

Harbour seal population assessment in the Republic of Ireland

August 2003



Irish Wildlife Manuals No. 11



Harbour seal population assessment in the Republic of Ireland

August 2003

Michelle Cronin ¹, Callan Duck ², Oliver Ó Cadhla ¹, Richard Nairn ³,
Denis Strong ⁴, Ciarán O' Keeffe ⁵

1. COASTAL AND MARINE RESOURCES CENTRE

ERI, University College Cork,
Naval Base,
Haulbowline, Cobh,
Co. Cork.
IRELAND

2. SEA MAMMAL RESEARCH UNIT

Gatty Marine Laboratory,
University of St. Andrews,
St. Andrews, Fife KY16 8LB.
SCOTLAND

3. NATURA ENVIRONMENTAL CONSULTANTS LTD.

Enterprise Centre, Wicklow
Co. Wicklow.
IRELAND

4. NATIONAL PARKS & WILDLIFE SERVICE

Lagduff More,
Ballycroy,
Co. Mayo.
IRELAND

5. NATIONAL PARKS & WILDLIFE SERVICE

7 Ely Place,
Dublin 2.
IRELAND

Citation:

Cronin, M., Duck, C., Ó Cadhla, O., Nairn, R., Strong, D. & O' Keeffe, C. (2004). Harbour seal population assessment in the Republic of Ireland: August 2003. *Irish Wildlife Manuals*, No. 11. National Parks & Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

Cover photo: Harbour seals and grey seals in Ballysadare Bay, Co. Sligo © Michelle Cronin

Irish Wildlife Manuals Series Editor: F. Marnell
© National Parks & Wildlife Service 2004

ISSN 1393 - 6670

CONTENTS

	Page
Summary	3
1 - Introduction	4
1.1 Background to the study	4
1.2 Rationale	5
1.3 Research objectives	5
1.4 Partnership & Responsibilities	6
2 - Methods	7
2.1 Introduction	7
2.2 Aerial survey method	8
2.2.1 <i>Thermal imaging equipment</i>	8
2.2.2 <i>Flight operations</i>	9
2.2.3 <i>Aerial-counts of haul-out groups</i>	10
2.3 Ground survey method	11
2.4 Analysis of data	12
3 - Results	13
3.1 Ground-truthing and observer error	13
3.1.1 <i>Importance of the ground-truthing exercise</i>	13
3.1.2 <i>Ground-count data</i>	13
3.1.3 <i>Aerial Vs Groundcount data</i>	14
3.2 Minimum population estimate for harbour seals	15
3.3 Harbour seal distribution on a regional scale	17
3.4 Ancillary data on Ireland's grey seal population	19
4 - Discussion	21
5 - Conclusions	25
6 - Recommendations	26
Acknowledgements	27
References	28
Appendix I - Summary table of harbour seal survey data and site locations	30
Appendix II - Map of locations of Special Areas of Conservation (SACs) with existing and proposed listings of the harbour seal as a qualifying interest	35
Appendix III - Summary table of grey seal survey data and site locations	36

SUMMARY

The status of Ireland's harbour seal population and its relationship with that of Britain and western Europe are poorly understood. The Republic of Ireland's last minimum population estimate for harbour seals dates back to the period 1978-1984. Limited spatial coverage of recent research efforts and poor co-ordination of methods/results have fallen short of providing an accurate assessment of overall distribution and population size on regional or national scales. Following discussions between interested government and research parties, it was decided that the Republic of Ireland's harbour seal population would be assessed by means of a geographically extensive survey conducted during the annual moult in August 2003. This research project would complement data gathered during a similar survey of Northern Ireland's coastline in 2002.

The primary objectives of the research were:

1. To obtain an up-to-date harbour seal population estimate for the Republic of Ireland, as a whole, and for individual colonies or regions;
2. To gather and update important information on current harbour seal distribution in Ireland.

Detailed planning for a co-ordinated aerial and ground survey of the Republic of Ireland took place during the spring and early summer 2003. The survey took place in August 2003 and consisted of collaboration between Irish and UK-based parties. Using thermal imaging technology, aerial-counts of haul-out groups were compared with simultaneous data gathered by ground-based research personnel. The data acquired by these methods yielded the following key results:

- A minimum population estimate for the Republic of Ireland of 2,905 harbour seals;
- This figure represents an effective baseline for future evaluation of the population;
- Group sizes of up to 148 animals were recorded during the survey but the vast majority of 231 distinct haul-out sites recorded in the Republic of Ireland contained <50 harbour seals;
- Harbour seal distribution during the 2003 moult season was found to be concentrated in the southwest, west and northwest of the country;
- Noticeable gaps in harbour seal distribution were recorded along the south and east coasts of Counties Cork, Waterford, Wexford and Wicklow;
- In comparison with information from previous surveys and historical records, a greater than expected proportion of the population was found among sites in the southwest of Ireland. This underlines the region's discrete importance for the species on a national scale;
- Other important areas were: Galway Bay, Connemara, west Mayo, Sligo, Donegal and Carlingford Lough, Co Louth;
- The survey of the entire coastline of the Republic of Ireland was surveyed in nine days and, as such, represented a considerable logistical and operational success;
- Ground-truthing exercises performed simultaneous to the aerial survey were successful in providing validation for aerial- and ground-count data and highlighting areas for potential improvement of methods;
- The aerial data, when combined with information gathered in a similar survey of Northern Ireland in 2002, yielded a minimum population estimate for Ireland of 4,153 harbour seals.

The findings presented in this report are discussed in detail and a number of recommendations made, based on the study's findings.

1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The harbour seal *Phoca vitulina vitulina* (also known as “common seal”; Plate 1) is one of two seal species native to Irish waters. Like their larger grey seal (*Halichoerus grypus*) relatives, harbour seals have established themselves at terrestrial colonies (or *haul-outs*) along all coastlines of Ireland, which they leave when foraging or moving between areas, for example, and to which they return to rest ashore, rear young, engage in social activity, etc. These haul-out groups of harbour seals have tended historically to be found among inshore bays and islands, coves and estuaries (Lockley, 1966; Summers *et al.*, 1980), particularly around the hours of lowest tide.

Grey and harbour seals are strictly protected in the Republic of Ireland under the Wildlife Acts, 1976 and 2000. They are listed under Annex II of the EU Habitats Directive as species of Community Interest, whose conservation requires the designation of Special Areas of Conservation (SACs). In the latter part of the 1990s, the National Parks & Wildlife Service, NPWS (formerly part of Dúchas the Heritage Service) proposed all of the known major breeding sites of the two species as SACs, ten for the grey seal and seven for the harbour seal.



Plate 1. An adult harbour seal hauled out on an inter-tidal shoreline in south-western Ireland.

Investigations of the status of Ireland’s harbour seal population have been limited. NPWS staff conducted annual counts since the late 1980s in the southwest of Ireland (D. O’Donnell, NPWS, *pers. comm.*). Harrington (1990) reported on NPWS counts at 24 sites in eight counties following the first publicised outbreak of Phocine Distemper Virus (PDV) in 1988-89. The last population estimate for the Republic of Ireland dates back to the period 1978-84 (Summers *et al.*, 1980; Warner, 1983, 84). Haul-out counts have been conducted in some localities by NPWS staff (including Clew Bay, Donegal Bay, Sligo Bay, Mannin Bay, Bantry Bay and Kenmare River) and postgraduate studies are currently being conducted at harbour seal colonies in Co. Galway (J. Gilleran, National University of Ireland Galway [NUIG], 2000-) and Counties Cork and Kerry (M. Cronin, Coastal and Marine Resources Centre [CMRC], University College Cork, 2003-). However, these counts vary in spatial coverage and

methodology, thus do not provide a complete national perspective on population distribution and abundance.

Research on Northern Ireland's harbour seal population, under the Environment & Heritage Service, recently delivered a minimum population estimate for the province of 1,248 harbour seals (inclusive of Carlingford Lough which straddles the border with the Republic). While this survey set an effective baseline for future studies, annual monitoring at Strangford Lough has indicated a significant reduction in the numbers of harbour seals inhabiting the area (Wilson & Corpe, 1996). With little known about the population inhabiting the rest of the island, these important findings have been difficult to place into a wider context.

1.2 RATIONALE

Reliable population estimates and up-to-date information on harbour seal distribution are needed for the effective conservation of this Annex II species in Ireland. Such data are necessary for environmental impact assessment and species management plans. They are also significant with respect to the 2002 outbreak of PDV disease, which affected animals in Northern Ireland and the Republic and may have caused reduced haul-out counts at some colonies along the west coast (D. Strong/S. Callaghan/G. O' Donnell, NPWS; J. Gilleran, NUIG; *unpublished data*).

An outbreak of PDV in the summer of 1988 caused the deaths of approximately 17,000 seals in western Europe between April 1988 and June 1989 (Van der Toorn, 1990) causing widespread concern for the welfare of seal stocks around the British Isles. It also highlighted many inadequacies in the scientific knowledge of the population ecology, migration and health status of harbour seals in the north-east Atlantic. In May 2002, the second major outbreak of PDV disease resulted in the deaths of ca. 22,500 seals (most of which were harbour seals) in the Kattegat/Skagerrak area, the Limfjord region (Denmark), the Baltic Sea, the Wadden Sea and the North Sea (TSEG, 2001). Approximately 3,990 deaths occurred in the UK during this second outbreak (SMRU, *pers. comm.*). Yet, in spite of apparent local increases in harbour seal deaths along Ireland's west coast and confirmed pathology from an animal found on the Aran Islands (NPWS, Dept. of the Environment, *unpublished information*), it was not clear if the disease had caused a significant decline in population size in the Republic or indeed around the island of Ireland as a whole.

In addition, a well-established decline in population size within Northern Ireland (Wilson & Montgomery-Watson, 2002) and background information indicating the establishment of several 'new' (to record) colonies around the Irish coast (CMRC, *unpublished data*) underlined the importance of obtaining accurate population information for the species as soon as possible.

1.3 RESEARCH OBJECTIVES

The primary objectives of this survey were:

1. To obtain an up-to-date harbour seal population estimate for the Republic of Ireland, as a whole, and for individual colonies or regions;
2. To gather and update important information on current harbour seal distribution in Ireland.

While the success of the survey methods used in 2003 might determine the most effective means for future monitoring of the harbour seal population, it was acknowledged in its planning stages that the project might also provide important information on the size and distribution of pre-breeding haul-outs of grey seals around the coast, giving an indication of the numbers of grey seals utilising Irish waters in the 2003 summer season. Such data would be useful in addressing issues concerning current grey seal population size and in planning any future population assessments of this species.

1.4 PARTNERSHIP & RESPONSIBILITIES

The project was funded by the National Parks & Wildlife Service of the Department of the Environment, Heritage and Local Government. Principal partners to NPWS were the Coastal and Marine Resources Centre (CMRC), University College Cork and the Sea Mammal Research Unit (SMRU), University of St. Andrews, while significant elements of the research were co-ordinated and contributed by NATURA Environmental Consultants Ltd. on subcontract to CMRC. All of the above were centrally involved in the design and planning of the project from its inception in January 2003. Contact was also established with the Environment & Heritage Service, Northern Ireland during the course of the project, allowing the transfer of recent experience and relevant information, strengthening links between statutory bodies on both sides of the border.

Project partners and their tasks:

- **NPWS** - Overall project leaders

Collation of data from NPWS personnel in the Republic of Ireland

Ground-counts at selected harbour seal colonies

- **CMRC** - Principal researchers

Aerial survey co-ordination and operation

Ground-counts at selected harbour seal colonies

Data analysis

Report-writing

- **NATURA**

Co-ordination of ground-counts at colonies chosen for ground-truthing

Design of datasheets and collation of data from all parties

Ground-counts at selected harbour seal colonies

Report-writing

- **SMRU**

Aerial survey planning and operation

Assistance with data analysis

- **OTHER**

Researchers based at NUI, Galway were also involved in the project, conducting ground-counts in Galway Bay during the survey and liaising with the research team in the project's planning and data collection stages.

2. **METHODS**

2.1 INTRODUCTION

A large proportion of a harbour seal's life is spent under water. This makes ecological characteristics such as (i) population size; (ii) distribution; (iii) habitat use; (iv) behaviour; (v) diet and other aspects of their natural history, difficult to observe or determine with scientific accuracy. A critical decision in the project's design was to determine the best method by which Ireland's harbour seal population might be assessed. Like other seals, each year members of the harbour seal population go through a generalised annual cycle (see Bonner, 1990) which includes (a) a summer breeding season followed by (b) an annual moult. Unlike grey seals, whose newborn pups remain ashore for several weeks, allowing the assessment of population size through a breeding season census (e.g. Ward *et al.*, 1987; Kiely & Myers, 1998), harbour seal pups are able to swim with their mothers from birth, making their population size more difficult to determine using typical breeding season census methods.

The moult season is a protracted period during which a large proportion of the population can be found ashore for several weeks (Bonner, 1972; Thompson & Harwood, 1990). While studies conducted in an estuarine habitat in Scotland showed that annual counts of harbour seals conducted during the breeding season provide reliable estimates of abundance in this habitat, these results contrast with those from studies in rocky-shore habitats, where counts made during the August moult provided more reliable population estimates (Thompson *et al.*, 1997). In addition, telemetry studies of harbour seal activity patterns showed that moulting males spend a higher proportion of their day on land than at other times of the year and their choice of moult site may be driven towards locations which allow them do so (Jeffries, 1986; Thompson, 1987). An added advantage of conducting population surveys during the moult lies in the physiological constraints placed on seals during this period, which make haul-out frequency likely to remain constant between years (Thompson & Harwood, 1990). Thus a suitable survey method could be repeated at intervals of 1+ years with some degree of comparability between population estimates.

In Ireland the annual moult is thought to occur from late July through August, as is the case in nearby Britain (Bonner, 1972). Though little dedicated research has been conducted on the Republic of Ireland's harbour seals, consultation between the participant organisations and consideration of background research suggested that the moult represented the best single period in which to count animals across a range of habitats and thereby derive estimates of population size. Following a series of planning meetings and scoping surveys to known harbour seal colonies by the core research team (NPWS, CMRC, NATURA), all available knowledge on the distribution and numbers of harbour seals in the Republic of Ireland were collated and reviewed.

A well-established, cost-effective technique for counting harbour seal populations from the air was chosen by the research team. This helicopter-based technique has been used for monitoring harbour seal populations in the UK since 1988 (SMRU, unpublished). It was also decided that, since the method had not previously been used in the Republic of Ireland, the aerial census data should be verified by means of ground-counts at pre-selected colonies (i.e. "ground-truthing"). These ground-counts could also provide information on mixed haul-outs of harbour and grey seals, haul-out behaviour during the interval two hours either side of low tide, and effects of disturbance on the seals by the survey helicopter or other sources.

Detailed plans were made for simultaneous aerial and ground surveys in August 2003 and a meeting for all Irish-based aerial-survey and ground-survey participants took place in mid June, in order to familiarise each member with survey requirements, time-schedules, etc.

2.2 AERIAL SURVEY METHOD

2.2.1 Thermal imaging equipment

A thermal-imaging technique, developed in the UK by SMRU, was employed for the survey of the Republic of Ireland. The equipment used consists of a *Barr and Stroud IR18* thermal imager deployed inside the left door of a single engine Squirrel AS350B helicopter (Plate 2). Developed for military use, this equipment is sensitive to infrared radiation with a wavelength range between 8 and 14 μ m, the level emitted by mammals and one at which there is no atmospheric absorption of radiation. The thermal imager operates using a high-pressure pure-air cooled cadmium mercury telluride SPRITE (Signal Processing in the Element) detector which can detect differences in temperature of 0.1°C. The imager, which was mounted on a liquid-damped pan and tilt head (Plate 3) was equipped with a dual telescope, providing effective magnifications of 2.5x and 9x.

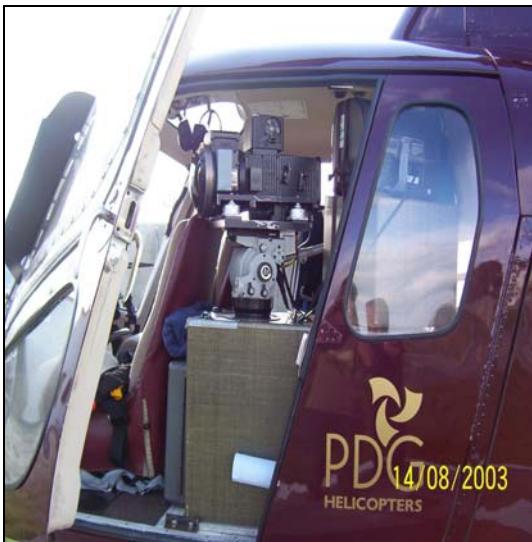


Plate 2. Position of thermal-imager in helicopter.



Plate 3. Thermal-imager mounted on pan & tilt head.

As the operating camera "scans" the environment, the thermal image of the coast (Plate 4) is viewed on a black and white monitor and recorded directly onto VHS videotape. A CANON Hi8 camcorder was also mounted in parallel to the thermal imager and the 'real' image viewed on a second colour monitor.

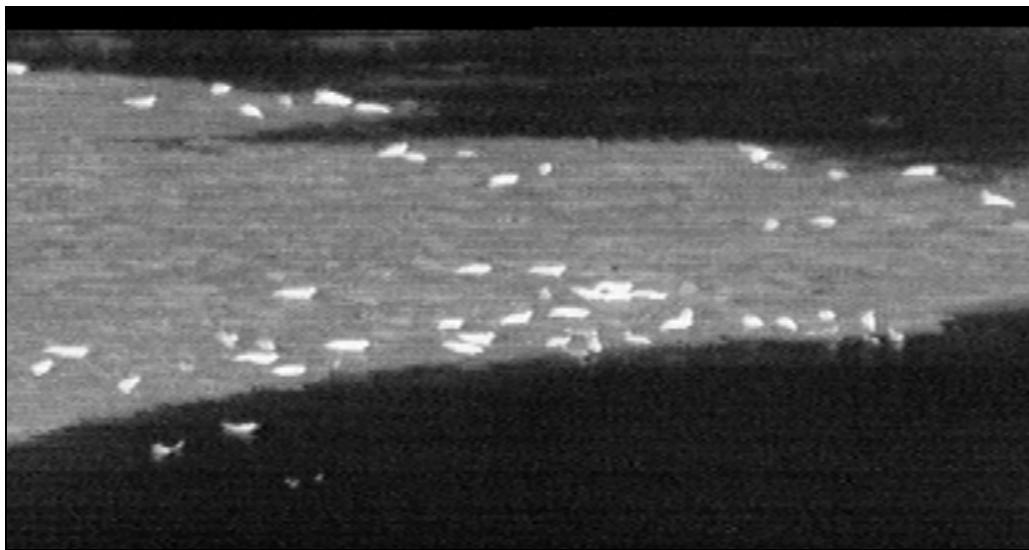


Plate 4. Thermal image of harbour seals hauled out along a rocky shore.

With practice, harbour and grey seals can be differentiated according to the thermal profile of individual seals, the spatial structure of the groups hauled out, the Hi8 image on the colour screen, or using binoculars. While adult grey seals are readily differentiated from harbour seals, juvenile grey seals are considerably more problematic. These factors underlined (i) the need for a collaborative research partnership with the SMRU who are the experts in the field and (ii) an element of ground-truthing in the 2003 survey.

The chosen aerial survey method enabled the detection of otherwise well-camouflaged seals on rocky or seaweed-dominated shores as well as on sand or mud-banks. The technique also had several distinct advantages over boat-based survey methods used heretofore in Ireland, including:

1. Since the thermal imaging camera operates in the infra-red spectrum it is not influenced by light conditions and seal haul-outs can easily be "seen" from distances of up to three km, minimising disturbance to the animals and providing more accurate counts;
2. The technology also enables the detection of the heat-shadow or thermal footprint of animals that have entered the water, improving the accuracy of aerial-counts over those conducted by eye;
3. The method allowed for the detection of previously undocumented haul-out sites since the entire coastline was covered;
4. The use of a helicopter allowed for maximum area coverage in a short period of time thereby reducing the manpower required to conduct such an extensive survey;
5. Significantly less time would be required in the planning and analysis stages of this work and biases due to differences in land-based observer ability could be avoided;
6. Any potential errors in aerial survey data (e.g. where grey seals were hauled out among harbour seals) could easily be assessed by ground-truthing at a number of accessible sites;
7. The use of a helicopter for thermal-imaging surveys is often less susceptible to adverse weather conditions than boat survey methods.

2.2.2 Flight operations

The survey carried out in the Republic of Ireland used the same technique as that employed in Northern Ireland in 2002 and was planned as an extension to a survey of the Outer Hebrides conducted by SMRU in early August 2003. Thus the data gathered would be identical to those from Northern Ireland, while planning and logistical considerations could be dealt with in an efficient and cost-effective manner.

Following planning consultations, an estimated 7-10 day period was allocated for the aerial survey, taking account of weather conditions and budgetary constraints. The chosen start point for the

Republic of Ireland was Lough Foyle in Co. Donegal (Fig. 1) and the research team planned to survey the entire coastline in an anti-clockwise direction around the coast, finishing at Carlingford Lough, Co. Louth in as few days as possible. Transit-time to refuelling points was also minimised with the addition of a ground-based mobile refuelling unit to the survey operations. Completion of the survey saw the return of SMRU personnel, the helicopter and thermal imaging equipment to the UK.

The helicopter operated off the coast at a distance of approximately 500m and at an altitude of approximately 215m. At this distance, harbour seals were highly unlikely to be disturbed from their haul-out sites. In contrast, occasionally grey seals were disturbed and moved into the sea. This difference in species' reaction to the helicopter could be due to a reluctance of harbour seals to enter the water during the moult or to grey seals' sensitivity to disturbance when hauled out ashore.

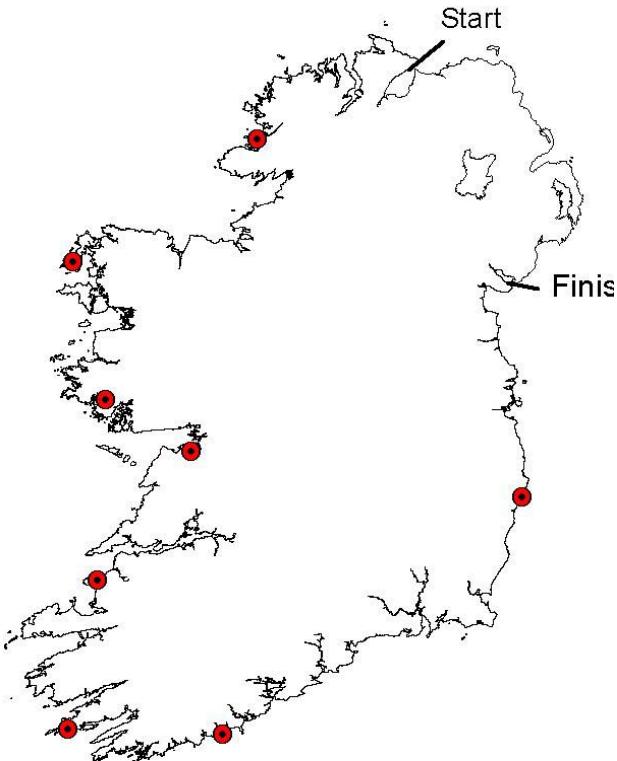


Figure 1. Map of aerial survey start and finish points with daily set-down locations (red dots).

The pattern of harbour seal haul-out is known to be influenced by climatic variables, particularly the state of tide, the time of low tide, wind speed, wind direction and degree of precipitation (e.g. Pauli & Terhure, 1987; Yochem *et al.*, 1987; Thompson *et al.*, 1994; Withrow & Loughlin, 1996). In general, however, the number of harbour seals ashore at a site appears to reach a maximum within two hours of low tides occurring in the afternoon (Thompson *et al.*, 1997), though this can vary with location, haul-out habitat type and site availability during the tidal cycle (Stewart, 1984; Yochem *et al.*, 1987; Thompson *et al.*, 1989; Thompson & Miller, 1990). While it is not possible to control for all of these variables simultaneously, surveys in 2003 were conducted within strict limits with respect to the state of tide, time of day and amount of precipitation. All surveys were thereby restricted (i) to within two hours either side of low tide and (ii) to low tides occurring between 12:00 and 18:30hrs.

2.2.3 Aerial-counts of haul-out groups

Counts of groups of seals recorded from the air were made in real time (i.e. aboard the airborne helicopter) and recorded with their location on 1:50,000 OSI *Discovery series* maps, at a resolution of

±50m. The survey continued whenever a satisfactory count of each group of seals was obtained. Very large groups were also photographed using a 35mm stills camera equipped with a 70-210mm autofocus zoom lens. In order to collate information gathered on each survey day, the principal researcher (Michelle Cronin, CMRC) liaised by mobile phone with Richard Nairn (RN, NATURA) prior to each day's survey operations and at the end of each survey-day, informing him of the flight plan and data gathered during the survey day. RN thus co-ordinated all ground-truthing operations by liaison with the relevant CMRC/NPWS/NUIG personnel as the aerial survey proceeded around the coast.

2.3 GROUND SURVEY METHOD

Instead of attempting to monitor dozens of known harbour seal colonies simultaneous to the passage of the aerial survey aircraft, it was decided that a representative subset of known, accessible sites should be chosen as ground-truthing sites. These are listed in Table I. These sites were pre-selected, based on site-visits by individual team members and background information made available through a questionnaire survey distributed to NPWS rangers before the summer. The following features were considered in selecting ground-truthing sites:

1. The regional distribution of the harbour seal population;
2. The accessibility and proximity to the haul-out site from mainland vantage points;
3. The availability of experienced observers in those locations;
4. The size of the haul-out group (>30 individuals preferred);
5. The ability to clearly sight and identify all the species of seal present;
6. The presence/absence of mixed groups of grey and harbour seals;
7. The relative absence of human disturbance, which might impact upon count data.

All ground-truthing personnel (drawn from CMRC/NATURA/NPWS/NUIG) were experienced in accurately determining the size of harbour seal haul-outs and in discriminating between grey and harbour seals. Three ground-truthing exercises were conducted during the project. Two exercises took place among nine pre-selected sites in mid-June and mid-July, respectively, prior to commencement of the aerial survey. These sought to iron out any operational or logistical problems encountered before the nationwide survey in August. All ground-counts were conducted using appropriate optical equipment (e.g. high-powered telescope). Subsequent to these exercises, three additional sites were included for the third ground-truthing exercise during the survey proper.

On the relevant aerial survey date in each region, observers performed ground-counts of harbour seal haul-out size over a minimum four-hour period (i.e. two hours either side of low tide). These counts, conducted over a key part of the tidal cycle give an indication of the efficacy of the chosen survey methods for the Republic of Ireland. At most sites these counts were conducted at hourly intervals, beginning two hours prior to low tide and finishing two hours after low tide. A simultaneous count was also carried out at the time of the helicopter fly-over.

2.4 ANALYSIS OF DATA

Upon collation of the data, aerial- and ground-count figures were compared to assess the accuracy of the aerial technique in determining group size and species composition. Where discrepancies occurred, the thermal imagery was replayed and the slow-frame feature on a VCR recorder at SMRU was used to recheck group sizes at these sites.

Ground-count data for the three exercises at each ground-truthing site were also compared and changes in group size noted between counts conducted in the pre-moult and moult period. Numbers of seals hauled-out over the four-hour counting period were also compared and tidal influences (if any) noted.

The corrected total numbers of grey and harbour seals observed at haul-out sites from the air/ground yielded minimum counts for both species occurring around the coast of the Republic of Ireland in August 2003. The harbour seal data were combined with data from the 2002 survey of Northern Ireland, enabling a generalised minimum population estimate to be derived for the island of Ireland. Haul-out distribution and count data from an SQL-driven database were displayed using ARCVIEW Geographical Information Systems (GIS) software. This enabled the production of maps showing the locations and estimated group sizes of all seal haul-outs in August 2003. Grey seal distribution and count data acquired during the August 2003 aerial survey were overlaid on an ARCVIEW map of harbour seal group-size and distribution, thereby allowing the visualisation of interspecific patterns in distribution and habitat use.

3. RESULTS

3.1 GROUND-TRUTHING AND OBSERVER ERROR

3.1.1 *Importance of the ground-truthing exercise*

The combined aerial/ground-truthing exercise provided a good means of verifying ground-count data and it was apparent that, at some sites in the Republic of Ireland, ground-counting techniques may be ineffective for obtaining accurate figures (e.g. due to topography, observer distance from the animals, large group sizes and haul-out groups distributed over large areas). Such was the case with a number of combined aerial/ground-count sites (*see below*). The ground-counting exercise supported the accuracy of data acquired aerially. While underlining the efficacy of the thermal imaging technique, it highlighted the potential for occasional observer errors in counting thermal images in 'real-time'. Based on ground-acquired data, aerial counts from five locations (Gweebara Estuary, Co. Donegal; Donegal Bay, Co. Donegal; Ballysadare Bay, Co. Donegal; Killala Bay, Co. Sligo and Tarrea Pier, Co. Galway) were revised upon rechecking of their thermal imagery. In addition it prompted a recheck of thermal imagery at sites other than ground-count sites and minor revisions were made to some aerial counts in Cos. Cork and Kerry, as a result.

3.1.2 *Ground-count data*

The objectives of 'trial runs' held at ground-truthing sites were (a) to familiarise observers with survey methods and protocol and (b) to establish if animals were routinely using these haul-out locations prior to the aerial survey, in order to ensure the predictable presence of animals at these sites at the time of the aerial survey.

TABLE I. Peak ground-counts of harbour seals at selected 'ground-truthing' sites in the Republic of Ireland between June and August 2003. Counts in August took place simultaneous to the aerial survey.

Site	June	July	August	Mean
Gweebara Estuary	51	59	50	53
Donegal Bay	132	164	148	148
Ballysadare Bay	298	395	352	348
Killala Bay	55	37	100	64
Rooneagh Quay	21	19	21	20
Mannin Bay	14	33	45	31
Tawin	22	5	0	9
Kenmare	52	30	38	40
Carlingford Lough	23	31	11	22
Total	688	773	765	735

Peak counts of harbour seals at ground-truthing sites were quite variable on 'trial run' days and on their relevant aerial survey day (Table I). While numbers of seals hauled out at most sites did not vary much between monthly sampling dates, marked differences were observed in successive counts (i) at Killala Bay, Co. Sligo (August peak count was almost double that of June) and (ii) at Tawin, Co. Galway (Table I). Due to the decline in numbers of harbour seals hauling out at Tawin during the summer months, another site in Galway Bay (i.e. Tarrea Pier) was included as a ground-count site for the aerial survey in August.

On each ground-truthing site's day-of-survey, observers were in place several hours before low water. Harbour seal group sizes were highly variable between ground-truthing sites (Table II). In addition, observers recorded an increase in the numbers of seals during the interval two hours either side of low water at sites in Donegal Bay, Ballysadare Bay, Killala Bay and Carlingford Lough. However, data collected at the remaining sites showed little change in haul-out size over the 4+ hour period with the exception of Tarrea Pier, where numbers dropped at and shortly after low tide but recovered to near-peak level within two hours of the flooding tide.

TABLE II. Counts of harbour seals at ground-truthing sites, carried out over a four-hour count period on each site's aerial survey day in August 2003.

Site	Date	Time of low tide	Tidal		State		
			Low -2hr	-1hr	Low	Low +1hr	Low +2hr
Dungloe Bay	12.08.03	13.10		178*		180	
Gweebara Estuary	12.08.03	13.00	46	45	39	39	41
Donegal Bay	13.08.03	13.31	132	148	164	172	179
Ballysadare Bay	13.08.03	13.30	232	236	352	292	307
Killala Bay	13.08.03	13.30	87	89	98	97	
Bellacragher Bay	14.08.03	14.35		33	33		
Rooneagh Quay	14.08.03	14.10	21	20	21	20	
Mannin Bay	14.08.03	13.50	45		23		
Tawin	15.08.03	14.00	0	0	0	0	0
Tarrea Pier	15.08.03	13.55	75	103	89	67	102
Kenmare	18.08.03	15.30	38	39	38	38	29
Carlingford Lough	20.08.03	11.30	3	9	11	11	5

* count assigned to the nearest tidal interval.

3.1.3 *Aerial- Vs Ground-count data*

A comparison of harbour seal and grey seal count data collected via simultaneous aerial and ground-count methods is shown in Table III. Aerial-counts were obtained in real time. However, where discrepancies occurred between the data gathered from the air and those from the ground, thermal and video imagery were rechecked. The amended counts are shown here. Aerial and ground-counts were very similar (± 2 animals) at all sites except the following:

Dungloe Bay: A significantly **higher aerial-count** than ground-count was obtained, possibly as a result of segregated distribution of animals over a large area, making a ground-count more difficult to execute. The aerial-count was rechecked and no changes were made to the real time count.

Ballysadare Bay: A significantly **higher ground-count** than aerial-count was obtained. The aerial-count was rechecked and its harbour seal count reduced from 294 to 257, while its grey seal count was increased from 12 to 20. Seals were distributed in four discrete groups within the bay at the time of the helicopter fly-over. Since four groups were evident on the imagery when rechecked it is unlikely that the aerial team missed a group. With large groups, the detection error in ground counting will increase with distance and this may explain the discrepancies between the counts at this location. A 'sub-site' was subsequently chosen for comparing the aerial and ground counts, as it was considered a more feasible means of comparing the counts across such a large survey area (Table III). The total aerial and ground counts are similar for this sub-site; rechecking the aerial imagery confirmed the presence of harbour seals only.

Mannin Bay: Aerial and ground-counts were not conducted simultaneously at this site due to the unavailability of the ground-counter on the date of the aerial survey; ground-counts shown are for the day preceding the aerial survey.

TABLE III. Summary of aerial- and ground-counts of harbour seals and grey seals at all ground-truthing sites selected during the 2003 survey.

Site	Grid Ref.	Date	Aerial-count		Ground-count		Disturbance
			<i>Harbour</i>	<i>Grey</i>	<i>Harbour</i>	<i>Grey</i>	
Dungloe Bay	B720 130 B750 110	12.08.03	266	0	180	0	None
Gweebara Estuary	G708 994	12.08.03	41	0	41	0	Boats/walker
Donegal Bay	G910 748	13.08.03	148	0	148	0	None
Ballysadare Bay+	G613 322	13.08.03	96	0	64	30	None
Killala Bay	G624 277	13.08.03	107	0	100	6	Boats/angler
Bellacragher Bay	F810 030	14.08.03	34	0	33	3	None
Roonagh Quay*	L 744 007	14.08.03	24	1	21	6	None
Mannin Bay**	L647 475	14.08.03	13	1	45	0	None
Tawin	M322 187	15.08.03	0	0	0	0	None
Tarrea Pier***	M370 133	15.08.03	99	1	102	0	None
Kenmare	V620 600	18.08.03	37	1	38	0	None
Carlingford Lough	J205 115	20.08.03	13	0	10	1	None

+ Sub-site chosen for comparison of ground with aerial count

Aerial- and ground-counts were conducted simultaneously apart from:

* ground-count conducted 10 minutes prior to aerial-count

** ground-count conducted one day prior to aerial-count

*** ground-count conducted 50 minutes prior to aerial-count

3.2 MINIMUM POPULATION ESTIMATE FOR HARBOUR SEALS

Groups of harbour seals were observed on all coastlines of the Republic of Ireland, including a number of offshore islands. Collated aerial- and ground-count figures yielded a 2003 minimum population estimate in the Republic of Ireland of 2,905 harbour seals.

When added to information from the near-identical survey of Northern Ireland in 2002 (Fig. 2), the combined data yield an all-Ireland minimum population estimate of 4,153 harbour seals.

Harbour seal minimum population estimates - Republic of Ireland (2003) = 2,905
-All of Ireland * (2002/03) = 4,153

* Data for Northern Ireland are reproduced with permission of the Environment & Heritage Service of Northern Ireland.

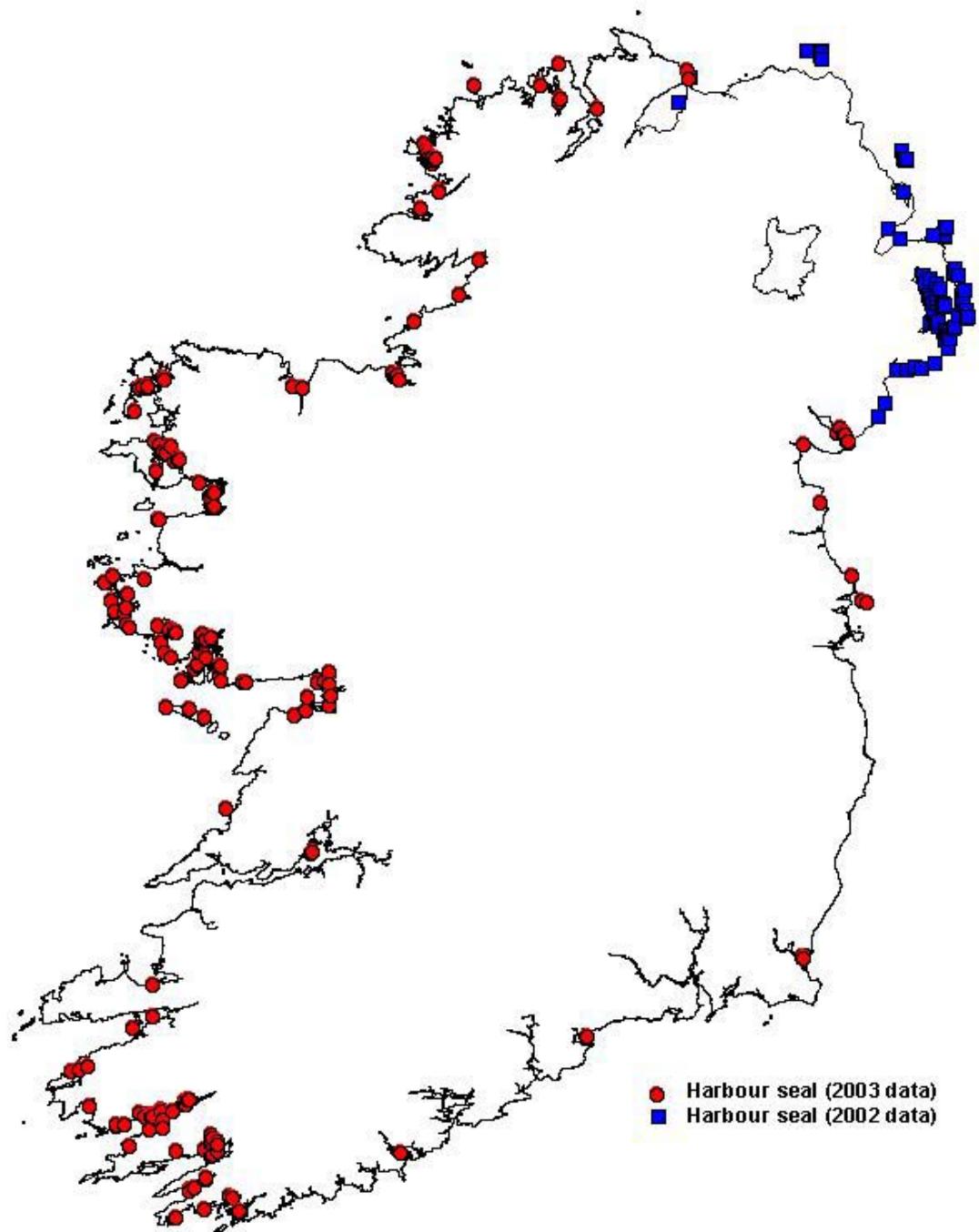


Figure 2. Map of the locations of groups of harbour seals (*Phoca vitulina*) recorded in the Republic of Ireland, August 2003 and in Northern Ireland, August 2002.

3.3 HARBOUR SEAL DISTRIBUTION ON A REGIONAL SCALE

Following entry of all location and group size data into the SQL-driven database, regional and local harbour seal distribution and group size data were examined for all previously-known and newly-discovered sites. These data were mapped to give a graphical representation of harbour seal distribution and areas of importance along the coastline of the Republic of Ireland (Fig. 3). The raw figures are included in the closing pages of this report (Appendix I), allowing site-specific estimates to be examined for informational, monitoring and management purposes.

An examination of the 2003 survey data indicates that areas of particular importance for moulting harbour seals occur in the southwest of Ireland, in Galway Bay and broadly along the coasts of Connemara, Mayo, Sligo, West Donegal and Carlingford Lough, Co. Down. In Carlingford Lough, highest numbers were found north of the border [Appendix I]. Despite the area being outside the Republic it was surveyed nonetheless in order to obtain a complete count for the Lough. In contrast, there were noticeable gaps in harbour seal distribution along the coasts of Clare, the Shannon Estuary, north Kerry and much of southern counties Cork and Waterford, Wexford and Wicklow. Minimum population estimates, grouped by county, are given below (Table IV).

TABLE IV. Minimum numbers of harbour seals in each county of the Republic of Ireland from survey data gathered in August 2003.

County	No. of haul-out sites	Total no. of harbour seals	% of Total
Donegal	40	555	19
Leitrim	0	0	0
Sligo*	10	376	12
Mayo*	33	316	11
Galway	62	484	17
Clare	11	164	6
Limerick	0	0	0
Kerry	31	430	15
Cork	35	489	17
Waterford	1	1	0
Wexford	2	17	1
Wicklow	0	0	0
Dublin	3	34	1
Meath	0	0	0
Louth	3	39	1
Total	231	2,905	

* Data collected from 2 sites on the Moy Estuary were classified as belonging to western County Sligo due to their location.

At the time of survey, seven Special Areas of Conservation (SACs) are listed with the harbour seal as qualifying interest (i.e. one of the factors meriting designation was the importance of the site for the harbour seal). The survey results suggest two further SACs should have additional qualifying interest due to harbour seal occurrence in the SAC. These are Kenmare River (Site Code 2158) and Rutland Island and Sound (Site Code 2283) (Appendix II). The latter would require a small extension into Dungloe Bay to include all harbour seal haul-out areas. Based on the 2003 survey, 51% of the population estimate for the Republic of Ireland would then be included in SACs. This is consistent with the requirements of the EU Habitats Directive.

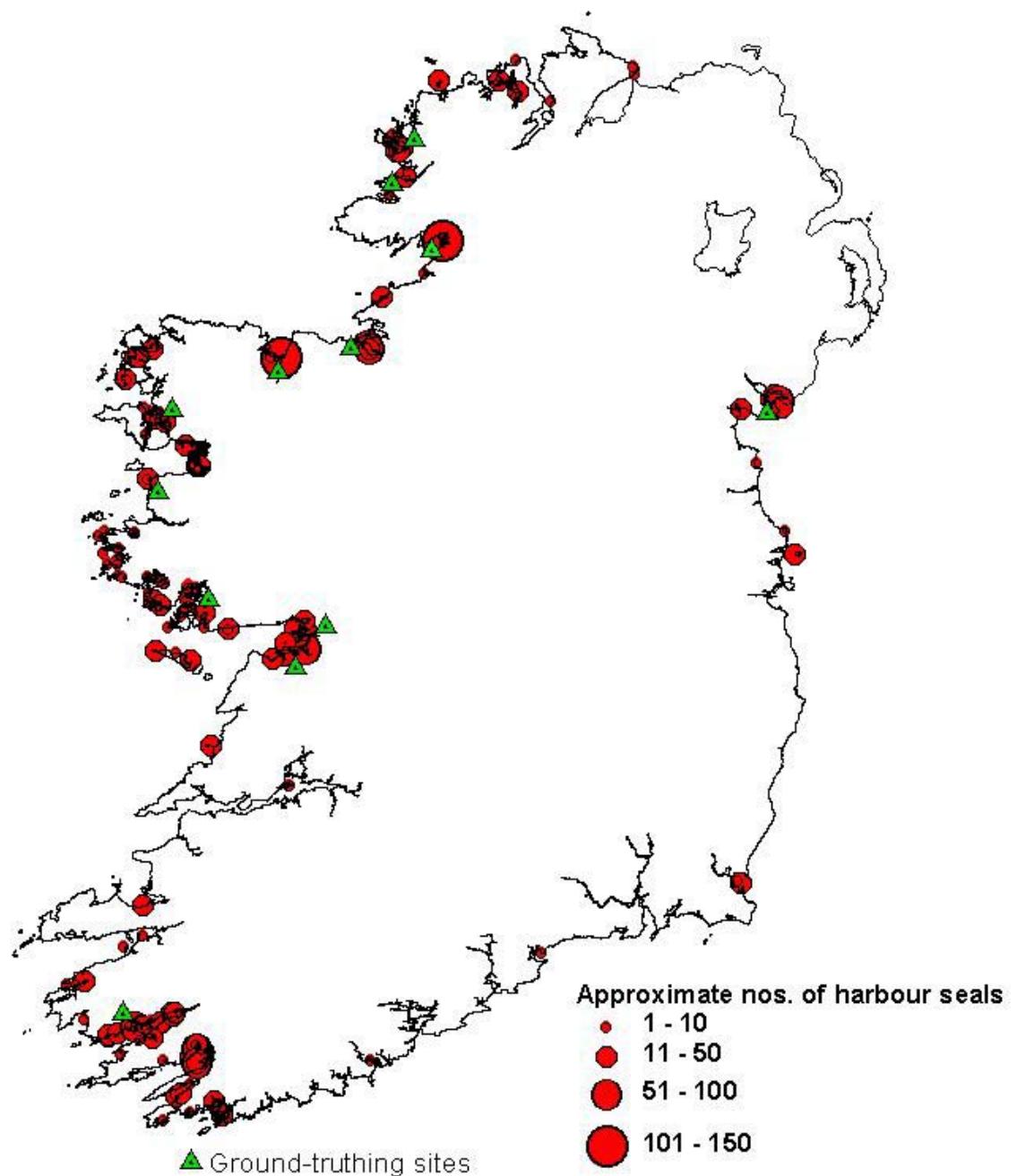


Figure 3. Distribution and size range of harbour seal (*Phoca vitulina*) haul-out groups recorded in the combined aerial/ground survey of the Republic of Ireland and Carlingford Lough, Co. Down, August 2003.

3.4 ANCILLARY DATA ON IRELAND'S GREY SEAL POPULATION

A total of 1,287 grey seals were recorded during the survey. Although small groups of one or more grey seals were found adjacent to harbour seals at many sites, haul-out sites/habitats used by either species were largely discrete and there appeared to be little overlap in their distribution in August 2003 (Fig. 4); grey seals primarily being distributed in the outer parts of bays or on offshore islands. It is interesting to note, however, that within coastal waters of the Republic of Ireland similar gaps in distribution to those observed for harbour seals were recorded for grey seals (i.e. west Clare, south Cork, Waterford, Wicklow; Fig. 4) (Appendix III).

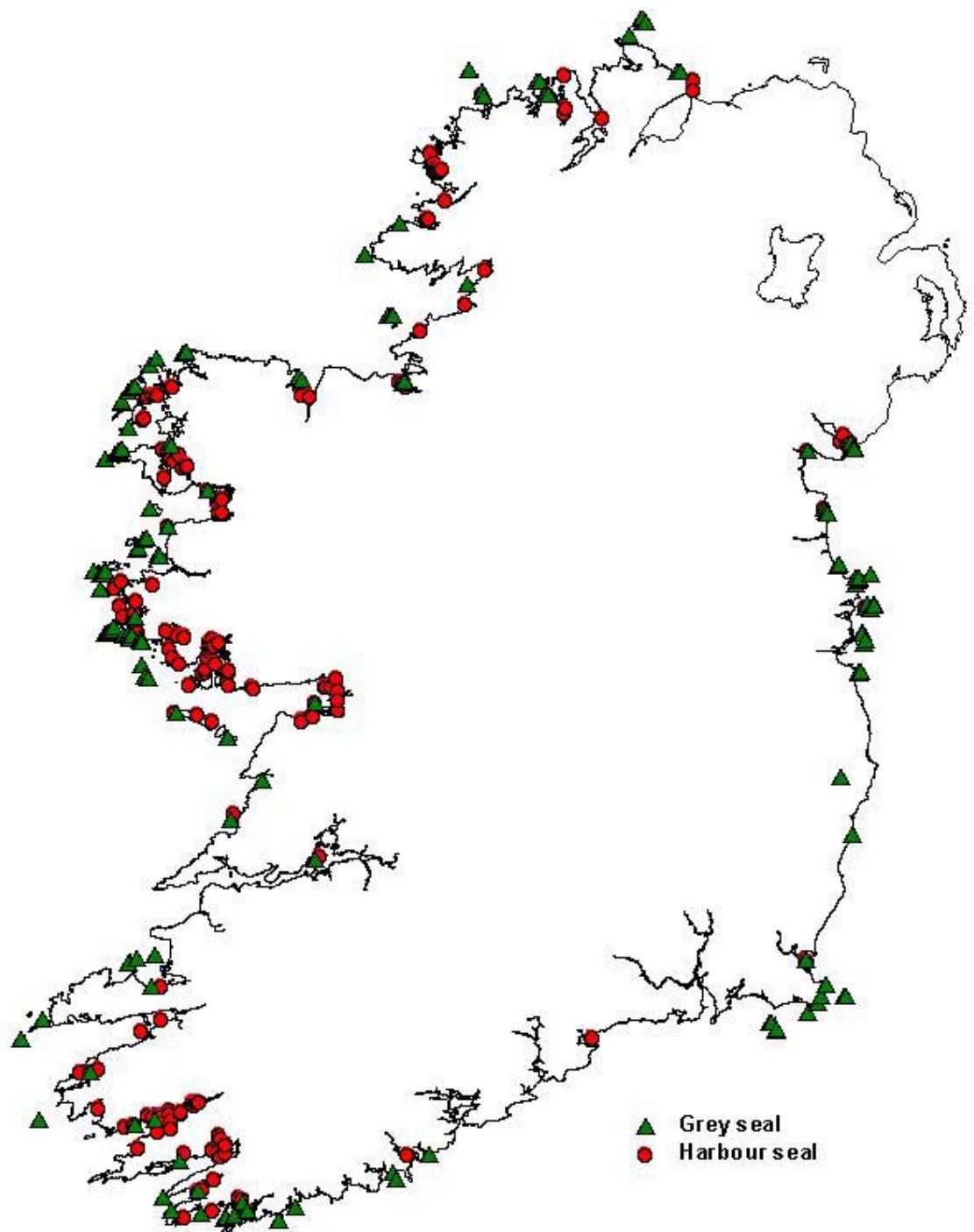


Figure 4. Map of the locations of groups of grey seals (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) recorded in the Republic of Ireland and Carlingford Lough, Co. Down, August 2003.

4. DISCUSSION

The collaborative survey carried out in August 2003 provided essential data and formed a cost-effective means of obtaining a minimum population estimate for harbour seals along Ireland's indented and often exposed coastline. Invaluable experience in planning and carrying out seal surveys using aerial and ground-count techniques was gained by members of CMRC, NPWS and NATURA, improving thereby the expertise and methods by which seal populations are assessed in Ireland, providing a sound basis for future monitoring in the Republic and increasing the transfer of knowledge between Ireland, Northern Ireland and Britain.

The ground-truthing element of the survey also proved to be a worthwhile exercise. In addition to providing a means of assessing aerial-count data being gathered for the first time in the Republic of Ireland, it provided some insight into the variability in harbour seal haul-out patterns and gave many observers hands-on experience in seal survey methodology. The strategy of incorporating ground-truthing sites in the 2003 survey now provides the possibility of low cost annual monitoring of some important sites.

While the combined aerial/ground method highlighted areas of potential error in counting seals ashore, the aerial method was generally shown to be superior in terms of (i) ease-of-operation; (ii) detectability of seals and (iii) spatial coverage.

Thermal imaging provided a means of picking out animals against a variety of backgrounds and verifying ground-count data from sites at which it may be difficult to count seals using standard ground-counting techniques (e.g. at large haul-outs and/or where animals are dispersed over a large area). Significant differences between aerial- and ground-count data at two locations (Dungloe Bay and Ballysadare Bay, Co. Donegal) in August 2003 were thought to have resulted from a combination of distance from the observer and/or the spatial distribution of harbour seals along the shoreline at these particular sites, which made it difficult for ground-based observers to estimate group size accurately.

An additional outcome of the combined aerial-/ground-counting exercise was to examine the accuracy of 'real-time' counting of thermal imagery as the aerial survey proceeds. Preliminary comparison of aerial and ground-count data revealed discrepancies in the counts from six of the twelve test sites. Upon subsequent examination of the thermal imagery recorded on VHS tapes, changes were made to five of the aerial-counts at the ground-truthing sites. Two of these revised counts matched their corresponding ground-counts exactly and a further two were significantly closer (than the original counts) to the corresponding ground-counts. In addition, minor revisions were made to aerial counts in Cos. Cork and Kerry.

Since weather conditions may affect haul-out behaviour (e.g. Olesiuk *et al.*, 1990; Withrow & Loughlin, 1996; Jemison & Pendleton, 2002), consideration was given to weather conditions during the survey design. Optimal survey conditions experienced in August 2003 were light winds, no precipitation and some degree of cloud cover. Although conditions were generally good for much of the survey, high ground temperatures led to a reduction in definition of the seals' thermal image against the warm substrate and made counting difficult in places. To overcome this, the survey could ideally be terminated until conditions improved. While the discrepancies between 'real-time' counts and revised counts may have been caused by observer fatigue and/or difficulties in viewing thermal imagery from habitats experiencing high land temperatures, caution must be exercised when carrying out 'real-time' counts. It is also advised that, on future surveys of this kind, every effort be made to double-check thermal imagery upon return to the laboratory.

Haul-out behaviour of harbour seals in rocky habitats tends to be strongly influenced by diurnal cycles (Stewart, 1984; Yochem *et al.*, 1987; Thompson & Harwood, 1990; Jemison & Pendleton, 2002). In contrast, harbour seal activity in estuarine areas has been shown to be strongly influenced by tidal cycles (Thompson & Miller, 1990), with little variation in the amount of time spent ashore during the period 2 hours either side of low tide (Thompson *et al.*, 1997). The survey conducted in 2003 was therefore carried out during this ca. 4-hour period and between the hours of 12.30 and 18.30. Fine-

scale changes in harbour seal group size and distribution are also influenced by weather and disturbance, in addition to tidal influences (Olesiuk *et al.*, 1990), and this was apparent in the results of the three ground-counting exercises. Such information, however elementary, highlights the extreme variability in harbour seal behaviour patterns. It is considered that local/regional studies, investigating the extent of seasonal, tidal and diurnal variations in haul-out distribution and behaviour, will be essential to improving population assessment methods and, consequently, the accuracy of future estimates of population size.

The 2003 survey yielded a population estimate of 2,905 harbour seals for the Republic of Ireland. This estimate is a minimum number because, even though the survey was conducted at the time of year when a large proportion of the population is ashore, a certain proportion will be at sea and therefore unavailable for counting. Prior to this survey, the most recent minimum population estimate for harbour seals in the Republic of Ireland dated back to 1978 (Summers *et al.*, 1980). However, a direct comparison between estimates cannot be made due to fundamental differences in survey methods, chosen survey season and geographical coverage. The 1978 harbour seal survey was conducted (i) only among known and probable breeding sites; (ii) during the breeding season; (iii) primarily by boat, and (iv) it did not cover the entire coastline as did the current survey (see Summers *et al.*, 1980).

When combined with data from the 2002 aerial survey of Northern Ireland, the present survey tentatively indicates a minimum population size of 4,153 harbour seals for the entire island of Ireland. While both surveys used near-identical techniques and were conducted at the same time of year, this figure is based upon the assumption that little or no change (due to deaths, births, immigration or emigration) occurred in Northern Ireland's harbour seal population since August 2002. This is an unlikely scenario given the 2002 outbreak of PDV, which affected both Northern Ireland and the Republic to some degree (albeit minimally), and natural variation in inter-annual survivorship and population size. Yet the combined all-Ireland figure is the first of its kind and represents a useful approximation for future reference.

Harbour seals spend an unknown proportion of their time in the water, even as pups. Thus counts, whether from the air or ground, can only be regarded as minimum estimators. If such counts are to be used to assess long-term trends, it is necessary to estimate the proportion of seals which are in the water at the time of the survey, or to assume that this proportion does not vary from year to year or from site to site (Thompson & Harwood, 1990). Determining the proportion of individuals in the water has typically been addressed by (a) employing radio-telemetry or time-depth recorders to estimate the average proportion of seals hauled out during a survey and (b) using the reciprocal of that proportion as a correction factor applied to the unadjusted counts.

Studies on the proportion of harbour seal populations hauled out during the moult have yielded the approximation of 60-70% of the total population size (Yochem *et al.*, 1987; Ries *et al.*, 1998; Olesiuk, 1999). There are several potential sources of error involved in this approximation. For example, samples of radio- or satellite-tagged animals can seldom be expected to be representative (by age or sex) of the population due to (i) segregational behaviour (Kovacs *et al.*, 1990) and (ii) variability in the average time spent on land by various population segments (Thompson & Rothery, 1987). Therefore detailed data on the composition of local groups and the haul-out behaviour of population segments are needed for accurate estimates of the true population size among spatially- and temporally-structured harbour seal populations (Härkönen & Harding, 2001). Current CMRC studies on harbour seal populations in the southwest of Ireland (project acronym RAMSSI, see <http://www.cmrc.ie>) aim to address some of these issues and provide information on seasonal and diurnal haul-out behaviour in the region. This may enable the derivation of a correction factor that can be applied to the 2003 minimum population estimate reported herein, resulting in a more accurate harbour seal abundance estimate for Ireland.

Harbour seal distribution within the Republic of Ireland in August 2003 was predominantly along the west coast with highest concentrations in Counties Donegal, Sligo, Mayo, Galway, Cork and Kerry. This was an expected result, based upon anecdotal and historical information collated in the planning stages of the survey, together with data from the 1978 harbour seal survey (Summers *et al.*, 1980). However the relative importance of the southwest of Ireland, which contained almost one-third of all

harbour seals recorded in August 2003, was unexpected, in spite of considerable data gathered by members of NPWS in the region over the last decade and repetitive surveys conducted in the region by CMRC in early 2003. Thus the 2003 aerial survey (i) augmented background data very effectively, and (ii) provided data essential for management purposes.

Seasonal changes in the distribution and composition of harbour seal haul-out groups are well documented from studies elsewhere, with certain regional haul-out sites used only in the breeding season, for example, while others are used during the winter (e.g. Thompson, 1989). In the present study, one ground-count site showed a marked seasonal change in habitat use. This site at Tawin, Co. Galway was used by animals as a haul-out site in spring and early summer 2003 (M. Byrnes, Oranmore, Co. Galway, *pers. comm.*) and in previous years (T. Doyle, University College Cork, *pers. comm.*). However no seals were recorded at this site during the ground count in August and as a result, an alternative ground-truthing site was required.

As seen at the Tawin site, background data on local harbour seal populations in Ireland, albeit patchy in nature (due to differences in observer experience, survey effort etc.), are valuable. The incorporation of dedicated local studies into a national monitoring programme would provide important information to the understanding of regional and national population status. Such effort if planned and coordinated effectively, would be inexpensive and logically undemanding when compared to a national census of the kind performed in 2003 and would be a worthwhile element within a national monitoring programme.

Considering a predominance of rocky habitats along the west coast of Ireland, the annual moult is likely to be the optimal period for estimating most sub-populations of this species in Ireland. Harbour seals may use the same moult haul-out site consistently from year to year (Anderson, 1981; Thompson, 1989), so that once the major sites in an area have been identified, future surveys will be less likely to miss large aggregations. However, it would be unwise to design surveys on the assumption that seals will only be found at traditional sites (Thompson & Harwood, 1990). Similarly, the exact space occupied by seals within a site (e.g. along a rocky shoreline or sandbar) may vary with weather, topography and other factors, making localised, annual ground-counts somewhat unreliable in determining small-scale population trends or implementing monitoring programmes. The aerial survey technique employed in the present study enables large areas to be surveyed in a short time period. Thus all potential haul-out sites can be covered in a relatively short time-frame, reducing bias in survey methods and removing the need for assumptions on seal distribution.

Comparative differences between harbour seal counts in estuarine and rocky habitats indicate how habitat differences can strongly influence the behaviour of harbour seals with subsequent implications for suitable counting techniques in different areas. Studies show annual counts conducted during both the breeding season and the moult provide reliable estimates of abundance in estuarine habitat, in contrast to rocky-shore habitat (where counts during the moult provide more reliable abundance estimates) (Thompson *et al.*, 1997). Conducting counts during the breeding season in estuarine habitats provides the opportunity for the simultaneous collection of information on haul-out behaviour, using VHF or satellite telemetry (prior to tag loss associated with the moult). Such data are not available for harbour seals in the Republic of Ireland and this reiterates the necessity for further research to investigate seasonal and diurnal patterns in haul-out behaviour, if the accuracy of population estimates is to be optimised. The 2003 survey demonstrated that some estuarine areas and inter-tidal sandbanks may form very significant haul-out sites, particularly in Counties Donegal, Down and Sligo, Wexford and inner Galway Bay. Potential differences in haul-out behaviour between hard and soft substrates warrants an investigation of the suitability of population estimation surveys during the breeding season in some localities.

Data gathered on grey seal distribution along the coast of the Republic of Ireland during the 2003 survey, while unsuitable for use in the estimation of population size, due to differences in their annual cycle (Bonner, 1990) and seasonal behaviour and distribution, provided important information on the summer distribution and numbers of this species around the coast of Ireland, valuable information for seal foraging studies. Other data gathered since 1995 (Kiely, 1998; Kiely *et al.*, 2000) highlight interesting seasonal patterns in the size and distribution of grey seals among the Republic's offshore islands, yet a minimum population estimate for this species is not currently available. While

boat-based surveys have been carried out at a number of regionally important grey seal breeding colonies since 1995 (e.g. Kiely & Myers, 1998; Lidgard *et al.*, 2001; Ó Cadhla & Strong, 2003), the issue of current population status yet requires scientific investigation by means of a co-coordinated national census for grey seals. In its absence, studies at individual breeding colonies will continue to fall short of providing a minimum population estimate for the Republic of Ireland. The success of the 2003 aerial survey for harbour seals supports the inclusion of an aerial survey technique, as an effective means of achieving the spatial coverage necessary to effectively determine the status and size of Ireland's grey seal population. Based on the experience gained by all parties in the 2003 harbour seal survey, a trial aerial survey for grey seals was conducted for the first time between September and December 2003, the results of which will assist in determining the best way forward.

5. CONCLUSIONS

1. Implementation of the research project

The project was implemented with considerable success in 2003 and valuable expertise was gained by members of all participating organisations in methods, analysis and logistics necessary for future operations of this kind.

2. The status of the harbour seal population in the Republic of Ireland

Due to limited background information on regional population size and distribution, data generated from the survey carried out in 2003 cannot be reliably compared with previous data. Thus, in spite of the 1988 and 2002 outbreaks of PDV and recent research efforts including those herein, the status of the harbour seal population in the Republic of Ireland and its relationship to that of Northern Ireland are poorly understood. Nor can population trends be evaluated because earlier population estimates are not comparable.

3. Areas of importance for harbour seal populations, regional and local

The 2003 survey successfully highlighted the potential significance of individual haul-out sites and regions within a national context. While the research undertaken largely represents a snapshot of the Republic of Ireland's harbour seal population in space and time, it is nevertheless an important step in identifying individual sites and regions of importance for the species and in subsequently effecting their conservation.

4. Ancillary information gathered on grey seal populations during the 2003 survey

The 2003 survey demonstrated the feasibility of surveying Ireland's seal populations from the air in relatively short time and cost-effective manner. Yet, in spite of providing additional information on the Republic's grey seal population, it also highlighted the continued absence of an equivalent population estimate for grey seals throughout the island of Ireland.

6. RECOMMENDATIONS

1. Future national census

It is recommended that the described techniques be used in any future national census for harbour seals. It is recommended that such surveys be repeated at intervals of no less than six years.

2. Co-ordinated transnational process

Considering the ability of the 2003 research team to survey the Republic of Ireland in nine days (N. Ireland was covered in 2.5 days in 2002), it is recommended that future population estimation surveys of this kind be conducted over the entire island of Ireland through a co-ordinated trans-boundary process.

3. National monitoring programme for harbour seals

It is recommended that the momentum generated by this project be built upon, through the initiation of a smaller-scale, achievable national monitoring programme for harbour seals. This could now be developed relatively easily, be operated in a relatively low-cost manner, be supported by ongoing in-depth research, and the data reviewed at annual intervals in order to determine the most appropriate time for a repeat national census of the kind performed in 2003. These research efforts will be essential if the importance of specific sites and/or regions are to have a sound scientific basis.

4. Priority studies

It is recommended that future priority studies should be supported by all means available. Current priority research areas include (i) seasonal and diurnal patterns in terrestrial distribution and haul-out duration; (ii) development of survey correction factors and (iii) foraging ecology.

5. Grey seal census

It is recommended that a coordinated national grey seal census be undertaken as soon as possible, using the experience and contacts now available, augmenting expertise among local personnel and employing the most cost-effective strategy.

ACKNOWLEDGEMENTS

The 2003 harbour seal population survey was funded by the Republic of Ireland's Department of the Environment, Heritage and Local Government and kindly provided with assistance by members of its National Parks & Wildlife Service at all levels.

We were very fortunate to be able to call upon the services and considerable experience of helicopter pilot Dave Clem (PDG Ltd.) in conducting the aerial survey. Thanks to his advice and organisation, Billy McKenzie (PDG Ltd.) joined the survey team as a mobile refueling agent, a strategy that proved crucial to the survey's success. We're also very grateful to Vincent Sweeney (Irish Lights, Blacksod) for his comments, advice and help during planning and operation stages of the survey.

Many thanks to ground-truthing personnel who got involved so enthusiastically in the project, formed an important component of the survey team in June, July and August 2003, and patiently contributed their time and knowledge to the steering group: Martin Byrnes, Jane Gilleran (NUIG) and Susan Callaghan, Paul Duffy, Clare Heardman, Gerry Higgins, James Kilroy, Emer Magee, Dave McDonagh, Eoin McGreal, Tony Murray, Ger O' Donnell, Tim Roderick and Pat Smiddy (NPWS). Sincere thanks also to Tom Doyle (formerly of NUIG) and Declan O' Donnell (NPWS), Dr Sue Wilson and Judith Montgomery-Watson (Environment & Heritage Service, Northern Ireland) who provided information and assistance relating to harbour seals in Galway Bay, Cos. Cork and Kerry and Northern Ireland, respectively. Thanks also to other members of NPWS who took the time to fill in questionnaires and relay their information back to the steering group.

The use of harbour seal population estimates for Northern Ireland was kindly facilitated by Howard Platt and Judith Montgomery-Watson of the Environment & Heritage Service, Northern Ireland.

Go raibh mile maith agaibh go léir.

PHOTOGRAPHIC CREDITS

Photographic images used in this report are credited as follows: Cover photo and Plate 1, © Michelle Cronin, CMRC; Plate 2, © Denis Strong, NPWS; Plates 3-4, © Callan Duck, SMRU.

REFERENCES

Adkison, M.D., Quinn, T.J. & Small, R.J. (2001). Evaluation of Alaska harbour seal (*Phoca vitulina*) population surveys: a simulation study. In *Harbour Seal Investigations in Alaska*. p. 88-127. Annual report for NOAA award NA87FXO300. Alaska Department of Fish and Game, Division of Wildlife Conservation Anchorage, AK. 356 pp.

Anderson, S.S. (1981). Seals in Shetland waters. *Proc. R. Soc. Edin.* **80B**: 181-188.

Bonner, W.N. (1972). The grey and common seal in European waters. *Oceanogr. and Mar. Biol. Ann. Rev.* **10**: 461-507.

Bonner, W.N. (1990). *The natural history of seals*. Facts on File Inc. New York.

Härkonen, T. & Harding, K.C. (2001). Spatial structure of harbour seal populations and the implications thereof. *Can. J. Zool.* **79**: 2115-2127.

Harrington, R. (1990). 1989 survey of breeding herds of common seal *Phoca vitulina* with reference to previous surveys. Unpublished Wildlife Service Report. Mammal Conservation Section, Research Laboratory, Newtownmountkennedy, Co. Wicklow. 9pp.

Jemison, L.A., Pendleton, G.W. & Wilson, C.A. (2001). *Harbour seal population trends and factors influencing counts at Nanvak Bay, northern Bristol Bay Alaska*. In *Harbour Seal Investigations in Alaska*. p. 53-70. Annual report for NOAA award NA87FXO300. Alaska Department of Fish and Game, Division of Wildlife Conservation Anchorage, AK. 356 pp.

Kiely, O.R.M. (1998). *Population biology of grey seals (Halichoerus grypus Fabricius 1791) in western Ireland*. Unpublished PhD. thesis, University College Cork. Ireland.

Kiely, O. & Myers, A.A. (1998). Grey seal (*Halichoerus grypus*) pup production at the Inishkea island group, Co. Mayo and the Blasket Islands, Co. Kerry. *Biology and Environment: Proc. Royal Ir. Acad.* **98B (2)**: 113-122.

Kiely, O., Lidgard, D.C., McKibben, M., Baines, M.E. & Connolly, N. (2000). *Grey Seals: Status & Monitoring in the Irish & Celtic Seas*. Maritime Ireland/Wales INTERREG report No. 3. Marine Institute, 80 Harcourt St., Dublin.

Kovacs, K.M., Jonas, K.M. & Welke, S.E. (1990). Sex and age segregation by *Phoca vitulina concolor* at haul out sites during the breeding season in Passamaquoddy Bay region, New Brunswick. *Mar. Mamm. Sci.* **6**: 204-214.

Lidgard, D.C., Kiely, O., Rogan, E. & Connolly, N. (2000). The status of breeding grey seals (*Halichoerus grypus*) on the east and south-east coast of Ireland. *Mammalia* **65(3)**: 283-294.

Lockley, R.M. (1966). The distribution of grey and common seals on the coasts of Ireland. *Ir. Nat. J.* **15**: 136-143.

Ó Cadhla, O. & Strong, D. (2003). *Grey seal population status at islands in the Inishkea Group, as determined from breeding ground surveys in 2002*. Unpublished report to DÚCHAS the Heritage Service. Coastal and Marine Resources Centre, University College, Cork. 7pp.

Olesiuk, P.F. (1999). *An assessment of the status of harbour seals (Phoca vitulina) in British Columbia: Canadian Stock Assessment Secretariat Research Document 99/33*. Fisheries and Oceans Canada, Ottawa, Ontario, Canada. 130pp.

Olesiuk, P.F., Bigg, M.A. & Ellis, G.M. (1990). Recent trends in the abundance of harbour seals *Phoca vitulina* in British Columbia. *Can. J. Fish. Aquat. Sci.* **47**: 992-1003.

Pauli, B.D. & Terhune, J.M. (1987). Tidal and temporal interaction on harbour seal haul-out patterns. *Aquat. Mamm.* **13**: 93-95.

Ries, E.H., Hiby, L.R. & Reijnders, P.J.H. (1998). Maximum likelihood population size estimation of harbour seals in the Dutch Wadden Sea based on a mark-recapture experiment. *J. Appl. Ecol.* **35**: 332-339.

Stewart, B.S. (1984). Diurnal hauling patterns of harbour seals at San Miguel Island, California. *J. Wildl. Manage.* **48**: 1459-1461.

Summers, C.F., Warner, P.J., Nairn, R.G.W., Curry, M.G. & Flynn, J. (1980). An assessment of the status of the common seal *Phoca vitulina vitulina* in Ireland. *Biol. Conserv.* **17**: 115-123.

Summers, C.F. (1983). *The grey seal, Halichoerus grypus, in Ireland*. Unpublished internal report to the Minister for Fisheries, Forestry and Wildlife. 13pp.

Thompson, P.M. & Rothery, P. (1987). Age and sex differences in the timing of moult in the common seal, *Phoca vitulina*. *J. Zool. Lond.* **212**: 597-603.

Thompson, P.M. (1989). Seasonal changes in the distribution and composition of common seal (*Phoca vitulina*) haul-out groups. *J. Zool. Lond.* **217**: 281-294.

Thompson, P.M., Fedak, M.A., McConnell, B.J. & Nicholas, K.S. (1989). Seasonal and sex related variation in the activity patterns of common seals (*Phoca vitulina*). *J. Appl. Ecol.* **26**: 521-535.

Thompson, P.M. & Miller, D. (1990). Summer foraging activity and movements of radio-tagged common seals (*Phoca vitulina* L.) in the Moray Firth, Scotland. *J. Appl. Ecol.* **27**: 492-501.

Thompson, P.M. & Harwood, J. (1990). Methods for estimating the population size of common seals, *Phoca vitulina*. *J. Appl. Ecol.* **27**: 924-938.

Thompson, P.M., Miller, D., Cooper, R. & Hammond, P.S. (1994). Changes in distribution and activity of female harbour seals during breeding season; implications for their lactation strategy and mating patterns. *J. Anim. Ecol.* **63**: 24-50.

Thompson, P.M., Fedak, M.A., Wood, D., Corpe, H., Hammond, P.S. & Mackay, A. (1997). Estimating harbour seal abundance and status in an estuarine habitat in north-east Scotland. *J. Appl. Ecol.* **34**: 43-52.

Trilateral Seal Expert Group (TSEG). (2001). Common seals in the Wadden Sea in 2001. *Wadden Sea Newsletter 2001-3*: 20.

Van der Toorn, J.D. (1990). The seal epidemic in Europe and its consequences. *Soundings*. **15**: 1-5.

Ward, A.J., Thompson, D. & Hiby, A.R. (1987). Census techniques for grey seal populations. *Symp. Zool. Soc. Lond.* **58**: 181-191.

Warner, P.J. (1983). An assessment of the breeding populations of common seals (*Phoca vitulina vitulina* L.) in the Republic of Ireland during 1979. *Ir. Nat. J.* **21**: 24-26.

Warner, P.J. (1984). *Report on the census of common seals (Phoca vitulina vitulina) in the Republic of Ireland during 1984*. Unpublished report to the Forestry & Wildlife Service.

Wilson, S.C. & Corpe, H.M. (1996). An investigation into the status quo of the harbour seals of Co. Down, Northern Ireland. *Environment and Heritage Service Research and Development Series*. No. **97/13**.

Wilson, S.C. & Montgomery-Watson, J. (2002). Recent changes in the pattern of harbour seal pupping in Co. Down, north-east Ireland. *Ir. Nat. J.* **27**: 89-100.

Withrow, D.E. & Loughlin, T.R. (1996). *Abundance and distribution of harbour seals (Phoca vitulina richardsi) along the north side of the Alaska Peninsula and Bristol Bay during 1995*. Office of Protected Resources, National Marine Fisheries Service, 1335 East-West Highway, Silver Spring, MD 20910. Annual report (unpublished).

Yocom, P.K., Stewart, B.S., DeLong, R.L. & DeMaster, D.P. (1987). Diel haul-out patterns and site fidelity of harbour seals (*Phoca vitulina richardsi*) on San Miguel Island, California in autumn. *Mar. Mamm. Sci.* **3**: 323-333.

APPENDIX I – Summary table of harbour seal (*Phoca vitulina*) survey data and site locations

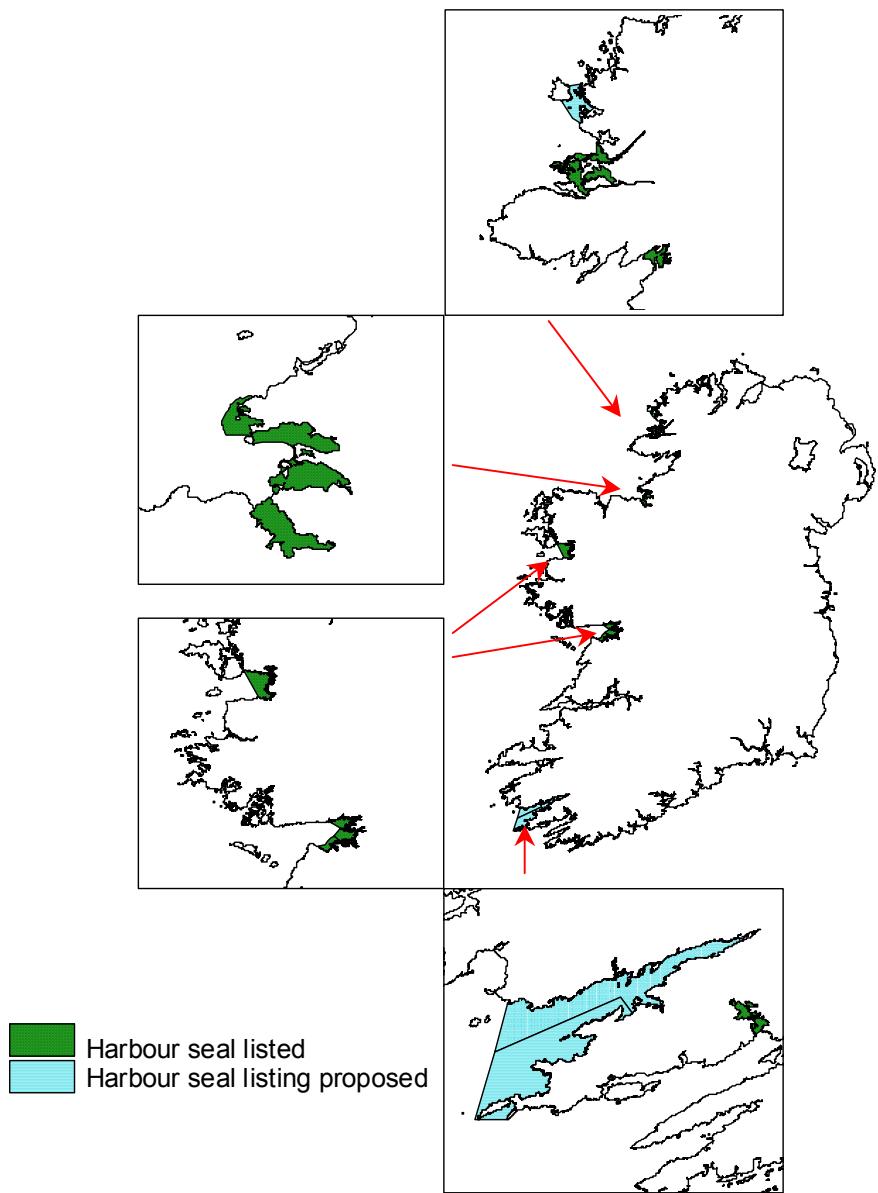
Survey Date	County	Survey region	Location	No. of harbour seals	EASTINGS	NORTHINGS
12/08/2003	Donegal	W L Foyle	Greencastle	2	2669	4409
12/08/2003	Donegal	W L Foyle	Greencastle	2	2668	4442
12/08/2003	Donegal	Fanad Hd	Loch Swilly	5	2337	4303
12/08/2003	Donegal	Mulroy Bay	Fanny's Bay	25	2135	4386
12/08/2003	Donegal	Mulroy Bay	Broadwater	22	2207	4338
12/08/2003	Donegal	Mulroy Bay	Broadwater	8	2206	4337
12/08/2003	Donegal	Mulroy Bay	Broadwater	1	2200	4323
12/08/2003	Donegal	Inishbofin	Inishbeg	12	1893	4385
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	20	1715	4148
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	13	1718	4143
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	9	1721	4141
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	6	1722	4137
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	4	1725	4128
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	3	1727	4124
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	7	1728	4124
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	19	1728	4117
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	8	1726	4117
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	3	1725	4117
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	9	1724	4116
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	3	1722	4111
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	12	1726	4105
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	28	1737	4123
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	4	1736	4118
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	9	1737	4117
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	5	1732	4114
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	26	1737	4111
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	9	1737	4118
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	3	1746	4113
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	14	1752	4117
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	5	1747	4113
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	19	1737	4102
12/08/2003	Donegal	Inishfee Bay	Dungloe Bay	28	1736	4103
12/08/2003	Donegal	Gweebarra Bay	Gweebarra River	1	1761	4001
12/08/2003	Donegal	Gweebarra Bay	Gweebarra River	41	1762	4000
12/08/2003	Donegal	Rossan Pt	Loughrosmore Bay	8	1697	3934
12/08/2003	Donegal	Rossan Pt	Loughrosmore Bay	9	1699	3934
12/08/2003	Donegal	Mulroy Bay	Fanad Hd	1	2200	4463
12/08/2003	Donegal	Inishfree Bay	Burtonport	2	1709	4174
13/08/2003	Donegal	Donegal Bay	Inner Bay	148	1908	3747
13/08/2003	Donegal	Donegal Bay	River Erne	2	1837	3621
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	85	1611	3329
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	35	1608	3325
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	15	1605	3325
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	26	1603	3334
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	96	1613	3322
13/08/2003	Sligo	Sligo West	Killala Bay	107	1264	3281
13/08/2003	Sligo	Sligo West	Killala Bay	1	1232	3287
13/08/2003	Sligo	Dernish	Dernish Isl	12	1669	3522
13/08/2003	Mayo	Broad Haven	Belmullet	5	762	3313
13/08/2003	Mayo	Broad Haven	Belmullet	25	759	3318
13/08/2003	Mayo	Broad Haven	Belmullet	17	758	3317

Survey Date	County	Survey Region	Location	No. of harbour seals	EASTINGS	NORTHINGS
14/08/2003	Mayo	Blacksod Pt	Blacksod	27	654	3197
14/08/2003	Mayo	Blacksod Pt	Blacksod	1	656	3198
14/08/2003	Mayo	Blacksod Pt	Blacksod	1	671	3279
14/08/2003	Mayo	Blacksod Pt	Belmullet	12	687	3286
14/08/2003	Mayo	Blacksod Pt	Belmullet	15	702	3284
14/08/2003	Mayo	Blacksod Pt	Belmullet	13	705	3286
14/08/2003	Mayo	Achill Is	North narrows	5	746	3076
14/08/2003	Mayo	Achill Is	North narrows	1	726	3087
14/08/2003	Mayo	Achill Is	Achill Sound	5	788	3068
14/08/2003	Mayo	Achill Is	Achill Sound	1	757	3053
14/08/2003	Mayo	Achill Is	Achill Sound	5	767	3047
14/08/2003	Mayo	Achill Is	Achill Sound	22	770	3045
14/08/2003	Mayo	Achill Is	Achill Sound	2	771	3044
14/08/2003	Mayo	Achill Is	Achill Sound	1	799	3018
14/08/2003	Mayo	Achill Is	Achill Sound	8	813	3030
14/08/2003	Mayo	Achill Is	Achill Sound	13	810	3027
14/08/2003	Mayo	Achill Is	Achill Sound	9	809	3025
14/08/2003	Mayo	Achill Is	Achill Sound	2	810	3023
14/08/2003	Mayo	Achill Is	Achill Sound	1	817	3022
14/08/2003	Mayo	Achill Is	Achill Sound	5	733	2982
14/08/2003	Mayo	Clew Bay	Clew Is	16	890	2934
14/08/2003	Mayo	Clew Bay	Clew Is	1	945	2902
14/08/2003	Mayo	Clew Bay	Clew Is	1	932	2858
14/08/2003	Mayo	Clew Bay	Clew Is	20	933	2857
14/08/2003	Mayo	Clew Bay	Clew Is	20	941	2853
14/08/2003	Mayo	Clew Bay	Clew Is	19	942	2852
14/08/2003	Mayo	Clew Bay	Clew Is	15	945	2852
14/08/2003	Mayo	Clew Bay	Clew Is	3	944	2848
14/08/2003	Mayo	Killary Hbr north	Roonagh	19	742	2803
14/08/2003	Mayo	Killary Hbr north	Roonagh	5	741	2803
14/08/2003	Galway	Clifden Bay	Ballynakill Hbr	5	690	2588
15/08/2003	Galway	Clifden Bay	Cleggan	9	572	2598
15/08/2003	Galway	Clifden Bay	Cleggan	1	547	2576
15/08/2003	Galway	Clifden Bay	Cleggan	4	566	2507
15/08/2003	Galway	Clifden Bay	Cleggan	1	627	2528
15/08/2003	Galway	Clifden Bay	Mannin Bay	1	622	2483
15/08/2003	Galway	Clifden Bay	Mannin Bay	5	620	2466
15/08/2003	Galway	Clifden Bay	Mannin Bay	7	619	2466
15/08/2003	Galway	Clifden Bay	Mannin Bay	2	582	2471
15/08/2003	Galway	Clifden Bay	Mannin Bay	1	582	2466
15/08/2003	Galway	Bertraghboy Bay	Slyne Head	2	624	2420
15/08/2003	Galway	Bertraghboy Bay	Slyne Head	2	637	2412
15/08/2003	Galway	Bertraghboy Bay	Bertraghboy	2	737	2417
15/08/2003	Galway	Bertraghboy Bay	Bertraghboy	7	783	2401
15/08/2003	Galway	Bertraghboy Bay	Bertraghboy	9	802	2399
15/08/2003	Galway	Bertraghboy Bay	Bertraghboy	7	806	2393
15/08/2003	Galway	Bertraghboy Bay	Bertraghboy	6	802	2391
15/08/2003	Galway	Bertraghboy Bay	Bertraghboy	1	748	2354
15/08/2003	Galway	Kilkieran Bay	Mweenish	6	762	2320
15/08/2003	Galway	Kilkieran Bay	Mweenish	16	762	2318

Survey Date	County	Survey region	Location	No. of harbour seals	EASTINGS	NORTHINGS
15/08/2003	Galway	Kilkieran Bay	Mweenish	4	761	2317
15/08/2003	Galway	Kilkieran Bay	Mweenish	18	787	2300
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	3	894	2356
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	8	894	2375
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	2	895	2377
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	1	905	2385
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	6	903	2377
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	6	903	2373
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	8	903	2374
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	2	904	2368
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	1	912	2366
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	2	912	2362
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	4	901	2357
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	3	898	2347
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	6	890	2320
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	1	917	2298
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	7	882	2268
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	7	886	2276
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	1	871	2258
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	2	823	2217
15/08/2003	Galway	Kilkieran Bay	Lettermore Is	2	934	2373
15/08/2003	Galway	Inner Galway Bay	Oranmore	1	1364	2243
15/08/2003	Galway	Inner Galway Bay	Oranmore	1	1364	2243
15/08/2003	Galway	Inner Galway Bay	Oranmore	48	1365	2203
15/08/2003	Galway	Inner Galway Bay	Oranmore	17	1362	2240
15/08/2003	Galway	Inner Galway Bay	Oranmore	1	1344	2215
15/08/2003	Galway	Inner Galway Bay	Inner Bay	14	1323	2210
15/08/2003	Galway	Inner Galway Bay	Inner Bay	18	1322	2210
15/08/2003	Galway	Inner Galway Bay	Kinvara	1	1367	2162
15/08/2003	Galway	Inner Galway Bay	Kinvara	99	1365	2127
16/08/2003	Galway	Kilkieran Bay	Rossaveel	1	963	2256
16/08/2003	Galway	Kilkieran Bay	Rossaveel	1	965	2272
16/08/2003	Galway	Kilkieran Bay	Rossaveel	5	969	2270
16/08/2003	Galway	Kilkieran Bay	Rossaveel	6	968	2268
16/08/2003	Galway	Kilkieran Bay	Rossaveel	12	968	2268
16/08/2003	Galway	Kilkieran Bay	Rossaveel	4	964	2233
16/08/2003	Galway	Kilkieran Bay	Rossaveel	1	966	2217
16/08/2003	Galway	Galway Bay north	Rossaveel	6	1050	2211
16/08/2003	Galway	Galway Bay north	Rossaveel	39	1058	2207
16/08/2003	Galway	Galway Bay north	Rossaveel	4	1061	2208
16/08/2003	Galway	Inner Galway Bay	Kinvara	4	1283	2153
16/08/2003	Galway	Inner Galway Bay	Kinvara	13	1283	2153
15/08/2003	Clare	Black Hd	Poulnaclogh	37	1278	2104
16/08/2003	Clare	Aran Is	Inishmore	5	770	2118
16/08/2003	Clare	Aran Is	Inishmore	14	769	2118
16/08/2003	Clare	Aran Is	Inishmore	4	854	2111
16/08/2003	Clare	Aran Is	Inishmore	16	910	2085
16/08/2003	Clare	Black Hd	Ballyvaughan Bay	28	1234	2090
16/08/2003	Clare	Black Hd	Ballyvaughan Bay	6	1235	2088
16/08/2003	Clare	Black Hd	Ballyvaughan Bay	29	1236	2086
16/08/2003	Clare	Liscanore Bay	Mutton Is	17	989	1746
16/08/2003	Clare	Inner Shannon	Fergus Estuary	2	1299	1588
16/08/2003	Clare	Inner Shannon	Fergus Estuary	6	1304	1589

Survey Date	County	Survey region	Location	No. of harbour seals	EASTINGS	NORTHINGS
17/08/2003	Kerry	Dingle Bay	Dingle Bay	13	720	1108
17/08/2003	Kerry	Dingle Bay	Inch	1	647	948
17/08/2003	Kerry	Dingle Bay	Inch	8	719	989
17/08/2003	Kerry	Valencia	Cahersiveen	12	487	808
17/08/2003	Kerry	Valencia	Cahersiveen	1	456	796
17/08/2003	Kerry	Valencia	Cahersiveen	1	421	794
17/08/2003	Kerry	Valencia	Ballinskelligs Bay	8	491	661
18/08/2003	Kerry	Kenmare	Castle Cove	2	585	593
18/08/2003	Kerry	Kenmare	Castle Cove	24	584	593
18/08/2003	Kerry	Kenmare	Castle Cove	21	585	597
18/08/2003	Kerry	Kenmare	Castle Cove	12	619	600
18/08/2003	Kerry	Kenmare	Castle Cove	25	620	600
18/08/2003	Kerry	Kenmare	Castle Cove	66	692	628
18/08/2003	Kerry	Kenmare	Castle Cove	1	671	637
18/08/2003	Kerry	Kenmare	Sneem Hbr	21	712	634
18/08/2003	Kerry	Kenmare	Sneem Hbr	25	717	630
18/08/2003	Kerry	Kenmare	Sneem Hbr	3	718	629
18/08/2003	Kerry	Kenmare	Sneem Hbr	3	750	653
18/08/2003	Kerry	Kenmare	Sneem Hbr	1	752	645
18/08/2003	Kerry	Kenmare	Sneem Hbr	1	756	617
18/08/2003	Kerry	Kenmare	Ormonds Is	11	794	646
18/08/2003	Kerry	Kenmare	Ormonds Is	14	793	644
18/08/2003	Kerry	Kenmare	Upper Kenmare	5	836	682
18/08/2003	Kerry	Kenmare	Upper Kenmare	41	837	681
18/08/2003	Kerry	Kenmare	Upper Kenmare	15	838	671
18/08/2003	Kerry	Kenmare	Upper Kenmare	44	845	686
18/08/2003	Kerry	Kenmare	Upper Kenmare	20	848	687
18/08/2003	Kerry	Kenmare	Upper Kenmare	6	855	686
18/08/2003	Kerry	Kenmare	Upper Kenmare	1	856	687
18/08/2003	Kerry	Kenmare	Upper Kenmare	3	842	673
18/08/2003	Kerry	Kenmare	Kilmakillogue	21	758	586
18/08/2003	Cork	Outer Kenmare	Ardgroom Hbr	3	709	578
18/08/2003	Cork	Outer Kenmare	Ardgroom Hbr	2	636	518
18/08/2003	Cork	Bantry Bay	Bear Island	5	804	498
18/08/2003	Cork	Bantry Bay	Coolieragh Hbr	30	907	508
18/08/2003	Cork	Bantry Bay	Coolieragh Hbr	3	907	508
18/08/2003	Cork	Bantry Bay	Coolieragh Hbr	12	909	507
18/08/2003	Cork	Bantry Bay	Coolieragh Hbr	1	931	523
18/08/2003	Cork	Bantry Bay	Whiddy	21	955	498
18/08/2003	Cork	Bantry Bay	Whiddy	21	956	525
18/08/2003	Cork	Bantry Bay	Yellow Rocks	17	955	534
18/08/2003	Cork	Bantry Bay	Big Point	67	932	537
18/08/2003	Cork	Bantry Bay	Garinish	36	938	550
18/08/2003	Cork	Bantry Bay	Garinish	7	940	550
18/08/2003	Cork	Bantry Bay	Garinish	18	933	561
18/08/2003	Cork	Bantry Bay	Garinish	3	933	556
18/08/2003	Cork	Bantry Bay	Garinish	3	932	557
18/08/2003	Cork	Bantry Bay	Whiddy	1	940	488
18/08/2003	Cork	Bantry Bay	Whiddy	54	934	485
18/08/2003	Cork	Bantry Bay	Whiddy	8	930	482
18/08/2003	Cork	Bantry Bay	Whiddy	34	934	484
18/08/2003	Cork	Dunmanus Bay	Dunmanus	9	852	359
18/08/2003	Cork	Dunmanus Bay	Dunmanus	14	854	353

Survey Date	County	Survey region	Location	No. of harbour seals	EASTINGS	NORTHINGS
18/08/2003	Cork	Dunmanus Bay	Dunmanus	16	851	354
18/08/2003	Cork	Dunmanus Bay	Dunmanus	33	872	365
18/08/2003	Cork	Dunmanus Bay	Dunmanus	4	912	401
18/08/2003	Cork	Dunmanus Bay	Dunmanus	5	912	399
18/08/2003	Cork	Roaringwater Bay	Crookhaven	1	805	260
18/08/2003	Cork	Roaringwater Bay	Crookhaven	1	908	286
18/08/2003	Cork	Roaringwater Bay	Ballydehob	15	1002	336
18/08/2003	Cork	Roaringwater Bay	Ballydehob	2	1014	328
18/08/2003	Cork	Roaringwater Bay	Ringarogy Is	11	1036	282
18/08/2003	Cork	Roaringwater Bay	Ringarogy Is	3	1034	283
18/08/2003	Cork	Roaringwater Bay	Ringarogy Is	8	1037	281
18/08/2003	Cork	Roaringwater Bay	Ringarogy Is	11	1035	279
19/08/2003	Cork	Kinsale	Kinsale Hbr	10	1624	493
19/08/2003	Waterford	Helvic Hd	Dungarvan	1	2303	921
19/08/2003	Wexford	Carnsore - Wexford	Wexford Hbr	14	3092	1201
19/08/2003	Wexford	Carnsore - Wexford	Wexford Hbr	3	3082	1209
20/08/2003	Dublin	Lambay Is	Lambay Is	1	3320	2498
20/08/2003	Dublin	Lambay Is	Lambay Is	30	3303	2505
20/08/2003	Dublin	Skerries	Skerries	3	3268	2599
20/08/2003	Louth	South Bull	Clogher Hd	8	3152	2865
20/08/2003	Louth	Dundalk Bay	Dundalk Hbr	18	3091	3078
20/08/2003	Louth	Carlingford L south	Black Rock	13	3211	3116
20/08/2003	Down	Carlingford L north	Greencastle	33	3222	3137
20/08/2003	Down	Carlingford L north	Greencastle	13	3236	3116
20/08/2003	Down	Carlingford L north	Greencastle	18	3238	3116
20/08/2003	Down	Carlingford L north	Greencastle	19	3239	3109
20/08/2003	Down	Carlingford L north	Greencastle	27	3244	3112
20/08/2003	Down	Carlingford L north	Greencastle	54	3242	3110
20/08/2003	Down	Carlingford L north	Greencastle	37	3238	3112
20/08/2003	Down	Carlingford L north	Greencastle	1	3238	3113
20/08/2003	Down	Carlingford L north	Greencastle	45	3237	3111
20/08/2003	Down	Carlingford L north	Greencastle	3	3245	3086
20/08/2003	Down	Carlingford L north	Greencastle	15	3249	3087
20/08/2003	Down	Carlingford L north	Greencastle	2	3247	3087
20/08/2003	Down	Carlingford L north	Greencastle	4	3255	3087
20/08/2003	Down	Carlingford L north	Greencastle	7	3256	3086
20/08/2003	Down	Carlingford L north	Greencastle	19	3256	3085



APPENDIX II. Map of locations of Special Areas of Conservation (SACs) with existing (seven sites) and proposed (two sites) listings of the harbour seal (*Phoca vitulina*) as a qualifying interest

APPENDIX III – Summary table of grey seal (*Halichoerus grypus*) survey data and site locations

Survey Date	County	Survey region	Location	No. of grey seals	EASTINGS	NORTHINGS
12/08/2003	Donegal	Garvan Is	Garvan	2	2435	4602
12/08/2003	Donegal	Garvan Is	Garvan	1	2437	4604
12/08/2003	Donegal	Garvan Is	Garvan	11	2435	4608
12/08/2003	Donegal	Garvan Is	Inishtrahull	6	2493	4653
12/08/2003	Donegal	Garvan Is	Inishtrahull	15	2482	4656
12/08/2003	Donegal	Garvan Is	Inishtrahull	21	2474	4669
12/08/2003	Donegal	Garvan Is	Inishtrahull	4	2482	4673
12/08/2003	Donegal	Mulroy Bay	Fannys Bay	1	2135	4386
12/08/2003	Donegal	Mulroy Bay	Fannys Bay	2	2128	4390
12/08/2003	Donegal	Mulroy Bay	Rosguil	1	2105	4436
12/08/2003	Donegal	Mulroy Bay	Rosguil	3	2095	4434
12/08/2003	Donegal	Inishbofin Donegal	Inishbeg	1	1897	4397
12/08/2003	Donegal	Inishbofin Donegal	Inishbeg	22	1899	4379
12/08/2003	Donegal	Troy Is	West Tory	4	1846	4476
12/08/2003	Donegal	Inishowen-Malin Hd	Kinnagoe Bay	3	2620	4471
12/08/2003	Donegal	Inishowen-Malin Hd	Kinnagoe Bay	1	2613	4473
13/08/2003	Donegal	Rossan Pt-Dawros Pt	Loughros Bay	90	1594	3918
13/08/2003	Donegal	Killibegs	Rathlin Is	23	1467	3803
13/08/2003	Donegal	Killibegs	Rathlin Is	3	1462	3797
13/08/2003	Donegal	Donegal Bay	Outer Bay	1	1842	3691
13/08/2003	Sligo	Inishmurray	Inishmurray	59	1564	3573
13/08/2003	Sligo	Inishmurray	Inishmurray	4	1566	3574
13/08/2003	Sligo	Inishmurray	Inishmurray	32	1564	3574
13/08/2003	Sligo	Inishmurray	Inishmurray	8	1563	3574
13/08/2003	Sligo	Inishmurray	Inishmurray	6	1552	3575
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	8	1611	3329
13/08/2003	Sligo	Sligo Bay	Ballysadare Bay	12	1608	3325
13/08/2003	Mayo	Killala Bay west	Killala Bay	1	1235	3342
13/08/2003	Mayo	Killala Bay west	Killala Bay	4	1225	3353
13/08/2003	Mayo	Broad Haven	Benwee Hd	3	812	3443
13/08/2003	Mayo	Broad Haven	Benwee Hd	1	803	3435
13/08/2003	Mayo	Broad Haven	Benwee Hd	16	799	3434
13/08/2003	Mayo	Broad Haven	Erris Hd	2	702	3419
13/08/2003	Mayo	Blacksod Pt	Erris Hd	2	679	3391
13/08/2003	Mayo	Inishglora	Inishkeas	14	622	3318
13/08/2003	Mayo	Inishglora	Inishkeas	10	613	3307
13/08/2003	Mayo	Inishglora	Inishkeas	34	597	3296
13/08/2003	Mayo	Inishkea N & S	Inishkeas	50	572	3256
13/08/2003	Mayo	Inishkea N & S	Inishkeas	18	572	3252
13/08/2003	Mayo	Inishkea N & S	Inishkeas	3	573	3258
13/08/2003	Mayo	Duvillaun More	Inishkeas	4	599	3163
14/08/2003	Mayo	Achill Is	North narrows	9	752	3111
14/08/2003	Mayo	Achill Is	North narrows	3	752	3108
14/08/2003	Mayo	Achill Is	North narrows	9	754	3100
14/08/2003	Mayo	Achill Is	North Achill	1	576	3087
14/08/2003	Mayo	Achill Is	North Achill	7	564	3078
14/08/2003	Mayo	Achill Is	North Achill	11	563	3073
14/08/2003	Mayo	Achill Is	North Achill	5	562	3072

Survey Date	County	Survey region	Location	No. of grey seals	EASTINGS	NORTHINGS
14/08/2003	Mayo	Achill Is	North Achill	2	556	3068
14/08/2003	Mayo	Achill Is	North Achill	15	551	3066
14/08/2003	Mayo	Clare Is	Clare Is	1	675	2865
14/08/2003	Mayo	Clew Bay	Clew Is	1	890	2934
14/08/2003	Mayo	Roonagh	Roonagh	1	741	2803
14/08/2003	Mayo	Killary Hbr	Killary	3	710	2696
14/08/2003	Mayo	Killary Hbr	Killary	15	711	2694
14/08/2003	Galway	Inishbofin, Galway	Inishbofin	1	514	2638
14/08/2003	Galway	Inishbofin, Galway	Inishbofin	3	505	2627
14/08/2003	Galway	Inishbofin, Galway	Inishbofin	1	504	2627
14/08/2003	Galway	Inishbofin, Galway	Inishbofin	3	494	2627
14/08/2003	Galway	Inishbofin, Galway	Inishbofin	2	470	2637
14/08/2003	Mayo	Inishturk	Inishturk	3	665	2758
14/08/2003	Mayo	Inishturk	Inishturk	2	653	2753
14/08/2003	Mayo	Inishturk	Inishturk	5	633	2722
14/08/2003	Mayo	Inishturk	Inishturk	8	634	2720
14/08/2003	Mayo	Inishturk	Inishturk	6	632	2719
14/08/2003	Mayo	Inishturk	Inishturk	5	630	2718
14/08/2003	Mayo	Achill Is	West Achill	1	515	3048
15/08/2003	Galway	Clifden Bay	Mannin Bay	1	620	2466
15/08/2003	Galway	Clifden Bay	Slyne Hd	1	544	2429
15/08/2003	Galway	Clifden Bay	Slyne Hd	1	538	2417
15/08/2003	Galway	Clifden Bay	Slyne Hd	5	523	2413
15/08/2003	Galway	Clifden Bay	Slyne Hd	2	523	2412
15/08/2003	Galway	Clifden Bay	Slyne Hd	2	514	2408
15/08/2003	Galway	Clifden Bay	Slyne Hd	8	521	2406
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	579	2401
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	2	597	2405
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	3	598	2404
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	602	2392
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	3	604	2389
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	611	2401
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	638	2389
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	638	2384
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	640	2385
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	3	645	2380
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	1	647	2378
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	3	646	2378
15/08/2003	Galway	Bertraghboy Bay	Slyne Hd	5	645	2382
15/08/2003	Galway	Bertraghboy Bay	Slyne ad	3	640	2388
15/08/2003	Galway	Skerdmore Skerries	Skerries	1	646	2288
15/08/2003	Galway	Skerdmore Skerries	Skerries	6	657	2250
15/08/2003	Galway	Skerdmore Skerries	Skerries	3	673	2245
15/08/2003	Galway	Clifden Bay	High Is	3	497	2569
16/08/2003	Clare	Aran Is	Iniseer	5	964	2025
16/08/2003	Clare	Aran Is	Inishmore	6	772	2118
16/08/2003	Galway	Inner Galway Bay	Kinvara	7	1285	2153
16/08/2003	Clare	Liscanore Bay	Lahinch	2	1091	1869
16/08/2003	Clare	Liscanore Bay	Mutton Is	9	975	1723
16/08/2003	Clare	Inner Shannon	Fergus Estuary	2	1283	1574
17/08/2003	Kerry	Tralee Bay	Ballyheige	1	698	1225
17/08/2003	Kerry	Brandon	Magharee Is	1	627	1213
17/08/2003	Kerry	Brandon	Magharee Is	1	596	1194

Survey Date	County	Survey region	Location	No. of grey seals	EASTINGS	NORTHINGS
17/08/2003	Kerry	Tralee Bay	Tralee Bay	11	682	1107
17/08/2003	Kerry	Blasket Is	Great Blasket	1	284	991
17/08/2003	Kerry	Blasket Is	Inishvickallane	1	203	913
17/08/2003	Kerry	Blasket Is	Inishvickallane	25	205	914
17/08/2003	Kerry	Blasket Is	Inishvickallane	4	207	913
17/08/2003	Kerry	Valencia	Cahersiveen	1	456	796
17/08/2003	Kerry	Skelligs	Skelligs Bay	1	269	619
18/08/2003	Kerry	Kenmare	Castle Cove	1	620	600
18/08/2003	Kerry	Kenmare	Castle Cove	2	696	619
18/08/2003	Kerry	Kenmare	Ormonds Is	5	794	645
18/08/2003	Cork	Bantry Bay	Bear Island	1	789	464
18/08/2003	Cork	Dunmanus Bay	Sheeps Hd	1	728	335
18/08/2003	Cork	Dunmanus Bay	Dunmanus	4	852	359
18/08/2003	Cork	Dunmanus Bay	Mizen	4	758	286
18/08/2003	Cork	Roaringwater	Crook Haven	1	862	272
18/08/2003	Cork	Roaringwater	Ballydehob	2	1017	313
18/08/2003	Cork	Roaringwater	Ringarogy Is	4	1032	286
18/08/2003	Cork	Roaringwater	Ringarogy Is	17	987	265
18/08/2003	Cork	Roaringwater	Ringarogy Is	2	985	264
18/08/2003	Cork	Roaringwater	Ringarogy Is	12	948	257
18/08/2003	Cork	Roaringwater	Ringarogy Is	10	953	259
18/08/2003	Cork	Roaringwater	Toe Head	7	1152	246
18/08/2003	Cork	Roscarberry	Castletownsend	3	1210	297
19/08/2003	Cork	Clonakilty Bay	Courtmacsherry	6	1583	399
19/08/2003	Cork	Clonakilty Bay	Courtmacsherry	1	1566	426
19/08/2003	Cork	Kinsale	Kinsale Hbr	6	1704	492
19/08/2003	Wexford	Saltee Is	Great Saltee	8	2957	977
19/08/2003	Wexford	Saltee Is	Great Saltee	8	2956	976
19/08/2003	Wexford	Saltee Is	Great Saltee	1	2952	976
19/08/2003	Wexford	Saltee Is	Great Saltee	4	2956	974
19/08/2003	Wexford	Saltee Is	Great Saltee	5	2974	949
19/08/2003	Wexford	Saltee Is	Great Saltee	35	2971	948
19/08/2003	Wexford	Hook Hd-Carnsore Pt	Carnsore	56	3087	1014
19/08/2003	Wexford	Carnsore	Tuskar Rock	3	3226	1072
19/08/2003	Wexford	Carnsore	Tuskar Rock	3	3225	1071
19/08/2003	Wexford	Carnsore	Tuskar Rock	9	3225	1071
19/08/2003	Wexford	Carnsore	Tuskar Rock	2	3225	1072
19/08/2003	Wexford	Carnsore	Carnsore	2	3128	1049
19/08/2003	Wexford	Carnsore	Carnsore	7	3128	1050
19/08/2003	Wexford	Carnsore	Carnsore	1	3138	1071
19/08/2003	Wexford	Carnsore	Greenore Pt	20	3157	1114
19/08/2003	Wexford	Carnsore	Wexford Hbr	25	3082	1209
20/08/2003	Wexford	Wexford	Kilmichael	1	3255	1664
20/08/2003	Wexford	Wexford	Kilmichael	3	3255	1665
20/08/2003	Wicklow	Wicklow	Ardmore Pt	8	3211	1878
20/08/2003	Dublin	Dublin Bay	Dalkey Is	2	3280	2262
20/08/2003	Dublin	Dublin Bay	Dalkey Is	2	3284	2266
20/08/2003	Dublin	Dublin Bay	Dalkey Is	4	3283	2267
20/08/2003	Dublin	Dublin Bay	Dalkey Is	8	3275	2267
20/08/2003	Dublin	Knocknaghin	Howth	6	3297	2372
20/08/2003	Dublin	Knocknaghin	Howth	1	3302	2382
20/08/2003	Dublin	Knocknaghin	Ireland's Eye	1	3290	2405
20/08/2003	Dublin	Knocknaghin	Ireland's Eye	21	3291	2406

Survey Date	County	Survey region	Location	No. of grey seals	EASTINGS	NORTHINGS
20/08/2003	Dublin	Knocknaghin	Ireland's Eye	6	3290	2410
20/08/2003	Dublin	Lambay Is	Lambay	6	3320	2498
20/08/2003	Dublin	Lambay Is	Lambay	13	3331	2512
20/08/2003	Dublin	Lambay Is	Lambay	23	3329	2514
20/08/2003	Dublin	Lambay Is	Lambay	17	3310	2516
20/08/2003	Dublin	Lambay Is	Lambay	2	3308	2517
20/08/2003	Dublin	Lambay Is	Lambay	3	3303	2505
20/08/2003	Dublin	Skerries	Skerries	6	3267	2585
20/08/2003	Dublin	Skerries	Skerries	3	3269	2598
20/08/2003	Dublin	Skerries	Skerries	3	3268	2599
20/08/2003	Dublin	Skerries	Skerries	1	3275	2609
20/08/2003	Dublin	Skerries	Skerries	30	3278	2613
20/08/2003	Dublin	Skerries	Skerries	1	3266	2612
20/08/2003	Dublin	Skerries	Rockabill	5	3322	2626
20/08/2003	Dublin	Balbriggan	Cardy Rocks	2	3198	2656
20/08/2003	Dublin	Balbriggan	Cardy Rocks	9	3205	2660
20/08/2003	Dublin	Balbriggan	Cardy Rocks	30	3204	2661
20/08/2003	Dublin	Balbriggan	Cardy Rocks	6	3204	2662
20/08/2003	Louth	South Bull-Dunanny	Clogher Hd	1	3159	2848
20/08/2003	Louth	South Bull-Dunanny	Clogher Hd	4	3155	2852
20/08/2003	Louth	South Bull-Dunanny	Clogher Hd	1	3154	2852
20/08/2003	Louth	South Bull-Dunanny	Clogher Hd	10	3152	2865
20/08/2003	Louth	Dundalk Bay	Dundalk Hrb	1	3091	3078
20/08/2003	Down	Carlingford L north	Greencastle	2	3245	3112
20/08/2003	Down	Carlingford L north	Greencastle	7	3245	3086
20/08/2003	Down	Carlingford L north	Greencastle	3	3258	3088
20/08/2003	Down	Carlingford L north	Greencastle	1	3259	3085
20/08/2003	Down	Carlingford L north	Greencastle	15	3254	3084