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How Much Shrimp Does the Cod Really Eat? – Five Years Later

by

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Abstract

The stock assessment of shrimp (*Pandalus borealis*) in the Barents Sea is problematic because of lack of direct methods to assess shrimp age and absolute biomass of the stock, and high variation in natural mortality due to predation by cod. The consumption of shrimp by cod is estimated annually and has varied between 200 and 500 thousand tons. The possibility of this being an overestimate has been raised; Cod might feed in the trawl, input temperatures used in the consumption model are too high, and stomach content data are pooled before they are entered in the consumption model. It is more correct not to pool stomach samples and use a finer resolution on the input temperature used in the model. It is concluded that the shrimp index is an underestimate of the total stock biomass and that the cod consumption often is over estimated.

Introduction

Stock assessment of shrimp (*Pandalus borealis*) is problematic because of lack of direct methods to assess shrimp age and high variation in natural mortality due to predation (Jakobsson and Stefánsson, 1998). In the Barents Sea, cod is the main predator on shrimp, and the predation from other predators is probably negligible in comparison (Bogstad *et al*., 2000). Shrimp is preyed upon by a number of predators, cod ranking as o the most important. From a meta-analysis Worm and Myers (2003) found evidence that shrimp populations are regulated by cod predation. Therefore, it is important to take cod predation into account when managing shrimp stocks.

Each year, the consumption of shrimp by cod in the Barents Sea is calculated by a method described in Bogstad and Mehl (1997). However, there are problems taking this estimate into account in shrimp management at present.

In a WD to the Arctic Fisheries working group, Aschan (2000) raised several points of concern regarding the estimated consumption of shrimp by cod in the Barents Sea (Bogstad and Mehl, 1997):

1) Cod consumption rate is less well correlated with changes in the shrimp stock than is the exploitation rate,
2) The catches are usually much lower than the estimated consumption by cod, and
3) The Norwegian consumption estimate is on average higher than the Norwegian shrimp index of shrimp abundance.

Based on this, Aschan (2000) suggested that the consumption of shrimp by cod is overestimated, and pointed out several factors that can lead to overestimation.

In the present WD we address the factors suggested by Aschan (2000) that may lead to overestimation of cod consumption. Further, we address the order of magnitude of the potential discrepancy between then cod consumption estimate and the Norwegian shrimp index, and outline some future work. In the Appendix, we present a simplified sensitivity index of the Norwegian consumption model.

Potential factors leading to overestimation of consumption

Aschan (2000) mentions three factors that can lead to overestimation of cod consumption:

1) Cod might feed in the trawl,
2) The input temperatures used in the consumption model are too high, and
3) Stomach content data are pooled before they are entered in the consumption model and this is corrected for by a constant factor that might be too low.

1) **Feeding in the trawl**

No studies of cod feeding in the trawl have been published as far as we know. Different people working with stomach and survey data do not agree on if and to what extent cod may feed in the trawl (pers. obs). If cod feed in the trawl, there should be a positive relationship between towing time and shrimp content in cod stomachs. Also, the proportion of newly eaten shrimp should increase with towing time. These predictions can be tested using the IMR PINRO stomach database. However; year, area and towing time is confounded. In August 2001 there were 15 min and 30 min towing times used in an experimental design, with 40 trawling stations of each towing time. These data was used to test the predictions above. The difference in shrimp content in stomachs (PFI, partial filling index: shrimp content in stomach adjusted for cod size) between stations with different towing time was tested. As expected if cod eat in the trawl, there was a tendency for shrimp content in stomachs to increase with towing time, but the difference was not significant (one-way ANOVA, $P = 0.09$, Fig. 1). There were no newly eaten shrimp in the stomachs (digestion stage 1, out of 5 different stages). Contrary to the expectations, there was a tendency for the proportion of slightly digested shrimp (digestion stage 2) to decrease with towing time, but not significantly (logistic regression, $P = 0.11$, Fig. 2).

The weight percentage of newly eaten shrimp (digestion stage 1) vary between 0-10% from 1984 to 2003, while the proportion shrimps in digestion stage 1 and 2 vary between 6-50%, depending on the year. Since the relationship between estimated consumption and shrimp content in stomachs is proportional (Appendix 1), excluding shrimp in digestion stage 1, or both 1 and 2, will reduce estimated shrimp consumption from 0-50%, depending on the year.

2) **Input temperature for the consumption model**

Aschan (2000) claims that most shrimp are eaten between 74-77ºN, in the Hopen area (see Map page 6). The Hopen area lies within the Northern area used in the consumption model (Map). The average temperature used for consumption model in the Northern area 1984 to 2003 was 3.9 for the first half of the year, and 4.4 for the second half of the year. Reducing the temperature for the Northern area to between 1 and 3 degrees for the first half of the year, and 1.5 and 3.5 for the second half of the year, reduced the average consumption by ~3-8% (Fig. 3). The reason why this reduction is not greater is because the consumption estimate from the consumption model is highest in the Eastern area (see Map and Table 2). This is mostly due to the high abundance of the youngest year-classes of cod in the Eastern area.

3) **Pooling of stomach content data – present approach**

When calculating individual consumption (see Appendix 1), input data are averaged over age groups, periods and areas, instead of calculated individually for each cod. Pooling or averaging the input parameters leads to 35% overestimation of consumption (dos Santos and Jobling, 1995), which is corrected for in the consumption model (Bogstad and Mehl, 1997). Aschan (2000) suggested that the correction factor is not large enough. I tested this by calculating individual consumption individually for each cod, using its individual weight, total stomach content and shrimp stomach content. The stomach content that was undetermined, or determined at a higher taxonomic level than species, was added to shrimp content proportionally to the shrimp content for each age class in each half year, area and year. This constituted on average 4% of the shrimp content in the stomachs. Years with more than 100 cod that lacked body weight data, were excluded for simplicity, as well as the age class, area and half year combinations that lacked data. On average, the consumption estimated when pooling data (and using a correction factor of 35%) was 16% higher than the estimate obtained not pooling data. However, the difference varied quite substantially by year (Table 1). Understanding the variation in the difference requires a detailed analysis.

The magnitude of the discrepancy

The Norwegian shrimp index, Norwegian consumption estimate and catches of shrimp in the Barents Sea from 1984 to 2004 are given in Table 2.

Production

There is no estimate of production of the Barents Sea shrimp stock. According to Aschan (2000), the shrimp in the Barents Sea is relatively slow growing and the production can be assumed to be 30-40%.

Shrimp Abundance

When excluding 1984, the shrimp index was between ±40% of the mean value of 229 thousand tons (Table 2), which is not an unreasonable level of sampling variation.

Consumption

The deviations from the mean in the consumption estimates were slightly negative in late eighties. There are two years that have strong positive deviations, 1994 and 2000. Excluding these years, the mean consumption 1985-2004 is 247 thousand tons. The high estimate of total consumption was due to higher individual consumption in 2000. In 1994, it was due to higher than average VPA for the youngest year-classes and higher estimated individual consumption Both years, individual consumption was estimated to be due to a higher than average shrimp content in cod stomachs.

Catches

The mean catches 1985-2004 were 59 000 tons.

As a first and simplified way of evaluating the potential discrepancy between the consumption and the Norwegian shrimp index (I do not consider the Russian shrimp index, e.g. Anon., 2004), one can assume that that the shrimp population is constant and that the variation in the shrimp index is only sampling variation. For simplicity, I assume constant production, cod consumption (disregarding other predators) and catches (disregarding by-catches), although I know that this is an over-simplification. We then have the following relationship:

$$N_t = N_{t+1,} \text{ and } N_{t+1} - N_t = \text{Production} \times N_t, \text{ -Catches-Consumption} = 0$$

so that

$$\text{Production} \times N_t = \text{Catches} + \text{Consumption}$$

The discrepancy between consumption estimate and shrimp index is evaluated in three ways, in all cases assuming that the annual catches are 59 thousand tons: 1) assuming that the cod consumption is an absolute estimate, and 2) assuming that the shrimp index is an absolute estimate, in both cases, production is assumed to be 35%, and 3) treating both consumption and shrimp index as absolute estimates, letting the production vary.

1. *Treating cod consumption as an absolute estimate*

   With catches of 59 thousand tons, consumption of 247 thousand tons and production of 35%, the shrimp population need to be about 866 thousand tons to be in equilibrium, i.e. about 3-4 times as high as the average estimate.

2. *Treating the shrimp index as an absolute estimate*

   With catches of 59 thousand tons and production of 35%, a shrimp stock of 229 thousand can sustain a cod consumption of 21 thousand tons to be in equilibrium, e.g. ~1/10 of the average estimate.

3. *Letting the production vary*

   If the shrimp index is taken as an absolute estimate of the shrimp stock and to be 229 thousand tons, the catches are set to 59 thousand tons, and the cod consumption is 247 thousand tons, the production need to be about 130%, e.g. 3-4 times higher, for the shrimp stock to be in equilibrium.

The extent of the shrimp surveys is shown in map on page 6. It covers the areas with the highest density of shrimp, but not of the whole Barents Sea. The cod consumption is estimated for the whole Barents Sea (see Map). If the shrimp content in cod stomachs can be taken as a proxy for the distribution and density of shrimp (Map), the

Norwegian shrimp index survey covers a little more than half of the shrimp population, estimated from the data on the Map on page 6. Assuming that the shrimp population is twice the Norwegian shrimp index, this population, with catches of 59 thousand tons and production of 35%, can sustain consumption by cod of 101 thousand ton, i.e., a consumption that is about 41% of the current mean estimate.

Conclusion and outline for future work

There is a discrepancy between the Norwegian estimate of cod consumption and the Norwegian shrimp index. The discrepancy between the consumption estimate and the shrimp index may in part be explained by the limited extent of the shrimp survey. Also potentially the shrimp index is an under estimate of the shrimp stock within the survey area, e.g. that at some shrimp is higher in the water column and thus not covered sampled by the bottom trawl. However, this was not evaluated in the present analysis.

There are potential problems with the Norwegian consumption model, e.g. that it is sensitive to variation in the VPA estimate and shrimp stomach content estimate of the youngest cod (see Appendix). From our analysis, neither not pooling data, reducing input temperature nor adjusting for feeding in trawl by excluding newly eaten shrimp (digestion stage 1) could reduce the Norwegian consumption estimate so much as required if assuming that the Norwegian shrimp index is an absolute estimate of the shrimp stock in the Barents Sea. Nevertheless, it is probably more correct not to pool stomach samples and to use a finer resolution on the input temperature used in the model. We could not conclude from our analysis whether cod feed on shrimp in the trawl. This should be tested for in a dedicated study, and could also be interesting regarding other of the prey species of cod.

The ecological interaction between cod and shrimp should also be studied in more detail. Studies on prey preference of cod could determine if shrimp are preferred and if preference is determined by shrimp abundance, or abundance of other prey species such as capelin. If shrimp is neither preferred nor avoided, e.g. eaten according to its abundance, mortality of shrimp due to cod predation will be determined by the size of the cod stock. Also, spatial overlap between shrimp and cod and rate of consumption of shrimp at various spatial scales, should be studied, to evaluate if the Barents Sea shrimp stock by cod predation. How rate of consumption of shrimp by cod (measured by FO, frequency of occurrence, proportion of non empty stomachs containing shrimp) is correlated with the abundance of shrimp at various spatial scales are given in the figures below. Unfortunately, there is not much stomach data taken synoptically with shrimp abundance data, but from 2005 on, cod stomach data, shrimp abundance data and abundance data on other prey species of the cod is sampled synoptically on the Joint PINRO-IMR cruise covering the whole of the Barents Sea in August-September. Data from this cruise should be valuable when evaluating the effect of cod predation on the Barents Sea shrimp stock.

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Table 1. Percentage higher consumption estimate by pooling data compared to not pooling input data.

YEAR	Percentage higher consumption
1992	16
1993	-7
1994	37
1995	4
1996	29
1997	25
1998	29
1999	10
2001	35
2002	0
2003	-7
Average	16

Table 2. Norwegian shrimp index, Norwegian cod cons. estimate and catches of Barents Sea shrimp in 1 000 tons.

	Shrimp index **Se map for area coverage**									Cod consumption **See map for area coverage**				Catches
	Survey 2. Quarter						Survey 3. Quarter							
	A	B	C	D	E	F	G	H	Total	East	West	North	Total	
1984	40	51	64	60	141	66	20	29	471	331	15	89	436	131
1985	23	17	27	18	96	31	17	17	246	99	44	13	155	129
1986	10	7	13	25	57	34	10	10	166	87	15	40	142	70
1987	29	13	18	23	31	10	9	13	146	27	36	129	191	45
1988	26	18	18	36	32	24	13	14	181	35	15	80	129	49
1989	41	17	13	17	33	53	22	20	216	62	12	58	132	63
1990	31	13	25	42	58	43	27	23	262	129	11	54	194	81
1991	22	28	22	54	107	44	21	10	308	104	43	42	188	81
1992	18	22	33	37	62	38	14	15	239	248	88	37	373	75
1993	17	19	32	29	90	20	12	19	238	188	106	21	315	59
1994	19	8	13	15	52	33	9	12	161	371	81	65	518	30
1995	10	10	11	17	83	33	16	13	193	173	176	13	362	27
1996	21	8	26	26	110	42	21	22	276	199	101	41	340	34
1997	24	34	20	34	116	44	12	16	300	216	45	49	311	37
1998	18	24	41	26	120	72	12	28	341	198	77	53	328	55
1999	17	19	23	21	169	31	21	16	317	157	60	45	262	76
2000	14	29	25	26	102	29	10	12	247	278	155	43	475	83
2001	18	10	30	15	61	25	10	17	186	155	110	30	295	58
2002	11	18	28	16	86	18	9	10	196	145	62	33	240	65
2003	15	17	36	12	94	15	8	16	213				237	38
2004	14	24	22	13	46	14	7	11	151				253	33
Mean 1985-2004									229				247* excl 1994 2000	59

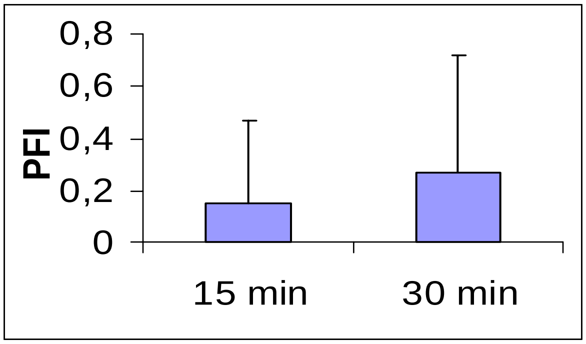


Fig. 1. Shrimp content by towing time with +SE bars.

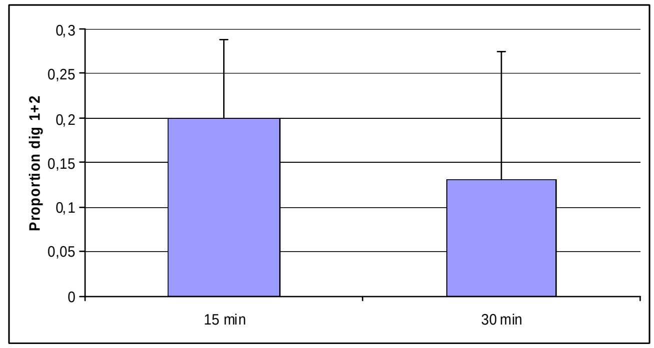


Fig. 2. Prop. of slightly digested shrimp by towing time.

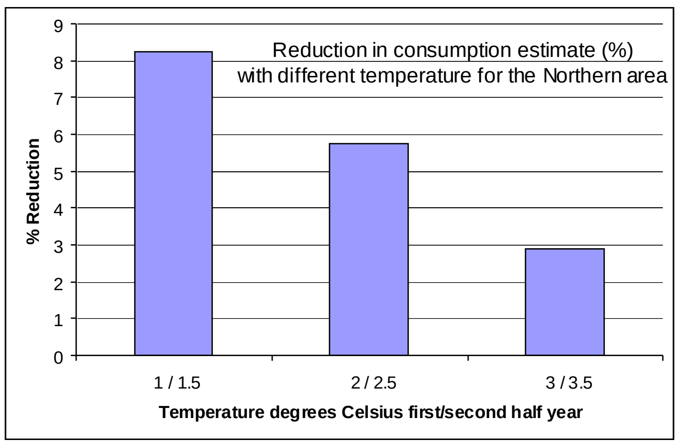


Fig. 3. Reduction in shrimp cons. est. in relation to different input temperatures for the Northern area (see map).

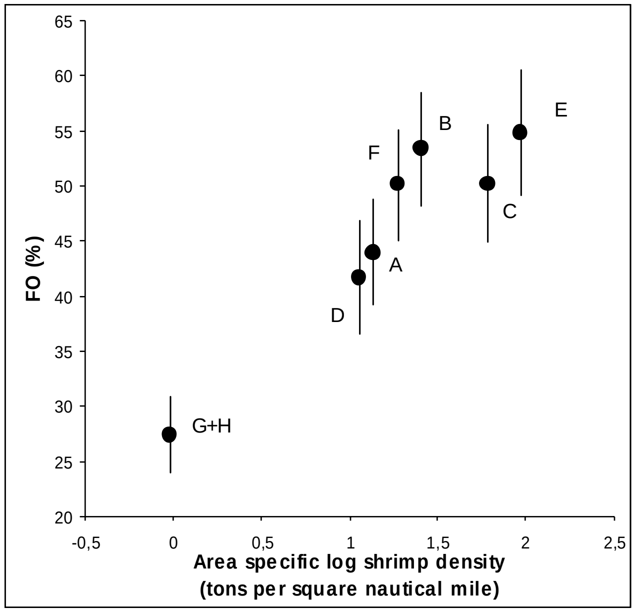


Fig. 4. Average frequency of occurrence (1996-2003) with confidence intervals of shrimp in cod stomachs by shrimp survey areas plotted against log average shrimp density (1996-2003) calculated from the Norwegian index of shrimp abundance.

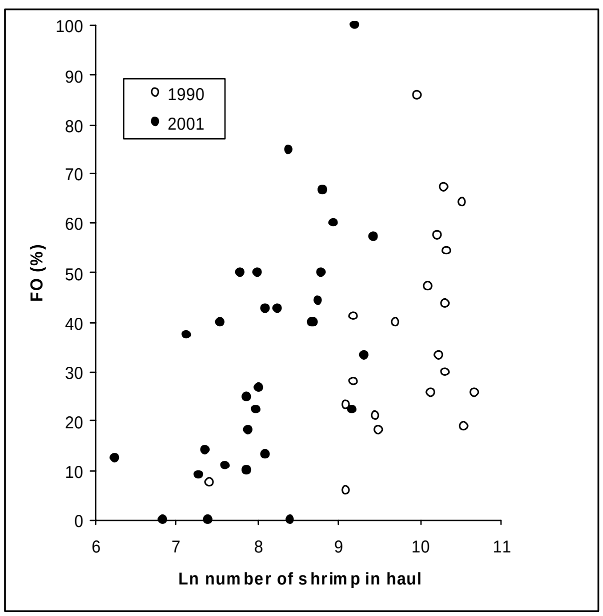
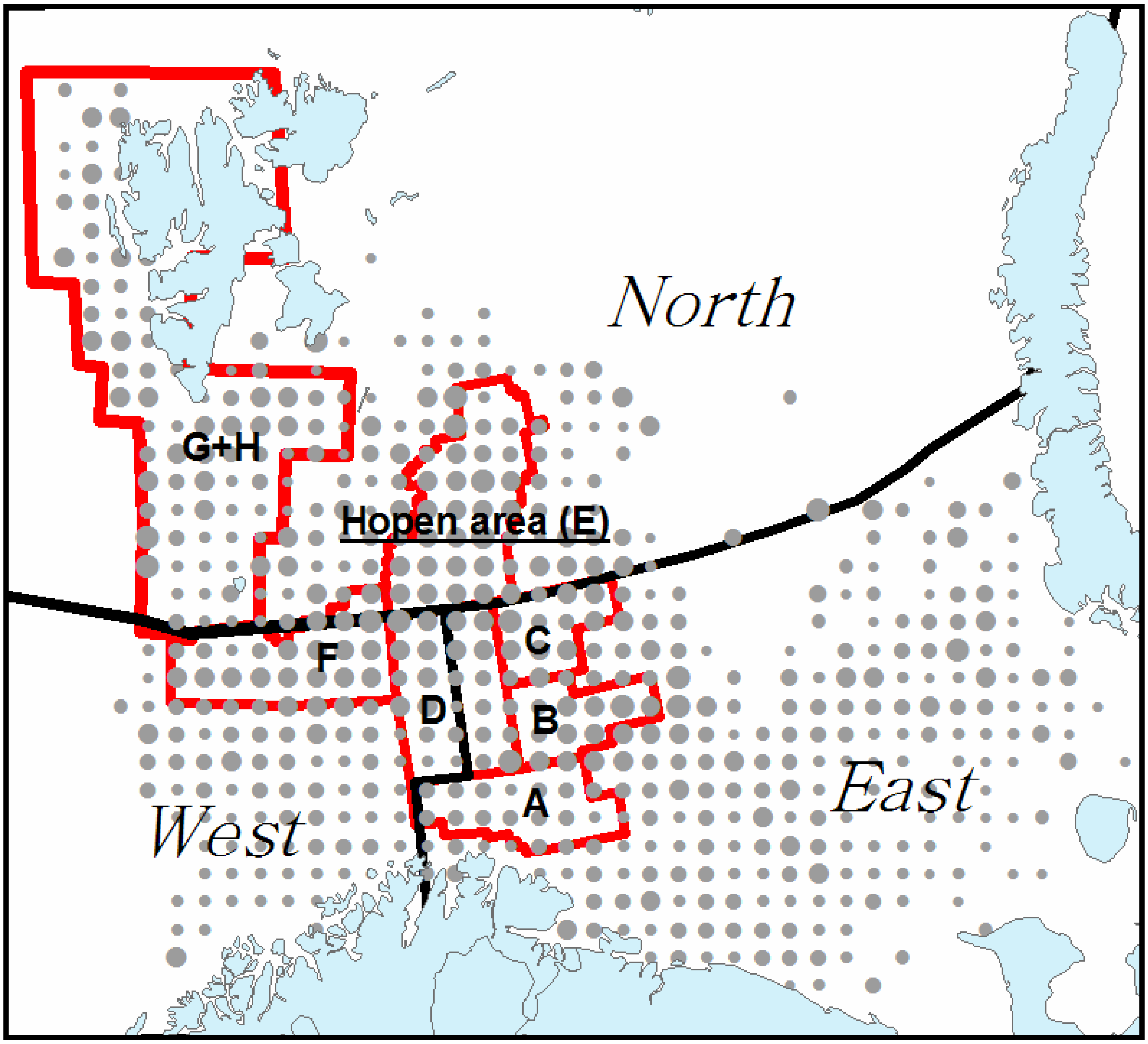


Fig. 5. Station specific frequency of occurrence of shrimp in cod stomachs plotted against station specific log number of shrimp in the haul.



MAP over the Barents Sea area. The areas delimited by red are the areas of the shrimp survey. The black lines are the borders between the three areas used in the consumption model. The grey dots are the average content (1984-2003) of shrimp in cod stomachs (PFI) in 20 by 20 nautical miles grid cells. The size of the dots is proportional to the PFI values.

APPENDIX 1. Simple Sensitivity Analysis of Cod Consumption Model in the Barents Sea

This simple analysis is meant exploratory to get an idea of the variability in the input parameters and how this affect the consumption estimates of shrimp given by the model derived by Bogstad and Mehl (1997).

The model

The consumption model is used to calculate the consumption of redfish, haddock, cod, polar cod, herring, capelin, shrimp, krill and amphipods by cod each year. The estimated consumption in a year is calculated from the sum of the consumption by year-class 1-11+ in the first and second half of the year, in three different areas of the Barents Sea (see Map). Each of these consumption estimates are made up by two parts: an estimate of the number of cod in the year-class in that area in that half year, and an estimate of the individual consumption by each cod in that half year, age class and area. Increasing either individual consumption or number of cod with 1%, will increase the consumption with 1%.

Number of cod per age class, area and half year

The number of cod in the first and second half of the year are given by the VPA estimate for 1st April and 1st October. These estimates are derived using the VPA estimate from 1st January and accounting for natural and fishing mortality for the first three and nine months respectively. The number of cod of each of the three areas is calculated by multiplying the number of cod derived from VPA with the proportion of cod in each area. The proportion in each area in each half year for each year-class is derived from survey data, predominately data from the Norwegian winter survey the first half of the year and the autumn survey second half of the year.

Individual consumption per age class, area and half year

Individual consumption is calculated from the stomach evacuation model taken from dos Santos and Jobling (1995): individual consumption = $\ln 2 e^{\gamma T} W^{\delta} S_i / \alpha_i S_0{}^{\beta}$

Input parameters are cod weight (W), temperature (T), initial meal size (S_0), and stomach content of a particular prey species (S_i). The coefficients γ, δ, α_i, β are determined from laboratory experiments by dos Santos and Jobling (1995). α_i vary by prey type.

Increasing each of the input parameters with 1% from their average values, leads to 1% increase in consumption for stomach content of prey, 0.52% decrease for total stomach content, 0.46% increase for temperature, and 0.26% increase for cod weight, which corresponds to the coefficients.

Input data are pooled and average by age, area and half year. Cod weight is determined from VPA data, and given by age and half year. Temperature is determined from climate data and is given by area and half year. Initial meal size and stomach content of a particular prey is calculated using data from the IMR PINRO stomach content database. Stomach content of a particular prey species estimated as the average content of a given prey type by age, area and half year. Initial meal size is unknown, but is approximated by the average total stomach content by age, area and half year. The stomach data is pooled and averaged of area, age group and half year, leading to an overestimation of individual consumption of on average 35% (dos Santos and Jobling, 1995). The individual consumption estimate is corrected by reducing it with 35% (Bogstad and Mehl, 1997).

Variability in input parameters

The consumption model is based on input parameters derived from several sources. For most of these parameters, there is no measure of uncertainty as far as I know. The variability in the parameters was taken as the range from maximum to minimum value observed for 20 years, 1984-2003. Since the input parameters are on different scales, the variability is scaled by their mean value. The variability in the parameters is presented in Table 1.

The parameters related to year-classes 1-2 showed the highest variability. The variabilities were similar among the quarters and areas. For the five groups of input parameters (see Table 1), the variability was highest for shrimp content in stomachs, VPA, total stomach content, proportion of cod in the area, cod weight and temperature respectively. Stomach content, and shrimp content were particular variable for age classes 1-2. VPA was most variable for year-class 1-2 and 8-11+.

Sensitivity analysis

The sensitivity analysis used is a kind of screening sensitivity analysis (Saltelli, Chan and Scott, 2001), where each parameter is set at discrete levels. To take interactions and correlation among parameters into account, each parameter should be set at all levels, with all combinations of other parameters at all their levels. The number of model runs will then be the number k^l, where k is the number of parameters, and l is the number of levels.

I chose five groups of parameters: VPA, proportion of cod in the area, temperature, and shrimp content in stomach. VPA is set as a different parameter for each half year and each age class, shrimp content and proportion of cod in area, is different for each age class, area and half year, whereas temperature is set to be different for each area and half year. That leaves 160 parameters to be varied. Setting all at their maximum, minimum and average levels in all combinations, means that consumption has to be calculated more than 4 million times. Therefore, I set each parameter at its minimum and maximum value, while keeping all of the other parameters at their average value, ignoring correlations and interaction among them. I calculated the difference in consumption when each parameter was at its minimum and maximum value, and then scaled the differences as percentage of the average consumption estimate. For the proportion parameters, when setting the proportion in one area as it maximum or minimum, the others was set at their average and scaled so the sum of all proportion was 1. The results are shown in Table 2.

The influence of the input parameters decreased according to age class. Variability in the parameters in the East and in the second half of the year leads to the highest variability in consumption. VPA was the most important input parameter, followed by shrimp content in stomach, temperature and proportion of cod in each area.

Appendix Table 1. Percent variability (max value-min value/ average value)*100% for the input parameters to the consumption model.

AGE	AREA	Half of the year	Temperature	Proportion of cod in each area	VPA	Cod weight	Shrimp in stomachs	Stomach content
1	East	1	60	84	370	112	756	513
2	East	1		80	214	118	446	220
3	East	1		99	155	100	442	256
4	East	1		94	157	95	322	262
5	East	1		137	163	72	243	233
6	East	1		141	185	56	334	191
7	East	1		162	243	45	468	231
8	East	1		162	424	36	478	308
9	East	1		162	633	41	534	309
10	East	1		162	843	39	534	309
11	East	1		162	684	25	534	309
1	East	2	39	125	294	118	846	264
2	East	2		112	148	116	506	277
3	East	2		134	154	114	177	150
4	East	2		127	151	82	271	271
5	East	2		143	157	65	328	228
6	East	2		148	186	54	457	197
7	East	2		175	313	45	451	239
8	East	2		175	525	53	322	325
9	East	2		175	743	46	360	289
10	East	2		175	895	42	360	289
11	East	2		175	617	19	360	289
1	North	1	44	412			513	707
2	North	1		328			435	322
3	North	1		326			314	250
4	North	1		137			293	197
5	North	1		218			441	157
6	North	1		296			434	172
7	North	1		322			537	286
8	North	1		322			356	220
9	North	1		322			360	254
10	North	1		322			360	254
11	North	1		322			364	265
1	North	2	30	347			506	736
2	North	2		245			352	291
3	North	2		270			294	218
4	North	2		191			342	180
5	North	2		170			490	120
6	North	2		186			540	140
7	North	2		171			273	109
8	North	2		171			290	105
9	North	2		171			250	150
10	North	2		171			250	150
11	North	2		171			250	150
1	West	1	31	444			1003	872
2	West	1		535			401	577
3	West	1		267			245	313
4	West	1		195			246	323
5	West	1		166			207	230
6	West	1		113			226	250
7	West	1		97			276	244
8	West	1		97			330	211
9	West	1		97			368	203
10	West	1		97			368	203
11	West	1		97			368	203
1	West	2	25	414			1223	377
2	West	2		542			332	428
3	West	2		386			201	162
4	West	2		273			218	255
5	West	2		276			383	277
6	West	2		360			337	291
7	West	2		374			246	224
8	West	2		374			458	181
9	West	2		374			227	157
10	West	2		374			227	157
11	West	2		374			219	151

Appendix Table 2. Each parameter is set at its maximum and minimum value and the corresponding consumption estimates are calculated. The percentage of the average consumption of the difference between the consumption estimates given by the maximum and minimum value of each input parameter is given below.

Area	Age	Half year	Proportion of cod in area	Shrimp in stomach	Temperature	VPA
East	1	1	-1.16	28.93	4.37	19.31
East	2	1	-2.11	20.49		14.15
East	3	1	-2.70	20.65		11.95
East	4	1	-0.68	15.82		14.59
East	5	1	0.25	9.35		9.47
East	6	1	0.18	5.64		8.23
East	7	1	0.31	2.39		3.33
East	8	1	0.06	0.67		1.80
East	9	1	0.00	0.15		0.68
East	10	1	0.00	0.06		0.36
East	11	1	0.00	0.03		0.15
East	1	2	3.29	49.85	5.70	21.54
East	2	2	0.97	36.33		15.86
East	3	2	-0.09	11.70		17.10
East	4	2	0.79	17.62		17.14
East	5	2	-0.68	12.96		13.55
East	6	2	-0.52	8.52		8.44
East	7	2	-0.05	3.27		5.88
East	8	2	-0.06	1.03		4.51
East	9	2	-0.09	0.23		1.76
East	10	2	-0.03	0.09		0.83
East	11	2	-0.02	0.04		0.28
North	1	1	0.84	5.21	2.09	
North	2	1	1.18	6.07		
North	3	1	2.36	5.97		
North	4	1	0.90	6.13		
North	5	1	1.67	7.60		
North	6	1	1.43	4.38		
North	7	1	0.13	1.31		
North	8	1	0.02	0.25		
North	9	1	0.03	0.08		
North	10	1	0.01	0.03		
North	11	1	0.01	0.02		
North	1	2	-4.24	4.62	2.41	
North	2	2	-2.55	8.74		
North	3	2	-2.97	8.23		
North	4	2	-2.25	9.28		
North	5	2	-0.55	11.69		
North	6	2	0.84	9.64		
North	7	2	-0.06	1.91		
North	8	2	0.05	1.01		
North	9	2	0.05	0.28		
North	10	2	0.02	0.11		
North	11	2	0.01	0.05		
West	1	1	0.56	3.81	1.79	
West	2	1	1.56	2.53		
West	3	1	0.59	2.81		
West	4	1	-0.61	5.59		
West	5	1	-2.10	4.97		
West	6	1	-1.15	3.96		
West	7	1	-0.41	1.70		
West	8	1	-0.07	0.71		
West	9	1	-0.02	0.20		
West	10	1	-0.01	0.08		
West	11	1	0.00	0.04		
West	1	2	0.51	6.22	1.59	
West	2	2	2.39	3.41		
West	3	2	3.27	3.40		
West	4	2	1.68	4.73		
West	5	2	1.64	8.76		
West	6	2	-0.52	2.97		
West	7	2	0.18	1.11		
West	8	2	0.00	0.87		
West	9	2	0.05	0.14		
West	10	2	0.02	0.06		
West	11	2	0.01	0.00		