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# Marine Scotland

## Grey and harbour seal diet composition and prey consumption in the west of Scotland 2010/11

Supporting paper

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This paper provides additional information to support the results presented in the research reports on grey and harbour seal diet composition and prey consumption around Scotland. In particular, the paper provides an overview of how the seal diet results were calculated and how the annual seal consumption estimates relate to the estimated cod stock size assessed by ICES in Division VIa (West of Scotland).

Key points:

- Diet estimates indicate that grey seals are consuming a large proportion of the cod stock off the west coast of Scotland;
- Grey seals largely forage in areas that are not suitable for fishing and are not included in the stock assessment;
- The cod stock assessment is based on catches, discards and survey data.

## **1. Harbour and grey seal diet composition and prey consumption**

Information needed to establish the diet of harbour (*Phoca vitulina*) and grey seals (*Halichoerus grypus*) involves an assessment of which fish species are taken and how much fish is consumed. Direct observation of seal diet is not possible, but a robust method for the assessment of diet is the analysis of the remains of fish and other hard prey recovered from seal scats. As part of this project, scats were collected on a quarterly basis for one year in 2010/11 from haul-out sites around Scotland. Fish otoliths and cephalopod beaks (e.g., squid, octopus) recovered from these scats were identified and measured, corrected for erosion due to the digestive process using well established methods, and the data used to estimate the contribution of each prey species to the diet as a proportion of the total estimated weight consumed.

Diet composition was estimated regionally (Inner Hebrides, Outer Hebrides, Shetland, Orkney and northern North Sea, central North Sea) and seasonally. Diet composition results were used to estimate the amount consumed of each prey species, assuming that grey seals, on average, met their estimated energy requirements. Annual consumption estimates were compared with the estimated size of stocks assessed by ICES Subarea IV (North Sea) and Division VIa (west of Scotland). Diet results for 2010/11 were compared with those previously presented for grey seal diet 1985 and 2002.

Statistical uncertainty in the estimates of diet composition and consumption exists due to a number of factors (e.g., sample size, percentage and size of prey consumed, regional vs. annual estimates), therefore estimated confidence intervals

are wide for most species in most seasons and regions. In the case of cod, estimates of the total consumption by seals are more precise than most other estimates but still have considerable uncertainty. For harbour and grey seal predation on cod to the west of Scotland, the estimated consumption of cod (in tonnes) and the 95% confidence intervals can be found in Table 1.

Table 1. Estimates of prey consumption and 95% confidence intervals for cod in ICES Division VIa (west of Scotland) in the 12 months from April 2010 to March 2011.

	Estimated prey consumption of cod (tonnes)	95% confidence intervals of estimated prey consumption for cod (tonnes)	
		Lower	Upper
Grey seals	7,632	3,542	13,937
Harbour seals	2,857	1,712	4,093

Although a possible contributing cause of these high consumption figures could be biases unaccounted for in diet analysis, such biases have been carefully considered and are believed to be small relative to the statistical uncertainty represented by the 95% confidence intervals.

When considering these results, it is important to note that grey seal population size and, therefore, overall predation has not increased west of Scotland since the last assessment in 2002; in fact, estimated consumption of cod has dropped slightly from 8,824 to 7,632 tonnes. It is the reduction in estimated Total Stock Biomass (TSB) for cod from 11,461 tonnes in 2002 to 4,228 tonnes in 2010 (and the inclusion of estimates of harbour seal consumption for the first time) that has caused cod consumption by seals as a simple percentage of TSB to increase markedly.

## 2. Cod stock assessment.

Total Stock Biomass (TSB) estimates for cod in Division VIa (west of Scotland) is generated by ICES as part of the annual assessment round. The assessment is conducted using a model called **TSA (Time-Series Analysis)**, which estimates the most likely stock biomass for cod in the area. The model is based partly on data on catches (landings and discards), 90% of which are currently taken from an area that is almost exclusively around the continental shelf edge, and partly on research-vessel survey data which excludes a substantial untrawlable area to the west of Lewis (the seabed in this area is extremely rocky). In contrast, the areas predicted to be used for foraging by grey and harbour seals, as determined from telemetry (tagging) data, are almost exclusively on the continental shelf in areas which are not

covered by the stock assessment. Between the area where 90% of the cod are taken by fisheries and the seal foraging areas (Figure 1) there is only a very small overlap for grey seals and no overlap for harbour seals. Furthermore, the survey does not cover well the area used by seals. Thus, the seals and the fishery remove cod from largely different areas and the estimated stock biomass relates primarily to the area where there are no seals.

Knowledge of the extent of the cod population estimated by the stock assessment and of the movements of cod found off the shelf (seasonal or otherwise) is incomplete, although there is genetic evidence for more than a single population including some coastal sub-populations. Components of the west coast cod population(s) may be targeted by both the fishery and the seals. However, the high spatial separation of the fishery and areas heavily used by seals for foraging is at least a partial explanation for how the estimated consumption by seals can be so large relative to the size of the assessed stock.

In conclusion, it is therefore highly likely that TSB estimated by the assessment is an underestimate of the total amount of cod present in Division VIa and that seals are mostly preying on cod in areas where they are not available to the fishery. This is currently only a hypothesis as data on cod abundance are not currently available from the untrawlable area to enable a more comprehensive assessment. That area therefore does represent a gap in our knowledge. To address this gap, Marine Scotland Science are running a pilot project looking at camera coverage of creelers, but this will take some time to yield useful data.

### **3. Implications of the report's findings for commercial fish stocks, especially cod to the West of Scotland**

Whether or not seals may limit the ability of some declining commercial fish stocks, including cod, to recover cannot be answered by this report alone. Simple comparisons between estimates of seal consumption of prey and estimates of fish stocks does not take into account the complexity of the ecosystem and other sources of fish mortality including other predators and fisheries.

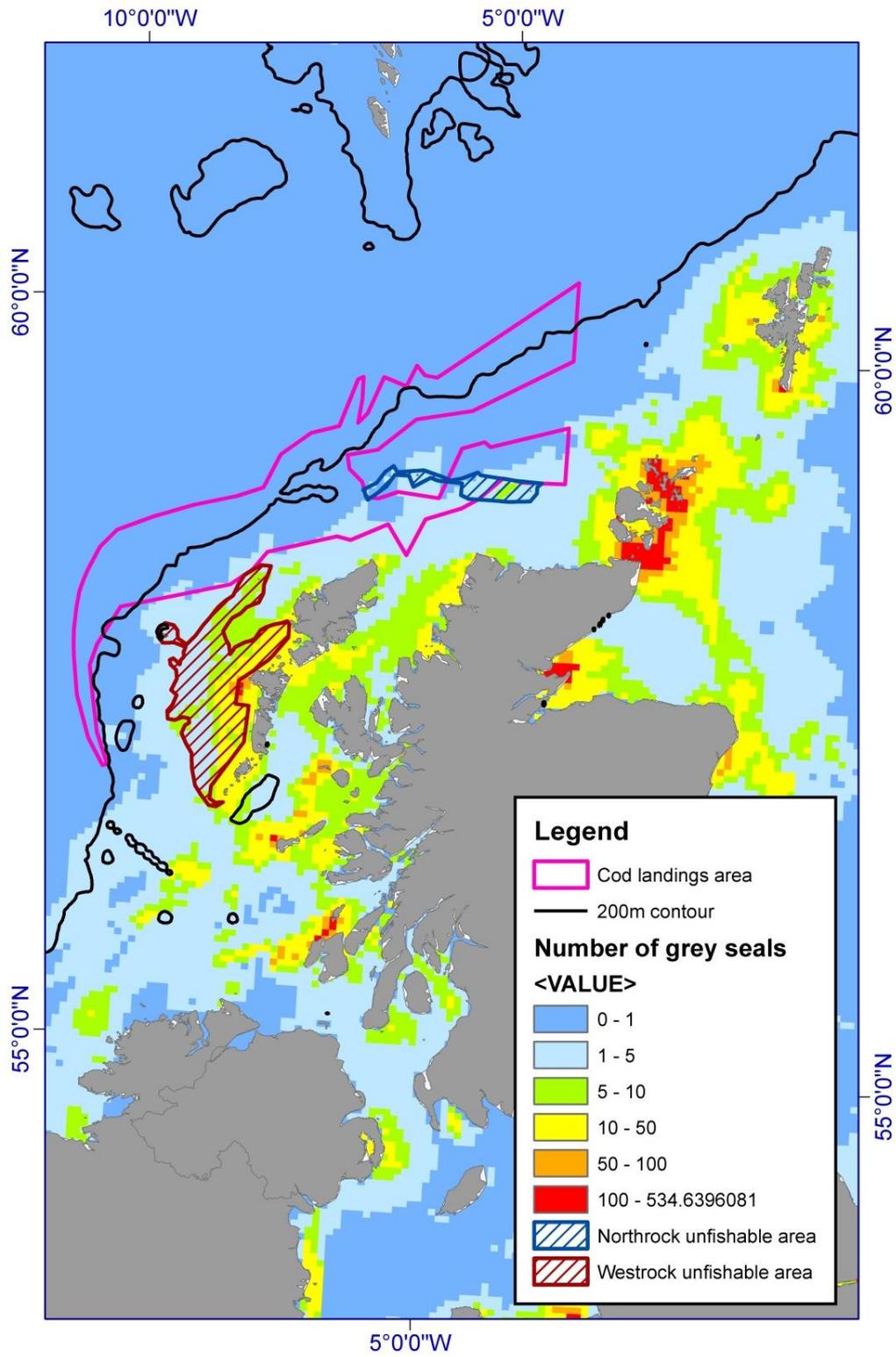


Figure 1. Map showing where 90% of the cod are taken by fisheries overlaid on the grey seal foraging areas. The number of grey seals is the estimated number in each 5 x 5 km grid square.



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