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The influence of multi-species feeding associations on the foraging behaviour of Australasian gannets (*Morus serrator*) in the Hauraki Gulf, New Zealand

A thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Conservation Biology

Massey University
Auckland, New Zealand

Cameron Mackenzie Purvin
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“It is good to have an end to journey toward; but it is the journey that matters, in the end.”

- Ernest Hemingway
Abstract

In order to successfully capture prey in a challenging and physically demanding environment, Australasian gannets (*Morus serrator*) have developed a number of foraging strategies. Foremost among such strategies is the joining in formation of mixed species feeding associations (MSFA’s) and the use of specialised plunge diving behaviours. This study sought to determine how gannets vary individual and group plunge diving behaviours in order to maximise the benefits and mitigate the risks associated with feeding in densely packed, highly active MSFA’s.

Specifically this study’s aims are to examine how variations in gannet dive heights, angles and completion rates are influenced by external stimuli, including weather parameters, oceanographic conditions and MSFA’s species composition and behaviour. This study additionally seeks to examine what mixed and/or con-specific cues are associated with the formation of synchronous diving bouts, and determine its role as a form of local enhancement for gannets foraging in MSFA’s.

Between March 2013 and June 2014, 45 independent boat based surveys were conducted aboard *Dolphin Explorer*, a 20m tour boat based in New Zealand’s Hauraki Gulf. Using a Canon XH A1S high definition video camera, approximately 11.9hrs of MSFA video footage was collected, containing 5565 recorded gannet plunge dives. Variations in these dives, including their height, angle of entry, and synchronous timing were examined in context of environmental variables including wind speeds, sea surface temperatures, and Beaufort sea states as well as against MSFA variables including the abundance of other foraging gannets, the abundance and behaviour of common dolphins (*Delphinus* sp.), and the presence of other species including shearwaters (*Puffinus* spp.), petrels (*Fregetta* spp.), terns (*Sterna* spp.), and Bryde’s whales (*Balaenoptera edeni*).

While weather influences were found to have minimal effects on gannet dive behaviours, higher winds were associated with lower altitude dives, and less frequent synchronous diving bouts. This is likely due to the decreased visibility of deeper prey caused by increased surface disturbances as a result of higher wind speeds, coupled with the inherent difficulties of performing highly coordinated aerial manoeuvres in high wind conditions.

Increased gannet flock sizes were found to correlate with more frequent high-altitude 90° dives, and increased rates of dive synchrony. This may be a result of the need to better coordinate dives in denser assemblages of con-specifics to avoid collisions, coupled with the increased foraging success associated with larger foraging groups, and local enhancement.

Increased foraging dolphin pods were also associated with more frequent high-altitude vertical dives. This may result from gannets capitalising on the increased bait-ball density and stability associated with larger foraging pods by taking deeper dives in order to make multiple prey captures with greater ease. Gannet synchrony,
however, was only found to decrease in the smallest dolphin pods, again attributed to the decreased foraging abilities of smaller pods.

Dolphin foraging behaviours most associated with the maintenance of dense stationary bait-balls were most heavily associated with high, vertical gannet dives, and increased gannet synchronous dives. This is likely the result of gannets capitalising on denser prey assemblages by taking deeper dives in pursuit of multiple prey capture.

The presence of Bryde's whales at MSFA's was found to decrease the frequency of both high vertical dives and synchronous dives, as lunge feeding on bait-balls scatters fish and decreases prey density.

The presence of hetero-specific avian species had various effects on gannet dive behaviours. Most notably, the presence of shearwaters and petrels was found to be associated with greater frequencies of low altitude gannet dives, thought to be a result of an increased collision risk in their presence. Terns meanwhile were associated with decreased dive synchrony, possibly as a result of false hetero-specific signalling caused by their white plumage.
**TABLE OF CONTENTS**

<table>
<thead>
<tr>
<th>Acknowledgements</th>
<th>Page Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>i</td>
</tr>
<tr>
<td>List of Figures</td>
<td>vii</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>vi</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>iii</td>
</tr>
</tbody>
</table>

### 1.0 Introduction

1.1 The Importance of Foraging

1.2 Challenges of Foraging in a Marine Environment

1.2.1 Challenges of Foraging in a Marine Environment (Seabirds)

1.3 Australasian Gannets (Morus serrator)

1.3.1 Australasian Gannet Foraging Ecology

1.4 Plunge Diving Behaviour

1.5 Common Dolphin (Delphinus sp.)

1.5.1 Common Dolphin Foraging Behaviour

1.6 Bryde’s Whale (Balaenoptera edeni)

1.7 Mixed Species Feeding Associations (MSFA’s)

1.8 Synchronous diving

### 2.0 Aims

2.1 Plunge Diving

2.2 MSFA’s

2.3 Dive Synchrony

### 3.0 Methods And Materials

3.1 Study Site

3.2 Data Collection

3.2.1 Research Vessel

3.2.2 Approach and Data Collection

3.3 Data Analysis

3.3.1 Gannet Dive Mechanics

3.3.2 External Influences on Gannet Diving Behaviour

3.3.3 Synchronised Plunge Diving

### 4.0 Results

4.1 Field Effort

4.2 Diving Mechanics

4.2.1 Dive Completions

4.2.2 Diving Altitude

4.2.3 Diving Angle

4.3 Gannet Flock Size Influence on Dive Mechanics

4.4 Influence of Environmental Factors in Plunge Diving Tactics

4.4.1 Wind

4.4.2 Sea Surface Temperature (SST)

4.4.3 Water Depth

4.5 Influence of Hetero-specifics On Gannet Plunge Diving Mechanics

4.5.1 Dolphin Pod Size Influence on Dive Mechanics

4.5.2 Dolphin Behaviour Influence on Dive Mechanics

4.5.3 Bryde's Whale Presence Influence on Dive Mechanics

4.5.4 Hetero-specific Seabird Presence Influence on Dive Mechanics
4.6 Synchronous Diving Bout Formation

4.6.1 Influence of Environmental Factors on Synchronous Diving Bout Formation

4.7 MSFA’s Species Composition influence on Dive Synchrony Bout Formation

4.7.1 Gannet Flock Size Influence on Synchronous Diving Bout Formation

4.7.2 Dolphin Pod Size Influence on Synchronous Diving Bout Formation

4.7.3 Dolphin Behaviour Influence on Synchronous Diving Bout Formation

4.7.4 Bryde’s Whale Influence on Synchronous Diving Bout Formation

4.7.5 Hetero-specific Seabird Presence Influence on Synchronous Diving Bout Formation

5.0 Discussion

5.1. Diving Mechanics

5.2 Influence of Weather on Diving Mechanics

5.3 Influence of MSFA Composition on Diving Mechanics

5.3.1 Gannet Flock Size Influence on Dive Mechanics

5.3.2 Dolphin Pod Size Influence on Dive Mechanics

5.3.3 Influence of Dolphin behaviour on Dive Mechanics

5.3.4 Influence of Bryde’s Whale presence on Dive Mechanics

5.3.5 Hetero-specific Seabird Presence Influence on Synchronous Diving Bout Formation

5.4 Diving Synchrony

5.5 Influence of Environmental Factors on Synchronous Diving Bout Formation

5.6 MSFA’s Species Composition influence on Synchronous Diving Bout Formations

5.6.1 Gannet Flock Size Influence on Synchronous Diving Bout Formations

5.6.2 Dolphin Pod Size Influence on Synchronous Diving Bout Formation

5.6.3 Dolphin Behaviour Influence on Synchronous Diving Bout Formation

5.6.4 Bryde’s Whale Influence on Synchronous Diving Bout Formation

5.6.5 Hetero-specific Seabird Presence Influence on Synchronous Diving Bout Formation

5.7 Conclusions

5.7.1 Plunge Diving

5.7.2 MSFA’s

5.7.3 Dive Synchrony

5.8 Study Limitations

5.9 Future Research

6.0 References
List of Abbreviations  (in alphabetical order)

hrs...............hours

km/h.............kilometres per hour

Kw..............kilowatt

L..............litre

m..............meters

m/s.............meters per second

List of Figures

Figure 1. Relationship between gannet foraging pressures and behavioural adaptations: Page 2.
Figure 2. Photo of Australasian gannet in the Hauraki Gulf, New Zealand: Page 6.
Figure 3. Variations in gannet dive profiles: Page 11.
Figure 4. Dolphins’ line-abreast foraging behaviour: Page 15.
Figure 5. Dolphins’ carouselling foraging behaviour: Page 15.
Figure 6. A map of the study location and geography of the Hauraki Gulf, New Zealand: Page 25.
Figure 7. Photo of research vessel Dolphin Explorer: Page 26.
Figure 8. Stages of a gannet plunge dive: Page 29
Figure 9. Synchronised plunge-diving in different diving bouts of gannets Page 34.
Figure 10. The total ratio of dive profiles recorded in foraging gannets Page 37.
Figure 11. The percentage of different dive angles recorded in different sized gannet flocks Page 39.
Figure 12. The percentages of different dive heights recorded in different sized flocks of foraging: Page 40.
Figure 13. The total percentage of each dive tactic recorded in different foraging gannet flock sizes: Page 41.
Figure 14. The percentage of gannet dive initiation heights recorded in various wind speeds: Page 42.
Figure 15. The percentage of gannet dive angles recorded under various wind conditions: Page 43.
Figure 16. The total percentage of each dive tactic recorded in foraging events occurring in different wind speeds: Page 44.
Figure 17. The variations and trend of increasing dive height frequencies in gannets as affected by increasing SST: Page 45.
Figure 18. The percentages of gannet dive angles recorded in various dolphin pod sizes: Page 47.
Figure 19. The percentage of gannet dive heights recorded in different sized foraging dolphin pods: Page 48.
Figure 20. The total percentage of each dive tactic recorded in feeding events occurring in different sized dolphin pods: Page 49.

Figure 21. The percentage of different gannet dive angles recorded during different dolphin foraging strategies: Page 50.

Figure 22. The percentage of gannet dive heights recorded during different dolphin foraging strategies: Page 51.

Figure 23. The relationship between dolphin foraging strategies and gannet dive mechanics: Page 52.

Figure 24. The relative percentage of gannet dive heights when foraging with or without Bryde’s whales: Page 53.

Figure 25. The relative percentage of gannet dive angles when foraging with or without Bryde’s whales: Page 54.

Figure 26. The relative percentage of gannet dive heights when foraging with or without shearwater species: Page 55.

Figure 27. The relative percentage of gannet dive angles when foraging in the presence and absence of shearwater species: Page 56.

Figure 28. The relative percentage of gannet dive heights when foraging with or without petrel species: Page 57.

Figure 29. The relative percentage of gannet dive angles when foraging with or without petrel species: Page 58.

Figure 30. The relative change in the rate of initiator dives as gannet flock sizes increase: Page 60.

Figure 31. The relative change in the rate of follower dives as gannet flock sizes increase: Page 61.

Figure 32. The percentage of synchronous dives performed in foraging flocks of gannets of varying size: Page 62.

Figure 33. Gannet initiator diving rate ratios as dolphin pod sizes increases: Page 63.

Figure 34. Gannet follower diving rate ratios as dolphin pod sizes increases: Page 64.

Figure 35. The percentage of synchronous dives performed with foraging dolphin pods of varying size: Page 65.

Figure 36. The relationship between synchronous gannet dive behaviour and dolphin foraging strategies: Page 66.

Figure 37. The influence of Bryde’s whale presence on the percentage of Synchronous dives performed feeding events: Page 67.