Biological Conservation 150 (2012) 136–142

Contents lists available at SciVerse ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

# Evidence of low spatial overlap between grey seals and a specific whitefish fishery off the west coast of Ireland

M.A. Cronin [a,*], H.D. Gerritsen [b], D.G. Reid [b]

[a] Coastal and Marine Research Centre, University College Cork, Naval Base, Haulbowline, Cobh, Co. Cork, Ireland
[b] Marine Institute, Rinville, Oranmore, Co. Galway, Ireland

ARTICLE INFO

*Article history:*
Received 26 September 2011
Received in revised form 13 February 2012
Accepted 15 February 2012
Available online 5 May 2012

*Keywords:*
Competition
Fastloc GPS
Habitat use
Pinnipeds
Telemetry
VMS

ABSTRACT

Competition between seals and man for valuable fish resources is a long-standing contentious issue and of concern with fish stocks in global decline. Estimating resource overlap between seals and fisheries is difficult and generally achieved by comparing seal consumption with fisheries catches and stock size; however spatial partitioning may mean that marine mammals and fisheries are not actually depleting the same local stocks. With the relatively recent availability of fine scale fishing effort data from Vessel Monitoring System (VMS) it is now possible to study the spatial overlap between fisheries and predators in more detail. We used VMS and fast acquisition GPS to compare the distribution of fisheries and seals in Irish waters on the same spatial and temporal scales to quantify overlap. Our findings suggest a significantly low rate of spatial overlap between a sample of female grey seals (*Halichoerus grypus*) and the offshore whitefish fishery on the Irish continental shelf, suggesting direct competition for the resource may be far less than expected, if the sample is representative. Seal/fisheries interactions in Irish waters could therefore be more of an issue at the operational and individual level suggesting population control measures such as culling will be ineffective and therefore unjustifiable. The approach could be applied elsewhere to examine spatial overlap of humans and key marine species such as turtles, seals and seabirds, providing critical data for the development of mitigation measures which will ultimately contribute to the conservation of these species, many of which are fundamental for healthy ecosystem functioning.


## 1. Introduction

Seals and humans are both top predators in many marine ecosystems, often targeting the same food resource. With global declines in fish stocks (Worm et al., 2009) their interactions are arousing considerable interest, among scientists, fishers and NGOs. Cod stocks have declined markedly off the west coast of Scotland and are now considered to be at an all time low, whilst the estimated consumption by grey seals has increased (Hammond and Harris, 2006). The concerns of the Irish fishing industry about the impact of seals on fisheries were highlighted recently at the European Committee for Fisheries (Cronin et al., 2010). Both seal species in Ireland, the grey seal and harbour seal (*Phoca vitulina vitulina*), are listed as Annex II species under the 1992 European Union's Habitats Directive (92/43/EC) and the European Communities (Natural Habitats) Regulations (1997) which affords strict protection to both species and habitats within the Irish Exclusive Fisheries Zone (EFZ). With frequent calls for seal culls made by a fishing industry (Cronin et al., 2010) struggling with dwindling fish stocks and decreased quotas (Marine Institute, 2011), the interests of conservationists, resource managers, industry and policy makers conflict and the situation urgently needs addressing.

Interactions between seals and fisheries could be operational and/or biological. Operational interaction would be in terms of interference e.g. marine mammals taking fish out of nets. Biological interactions imply competition for resources, either directly or indirectly via the wider food web (Abrams et al., 1996; Northridge and Hoffman, 1999). Research to date on seal and fisheries interactions in Ireland has dealt with operational interactions because competition at the ecosystem level is much more difficult to study and quantify as the extent of the shared resource overlap must be determined. Traditionally, resource overlap has been assessed by combining estimates of marine mammal energy requirements with empirically determined estimates of their diet composition and the energy content of the prey (e.g. Trites et al., 1997; Boyd, 2002). However quantifying competition by simply comparing predator consumption and fisheries catches is likely to be misleading and spatial partitioning may mean that marine mammals and fisheries are not actually depleting the same local stocks (Matthiopoulos et al., 2008). With advances in telemetry technologies it is now possible to track marine predators at sea for extended periods and relate their distribution to that of the resource (Reid et al., 2004;

* Corresponding author. Tel.: +353 0214703114; fax: +353 021703132.
*E-mail addresses:* michelle.cronin@ucc.ie (M.A. Cronin), hgerritsen@marine.ie (H.D. Gerritsen), dreid@marine.ie (D.G. Reid).

0006-3207/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biocon.2012.02.013

Pichegru et al., 2009). Emerging research in this area focuses on comparing predator and resource overlap. However, it is difficult to obtain spatially and temporally discrete resource (i.e. fish stock) distribution data. The main source for fish distribution data is from stock assessment surveys. These are commonly conducted once a year, and often target only part of the fish assemblage e.g. in bottom trawl surveys. Spatially and temporally explicit data is, however, available for fishing activity from VMS (Vessel Monitoring System). Using this we have the potential to study the spatial and temporal overlap between fisheries and predators in detail, and to examine whether overlap in space and time can be interpreted in terms of resource exploitation overlap. Historically this was not possible due to the low resolution data available for fishing effort (based on ICES statistical rectangles). Since January 2005, VMS data has been collected for all fishing vessels >15 m in European waters, and this can provide much higher resolution data. The general application of VMS to scientific research has been delayed by data security issues, but this has not prevented analytical approaches being developed (Lees et al., 2010; Gerritsen and Lordan, 2011). VMS data were recently used for the first time to relate fishing effort to cetacean distribution in the North Sea (Herr et al., 2009). Recent advances in telemetry technologies have also provided a means to evaluate seal at-sea distribution and habitat use more accurately. A long-standing Achilles heel for marine studies was that, for animals that surface only briefly (e.g. seals) there was insufficient time to generate GPS locations (Rutz and Hays, 2009). A novel fast tracking GPS system allowing rapid acquisition of GPS ephemeris, which can be relayed remotely via mobile-phone networks, provides opportunities to track marine animals for extended time periods and to assess fine scale patterns of space use. These tags provide very similar resolution positional data for seals as VMS does for fishing boats. Using these two sources of information we set out to examine the use of space by grey seals off the west coast of Ireland, and how that use related to the spatial pattern of the fishing vessels. The study focused on seals from a colony of national importance on the southwest coast of Ireland, being the second largest breeding and moult colony (Ó Cadhla and Strong, 2007; Ó Cadhla et al., 2007), and the most significant fishery on the western Irish seaboard in terms of effort and landings, accounting for 70% of the total Irish fishing effort off the west coast and 77% of the landings of demersal species. This fishery targets mixed whitefish (monkfish *Lophius piscatorius* and *Lophius budegassa*, hake *Merluccius merluccius*, megrim *Lepidorhombus whiffiagonis* and *Lepidorhombus boscii*, haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus*) and *Nephrops* on the Irish continental shelf.

## 2. Methods

### 2.1. Seal capture and tag deployment

Capture of grey seals and deployment of Fastloc/GSM tags was carried out at haul-out sites on the Trá Bán on the Great Blasket Island, in Co. Kerry, southwest Ireland (52°06′26N 10°30′43W) in February 2009. Up to 1000 grey seals occur at the capture site on the Great Blasket Island during the moult period between December and April each year, almost 20% of the national moult population estimate (Ó Cadhla and Strong, 2007). The tags were glued to the animals' fur and therefore tagging was conducted in late February to coincide with the completion of the female moult and to maximise the period of tag attachment. Due to sex-related differences in the timing of the grey seal moult and the significant efforts required to capture seals at an offshore exposed site, tagging efforts focused on females only.

Seals were captured at the haul-out site using hoop nets. These consisted of a 1 m diameter hoop made of 20 mm plastic hosing and a funnel net of 10 mm mesh attached. Researchers approached the haul-out site by sea using high speed zodiac boats. The direction and speed of approach was designed to maximise the likelihood of landing researchers ashore before the seals entered the water. Adult female seals were selected and individuals captured in hoop nets. The captured seals remained in the hoop nets throughout the administration of the anaesthetic and prior to the tagging procedure. Seals were weighed to the nearest 0.1 kg and anaesthetised using 0.05 ml of Zoletil (© Virbac) per 10 kg delivered intravenously. If intravenous administration of the anaesthetic proved difficult (as with a struggling animal) an intramuscular dose of 0.1 ml of Zoletil per 10 kg was delivered instead. Length (from nose to end of tail) and girth (immediately posterior to the fore-flippers) of the animal were measured to the nearest cm. The fur was dried with paper towels and degreased using acetone and the tag was secured in place using fast setting epoxy resin at the base of the skull (Fig. 1). All seal handling and tagging procedures were conducted under NPWS License No. C35/2008.

Tags incorporate a Fastloc GPS system (Wildtrack Telemetry Systems, Leeds) which captures GPS pseudo-range data that are compressed into 30 byte records and post-processed with archived orbitography data to calculate location. The significant advantage of this system is that the required data capture requires less than half a second at the surface enabling frequent and relatively accurate positions being acquired at sea (up to 26 m accuracy, depending on number of satellites available (Hazel, 2009)). The tags are programmed to attempt a location fix every 30 min but will only successfully do so if this coincides with the animal being at the surface. When the seal comes within range of the coastal GSM zone, after a period of perhaps days, weeks or even months offshore, the records are sent ashore via a data link call (Cronin and McConnell, 2008).

### 2.2. Estimating fishing effort

Since 1 January 2005, all EC fishing vessels exceeding 15 m in overall length have been required to transmit their position at least every 2 h (EC, 2003). Data were used from Irish Registered vessels, fishing with otter bottom trawls (this is the dominant gear type used in the study area) during the same time period that the tagged seals were observed (February–December 2009). The fishing effort associated with each VMS ping was defined as the time interval since the previous record (generally 2 h). Speed criteria were applied to remove all records where the vessels were inactive or steaming; only vessels moving at instantaneous speeds between 1.5 and 4.5 kn were considered to be fishing. Gerritsen and Lordan (2011) estimated that these speed criteria identified vessel activity

**Fig. 1.** A female grey seal tagged with a Fastloc GPS/GSM tag on the Great Blasket Island, Co Kerry, Ireland in February 2009.