Stout Whiting Fishery Summary
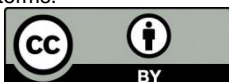
Commercial Quota Setting for 2017

Summary

This fishery assessment report describes the commercial stout whiting fishery operation along Australia's east coast between Sandy Cape and the Queensland-New South Wales border. The fishery is identified by a T$_4$ symbol.

This study follows methods applied in (O'Neill & Leigh, 2016a) and extends the results of that study by using the latest data available up to end of March 2016. The fishery statistics reported herein are for fishing years 1991 to 2016.

This study analysed stout whiting catch rates from both Queensland and New South Wales (NSW) for all vessels, areas and fishing gears. The 2016 catch rate index from Queensland and NSW waters was 0.86. This means that the 2016 catch rate index was 86% of the mean standardised catch rate. Results showed that there was a stable trend in catch rates from 2012 to 2016, as in the previous study (O'Neill & Leigh, 2016a), with the 2015 and 2014 catch rates 85% of the mean catch rate.

The fish-length frequency and age-length-otolith data were translated using two models which showed:

- Where patterns of fish age-abundance were estimated from the fish-length frequency and age-length data, there were slightly decreased estimated measures of fish survival at 38% for 2014, compared to fish survival estimates in 2013 at 40%. The 2014 and 2015 estimated age structure was dominated by 1+ and 2+ old fished, with a slightly higher frequency of age 2 - 3 fish for 2015.

- Where only the age-length data were used, estimates showed that from 2011 to 2014 the survival index increased. The estimated survival index increased from 35% in 2013 to 64% in 2014, indicating stronger survival of fish as they recruited and aged.

Together the stout whiting catch rate and survival indicators showed the recent fishery harvests were sustainable.

Since 1997, T$_4$ management (Stout Whiting Fishery) is centred on annual assessments of total allowable commercial catch (TACC). The TACC is assessed before the start of each fishing year using statistical assessment methodologies, namely evaluation of trends in fish catch rates and catch-at-age frequencies measured against management reference points. The TACC has been under-caught in many years.

Table 1. The T$_4$ stout whiting TACC

Fishing Year	TACC (t)	Change in TACC (t) from previous fishing year
1998	1400	
1999	1400	0
2000	1000	- 400
2001	1000	0
2002	1000	0
2003	800	- 200
2004	1000	+200
2005	1150	+150
2006	1200	+50
2007	1250	+50
2008	1350	+100
2009	1450	+100
2010	1500	+50
2011	1500	-50
2012	1400	-100
2013	1350	-50
2014	1150	-200
2015	1150	0
2016	1090	-60
2017	1100 – 1130?	+10?

Table 1 shows that the T_4 stout whiting TACC for 2015 remained unchanged at 1150 t and was adjusted down to 1090 t for 2016. Since 1998, the TACC has been reduced seven times, increased seven times and remained unchanged four times.

For setting the 2017 T_4 stout whiting TACC, the calculations covered a range of settings to account for the variance in the data and provide options for quota change. The overall (averaged) results suggested:

- The procedure where the quota was adjusted based on previous TACC setting in year 2016 gave a recommended TACC for 2017 of between 1100 and 1130 t.

- The procedure that focussed directly on optimising the average harvest to match target reference points gave a recommended TACC for 2017 of between 860 and 890 t.

Use of these estimates to set TACC will depend on management and industry aims for the fishery..

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Introduction

This fishery assessment report describes the commercial stout whiting fishery operation along Australia's east coast (Figure 1). In Queensland stout whiting (*Sillago robusta*) are caught by Danish seine and fish otter-trawl methods between Sandy Cape and the Queensland-NSW border. The Queensland fishing sector is identified by a T_4 symbol and is currently operated by two licenced vessels. The stout whiting T_4 sector is managed by limiting vessel participants and TACC between water depths of 20–50 fathoms. The T_4 sector is managed and monitored separately to the trawl-whiting (stout and eastern school whiting) vessels operating in NSW (T_{NSW}). The T_4 sector is also managed separately to the much larger otter-trawl sectors that target eastern king prawns along Australia's east coast. The stout whiting population along Australia's east coast constitutes a single stock unit. Its southern distribution overlaps with the northern distribution of the eastern school whiting.

Fisheries Queensland has monitored the stout whiting fishery since the formal development of management in 1991. Harvest and effort statistics are recorded in logbooks for each vessel's daily catch operation. Commercial fishers also provide Fisheries Queensland with two box-samples of fish from each fishing trip. Scientists measure the length of these fish and estimate their age by removing and examining their otoliths (ear bones). The information collected from stout whiting monitoring is combined to carry out annual assessments of the stout whiting stocks. The outputs of these assessments contribute to the management decisions of the T_4 fishery, including adjustments to the total allowable commercial catch (quota). For more information on the history of the T_4 fishery and TACC setting see (Brown & Butcher, 1995; O'Neill & Officer, 2007; O'Neill & Leigh, 2014; Thwaites & Andersen, 2008).
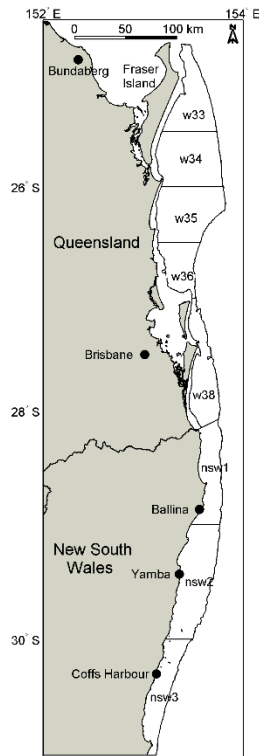
Figure 1. Map of the east Australia stout whiting fishing zones by analysis regions. The Queensland fishing zones (w33…w38) cover offshore water depths between 20 and 50 fathoms. NSW fishing zones (nsw1…nsw3) cover offshore waters up to 50 fathoms. Stout whiting from NSW and Queensland waters are considered a single biological stock of fish based on evidence from genetic analyses (Ovenden & Butcher, 1999).

This report has been prepared to inform Fisheries Queensland (Department of Agriculture and Fisheries) and T_4 licence holders of stout whiting stock indicators and the estimated quota (tonnes) of stout whiting for the 2017 fishing year from Queensland waters. The determination was made using methodology outlined in (O'Neill & Leigh, 2016a). Model details and equations are not reviewed in this study because all explanations are presented in detail in (O'Neill & Leigh, 2016a). Precaution should be used when interpreting all estimates given the fishery-dependant limitations of the data.

Catch Rate

Data

Harvest data were available from Queensland and NSW waters.

Fisheries Queensland has monitored harvests taken by the T_4 stout whiting sector since the development of management in 1991. Harvest and effort statistics are recorded in log books for each catch operation per day. In Queensland waters, two T_4 vessels fished for stout whiting in the 2016 fishing year, harvesting 506 tonnes (t). Data were recorded up to the end of March 2016, hence three months of data for the 2016 fishing year (April to June) is missing. Data for the previous study (O'Neill & Leigh, 2016a) used harvest data up to the end of March 2015.

Annual T_4 landings of stout whiting averaged 622 t for the fishing years 2014 to 2016, with a maximum harvest of 1140 t in the last ten fishing years. T_4 harvests in Queensland waters illustrated by fishing years and calendar years are summarised in Figure 2. The historical TACC settings shown in subplot b show that the TACC has been under-caught in many years.

Note that the Queensland eastern king prawn shallow water sector (T_1) catches significant quantities of stout whiting as by-catch, discarded and not reported (O'Neill & Leigh, 2014). These quantities are not included in Figure 2.

From 2011 to 2016 most of the T_4 harvest was taken from the 'w38' fishing zone (offshore waters from around the Stradbroke Islands and Gold Coast, Figure 3). There was also a shift to increased fishing in w33, the north zone, in 2016.

The NSW fishing sector (T_{NSW}) catches both stout whiting and eastern school whiting, with stout whiting harvests identified and reported suitably in recent years. Historical records of T_{NSW} stout whiting were not complete. In NSW, about 40 licences were estimated to harvest 160 t and 200 t in 2014 and 2015 respectively, Figure 4.

The amount of unreported T_1 stout whiting by-catch and T_{NSW} harvest has implications for setting T_4 harvest allocations.
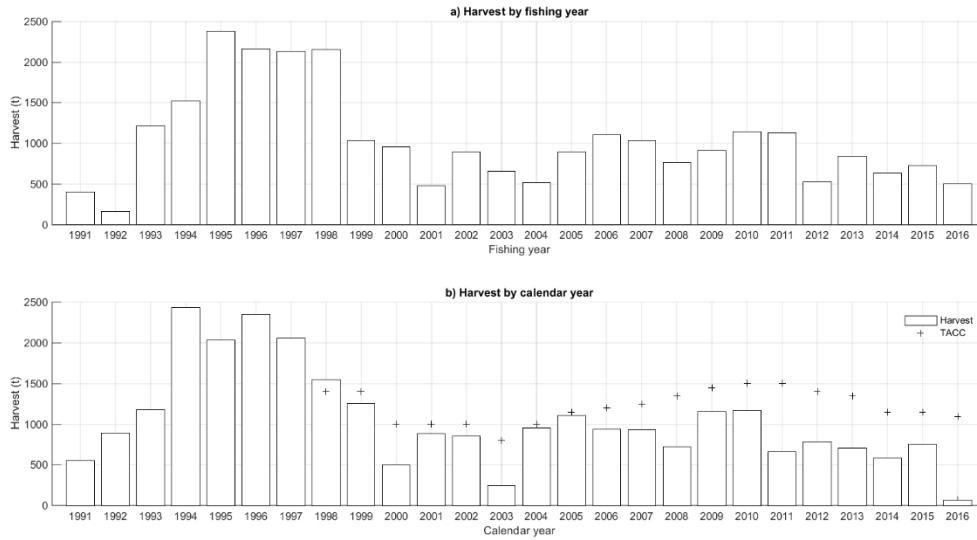
Figure 2. Tally of reported stout whiting harvests (tonnes) taken by T₄ licensed vessels in Queensland waters for a) fishing years aggregating months July-June and b) calendar years. The tonnages were summarised from the logbook records up to March 2016. The historical TACC settings are shown on subplot b.
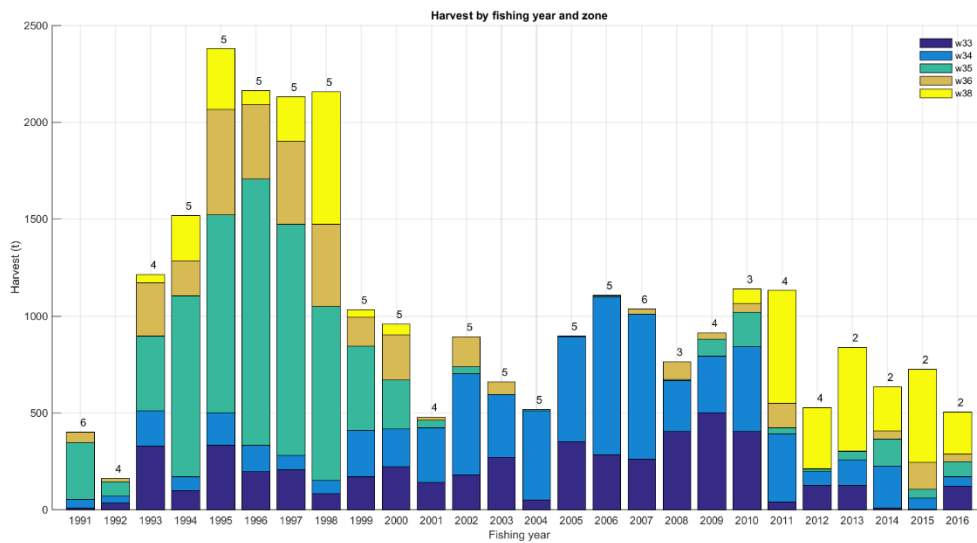

Figure 3. Tally of reported stout whiting harvests (tonnes) taken from each Queensland fishing zone. The number of fishing vessels in each fishing year is listed.
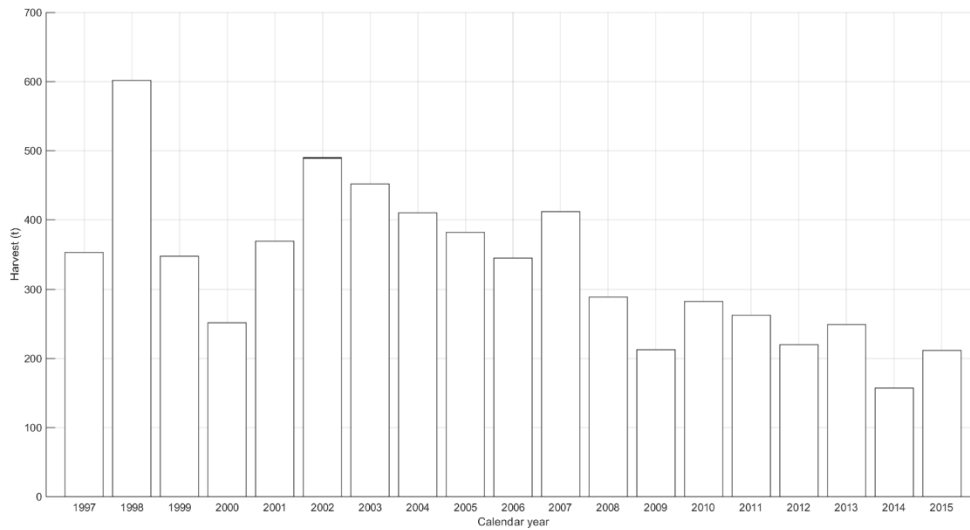
Figure 4. Estimated stout whiting harvests (tonnes) reported from NSW waters.

Results and Discussion

For each Queensland zone the T_4 catch rate index from 2012 to 2016 was on or below the long-term mean (Figure 5). There was a strong decline in the catch rate index in the 2011 and 2012 fishing year for all fishing zones. For all the zones combined the catch rate from 2014 to 2016 was stabilising with an average of 0.77.
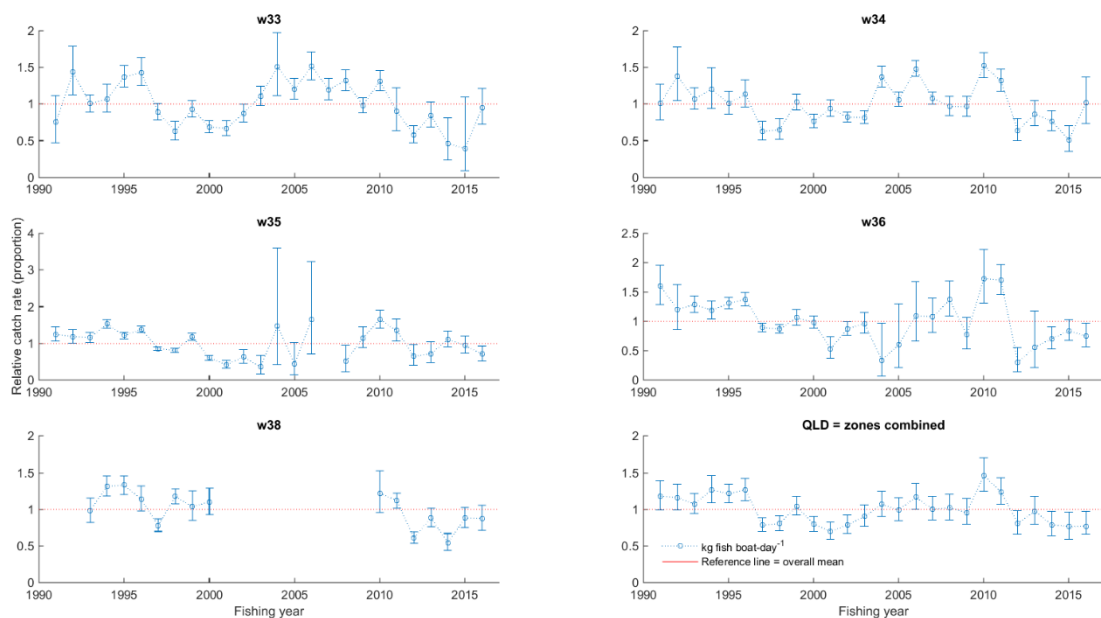

Figure 5. Standardised average harvests taken per boat day from fishing zones w33 to w38 and for Queensland overall (zones combined). Error bars indicate 95% confidence intervals on predictions. Each annual time series was scaled relative to its mean catch rate.

For NSW, the pattern of standardised catch rates from fishing zone 1002 was different to zones 1001 and 1003 (Figure 6). Overall there was an upward trend in the catch rate for the NSW combined zones from 2013 to 2016, with a standardised catch rate index above the mean for 2015 and 2016 (1.15). The 2016 jump in catch rate in zone 1003 was large and possibly an artefact of variance in the data and model for this zone. This requires further investigation.
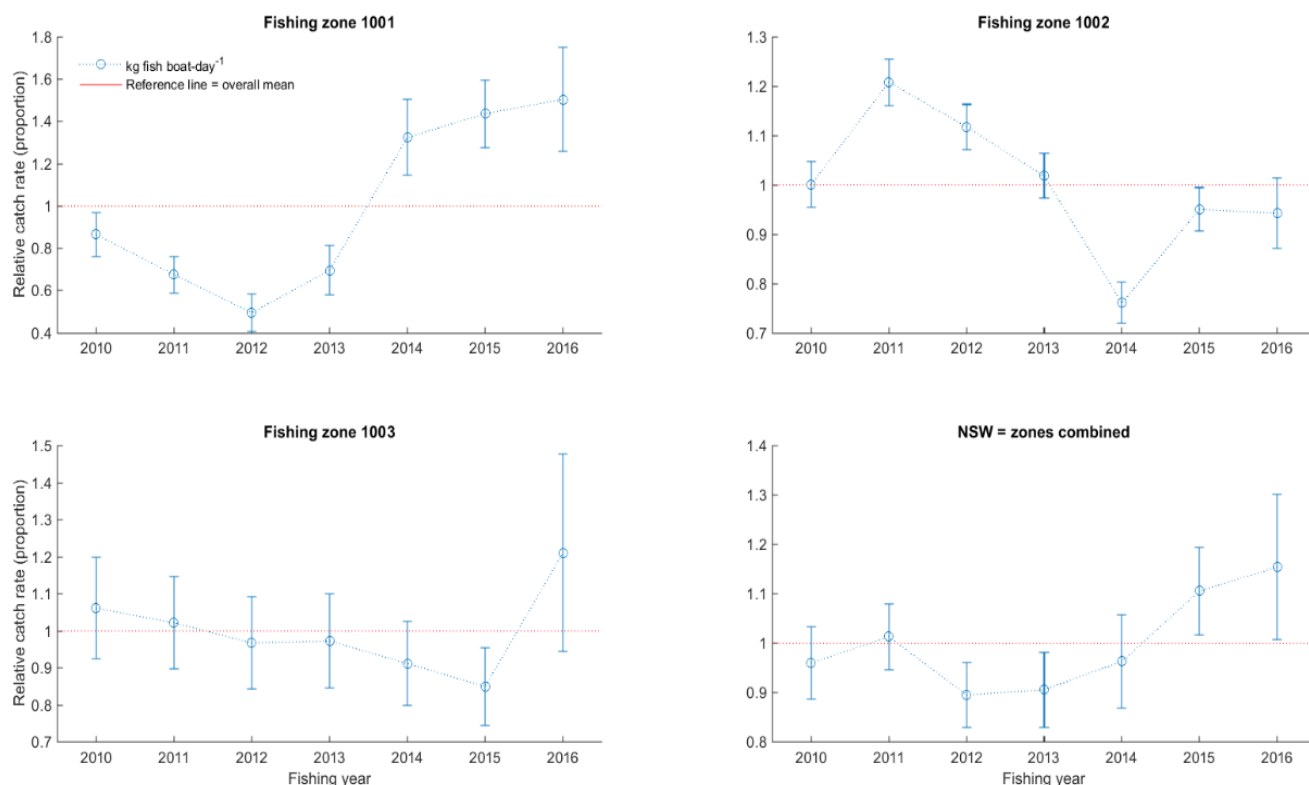
Figure 6. Standardised average harvests taken per boat day from fishing zones 1001, 1002, 1003 and for NSW overall (zones combined). Error bars indicate 95% confidence intervals on predictions. Each annual time series was scaled relative to its mean catch rate (1 = mean catch rate).

Fishery catches from Queensland and NSW were standardised using an area weighted approach (O'Neill & Leigh, 2016a). Results from this analysis indicated that the T_4 and T_{NSW} stout whiting catch rates across states showed a stable trend from 2012 to 2016, with the 2014 to 2016 fishing year indices around 85% of the mean catch rate (Figure 7). In 2010 the catch rate was 39% above the mean catch rate.

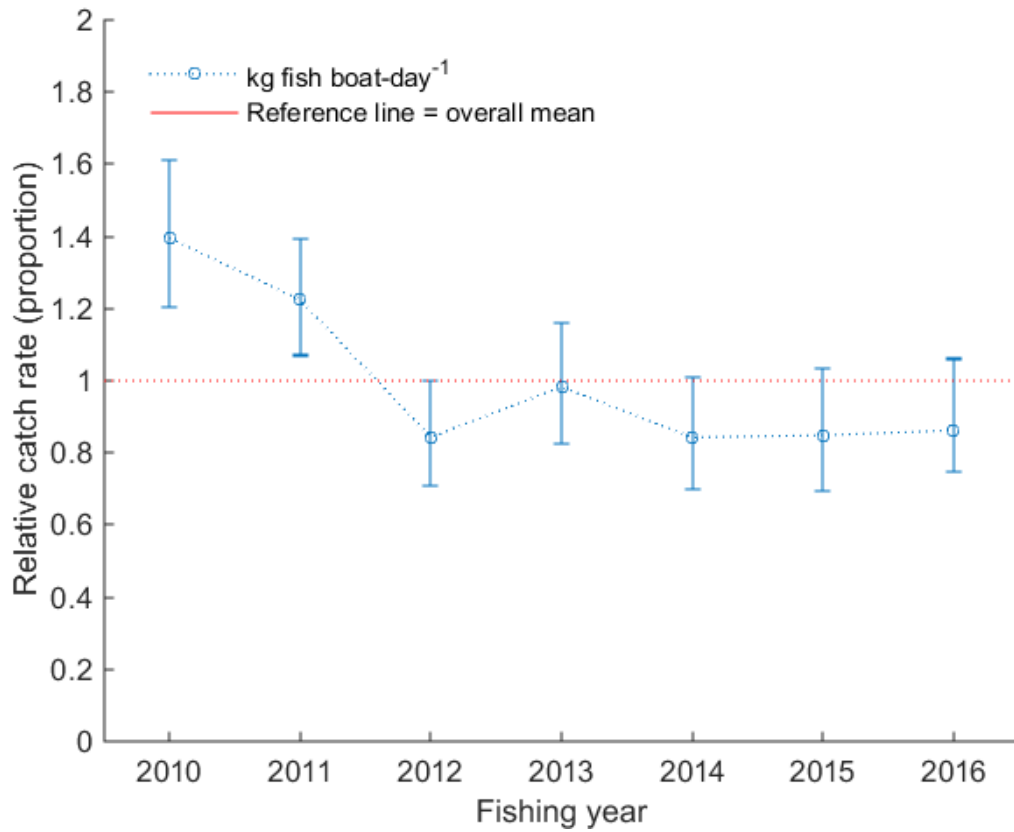*Figure 7. Final standardised catch rates of stout whiting from NSW and Queensland waters combined. Error bars indicate 95% confidence intervals on predictions. The annual time series was scaled relative to its mean catch rate (1 = mean catch rate).*

Catch Curve

Data

Data were available only from Queensland T_4 waters. No fish age or length data were available from NSW waters. Hence the analysis is reliant on the spatial and temporal data patterns sourced from the T_4 fishery.

Stout whiting length and age sampling from the T_4 sector was conducted from 1991 to 2015 following long-term monitoring protocols (Department of Primary Industries and Fisheries, 2007). Details on the sampling and laboratory processes are given in appendix 4 of (O'Neill & Leigh, 2016a).

The available data for the previous catch curve analysis in (O'Neill & Leigh, 2016a) included 2014 length frequency data. The age-length-otolith data used in (O'Neill & Leigh, 2016a) did not have any age data for 2014 and 2015.

The data provided for this study included 2015 length frequency data and 2014 and 2015 age-length data. Alignment of these data to fishing years is difficult because there are no 2015 otolith weightings and no length frequency data for 2016 calendar year. This is because of the long processing time to age fish.

A summary of the T_4 stout whiting length frequency distributions is displayed between calendar years (Figure 8).
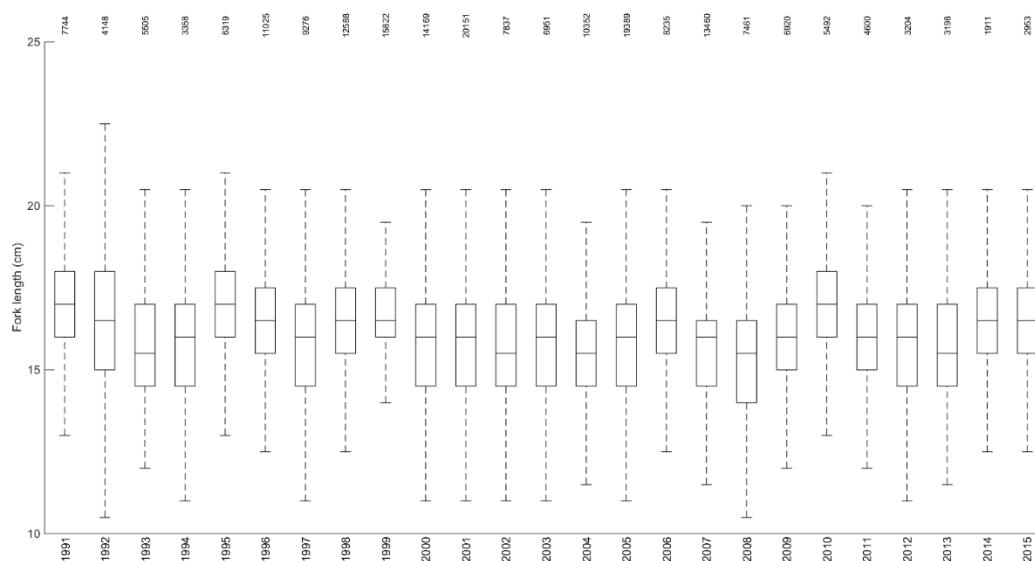
Figure 8. Box plot of the stout whiting length frequency samples recorded each calendar year. The plot shows the number of fish measured each year. On each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles and the whiskers extend to the most extreme data points.

The sampling in 2015 indicated there was no change in observed fish lengths from 2014. There was an increase in observed fish lengths in the 2014 sampling year, and these observed lengths have remained the same in the 2015 sample. Increases in the observed lengths also occurred in 2010, 2006, 1998-1999 and 1995. The nominal sample size in 2015 was higher than the sample size in 2014.

Subsamples of individual measures of matching fish length and age group showed the presence of older fish in 2015 samples (Figure 9).
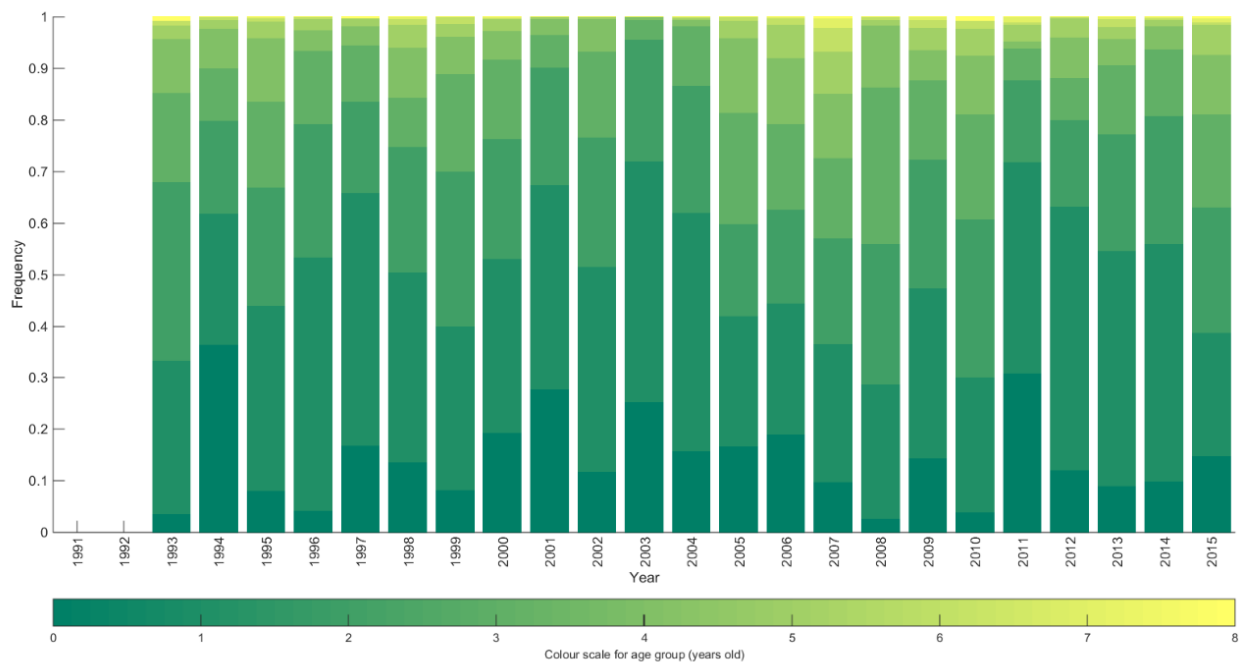
Figure 9. Summary of the stout whiting age samples recorded from the T4 fishery. The frequencies were only for fish with matching fish length and age group data.

Variability in sampling is dependent on fish retained by the vessels and their individual spatial-temporal patterns of fishing. The narrow range of fish lengths sampled each year suggests high sample correlation and small effective sample sizes. However, model outputs are still reliant on consistency of fish aging.

Results and Discussion

Survival

The objective of this analysis was to estimate annual survival fractions from the fish age, otolith weight and length samples. The survival fraction is defined as the ratio of abundance between older and younger age groups. Survival fractions were estimated for each cohort. The fractions compared the ratio of fully recruited cohort abundances to the next younger cohort in the same years they were fished. By comparing the same years, the survival estimates can be obtained.

Two different model versions were used: Catch Curve Model 2 and Catch Curve Model 3. Model 2 estimated the patterns of fish age-abundance from the fish-length frequency and age-length-otolith weight data for 1991 to 2015. Model 3 was used to analyse only the 1993-2015 sub sampled age-length data.

The following results were from Model 2:

- The age predictions, (which go up to 2013), from the previous analysis in (O'Neill & Leigh, 2016a) match closely to the current age predictions.
- Predicted age compositions suggested a slightly higher frequency of older 2-3 year old fish in 2015 (Figure 10). The 2015 predicted frequency of 1+ year old fish was less than previous years (Figure 10). The 2014 and 2015 estimated age structure was dominated by 1+ and 2+ year old fish. From 2013 the predicted patterns of age structure have shifted to older fish.
- The survival predicted for each year (Figure 11), closely matched the estimates from the previous study (O'Neill & Leigh, 2016a).
- Estimates of survival increased positively in 2012 and 2013 to 0.4015, and decreased slightly in 2014 to 0.3756 (Figure 11).
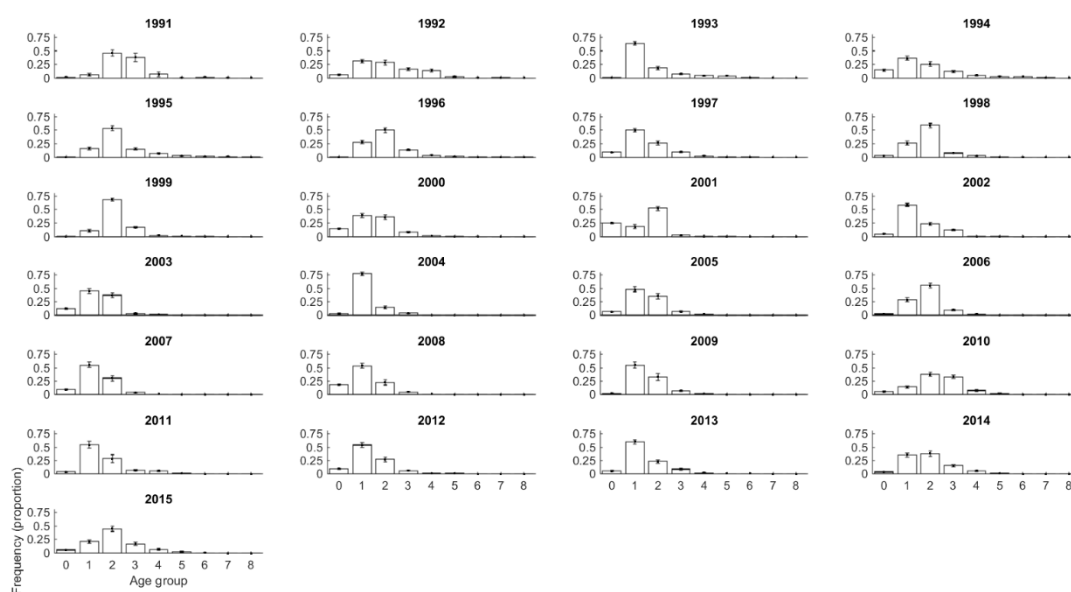

Figure 10. Predicted fish age frequencies of stout whiting by year. The predicted proportions were from catch curve Model 2, with 95% confidence intervals shown.
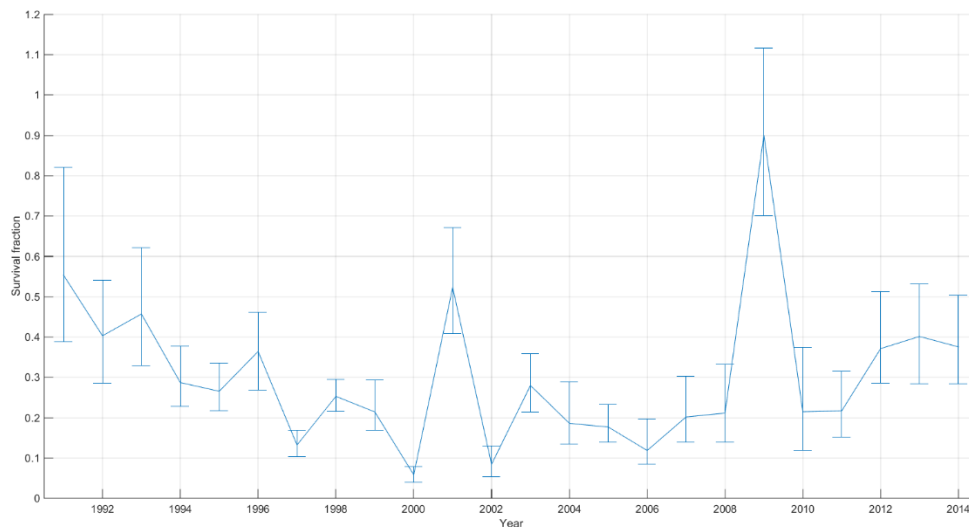
***Figure 11. Estimated survival fractions of stout whiting as calculated from the catch curve
Model 2. Error bars show the 95% confidence intervals.***

The following results were from Model 3:

- The previous study (O'Neill & Leigh, 2016a) predicted survival estimates up to 2012. These
  estimates matched very closely to the current predictions in Figure 12.
- The present study predicted a slight increase in survival in 2013 and a large increase to 0.64 in
  2014. Note the difference between Model 3 survival index of 0.64 for 2014 and Model 2 survival
  index of 0.38 in 2014. This difference is due to inconsistencies in the data used by the models.
  Model 3 used the subsampled data in Figure 9. These data indicate a shift to older fish in 2015,
  indicating strong survival in 2014. There are other years where the survival estimates predicted by
  the two models differ greatly; for example, the high peak in 2009 from Model 2 does not appear
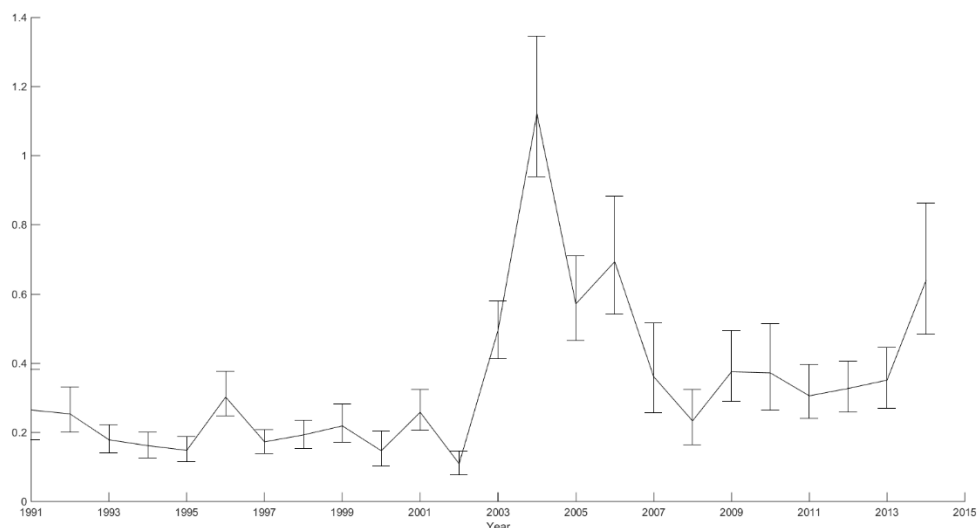 as a high peak in the estimate from Model 3.

***Figure 12. Estimates of stout whiting survival fractions from catch curve Model 3 using the
growth parameters estimated from catch curve Model 2. 95% confidence intervals are shown
on all estimates.***

TACC 2017

The calculations of the 2017 T_4 stout whiting TACC covered a range of settings outlined in Table 2.

The overall (averaged) results showed that:

- The procedure adjusting the quota from the TACC for 2016 recommended the TACC for 2017 to be between 1100 and 1130 t (Table 3, 4, 5).

- The procedure focussed on optimising average harvest to match the target reference points showed that the recommended TACC for 2017 was 860 to 890 t (Table 6, 7, 8).

Variations in quota results between indicators (columns 2–6 in Table 3-8), and uncertainty in all these TACC estimates should be considered as they were sensitive to the data inputs and assumptions.

In the tables below, S_{2015}, S_{2016} are the survival indexes predicted for 2015 and 2016.

Table 2. Definition of the six TACC tables. The same reference points were applied in all tables.

Table No.	Procedure	Multiplier	Reference points
Table 3	Using 2016 TACC	Cube-root	
Table 4	Using 2016 TACC	Square-root	$\begin{cases} \bar{S}_{model\ 1} = 0.38866 \\ \bar{S}_{model\ 2} = 0.4952 \\ S_{1.5M} = 0.4127 \\ Catch\ Rate = 1 \end{cases}$
Table 5	Using 2016 TACC	Linear	
Table 6	Using harvest data	Cube-root	
Table 7	Using harvest data	Square-root	
Table 8	Using harvest data	Linear	

Table 3. Simulation using 2016 TACC and a cube-root transformation.

Year	Model 2	Model 2	Model 3	Model 3	Catch rate	Overall
S_{2015}	0.4015	0.4015	0.3513	0.3513	0.8488	
S_{2016}	0.3756	0.3756	0.639	0.639	0.8624	
Mean S	0.3886	0.3886	0.4952	0.4952	0.8556	
Ref pt	0.4181	0.4127	0.3952	0.4127	1.0000	
Theta	0.9759	0.9801	1.0781	1.0626	0.9493	1.0092
TACC 2017	1064	1068	1175	1158	1035	1100

Table 4. Simulation using 2016 TACC and a square-root transformation.

Year	Model 2	Model 2	Model 3	Model 3	Catch rate	Overall
S_{2015}	0.4015	0.4015	0.3513	0.3513	0.8488	
S_{2016}	0.3756	0.3756	0.639	0.639	0.8624	
Mean S	0.3886	0.3886	0.4952	0.4952	0.8556	
Ref pt	0.4181	0.4127	0.3952	0.4127	1.0000	
Theta	0.9641	0.9703	1.1193	1.0953	0.9250	1.0148
TACC 2017	1051	1058	1220	1194	1008	1106

Table 5. Simulation using 2016 TACC and no transformation (linear).

Year	Model 2	Model 2	Model 3	Model 3	Catch rate	Overall
S_{2015}	0.4015	0.4015	0.3513	0.3513	0.8488	
S_{2016}	0.3756	0.3756	0.639	0.639	0.8624	
Mean S	0.3886	0.3886	0.4952	0.4952	0.8556	
Ref pt	0.4181	0.4127	0.3952	0.4127	1.0000	
Theta	0.9294	0.9415	1.2529	1.1997	0.8556	1.0358
TACC 2017	1013	1026	1366	1308	933	1129

Table 6. Simulation using average harvest and cube-root transformation.

Year	Model 2	Model 2	Model 3	Model 3	Catch rate	Overall
S_{2015}	0.4015	0.4015	0.3513	0.3513	0.8488	
S_{2016}	0.3756	0.3756	0.639	0.639	0.8624	
Mean S	0.3886	0.3886	0.4952	0.4952	0.8556	
Ref pt	0.4181	0.4127	0.3952	0.4127	1.0000	
Theta	0.9759	0.9801	1.0781	1.0626	0.9493	1.0092
TACC 2017	836	840	924	911	814	865

Table 7. Simulation using average harvest and square-root transformation.

Year	Model 2	Model 2	Model 3	Model 3	Catch rate	Overall
S_{2015}	0.4015	0.4015	0.3513	0.3513	0.8488	
S_{2016}	0.3756	0.3756	0.639	0.639	0.8624	
Mean S	0.3886	0.3886	0.4952	0.4952	0.8556	
Ref pt	0.4181	0.4127	0.3952	0.4127	1.0000	
Theta	0.9641	0.9703	1.1193	1.0953	0.9250	1.0148
TACC 2017	826	832	959	939	793	870

Table 8. Simulation using average harvest and no transformation (linear).

Year	Model 2	Model 2	Model 3	Model 3	Catch rate	Overall
S_{2015}	0.4015	0.4015	0.3513	0.3513	0.8488	
S_{2016}	0.3756	0.3756	0.639	0.639	0.8624	
Mean S	0.3886	0.3886	0.4952	0.4952	0.8556	
Ref pt	0.4181	0.4127	0.3952	0.4127	1.0000	
Theta	0.9294	0.9415	1.2529	1.1997	0.8556	1.0358
TACC 2017	797	807	1074	1028	733	888

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Acknowledgements