DRAGONFLY

Summary of data collected during the southern squid-fishery mincing trial

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Executive summary

This report gives a preliminary analysis of data collected to test whether mincing of waste and discards reduces the number of birds attending fishing trawlers. The trial was carried out on a Korean trawler, fishing in the southern squid fishery during April and March, 2007. The numbers of birds were counted in 40m and 10m semicircular sweep zones extending behind the vessel. Counts were made of five different species categories (large albatross, small albatross, giant petrel, other petrel and shearwater, and cape pigeon). The birds were also classified into three behavioural categories (flying, sitting on the water, and actively feeding).

Three different offal treatments were used (discharge without any processing, mincing all waste with continuous discharge, and mincing all waste with batched discharge). During the trip, the fisheries observer who was implementing the experimental protocol made a total of 85 observations. Of these, 35 were made when the factory was not operating and so when there was no discharge. These observations provide a control, but cannot be used for distinguishing between the different treatments. There were some problems with the minced and batched protocols. Early in the voyage there was a high volume of discards which could not be batched, as there was insufficient room in the factory. The batched protocol was then changed to minced. On one tow, when the vessel was targeting hoki, the bycatch clogged the mincer and an unprocessed treatment was substituted. In addition, there were sometimes rocks in the trawl and these could not be put through the mincer. Small numbers of rocks could be removed by hand by the crew, but large numbers meant the minced treatment had to be changed to unprocessed.

Despite these problems, the preliminary analysis suggests that there was a treatment effect, with fewer large and small albatross attending the vessel when the discharge was minced. The batched treatment also reduced the total numbers of large and small albatross within the 40m sweep zone. The significance of these results will be checked by statistical modelling.

The observer also made 100 strike observations, 50 of trawl warp strikes and 50 of strikes on the tori lines. There were no warp strikes observed during the voyage, and so only the tori line strikes are considered. The effect of treatment on the strikes is unclear. There are fewer large bird strikes when the discharge is minced, but more small bird strikes.

Introduction

The discharge of offal and other waste from trawlers is associated with the occurrence of strikes between seabirds and the trawl warps (Abraham 2005, Sullivan et al 2006, Middleton and Abraham 2007, Abraham et al 2007). The warp strikes are a cause of seabird mortality. In 2006, an experiment was carried out to test whether mincing all waste before it was discharged would reduce the number of seabirds attending vessels. The results of that experiment are reported in Abraham et al (2007). Mincing the offal reduced the numbers of large albatross (wandering and royal) feeding around the vessel, but did not reduce the numbers of other birds. The experiment was repeated in the southern squid fishery in early 2007, on a smaller vessel. Three experimental treatments were used:

1) A control, where offal (i.e. heads, frames, guts) and bycatch was discharged unprocessed as it is generated.
2) A batched treatment, all offal and bycatch retained and discarded in batches (when not towing, if possible).
3) A minced treatment, all offal and bycatch minced and discharged via the sump pump.

An industrial mincer was used to mince the waste (Figure 1). A drum with projecting fingers forced the waste through slots, breaking it into small pieces. A picture of the minced discharge is shown in Figure 2. In the water the minced discharge formed a diffuse cloud, with larger chunks. The size of the chunks and particles in the discharge has not been measured.

Figure 1 The mincer installed on the vessel

Figure 2 (a) Minced discharge at the outlet (b) Minced discharge in the water. The mince is fine particles, with larger shredded chunks.

The experiment was designed by an advisory group, with representatives from the fishing industry, the Department of Conservation, the Seafood Industry Council, the World Wildlife Fund (WWF-NZ), and the Ministry of Fisheries. A fisheries observer ran the experiment on the vessel and monitored the response of seabirds to the different experimental treatments.

In this report, a preliminary summary of the data is presented. No statistical modeling has been carried out at this stage, and only limited interpretations of the results are made. This report will be followed by a more detailed analysis.

Observation protocol

The primary data used for determining the effect of the treatments are counts of birds behind the vessel. These were collected using the seabird observation form (version dated 11/2/2007). An example of a completed form is given in Appendix C. Counts were made of five separate species groups:

- Large albatross (royal and wandering albatross; *Diomedea spp.*).
- Small albatross (other albatross; *Thalassarche spp*. and *Phoebetria spp.*).
- Giant petrels (*Macronectes spp.*).
- Shearwaters and other petrels apart from giant petrels and cape pigeons (other *Procellariidae*).
- Cape pigeons (*Daption capense*).

The birds were also grouped by their behaviour into three categories:

- Flying or gliding.
- Sitting on the water, but not feeding.
- Feeding or engaged in feeding related activity including diving, surfacing or aggressive interactions with other birds.

The numbers of birds were counted in a 40m sweep zone behind the vessel (Figure 3). The protocol requested that the observer estimate the number of birds in two areas (1)

the entire sweep zone, and (2) an inner 10m radius semicircle. The observer carried out counts of each species grouping and each behaviour category separately. To make each count, a single visual sweep was made through the area. The observer was instructed to spend no more than one minute on each count, a total of no more than 15 minutes per observation. Because each species-behaviour category was counted separately, some individual birds may have been counted more than once if they changed behaviour between counts. Similarly, some birds within the area may not have been counted.

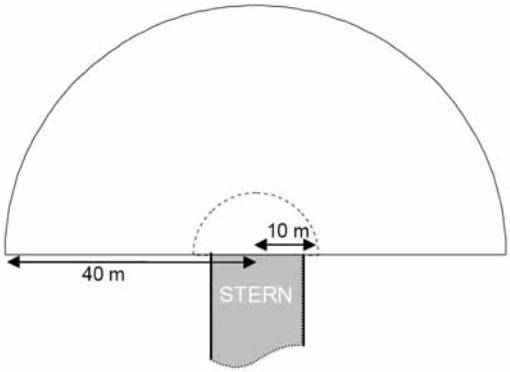

Figure 3 Diagram from the experimental protocol showing the area behind the vessel in which the bird counts are made.

In addition to counting the numbers of birds, the observer recorded some ancillary data to give a context to the observations (vessel speed in knots, swell height in meters, wind direction relative to the vessel and wind speed on the Beaufort scale). The observer also characterised the discharge by the presence or absence of each of the five categories:

- sump water
- minced material – material that had gone through the mincer
- offal – heads and guts of processed product
- cutter – cutter pump output
- discards – whole fish, squid or other bycatch

For each discharge type, the observer recorded whether there was no discharge, or whether the discharge was negligible, intermittent, or continuous. The position of each discharge type was also recorded on a diagram of the sweep region (Figure 4). If the vessel was fishing while the observation was made, the observer marked where the trawl warps entered the water (shown with crosses). The sides of the vessel stern were marked with lines.

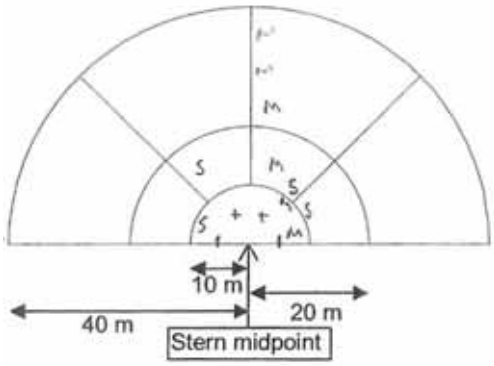

Figure 4 Example of a completed offal discharge diagram, showing position of mince (m) and sump (s) discharge, trawl warps (+), and the sides of the vessel (|).

The observer was requested to make observations through the day (between 0600 and 1800 hours). No specific sampling schedule was given, but it was suggested that observations be made approximately hourly. Observations could be made when the vessel was fishing or when there was no gear in the water, but not when the vessel was shooting or hauling the nets.

In addition to the seabird counts, the observer made strike observations, counting interactions between seabirds and the trawl warps and between seabirds and the mitigation devices. For the strike data, the birds were grouped into two size categories:

1) Large birds – all albatross and giant petrel.
2) Small birds – all other birds.

The data was collected using the warp-strike observation form (version dated 11/12/2006). An example of a completed form is given in Appendix C. If the vessel was fishing, the observer was asked to carry out observations in the following order:

1) Seabird count observation.
2) Seabird strike observation (trawl warps).
3) Seabird strike observation (mitigation device).
4) Seabird count observation.

In addition to completing the forms, the observer took photographs and video on an ad hoc basis.

Data entry

The observer completed a total of 85 seabird count observation forms throughout the trip. The completed observation forms were entered into a MySQL database. All data, except for the observer comments, were double entered. There were 17 errors in the data entry that were found by reconciling the two data sets, an error rate of 0.26%. Some of these errors related to difficulties in interpreting the hand written symbols on the offal discharge diagram, particularly in distinguishing between ‘D’ and ‘O’.

The data was then exported to a text format, for processing and analysis in R (version 2.4.0, R Development Core Team, 2006). There were no obvious issues with the seabird observation data. All forms were completed entirely and there was nothing in the comments to suggest that any of the forms should be abandoned.

The comments from each form were corrected for minor spelling and grammatical errors, and acronyms were expanded. All comments are given in Appendix A.

The offal diagrams from each form were scanned and then digitised. A script was written in R that allowed the corners of the diagram, and the position of each discharge symbol, to be selected through mouse-clicks. A linear coordinate transformation was then used to convert the positions from pixel coordinates to actual distances (in meters).

All images and video clips were viewed, and a brief description of each image was made. All photographic images in this report were taken by the observer. The video clips were also annotated, and where the observer talked during the clip, the dialog has been transcribed. These descriptions and transcriptions are given in Appendix B.

The warp strike data is usually entered into a database by the Ministry of Fisheries. At time of writing, this data was not available from the Ministry as changes to the form before this voyage led to delays with processing the data. The forms were entered directly into a spreadsheet. The observer made 50 warp strike observations and 50 mitigation device strike observations, from 17 different tows. There were no contacts recorded during observations of the trawl warps, so only the mitigation device data were entered.

On the bird observation form the observer recorded the counts from both of the sweep areas within each category, separated by a slash, i.e. as "5/0". It was intended that the first number should be the total count within the 40m sweep area and the second number should be the count within the 10m sweep area. In some cases, numbers were higher in the second count than the first. This suggested that the two numbers were birds in the 40m zone, but excluding the 10m zone, and birds within the 10m zone. A count for the 40m sweep was then made by adding the two numbers. A total count of each bird category was also made by adding the counts from each of three behavioural categories.

Experimental treatments

The vessel was a Korean stern trawler (58.2m long, 9.8m wide, commissioned in 1983). During the trip the vessel carried out 32 tows, with one tow targeting hoki on the way down to the southern squid grounds and the other tows targeting squid. Twenty tows were fished in SQU6T (Auckland Islands) and 11 in FMA SOU, SQU1T. The vessel used two bottom trawls (both with 35m ground ropes, wingspread 45m, headline height 3.8m, door spread 100m and net length 130m). Tori lines were used on all tows. In general, the birds avoided the rectangular area between the tori lines and between the stern of the vessel and the windy buoys (Figure 5). The vessel also deployed two-boom side bird bafflers when the weather permitted (Figure 6).

Figure 5 View from the stern of the vessel, looking back. The tori lines can be seen on either side of the vessel's wake. The birds are sitting on the water beyond the tori line windy buoys.

Figure 6 The top and bottom of the port side bird bafflers.

The observer carried out 85 bird count observations through the trip, on 17 days. All observations were made while the vessel was towing, during 27 different tows. The three experimental treatments differed in the way offal was processed. For the treatments to be meaningful, there needed to be some discharge. Of the 85 observations, 35 were made when the factory was closed and no processing was taking place. During these observations there was no discharge at all, not even of sump water. On 34 of these observations this is confirmed by a comment made by the observer such as "Sumps off. No processing" or "Factory idle". The remaining observation without sump discharge (number 5) occurs after an observation (number 4) with the comment "Processing completed". While these observations are useful as a control, they cannot be used to distinguish between the effects of the different experimental protocols, so we assign them to a fourth treatment category "No processing". A breakdown of the numbers of observations by day and by treatment is given in Table 1. There are small numbers of observations within each treatment, with the batched treatment only having a total of 10 observations on three separate days.

Table 1 Number of bird count observations made on each day

Date	Day number	Treatment	Number of observations				
			No processing	Unprocessed	Minced	Batched	Total
22/2/2007	1	Unprocessed	1	4	0	0	5
23/2/2007	2	Minced	0	0	5	0	5
24/2/2007	3	Minced	5	0	2	0	7
25/2/2007	4	Minced	5	0	0	0	5
27/2/2007	5	Unprocessed	1	0	0	0	1
28/2/2007	6	Minced	3	0	4	0	7
1/3/2007	7	Unprocessed	6	2	0	0	8
2/3/2007	8	Batched	2	0	0	3	5
3/3/2007	9	Minced	3	0	3	0	6
4/3/2007	10	Unprocessed	2	1	0	0	3
5/3/2007	11	Minced	4	0	4	0	8
6/3/2007	12	*Not applicable*	1	0	0	0	1
7/3/2007	13	Batched	0	0	0	2	2
8/3/2007	14	Unprocessed	2	2	0	0	4
9/3/2007	15	Minced	0	0	7	0	7
10/3/2007	16	Batched	0	0	0	5	5
11/3/2007	17	Unprocessed	0	6	0	0	6
Total number of observations			35	15	25	10	85

In the original protocol, it was intended that the batched treatment would result in the discharge of unprocessed offal, however all waste was minced during the batching. It was also hoped that most of the batched waste would be discharged while the vessel was not towing. In practice, there was insufficient capacity for the vessel to hold the waste for an entire tow. Observer comments indicated that during the batched treatments there were 10 to 20 minutes between discharge events.

There were problems during the experiment with both the batched and the minced protocols caused by rocks being trawled and discarded with the other waste (Figure 7). Although the rocks were small, they were unable to go through the mincer, as they would damage it. Either the crew had to pick the rocks out of the other discards, or the minced and batched protocols were changed to unprocessed.

Figure 7 Rocks on the conveyor, and compared to a pencil for scale.

Changes made to the order of the treatments are summarised in Table 2. On the first day the observer tried to use the mincer (February 21) the vessel was targeting hoki. In the voyage report he notes "on big bags of target hoki species they can't use the mincer due to the amount of discards of rat-tail and javelin fish, etc. Apparently it blocks up. It is only good for target squid". The treatment on February 22 was meant to be a minced treatment, however the observer changed it to an unprocessed treatment as they were still processing the first tow. There were also difficulties reported with holding waste during the batched treatment, as the factory didn't have sufficient storage space. On February 24, the observer reports in the trip log "Due to tows in 6T containing a large percentage of NCB, batching is causing major hold-ups in factory. Crew are not keen to do it. I see their point, mainly because factory conveyors are not set up to do it and the flow of NCB is so large". Because of this problem the batched protocol was replaced with the minced protocol. The first batched treatment was on the 8th experimental day, consequently the randomised block structure of the experimental design was not maintained during the first seven days of observations. The abandonment of the batched protocol when there were high bycatch volumes has the potential to bias the experiment and produce a false result, as numbers of birds around the vessel are expected to be related to the amount of bycatch being discharged.

The low numbers of observations mean that on five of the experimental days there were only two or fewer observations made during processing.

Table 2 Changes made to the original order of the experimental treatments

Date	Original protocol	Actual protocol	Reason
22/2/2007	Minced	Unprocessed	A hoki target tow, bycatch species are not going through the mincer
23/2/2007	Unprocessed	Minced	Swapped with 22/2
24/2/2007	Batched	Minced	Too many discards for batching
25/2/2007	Batched	Minced	Too many discards for batching
8/3/2007	Minced	Unprocessed	Rocks
9/3/2007	Batched	Minced	Swapped with 8/3 and 10/3
10/3/2007	Unprocessed	Batched	Swapped with 8/3 and 9/3
11/3/2007	Batched	Unprocessed	Rocks

Discharge

The number of observations, by discharge type and rate, is shown in Table 3. The 35 observations where the factory was not processing are not included in this table. Aside from these observations, and noting that the batched treatment produced minced discharge, the discharges were as expected from the experimental treatment. Only mince and sump water were discharged during the batched and minced treatments, and only offal, discards and sump water were discharged during the unprocessed treatment. There was one observation made during an unprocessed treatment when neither offal nor discards were discharged. Six observations were made when there was no offal discharged and the discharge of discards was negligible. Half of the observations in the batched treatment were made when there was negligible or no discharge occurring. This is consistent with the protocol, as the batching leads to an intermittent discharge, with a small discharge of mince between the large batches.

Table 3 Number of bird count observations made when the factory was processing, by treatment and discharge rate. During all these observations there was intermittent sump discharge. Only mince and sump water was discharged during the minced and batched treatments, and there was no discharge of mince during the unprocessed treatment.

Treatment	Discharge	Discharge rate			
		None	Negligible	Intermittent	Continuous
Unprocessed	Offal	9	0	6	0
Unprocessed	Discards	2	7	6	0
Minced	Mince	0	7	13	5
Batched	Mince	1	4	5	0

There were several comments indicating that the mince was primarily made of crab, and that the birds were not interested in the crab mince. For example, during observation 42 the observer notes “birds checking mince out however few feeding as it is only munched up crabs”. Across the 85 observations there were 11 observations where the observer noted that the discharge included crab. In four of those observations, the presence of fish was also noted. Seven of the comments referring to crab were during the minced treatment, four during the batched treatment and only one during an unprocessed treatment. An extract from the Ministry of Fisheries observer database that indicates which species were discarded has beenrequested, to help quantify variations in the occurrence of crabs.

The distribution of discharge behind the vessel is shown in Figure 8. Sump water was discharged from both sides, and flows in two streams behind the vessel. Offal and mince are concentrated on the port side, and remain within the lines of the sump water. The discards appear on both sides of the centerline. It appears that the mince remains on the surface for longer than the sump water or the other discharge.

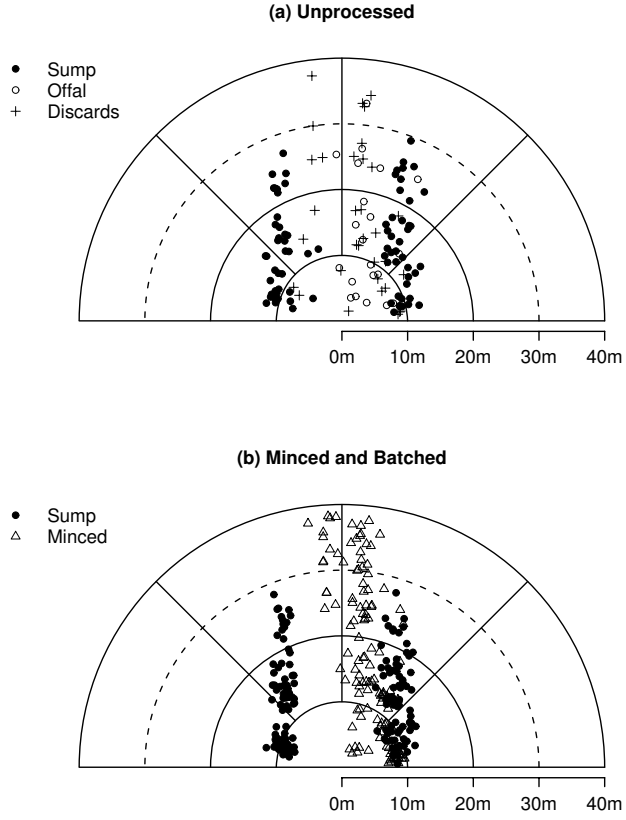

Figure 8 The digitised discharge data, showing the distributions of offal, sump discharge, discards and minced discharge behind the vessel for (a) the unprocessed treatment and (b) the minced and batched treatments combined.

Environmental data

Wind speed and swell height were associated with one another (Figure 9). Environmental data was only recorded when observations were made, so the peak wind speeds and sea states will not have been noted. There were two observations made when the wind was gale force (force 8), on the February 27 and March 4. On February 27 the swell reached a height of 4m.

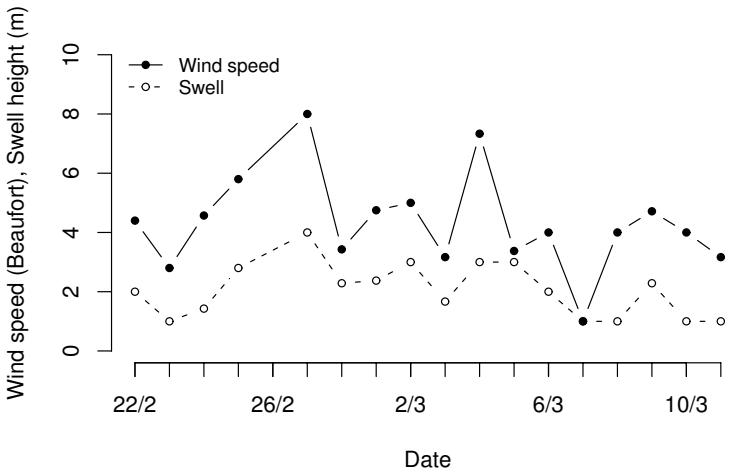

Figure 9 Daily average wind speed and swell height

The observer successfully made observations throughout the day (Figure 10), and the vessel speeds during observations were narrowly distributed (Figure 11), with the speed being close to 4 knots (a minimum of 3.6 knots and a maximum of 4.4 knots were recorded).

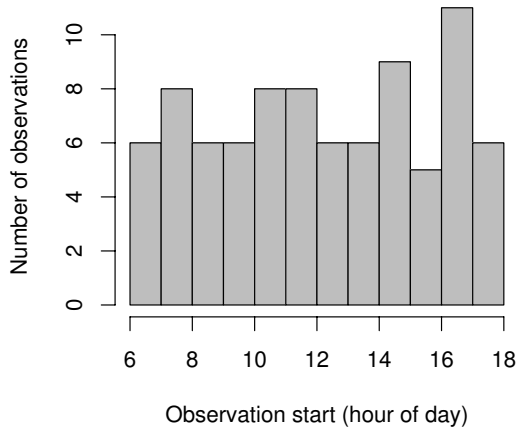

Figure 10 Distribution of observation start times through the day

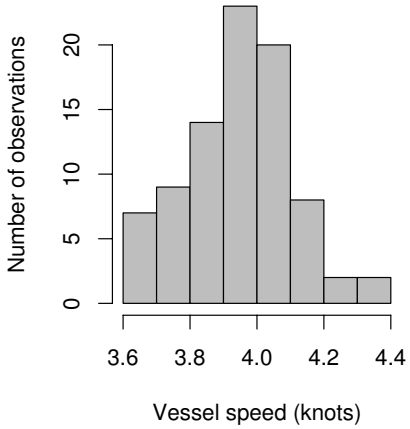

Figure 11 Distribution of vessel speeds

Bird counts

Summaries of the bird count data are given in Table 4. Across the whole experiment, the birds that most commonly attended the vessel were small albatross (an average total of 82 birds per observation) and other petrels and shearwaters (an average total of 51 birds per observation). Large albatross, giant petrel and cape pigeon together counted for less than 4% of the birds within the 40m sweep area. In all categories, apart from the giant petrel, there were on average more flying birds within the sweep area than sitting or feeding birds. In all categories, there were significantly more birds sitting on the water than actively feeding.

Numbers of birds within the inner 10m sweep region were low, with the most frequent being small albatross (an average total of 6.6 birds) and other petrel (an average total of 2.1 birds). The low numbers of birds close to the vessel is due to the use of tori lines. The observer reported numbers of birds feeding along the port side, close to the discharge outlet (Figure 12, see also the comments on the video in Appendix B). This feeding activity is not captured on the form and these birds aren't directly at risk from being hit by the warps. As the vessel moves forward, some birds stay feeding on patches of discharge and drift back, rather than keeping up with the vessel. These birds then move into the sweep zone, where they are counted. If the observations were intended to capture all activity, then birds should also be counted along the vessel's sides.

Table 4 Numbers of birds within each category, by behaviour, including data from all observations. The table gives the mean number, with a 95% confidence interval for the mean calculated using a bootstrap with 10,000 iterations.

(a) Number of birds within the 40m sweep area

Bird group	Total	Behaviour		
		Flying	Sitting	Feeding
Large albatross	3 (2.4 - 3.6)	1.5 (1.2 - 2)	1.2 (0.76 - 1.6)	0.26 (0.12 - 0.41)
Small albatross	82 (66 - 99)	48 (37 - 61)	29 (20 - 39)	5 (3 - 7.3)
Giant petrel	1.2 (0.91 - 1.6)	0.21 (0.12 - 0.31)	0.78 (0.52 - 1.1)	0.22 (0.11 - 0.36)
Other petrel	51 (44 - 58)	30 (25 - 35)	16 (13 - 19)	5.2 (4 - 6.5)
Cape pigeon	0.98 (0.64 - 1.4)	0.48 (0.2 - 0.88)	0.4 (0.26 - 0.55)	0.094 (0.034 - 0.16)

(b) Number of birds within the inner 10m sweep area

Bird group	Total	Behaviour		
		Flying		Feeding
Large albatross	0.035 (0.01 - 0.073)	0.012 (0 - 0.035)	0.012 (0 - 0.034)	0.012 (0 - 0.034)
Small albatross	6.6 (5 - 8.5)	3.5 (2.3 - 4.9)	2.5 (1.4 - 3.7)	0.62 (0.33 - 0.95)
Giant petrel	0.24 (0.11 - 0.38)	0 (0 - 0)	0.16 (0.06 - 0.29)	0.071 (0.013 - 0.14)
Other petrel	2.1 (1.5 - 2.8)	1.2 (0.81 - 1.7)	0.55 (0.24 - 0.91)	0.34 (0.12 - 0.6)
Cape pigeon	0.27 (0.15 - 0.41)	0.082 (0.013 - 0.18)	0.13 (0.052 - 0.22)	0.059 (0.012 - 0.11)

Figure 12 Albatross feeding on the port side of the vessel, close to the discharge outlet

With the exception of cape pigeon, the total counts in the 40m sweep zone were positively correlated with one another (Table 5). In particular the two most frequent groups (small albatross and other petrel) are highly correlated. This can be seen in a plot of the raw count data (Figure 13). Observations with high numbers of small albatross tend also to have high numbers of shearwaters and other petrels.

Table 5 Correlation (Pearson's ρ) between total counts for each bird group, across all observations

	Small albatross	Giant petrel	Other petrel	Cape pigeon
Large albatross	0.42	0.29	0.39	0.025
Small albatross		0.41	0.77	-0.086
Giant petrel			0.31	0.025
Other petrel				-0.12

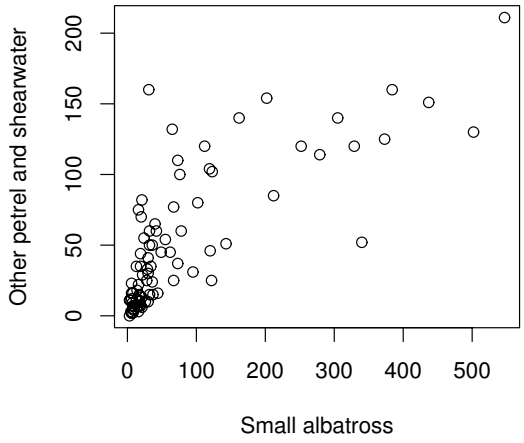

Figure 13 The relationship between total counts of small albatross and of other petrel and shearwater, from all observations.

The distribution of the total count observations is shown in Figure 14. In all categories, zero counts are common, and the distributions typically have a long right-tail, with occasional very high counts. A time series view of the total count data, for the 40m sweep zone, is shown in Figure 15. Variations in the numbers include any treatment effects. The time series show that all bird categories were present throughout the experiment.

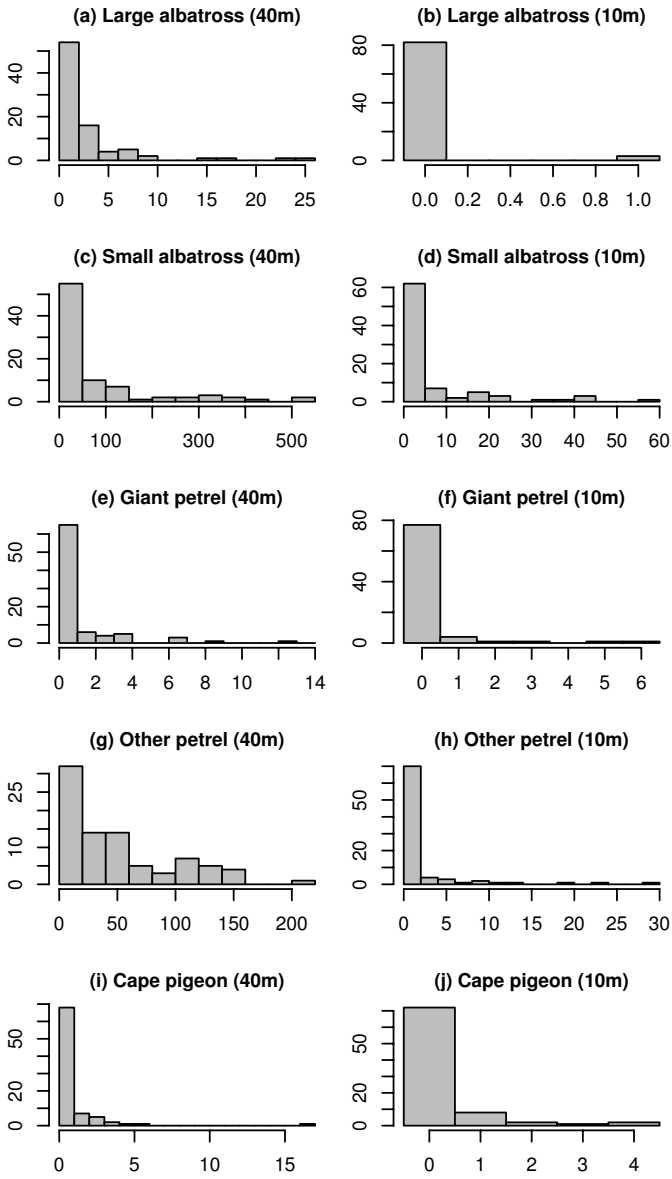

Figure 14 Histograms of the numbers of birds within the 40m and inner 10m sweep areas, showing the numbers of observations with the given counts. The count data is from all treatments, and is the sum of the counts from each of the three behavioural categories.

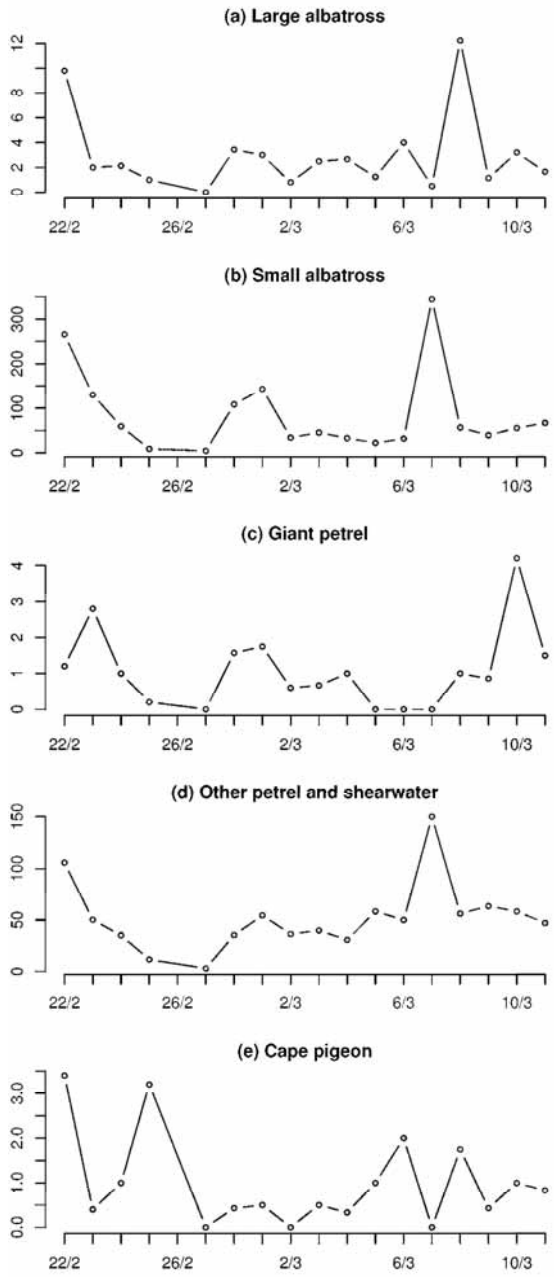

Figure 15 Time series of average daily total counts, for each of the five taxonomic groups. Data from all treatments is included, and the data is based on the sum of the flying, sitting and feeding counts within the 40m sweep area.

Bird counts by treatment

As an indication of potential treatment effects, the mean bird counts are shown in Table 6, grouped by treatment. There are many potential combinations of the data that could be analysed. Here the total counts in the two sweep areas and the numbers of birds on the water (sitting and feeding) in the larger 40m sweep area are presented. In most categories, apart from cape pigeon, there are significantly fewer birds within the sweep areas when there is no discharge. In the larger sweep zone, there are apparent treatment effects, with the minced treatment having fewer large and small albatross, and with there being a smaller total number of large and small albatross during the

batched treatment. There appears to be a treatment effect on the shearwater and other petrel, when assessed using the number of birds within the 10m zone as a measure. There are no other significant treatment effects in the 10m zone.

Table 6 Numbers of birds within each category, by treatment type. The table gives the mean number, with a 95% confidence interval for the mean calculated using a bootstrap with 10,000 iterations. Mean counts which are significantly different from the unprocessed treatment, at the 95% level, are shown in bold.

(a) Total number of birds within the 40m sweep area

Bird group	Treatment			
	No processing	Unprocessed	Minced	Batched
Large albatross	**1.7** (1.2 - 2.1)	7.7 (5 - 11)	**2.4** (1.6 - 3.1)	**2** (1.3 - 2.7)
Small albatross	**15** (13 - 18)	200 (140 - 260)	**95** (73 - 120)	**110** (62 - 170)
Giant petrel	**0.51** (0.31 - 0.74)	1.5 (0.73 - 2.3)	1.6 (0.88 - 2.4)	2.4 (1.3 - 3.7)
Other petrel	**13** (10 - 15)	92 (73 - 110)	**70** (61 - 80)	76 (55 - 99)
Cape pigeon	1.6 (0.81 - 2.6)	0.73 (0.34 - 1.2)	0.48 (0.27 - 0.71)	0.5 (0.059 - 1.1)

(b) Number of sitting and feeding birds within the 40m sweep area

Bird group	Treatment			
	No processing	Unprocessed	Minced	Batched
Large albatross	**0.43** (0.2 - 0.69)	4.5 (2.5 - 6.7)	**1.2** (0.69 - 1.9)	**0.8** (0.36 - 1.3)
Small albatross	**3.1** (2.2 - 4)	76 (49 - 110)	**37** (23 - 54)	69 (19 - 130)
Giant petrel	**0.4** (0.22 - 0.6)	1.3 (0.61 - 2.2)	1.2 (0.62 - 2)	2 (0.89 - 3.2)
Other petrel	**2.8** (1.8 - 4)	35 (27 - 44)	30 (26 - 35)	42 (24 - 62)
Cape pigeon	0.6 (0.34 - 0.89)	0.67 (0.29 - 1.1)	0.28 (0.11 - 0.48)	0.4 (0 - 0.9)

(c) Number of birds in the inner 10m radius area

Bird group	Treatment			
	No processing	Unprocessed	Minced	Batched
Large albatross	0 (0 - 0)	0.13 (0 - 0.31)	0.04 (0 - 0.12)	0 (0 - 0)
Small albatross	**0.94** (0.56 - 1.4)	13 (8.8 - 19)	9 (5.9 - 12)	10 (3.1 - 19)
Giant petrel	**0** (0 - 0)	0.53 (0.1 - 1.1)	0.32 (0.079 - 0.64)	0.4 (0 - 1)
Other petrel	**0.51** (0.26 - 0.79)	6.8 (4 - 9.8)	**2.2** (1.4 - 3)	**0.6** (0.14 - 1.1)
Cape pigeon	0.29 (0.061 - 0.56)	0.53 (0.2 - 0.91)	0.2 (0.071 - 0.35)	**0** (0 - 0)

Warp strike observations

There were 100 strike observations from 17 different tows, 50 of which were of the trawl warps and 50 of the mitigation devices. There were no contacts recorded on the warps during the entire voyage and so the warp strike observations are not considered any further. The vessel was using tori lines (all 50 observations, with 3 different lines being used during the voyage), and side bird bafflers when the weather permitted (41 observations). During mitigation device trials it was found that there were many strikes on the tori lines, but few on the bird bafflers (Middleton and Abraham 2007, Abraham et al 2007). It is assumed that the mitigation device strikes recorded here were on the tori lines.

Of the 50 observations of warp strikes on the mitigation devices, all apart from one were made when there was discharge. The observer avoided making observations when the factory was not processing. The single no discharge observation was removed from the dataset. There was one observation that had a recorded time of 14 minutes. On one observation the number of contacts had been left blank and these were assumed to be zeros. Otherwise, the forms were all filled in as specified by the protocol.

The mitigation device strike data is summarised in Figure 16. There were many observations without strikes (22 observations or 44%), although the frequency of observations without strikes was lower than has been seen previously (Middleton and Abraham 2007, Abraham et al 2007). The maximum number of large-bird strikes during any observation was 11 large birds, and the maximum number of small-bird strikes was six.

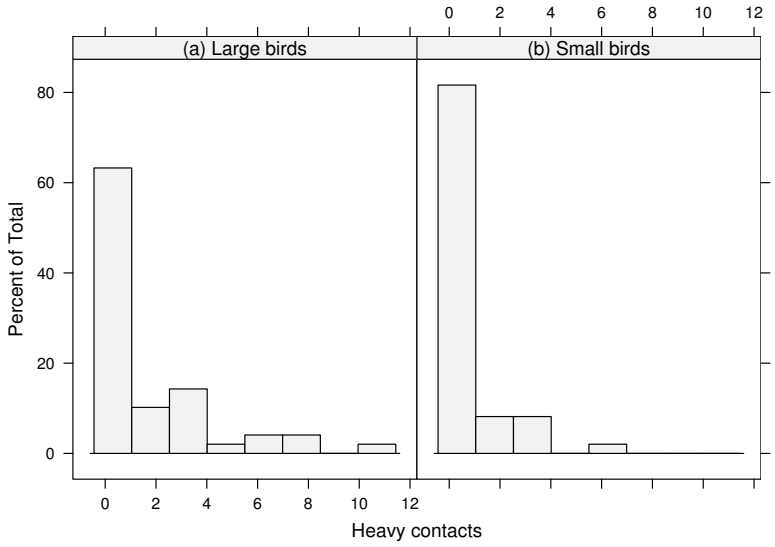

Figure 16 Histograms of heavy contacts on the mitigation device, for (a) large birds and (b) small birds.

The mean strike rates, and associated uncertainty, are given in Table 7. From this analysis it appears that there was a reduction in large bird strikes during the minced treatment, but an increase in the number of small bird strikes, so that the total number of strikes is unchanged. The estimation of the confidence intervals from the bootstrap method may not be reliable, because of the small number of observations and the long right-tail to the strike distributions. The statistical significance of the variation in the mean strike rates will be checked through generalised linear modeling of the data.

Table 7 Mean contact rate (number of mitigation device strikes per 15 minute observation period) grouped by treatment, for large bird contacts, small bird contacts and total contacts. The numbers in brackets are the 95% confidence intervals in the means from 10,000 bootstrap resamplings of the data. Numbers that are significantly different from the unprocessed treatment are shown in bold.

	Treatment		
	Unprocessed	Minced	Batched
Number of observations	14	25	10
Mean large bird contacts	1.9 (0.72 - 3.2)	**0.68** (0.24 - 1.2)	3.4 (1.5 - 5.6)
Mean small bird contacts	0.36 (0.071 - 0.71)	**1.1** (0.48 - 1.8)	**0** (0 - 0)
Mean total contacts	2.3 (0.93 - 3.8)	1.8 (0.96 - 2.6)	3.4 (1.5 - 5.7)

Discussion

The observer had difficulties implementing the experimental protocol on this voyage. Early in the voyage, high volumes of bycatch meant that the batched protocol could not be used. At other times, there were rocks caught in the trawl which meant that the bycatch could not be minced. In addition, many observations were made when there was no processing being carried out, and these observations are not suitable for distinguishing between experimental treatments. On some days, bad weather prevented observations being made. Taken together, these difficulties reduce the amount of data that was collected by the observer, to the point where it may be difficult to convincingly demonstrate a result.

Despite these issues, the initial analysis suggests that there is a significant treatment effect. In particular, that both the batched and the minced treatments reduce the total number of both large and small albatross within the 40m sweep zone. When just the inner zone is considered, there is a reduction in other petrels and shearwaters during both the minced and batched treatments. Statistical modelling will be used to help assess whether these apparent effects may be caused by a coincidental variation in other factors, such as discharge, rather than being a true treatment effect.

There are difficulties comparing the batched and minced treatments as it is unclear how the observer chose the time of the observations relative to the timing of the discharge, during the batched treatments. No detailed information on the time between discharges and the duration of each discharge was collected. The interpretation of the data is also complicated by the variation in the discharge type, with the observer noting that the birds were disinterested in minced crab and spiny dogfish. There were several tows where the bycatch was predominantly crab. The low number of observations makes the experiment prone to being biased by the variation in discharge composition, as it is not well captured in the data.

Acknowledgements

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Appendix A: Comments

These are comments from the forms, grouped by treatment. The comments are listed by form number and by the date of each observation. Other text included within square brackets was not part of the comment, but has been included to provide additional information.

Unprocessed

1 (22/02/2007). Majority of discards and offal being eaten portside midships at discard outlet. Approx 120 birds feeding here. No feeding around warps due to toris and side bafflers.

2 (22/02/2007). Same feeding places as in observation number 1.

4 (22/02/2007). Vessel lifting doors to make a turn as I finish these observations. Processing completed.

23 (27/02/2007). No processing. No sumps on. Weather still rough. Not that safe down there.

31 (01/03/2007). Factory nearing end of processing. Small amounts of offal coming out intermittently/negligible. Should increase more nearer end of processing.

32 (01/03/2007). Birds high in the air within 10m sweep and spreading back due to 2 o'clock wind. Intermittently offal discharging. Negligible discards coming from starboard side outlet.

33 (01/03/2007). No processing. Sumps off.

34 (01/03/2007). No processing. Sumps off.

35 (01/03/2007). No processing.

36 (01/03/2007). No processing.

37 (01/03/2007). No processing.

38 (01/03/2007). No processing.

50 (04/03/2007). Weather conditions more to the birds liking today. 30kts with most on wing. Our vessel in line with 7 others close by. Birds visible behind the vessels I can see. Factory not processing so nothing coming out. Bird numbers higher as they don't spend much energy in this wind compared to light winds as they have to do big arcs to check things out.

51 (04/03/2007). Still no processing. Sumps off.

52 (04/03/2007). Not long into processing this tow. Discards are minimal at present. Weather turning nasty and wind increasing. What discards that are coming out are getting eaten by birds at port side of vessel. None making into sweep zone at present.

65 (08/03/2007). Discards are small rattails and spiny dogfish along with crabs. Also a number of small rocks. Bird numbers not high. 2 russian vessels beside us. They have streams of birds following them. May be a bit of interaction between vessels. No feeding around warps and due to calmish conditions the small rattails are getting eaten by birds at portside discharge chute. See video.

66 (08/03/2007). Same scenario and conditions as in observation number 65. Smaller discard fish being eaten at discard output. Large species including spiny dogfish being eaten in area between tori windy buoys by large and small albys.

67 (08/03/2007). No processing.

80 (11/03/2007). Discards are minimal and mainly rocks. 4 other vessels in vicinity. Was meant to be batched protocol today, however this tow being processed has numerous small limestone rocks in it which damages mincer machine.

81 (11/03/2007). Minimal discard of fish. Heaps of rocks coming out of discard chute. Birds hanging around discard chute seem to get the few discard eatables before reaching past stern. Some popping up behind windy buoys. Not enough to attract birds in large numbers. Small petrels diving into prop wash. I have called they are feeding. Thats their intention anyways I guess.

82 (11/03/2007). Discards still minimal. Bird numbers have dropped away in sweep zone. Numerous birds sitting on water out of zones.

83 (11/03/2007). Bird numbers continue to die away. Discards that minimal. Not enough to encourage feeding behaviour.

84 (11/03/2007). Factory processing tow 30. Very few discards. Non ITQ.

85 (11/03/2007). Factory nearing end of processing and are processing bycatch. Discarding heads, offal and whole spiny dogfish. Bird numbers high. A lot feeding around discard release point. Discharge rate not entirely continuous but close to it.

Minced

6 (23/02/2007). Mincer currently not processing bulk amounts of discard species due to factory packing squid. Discharge will be negligible until factory gets near end of processing. Crew have to be careful as large amounts of sandstone/rock in bag processing. Don't want them to go through mincer. When mincer outlet discharges most eaten before getting through stern. Petrels and shearwaters diving down feeding on remaining mince past tori windy buoy on port side.

7 (23/02/2007). Birds flying in 10 metre area due to wind direction.

8 (23/02/2007). Very light wind. Majority of birds sitting.

9 (23/02/2007). Only crabs going through mincer. Birds not that interested.

10 (23/02/2007). Minced crab still pumping out of outlet. Birds feeding out past tori windy buoys.

15 (24/02/2007). Have changed protocol from batching to mincer due to batching causing major delays in processing. Earlier observations today under batching done when no processing carried out.

16 (24/02/2007). [Diagram - the observer has added a comment to the offal diagram. With an arrow pointing to an area between the middle outer segments he notes that "majority of birds sitting and feeding here"].

17 (24/02/2007). No processing. All factory sumps off.

18 (25/02/2007). Factory idle. No sumps going.

19 (25/02/2007). No processing. Sumps off.

20 (25/02/2007). No processing. Sumps off. 5 other vessels visible in mist close by.

21 (25/02/2007). No processing. Sumps off.

22 (25/02/2007). Sumps off. No processing.

24 (28/02/2007). No processing. Sumps off.

25 (28/02/2007). No processing. 6 other vessels in vicinity.

26 (28/02/2007). No processing. Factory idle. Sumps off.

27 (28/02/2007). Mincer processing spiny dogfosh only at this stage. Fed in only intermittently. Birds not all that keen on spiny dogfish mince. Majority of feeding taking place beyond sweep zone.

28 (28/02/2007). Similar events as in observation number 27. Intermittent discharge of mainly spiny dogfish mince. Majority of bird numbers aft of sweep zone.

29 (28/02/2007). Birds mainly on wing flying in big arcs. Up to 100 birds in and out of sweep zone. Still mainly spiny dogfish mince.

30 (28/02/2007). Mix of fish and spiny dogfish mince now. Attracting more birds. Birds coming in waves both port and starboard side into wind and landing in middle between tori floats, then floating back beyond sweep area.

44 (03/03/2007). No processing.

45 (03/03/2007). No processing. Sumps off.

46 (03/03/2007). Factory not long into processing. Bycatch at this stage minimal. Very little mince coming out of sump.

47 (03/03/2007). Mince coming out on regular basis now - every 20 sec from sump mainly large seabirds, white chin petrels only interested. Mollys on wing flying in big arcs checking things out every now and then. Not a lot of eating food attracting them as mince is mainly crab.

48 (03/03/2007). Bird number increase due to processing nearing end and bycatch species being processed ie silver warehou etc offal coming through mincer. Big difference from when only crab coming out.

49 (03/03/2007). No processing. Sumps off.

53 (05/03/2007). No processing. Light wind. Foggy. Just can see end of sweep zone.

54 (05/03/2007). No processing. Sumps off.

55 (05/03/2007). No processing.

56 (05/03/2007). No processing. Still overcast foggy conditions.

57 (05/03/2007). Mince coming out every 20 - 25 sec. Small birds (petrels) only ones interested. Albys cruising around on wing having looksee, however not feeding. Mince at this stage mainly crab.

58 (05/03/2007). Wind has dropped to near still. Albys now flying in big arcs checking things out. Still mainly crab mince being discharged.

59 (05/03/2007). Wind picking up. Alby still flying in arcs. Some fish now mixed in with crab. Negligible amount though. Still majority crab.

60 (05/03/2007). Processing nearing end. Approx 30kg of silver warehou and red cod to process along with remaining squid and crabs. Vessel just completed turn. Back fishing now. Bird numbers still similar with feeding mainly from shearwaters and petrels.

64 (08/03/2007). No processing. Sumps off.

68 (09/03/2007). Mince is negligible due to factory processing mainly squid.

69 (09/03/2007). Mince still negligible. Not enough to attract large numbers of birds. Another Korean vessel in vicinity has big numbers following her.

70 (09/03/2007). Mince still negligible.

71 (09/03/2007). Mincer conveyor turned off due to small rocks prior to these observations. Got them to turn conveyor on and leave on and try to pick rocks out. Crew fairly tired as they have been working since 1930 hours yesterday.

72 (09/03/2007). Mince starting to come out more regularly as nearing end of processing.

73 (09/03/2007). Mince coming out every 20 seconds. Mainly fish. Have got 4 other vessels close by.

74 (09/03/2007). Fish mince still coming out every 20 seconds or so. However, not a large amount.

Batched

11 (24/02/2007). Factory idle and sump pumps off.

12 (24/02/2007). Factory idle. Two other vessels in vicinity with streams of birds following them.

13 (24/02/2007). No processing.

14 (24/02/2007). No processing. All sumps off.

39 (02/03/2007). No processing. Sumps off.

40 (02/03/2007). No processing.

41 (02/03/2007). At time of these observations mincer hadn't discharged. It is why bird numbers low. Factory is building up conveyor approx 200kg worth and then putting through mincer. This is occurring every 20min - 30 min. Small amount of bycatch this tow.

42 (02/03/2007). This set of observations mince being discharged. Bird numbers have increased slightly as mincer has discharged 4 times before this set of observations. When mincer is on it discharges approx every 20 - 25 sec. Birds checking mince out however few feeding as it is only munched up crabs.

43 (02/03/2007). Mince being discharged at time of observations. Still not large numbers of birds in sweep zone. Approx another 30 birds sitting on water beyond zone.

61 (06/03/2007). Only one other vessel in vicinity. No processing.

62 (07/03/2007). Mince is a mix of red cod heads and offal along with crab. Estimate ratio to be 70% red cod and 30% crab. Benign weather conditions up to 300 or more small albys sitting on water beyond sweep zone (see video). No feeding around warp area even though mince is passing under it. Some birds feeding to portside of vessel.

63 (07/03/2007). Same scenario as in observation number 62. Long stream of birds sitting beyond sweep zone. This is due to benign conditions. No feeding around warp area. Mince coming out approx every 60 - 70 seconds.

75 (10/03/2007). Approx 10 min between discharges of mince due to low amount of bycatch. High bird numbers beyond sweep zones either flying or sitting on water. No discharge when this sweep carried out. Next set will be # 76. Fishing on our own. No other vessels around us.

76 (10/03/2007). Mince being discharged this sweep.

77 (10/03/2007). No mince discharged this sweep.

78 (10/03/2007). No mince this sweep. Last discharge some 5 minutes ago.

79 (10/03/2007). No mince this sweep.

Appendix B: Video footage

The observer took ad hoc hand held video of the activity around the vessel. The following is a list of all the 38 video clips that were returned from the voyage. The first line of each entry gives the name of the file, the date of the clip, and its duration (minutes and seconds). A short description of each clip is included. If the observer made comments during the filming, then the dialog is transcribed and is given in the italicised text. Numbers in brackets within each transcription indicate the position in the clip of each comment. Other text is included within square brackets where a context is needed. Dialog that couldn't be clearly heard is indicated by ellipses.

Unprocessed

P2220022.MOV (22/02/2007, 1:16)
View from stern of port warp and tori line. Sunny day and calm sea. Birds sitting on water outside tori line and in distance. Shows patches of milky water moving past warp and tori line. A few birds are drifting past with each patch

P2220023.MOV (22/02/2007, 0:39)
Closer view of milky patches drifting past the warp and the tori line, showing occasional feeding. Pans back to view of birds in distance (20 - 28s), and then follows another patch.

P2220024.MOV (22/02/2007, 0:23)
Follows milky patch from discharge at side of vessel past bird bafflers and past warps. No birds feeding on patch.

P2270056.MOV (27/02/2007, 1:01)
Mincer in factory, showing waste passing through the mincer.

P2270057.MOV (27/02/2007, 1:35)
Shows warp and tori line on port side. A few albatross on water feeding outside tori line. Birds in air landing close to windy buoy. Birds in air and on water beyond the buoy.

P2270058.MOV (27/02/2007, 1:24)
Albatross feeding on discharge at side of vessel and drifting back beyond the tori lines. At end shows a giant petrel on water getting out of the way of the bafflers.

P2270059.MOV (27/02/2007, 0:54)
View from stern looking back at tori line. Other vessels in distance. Birds on air and in water beyond the buoy.

P3010005.MOV (1/03/2007, 2:09)
First minute shows the side of the vessel, with birds near the discharge outlet. Second minute gives the view from the stern of birds beyond the tori line buoys.
(25) Unprocessed fish and offal coming out. Increase in bird numbers compared to the mincer. (1:03) There is the discharge outlet. No bafflers today because of the wind. (1:15) Seabird numbers are much bigger than other days, mind you there's about three other vessels here and it doesn't look like they are processing. We are still processing from last night. Not all that much offal and discards coming out. Getting near to the end of the bag, so should have a bit more soon.

P3010006.MOV (1/03/2007, 0:09)
Short clip. Zoomed in on birds in distance beyond buoy.

P3010008.MOV (1/03/2007, 0:32)
Some wind and swell. View from stern of tori line and warp. Birds in air and on water beyond the buoy.

P3010009.MOV (1/03/2007, 4:03)
Some wind and swell. View from stern of tori line and warp. Birds in air and on water beyond the buoy. Switches to starboard side (1:20) and shows warp entry point. Starboard warp is unprotected by the tori line and some birds get close to the warp (see 1:50)
(35) … they are well away from the warp area. Bits and pieces of guts keep coming out. Just intermittently though. (1:23) Stuff coming out the starboard side now. They are just cleaning up the factory. (1:46) Got no bafflers out today because of the wind.... pretty close to the warp... that's because of the wind blowing the way it is ... (2:40) Getting a bit rocky and rolly here. Hard to keep the camera still.

P2270001.MOV (27/02/2007, 1:52)
View from stern, looking down port tori line. Sunny and calm. Low numbers of birds beyond windy buoy.
(47) Most of the offal going through the mincer is spiny dogfish. It is not all that encouraging for the birds to feed on. They just peck at it. (1:33) You only get up to a maximum of ten at any one time having a go at it.

P3040019.MOV (4/03/2007, 2:09)
View from stern of port warp and tori line. Processing tow 16. Rough weather. Most visible birds are in the air. Has a shot of albatross on water by discharge outlet (after 1:40).
(4) We are processing tow 16. The protocol is unprocessed, the discards are negligible because it is mainly all squid. You'll find it will come out in bursts every now and then as they clear their trays from the sorting tables. (32) The port side warp here is sticking out to the port a bit, not where it usually is. The starboard one is more

or less in the middle (48) We've got birds following us and when there is a bit of a discard they come pretty close up. The discards are few and far between at the moment. (1:07) We're back to normal weather for down here. It's nearly 40 knots now. Its going to get worse as the day wears on. (1:40) I'll just go over here [goes to port side to look at discharge] got a few fellows hanging around, like I say, there's not much coming out.

P3080027.MOV (8/03/2007, 3:09)
View from stern of are behind vessel and of feeding around the discharge outlet. Albatross at side of vessel and in distance, beyond buoys.
(6) We've got tow 26 in the water. We've got unprocessed coming out. Due to the last tow having a lot of rocks in it they asked if we could change protocol from a mincer to unprocessed. (27) We've got whole discards coming out. We've got other vessels in the vicinity. Two Russians. Good streams of birds coming from both of them. So our numbers aren't so high really. Not as high as they would be if those birds weren't there. (53) The discards are mainly small rattails and spiny dogs with a few crabs thrown in, plus plenty of rocks. (1:06) Bit of feeding on the ones that get down there, see that guy just got a fish. Not a lot of feeding down there compared to round the corner here (1:20) Where the discards come out the birds seem to snaffle most of it before it gets down to the stern. That's due to the calm conditions, or calmish conditions, and the lee side of the vessel, where the birds can sort of hang around. If the wind was the other way they wouldn't be there. (2:06) We'll see the discard chute open up soon. Here we go (2:16) See they are all into it ... that comes out, just a couple of fish and spiny dogs ... So there's a lot of feeding down there. (2:45) The only other place is back in the middle of, between the tori lines, the windy buoys. The prop wash is quite big today, churning them up, way down there. That's the idea, I suppose.

Minced

P2230043.MOV (23/02/2007, 1:28)
Follows discharge patches down the side of the vessel, past bafflers and into distance. Some feeding activity.

P2230044.MOV (23/02/2007, 1:11)
View of discharge from close to outlets. Shows stream of discharge hosing onto the water, with a few birds feeding from each pulse.

P2280002.MOV (28/02/2007, 0:11)
Short clip of poor quality. View from stern showing birds landing on water by buoy.

P2280003.MOV (28/02/2007, 1:27)
View from stern. Birds on water beyond tori line. Shows birds flying and landing.

P3030016.MOV (3/03/2007, 3:01)
View from stern. Flat sunny day. Generally watching a few birds in air and on water beyond buoy. Switches to a view of the discharge at around 2:20. Few birds.
(11) Tow 15 in the water. We are mincing today but the birds don't seem to be interested at all. Just a few small ones down the back beyond the sweep zone who are diving down feeding but not much happening at all. (33) We have got about 6 other Korean vessels with us. They have all recently hauled so maybe the bird numbers are around them. (58) You can see its a beautiful day down here for a change ... might even have to get the suntan lotion out. That'd be a first! (1:15) Can see the Korean fleet in the distance there. (1:24) Yeah, not much action at all. The mince is coming out about every 25 seconds. (2:19) There is not even bird numbers around the outlet which there usually is when we are doing mince (2:24) There is the mince there. Mainly crab again. Just not exciting for them, I guess.

P3030017.MOV (3/03/2007, 1:26)
Starts with a view of discharge in water drifting back, then after 20s settles on a view looking back from stern. Few birds around, sunny calm weather.
(23) Mince is coming out regular now, every 20 seconds or so. Mainly the white chinned petrels and the sooty shearwaters that are feeding on it. (33) Every now and then a small alby has a go but there is not much there to attract them, mainly crabs. (43) Still, numbers are pretty low. You get groups doing big arcs checking out things as they go by. (1:00) Not a high number of birds... most of them will be behind those Koreans behind us.

P3030018.MOV (3/03/2007, 3:11)
View from stern of tori line and birds feeding beyond. Some more birds around. Sunny day and calm weather.
(7) We are getting near the end of processing now .. A bit more mince and stuff coming out attracting a few more birds. (20) A big difference when there is bits of fish and stuff coming out through the mincer. It is not just only crabs, but the majority of it is. (58) It is the difference between crab mince and mixed with a bit of fish (1:24) See down the back there, petrels are diving down bringing bits and pieces up. That's what the larger birds are beating them up for (1:58) That mince there is all guts and stuff from processing the bycatch.

P3050020.MOV (5/03/2007, 2:25)
View from stern along port tori line. White chin petrels and shearwater in air beyond windy buoy. Some diving activity. Windy weather.
(3) We've got tow 18 in the water. We've got tow 19 processing in the factory at the moment. We're on mince. Mince is going every 20 seconds. Mainly crab again. Not attracting the birds, just the white chin petrels mainly and the shearwaters. They're sort of diving down but no feeding whatsoever around by the warps. Hardly any birds at all. (42) See the petrels diving down the back there, just beyond where the windy buoys reach. (1:07) Another beautiful day down here [Sarcasm]. You can see mince coming down there by the prop wash. Definitely churns up by the warps. But I don't know what it is, either the bafflers, the gear or the tori lines, sort of keep them at bay. Not much .. big birds. Like I say, it is not till you get near the end of processing when they are directing the silver warehou and bycatch species that you seem to attract the larger birds. (2:20) Just keep sitting here in the rain and doing my warp and tori line obs.

P3050021.MOV (5/03/2007, 5:12)
View from the stern. Mixed petrel and albatross. Shows petrel feeding around the tori line. Overcast and moderate wind.
(11) Third set of obs for the tow. Can see the small albies are going around in big arcs. The wind isn't that strong. The mince is attracting the white chinned petrels quite a bit. Every now and then a bit of fish gets mixed up with it and they all sort of want to have a go at it. Most of the feeding's being done beyond the warp area. (1:12) The feeding that does happen in the 10m zone is usually to the outside of the tori line. Negligible amount of feeding around the warps, if any. (1:58) Still mainly all crab coming out. There must be a bit of fish in there to attract the numbers of birds we've got at the moment. The previous video footage there was probably half this many birds here. (2:47) There's no feeding down at the discard outlet there. No birds around there. They are all sort of waiting for it to get down there. There's a bit of fish mixed up and they are straight on to that. But the amount of fish compared to the crab is minimal (3:14) Like I said, it is not until near the end of processing, when they are processing the bycatch and silver warehou that the bigger birds get into it (3:50) definitely all the feeding is away from the warp. See, there's mince going under the warp there. (4:20) Probably gives you a good idea on what happens when you are mincing. Especially in these wind conditions. The wind is just starting to pick up now. Usually ... the small albies, they swing a big arc, whereas if it is a strong wind they would just hover here. Wind direction and strength has a bearing on their behaviour.

P3080030.MOV (9/03/2007, 1:33)
View from stern around vessel. Few birds in air.
(4) We've got mince, but its very negligible. Hardly anything coming out because they are mainly processing squid. As you can see by the bird numbers, they are not that great. Another Korean vessel in the distance that's got quite a large number of birds following it. Probably there's more attracted to that vessel than this one. (40) We've got ... birds feeding down the back there, just on the little bits of mince that are coming out. They are processing the bag from last night. The majority of the haul was squid. A few bits and pieces of bycatch going through the mincer ... crabs and things.

P3080031.MOV (9/03/2007, 1:53)
View from stern. Good weather. Birds in the air, but not large numbers.
(5) Still processing tow 26. The mince is still coming out in negligible amounts. It is not there to be chewed up. A wee bit different. A lot of small birds here now, more than what was here earlier. The larger birds seem to have disappeared a bit. (40) When the mince comes out it is only a few bits and pieces. They are a bit concerned in the factory that there's a few more rocks in there. Just have to be careful. Not as many as there was yesterday. It is not good on the old mincer. Breaks it's teeth. (1:15) As you can see there is no feeding whatsoever, not even hardly any in the gaps between the windy buoys. More or less birds just checking out to see what's happening. (1:39) A few around. A few further way back past the sweep zone, but not huge numbers.

P3080032.MOV (9/03/2007, 3:22)
View from stern looking back. Birds in air. Some shots of minced discharge at side of the vessel.

(5) Still processing tow 26. The mince is starting to come out a bit more now .. Attracting the larger birds. Still all feeding well away from the warps. (2:10) [shots of cloudy water] Still not a large amount of mince. As you can see there, its pretty well munched up. … deck wash come off the floor ... what's coming out

P3080034.MOV (9/03/2007, 1:49)
View from stern. Calm conditions. Few birds around. Shots of the other 3 vessels in the vicinity, including one which is very close.
(3) Still processing tow 28 in the water. Must be near the end of it now. Bird numbers have increased since the last obs. TM [vessel name] over there passed us, and they just turned around to come back. Had another Russian pass us. Still got the A [vessel name] right there beside us. Very few birds around here. She obviously is not processing. Got the M [vessel name] up there, quite a few birds around that. (52) The amount of mince coming out, they are all feeding beyond the tori line windy buoys there. The odd bird just flying around checking things out.

Batched

P3010010.MOV (2/03/2007, 0:38)
View from stern of wake, tori lines and warps. Few birds as there is no processing.
(6) This is the view of bird numbers when they are not processing. Every now and then you get a few fly bys … discharging anything, that's about it. (35) Not much to see

P3010012.MOV (2/03/2007, 1:24)
View from the stern. Mince is being batched, and this is from the period between batches. Bird numbers are low.
(2) OK, here we are, we are in batching mode. The factory is processing. They are batching via putting bycatch on the conveyor. When that builds up they put it through the mincer. It is occurring about every 20 to 30 minutes. About 200 kilos worth of bycatch going through the mincer. Mainly crabs, but you can see its not attracting the birds. Processing has been going for about 40 minutes and we have had two discharges so far. (55) There are only about 30 large birds out there and about 30 small birds. The small birds seem to be feeding more than the large ones. I will flick the film on again when the mince comes out.

P3010015.MOV (2/03/2007, 1:16)
View from the stern. Mince is being batched, and this is during discharge of a batch. Bird numbers are low.
(3) Ok, we have had a discharge of mince, but the birds aren't hanging around in the first place. You can see the little ones getting a feed back there. Not much to write home about really. (37) When it is discharging all the time they tend to hang around the outlets which attracts the other birds around. (48) A couple of large ones dived back there to grab a bit, but nothing of significance really.

P3070022.MOV (7/03/2007, 2:38)
View from stern of large numbers of albatross feeding beyond the windy buoys. Some footage of the discharge outlet. Calm weather.

(8) We are processing red cod. Not much squid in this bag, but mainly red cod. We are batching. As you can see, very calm conditions. Bird numbers stretching way down the back are in the hundreds and most of the feeding is done near those windy buoys. (34) If we come over here to where the outlet is, there are quite a few birds feeding here. (45) There's the ... coming out there. Feeding on the red cod heads and guts (57) Look at the size of the mince there. They are not all that keen on it. They initially are when it comes out, and the odd few have a peck at bits and pieces ... (1:26) 500 birds way out the back there. (1:44) I noticed on other days when there is a bit of wind the birds don't seem to hang around there [indicates outlet] See that's come out again, that conveyor must have been filled up. getting filled up pretty quick. (2:24) No feeding around the warp whatsoever. There is mince going straight underneath it.

P3100014.MOV (10/03/2007, 1:18)
View from stern of activity during a pulse of mince, while in batch mode. Albatross and some petrels feeding mainly beyond windy buoys. Some shots of mince in water.
(5) Tow 29 in the water. Factory still processing tow 28. We have just had a run of mince come through, as you can see down there. Bird numbers have increased as you would expect when the batch comes out. Numbers are just not that high (38) Got a wind coming off our quarter there. 10 o'clock so birds are honing in a wee bit ... mince coming out. This will stop after a few minutes once it all gets run through and they wait for the next batch to come out. (1:05) You can see the numbers now with the mince coming out and the next video I'll show when there is not any mince coming.

P3100017.MOV (10/03/2007, 1:04)
View from stern showing activity with no mince being discharged, during match mode. Some albatross flying around, and some giant petrel on the water on the port side. Fewer birds than in the previous clip.
(3) Got no mince coming out now. You can see the bird numbers are completely different. There is always a little bit of mince still left in the system that seems to come out, just little bits and pieces that is keeping these giant petrels here and a couple of capies. All the rest seem to have buggered off. The small albies and that, they'll return when the mince starts coming out again .. see birds in the distance, flying around and that ... bigger numbers. That's with no mince coming out.

P3100018.MOV (10/03/2007, 1:56)
View from stern looking back. Albatross are beyond tori lines. Some shots of cape pigeons and giant petrel on water on port side.
(1) We've had the batch mince come out now. The bulk of its gone because I was doing a count. Still a bit coming out now as you can see. (25) Numbers have increased … when I initially came out they were all, numbers were a lot higher. Now they've sort of spread out way down the back there. (1:10) Bit more coming out, through. It is noticeable when it is not coming out the birds seem to fly away. It is only the little fellows hanging around, and when it initially comes out they all come to have a quick look at it, and they sort of disperse themselves out a bit. (1:30) There is a bit of feeding around here by the giant petrels and cape pigeons.

P3100019.MOV (10/03/2007, 0:43)
View from stern looking back. Some birds in air. No mince or discharge.
(4) The mince has stopped now. You can see there's a bit of a difference.

P3100020.MOV (10/03/2007, 8:47)
View from stern looking back. Calm weather. Albatross and petrel. A long sequence showing birds feeding on patches of mince as they drift back from the vessel. The observer had intended to show how the birds react when the mince stops being produced, but this took longer to happened than expected (7 minutes), and so there isn't much footage once the mince had stopped.
(2) Mince has just started to come out again. There it is. Bird numbers are increasing. Well down near the end of the sweep zone.(39)[shot of mince in water] (2:06) Getting near the end of its run through. (2:57) Oop. Nah. Put a bit more through. (4:50) Now it is starting to stop I think. Knowing these guys, they might prove me wrong though. Still a little bit coming through. Takes a few shots to get it all through the system. (6:51) Running out now. Not much coming through now. I'll just try and keep the video going and I'll show you how they sort of disperse from the amount of birds we had before. They'll keep coming to have a look for a little why and then they'll all bugger off ... what sort of game you're playing. (8:45) There you are that gives you a good idea on how it works.

P3100021.MOV (10/03/2007, 4:24)
View from stern looking back. Birds on water and in air beyond buoys. Some shots of birds feeding on patches of mince, close to vessel. Shots of warp entry point, that is free of birds.
(3) Coming near the end of the processing now. This is all spiny dog going through the mincer. As you can see she attracts all the birds. (1:30) I didn't tell you before, but we are the only people here, which is probably why we have got good bird numbers (4:07) Looks like it has just come to an end there. The end of processing

P3100022.MOV (10/03/2007, 0:34)
View from stern looking back. Birds in air, but few on water.
(2) I thought, the last video clip, I thought we were near the end of processing, but we are not. Still got a little bit to go. That was just another batch coming through. Can see the birds have all disappeared. That was only a few minutes ago.

Appendix C: Example forms

Completed seabird observation form

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Seabird observation form

Offal treatment for day (circle one)		
Unprocessed	Minced	Batched

Sample identification

Trip number	2 3 7 4	Date observations started (ddmmyy)	2 8 0 2 0 7
Tow number (if towing)	0 0 1 0	Time observations started (hhmm, NZST)	1 1 5 2

Environmental information

Vessel speed (knots)	3.7	Wind direction (12 hr)	12
Swell height (metres)	2	Wind speed (Beaufort)	4

Offal visible in observation area

Discharge type	*Discharge rate*
Sump water (S)	2
Minced offal (M)	2
Cutter pump output (C)	0
Unprocessed offal (heads, frames, guts) (O)	0
Whole fish discards (D)	0

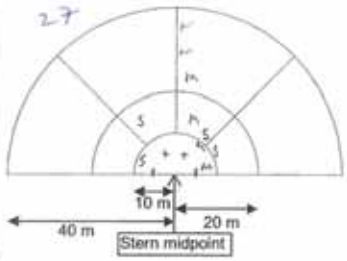
Record rate of arrival of offal into observation area

0 = none

1 = negligible

2 = intermittent

3 = continuous



Sweep counts of seabirds in observation area (carry out sweep counts in order indicated)

	Flying	*Sitting*	*Feeding*
Large albatrosses (Royal and Wandering)	1: 3 / 0	2: 4 / 1	3: 0 / 0
Small albatrosses (Mollymawks)	4: 50 / 10	5: 40 / 7	6: 10 / 5
Giant petrels	7: 0 / 0	8: 0 / 1	9: 0 / 0
Shearwaters, prions, petrels (other than Giant, and Cape Pigeons)	10: 10 / 0	11: 10 / 0	12: 5 / 0
Cape pigeons	13: 0 / 0	14: 0 / 0	15: 0 / 0

Comments

MINCER PROCESSING SPD ONLY AT THIS STAGE
FED IN ONLY INTERMITTENTLY.
BIRDS NOT ALL YET KEEN ON SPD MINCE
MAJORITY OF FEEDING TAKING PLACE BEYOND SWEEP ZONE.

Form version: 11/02/2007

Completed warp strike form

SEABIRD WARP-STRIKE OBSERVATIONS (TRAWL)

1. Fishing event descriptors

Observer trip number: 2374 | Observer tow no.: 003 | TCEPR form number: 7114286 | Page 1 of 1 for this tow

Date tow ended: 230207 | Tow start time: 0651 | Tow start time code: 2A | Observer initials: RG | Side observed: P / S

2. Fifteen-minute warp/mitigation device strike observations and bird abundance

	Sampling period 1		Sampling period 2		Sampling period 3		Sampling period 4	
Observed	✓ Warp / Mitigation device:		Warp / ✓ Mitigation device:		✓ Warp / Mitigation device:		Warp / ✓ Mitigation device:	
15-Minute Observation	*Time Start* 0717	*Time End* 0732	*Time Start* 0732	*Time End* 0747	*Time Start* 0924	*Time End* 0939	*Time Start* 0939	*Time End* 0954
	Large birds	*Small birds*	*Large birds*	*Small birds*	*Large birds*	*Small birds*	*Large birds*	*Small birds*
Bird abundance	80	60	100	60	70	30	80	50
No. heavy contacts	0	0	1	0	0	0	2	0

3. Mitigation devices and environmental factors

Mitigation equipment codes	T1	T2	B1		B2		T1	T2	B1		B2		T1	T2	B1		B2		T1	T2	B1		B2	
Mitigation event codes							A												A					

Swell height (m)	1	1	1	1
Swell direction (1-12 h)	12	12	3	3
Wind speed (Beaufort)	4	4	4	4
Wind direction (1-12 h)	12	12	3	3
Discharge side	P / S / (B) / N	P / S / (B) / N	P / S / (B) / N	P / S / (B) / N
Discharge rate	0 / (1) / 2 / 3	0 / (1) / 2 / 3	0 / (1) / 2 / 3	0 / (1) / 2 / 3
Discharge type *	(S) (M) / C / O / D	(S) (M) / C / O / D	(S) (M) / C / O / D	(S) (M) / C / O / D

*several types permissible

Codes for use in completing this form

Discharge rate:
Record one only
0 = none
1 = negligible
2 = intermittent
3 = continuous

Discharge type:
Record one or more
S = sump water
M = minced
C = cutter pump
O = offal, i.e. heads and guts
D = discards of whole fish.

Elsewhere:
P = Port
S = Starboard
B = Both
N = Neither / None / No
Y = Yes
U = Unknown

Form version: 11/12/2006

Warp strike form instructions (reverse side of form)

4. Comments : Record anything that may result in a sample being removed from the analysis, e.g. gear failure or the environmental or fishing factors changed, or the vessel does a turn meaning that the conditions, such as wind direction changes during the sampling period

Sample 1	
Sample 2	
Sample 3	
Sample 4	

Beaufort Scale of Wind Force

Beaufort Number	Descriptive term	Mean wind speed (knots)	Probable wave height * (m)
0	Calm	<1	
1	Light air	1 - 3	0.1 (0.1)
2	Light breeze	4 - 6	0.2 (0.3)
3	Gentle breeze	7 - 10	0.6 (1.0)
4	Moderate breeze	11 - 16	1.0 (1.5)
5	Fresh breeze	17 - 21	2.0 (2.5)
6	Strong breeze	22 - 27	3.0 (4.0)
7	Near gale	28 - 33	4.0 (5.5)
8	Gale	34 - 40	5.5 (7.5)
9	Strong gale	41 - 47	7.0 (10.5)
10	Storm	48 - 55	9.0 (12.5)
11	Violent storm	56 - 63	11.5 (16.0)
12	Hurricane	64 and over	14 (-)

* This table is intended as a rough guide for the open sea. Figures in brackets indicate the probable maximum wave heights. In coastal areas greater heights will be experienced.

Mitigation Event codes

Enter up to six codes indicating mitigation related events that you observed during the observation period:

A = Tori line observed to be continuously slack (i.e. not taut) for some of the time that it was deployed

B = Aerial extent of Tori line observed to extend less than about10m beyond the warp for some of the time that it was deployed

C = Tori line observed to have tangled streamers for some of the time that it was deployed

D = Tori line main-line observed to be entangled with a warp, or another Tori line, for some of the time it was deployed

E = Streamers of Tori line observed not to reach to waterline, allowing for wind and swell. If this is a permanent problem for this tori line, then put a comment on the relevant Tori Line Details Form

F = A delay between when the brakes went on and when the Tori line was deployed (specify in Comments)

G = A delay between when the Tori line was removed and when hauling began (specify in Comments)

H = Warp scarer main-line observed to be set more than 4 metres from the stern

I = Warp scarer main-line does not extend to within about 1 metre of the point where the warps enter the water (allowing for wind and swell)

J = Warp scarer main-line observed to be entangled with the warp, for some of the time that it was deployed

K = Warp scarer streamers (if present) observed not to reach the waterline

L = Warp scarer observed to have tangled streamers for some of the time that it was deployed

M = Warp scarer observed to snag when warp length is adjusted

N = A delay between when the brakes went on and when the Warp scarer was deployed (specify in Comments)

O = A delay between when the Warp Scarer was removed and when hauling began (specify in Comments)

P = Bird baffler observed not to reach within 0.5m of waterline, allowing for wind and swell (aft booms)

Q = Bird baffler observed not to reach within 0.5m of waterline, allowing for wind and swell (side booms)

R = Bird baffler dropper lines observed to be tangled for some of the time that it was deployed

U = An acoustic deterrent was used to scare birds away from the vessel

V = A water hose or water spray was used to dissuade birds

Y = more than six mitigation events, or mitigation events not covered by existing codes – document in comments section