

# Survey of beached birds and mammals: São Jacinto - Torreira (Portugal)

March 2014 to March 2015



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May 3, 2015

## **Introduction**

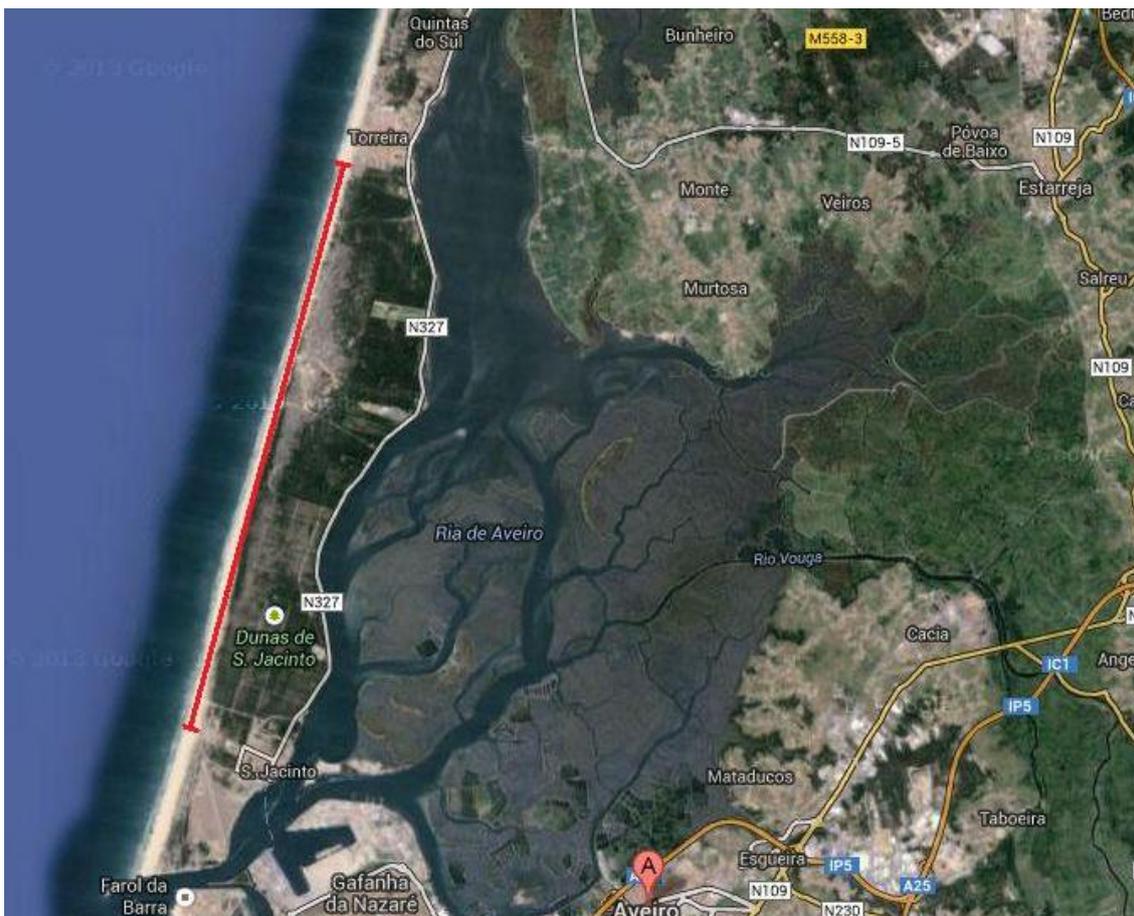
Coastal seabirds and marine mammals are good indicators of the health of marine ecosystems and high mortality events of these species can signal changes in oceanic conditions, such as those caused by oil spills, fisheries, habitat loss, lack of food supply and extreme weather conditions possibly resulting from climatic changes. Surveys of beached birds and mammals are thus highly informative and provide a valuable tool to address the causes and rates of marine animal mortalities. Information collected from those surveys helps understanding local patterns in mortality, the time of the year when mortality is most severe, which species are most vulnerable, and allows quantifying the number of animals affected. When conducted routinely, beach surveys provide baseline information against which any exceptional mortality event can be quantitatively assessed (e.g. due to oil spills or extreme weather conditions) and, for instance, to address whether human activities are hazardous for seabirds and marine mammals (e.g. oil spills and entanglement in fishing gear).

In early 2014 massive seabird mortality was reported along the coasts of southern England, SW France and northern Spain, where thousands of live and dead birds were found ashore by the end of February. This seabird wreck is amongst the worst ever recorded and was possibly caused by severe and continuing storms in the Atlantic Ocean. Unusually high numbers of dead seabirds were also reported in the Portuguese coast in late February (Van Nus & Moreira 2014a,b). Task-force work to rescue live birds and to record the magnitude of the event was promptly put in place in many European countries but, to our knowledge, Portuguese authorities and NGOs did not organize any surveying of its beaches. Upon knowing about the seabird wreck we decided to voluntarily survey beached seabirds near Aveiro so as to provide information for a stretch of the Portuguese coast. The beach extending from São Jacinto to Torreira (10 Km) located in NW Portugal suited our goal because it is not regularly cleaned and is partly closed off to the public. When receiving permission from the Reserva Natural das Dunas de São Jacinto to include the reserve's beach in the study we conducted two surveys on March 14 and 27, 2014 (Van Nus & Moreira, 2014a,b). The reporting of our findings contributed to a better understanding of the geographical magnitude of the 2014 seabird wreck (<http://www.oiledwildlife.eu/news/final-update-2014-european-seabird-wreck>).

Following our surveys at the aftermath of the 2014 seabird wreck, we continued surveying the same beach transect on a regular basis, aiming to provide a year round picture of the mortality of marine birds and mammals. Here, we report the findings from twelve surveys conducted from March 14, 2014 to March 23, 2015.

## Methods

The survey transect followed the coastline from São Jacinto to Torreira and covered 10 Km. It was most often accessed from the north, starting at the southernmost pier at the beach of Torreira, followed through to the northern limit of the reserve (5.7 Km), continued along the entire length of the reserve's beach (3.9 Km) and ended south at the boardwalk of the public beach of São Jacinto (0.4 Km) (Figure 1). The reserve's beach was surveyed under permission from the reserve's authorities. Surveys were always conducted by two observers (usually both authors), who walked the beach while keeping a reasonable distance between each other so as to inspect the wide band of materials often deposited by the sea. One observer walked along the high tide line, while also checking for recently deposited materials at the low tide line, and the other walked higher up on the beach along the storm line. When a storm line was not visible (that is, when it was mostly covered by windblown sand), observers covered a narrower band of washed up materials along the low and high tide lines. When walking the vegetated



**Figure 1.** Location of the 10 Km survey transect from São Jacinto to Torreira at the Atlantic coast of NW Portugal (source: Google Earth).

dunes, care was taken not to trample on the vegetation. By surveying a long transect we aimed to provide a reliable estimate of the average number of birds and mammals beached on the region's coast, as we would likely sample coastline sections that differ in the amounts of materials deposited by the sea.

We photographed all animal carcasses, examined them for taxonomic identification and determined, when possible, the sex and age of the individuals. Carcasses were also examined for any markings (i.e. rings) and for a possible cause of death, such as oil contamination and entanglement in fishing gear.

Furthermore, we recorded the condition of the carcasses (e.g. complete or incomplete) and whether they had been scavenged upon by carnivorous animals. To evaluate the probable time of death of the animals (that is, the age of a carcass) we recorded the following aspects: the condition of the eyes, whether the carcass was limp or stiff and whether (in the case of birds) feathers were largely missing. Although the rate of decay of animal carcasses varies dramatically depending on a wide array of factors, including weather conditions and time spent floating on the ocean, clearness of the eyes often indicates that a carcass is one to three days old. In turn, carcasses with sunk eyes may be about three days to several weeks old, while carcasses without eyes may be several weeks old, unless the eyes have been earlier removed by scavengers. Regarding limpness/stiffness, a bird carcass may be one day to several months old if limp. In contrast, carcasses that stay out of reach from the highest tides dry up after several weeks, so that stiff carcasses are usually older than a month. Carcasses of marine mammals, however, remain limp for a long time. When floating on the ocean, bird carcasses start losing feathers (firstly the primaries) usually after about a week. Based on these aspects, for simplicity, carcasses were classified into the following categories: i) 'fresh' (< 1 week old), ii) 'old' (> 1 week to several months old) and iii) 'very old' (more than several months old).

To avoid counting the same specimens repeatedly we disposed bird carcasses in the dunes, well above the highest tide line, so these would still remain accessible to scavengers. However, due to their large size and often decayed condition, marine mammals and Leatherback Sea Turtles were not moved. Instead, we photographed the carcasses that raised doubts whether they had been recorded in previous surveys and compared the photographs with those taken earlier. Animals that we assumed to deserve further investigation, such as the freshly beached marine mammals and the Leatherback Sea Turtles, were reported to the reserve's staff and to the Centro de Reabilitação de Animais Marinhos de Quiaios (CRAM-Q). Although most of the

birds could be easily identified by us, identification of marine mammals proved difficult, as it often required detailed examination and sample collection. To identify most of the marine mammals and some of the highly decayed birds we looked for advice and made our photographs available to several specialists.

While conducting the surveys of beached animals we also recorded the observation of live birds and mammals as well as their behaviors (i.e. scavenging of beached carcasses). We always carried binoculars, and only once also scopes, which meant that our observations focused on the animals present at the beach, adjacent dunes, and at sea but closer to shore.

## **Results**

Twelve surveys were conducted from March 14, 2014 to March 23, 2015. The initial two surveys were conducted within 13 days so as to better quantify the number of dead seabirds at the aftermath of the 2014 seabird wreck (Van Nus & Moreira 2014a,b). Thereafter, we conducted surveys on a regular (monthly) basis but could not always keep a 30-day interval between surveys because of other commitments (and the absence of a second observer) and because some surveys were delayed due to bad weather. The number of days between consecutive surveys ranged between 23 and 49 days (average = 36 days). Surveys took 2h:30min to 5h:00min (average=3h:18min) to complete, lasting longer when the number of carcasses was higher.

We recorded a total of 218 dead animals (Table 1 and Appendix I). As expected, birds comprised the majority of the records with a total of 197 (90.4%) carcasses; 184 belonged to 13 wild species and four to two domestic animals. Besides, eight carcasses were only identified to the genus (7 *Larus sp.*) or family (1 Alcidae) and one remained unidentified (see examples of bird carcasses difficult to identify in Appendix II). Most carcasses belonged to seabirds (190; including the birds identified to the genus and family) and three seabird species accounted for 164 (83.5% of all birds) records. Those species were the Atlantic Puffin (102 carcasses; one bird was ringed, item 124 in Appendix I), Lesser Black-backed Gull (39) and Northern Gannet (23). We also recorded five Razorbills, four Common Scoters and four Black-legged Kittiwakes, while five other species were recorded once. Only two wild birds were not seabirds (1 Little Egret and 1 Whimbrel). Furthermore, we recorded 18 (8.3% of all carcasses) mammals, including 14 marine species, two carcasses from domestic animals and two unidentified mammals. The marine mammals included the Harbour Porpoise (4 carcasses) and the Common Dolphin (3),

but three carcasses belonged to the genus *Delphinus* or *Stenella*, three belonged (or possibly belonged) to the genus *Mesoplodon* and one possibly belonged to the genus *Balaenoptera*. Marine mammal carcasses that were sun burnt, highly decayed or consisted of a few bones were, in most cases, not identified to the species (Appendix I; see examples of marine mammal carcasses difficult to identify in Appendix III). We also recorded three (1.4% of all carcasses) Leatherback Sea Turtles (Table 1 and Appendix I).

The total number of dead animals showed large variation between surveys, ranging from two in May and December 2014 to 121 in the first survey of March 2014. Among the birds, the number of carcasses per survey ranged from two (May to July and December 2014) to 119 in the first survey of March 2014. Following the 2014 seabird wreck, in March of that year we recorded a large number of affected seabirds (altogether 9 species), with the Atlantic Puffin being the most affected species (see Van Nus & Moreira 2014a,b for detailed description of the findings from March 2014). During the surveys conducted after March, the number of birds varied between two and eight, with the exception of the survey conducted on November 12 where we recorded 31 seabirds. This high mortality event was largely due to increased numbers of Lesser Black-backed Gulls (20 carcasses) and Northern Gannets (10) and most of these carcasses were from immature birds (75% of the Lesser Black-backed Gulls and 80% of the Northern Gannets). Moreover, seabird carcasses in this event were both 'old' (55% of the Lesser Black-backed Gulls, 70% of the Northern Gannets and one Great Skua; altogether 61% of the carcasses) and 'fresh' (45% of the Lesser Black-backed Gulls and 30% of the Northern Gannets; altogether 39% of the carcasses). Regarding the marine mammals, the number of carcasses recorded per survey ranged between zero (May, August, November and December 2014) and five (June 2014). Thus, in contrast with the seabirds, the number of dead marine mammals was not highest in March 2014. Instead, these animals washed ashore regularly and year round (Table 1).

Most animal carcasses were classified as 'old' (172). Carcasses classified as 'very old' (8) consisted mostly of bones of marine mammals and Northern Gannets. Only 32 carcasses were classified as 'fresh' and they included 28 birds from seven species (16 Lesser Black-backed Gulls, 5 Northern Gannets, 4 Razorbills, 1 Yellow-legged Gull, 1 Common Scoter, 1 Little Egret and 1 Whimbrel) and three mammals, namely a domestic animal and two dolphins (Appendix I).

**Table 1.** Number of animal carcasses at the 10 Km transect from São Jacinto to Torreira during twelve surveys conducted from March 14, 2014 to March 23, 2015. Totals per surveying date and among the surveys are also shown.

Classe	Order	Family	Species	English name	2014						2015			Total			
					14 Mar	27 Mar	2 May	9 Jun	7 Jul	25 Aug	2 Oct	12 Nov	5 Dec		23 Jan	25 Feb	23 Mar
REPTILIA	TESTUDINES	DERMOCHELYIDAE	<i>Dermochelys coriacea</i>	Leatherback Sea Turtle								2		1		3	
AVES	ANSERIFORMES	ANATIDAE	<i>Melanitta nigra</i>	Common Scoter	1	1					1			1		4	
AVES	GAVIIFORMES	GAVIIDAE	<i>Gavia immer</i>	Great Northern Diver	1											1	
AVES	PROCELLARIIFORMES	PROCELLARIIDAE	<i>Fulmarus glacialis</i>	Northern Fulmar	1											1	
AVES	SULIFORMES	SULIDAE	<i>Morus bassanus</i>	Northern Gannet	3		1	1	1	2	1	10			3	1	23
AVES	PELECANIFORMES	ARDEIDAE	<i>Egretta garzetta</i>	Little Egret		1										1	
AVES	CHARADRIIFORMES	SCOLOPACIDAE	<i>Numenius phaeopus</i>	Whimbrel			1									1	
AVES	CHARADRIIFORMES	STERCORARIIDAE	<i>Catharacta skua</i>	Great Skua								1				1	
AVES	CHARADRIIFORMES	LARIDAE	<i>Larus canus</i>	Common Gull	1											1	
AVES	CHARADRIIFORMES	LARIDAE	<i>Larus fuscus</i>	Lesser Black-backed Gull	6	1			1	1	2	20	2	1	4	1	39
AVES	CHARADRIIFORMES	LARIDAE	<i>Larus michahellis</i>	Yellow-legged Gull							1					1	
AVES	CHARADRIIFORMES	LARIDAE	<i>Rissa tridactyla</i>	Black-legged Kittiwake	4											4	
AVES	CHARADRIIFORMES	LARIDAE	Unidentified <i>Larus sp.</i>	-	1			1		1				1	1	2	7
AVES	CHARADRIIFORMES	ALCIDAE	<i>Alca torda</i>	Razorbill	5												5
AVES	CHARADRIIFORMES	ALCIDAE	<i>Fratercula arctica</i>	Atlantic Puffin	94	8											102
AVES	CHARADRIIFORMES	ALCIDAE	Unidentified Alcid	-		1										1	
AVES	COLUMBIFORMES	COLUMBIDAE	<i>Columba livia</i> (domestic)	Domestic/Feral Pigeon	1						1			1		3	
AVES	GALLIFORMES	PHASIANIDAE	<i>Gallus gallus domesticus</i>	Chicken												1	1
AVES	-	-	Unidentified bird	-	1												1
MAMMALIA	CETARTIODACTYLA	BOVIDAE	<i>Capra aegagrus hircus</i>	Domestic goat										1		1	
MAMMALIA	CETARTIODACTYLA	DELPHINIDAE	<i>Delphinus delphis</i>	Common Dolphin		1									2	3	
MAMMALIA	CETARTIODACTYLA	DELPHINIDAE	<i>Delphinus sp. or Stenella sp.</i>	-										1	1	1	3
MAMMALIA	CETARTIODACTYLA	PHOCOENIDAE	<i>Phocoena phocoena</i>	Harbour Porpoise				3						1		4	
MAMMALIA	CETARTIODACTYLA	ZIPHIIDAE	<i>Mesoplodon sp.</i>	-				1								1	
MAMMALIA	CETARTIODACTYLA	ZIPHIIDAE	possible <i>Mesoplodon sp.</i>	-				1			1					2	
MAMMALIA	CETARTIODACTYLA	BALAENOPTERIDAE	possible <i>Balaenoptera sp.</i>	-					1							1	
MAMMALIA	CARNIVORA	CANIDAE	<i>Canis familiaris</i>	Domestic dog											1	1	
MAMMALIA	-	-	Unidentified mammal	-	2											2	
<b>TOTAL</b>					<b>121</b>	<b>13</b>	<b>2</b>	<b>7</b>	<b>3</b>	<b>4</b>	<b>7</b>	<b>33</b>	<b>2</b>	<b>8</b>	<b>12</b>	<b>6</b>	<b>218</b>

The cause of death of the recorded specimens could only be addressed in five cases. Four animals (all classified as 'fresh') appeared to have their deaths related to entanglement in fishing gear. Namely, two Lesser Black-backed Gulls (items 159 and 169; Appendix I and Appendix IV), which were found with fishing lines and nets coiled around the body, and two Common Dolphins that beached fresh and close together (items 202 and 203; Appendix I and Appendix IV). Those dolphins seem to have been discarded after being entangled in fishing nets because one specimen had part of a fishing net around the tail fin and another had its tail fin cleanly cut off. Oil contamination was only recorded on one Northern Gannet (item 151; Appendix I).

Furthermore, we found that beached carcasses were often scavenged both by carnivorous birds and mammals. Altogether, we recorded 34 scavenged carcasses, including 26 birds, six marine mammals and two Leatherback Sea Turtles. Scavenging was mostly performed by Black Kites and Greater Black-backed Gulls, which we observed, respectively, scavenging on birds (item 136, Appendix I) and marine mammals (items 202, 203 and 209, Appendix I; see examples of carcasses scavenged by birds in Appendix V) and by the Red Fox and stray dogs, whose footprints and scat were often observed along the beach and nearby the carcasses (see examples of carcasses scavenged by carnivorous mammals in Appendix VI). We also recorded 51 carcasses that had missing body parts but, in these cases, it was not possible to ascertain whether this had been caused by scavengers or the decaying of carcasses.

During the surveys, we also recorded live birds from 32 species (Table 2). The most abundant species were the Lesser Black-backed Gulls, which gathered in large flocks at the beach, particularly during the Arte Xávega fishing season, and waders, namely the Ringed-Plover, Dunlin and Sanderling that roosted at high tide mostly at the northern side of the Torreira beach. Migratory waders, such as the Whimbrel and Bar-tailed Godwit, also sat at the beach during spring migration. Furthermore, we frequently observed Little-ringed Plovers, as they nested at the dunes, Black Kites that patrolled the beach for carcasses and Sandwich Terns that fished (and migrated) close to shore. Greater Black-backed Gulls (all immature) were observed in January and February 2015 scavenging on marine mammal carcasses. Many other species, including passerines and raptors, were also observed at the beach and dunes (Table 2). Given that during surveys we did not spend much time seawatching, live marine mammals were never recorded. Signs of the presence of the Red Fox and dogs were frequently observed and, on two occasions, we encountered the pack of about six stray dogs that roams at the reserve.

**Table 2.** Live birds recorded at the 10 Km transect from São Jacinto to Torreira during twelve surveys conducted from March 14, 2014 to March 23, 2015 . Number of individuals was not always counted ('+ '- species present; '++' - species present and abundant).

English name	Scientific name	2014							2015				
		14 Mar	27 Mar	2 May	9 Jun	7 Jul	25 Aug	2 Oct	12 Nov	5 Dec	23 Jan	25 Feb	23 Mar
Balearic Shearwater	<i>Puffinus mauretanicus</i>						>24						
Northern gannet	<i>Morus bassanus</i>					2	2	1					16
Great Cormorant	<i>Phalacrocorax carbo</i>									1			
Common Scoter	<i>Melanitta nigra</i>					++	>4						2
Black Kite	<i>Milvus migrans</i>	3	3	3	5	3							
Common Buzzard	<i>Buteo buteo</i>									1			
Common Kestrel	<i>Falco tinnunculus</i>												1
Peregrine Falcon	<i>Falco peregrinus</i>		1										
Ringed Plover	<i>Charadrius hiaticula</i>	2000	+					800	2		++	10	
Kentish plover	<i>Charadrius alexandrinus</i>	5	+	4	49	47	4		1		2	4	8
Sanderling	<i>Calidris alba</i>	+	+	12	51		3	300	2	1	+	156	
Dunlin	<i>Calidris alpina</i>	2000						+			++		
Bar-tailed Godwit	<i>Limosa lapponica</i>			13									
Whimbrel	<i>Numenius phaeopus</i>			6		1	8						
Waders	<i>Charadriiformes sp.</i>										2500		
Skuas	<i>Stercorarius sp.</i>									1			
Black-headed Gull	<i>Chroicocephalus ridibundus</i>							6					
Mediterranean Gull	<i>Ichthyaeetus melanocephalus</i>					2	2	18					
Lesser Black-backed Gull	<i>Larus fuscus</i>	+		++		++	700	3000	750	>150	88	8	>5200
Yellow-legged Gull	<i>Larus michahellis</i>					++	50	+	+	+	2		
Greater Black-backed Gull	<i>Larus marinus</i>										2	4	
Little Tern	<i>Sternula albifrons</i>			2									
Sandwich Tern	<i>Thalasseus sandvicensis</i>			20		3	43	6					25
Feral/Racing Pigeon	<i>Columbia livia (domestic)</i>												4
Pallid Swift	<i>Apus pallidus</i>							1					
Common/Pallid Swift	<i>Apus apus/Apus pallidus</i>				2								
Crested Lark	<i>Galerida cristata</i>	3		3	2	3	2	5	1	3	2	3	3
Woodlark	<i>Lullula arborea</i>						1	2			5	3	
Sand Martin	<i>Riparia riparia</i>							15					
Barn Swallow	<i>Hirundo rustica</i>							12					
White Wagtail	<i>Motacilla alba</i>				4		3	2	5	2	5	1	
House Sparrow	<i>Passer domesticus</i>							46					
European Greenfinch	<i>Chloris chloris</i>							80	2	3	25	7	
Snow Bunting	<i>Plectrophenax nivalis</i>								2				
Passerine sp.	<i>Passeriformes sp.</i>							50					

On most surveys, clear bands of materials were deposited at the high tide and storm lines (Figure 2). Less frequently, those bands were not visible either because they were mostly covered by windblown sand (March 27, 2014 and January 23, 2015) and because the ocean currents likely did not favor those deposits (December 5, 2014). Apart from the covering of carcasses by sand and the removal of carcasses by scavengers, other factors likely contributed to the underestimation of the number of beached carcasses. For instance, during summer months the washed up materials were cleaned from a few hundred meters south of Torreira beach and north of São Jacinto beach. Besides, upon reporting the finding of the Leatherback Sea Turtles and some of the dolphins (i.e. those that were fresher) to CRAM-Q, this

organization collected two of the dolphins, thus indicating that other carcasses may have been missed by us if reported to CRAM-Q by others. Moreover, there seemed to be some level of beach combing and collecting of marine animal carcasses that we cannot quantify, considering that one whale skull (item 146, Appendixes I and III) and one unidentified turtle shell (not recorded by us) were removed from the beach during the surveying period. While 6.1 Km of the transect are open to the public, we found that the reserve's beach (closed off to the public) is also frequently used by trespassers (we encountered 1 to 5 people on every survey) for sunbathing, fishing, digging for clams, and possibly also for beach combing.



**Figure 2.** Wide band of materials deposited by the sea at the high tide line on November 12, 2014.

### **Discussion**

Our beach surveys of dead animals along the 10 Km transect from São Jacinto to Torreira started in March 2014 at the aftermath of the 2014 seabird wreck. During this massive mortality event that is amongst the worst ever recorded in the Atlantic Ocean, thousands of

live and dead seabirds washed ashore in late February on the coasts of England, France and Spain, but the Portuguese authorities and NGOs did not organize any surveying of its beaches. To provide information for the Portuguese coast, we voluntarily surveyed 10 Km of the Aveiro coast upon obtaining permission from the Reserva Natural das Dunas de São Jacinto to include the reserve's beach in the study. Among the surveys conducted in March 14 and March 27 we recorded 134 dead animals, including 112 Atlantic Puffins, five Razorbills and 21 other seabirds from seven species (two specimens could not be identified to the species), some of which are rare or uncommon in Portugal (e.g. Northern Fulmar, Great Northern Diver and Common Gull) (see Van Nus & Moreira 2014a, b for detailed description of those findings). We confirmed that the 2014 seabird wreck was felt in Portugal and that it affected many seabird species, most severely the Atlantic Puffin. One of those Atlantic Puffins had been ringed as an adult in 2009 on Sule Skerry, Orkney, north Scotland. Our work thus contributed to a better understanding of the geographical magnitude of the 2014 seabird wreck (<http://www.oiledwildlife.eu/news/final-update-2014-european-seabird-wreck>).

In the following months, we continued surveying the same transect on a regular basis aiming to provide a picture of the year round number of beached birds and mammals. Among the ten surveys conducted after March 2014 we further recorded 84 dead animals; 63 birds (all but one Whimbrel were seabirds), 13 marine mammals, five domestic animals (3 birds and 2 mammals) and three Leatherback Sea Turtles. Seabirds (62 carcasses) continued to represent the majority of the specimens but, in contrast to March 2014, only six species were recorded. Three taxa alone, namely the Lesser Black-backed Gull (32), Northern Gannet (20) and gulls belonging to the genus *Larus* (6), comprised 94% of the seabirds. We found that seabirds washed ashore in small numbers year round but a distinct high mortality event was recorded in November 12, when 31 seabirds were recorded. These birds included 20 Lesser Black-backed Gulls (75% immature), ten Northern Gannets (80% immature) and one Great Skua of undetermined age. Moreover, these birds appeared to have died during an extended period of time because carcasses were both 'old' (55% of the Lesser Black-backed Gulls, 70% of the Northern Gannets and one Great Skua; altogether 61% of the carcasses) and 'fresh' (remainder carcasses). Such high mortalities of Lesser Black-backed Gulls and Northern Gannets were not recorded in any other surveys. In fact, the highest numbers of these species recorded in the other surveys were, respectively, six and three, and were both recorded at the aftermath of the 2014 seabird wreck in March 14, 2014. Because on November 12 we encountered a wide band of washed up materials along the entire transect (see Figure 2) it is likely that such increment in the number of carcasses was associated with ocean currents and/or prevailing

winds that favored the synchronous deposition on the beach of dead birds accumulated during an extended period and over a large sea expanse. This idea is also supported by the finding, on the same date, of two highly decayed Leatherback Sea Turtles, likely dead long ago, and also far offshore as this is a pelagic species. The high mortality event recorded on November 12 is, perhaps, to be expected because that time of the year coincides with the fall migration along the coast of thousands of seabirds from many species. That migration is also undertaken for the first time by (inexperienced) first year birds that typically suffer higher mortality than adults, simply because adults, for instance, forage more efficiently and endure better the storm weather conditions.

Although the causes for the observed high mortalities of Lesser Black-backed Gulls and Northern Gannets cannot be ascertained from our study, several explanatory hypotheses may be put forward. Because both species follow fishing boats closely, forage heavily on bycatch and dive for fish trapped in fishing nets, it is plausible that they are highly vulnerable (particularly the inexperienced first year birds) to entanglement in fishing nets. Granadeiro et al. (1997) estimated that seabirds killed by entanglement represented up to 7% of total mortalities and assessed this cause of death from its associated traumas, such as broken wings, missing heads and/or legs. In the present study, we did not quantify the number of birds killed by entanglement through the examination of the above traumas chiefly because these traumas are easily confounded by the effects of scavenging by carnivorous mammals. For instance, several of the freshly beached carcasses recorded on November 12 showed those traumas but many had also been scavenged upon (items 163, 181, 187). Although death by entanglement may be rarely associated with fishing lines and nets coiled around bird carcasses, simply because dead birds may fall off (or be taken off) the nets largely free of fishing gear remains, that was the only aspect we were able to quantify and thus only recorded 1% seabirds killed by entanglement. Accordingly, it is assured that other seabirds that we recorded likely died through entanglement. Another hypothesis is that the high seabird mortality recorded on November 12 was caused by malnourishment and/or disease. Fishing for sardine in Portugal was banned for five months, beginning in September 2014, and the Arte Xávega fishing at the coast of Aveiro that discards large amounts of bycatch on the beach, also ceased by the end of summer. It is, nonetheless, unclear whether Lesser Black-backed Gulls and Northern Gannets are that dependent on bycatch during fall migration so as to die from malnourishment when the fishing activity comes to a halt. This would perhaps seem paradoxical as lower fisheries might also be associated with higher prey availability at sea. However, to test the idea that birds died from malnourishment would imply detailed

examination of the carcasses (which we did not do) so as to determine, for instance, whether dead birds showed emaciated bodies. Considering that the Lesser Black-backed Gull was the most affected species during fall, and that die-offs of this species have been earlier recorded by one of us at Aveiro (<http://www.timvannus.blogspot.nl/2013/10/gull-die-off-in-ria-de-aveiro.html>) and also in October 2014 in northern Spain (<http://gaviotasyanillas.blogspot.pt/2014/10/unas-fotos.html>) the possibility that many gulls died from disease should not be discarded.

The hypothesis that bird mortalities were related to oil pollution is not supported by our findings. Teixeira (1986) and Granadeiro et al. (1997) both reported about 8% seabirds killed by oiling on the Portuguese coast, while we only recorded one Northern Gannet (0.5% of all birds) partly covered in oil. Though oil may be difficult to detect on highly decayed bird carcasses, the number of bird carcasses that we classified as 'old' and 'very old' was low, thus indicating that oil contamination did not play an important role in recorded bird mortalities. Oil was also not detected on dead marine mammals although, in most cases, those carcasses were highly decayed and released strong odor, which hindered the ability to detect oil contamination.

We also recorded 14 dead marine mammals, which washed ashore regularly and year round. Their numbers varied between zero (on 5 occasions) and five per survey (average = 1.2 marine mammals per survey). The most abundant species were the Harbour Porpoise (4 carcasses) and Common Dolphin (3). However, due to difficulties identifying certain specimens (see Appendix IV), seven other carcasses were not identified to the species. They belonged to the genus *Delphinus* or *Stenella* (3 carcasses) and to (or possibly to) the genus *Mesoplodon* (3) and *Balaenoptera* (1), indicating that the array of marine mammals that regularly wash ashore at the coast of Aveiro is quite diverse. Our results include three 'very old' carcasses belonging to animals that likely died before we started our surveys thus recommending that they should be excluded from the estimation of mortalities. Even so, recorded numbers of dead marine mammals are seemingly high, but it is difficult to appraise (without further data) how they relate to numbers of live specimens living offshore and whether they represent commonly observed species' mortalities. Most of the recorded marine mammal carcasses were highly decayed and may have washed ashore after floating at sea for long distances. Nonetheless, it remains plausible that many animals died locally, for instance due to entanglement in fishing nets. The freshest Common Dolphins that we recorded clearly died at a close distance entangled in fishing nets (see Appendix V), which places the rate of marine mammals known to

have died from this cause at 14%. This figure is, however, surely conservative because the signs of entanglement can be easily missed (unless detailed autopsies are conducted) when carcasses are highly decayed and also because, in this study, 85% of the marine mammal carcasses were 'old' or 'very old'.

The removal of carcasses from the beach by stray dogs, Red Fox, Black Kites and gulls is likely to have biased the results here reported towards the larger sized carcasses. Large sized marine mammals and seabirds (e.g. Northern Gannet) may be preferentially eaten at the spot by carnivorous mammals, as they may be difficult to carry out of the beach. Besides, scavenging of large carcasses by gulls (mostly by the Greater Black-backed Gull), although it leaves typical perforations to the bodies, can hardly contribute to the disappearance of carcasses from the beach. Thus, the observed number of beached mammals and large birds (notwithstanding other factors discussed below) may provide an accurate picture of the monthly rate of carcasses washing ashore. However, medium to small sized birds may be easily consumed whole by scavengers, torn apart and carried away from the beach. In this regard, it is noteworthy that we did not record dead waders (with the exception of one Whimbrel that is a large wader) even though thousands of small waders roost at the São Jacinto – Torreira beach during high tide. Moreover, and disregarding the Atlantic Puffins recorded at the aftermath of 2014 seabird wreck, we did not record medium to small sized migratory seabirds (e.g. any of the terns) and passerines despite their migration in large numbers along the coast. Accordingly, carcasses from medium to small sized birds appear to be quickly consumed by scavengers, which render the results from this study unsuitable to address the mortalities of that group of birds. Other factors surely also contributed to the underestimation of animal mortalities from our simple counts of dead animals along the transect, such as the covering of carcasses by windblown sand, cleaning of public beaches by authorities and the removal of carcasses by other people.

It is widely recognized that numbers of carcasses washed ashore depend on a variety of factors, such as densities at sea, local currents, predominant winds and type and intensity of mortality factors (Bibby, 1981; Camphuysen, 1989, 1995; Camphuysen & van Franeker, 1992). Therefore, in order to provide reliable estimates of the scale of these events in the Portuguese coast it would be necessary to survey many other stretches of the coast using standardized methods. In order to record seabird mortalities, beach surveys might be focused on the winter months (Granadeiro et al., 1997) and during the peaks of seabird migration, when mortality is expectedly higher. However, to encompass the evaluation of the mortalities of marine

mammals and of seabird species that occur in the Portuguese coast mostly during spring and summer (e.g. the Balearic Shearwater, *Puffinus mauretanicus*) beach surveys would necessarily have to be undertaken year round.

### **Acknowledgements**

We thank Paulo Cartaxana who aided conducting surveys on three occasions. We also thank Angelina S. Barbosa for logistical support and Guido Keijl (NATURALIS), Hans Verdaat (IMARES) and Kees Camphuysen (NIOZ) for their help identifying some of the animal carcasses. Surveying of the reserve's beach was conducted under permission from the Reserva Natural das Dunas de São Jacinto.

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**Appendix I.** Animal carcasses recorded at the 10 Km survey transect from São Jacinto to Torreira during twelve surveys conducted from March 14, 2014 to March 23, 2015. Carcasses (items) are shown according to the order they were found.

Date	Item	English name	Scientific name	Condition of carcass	Age	Status	Scavenged	Entangled
14-3-14	1	Black-legged Kittiwake	<i>Rissa tridactyla</i>	Complete carcass	Adult	Old	No	No
14-3-14	2	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	3	Black-legged Kittiwake	<i>Rissa tridactyla</i>	Wingset	Adult	Old	Unknown	No
14-3-14	4	Northern Gannet	<i>Morus bassanus</i>	Complete carcass	Immature	Old	No	No
14-3-14	5	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	6	Northern Gannet	<i>Morus bassanus</i>	Legs missing	Adult	Old	Unknown	No
14-3-14	7	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	8	Black-legged Kittiwake	<i>Rissa tridactyla</i>	Complete carcass	Adult	Old	No	No
14-3-14	9	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	10	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in left wing	?	Old	No	No
14-3-14	11	Atlantic Puffin	<i>Fratercula arctica</i>	Only head and part of body	Not 1st winter	Old	Unknown	No
14-3-14	12	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass	Adult	Old	No	No
14-3-14	13	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Adult	Old	No	No
14-3-14	14	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	15	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	16	Common Gull	<i>Larus canus</i>	Wingset	Adult	Old	Unknown	No
14-3-14	17	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	18	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	19	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	20	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	21	Razorbill	<i>Alca torda</i>	Complete carcass	Immature	Old	No	No
14-3-14	22	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	23	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Probably adult	Old	No	No
14-3-14	24	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	25	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	26	Atlantic Puffin	<i>Fratercula arctica</i>	Missing primaries in wings	Adult	Old	No	No
14-3-14	27	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Probably adult	Old	No	No
14-3-14	28	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	29	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	30	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	31	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	32	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	33	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Adult	Old	No	No
14-3-14	34	Atlantic Puffin	<i>Fratercula arctica</i>	One leg missing	?	Old	Unknown	No
14-3-14	35	Northern Gannet	<i>Morus bassanus</i>	Complete carcass	Adult	Old	No	No
14-3-14	36	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	37	Atlantic Puffin	<i>Fratercula arctica</i>	Head missing	Not 1st winter	Old	Unknown	No
14-3-14	38	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	?	Old	No	No
14-3-14	39	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	?	Old	No	No
14-3-14	40	Northern Fulmar	<i>Fulmarus glacialis</i>	Complete carcass	?	Old	No	No
14-3-14	41	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Probably adult	Old	No	No
14-3-14	42	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Adult	Old	No	No
14-3-14	43	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	Adult	Old	No	No
14-3-14	44	Common Scooter	<i>Melanitta nigra</i>	Wing and skin with feathers	?	Fresh	Yes	No
14-3-14	45	Black-legged Kittiwake	<i>Rissa tridactyla</i>	Complete carcass	Adult	Old	No	No
14-3-14	46	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	47	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	48	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	49	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	?	Old	No	No
14-3-14	50	Unidentified Larus	-	Wingset	Immature	Old	Unknown	No

Date	Item	English name	Scientific name	Condition of carcass	Age	Status	Scavenged	Entangled
14-3-14	51	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	52	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	53	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	54	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	Not 1st winter	Old	No	No
14-3-14	55	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	?	Old	No	No
14-3-14	56	Atlantic Puffin	<i>Fratercula arctica</i>	Dried up; one leg missing	Adult	Old	Unknown	No
14-3-14	57	Atlantic Puffin	<i>Fratercula arctica</i>	Dried up; one leg missing	Adult	Old	Unknown	No
14-3-14	58	Unidentified mammal	-	Two vertebrae	?	Very old	Unknown	No
14-3-14	59	Atlantic Puffin	<i>Fratercula arctica</i>	Dried up; complete carcass	Not 1st winter	Old	No	No
14-3-14	60	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	Not 1st winter	Old	No	No
14-3-14	61	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	62	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Not 1st winter	Old	No	No
14-3-14	63	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in one wing	?	Old	No	No
14-3-14	64	Atlantic Puffin	<i>Fratercula arctica</i>	Incomplete wings	Adult	Old	No	No
14-3-14	65	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	66	Atlantic Puffin	<i>Fratercula arctica</i>	One wing incomplete	Adult	Old	No	No
14-3-14	67	Domestic Pigeon	<i>Columba livia domestica</i>	Wingset	Adult	Old	No	No
14-3-14	68	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass; scavaged	Immature	Fresh	Yes	No
14-3-14	69	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass; scavaged	Adult	Fresh	Yes	No
14-3-14	70	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass	Adult	Fresh	No	No
14-3-14	71	Razorbill	<i>Alca torda</i>	Complete carcass	Immature	Fresh	No	No
14-3-14	72	Razorbill	<i>Alca torda</i>	Complete carcass	Adult	Fresh	No	No
14-3-14	73	Atlantic Puffin	<i>Fratercula arctica</i>	Head missing	?	Old	Unknown	No
14-3-14	74	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	75	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	76	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	77	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	78	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Probably adult	Old	No	No
14-3-14	79	Unidentified mammal	-	Spinal chord + ribs	?	Very old	Unknown	No
14-3-14	80	Atlantic Puffin	<i>Fratercula arctica</i>	Dried up; complete carcass	Adult	Old	No	No
14-3-14	81	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	82	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in right wing	Adult	Old	No	No
14-3-14	83	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	84	Razorbill	<i>Alca torda</i>	Complete carcass	Immature	Fresh	No	No
14-3-14	85	Great Northern Loon	<i>Gavia immer</i>	Right leg missing	Immature	Old	Yes	No
14-3-14	86	Razorbill	<i>Uria aalge</i>	Head missing	Adult	Fresh	Yes	No
14-3-14	87	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	Probably adult	2nd Old	No	No
14-3-14	88	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Probably adult	Old	No	No
14-3-14	89	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	90	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	91	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Not 1st winter	Old	No	No
14-3-14	92	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	93	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	94	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	95	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	96	Atlantic Puffin	<i>Fratercula arctica</i>	Dried; complete carcass	?	Old	No	No
14-3-14	97	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	?	Old	No	No
14-3-14	98	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	?	Old	No	No
14-3-14	99	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Immature	Old	No	No
14-3-14	100	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No

Date	Item	English name	Scientific name	Condition of carcass	Age	Status	Scavenged	Entangled
14-3-14	101	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	102	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Immature	Old	No	No
14-3-14	103	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	104	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	105	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Adult	Old	No	No
14-3-14	106	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Adult	Old	No	No
14-3-14	107	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass	Adult	Old	No	No
14-3-14	108	Atlantic Puffin	<i>Fratercula arctica</i>	No feathers in wings	Adult	Old	No	No
14-3-14	109	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Not 1st winter	Old	No	No
14-3-14	110	Unidentified bird	-	Wingset, no primaries	?	Old	?	No
14-3-14	111	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	Yes (by bird)	No
14-3-14	112	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in right wing	Adult	Old	No	No
14-3-14	113	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in right wing	Adult	Old	No	No
14-3-14	114	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	115	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	116	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Adult	Old	No	No
14-3-14	117	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in right wing	Immature	Old	No	No
14-3-14	118	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	119	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries in wings	Immature	Old	No	No
14-3-14	120	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
14-3-14	121	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass	Immature	Fresh	No	No
27-3-14	122	Common Dolphin	<i>Delphinus delphis</i>	Complete, circa 190 cm	?	Old	Unknown	No
27-3-14	123	Atlantic Puffin	<i>Fratercula arctica</i>	No head, no legs, missing ? primaries in right wing		Old	Unknown	No
27-3-14	124	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass, ringed London EX22197	Adult	Old	No	No
27-3-14	125	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass, belly gone	Adult	Old	Yes	No
27-3-14	126	Atlantic Puffin	<i>Fratercula arctica</i>	Skeleton, head, spinal chord, ? legs, no wings		Old	Unknown	No
27-3-14	127	Little Egret	<i>Egretta garzetta</i>	Complete carcass	?	Fresh	No	No
27-3-14	128	Common Scoter	<i>Melanitta nigra</i>	Left wing only	?	?	Yes	No
27-3-14	129	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass, no primaries in right wing	Adult	Old	No	No
27-3-14	130	Lesser Black-backed Gull	<i>Larus fuscus</i>	Complete carcass	Immature	Old	Yes	No
27-3-14	131	Atlantic Puffin	<i>Fratercula arctica</i>	No primaries/wings gone	Adult	Old	No	No
27-3-14	132	Unidentified Alcids	<i>Alcidae (family)</i>	Skin with feathers	?	Old	Yes	No
27-3-14	133	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass	Adult	Old	No	No
27-3-14	134	Atlantic Puffin	<i>Fratercula arctica</i>	Complete carcass, no feathers in wings	Adult	Old	No	No
2-5-14	135	Northern Gannet	<i>Morus bassanus</i>	Incomplete, headless		Very old	Unknown	No
2-5-14	136	Whimbrel	<i>Numenius phaeopus</i>	Complete skeleton	Adult	Fresh	Yes (by Black kites)	No
9-6-14	137	Northern Gannet	<i>Morus bassanus</i>	Incomplete (legs missing)	Adult	Old	Unknown	No
9-6-14	138	Harbour Porpoise	<i>Phocoena phocoena</i>	Complete carcass	?	Old	No	No
9-6-14	139	Possibly mesoplodon	<i>Mesoplodon?</i>	Incomplete (head missing)	?	Very old	Unknown	No
9-6-14	140	Larus sp.	<i>Larus sp.</i>	Wingset	Adult	Old	Unknown	No
9-6-14	141	Harbour Porpoise	<i>Phocoena phocoena</i>	Complete carcass	?	Old	Unknown	No
9-6-14	142	Mesoplodon	<i>Mesoplodon sp.</i>	Incomplete. Skull	?	Very old	Unknown	No
9-6-14	143	Harbour Porpoise	<i>Phocoena phocoena</i>	Complete carcass		Old	Unknown	No
7-7-14	144	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (legs missing).	Adult	Old	Unknown	No
7-7-14	145	Northern Gannet	<i>Morus bassanus</i>	Incomplete (legs missing).	Immature	Old	Unknown	No
7-7-14	146	Whale, possibly Balaenoptera	<i>Balaenoptera?</i>	Incomplete. Skull	?	Very old	Unknown	No
25-8-14	147	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (legs missing).	Immature	Old	Unknown	No
25-8-14	148	Northern Gannet	<i>Morus bassanus</i>	Incomplete, skeleton of body and wings, few feathers on wings		Very old	Unknown	No
25-8-14	149	Northern Gannet	<i>Morus bassanus</i>	Incomplete, skeleton of body and wings, few feathers on wings		Very old	Unknown	No
25-8-14	150	Larus sp.	<i>Larus sp.</i>	Complete.	2 cy	Old	No	No

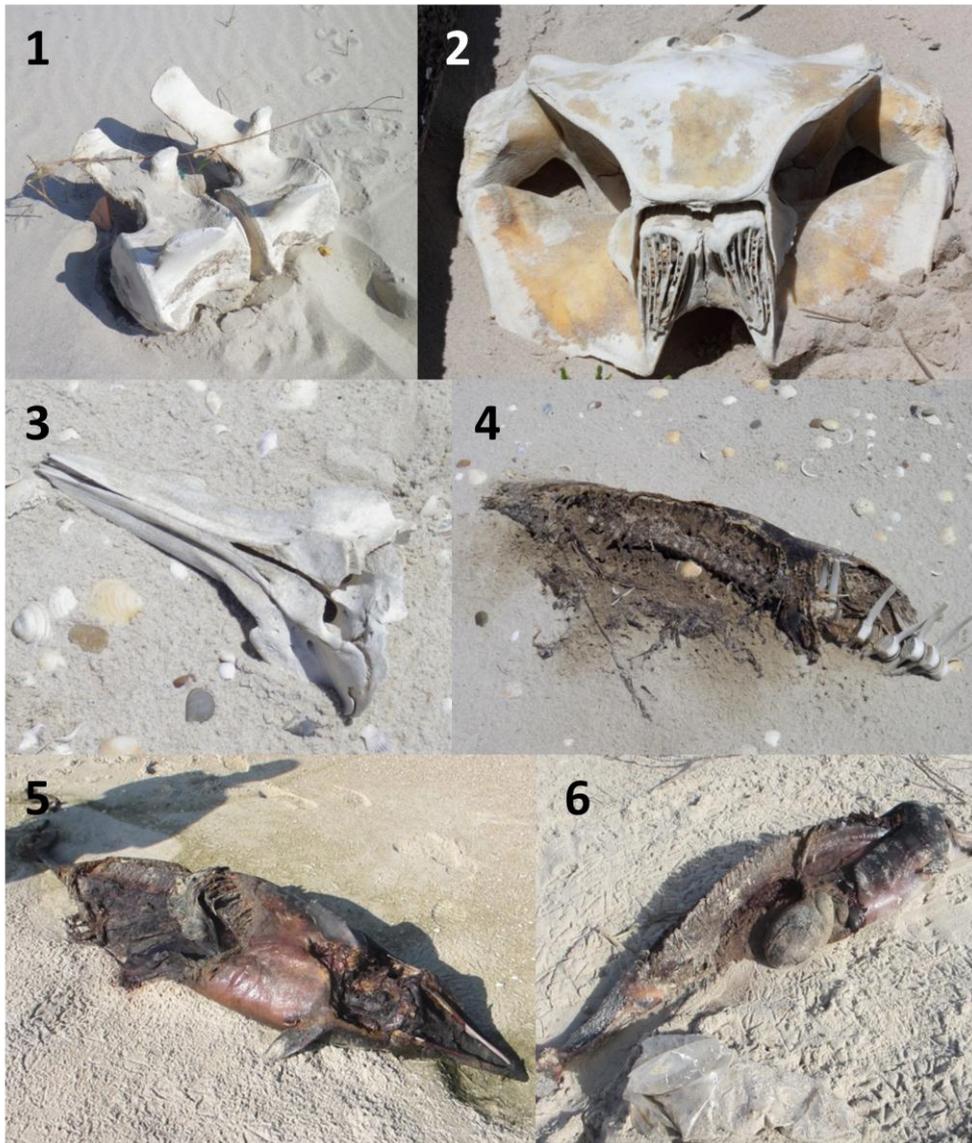
Date	Item	English name	Scientific name	Condition of carcass	Age	Status	Scavenged	Entangled
2-10-14	151	Northern Gannet	<i>Morus bassanus</i>	Eyes gone, complete, possibly contaminated with oil	Juvenile	Old	No	No
2-10-14	152	Common scoter	<i>Melanitta nigra</i>	Eyes gone, complete	Adult	Old	No	No
2-10-14	153	Lesser black-backed gull	<i>Larus fuscus</i>	Eyes sunk, complete	Subadult	Fresh	No	No
2-10-14	154	Lesser black-backed gull	<i>Larus fuscus</i>	Eyes clear, complete	Adult	Fresh	No	No
2-10-14	155	Yellow-legged gull	<i>Larus michahellis</i>	Eyes clear, complete	Adult	Fresh	No	No
2-10-14	156	Harbour porpoise	<i>Phocoena phocoena</i>	Complete, swollen	Adult	Old	No	No
2-10-14	157	Racing pigeon	<i>Columba livia domestica</i>	Leg and breastbone only, ringed	Unknown	Old	Unknown	No
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12-11-14	158	Northern Gannet	<i>Morus bassanus</i>	Complete, eyes sunk, limp	Immature	Old	No	No
12-11-14	159	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	Yes (in net)
12-11-14	160	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Adult	Old	No	No
12-11-14	161	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete, eyes sunk, limp	Immature	Old	Yes	No
12-11-14	162	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Adult	Old	No	No
12-11-14	163	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (head missing), limp	Immature	Old	Yes	No
12-11-14	164	Northern Gannet	<i>Morus bassanus</i>	Complete, eyes sunk, limp	Immature	Old	No	No
12-11-14	165	Northern Gannet	<i>Morus bassanus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
12-11-14	166	Northern Gannet	<i>Morus bassanus</i>	Incomplete (legs and belly missing), eyes sunk, limp	Immature	Old	Unknown	No
12-11-14	167	Leatherback Sea Turtle	<i>Dermochelys coriacea</i>	Incomplete (head and back about 1.40 m flippers missing)		Old	Yes	No
12-11-14	168	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (one leg missing), eyes sunk, limp	Immature	Old	Yes	No
12-11-14	169	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (one leg missing), eyes sunk, limp	Immature	Fresh	Yes	Yes (in nets)
12-11-14	170	Northern Gannet	<i>Morus bassanus</i>	Incomplete (head and 1 leg missing), skeleton	Immature	Old	Unknown	No
12-11-14	171	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (1 leg missing), eyes sunk, limp	Immature	Old	Yes	No
12-11-14	172	Great Skua	<i>Stercorarius skua</i>	Incomplete (1 leg missing), eyes gone, limp		Old	Unknown	No
12-11-14	173	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (head and wings missing)	Adult	Old	Unknown	No
12-11-14	174	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Adult	Old	No	No
12-11-14	175	Northern Gannet	<i>Morus bassanus</i>	Complete, eyes gone, limp	Immature	Old	No	No
12-11-14	176	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
12-11-14	177	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Adult	Fresh	No	No
12-11-14	178	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (legs and head missing)	Immature	Old	Unknown	No
12-11-14	179	Northern Gannet	<i>Morus bassanus</i>	Incomplete (1 leg missing), eyes sunk, limp	Immature	Old	Unknown	No
12-11-14	180	Lesser black-backed gull	<i>Larus fuscus</i>	Complete	Immature	Old	Yes	No
12-11-14	181	Northern Gannet	<i>Morus bassanus</i>	Incomplete (head missing), eyes sunk, limp	Adult	Fresh	Yes	No
12-11-14	182	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
12-11-14	183	Northern Gannet	<i>Morus bassanus</i>	Incomplete (legs and wings missing), skeleton	Immature	Old	Unknown	No
12-11-14	184	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (head, legs and one wing missing)	Immature	Old	Unknown	No
12-11-14	185	Leatherback Sea Turtle	<i>Dermochelys coriacea</i>	Complete	about 1.65 m	Old	Yes	No
12-11-14	186	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
12-11-14	187	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (1 leg missing), eyes sunk, limp	Immature	Fresh	Yes	No
12-11-14	188	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
12-11-14	189	Northern Gannet	<i>Morus bassanus</i>	Complete, eyes sunk, limp	Adult	Fresh	No	No
12-11-14	190	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
5-12-14	191	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete (1 wing, 1 leg and head missing)	Immature	?	?	No
5-12-14	192	Lesser black-backed gull	<i>Larus fuscus</i>	Complete, eyes sunk, limp	Immature	Fresh	No	No
23-1-15	193	Harbour porpoise	<i>Phocoena phocoena</i>	170 cm, no tail end, eyes gone	Adult	Old	Yes	No
23-1-15	194	Common scoter	<i>Melanitta nigra</i>	eyes gone, limp, no legs	Adult	?	Yes	No
23-1-15	195	Domestic goat	<i>Capra aegagrus hircus</i>	C. 50 cm, intact, eyes sunk, lamb	Juvenile	Fresh	No	No
23-1-15	196	Delphinus or Stenella	<i>Delphinus or Stenella</i>	200 cm, eyes gone, lower jaw gone, tail end gone	Adult	Old	Yes	No
23-1-15	197	Larus sp.	<i>Larus sp.</i>	Right wing only	1st winter	?	Unknown	No
23-1-15	198	Domestic pigeon	<i>Columba livia domestica</i>	Right wing only	?	?	Unknown	No
23-1-15	199	Leatherback Sea Turtle	<i>Dermochelys coriacea</i>	150 cm, missing at least lower left peddle. Including head, eyes gone, limp	?	Old	Yes	No
23-1-15	200	Lesser black-backed gull	<i>Larus fuscus</i>	Right wing only + connected keel	Subadult	?	Unknown	No

Date	Item	English name	Scientific name	Condition of carcass	Age	Status	Scavenged	Entangled
25-2-15	201	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete. Eyes gone, limp. No belly	Adult	Old	Yes	No
25-2-15	202	Common dolphin	<i>Delphinus delphis</i>	Fresh. 170 cm. Eyes gone, limp	Adult	Fresh	Yes (by marinus)	L. Poss.(net around tail)
25-2-15	203	Common dolphin	<i>Delphinus delphis</i>	Fresh. 180 cm. Eyes gone, limp. (Poss. Long-beaked Common dolphin D. capensis?)	Adult	Fresh	Yes (by marinus)	L. Poss. (tail cut off)
25-2-15	204	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete. Wingset only. head, no legs	No Adult	Old	Yes	No
25-2-15	205	Northern Gannet	<i>Morus bassanus</i>	Incomplete. Limp, eyes clear/sunk	Adult	Fresh	Yes	No
25-2-15	206	Northern Gannet	<i>Morus bassanus</i>	Incomplete. Limp, eyes clear/sunk	Adult	Old	Yes	No
25-2-15	207	Domestic dog	<i>Canis familiaris</i>	Complete. 65 cm. Black. Stiff, eyes sunk?	Adult	Old	No	No
25-2-15	208	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete. No head, no legs. Scavenged	Adult	Old	Yes	No
25-2-15	209	Delphinus or Stenella	<i>Delphinus or Stenella</i>	Old. 165 cm.	Adult	Old	Yes (by marinus)	L. No
25-2-15	210	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete. Wingset only. Limp	Adult	Old	Unknown	No
25-2-15	211	Larus sp.	<i>Larus sp.</i>	Incomplete. Left wing only. Limp	Subadult	Old	Unknown	No
25-2-15	212	Northern Gannet	<i>Morus bassanus</i>	Incomplete. No legs and belly. Limp, eyes sunk?	Adult	Fresh	Yes	No
23-3-15	213	Chicken	<i>Gallus gallus domesticus</i>	Incomplete. Part of wing only	?	Old	Unknown	No
23-3-15	214	Delphinus or Stenella	<i>Delphinus or Stenella</i>	Complete. Eyes gone, limp	2.15 m	Old	Yes (by gulls)	No
23-3-15	215	Larus sp.	<i>Larus sp.</i>	Incomplete. Only the breast bones and part of wings attached	Adult	Old	Unknown	No
23-3-15	216	Larus sp.	<i>Larus sp.</i>	Incomplete. Only the breast bones and part of one wing attached	1st winter	Old	Unknown	No
23-3-15	217	Northern Gannet	<i>Morus bassanus</i>	Incomplete. Wingset connected by breast bones	Adult	Old	Unknown	No
23-3-15	218	Lesser black-backed gull	<i>Larus fuscus</i>	Incomplete. Just two wings separated	Adult	Old	Unknown	No

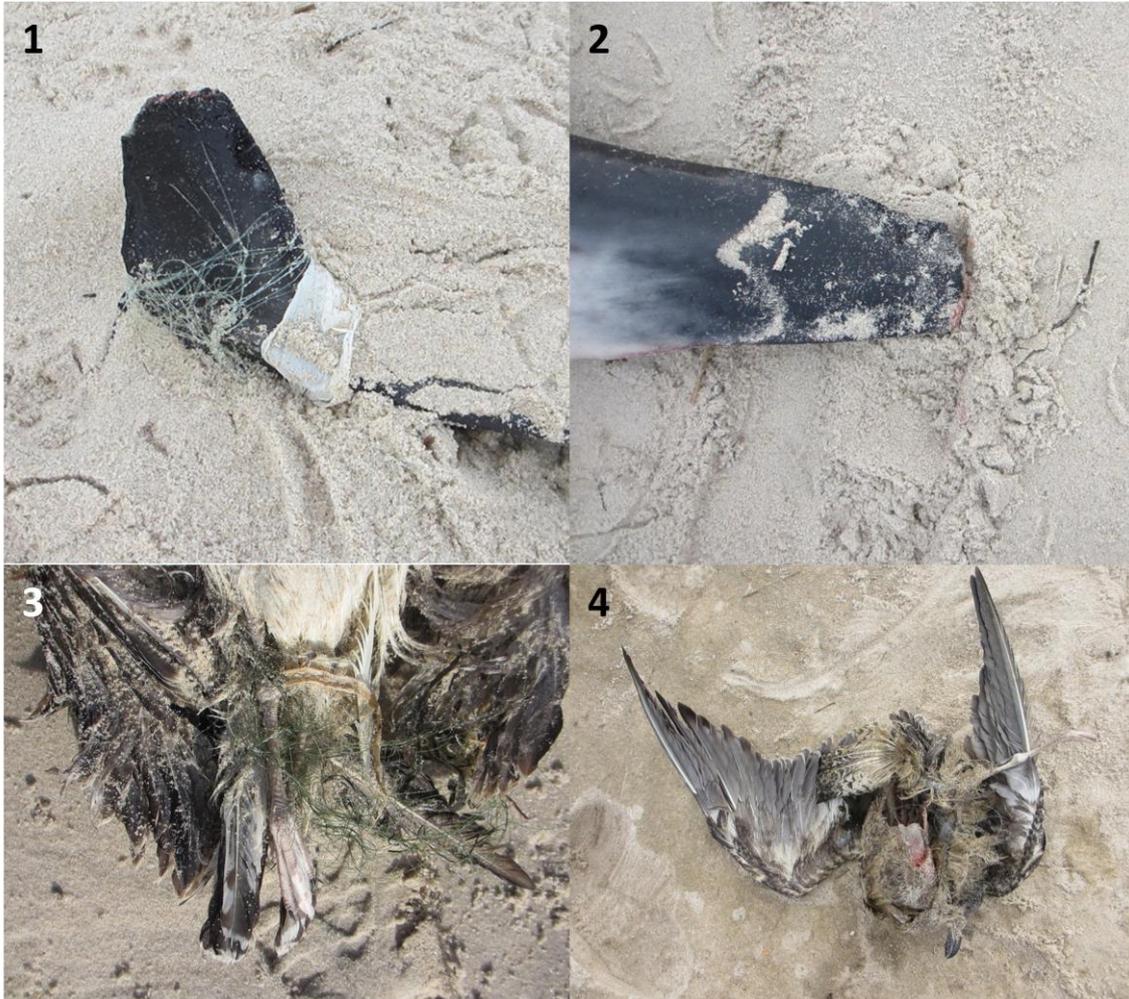
**Appendix II.** Examples of bird carcasses whose identification at the species level was not possible: (1) piece of skin with attached feathers (item 132; unidentified Alcid); (2) wingset with no primaries (item 110; unidentified bird); (3) part of wingset with attached breast bone (item 216; *Larus sp.*); (4) wingset without attached breast bone (item 140; *Larus sp.*).



**Appendix III.** Examples of marine mammal carcasses whose identification at the species level was not possible: (1) vertebrae from a large mammal (item 58; unidentified marine mammal); skulls from (2) a whale (item 146; possibly from the genus *Balaenoptera*) and (3) a dolphin from the genus *Mesoplodon* (item 142); highly decayed bodies of dolphins (4) possibly from the genus *Mesoplodon* (item 139) and (5 and 6) *Delphinus* or *Stenella* (items 209 and 214).



**Appendix IV.** Beached animals that appeared to have died entangled in fishing gear: freshly beached Common Dolphins (1) with net round the tail fin (item 202) and (2) with tail fin cleanly cut off (item 203); Lesser Black-backed Gulls (3) with fishing net (item 159) and (4) fishing lines round the body (item 169).



**Appendix V.** Example of beached carcasses scavenged by birds: (1) Atlantic Puffin with plucked feathers (item 111) and (2) Whimbrel with most of the flesh removed (item 136) by a Black Kite; (3) Leatherback Sea Turtle with a perforation in the front left flipper and surrounded by gull footprints (item 185); (4) dolphin with perforations to the body consistent with scavenging by Greater Black-backed Gulls (item 196); (5 and 6) Common Dolphins scavenged by Greater Black-backed Gulls and showing plucked out eyes and perforations to the jaws and belly (item 202).



**Appendix VI.** Examples of beached carcasses scavenged by carnivorous mammals, likely Red Foxes and stray dogs: (1) Great Northern Loon (item 85), (2) Northern Gannet (item 181) and Lesser Black-backed Gull (item 171) where large parts of the body were consumed and (4) Lesser Black-backed Gull where most of the flesh was consumed (item 161); (5) Left wing of a Common Scoter broken at the bone (item 128) and (6) remains of the skin of a Common Scoter (item 44).

