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Stomach contents of stranded Common Dolphins *Delphinus delphis* from the south-east of Southern Africa

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Abstract

Examined were the stomach contents of common dolphins stranded, both singly and mass, along the south-east coast of southern Africa between 1975 and 1991. Prey are an indication of the prey resources available to predators, during the summer months. Overall, the diet was dominated by cephalopods, particularly the locally abundant squid species *Loligo vulgaris reynaudi*, occurring in 92.9% of the total number of stomachs and constituting 18.6% and 40.3% of the total percentage number and percentage reconstituted mass, respectively. Other important cephalopods were *Sepia officinalis* and *Lycoteuthis diadema*. The fish content of the diet was made up predominantly of three species of clupeoid fish – *Sardinops sagax*, *Etrumeus whiteheadi* and *Engraulis japonicus*. Fish species dominate the diet between 1975 and 1979 but between 1980 and 1989 cephalopod species constitute 89.9% of the total reconstituted mass of prey. Reproductive activities and nutritional demands result in a form of resource partitioning, whereby lactating dolphins and calves have the same dietary preference. The results of the study reflect the summer diet of common dolphins in the region and are compared to the winter diet, as found in the stomach contents of incidentally-caught common dolphins, further north. The diet of the mass-stranded common dolphins stress the important influence that nutritional demands and regionally distinct prey abundance have on the distribution and movements of common dolphins along the south-east coast of southern Africa.

Introduction

It has been suggested that dietary studies based on the stomach contents of stranded animals may be biased because of illness (Jones 1981) and/or show differences between stranded and non-stranded animals of the same species, because of their passage through coastal waters prior to stranding (Leatherwood et al. 1978; Sekiguchi et al. 1992). However, the usefulness of interpreting cetacean diets from the examination of stomach contents of stranded animals remains equivocal. Ross (1984), in a study of 24 cetacean species, found no bias and concluded that stranded cetaceans provide an accurate indication of the normal diet, at least in the region sampled. The diet of seven incidental common dolphin captures and nine strandings off the south-east coast of southern Africa showed the diet of both samples to be an indication of the local fish fauna. In addition to this, the type of prey dominant in the diet of both stranded and free-ranging common dolphins in this region matched that of common dolphins in the Black Sea (Tomilin 1967); the Pacific (Evans 1976); British waters (Evans 1980); the Mediterranean (Schmidt 1923); the north-east Atlantic (Collet 1981), the south-west (Sekiguchi et al. 1992) and south-east (Young and Cockcroft 1994) coasts of southern Africa.

Common dolphins, from all geographic regions, are generally considered to be opportunistic feeders, consuming seasonally and locally abundant, easily captured, small shoal-

ing prey, associated with the deep scattering layer (SCHMIDT 1923; TOMILIN 1967; EVANS 1976; COLLET 1981; PASCOE 1986; EVANS 1987; OVERHOLTZ and WARING 1991; YOUNG and COCKCROFT 1994). In this respect, they are similar to other delphinids, whose movements closely parallel that of potential prey – dolphin distribution and diet apparently determined by seasonal and topographic changes in preferred prey abundance (HUI 1979; EVANS 1980; LEATHERWOOD et al. 1982; PASCOE 1986; SELZER and PAYNE 1988).

On the south-east coast of southern Africa, common dolphins inhabit cool temperate waters, south of about 33° latitude, in the austral summer, but large numbers make an extensive northerly migration into warm, more tropical waters during winter. This migration appears to be closely linked to the winter, northward migration of large shoals of South African pilchard (*Sardinops sagax*) known as the 'sardine run' (COCKCROFT and PEDDEMORS 1990). The diet of common dolphins off this coast, during the winter months, was reported to be dominated by pelagic, shoaling fish, such as pilchard, anchovy (*Engraulis japonicus*) and red-eye herring (*Etrumeus whiteheadi*) and squids (COCKCROFT and ROSS 1983; COCKCROFT and PEDDEMORS 1990); although YOUNG and COCKCROFT (1994) showed there to be a large content of elf (*Pomatomus saltatrix*), maasbanker (*Trachurus delagoa*), mackerel (*Scomber japonicus*) and strepie (*Sarpa salpa*) in the diet during this time. This diet composition is a reflection of those fish species present during the annual migration.

This study examines the diet of common dolphins along the south and south-east coasts of southern Africa, using animals stranded in this region between 1975 and 1992. Regardless of biases inherent in data from stranded animals, these data are often the only data available for certain areas or populations/stocks; and are able to provide an important counter perspective where data for free-ranging animals are also accessible. In this respect, the results of this study will be compared with the diet of common dolphins incidentally captured 1 000 km further north in Natal (YOUNG and COCKCROFT 1994).

Common dolphins examined for this study do not fit the classification of HEYNING and PERRIN (1994). They show a combination of the colour pattern of *Delphinus delphis* and the long rostrum of *D. capensis*. Consequently, the earlier, single species classification of *D. delphis* is used.

Material and methods

A total of 83 common dolphins stranded between Mossel Bay (34°10′ S; 22°08′ E) and Mzamba (31°06′ S; 30°10′ E), Transkei (Fig. 1), between 1970 and 1992. However, only 39 stomachs were available for examination. This number also includes samples from a mass stranding; at Hluleka Nature Reserve (31°37,4′ S; 29°18′ E), Transkei. Morphological measurements and biological samples, wherever possible, were taken for all specimens and are kept at the Port Elizabeth Museum. The methodology used for stomach excision, sorting of stomach contents and prey identification are described in COCKCROFT (1990) and YOUNG and COCKCROFT (1994). Fish nomenclature follows that of SMITH and HEEMSTRA (1986).

The maximum number of left or right otoliths, and upper or lower cephalopod beaks, was used as an indication of the total number of prey in each stomach. Otoliths and beaks were measured across the greatest diameter and across the lower rostral length, respectively. (Lower hood length was used in the case of sepiids (CLARKE 1986 a, b). Reconstituted weight and length data were calculated using the appropriate regression or estimate (COCKCROFT and ROSS 1990; YOUNG and COCKCROFT 1994). An index of relative importance (IRI) was calculated for each species such that, IRI = (percentage number + percentage reconstituted weight)×percentage frequency occurrence (PINKAS et al. 1971).

Results

Twenty eight of the 39 stomachs contained solid prey remains. From these, fifteen fish species and four cephalopod species were identified. Cephalopods (particularly *Loligo*

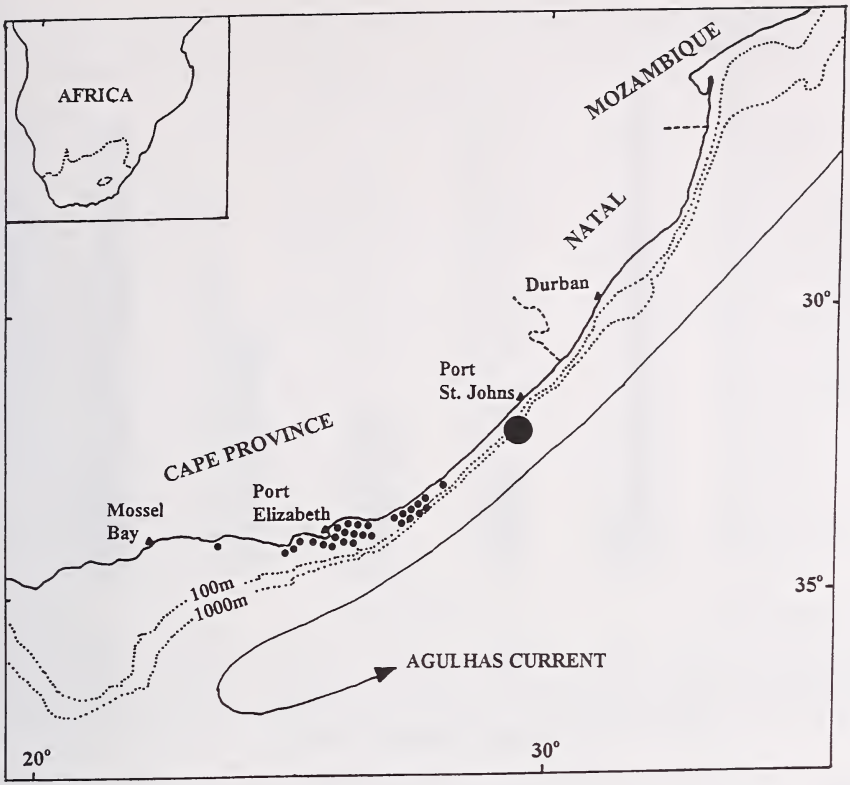

Fig. 1. Map showing the location of common dolphin strandings along the south-east coast of southern Africa (• single stranding; ● mass stranding).

squid) and clupeoid fish prey dominated the diet of stranded common dolphins (Tab. 1). However, there were clear interannual variations (between 1975 and 1991) in the relative importances of the five most important prey according to percentage weight, percentage frequency of occurrence and/or percentage reconstituted mass (Tab. 2).

Between 1975 and 1979 the diet was dominated by pelagic clupeoid fish, whereas cephalopod species dominated the diet between 1980 and 1989. In 1990 and 1991, the diet was again dominated by fish species, similar to that of 1975–1979 (Tab. 2). The ratio of fish to squid in the diet varied with sex-size groups and reproductive state (Fig. 2). Lactating females and calves ate mainly cephalopod prey (*Loligo* squid and cuttlefish, *S. officinalis*), in contrast to mature males, resting and pregnant females, which apparently preferred small, shoaling fish (pilchard and herring). However, the total number of prey species consumed did not differ significantly between sex-size groups ($\chi^2 = 2.29$; df = 5; $P > 0.05$) (Fig. 2).

Though there was a low correlation between dolphin length and actual stomach content weight ($r = 0.12$; $p < 0.05$; $n = 27$), the correlaton between dolphin length and total reconstituted weight of prey in the stomach was significant ($r = 0.34$; $p < 0.05$; $n = 27$). Similarly, although the correlation between dolphin length and the total number of prey items consumed was significant ($r = 0.36$; $p < 0.05$; $n = 28$), that between dolphin length and the number of prey species eaten was not ($r = 0.14$; $p > 0.05$; $n = 28$). Additionally, there was a significant correlation between dolphin length and mean length of prey ($r = 0.45$; $p < 0.05$; $n = 21$).

Table 1. Fish and cephalopod prey consumed by stranded common dolphins along the south-east coast. (A – number; B – percentage number; C – frequency of occurrence; D – percentage frequency of occurrence; E – reconstituted mass; F – percentage reconstituted mass; IRI – Index of Relative Importance, see text) (ND – no data)

SPECIES	A	B	C	D	E	F	IRI
Fish							
Etrumeus whiteheadi	403	22.9	16	57.1	26 668.2	17.5	2 312.5
Sardinops sagax	298	22.6	12	42.9	32 358.4	21.3	1 882.6
Engraulis japonicus	182	10.4	13	46.4	2 962	2	571.1
Unid. myctophid spp.*	116	6.6	3	10.7	9 562.2	6.3	138.1
Merluccius capensis	36	2.1	4	14.3	758.7	0.5	36.4
Pomadasys olivaceum	1	0.1	1	3.6	ND	ND	0.2
Pagellus bellotti	7	0.4	2	7.1	47.6	ND	3.1
Atrobucca nibe	1	0.1	1	3.6	371.3	0.2	1.1
Trachurus delagoa	3	0.2	1	3.6	1 176	0.8	3.4
Unid. trachurid	6	0.3	1	3.6	ND	ND	1.2
Liza sp. 1*	29	1.7	4	14.3	758.7	0.5	36.4
Liza sp. 2*	1	0.1	1	3.6	219.5	0.1	0.7
Sphyraena spp.	1	0.1	1	3.6	16.1	ND	0.2
Trichiurus lepturus	3	0.2	2	7.1	ND	ND	1.2
Scomber japonicus	6	0.3	5	17.9	1 766.5	1.2	26.9
Unidentified fish	10	0.6	3	10.7	ND	ND	6.1
Cephalopods							
Sepia officinalis	43	2.5	7	25	2 650.7	1.7	104.7
Loligo spp.	327	18.6	26	92.9	61 227.7	40.3	5 467.5
Lycoteuthis diadema	184	10.5	7	25	5 771.5	3.8	356.6
Ommastrephes bartrami	1	0.1	1	3.6	18.8	0.1	0.3

* common regression calculated

Table 2. Annual changes in the five most important prey species in the diet of stranded common dolphins between 1975 and 1991 (A – percentage number; B – percentage frequency of occurrence; C – percentage reconstituted mass; IRI – Index of Relative Importance, see text) (ND – no data).

SPECIES	A	B	C	IRI	IRI RANK
1975–1979					
E. whiteheadi	32.8	28.6	36.9	1 992.7	2
S. sagax	19.8	42.9	32.8	2 250.2	1
Myctophid spp.	28.4	28.6	ND	811.3	4
S. officinalis	2.5	42.9	2.8	224.2	5
Loligo spp.	4.7	42.9	16.2	893.6	3
No. stomachs = 7					
1980–1989					
A. nibe	0.5	16.7	3.1	59.7	5
Liza sp. 1	3.7	16.7	6.2	165.2	4
S. officinalis	15.9	50	7.8	1 185.2	2
Loligo spp.	53.4	66.7	77.7	8 740.2	1
L. diadema	17.5	33.3	4.4	727.7	3
No. stomachs = 6					
1990–1991					
E. whiteheadi	23.7	78.6	25.9	3 893.5	2
S. sagax	48.3	64.3	63.5	7 181.1	1
E. japonicus	25.8	78.6	6.9	2 566.6	3
S. japonicus	0.5	21.4	2.2	56.9	4
Loligo spp.	0.8	21.4	1.6	50.2	5
No. stomachs = 14					

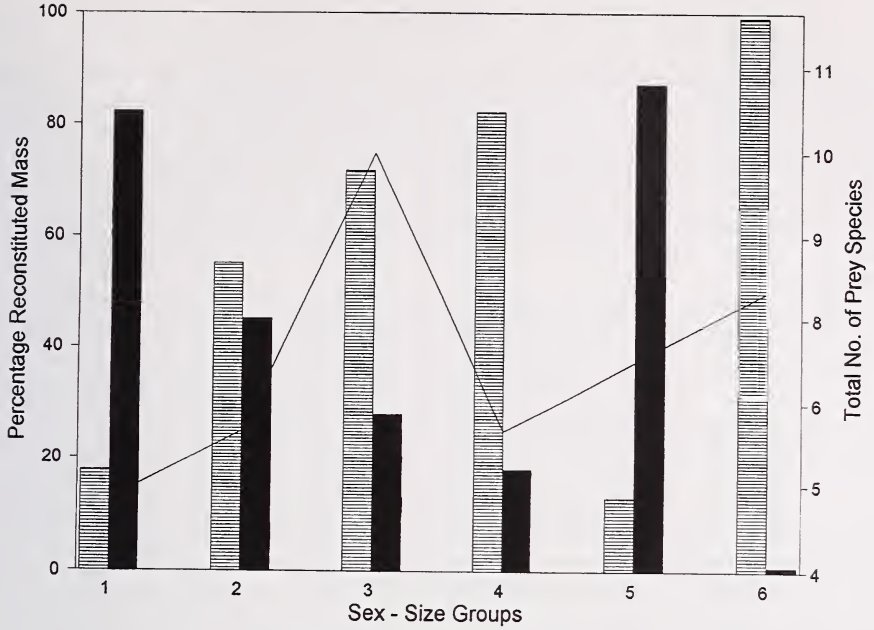

Fig. 2. The proportion of fish (hatched) and cephalopod (solid) prey items (by percentage reconstituted mass) in the diet of different sex-size groups of stranded common dolphins (the solid line indicates the total number of prey species consumed by each group – 1. calves; 2. adolescents; 3. mature males; 4. non-lactating females; 5. lactating females; 6. pregnant females).

Fifteen animals originated from a mass stranding at Hluleka Nature Reserve, Transkei (31°47′ S; 29°18′ E). The total reconstituted prey weight of this sub-sample comprised 26.2% of the total for all stranded common dolphins. Three fish species accounted for 96.8% of the total prey weight for this group, i.e. pilchard, (64.5%), herring (25.8%) and Cape anchovy (6.9%) (Tab. 3). Although anchovy accounted for only a small portion of the reconstituted weight, it was the most frequent prey species, identified from 84.6% of stomachs. *Loligo* squid accounted for only 1% (by reconstituted prey weight) and was found in only two of the 13 stomachs.

Table 3. Fish and cephalopod prey species in the diet of common dolphins mass stranded at Hluleka Nature Reserve, Transkei (A – percentage number; B – percentage frequency of occurrence; C – percentage reconstituted mass; IRI – Index of Relative Importance, see text).

SPECIES	A	B	C	IRI	IRI RANK
Fish					
E. whiteheadi	22.9	76.9	25.8	3742.2	2
S. sagax	49.5	69.2	64.1	7858.4	1
E. japonicus	26.4	84.6	6.9	2823.9	3
S. japonicus	0.5	23.1	2.2	62	4
Cephalopods					
Loligo spp.	0.3	15.4	1.00	20.2	5

No. stomachs = 13

Discussion

The mass-stranded group was found to comprise 13 mature females and 2 males: an adult and an adolescent. Of the 13 females, 11 were pregnant. The dietary composition of these animals was similar to free-ranging common dolphins off Natal (Young and Cockcroft 1994) characterized by an abundance of pilchard and a lack of cephalopod species. In contrast, the stranded common dolphins from the Eastern Cape coast consumed predominantly cephalopod species and a large amount of herring. The reasons for these differences are unclear, but they could reflect regionally disparate prey abundance and availability.

Common dolphins, along the south-east coast are found throughout the year below the 33° latitude (Cockcroft and Peddemors 1990). However, they are only found north of this during the annual winter fish migration, locally known as the 'sardine run'. As the shoals of pilchard, other clupeoids and migratory fish species are followed by predatory fish, sharks, whales and dolphins, the distribution of common dolphins, in particular, undergoes a massive shift norhwards. In this respect, the presence of common dolphins along the Transkei coast (31°47′ S; 29°18′ E), during the austral summer is unusual. The mass stranding took place in December, three months after the end of the 'sardine run', and it is possible that these animals may have been feeding on pilchard, and other clupeoids, returning to the south on the Agulhas current (Davies 1956; Baird 1971; Crawford 1981). However, the size of pilchard in the diet does not suggest this. The mean size of pilchard found in stomachs of mass-stranded animals (21.5 cm) did not differ from those in the stomachs of dolphins stranded elsewhere (22.5 cm), or from the free-ranging animals in Natal (22.5 cm) (Young and Cockcroft 1994).

Results of both the present study and Young and Cockcroft (1994) show that pregnant common dolphins consume a larger proportion of fish than lactating females. The nutritional demands of the mass-stranded group (predominantly pregnant females) may have forced them to move northwards in search of more abundant, energy-rich prey. Lactating females, which depend more on cephalopod prey, probably remained further south where squid resources are more abundant, during summer.

For single-stranded common dolphins the majority of the diet is accounted for by cephalopods, especially *Loligo* spp. *Loligo vulgaris reynaudii* is an abundant, common squid along the continental shelf of the southern and eastern coasts of southern Africa (Augustyn 1989, 1990; Sauer 1993). Comparable to the pelagic schooling fish species which play a major role in the diet of common dolphins from other regions (Tomilin 1967; Collet 1981; Jones 1981; Leatherwood et al. 1982; Ross 1984; Klinowska 1991, Young and Cockcroft 1994), this semi-pelagic species occurs in the coastal waters, during the summer, forming dense "spawning concentrations" in the inshore zone. These seasonally abundant, spawning squid masses, appear to have an important influence on the distribution and diet of common dolphins in the area. Although stranding localities cannot be used as a direct indication of dolphin distribution and the causes of single strandings are unknown, the areas where squid form spawning concentrations along the East Cape coast (Sauer 1993), coincide with the areas where the majority of single strandings occur. Of the 39 animals, all except four, stranded in spring and summer, coinciding with those months in which dense concentrations of spawning squid form. It is uncertain whether the higher number of common dolphin strandings can be directly related to their close proximity to the shore, making them more susceptible to stranding; or is merely an indication of a larger number of dolphins in the area, due to an abundance of prey.

Besides the large number of cephalopods in the diet, the stomach contents can also be used as an indication of the fish fauna along the coast. Of the dominant clupeoid component, round herring, which is abundant and widespread along the east coast, throughout the year, makes up the largest percentage. The distribution of pilchard, herring and an-

chovy is reported to be significant and almost continuous along the South African south-east coast; and the respective biomasses are of approximately the same proportions as that found in the diet (Armstrong et al. 1991). However, the biomass of pilchard and round-herring is reduced in winter, when a portion of the stock moves northwards during the 'sardine run' (Smale 1983; Armstrong et al. 1991).

Common dolphin diet has undergone various fluctuations between 1975 and 1991, the most dramatic change coinciding with increased commercial squid catches during the late 1980's, reaching a peak of 10 000 tons in 1989, whereafter, commercial catches declined markedly (Sauer 1993). This temporal pattern in prey abundance is reflected in common dolphin diet during this time.

Although only four common dolphins stranded in the winter months, specifically May, the diet of these animals does not differ significantly from strandings in spring and summer. The winter diet consists of an abundance of cephalopod species. Fish species found in the winter diet include herring, pilchard and myctophids.

The few winter samples give no evidence of a reduction in squid content in the diet, and possibly even an increase in cephalopod consumption. It is possible that those common dolphins which remain in southern waters during winter increase the proportion of squid in the diet to compensate for the reduced clupeoid abundance.

The prey spectrum consumed by all sex-size groups is narrow and most categories feed on similar prey. All adolescent and mature animals (excepting lactating females) fed primarily on fish, whereas calves and lactating females ate mainly cephalopods. Lactating spotted dolphins (*Stenella attenuata*) consumed a larger proportion of fish during lactation, attributed to higher nutritional demands (Bernard and Hohn 1989). Although fish tend to have higher energy contents than cephalopods, the most influential factor governing this dietary change may be the production of milk. Calves stranded in the Eastern Cape were younger than those captured in Natal, and therefore still dependent on the mother for milk and maternal care, reflected by a close dietary relationship. The similarities in diet may also indicate that common dolphins may teach and assist young calves to feed, as reported for bottlenose dolphins (Cockcroft and Ross 1990).

Energy stores may be severely depleted following the energetically expensive period of calving, maternal care and early weaning in Eastern Cape waters. The winter 'sardine run' presents an ideal opportunity for both the final weaning of calves from milk to the energy-rich solid foods necessary for growth and the mother's replenishment of depleted energy stores.

In Natal, free-ranging common dolphins appear to make use of resource partitioning to a greater extent than do those in the Eastern Cape (Young and Cockcroft 1994). This difference may be related to the nature of feeding activity in the two regions. The highly seasonal influx of prey, together with huge schools of common dolphins (Cockcroft and Peddemors 1990), during the 'sardine run' may result in concentrated, high-density feeding. Nursery groups may serve not only to reduce the costs of maternal care but also to protect the calves from potential predators during feeding activity (Young and Cockcroft 1994). Lactating females are then able to remain within the main feeding group, making optimum use of the available prey.

These data confirm that common dolphins are opportunists, making use of those prey species most abundant and readily available, on a temporal and regional scale. The diet of the mass-stranded common dolphins provides an interesting example of the effect that reproductive-related nutritional demands and regionally disparate prey resources have on the distribution and movements of common dolphins in the region. The different diet and feeding biology regimes of stranded and incidentally-caught dolphins (Young and Cockcroft 1994) can be attributed primarily to seasonally distinct prey abundance and distribution and reproductive-associated nutritional demands.

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Zusammenfassung

Mageninhalt gestrandeter Gemeiner Tümmler Delphinus delphis von der Südostküste des südlichen Afrika

Untersucht wurden die Mageninhalte von Gemeinen Tümmlern, die einzeln und in Massen, an der Südost-Küste von Südafrika zwischen 1975 und 1991 gestrandet waren. Die Beute lieferte Hinweise auf die Nahrungsressourcen, die während der Sommermonate zur Verfügung stehen. Cephalopoden dominierten die Nahrung, insbesondere die lokal häufige Art *Loligo vulgaris reynaudii*, die in 92.9% aller Mägen vorkam, 18.6% aller gezählten Beute ausmachte, sowie 40.3% Gewichtsanteil erreichte. Andere Cephalopoden von Bedeutung waren *Sepia officinalis* und *Lycotheuthis diadema*. Die wichtigsten drei Fischarten waren die Clupeiden *Sardinops sagax*, *Etrumeus whiteheadi* und *Engraulis japonicus*. Fische dominierten die Nahrungszusammensetzung zwischen 1975 und 1979, jedoch in den Jahren von 1980 bis 1989 machten Cephalopoden 89.9% Gewichtsanteil aus. Fortpflanzungsaktivitäten und Nahrungsbedarf führen zu einer Aufteilung der Beute, mit dem Resultat, daß säugende Weibchen und Kälber die gleiche Nahrung bevorzugen. Die Ergebnisse der Sommernahrung dieser Studie werden mit der Winternahrung von Gemeinen Tümmlern verglichen, die weiter im Norden in Netze geraten sind. Die Ergebnisse von Massenstrandungen machen deutlich, wie stark Nahrungsbedürfnisse und regionale Beutevorkommen die Verteilung und Wanderungen von Gemeinen Tümmlern entlang der Südost-Küste von Südafrika beeinflussen.

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