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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 104

The Effect of Different Diets on the Incidence of Bloat in Seawater Reared Chinook Salmon

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and
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Report to: Southern Ocean Seafoods Ltd.
and GFW Agri-Products

Confidential to clients

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Introduction

Salmonids reared in sea water may be affected by a condition known as bloat. The stomach and/or swim bladder of an affected fish becomes distended, and filled with seawater and food remains. The condition, which causes chronic losses in fish of all ages, has been reported from Norway (Stuarnes et al 1990) and Canada (Hicks 1989), and also occurs in New Zealand.

The cause of bloat is not known. Bacterial, virological and histopathological examinations of affected fish have not revealed any evidence that the condition is caused by infectious disease. There is speculation that the cause is related to feed and/or feeding practices, although there are no published reports to support this. Published data on salmon losses due to bloat are also lacking. Losses of up to 35% have been reported in the United States (Harrell pers. comm.). In New Zealand, losses of up to 5% per month have occurred, with one case involving substantial losses of bloated fish apparently resulting from the collapse of a net pen subjected to accumulated pressure from drifting jellyfish.

Following expressions of concern from some industry staff in New Zealand that the incidence of bloat was related to the type of diet used, Boustead (1991) proposed a feeding trial. As a result of this proposal, the present study was commissioned jointly by G F W Agri-Products Ltd. through NRM Feeds Ltd. (who produce commercially available salmon diets in New Zealand), and by Southern Ocean Seafoods Ltd., whose operations include salmon farms at Takaka, and at Bulwer in the outer reaches of the Marlborough Sounds. The agreement between those companies and the Freshwater Fisheries Centre (FFC) of MAF Fisheries was for the FFC to design a trial to monitor the incidence of bloat in relation to the different diets fed, to analyse these data, and to prepare a confidential report. The trial was carried out at the Bulwer farm, with feed and stock husbandry provided by the clients. Data collection was carried out by the staff at Bulwer, using procedures and recording forms developed in consultation with FFC staff.

Methods

Three commercially available diets were used in the trial. These were all of the standard dry pelletised type, comprising about 50% fish meal, with oil, appropriate minerals and vitamins, and other ingredients added. Precise formulations are the property of the respective companies. The diets were the standard NRM diet, which includes 15% Chilean fish meal; a modified NRM diet, including 25% Chilean fish meal; and a diet produced by Salmon Services (NZ) Ltd., Christchurch. Each diet was prepared in a single batch prior to the trial, stored frozen, and then transferred to the farm for use. Pellet size was 4 mm throughout.

All fish used in the trial originated from the Southern Ocean Seafoods farm at Takaka. Since the standard NRM diet was normally fed to all fish on the farm, fish set aside to receive the Salmon Services diet during the trial were introduced to the new diet on 26 April, at least 32 days prior to their transfer to seawater. Transportation to Bulwer (by road and barge) took place from 28 May and 18 June 1991.

Eight 1000 m^3 cages, constructed from 40 mm or 50 mm mesh, were available for the trial, enabling three replicates of the two NRM diets and two of the Salmon Services diet. To minimise any differences caused by environmental factors such as the prevailing tide or seas, diets were allocated to cages so that replicate groups of fish receiving the same diet were located on either side of the farm (Figure 1). While it would have been desirable for each group to comprise an equal number of fish at a standard weight, and which had been were introduced to seawater at the same time, this was not possible. In practice, numbers of fish per cage ranged from 13 500 to 21 900, and the date of introduction to seawater ranging from 28 May to 18 June. Details of the fish held in each cage are listed in Table 1. Temperature, salinity, and weather/sea conditions during the trial were recorded daily.

For each cage, records were kept of the amount of food distributed to the feed hoppers, although this corresponds only approximately to the amount actually fed out over the preceding two or three days. Divers collected mortalities from the bottom of each cage every one to six days, and also noted whether any live fish showed visible signs of bloat. In practice, the counts from these observations were so low (an average of two fish per cage over the entire duration of trial) that the data were not able to be used.

All mortalities were examined externally and internally, and classified as to the probable cause of death. Fish considered to have died as a result of bloat were recorded as those with fluid and/or swelling in the stomach; fluid and or swelling in the air bladder; and fluid and/or swelling in both the stomach and the air bladder. Other mortalities were categorised as those resulting from lesions on the external surface; runts (small, emaciated fish); apparently normal, healthy fish for which the cause of death was not apparent; fish which were too necrotic to determine the cause of death; and those due to mechanical damage. This latter category accommodated all losses attributed to damage from transfer to seawater, net changes and bird strikes. On two occasions (29 July and 3 September), during routine sampling for

Table 1. Stocking details for the eight experimental groups of fish used in the bloat trials. The trials ceased on 9 September.

Cage	Diet [1]	Number of fish	Stocking date(s)	Trial duration (days from date of first stocking)	Weight (g) Start	Weight (g) End [2]
920	SS	18 000	28/5 - 1/6	104	152	374
921	SS	14 050	29/5 - 1/6	103	167	394
922	NRM 1	15 700	31/5 - 3/6	101	185	307
923	NRM 1	15 700	4/6 - 5/6	97	192	377
924	NRM 1	16 640	6/6 - 7/6	95	180	346
925	NRM 2	13 502	10/6 - 12/6	91	192	425
926	SS	21 872	12/6 - 14/6	89	164	351
927	NRM 2	18 400	14/6 - 18/6	87	158	334

1 Diets are indicated by SS = Salmon Services diet; NRM 1 = unmodified NRM diet; NRM 2 = modified NRM diet

2 Recorded on 3 September

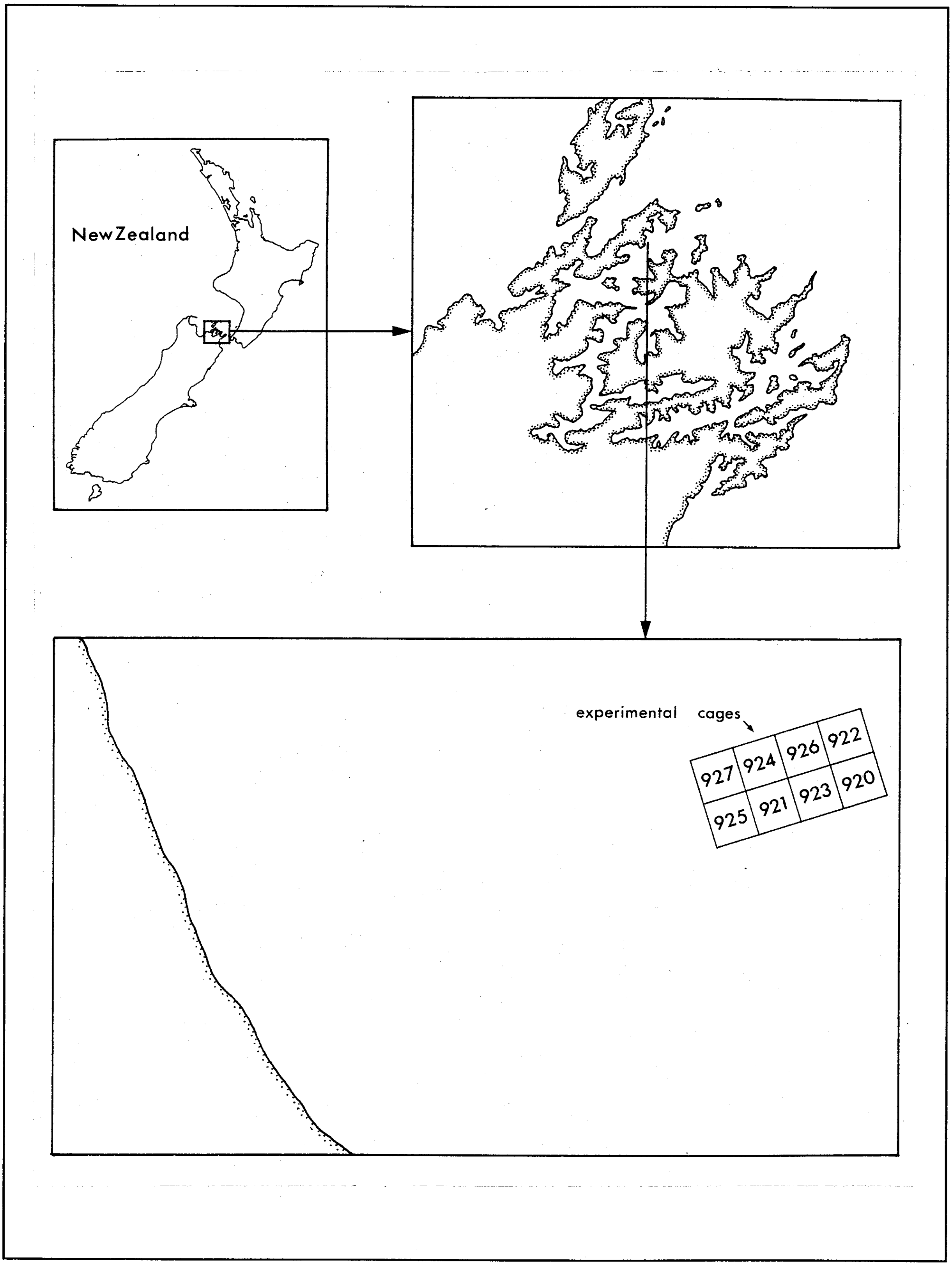

FIGURE 1. Schematic diagram of the Bulwer salmon farm, showing the approximate location and layout of the eight experimental cages. The cages are not drawn to scale.

weight determination, 30 apparently healthy fish taken at random from each cage were examined internally for evidence of bloat.

To eliminate any effects due to different numbers of fish per cage, thereby enabling comparisons between cages and diets, all mortality counts were converted to a standard unit of mortalities per 10 000 fish per day. Trends were examined graphically, by plotting these mortality rates against time, expressed as day of the year. Comparisons between diets were carried out using both non-parametric (Kruskal-Wallis) and parametric (analysis of variance) tests (Sokal and Rohlf 1981). Despite substantial deviations from normality (which can, in some cases, render the results of parametric tests invalid), both sets of tests gave virtually identical results. Significance tests quoted in this report are based on analysis of variance. Linear regression analysis was used to investigate the relationships between bloat mortality rates, feeding rates, and the number of days elapsed since the beginning of the trial. Statistical and graphical analysis of the data were carried out using SYSTAT (Wilkinson 1990), running on an IBM compatible 80386 PC.

Results

A total of 3052 mortalities was recorded over the duration of the trial (Table 2, Appendix 1), representing an overall loss of 2.28%. Just under half (48%) of these were classified as resulting from mechanical damage, with nearly 80% of the losses occurring in two cages (926 and 927) during June, apparently as a result of the initial transfer to sea water. The remaining mortalities were attributed to a variety of causes, with bloat accounting for 442

Table 2. Mortalities recorded during the trials, classified by the presence or absence of bloat, and the diagnosis or probable cause of death.

Bloat?	Diagnosis/Cause of death	May	June	July	August	Sept	Total
Yes	Stomach only	1	1	22	35	17	76
Yes	Air bladder only	14	10	29	49	11	113
Yes	Stomach and air bladder	6	10	71	112	54	253
	Total mortalities	21	21	122	196	82	442
No	External lesions	28	55	7	13	5	108
No	Necrotic	0	21	70	39	27	157
No	Runts	1	110	52	86	68	317
No	Apparently normal	20	288	45	43	17	413
No	Mechanical damage	17	1453	2	2	0	1474
	Total mortalities	66	2068	176	183	117	2610
Total mortalities, all sources		**87**	**2089**	**298**	**379**	**199**	**3052**

(14%) of the total. These included 108 fish with external lesions (3.5%), 317 runts (10.4%), 157 necrotic fish (5.1%), and 413 "normal" fish (13.5%). It is, however, possible that some fish in the "necrotic" and "apparently normal" categories had suffered from bloat. The 442 mortalities directly attributable to bloat represent an overall loss of 0.33%, or 0.37 fish per 10 000 fish per day.

Losses from bloat generally followed a similar pattern in all eight experimental cages (Fig. 2). Three cages (920, 921, and 922) showed a high incidence of bloat during the first two or three days after the initial transfer of fish into seawater, but relatively few bloat-induced mortalities were recorded in any of the cages during the next four to five weeks. From early July onwards, the incidence of bloat in all eight cages increased. Since the initial mortalities in cages 920, 921, and 922 may have been related to transfer and handling effects as much as to the influence of diet, these data were excluded from all subsequent analyses.

The incidence of bloat was strongly related to diet (Table 3). The average mortality rate for the three cages on the standard NRM diet (0.49 - 0.67) was four to five times higher than for the other two diets (0.07 - 0.17), with the difference being highly significant ($F_{2,172} = 24.2$, $p \approx 0$). Mortality rates for the remaining two diets differed slightly from each other, but this result is only just significant at the 95% level ($F_{1,107} = 4.40$, $p=0.038$). Since the modified NRM diet was replicated only twice, with both replicates located at the shoreward end of the experimental set-up, further trials would be desirable to confirm this result.

For the three groups on the standard NRM diet, the incidence of bloat increased throughout the duration of the trial, but there was no evidence of any relationship with feeding rate (expressed as Kg per day per 10 000 fish). The mortality rate was moderately correlated with time ($r^2 = 0.36$), but the inclusion of feeding rate did not significantly improve this result. Water temperature did not vary significantly (11°C ± 1°C) over the duration of the

Table 3. Bloat mortalities, expressed as mean deaths per 10 000 fish per day (± one standard error), based on observed counts at intervals of 1 to 5 days. Refer to Table 1 for the terms used to identify the three diets.

Cage	Diet	Number of observations	Bloat mortality rate Range	Bloat mortality rate Mean ± SE
920	SS	24	0 - 0.56	0.17 ± 0.04
921	SS	23	0 - 0.57	0.17 ± 0.04
922	NRM 1	23	0 - 2.55	0.67 ± 0.16
923	NRM 1	22	0 - 1.66	0.49 ± 0.12
924	NRM 1	21	0 - 2.52	0.63 ± 0.15
925	NRM 2	20	0 - 0.44	0.10 ± 0.03
926	SS	21	0 - 0.46	0.11 ± 0.03
927	NRM 2	21	0 - 0.42	0.07 ± 0.02

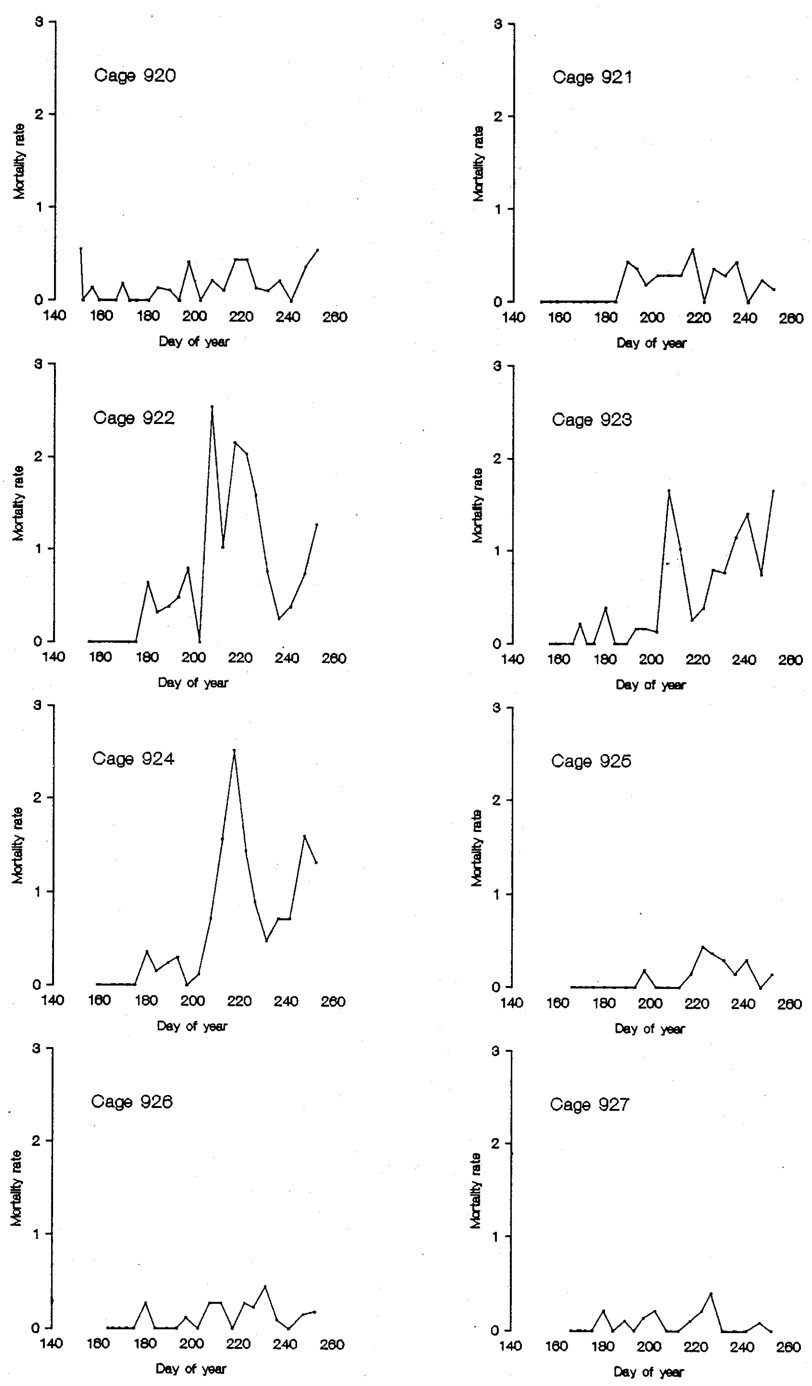

FIGURE 2. Bloat mortality rates (deaths per 10 000 fish per day) recorded during the trials. Day 151 = 1 June; day 212 = 1 August. Refer to Table 1 for details of the diet fed to the fish in each cage.

trial. Other environmental parameters, such as dissolved oxygen and weather/sea conditions, showed rather more day-to-day variation. However, because mortalities were generally recorded at five day intervals, no direct correlation was possible between the observed mortality rates, and oxygen levels etc. Consequently, no attempt was made to look for any relation between environmental parameters and the incidence of bloat.

On a day-to-day basis, the incidence of bloat differed markedly between the standard NRM diet and the other two diets (Table 4). For the Salmon Services and modified NRM diets, mortalities seldom exceeded one or two fish in any five day period, and were generally consistent with what would be expected, on a purely random basis, given an average mortality of approximately one fish every five days. By contrast, for the standard NRM diet, mortalities tended to occur in larger numbers than would be expected on a random basis. The loss of 10 or more fish over a five day period should have occurred just once during the trial period, but in practice there were 13 such occasions, including one instance when 21 mortalities were recorded. The relationship between these data and the monthly net changes, is discussed in the next section.

Table 4. "Expected" (see text for details) and observed bloat mortality rates during the feeding trials. Observed mortalities are for a nominal 5-day period, but also include some periods of 4 and 6 days.

Salmon Services and modified NRM diets (82 observations)			Unmodified NRM diet (48 observations)		
Mortalities per five day period	Expected	Observed	Mortalities per five day period	Expected	Observed
0	17.9	31	0 - 2	10.8	14
1	27.2	18	3 - 5	26.3	10
2	20.7	18	6 - 8	9.8	10
3	10.5	9	9 - 11	1.1	5
4	4.0	5	12 - 14	< 0.05	4
5	1.2	1	15 - 17	< 0.001	3
6	0.2	0	> 18	< 0.00001	2

Observations made during the two weigh-ups are listed in Table 5. Sub-clinical levels of bloat were recorded in all eight groups, with the highest incidence (average 43%) corresponding to the standard NRM diet, and the lowest incidence (average 6%) corresponding to the modified NRM diet.

Discussion

The overall incidence of bloat during the trial was lower than anticipated, and bloat-induced mortalities were only slightly higher than mortalities due to other sources. Nevertheless, the experimental results were sufficiently consistent between the three diets tested as to leave no doubt that fish fed the standard NRM diet incurred a significantly higher rate of bloat than those fed either the Salmon Services or modified NRM diets. The incidence of bloat was lowest for the modified NRM diet, but further trials would be needed to confirm the statistical significance of this.

The tendency for the incidence of bloat to increase with time for all three diets suggests that further increases may well have been likely had the trial continued. Irrespective of diet, some degree of bloat was apparently inevitable under the conditions prevailing during the trial. Under these conditions, however, fish on the standard NRM diet were significantly more susceptible to bloat.

Although susceptibility to bloat was clearly related to diet, other factors also appear to be involved. Among the fish receiving the standard NRM diet, almost 60% of the bloat mortalities were recorded during "outbreaks" in which ten or more deaths were recorded. Between these outbreaks, mortalities sometimes fell to a level of only one or two deaths per 10 000 fish per five day period, suggesting that mortalities may have been triggered by some external factor.

Table 5. Sub-clinical incidence of bloat amongst fish sampled at random during two weigh-ups on 29 July and 3 September, and examined internally. Refer to Table 1 for a list of the terms used to identify the three diets.

Cage	Diet	Fish examined	Incidence of bloat Number	Percentage
920	SS	60	13	22
921	SS	60	1	2
922	NRM 1	63	29	46
923	NRM 1	61	29	48
924	NRM 1	60	21	35
925	NRM 2	60	4	7
926	SS	60	7	12
927	NRM 2	60	3	5

Unfortunately, the trial results fall short of identifying what the supposed triggering mechanism(s) might be. For the reasons outlined in the previous section it did not prove feasible to investigate possible relationships between environmental factors (such as water temperature and oxygen levels) and the incidence of bloat. Stress resulting from increased handling may have contributed to increased bloat levels. Net changes were carried out three times during the trial, during the last week of each month, but the relation between the timing of these changes and the incidence of bloat in the three experimental groups receiving the standard NRM diet was not consistent (Fig. 3). Losses due to bloat were first recorded immediately after the first series of net changes, on 26/27 June, although at a minimal level. The second series of net changes (on 26 and 27 July) was followed by relatively high levels of bloat in all three groups, but only one of the three groups

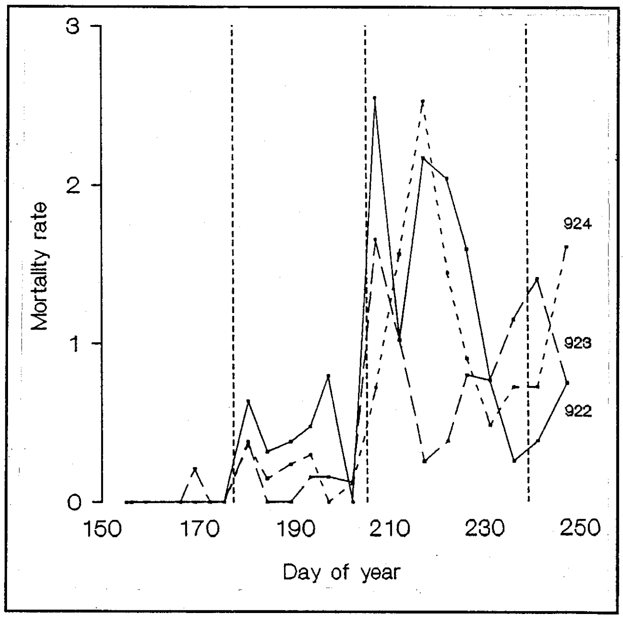

FIGURE 3. Bloat mortality rates (deaths per 10 000 fish per day) for the three experimental groups (922, 923, and 924) receiving the unmodified NRM diet. Dates of net changes are indicated by the vertical dashed lines.

(cage 923) showed an increase in bloat mortalities following the August changes. Other occasions (5 August, 10 August, 9 September) when higher levels of bloat were recorded did not coincide with net changes.

Internal examination of fish selected from each cage (Table 5), although not part of the original experimental design, lends considerable support to our conclusions regarding the three diets. Although the overall mortality rate due to bloat was low, fish in all eight groups exhibited sub-clinical levels of bloat, with nearly half of the fish in some groups affected to some degree. For this reason, internal examination of fish from each group, at regular intervals throughout the trial, would have provided a much more sensitive index of the occurrence of bloat than the actual mortality counts. We would recommend that these counts be included in any future studies of this type.

Any conclusions as to the chemical/nutritional factors relating to the differing incidence of bloat among the three diets used in the trial are beyond the scope of this report. The substitution of Chilean fish meal for New Zealand fish meal is favoured by some companies, as the Chilean meal has a lower mercury content, and is considered to be of superior quality. The increased proportion of Chilean meal (25%) in the modified NRM diet, compared to the unmodified diet (15%) may therefore be significant in relation to the lower incidence of bloat amongst fish receiving the modified diet. However, the incidence of bloat was equally low, if not lower, for fish receiving the Salmon Services diet, which is understood by the FFC (Wright, pers. comm.) to include only 12.5% Chilean meal. Factors other than the nature of the fish meal used are obviously relevant, but would require further trials to investigate.

Acknowledgements

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Appendix 1. Mortalities recorded during the trials by cage and date. Each record in the following table shows the date of observation; the period (in days) over which mortalities were counted; the weight of food distributed; and the mortalities attributable to bloat and to other causes. A dash (-) indicates that no observation was made.

			Bloat mortalities				Other mortalities					
Date	Period	Food fed (Kg)	Stomach and air bladder	Stomach only	Air bladder only	Total	Lesions	Necrotic	Runts	Normal	Mechanical damage	TOTAL
Cage 920												
29/5	1	2	0	1	8	9	5	0	1	6	0	21
30/5	1	2	2	0	2	4	14	0	0	8	0	26
31/5	1	15	0	0	1	1	0	0	0	0	17	18
1/6	1	20	0	0	0	0	0	0	7	2	0	9
5/6	4	100	0	1	0	1	0	0	0	9	0	10
8/6	3	100	0	0	0	0	0	0	0	2	0	2
12/6	4	185	-	-	-	-	-	-	-	-	-	10
15/6	3	150	0	0	0	0	0	0	2	3	0	5
18/6	3	100	0	0	1	1	0	0	0	0	0	1
21/6	3	100	0	0	0	0	0	3	0	0	0	3
24/6	3	150	0	0	0	0	0	0	0	0	1	1
29/6	5	300	0	0	0	0	0	0	4	4	0	8
3/7	4	250	1	0	0	1	0	0	0	0	0	1
8/7	5	350	0	0	1	1	0	0	1	1	0	3
12/7	4	400	0	0	0	0	0	0	1	3	0	4
16/7	4	175	3	0	0	3	0	0	2	0	0	5
21/7	5	400	0	0	0	0	0	1	0	0	0	1
26/7	5	480	2	0	0	2	0	1	1	0	0	4
31/7	5	175	1	0	0	1	0	1	1	0	0	3
5/8	5	375	3	0	1	4	0	0	0	0	0	4
10/8	5	425	1	0	3	4	0	0	0	0	0	4
14/8	4	250	0	0	1	1	0	0	1	0	1	3
19/8	5	250	0	0	1	1	0	1	2	1	0	5
24/8	5	400	0	1	1	2	0	1	5	1	0	9
29/8	5	300	0	0	0	0	0	0	0	0	0	0
4/9	6	250	2	2	0	4	0	2	8	0	0	14
9/9	5	375	4	1	0	5	0	2	0	0	0	7
Cage 921												
30/5	1	1	4	0	3	7	9	0	0	6	0	22
1/6	2	15	0	0	0	0	0	0	1	0	0	1
5/6	4	100	0	0	0	0	0	0	3	7	0	10
8/6	3	100	0	0	0	0	1	0	1	2	0	4
12/6	4	175	-	-	-	-	-	-	-	-	-	8
15/6	3	150	0	0	0	0	0	0	6	15	0	21
18/6	3	100	0	0	0	0	0	0	1	1	0	2
21/6	3	75	0	0	0	0	4	1	1	0	0	6
24/6	3	125	0	0	0	0	0	0	0	0	1	1
29/6	5	325	0	0	0	0	1	0	0	1	0	2
3/7	4	250	0	0	0	0	0	1	0	1	0	2
8/7	5	325	0	0	3	3	0	0	0	1	0	4
12/7	4	400	0	0	2	2	0	0	1	0	0	3
16/7	4	195	0	1	0	1	0	0	0	0	0	1
21/7	5	425	1	1	0	2	0	1	0	1	0	4
26/7	5	475	2	0	0	2	0	1	0	1	0	4
31/7	5	325	1	1	0	2	0	3	7	0	0	12
5/8	5	375	3	0	1	4	0	2	3	0	0	9
10/8	5	475	0	0	0	0	0	2	2	1	0	5
14/8	4	375	2	0	0	2	0	0	2	0	0	4
19/8	5	250	2	0	0	2	0	0	1	0	0	3
24/8	5	475	3	0	0	3	0	0	1	0	0	4
29/8	5	300	0	0	0	0	0	0	1	1	0	2
4/9	6	250	2	0	0	2	0	0	11	1	0	14
9/9	5	400	1	0	0	1	0	0	2	3	0	6
Cage 922												
1/6	1	10	0	0	2	2	0	0	0	17	0	19
4/6	3	90	0	0	0	0	0	0	0	0	45	45
5/6	1	30	0	0	0	0	5	0	0	8	0	13
8/6	3	60	0	0	0	0	2	0	2	17	0	21
12/6	4	135	-	-	-	-	-	-	-	-	-	7
15/6	3	120	0	0	0	0	0	1	0	5	0	6

Date	Period	Food fed (Kg)	Bloat mortalities: Stomach and air bladder	Stomach only	Air bladder only	Total	Other mortalities: Lesions	Necrotic	Runts	Normal	Mechanical damage	TOTAL
18/6	3	60	0	0	0	0	0	2	0	1	0	3
21/6	3	60	0	0	0	0	1	0	1	0	0	2
24/6	3	150	0	0	0	0	0	0	0	0	0	0
29/6	5	210	1	0	4	5	0	0	0	2	0	7
3/7	4	150	0	2	0	2	0	3	0	1	0	6
8/7	5	240	0	2	1	3	0	0	0	3	0	6
12/7	4	300	0	0	3	3	0	0	1	1	0	5
16/7	4	210	3	2	0	5	0	0	1	0	0	6
21/7	5	210	0	0	0	0	0	5	1	1	0	7
26/7	5	330	13	2	5	20	1	6	6	0	0	33
31/7	5	210	5	2	1	8	0	14	5	2	0	29
5/8	5	210	10	1	6	17	1	0	4	0	0	22
10/8	5	210	8	7	1	16	0	0	10	7	0	33
14/8	4	210	7	0	3	10	1	0	7	1	0	19
19/8	5	240	1	5	0	6	0	7	2	5	0	20
24/8	5	330	0	1	1	2	0	0	1	1	0	4
29/8	5	300	3	0	0	3	1	3	5	0	0	12
4/9	6	240	4	2	1	7	0	0	7	3	0	17
9/9	5	300	8	1	1	10	1	4	1	0	0	16
Cage 923												
5/6	1	30	0	0	0	0	0	0	0	8	27	35
8/6	3	60	0	0	0	0	3	0	1	10	0	14
12/6	4	130	-	-	-	-	-	-	-	-	-	58
15/6	3	120	0	0	0	0	0	0	0	5	0	5
18/6	3	60	1	0	0	1	8	2	0	3	0	14
21/6	3	60	0	0	0	0	1	0	0	0	0	1
24/6	3	120	0	0	0	0	0	0	0	0	0	0
29/6	5	240	2	0	1	3	0	0	0	1	0	4
3/7	4	150	0	0	0	0	0	1	0	1	0	2
8/7	5	300	0	0	0	0	0	0	0	0	0	0
12/7	4	270	1	0	0	1	0	0	0	0	0	1
16/7	4	150	1	0	0	1	0	0	0	0	0	1
21/7	5	300	0	1	0	1	0	1	0	1	0	3
26/7	5	540	12	1	0	13	0	1	0	1	0	15
31/7	5	270	8	0	0	8	0	4	4	3	0	19
5/8	5	300	1	0	1	2	0	1	0	0	0	3
10/8	5	240	2	1	0	3	0	1	0	0	0	4
14/8	4	300	3	0	2	5	0	0	0	0	0	5
19/8	5	360	3	0	3	6	0	0	0	3	0	9
24/8	5	360	6	0	3	9	0	0	1	0	0	10
29/8	5	330	6	5	0	11	0	5	2	4	0	22
4/9	6	300	6	0	1	7	0	0	5	2	0	14
9/9	5	300	5	5	3	13	0	1	2	0	0	16
Cage 924												
8/6	2	30	0	0	0	0	12	0	18	25	48	103
12/6	4	120	-	-	-	-	-	-	-	-	-	58
15/6	3	120	0	0	0	0	0	0	3	11	0	14
18/6	3	60	0	0	0	0	0	0	0	0	96	96
21/6	3	60	0	0	0	0	2	2	0	0	0	4
24/6	3	90	0	0	0	0	0	0	0	3	0	3
29/6	5	240	3	0	0	3	0	1	0	4	0	8
3/7	4	150	1	0	0	1	0	3	1	0	2	7
8/7	5	270	0	0	2	2	0	0	2	2	0	6
12/7	4	270	1	0	1	2	0	0	0	1	0	3
16/7	4	150	0	0	0	0	2	0	0	0	0	2
21/7	5	300	0	1	0	1	0	4	0	1	0	6
26/7	5	360	2	1	3	6	3	0	4	1	0	14
31/7	5	180	8	2	3	13	0	7	4	4	0	28
5/8	5	300	11	2	8	21	5	1	6	1	0	34
10/8	5	330	5	3	4	12	2	7	4	0	0	25
14/8	4	360	6	0	0	6	0	0	0	0	0	6
19/8	5	360	2	0	2	4	0	0	2	1	0	7
24/8	5	360	4	2	0	6	1	0	0	0	0	7
29/8	5	300	3	1	2	6	0	2	0	2	0	10
4/9	6	300	11	4	1	16	1	1	11	0	0	29
9/9	5	300	6	2	3	11	0	8	4	3	0	26

Date	Period	Food fed (Kg)	Bloat mortalities: Stomach and air bladder	Stomach only	Air bladder only	Total	Other mortalities: Lesions	Necrotic	Runts	Normal	Mechanical damage	TOTAL
Cage 925												
12/6	1	30	-	-	-	-	-	-	-	-	95	95
15/6	3	60	0	0	0	0	0	0	13	40	0	53
18/6	3	30	0	0	0	0	3	7	1	4	0	15
21/6	3	30	0	0	0	0	2	0	0	0	0	2
24/6	3	90	0	0	0	0	0	1	1	2	0	4
29/6	5	180	0	0	0	0	0	0	0	1	0	1
3/7	4	195	0	0	0	0	0	0	0	0	0	0
8/7	5	180	0	0	0	0	0	0	0	0	0	0
12/7	4	360	0	0	0	0	0	0	1	2	0	3
16/7	4	120	1	0	0	1	0	0	0	0	0	1
21/7	5	300	0	0	0	0	0	0	1	2	0	3
26/7	5	360	0	0	0	0	0	1	0	0	0	1
31/7	5	90	0	0	0	0	0	0	0	1	0	1
5/8	5	300	1	0	0	1	1	0	2	0	0	4
10/8	5	300	0	3	0	3	0	2	3	3	0	11
14/8	4	-	1	0	1	2	0	0	0	0	0	2
19/8	5	150	1	0	1	2	0	0	2	1	0	5
24/8	5	300	1	0	0	1	0	0	0	0	0	1
29/8	5	330	1	1	0	2	0	1	0	0	0	3
4/9	6	300	0	0	0	0	0	0	0	0	0	0
9/9	5	227	1	0	0	1	0	2	2	0	0	5
Cage 926												
13/6	1	25	0	0	0	0	10	0	0	2	0	12
15/6	2	50	0	0	0	0	0	0	14	0	228	242
18/6	3	25	0	0	0	0	0	0	0	0	4	4
21/6	3	55	0	0	0	0	0	0	0	0	25	25
24/6	3	80	0	0	0	0	0	0	1	2	0	3
29/6	5	275	1	0	2	3	0	1	0	2	0	6
3/7	4	155	0	0	0	0	0	3	0	0	0	3
8/7	5	310	0	0	0	0	0	0	1	0	0	1
12/7	4	350	0	0	0	0	0	0	0	0	0	0
16/7	4	125	0	1	0	1	1	0	0	0	0	2
21/7	5	400	0	0	0	0	0	0	2	3	0	5
26/7	5	550	2	1	0	3	0	0	1	3	0	7
31/7	5	450	2	0	1	3	0	3	1	0	0	7
5/8	5	250	0	0	0	0	0	0	1	0	0	1
10/8	5	450	2	1	0	3	0	0	0	0	0	3
14/8	4	250	2	0	0	2	1	0	1	0	0	4
19/8	5	375	3	0	2	5	0	0	4	2	0	11
24/8	5	225	0	1	0	1	0	0	2	3	0	6
29/8	5	300	0	0	0	0	0	1	2	0	1	4
4/9	6	250	1	0	1	2	0	0	9	2	0	13
9/9	5	400	2	0	0	2	1	1	2	0	0	6
Cage 927												
15/6	2	75	0	0	0	0	0	0	0	0	73	73
18/6	3	25	0	0	0	0	0	0	0	0	145	145
19/6	1	30	0	0	0	0	0	0	0	0	591	591
21/6	2	-	0	0	0	0	0	0	12	0	74	86
24/6	3	55	0	0	0	0	0	0	12	62	0	74
29/6	5	180	2	0	0	2	0	0	5	7	0	14
3/7	4	120	0	0	0	0	0	3	1	1	0	5
8/7	5	210	0	0	1	1	0	0	0	2	0	3
12/7	4	360	0	0	0	0	0	0	0	0	0	0
16/7	4	150	0	1	0	1	0	0	0	0	0	1
21/7	5	300	0	0	2	2	0	0	0	0	0	2
26/7	5	360	0	0	0	0	0	0	1	0	0	1
31/7	5	240	0	0	0	0	0	2	0	0	0	2
5/8	5	300	0	0	1	1	0	0	3	0	0	4
10/8	5	450	2	0	0	2	0	2	0	4	0	8
14/8	4	150	3	0	0	3	0	0	1	0	0	4
19/8	5	150	0	0	0	0	0	0	1	1	0	2
24/8	5	300	0	0	0	0	0	0	2	0	0	2
29/8	5	300	0	0	0	0	0	0	0	0	0	0
4/9	6	300	1	0	0	1	2	1	4	0	0	8
9/9	5	227	0	0	0	0	0	5	0	3	0	8