

SCAR/SCOR/IABO/ACMRR
GROUP OF SPECIALISTS ON
LIVING RESOURCES OF THE SOUTHERN OCEANS

**A GUIDE TO FORAGING METHODS USED BY MARINE BIRDS
IN ANTARCTIC AND SUBANTARCTIC SEAS**

Compiled, on behalf of the BIOMASS Working Party on Bird Ecology

by

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Foreword

The purpose of these Handbooks is to disseminate existing information on methods relevant to BIOMASS in time for those methods to be put to use. They are therefore not intended to be definitive treatises, although in some cases they may well be so. Their primary purpose is to provide an early guide. The Handbooks will be reviewed as new information becomes available and updated if required. A number of Handbooks are in preparation. They will be issued as they are completed. The costs of preparation and distribution are subsidized by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA/NMFS). Copies are distributed to individuals whose names are included in the "BIOMASS Directory". The Technical Group on Methods is grateful to those who have volunteered to prepare these Handbooks for the use and guidance of their colleagues and to the CSIRO, Australia for their technical assistance. Our role is to identify the needs for Methods Handbooks and Leaflets and to arrange, if possible, for those needs to be met.

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INTRODUCTION

This handbook deals with the foraging techniques of marine birds frequenting seas south of the Subtropical Convergence. It includes albatrosses, all petrels, penguins, cormorants, skuas, gulls, and terns. Its aim is to enable seabird observers to record feeding observations more precisely and with some measure of conformity. Comparable data from many sources covering a wide tract of Southern Ocean will hopefully lead to an understanding of the dynamics of feeding adaptations of southern marine birds.

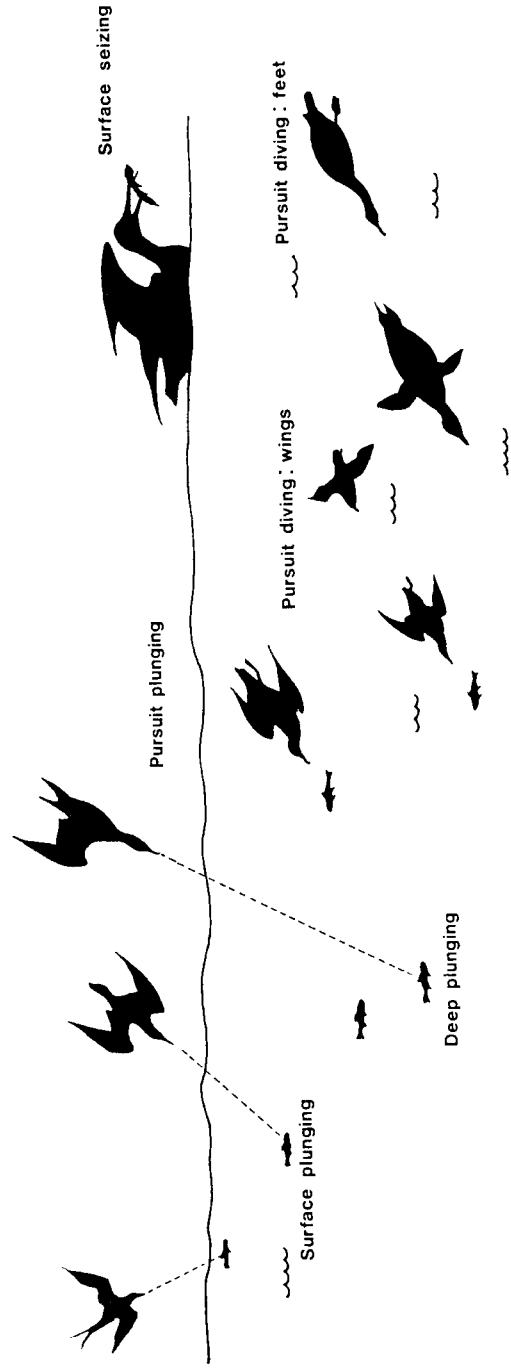
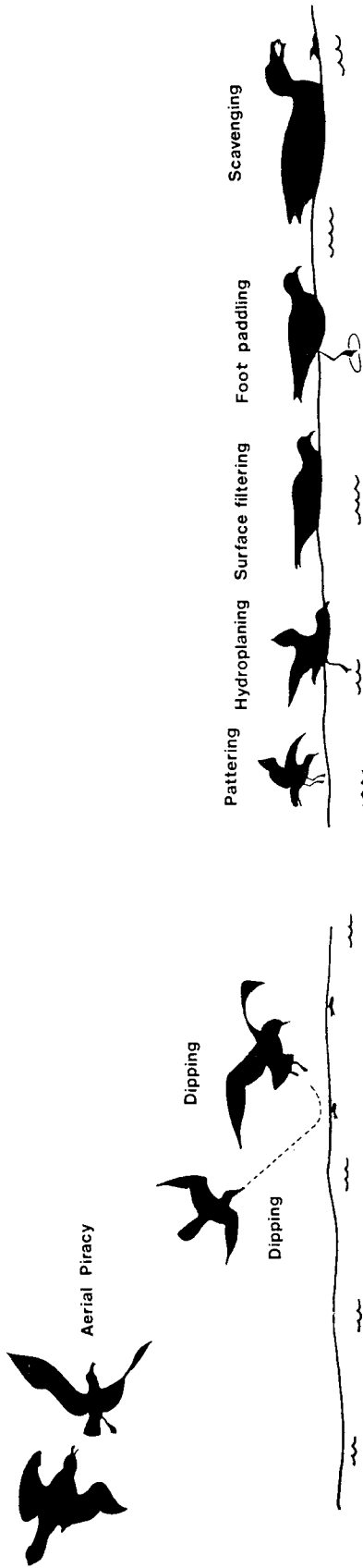
The methods here described are derived chiefly from the seminal paper on the subject by Ashmole (1971) and more recent contributions by Ainley (1977), Croxall and Prince (1980), and Griffiths et al. (1982).

The species list largely follows Watson (1975) but includes New Zealand species not covered in Watson's guide. Species listed in that guide as stragglers are not included.

In addition it was thought useful to summarize our knowledge of the diet of the species concerned and to provide references to the more important papers reporting on this.

DEFINITIONS

Definitions largely follow those given by Ashmole (1971) with adaptations based on Cramp and Simmons (1983). Because of the importance of 'pursuit-plunging' in Antarctic and Subantarctic marine birds we have made 'pursuit-plunging' a separate category rather than a variation on plunge-diving as the above contributors have done. Some methods described by Ashmole (1971) and Cramp and Simmons (1983) are not used by Antarctic or Subantarctic marine birds and are not listed below.



A. DIVING

A bird settled on the water surface submerges completely to catch prey.

- i. Pursuit Diving - the bird dives and pursues its prey underwater by pursuit swimming. It may be wing propelled or foot propelled.
- ii. Surface Diving - the bird submerges only momentarily, directly onto prey with little or no pursuit swimming. Such a dive is often preceded by a 'belly flop' onto the surface by flying birds.

B. PLUNGING

A bird in flight plunges into the water using the momentum of the fall to assist in catching prey without pursuit swimming.

- i. Surface Plunging - the bird splashes into the water without fully submerging.
- ii. Shallow Plunging - the bird submerges completely but penetrates little more than its own body length below the water surface.
- iii. Deep Plunging - the bird submerges completely and penetrates a substantial distance (several metres) underwater, usually preceded by a high near-vertical dive.

C. PURSUIT-PLUNGING

A bird in flight plunges into the water, then pursues prey underwater by pursuit swimming, using either wings or feet for propulsion.

D. SURFACE FEEDING

A bird remains on the water surface while taking food.

- i. Surface Seize - the bird grasps individual prey items with the bill while floating on the surface.

Head and neck but not the rest of the body may submerge beneath surface. Prey may be alive (surface seize) or dead (surface scavenge).

- ii. Surface Filtering - the bird filters small organisms (usually zooplankton) from the water while floating on the surface. It captures and swallows many food items at a time (compare D(i) above).
- iii. Hydroplaning - the bird filters plankton from the water with the breast on the water surface, head immersed, wings outstretched, propelling itself through the water using its feet.
- iv. Foot Paddling - the bird agitates the water with its feet and captures small food items thus disturbed.

E. FLIGHT-FEEDING

A bird remains airborne, capturing prey in the air or at the water surface; it may momentarily cease flying, but makes little or no contact with the water.

- i. Aerial pursuit - the bird pursues and captures aerial prey.
- ii. Dipping - the bird in flight picks its prey from just above or just below the surface, without significant use of its feet, either without touching the water (non-contact) or by wetting only its bill or head or its breast momentarily (contact).
- iii. Pattering - the bird uses its feet as well as its wings to maintain a precise height above the water

and feeds by picking minute prey items or oil droplets from the surface.

- iv. Piracy - the bird pursues other birds for their food.

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Unpublished personal observations

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Table 1 Penguins

SPECIES	DIVING		PLUNGING			SURFACE FEEDING			FLIGHT FEEDING				FOOD					REFERENCES						
	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	Pursuit Plunge	Surface seize	Surface filter	Hydroplane	Foot paddling	Aerial pursuit	Dipping	Pattering	Piracy	Cephalopods	Fish	Euphausiids		Amphipods	Copepods	Unidentified	Other	Molluscs	Carrion/refuse
Penguins	+++														+++	++	+++	+	+	+				11,33,53,89
<u>A. forsteri</u>	+++														+++	++	+							7,23,24,54
<u>A. patagonicus</u>	+++														+++	++	++	+						31,83,85,(f)
<u>P. adeliae</u>	+++														+++	+	++	+						21,23,55,85,(f)
<u>P. antarctica</u>	+++														+	+	+++	+						1,19,22,23,29,85
<u>P. papua</u>	+++														++	+	+++	+	+					28,29,33,72,86,(c)
<u>E. chrysocome</u>	+++														++	+	+++	+	+					21,22,88
<u>E. chrysolophus</u>	+++														++	+	+++	+	+					33,72,(c)
<u>E.c. schlegelii</u>	+++														++	+	++	+	+			+		

Key: o food or behaviour recorded not to occur in this species ++ food or behaviour frequently recorded for this species
+ food or behaviour occasionally recorded for this species +++ food or behaviour usually recorded for this species

Table 2 Albatrosses

SPECIES	DIVING		PLUNGING			PURSUIT PLUNGE		SURFACE FEEDING		FLIGHT FEEDING				FOOD						REFERENCES				
	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	PURSUIT PLUNGE	Surface seize	Surface filter	Hydroplane	Aerial pursuit	Dipping	Patterning	Piracy	Cephalopods	Fish	Duphausiids	Amphipods	Copepods	Unidentified		Other	Molluscs	Carrion/refuse	
Albatrosses						+ ^c	+++							+++	++	+	+	+	+	+	+	+	+	38,47,(d)
<i>D. exulans</i>			+ ^c	+		+	+++							+++	++	+	oc	+	+	+	+	+	+	17,23,49,83,(b)
<i>D. epomophora</i>				+			+++							+++	++									2,72
<i>D. melanophrys</i>				+		+	+++							+++	+++	+++	+	+	+	+	+	+	+	64,68,72,81
<i>D. chrysostoma</i>				+			+++							+++	+++	+								23,68,81
<i>D. chlororhynchos</i>		+ ^c	+ ^c	+ ^c		+	+++							+++	o						oc			38,40,70,85
<i>D. cauta</i>						+	+++							+++	o							o		38,64,72
<i>D. bulleri</i>							+++							+++	o							o		72,(b)
<i>P. fusca</i>							+++							+++	o							o	+	10,38,87
<i>P. palpebrata</i>			+ ^d	+			+++							+++	++	+++	oc					+	+	2,10,38,79

Key: o food or behaviour recorded not to occur in this species ++ food or behaviour frequently recorded for this species
+ food or behaviour occasionally recorded for this species +++ food or behaviour usually recorded for this species

Table 3 Fulmarine petrels and prions

SPECIES	DIVING		PLUNGING			SURFACE FEEDING			FLIGHT FEEDING				FOOD					REFERENCES							
	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	PURSUIT PLUNGE	Surface seize	Surface filter	Hydroplane	Foot paddling	Aerial pursuit	Dipping	Patterning	Piracy	Cephalopods	Fish	Euphausiids		Amphipods	Copepods	Unidentified	Other	Molluscs	Carrion/refuse	
Fulmarine petrels																									3,60
Macronectes sp.																									38,43,50
<u>M. giganteus</u>																									18,43,50
<u>M. halli</u>																									3,43,50,84,(h)
<u>F. glacialisoides</u>																									11,35,72,87
<u>T. antarctica</u>																									3,11,33,37,(a)
<u>D. capense</u>																									8,11,23,32,36,38,60
<u>P. nivea</u>																									3,11,24,33,36,37,56,91
<u>Pachytrifa</u> sp.																									3,36,46,38
<u>P. belcheri</u>																									41,77
<u>P. desolata</u>																									3,23,27,29,41,46,67,80,(b)
<u>P. salvini</u>																									11,65,72,87,(g)
<u>P. vittata</u>																									33,46,69,72,87,(b),(g)
<u>P. turtur</u>																									46,69,87,(b)
<u>P. crassirostris</u>																									29,46,87,(b)

Key: o food or behaviour recorded not to occur in this species ++ food or behaviour frequently recorded for this species
+ food or behaviour occasionally recorded for this species +++ food or behaviour usually recorded for this species

Table 4 Gadfly petrels, *Procellaria* petrels, and shearwaters

SPECIES	DIVING		PLUNGING			SURFACE FEEDING			FLIGHT FEEDING			FOOD					REFERENCES									
	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	Pursuit Plunge	Surface seize	Surface filter	Hydroplane	Foot paddling	Aerial pursuit	Dipping	Patenting	Piracy	Fish	Cephalopods		Fish	Euphausiids	Amphipods	Copepods	Unidentified	Other	Molluscs	Carton/refuse	
Gadfly petrels																										3,44,(a)
<i>H. caerulea</i>																										11,23,38,67,(b)
<i>Pt. macroptera</i>																										38,40,44,65
<i>Pt. lessona</i>																										3,26,38,44,87
<i>Pt. incerta</i>																										36,38
<i>Pt. brevirostris</i>																										11,26,38,65
<i>Pt. mollis</i>																										26,36,38,40,87,(b)
<i>Pt. inexpectata</i>																										3,4,(b)
<i>Pt. cooki</i>																										44,52,(b)
<i>Procellaria</i> petrels																										
<i>P. aquinoctialis</i>																										23,26,45,61
<i>P. westlandica</i>																										45
<i>P. cinerea</i>																										33,38,87
Shearwaters																										13,47,86
<i>P. griseus</i>																										3,4,13,52
<i>P. tenuirostris</i>																										4,14,52,58
<i>P. carneipes</i>																										4,14,52
<i>P. gravis</i>																										13,14,36,52,87
<i>P. bulleri</i>																										5,32,42,(b)
<i>P. assimilis</i>																										14,32,38,87

Key: 0 food or behaviour recorded not to occur in this species ++ food or behaviour frequently recorded for this species
+ food or behaviour occasionally recorded for this species +++ food or behaviour usually recorded for this species

Table 5 Storm petrels and diving petrels

SPECIES	DIVING		PLUNGING			SURFACE FEEDING			FLIGHT FEEDING				FOOD						REFERENCES						
	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	Pursuit Plunge	Surface seize	Surface filter	Hydroplane	Foot paddling	Aerial pursuit	Dipping	Patterning	Piracy	Cephalopods	Fish	Euphausiids	Amphipods		Copepods	Unidentified	Other	Molluscs	Carrion/refuse	
Storm petrels																									
<i>O. oceanicus</i>	+		+	+			++				++	++	++		+	+	++	+		+					2, 9, 23, 32, 36, 38, 58, 60, 72
<i>F. tropica</i>											++	++	++				++			+					23, 38, 87
<i>F. grallaria</i>											++	++	++				++								2, 38, 87
<i>G. nereis</i>											++	++	++				++								23, 39, 46, 87
<i>P. marina</i>	++																++								38, 46, 72, 87
Diving petrels	++	++	++	++							+					++	++	++	+						23, 38, 66
<i>P. georgicus</i>	++	++	++	++			++									+	++	++	++						23, 38, 66
<i>P. exsul</i>	++	++	++	++			++										++	++	++						23, 38, 48, 66
<i>P. urinatrix</i>	++	++	++	++			++										++	++	++						23, 38, 66 (b)

Key: 0 food or behaviour recorded not to occur in this species ++ food or behaviour frequently recorded for this species
 + food or behaviour occasionally recorded for this species +++ food or behaviour usually recorded for this species

Table 6 Cormorants, gulls and terns

SPECIES	DIVING		PLUNGING			SURFACE FEEDING			FLIGHT FEEDING				FOOD						REFERENCES						
	Pursuit dive	Surface dive	Surface plunge	Shallow plunge	Deep plunge	PURSUIT PLUNGE	Surface seize	Surface filter	Hydroplane	Foot paddling	Aerial pursuit	Dipping	Patterning	Piracy	Cephalopods	Fish	Euphausiids	Amphipods		Copepods	Unidentified	Other	Molluscs	Carrion/refuse	
Cormorants	++																								
<u>P. atriceps</u>	+++																								12,19,23,25,26,71
<u>P. albiventer</u>	+++																								12,33,87
<u>P. colensoi</u>	+++																								33
Skuas							++																		
<u>C. macormicki</u>							+++																		3,30,59,63,74,82,87,90
<u>C. lonnbergi</u>							+++																		16,27,51,57,73,76,82
Gulls							+++																		
<u>L. dominicanus</u>							+++																		12,23,26,78,(g),(h)
<u>L. novaehollandiae</u>							+++																		72
Terns																									
<u>S. vittata</u>							+++					+++													15,23,24,29,75
<u>S. virgata</u>							++					++													33,75
<u>S. paradisaea</u>							++					++													3,29,33,91

Key: 0 food or behaviour recorded not to occur in this species ++ food or behaviour frequently recorded for this species
+ food or behaviour occasionally recorded for this species +++ food or behaviour usually recorded for this species

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