/night winter stabling:	2		

Feeding

Hay:	1	Sugar beet pulp:	1	Other 1:	bruised barley
Haylage/silage:	0	Coarse mix:	1	Other 2:	
Bran:	0	Oats:	0	Other 3:	
Nuts:	0				

Activity

Breeding:	0	Hacking:	0	Riding/Pony Club Events:	1
Companion/retired:	0	Horse trials/Eventing:	0	Showjumping:	0
Dressage:	0	Hunting:	0	Showing:	0
Driving:	0	Point-to-Point:	0	Other:	
Endurance riding:	0	Racing:	0		

Health

Shoeing rate (times / year): 9 Vaccination rate (times / year): 1 Worming rate (times / year): 9

Disease problem 1:		Disease problem 2:	
Last vet visit (days):	180	Vet visit reason:	tendon problems (RH)
Insured ?:	2	Insurance details:	

APPENDIX 22

PHASE II SURVEY OF HORSE OWNERS - SUMMARY STATISTICS BY PRACTICE AFFILIATION

activities/owner - the number of activities an in which an owner's animals were involved.

animals/activity - the number of animals involved in each activity.

activities/animal - the number of activities in which each animal was involved.

Practice 2	**Animals / owner**	**Activities / owner**	**Animals / activity**	**Activities / animal**
mean	4.3	2.6	1.8	1.4
standard deviation	6.2	1.4	2.3	0.8
standard error	0.59	0.13	0.21	0.08
median	2	2	1.1	1.0
range	59	6	19.8	5.0
minimum	1	1	0.17	1.0
25th percentile	2	2	1.0	1.0
75th percentile	5	3	2.0	1.5
maximum	60	7	20.0	6.0
semi-interquartile range	1.5	0.50	0.50	0.25
mode	2	2	1.0	1.0
total animals	467	-	-	-
total owners	110	-	-	-

Practice 3	**Animals / owner**	**Activities / owner**	**Animals / activity**	**Activities / animal**
mean	4.2	2.8	1.7	1.6
standard deviation	4.6	1.8	2.0	1.1
standard error	0.45	0.17	0.19	0.11
median	2	2	1.0	1.0
range	22	8	16.8	5.0
minimum	1	1	0.17	1.0
25th percentile	1	1	1.0	1.0
75th percentile	5	4	2.0	1.6
maximum	23	9	17	6.0
semi-interquartile range	2.0	1.5	0.50	0.32
mode	1	1	1.0	1.0
total animals	442	-	-	-
total owners	105	-	-	-

Practice 4	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.6	2.6	1.4	1.6
standard deviation	5.7	1.6	1.5	1.1
standard error	0.53	0.15	0.14	0.10
median	2	2	1.0	1.0
range	54	7	13.6	5.0
minimum	1	1	0.17	1.0
25th percentile	1	1	0.84	1.0
75th percentile	4	3	1.8	2.0
maximum	55	8	13.8	6.0
semi-interquartile range	1.5	1.0	0.5	0.5
mode	2	2	1.0	1.0
total animals	412	-	-	-
total owners	114	-	-	-

Practice 6	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.7	2.7	1.5	1.6
standard deviation	3.9	1.6	1.3	1.0
standard error	0.26	0.11	0.08	0.07
median	2	2	1.0	1.0
range	24	7	12.3	5.0
minimum	1	1	0.17	1.0
25th percentile	2	1	1.0	1.0
75th percentile	4	4	2.0	2.0
maximum	25	8	12.5	6.0
semi-interquartile range	1.0	1.5	0.5	0.5
mode	2	2	1.0	1.0
total animals	828	-	-	-
total owners	223	-	-	-

Practice 8	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.5	2.4	1.7	1.6
standard deviation	3.9	1.4	1.8	1.1
standard error	0.4	0.15	0.18	0.12
median	2	2	1.0	1.0
range	23	7	9.8	6.5
minimum	1	1	0.20	1.0
25th percentile	1	1	1.0	1.0
75th percentile	4	3	1.5	2.0
maximum	24	8	10.0	7.5
semi-interquartile range	1.5	1.0	0.25	0.50
mode	1	2	1.0	1.0
total animals	322	-	-	-
total owners	92	-	-	-

Practice 9	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	2.8	2.0	1.4	1.3
standard deviation	3.2	1.1	0.95	0.71
standard error	0.48	0.17	0.14	0.11
median	2	2	1.0	1.0
range	14	4	4.8	3.0
minimum	1	1	0.25	1.0
25th percentile	1	1	1.0	1.0
75th percentile	4	3	1.5	2.0
maximum	15	5	5.0	4.0
semi-interquartile range	1.5	1.0	0.25	0.50
mode	1	1	1.0	1.0
total animals	125	-	-	-
total owners	44	-	-	-

Practice 10	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	4.5	2.5	2.1	1.3
standard deviation	4.2	1.4	2.7	0.67
standard error	1.0	0.33	0.65	0.16
median	3	2	1.3	1.0
range	15	5	11.7	2.0
minimum	1	1	0.33	1.0
25th percentile	2	1	1.0	1.0
75th percentile	5	3	2.0	1.0
maximum	16	6	12.0	3.0
semi-interquartile range	1.5	1.0	0.50	0
mode	2	1	1.0	1.0
total animals	77	-	-	-
total owners	17	-	-	-

Practice 11	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.6	2.4	1.6	1.5
standard deviation	6.0	1.5	3.3	0.91
standard error	0.30	0.07	0.17	0.05
median	2	2	1.0	1.0
range	57	7	57.8	5.0
minimum	1	1	0.20	1.0
25th percentile	1	1	1.0	1.0
75th percentile	3	3	1.5	1.8
maximum	58	8	58.0	6.0
semi-interquartile range	1.0	1.0	0.25	0.41
mode	1	1	1.0	1.0
total animals	1419	-	-	-
total owners	393	-	-	-

Practice 12	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	2.9	2.2	1.3	1.6
standard deviation	4.0	1.3	1.3	1.0
standard error	0.27	0.09	0.09	0.07
median	2	2	1.0	1.0
range	39	6	8.8	5.0
minimum	1	1	0.17	1.0
25th percentile	1	1	0.67	1.0
75th percentile	3	3	1.5	2.0
maximum	40	7	9.0	6.0
semi-interquartile range	1.0	1.0	0.42	0.50
mode	1	1	1.0	1.0
total animals	628	-	-	-
total owners	220	-	-	-

Practice 16	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.3	2.3	1.4	1.5
standard deviation	6.0	1.6	1.3	1.0
standard error	0.70	0.18	0.15	0.12
median	2	2	1.0	1.0
range	49	8	9.8	5.0
minimum	1	1	0.20	1.0
25th percentile	1	1	1.0	1.0
75th percentile	3	3	1.5	2.0
maximum	50	9	10.0	6.0
semi-interquartile range	1.0	1.0	0.25	0.5
mode	1	1	1.0	1.0
total animals	243	-	-	-
total owners	74	-	-	-

Practice 17	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	2.3	2.2	1.3	1.6
standard deviation	3.4	1.5	2.4	0.97
standard error	0.38	0.16	0.27	0.11
median	1	2	1.0	1.0
range	20	7	20.8	4.0
minimum	1	1	0.20	1.0
25th percentile	1	1	0.67	1.0
75th percentile	2	3	1.0	2.0
maximum	21	8	21.0	5.0
semi-interquartile range	0.5	1.0	0.17	0.50
mode	1	1	1.0	1.0
total animals	184	-	-	-
total owners	79	-	-	-

Practice 18	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	4.5	2.8	1.7	1.5
standard deviation	6.0	1.6	1.9	1.1
standard error	0.41	0.11	0.13	0.07
median	3	2	1.0	1.0
range	57	6	14.9	6.0
minimum	1	1	0.14	1.0
25th percentile	2	2	1.0	1.0
75th percentile	5	4	2.0	1.6
maximum	58	7	15.0	7.0
semi-interquartile range	1.5	1.0	0.50	0.29
mode	2	2	1.0	1.0
total animals	959	-	-	-
total owners	214	-	-	-

Practice 19	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	5.5	2.6	2.2	1.2
standard deviation	7.3	1.6	3.7	0.5
standard error	0.88	0.19	0.45	0.06
median	3	2	1.0	1.0
range	31	7	29.7	2.3
minimum	1	1	0.3	1.0
25th percentile	2	1	1.0	1.0
75th percentile	4	3	2.0	1.1
maximum	32	8	30.0	3.3
semi-interquartile range	1.0	1.0	0.50	0.03
mode	3	1	1.0	1.0
total animals	380	-	-	-
total owners	69	-	-	-

Practice 20	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.4	2.5	1.5	1.7
standard deviation	3.2	1.2	1.0	1.3
standard error	0.67	0.26	0.21	0.27
median	3	2	1.0	1.0
range	14	4	3.6	4.0
minimum	1	1	0.20	1.0
25th percentile	1.5	2	0.75	1.0
75th percentile	3.5	3	2.0	2.0
maximum	15	5	3.8	5.0
semi-interquartile range	1.0	0.50	0.63	0.50
mode	1	2	1.0	1.0
total animals	77	-	-	-
total owners	23	-	-	-

Practice 21	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	4.0	2.4	1.7	1.3
standard deviation	4.1	1.3	1.4	0.64
standard error	0.50	0.15	0.17	0.08
median	3	2	1.0	1.0
range	19	4	7.8	3.0
minimum	1	1	0.25	1.0
25th percentile	1	1.5	1.0	1.0
75th percentile	4.5	3	2.0	1.1
maximum	20	5	8.0	4.0
semi-interquartile range	1.8	0.75	0.50	0.05
mode	1	2	1.0	1.0
total animals	267	-	-	-
total owners	67	-	-	-

Practice 22	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	4.2	2.1	1.8	1.4
standard deviation	6.6	1.3	1.6	0.77
standard error	1.2	0.22	0.28	0.14
median	2	2	1.0	1.0
range	28	4	7.0	3.0
minimum	1	1	0.25	1.0
25th percentile	1	1	1.0	1.0
75th percentile	3	3	2.0	1.2
maximum	29	5	7.3	4.0
semi-interquartile range	1.0	1.0	0.50	0.10
mode	1	1	1.0	1.0
total animals	135	-	-	-
total owners	32	-	-	-

Practice 24	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	4.1	2.5	1.7	1.3
standard deviation	4.5	1.4	1.5	0.75
standard error	0.40	0.13	0.13	0.07
median	3	2	1.3	1.0
range	29	6	10.3	5.0
minimum	1	1	0.17	1.0
25th percentile	2	1	1.0	1.0
75th percentile	5	3	2.0	1.2
maximum	30	7	10.5	6.0
semi-interquartile range	1.5	1.0	0.50	0.10
mode	1	1	1.0	1.0
	512	-	-	-
	125	-	-	-

Practice 25	Animals / owner	Activities / owner	Animals / activity	Activities / animal
mean	3.7	2.4	1.6	1.4
standard deviation	4.9	1.4	2.2	0.88
standard error	0.20	0.06	0.09	0.04
median	2	2	1.0	1.0
range	41	9	38.8	5.0
minimum	1	1	0.17	1.0
25th percentile	1	1	1.0	1.0
75th percentile	4	3	2.0	1.5
maximum	42	10	39.0	6.0
semi-interquartile range	1.5	1.0	0.50	0.24
mode	1	1	1.0	1.0
total animals	2353	-	-	-
total owners	631	-	-	-

APPENDIX 23

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - SUMMARY STATISTICS BY PRACTICE AFFILIATION

count of animals* - the number of animals for which an entry was made in this category on the fact sheet.

Practice 2	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.1	6.5	5.3	0.68	6.1	249
standard deviation	8.2	5.8	4.3	0.47	2.5	281
standard error	1.0	0.72	0.52	0.06	0.30	38
median	11	5	7	1	7	186
range	34.8	29.8	10	1	11	1805
minimum	0.25	0.25	0	0	2	20
25th percentile	6	2	0	0	4	93
75th percentile	17	8	9	1	8	284
maximum	35	30	10	1	13	1825
semi-interquartile range	5.5	3	4.5	0.50	2	96
mode	6	6	0	1	7	93
count of animals*	67	65	67	66	67	56

Practice 3	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	10.1	4.7	6.4	0.97	6.1	128
standard deviation	7.1	5.4	6.8	0.28	2.2	114
standard error	0.81	0.62	0.78	0.03	0.25	14
median	10	3	8	1	7	93
range	29.8	21.8	52	2	12	544
minimum	0.25	0.20	0	0	1	7
25th percentile	4	1	0	1	5	31
75th percentile	15	6	9	1	7	186
maximum	30	22	52	2	13	551
semi-interquartile range	5.5	2.5	4.5	0	1	78
mode	1	1	0	1	7	31
count of animals*	77	74	77	78	78	71

Practice 4	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.6	5.1	4.8	0.76	6.5	220
standard deviation	7.5	4.01	3.7	0.42	2.1	321
standard error	1.1	0.62	0.55	0.06	0.31	48
median	12	4.5	7	1	7	120
range	33.8	15.9	10	1	9	1584
minimum	0.17	0.10	0	0	0	16
25th percentile	6.3	2	0	0.63	5	62
75th percentile	17	6	8	1	8	272
maximum	34	16	10	1	9	1600
semi-interquartile range	5.4	2	4	0.19	1.5	105
mode	12	5	0	1	7	62
count of animals*	46	42	46	46	46	44

Practice 6	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.7	7.0	7.0	0.81	6.8	237
standard deviation	7.6	5.8	4.3	0.35	2.4	318
standard error	0.63	0.49	0.36	0.03	0.20	28
median	12	6	8	1	7	124
range	34.5	28.0	17	1	10	1820
minimum	0.5	0.01	0	0	2	5
25th percentile	7	3	6	1	5	62
75th percentile	17	9	9	1	9	330
maximum	35	28	17	1	12	1825
semi-interquartile range	5	3	1.5	0	2	134
mode	12	3	7	1	7	124
count of animals*	145	141	145	145	145	122

Practice 8	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.8	6.1	4.6	0.77	5.1	135
standard deviation	7.3	6.6	4.3	0.36	2.2	121
standard error	1.3	1.2	0.77	0.06	0.40	24
median	11	3	6	1	5	100
range	29	28.8	17	1	9	414
minimum	1	0.20	0	0	0	31
25th percentile	6	2	0	0.50	4	31
75th percentile	17.5	9	7	1	7	155
maximum	30	29	17	1	9	445
semi-interquartile range	5.8	3.5	3.5	0.25	1.5	62
mode	6	3	0	1	5	31
count of animals*	31	31	31	31	31	25

Practice 9	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	10.7	5.5	2.5	0.29	8.3	162
standard deviation	5.9	3.8	4.1	0.62	1.4	120
standard error	1.2	0.83	0.85	0.13	0.28	40
median	11.5	5	0	0	9	135
range	21	12.5	12	2	5	358
minimum	1	0.50	0	0	4	7
25th percentile	7.3	2	0	0	8	124
75th percentile	14.3	8	6.5	0	9	180
maximum	22	13	12	2	9	365
semi-interquartile range	3.5	3	3.3	0	0.50	28
mode	2	8	0	0	9	124
count of animals*	24	21	24	24	24	9

Practice 11	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	9.5	4.7	3.9	0.81	6.5	167
standard deviation	6.9	4.6	4.0	0.40	2.3	271
standard error	0.53	0.36	0.31	0.03	0.17	23
median	8	3	4	1	7	124
range	33.8	23.9	13	2	10	2548
minimum	0.25	0.10	0	0	2	7
25th percentile	4	1.5	0	1	5.5	49
75th percentile	14	6	8	1	8	186
maximum	34	24	13	2	12	2555
semi-interquartile range	5	2.3	4	0	1.3	69
mode	6	2	0	1	6	124
count of animals*	171	166	170	171	171	138

Practice 12	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.0	7.2	6.1	0.83	6.4	221
standard deviation	7.5	6.72	4.4	0.37	2.35	295
standard error	0.79	0.72	0.47	0.04	0.25	34
median	11	5	8	1	7	155
range	34.8	31.6	13	1	12	2183
minimum	0.25	0.10	0	0	0	7
25th percentile	6	1.9	0	1	4	62
75th percentile	16	11	9	1	8	275
maximum	35	31.7	13	1	12	2190
semi-interquartile range	5	4.6	4.5	0	2	106
mode	9	1	0	1	7	93
count of animals*	90	88	86	86	86	75

Practice 16	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	7.0	3.4	3.0	0.92	6.4	117
standard deviation	6.0	2.9	3.8	0.28	2.5	93
standard error	1.0	0.48	0.63	0.05	0.42	16
median	5	3	0	1	6.5	124
range	24.7	10.9	10	1	12	351
minimum	0.30	0.10	0	0	1	14
25^{th} percentile	2.8	1	0	1	5	31
75^{th} percentile	10.3	5	7	1	7	155
maximum	25	11	10	1	13	365
semi-interquartile range	3.8	2	3.5	0	1	62
mode	4	5	0	1	5	124
count of animals*	36	36	36	36	36	33

Practice 17	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	14.5	6.7	6.6	0.89	8	100
standard deviation	7.0	5.8	3.7	0.29	0.78	64
standard error	1.9	1.8	0.98	0.08	0.21	17
median	14.5	5	8	1	8	99
range	19	16.9	10	1	3	203
minimum	4	0.10	0	0	7	14
25^{th} percentile	9.3	2.5	7	1	8	39
75^{th} percentile	21.3	8.5	9	1	8	148
maximum	23	17	10	1	10	217
semi-interquartile range	6	3	1	0	0	54
mode	19	2	9	1	8	31
count of animals*	14	11	14	14	14	14

Practice 18	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.4	5.6	4.6	0.82	5.4	152
standard deviation	7.8	4.6	5.0	0.38	2.6	95
standard error	0.87	0.51	0.55	0.04	0.28	11
median	11	5	5	1	6	124
range	28.7	19.8	26	2	11	335
minimum	0.33	0.25	0	0	1	30
25th percentile	5	2	0	0.75	4	76
75th percentile	17.5	8	9	1	7	217
maximum	29	20	26	2	12	365
semi-interquartile range	6.3	3	4.5	0.13	1.5	71
mode	5	6	0	1	4	93
count of animals*	82	81	82	83	83	75

Practice 19	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	10.7	6.2	3.0	0.77	5.6	239
standard deviation	6.8	4.8	4.0	0.35	1.4	437
standard error	1.0	0.74	0.61	0.05	0.22	76
median	10	5	0	1	7	124
range	25	19.9	13	1	6	2541
minimum	1	0.10	0	0	2	14
25th percentile	5	2.5	0	0.50	5	93
75th percentile	15	8.5	7	1	7	186
maximum	26	20	13	1	8	2555
semi-interquartile range	5	3	3.5	0.25	1	47
mode	3	3	0	1	7	124
count of animals*	43	43	43	43	43	33

Practice 20	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.2	5.0	2.7	0.69	5.3	153
standard deviation	8.7	3.5	4.3	0.48	1.8	105
standard error	2.4	0.98	1.2	0.13	0.50	33
median	8	4	0	1	4	158
range	29	13	10	1	5	334
minimum	1	1	0	0	4	31
25th percentile	4	3	0	0	4	62
75th percentile	18	6	7	1	7	180
maximum	30	14	10	1	9	365
semi-interquartile range	7	1.5	3.5	0.5	1.5	59
mode	4	4	0	1	4	62
count of animals*	13	13	13	13	13	10

Practice 21	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	13.7	6.0	5.2	0.70	5.9	240
standard deviation	6.6	5.0	4.1	0.43	2.7	197
standard error	1.4	1.1	0.87	0.09	0.58	48
median	13	5	7	1	5	186
range	28	18.5	9	1	9	668
minimum	2	1.5	0	0	3	31
25th percentile	10	3	0	0.50	4	93
75th percentile	16.8	6.5	9	1	7.5	334
maximum	30	20	9	1	12	699
semi-interquartile range	3.4	1.8	4.5	0.25	1.8	121
mode	10	6	0	1	4	93
count of animals*	22	19	22	22	22	17

Practice 22	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.2	5.7	9.8	0.83	6.8	161
standard deviation	6.1	5.2	1.7	0.41	2.7	143
standard error	2.5	2.1	0.70	0.17	1.1	64
median	11	4	9.5	1	8	124
range	16	13.7	5	1	6	389
minimum	4	0.30	8	0	3	7
25th percentile	6.5	2.5	9	1	4.8	124
75th percentile	14.8	8.5	10	1	9	155
maximum	20	14	13	1	9	396
semi-interquartile range	4.1	3	0.50	0	2.1	16
mode		4	9	1	9	124
count of animals*	6	6	6	6	6	5

Practice 24	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.1	6.1	3.5	0.58	5.1	241
standard deviation	7.5	4.5	3.8	0.61	2.5	226
standard error	0.795	0.49	0.41	0.07	0.26	25
median	11	5	0	1	7	186
range	29.7	17.8	12	3	9	1430
minimum	0.33	0.25	0	0	0	30
25th percentile	7	2.5	0	0	3	124
75th percentile	18	8.5	7	1	7	300
maximum	30	18	12	3	9	1460
semi-interquartile range	5.5	3	3.5	0.5	2	88
mode	14	4	0	1	7	210
count of animals*	89	87	89	89	89	85

Practice 25	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	10.1	5.0	5.0	0.86	6.6	163
standard deviation	7.8	5.1	4.4	0.35	2.6	157
standard error	0.45	30	0.25	0.02	0.15	10
median	8	3	7	1	7	124
range	36.9	27.5	17	2	13	1457
minimum	0.10	0.02	0	0	0	3
25th percentile	4	1.5	0	1	5	62
75th percentile	15	7	9	1	8	217
maximum	37	27.5	17	2	13	1460
semi-interquartile range	5.5	2.8	4.5	0	1.5	78
mode	1	2	0	1	8	124
count of animals*	301	292	302	302	303	266

APPENDIX 24

PHASE IV IN DEPTH SURVEY OF HORSE OWNERS - SUMMARY STATISTICS BY ACTIVITY GROUPING

count of animals* - the number of animals for which an entry was made in this category on the fact sheet.

Breeding	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.0	6.5	2.2	0.75	6.5	206
standard deviation	6.1	4.9	3.6	0.44	2.2	318
standard error	0.43	0.34	0.25	0.03	0.16	23
median	11	5	0	1	7	124
range	29.9	27.9	12	2	13	2552
minimum	0.10	0.10	0	0	0	3
25th percentile	5.5	3	0	0.50	5	62
75th percentile	15	9	5	1	8	217
maximum	30	28	12	2	13	2555
semi-interquartile range	4.8	3	2.5	0.25	1.5	78
mode	5	6	0	1	7	124
count of animals*	207	206	207	208	208	184

Companion/retired	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	18.3	10.2	1.9	0.64	5.6	312
standard deviation	8.4	6.9	3.3	0.48	2.4	419
standard error	0.60	0.50	0.23	0.03	0.17	33
median	20	9	0	1	6	168
range	36	31.6	10	2	12	2548
minimum	1	0.10	0	0	0	7
25th percentile	13	5	0	0	4	93
75th percentile	24	15	4	1	7	334
maximum	37	31.7	10	2	12	2555
semi-interquartile range	5.5	5	2	0.50	1.5	121
mode	20	5	0	1	7	155
count of animals*	195	187	195	195	195	158

Dressage	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	10.2	4.5	8.7	0.99	6.7	151
standard deviation	5.0	3.7	2.3	0.23	2.1	161
standard error	0.39	0.29	0.18	0.02	0.16	13
median	9	3.5	9	1	7	124
range	28	20.0	26	2	11	1453
minimum	4	0.01	0	0	1	7
25th percentile	6	2	8	1	5	62
75th percentile	14	6	10	1	8	186
maximum	32	20	26	2	12	1460
semi-interquartile range	4	2	1	0	1.5	62
mode	6	3	9	1	7	31
count of animals*	165	163	166	166	166	153

Driving	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	9.5	5.0	6.6	0.80	6.1	372
standard deviation	5.4	3.9	3.9	0.39	2.0	551
standard error	0.92	0.69	0.66	0.07	0.34	112
median	8	4.5	8	1	7	214
range	22	12.9	12	1	7	2548
minimum	3	0.10	0	0	2	7
25th percentile	5	2.1	5.5	1	4	147
75th percentile	12.5	8.3	9	1	8	316
maximum	25	13	12	1	9	2555
semi-interquartile range	3.8	3.1	1.8	0	2	84
mode	7	3	8	1	7	155
count of animals*	35	32	35	35	35	24

Endurance riding	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.0	6.2	8.0	1.0	6.1	180
standard deviation	4.8	3.8	1.9	0	2.5	124
standard error	0.82	0.64	0.3	0	0.42	22
median	12	6	8	1	6	124
range	18	15.9	8	0	10	520
minimum	5	0.10	5	1	3	31
25th percentile	7.3	3.6	7	1	4	93
75th percentile	14.8	8.8	9	1	7.8	186
maximum	23	16	13	1	13	551
semi-interquartile range	3.8	2.6	1	0	1.9	47
mode	6	10	9	1	4	124
count of animals*	34	34	34	34	34	33

Hacking	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.6	6.0	6.9	0.83	6.2	179
standard deviation	6.1	4.9	3.3	0.37	2.4	214
standard error	0.25	0.21	0.14	0.02	0.10	9
median	12	5	8	1	7	124
range	33	30.0	26	2	12	2552
minimum	2	0.01	0	0	0	3
25th percentile	7.5	2.5	6	1	4	62
75th percentile	17	8	9	1	8	240
maximum	35	30	26	2	12	2555
semi-interquartile range	4.8	2.8	1.5	0	2	89
mode	5	3	7	1	7	31
count of animals*	575	553	576	574	576	513

Horse trials/eventing	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	10.9	4.3	9.0	0.99	6.6	152
standard deviation	5.2	3.3	4.4	0.25	2.4	108
standard error	0.45	0.30	0.38	0.02	0.21	10
median	10	4	9	1	7	124
range	28	18.0	52	2	13	422
minimum	4	0.01	0	0	0	7
25th percentile	7	1.5	7.8	1	5	62
75th percentile	14	6	10	1	8	217
maximum	32	18	52	2	13	429
semi-interquartile range	3.5	2.3	1.1	0	1.5	78
mode	7	1	9	1	7	31
count of animals*	132	125	132	132	132	121

Hunting	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.2	5.3	9.3	0.94	5.8	177
standard deviation	4.1	3.9	3.07	0.30	2.9	241
standard error	0.38	0.36	0.28	0.03	0.26	23
median	11	4.5	9	1	6	124
range	17	21.0	17	2	12	1818
minimum	4	0.01	0	0	0	7
25th percentile	8	2	7.3	1	4	53
75th percentile	14	7.8	10	1	8	240
maximum	21	21	17	2	12	1825
semi-interquartile range	3	2.9	1.4	0	2	94
mode	10	4	9	1	4	31
count of animals*	116	115	118	118	118	107

Point-to-point	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	8.1	4.3	9.4	1	4.4	145
standard deviation	2.8	3.6	2.0	0	2.9	206
standard error	0.68	0.87	0.48	0	0.68	50
median	7	5	9.5	1	4	93
range	8	12.5	6	0	8	870
minimum	5	0.5	7	1	1	30
25^{th} percentile	6	1	7.5	1	1.5	62
75^{th} percentile	11	6	10	1	6.8	124
maximum	13	13	13	1	9	900
semi-interquartile range	2.5	2.5	1.3	0	2.6	31
mode	5	5	10	1	4	93
count of animals*	17	17	18	18	18	17

Racing	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	7.2	4.6	8.6	1	6.2	133
standard deviation	3.9	4.4	4.0	0.26	2.3	175
standard error	0.72	0.81	0.72	0.05	0.4	33
median	7	4	9	1	7	93
range	19	21.0	13	2	11	893
minimum	2	0.02	0	0	1	7
25^{th} percentile	5	1.5	9	1	4	54
75^{th} percentile	8	6	10	1	7.8	132
maximum	21	21	13	2	12	900
semi-interquartile range	1.5	2.3	0.5	0	1.9	39
mode	7	5	9	1	7	62
count of animals*	30	29	30	30	30	28

Riding/pony club events	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	12.0	4.9	7.7	0.87	6.5	186
standard deviation	5.8	4.1	2.5	0.33	2.4	192
standard error	0.33	0.24	0.14	0.02	0.14	11
median	11	4	8	1	7	155
range	32	27.0	13	2	12	1595
minimum	3	0.01	0	0	0	5
25th percentile	7	2	7	1	5	62
75th percentile	15	6.8	9	1	8	249
maximum	35	27	13	2	12	1600
semi-interquartile range	4	2.4	1	0	1.5	94
mode	5	4	9	1	7	31
count of animals*	306	291	306	305	306	279

Showjumping	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	11.6	4.7	8.1	0.94	6.3	167
standard deviation	5.6	3.9	2.0	0.26	2.4	165
standard error	0.39	0.28	0.14	0.02	0.17	12
median	10	4	8	1	7	124
range	28	21.0	13	2	12	1453
minimum	4	0.01	0	0	0	7
25th percentile	7	2	7	1	5	62
75th percentile	15	6	9	1	8	217
maximum	32	21	13	2	12	1460
semi-interquartile range	4	2	1	0	1.5	78
mode	6	3	9	1	7	124
count of animals*	209	197	209	208	209	183

Showing	Age of animal (years)	Ownership (years)	Shoeing rate (/ year)	Vaccination rate (/ year)	Worming rate (/ year)	Last veterinary attention (days ago)
mean	7.6	4.2	5.0	0.88	6.9	167
standard deviation	5.7	3.7	4.5	0.30	2.2	176
standard error	0.37	0.24	0.29	0.02	0.14	12
median	7	3	7	1	7	124
range	31.8	20.9	26	1	12	1455
minimum	0.25	0.10	0	0	1	5
25^{th} percentile	3	1.5	0	1	5	62
75^{th} percentile	11	5.5	9	1	8	217
maximum	32	21	26	1	13	1460
semi-interquartile range	4	2	4.5	0	1.5	78
mode	1	1	0	1	8	124
count of animals*	237	229	238	238	238	209

APPENDIX 25

LIST OF SUPPLIERS

Compaq Computer Corporation, PO Box 692000, Houston, TX 77269-9976, USA.

Elonex plc, 2 Apsley Way, London NW2 7LF.

Graphical Data Capture Ltd., 262 Regents Park Road, London, N3 3HN.

Hewlett-Packard Company, 3000 Hanover Street, Palo Albo, CA 94304, USA.

MapInfo Corporation, One Global View, Troy, New York 12180-8399, USA.

Microsoft Corporation, One Microsoft Way, Redmond, WA 98052-6399, USA.

Neat Ideas, Sandal Stones Road, Kirk Sandal Industrial Estate, Doncaster, DN3 1BR.

The Stampiton group of Companies Ltd., Stockport SK13 7LY.

Viglen Ltd., Viglen House, Alperton Lane, Alperton, Middlesex HA0 1DX.

REFERENCES

Alterman, H., (1969) *Counting People: The Census in History*. Harcourt, Brace & World, Inc., New York.

Anderson, R.M., (1988) The role of mathematical models in the study of HIV transmission and the epidemiology of AIDS. *AIDS*, **1**: 241-256.

Anderson, R.M., (1989) Mathematical and statistical studies of the epidemiology of HIV. *AIDS*, **3**: 333-346.

Baker, D. (1994) Surveys on horse worming. *Veterinary Times*, **24** (11): 29.

Baltazar, J., Briscoe, J., Mesola, V., Moe, C., Solon, F., Vanderslice, J. and Young, B. (1988) Can the case-control method be used to assess the impact of water supply and sanitation on diarrhoea? A study in the Philippines. *Bulletin of the World Health Organisation*, **66** (5): 627-635.

Barker, T.C., (1983) The delayed decline of the horse in the twentieth century. From: *Horses in European Economic History*. Thompson, F.M.L. (editor), Leeds University Printing Service, ISBN 0 903269 02 3, pp. 101-112.

Barrett, D.C., Taylor, F.G.R. and Morgan, K.L. (1992) A telephone based case-control study of fatal equine colics in Wales during 1988 with particular reference to grass disease. *Preventive Veterinary Medicine*, **12**: 205-215.

Barrowman, P.R. and Van Vuurnen, M., (1976) The prevalence of Dourine in South Africa. *Journal of the South African Veterinary Association*, **47** (2): 83-85.

Bartelds, A.I. (1993) Validation of sentinel data. *Gesundheitswesen*, **55** (supplement 1): 3-7.

Blackshaw, J.K. and Day, C. (1994) Attitudes of dog owners to neutering pets: Demographic data and effects of owner attitudes. *Australian Veterinary Journal*, **71** (4): 113-116.

Blood, D.C., (1991) *BOVID - BOVine Information and Diagnosis system*, Version 2.1. From Professor D.C. Blood, 209 Watton Street, Werribee, Victoria, Australia, 3030.

Bourque, L.B. and Fielder, E.P. (1995) *How to Conduct Self-Administered and Mail Surveys*. SAGE Publications, Thousand Oaks, London, New Delhi, ISBN0-8039-7168-0.

British Horse Society (1996) Personal communication.

Britton, D.K. (editor) (1989) *A Hundred Years of British Food and Farming: A Statistical Survey*. Taylor & Francis Ltd., 4 John Street, London WC1N 2ET, ISBN 0-85066-452-7.

Cambell, G. (1992) GIS in the police environment. *The Yearbook of the Association for Geographic Information 1992/93*. Taylor & Francis Ltd., 4 John Street, London WC1N 2ET, ISBN 0-7480-0046-X, pp. 114-118.

Canon, R.M. and Roe, R.T. (1982) *Livestock Disease Surveys: A Field Manual for Veterinarians*. Australian Bureau of Animal Health, Department of Primary Industry, Australian Government Publishing Service.

Carter-Melloy Corporation, PO Box 9219, College Station, TX 77842.

Cecile, M. and McCleish, M., (1990). Induction and uncertainty management techniques applied to veterinary medical diagnosis. In: *Uncertainty in Artificial Intelligence 4*. Shachter, R.D., Levitt, T.S., and Kanal, J.F.(editors) Elsevier Science Publishers B.V., North Holland, pp. 369-381.

Central Statistical Office (1995) Social trends, 1970-1995 [CD-ROM]. London: CSO.

1991 Census on CD-ROM, Chadwyck-Healey, Cambridge.

Chackraverty, P. (1994) Surveillance of influenza in the United Kingdom. Pandemic and interpandemic period. *European Journal of Epidemiology*, **10** (2): 493-495.

Charles, Charles and Associates (1983) The veterinary services market. *Journal of the American Veterinary Medical Association*, **183** (8): 841-843.

Charles, Charles Research Group (1988a) Veterinary services market for companion animals. Summary report. *Journal of the American Veterinary Medical Association*, **193** (8): 920-922.

Charles, Charles Research Group (1988b) Veterinary services market for companion animals. Horse owners and their use of veterinary services. *Journal of the American Veterinary Medical Association*, **193** (11): 1362-1363.

Childers, T.L. and Ferrell, O.C. (1979) Response rates and perceived questionnaire length in mail surveys. *Journal of Marketing Research*, **16**: 429-431.

Chivers, K., (1983) The supply of horses in Great Britain in the nineteenth century. From: *Horses in European Economic History*. Thompson, F.M.L. (editor), Leeds University Printing Service, ISBN 0 903269 02 3, pp. 31-49.

Choi, B.C.K., Pak, A.W.P. and Purdham, J.T. (1990) Effects of mailing strategies on response rate, response time, and cost in a questionnaire study among nurses. *Epidemiology*, **1** (1): 72-74.

Clarke, A.F. (1989a) Management and housing practices in relation to *Rhodococcus equi* infection of foals. *Equine Veterinary Education*, **1** (1): 30-32.

Clarke, A.F. (1989b) Preserved forage: nutritional and respiratory aspects. *Equine Veterinary Education*, **1** (2): 65-68.

Clarke, G.M. and Cooke, D. (1992) *A Basic Course in Statistics.* 3rd Edition, Edward Arnold, London, Melbourne, Aukland, ISBN 0-340-56772-4.

Clifton-Hadley, R. (1995) Geographic Information Systems and their use in animal disease research and control. *State Veterinary Journal*, **5** (4): 1-4.

Clutton-Brock, J. (1992) *Horse Power.* Harvard University Press, Cambridge, Massachusetts, ISBN 0-674-40646-X.

Cohen, N.D. (1994) Causes of and farm management factors associated with disease and death in foals. *Journal of the American Veterinary Medical Association*, **204**: 1644-1651.

Cohen, N.D., Matejka, P.L., Honnas, C.M. and Hooper, R.N. (1995) Case-control study of the association between various management factors and development of colic in horses. *Journal of the American Veterinary Medical Association*, **206** (5): 667-673.

Collaborative Group for the Study of Stroke in Young Women (1975) Oral contraceptives and stroke in young women. *Journal of the American Medical Association*, **231** (7): 718-722.

Colledge, M., Maxwell, H., Parker, R. and Morse, D.J. (1996) Geographical Information Systems in general practice: A new tool for needs assessment. *Journal of Informatics in Primary Care*, March 1996, 7-11.
http://www.ncl.ac.uk:80/~nphcare/PHCSG/Journal/index.htm

Collins English Dictionary and Thesaurus (1993) Harper Collins Publishers, PO Box, Glasgow, G4 0NB, ISBN 0 00 470269-7.

Coppock, J.T. (1964) *An Agricultural Atlas of England and Wales.* Faber and Faber Ltd..

Coppock, J.T. (1976a) *An Agricultural Atlas of England and Wales.* 2nd Edition, Faber and Faber Ltd., ISBN 0571 04829 3.

Coppock, J.T. (1976b) *An Agricultural Atlas of Scotland.* John Donald Publishers, Edinburgh, ISBN 0 85976 016 2.

Cordes, T. and Hooper, P. (1995) Morbillivrus of horses and humans in Australia: An overview and update. Proceedings: *Annual Meeting of the United States Health Association*, **99**: 301-306.

Cornelius, S. (1992) GIS in environmental management. *The Yearbook of the Association for Geographic Information 1992/93.* Taylor & Francis Ltd., 4 John Street, London WC1N 2ET, ISBN 0-7480-0046-X, pp. 53-60.

Cowen, P., Schwabe, C.W., Rosenburg, H.R., BonDurant, R.H., Franti, C.E. and Goodger, W.J. (1989) Reproductive management practices among Tulare, California, dairy herds. I. Census and descriptive aspects. *Preventive Veterinary Medicine*, **7** (2): 83-100.

Dargatz, D.A. and Salman, M.D. (1993) Application of epidemiologic principles and methods to investigating and controlling equine infectious diseases. *Veterinary Clinics of North America: Equine Practice*, **9** (2): 247-255.

Davies, G. (1983) Development of veterinary epidemiology. *The Veterinary Record,* **112**: 51-53.

Del-Mar, C. and Pincus, D. (1995) Incidence patterns of respiratory illness in Queensland estimated from sentinel general practice. *Australian Family Physician,* **24** (4): 625-629, 632.

Dent, B.D. (1985) *Principles of Thematic Map Design.* Addison-Wesley Publishing Company, Inc., Reading, Massachusetts, London, Amsterdam, ISBN 0 201 11334 1.

Dewdney, J.C. (1984) United Kingdom. From: *Census Mapping Survey.* Nag, P. (editor), International Geographical Union Commission on Population Geography, Concept publishing Company, New Delhi, pp. 200-214.

Dillman, D.A. (1978) *Mail and Telephone Surveys: The Total Design Method.* John Wiley & Sons Inc., New York, ISBN 0-471-21555-4.

Domecq, J.J., Nebel, R.L., McGilliard, M.L. and Pasquino, A.T. (1991) Expert system for evaluation of reproductive performance and management. *Journal of Dairy Science*, **74**: 3446-3453.

Dohoo, I.R., Curtis, R.A. and Finley, G.G. (1985) A survey of sheep diseases in Canada. *Canadian Journal of Comparative Medicine*, **49**: 239-247.

Doxey, D.L., Gilmour, J.S. and Milne, E.M. (1991) A comparative study of normal equine populations and those with grass sickness (dysautonomia) in eastern Scotland. *Equine Veterinary Journal*, **25** (5): 365-369.

Dunlop, R.H and Williams, D.J. (1996) *Veterinary Medicine: An Illustrated History.* Mosby - Year Book Inc., St. Louis, ISBN 0-8016-3209-9, pp.435-487.

Dunn, C.E., Woodhouse, J., Bhopal, R.S. and Acquilla, S.D. (1995) Asthma and factory emissions in northern England: addressing public concern by combining geographical and epidemiological methods. *Journal of Epidemiology and Community Health*, **49**: 395-400.

Edney, A.T.B. and Smith, P.M. (1986) Study of obesity in dogs visiting veterinary practices in the United Kingdom. *The Veterinary Record*, **118**: 391-396.

Estberg, L., Gardner, I.A., Stover, S.M., Johnson, W.J., Case, J.T. and Adrans, A. (1995) Cumulative racing-speed exercise distance cluster as a risk for fatal musculoskeletal injury in Thoroughbred racehorses in California. *Preventive Veterinary Medicine*, **24**: 253-263.

Finn, R.W. (1963) *An introduction to Domesday Book.* Longmans.

Flew, A. (1970) (editor) *An Essay on the Principle of Population.* Malthus, T. M., Penguin Books Ltd, ISBN 0 14040.018 4.

Forsyth, A.J., Gettinby, G. and Revie, C.W. (1992) Integrating hypertext and expert systems: A hybrid information system for the domain of animal trypanosomiasis. Proceedings: *Intelligent Library Systems '92*, 175-196.

Frankena, K., van Keulen, K.A.S., Noordhuizen, J.P., Noordhuizen-Stassen, E.N., Gundelach, J., de Jong, D.J., and Saedt, I. (1992) A cross-sectional study into prevalence and risk of digital haemorrhages in female dairy calves. *Preventive Veterinary Medicine*, **14** (1-2): 1-12.

French, N.P., Wall, R., Cripps, P.J. and Morgan, K.L. (1992) Prevalence, regional distribution and control of blowfly strike in England and Wales. *The Veterinary Record,* **131** (15): 337-342.

Gerrard, W. and Little, C.J.L. (1994) Technology audit of veterinary practice in the UK. *In Practice*, **16**: 226-231.

Gettinby, G., Soutar, A., Armour, J. and Evans, P. (1989) Anthelmintic resistance and the control of ovine ostertagiasis: a drug action model for genetic selection. *International Journal of Parasitology*, **19**: 369-376.

Gilmour, J.S. and Jolly, G.M. (1974) Some aspects of the epidemiology of equine grass sickness. *The Veterinary Record,* **95**: 77-81.

Green, L.A., Miller, R.S., Reed F.M., Iverson, D.C. and Barley, C.E. (1993) How representative of typical practice are practice based research networks? A report from the Ambulatory Sentinel Practice Network Inc. (ASPN). *Archives of Family Medicine*, **2** (9): 939-949.

Green, L.A., Curtis, M.D and Nutting, P.A. (1994) Potential of practice-based research networks: Experiences from ASPN. *The Journal of Family Practice*, **38** (4): 400-406.

Green, P. (1997) Harnessing epidemiology - a view from racing. In: Equine epidemiology: HBLB Workshop. Mellor, D.J. and Newton, J.R. (authors). *Equine Veterinary Journal*, **29** (2): 92-97.

Hall, S.A. (1991) *The Directory of Veterinary Practices 1992*. The Royal College of Veterinary Surgeons, ISBN 0 902183 10 9.

Hart, E. (1986) *The Book of the Heavy Horse*. Patrick Stephens, Wellingborough, ISBN 0-85059-648-0.

Hata, A. (1993) An equine revival. *Veterinary Times*, **23** (7): 10.

Haviland, A. (1892) *The Geographical Distribution of Disease in Great Britain*. Swan Sonnenschein & Co., London.

Haws, I.J. and Anthony, M.G. (1996) Small animal dentistry in Canada: 1994 survey. *Canadian Veterinary Journal*, **37**: 49-52.

Henny, L.H.S. and Gambardella, P.C. (1989) Premature closure of the ulnar physis in the dog: A retrospective clinical study. *Journal of the American Animal Hospital Association*, **25** (5): 573-581.

Hoffsis, D.F., Dorn, C.R. and Bonham, J.B. (1983) A bovine practitioner survey of Johne's disease. *Bovine Practitioner*, **18**: 58-66.

Hollingsworth, T.H. (1969) *Historical Demography*. The Sources of History Limited, 47 Dean Street, London and The Camelot Press Limited, London and Southampton, ISBN 340 10714 6.

Hugh-Jones, M. (1991) Introductory remarks on the application of remote sensing and geographical information systems to epidemiology and disease control. *Preventive Veterinary Medicine*, **11**: 159-161.

Hunt, R.J. (1993) A retrospective evaluation of laminitis in horses. *Equine Veterinary Journal*, **25** (1): 61-64.

Jenny, B.F., Gramling, G.E. and Glaze, T.M. (1981) Management factors associated with calf mortality in South Carolina dairy herds. *Journal of Dairy Science*, **64** (11): 2284-2289.

Johnston, G.M. (1994) Epidemiological aspects of the Confidential Enquiry of Perioperative Equine Fatalities (CEPEF) and some preliminary results. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, Belfast, 174-184.

Johnston, G.M., Taylor, P.M., Holmes, M.A. and Wood, J.L.N. (1995) Confidential enquiry of perioperative equine fatalities (CEPEF-1): preliminary results. *Equine Veterinary Journal*, **27** (3): 193-200.

Jones A.P. and Bentham, G. (1995) Emergency medical service accessibility and outcome from road traffic accidents. *Public Health*, **109** (3): 169-177.

Jones, T. (1995) The practising veterinary surgeon at the front line of research. *Veterinary Times*, **25**, 11 (8): 18-19.

Kaneene, J.B., Miller, R.A., Ross, W. and Gilbert, L. (1996) Patterns of health maintenance on Michigan equine operations. *Preventive Veterinary Medicine*, **29**: 201-220.

Kelsey, J.L., Thompson, W.D. and Evans, A.S. (1986) *Methods in Observational Epidemiology*. Monographs in Epidemiology and Biostatistics Volume 10, Lilienfeld, A.M. (editor). Oxford University Press, New York, Oxford, ISBN 0-19-503657-3.

Kelton, D.F. and Lissemore, K.D. (1997) Towards an integrated dairy industry database. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, Chester, 236-245.

Kent, J.E., Thrusfield, M.V., Robertson, I.S. and Molony, V. (1996) Castration of calves: A study of methods used by farmers in the United Kingdom. *The Veterinary Record*, **138** (16): 384-387.

Keyfitz, N. and Beekman, J.A. (1984) *Demography Through Problems*. Springer-Verlag, New York, ISBN 0-387-90836-6.

Kiper, M.L., Traub-Dargatz, J.L. and Curtis, C.R. (1990) Gastric rupture in horses: 50 cases (1979-1987). *Journal of the American Veterinary Medical Association*, **196** (2): 333-336.

Kornblatt, A.N. and Schantz, P.M. (1980) Veterinary and public health considerations in canine roundworm control: A survey of practising veterinarians. *Journal of the American Veterinary Medical Association*, **177** (12): 1212-1215.

Lemeshow, S., Klar, J., Teres, D., Avrunin, J.S., Gehlbach, S.H., Rapoport, J. and Rue, M. (1994) Mortality probability models for patients in the intensive care unit for 48 and 72 hours: A prospective multicenter study. *Critical Care in Medicine*, **22**, 1351-1358.

Lessard, P., L'Eplattenier, R., Norval, R.A.I., Kundert, K., Dolan, T.T., Croze, H., Walker, J.B., Irvin, A.D. and Perry, B.D. (1990) Geographical information systems for studying the epidemiology of diseases caused by *Theileria parva*. *The Veterinary Record*, **126**: 255-262.

Levy, P.S. and Lemeshow, S. (1991) *Sampling of Populations: Methods and Applications*. John Wiley & Sons Inc., New York, ISBN 0-471-50822-5.

Lilienfeld, D.E. and Stolley, P.D. (1994) *Foundations of Epidemiology*. Oxford University Press, New York, Oxford, ISBN 0-19-505036-3.

Lilly, D. (1995) Developing a strategic marketing system. Proceedings: *MapWorld '95*, 2nd Annual MapInfo User Conference, Orlando.

Lindblom, G.B., Sjorgen, E. and Kaijser, B. (1986) Natural Campylobacter colonisation in chickens raised under different environmental conditions. *Journal of Hygiene*, **96** (3): 385-391.

Lovett, A.A. (1992) GIS and health services. *The Yearbook of the Association for Geographic Information 1992/93*. Taylor & Francis Ltd., 4 John Street, London WC1N 2ET, ISBN 0-7480-0046-X, pp. 119-122.

Lumsden, J.M., Stick, J.A., Caron, J.P. and Nickels, F.A. (1994) Surgical treatment for epiglottic entrapment in horses: 51 cases (1981-1992). *Journal of the American Veterinary Medical Association*, **205** (5): 729-735.

McGreevy, P.D., Cripps, P.J., French, N.P., Green, L.E. and Nicol, C.J. (1995a) Management factors associated with stereotypic and redirected behaviour in the Thoroughbred horse. *Equine Veterinary Journal*, **27** (2): 86-91.

McGreevy, P.D., French, N.P. and Nicol, C.J. (1995b) The prevalence of abnormal behaviours in dressage, eventing and endurance horses in relation to stabling. *The Veterinary Record*, **137**: 36-37.

Macro International Inc. (1996) *Sampling Manual*. Demographic and Health Surveys Phase III basic Documentation No. 6, Calverton, Maryland.

Marsh, W.E., Damrongwatanapokin, T., Larntz, K. and Morrison, R.B. (1991) The use of a geographic information system in an epidemiological study of pseudorabies (Aujeszky's disease) in Minnesota swine herds. *Preventive Veterinary Medicine*, **11**: 249-254.

Mayhew, E. (1881) *The Illustrated Horse Doctor*. 12th Edition, W.H. Allen, London.

Mellor, D.J., Reid, S.W.J., Irwin, T., Love, S. and Gettinby, G. (1994) The development of EQWISE - Equine Welfare Information System / Expert. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine, Belfast*, 148-154.

Mellor, D.J., Reid, S.W.J., Irwin, T., Love, S. and Gettinby, G. (1995) An information system for the delivery of equine disease models. *Building a Man in the Machine: Computational Medicine, Biotechnology and Public Health*, Part III, ISBN 981-02-2500-8, pp. 1430 - 1437.

Michael, E. (1993) Mathematical modelling of disease epidemiology. *Parasitology Today*, **9**: 397-399.

Miller, R.A. and Massarie, jr., F.E. (1989) Use of the quick medical reference program as a tool for medical education. *Methods of Information in Medicine*, **28**: 340-345.

Ministry of Agriculture Fisheries and Food & Department of Agriculture and Fisheries for Scotland (1968). *A Century of Agricultural Statistics 1866-1966*. HMSO, London.

Ministry of Agriculture Fisheries and Food, Scottish Office Department of Agriculture and Fisheries and Welsh Office Agricultural Department (1991) *Animal Health 1990 The Report of the Chief Veterinary Officer*. HMSO, ISBN 0 11 242917 3.

Ministry of Agriculture Fisheries and Food, Scottish Office Department of Agriculture and Fisheries and Welsh Office Agricultural Department (1992) *Animal Health 1991 The Report of the Chief Veterinary Officer*. HMSO, ISBN 0 11 242 9335.

Ministry of Agriculture Fisheries and Food, Scottish Office Department of Agriculture and Fisheries and Welsh Office Agricultural Department (1993) *Animal Health 1992 The Report of the Chief Veterinary Officer*. HMSO, ISBN 0 11 242943 2.

Ministry of Agriculture Fisheries and Food, Scottish Office Department of Agriculture and Fisheries and Welsh Office Agricultural Department (1994) *Animal Health 1993 The Report of the Chief Veterinary Officer*. HMSO, ISBN 0 11 242979 3.

Ministry of Agriculture Fisheries and Food, Scottish Office Department of Agriculture and Fisheries and Welsh Office Agricultural Department (1995) *Animal Health 1994 The Report of the Chief Veterinary Officer*. HMSO, ISBN 0 11 242989 0.

Ministry of Agriculture Fisheries and Food (1996) Personal communication.

Moll, H.D., Pelzer, K.D., Pleasant, R.S. and Modransky, P.D. (1995) A survey of equine castration complications. *Journal of Equine Veterinary Science*, **15** (12): 522-526.

Morris, R.S., Sanson, R.L., McKenzie, J.S. and Marsh, W.E. (1993) Decision support systems in animal health. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine, Exeter*, 188-199.

Nassar, R., Mosier, J.E. and Williams L.W. (1984) Study of the feline and canine populations of the Greater Las Vegas area. *American Journal of Veterinary Research*, **45** (2): 282-287.

Niebauer, L. and Nutting, P.A. (1994) Practice-based research networks: The view from the office. *The Journal of Family Practice*, **38** (4): 409-414.

Nielen, M., Jalvingh, A.W., Dijkhuizen, A.A. and Lattuda, R. (1996) Requirements of a geographical information system to be used during a foot-and-mouth disease outbreak. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, Glasgow, 178-184.

Nielsen, J. (1990) *Hypertext and Hypermedia*. Boston, Academic Press, 1990.

Nutting, P.A. and Green, L.A. (1994) Practice-based research networks: Reuniting practice and research around the problems most of the people have most of the time. *The Journal of Family Practice*, **38** (4): 335-336.

Paage, J. (1995) Mapping the distribution of health care resources. Proceedings: *MapWorld '95*, 2nd Annual MapInfo User Conference, Orlando.

Partlow, G.D., Fisher, K.R.S., Page, P.D., MacMillan, K. and Walker, A.F. (1993) Prevalence and types of birth defects in Ontario swine determined by mail survey. *Canadian Journal of Veterinary Research*, **57** (2): 67-73.

Paterson, A.D. (1995) Problems encountered in the practical implementation of Geographical Information Systems (GIS) in veterinary epidemiology. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, Reading, 162-171.

Pfeiffer, D.U., Morris, R.S. and Sanson, R.L. (1994) Application of GIS in animal disease control - possibilities and limits. Proceedings: *World Health Organisation Consultation on the Development and Application of Geographical Methods in the Epidemiology of Zoonoses*, Wusterhausen, pp.1-14.

Piga, A.M., Lopez-Abente, G., Ibanez, A.E., Vadillo, A.G., Lanza, M.G. and Jorda, V.M. (1988) Risk factors for Paget's disease: a new hypothesis. *International Journal of Epidemiology*, **17** (1): 198-201.

Pol, L.G. and Thomas, R.K. (1992) *The Demography of Health and Health Care*. The Plenum Series on Demographic Methods and Population Analysis. Plenum Press, New York and London, ISBN 0-306-43918-6.

Pople, H.E. Jr. (1982) Heuristic methods for imposing structure on ill-structured problems: the structuring of medical diagnostics. In: P. Szolovits (editor), *Artificial Intelligence in Medicine*. Boulder, CO., Westview Press, pp. 119-190.

Proudman, C.J. (1991) A two year, prospective survey of equine colic in general practice. *Equine Veterinary Journal*, **24** (2): 90-93.

Pryse Howell, J. (1925) *Agricultural Atlas of England and Wales.* Published by direction of The Ministry of Agriculture and Fisheries by Ordnance Survey, Southampton.

Reeves, M.J., Curtis, C.R., Salman, M.D., Stashak, T.S. and Reif, J.S. (1990) A multivariable prognostic model for equine colic patients. *Preventive Veterinary Medicine*, **9** (4): 241-257.

Reeves, M.J., Curtis, C.R., Salman, M.D., Stashak, T.S. and Reif, J.S. (1991) Multivariable prediction model for the need for surgery in horses with colic. *American Journal of Veterinary Research*, **52**, 1903-1907.

Reeves, M.J. and Smith, G. (1995) The application and use of epidemiological modelling in the study of equine health problems. *Equine Veterinary Journal*, **27** (2): 84-85.

Reeves, M.J., Salman, M.D. and Smith, G. (1996) Risk factors for equine acute abdominal disease (colic): Results from a multi-center case-control study. *Preventive Veterinary Medicine*, **26**: 285-301.

Reid, S.W.J., Gettinby, G., Fowler, J.N. and Ikin, P. (1994) Epidemiological observations on sarcoids in a population of donkeys (Equus asinus). *The Veterinary Record*, **134**: 207-211.

Reid, S.W.J., Mair, T.S., Hillyer , M.H. and Love, S. (1995) Epidemiological risk factors associated with a diagnosis of clinical cyathostomiasis in the horse. *Equine Veterinary Journal*, **27** (2): 127-130.

Reid, S.W.J., Mellor, D.J., Irwin, T., Love, S. and Gettinby, G. (1996) A hypertext knowledge base medium for the delivery of epidemiological models and expert systems. *Preventive Veterinary Medicine*, **26**:97-105.

Reif, J.S. (1979) Epidemiology of equine infectious respiratory disease. *Veterinary Clinics of North America: Large Animal Practice*, **1** (1): 3-15.

Reinemeyer, C.R. and Rohrbach, B.W. (1990) A survey of equine parasite control practices in Tennessee. *Journal of the American Veterinary Medical Association*, **196** (5): 712-716.

Revie, C.W., Reid, S.W.J., Irwin, T., Mellor, D.J., Love, S., Gettinby, G. (1994) EQWISE and the Development of Diagnostic aids in Equine Coughing. *International Journal of Applied Expert Systems*, **2**, 3: 175 - 195.

Revie, C.W., McKendrick, I., Irwin, T., Gu, Y., Reid, S.W.J. and Gettinby, G. (1996) The application of hybrid information systems to decision support in the veterinary and agricultural domains. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, Glasgow, 48-57.

Rickman, J. (1796) Thoughts on the utility and facility of a general enumeration of the people of the British empire. *Gentleman's Magazine*.

Rothman, K.J. (1986) *Modern Epidemiology*. Little, Brown and Company, Boston / Toronto, ISBN 0-316-75776-4.

Rossdale, P.D., Hopes, R., Wingfield Digby, N.J. and Offord, K. (1985) Epidemiological study of wastage among racehorses 1982 and 1983. *The Veterinary Record*, **116**: 66-69.

Royal College of Veterinary Surgeons / British Veterinary Association (1994) Draft report of the joint RCVS/BVA review group on continuing professional development. *The Veterinary Record*, **134**: 244-251.

Salmon, R.L. (1997) Surveillance of infectious disease in man in the UK. In: Equine epidemiology: HBLB Workshop. Mellor, D.J. and Newton, J.R. (authors). *Equine Veterinary Journal*, **29** (2): 92-97.

Sanson, R.L., Liberona, H. and Morris, R.S. (1991) The use of a geographical information system in the management of a foot-and-mouth disease outbreak. *Preventive Veterinary Medicine*, **11**: 309-313.

Schlaud, M., Seidler, A., Salje, A., Behrendt, W. Schwartz, F.W., Ende, M., Knoll, A. and Grugel, C. (1995) Organochlorine residues in human breast milk: Analysis through a sentinel practice network. *Journal of Epidemiology and Community Health*, **49** (supplement 1): 17-21.

Schmisseur, E., Pankratz, J. and Gehman, M. (1989) XLAYER: An expert system for layer management. *Poultry Science*, **68**: 1047-1054.

The Scottish Office Agriculture, Environment and Fisheries Department (1996a) Personal communication.

The Scottish Office Agriculture, Environment and Fisheries Department (1996b) *The Cattle Passport Order-1996. Notes for Guidance*.

The Scottish Office Agriculture, Environment and Fisheries Department (1997) *Aide-Memoire for LVIs*.

Senturia, Y.D., Binns, H.J., and Christoffel, K.K. (1994) Sampling issues in a regional pediatric practice-based network. *The Journal of Family Practice*, **38** (4): 415-412.

Shuster, R., Traub-Dargatz, J. and Baxter, G. (1997) Survey of diplomates of the American College of Veterinary Internal Medicine and the American College of Veterinary Surgeons regarding clinical aspects and treatment of endotoxaemia in horses. *Journal of the American Veterinary Medical Association*, **210** (1): 87-92.

Siemiatycki, J. (1979) A comparison of mail, telephone and home interview strategies for household health surveys. *American Journal of Public Health*, **69** (3): 238-245.

Siemiatycki, J., Campbell, S., Richardson, L. and Aubert, D. (1984) Quality of response in different groups in mail and telephone surveys. *American Journal of Epidemiology*, **120**, (2): 302-314.

Singleton, G.H., and Dobson, H. (1995) A survey of the reasons for culling pregnant cows. *The Veterinary Record*, **18**: 162-165.

Sischo, W.M., Heider, L.E., Miller, G.Y. and Moore, D.A. (1993) Prevalence of contagious pathogens of bovine mastitis and use of mastitis control practices. *Journal of the American Veterinary Medical Association*, **202** (4): 595-600.

Slater, M.R. and Boothe, D. (1995) Integrating epidemiologic research and veterinary practice: Ideas and experiences. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine, Reading*, 84-90.

Slater, M.R., Hood, D.M. and Carter, G.K. (1995) Descriptive epidemiological study of equine laminitis. *Equine Veterinary Journal*, **27** (5): 364-367.

Smith, G. and Grenfell, B.T. (1994) Modelling of parasite and nematode populations: gastrointestinal nematode models. *Veterinary Parasitology*, **54**: 127-143.

Snow, J. (1855) *On the Mode of Communicating Cholera.* 2nd Edition, John Churchill, London.

Solarsh, G.C., and Dammann, D.F. (1992) A community paediatric information system - a tool for measles surveillance in a fragmented health ward. *South African Medical Journal*, **82** (2): 114-118.

Spicer, H.M., Goonewardene, L.A., McNeil, A.O. and Slack, W.L. (1994) Alberta dairy farm response. *Journal of Dairy Science*, **77**: 3460-3472.

Thirsk, J. (1978) *Horses in Early Modern England: for Service, for Pleasure, for Power.* University of Reading (The Stenton Lecture 1977), ISBN 0 7049 0208 7.

Thrusfield, M. (1989) Demographic characteristics of the canine and feline populations of the UK in 1986. *Journal of Small Animal Practice*, **30**: 76-80.

Thrusfield, M. (1995) *Veterinary Epidemiology.* 2nd Edition, Blackwell Science Ltd., 25 John Street, London, WC1N 2BL, ISBN 0-632-04036-X.

Thompson, F.M.L. (editor) (1983), *Horses in European Economic History.* Leeds University Printing Service, ISBN 0 903269 02 3.

Traub-Dargatz, J.L., Salman, M.D. and Voss, J.L. (1991) Medical problems of adult horses, as ranked by equine practitioners. *Journal of the American Veterinary Medical Association*, **198** (10): 1745-1747.

Turban, E. (1993) *Decision Support and Expert Systems.* 3rd Edition, Collier Macmillan Publishers, London.

Underhill, L.J.P. and Showalter, T.L. (1989) The wellness movement. *Equus*, **145**: 44-48, 126-127.

Urquhart, J. (1983) *Animals on the Farm: Their History from the Earliest Times to the Present Day.* MacDonald & Co., London & Sydney, ISBN 0 356 07897 3, pp.114-140.

Van Royen, W. (1954) *Atlas of the World's Resources. Volume 1. The Agricultural Resources of the World.* Prentice-Hall Inc., New York, for the University of Maryland.

Vaillancourt, J-P., Martineau, G., Morrow, M., Marsh, W. and Robinson, A. (1991) Construction of Questionnaires and their use in Veterinary Medicine. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, London, 94-106.

Vaughan, L. and Mulville, P. (1995) A survey of bovine caesarean sections in Ireland. *Irish Veterinary Journal*, **48** (11-12): 411-415.

Vos, V.L., Shreinmarkers, J.F., Bree, D.S. and Verheijden, J.H.M. (1990) The Electronic Pig: a prototype of a knowledge-based computer system for swine herd health. *Preventive Veterinary Medicine*, **9**: 95-106.

Webster, A.J.F., Clarke, A.F., Madelin, T.M. and Wathes, C.M. (1987) Air hygiene in stables 1: Effects of stable design, ventilation and management on the concentration of respirable dust. *Equine Veterinary Journal*, **19** (5): 448-453.

Weiding, J.U., Kretschmar, T. and Schlone, P.W.(1990) Development of a computer aided reference system for differential diagnostics support. *Methods of Information in Medicine*, **29**: 132-139.

Wells, S.J., Trent, A.M., Marsh, W.E., Williamson, N.B. and Robinson, R.A. (1995) Some risk factors associated with clinical lameness in dairy herds in Minnesota and Wisconsin. *The Veterinary Record*, **136**, 537-540.

Wilson, D. (1995) Mapping the oil fields of Alaska. Proceedings: *MapWorld '95*, 2nd Annual MapInfo User Conference, Orlando.

Winer, B.J., Brown, D.R. and Michels, K.M. (1991) *Statistical Principles in Experimental Design*. 3rd Edition, McGraw-Hill, Inc., New York, ISBN 0-07-070982-3.

Wood, J.L.N., Doxey, D.L. and Milne, E.M. (1994) Preliminary analysis of a matched case control study of grass sickness in the United Kingdom. Proceedings: *Society for Veterinary Epidemiology and Preventive Medicine*, Belfast, 155-166.

Woodhead, N. (1991) *Hypertext and Hypermedia: Theory and Applications*. Sigma Press.

Wortley Axe, J. (editor) (1908) *The Horse: Its Treatment in Health and Disease (volume 3)*. The London Publishing Company, 34 Southampton Street, Strand, London, pp. 535-550.

Zisman, S. (1992) GIS in estuary management: The need, the reality and the scope. *The Yearbook of the Association for Geographic Information 1992/93*. Taylor & Francis Ltd., 4 John Street, London WC1N 2ET, ISBN 0-7480-0046-X, pp. 76-81.