Marine Mammals and Salmon Bag-Nets

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R.N. Harris

Seal and Salmon Research Project

Sea Mammal Research Unit,

Scottish Oceans Institute,

University of St Andrews,

St Andrews, KY16 8LB

Contents

Executive Summary

This document reports the findings of observations of marine mammals at salmon bag-nets near Montrose, off the coast of Angus, during the salmon net seasons between 2009 and 2011. Sightings of seals, dolphins and harbour porpoise at nets, prey capture events by seals and dolphins, and the identification of individual seals are reported and discussed. To place these findings in context, we refer to observations carried out in the Moray Firth in 2009 and 2010 during Acoustic Deterrent Device (ADD) trials (Harris 2011; Harris *et al.* 2014) and SMRU observations at Boddin bag-net site in 1982 (SMRU 1983). We also report on the diet of dead seals recovered from salmon net sites between 2005 and 2010.

We used photo-identification of seals to study the number of individual seals that visited nets. The duration of seal visits provided a level of seal activity at each site. We found considerable temporal and spatial variation in the activity of seals at salmon bag-nets, some of which may be explained by the status of different salmonid stocks and the presence of other marine mammals. The rate at which 'new' seals (previously unidentified through photo-identification) were identified at nets was higher at Moray Firth sites compared with Montrose sites. It was not possible to say how past or present levels of lethal control might have affected encounter rates. However fishermen anecdotally remarked that the level of shooting at these sites was low. Overall grey seal activity at both Moray Firth and Montrose sites peaked in 2010 coinciding with an increase in the numbers of grilse returning to rivers in that year (www.scotland.gov.uk[1]). The observed grey seal activity levels were primarily driven by known seals habitually returning to salmon nets. Harbour seal activity at nets was generally low, especially at Moray Firth sites.

The level of dolphin activity at nets in May and June may also be linked to fluctuations in different salmonid stocks. Observations of dolphins interacting with nets and swimming away with 'small' salmonids suggested that dolphins were able to depredate small salmonids (possibly sea trout) from nets (Appendix A. Figures 1A, 2A, 3A). Bottlenose dolphins regularly visited nets near Montrose during May and June each year, a time when net catches of sea trout are at their highest (Usan Salmon Ltd. per. coms.). Seals were observed leaving nets as dolphins approached suggesting that bottlenose dolphin presence affected seal activity at the Montrose nets. Interestingly grey seal activity at the Montrose nets in May and June was low or absent. Bottlenose dolphin activity was often low or absent during July and August when grey seal activity at times was high. Observational effort to allow comparison with data from 1982 was low. Results from both studies suggested that seal activity at the Boddin site was generally low in both the 1982 and the present study. Interestingly, no dolphins were present at Boddin in 1982 and seal activity peaked in June whereas it was at its lowest level at Boddin in the present study. The average hourly harbour porpoise sightings rate at Boddin also declined from 0.14 in 1982 to 0.05 in the present study. It is not possible to say if the increase in dolphin activity at this site contributed to the decrease in porpoise activity.

Sixteen seal carcases were examined between 2005 and 2010 to assess the diet of seals shot at salmon nets. Qualitative assessments were made by both the identification of pink flesh (associated with migratory salmonid prey) and using molecular techniques to determine the presence of salmon and trout DNA. The presence of otoliths (fish) and beaks (cephalopods) provided a quantitative assessment of the size and number of prey consumed. No sea trout was detected in any sample and,

[1] These data can be requested from Marine Scotland Science at ms.catchform@scotland.gsi.gov.uk

interestingly, no salmon was detected from seals that were killed inside salmon nets (n=8). Three out of the 16 seals examined did contain salmonid prey (19%). Whitefish and flatfish were encountered most frequently. The proportion of seals that contained salmonid prey and the prevalence of other prey were consistent with results from previous seal diet studies from salmon bag-nets in Scotland. We discuss two forms of sampling bias and suggest that both past and present diet studies of seals taken from salmon bag-nets are unlikely to be representative of those seals that habitually return to nets.

Although the diet studies provided little information to support the existence of net specialist seals, this was in contrast to information gathered from observations at salmon bag-nets, supporting the (possible) existence of net specialist seals. This apparent mismatch in the results from the diet study and the observations is of interest and the study of seal digestive tracts from seals shot to protect fisheries is continuing. Something to be considered is the uneven distribution of shooting effort, which may in part be due to access difficulties at some nets. This may be contributing to the longevity of particular problem seals, especially if individual seals rarely visit sites where shooting effort is concentrated. In addition, certain seals may simply surface out of range of land-based marksmen or possess other behavioural traits that make them harder to shoot (Appendix A. Figure 8A).

As discussed previously the study of seal digestive tracts is continuing. The progress highlighted in this report has also been continued and built upon through the evaluation of non-lethal mitigation methods such as acoustic seal deterrents and the trialling of modifications made to salmon nets in attempts to reduce seal depredation.

Summary of the main findings:

- Seal activity at Montrose nets in both 1982 and the present study was generally low compared with results from the Moray Firth. Understanding why these differences occur will improve our ability to mitigation the effects of seals;
- Observations suggested the existence of net specialist seals in direct contrast to information from past and present diet studies of seals shot at salmon net sites;
- The number of 'net specialist' seals was low. They returned each year and their presence at nets contributed to the majority of seal sightings at nets;
- Peaks in marine mammal activity at nets coincided with peaks in relative salmonid abundance;
- Observations of seals leaving salmon net sites when dolphins approached suggests that the use of dolphin vocalisations might warrant investigation as part of an acoustic deterrent trial;
- Particular net sites appeared to be more 'attractive' to net specialist seals than others. Identifying the reasons why specific nets appear more attractive to seals, whether due to shooting effort, net modifications or the number of fish caught by particular nets is of interest and may improve our understanding;
- The identification of different methods by which seals damage and remove salmon from bag nets will help to develop mitigation measures. Observations during these field studies has

increased awareness of the range of ways in which seals intercept fish and damage/remove fish from within nets. These observations stress the need not only to produce a seal safe inner chamber but also reduce the time salmon spend at leaders or in the outer chambers of the net. Reducing leader lengths and the size/structure of the outer chambers may warrant trialling in an attempt to reduce the bottleneck effect that aids depredation.

2 Observations at salmon bag-nets near Montrose and in the Moray Firth

2.1 Introduction

Salmon net fishermen have long held the belief that seals adversely affect their livelihoods by damaging and removing fish from their nets. Licences may be obtained from Marine Scotland to allow nominated marksmen to lethally remove seals that are causing damage to catches. Despite a long history of lethal control at salmon net sites, seals are still perceived to be a significant problem by net fishermen (Butler et al. 2011). The majority of salmon net fishermen who responded to a questionnaire in the Moray Firth (Butler et al. 2011) and from other east coast bag-net sites (Harris unpublished data), believed that seal predation had a significant effect on salmon and sea trout stocks and net catches. They also felt that all seals were responsible for damage, although some felt that specialist ‘rogue’ seals were also a problem. Furthermore, most felt that seal predation should be controlled by a reduction in the size of seal populations (Butler et al. 2011).

In 1983, SMRU published an extensive study on seal interactions at Scottish salmon bag-nets that looked at many aspects of the conflict between seals and salmon bag-net fisheries and included observations of east coast nets in 1981 and 1982 (SMRU 1983). The resulting report produced some interesting findings relevant to this study:

- The considerable difference that existed between the size / sex ratio of seals shot by the industry and the size / sex ratio of seals seen at nets by SMRU observers.
- In 1982 observations were made at two net sites near Montrose where grey seal activity was found to be higher than previously observed at net sites at Macduff and Cruden Bay in 1981.
- In general, seal activity was highest between February and April, when seals were seen feeding predominantly on lumpsucker, whereas between May and August seals were seen feeding predominantly on salmonid prey.
- At all sites harbour seals were absent or rarely seen.

The decline of the industry since the 1980’s has meant that many net sites are no longer active, and of those sites visited in 1981 and 1982, only one site (Boddin near Montrose) remains active although fishing occurs over a reduced season.

2.2 Methods

Salmon bag-nets near Montrose were fished from 1st May to 31st August between 2009 and 2011. Nets in the Moray Firth were fished during July and August in 2009 and 2010. Observations were made at five bag-net sites (Figure 1); these were not chosen at random and are listed below.

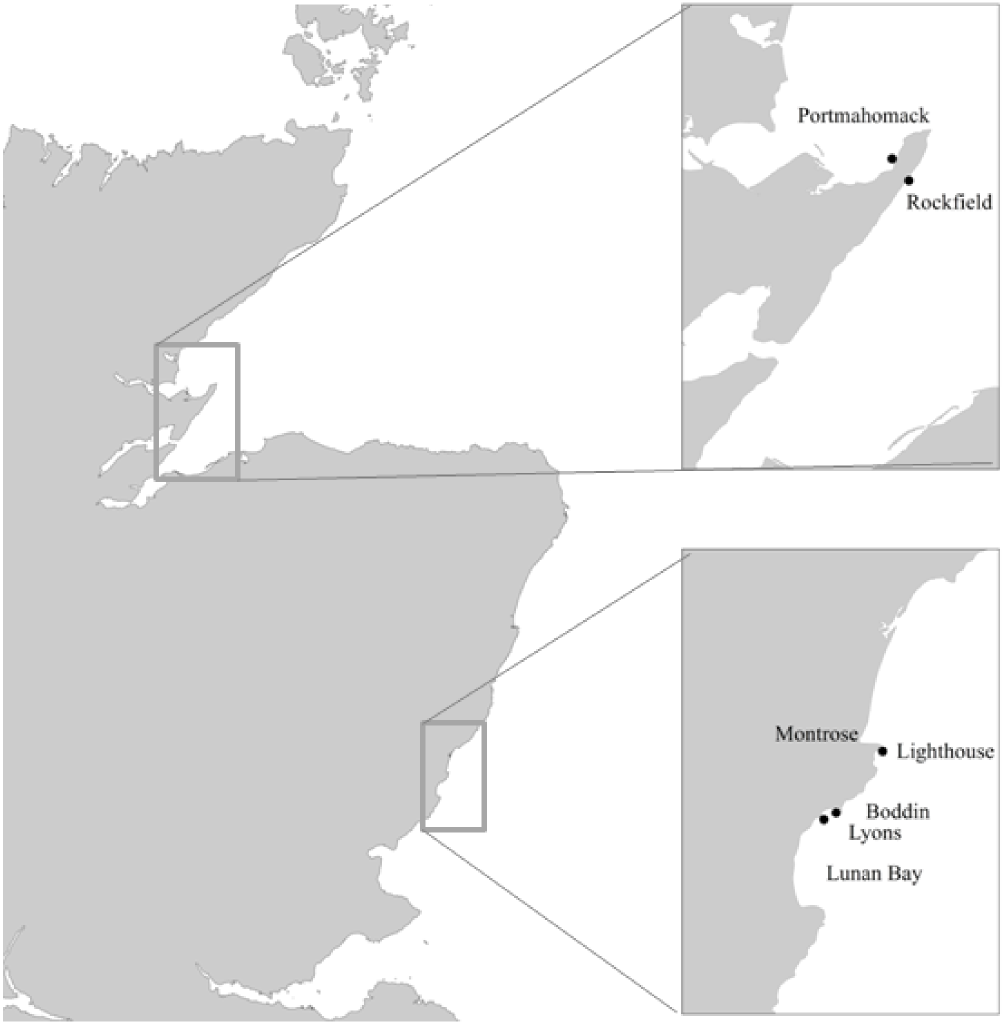

Figure 1. Black circles mark the locations of Scottish salmon bag-net sites where marine mammal observations took place

- Boddin (near Montrose) was selected as it represented the only site still fishing where observations were collected in 1982. In 1982 observations were made between February and August as part of the project studying the 'Interactions between grey seals and UK fisheries' funded by the Department of Agriculture and Fisheries Scotland. It was selected in 1982 due to ease of access to an elevated position overlooking the nets. During the present study, the number of nets at this site varied, with up to four double bag-nets in use compared with a maximum of 12 single bag-nets in 1982. The observation position was at a height of approximately 30m above sea level. We carried out observations here in 2009 and 2010

- Lyons (near Montrose) was selected following observations from Boddin in 2009 of seals frequenting the Lyons net that suggested a higher level of seal interference at Lyons compared with Boddin. Lyons held one double bag-net. The observation position was approximately 35m above sea level. Observations were made in 2010 and 2011.

- Lighthouse (near Montrose) was selected due to reports from fishermen claiming that this site likely represents the one most prone to seal attacks in recent years. The site held one double bag-net. The observation position was close to the start of the leader net at approximately 5m above sea level. Observations were made in 2010 and 2011.

- Portmahomack (Moray Firth) was selected due to the willingness of the fishermen to fully participate with research. An Acoustic Deterrent Device (ADD) was used intermittently at this site which held one double bag-net. The observation position was close to the start of the leader net at approximately 5m above sea level. Observations were made in 2009 and 2010.

- Rockfield (Moray Firth) was selected due to its proximity to Portmahomack and willingness of the fishermen to record seal damage events. This site held one single bag-net. The observation position was close to the high-tide mark at approximately 5m above sea level. Observations were made in 2009 and 2010.

Nets at Boddin, Lyons and Lighthouse have been modified by fishermen in an attempt to better cope with seal depredation (Figure 2). Modifications involved changes to the inner chamber of the net that included:

- Reducing mesh size throughout the inner chamber, including the floor, to the industry minimum (90mm);
- Increasing the thickness of the net material from 2mm twisted nylon to 4mm braided nylon(Figure 2);
- Tight corners within the inner chamber were closed off (Figure 2);
- A steel frame reinforced the inner door, in an attempt to prevent seals from entering the inner chamber (Figure 2).

Fishermen in the Moray Firth have not made these modifications nor were they used at Boddin in 1982.

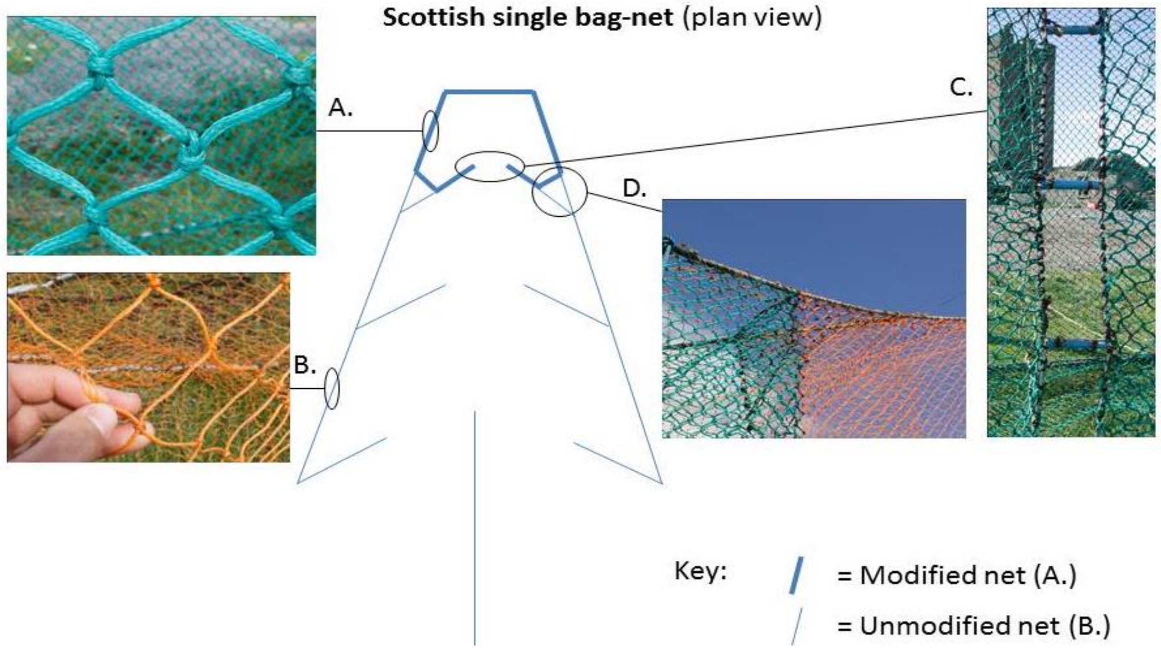

Figure 2. Scottish single bag-net showing modified inner chamber. A=heavy net material (4mm braided nylon), B=unmodified sections (2mm twisted nylon), C=steel frame reinforcing door to inner chamber, D=tight corners in the inner chamber are closed off.

No information on seal damage to net caught fish was available from sites near Montrose. Moray Firth fishermen provided landings and seal damage by site but requested landings be kept confidential.

To investigate the level of seal activity in the study areas and at the nets, observations were carried out with the aid of 10x binoculars and a Canon EOS 50D digital camera equipped with 600mm lens and 1.4 converter. Observations were made by one observer to maintain consistency in estimating distances.

The visible area was scanned from the observation point with the naked eye using optical equipment to confirm and photograph all seals sighted. Each seal surfacing event was recorded with time, estimated distance and direction from the net. Individual seals were identified from photographs, using differences in pelage and other individual characteristics. Where individuals could not be identified, seal sightings were assumed to be independent if no sightings were recorded for 30 minutes.

Distances were estimated from the observation position using known distances between nets, known lengths of net leaders, anchor trip buoys and features at known distances along the coast. The duration of a seal visit was defined as the time between the first and the last surfacings. When only one surfacing was observed, the seal was assumed to be present for 5 minutes. A seal activity index was generated by summing the duration of all seal visits within a predefined area and dividing by observation effort (minutes) and expressed as a percentage of time. A bottlenose dolphin activity index was generated in a similar fashion. However, the number of dolphins, their highly mobile nature and frequent surfacing made tracking individual dolphins within groups difficult therefore the index was based on presence / absence of groups of dolphins rather than individuals.

Images of seals were categorised (1 = best to 4 = worst) on the basis of the likelihood that pelage could be identified during a subsequent encounter. Images of quality grade one or two were considered to be of sufficient quality to be used in further analysis.

The proximity of the observation positions to the nets or their elevated position meant that sightings at the net were unlikely to be significantly affected by sea conditions. None the less, observations were not carried out during heavy rain or in stormy weather. Days when the weather conditions were forecast to be Beaufort sea-state 3 or less and lightly overcast (soft light) were preferentially selected for the benefit of seal photo-identification and the sighting of distant animals.

2.2.1 Temporal and spatial seal and dolphin activity

We present activity indices using sightings of marine mammals ‘at the net’ (within anchor trip buoys, approximately 80m of a net central point) and ‘in the study area’ (animals visible from the observation position and may include seals at other nearby nets). We present data for individual grey and harbour seals while bottlenose dolphin activity rates are based on presence or absence.

2.2.2 Assessing the number of seals and their prevalence at nets

An attempt was made to photograph each seal surfacing event. Post-processing of images allowed individual seals to be identified. Seal surfacings were then assigned to individual seals, enabling the number of individuals visiting the site and the frequency and duration of their visits to be assessed. Seals with salmonids were recorded as either ‘whole salmonid’ (apparently whole fish) or ‘part salmonid’ (incomplete fish varying from the greater portion of a salmonid to a small amount of pink flesh).

2.2.3 Comparison with Boddin 1982

To allow comparison of observations from 1982 with the present study, we provide comparable data taken from the SMRU report ‘Interactions between grey seals and fisheries in the UK’ (SMRU 1983). For comparison, results from Boddin in 2009 and 2010 which follow the same methodology used in 1982 are presented here. These are the same as described previously but exclude all information from photo-identification, therefore, a seal sighting was attributed to a new individual once 30 minutes had elapsed between sightings. The size of the study area in 1982 was estimated from sketches made that included the position of the nets and seal sightings relative to the observation point and other land features along the coast. We estimated that seals within 350m of the net were recorded by observers in 1982. For comparative purposes, we present only those sightings from 2009 and 2010 within this range. No harbour seals were reported at this site in 1982 although 22% of sightings were recorded as unidentified. Some or all of these could have been harbour seals so we combined seal species from the present study for comparison.

A Boddin sighting rate for harbour porpoise was generated by taking the number of porpoise sightings during the study and dividing by the hours observed.

2.3 Results

Weather and other project commitments affected the temporal spread and quantity of observation effort at nets (Table 1). Observations at Portmahomack and Rockfield took place during July and August in 2009 and 2010 (Table 1) although effort was focused on Portmahomack. An ADD used intermittently at Portmahomack prevented us from including observations when the ADD was in use. Data from May 2009 at Boddin were excluded due to low observational effort in that month. In 2010 data were only collected from Lyons in May and from June; observations were carried out at Lighthouse and Boddin whenever Moray Firth commitments and weather permitted. In 2011 observer effort was dedicated to the Lyons and Lighthouse nets and a reduction in commitments elsewhere allowed for an improved spread of effort.

Table 1. Number of hours of observational effort at nets near Montrose and in the Moray Firth

		Montrose			Moray Firth	
		Lyons	Boddin	Lighthouse	Portmahomack	Rockfield
2009	June	-	21	-	-	-
	July	-	21	-	26	4
	August	-	26	-	24	-
2010	May	23	-	-	-	-
	June	26	20	16	-	-
	July	17	9	-	22	12
	August	20	19	18	24	5
2011	May	30	-	20	-	-
	June	35	-	29	-	-
	July	35	-	28	-	-
	August	33	-	30	-	-
1982	June	-	38	-	-	-
	July	-	41	-	-	-
	August	-	37	-	-	-

2.3.1 Temporal and spatial seal and dolphin activity indices

We present detailed results tables for each location and year in Appendix A.

Overall seal activity at Moray Firth sites was higher than at Montrose sites (Figures 3 and 4). Both Boddin (Tables 1A and 4A) and Lighthouse (Tables 5A and 9A) had the lowest grey seal activity at nets. Grey seal activity at Lyons and Portmahomack was highest in 2010 (Tables 2A; 3A; 6A and 8A). Grey seals were observed swimming inside all chambers of the net at Portmahomack in 2010 and inside the outer chambers of the Lyons net in 2010 and 2011. Grey seal activity was low or completely absent from the Lighthouse (Tables 5A & 9A). Observational effort was low for Rockfield so the data was pooled (Table 7A).

In general, harbour seal activity at nets and within study areas was low. The highest harbour seal activity values for both ‘at net’ and ‘study area’ occurred at the Lighthouse in June 2010 (Table 5A). Harbour seal activity at Lyons also peaked in June (Tables 3A and 8A) but this June peak was not seen at Boddin (Table 1A and 4A). Harbour seals were not observed inside a net.

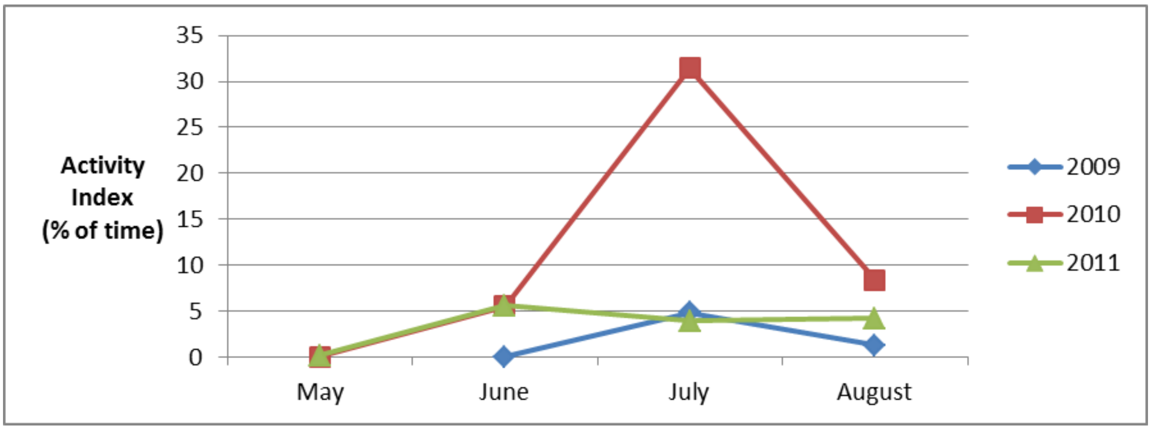

Figure 3. Grey seal and harbour seal 'at net' activity index (percentage of time) from all observation sites near Montrose

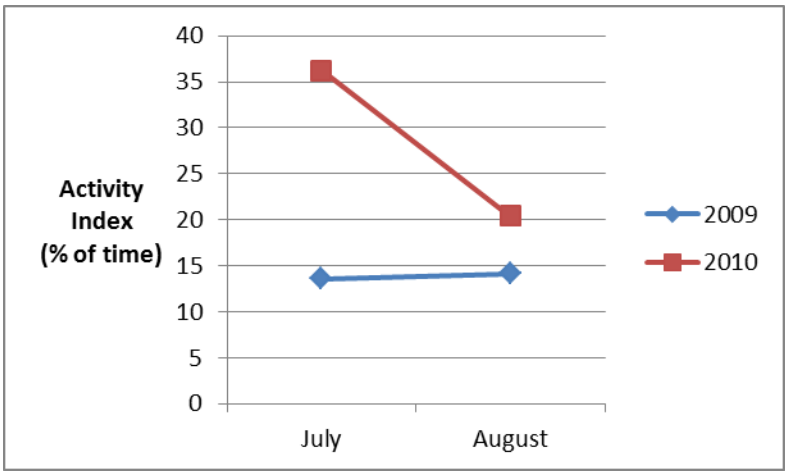

Figure 4. Grey seal and harbour seal 'at net' activity index (percentage of time) for Moray Firth sites

Bottlenose dolphin activity at both the Moray Firth and Montrose study areas was low during July and August. This was in contrast to data from May and June at the Montrose sites when dolphin activity was highest (Tables 1A, 3A, 4A, 5A, 8A & 9A). The pattern of dolphin activity at Montrose sites was consistent between years. In addition dolphins made brief but regular visits to the observation nets in May and June, resulting in relatively low activity indices for dolphins at the observation nets (Figure 5). Dolphins typically visit several nets in quick succession rather than maintaining a sustained interest in any one particular net as seals were observed to do for substantial periods of time. This further contributed to the low 'at net' activity indices as dolphins visiting other nearby nets were not recorded as 'at net' but were instead categorised as within the 'study area' indices, as they were no longer at the observation net. Dolphins were observed swimming away from nets with salmonids (n = 8). Observed dolphin behaviours included:

- dolphins swimming along the length of the leader and net,
- swimming into the first chamber of the net,
- lunging at the inner chamber,
- as dolphins were unable to enter the inner chamber, large eruptions of bubbles from inside the chamber indicated that dolphins were blowing bubbles from beneath the net (possibly an attempt to panic fish)

Interestingly seals at the net site typically moved away from nets as dolphins approached. On 13 occasions, seals at nets moved away or 'disappeared' as dolphins approached the net. In seven of these occasions, the seal reappeared back at the net within an hour of the dolphins passing. On two occasions, a seal remained at the net when dolphins remained beyond 500m of the net. On one occasion a seal remained at the net when dolphins approached within 500m of the net.

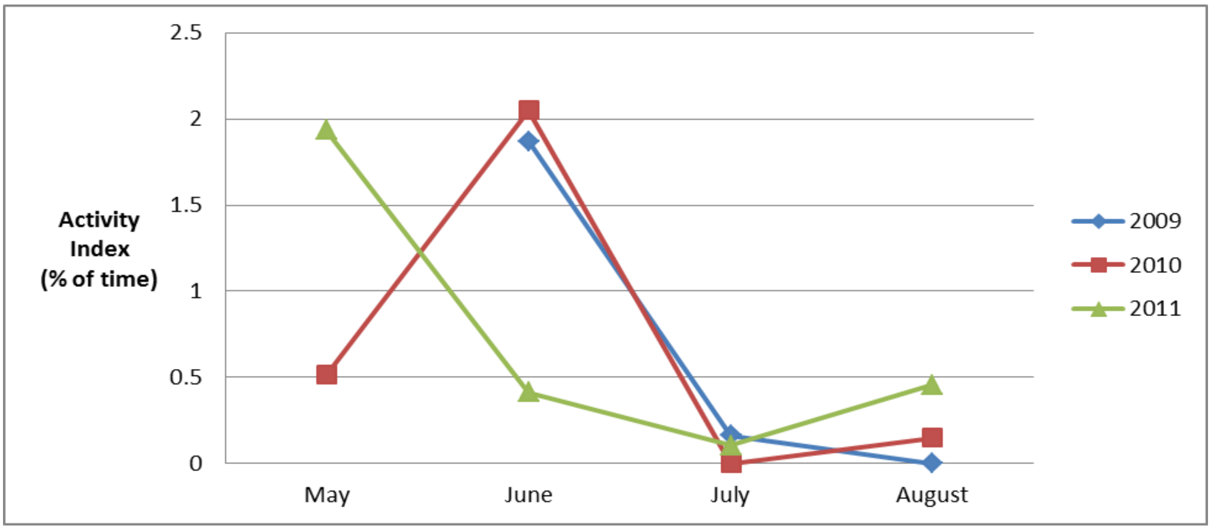

Figure 5. Bottlenose dolphin 'at net' activity index (percentage of time) from all observation nets near Montrose

2.3.2 Salmonid variability at Montrose bag-nets

One explanatory variable that may be responsible for the variability in seal and dolphin activity levels at nets is the number of salmonids being caught in the bag-nets. We investigated this relationship qualitatively by dividing the total salmon and grilse catch from bag-nets near Montrose by the median number of traps fishing each month (Figure 6) and comparing with the marine mammal activity levels (Figures 3 and 5). Conservation measures resulted in a large proportion of sea trout being released unrecorded. As this proportion probably differed between years, the number of sea trout retained by nets provides an unreliable indication of the numbers of trout at bag-nets. Instead we present the total rod catch for sea trout from the rivers South Esk and North Esk (www.scotland.gov.uk[2]). Montrose bag-nets intercept the majority of their sea trout catch in May and June (Usan Salmon Fishery Ltd. pers. comm.). The relative difference in the rod catch between years provides an indication of the variability in sea trout abundance that would likely have been present at Montrose nets in May and June (Figure 7).

[2] These data can be requested from Marine Scotland Science at ms.catchform@scotland.gsi.gov.uk

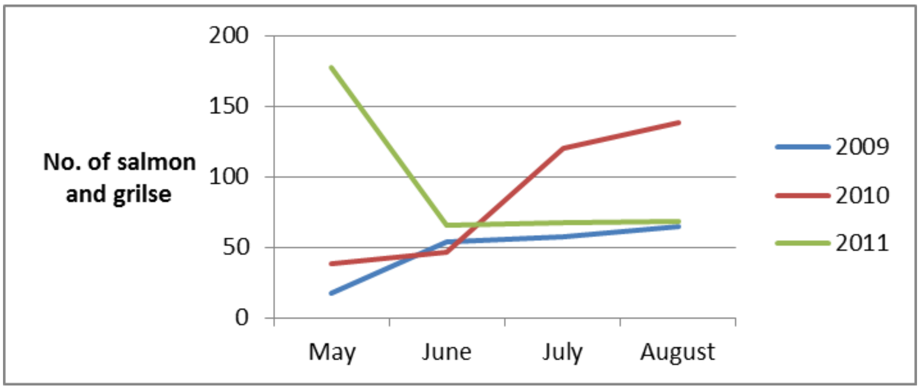

Figure 6. An effort-related number of salmon and grilse caught by bag-nets near Montrose[3]

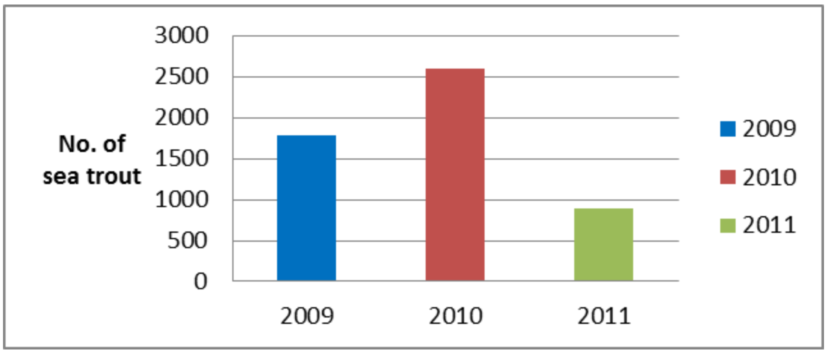

Figure 7. The total number of rod caught sea trout from the North Esk and South Esk[3]

It is unfortunate that we cannot incorporate sea trout net catches into the salmon and grilse catch to provide the monthly number of fish caught. However as the majority of sea trout are caught in May and June this should mean that the number of fish caught during July and August is a relatively accurate reflection of the number of fish at these nets (Figure 6). The following points provide a summary of the comparison of net catches and rod catches with marine mammal activity levels.

- Seal activity at nets in July and August between years was comparable to relative differences in the number of salmon and grilse caught: the 2010 peak in seal activity (Figure 3) coincided with increased catches of salmon and grilse (Figure 6) whilst the relatively low levels of seal activity in July and August in 2009 and 2011 coincided with lower catches compared to 2010.

- Neither the number of salmon and grilse caught by nets in May and June (Figure 6), nor the possibility of 'good' or 'poor' sea trout years (Figure 7), compare to the level of seal activity in these months possibly indicating that another variable (possibly dolphin presence) may have affected seal activity at these times (Figure 3).

- Despite marine mammal activity at nets in May and June being obscured by the lack of sea trout data from nets, the pattern of two relatively good sea trout years in 2009 and 2010

[3] The data used in this figure are Crown copyright, used with the permission of Marine Scotland Science. Marine Scotland is not responsible for interpretation of these data by third parties.

followed by the poor year of 2011 (Figure 7) is seemingly reflected in the level of dolphin activity at these nets in June (Figure 5), particularly as salmon and grilse catches in June remained relatively constant between years (Figure 6).

The relatively high dolphin activity at nets in May 2011 (Figure 5) is of interest because it coincided with apparently low numbers of sea trout (Figure 7). However it also coincided with a large number of salmon and grilse caught by nets in that year (Figure 6).

2.3.3 Assessing the number of seals and their prevalence

No seal was seen at both Montrose nets and Moray Firth nets. Of seal sightings 'at the net', 71% of Montrose sightings and 57% of Moray Firth sightings were photographed at sufficient quality to be classified as grade 1 or grade 2. The sightings rate at which 'new' (previously unidentified) seals were identified through pelage photography in each study area was higher at the Moray Firth sites than at the Montrose sites (Table 2).

Table 2. Hourly sightings rate for 'new', previously unidentified seals (grey and harbour) at net study sites

	2009	**2010**	**2011**
Montrose	0.06	0.02	0.02
Moray Firth	0.11	0.08	-

Montrose

Twelve seals (6 grey seals and 6 harbour seals) were identified at the Montrose sites and all were identified 'at the net' on at least one occasion (Table 3). Three seals accounted for 70% of the sightings and were seen in each year of the study. These three seals were responsible for all but one of the 17 sightings of seals with salmonid prey from the Montrose nets. Harbour seal (Pv101) was believed to have been shot in May 2009 (Table 3). Sightings of seals in the final months of the study confirmed the survival of a minimum of ten of the 12 seals. Five seals were seen at more than one salmon net site.

Table 3. Summary of seals identified in Montrose study areas in 2009, 2010 and 2011 and the number of salmonids taken at the observation net (Hg = grey seal, Pv = harbour seal)

Seal ID	Date		No. of sightings	No. of years seen	No. of net sites	Salmonid	
	1st seen	Last seen				Whole	Part
Hg101	20/05/2009	25/08/2011	12	3	2	3	0
Hg102	13/07/2009	26/07/2011	15	3	2	11	0
Hg104	16/08/2010	13/07/2011	4	2	1	0	0
Hg106	22/07/2011		1	1	1	0	0
Hg107	26/08/2011		1	1	1	0	0
Hg108	31/08/2011		1	1	1	0	0
Pv101*	20/05/2009		1	1	1	0	0
Pv102†	09/07/2009	29/08/2011	11	3	3	0	2
Pv103	11/06/2010	29/08/2011	3	2	2	0	1
Pv104	22/06/2010	23/06/2010	2	1	1	0	0
Pv106	10/06/2011	14/06/2011	2	1	2	0	0
Pv107	28/06/2011		1	1	1	0	0

*Seal likely shot on 20/05/2009

†Seal shot at on two occasions

Moray Firth

Eleven seals (9 grey seals and 2 harbour seals) were identified at Moray Firth sites and all were identified 'at the net' on at least one occasion (Table 4). One grey seal accounted for 45% of the sightings and was responsible for all but one of the 12 sightings of seals with salmonid prey. Two harbour seals were identified, each on one occasion. Two grey seals were identified at both Portmahomack and Rockfield net sites. Two grey seals were identified in both years of the study.

Table 4. Summary of seals identified in Moray Firth study areas in 2009 and 2010 and number of salmonids taken at the observation net (Hg = grey seal, Pv = harbour seals)

Seal ID	Date		No. of sightings	No. of years seen	No. of net sites	Salmonid	
	1st seen	Last seen				Whole	Part
Hg111	22/07/2009	07/08/2009	3	1	1	0	0
Hg112	27/07/2009	-	1	1	1	0	0
Hg113	30/07/2009	12/08/2010	3	2	1	0	0
Hg114	11/08/2009	-	1	1	1	0	0
Hg115	11/08/2009	-	1	1	1	0	0
Hg116	14/08/2009	11/08/2010	14	2	2	11	0
Hg212	22/07/2010	28/07/2010	3	1	1	0	1
Hg217	29/07/2010	06/08/2010	2	1	2	0	0
Hg219	21/07/2010	-	1	1	1	0	0
Pv211	23/07/2010	-	1	1	1	0	0
Pv214	09/08/2010	-	1	1	1	0	0

No seals were shot at Portmahomack in 2009 and 2010 and anecdotal reports from fishermen at Rockfield suggest that a 'few' seals were shot at this site. Nets near Montrose reported a total of ten seals shot in 2009 and 2010 (three grey, six harbour and one small unidentified seal). The majority of seals were shot during May and June (Table 5). No information on the numbers of seals shot at Montrose nets was provided by fishermen to the author for 2011 but these data were available from Marine Scotland. The observer witnessed four attempts to shoot seals; all were unsuccessful (two attempts on Hg116 and two attempts on Pv102).

Table 5. Reported number of seals shot at nets near Montrose (in 2009 & 2010 marksmen reported numbers directly to the author, numbers for 2011 were provided by Marine Scotland)

	2009		2010			2011	
	Grey	Harbour	Grey	Harbour	Unidentified	Grey	Harbour
May	1	2	0	2	0	7	0
June	1	0	0	0	1	2	0
July	0	1	0	1	0	0	0
August	0	0	1	0	0	0	0
Total	**2**	**3**	**1**	**3**	**1**	**9**	**0**

2.3.4 Comparable data from Boddin in 1982, 2009 & 2010

Seal activity at Boddin was low in both 1982 and the present study (Figure 8). Using comparable data, seal activity in 1982 was highest in June whereas this was the lowest month for seal activity in both 2009 and 2010. Overall seal activity at Boddin was similar between the studies especially in 1982 and 2009. Seal activity at Boddin was at its lowest in 2010.

No dolphins were sighted at Boddin in 1982. The average hourly harbour porpoise sighting rate for comparable data from 1982 was 0.14 (22 sightings) compared with an average of 0.05 (6 sightings) in the present study. Harbour porpoise, as well as minke whale sightings were collected at each site and therefore these sightings rates are available for each site. We do not present them here due to their low number.

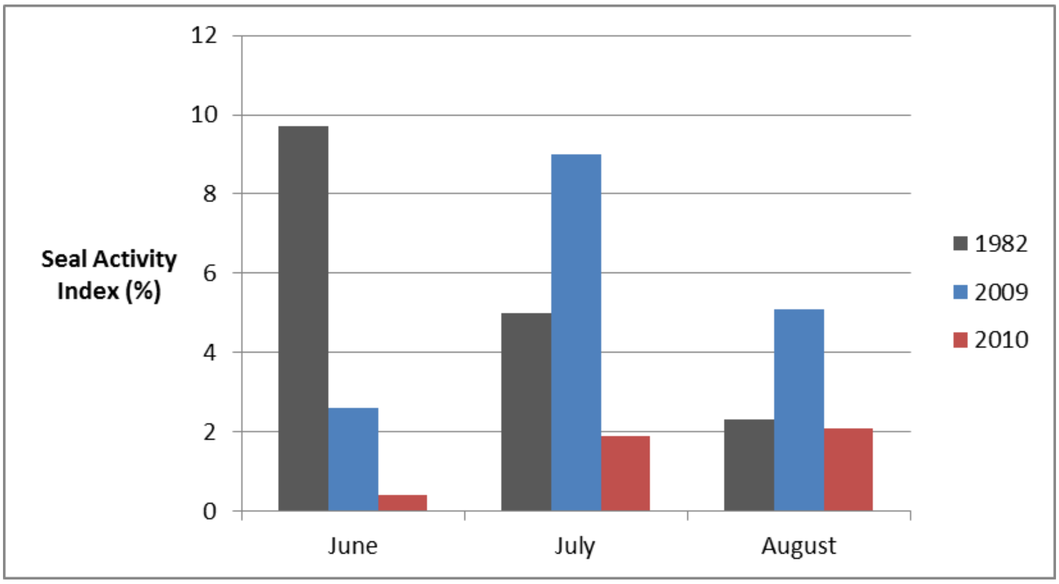

Figure 8. Comparable seal activity indices for Boddin following 1982 methodologies

2.4 Discussion

Interestingly, only grey seals and harbour porpoise were reported at Boddin in 1982, no harbour seals or bottlenose dolphins were recorded. However, approximately 22% of seal sightings were recorded as unidentified species and it is possible that some of these sightings were harbour seals. Anecdotal reports from the fishermen suggest that dolphins began regularly visiting this area during the 1990s and were not seen by fishermen prior to this. For 2009 and 2010 combined, harbour seals accounted for 32% of seal sightings from Boddin. Although the comparable information from the two studies is of interest, the low level of seal activity means that these data may be susceptible to low levels of observer effort achieved in 2009 and 2010. Direct comparisons are difficult due to the difference in the type and number of nets fished and the area they covered as well as uncertainties over the size of the study areas. Regardless of this, it is of interest that seal activity at this site seems to have changed little in almost three decades, despite a large increase in the size of the grey seal population. It is not possible to assess the effect of net modifications, although anecdotal reports from fishermen suggested that damage to landed fish has been reduced.

In May and June sea trout are caught in these bag-nets. Live sea trout not damaged by predators or net abrasions were returned by the fishermen as part of conservation measures (Appendix A. Figure 4A). However, many are hung in the net due to their size relative to the net mesh size (Appendix A. Figure 5A) or leader mesh size (Appendix A. Figure 6A). Sea trout suffering extensive scale damage due to 'hanging' were killed (Appendix A. Figure 7A). Observations of fishermen removing hung sea trout from nets near Montrose and the number released suggested that a high proportion of sea trout found in these nets were hung (Harris pers. obs.). Observations suggest that hung fish are easily damaged or removed by birds, otters, seals and dolphins therefore the true catch of these nets is not known.

Dolphins were regularly seen to interact with Montrose nets in May and June, at a time when the nets were catching sea trout and dolphins were seen leaving nets with 'small' salmonids. The variability in dolphin activity in June across years at Montrose nets (Figure 5) coincide with 'good' and 'poor' sea trout years from both Esk DSFB rod catches (Figure 7) and the Logie fish counter on the North Esk (Annual Review 2012). It is possible that dolphin interest in these nets may have been partly driven by the presence of hung fish (in particular sea trout). The high activity at nets in May 2011 coincides with large numbers of spring salmon being caught in that year (Figure 6). Due to the size of salmon, relative to mesh size, it is less likely that dolphins are removing hung salmon from these nets, however dolphins may damage fish in nets or may catch fish against leaders or by cornering fish in the outer chambers of the net.

The higher level of dolphin activity in the Montrose study areas, in comparison with the nets, particular in May and June, is difficult to explain (e.g. Tables 3A, 4A, 8A and 9A). Overall dolphin activity in the Montrose study areas revealed a consistent pattern between years that may be partly driven by the presence of salmonids bound for East Coast Rivers, however, is unlikely directly related to the nets. The relative lack of dolphin activity in the study areas in July is equally of interest. Marine mammal researchers have noted that dolphins are frequently encountered in or near the Firth of Tay at this time (N. Quick pers. comm.).

The rate at which 'new' seals were identified through pelage photography was higher in the Moray Firth (Table 2.) suggesting that the rate at which seals might encounter nets is higher at Moray Firth sites. This may be a consequence of proximity to large haul-out sites. The rate at which seals encounter nets have important implications for the choice of mitigation method, however, such considerations need to take into account past and present mitigation methods. The lethal removal of seals is unlikely to be effective or sustainable at net locations close to important seal haul-out sites where high encounter rates might be expected.

A high encounter rate for seals does not necessarily imply high activity of seals at nets although seal activity was higher at the Moray Firth sites than at Montrose sites. Seal activity at Montrose nets was generally low, with the exception of a peak in 2010 that was also mirrored in the Moray Firth. This peak was not mirrored in other years despite the same seals returning to the net. The peak in grey seal activity observed in 2010 at both Moray Firth and Montrose sites is possibly explained by the exceptionally high numbers of grilse returning to rivers in that year. Conversely, the relative lack of observed seal activity at nets in the following year may be explained by a large reduction in the number grilse from the previous year (www.scotland.gov.uk[4]). These results might suggest that net specialist seals spend time elsewhere when net catches are low and thus their diets are likely to be more varied at these times.

Why a small number of grey seals focused their attention on Lyons and not Lighthouse or Boddin is of interest, particularly as all these sites used the same modified nets. Grey seals were virtually absent from the Lighthouse net and grey seal activity at Boddin was very low despite high activity at Lyons approximately 800m away. Investigating why some sites/nets are of interest to net specialist seals compared with other nets may help improve our understanding of the problem and improve mitigation measures.

Montrose fishermen stated that, 'the Lighthouse net was one of the ones most prone to seal damage'. Observations suggested a virtual absence of grey seals at this site, and the shooting of more harbour seals than grey seals in 2009 and 2010 might suggest that harbour seals are perceived by fishermen to cause more damage than grey seals. As there is no damage recording scheme in place it is not possible to say whether a proportion of this 'seal damage' may be due to dolphins.

From all study sites near Montrose and the Moray Firth, three grey seals accounted for all the observations of seals with whole salmonids (n=25); observations suggest that these seals were taking fish from the chambers of the nets during July and August. Foraging success by seals during these months was not evenly distributed and was high at specific times. This suggests that simple extrapolation of foraging success rates may be unwise. Anecdotal reports from Montrose fishermen suggest that these times coincided with good landings with little seal damage to landed fish, supporting observations by the observer that specific seals appeared only to target the removal of whole fish from the outer chambers of the net.

On other occasions different seals were observed with salmonid flesh or partly consumed salmonids (n=4). The sighting of a seal with pink salmonid flesh, prior to the landing of a partly eaten salmon from the inner chamber of the Portmahomack net may suggest that these sightings are attributed to seals feeding on salmonids through the meshes of the net, rather than entering the net and removing whole fish. These observations suggest that different seals use different foraging strategies in their depredation of salmon from nets. Broadly speaking individuals may be divided into two groups - those that appear willing to enter nets in pursuit of whole fish and those that depredate fish in the inner chamber through the net meshes.

[4] These data can be requested from Marine Scotland Science at ms.catchform@scotland.gsi.gov.uk

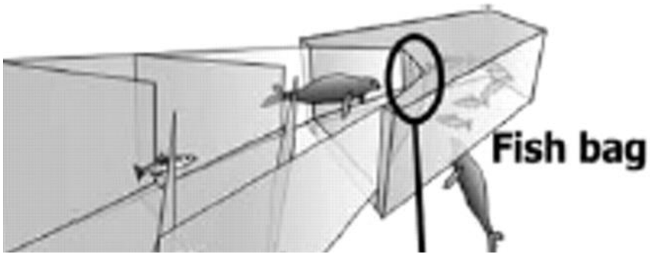

Figure 8. Illustration showing one seal entering the net in pursuit of 'whole' fish and another seal approaching from below and attacking fish through the meshes of the net (from Lehtonen & Suuronen 2004)

As fishermen rarely observe seals removing whole fish, this form of depredation remains relatively hidden and therefore appears to generate less apparent conflict between fishermen and seals. In contrast seals that remove fish by tearing small pieces through the meshes of the inner chamber often leave evidence that is seen by fishermen and may be one of the main drivers of conflict.

Relatively few seals habitually returned to the salmon nets in both the Moray Firth and Montrose sites although these individual seals did return each year and were observed at more than one salmon net site. The survival of these seals, that might be termed 'problem' seals, may stem from differences in the level of effort employed to shoot seals or behavioural traits exhibited by particular seals.

Anecdotally fishermen claim shooting effort was low and often concentrated at specific sites. The failed attempts to shoot seals suggests shooting seals at these salmon nets is not a simple task that may require a significant investment of time to be effective. In addition, differences in the behaviour of naïve seals to those that habitually return to nets may render some individuals more susceptible to being shot. The same effect may be caused if shooting effort is not employed at times of the year when 'problem' seals are utilising the nets. Records from Montrose fishermen during 2009 and 2010 suggested that more seals were shot in May and June and that more harbour seals were shot than grey seals, despite activity often being higher in July and August and overall grey seal activity higher than harbour seal activity.

Given the design differences that exist between the Montrose and Moray Firth nets, the rates of seal depredation are of interest. We compared the rate at which seals were observed swimming away with whole salmonids from the Lyons and Portmahomack nets during July and August 2010. Rates were for salmonids per hour and revealed similar depredation rates of 0.22 for Lyons and 0.24 for Portmahomack. In contrast, rates of damage sustained to fish in the inner chamber of the Lyons net (available through anecdotal reports only) appeared to be very low whereas fish damaged by seals in the inner chambers of the Portmahomack net expressed as a percentage of the landed catch was 33%. As a result of this possible difference in damage levels, it is therefore of interest to properly investigate the effectiveness of the net modifications made by Montrose fishermen.

Seal activity at nets and seal-damaged fish in the landings, fuels conflict. Naïve seals will likely always investigate a net and a net with fish will likely hold the attention of a seal for longer. Seals that receive no food reward are unlikely to habitually return to the net. Reducing seal damage in the landed catch is achievable (Hemmingsson et al. 2008; Lehtonen & Suuronen 2004; Usan Salmon Fishery Ltd. pers. comm.) and reducing the activity of seals around salmon nets is also achievable (Lunneryd et al. 2003; Harris 2011; Fjalling et al. 2006). There are an increasing number of mitigation measures available to salmon bag-net fisherman however the cost benefits of each method need to be evaluated on a site-by-site basis and, perhaps most importantly, there has to be a willingness from fishermen to experiment with new options.

2.5 Suggested further studies

The following are possible options for future studies:

- Investigation of the effectiveness of the modifications made to nets near Montrose as a cost effective seal mitigation measure.
- Investigate whether seals that habitually use nets can be discouraged from approaching nets through the use of dolphin vocalisations.
- Investigate ways of reducing the rate at which whole salmonids are depredated from the outer chambers of the net whilst maintaining the level of landings.

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3 Diet of seals at salmon nets

3.1 Introduction

Rae (1968) reported the stomach contents for 158 grey seals drowned or shot at salmon nets from 1958 to 1966, of which 22% had salmonid remains. Other prey species were encountered more frequently and a large number of seals had no prey remains in their stomachs (37%). The author suggests that the low level of salmon in the diets of these seals may stem from seals regurgitating prey once they become trapped inside nets, although no evidence is provided to support this claim.

Pierce et al (1991) found a significant difference in the presence of salmonids in seals killed at salmon nets and those killed elsewhere from 1986 to 1988, despite whitefish and flatfish dominating the prey items found in seals from nets. They also suggest that these latter prey items probably didn't come from salmon nets. Pierce reported findings from stomachs and intestines of 29 seals from salmon nets; 6 (21%) held salmonid prey and all seals examined held prey remains.

Diet information from seals shot at salmon nets is important in gauging the effectiveness of this management approach. Seals may be shot legally at salmon nets to prevent serious damage to the fishery. The primary reason for this is due to the belief that seals at nets remove or damage fish in the net so that they are not saleable. It also used to prevent seals from damaging the fishing gear itself, however, since the advent of synthetic materials this has become less of a problem. The need for lethal control is on the basis of last resort. It assumes that seals shot at nets consume salmon from the nets and therefore provides the justification for lethal control. Co-operation from net fishermen allowed seals shot at nets between 2005 and 2010 to be recovered for dietary analysis when carcasses were accessible.

The presence of salmon or trout in samples enables an assessment of the prevalence of salmonids in the diet of seals. Results from seals shot at coastal nets was compared to those seals sampled from rivers (n=9) between 2005 and 2008 (Graham et al. 2011) and to the DNA extracted from seal scat samples (n=182) from haul-out sites in the Cromarty Firth and Findhorn Bay during 2003 and 2005 (Matejusova et al. 2008). We present data as salmonids rather than by species as the proportion of salmon to trout in the diet may simply be a reflection of the timing of sampling of seals from coastal nets and from rivers.

3.2 Methods

Methods employed during this work followed those described in Graham et al. (2011). In overview, stomachs were placed into separate bags and stored at -20°C. They were subsequently thawed and then opened using new disposable scalpels and new disposable gloves to avoid any cross contamination. Stomach contents were carefully mixed by hand and 1 to 3 sub-samples were taken for DNA analysis; these were stored at -70°C. Any pink flesh was noted and hard-parts were removed from the remaining material. Sub-samples were tested for the presence of salmon or trout DNA by Marine Scotland Science (MSS). Otoliths were identified using Harkonen (1986). The salmon otolith length to fish length regression equation was provided by Marine Scotland Science and was based on salmon and grilse (n=118) caught in the river Conon.

3.3 Results & Discussion

One grey seal was shot in June whilst all others were shot in July or August and were from bag-net fisheries except two harbour seal pups that were from sweep-net fisheries - cause of death for these two seals was drowning whilst all other seals were shot by the fishery. One grey seal was recovered from salmon nets near Montrose in 2010 the remaining seals were recovered from Moray Firth salmon nets in 2005-2008 (Table 1).

Table 1. Number of seals sampled from salmon net sites for the purpose of dietary analysis

	Grey seal		**Harbour seal**	
	Juvenile	Adult	Pup	Adult
Female	3	5	2	1
Male	2	0	3	0

Harbour seals were assumed to be pups if their standard length was less than 1 m, juveniles in their first or second year if 1-1.1 m in length and adults if longer than 1.1 m (Corpe, 1996; Thompson *et al.*, 1992).

Grey seals were assumed to be juveniles if less than 110 kg and adults if greater than 110 kg (SMRU, 1984).

Stomachs were removed from 16 seals for the purpose of gathering dietary information at salmon net sites. In addition, intestines were also removed from eight of these seals. Unfortunately the small sample sizes associated with both seals from nets (Table 1) and from rivers (Graham et al. 2011) prevents us from sensibly presenting comparable information by species and age group. One seal whose stomach contents held whitefish and flatfish remains to be tested for the molecular presence of salmonid DNA. This seal was excluded from our comparison between salmonid DNA presence from haul-out sites, rivers and those taken in this study from net sites (Table 2). These results demonstrated that few seals recovered for diet sampling from salmon nets held salmonid prey.

Table 2. The number and proportion of scat samples or seal carcasses testing positive for salmonid DNA; from 182 estuarine haul-out scat samples from Matejusova et al. (2008) and 9 seals shot in rivers from Graham et al. (2011) compared with 15 seals killed at salmon nets.

	Estuary haul-out (%)	**River carcasses (%)**	**Net carcasses (%)**
Salmonid	**24 scats (13%)**	**5 (56%)**	**3 (20%)**

Note: Net proportion taken from 15 seals, not 16 seals, as one adult grey seal from 2010 remains to be tested for salmonid DNA (hard-part analysis and a lack of any visual sign of salmonid flesh suggested a diet of whitefish and flatfish from this 16th seal)

Salmonid DNA was detected in the stomachs of three female seals (one harbour seal adult, one grey seal adult and one grey seal juvenile) from the Moray Firth. The presence of salmonid prey in these three seals was confirmed visually by the presence of salmon otoliths (n=8) from the two grey seals and the presence of pink flesh in the stomach of the harbour seal.

As each fish has two otoliths; a left and a right otolith and four of each were recovered then these eight otoliths may have come from a minimum of four salmon. The length of these bones suggests that all fish were grilse; average fish length was estimated to be 557mm (range 498mm – 608mm). The presence of 27 other otoliths from nine different prey species suggests that these three seals were also feeding on other prey besides salmon.

Table 3. The number of otoliths and their frequency of occurrence from sixteen seals sampled from salmon net sites (three seals contained no prey remains)

Prey group	**Frequency of occurrence**	**Number of otoliths or beaks**
Gadids	7	51
Pleuronectids	7	15
Perciforms	5	11
Salmon	2	8
Cephalopods	1	4
Clupeids	2	17
Cottids	1	5
Unidentified	4	6*
Total	N = 13	117

*6 otoliths were unidentified due to their small size or level of digestion; it was thought likely that four may have been from pipefish and were recovered from the stomachs of harbour seal pups.

The fatty acid composition and stable isotope ratios of carbon and nitrogen in seal tissues may be used to give a qualitative assessment of seal diet over a longer time period. These samples have been stored from seals shot to protect salmon fisheries however as yet there are no plans to use these.

Based on the available information, three seals (19%) from 16 recovered at salmon nets held salmonid prey, however, the presence of other prey items suggests that these seals were not feeding exclusively on salmonids. Whitefish and flatfish were the most prevalent prey from sampled seals. These results are consistent with previous studies (Rae 1968; Pierce et al. 1991) that demonstrate a relatively low frequency of occurrence of salmonids in seals sampled from salmon net sites. Pierce suggested that seals sampled from nets are probably not specialists at foraging on salmon caught in nets based on the presence of other prey items in their diet (Pierce et al. 1991). These results are in contrast to those shot in rivers where seals containing salmonid prey held only salmonid prey and therefore may represent a level of specialisation. However, observations of known seals repeatedly removing salmon from nets suggests that net specialists may exist and the rate at which seals remove salmonids can be high at specific times.

In the present study, as in previous studies (Rae 1968; Pierce et al. 1991), the majority of samples have come from seals that have found their way into a salmon net and been unable to find their way out again. As seals that habitually return to the nets are known to be able to negotiate the chambers of salmon nets (Konigson 2007; Harris pers.obs.) it suggests that the diet samples in these studies may be biased towards those naïve seals unfamiliar with the chambers of a salmon net and may therefore not represent the diet of those habitual net users. Surprisingly in this study none of the seals killed inside salmon nets (3 grey seals and 5 harbour seal pups) held evidence of salmonid prey although most held other prey species, countering claims that seals stuck in nets regurgitate or quickly digested their prey before being killed by fishermen. Furthermore seals killed inside nets are easily recovered whereas seals shot outside the net may be too difficult to recover, introducing another possible bias.

Results from diet studies do not appear to support the existence of net specialist seals; however, the low level of salmonid prey in the diets of seals sampled at salmon nets may be largely related to sampling bias. Two important questions exist: do seals at salmon nets have an equal chance of being shot and of those that are shot do carcasses have an equal chance of being recovered and sampled. If significant sampling bias exists, as suggested by the present study, then present and past assessments of the diets of seals sampled from salmon nets are unlikely to be representative of the diets of those seals observed at salmon nets.

3.4 Suggested further studies

Contact with marksmen should be maintained to help encourage and assist where necessary the recovery of seal carcasses for dietary analysis. Stomach and intestines should be subjected to both descriptive and hard-part analysis as well as the molecular methods for salmonid DNA.

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Appendix A: Results tables and images from observational studies

Grey seal, harbour seal and bottlenose dolphin activity indices 'at the net' and within the 'study area'.

Note: Seal activity based on sum of individual durations (therefore possible to attain more than 100% when more than one seal present) whereas bottlenose dolphin activity based on presence / absence (therefore maximum activity = 100%).

Note: 'at net' activity indices for both seals and dolphins represent only those at the observation net and therefore visits to other nearby nets are only recorded as 'study area'.

Table 1A. Activity indices for Boddin 2009

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
June	21	0	5.4	0	0	1.9	7.6
July	21	1.2	45.7	3.6	4.4	0.2	1.6
August	26	0.6	5.9	0.6	0.7	0	0

Table 2A. Activity indices for Portmahomack 2009

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
July	26	14.7	22.1	0.6	1.2	0	0.3
August	24	12.3	26.0	1.8	16.6	0	0

Table 3A. Activity indices for Lyons 2010

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
May	23	0	0	0	0	0.5	28.1
June	26	0.3	0.7	4.2	7.2	1.2	30.4
July	17	47.1	50.4	0.5	0.5	0	2.9
August	20	20.4	55.3	0.4	2.4	0.4	7

Table 4A. Activity indices for Boddin 2010

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
June	20	0	14.2	0.4	0.4	3.6	29.7
July	9	0	39.8	0.9	0.9	0	0.9
August	19	0.9	25.6	0	0	0	4.5

Table 5A. Activity indices for Lighthouse 2010

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
June	16	0	0	13.9	31.1	1.0	7.3
July	-	-	-	-	-	-	-
August	18	0	0	2.3	12.7	0	0

Table 6A. Activity indices for Portmahomack 2010

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
July	22	48.2	62.0	0.4	1.9	0	0.4
August	24	22.2	50.4	1.1	1.8	0	1.4

Table 7A. Activity indices for Rockfield 2009 & 2010 combined

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
July & August	21	9.6	14.8	0	0	0.4	2.8

Table 8A. Activity indices for Lyons 2011

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
May	30	0.3	1.3	0	0	1.3	19.2
June	35	6.6	21.4	2.7	6.5	0.2	8.8
July	35	5.8	19.7	0.5	0.5	0.1	8.8
August	33	5.0	12.7	1.7	2.8	0	1.8

Table 9A. Activity indices for Lighthouse 2011

		Seal Activity Index (%)				Dolphin Activity Index (%)	
		Grey seals		Harbour seals		Bottlenose dolphin	
Months	Hours	Net	Study area	Net	Study area	Net	Study area
May	20	0	0	0	0.4	2.8	50.6
June	29	0	0	1.0	2.4	0.6	11.4
July	28	0.3	0.3	0.6	1.5	0.1	13.8
August	30	1.0	1.1	0.6	1.4	1.0	10.6

Figure 1A. Bottlenose dolphins at the inner chamber (otherwise known as the fish bag or fish court) of a salmon bag-net (Lighthouse) near Montrose

Figure 2A. Bottlenose dolphin swimming away from the Lyons net with prey (possibly sea trout)

Figure 3A. Bottlenose dolphin and double bag-net (Lyons) near Montrose

Figure 4A. Sea trout is returned by fishermen as part of conservation measures

Figure 5A. Two sea trout hung in the meshes of the outer chamber of a salmon bag-net (Lyons)

Figure 6A. Salmonid hung in the meshes of a salmon net leader (Lyons)

Figure 7A. A sea trout being killed due to the extensive scale loss (seen by the marks that encircle the fishes body behind the pectoral fins) caused by being hung in a salmon net

Figure 8A. Grey seal surfaces at a salmon net with only its nostrils above water, behaviour also observed in grey seals foraging in salmon rivers and in captivity, the reasons for each situation may be different although most likely stem from seals wanting to avoid being detected by ‘man’.