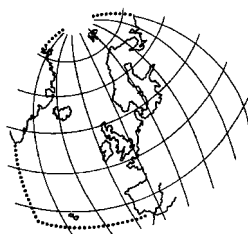


# **North Sea Pilot Project on Ecological Quality Objectives**

## **Background Document on the Ecological Quality Objective for Seal Population Trends in the North Sea**



**OSPAR Commission  
2005**

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

*La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.*

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## 1. Background

This Background Document aims to provide information to support the development of the ecological quality objectives (EcoQOs) on seal population trends in the North Sea.

The Bergen Declaration of the 5<sup>th</sup> North Sea Conference identified ten issues relating to the ecological quality of the North Sea for the development of ecological quality objectives (EcoQOs). "Marine Mammals" is one of these ten issues. Three Ecological Quality (EcoQ) elements were identified for this issue, including: (c) *seal population trends in the North Sea*.

The 5<sup>th</sup> North Sea Conference adopted the following EcoQO for this element in the Bergen Declaration: "No decline in population size or pup production of  $\geq 10\%$  over a period of up to 10 years."

This Background Document was prepared by the United Kingdom (lead country for this EcoQO in OSPAR) as input to the review of the advanced EcoQOs under the North Sea Pilot Project.

## 2. Seal population trends in the North Sea

The grey seal *Halichoerus grypus* and harbour (or common) seal *Phoca vitulina* are both resident in the North Sea.

### 2.1 Grey seal

It was agreed at BDC 2004 to track seal population numbers in nine parts of the North Sea (Table 1). The vast majority of these grey seals breed on UK coasts (Table 2). Their UK distribution is described in more detail in the following paragraphs.

**Table 1.** Sections of the North Sea coast used for describing the grey seal population.

Grey seal	
UK	Orkney
	Fast Castle/Isle of May
	Farne Islands
	Donna Nook
France	
Netherlands	
Germany	Schleswig-Holstein Wadden Sea
	Helgoland
Norway	Kjørholmane, Rogaland, Norway

**Table 2.** Current estimates of abundance of grey seals in North Sea waters.

Region	Year	Estimate of abundance
UK	2002	54,600
Germany	1998	100
The Netherlands	2000	500
France		?
Norway	2003	35 (pup count, not extrapolated)

The number of grey seal pups born in different areas in the UK bordering the North Sea is shown in Table 3. These estimates are produced from counts of pups from aerial photographic surveys of the breeding colonies taken annually between October and December. Between four and six counts are made of each colony during the breeding season and the total number of pups born is estimated using a model of the birth-lactation-weaning process. Numbers of pups born have been collected using consistent methods each year since 1984. Additional data are available for most North Sea breeding colonies from 1964 but the methods used to collect the data differ from the later part of the time series.

**Table 3.** The number of grey seal pups born at each of the major UK breeding sites bordering the North Sea.

Year	Orkney	Isle of May & Fast Castle	Farne Islands	Donna Nook	Total
1984	4741		778	30	5549
1985	5199		848	53	6100
1986	5796		908	35	6739
1987	6389		930	72	7391
1988	5948		812	54	6814
1989	6773		892	94	7759
1990	6982		1004	152	8138
1991	8412		927	223	9562
1992	9608	1251	985	200	12044
1993	10790	1454	1051	205	13500
1994	11593	1325	1025	302	14245
1995	12412	1353	1070	334	15169
1996	14273	1567	1061	310	17211
1997	14051	2032	1284	382	17749
1998	16352	2241	1309	439	20341
1999	15455	2034	843	503	18835
2000	16281	2514	1171	618	20584
2001	17928	2253	1247	634	22062
2002	17598	2509	1200	709	22016

Pup production is the only direct measure of population size in grey seals. Using a demographic model, it is possible to estimate the total population of grey seals but this introduces additional uncertainties. Pup production is, therefore, the most accurate index of population status in this species.

Orkney produces 80% of the pups born in colonies bordering the North Sea. Pup production at Orkney increased year on year by about 8% per annum until 1997. The increase has continued since then, but at a slower rate of 4.6% per annum (Table 4). The grey seal breeding population at the Farne Islands has been managed in the past both by culls of adults in 1972 and 1975 and by small culls of pups born on specific islands up to the present day. Consequently, there has been a highly variable rate of increase at this location. A probable consequence of the management activities at the Farne Islands was the establishment of satellite colonies at the Isle of May, Fast Castle and Donna Nook. The Isle of May and Fast Castle are so close to one another that they are considered here as a single location. Both the Isle of May/Fast Castle and Donna Nook sites have shown relatively rapid annual rates of increase although the increase at the Isle of May/Fast Castle appears to have reduced in recent years. The pup production attributable to locations that are not included in the annual surveys are shown in Table 5. This constitutes about 17% of the total pup production on the UK North Sea coasts.

**Table 4.** The mean annual rate of change in grey seal pup production during 5-year periods from 1987 to 2002.

Years	Orkney	Isle of May & Fast Castle	Farne Islands	Donna Nook	Overall
1987-1992	8.5		1.1	22.7	10.3
1992-1997	7.9	10.2	5.4	13.8	8.1
1997-2002	4.6	4.3	-1.3	13.2	4.4

**Table 5.** Pup production estimates for UK North Sea breeding colonies surveyed less regularly.

Location	Date and location of last survey	Pup production (to nearest 100)
Mainland Scotland & South Ronaldsay	Helmsdale (including Berriedale) 2001 Loch Eriboll, Eilean nan Ron 2002 South Ronaldsay 2002	2800
Shetland	1977	1000
Forth Islands	2002	30

Relatively few grey seal pups are born on German coasts (Table 6). There is a gradual increase in numbers, but note the large interannual fluctuations.

**Table 6.** The number of grey seal pups born at regular German breeding sites in the North Sea, 1988 - 2004.

Season	Junghnamsand (Schleswig-Holstein)	Helgoland	Total
1988/89	9		
1989/90	2		
1990/91	6		
1991/92	5		
1992/93	9		
1993/94	4		
1994/95	3		
1995/96	8		
1996/97	8	1	9
1997/98	9	2-3	~11
1998/99	9	2-3	~11
1999/00	10	5	15
2000/01	11	?	11+
2001/02	21	6	27
2002/03	24	8	32
2003/04	~23	7	~30

## 2.2 Harbour seal

Harbour seals breed more widely around the North Sea than grey seals and BDC 2004 agreed that 15 sections of coast should be used to describe population trends (Table 7). Further details on trends are available for a number of sub-areas (Table 8) and these are detailed in following paragraphs. Harbour seals have been affected by two epizootics in recent years that have caused dramatic declines in numbers, particularly in the southern and eastern North Sea. The results of the first such epizootic (1988-89) are included below, but those of the second (2002-03) are not. Consequently current population sizes will be smaller than those shown here.

**Table 7.** Subunit boundaries for the North Sea seal populations. Superscripts indicate the counting technique.

<b>Harbour seal</b>	
UK	Shetland <sup>1</sup>
	Orkney <sup>1</sup>
	North and East Scotland <sup>1,2,3</sup>
	South-east Scotland <sup>2</sup>
	Greater Wash/Scroby Sands <sup>2</sup>
Netherlands	Delta area <sup>2</sup>
Germany	Schleswig-Holstein Wadden Sea <sup>2</sup>
	Niedersachsen/Hamburg W. Sea <sup>2</sup>
	Helgoland <sup>3</sup>
	Wadden Sea <sup>2</sup>
Denmark	Wadden Sea <sup>2</sup>
	Limfjord <sup>2</sup>
DK + SE	Kattegat <sup>2</sup>
DK, SE + N	Skagerrak & Oslofjord <sup>2</sup>
Norway	

<sup>1</sup> Aerial surveys using thermal imaging

<sup>2</sup> Aerial surveys using oblique photography

<sup>3</sup> Land-based counts

**Table 8.** Current estimates of abundance of harbour seals in the North Sea.

Area	Year	Estimate Hauled out	CI	Total	Trend Years	Estimate
Shetland	2001	4883	na	na		
Orkney	2001	7752	na	na		
North and East Scotland	1997, 2002	1813	na			
South-east Scotland	1997	40	na	na		
Greater Wash	2002	3806		na		
Scroby Sands	2001	75	na	na		
Other UK east coast sites	1994, 2000, 2002	117				
South and west England (estimated)				20		
<b>Total UK North Sea</b>		<b>18506</b>				
Delta area Netherlands	2000	97			1989 2000	+21 %
Wadden Sea, Netherlands	2000	3330			1989 2000	+18.2 %
Wadden Sea Niedersachsen	2002	6481			1989 2000	
Wadden Sea, Schleswig- Holstein	2002	7876			1989 2000	
Wadden Sea Denmark	2000	2140			1989 2000	
<b>Wadden Sea total</b>	<b>2000</b>	<b>18000</b>	<b>na</b>	<b>na</b>	<b>1989–1999</b>	<b>+13 %**</b>
Limfjord east	2000	410		732.1	1998 2000	-46 %
Limfjord west	2000	85		151.8	1998 2000	- 5 %
<b>Limfjord total</b>	<b>2000</b>	<b>495</b>		<b>883.9</b>	<b>1998 2000</b>	<b>-40 %</b>
Kattegat	2000	5814	696	10400	1988-2000	+9.4 %*
Skagerrak	2000	3658	596	6500	1988-2000	+14.2 %
Oslofjord	2000	280	56	500	1988-2000	+12 %
Kattegat-Skagerrak total	2000	9752		17414	1988–2000	
Norwegian west coast	1996–1998	2285	na	na		

\* for the period 1996 2000 the rate of increase was 5.2%

\*\* =6 % for 1998 2000

Harbour seal populations in the UK are monitored using aerial surveys. These take place at the height of the moulting season (August) when the greatest proportion of the population is present on land. Surveys use a thermal imager mounted in a helicopter allowing seals to be identified using a heat trace. There is currently no reliable method for translating the number of seals counted to an estimate of the total population or to an estimate of the productivity of the population. Therefore, these counts represent indices of minimum population size. Costs and logistics also mean that it is only possible to carry out annual surveys of sub-sections of coastline. The objective is to survey the whole of Scotland on a 5-year time cycle. Specific regions, such as the Moray Firth, Firth of Tay and The Wash are surveyed more frequently using fixed-wing aircraft. Time-series of counts for particular locations on the UK coast of the North Sea are presented in Tables 9 and 10 and Figure 1.

Even though these surveys have been conducted regularly they are mostly insufficient in number to allow an estimate of the trend in abundance within a particular area. With the possible exception of The Wash, it is also difficult to interpret trends in abundance in particular regions because of the inherent inaccuracies in the survey methods. However, it is thought that the decline in the abundance of harbour seals in the Moray Firth (Table 9) is real even though it is not currently possible to provide a level of statistical confidence in this conclusion. At present there is no reliable way of relating the current estimates of harbour seal abundance to the total pup production for the species. Therefore, based on the current definition of the EcoQO, these data would not provide the necessary information about trends in pup production.

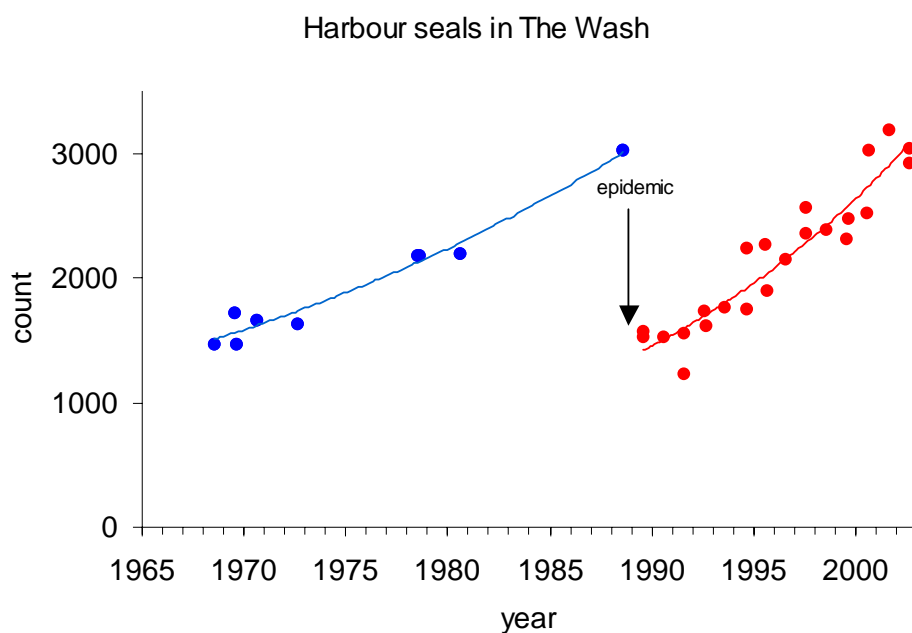
**Table 9.** Numbers of harbour seals in the Inner Moray Firth.

Location	07/08/92	13/8/94	15/8/97	11/8/00	11/8/02
Ardersier	154	221	234	191	110
Beaully Firth	220	203	219	204	66
Cromarty Firth	41	95	95	38	42
Dornoch Firth	662	542	593	405	220
<b>Inner Moray Firth Total</b>	<b>1077</b>	<b>1061</b>	<b>1141</b>	<b>838</b>	<b>438</b>

**Table 10.** Numbers of harbour seals in the Firth of Tay.

Location	13/8/90	11/8/91	07/08/92	13/8/94	13/8/97	12/8/00	11/8/02
Eden Estuary	31	0	0	80	223	267	341
Abertay & Tentsmuir	409	428	456	289	262	153	167
Upper Tay	27	73	148	89	113	115	51
Broughty Ferry		83	97	64	35	52	
Buddon Ness		86	72	53	0	113	109
<b>Firth of Tay Total</b>	<b>467</b>	<b>670</b>	<b>773</b>	<b>575</b>	<b>633</b>	<b>700</b>	<b>668</b>





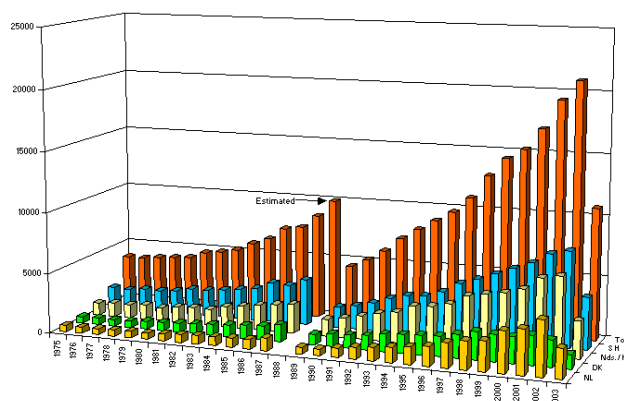
**Figure 1.** Counts of harbour seals in The Wash in August. These data are an index of the population size through time. Fitted lines are exponential growth curves.

Counts of harbour seals in the Wadden Sea are also undertaken by aircraft (Table 11, Figure 2) and a time series is available from 1975 onwards. In 2003, the maximum number of common seals counted during the moult period (August) in the Wadden Sea was around 10,800 animals. A high birth rate of pups was noted in June 2003 leading to an expectation of a quick recovery of the population from the massive decline in 2002 due to the seal epizootic.

**Table 11.** Time series of counts of harbour seals from the Wadden Sea

Year	Netherlands	Nieder- sachsen	Schleswig Holstein	Denmark	Wadden Sea total
1975		1049	1749		3492
1976		1163	1682		3526
1977		1140	1741		3622
1978		1228	1712		3620
1979		1109	1856		3745
1980		1298	2025		4410
1981		1441	2200		4672
1982		1543			5247
1983		1777			5851
1984		1936	3300		6249
1985		2062			6878
1986		2272			7740
1987		2400	3986		8790
1988		2508	4124		9800
1989		1401	1685		4355
1990		1620	1930		5005
1991		1924	2304		5921
1992		2255	2792		6988
1993		2482	3269		8107
1994		3111	3266		8916
1995		3214	3745		9761
1996		3529	4537		11013
1997		4319	5003		12927

Year	Netherlands	Nieder- sachsen	Schleswig Holstein	Denmark	Wadden Sea total
1998		4588	5568		14446
1999		4809	6134		15244
2000		5233	6700		17008
2001		6223	7534		19387
2002		6481	7876		20975
2003	2365	3050	4235	1160	10810



**Figure 2.** Number of harbour seals counted in the Wadden Sea since 1975 (NL = Netherlands; DK = Denmark; Nds/HH = Niedersachsen and Hamburg, SH = Schleswig-Holstein).

### 3. Utilisation of seal breeding sites in the North Sea

#### 3.1 Grey seal

##### 3.1.1 Number of sites

Breeding sites, together with the number of pups born at each site, used by grey seals are listed in Tables 12 and 13 for Orkney and Table 14 for other North Sea colonies. Especially in the case of Orkney, the number of sites where grey seals breed has increased in step with the increasing population size. In a few cases, there have been declines in abundance at some sites (e.g. Ruskholm, Table 12) and at least one site (Wartholm, Table 12) is no longer used by seals. In the rest of the North Sea, the most notable changes in site use have been the establishment of the Isle of May and Fast Castle as breeding sites.

There are a total of 23 breeding sites for grey seals in Orkney, two of which have become established within the past eight years (Table 13). One additional site (South Ronaldsay) is included within the other North Sea sites (Table 14) because it is geographically isolated from the main grouping of Orkney sites. Table 13 shows a total of nine sites for the remainder of the North Sea. However, relatively little is known about the dispersion of grey seal breeding colonies in Shetland and, by the definitions of sites in Orkney, Shetland contains several breeding sites.

**Table 12.** Grey seal pup production estimates for islands in the Orkney group. Estimates were made annually, but 5-year intervals only are shown.

Year	Muckle Green-holm	Little Green-holm	Little Linga	Holm of Spurness	Point of Spurness	Linga-holm	Holm of Huip	Fara-holm	Faray	Rusk-holm	Wart-holm
1960	734	190	239	90	0	0	0	441	0	208	41
1965	671	366	279	138	0	0	0	113	151	247	29
1970	747	318	519	135	45	42	22	171	95	223	4
1975	483	230	483	271	49	39	117	477	65	63	4
1980	496	166	676	415	107	315	275	817	165	336	0
1985	483	191	568	643	0	342	245	796	526	315	0
1990	334	201	625	341	0	807	731	970	1313	179	0
1995	728	300	795	420	0	2128	887	1387	2136	251	0
2000	898	367	704	419	0	2890	1347	1293	2061	191	0
2001	1000	427	723	482	0	3156	1402	1291	2168	239	0
2002	914	373	704	442	0	3125	1190	1252	1955	194	0

Year	Sweynholm & Gairsay	Grass-holm	Swona	Pentland Skerry	Auskerry	Switha	Stroma	Calf of Eday	Copinsay	Stron-say	Total
1960	0	0	2	98	0	0	0	0	0	0	<b>2048</b>
1965	21	66	19	85	0	0	0	0	0	0	<b>2191</b>
1970	13	66	43	85	0	0	0	0	0	0	<b>2535</b>
1975	111	21	59	48	152	0	0	0	0	0	<b>2679</b>
1980	167	74	108	81	97	0	174	0	0	0	<b>4476</b>
1985	115	60	260	82	261	151	161	0	0	0	<b>5199</b>
1990	195	49	351	79	252	206	349	0	0	0	<b>6982</b>
1995	461	32	578	71	125	442	339	274	940	118	<b>12412</b>
2000	482	22	1005	60	54	474	826	456	2082	362	<b>15993</b>
2001	563	26	1077	55	58	441	1091	556	2540	300	<b>17523</b>
2002	486	22	1304	64	85	446	1296	612	2403	301	<b>17168</b>

**Table 13.** Grey seal pup production estimates for new breeding colonies in Orkney

Year	Calf of Flotta	South Fara
1996	78	
1997		
1998	121	
1999	110	92
2000	154	134
2001	250	155
2002	204	226

**Table 14.** Grey seal pup production estimates for other colonies routinely monitored on UK North Sea coasts. In many cases estimates were made annually, but 5-year intervals only are shown.

Year	Farne Islands	Isle of May	Fast Castle	Donna Nook	Helmsdale	Loch Eriboll	Eilean nan Ron, Tongue	Shetland	S. Ronaldsay (Orkney)
1960	1020								123
1965	1404								74
1970	1987			15					103
1975	1617								197
1980	1118	499							140
1985	848	810		53					
1990	1004	1122		152					
1995	1070	1353		334	300	516			250
2000	1171	2133	381	618		670	235		
2001	1247	1932	321	634	676				
2002	1200	1977	532	709		675	275		344

### 3.1.2 Definition of sites

Apart from Shetland, sites are defined here by convenient geographical descriptors. However, these may not represent biologically relevant definitions. For example, several of the sites in Orkney are represented by neighbouring islands and their dynamics are likely to be closely linked. There is increasing evidence that the population dynamics of all grey seal breeding sites are linked to some extent. The strength of the linkage depends upon the distance between the sites and the density of animals at each site. Some sites act as sources and others as sinks for dispersal. However, overall, it appears that the number of sites (based on current definitions) occupied by grey seals is broadly indicative of the changes in the size of the population as indicated by pup production.

### 3.1.3 Harbour seals

Breeding sites for harbour seals are more dispersed than for grey seals. In Norway at least, harbour seals may alter breeding sites slightly between years depending for example, on wind direction. The numbers provided in Tables 9 and 10 for the Moray Firth and the Firth of Tay are likely to be given at a geographical scale that reflects biological sub-populations. Those given in terms of broad regions in Table 7 are likely to be at too large a scale for the purpose of EcoQOs.

## 3.2 Costs

The monitoring of seal populations is not required under any EU or international legislation, but many relevant Parties already undertake this as part of national legislation or policies. Seal monitoring on Special Areas of Conservation set up under the EU Habitats Directive is required and it seems sensible to be able to place such monitoring in context. The minimum frequency of such monitoring is about once every six years. Seal monitoring in the Wadden Sea is undertaken as part of the trilateral monitoring programme. Costs of these programmes are not known. The costs associated with any research or further management needed to help “meet” the EcoQO cannot easily be estimated.

## 4. Discussion

### 4.1 Using trends in grey seal pup production as an EcoQO

Grey seal pup production has several strengths and weaknesses as a potential EcoQO. The strengths include:

- (1) long time series collected at a fine spatial and temporal resolution using a standardized method that will provide the statistical power to detect trends;
- (2) a commitment within the UK and some other Contracting Parties/regions to collect data using consistent and robust methods into the future;
- (3) compared with many other indices, data are relatively easy to collect;

- (4) an active research programme exists that can underpin this index with biologically meaningful interpretations of trends in abundance and
- (5) grey seals forage throughout the North Sea so that this index is likely to integrate environmental variability across a wide range of spatial and temporal scales.

In contrast, the weaknesses include:

- (1) a complex linkage between trends in pup production and trends in the population as a whole;
- (2) uncertainty about the extent to which changes in pup production will be an indicator of environmental events or trends because they could be driven to an extent by internal population dynamics and
- (3) uncertainty about which environmental factors are likely to cause changes in pup production and about which stages in the life histories of grey seals are affected.

Using breeding site usage as an EcoQO has strengths and weaknesses. Its greatest strength is that it is relatively easy to monitor. Its weakness is in the uncertain and variable definition of a site.

## **4.2 Using trends in harbour seal pup production as an EcoQO**

Harbour seal numbers also has certain strengths and weaknesses as a potential EcoQO. The strengths include:

- (1) Regular surveying at specific sites;
- (2) even coverage of survey effort across most of the major concentrations of harbour seals in the North Sea;
- (3) the ability to apply consistent methods of counting across years;
- (4) long time-series of counts are already available in several key areas;
- (5) several research programmes investigating the biology of the species.

Weaknesses include:

- (1) counts provide a measure of relative changes in the population of seals in a region and do not provide an accurate view of the total population using a region;
- (2) counts of pups are not normally included which means that the index of population size will have a low level of sensitivity to factors affecting reproductive rate.

The strengths and weaknesses associated with the use of breeding site as a potential EcoQO are the same as for grey seals, but this species seems more mobile in choice of breeding site between years than that species.