THE IMPACT OF THE *SEA EMPRESS* OIL SPILL ON BIRDS OF THE PEMBROKESHIRE COAST AND ISLANDS

Stephen J. Parr, Robert J. Haycock, and Malcolm E. Smith
Countryside Council for Wales
Plas Penrhos
Bangor, Gwynedd LL57 2LQ
United Kingdom

ABSTRACT: *Much of the Pembrokeshire coast and islands, together with its inshore waters, are of international importance for their breeding seabirds and wintering seaduck. Although the* Sea Empress *oil spill occurred before the breeding season, some 7000 oiled birds were recovered dead or alive. The impact of the oil spill on birds can be classified as follows: immediate mortality especially of more than 4500 wintering common scoter in Carmarthen Bay; sublethal effects on productivity of colonies and reduced adult survival from oil or dispersant ingestion; and chronic effects on bird populations from long-term pollution, particularly of prey. A range of monitoring and research projects are under way to investigate the impact, but it is premature to provide many results. The oil spill probably caused significant local declines in seabird colony sizes, especially of guillemot. The impact on common scoter will prove difficult to determine because of the poor quality and high variability of preincident data. Large numbers of oiled birds, particularly common scoter, were treated and subsequently released. The successful rehabilitation of such released birds is controversial; research and review results will be reported.*

On February 15, 1996, the *Sea Empress* ran aground off St. Anne's Head, at the mouth of Milford Haven in Pembrokeshire, southwest Wales. Up until February 21 she discharged 72,000 tons of crude oil and 360 tons of heavy fuel oil into the sea. As part of the cleanup operation, 445 tons of dispersant and 8 tons of demulsifier were aerially sprayed on the larger patches of oil (SEEEC, 1996). The most heavily oiled stretches of coast included much of Milford Haven, the Castlemartin coast, St. Margaret's and Caldey islands, and the west end of Carmarthen Bay (Figure 1).

The Pembrokeshire coast and particularly the islands, together with its inshore waters, are of international importance for their breeding seabirds, wintering seaduck, and wintering waterfowl (Table 1). The affected area supports approximately half a million breeding seabirds, including 50% of the U.K. population of Manx shearwater (*Puffinus puffinus*), the fourth largest gannetry (*Morus bassanus*) in the world, and 40,000 auks, principally on Skomer and Skokholm (Lloyd *et al.*, 1991). In winter it supports over 40,000 wintering waterfowl, including up to 30% of the U.K. common scoter (*Melanitta nigra*) wintering population, in Carmarthen Bay (Stewart, 1995). Consequently the area is unusually rich in European Union (EU) and U.K. site protection designations (Figure 2). However, both Ramsey and St. David's Peninsula Coast and Castlemartin Coast Special Protection Areas (SPAs) are designated under the EU's Wild Birds Directive solely for their chough *Pyrrhocorax pyrrhocorax* populations and not for seabirds.

The initial priority as a result of the spill was to count and collect dead and oiled birds and to monitor the effect of the oil on birds at sea. These projects were classified as short-term "reaction" projects (Table 2). Subsequently a second group of medium- to longer-term "impact" projects were instigated to measure the ongoing effects on birds, especially on breeding seabird populations. A third group of projects relating to the separate issue of the welfare of oiled birds are classified as "rehabilitation" projects. Hence the structure of this paper reflects this temporal change in project type and the separate issue of rehabilitation. Since the outputs from most of the impact projects are still due, this must remain a provisional assessment until all the results are available. Much of these data will be provided as an update at the conference.

Reaction to the oil spill

Following the grounding on February 15, 1996, an immediate bird casualty monitoring program was established along the Pembrokeshire coastline. Data were also collated from other important seabird areas affected, including Lundy Island, the North Devon coast, and southeast Ireland. Numbers of casualties were logged, and, where possible, dead birds were retrieved and frozen for further research. Coordinated ground-based surveillance of birds and collection of oiled bird casualties continued almost daily between February 16 and March 31 over an extensive shoreline. Thereafter occasional surveys were made of selected areas of the coastline in April and May. Aerial surveys of coastal waters, particularly Carmarthen Bay and around Skomer and Skokholm, were conducted daily between February 20 and March 7. Provisional identification of casualties up to June 1, 1996, indicates that some 6935 birds of at least 28 species were recovered dead or alive (Table 3). Oiled bird casualties were reported from February 17 onwards. Small numbers were still being found during May, but the peak numbers, about 85% of the dead and rescued birds, were recorded between February 24 and March 4, 1996 (Figure 3).

Seabirds. Dead and live oiled seabirds were recovered from many mainland beaches. The majority were found along the south Pembrokeshire and Carmarthenshire coastline (see Table 3). Over 1900 (28%) of bird casualties were guillemot (*Uria aalge*), and 66% of the dead oiled auks recovered were found between Linney Head and Tenby, close to the important seabird colonies at Elegug Stacks (Castlemartin coast), Stackpole Head, and St. Margaret's Island. Bird casualty figures reported from the main seabird colonies on the islands of Skomer, Skokholm, and Ramsey were small, but nonetheless 155 oiled bird corpses were found on the adjacent mainland between the mouth of Milford Haven and St. Brides Bay, most of which were auks.

Offshore boat surveys, following standard transect methods, were conducted between February 25 and 29 at the time of peak corpse retrieval from beaches (see Figure 3). This provided data on seabird densities. A mean density of 3.4 birds/km^2 (of 15 species) was recorded within a 4% sample of a 5500-km^2 total sea area. This suggests that there were approximately 20,000 seabirds in offshore waters. There was no

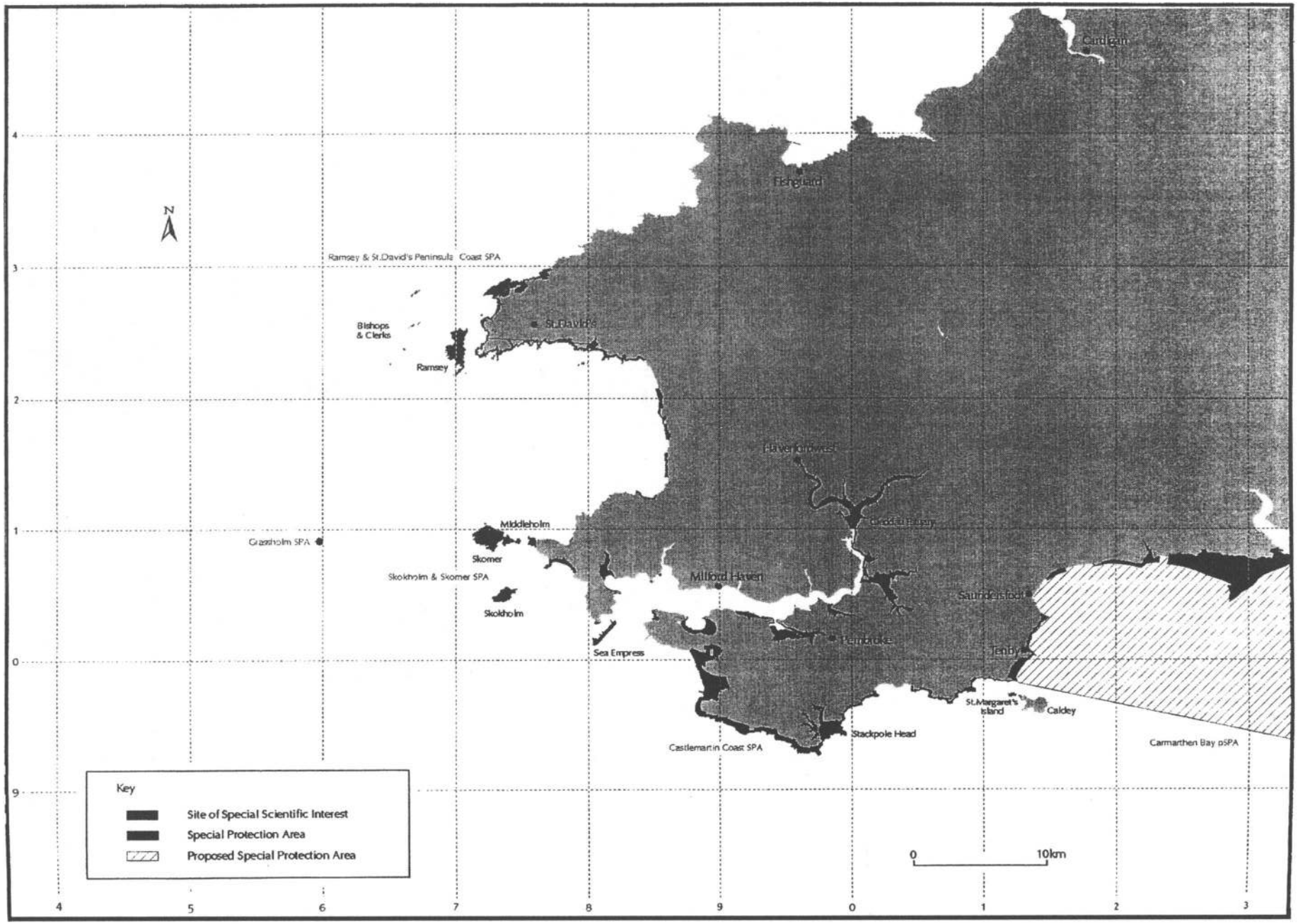

Figure 2. Distribution of Special Protection Areas and Sites of Special Scientific Interest in southwest Wales

Table 1. Important concentrations of breeding and wintering birds in southwest Wales

Site name	Criteria[1]	Species	Abundance[2]
Skomer	SPA	Manx shearwater *Puffinus puffinus*	150,000
		Fulmar *Fulmarus glacialis*	700
		Storm petrel *Hydrobates pelagicus*	100
		Great black-backed gull *Larus marinus*	60
	SPA	Lesser black-backed gull *Larus fuscus*	15,500
		Herring gull *Larus argentatus*	450
		Kittiwake *Rissa tridactyla*	2,300
	SSSI	Guillemot *Uria aalge*	10,000 I
	SSSI	Razorbill *Alca torda*	3,300 I
	SSSI	Puffin *Fratercula arctica*	10,500 I
Middleholm		Manx shearwater *Puffinus puffinus*	2,000
		Shag *Phalacrocorax aristotelis*	25
		Razorbill *Alca torda*	200
		Puffin *Fratercula arctica*	200
Skokholm	SPA	Manx shearwater *Puffinus puffinus*	40,000
		Fulmar *Fulmarus glacialis*	150
	SPA	Storm petrel *Hydrobates pelagicus*	4,000
		Great black-backed gull *Larus marinus*	40
	SSSI	Lesser black-backed gull *Larus fuscus*	3,000
		Herring gull *Larus argentatus*	400
	SSSI	Razorbill *Alca torda*	900 I
	SSSI	Puffin *Fratercula arctica*	2,700 I
Grassholm	SPA	Gannet *Morus bassanus*	33,000
		Guillemot *Uria aalge*	700
Ramsey and Bishops and Clerks		Fulmar *Fulmarus glacialis*	250
		Storm petrel *Hydrobates pelagicus*	200
		Lesser black-backed gull *Larus fuscus*	250
		Herring gull *Larus argentatus*	150
		Kittiwake *Rissa tridactyla*	500
		Guillemot *Uria aalge*	2,500 I
	SSSI	Razorbill *Alca torda*	1,250 I
	SPA	Chough *Pyrrhocorax pyrrhocorax*	8
Stackpole Head and Castlemartin		Kittiwake *Rissa tridactyla*	400
		Guillemot *Uria aalge*	6,750 I
		Razorbill *Alca torda*	600 I
	SPA	Chough *Pyrrhocorax pyrrhocorax*	12
St. Margaret's Island		Cormorant *Phalacrocorax carbo*	200
		Shag *Phalacrocorax aristotelis*	20
		Guillemot *Uria aalge*	800 I
		Razorbill *Alca torda*	200 I
Caldey		Lesser black-backed gull *Larus fuscus*	400
		Herring gull *Larus argentatus*	1,400
Milford Haven and Cleddau estuary (winter)	SSSI	Total wildfowl	4,050
	SSSI	Total waders	7,100
		Total gulls	4,700
Carmarthen Bay (winter)		Red-throated diver *Gavia stellata*	100
		Cormorant *Phalacrocorax carbo*	250
	SPA	Common scoter *Melanitta nigra*	Max 25,000
Total breeding birds			**485,330**
Total wintering birds			**41,200**

I = individuals; otherwise abundance measured in pairs.
1. SPA: > 1% of UK breeding population of species on Annex 1 of the EU 'Birds' Directive 1979, hence site of international importance and designated as Special Protection Area.
SSSI: > 1% of U.K. breeding population, hence site of national importance and notified as Site of Special Scientific Interest.
2. From Seabird Colony Register of the Joint Nature Conservation Committee and Lloyd *et al.* (1991).

apparent relationship between the numbers of guillemots and razorbills (*Alca torda*) recorded in coastal waters and the numbers recorded dead on adjacent coasts. A corpse-drift experiment was also conducted off the south Pembrokeshire coastline in early March to try to determine the recovery rate of birds that died at sea. At least 12 of the 238 oiled corpses have so far been recovered, all between Wexford and Cork in southeast Ireland, where some 362 dead oiled birds, mainly auks, were reported from mid-March onward, including a high proportion of guillemot (see Table 3). Computer modeling of corpses and oil dispersal suggests that both traveled south toward Devon and Cornwall before being blown across the Celtic Sea toward Ireland. It is thus likely that a high proportion of oiled birds sunk before reaching Ireland. The total mortality of

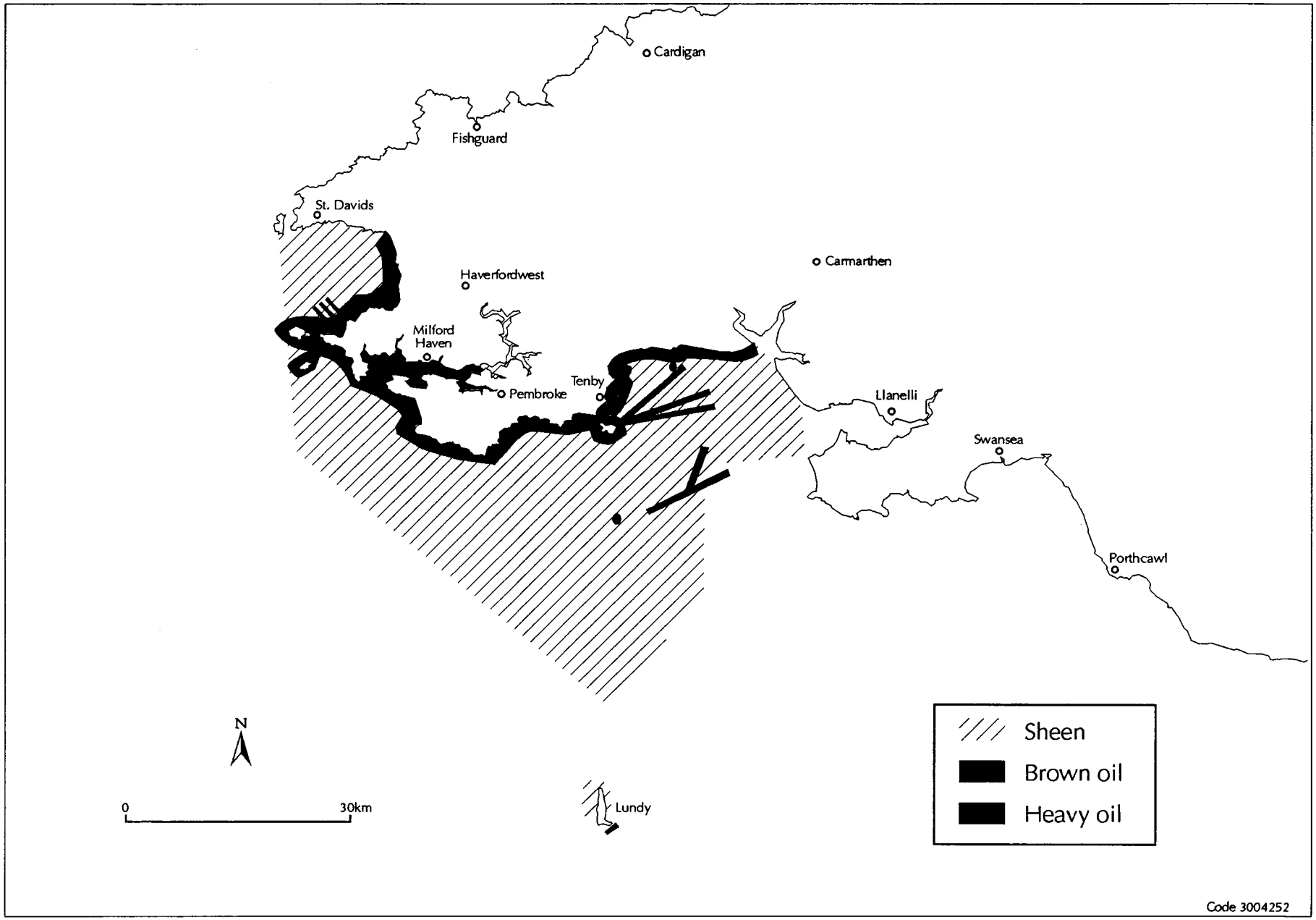

Figure 1. Distribution of oil from the *Sea Empress* in southwest Wales at the time of peak bird mortality, February 27, 1996

Table 2. Summary of ornithological projects initiated after the *Sea Empress* oil spill

Reaction projects	Contractor	Duration	Cost (£000s)
1. Storage of dead birds in freezer lorry	British Road Services	1996	10.0
2. Storage and sorting of dead birds	National Museum of Wales	1996	7.5
3. Ringing rehabilitated birds	British Trust for Ornithology	1996	3.0
4. Boat survey and tagged bird release SW Wales and beached bird survey of SE Ireland	Channel Seabirds Research Group	1996	24.0
5. Pembrokeshire seabird colony counts	CCW honourary wardens	1996	1.5
6. Pembrokeshire coastal waterfowl counts	CCW honourary wardens	1996	5.0
7. Milford Haven/Cleddau estuary waterfowl counts	CCW honourary wardens	1996	4.3
8. Land-based common scoter *Melanitta nigra* counts in Carmarthen Bay and data collection	B. Stewart	1996	2.0
9. Aerial survey of seabirds and common scoter *Melanitta nigra* in southwest Wales	Royal Society for the Protection of Birds	1996	9.8
Impact projects			
10. Land-based counts of common scoter *Melanitta nigra* in Carmarthen Bay	Wildfowl and Wetlands Trust	1996–00[1]	16.0
11. Bimonthly aerial surveys of common scoter *Melanitta nigra* in Carmarthen and Cardigan bays	Royal Society for the Protection of Birds	1996–97	12.0
12. Repeat breeding survey of common scoter *Melanitta nigra* in Scotland and Ireland	Wildfowl and Wetlands Trust	1996	5.2
13. Biometric and gut-content analyses of dead common scoter *Melanitta nigra* from Carmarthen Bay	Wildfowl and Wetlands Trust	1996–97	20.0
14. Razorbill *Alca torda* survival monitoring Skomer	Sheffield University	1997–99	30.0
15. Impact on breeding cormorant *Phalacrocorax carbo* colonies	Wildfowl and Wetlands Trust	1996–00[1]	30.0
16. Biometric and gut content analyses of dead seabirds, especially auk spp. recovered from SW Wales and SE Ireland	National Museums of Scotland	1996–97	15.0
17. Southwest Wales seabird colony counts	Dyfed Wildlife Trust	1996–98[1]	24.0
18. Impacts on the breeding ecology of kittiwakes *Rissa tridactyla* at Skomer	Durham University	1996	6.0
19. Oil contamination of gannets *Morus bassanus* and their nests on Grassholm	Channel Seabirds Research Group	1996	1.7
20. Analysis of seabird blood samples for sublethal effects of hydrocarbons	Glasgow University	1996	5.0
21. Analysis of egg samples from seabirds for sublethal effects of hydrocarbons	Institute of Terrestrial Ecology	1996–97	5.0
22. Winter waterfowl counts and condition studies in Milford Haven and Cleddau estuary	British Trust for Ornithology	1996–99[1]	45.0
Rehabilitation projects			
23. Survival rates of rehabilitated guillemots *Uria aalge*	British Trust for Ornithology	1996	16.0
24. Review of rehabilitation methods of seabirds	To be tendered	1996–97	15.0
Total			**313.0**

1. Review after first year

auks in particular is therefore likely to be significantly higher than the 1800 found dead on Welsh beaches.

Aerial and ground-based surveillance recorded auk attendance and offshore distribution of feeding seabirds between February 21 and early March. It was particularly evident that several thousand auks (mostly guillemots) and kittiwakes (*Rissa tridactyla*) were feeding over the Hats and Barrels reef about 25 km west of Skomer several days after the tanker grounded. On February 22 it was confirmed that most of the approximately 27,000 pairs of gannet (*Morus bassanus*) had returned to Grassholm and were feeding to the west. There were also large-scale synchronized arrivals of guillemot and razorbill to all large colonies on February 23.

Wintering seaduck and divers. Carmarthen Bay, which supports about 30% of the British wintering common scoter population, was heavily impacted by oil. Aerial transects between February 20 and 22, plus systematic counts along the coast from February 18 onwards, revealed more than 8000 common scoters in the area. By the beginning of March, about 50% were oiled and either dead or rescued. Casualties were mainly from the flock feeding within the western side of the bay, but several hundred birds were recovered on the eastern side. Of more than 1700 scoter corpses identified along the southwest Wales coastline, about 60% were recovered from Carmarthen Bay. Monitoring of the scoter flocks continued throughout late winter and spring. During the first 10 days of March scoter numbers remained significantly depleted on the western side of the bay, but later in the month numbers began to increase again because of immigration into the area. By March 17 the total population had risen to nearly 10,700 birds. Numbers remained high until late April, when the flocks began to migrate, and by mid-May very few birds remained.

Fifty-nine oiled red-throated divers (*Gavia stellata*) were also recovered. Although only about 1% of the casualties, these may have represented a high proportion of the local wintering population at the time of the spill.

Wintering waterfowl and gulls. Within the Milford Haven and Cleddau estuary, a routine monthly count revealed more than 12,000 waterfowl and gulls present on February 18. During the remainder of February and March systematic counts were made in the main embayments to assess maximum numbers of birds of all species present and the proportion oiled. Daily counts were achieved up to February 25. Thereafter, weekly counts were undertaken up to March 31. By late February many species were beginning to leave the estuary on annual migration, but shelduck (*Tadorna tadorna*) and curlew (*Numenius arquata*) were still present in nationally important numbers. Between February 18 and March 3 the proportion of oiled waterfowl and gulls recorded was much higher than during the remainder of the winter period (Table 4). The maximum number recorded was more than 1000

Table 3. Regional breakdown of *Sea Empress* oiled bird casualties

Species	Pembs	Carms	WGlam	Cered	Lundy	Eire	Rescued	Total
Manx shearwater	1	0	0	0	0	0	0	1
Fulmar	1	0	0	0	0	0	1	2
Great northern diver	0	0	2	0	0	0	5	7
Black-throated diver	0	0	1	0	0	0	1	2
Red-throated diver	10	3	4	0	1	1	40	59
Great crested grebe	1	0	0	0	0	0	2	3
Red-necked grebe	0	0	0	0	0	0	3	3
Gannet	0	0	1	0	1	9	0	11
Shag	7	0	0	0	1	2	12	22
Cormorant	20	0	1	1	0	0	1	23
Grey heron	1	0	1	0	0	0	1	3
Mute swan	1	0	0	0	0	0	23	24
Shelduck	0	1	0	0	0	0	1	2
Scaup	0	0	0	0	0	0	2	2
Common scoter	515	791	450	5	1	56	2753	4571
Velvet scoter	0	0	0	0	0	0	3	3
Eider	0	0	0	0	0	0	9	9
Red-breasted merganser	0	0	0	0	0	0	1	1
Oystercatcher	13	1	3	0	0	0	13	30
Curlew	2	0	0	0	0	0	0	2
Turnstone	0	0	1	0	0	0	0	1
Black-headed gull	4	0	5	1	0	0	1	11
Common gull	1	0	0	0	0	0	0	1
Herring gull	8	1	1	0	0	12	27	49
Kittiwake	0	0	1	0	0	0	6	7
Guillemot	798	27	38	1	44	196	487	1591
Razorbill	192	12	9	17	9	73	29	341
Unidentified/others	122	0	0	0	0	13	7	142
Total	**1697**	**836**	**518**	**25**	**57**	**362**	**3428**	**6923**

Pembs: Pembrokeshire.
Carms: Carmarthenshire.
WGlam: West Glamorgan.
Cered: Ceredigion.
Eire: southeast Ireland.

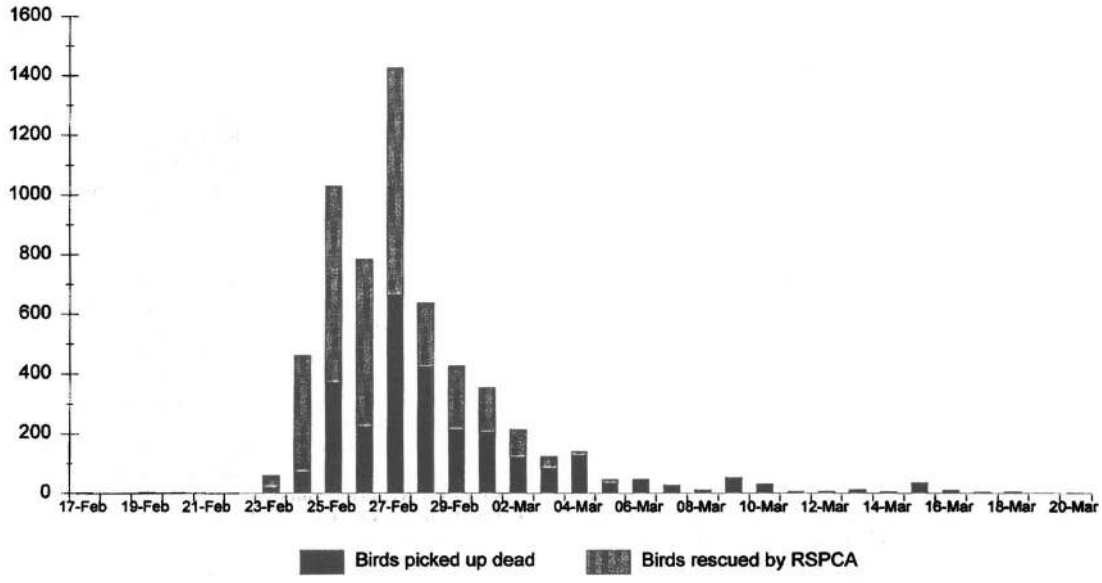

Figure 3. Frequency of bird casualties in southwest Wales following the *Sea Empress* oil spill

Table 4. Milford Haven/Cleddau Estuary maximum bird counts between February 18 and March 31, 1996

	Feb 18–March 3			March 10–31		
Species	Max on any day	Max oiled on any day	Min % oiled	Max on any day	Max oiled on any day	Min % oiled
Little grebe	22	0	0.0	15	0	0.0
Great crested grebe	13	2	15.4	10	0	0.0
Cormorant	44	7	15.9	73	1	1.4
Grey heron	16	0	0.0	20	0	0.0
Little egret	13	1	7.7	8	0	0.0
Mute swan	42	7	16.7	43	4	9.3
Canada goose	215	0	0.0	86	0	0.0
Shelduck	1,047	46	4.4	703	6	0.9
Wigeon	1,137	6	0.5	667	0	0.0
Teal	1,247	1	0.1	791	0	0.0
Mallard	131	3	2.3	53	0	0.0
Pintail	44	2	4.5	36	0	0.0
Shoveler	12	0	0.0	6	0	0.0
Goldeneye	33	1	3.0	19	0	0.0
Red-breasted merganser	12	3	25.0	14	0	0.0
Maximum wildfowl	**4,028**	**79**	**2.0**	**2,544**	**11**	**0.4**
Oystercatcher	412	86	20.9	311	23	7.4
Ringed plover	49	24	49.0	40	0	0.0
Grey plover	55	16	29.1	36	1	2.8
Knot	85	19	22.4	46	0	0.0
Snipe	95	3	3.2	53	0	0.0
Dunlin	4,426	23	0.5	2,987	0	0.0
Curlew	1,369	4	0.3	927	0	0.0
Redshank	514	14	2.7	489	0	0.0
Greenshank	10	1	10.0	14	0	0.0
Turnstone	65	16	24.6	25	0	0.0
Maximum waders	**7,080**	**206**	**2.9**	**4,928**	**24**	**0.5**
Black-headed gull	3,900	473	12.1	1,816	12	0.7
Common gull	247	65	26.3	215	0	0.0
Lesser black-backed gull	158	35	22.2	178	0	0.0
Herring gull	366	144	39.3	291	5	1.7
Great black-backed gull	14	1	7.1	21	0	0.0
Maximum gulls	**4,685**	**718**	**15.3**	**2,521**	**17**	**0.7**
Maximum	**15,793**	**1,003**	**6.4**	**9,993**	**52**	**0.5**

oiled birds of 27 species, mainly gulls, some waders, and shelduck. Between March 10 and March 31, numbers of waterfowl and gulls generally declined in the estuary, and the overall number of oiled birds was less than 1%. Some important estuary embayments were especially contaminated by oil. Total waterfowl numbers appeared to decline sharply throughout the estuary complex just after the tanker was grounded (Figure 4). Although numbers generally increased again a few days later in those upstream embayments that escaped significant oiling, numbers remained depleted in the worst affected areas (see Figure 3).

Impact studies

Seabirds. Repeat surveys of seabird breeding colonies, including auks, kittiwake, cormorant (*Phalacrocorax carbo*), shag (*Phalacroco-*

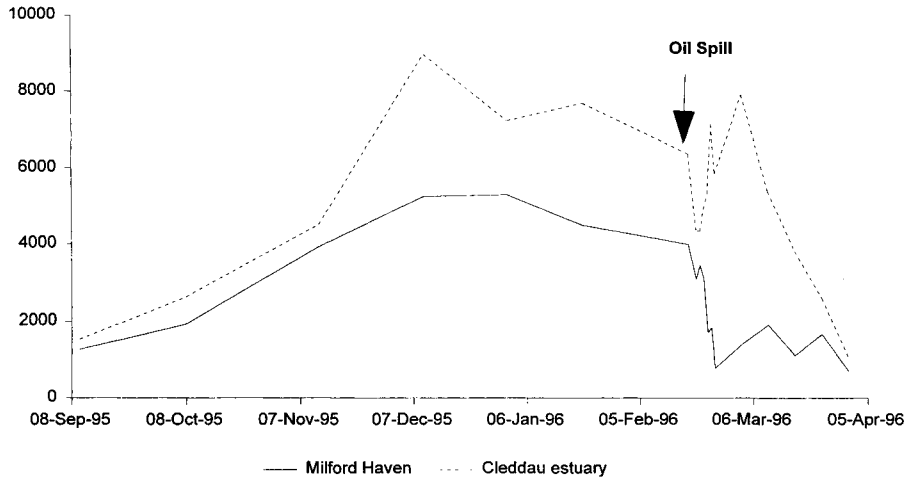

Figure 4. Waterfowl counts in Milford Haven and the Cleddau estuary

Table 5. Guillemot *Uria aalge* colony counts in southwest Wales 1969–1996 (count unit is individual birds on breeding ledges)

Site	1969	1979	1987	1995	1996	% change 1969–87	% change 1987–95	% change 1995–96
New Quay Head	330	nc	2,336	2,062	2,908	11	−1	41
Ramsey	623	731	1,740	2,487	2,640	6	5	6
Total north Pembs and Ceredigion	**953**	—	**4,076**	**4,549**	**5,548**	**9**	**2**	**22**
Skomer	3,925	3,282	6,192	9,995	8,397	3	7	−16
Middleholm	60	42	nc	183	212	—	—	16
Skokholm	120	nc	292	684	509	6	12	−26
Elegug Stack	520	506	3,470	5,928	4,865	13	6	−18
Castlemartin	322	959	1,224	2,149	2,037	9	6	−5
St. Margaret's Island	118	151	437	791	334	8	8	−58
Caldey	1	nc	27	38	11	20	5	−71
Total south Pembs	**5,006**	—	**11,642**	**19,768**	**16,365**	**5**	**7**	**−17**

rax aristotelis), and gulls, along the Pembrokeshire coastline have been conducted, especially in areas nearest to the oil spill. Methods followed the *Seabird Monitoring Handbook* (Walsh *et al.*, 1995).

Guillemot. There was a general trend of increasing guillemot numbers in southwest Wales from "Operation Seafarer" in 1969 (Cramp *et al.*, 1974) until 1995 (Tables 5 and 6). Initial results from 1996 suggest that in Ceredigion and north Pembrokeshire this expansion in numbers was maintained. In contrast, numbers at all of the south Pembrokeshire colonies (those closest to the oil spill) declined, except those on Middleholm. The decline was most pronounced on St. Margaret's Island (58%). Skomer and Elegug Stack suffered the greatest declines in absolute numbers, totaling more than 2650 birds. At south Pembrokeshire breeding sites overall, there were 3403 fewer birds in 1996 compared with 1995, a 17% decline. Productivity was monitored at three colonies in south Pembrokeshire and at one in north Pembrokeshire. Numbers at all colonies were within the range recorded on Skomer during the period 1989 to 1996.

Razorbill. Razorbills are less numerous than guillemots in Pembrokeshire, with the largest concentrations at Skomer, Ramsey, Skokholm, and Elegug Stacks. There has been a similar annual long-term increase of approximately 5% at most colonies in the region. Some new sites have also been colonized. In north Pembrokeshire, there was an overall increase of 3% between 1995 and 1996. At south Pembrokeshire colonies there were considerable fluctuations in attendance near areas affected by oil. Changes ranged from localized increases in numbers (e.g., of up to c. 30% at Elegug Stacks) to declines of between 55% and 85% affecting the smaller colonies at St. Margaret's and Caldey islands. Numbers overall in south Pembrokeshire declined by about 7% compared to 1995, a reduction of at least 400 birds.

Cormorant attendance was at the lower end of the normal variation at their five Pembrokeshire colonies. There were 207 apparently occupied nests (aon) on St. Margaret's Island, the largest colony. In the previous 10 years the colony had varied in size from 187 aon to 320 aon. Productivity data for colonies are not significantly lower than those recorded in southwest England and north Wales. However, counts of shag suggest that the small breeding population, which was widely distributed along the coast of south Pembrokeshire, has been greatly reduced.

Samples of seabird eggs and blood have been collected under license for analysis of sublethal effects of hydrocarbons. Biometric and gut content analysis of dead guillemot razorbill are also being undertaken. Results will be reported at the conference.

Common scoter. Regular monitoring, both by land counts and by aerial survey, of common scoter has been initiated to record the distribution and numbers in Carmarthen Bay and Cardigan Bay over the next 3 years. These data will be reviewed with existing baseline data, although the poor monitoring history and high variability in counts make assessing any impact difficult (Figure 5). A repeat survey of the Scottish and Irish common scoter breeding population was undertaken and suggests that the population has declined by 20% since 1995. However, the population is small and has been declining for some years. Hence attributing the decline to adult mortality in Carmarthen Bay is impossible. Biometric and gut content analysis of dead common scoter is under way. Preliminary data from an initial sample of 200 birds suggest that the main prey were a small razorshell *Pharus legumen* and cockle (*Cerastoderma edule*). The razorshell was possibly more readily available because of pollutant effects, since this organism is normally found deep in the sediment. Razorshells have not been recorded as prey of common scoter before. The large sample of frozen oiled corpses will provide the best available data on the origins of the dead scoter.

Wintering waterfowl. Within Milford Haven and the Cleddau estuary, further systematic counts of the waterfowl populations within oiled and nonoiled sections will be conducted over the next 3 years. Four sites, two heavily oiled and two nonoiled, will be counted at all states of the tide to compare feeding distribution. This will repeat similar work undertaken in winter 1988–89 (Prŷs-Jones, 1989). These data will be used in conjunction with invertebrate surveys of intertidal sediments within the study sites to investigate bioaccumulation of hydrocarbons.

Table 6. Guillemot *Uria aalge* productivity at colonies in south Pembrokeshire in 1996

Site	Mean productivity	SE	N
Needle Rock, Dinas	0.89	0.89	51
Skomer	0.77		
Elegug Stack	0.75	0.04	262
St. Margaret's Island	0.72	0.09	52

Sublethal impacts

Any sublethal effects from external or internal exposure to *Sea Empress* oil or dispersant are being investigated using eggs of cor-

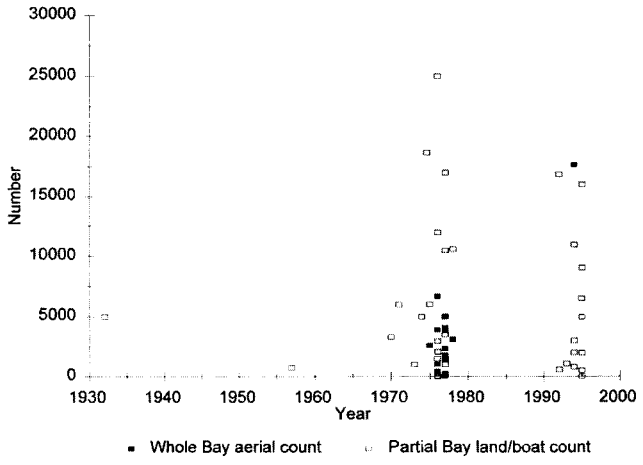

Figure 5. Counts of common scoter (*Melanitta nigra*) in Carmarthen Bay 1932–1995 (From Stewart, 1995.)

morants and gulls. Evidence for hemolytic anemia is also being investigated in shags. Results will be reported.

Rehabilitation of oiled birds

Two projects have been commissioned. The first will analyze over 1500 guillemot ringing recoveries and compare these with 170 recoveries of oiled guillemots. The second will review rehabilitation methods used by the Royal Society for the Prevention of Cruelty to Animals (RSPCA), which are currently based on Clarke and Kennedy (1972).

Discussion

The *Sea Empress* oil spill has probably led to reductions in breeding seabird populations, especially of guillemot. The overall decline in guillemot attendance of 17% indicates that there was a high level of unrecorded direct mortality to adult birds. Corpse drift experiments appear to confirm this. There is no indication from color-ringed birds that adults have dispersed elsewhere. Continued counts at selected colonies will be required to measure the recovery of the south Pembrokeshire population. These are in hand.

The impact on wintering common scoter will be difficult to determine. Historical counts within Carmarthen Bay are restricted to two short periods in the 1970s and 1990s, and the high variability in flock sizes makes long-term trends impossible to determine.

Biography

Stephen J. Parr is the Countryside Council for Wales's vertebrate ecologist. Robert J. Haycock is the Countryside Council for Wales's warden for its South Pembrokeshire Reserves. Dr. Malcolm E. Smith is the Countryside Council for Wales's Director of Policy and Science.

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