Tara Seal Research

MARINE MAMMAL MORTALITY RECORDED IN NORTHERN IRELAND BETWEEN AUGUST 2002 AND AUGUST 2003

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ABSTRACT. A high mortality of Northern Ireland harbour seals from distemper was predicted to occur in the summer and autumn of 2002. The high mortality did occur, and post-mortems were carried out on 19 harbour seals, four grey seals and four porpoises. Two cases of distemper were diagnosed, but the majority of deaths involved undersized harbour seal pups aged 3–5 months dying with severe lungworm and mild to severe infection with opportunistic bacteria, and up to 80% of the 2002 cohort of harbour seal pups in Co. Down may have died. It is suggested that the underlying cause of this mortality may have been poor abundance locally of appropriate fish prey leading to physical and physiological weakening of the pups, resulting in vulnerability to parasitic and bacterial infection.

INTRODUCTION

In the spring of 2002 a new outbreak of phocine distemper virus (PDV) was confirmed to be occurring in the Dutch Wadden Sea (Jensen et al., 2002). The virus was also confirmed to be the same strain as that which afflicted the seals of the North Sea, Irish Sea and East Atlantic in the summer of 1988 (Kennedy et al., 1988; Osterhaus & Vedder, 1988). In view of this threat, a nationally funded programme, to be coordinated by the marine mammal stranding team at the Institute of Zoology, London, was initiated to monitor seal and other marine mammal deaths around the UK coastline. Post-mortems were to be carried out on marine mammals found freshly dead.

In the summer of 1988 the PDV virus was confirmed to be the principle cause of the death of over 200 seals in Northern Ireland, mainly in the vicinity of the Co. Down coast (Kennedy et al., 1989; Montgomery-Watson, 2000). The Northern Ireland Environment & Heritage Service (EHS) set up a monitoring programme whereby EHS personnel and volunteers, in conjunction with local council authorities and Exploris Aquarium, monitored much of the Northern Ireland coastline on a weekly basis, recorded details of any dead marine mammals prior to their removal by the council, and transported any found freshly dead to the veterinary laboratories at Stormont for post-mortem examination and pathology analysis.

During the period of this monitoring programme, which extended from August 2002 until the present, counts of harbour (common) and grey seals in Northern Ireland

continued. These counts give an estimate of population size and pupping success in the 2002/03 season, against which the recorded mortality may be compared.

The purpose of the present report is to gather together all the information obtained from dead seal monitoring, post-mortem examinations and live seal counts and live pup monitoring during this period. The number of harbour seal pup births in both the 2002 and 2003 summer seasons will be compared with the number of harbour seal pup deaths recorded in the post-pupping period.

METHODS

A database recording all reported incidence of marine mammal mortality was collected by EHS personnel at the Quoile Countryside Centre, Downpatrick, Co. Down. The public was encouraged to phone in with any sightings of a dead or stranded marine mammal and the QCC phone 'hotline' was widely publicised in the province. In addition to this opportunistic reporting, a number of 1km stretches of Northern Ireland coastline were surveyed weekly by teams of EHS personnel and volunteers.

Animals found dead were sprayed with yellow dye and tagged with a yellow warning plastic tag to ensure that animals were not re-reported. Freshly dead carcases were then transported to the Veterinary Science Division (VSD) at Stormont for post-mortem examination. Altogether there were 19 post-mortems on harbour seals, 4 on grey seals and 4 on harbour porpoises.

Where possible, the animal was identified as to species and sex, and basic body dimensions (body length (nose-to-tail) and maximum girth) were either measured or estimated in the field. Where there was a discrepancy in the measurements, the measurements taken at post-mortem were used. For the purposes of this report, seals were assigned to age classes according to estimated or measured body length (pup ≤100cm; juvenile/subadult harbour seal, 100-120cm; juvenile/subadult grey seal 100–140cm; adult – larger than these measurement). Porpoises ≤ 90cm were classed as calves, 90-115cm as juveniles and adults > 115cm. Body condition index was calculated from the ratio of body weight to body length (W/L; Hall et al., 2001).

All the seals were tested for morbillivirus infection by means of immunohistochemistry (IHC) labelling of the lymph nodes, brain, spleen, kidney, bladder and lung). This test confirms the presence of viral lesions in these organs. Diagnostic virology was also carried out on samples from these organs. However, ELISA tests for antibodies to the virus in blood sera (e.g. Kennedy et al., 2000) were not carried out.

The harbour seal population estimates and number of births for the summer of 2002 and 2003 were obtained from surveys conducted or coordinated by EHS personnel and from surveys carried out independently at Ballykinler and Minerstown in Dundrum Bay and along the outer Ards coast.

RESULTS AND DISCUSSION

Number, location and age class of dead or live-stranded marine mammals recorded

The strandings were divided into those found before and after the start of the 2003 harbour seal pupping season. Altogether 125 marine mammals were found dead or sick along the coast of Northern Ireland between August 2002 and May 2003. These included 57 harbour seals, 31 grey seals, 32 seal species unidentified and 5 harbour porpoises. Of these, 19 post-mortems were carried out on harbour seals, 4 on grey seals and 3 on harbour porpoises. From June to September 2003 a further 14 marine mammal deaths were recorded, including 5 harbour seals, 1 grey seal, two seal species unidentified, 5 porpoises and one unidentified small cetacean. Of these, 1 post-mortem was carried out on a harbour porpoise.

There were nearly twice as many identified harbour seals found as identified grey seals, but 27% of all seals found were not identified as to species (Table 1). Nearly half of all seal strandings occurred in South Down, while a third occurred in Antrim/Derry and slightly fewer in North Down/Ards (Table 1).

Table 1. Distribution of total seal mortality August 02–May 03

	South Down	**North Down/Ards**	**Antrim/Derry**	**TOTALS**	**% TOTAL**
Harbour seals	31	11	15	57	48%
Grey Seals	7	11	13	31	26%
Unidentified	17	6	9	32	27%
TOTAL SEALS	55	28	37	120	
% TOTAL	46%	23%	31%		

Over all of Northern Ireland, 78 stranded seals were estimated, either from description or body measurements, to be either pups of the year (P) or juveniles (J). This represented 65% of all seals stranded, or 77% of the 101 seals for which body measurements or description were available. Of 57 confirmed harbour seals between August 2002 and May 2003, 36 (63%) were thought to be pups of the year and a further 9 (16%) were thought to be juveniles over a year old (Table 2). Of the total confirmed 31 grey seals, description and/or measurements were available for 29. Of these, 15 (52%) were thought to pups of the year and a further 5 (17%) were considered to be juveniles over a year old (Table 2).

Table 2. Distribution of pup(P) and juvenile(J) seal mortality, August 02–May 03

	South Down	**North Down/Ards**	**Antrim/Derry**	**TOTALS**
Harbour seals	15P + 7J	9P + 0J	11P + 2J	36P + 9J
Grey Seals	5P + 0J	5P + 2J	5P + 3J	15P + 5J
Unidentified	4P + 0J	2P + 0J	4P + 1J	10P + 3J
TOTAL YOUNG	24P + 7J	16P + 2J	20P + 6J	61P + 17J

Of the ten confirmed porpoises found dead in the 14 month period, 6 (60%) were in South Down, 4 (40%) in Antrim/Derry and none in North Down/Ards. Measurements were taken on eight of the 10, and of these, three (38%) were calves and two (25%) were juvenile (Table 3).

Table 3. Distribution of harbour porpoise mortality, August 02–September 03

	South Down	**North Down/Ards**	**Antrim/Derry**	**TOTALS**
Harbour porpoise totals	6	0	4	10
Porpoise calves and juveniles	2C + 1J	0C + 0J	1C + 1J	3C +2J

Results of the gross post-mortem examinations

Body condition

Harbour seals. The average nose-to-tail body length recorded for stranded harbour seal pups was 79 cm (range 63–96 cm). As a comparison, the nose-tail body lengths for 16 healthy pups in Co. Down in August and early September (10 rehabilitated and 6 wild pups) were found to range between 84–103cm, average 93 cm. The nose-to-tail measurements for the stranded pups in 2002 were significantly shorter than the healthy sample of pups ($P < 0.001$; 2-tailed T test).

Girths recorded for the 10 dead pups averaged 58cm (range 43–76cm), suggesting that they were generally thinner than the 16 healthy pups recorded between late July and early September (average 70.5 cm; range 60–79cm). The average weight of the dead pups was 12.7 kg (range 10–19 kg), compared to an average weight of the 16 healthy pups of 20.2 kg (range 15.5–27 kg). However, the dead and dying pups were collected between October and December, by which time some weight loss and girth reduction would be expected. Nevertheless, weights of 14 kg or less may be considered unhealthy. Only one of the nine pups (ID 39) weighed was over 14 kg.

The body weight/length (W/L) ratio has been used as a body condition index for live grey seal pups at weaning (Hall et al., 2001). For 9 dead pups, this ratio ranged between 0.13 and 0.20 ($\chi = 0.17$; Table 4). This ratio is smaller than that for the 16 healthy pups (0.16–0.24; $\chi = 0.22$). The W/BL indices were 0.23 and 0.49 for the adult harbour seals and 0.13 and 0.36 for the juveniles.

In general, therefore, the harbour seal pups that stranded seemed to be relatively thin, of low body weight, and short in stature compared with healthy pups. Poor body condition may have resulted from a shortage of suitable small prey available to pups, *or* to a failure of those pups to make the post-weaning transition to independent foraging, *or* to debilitation due to illness. The short body lengths recorded for most of the pups were mostly shorter than normal weaning size, and therefore might signify nutritional deficiency either prenatally or during lactation.

Grey seals and harbour porpoises. Measurements were available from four grey seals, all pups, with W/BL indices ranging from 0.12 to 0.27 (Table 4). This compares

poorly with an average W/L ratio at weaning for healthy wild grey seal pups of 0.40 kg/cm, range 0.24–0.55 (Hall et al., 2001), although some weight loss after weaning would be considered normal. The W/L index for one porpoise calf was 0.11.

Gross post-mortem examination and histology

Trauma. The immediate cause of death may have been trauma in three cases. A harbour seal pup (ID46) was found dead with a fractured skull in Newcastle, Co. Down in October 2002. However, this seal had apparently stranded and was diagnosed also with distemper and emphysema. Trauma to the back of the head to porpoise no. 9 had resulted in brain haemorrhage near the brain stem. However, this animal had probably stranded prior to the trauma due to heavy worm infestation of both the liver and lung. The porpoise calf (ID 27) had suffered bite wounds, but had probably stranded prior to these due to other causes – possibly starvation and jaundice.

Gastro-intestinal contents. Gastro-intestinal (GI) contents were reported for 12 of the 19 harbour seal post-mortem reports. None of these 12 seals (with the exception of pup 39, which died in rehabilitation facilities) had any food in the stomach and scant intestinal contents. Four of the seals, all pups, had ascarid worms in the stomach and one (no. 24) had congested stomach mucosa. GI contents were reported for two of the four grey seal pups, and three of the four porpoises. Both grey seal pups and all three porpoises had empty or scant GI contents. Both grey seal pups had ascarids in the stomach and one pup (no. 100) also had intestinal tapeworms. It may be inferred, that none of these seals or porpoises had fed in the few days before stranding.

Condition of lungs and trachea. Eighteen of the 19 harbour seals examined had congested lungs, involving 15–80% of the lung tissue. The exception to this was the large adult (ID 122), for which the cause of death was not diagnosed. Heavy lungworm infection was confirmed to be associated with the pneumonia in 15 of the 18 cases. The only case where lungworm was stated not to be associated with the pneumonia was in seal no. 42, which died of distemper (see below). Eight of the seals were observed to have lungworms in the trachea and bronchi. Three of the four grey seal pups were reported to have congested lungs, confirmed to be associated with heavy lungworm infection in one pup (ID 100). The fourth pup (ID 114) had lungworms in the trachea and bronchi, but pneumonia was not reported. All four porpoises had congested lungs, confirmed to be associated with heavy lungworm, infection in the two adults and juvenile (but not in the calf). In the juvenile porpoise (ID 56) all airways were completely blocked by adult worms and in one adult (ID 133) the lungs were 90% consolidated with multiple necrotic foci. In summary, most of the stranded and dead seals and porpoises had broncho-pneumonia, and in most cases this was associated with heavy lungworm infection.

Brain. Severe non-suppurative meningitis was reported from one pup (ID84). Meningeal congestion was reported for seal ID 59 and possibly for seal ID48. Otherwise, no brain abnormalities were detected. Meningeal congestion was also reported for two of the four grey seal pups.

Liver. The livers of six of the 19 harbour seals showed abnormalities, four of which indicated parasitic granulomas (presumably from lungworm). One of the four porpoises (ID 9) showed severe trematode infestation and one (ID 133) was enlarged and cirrhotic in appearance.

Lymph nodes. Lymphoid depletion was noted in two of 18 harbour seals, including one that was not morbillivirus positive (ID63). (One of the morbillivirus positive seals, no. 42, was not reported). One of the grey seal pups (!D 78) showed marked lymphoid depletion.

Virology. Of the 19 harbour seals, four grey seals and four porpoises tested by IHC for infection of the body tissues with the distemper virus, only two animals, both harbour seals (ID 42 & 46), were found to be positive. Both of these seals died in the second week of October 2002. The first was a young (virgin) adult female found at Minerstown (near the haul-out site), Co. Down, and the second was a pup, found at Newcastle, Co. Down. The pup's skull had also been fractured (possibly by a blow to the head after stranding sick). Virus isolation from tissues from all of these animals did not reveal any other viral infection.

Bacteriology. The bacteriological analyses of samples from all the carcases revealed infection by a variety of opportunist bacteria in 14 of the 19 harbour seals, three of the four grey seal pups and three of the four porpoises. Septicaemia due to severe β-haemolytic *Streptococcus* and haemolytic *E. coli* infection was probably the primary cause of death by septicaemia of one grey seal pup (ID 78). *Brucella* was isolated from tissues of four harbour seals (Watson et al., 2003). These four seals (IDs 24, 63, 91 & 96) included three pups born earlier in the season (IDs 24, 63 & 96) and one small juvenile (ID 91) which might also have been that season's pup.

Table 4. Principal contributory causes of death of 19 harbour seals, four grey seals and four harbour porpoises

Animal ID	**Sex and age class**	**Body condition W/L**	**Distemper**	**Severe lung worm**	**Bacterial infections (>++ in ≥3 organs)**	**Other pathology noted**
Harbour seals						
24	F PUP	?		YES	YES	
39	M PUP	0.20		YES	Mild	Enlarged liver
42	F ADULT	0.23	YES		Mild	Emphysema
46	F PUP	?	YES	YES		Fractured skull
48	F PUP	?			Mild	?Meningeal congestion
59	M PUP	0.17		YES	YES	Meningeal congestion
63	M PUP	0.16		YES	Mild	Parasitic granulomas in liver
67	M PUP	0.19		YES	Mild	Parasitic granulomas in liver
76	M JUV	0.13		YES	Mild	
77	F PUP	0.16		YES	Mild	

81	M JUV	0.36				Severe meningitis
82	M PUP	0.14			YES	Lung congestion
84	F PUP	0.18		YES		
88	F PUP	?		YES		
91	F JUV	?		YES	Mild	
96	? PUP	0.14		YES	Mild	
101	F PUP	0.15		YES	Mild	Parasitic granulomas in liver
103	M PUP	?		YES		
122	F ADULT	0.49		Mild	Mild	
Grey seals						
78	F PUP	0.12			YES	Meningeal congestion
100	M PUP	0.15		YES	YES	
108	F PUP	?				Meningeal congestion
114	M PUP	0.22		YES	Mild	
Harbour porpoises						
9	F ADULT	?		YES	Mild	Fractured skull; severe trematode infection in liver
27	M CALF	?				Bite marks
56	? JUV	0.11		YES	Mild	
133	F ADULT	?		YES	Mild	Cirrhosis of liver

Summary. The principal contributory causes of the death of each animal are summarised in Table 4. In Of 18 cases (excluding the two seals dying of distemper) where lungworm infection was severe, 15 also had mild to severe opportunistic bacterial infections of major organs, which included the lung in 11 cases. In two cases where no serious lungworm infection was reported (ID 82 and 78), the pups had heavy bacterial infection, which was probably the immediate cause of death. Meningitis was reported in four pups and one juvenile. This was associated with lungworm infection in only one case (ID 59) and with no other pathology in two cases (ID 81 and 108). In three cases where parasitic granulomas of the liver were recorded, heavy lungworm was also recorded, and was presumably related to the former. Four harbour seals pups and two grey seal pups had ascarid worms in the stomach, one grey seal pup had intestinal tapeworm and one porpoise had a heavy trematode infection in the liver.

Number of harbour seal deaths in relation to the number of harbour seals in Northern Ireland.

The total number of harbour seals, excluding pups of the year, counted in August 2002 in Co. Down may be estimated at a minimum of 500 individuals. The number of dead harbour seal and unidentified seal adults and juveniles in Co. Down (N. and S.

Down combined) was 34, or possibly about 7% of the population (although the actual number of seals may actually be higher than this, as revealed by a thermal imaging survey in August 2002; J. Montgomery-Watson, pers. comm.). The total number of harbour seal pups counted in all of Co. Down in July 2002 was approximately 38. The number of harbour and unidentified seal pups found dead or dying in autumn 2002 in Co. Down was 31 (including 6 of unidentified species), or possibly as much as 82% of the 2002 cohort of pups. The origin of the 11–15 harbour seal pups found dying or dead on the north Antrim/Derry coast is not known, although a few pups may be born in the small harbour seal colony on Rathlin Island.

Role of distemper virus in the mortality

Since two of 13 harbour seals (15%) that died on the Co. Down coast were confirmed at post-mortem to have died of distemper, it is possible that altogether about 15% of the 65 dead harbour and unidentified seals in Co. Down, i.e. about 10 seals, may have actually died of the disease. Without an ELISA test of serum, the possibility cannot be ruled out that some of the other seals autopsied may have been exposed to the virus and developed antibodies without the disease having progressed to the body tissues (e.g. Kennedy et al., 2000).

Underlying causes of deaths of harbour seal pups with lungworm and bacterial infections

The majority of the harbour seal deaths were 3–5 month old pups with lungworm and opportunistic bacterial infections, and this fate may have been suffered by up to 80% of the 2002 cohort of pups in Co. Down. This high rate of severe lungworm infection in the pups may have been associated with their poor nutritional status. A comprehensive study of nematode infection in 115 harbour seals, found dead in the German Wadden Sea during the 1988 distemper epizootic, found that 26% of the seals were infected with lungworm, but that the most heavily infected were seals less than a year old (Claussen et al., 1991). These authors investigated the correlation between nematode infestation and nutritional status by allocating seals to 3 categories of blubber thickness (>15 mm; 11–15mm & <11 mm), and found that the number of lungworms (*Parafilaroides gymnurus*) was highest in the ‘ill-fed’ and ‘underfed’ categories. They concluded that this correlation was independent of the distemper epidemic. The most heavily infected seals were less than a year old, and the authors concluded that in healthy young seals, immunity to these worms is in fact stimulated by infection (from infected prey) in the first year of life. Other studies during the 1988 mortality found that only two of 48 harbour seals (12 juveniles, the remainder subadult or adult) dying on the German North Sea coast had severe lungworm infection (Schumacher et al., 1990), while 8 harbour seal yearlings found dead or moribund off the Wadden Sea Friesian coast in early June 1988 all had severe lungworm infestation (Breuer et al., 1988).

The post-mortem measurements of the Northern Ireland pups in 2002 indicated that most of the dead pups were smaller in stature than normal and were also relatively

thin and of low body weight. Possibly there was a shortage of suitable prey for pups in Co. Down in the autumn of 2002.

Diet of the seals of Dundrum Bay

It has previously been shown that the harbour seals of Dundrum Bay in recent years have a diet in the summer months which is high in gadid fish, particularly haddock/pollock/saithe and whiting, while being low in oily fish such as herring Wilson et al., 2002). This dietary balance is thought to be unsuited to harbour seals, because not only do gadid fish have relatively low energy densities, but they also contain an anti-metabolite which may reduce iron absorption in genetically susceptible species, including the harbour seal. This can result in anaemia, decreased growth rates and increased mortality, particularly of pups in their first winter (Thompson et al., 1996; 1997; see discussion in Wilson et al., 2002).

An extension of the above study in August 2002 indicated that this unsuitable dietary balance was also in evidence then (C. Richards, unpublished). Oily fish (herring and sprat) accounted for only 1.3% of fish eaten and 2.7% of the diet by weight. Sandeels were the commonest fish caught (66%), but accounted for only 6.3% of the diet by weight. The largest proportion of the diet by weight was from gadids — haddock/pollock/saithe (71%), whiting (7%) and cod (1.2%). The remainder of the diet was mostly pleuronectid flatfish. It seems likely, therefore, that the pups that stranded in a debilitated condition in the autumn of 2002 may have been unable to find sufficient food except for gadid fish. As a result, they became physically and physiologically weak, and became increasingly unable to attempt to forage. They would then have been physiologically vulnerable to severe lungworm and opportunistic bacterial infection, since they would have been unable to meet the high energetic costs of maintaining an effective immune system response (Lochmiller & Deerenberg, 2000). By way of contrast, one pup, that was found to be healthy and weighing 21 kg in early November 2002, was found (most unusually) to have been feeding on dragonets and octopus, thereby avoiding the physiological problems associated with feeding on gadid fish (Wilson, unpublished).

Harbour porpoises in Scottish waters in the late 1960s were reported to eat mainly clupeoids (herring and sprat) and gadids (Rae, 1973), while more recently they were reported to eat mainly gadids and sandeels (Santos et al., 1995). Their tolerance of gadid fish is not known. Grey seals seem to feed typically on gadids, flatfish and sandeels and not on clupeoids (e.g. Hammond & Prime, 1995; Kiely et al., 2000); grey seals are not thought to be susceptible to the gadid anti-metabolite.

Conclusions and recommendations

Since the breeding success of the Co. Down harbour seal population appears to have been declining in recent years (Wilson & Montgomery-Watson, 2002), the poor survival rate of post-weaning pups in 2002 must be a subject for concern. Since the pup mortality seems not to have been, in the main, due to the distemper virus, but most probably resulted from poor nutrition gives rise to concern for the future health of the population. A local shortage of suitable fish prey is consistent with observations on the diet of these seals over the past few years (Wilson et al., 2002), although 2002

may have been a particularly bad year. We therefore recommend that the situation be monitored carefully in the next few years. Dead marine mammals throughout Northern Ireland should be autopsied whenever possible. Body measurements, weight and blubber thickness should be taken routinely in order to assess body condition, and blood samples should be taken for haematology, in order to test for anaemia and other blood parameters. Diet studies in Dundrum Bay should be continued, and extended to include the autumn and winter seasons.

ACKNOWLEDGMENTS

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