Operation Overdue: Report of s 9(2)(a)

Product from the s 9(2)(b)(ii)

1. The nature of the issue

As I understand the situation, s 9(2)(b)(ii) operates a number of factory trawlers, of which the s 9(2)(b)(ii) and s 9(2)(b)(ii) are two. When these vessels land in s 9(2)(b) , the fish is received by s 9(2)(b)(ii) . Both companies keep records of the number of cartons produced and undertake some checks on the weights of these. The law requires that the greenweight of fish taken be reported to the Chief Executive of the Ministry of Fisheries, and provides a statutory mechanism for calculating greenweight from processed weight.

The Ministry of Fisheries is alleging that

(i) The greenweights reported for four product lines seized from the s 9(2)(b)(ii) are understated; and

(ii) The system used for determining greenweights for all product lines discharged from s 9(2)(b)(ii) factory vessels by s 9(2)(b)(ii) is inherently biased, and under-reporting of greenweights will be the normal result.

There is a wealth of information available to me about the product lines landed by the s 9(2)(b)(ii) and s 9(2)(b)(ii) . For simplicity I have described the data sources and the assumptions I have made about their origin below.

2. The data sources

The cartons

The labels on the cartons provide a statement of net weight for trading purposes. I refer to this as the "nominal net weight".

At sea

The factory managers on these vessels are issued with a manual of specifications for at sea processing, which set out exactly how the fish is to be processed and packed on board, and the required net weights. The specifications for producing hake fillets, trimmed skinned ling fillets and hoki international standard fillet block are attached as Appendix A. I refer to these below as "The Specifications".

The factory managers undertake quality control monitoring whilst at sea, and check that the fish being packed meets these specifications. Detailed records are kept of each block checked on paper, and an example of one of these is attached as Appendix B. These records are then transcribed daily into an electronic spreadsheet, and it is these spreadsheets that I refer to in my analyses below as the "On-board QA data".

The Onboard QA data is collected on (i) fish product packed ready to be put through the plate freezer, which I refer to as a "fresh check"; and (ii) frozen blocks removed from the plate

freezer, which I refer to as a "frozen check". Whether fresh or frozen checks are done depends on the product line. Dressed fish seems to be checked in the frozen state, and the blocks are weighed both immediately prior to and after glazing. Hoki filletblock is checked both fresh and frozen; and the other filleted lines are checked fresh only.

Complete cartons have a bar-coded product label affixed immediately before they are stowed in the hold, and the gross weight of each carton is recorded electronically at this time on a computer system. This data is referred to below as the "Marel computer data".

There are two independent records of the number of cartons produced. A physical tally is kept, and used to produce a daily production summary in electronic form, and these production summaries are then aggregated to provide the basis for the Catch Landing Return. The Marel computer data also provides a carton count. I refer to these counts below as the "CLR carton count" and the "Marel carton count" respectively.

On shore

s 9(2)(b)(ii) staff draw a sample of cartons from some product lines as the vessel is being discharged, and the gross weights of these cartons and the product temperature is recorded. Other product lines are not weighed at all. I haven't seen any raw data from this weighing exercise, and don't know how the cartons to be weighed are selected. However, the sample averages are recorded on "Vessel Quality Summary" forms, which I have attached as Appendix C. I refer to these averages as "Hobson sampling averages" below.

I understand that cartons from product lines that are not weighed at all are assumed by s 9(2)(b)(ii) to contain the nominal net weight.

A small sample of cartons from some of the lines is removed to the s 9(2)(b)(ii) factory, and destructive sampling is undertaken on these. The destructive sampling records for three product lines are attached as Appendix D, and I refer to these below as the "On-shore destructive sampling data".

The number of cartons in each line is counted on shore, and a discharge tally sheet is then produced for the landing. Discharge tally sheets for the two landings of interest are attached as Appendix E. I refer to this data below as the "discharge carton count".

MFish records for the seized product lines

Ministry of Fisheries officers weighed all of the cartons available in each of the product lines seized, and recorded the serial number of each carton. The cartons were also weighed independently by s 9(2)(b)(ii) staff on another set of scales, and the gross weight recorded for a second time. This data (both the MFish and s 9(2)(b)(ii) gross weights) I refer to below as the "Evidential weighing data". I note that none of the seized lines was absolutely complete, and understand that some cartons had already been sold or used in the on-shore destructive sampling process prior to the seizure. However, there is a gross weight available for each of the missing cartons amidst the Marel Computer data, and these datasets can be combined.

Ministry officers then drew a formal random sample of cartons from each of the seized lines, and conducted their own destructive sampling programme. I refer to the data generated as the "MFish destructive sampling data" below.

3. Dressed product lines from the s 9(2)(b)(ii)

In many respects the lines of dressed product are the simplest to deal with, since there is only limited information about their weight. The only information I have available to me is the On-Board QA data.

The On-Board QA data contains individual block weights for 311 blocks of dressed product. The number of blocks per product line varies. I've assumed that the individual block weights reflect just the weight of fish, and that they do not include any packaging. White warehou was packed to two nominal weights (10.5 and 12.5 kg blocks), and to avoid complication I have omitted the 20 cartons of this species from consideration. There are QA records for six blocks of green squid which have been considered.

I don't know how the samples were drawn, but it seems reasonable to assume that the sample blocks were not biased in favour of especially heavy blocks. A systematically biased sample would be of no use for quality control purposes.

From this data it is possible to calculate the mean weight of fish per block, and also to estimate the probability that the mean weight of the blocks landed is equal to the nominal weight of the blocks. The result is shown in the Table 1 below:

Species	Nominal block (kg)	Mean block (kg)	Sample size	Mean difference (kg)	Probability that mean block = nominal block	Blocks landed
BOE	11.000	11.240	4	0.240	0.0035	320
GSH	12.500	12.598	8	0.098	0.0313	64
GSP	12.500	12.614	27	0.114	<0.0001	96
LDO	12.500	12.639	7	0.139	0.0036	28
RBM	12.500	12.604	22	0.104	< 0.0001	70
RCO	12.500	12.580	8	0.080	0.0000	8
RIB	12.500	12.609	12	0.109	0.0009	42
SBW	12.500	12.610	68	0.110	<0.0001	1749
SPD	12.500	12.640	10	0.140	0.0004	36
SQU	7.500	7.625	97	0.125	<0.0001	12567
SSO	12.500	12.587	3	0.087	0.0057	96
STA	12.500	12.642	13	0.142	<0.0001	38
SWA	10.500	10.647	18	0.147	<0.0001	346
SQU GRE	7.500	7.587	6	0.087	0.0306	3405

It seems very clear that these lines have been systematically packed above the nominal weight; and that the nominal weight is not a reasonable estimate of the actual weight of fish the carton contains.

This is not surprising, as dressed fish are indivisible, and have a large piece weight. Packing over the nominal net weight is probably the only way to ensure that the end customer receives full measure.

Assuming that these cartons have been declared at the nominal weight on the purchase tax invoice and Catch Landing return, it is possible to calculate the greenweight of processed fish that has gone unreported from the formula:

Unreported greenweight = blocks landed x mean difference x conversion factor.

I have made this calculation in Table 2 below: Note that I have calculated the number of blocks from the discharge count.

Species	Blocks landed	State	Mean difference (kg)	Conversion factor	Unreported greenweight (kg)
BOE	320	DRE	0.240	2.25	172.8
GSH	64	DRE	0.098	3.4	21.2
GSP	96	DRE	0.114	3.4	37.2
LDO	28	DRE	0.139	1.8	7.0
RBM	70	DRE	0.103	1.8	13.1
RCO	8	DRE	0.080	1.8	1.2
RIB	42	DRE	0.109	1.8	8.3
SBW	1749	DRE	0.110	1.7	326.0
SPD	36	DRE	0.140	2.7	13.6
SQU	12567	DRE	0.125	1.9	2984.7
SSO	96	DRE	0.087	2.25	18.7
STA	38	DVC	0.142	2.15	11.6
SWA	346	DRE	0.147	1.7	86.6
SQU GRE	3405	GRE	0.087	1.0	296.1

4. Hoki TSK shatterpacks from the s 9(2)(b)(ii)

Again, the only information I have available to me about the weight of these is the On-Board QA data.

The On-Board QA data contains individual weights for 129 hoki TSK shatterpacks. I've assumed that the individual weights reflect just the weight of fish, and that they do not include any packaging. The nominal net weight of these shatterpacks is 6.8 kg each.

I don't know how the samples were drawn, but it seems reasonable to assume that the sampled shatterpacks were not biased in favour of especially heavy packs. A systematically biased sample would be of no use for quality control purposes.

From this data I have calculated the mean weight of fish per shatterpack, and also estimated the probability that the mean weight of the shatterpacks landed is equal to the nominal weight.

Species	Nominal block (kg)	Mean block (kg)	Sample size	Mean difference (kg)	Probability that mean block = nominal block	Blocks landed
HOK TSK	6.800	6.873	129	0.073	<0.0001	4822

Again, it seems very clear that these lines have been systematically packed above the nominal weight; and that the nominal weight is not a reasonable estimate of the actual weight of fish the carton contains.

Assuming that these cartons have been declared at the nominal weight on the purchase tax invoice and Catch Landing return, it is possible to calculate the greenweight of processed fish that has gone unreported from the formula:

Unreported greenweight = blocks landed x mean difference x conversion factor.

I have made this calculation in Table 4 below: I have again calculated the number of blocks from the discharge carton count.

Species	State	Blocks landed	Mean difference (kg)	Conversion factor	Unreported greenweight (kg)
HOK TSK	TSK	4822	0.073	2.75	969.4

5. Shatterpacked hake fillets from the s 9(2)(b)(ii)

The specifications for this line clearly state that minimum and maximum net weights for the shatterpacks are 6.800 kg and 6.900 kg respectively. If the packers on-board follow these instructions it is not possible for the contents to weigh an average of 6.800 kg.

The On-Board QA data for this line consists of only two weights, 6.98 and 6.9 kg, with a piece count of 5 and 4 fillets respectively. I am unable to draw any conclusions from so small a sample. However, the average fillet weight (being net weight / piece count) is evidently around 1.5 kg, which suggests that packing to a fine tolerance may be quite challenging.

I don't have any On-shore destructive sampling data for this line either, but I do have MFish destructive sampling data, from which I have calculated the average content weight of the shatterpacks is 6.931 kg.

There are two important considerations to bear in mind in interpreting this figure.

(a) Not all of the cartons were seized

The MFish destructive sampling data is based on a formal random sample drawn from the cartons seized in a cold store. However, the cartons found in the cold store were only a subset of the cartons landed (51 of the total 125.6 cartons in the discharge count). If the cartons already exported were lighter than those retained then the average content weight from the MFish random sample would be misleading.

Fortunately, the gross weight of all the individual cartons is available from the Marel Computer data, and I assume that the packaging on the seized and exported cartons was of identical weight. Since the serial numbers of the seized cartons are known, it is a straightforward exercise to contrast the average gross weights of the seized and exported cartons. I have done this, and found the average weight of export cartons to be 21.611 kg and the average weight of seized cartons to be 14g heavier at 21.625 kg. Had the MFish destructive sample been drawn from all the cartons rather than just those seized the average shatterpack content weight would be 6.928 kg.

(b) The MFish content weight comprises several components

The destructive sampling undertaken by MFish staff involved several steps, and the average content weight is derived from the formula:

Content weight = weight of fillets + difference in weight of inner cartons on drying
+ difference in weight of Mylar sheet on washing and drying +
+ weight of "ice".

The relative contributions of these to the total content weight of 6.931 kg are:

Weight of fillets	6.906 kg
Difference inner cartons	0.010
Difference Mylar sheet	0.012
"Ice"	0.004

(Note these figures do not sum to 6.931 kg due to rounding to the nearest gram)

Again, it is my opinion that this line has been systematically packed above the nominal weight; and that the nominal weight is not a reasonable estimate of the actual weight of fish the carton contains.

Assuming that these cartons have been declared at the nominal weight on the purchase tax invoice and Catch Landing return, it is possible to calculate the greenweight of processed fish that has gone unreported from the formula:

Unreported greenweight = blocks landed x mean difference x conversion factor.

I have made this calculation in Table 5 below: I have again calculated the number of blocks from the discharge carton count.

Species	State	Blocks	Mean	Conversion	Unreported

		landed	difference (kg)	factor	greenweight (kg)
HAK	FIL	374	0.131	1.85	90.6

6. Shatterpacked ling fillets from the s 9(2)(b)(ii)

The Specifications for this line clearly state that minimum and maximum net weights for the shatterpacks are 6.800 and 6.900 kg respectively. If the packers on-board follow these instructions it is not possible for the contents to weigh an average of 6.800 kg, which is the nominal net weight.

Several independent estimates of content weight are available, from the On-Board QA data, the On-shore destructive sampling data and the MFish destructive sampling data respectively.

On-Board QA data

The On-Board QA data contains individual weights for 40 ling TSK shatterpacks. I've assumed that the individual weights reflect just the weight of fish, and that they do not include any packaging.

I don't know how the samples were drawn, but it seems reasonable to assume that the sampled shatterpacks were not biased in favour of especially heavy packs. A systematically biased sample would be of no use for quality control purposes.

From this data I have calculated the mean weight of fish per shatterpack, and also estimated the probability that the mean weight of the shatterpacks landed is equal to the nominal weight. This is shown in Table 6 below:

Species	Nominal block (kg)	Mean block (kg)	Sample size	Mean difference (kg)	Probability that mean block = nominal block	Blocks landed
LIN TSK	6.800	6.878	40	0.078	<0.0001	2404

On-shore destructive sampling data

The On-shore destructive sampling looked at 8 individual shatterpacks. Again, I have no information as to how these 8 blocks were selected, but it seems reasonable to assume that they were taken haphazardly or randomly, and that selection was not biased in favour of especially light or heavy packs. A systematically biased sample would be of no use for quality control purposes.

A number of weights are shown in the data sheet, including:

- Frozen gross weight
- Frozen net weight
- Ice weight
- Inner box weight
- Plastic interleave weight

It seems clear from these sheets that the frozen gross weight is the sum of the other weights, and therefore that the content weight should be the frozen net weight plus the weight of ice (a variable which I have arbitrarily named "Yice" for convenience in my working documents).

If this is correct, then the average content weight of the eight shatterpacks is 6.847 kg.

MFish Destructive sampling

Ministry staff drew a formal random sample of 119 cartons from the total number seized, and destructively sampled one shatterpack from each. I have calculated the average content weight of these shatterpacks at 6.871 kg.

The destructive sampling undertaken by MFish staff involved several steps, and the average content weight is derived from the formula:

Content weight = weight of fillets + difference in weight of inner cartons on drying
+ difference in weight of Mylar sheet on washing and drying +
+ weight of "ice".

The relative contributions of these to the total content weight of 6.871 kg are:

Weight of fillets	6.812 kg
Difference inner cartons	0.014
Difference Mylar sheet	0.033
"Ice"	0.012

The estimates of content weight from the MFish destructive sampling and the On-board QA sampling are only 7 grams apart, and the difference is not statistically significant. Using the MFish destructive sampling data Table 6 would be recast as Table 6A below:

Species	Nominal block (kg)	Mean block (kg)	Sample size	Mean difference (kg)	Probability that mean block = nominal block	Blocks landed
LIN TSK	6.800	6.871	119	0.071	<0.0001	2404

Again, it is my opinion that this line has been systematically packed above the nominal weight; and that the nominal weight is not a reasonable estimate of the actual weight of fish the carton contains.

Assuming that these cartons have been declared at the nominal weight on the purchase tax invoice and Catch Landing return, it is possible to calculate the greenweight of processed fish that has gone unreported from the formula:

Unreported greenweight = blocks landed x mean difference x conversion factor.

I have made this calculation in Table 7 below: I have again calculated the number of blocks from the discharge carton count. I have used the mean difference from the MFish destructive sampling as this is the smaller of the two reliable estimates.

Species	State	Blocks landed	Mean difference (kg)	Conversion factor	Unreported greenweight (kg)
LIN	TSK	2404	0.071	2.85	486.4

7. Hoki filletblock from the s 9(2)(b)(ii)

Several independent estimates of content weight are available, from the On-Board QA data, the On-shore destructive sampling data and the MFish destructive sampling data respectively.

On-Board QA data

The On-Board QA data contains individual weights for 88 filletblocks checked prior to freezing, and 147 filletblocks checked after freezing. I've assumed that the individual weights reflect just the weight of fish, and that they do not include any packaging.

I don't know how the samples were drawn, but it seems reasonable to assume that the blocks were taken haphazardly or randomly, and that selection was not biased in favour of especially heavy or light blocks. A systematically biased sample would be of no use for quality control purposes.

From this data I have calculated the mean weight of fish per block, and also estimated the probability that the mean weight of the blocks landed is equal to the nominal weight. This is shown in Table 8 below:

Species	Nominal block (kg)	Mean block (kg)	Sample size	Mean difference (kg)	Probability that mean block = nominal block	Blocks landed
HOK TSK filletblock (fresh)	7.487	7.549	88	0.062	<0.0001	5391
HOK TSK filletblock (frozen)	7.487	7.523	147	0.036	<0.0001	5391

The weights from the frozen and fresh checks are significantly different. This would be expected only if the samples were biased in some way, or if the weights of fish change in the plate freezer.

On-shore destructive sampling data

The On-shore destructive sampling looked at 14 individual filletblocks. Again, I have no information as to how these 14 blocks were selected, but it seems reasonable to assume that they were taken haphazardly or randomly, and that selection was not biased in favour of especially light or heavy blocks. A systematically biased sample would be of no use for quality control purposes.

A number of weights are shown in the data sheet, but I have relied on the one labelled "Frozen net wt (kg)". I assume that this weight is the weight of the naked filletblock, and that the figure includes no packaging.

The average content weight of the fourteen blocks is 7.681 kg, with a standard error of only 5 grams.

MFish destructive sampling data

Ministry staff drew a formal random sample of 121 cartons from the total number seized, and destructively sampled one shatterpack from each. I have calculated the average content weight of these shatterpacks at 7.529 kg.

The destructive sampling undertaken by MFish staff involved several steps, and the average content weight is derived from the formula:

Content weight = weight of naked filletblock
+ difference in weight of inner cartons on drying
+ weight of "ice".

The relative contributions of these to the total content weight of 7.529 kg are:

Weight of filletblock	7.509 kg
Difference inner cartons	0.019
"Ice"	0.0003

The MFish destructive sampling data is based on a formal random sample drawn from the cartons seized in a cold store. However, the cartons found in the cold store were only a subset of the cartons landed (1506 of the total 1797 cartons in the discharge count). If the missing cartons were lighter than those seized then the average content weight from the MFish random sample would be misleading.

Fortunately, the gross weight of most of the individual cartons is available from the Marel Computer data, and I assume that the packaging on the seized and missing cartons was of identical weight. Since the serial numbers of the seized cartons are known, it is a straightforward exercise to contrast the average gross weights of the seized and exported cartons. I have done this, and found an average difference of 120 g per carton in the gross

weights. This is statistically significant, and seems to be due in the main to a product line recorded in the Marel data as "Fillet block underweights", which were not found in the cold store.. Had the MFish destructive sample been drawn from all the cartons rather than just those seized the average filletblock weight would probably have been about 7.523 kg, which is identical to the weight of the On-board QA data frozen checks.

Again, it is my opinion that the hoki filletblock has been systematically packed above the nominal weight; and that the nominal weight is not a reasonable estimate of the actual weight of fish the carton contains.

Assuming that these cartons have been declared at the nominal weight on the purchase tax invoice and Catch Landing return, it is possible to calculate the greenweight of processed fish that has gone unreported from the formula:

Unreported greenweight = blocks landed x mean difference x conversion factor.

I have made this calculation in Table 9 below: I have again calculated the number of blocks from the discharge carton count. "Mean difference" presents greater problems, since there are three quite different estimates of content weight available. I lean toward the mean difference from the MFish destructive sampling as this is the smallest of the estimates, but have repeated the calculations using the "Fresh check" and On-shore destructive sampling" estimates of content weight for comparison.

Species	State	Estimate	Blocks landed	Mean difference (kg)	Conversion factor	Unreported greenweight (kg)
HOK	TSK	MFish	5391	0.036	2.75	533.7
HOK	TSK	Onboard Fresh	5391	0.062	2.75	919.2
HOK	TSK	On-shore destructive	5391	0.194	2.75	2876.1

8. Opinion and Conclusions

Weights and measures systems around the world vary. However, the basic principle is that packages marked with a statement of the quantity the package contains must actually contain at least that quantity. This requirement extends throughout the distribution chain. Weights and measures laws reflect the fact that there will inevitably be hiccups in filling packages, and allow some latitude to packers, but the basic principle remains.

Producing packaged goods with a constant nominal content is very difficult, especially where individual piece weights of the material packed are large, and this often requires the packer to deliberately overfill the packages in order to ensure that the customers do actually receive full measure. Overfilling is also required where weights may decrease through time, since the package must still contain at least the nominal weight when the package finally reaches the consumer. It is therefore the norm rather than the exception for packages (on average) to

contain more than the stated nominal weight, and statisticians are frequently employed to determine just how much overfilling is required.

In my opinion the staff in the factory of the s 9(2)(b)(ii) are indisputably packing packages of fish so that they contain more than the nominal net weight, and at least with respect to the shatterpacks of ling and hake fillets, they are following company instructions to do so.

However, the declarations of weight made to the Chief Executive of the Ministry of Fisheries reflect the nominal weight rather than the actual weight of fish in the cartons. I understand that s 9(2)(b)(ii), as the licensed fish receiver, is required to determine the actual weight of fish landed. Given that the cartons produced on the s 9(2)(b)(ii) are deliberately being over packed, simply multiplying the nominal carton weight by the number of cartons will always understate the actual weight. Since the vessel processes a lot of fish the discrepancy will inevitably amount to several tonnes per landing.

It is unclear to me exactly what purpose the On-shore destructive sampling undertaken by s 9(2)(b)(ii) serves. Despite the small sample size it must have been clear to anyone in possession of the Hoki TSK filletblock sampling sheet that the average block weight was well above the nominal weight, and that the line had been over packed. The same is also true for the ling TSK shatterpacks.

s 9(2)(a)
3 February 2004