A Brief Guide to a Simple Gadget Example

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1 Introduction

This is a guide to a Gadget model example that is currently available for the Gadget software. This example is intended to show how the basics of how Gadget works, and as such some elements of the model have been skipped for simplicity. The stock used in this example is haddock in Icelandic waters, and the data files for this example can be downloaded from the Hafro ftp site, and extracts from these data files are included in this guide.

It is recommended that this guide is read in conjunction with the Gadget User Guide, which is also available from the Hafro ftp site. As explained in the user guide, comments in the data files are denoted by a semi-colon ";", and parameters that can be optimised by Gadget are denoted by a hash "#". This guide, and the example Gadget model, have been updated to include features introduced in Gadget version 2.1.05.

The run this example, the user should ensure that a copy of the Gadget executable has been compiled and placed in the directory containing the model files, and then run Gadget using the following command:

```
gadget -s -i refinputfile
```

2 Main File

The main input file is called "main". This file contains links to other files which make up the Gadget model. There is no data declared in this file, only links to other files.

```
;
; Main file for the haddock example
;
timefile    time        ; specifying years 1978-2006
areafile    area        ; specifying only one area
printfiles  printfile   ; specifying the printer classes
;
[stock]          ; the description of the stock data
stockfiles       had
;
[tagging]        ; the description of the tagging data
; currently no tagging experiments in this haddock model
;
[otherfood]      ; the description of the otherfood data
; currently no otherfood in this haddock model
;
[fleet]          ; the description of the fleet data
```

```
fleetfiles       fleet
;
[likelihood]     ; the description of the likelihood data
likelihoodfiles  likelihood
```

The first 2 lines of the main file for this haddock example list the files that define the timesteps and area to be used for the example. The next line lists the file that is to be used to specify the printing that is required - that is output from the modelled data, not output from the model parameters.

In the [stock] section, there is one file listed which describes the haddock stock to be used for this example. There are then sections for the tagging experiments and the otherfood, which are blank for this example. The [fleet] section lists the file that is required to define the fleets for this example. Finally there is the [likelihood] section which lists the file that defines the likelihood components for this example.

3 Time File

The time file defines the timesteps to be used by Gadget for this example. In this case, Gadget is to run a model from 1978 through to 2006, with 4 equal timesteps in each year.

```
;
; Time file for this haddock model
;
firstyear       1978
firststep       1
lastyear        2006
laststep        4
notimesteps     4 3 3 3 3
```

4 Area file

The area file defines the area data to be used by Gadget for this example. In this example, a single area has been defined, with a constant temperature for the duration of the model.

```
;
; Area file for this haddock model
;
areas  1
size   200000
temperature
;
; year  step  area  temperature
1978    1     1     5
1978    2     1     5
1978    3     1     5
1978    4     1     5
1979    1     1     5
1979    2     1     5
1979    3     1     5
1979    4     1     5
1980    1     1     5
1980    2     1     5
1980    3     1     5
1980    4     1     5
1981    1     1     5
```

```
1981    2     1     5
1981    3     1     5
1981    4     1     5
1982    1     1     5
1982    2     1     5
...
2004    3     1     5
2004    4     1     5
2005    1     1     5
2005    2     1     5
2005    3     1     5
2005    4     1     5
2006    1     1     5
2006    2     1     5
2006    3     1     5
2006    4     1     5
```

5 Aggregation Files

There are a number of simple aggregation files that are required for this example.

5.1 Age Aggregation Files

There are 2 age aggregation files - one that lists the possible ages individually (ie. no aggregation) and one that groups all the ages together into one age group. These age aggregation files also define the text labels that are to be used when inputting and outputting the data for this example.

```
;
; Age aggregation file - no aggregation
;
age1    1
age2    2
age3    3
age4    4
age5    5
age6    6
age7    7
age8    8
age9    9
age10   10

;
; Age aggregation file - all ages aggregated together
;
allages    1  2  3  4  5  6  7  8  9  10
```

5.2 Area Aggregation File

Although there is only one area in this example, it is still necessary to define a area aggregation file. This is because it defines a text label that is to be used when inputting and outputting the data for this example.

```
;
; Area aggregation file - only one area
;
allareas   1
```

5.3 Length Aggregation Files

There are a total of 8 length aggregation files for this example. One aggregation file aggregates the stock into 2cm length groups (by combining the 1cm length groups that are declared for the stock), and a second file aggregates all the length groups together into one length group. There are also 6 aggregation files corresponding to the 6 survey index likelihood components that are declared in the likelihood file, which aggregate the stock into one or more 5cm length groups.

```
;
; Length aggregation file - 2cm length groups
;
len1     4.5     6.5
len2     6.5     8.5
len3     8.5     10.5
len4     10.5    12.5
len5     12.5    14.5
len6     14.5    16.5
len7     16.5    18.5
len8     18.5    20.5
len9     20.5    22.5
len10    22.5    24.5
len11    24.5    26.5
len12    26.5    28.5
len13    28.5    30.5
len14    30.5    32.5
len15    32.5    34.5
len16    34.5    36.5
len17    36.5    38.5
len18    38.5    40.5
len19    40.5    42.5
len20    42.5    44.5
len21    44.5    46.5
len22    46.5    48.5
len23    48.5    50.5
...
len34    70.5    72.5
len35    72.5    74.5
len36    74.5    76.5
len37    76.5    78.5
len38    78.5    80.5
len39    80.5    82.5
len40    82.5    84.5
len41    84.5    86.5
len42    86.5    88.5
len43    88.5    90.5

;
; Length aggregation file - all lengths aggregated together
;
all      4.5     90.5

;
; Length aggregation file for survey indices
;
mlen10   7.5     12.5

;
; Length aggregation file for survey indices
;
mlen15   12.5    17.5
```

```
;
; Length aggregation file for survey indices
;
mlen20   17.5    22.5

;
; Length aggregation file for survey indices
;
mlen25   22.5    27.5
mlen30   27.5    32.5
mlen35   32.5    37.5
mlen40   37.5    42.5
mlen45   42.5    47.5

;
; Length aggregation file for survey indices
;
mlen50   47.5    52.5
mlen55   52.5    57.5
mlen60   57.5    62.5

;
; Length aggregation file for survey indices
;
mlen65   62.5    67.5
mlen70   67.5    72.5
mlen75   72.5    77.5
```

6 Stock File

The stock file contains the various parameters that define the stock to be used in the Gadget model. The first section of this file gives the minimum and maximum age and length of the stock and the location of a reference weight file that specifies a reference weight for each length group for the stock.

The next section of this file covers the parameters required for the growth of the stock. The growth function used in this example is an expanded form of the Von Bertalanffy growth function, split so that the increase in weight is calculated first, and then the change in weight is used to calculate a change in length, as shown in equation 1 and equation 4 below:

$$\Delta W_i = \Delta t q_0 e^{q_1 T} \left(\left(\frac{W_i}{q_2} \right)^{q_4} - \left(\frac{W_i}{q_3} \right)^{q_5} \right) \tag{1}$$

$$r = \frac{W - (p_0 + p_8 (p_1 + p_2 p_8)) W_{ref}}{W} \tag{2}$$

$$f(x) = \begin{cases} 0 & \text{if } p_3 + p_4 x \leq 0 \\ p_5 & \text{if } p_3 + p_4 x \geq p_5 \\ p_3 + p_4 x & \text{otherwise} \end{cases} \tag{3}$$

$$\Delta L_i = \frac{\Delta W_i}{p_6 p_7 l^{p_7 - 1}} f(r) \tag{4}$$

where:
$< \Delta t >$ is the length of the timestep
$<$ T $>$ is the temperature
$< W_{ref} >$ is the reference weight

For this example, q_1 is set to zero, removing the temperature dependance from the equation, and q_2 is set equal to q_3, further simplifying the equation. Equations 2 and 3 introduce the concept of starvation to the Gadget model, by using a function of the weight and the reference weight when calculating the length increase due to the growth. For this example, p_0 is set to one and p_8 to zero, which considerably simplifies equation 2. To simplify the growth function further, it is possible to remove the concept of starvation from equation 3 by setting p_3 to zero and p_4 and p_5 to one. Once Gadget has calculated the mean increase in weight and length, this increase is then distributed amongst the length groups using a beta-binomial distribution that is defined by the parameters beta and maxlengthgroupgrowth.

The stock file then defines the age based natural mortality that is to be applied to the stock. The next section of the stock file defines whether the stock acts as a prey or a predator, and specifies the initial conditions, which are used to calculate the stock that exists at the beginning of the first timestep. There then follows sections used to describe how the stock would migrate, mature, move, recruit, spawn and stray, which are mostly unused for the example. However, the stock does have recruits to ensure that it doesn't die out, which are defined in the recruitment file.

```
;
; Haddock stock file for this haddock model
;
stockname       had
livesonareas    1
minage          1
maxage          10
minlength       4.5
maxlength       90.5
dl              1
refweightfile   had.refweights
;
; the growth and consumption can be calculated on a finer scale
; so the length groups for this are specified here
;
growthandeatlengths   len.agg
;
; information about the growth of the stock
;
doesgrow              1
growthfunction        weightvb
;
; the parameters required for this growth function are
;
wgrowthparameters     #grq0  0  #grq2  #grq2  0.666  1
lgrowthparameters     1  0  0  1  2.2  1.4  8.85e-6  3.0257  0
;
beta                  #bbeta
maxlengthgroupgrowth  20
;
; information about the natural mortality of the stock
; age             1   2    3   4   5   6   7   8   9   10
naturalmortality  0.5 0.35 0.2 0.2 0.2 0.2 0.2 0.3 0.4 0.7
;
; information about the stock acting as a prey
;
iseaten           1 ; the fleet is considered a predator
preylengths       len.agg
energycontent     1
;
; information about the stock acting as a predator
```

```
;
doeseat           0
;
; information about the initial conditions of the stock
;
initialconditions
minage            1
maxage            10
minlength         4.5
maxlength         90.5
normalcondfile    had.init
;
; information about the migration of the stock
;
doesmigrate       0
;
; information about the maturation of the stock
;
doesmature        0
;
; information about the movement of the stock
;
doesmove          0
;
; information about the recruitment to the stock
;
doesrenew         1
minlength         4.5
maxlength         28.5
normalparamfile   had.rec
;
; information about the spawning of the stock
;
doesspawn         0
;
; information about the straying of the stock
;
doesstray         0
```

6.1 Reference Weight File

The reference weight file gives a reference length-weight relationship for the stock in this example. This is used to generate the entries in the age-length cells for the initial conditions, and to modify the growth of the stock after starvation (so that the growth results in an increase in weight not length for the underweight fish). This files simply lists a ”reference” mean weight for each length group for the stock.

```
;
; Reference length-weight relationship for this haddock model
;
;length weight
5       0.001307
6       0.002154
7       0.003285
8       0.004735
9       0.006538
10      0.008725
11      0.011328
```

```
12      0.013848
13      0.017795
14      0.021701
15      0.025792
16      0.030797
17      0.036149
18      0.045531
19      0.052379
20      0.064773
21      0.080277
22      0.092542
23      0.104681
24      0.116645
25      0.13377
26      0.150614
...
81      4.753127
82      4.918877
83      5.088293
84      5.261409
85      5.438262
86      5.618887
87      5.803317
88      5.99159
89      6.183739
90      6.3798
```

6.2 Initial Conditions File

The initial conditions file gives a Normal distribution for each area/age group combination. This will be used by Gadget to construct an initial population of 10,000 fish in each area/age group, with the length groups specified by a mean length and standard deviation. The mean weight for the length groups of the initial population is calculated by multiplying the reference weight by the condition factor. To change from a population with 10,000 fish in each area/age group to the initial population used in the model, each age group is multiplied by an area weighting factor and an age weighting factor, as specified in the initial conditions file.

```
;
; Initial conditions file for this haddock model
;
; age  area  agemultiplier     areamult  meanlength  standdev  condition
1      1     0                 100       16.41203    2.247188  1
2      1    (* 10000 #inage2)  100       27.15520    2.898219  1
3      1    (* 6065.3 #inage3) 100       36.98713    4.070510  1
4      1    (* 3678.8 #inage4) 100       43.77545    4.927558  1
5      1    (* 2231.3 #inage5) 100       49.43773    5.540416  1
6      1    (* 1353.4 #inage6) 100       53.76334    5.807182  1
7      1    (* 820.8 #inage7)  100       58.64396    6.023261  1
8      1    (* 497.9 #inage8)  100       66.10526    8         1
9      1    (* 302 #inage9)    100       60.88235    9         1
10     1    (* 10 #inage9)     100       63.00       9         1
```

6.3 Recruitment File

The recruitment file defines the number of the recruits that are to be added to the stock, along with information about the age, length and weight of these recruits. The number of these recruits

is given, for each timestep/area combination, in units of 10,000 fish. The age is specified as the minimum age of the stock.

These recruits are defined as a simple length based stock, with a Normal distribution around a mean length and standard deviation of the length given in the input file. The mean weight of the recruits is then calculated from the standard weight-length relationship, given in equation 5 below:

$$W = \alpha L^{\beta} \tag{5}$$

Note that in this example, the recruits are assumed to have the same weight and length distribution in each year. The number of recruits for years that there is data available (1978 - 1999) are parameters that the optimiser can adjust to try to get a better fit between the modelled data and the input data, where as for future years when there is no data available it is assumed that there is a constant number of recruits.

```
;
; Recruitment data for this haddock model
;
; year  step  area  age  number          meanlen  stddev alpha    beta
1978    1     1     1   (* 1000 #rec78) 16.41    2.25   8.85e-6  3.0257
1979    1     1     1   (* 1000 #rec79) 16.41    2.25   8.85e-6  3.0257
1980    1     1     1   (* 1000 #rec80) 16.41    2.25   8.85e-6  3.0257
1981    1     1     1   (* 1000 #rec81) 16.41    2.25   8.85e-6  3.0257
1982    1     1     1   (* 1000 #rec82) 16.41    2.25   8.85e-6  3.0257
1983    1     1     1   (* 1000 #rec83) 16.41    2.25   8.85e-6  3.0257
1984    1     1     1   (* 1000 #rec84) 16.41    2.25   8.85e-6  3.0257
1985    1     1     1   (* 1000 #rec85) 16.41    2.25   8.85e-6  3.0257
1986    1     1     1   (* 1000 #rec86) 16.41    2.25   8.85e-6  3.0257
1987    1     1     1   (* 1000 #rec87) 16.41    2.25   8.85e-6  3.0257
1988    1     1     1   (* 1000 #rec88) 16.41    2.25   8.85e-6  3.0257
1989    1     1     1   (* 1000 #rec89) 16.41    2.25   8.85e-6  3.0257
1990    1     1     1   (* 1000 #rec90) 16.41    2.25   8.85e-6  3.0257
1991    1     1     1   (* 1000 #rec91) 16.41    2.25   8.85e-6  3.0257
1992    1     1     1   (* 1000 #rec92) 16.41    2.25   8.85e-6  3.0257
1993    1     1     1   (* 1000 #rec93) 16.41    2.25   8.85e-6  3.0257
1994    1     1     1   (* 1000 #rec94) 16.41    2.25   8.85e-6  3.0257
1995    1     1     1   (* 1000 #rec95) 16.41    2.25   8.85e-6  3.0257
1996    1     1     1   (* 1000 #rec96) 16.41    2.25   8.85e-6  3.0257
1997    1     1     1   (* 1000 #rec97) 16.41    2.25   8.85e-6  3.0257
1998    1     1     1   (* 1000 #rec98) 16.41    2.25   8.85e-6  3.0257
1999    1     1     1   (* 1000 #rec99) 16.41    2.25   8.85e-6  3.0257
2000    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
2001    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
2002    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
2003    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
2004    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
2005    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
2006    1     1     1    9000           16.41    2.25   8.85e-6  3.0257
```

7 Fleet File

The fleet file defines the fleets that are present in the Gadget model. The fleets are defined by specifying the fleet type, name, area and length groups (which in this example are set to the minimum and maximum lengths of the stock). The fleets also have a suitability function, that describes how likely it is that the fleet will catch fish of a given length. The suitability function used is an exponential suitability function, given in equation 6 below:

$$S(l, L) = \frac{\delta}{1 + e^{-\alpha - \beta l - \gamma L}} \tag{6}$$

where:
< l > is the length of the prey
< L > is the length of the predator

Note that in this example, $< \gamma >$ is set to 0 which removes any dependance on the length of the predator, and $< \delta >$ is always set to 1. $< \alpha >$ and $< \beta >$ are parameters that the optimiser can adjust to try to get a better fit between the modelled data and the input data.

There are 3 fleets defined in this example. The commercial fleet (”comm”) covers all the commercial fishing activity, and all the available landings data is specified in the data file. The survey fleet (”survey”) covers all the government survey activity, and this fleet is assumed to land a constant amount of fish for all the years in the model. The third fleet (”future”) covers all the predicted commercial fishing activity from mid 1999 (when the commercial landing data stops being available) to the end of the models timesteps.

```
;
; Fleet data for this haddock model
;
; Details for the commercial fleet
;
[component]
totalfleet      comm            ; fleet name
livesonareas    1               ; areas for the fleet
suitability                     ; alpha    beta     gamma  delta
had    function exponential       #acomm   #bcomm   0      1
amount          fleet.data      ; where the catch data is stored
;
; Details for the survey fleet
;
[component]
totalfleet      survey          ; fleet name
livesonareas    1               ; areas for the fleet
suitability
had    function exponential       #asur    #bsur    0      1
amount          fleet.data      ; where the catch data is stored
;
; Details for the predicted fleet
;
[component]
linearfleet     future          ; fleet name
livesonareas    1               ; areas for the fleet
multiplicative  #mult           ; scaling factor
suitability
had    function exponential       #acomm   #bcomm   0      1
amount          fleet.predict   ; where the catch data is stored
```

7.1 Fleet Data Files

The 2 fleet data files contain details of the landings made in each timestep/area/fleet combination for the fleets that have been declared in the main fleet file. The first data file is a list of the total weight of the landing data currently available (ie. all the survey data and the commercial landings data up to the first timestep of 1999) for each timestep/area/fleet combination. The second data file contains a list of the ratios to be used when calculating the amount that the fleet

will catch, for the timestep/area combinations when commercial fleet effort is required in the future and no landings data is available (ie. from the second timestep of 1999).

```
;
; Fleet catch data in kilos for this haddock model
;
; year  step  area  fleet   amount
1978    1     1     comm    8444000
1978    2     1     comm    14834000
1978    3     1     comm    9985000
1978    4     1     comm    10184000
1979    1     1     comm    10753000
1979    2     1     comm    18893000
1979    3     1     comm    12717000
1979    4     1     comm    12971000
1980    1     1     comm    9933000
1980    2     1     comm    17451000
1980    3     1     comm    11747000
1980    4     1     comm    11981000
1981    1     1     comm    12352000
1981    2     1     comm    21701000
1981    3     1     comm    14608000
1981    4     1     comm    14899000
1982    1     1     comm    13023000
1982    2     1     comm    22880000
1982    3     1     comm    15401000
1982    4     1     comm    15708000
1983    1     1     comm    15853000
1983    2     1     comm    25218000
...
1997    2     1     survey  30000
1998    2     1     survey  30000
1999    2     1     survey  30000
2000    2     1     survey  30000
2001    2     1     survey  30000
2002    2     1     survey  30000
2003    2     1     survey  30000
2004    2     1     survey  30000
2005    2     1     survey  30000
2006    2     1     survey  30000

;
; Predicted fleet effort for this haddock model
;
; year  step  area  fleet   effort
1999    2     1     future  1
1999    3     1     future  1
1999    4     1     future  1
2000    1     1     future  1
2000    2     1     future  1
2000    3     1     future  1
2000    4     1     future  1
2001    1     1     future  1
2001    2     1     future  1
2001    3     1     future  1
2001    4     1     future  1
2002    1     1     future  1
2002    2     1     future  1
2002    3     1     future  1
```

```
2002    4     1     future  1
2003    1     1     future  1
2003    2     1     future  1
2003    3     1     future  1
2003    4     1     future  1
2004    1     1     future  1
2004    2     1     future  1
2004    3     1     future  1
2004    4     1     future  1
2005    1     1     future  1
2005    2     1     future  1
2005    3     1     future  1
2005    4     1     future  1
2006    1     1     future  1
2006    2     1     future  1
2006    3     1     future  1
2006    4     1     future  1
```

8 Likelihood File

The likelihood file defines the various likelihood components that will be used to compare the data from within the Gadget model with external data. Each likelihood component calculates a ”goodness of fit” between the 2 sets of data to give a a likelihood score, and there is then a weighted sum of these likelihood scores to give an overall likelihood score, which can be minimised if Gadget is performing an optimising run.

In this example, there are a total of 14 likelihood components defined to test the goodness of fit between the 2 sets of data. These are ”BoundLikelihood”, ”Understocking”, 2 ”CatchStatistics”, 4 ”CatchDistribution” and 6 ”SurveyIndices” components.

BoundLikelihood
The BoundLikelihood component is used to apply a penalty weight to any parameter that goes outside the bounds during the optimising process. Applying this penalty weight will force the parameter away from the bounds and back into the range of numbers that have been specified in the parameter file.

Understocking
The Understocking component is used to apply a penalty whenever there has been overconsumption by predators (in this case the fleets), and there is insufficient stock for the predator to consume. In this example this penalty is the sum of squares of the understocking that has occurred in the model.

CatchStatistics
The CatchStatistics components are used to compare biological data sampled from the model with that sampled from landings data for the fleets. In this example there are 2 comparisons, one for data from the commercial fleet and one for the survey fleet. In each case a weighted sum of squares of the mean length at age is used to calculate the goodness of fit between the 2 sets of data. The data which will be compared to the results from within the Gadget model are given in the 2 data files that are specified.

CatchDistribution
The CatchDistribution components are used to compare distribution data sampled from the model with that sampled from landings data for the fleets. In this example there are 2 comparisons (one for the commercial fleet, one for the survey fleet) with the data aggregated into length groups and a further 2 comparisons with the data aggregated into age-length groups. In

each case a multinomial function is used to calculate the goodness of fit between the 2 sets of data. The data which will be compared to the results from within the Gadget model are given in the 4 data files that are specified.

SurveyIndices
The SurveyIndices components are used to compare stock indices calculated within the Gadget model to indices calculated from a standardized survey for that stock. In this example the survey indices calculated are based on a length group survey, and there are 6 comparisons for 6 different length group aggregations, defined in the various length aggregation files. The index calculated in the model will be compared to the index that is specified in the data file, using a log linear regression line with the slope fixed and the intercept estimated within the model.

```
;
; Likelihood file for this haddock model
;
; first specify the likelihood bounds
[component]
name                bounds            ; likelihood component name
weight              10                ; weight for component
type                penalty           ; type of component
datafile            penaltyfile       ; data file for this component
;
; now specify when to check for understocking
;
[component]
name                understocking     ; likelihood component name
weight              1e-12             ; weight for component
type                understocking     ; type of component
;
; the mean length statistics data
;
[component]
name                meanl.sur         ; likelihood component name
weight              2e-6              ; weight for component
type                catchstatistics   ; type of component
datafile            had.meanle.sur    ; data file for this component
function            lengthgivenstddev ; function type
areaaggfile         allarea.agg       ; area aggregation file
ageaggfile          age.agg           ; age aggregation file
fleetnames          survey            ; source of fleet data
stocknames          had               ; source of stock data
;
[component]
name                meanl.catch       ; likelihood component name
weight              0.3e-6            ; weight for component
type                catchstatistics   ; type of component
datafile            had.meanle.catch  ; data file for this component
function            lengthgivenstddev ; function type
areaaggfile         allarea.agg       ; area aggregation file
ageaggfile          age.agg           ; age aggregation file
fleetnames          comm              ; source of fleet data
stocknames          had               ; source of stock data
;
; the length distribution data
;
[component]
name                ldist.sur         ; likelihood component name
weight              0.05e-6           ; weight for component
```

```
type                catchdistribution ; type of component
datafile            had.ldist.sur     ; data file for this component
function            multinomial       ; function type
epsilon             20                ; used when outcome is improbable
areaaggfile         allarea.agg       ; area aggregation file
ageaggfile          allage.agg        ; age aggregation file
lenaggfile          len.agg           ; length aggregation file
fleetnames          survey            ; source of fleet data
stocknames          had               ; source of stock data
;
[component]
name                ldist.catch       ; likelihood component name
weight              3e-6              ; weight for component
type                catchdistribution ; type of component
datafile            had.ldist.catch   ; data file for this component
function            multinomial       ; function type
epsilon             20                ; used when outcome is improbable
areaaggfile         allarea.agg       ; area aggregation file
ageaggfile          allage.agg        ; age aggregation file
lenaggfile          len.agg           ; length aggregation file
fleetnames          comm              ; source of fleet data
stocknames          had               ; source of stock data
;
; the age-length distribution data
;
[component]
name                alkeys.sur        ; likelihood component name
weight              7e-6              ; weight for component
type                catchdistribution ; type of component
datafile            had.alkeys.sur    ; data file for this component
function            multinomial       ; function type
epsilon             20                ; used when outcome is improbable
areaaggfile         allarea.agg       ; area aggregation file
ageaggfile          age.agg           ; age aggregation file
lenaggfile          len.agg           ; length aggregation file
fleetnames          survey            ; source of fleet data
stocknames          had               ; source of stock data
;
[component]
name                alkeys.catch      ; likelihood component name
weight              2e-6              ; weight for component
type                catchdistribution ; type of component
datafile            had.alkeys.catch  ; data file for this component
function            multinomial       ; function type
epsilon             20                ; used when outcome is improbable
areaaggfile         allarea.agg       ; area aggregation file
ageaggfile          age.agg           ; age aggregation file
lenaggfile          len.agg           ; length aggregation file
fleetnames          comm              ; source of fleet data
stocknames          had               ; source of stock data
;
; the survey index data
;
[component]
name          si10                    ; likelihood component name
weight        70e-4                   ; weight for component
type          surveyindices           ; type of component
datafile      had.surveyindex         ; data file for this component
```

```
sitype        lengths                ; survey index type
areaaggfile   allarea.agg            ; area aggregation file
lenaggfile    si10len.agg            ; length aggregation file
stocknames    had                    ; source of stock data
fittype       fixedslopeloglinearfit ; type of data fit
slope         1                      ; slope is fixed
;
[component]
name          si15                   ; likelihood component name
weight        100e-4                 ; weight for component
type          surveyindices          ; type of component
datafile      had.surveyindex        ; data file for this component
sitype        lengths                ; survey index type
areaaggfile   allarea.agg            ; area aggregation file
lenaggfile    si15len.agg            ; length aggregation file
stocknames    had                    ; source of stock data
fittype       fixedslopeloglinearfit ; type of data fit
slope         1                      ; slope is fixed
;
[component]
name          si20                   ; likelihood component name
weight        100e-4                 ; weight for component
type          surveyindices          ; type of component
datafile      had.surveyindex        ; data file for this component
sitype        lengths                ; survey index type
areaaggfile   allarea.agg            ; area aggregation file
lenaggfile    si20len.agg            ; length aggregation file
stocknames    had                    ; source of stock data
fittype       fixedslopeloglinearfit ; type of data fit
slope         1                      ; slope is fixed
;
[component]
name          si25to45               ; likelihood component name
weight        100e-4                 ; weight for component
type          surveyindices          ; type of component
datafile      had.surveyindex        ; data file for this component
sitype        lengths                ; survey index type
areaaggfile   allarea.agg            ; area aggregation file
lenaggfile    si2545len.agg          ; length aggregation file
stocknames    had                    ; source of stock data
fittype       fixedslopeloglinearfit ; type of data fit
slope         1                      ; slope is fixed
;
[component]
name          si50to60               ; likelihood component name
weight        100e-4                 ; weight for component
type          surveyindices          ; type of component
datafile      had.surveyindex        ; data file for this component
sitype        lengths                ; survey index type
areaaggfile   allarea.agg            ; area aggregation file
lenaggfile    si5060len.agg          ; length aggregation file
stocknames    had                    ; source of stock data
fittype       fixedslopeloglinearfit ; type of data fit
slope         1                      ; slope is fixed
;
[component]
name          si65to75               ; likelihood component name
weight        70e-4                  ; weight for component
```

```
type          surveyindices          ; type of component
datafile      had.surveyindex        ; data file for this component
sitype        lengths                ; survey index type
areaaggfile   allarea.agg            ; area aggregation file
lenaggfile    si6575len.agg          ; length aggregation file
stocknames    had                    ; source of stock data
fittype       fixedslopeloglinearfit ; type of data fit
slope         1                      ; slope is fixed
```

8.1 Penalty File

The penalty file contains the likelihood penalty that is to be applied when any of the parameters goes outside its bound, defined in the parameter input file. For this example, only a default setting is given which will be applied to each parameter that goes outside a bound.

```
;
; Penalty file for this haddock model
; This file lists the penalties applied to the variables
; when the value reaches the bound specified in the inputfile
;
; switch   power  lowerW   upperW
default    2      10000    10000 ; default setting
```

8.2 Mean Length Files

The 2 mean length data files contain the number of samples, and the mean length and standard deviation of the length for these samples, in each timestep/area/age combination for the 2 fleets. For this likelihood component there is no area or age aggregation, as defined by the aggregation files declared in the main likelihood file.

The likelihood function that is used to compare the data from these files with the corresponding data from the model is a weighted sum of squares of the mean length, given in equation 7 below:

$$\ell = \sum_{time} \sum_{areas} \sum_{ages} \left(\frac{(x-\mu)^2}{s^2} N \right) \tag{7}$$

where:
$< \mathrm{x} >$ is the sample mean length from the data
$< \mu >$ is the mean length calculated from the model
$< \mathrm{s} >$ is the standard deviation of the length from the data
$< \mathrm{N} >$ is the sample size

```
;
; Mean length data for the survey catch for this haddock model
;
; year   step  area      age    number  mean   stddev
1989     2     allareas  age1   60      15.35  2.0
1989     2     allareas  age2   124     28.01  3.7
1989     2     allareas  age3   238     36.14  6.2
1989     2     allareas  age4   829     45.64  5.0
1989     2     allareas  age5   336     54.41  5.5
1989     2     allareas  age6   106     63.42  6.3
1989     2     allareas  age7   8       67.88  7.1
1989     2     allareas  age8   8       72.88  6.6
1989     2     allareas  age9   4       70.75  5.8
1989     2     allareas  age10  3       75     5.6
1990     2     allareas  age1   235     15.63  2.0
```

```
1990     2     allareas  age2   227     27.51  3.7
1990     2     allareas  age3   192     37.13  6.2
1990     2     allareas  age4   267     44.58  5.0
1990     2     allareas  age5   620     51.01  5.5
1990     2     allareas  age6   299     59.47  6.3
1990     2     allareas  age7   38      67.29  7.1
1990     2     allareas  age8   9       72.11  6.6
1990     2     allareas  age9   2       71     5.8
1990     2     allareas  age10  0       0      5.6
1991     2     allareas  age1   350     15.85  2.0
1991     2     allareas  age2   808     27.49  3.7
...
1999     2     allareas  age1   310     14.67  2.0
1999     2     allareas  age2   312     27.63  3.7
1999     2     allareas  age3   148     36.2   6.2
1999     2     allareas  age4   174     44.36  5.0
1999     2     allareas  age5   24      50.21  5.5
1999     2     allareas  age6   15      55.53  6.3
1999     2     allareas  age7   4       63.25  7.1
1999     2     allareas  age8   6       60.33  6.6
1999     2     allareas  age9   1       69     5.8
1999     2     allareas  age10  0       0      5.6

;
; Mean length data for the commercial catch for this haddock model
;
; year   step  area      age    number  mean   stddev
1979     1     allareas  age1   0       0      2.0
1979     1     allareas  age2   0       0      3.7
1979     1     allareas  age3   0       0      6.2
1979     1     allareas  age4   7       55.43  5.0
1979     1     allareas  age5   48      58.92  5.5
1979     1     allareas  age6   96      64.2   6.3
1979     1     allareas  age7   36      68.61  7.1
1979     1     allareas  age8   4       73.5   6.6
1979     1     allareas  age9   1       73     5.8
1979     1     allareas  age10  0       0      5.6
1979     2     allareas  age1   0       0      2.0
1979     2     allareas  age2   0       0      3.7
1979     2     allareas  age3   13      42.15  6.2
1979     2     allareas  age4   73      51.44  5.0
1979     2     allareas  age5   224     58.56  5.5
1979     2     allareas  age6   258     62.16  6.3
1979     2     allareas  age7   20      69.6   7.1
1979     2     allareas  age8   8       70.5   6.6
1979     2     allareas  age9   1       72     5.8
1979     2     allareas  age10  0       0      5.6
1979     3     allareas  age1   0       0      2.0
1979     3     allareas  age2   0       0      3.7
...
1998     3     allareas  age1   0       0      2.0
1998     3     allareas  age2   0       0      3.7
1998     3     allareas  age3   17      45     6.2
1998     3     allareas  age4   33      49.42  5.0
1998     3     allareas  age5   78      56.26  5.5
1998     3     allareas  age6   19      58.26  6.3
1998     3     allareas  age7   16      63.31  7.1
1998     3     allareas  age8   28      66.04  6.6
1998     3     allareas  age9   3       74.67  5.8
```

```
1998     3     allareas  age10  0       0      5.6
```

8.3 Length Distribution Files

The 2 length distribution data files contain the number of samples in each timestep/ area/age/length group combination for the 2 fleets. For this likelihood component, there is no area aggregation, all the age groups have been aggregated together into one age group, and the length groups have been aggregated into 2cm length groups, as defined by the aggregation files declared in the main likelihood file.

The likelihood function that is used to compare the data from these files with the corresponding data from the model is a multinomial function, given in equation 8 below:

$$\ell = 2 \sum_{time} \sum_{areas} \sum_{age} \left(\log N_{tra}! - \sum_{length} \log N_{tral}! + \sum_{length} \left(N_{tral} \log \frac{\pi_{tral}}{\sum \pi_{tral}} \right) \right) \tag{8}$$

where:
$< \pi >$ is the model sample size for that time/area/age/length combination
$<$ N $>$ is the data sample size for that time/area/age/length combination

```
;
; Length distribution of the survey data for this haddock model
;
; year   step  area       age      length   number
1985     2     allareas   allages  len1     0
1985     2     allareas   allages  len2     0
1985     2     allareas   allages  len3     4
1985     2     allareas   allages  len4     112
1985     2     allareas   allages  len5     1718
1985     2     allareas   allages  len6     4419
1985     2     allareas   allages  len7     3503
1985     2     allareas   allages  len8     1408
1985     2     allareas   allages  len9     403
1985     2     allareas   allages  len10    216
1985     2     allareas   allages  len11    880
1985     2     allareas   allages  len12    2423
1985     2     allareas   allages  len13    4311
1985     2     allareas   allages  len14    4699
1985     2     allareas   allages  len15    2663
1985     2     allareas   allages  len16    1204
1985     2     allareas   allages  len17    683
1985     2     allareas   allages  len18    962
1985     2     allareas   allages  len19    1588
1985     2     allareas   allages  len20    1935
1985     2     allareas   allages  len21    2508
1985     2     allareas   allages  len22    2222
...
1999     2     allareas   allages  len34    192
1999     2     allareas   allages  len35    87
1999     2     allareas   allages  len36    137
1999     2     allareas   allages  len37    63
1999     2     allareas   allages  len38    39
1999     2     allareas   allages  len39    11
1999     2     allareas   allages  len40    16
1999     2     allareas   allages  len41    1
1999     2     allareas   allages  len42    1
1999     2     allareas   allages  len43    1
```

```
;
; Length distribution of the commercial data for this haddock model
;
; year   step  area       age      length   number
1979     1     allareas   allages  len1     0
1979     1     allareas   allages  len2     0
1979     1     allareas   allages  len3     0
1979     1     allareas   allages  len4     0
1979     1     allareas   allages  len5     0
1979     1     allareas   allages  len6     0
1979     1     allareas   allages  len7     0
1979     1     allareas   allages  len8     0
1979     1     allareas   allages  len9     0
1979     1     allareas   allages  len10    0
1979     1     allareas   allages  len11    0
1979     1     allareas   allages  len12    0
1979     1     allareas   allages  len13    0
1979     1     allareas   allages  len14    0
1979     1     allareas   allages  len15    1
1979     1     allareas   allages  len16    3
1979     1     allareas   allages  len17    11
1979     1     allareas   allages  len18    17
1979     1     allareas   allages  len19    32
1979     1     allareas   allages  len20    53
1979     1     allareas   allages  len21    97
1979     1     allareas   allages  len22    145
...
1999     1     allareas   allages  len34    56
1999     1     allareas   allages  len35    38
1999     1     allareas   allages  len36    31
1999     1     allareas   allages  len37    22
1999     1     allareas   allages  len38    14
1999     1     allareas   allages  len39    12
1999     1     allareas   allages  len40    5
1999     1     allareas   allages  len41    0
1999     1     allareas   allages  len42    0
1999     1     allareas   allages  len43    1
```

8.4 Age-length Distribution Files

The 2 age-length distribution data files contain the number of samples in each timestep/area/age/length group combination for the 2 fleets. For this likelihood component, there is no area or age group aggregation, and the length groups have been aggregated into 2cm length groups, as defined by the aggregation files declared in the main likelihood file.

The only difference between the age-length distribution data files and the length distribution data files is the age aggregation that takes place for the length distribution. The likelihood function that is used to compare the data from these files with the corresponding data from the model is a multinomial function, given in equation 8 above.

```
;
; Age-length distribution of the survey data for this haddock model
;
; year   step  area       age    length   number
1985     2     allareas   age1   len1     0
1985     2     allareas   age2   len1     0
1985     2     allareas   age3   len1     0
1985     2     allareas   age4   len1     0
```

```
1985     2     allareas   age5   len1     0
1985     2     allareas   age6   len1     0
1985     2     allareas   age7   len1     0
1985     2     allareas   age8   len1     0
1985     2     allareas   age9   len1     0
1985     2     allareas   age10  len1     0
1985     2     allareas   age1   len2     0
1985     2     allareas   age2   len2     0
1985     2     allareas   age3   len2     0
1985     2     allareas   age4   len2     0
1985     2     allareas   age5   len2     0
1985     2     allareas   age6   len2     0
1985     2     allareas   age7   len2     0
1985     2     allareas   age8   len2     0
1985     2     allareas   age9   len2     0
1985     2     allareas   age10  len2     0
1985     2     allareas   age1   len3     1
1985     2     allareas   age2   len3     0
...
1999     2     allareas   age1   len43    0
1999     2     allareas   age2   len43    0
1999     2     allareas   age3   len43    0
1999     2     allareas   age4   len43    0
1999     2     allareas   age5   len43    0
1999     2     allareas   age6   len43    0
1999     2     allareas   age7   len43    0
1999     2     allareas   age8   len43    0
1999     2     allareas   age9   len43    0
1999     2     allareas   age10  len43    0

;
; Age-length distribution of the commercial data for this haddock model
;
; year   step  area       age    length   number
1979     1     allareas   age1   len1     0
1979     1     allareas   age2   len1     0
1979     1     allareas   age3   len1     0
1979     1     allareas   age4   len1     0
1979     1     allareas   age5   len1     0
1979     1     allareas   age6   len1     0
1979     1     allareas   age7   len1     0
1979     1     allareas   age8   len1     0
1979     1     allareas   age9   len1     0
1979     1     allareas   age10  len1     0
1979     1     allareas   age1   len2     0
1979     1     allareas   age2   len2     0
1979     1     allareas   age3   len2     0
1979     1     allareas   age4   len2     0
1979     1     allareas   age5   len2     0
1979     1     allareas   age6   len2     0
1979     1     allareas   age7   len2     0
1979     1     allareas   age8   len2     0
1979     1     allareas   age9   len2     0
1979     1     allareas   age10  len2     0
1979     1     allareas   age1   len3     0
1979     1     allareas   age2   len3     0
...
1998     3     allareas   age1   len43    0
1998     3     allareas   age2   len43    0
```

```
1998     3     allareas   age3   len43    0
1998     3     allareas   age4   len43    0
1998     3     allareas   age5   len43    0
1998     3     allareas   age6   len43    0
1998     3     allareas   age7   len43    0
1998     3     allareas   age8   len43    0
1998     3     allareas   age9   len43    0
1998     3     allareas   age10  len43    0
```

8.5 Survey Index File

The survey index data file contains the number of samples in each timestep/area/length group combination for the 6 survey indices defined in the main likelihood file. For this likelihood component, there is no area or age group aggregation, and the length groups have been aggregated into 5cm length groups, as defined by the various length aggregation files declared in the main likelihood file.

The likelihood function that is used to compare the data from these files with the corresponding data from the model is a log linear regression function. For the regression line (specified in the main likelihood file), the slope is fixed and the intercept calculated by Gadget. This is given in equation 9 below:

$$\ell = \sum_{time} \Big(I_t - (\alpha + \beta N_t) \Big)^2 \tag{9}$$

where:
$< \mathrm{I} >$ is the survey index
$< \mathrm{N} >$ is the corresponding index calculated in the Gadget model
$< \alpha >$ is the intercept of the regression line
$< \beta >$ is the slope of the regression line (which has been set to 1)

```
;
; Survey index data for this haddock model
;
; year  step  area      length  number
1985    1     allareas  mlen10  258
1986    1     allareas  mlen10  808
1987    1     allareas  mlen10  286
1988    1     allareas  mlen10  131
1989    1     allareas  mlen10  361
1990    1     allareas  mlen10  568
1991    1     allareas  mlen10  1163
1992    1     allareas  mlen10  1713
1993    1     allareas  mlen10  642
1994    1     allareas  mlen10  782
1995    1     allareas  mlen10  171
1996    1     allareas  mlen10  508
1997    1     allareas  mlen10  217
1998    1     allareas  mlen10  197
1999    1     allareas  mlen10  2690
1985    1     allareas  mlen15  20063
1986    1     allareas  mlen15  91563
1987    1     allareas  mlen15  20086
1988    1     allareas  mlen15  12051
1989    1     allareas  mlen15  8853
1990    1     allareas  mlen15  64132
1991    1     allareas  mlen15  76318
```

```
...
1990    1     allareas  mlen75  1035
1991    1     allareas  mlen75  945
1992    1     allareas  mlen75  2101
1993    1     allareas  mlen75  948
1994    1     allareas  mlen75  533
1995    1     allareas  mlen75  371
1996    1     allareas  mlen75  553
1997    1     allareas  mlen75  318
1998    1     allareas  mlen75  505
1999    1     allareas  mlen75  674
```

9 Print File

The printfile defines the content of the output files that will be generated when a stochastic run of Gadget is performed (by specifying the "-s" command line option when Gadget is started). This output is defined by specifying details of the stock, area, age and length groups and the name of the output file that is to be generated.

In this example there are 6 output files to be generated. The first file (created by "StockStdPrinter") contains an age-based summary of the stock, giving details of the number, length, mean weight and consumption for each timestep/area/age group combination. The next two files (created by "StockPrinter" and "StockFullPrinter") give details of the number and mean weight for each timestep/area/age group/length group combination - the difference being the amount of aggregation that takes place. The 4th file (created by "PredatorPrinter") contains information about the predator/prey combination (with the predator being the fleets) and gives details of the biomass consumed for each timestep/area/predator length group/prey length group combination.

The final two files deal with the output from the likelihood components that have been used to compare this modelled population to observed data. The first file (created by "LikelihoodPrinter") gives detailed information on the modelled data compared to the data specified for the 'ldist.sur' likelihood component, as defined in the likelihood file. The second file (created by "LikelihoodSummaryPrinter") gives a summary of the likelihood information from each timestep in the model.

```
;
; Print file for this haddock model
;
[component]
type            stockstdprinter
stockname       had             ; name of the stock
printfile       out/had.std     ; name for the output file
yearsandsteps   all all         ; timesteps to print
;
[component]
type            stockprinter
stocknames      had             ; names of the stocks (could be more than one)
areaaggfile     allarea.agg     ; area aggregation file
ageaggfile      allage.agg      ; age aggregation file
lenaggfile      len.agg         ; length aggregation file
printfile       out/had.print   ; name for the output file
yearsandsteps   all all         ; timesteps to print
;
[component]
type            stockfullprinter
```

```
stockname       had              ; name of the stock
printfile       out/had.stock    ; name for the output file
yearsandsteps   all all          ; timesteps to print
;
[component]
type            predatorprinter
predatornames   comm future      ; names of the predators (fleets)
preynames       had              ; names of the preys
areaaggfile     allarea.agg      ; area aggregation file
predlenaggfile  alllen.agg       ; length aggregation file for the predators
preylenaggfile  len.agg          ; length aggregation file for the preys
printfile       out/had.fleet    ; name for the output file
yearsandsteps   all all          ; timesteps to print
;
[component]
type            likelihoodprinter
likelihood      ldist.sur        ; name of the likelihood component
printfile       out/ldist.sur    ; name for the output file
;
[component]
type            likelihoodsummaryprinter
printfile       out/summary.txt  ; name for the output file
```

9.1 StockStdPrinter Output

The output file that is generated by the stockstdprinter printer class is given below. This class summarises the data available for the stock, giving the number, mean length, mean weight, standard deviation of the length, number consumed and biomass consumed for each timestep/area/age group combination.

```
; Gadget version 2.1.05 running on hafnasandur Fri Dec 15 11:47:45 2006
; Standard output file for the stock had
; Printing the following information at the end of each timestep
; year-step-area-age-number-mean length-mean weight-stddev length- ...
1978    1    1    1 2.2377895e+08      16.41  0.0444454      2.25  ...
1978    1    1    2 1.0285316e+08    29.8986   0.239963   3.61989  ...
1978    1    1    3     13576599    39.4734   0.585367    4.57133  ...
1978    1    1    4     20759863    46.0429   0.940242    5.24777  ...
1978    1    1    5     46760270     51.507    1.31759     5.7698  ...
1978    1    1    6    1808503.8    55.7022    1.65875     6.0014  ...
1978    1    1    7    741868.46    60.4509      2.101    6.18222  ...
1978    1    1    8     11378896    67.6647    2.94619    7.95431  ...
1978    1    1    9     25158880    62.5636    2.38451    8.94957  ...
1978    1    1   10    771144.33    64.6152    2.61065     8.9165  ...
1978    2    1    1 1.9745062e+08    20.9102  0.0699865   3.39601  ...
1978    2    1    2     93984352    32.4556   0.309357    4.01812  ...
1978    2    1    3     12697802    41.6404   0.693019    5.02845  ...
1978    2    1    4     18951490    48.1062    1.07242    5.57866  ...
1978    2    1    5     41693765      53.43    1.46936    6.00304  ...
1978    2    1    6    1588083.2    57.5301    1.82684     6.1989  ...
1978    2    1    7    643580.75    62.1815    2.28764    6.34419  ...
1978    2    1    8    9554725.5    69.1975    3.15214    7.96035  ...
1978    2    1    9     20769197    64.1639    2.56871    8.96043  ...
1978    2    1   10    588659.57    66.1818    2.80272    8.91073  ...
1978    3    1    1 1.7420549e+08    22.8453   0.104041   3.72832  ...
1978    3    1    2     85845884    34.6377   0.387975    4.60743  ...
...
2006    4    1    1     61764706     25.812   0.147929    4.15511  ...
```

```
2006    4    1    2     42757071    35.5567    0.41957     5.6528  ...
2006    4    1    3     31974330    44.0339   0.826287     6.5416  ...
2006    4    1    4     20854393    51.4965    1.33828    7.15737  ...
2006    4    1    5     11854129    58.3533    1.95177    7.69252  ...
2006    4    1    6    6130993.1    64.9045    2.67258    8.10018  ...
2006    4    1    7    2971731.6    71.2803    3.50628    8.20964  ...
2006    4    1    8    3630883.7    76.8385    4.38653    7.65143  ...
2006    4    1    9    487102.34    80.8852    5.20972    6.94081  ...
2006    4    1   10    157279.59    86.1688     6.7596    5.23485  ...
```

9.2 StockPrinter Output

The output file that is generated by the stockprinter printer class is given below. This class gives a more detailed view of the information available for the stock, giving the number and mean weight for each timestep/area/age group/length group combination specified in the aggregation files. The labels displayed for the area, age group and length group come from those given in the aggregation files.

```
; Gadget version 2.1.05 running on hafnasandur Fri Dec 15 11:47:45 2006
; Output file for the following stocks had
; Printing the following information at the end of each timestep
; year-step-area-age-length-number-mean weight
1978    1   allareas    allages       len1    995.19332 0.0019135364
1978    1   allareas    allages       len2    43025.981 0.0045467325
1978    1   allareas    allages       len3    860843.64 0.0088680894
1978    1   allareas    allages       len4    8016028.2  0.015264019
1978    1   allareas    allages       len5     34940181  0.024108638
1978    1   allareas    allages       len6     71630096  0.035783594
1978    1   allareas    allages       len7     69270462  0.050703387
1978    1   allareas    allages       len8     31771142  0.069301761
1978    1   allareas    allages       len9    7945568.1  0.091583901
1978    1   allareas    allages      len10    5266105.1   0.11581048
1978    1   allareas    allages      len11     11629097   0.14588475
1978    1   allareas    allages      len12     19660149     0.181742
1978    1   allareas    allages      len13     23220662   0.22333713
1978    1   allareas    allages      len14     20105226   0.27015473
1978    1   allareas    allages      len15     13805359   0.32280877
1978    1   allareas    allages      len16    8682302.8    0.3848269
1978    1   allareas    allages      len17    6180120.7   0.46348323
1978    1   allareas    allages      len18    5683633.2   0.55737393
1978    1   allareas    allages      len19    6244621.3   0.65737678
1978    1   allareas    allages      len20      7248994   0.76533392
1978    1   allareas    allages      len21    8397645.4   0.87947095
1978    1   allareas    allages      len22    9384257.1    1.0001353
...
2006    4   allareas    allages      len34    1389557.6    3.3507992
2006    4   allareas    allages      len35    1212053.6    3.6419917
2006    4   allareas    allages      len36    1042789.9    3.9465744
2006    4   allareas    allages      len37    887725.93    4.2648003
2006    4   allareas    allages      len38    742220.95    4.5968777
2006    4   allareas    allages      len39    604583.65      4.94306
2006    4   allareas    allages      len40    476775.63    5.3037262
2006    4   allareas    allages      len41    362510.56    5.6793596
2006    4   allareas    allages      len42       263106    6.0667065
2006    4   allareas    allages      len43    528590.59    7.2129296
```

9.3 StockFullPrinter Output

The output file that is generated by the stockfullprinter printer class is given below. This class gives a more detailed view of the information available for the stock, giving the number and mean weight for each timestep/area/age group/length group combination with no aggregation.

```
; Gadget version 2.1.05 running on hafnasandur Fri Dec 15 11:47:45 2006
; Full output file for the stock had
; Printing the following information at the end of each timestep
; year-step-area-age-length-number-mean weight
1978    1    1    1    5    103.35986 0.0011529668
1978    1    1    1    6    891.83256  0.002001684
1978    1    1    1    7    6315.7972 0.0031912175
1978    1    1    1    8    36710.176 0.0047799422
1978    1    1    1    9    175129.05 0.0068264487
1978    1    1    1   10    685714.52 0.0093895174
1978    1    1    1   11    2203646.6  0.012528097
1978    1    1    1   12    5812379.6   0.01630129
1978    1    1    1   13     12582862  0.020768335
1978    1    1    1   14     22357248  0.025988599
1978    1    1    1   15     32603985  0.032021568
1978    1    1    1   16     39024420  0.038926836
1978    1    1    1   17     38336783  0.046764099
1978    1    1    1   18     30910662  0.055593151
1978    1    1    1   19     20455702  0.065473874
1978    1    1    1   20     11110508  0.076466239
1978    1    1    1   21    4952983.2  0.088630294
1978    1    1    1   22    1812229.7   0.10202617
1978    1    1    1   23    544218.21   0.11671406
1978    1    1    1   24     134136.3   0.13275425
1978    1    1    1   25      27135.2   0.15020706
1978    1    1    1   26    4505.3979   0.16913291
...
2006    4    1   10   81    4698.1858    5.1098441
2006    4    1   10   82    5209.5173    5.2807009
2006    4    1   10   83    5699.0684    5.4551787
2006    4    1   10   84    6151.7583    5.6333312
2006    4    1   10   85    6552.6155    5.8152331
2006    4    1   10   86    6889.0637    6.0010163
2006    4    1   10   87    7149.2775    6.1908312
2006    4    1   10   88    7113.2096    6.3746684
2006    4    1   10   89    6770.1158    6.5459936
2006    4    1   10   90    76601.376    8.1745838
```

9.4 PredatorPrinter Output

The output file that is generated by the predatorprinter printer class is given below. This class gives a detailed view of the information available for the predator/prey combination specified in the printfile, giving the biomass consumed for each timestep/area/predator length group/prey length group combination specified in the aggregation files. The labels displayed for the area, predator length group and prey length group come from those given in the aggregation files. Note that there is only one predator length group in this example, since the predator is a combination of the commercial fleet and the future fleet.

```
; Gadget version 2.1.05 running on hafnasandur Fri Dec 15 11:47:45 2006
; Predation output file for the following predators comm future
; Consuming the following preys had
; Printing the following information at the end of each timestep
```

```
; year-step-area-pred length-prey length-biomass consumed
1978    1   allareas        all       len1 1.9095251e-10
1978    1   allareas        all       len2 2.769502e-09
1978    1   allareas        all       len3 7.9066149e-08
1978    1   allareas        all       len4 6.4153963e-06
1978    1   allareas        all       len5 0.00044759835
1978    1   allareas        all       len6  0.018265668
1978    1   allareas        all       len7   0.48086564
1978    1   allareas        all       len8    7.7410596
1978    1   allareas        all       len9    79.910456
1978    1   allareas        all      len10    454.94757
1978    1   allareas        all      len11    1645.1663
1978    1   allareas        all      len12    3701.4821
1978    1   allareas        all      len13     5278.777
1978    1   allareas        all      len14    5011.2433
1978    1   allareas        all      len15    4426.3962
1978    1   allareas        all      len16    6467.4621
1978    1   allareas        all      len17    13664.742
1978    1   allareas        all      len18    28604.035
1978    1   allareas        all      len19    56645.296
1978    1   allareas        all      len20    107851.13
1978    1   allareas        all      len21    186017.84
...
2006    4   allareas        all      len34    606481.45
2006    4   allareas        all      len35       580115
2006    4   allareas        all      len36    542142.07
2006    4   allareas        all      len37    496458.59
2006    4   allareas        all      len38    442529.33
2006    4   allareas        all      len39    381503.37
2006    4   allareas        all      len40    316747.06
2006    4   allareas        all      len41    252781.86
2006    4   allareas        all      len42    192291.71
2006    4   allareas        all      len43    447616.23
```

9.5 LikelihoodPrinter Output

The output file that is generated by the likelihoodprinter printer class is given below. This class gives a detailed view of the internal model information used when calculating the likelihood score for the likelihood component, in the same format as the data in the input file. The likelihood component that has been used for this example print file is "ldist.sur", which is a 'CatchDistribution' likelihood component, so the output here is in the same format as the Length Distribution Files (see section8.3).

```
; Gadget version 2.1.05 running on hafnasandur Fri Dec 15 11:47:45 2006
; Likelihood output file for the likelihood component ldist.sur
; year-step-area-age-length-number
1985    2   allareas    allages       len1 0.0034991834
1985    2   allareas    allages       len2   0.23145168
1985    2   allareas    allages       len3    6.9983078
1985    2   allareas    allages       len4    96.714259
1985    2   allareas    allages       len5     609.8366
1985    2   allareas    allages       len6     1750.113
1985    2   allareas    allages       len7    2285.2735
1985    2   allareas    allages       len8    1421.8431
1985    2   allareas    allages       len9    720.93139
1985    2   allareas    allages      len10    897.46163
1985    2   allareas    allages      len11    1394.5465
1985    2   allareas    allages      len12    1756.9466
```

```
1985    2   allareas    allages      len13    1781.9329
1985    2   allareas    allages      len14    1521.8945
1985    2   allareas    allages      len15      1198.61
1985    2   allareas    allages      len16    954.11375
1985    2   allareas    allages      len17    825.81861
1985    2   allareas    allages      len18    781.30324
1985    2   allareas    allages      len19    787.07736
1985    2   allareas    allages      len20    833.37398
1985    2   allareas    allages      len21    883.49435
1985    2   allareas    allages      len22    924.91969
1985    2   allareas    allages      len23    949.26513
...
1999    2   allareas    allages      len34    195.33312
1999    2   allareas    allages      len35     149.5913
1999    2   allareas    allages      len36    112.17573
1999    2   allareas    allages      len37    83.272268
1999    2   allareas    allages      len38    61.178262
1999    2   allareas    allages      len39    44.320533
1999    2   allareas    allages      len40    31.505514
1999    2   allareas    allages      len41    21.860349
1999    2   allareas    allages      len42    14.646656
1999    2   allareas    allages      len43    23.943981
```

9.6 LikelihoodSummaryPrinter Output

The output file that is generated by the likelihoodsummaryprinter printer class is given below. This class gives a summary view of the scores on each timestep from each of the likelihood components that have been specified for the current model.

```
; Gadget version 2.1.05 running on hafnasandur Fri Dec 15 11:47:45 2006
; Summary likelihood information from the current run
; year-step-area-component-weight-likelihood value
1989    2   allareas    meanl.sur    2e-06    225.29312
1990    2   allareas    meanl.sur    2e-06     305.8889
1991    2   allareas    meanl.sur    2e-06    296.40938
1992    2   allareas    meanl.sur    2e-06     384.3281
1993    2   allareas    meanl.sur    2e-06    460.41256
1994    2   allareas    meanl.sur    2e-06    963.15011
1995    2   allareas    meanl.sur    2e-06     382.0248
1996    2   allareas    meanl.sur    2e-06     599.1694
1997    2   allareas    meanl.sur    2e-06    513.14933
1998    2   allareas    meanl.sur    2e-06    531.96395
1999    2   allareas    meanl.sur    2e-06    573.03989
1979    1   allareas  meanl.catch    3e-07    160.85429
1979    2   allareas  meanl.catch    3e-07    98.793133
1979    3   allareas  meanl.catch    3e-07    23.869148
1979    4   allareas  meanl.catch    3e-07    202.96922
1980    1   allareas  meanl.catch    3e-07    236.41646
1980    2   allareas  meanl.catch    3e-07     44.15178
1980    4   allareas  meanl.catch    3e-07    29.887795
1981    1   allareas  meanl.catch    3e-07    97.947644
1981    2   allareas  meanl.catch    3e-07    43.617345
1981    3   allareas  meanl.catch    3e-07    140.49857
1981    4   allareas  meanl.catch    3e-07    13.503321
1982    1   allareas  meanl.catch    3e-07    87.779096
...
1997    4   allareas alkeys.catch    2e-06    902.57365
1998    1   allareas alkeys.catch    2e-06    617.79915
```

```
1998    2   allareas alkeys.catch    2e-06    572.60255
1998    3   allareas alkeys.catch    2e-06    271.22842
all   all   allareas         si10    0.007    4.5148467
all   all   allareas         si15     0.01    2.6221572
all   all   allareas         si20     0.01    5.2799002
all   all   allareas     si25to45     0.01    11.486399
all   all   allareas     si50to60     0.01    4.8039545
all   all   allareas     si65to75    0.007    6.9859794
```

10 Parameter File

The parameter file is used to specify the initial values for the switches that are to be used in the Gadget model. This file is specified by a "-i <filename>" command line option when Gadget is started, and contains a list of all the switches, their initial value, the lower and upper bounds and a flag to note whether the optimiser should optimise that switch or not.

```
;
; Reference parameter file for this haddock model
;
switch   value        lower   upper  optimise
grq0     6.3421717    1       10     1 ; q0 in growth function
grq2     17.020301    5       20     1 ; q2, q3 in growth function
bbeta    11.792983    0.1     5000   1 ; beta in beta-binomial
inage2   0.011234341  0.00001 1      1 ; initial number of age 2 fish
inage3   0.0023677952 0.00001 1      1 ; initial number of age 3 fish
inage4   0.0060429722 0.00001 1      1 ; initial number of age 4 fish
inage5   0.022761935  0.00001 1      1 ; initial number of age 5 fish
inage6   0.0014660210 0.00001 1      1 ; initial number of age 6 fish
inage7   0.0010000000 0.00001 1      1 ; initial number of age 7 fish
inage8   0.026070485  0.00001 1      1 ; initial number of age 8 fish
inage9   0.096904951  0.00001 1      1 ; initial number of age 9 fish
rec78    22.377895    0.2     34     1 ; number of recruits in 1978
rec79    9.9845325    0.2     34     1 ; number of recruits in 1979
rec80    1.2187327    0.2     34     1 ; number of recruits in 1980
rec81    11.258073    0.2     34     1 ; number of recruits in 1981
rec82    4.8916410    0.2     34     1 ; number of recruits in 1982
rec83    3.5328430    0.2     34     1 ; number of recruits in 1983
rec84    8.2212940    0.2     34     1 ; number of recruits in 1984
rec85    9.0904755    0.2     34     1 ; number of recruits in 1985
rec86    24.934956    0.2     34     1 ; number of recruits in 1986
rec87    9.0852408    0.2     34     1 ; number of recruits in 1987
rec88    5.0242726    0.2     34     1 ; number of recruits in 1988
...
rec95    6.5406113    0.2     34     1 ; number of recruits in 1995
rec96    14.777468    0.2     34     1 ; number of recruits in 1996
rec97    4.2329148    0.2     34     1 ; number of recruits in 1997
rec98    7.9890151    0.2     34     1 ; number of recruits in 1998
rec99    24.796618    0.2     34     1 ; number of recruits in 1999
acomm    -10.342371   -100    -1     1 ; alpha in fleet suitability
bcomm    0.21405130   0.1     10     1 ; beta in fleet suitability
asur     -4.3391371   -100    -1     1 ; alpha in survey suitability
bsur     0.22464659   0.1     10     1 ; beta in survey suitability
mult     0.5          0.1     1      1 ; multiplier for future fleet
```