48.4 Assessment Summary

Tim Earl

# Abstract

*The following document was submitted to the Stock Assessment Review process to outline the source of current model data and parameters, and to summarise the development of the model. Section 1 summarises the development of the model, this is documented in more detail in Section 15, with a comprehensive reference list of papers related to the development of the model. Sections 2-13 describe the input files used in the most recent (2017) assessment, indicating the source of externally estimated parameters, and the data used in fitting the model. Section 14 outlines the data weighting approach used in fitting the model to multiple sources of data.*

48.4 Assessment Summary

Tim Earl

# Development history

|  |  |
| --- | --- |
| **Year** | **Changes from previous assessment** |
| 2013 | First assessment of TOP in 484 |
| 2014 | Comparison of maturity ogives |
| 2015 | Updated maturity ogives. Changes to mortality post tagging |
| 2017 | Number of years of recaptures post-tagging reduced from 6 to 4 |

In the associated bundle:

* Input files after Francis weighting
* All papers referred to in this document (FSA-17-52 is the most recent assessment) These are referenced in full in Table 1.

**Current assessment:**

|  |  |
| --- | --- |
|  |  |
|  |  |

Figure 1: Recruitment (top), and SSB (bottom) estimates for the 2017 assessment, base on MCMC uncertainty estimates

# Model setup

## Values

Age range: 1-50+

Year range 1990-present[[1]](#footnote-1)

Single area, single stock with no separate sex/maturity partition

Annual cycle:

* t=0.25 years
* Spawning\_time, fishery t=0.3333333 years (partial mortality 0.5) years spawning\_ps
* Recruitment t=0.4166667 years
* Aging t=0 years

Apart from the year range, these are consistent with 483 to allow combination into a single model if appropriate in the future.

## Model representation

Population.csl

@size\_based False

@min\_age 1

@max\_age 50

@plus\_group True

@sex\_partition False

@mature\_partition False

@n\_areas 1

@n\_stocks 1

@n\_tags 12

@tag\_names 2005Tags ... 2016Tags

@initial 1990

@current 2017

@final 2052

@annual\_cycle

time\_steps 4

recruitment\_time 1

spawning\_time 2

spawning\_part\_mort 0.5

spawning\_ps 1.0

aging\_time 4

M\_props 0.4166667 0.3333333 0.25 0.0

growth\_props 0.4166667 0.75 1.0 0.0

baranov False

fishery\_names FSSI

fishery\_times 2

@y\_enter 1

@n\_quant 15

## Notes

Annual cycle chosen to be consistent with 48.3

## References

# Optimiser settings

## Model representation

Estimation.csl

@estimator Bayes

@max\_iters 1000

@max\_evals 4000

@grad\_tol 0.002

@MCMC

start 0

length 1300000

keep 3000

adaptive\_stepsize True

adapt\_at 100000 200000

burn\_in 100

proposal\_t True

df 4

@profile

parameter initialization.B0

n 10

l 600

u 3000

@q\_method nuisance

@ageing\_error

type normal

c 0.1

## Notes

Profile range updated in 2018

# Initial biomass

## Values

B0 initialised at 2,000 tonnes

Uniform-log prior on 500 tonnes to 5,000 tonnes

## Processing

### Scripts

### Assumptions

## Model representation

Population.csl

@initialization

B0 2000

Estimation.csl

@estimate

parameter initialization.B0

lower\_bound 500

upper\_bound 5000

prior uniform-log

phase 1

# Recruitment

Beverton Holt recruitment form, with initial value of steepness set to 0.75.

## Source data/Values

Free estimates 1985-(current-7)

Year\_range 1992-(current-6)

@randomisation\_method lognormal-empirical

Priors bounded on [0.001,20], lognormally distributed with mu=1, cv=0.8, except first year and last 7 which are fixed to 1.

## Model representation

Population.csl

@recruitment

YCS\_years 1989 ... 2016

YCS 1 ...1

SR BH

steepness 0.75

sigma\_r 1.0

first\_free 1989

last\_free 2009

@first\_random\_year 2010

@randomisation\_method lognormal

@standardise\_YCS True

Estimation.csl

@estimate

parameter recruitment.YCS

#YCS\_years 1989 ... 2016

lower\_bound 0.001 ... 0.001

upper\_bound 20 ... 20

prior lognormal

mu 1 ... 1

cv 0.658 ... 0.658

phase 1

# Maturity ogive

Fixed ogive at age

## Source data/Values

Taken from 48.3, note that there is no evidence of spawning in 48.4, an alternative hypothesis to a unit stock, is that fish return to 48.3 to spawn.

## Model representation

Population.csl

@maturity\_props

all allvalues\_bounded 1 23 0 0 0 0 0 0.06 0.14 0.22 0.3 0.38 0.46 0.54 0.62 0.658 0.7 0.742 0.784 0.826 0.868 0.91 0.952 0.994 1

# Natural mortality

Fixed value for all ages

## Source data/Values

0.13

## Model representation

Population.csl

@natural\_mortality

all 0.13

## References

WG-FSA-05/18

# Growth

Growth data is estimated within the model. Because of lack of data on small fish, t0 is assumed zero.

## Source data/Values

## Model representation

Population.csl

@size\_at\_age\_type von\_Bert

@size\_at\_age\_dist normal

@size\_at\_age

k 0.092

t0 0.00

Linf 153.0

cv 0.08

@size\_weight

a 4.150e-09

b 3.194

verify\_size\_weight 150 30 50

Estimation.csl

@estimate

parameter size\_at\_age.k

lower\_bound 0.03 #changed from 0.05

upper\_bound 0.20 # changed from 0.15 - VL

prior uniform

phase 1

@estimate

parameter size\_at\_age.Linf

lower\_bound 110

upper\_bound 250

prior uniform

phase 1

MCMC\_fixed True

@age\_size sizedata2011

...

@age\_size sizedata2017

year 2017

step 2

sample random

ogive SelSSI

ages <Ages of aged fish>

sizes <Lengths of aged fish>

## Notes

Growth estimated externally in 48.3, internally in 48.4

# Tagging release data

Tagging data is available from 2003 release cohort onwards. Release mortality is estimated externally using a length dependent relationship:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Length class (cm) | 30, 40 | 50 | 60 | 70 | 80 | 90 | 100+ |
| Survival | 0 | 0.96 | 0.95 | 0.95 | 0.94 | 0.83 | 0.80 |

Within the model, no further post-release tagging occurs.

All releases since 2003 are included where the fish length is in the range [30,200) cm, the release area is 48.4 and the release species is recorded as “TOP”.

## Source data/Values

Tag shedding rate 0.006377 based on linear approximation over four years to the observed double tag loss rate.

There is a 0.75 year no growth period – WG-FSA-07/29

## Model representation

Population.csl

@tag\_shedding\_rate 0.0064 ... 0.0064

@tag\_loss\_props 0.4166667 0.3333333 0.25 0.0

@tag\_growth\_loss 2005Tags

nogrowth\_period 0.75

...

@tag\_growth\_loss 2016Tags

nogrowth\_period 0.75

@tag 2005Tags

...

@tag 2016Tags

tag\_name 2016Tags

release\_type deterministic

sex both

year 2016

step 2

mature\_only False

number 159

plus\_group False

class\_mins 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

props\_all 0.000 0.000 0.000 0.000 0.006 0.013 0.019 0.031 0.157 0.094 0.107 0.245 0.176 0.101 0.044 0.006

mortality 0.1

ogive SelSSI

## Notes

Instant tag mortality is estimated externally, based on a length-dependent relationship, and so no further tag mortality is applied in the model.

## References

Tag mortality at length described in WG-FSA-07/29

Effect of double tagging: WG-SAM-11/16 and WG-SAM-11/12 leading to tag loss rate estimate

WG-SAM-09/13: Adding catch at age and survey data to the 48.3 toothfish CASAL assessment.

# Tag recaptures

## Model representation

Estimation.csl

@tag\_recapture 2005Tags

...

@tag\_recapture 2016Tags

tag\_name 2016Tags

sample size

detection\_probability 1

years 2017

step 2

proportion\_mortality 1.0

plus\_group True

class\_mins 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200

recaptured\_2017 0 0 0 0 0 0 0 0 1 2 3 0 0 0 0 0 0 0

scanned\_2017 0.000 0.000 0.000 4.256 4.711 20.086 50.288 111.235 91.742 182.692 285.505 253.355 119.596 42.795 12.119 2.441 0.000 0.000

do\_bootstrap True

r 1e-11

dispersion 2.070249

@fish\_tagged\_penalty

label 2005TagPenalty

tagging\_episode 2005Tags

multiplier 1

...

@fish\_tagged\_penalty

label 2016TagPenalty

tagging\_episode 2016Tags

multiplier 1

## Notes

For each tagging cohort, the four following years recaptures are included. Scanned numbers based on raised numbers at length. Prior to 2017, this was six years (WG-SAM-17/35)

# Catches

Future catches (for 35 years based on the CCAMLR harvest control rule)

## Model representation

Population.csl

@fishery FSSI

years 2005 ... 2017

catches 26.88 18.73 54.04 97.63 74.4 57.46 38.65 55.41 72.32 43.8 41.696 41.601 27.912 #Check 2017 catch

U\_max 0.999

selectivity SelSSI

future\_years 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052

future\_catches <Constant value to achieve CCAMLR objectives>

Estimation.csl

@catch\_limit\_penalty

label catch\_limit

log\_scale False

fishery FSSI

multiplier 100

# Catch composition

The observed length distribution is raised to an age distribution using a year-specific age length relationship.

## Model representation

Population.csl

@selectivity\_names SelSSI

@selectivity SelSSI

all logistic 8 4

Estimation.csl

@catch\_at FSSICatch

years 2011 2012 2013 2014 2015 2016 2017

fishery FSSI

at\_size False

sexed False

sum\_to\_one True

plus\_group False

min\_class 1

max\_class 36

2011 <proportions at age>

...

2017

dist multinomial

N\_2011 24.01

N\_2012 23.35

N\_2013 32.24

N\_2014 26.91

N\_2015 26.62

N\_2016 127.84

N\_2017 20

r 1e-11

@estimate

parameter selectivity[SelSSI].all

#lower\_bound 1 0.05 1

#upper\_bound 50 50 50

lower\_bound 1 1

upper\_bound 50 50

prior uniform

phase 1

## Notes

## References

# Model Output

## Model representation

Output.csl

@print

# estimation section stuff

parameters false

fits\_every\_eval false

objective\_every\_eval false

parameters\_every\_eval false

parameter\_vector\_every\_eval false

fits true

resids true

pearson\_resids true

normalised\_resids false

estimation\_section false

# population section stuff

requests true

initial\_state false

state\_annually false

state\_every\_step false

final\_state true

results false

#output section stuff

yields true

unused\_parameters true

covariance True

@quantities

all\_free\_parameters true

fishing\_pressures true

nuisance\_qs true

true\_YCS true

B0 true

R0 true

SSBs true

YCS true

actual\_catches false

ogive\_parameters selectivity[SelSSI].all

fits true

normalised\_resids false # set to true later

pearson\_resids false

tagged\_age\_distribution true

@abundance vulnerable

biomass true

mature\_only false

step 2

proportion\_mortality 0.5

ogive SelSSI

years 2005 ... 2017

@numbers\_at AgeStructure

step 2

proportion\_mortality 0.5

years 2010 ... 2017

# Data weighting

The data weighting is an iterative process. Initially an arbitrary effective sample size is assigned to the age composition in the year being added. The model is run, and the sample size recalculated based on the cv estimated for the age composition in this year. This process is repeated until the sample size converges (typically 3 or 4 iterations).

# Papers used in the development of the assessment

Table 1: Papers relevant to the assessment of Toothfish in 48.4

|  |  |
| --- | --- |
| **Meeting** | **Paper summary** |
| FSA-17 | WG-FSA-17/46 Preliminary results from the first year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4. K. Olsson, M. Belchier and M. Söffker  *Very little catch of Patagonian toothfish so far*  WG-FSA-17/52 Assessment of Patagonian toothfish (D. eleginoides) in Subarea 48.4. T. Earl  *Update of assessment. Tagging truncated to four years following releasen season, rather than six used previously (following paper and discussion at SAM).*  WG-FSA-17  *3.20 Recommends to only use complete seasons of data that have been quality checked by the CCAMLR secretariat in future.*  *3.21 Recommends fitting survey as biomass and proportions in composition (not applicable)*  *3.28 Investigate temporal effects in fits to the tagging data*  *3.29 Further review of stock hypothesis to reflect links with 48.3* |
| SAM-17 | 17/35 Sensitivities in the assessment of the Patagonian toothfish (D. eleginoides) in Subareas 48.3 and 48.4 to truncation of tagging data. T. Earl  *Looking at the effect of including different numbers of years post release in the assessment. There is some outstanding bias in the tag recaptures not explained by the double-tagging effect.*  WG-SAM-17  *2.12 Recommendation to re-estimate the tag loss and instantaneous mortality using the most up to date data. Reduce years of tagging to four to reduce bias from double-tagging.* |
| FSA-16 | NA |
| SAM-16 | NA |
| FSA-15 | WG-FSA-15/28 An integrated stock assessment of Patagonian toothfish (Dissostichus eleginoides) in CCAMLR Subarea 48.4  M. Soeffker, V. Laptikhovsky, T. Earl and C. Darby (United Kingdom)  *Update of assessment*  *Updated maturity ogive and change to growth retardation period (0.5 changed to 0.75)*  WG-FSA-15  *4.15 Fixed recruitment from 2008-2015 investigated and used for catch advice, made little difference*  *4.17 WG recommends continuing with separate 48.3/48.4 assessments*  *4.18 Recommendations to reconsider recruitment used in projections*  *4.19 Only use 4 years recaptures in each tag cohort.*  *4.117(i)-(vii) Areas to develop stock assessments* |
| SAM-15 | WG-SAM-15/30 A potential link between the D. eleginoides stocks of Statistical Subareas 48.3 and 48.4. M. Soeffker, M. Belchier and V. Laptikhovsky (United Kingdom)  *Tags between 48.4 and 48.3 (mostly males moving to SG and females to SR) Lack of older and younger fish in 48.4 and different growth curves.*  *2.34-2.37, 2.42 Diagnostic documents*  *2.40 Document changes in a stepwise fashion* |
| FSA-14 | WG-FSA-14/29 Rev. 1 A preliminary CASAL population assessment of Patagonian toothfish in CCAMLR Subarea 48.4 based on data for the 2009–2014 fishing seasons. V. Laptikhovsky, R. Scott, M. Söffker and C. Darby (United Kingdom)  *Update of assessment*  *Comparison of maturity ogives*  *4.4 Spread sampling of otoliths across the length distribution* |
| SAM-14 | WG-SAM-14  *2.29 CASAL version 2.30-2012-03-21 rev 4648 be considered the current approved CCAMLR version* |
| FSA-13 | WG-FSA-13/31 Preliminary assessment of Patagonian toothfish in Subarea 48.4. R. Scott and V. Laptikohvsky (United Kingdom)  *First TOP specific assessment (previously northern combined TOP and TOA). Maturity data based on limited samples from 48.4. 2009 catch composition rejected as based on few samples and introduces convergence issues as conflict with 2012 data – the more recent data was thought to be more reliable. Francis data weighting introduced*  WG-FSA-13  *4.28 exclude 2009 length composition data*  *4.29 Data weighting by Francis method not adopted due to reducing the uncertainty in MCMC estimates unexpectedly*  *4.93 MPD B0 estimates are validated by the secretariat rerunning assessment.*  *4.96 Differences in B0 from different versions of CASAL not explained* |
| SAM-13 | WG-SAM-13/24 A revised assessment of Patagonian toothfish in Subarea 48.4. R. Scott (United Kingdom)  *Change to maturity ogive, change in selectivity pattern* |
| FSA-12 | WG-FSA-12/36 Population assessment of Patagonian toothfish in Subarea 48.4. R. Scott (United Kingdom)  *Assessment for Northern 48.4 combined toothfish*  *5.32 Assess 48.4 toothfish by species rather than area* |
| SAM-12 |  |
| **Before 2012 the assessment covered a considerably different stock, and so subsequent papers only refer to general stock assessment methodology rather than the specific assessments in 48.4** | |
| FSA-11 |  |
| SAM-11 | WG-SAM-11/12 Models of tag shedding for double tagging as a function of time at liberty and approximate solutions for the single tagging model in CASAL. S.G. Candy (Australia)  WG-SAM-11/18 Estimates of the tag loss rates for single and double tagged toothfish (Dissostichus mawsoni) fishery in the Ross Sea. A. Dunn, M.H. Smith (New Zealand), D.J. Agnew (UK) and S. Mormede (New Zealand)  *Discussion of double tagging effect, and its application to the Ross Sea fishery* |
| FSA-10 | WG-FSA-10/P05 The Patagonian toothfish: biology, ecology and fishery. M.A. Collins, P. Brickle, J. Brown and M. Belchier  *Everything about Toothfish* |
| SAM-10 | WG-SAM-10/11 Rev. 1 Estimation of natural mortality using catch-at-age and aged mark-recapture data: a simulation study comparing estimation for a model based on the Baranov equations versus a new mortality equation. S.G. Candy (Australia)  *Simulation testing estimation of M*  WG-SAM-10  *Discussion of estimates of M* |
| FSA-09 | WG-FSA-09/22 Rev. 1 COMPARISON OF THE PRECISION OF DIRECT VERSUS AGE LENGTH KEY METHODS OF ESTIMATING CATCH-AT-AGE PROPORTIONS  S.G. Candy (Australia)  *Sampling ages based on length binned samples rather than unbinned samples* |
| SAM-09 | NA |
| FSA-08 | NA |
| SAM-08 | NA |
| FSA-07 | WG-FSA-07  *Report: Investigate issues including use of catch-at-age and tag recapture at length bias in 48.3 assessment.* |
| SAM-07 | WG-SAM-07/13 An assessment strategy evaluation framework for testing the application of a CASAL based management system to the HIMI fishery  I.R. Ball and S.G. Candy (Australia)  WG-SAM-07/7 Comparison of estimators of effective sample size for catch-at-age and catch-at-length data using simulated data from the Dirichlet-multinomial Distribution  S.G. Candy (Australia)  *Method of calculating sample size* |
| FSA-06 | NA |
| FSA-SAM-06 | NA |
| FSA-05 | WG-FSA-05/18 Parameters for the assessment of toothfish in Subarea 48.3. D.J. Agnew, G.P. Kirkwood, A. Payne, J. Pearce and J. Clarke (United Kingdom)  *Beverton-Holt invariants presented*  WG-FSA-05  4.18 Discussion about recruitment uncertainty in projections |

1. Throughout this document the data included is that which was available at the end of the 2016/17 fishing season, i.e. the extent of the data is the same as for the assessment presented at WG-FSA-17. [↑](#footnote-ref-1)