

DIURNAL OCCURRENCE OF DEAD MESOPELAGIC FISH AND SQUID AT THE SEA SURFACE AND THEIR IMPORTANCE AS A PREVIOUSLY UNRECOGNIZED PREDICTABLE FOOD RESOURCE FOR OCEANIC MARINE BIRDS

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The presence of mesopelagic fish and cephalopods, (most of which do not normally occur alive at the surface at any time) in the diets of many procellariiformes has been the source of considerable controversy. This is particularly true for some species of albatrosses where large numbers of beaks from a wide range of mesopelagic cephalopods is a common finding in dietary studies in both northern and southern hemispheres. How do these birds gain access to these deepwater cephalopods? The literature on this subject is full of controversy. Opportunistic scavenging on a variety of sources such as post-spawning die-offs, whale regurgitations and commercial fishery by-catch discards, or a direct predation strategy involving nocturnal feeding on vertical migrating, bioluminescent species have been proposed (Croxall and Prince 1994). Recent research on Wandering and Laysan Albatrosses strongly suggests scavenging on dead squid at the surface is the primary feeding strategy of both these species (Weimerskirch et al. 2003; Pitman et al. 2004). In addition, recent telemetry and immersion monitor studies of Laysan Albatross (LAAL) in Hawaiian Leeward Islands confirms a diurnal surface scavenging strategy for this species (Fernandez and Anderson 2000). When reading these accounts, one of the fundamental questions that comes to mind is, if these albatross rely heavily on scavenging as a primary feeding strategy, do enough dead mesopelagic cephalopods occur in sufficient numbers year round at the sea surface to support such a feeding strategy? Until now, direct evidence to address this has been largely absent.

In 2006, during ongoing small-vessel odontocete surveys in Hawai'i by Cascadia Research Collective, we began noting the presence of seabirds feeding on dead floating cephalopods and fish. In the last seven years (2006-2012) we have collected 109 specimens and obtained an additional 20 from other individuals working on the water (Fig 1). Specimens were frozen and returned to the National Marine Mammal Laboratory, Seattle, for identification and analysis. A total of 131 specimens (two identified from photos) included 9 fish and 121 cephalopods (Table 1). More than half were collected in association with scavenging seabirds (seven procellariiformes), and 13 were associated with or in the general proximity of odontocete cetaceans (five species). Specimens were generally widely dispersed and collected year-round. Most of the cephalopods recovered were adults of species that were too large to be consumed by an individual bird. Smaller adult mesopelagic species known to inhabit the area were notably underrepresented. This bias toward larger specimens is probably due to the smaller specimens being rapidly consumed by birds, indicating that the number of specimens recovered is a crude index at best and under represents the number of floating cephalopods in the study area. The species composition of the survey sample resembles that from LAAL chick regurgitation pellets collected from several breeding sites in the Hawaiian Leeward Islands (Table 1). Though during the chick rearing stage LAAL are known to forage north of Hawai'i, sometimes extending north to off the coast of North America and the Aleutian Island Chain, the cephalopod species represented are remarkably similar to the survey samples collected off Hawai'i. This indicates the occurrence of widely dispersed dead cephalopods at the surface in the survey area are probably not unique to the west coast of the island of Hawai'i but are found in other regions of the North Pacific as well as other oceanic regions of the world.

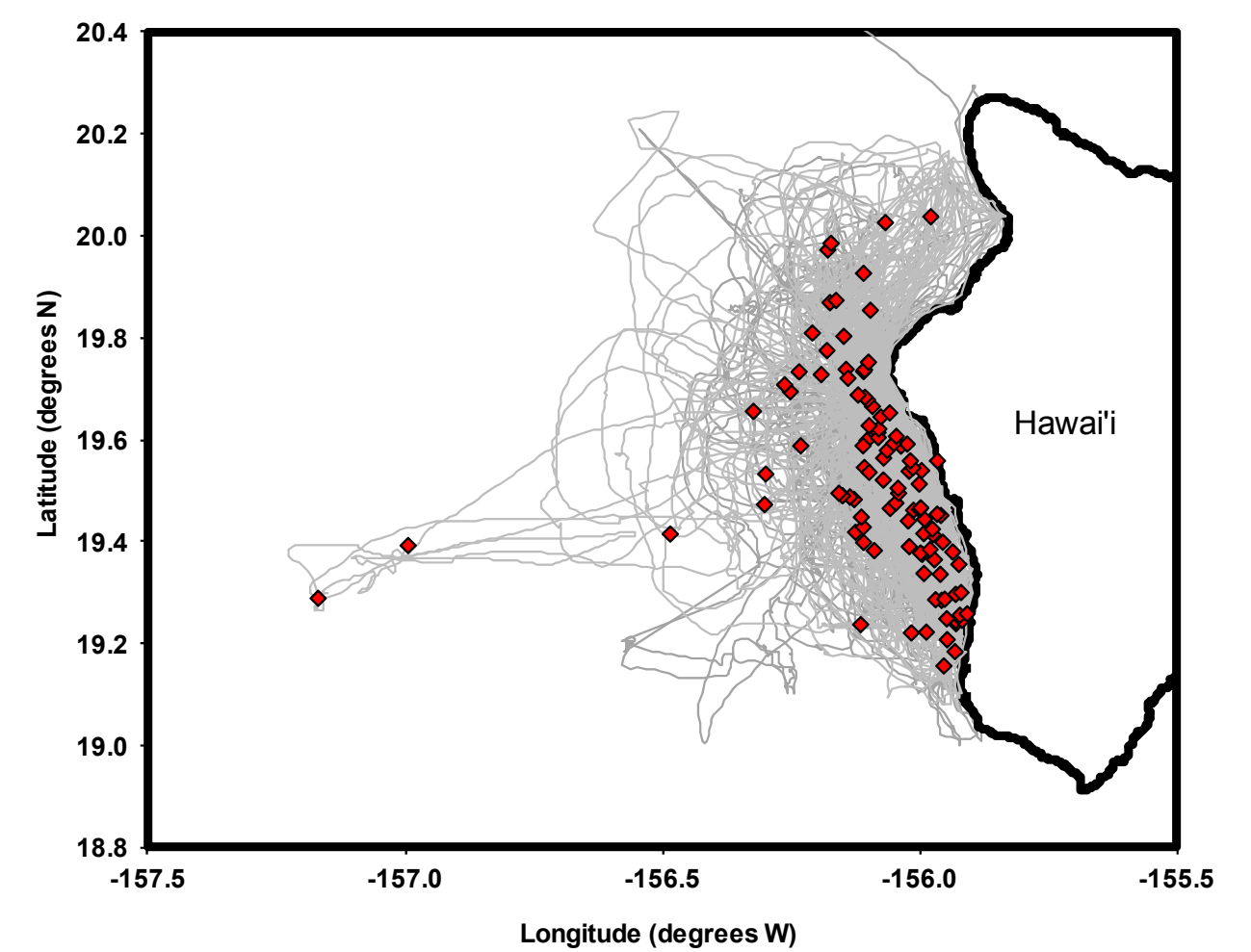


Figure 1. Map of odontocete survey tracklines off the west coast of Hawai'i with the approximate cephalopod specimen locations.

TABLE 1. Percent frequency by number of fish and mesopelagic cephalopod species found floating off Hawai'i and comparison with similar cephalopod prey taxa identified from beaks from 50 Laysan albatross (LAAL) chick regurgitation pellets collected from nesting sites in the Hawaiian Leeward Islands

Species	FLOATING SAMPLE		LAAL CHICK PELLETS
	No.	% by No.	
Fishes	9	6.9	-
Synphobranchiidae			
<i>Synphobranchus affinis</i>	1	0.8	-
Congidae			
<i>Acromycter alcocki</i>	1	0.8	-
Serrivomeridae			
<i>Serrivomer secor</i>	1	0.8	-
Sternopychidae			
<i>Argyropelecus aculeatus</i>	3	2.3	-
<i>Argyropelecus sladeni</i>	1	0.8	-
<i>Sternopyx diaphana</i>	1	0.8	-
Neoscolopelidae			
<i>Neoscolopelus macrolepidotus</i>	1	0.8	-
Tetrodontidae			
<i>Lagocephalus</i> sp.	2	1.5	-
<i>Canthigaster coronata</i>	1	0.8	-
Cephalopods	121	92.4	X
Enoploteuthidae			
<i>Enoploteuthis reticulata</i>	1	0.8	0
Octopoteuthidae			
<i>Taningia danae</i>	5	3.8	X
Onychoteuthidae			
<i>Moroteuthis</i> sp. A*	26	19.8	X
<i>Onychoteuthis</i> sp.	10	7.6	X
<i>Callimachus youngorum</i>	3	2.3	X
	13	9.9	X
Histioteuthidae			
<i>Stigmatoteuthis hoylei</i>	53	40.5	X
<i>Histioteuthis</i> sp.	46	35.1	X
unid. histioteuthid	6	4.6	X
	1	0.8	X
Psychroteuthidae			
<i>Psychroteuthis laciniosa</i>	1	0.8	X
Architeuthidae			
<i>Architeuthis</i> sp.	2	1.5	X
Lepidoteuthidae			
<i>Pholidoteuthis massyae</i>	1	0.8	X
Cycloteuthidae			
<i>Cycloteuthis sirventyi</i>	12	9.2	X
Chiroteuthidae			
<i>Chiroteuthis picteti</i>	8	6.1	X
<i>Grimalditeuthis bonplandi</i>	7	5.3	X
	1	0.8	X
Mastigoteuthidae			
<i>Mastigoteuthis pyrodes</i>	2	1.5	X
Cranchiidae			
<i>Magalocranchia fisheri</i>	4	3.1	X
<i>Taonius belone</i>	1	0.8	X
	3	2.3	X
Octopods			
Alloposidae			
<i>Haliphron atlantica</i>	5	3.8	X
Tremoctopodidae			
<i>Tremoctopus violaceus</i>	1	0.8	0
TOTAL	131	100.0	

** includes two specimens identified from photographs.



Heavily scavenged giant squid, *Architeuthis* sp. floating on the surface. The long, thin objects extending beneath the surface are the tentacles. A Wedge-tailed Shearwater is in the background.



Wedge-tailed Shearwater feeding on the cephalic portion of a jewel squid, *Stigmatoteuthis boylei*. The main body or mantle portion has already been removed by scavenging birds.



Close-up of the above giant squid in the process of being netted aboard. Large patches of skin have been removed and the arms have been severely truncated by scavenging birds.



Close-up of above squid shortly after the shearwater has departed. One of the arms has been torn free of the squid carcass.

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