

Provisional Regional PBR values for Scottish seals in 2021

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Abstract

This document estimates PBR values for the grey and harbour seal “populations” that haul out in each of the seven Seal Management Areas in Scotland. Sets of possible values are tabulated for each area using the equation in Wade (1998) with different values of that equation’s recovery factor. A value is suggested for this parameter in each population, the resulting PBR is highlighted, and a rationale is provided for each suggestion. The PBR values are calculated using the latest confirmed counts in each management area.

Changes since last year:

- Recovery factors have been held constant for both species in all management regions.
- The latest harbour seal survey counts for the North coast and Orkney and for the Moray Firth management regions were similar to previous counts and there has been no change in the PBR estimates for those management units.
- The grey seal counts for the North coast and Orkney and the Shetland management regions were approximately 12% and 35% respectively lower than previous estimates. The Moray Firth count was 115% higher than the previous count. These changes result in pro-rata changes in PBRs for grey seals in those management regions.

Introduction

Potential Biological Removal is a widely used way of calculating whether current levels of anthropogenic mortality are consistent with reaching or exceeding a specific target population, chosen to be the Optimum Sustainable Population. It is explicitly given, in an amendment to the US Marine Mammal Protection Act, as the method to be used for assessing anthropogenic impacts in the waters around that country. The method has been supported by simulations demonstrating its performance under certain assumptions (Wade 1998). The formulation of the equation allows for small anthropogenic takes from any population, however much it is depleted or fast it is declining. Scottish Government uses PBR to estimate permissible anthropogenic takes for each of the ten seal management regions and uses this information to assess licence applications for seal control and for other licensable marine activities.

Materials and Methods

The PBR calculation:

$$\text{PBR} = N_{\min} \cdot (R_{\max}/2) \cdot F_R$$

where:

PBR is a number of animals considered safely removable from the population.

N_{min} is a minimum population estimate (usually the 20th percentile of a distribution).

R_{max} is the population growth rate at low densities (by default set 0.12 for pinnipeds), this is halved to give an estimate of the growth rate at higher populations. This estimate should be conservative for most populations at their OSP.

F_R is a recovery factor, usually in the range 0.1 to 1. Low recovery factors give some protection from stochastic effects and overestimation of the other parameters. They also increase the expected equilibrium population size under the PBR.

The approach and calculation is discussed in detail in Wade (1998).

Data used in these calculations:

N_{min} values used in these calculations are from the most recent summer surveys of each area, for both species:

- Harbour seals: The surveys took place during the harbour seal moult, when the majority of this species will be hauled out, so the counts are used directly as values for N_{min} . (An alternative approach, closer to that suggested by Wade (1998), would be to rescale these counts into abundance estimates and take the 20th centile of the resulting distributions. Results of a recent telemetry study in Orkney (Loneragan et al., 2012) suggest that would increase the PBRs by between 8%, if the populations are predominantly female, and 37%, if most of the animals are male.)
- Grey seals: Analysis of telemetry data from 107 grey seals tagged by SMRU between 1998 and 2016 shows that around 23.9% (95% CI: 19.2 - 28.6%) were hauled out during the survey windows (Russell et al. 2016 SCOS-BP 16/03). The 20th centile of the distribution of multipliers from counts to abundances implied by that data is 3.86. This represents a 50% increase over the previous estimates due to a revised estimate of the proportion of time seals spend hauled out and available to be counted during the aerial survey window. This estimate is substantially lower than the estimate used in calculations prior to 2017 and has narrower confidence intervals. In combination these factors have raised the N_{min} value and hence the PBR estimate for any given grey seal count.

R_{max} is set at 0.12, the default value for pinnipeds, since very little information relevant to this parameter is available for Scottish seals. A lower value could be argued for, on the basis that the fastest recorded growth rate for the East Anglian harbour seal population has been below 10% (Loneragan et al. 2007), though that in the Wadden Sea has been consistently growing at slightly over 12% p.a. (Reijnders et al. 2010).

Regional pup production estimates for the UK grey seal population have also had maximum growth rates in the range 5-10% p.a. (Loneragan et al. 2011b). However, the large grey seal population at Sable Island in Canada has grown at nearly 13% p.a. for long periods (Bowen et al. 2003).

F_R needs to be chosen from the range [0.1, 1]. Estimated PBR values for the entire range of F_R values are presented. A recommended F_R value is indicated for each species in each region, together with a justification for the recommended value.

Areas used in the calculations:

Figure 1 and Table 1 shows the boundaries of the Seal Management Areas.

Particularly for grey seals, there will probably be substantial movement of animals between these areas. The division is a pragmatic compromise that attempts to balance current biological knowledge,

distances between major haul-outs, environmental conditions, the spatial structure of existing data, practical constraints on future data collection and management requirements

Rationale for the suggested recovery factors

The original PBR methodology leaves the setting of the recovery factor as a subjective choice for managers. Factors such as the amount of information available about the population (and in particular its maximum annual growth rate), recent trends in local abundance, and the connections to neighbouring populations are relevant to setting this. The main factors affecting the value suggested for each species in each area are given below:

Harbour seals

1) Shetland, Orkney + North Coast, and Eastern Scotland ($F_R = 0.1$)

F_R set to minimum because populations are experiencing prolonged declines and have not shown any signs of recovery.

2) Western Isles ($F_R = 0.5$)

Population was apparently undergoing a protracted but gradual decline during the 2000s, but the 2011 count was close to the pre-decline numbers and a trend analysis suggested no significant change since 1992. The population is only partly closed being close to the relatively much larger population in the Western Scotland region, and the R_{max} parameter is derived from other seal populations. The most recent count for the Western Isles was 25% higher than the previous count. On that basis there may be an argument for increasing the recovery factor to bring it in line with the other western Scottish management areas. However, there is an existing conservation order in place for the management unit and it is therefore recommended that the recovery factor is left at 0.5 and reviewed again when a new count is available for the larger, adjacent West Scotland region.

3) West Scotland ($F_R = 1.0$)

The population is largely closed, likely to have limited interchange with much smaller adjacent populations. The most recent count was the highest ever recorded and the population is apparently stable or increasing.

4) South West Scotland ($F_R = 0.7$)

The population is apparently stable, is closed to the south and the adjacent population to the north is apparently stable or increasing. The intrinsic population growth rate is taken from other similar populations.

5) Moray Firth ($F_R = 0.1$)

Counts for 2019 in the Moray Firth were similar to the previous 5 years, confirming the absence of any overall trend over the past 15 years. The neighbouring Orkney and Tay populations are continuing to undergo unexplained, rapid and catastrophic declines in abundance. Data available from tracking studies suggest there is movement between these three areas. In the absence of a sustained increase in the Moray Firth counts it is recommended that the F_R should be left at its previously recommended value of 0.1.

Grey seals

All regions ($F_R = 1.0$)

There has been sustained growth in the numbers of pups born in all areas over the last 30 years. All UK populations are either increasing or apparently stable at the maximum levels ever recorded and therefore assumed to be at or close to their carrying capacities (Lonergan et al., 2011b; Thomas et

al., 2019; Russell et al., 2019). Available telemetry data and the differences in the regional patterns of pup production and summer haul-out counts (Lonergan et al. 2011a) also suggest substantial long-distance movements of individuals.

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Table 1: Boundaries of the Seal Management Areas in Scotland.

| Seal Management Area | Area Covered |
|------------------------|---|
| 1 Southwest Scotland | English border to Mull of Kintyre |
| 2 West Scotland | Mull of Kintyre to Cape Wrath |
| 3 Western Isles | Western Isles incl. Flannan Isles, North Rona |
| 4 North Coast & Orkney | North mainland coast & Orkney |
| 5 Shetland | Shetland incl. Foula & Fair Isle |
| 6 Moray Firth | Duncansby Head to Fraserburgh |
| 7 East Scotland | Fraserburgh to English border |

Results

PBR values for grey and harbour seals for each Seal Management Area for with the full range of F_R values from 0.1 to 1.0 are given in table 1 for harbour seals and table 2 for grey seals. In each table the value corresponding to the recommended F_R is highlighted

Table 1. Potential Biological Removal (PBR) values for harbour seals in Scotland by Seal Management Unit for the year 2021. Recommended F_R values are highlighted in grey cells.

| Seal Management Area | 2016-2019 | | PBRs based on recovery factors F_R ranging from 0.1 to 1.0 | | | | | | | | | | selected | |
|------------------------|-----------|-----------|--|-----|-----|-----|-----|-----|------|------|------|------|----------|------|
| | count | N_{min} | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | F_R | PBR |
| 1 Southwest Scotland | 1709 | 1709 | 10 | 20 | 30 | 41 | 51 | 61 | 71 | 82 | 92 | 102 | 0.7 | 71 |
| 2 West Scotland | 15600 | 15600 | 93 | 187 | 280 | 374 | 468 | 561 | 655 | 748 | 842 | 936 | 1.0 | 936 |
| 3 Western Isles | 3532 | 3532 | 21 | 42 | 63 | 84 | 105 | 127 | 148 | 169 | 190 | 211 | 0.5 | 105 |
| 4 North Coast & Orkney | 1405 | 1405 | 8 | 16 | 25 | 33 | 42 | 50 | 59 | 67 | 75 | 84 | 0.1 | 8 |
| 5 Shetland | 3180 | 3180 | 19 | 38 | 57 | 76 | 95 | 114 | 133 | 152 | 171 | 190 | 0.1 | 19 |
| 6 Moray Firth | 1077 | 1077 | 6 | 12 | 19 | 25 | 32 | 38 | 45 | 51 | 58 | 64 | 0.1 | 6 |
| 7 East Scotland | 343 | 343 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 0.1 | 2 |
| SCOTLAND TOTAL | 26846 | 26846 | 159 | 319 | 480 | 641 | 803 | 963 | 1125 | 1285 | 1446 | 1607 | | 1147 |

Table 2. Potential Biological Removal (PBR) values for grey seals in Scotland by Seal Management Unit for the year 2021. Recommended F_R values are highlighted in grey cells.

| Seal Management Area | 2016-2019 | | PBRs based on recovery factors F_R ranging from 0.1 to 1.0 | | | | | | | | | | selected | |
|------------------------|--------------|--------------|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------|-------------|
| | count | Nmin | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | FR | PBR |
| 1 Southwest Scotland | 517 | 1995 | 11 | 23 | 35 | 47 | 59 | 71 | 83 | 95 | 107 | 119 | 1.0 | 119 |
| 2 West Scotland | 4174 | 16111 | 96 | 193 | 289 | 386 | 483 | 579 | 676 | 773 | 869 | 966 | 1.0 | 966 |
| 3 Western Isles | 5773 | 22283 | 133 | 267 | 401 | 534 | 668 | 802 | 935 | 1069 | 1203 | 1336 | 1.0 | 1336 |
| 4 North Coast & Orkney | 8599 | 33192 | 199 | 398 | 597 | 796 | 995 | 1194 | 1394 | 1593 | 1792 | 1991 | 1.0 | 1991 |
| 5 Shetland | 1009 | 3894 | 23 | 46 | 70 | 93 | 116 | 140 | 163 | 186 | 210 | 233 | 1.0 | 233 |
| 6 Moray Firth | 1657 | 6396 | 38 | 76 | 115 | 153 | 191 | 230 | 268 | 307 | 345 | 383 | 1.0 | 383 |
| 7 East Scotland | 3683 | 14216 | 85 | 170 | 255 | 341 | 426 | 511 | 597 | 682 | 767 | 852 | 1.0 | 852 |
| SCOTLAND TOTAL | 25412 | 98087 | 585 | 1173 | 1762 | 2350 | 2938 | 3527 | 4116 | 4705 | 5293 | 5880 | | 5880 |

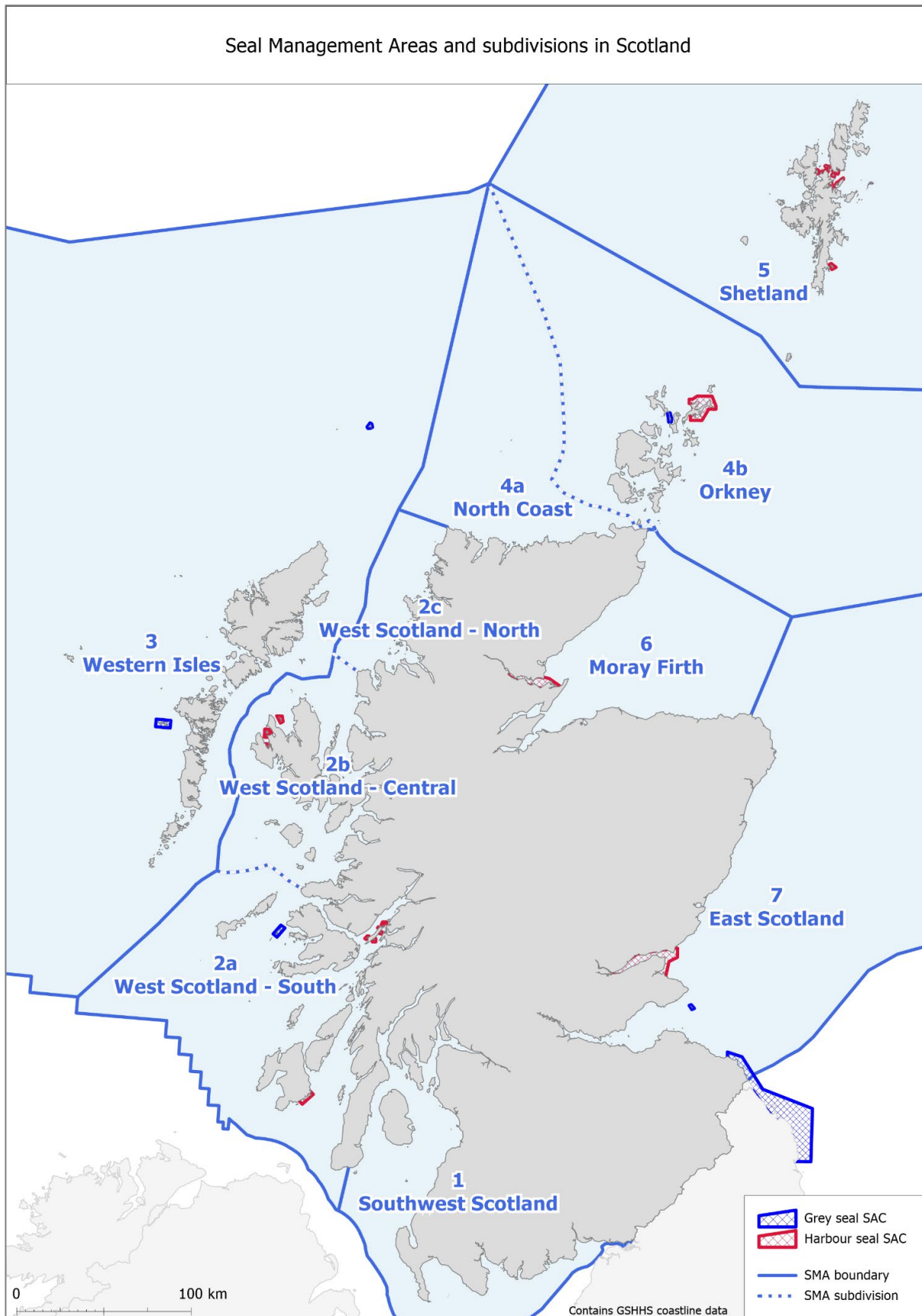


Figure 1. Seal management areas in Scotland. For purposes of PBR calculations West Scotland is