

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**FEMALE REPRODUCTIVE STRATEGIES AND MOTHER-CALF
RELATIONSHIPS OF COMMON DOLPHINS (*Delphinus delphis*) IN
THE HAURAKI GULF, NEW ZEALAND.**

A thesis presented in partial fulfilment of the requirements for the degree of

Master of Science

in

Zoology

at Massey University, Albany, New Zealand.

Aline Schaffar-Delaney

2004

ABSTRACT

This study reviewed the habitat use, social organisation and behaviour of common dolphin groups categorised by their youngest member, as well as the behaviour of common dolphin calves of different age classes.

Most newborn calves were sighted over late spring and early summer, and in water temperatures warmer than for other groups. The water depths at which common dolphin groups were found did not vary according to the age class of their youngest member. However, only groups containing newborns or infants were sighted under 20 metres of water depth. A high percentage of groups encountered contained calves (82.5%), suggesting the importance of the Hauraki Gulf for common dolphins' reproduction.

Groups of common dolphins containing calves were found to be of larger size than any other group type. All groups proved to be similarly involved in different behavioural states and showed comparable patterns of association with other species, although groups including newborns were significantly less likely to be seen associated with whales and birds. Groups of common dolphins as a whole did not show a differential reaction to the boat according to the age class of their youngest member. However, mothers and their young calves kept greater distances to the boat than mothers and older calves did, suggesting that the boat may be perceived as a threat during the newborn period.

Most of the behaviours that characterise mother-calf relationships varied according to calf age class. The occurrence, frequency, duration and distance of separations increased with older aged calves. A similar increase was found in the time spent without the mother, in the occurrence of association with non-mother dolphins, in the time spent in 'echelon position', and in both mothers' and calves' dive time. Mothers also had longer dive times than calves. Older aged calves tend to present the lowest proportion of synchronous breaths. These changes are likely to represent a gradual increase in calves' independence.

Results from this study have extended our knowledge of common dolphins' reproductive ecology, demonstrated that studies of mother-calf relationships in pelagic species of dolphins can be achieved, and allowed future research needs to be identified and management recommendations to be made.

ACKNOWLEDGEMENTS

Firstly, my deepest thanks go to my supervisor, Dr Mark Orams, for giving me the opportunity to conduct this project, and for his precious advice and support in the completion of my thesis. This project could not have been achieved without the participation of ‘Dolphin Explorer’, and I sincerely thank all the crew, both on land and at sea, for supporting my research and integrating me into the team. A special thanks to Joanna Keane, Andy Light and Keith Algie for their valuable friendship and for teaching me what my years of university hadn’t. I would like to express my gratitude to the late Stephen Stenbridge for his enterprise of combining the commercial and academic worlds. This work is a result of his honourable ambition.

I would also like to thank Associate Professor C. Scott Baker from The University of Auckland, as well as all the students under his supervision for their great welcome and valuable advice. I’m also grateful to my friends and colleagues Karen Stockin and Nicky Wiseman, who have helped me with this project in many ways. Thanks to Associate Professor Denny Meyer for her assistance regarding the statistical analyses used in this study. Vicky Binedell (Royal Society of New Zealand Teacher Fellow 2004) also deserves my greatest thanks for answering my endless questions; her help throughout the last months of this thesis has been inestimable.

I’m indebted to all the volunteers who worked on ‘Dolphin Explorer’ during the course of this study and assisted me during field observations. I’m especially grateful to Géraldine de Montpellier who was of great help in different aspects of this project, from data entry to shared traditions. A special thanks also goes to my friend Dirk Neumann for showing me my first common dolphins and so much more. Without the support and care of my husband Gregory, this project would not have been the same adventure and I thank him for his patience.

Finally, I would like to most sincerely thank my family in France, and especially my parents François and Christiane, for believing in me since day one and helping me realise the dreams that took me so far away from home. I dedicate this thesis to them.

This project was financially supported by Project AWARE Foundation and the Conseil Général du Haut-Rhin.

TABLE OF CONTENTS

Chapter 1: INTRODUCTION	1
Chapter 2: LITERATURE REVIEW	6
1) Introduction	6
2) Species biology	8
2.1. Taxonomy	8
2.2. Biology	9
2.3. Distribution and abundance	12
2.4. Ecology of common dolphins	15
- Habitat	15
- Group characteristics and social organisation	17
- Feeding ecology	18
- Vocalisation	19
- Conservation ecology	20
3) Reproduction	21
3.1. Reproductive ecology	21
- Gestation	21
- Reproductive rate	22
- Parturition	22
- Physical characteristics at birth and calf growth	23
- Lactation and weaning	28
- Sexual maturity	32
3.2. Reproductive ecology	33
- Mating system	33
- Calving and mating	34
- Calf development and mother-calf relationships	37
- Allomaternal behaviour	41
4) Conclusion and hypotheses	42
4.1. Influence of environmental variables on group type	43
4.2. Influence of group size on group type	44

4.3. Influence of group type on the behaviour of common dolphins	44
4.4. Mating season	44
4.5. Development of common dolphin calves' behaviour	44
4.6. Allomaternal behaviour	46
4.7. Grouping patterns	46
Chapter 3: METHODS	47
1) Introduction	47
2) Location of study	48
3) Research vessel	51
4) Data collection	53
5) Observational methods	56
5.1. Follow protocols	56
5.2. Sampling methods	57
- Environmental variables	57
- Group follows	58
<i>a. Group definition</i>	58
<i>b. Group size and composition</i>	60
<i>c. Behaviours</i>	64
Activity state	66
Events	67
<i>d. Association with other species</i>	69
<i>e. Behaviour towards the boat</i>	70
- Focal mother-calf follows	71
<i>a. Swimming position</i>	72
<i>b. Proximity and separations</i>	73
<i>c. Nursing</i>	76
<i>d. Synchrony and dive time</i>	76
<i>e. Behaviour towards the boat</i>	78
<i>f. Allomaternal behaviour</i>	78
<i>g. Association with other mother-calf pairs</i>	79
<i>h. Foetal folds</i>	79

6) Data analysis	80
7) Summary	86
Chapter 4: RESULTS	87
1) Introduction	87
2) Field effort	89
3) Group composition	89
4) Influence of environmental variables on group type	94
4.1. Water depth	94
4.2. Water temperature	97
4.3. Season	99
5) Influence of group size on group type	108
6) Influence of group type on the behaviour of common dolphins	108
6.1. Behavioural state	108
6.2. Association with other species	110
6.3. Reaction to the boat	115
- Reaction of groups to the boat	115
- Reaction of mother-calf pairs to the boat	118
7) Mating season	122
8) Behavioural development of common dolphin calves	128
8.1. Swimming position	128
8.2. Separations	130
- Occurrence and frequency	130
- Duration of separation	133
- Distance of separation	136
8.3. Proximity	136
8.4. Nursing position	138
8.5. Breathing synchrony	138
8.6. Dive time	142
9) Escorting behaviour	146
10) Grouping patterns	149
11) Other calf characteristics	151
12) Summary	153

Chapter 5: DISCUSSION	156
1) Introduction	156
2) Environmental influences	158
2.1. Breeding seasonality and water temperature	158
2.2. Mating season	161
2.3. Water depth	162
2.4. Role of the Hauraki Gulf for common dolphins	164
3) Social organisation and behaviours	165
3.1. Group size	165
3.2. Association between mother-calf pairs	168
3.3. Feeding and association with other species	169
3.4. Reaction to the boat	170
4) Calf development	172
4.1. Mother-calf relationships	172
- Mother-calf separations	172
- Escorting behaviour	174
- Swimming position	175
- Breathing synchrony	177
- Dive time	178
- Nursing	179
4.2. Foetal folds	179
4.3. Other calves' behavioural characteristics	180
5) Research platform	181
6) Summary	183
Chapter 6: CONCLUSION	185
1) Summary	185
2) Limitations and significance	189
3) Future research	191
4) Management recommendations	192
5) Conclusion	194

REFERENCES	195
APPENDIX 1	219
APPENDIX 2	221

LIST OF FIGURES

Figure 1. Thesis structure diagram	5
Figure 2. Structure diagram of the 'Literature review' chapter	7
Figure 3. Distribution of common dolphins worldwide	13
Figure 4. Distribution of common dolphins around New Zealand	14
Figure 5. Structure diagram of the 'Methods' chapter	49
Figure 6. Map of the Hauraki Gulf	50
Figure 7. Search routes	54
Figure 8. Structure diagram of the 'Results' chapter	88
Figure 9. Breathing frequency of a mother-calf pair	148
Figure 10. Structure diagram of the 'Discussion' chapter	157
Figure 11. Structure diagram of the 'Conclusion' chapter	186

LIST OF TABLES

Table 1. Research effort	90
Table 2. Summary of group and focal follows	91
Table 3. Observations of common dolphins under 20 metres of depth	96
Table 4. Mean number of calves sighted per season	101
Table 5. Initiator of overlapping surfacing	144
Table 6. Association between mother-calf pairs	152

LIST OF GRAPHS

Graph 1. Percentage of observations of each group type	92
Graph 2. Number of calves	93
Graph 3. Mean water depth for each group type	95
Graph 4. Distribution of water depths for each group type	95
Graph 5. Mean water temperature for each group type	98
Graph 6. Percentage of observations of group type 1 (newborn) per month	100
Graph 7. Percentage of observations of group type 1 (newborn) per season	100
Graph 8. Percentage of observations of group type 2 (infant) per month	102
Graph 9. Percentage of observations of group type 2 (infant) per season	102
Graph 10. Percentage of observations of group type 3 (juvenile) per month	103
Graph 11. Percentage of observations of group type 3 (juvenile) per season	103
Graph 12. Percentage of observations of group type 4 (adult) per month	105
Graph 13. Percentage of observations of group type 4 (adult) per season	105
Graph 14. Inter-relationships between water temperature, occurrence of group type 1 and seasons	106
Graph 15. Inter-relationships between water temperature, occurrence of group type 2 and seasons	106
Graph 16. Inter-relationships between water temperature, occurrence of group type 3 and seasons	107
Graph 17. Inter-relationships between water temperature, occurrence of group type 4 and seasons	107
Graph 18. Mean group size for each group type	109
Graph 19. Percentage of observations of feeding for each group type	111
Graph 20. Percentage of observations of travelling for each group type	111
Graph 21. Percentage of observations of milling for each group type	112
Graph 22. Percentage of observations of resting for each group type	112
Graph 23. Percentage of observations of socialising for each group type	113
Graph 24. Percentage of association with other species for each group type	114
Graph 25. Percentage of association with birds and whales for each group type	116

Graph 26. Percentage of association with birds only for each group type	116
Graph 27. Percentage of association with whales only for each group type	117
Graph 28. Percentage of observations of avoidance for each group type	119
Graph 29. Percentage of observations of neutral reaction for each group type	119
Graph 30. Percentage of observations of attraction to the boat for each group type	120
Graph 31. Mean minimum distance to the boat for each group type	121
Graph 32. Mean minimum distance to the boat for each calf age class	123
Graph 33. Percentage of observations of mating behaviours per month	125
Graph 34. Percentage of observations of mating behaviours per season	125
Graph 35. Percentage of observations of mating behaviours involving genital contact per month	126
Graph 36. Percentage of observations of mating behaviours involving genital contact per season	126
Graph 37. Percentage of observations of mating behaviours without genital contact per month	127
Graph 38. Percentage of observations of mating behaviours without genital contact per season	127
Graph 39. Percentage of observations of 'echelon position' swimming for each calf age class	129
Graph 40. Percentage of observations of 'infant position' swimming for each calf age class	129
Graph 41. Mean percentage of time spent in 'echelon position' for each calf age class	131
Graph 42. Mean percentage of time spent in 'infant position' for each calf age class	131
Graph 43. Percentage of observations of separations for each calf age class	132
Graph 44. Mean frequency of separation per five-minute interval for each age class	134
Graph 45. Mean maximum duration of separation for each calf age class	134
Graph 46. Mean percentage of time spent without the mother for each calf age class	135
Graph 47. Mean maximum distance of separation for each calf age class	137

Graph 48. Percentage of observations of nursing position for each calf age class	139
Graph 49. Percentage of observations of synchronous and calves' solitary surfacing for each calf age class	141
Graph 50. Mean frequency of synchronous and calves' solitary surfacing per five-minute interval for each age class	141
Graph 51. Percentage of observations of overlapping surfacing for each calf age class	143
Graph 52. Mean frequency of overlapping surfacing per five-minute interval for each age class	143
Graph 53. Mean dive time of mothers and calves for each calf age class	145
Graph 54. Mean difference between mothers' and calves' dive time for each age class	147
Graph 55. Percentage of observations of escorting behaviour for each calf age class	150

LIST OF PLATES

Plate 1. Common dolphin colouration	10
Plate 2. Size of common dolphin calf	24
Plate 3. Difference of colouration between a common dolphin calf and its mother	26
Plate 4. Common dolphin calf featuring foetal folds	27
Plate 5. Common dolphin newborn showing bent dorsal fin	29
Plate 6. Research vessel 'Dolphin Explorer'	52
Plate 7. Common dolphin newborn	62
Plate 8. Common dolphin infant	63
Plate 9. Common dolphin juvenile	65
Plate 10. Two mother-calf pairs in association with calves showing different swimming positions	74
Plate 11. Common dolphin calf in nursing position	77

EXPLANATION OF TERMS

Calf age classes

Common dolphin calves were categorised according to their size relative to that of their mothers.

Infant: individual around half the size of the mother.

Juvenile: individual around two-thirds the size of the mother.

Newborn: individual noticeably less than half the size of the mother.

Group and individual identification

Adult: all individuals that are neither newborns, nor infants or juveniles.

Calf: general term designating non-adult dolphins and including newborns, infants and juveniles.

Group: dolphins observed in close proximity, within 200 metres of each other, and in apparent association, moving in the same direction or engaged in the same behaviour.

Mother: adult individual consistently associated with a smaller animal.

Group type

Each group of common dolphins was categorised according to the age class of its youngest member.

Group type 1: the youngest member of the group was a newborn calf.

Group type 2: the youngest member of the group was an infant.

Group type 3: the youngest member of the group was a juvenile.

Group type 4: group composed only of adults.

Activity state (definitions derived from Shane *et al.*, 1986; and Shane, 1990a)

Feeding: dolphins are involved in an effort to capture and consume prey. They are observed herding and chasing fish.

Milling: dolphins remain within a given area, not moving in any definite direction, and continuously changing their heading.

Resting: dolphins are grouped in a tight formation and are moving slowly at the surface in a co-ordinated manner, and in one particular direction.

Socialising: dolphins are essentially involved in social behaviours, such as mating, rubbing and playing. Much physical interaction and surface displays can be observed.

Travelling: dolphins are all moving at a sustained speed in a persistent direction.

Mother-calf relationships

Allomaternal behaviour: association of a calf with a non-mother dolphin.

Calf solitary surfacing: calf breaks the surface of the water for a breath on its own.

Echelon position: calf is swimming alongside its mother, paralleling her course less than 30cm from her side.

Infant position: calf is swimming underneath its mother.

Nursing position: the calf's rostrum is in contact with the mother's mammary slit area for over two seconds.

Overlapping surfacing: mother and calf break the surface of the water one immediately after the other, resulting in a breathing overlap.

Separation: observable increase (>1 metre) in the distance between a calf and its mother.

Synchronous surfacing: mother and calf break the surface of the water in perfect unison.

Reaction to the boat

Attraction: the dolphins are coming towards the boat, swimming at the bow for extended periods of time and staying around the boat even if stopped.

Avoidance: dolphins are continuously changing their heading away from the boat.

Neutral: no observable reaction or change in the behaviour of the dolphins can be noticed, they are not attracted to the boat and neither avoiding it.

Mating behaviours

Mating behaviours with genital contact: genital-to-genital presentation, beak-to-genital contact.

Mating behaviours without genital contact: non-genital contact including rubbing, chase, leap, head slap.

Oceanographic seasons

Summer: January to March.

Autumn: April to June.

Winter: July to September.

Spring: October to December.

Chapter 1: INTRODUCTION

Common dolphins (*Delphinus delphis*) represent one of the most abundant and most widely distributed species of cetaceans (Evans, 1987). They can be found in all oceans and all seas of the world, and their abundance has been estimated to a few million (Gaskin, 1992). Paradoxically, common dolphins also represent one of the least studied species to date, and our knowledge on many aspects of their life history and behaviours appears to be rather limited.

For many years, post-mortem data from stranding events and fisheries by-catch have represented the only source of information available on common dolphins. Scientific investigations of wild populations of common dolphins have indeed been restricted by several of the factors that characterise the species. Common dolphins usually inhabit deep offshore waters that can prove difficult to access on a regular basis for researchers (Evans, 1987). Therefore, many of the observations made on wild common dolphins have remained of anecdotic status. Common dolphins are also mostly found in relatively large and fast moving groups (Dawson, 1985; Evans, 1994), limiting the range of data that can be collected, as well as the possibility of studying individual animals. As a result, most of the information found in the literature regarding common dolphins relates to their anatomy, genetics, and biology, and many of the questions regarding social organisation that have been answered for other cetacean species have not yet been addressed for common dolphins.

In order to enhance our knowledge of common dolphins, a few recent studies have focused on documenting the behaviour and ecology of the species. The identification of common dolphin populations located closer to shore, and the use of consistent surveys, have enabled these studies to gather relevant information on the distribution and abundance of the species in different locations (Bearzi *et al.*, 2003; Neumann, 2001; Cañadas *et al.*, 2002; Dohl *et al.*, 1986; Goold, 1998; Selzer and Payne, 1988), as well as on seasonal movements (Dohl *et al.*, 1986; Forney and Barlow, 1998; Yukhov *et al.*, 1986; Bearzi *et al.*, 2003; Würsig *et al.*, 1997; Neumann, 2001; Goold, 1998; Selzer and Payne, 1988), and feeding strategies and activity budgets (Neumann, 2001). Some insights into common dolphins' social organisation were also provided by the study

conducted by Neumann (2001). Although these findings provide basic data on common dolphins and constitute the foundation for further research to take place, several other aspects of common dolphins' behaviour need to be investigated in order to reach a better understanding of the population dynamics of the species. The main goal of this study is to redress the lack of information in certain areas of our knowledge of common dolphins, and more specifically to contribute to an increased understanding of their reproductive ecology.

The importance of studying the reproductive patterns of a species in order to comprehend its social organisation has been emphasised by several authors (Townsend, 1935; Sverdrup *et al.*, 1942; Whitehead and Mann, 2000; Thayer *et al.*, 2003). In fact, reproduction is one of the main drivers of animals' social behaviour, and as such, it has been identified as being the source of most of the behavioural biology that characterise a species (Townsend, 1935; Sverdrup *et al.*, 1942). In cetaceans, only females actively parent and therefore, their role as a mother represents a fundamental element of any whale or dolphin population and is likely to influence its social structure (Whitehead and Mann, 2000). For these reasons, investigating the reproductive strategies used by female cetaceans appears to be of primary importance in order to appreciate the dynamics of a population (Whitehead and Mann, 2000; Thayer *et al.*, 2003).

The only delphinid species for which female reproductive strategies and mother-calf relationships have been extensively studied is the bottlenose dolphin (*Tursiops truncatus*) (Evans, 1987; Whitehead and Mann, 2000). These studies have emphasised the conditions favoured by females in the production and care of their young, and this has led to an enhanced understanding of the behavioural ecology of the species (Mann and Smuts, 1998, 1999; Mann *et al.*, 2000). In the field of reproductive ecology, breeding seasonality represents the only variable ever investigated for common dolphins. However, many studies have relied on the analysis of postmortem specimens, which may not always provide reliable conclusions (Fernandez and Hohn, 1998). Observations of wild populations have led to some interesting results, but the significance of breeding seasonality for the species has never been discussed.

In an attempt to obtain an insight into female reproductive strategies and mother-calf relationships in common dolphins, a 14-month study was conducted in the Hauraki

Gulf, New Zealand. The waters of the Hauraki Gulf provide a great opportunity to further our knowledge of common dolphins. Compared to other locations worldwide, common dolphins can be found in relatively shallow waters and in smaller groups (O'Callaghan and Baker, 2002), allowing observations to take place on a daily basis and providing suitable conditions to monitor their behaviour. Common dolphins are also found year-round in the Hauraki Gulf, which enables the investigation of temporal patterns such as breeding seasonality. The objectives for this study are represented by the following general research questions:

- 1) Do the common dolphins in the Hauraki Gulf display reproductive seasonality?
- 2) What are the specific characteristics of common dolphin groups containing calves?
- 3) What is the role of the Hauraki Gulf for female common dolphins?
- 4) What are the behavioural patterns that describe the relationships between calves of different age and their mothers?

Answering these questions will have different beneficial outcomes. Firstly, it will enable us to increase our knowledge of common dolphins in a field never investigated before for the species. Secondly, due to the important role of mother-calf relationships within cetacean populations, a better understanding of females' reproductive strategies will lead to a better appreciation of the potential effects of different growing threats on the dolphins. Thirdly, the results of this study will provide baseline data on different characteristics of common dolphin groups, as well as on mother-calf relationships. The importance of baseline observations has been emphasised by different authors, especially in investigating the impact of tourism on the dolphins (Bejder and Dawson, 1999; Constantine, 1999), as they enable the identification of subsequent changes in the behaviour of the animals, and allow researchers to consider them relative to changes in their environment.

The content of this thesis is set as follows (Figure 1):

Chapter 2 presents a review of the current literature available on common dolphins, as well as on mother-calf relationships in other delphinid species. Based on this knowledge, specific hypotheses are developed in order to investigate the general research questions outlined above. The methods used to collect data during field observations are described in chapter 3. In chapter 4, the results of the statistical

analysis conducted on the empirical data are presented for each of the hypotheses investigated in this study. In chapter 5, results on common dolphins' breeding seasonality, on the characteristics of common dolphin groups containing calves, and on common dolphin calves' development are discussed in light of other studies conducted on similar topics. The significance of each of these results is also reviewed. Finally, chapter 6 summarises the main findings of this study, outlines their implications for the common dolphins of the Hauraki Gulf, and includes suggestions for future research and recommendations for the conservation of the species.

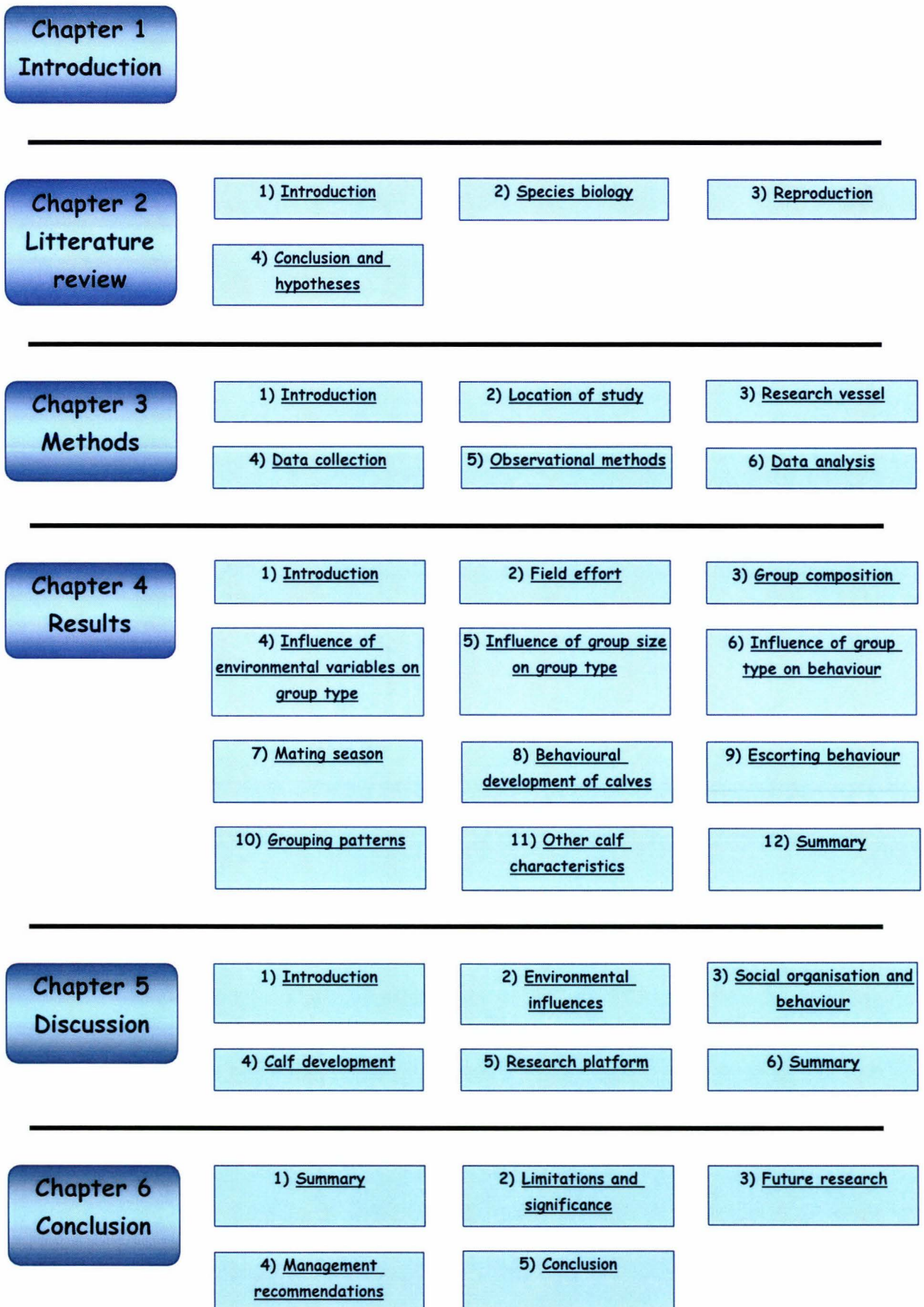


Figure1. Thesis structure diagram