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I. J. Doonan
P. J. McMillan
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I. J. Doonan
P. J. McMillan
A. C. Hart

NIWA
PO Box 14 901
Wellington

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EXECUTIVE SUMMARY

Doonan, I.J.; McMillan, P.J.; Hart, A.C. (2001). The use of mean length data for stock assessments of black oreo and smooth oreo in OEO 4.

New Zealand Fisheries Assessment Report 2001/34. **16 p.**

This was a preliminary study to gauge the usefulness of OEO 4 black oreo and smooth oreo research and observer length data for stock assessment modelling. Observed regression slopes for research and observer mean length data against year were compared with the predicted slopes of the mean length trajectories estimated from the population model in stock reduction analyses. Observer and research data were split into west and east parts of OEO 4 at 178° 20' W to reflect recognised spatial and temporal changes in the fishery. Data representativeness, comparability, and quantity were considered before the analysis.

Usefulness was determined by the possibility that using the length data in the stock assessment analysis would improve the assessment. There were three classes of results.

1. Data unlikely to be useful. Where predicted and observed trends were consistent, this implies that the population model used is appropriate and that adding length data into more complicated models will have little effect on the results.
2. Data likely to be useful. If the predicted trend was statistically different from the observed trend. then either the observed data are from an atypical part of the population, or the model used was not appropriate and a more complex model may be required, e.g., one that uses stochastic rather than deterministic recruitment. Hypotheses were suggested which specify changes needed in the model.
3. Data potentially useful. If observed and predicted trends are different, but differences are not statistically significant, i.e., outside the range of predicted slopes using a virgin biomass at a 20th and an 80th percentile of the distribution for the estimated virgin biomass.

Stock assessment modelling would be required for each case where data are likely, or are potentially useful, to determine if the data change the results compared to the current stock assessment (not using length data). This step is beyond the scope of this study.

Smooth oreo

The west observer and research regression slope results were significantly different from the model slope but were also in conflict with each other. The west data sets are useful and could be used in stock assessment. but this would require the development of more complex models than those currently employed and also a careful consideration of observer data structure and quality. The east data sets are potentially useful.

Black oreo

There were less data (small fishery with fewer years) and the west and east observer and research regression slopes were not significantly different from the model results. The west observer and east observer and research data sets are potentially useful. More data from continued observer sampling could provide sufficient data for future stock assessment modelling. Incorporating the data would require the development of more complex models than those currently used and a careful consideration of observer data structure and quality.

1. INTRODUCTION

1.1 Overview

This work addresses a part of the following objective in MFish project "Oreo stock assessment" (OEO1999/02).

Overall objective

1. To carry out a stock assessment of black oreo (*Allocyttus niger*) and smooth oreo (*Pseudocyttus maculatus*), including estimating biomass and sustainable yields.

Specific objective

2 To analyse length frequency, sex ratio, and reproductive condition data for black oreo and smooth oreo collected by the Scientific Observer Programme and other sources and from research projects OEO9801 and ORH9801 during the 1998/99 fishing year for input into stock assessment models.

The work reported here involves only the analysis of the possibility that use of length frequency data in stock assessment models for oreos would improve the assessments. Other parts of specific objective 2 were described by Doonan et al. (2001a & b). Past assessments, e.g., Doonan et al. (1999), examined research and observer mean length data to determine if there were trends in mean length over time, but these data were not incorporated into stock assessment models, largely because trends were not always apparent and also because of the uncertainty that the information would improve the assessment. It was also recognised that incorporating mean length data into oreo stock assessment analyses would require adoption or development of more complex models than those employed to date.

2. METHODS

Observer length data from commercial tows and research length data from trawl surveys were examined to determine, firstly, how much and what quality data were available and, secondly, to determine if there were trends or signals in the data which could be useful for stock assessment modelling. Usefulness of the length data was determined by testing if the slope of the mean annual lengths ("simple" regression where length was regressed against year only) was statistically different from the predicted slope from population dynamic modelling in the stock assessment. Results were classified according to whether the observed trend would require that the current stock assessment model be modified, i.e., is it likely that the data will add information to the assessment or not? There were three result classes.

1. Data are unlikely to be useful. If predicted and observed trends are consistent, then this implies that the population model used is appropriate and that adding length data into more complicated models will have little effect on the results.
2. Data are likely to be useful. If the predicted trend is statistically different from the observed trend, then either the observed data are from an atypical part of the population, or the model used was not appropriate and a more complex model may be required, e.g., one that uses stochastic recruitment. Hypotheses will be suggested which will specify changes needed in the model. For example, a constant mean length during fishdown of a stock is not predicted (expected) from a stock reduction analysis with deterministic recruitment. A hypothesis therefore would be that recent recruitment is below average and that stochastic recruitment should be added to the model.
3. Data are potentially useful. If observed and predicted trends are different, but differences are not statistically significant, i.e., outside the range of predicted slopes using a virgin biomass at a 20th and an 80th percentile of the distribution for the estimated virgin biomass, then modelling would be required to determine if the data are potentially useful.

This was a feasibility study and the next step of incorporating useful length data into a stock assessment was not carried out.

Males and females

Mean length was taken as the average of the means for females and males. This removed any effects due to changes in the sex ratios and simplified the analysis to only one series.

West-east fishery split

Separate analyses were carried out for the west and east parts of OEO 4, split at longitude 178° 20' W. The oreo fishery in OEO 4 is characterised by spatial shifts in effort and target species over time. The western part was exploited several years before the east and there was a shift in effort from the west to the east from 1989 to 1992 (Coburn et al. 2001). However, in each part, the fishery occurred over most of the area in each year, except for some exploratory fishing to find new fishing grounds in the early years of exploitation. This shift in catch and effort meant that observer and research data were not comparable over time.

Area

Observer and research data were restricted to the trawl survey area but cut off at the east end at 173° W, which excluded the Andes seamount complex.

2.1 Observer data

Commercial catch data

Oreo catch data for the south Chatham Rise for the fishing years 1978–79 to 1998–99 were extracted from the database dw_cdb which contains data from Trawl Catch Effort and Processing Return (TCEPR) forms only. Catch was reported for each tow, as well as the position and date. For each area (east and west), a "fishery set" of data was derived which covered the area where most fishing was carried out. To do this, a grid using 0.1 degree of longitude and 0.05 degree of latitude (approximately 25 km^2) was laid over the area and the total catch over all years in each cell summed. The fishery set was defined as the minimum set of grid cells that contained 95% of the total catch. Within this set, further divisions were made at 75%, 50%, and 25% of total catch, i.e., the fishery set was divided into, at most, four sub-sets of grid cells. The number of divisions used depended on the decrease in the fraction of the area covered when going from one division to the next, which was done informally from plots of the cells in each division.

Length data

Length data were extracted from the observer database (Obs_lf) for the south Chatham Rise.

Analyses

A simple regression was used to estimate the slope of mean length per tow against fishing year. Preliminary analyses showed that the main source of variance was between tows, not from sampling within a catch, so mean lengths per tow were weighted by the catch but not by the number of fish in each tow sample. The slopes from the simple regressions were compared with that from the smooth oreo and black oreo stock assessment (stock reduction) analyses (Doonan et al. 2001a & b). Issues of data representativeness, comparability, and quantity were considered before this analysis was carried out.

Representativeness. Observer data were not collected at random and may be skewed to unrepresentative parts of the fishery because of the requirement to collect samples of oreos irrespective of the target species or ground fished, e.g., oreo samples collected during hoki fishing. However, there were often few observer data samples collected so using target species to exclude data may result in too few data. For oreos, the target species ("OEO", "SSO", or "BOE") may not be useful as OEO is generic for black oreo and smooth oreo, and SSO or BOE may represent what was caught the most (i.e., filled in after the event). Thus, the first filter to be applied was to exclude observer data that were collected outside the main fishing areas (outside the fishery set defined above).

Comparability. Comparability was tested by looking for the effects of including auxiliary variables (longitude, depth, fishery sub-set, target species, and season (month)) on the slope of mean length with fishing year using Generalised Additive Model (GAM) regression analysis. For the variables longitude, depth, and season, a *smoothing spline* was used. Fishery sub-set and target species were treated as categorical variables. Slopes of the simple and GAM regression results that were statistically different (5% level) would show that assuming comparability of data across years is not justified.

Whether to use the slope from the simple regression or the GAM regression is beyond the brief for this study, but it does need investigating if observer data are to be used in future modelling. The key question is, how do observer data relate to the fishery when sampling coverage is low (as it is in oreo fisheries)?

Trends in the annual sampling profiles were also examined. The sampling profile was the observer sampling fractions in the fishery sub-sets. This profile approximately indexes the spread of samples over the fishery. Strong trends would indicate that sampling was biased.

Quantity. Sufficient data were needed to determine the slope with enough precision to make a comparison with the model predictions worthwhile. The quantity of data is implicitly included when testing the observed and predicted slopes because the estimated standard errors are used in the test. A low quantity of data will usually mean a relatively large standard error and a low chance of getting a significant result, i.e, data will not be useful, at least until more are available. Another problem involves low catches in commercial tows. These are atypical and may be due to gear failure. Therefore, data from catches under 500 kg were excluded. To provide a reasonable mean for the catch, samples with fewer than 10 fish of each sex were also excluded.

In summary, data were included in the analyses if the tow:

- caught 500 kg or more of the species (data with unreported catches were excluded)
- was within the fishery-set for that species
- provided a sample that had 10 or more fish of each sex.

2.2 Research data

The seven trawl surveys listed in Table 1 were considered. In the 1986 and 1987 surveys, only the west part of OEO 4 was covered so there are no mean length data available for the east part from those surveys.

Table 1: **Random stratified trawl surveys (standard, i.e., flat tows only) for oreos on the south Chatham Rise (OEO 3A & OEO 4).**

Year	Area (km^2)	Vessel	Survey area	No. of stations
1986	47 137	*Arrow*	South	186
1987	47 496	*Amaltal Explorer*	South	191
1990	56 841	*Cordella*	South, southeast	189
1991	56 841	*Tangaroa*	South, southeast	154
1992	60 503	*Tangaroa*	South, southeast	146
1993	60 503	*Tangaroa*	South, southeast	148
1995	60 503	*Tangaroa*	South, southeast	172

Mean length for a survey was given by:

$$\frac{\sum_{s}^{\text{strata}} N_s A_s L_s}{\sum_{s}^{\text{strata}} N_s A_s}$$

where N is proportional to the population density, A is the area, and L is the mean total length (male or female) for stratum s and is given by:

$$\frac{\sum_{i}^{\text{tows}} N_i l_i}{\sum_{i}^{\text{tows}} N_i}$$

where l is the mean length in tow i (male or female).

The standard error came from the residual error in the regression, but a check on each yearly estimate was made by considering the variation in the mean length per tow only, i.e., variance is:

$$\frac{\sum_{s}^{\text{strata}} N_s^2 A_s^2 V_s}{\left(\sum_{s}^{\text{strata}} N_s A_s\right)^2}$$

where V_s is the sample variance for the mean length per tow in stratum s. For each area and each species, these variances were approximately the same for each year. The survey mean length used in the regression was not weighted.

3. Results

Smooth oreo

For the observer data only 10–20% of the smooth oreo tows were excluded. The western part had two fishery sub-sets; one that covered 75% of the total catch (Fset.2) and another that covered 20% of the catch (Fset.1). In constructing these sub-sets, the cells from the grid were ordered by the total catch in each cell so that Fset.2 covered the cells with the highest catch density and was compact in area. Fset.1 contained the lower density cells and generally surrounded the area covered by Fset.2 and was larger in area.

The eastern part had three fishery sub-sets; one that covered 50% of the total catch but contained the densest catch cells (Fset.3). Another had 25% of the total catch and covered the next densest catch cells (Fset.2), and the third covered the lowest density cells and had 20% of the total catch (Fset.1).

The mean lengths for each year for observer and research data are given in Tables 2 and 3. The distribution of tows amongst the fishery sub-sets by year showed no clear trends.

For the western sub-sets, the expected proportions of tows by total catch were 21% (Fset.1) and 79% (Fset.2), close to the observed proportions, 18 and 82% (Table 2). For the eastern sub-sets, the expected proportions of tows were 21% (Fset.1), 25% (Fset.2), and 52% (Fset.3) and were also close to the observed proportions, 17, 27, and 56% (Table 3).

For the western part, both the observer and research slopes from the simple regression were significantly different from that for the model (Table 4). However, there were two conflicts within the results that need resolving before they can be used in the stock assessment. First, the GAM regression gave a significantly different slope (t-test, 5% level) to that from the simple regression for the observer data (Figure 1). Thus, the depth, longitude, and fishing year of the tow had an important effect on the mean length obtained (Table 5). Both regressions using the observer data gave slopes that were steeper than that from the model, even when using the virgin biomass at the 20th percentile, so that both the GAM and simple regressions would shift a stock assessment based on mean length in the same direction.

Secondly, the research slope had a smaller decline than that using the virgin biomass at the 80th percentile which was the opposite to that from the observer data and would tend to nullify the effect of the observer data. The years covered by the research data covered a large part of those for the observer data and in a homogeneous population the effect should have been similar for each. The main difference between the research and observer data was spatial extent, with research data coming from a wide expanse of flat ground. In contrast, observer data were concentrated around seamounts and other features, partly sampled by the survey, and from the tops of such features, which were not sampled by the research surveys. If we postulate that mean length indirectly indexes recruitment into the fishery, then the population model needs to couple the population in the wider area to that on the main fishing seamounts.

Table 2: Smooth oreo in the western part. Weighted mean total lengths (L, cm) and standard errors (s.e., cm) for research and observer data by fishing year. For the observer data, the number of tows observed (n, † = total) and the percentage of tows from each of the fishing sub-sets (Fset.1 and Fset.2) are also given (‡ = mean). –, no data.

Fishing	Research		Observer				
year	L	s.e.	n	L	s.e.	Fset.1	Fset.2
1986–87	37.6	1.1	4	38.1	0.8	0	100
1987–88	37.0	1.2	–	–	–	–	–
1988–89	–	–	12	39.4	0.4	17	83
1989–90	–	–	4	37.2	0.8	0	100
1990–91	37.4	1.0	16	36.7	0.4	0	100
1991–92	37.3	1.5	5	36.0	0.7	20	80
1992–93	36.9	1.1	–	–	–	–	–
1993–94	37.2	1.3	–	–	–	–	–
1994–95	–	–	1	37.0	1.5	0	100
1995–96	37.2	1.8	17	35.9	0.4	24	76
1996–97	–	–	10	36.9	0.5	20	80
1997–98	–	–	10	34.9	0.5	40	60
1998–99	–	–	6	36.6	0.6	17	83
1986–99	–	–	85†	–	–	18‡	82‡

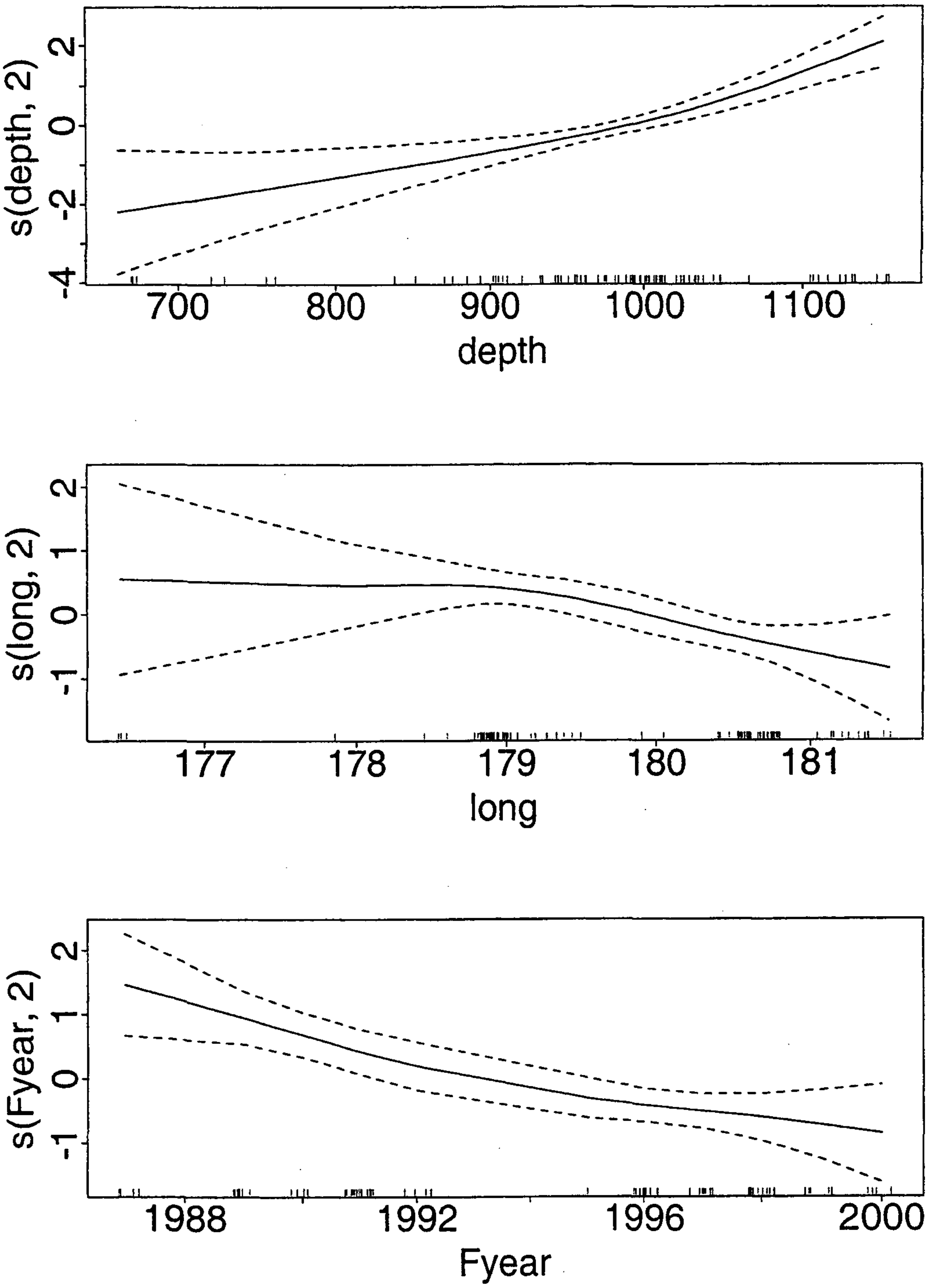

Figure 1: GAM regression results estimated for smooth oreo in the western part. "long", longitude. "Fyear", fishing year. Solid lines are the estimated response centred so that the weighted mean was zero (i.e., relative length). Dotted lines are the 95% confidence limits. "|" on the base line indicates the relative amounts of data. "s(X,2)", indicates the method used to model the response by variable X, using a smoothing spline with 2 degrees of freedom.

Table 3: **Smooth oreo in the eastern part. Weighted mean lengths (L, cm) and standard errors (s.e., cm) for research and observer data by fishing year. For the observer data, the number of tows observed (n, † = total) and the percentage of tows from each of the fishing sub-sets (Fset.1 to Fset.3) are also given (‡ = mean). –, no data.**

Fishing	Research		Observer					
year	L	s.e.	n	L	s.e.	Fset.1	Fset.2	Fset.3
1988–89	–	–	1	39.4	3.0	0	100	0
1989–90	–	–	–	–	–	–	–	–
1990–91	37.3	1.5	20	37.7	0.7	45	30	25
1991–92	36.9	1.6	13	34.7	0.8	23	31	46
1992–93	36.9	1.5	15	36.3	0.8	20	27	53
1993–94	36.8	1.1	52	35.6	0.4	4	42	54
1994–95	–	–	38	36.5	0.5	13	24	63
1995–96	37.0	1.4	10	37.8	0.9	0	0	100
1996–97	–	–	28	38.7	0.6	0	32	68
1997–98	–	–	26	36.6	0.6	12	15	73
1998–99	–	–	46	35.8	0.4	33	17	50
1988–99	–	–	249†	–	–	17‡	27‡	56‡

Table 4: **Smooth oreo, western part. Slopes of length with fishing year and standard errors from observer (1986–87 to 1998–99) and research (1986–87 to 1995–96) data ('Data') and those from model results ('Model') at the estimated virgin biomass (B_0) and also at the 20th and 80th percentile of the distribution for the estimated virgin biomass. *, the slope was statistically significantly different from the corresponding model estimate (t-test, 5% level). 'Simple': simple regression where length was regressed against fishing year only. 'GAM': GAM regression where other variables were included, such as depth, time within the year, fishing sub-set, target species, and longitude. –, not estimated.**

	Research		Observer	
Type	Slope	s.e.	Slope	s.e.
Data, simple	-0.026*	0.029	-0.320*	0.043
Data, GAM	–	–	-0.187	0.042
Model, estimated B_0	-0.159	0.013	-0.130	0.011
Model, B_0 (20th percentile)	-0.201	0.017	-0.163	0.014
Model, B_0 (80th percentile)	-0.138	0.011	-0.114	0.009

Table 5: **Smooth oreo, western part. Estimated effects ('Estimate'), standard error, and t-test values from the GAM regression on observer length data. The estimate for the effect of fishing year was significantly different from that estimated from a linear regression that used no other terms. The term 's(depth, 2)' means a smoothing spline was fitted to depth using 2 degrees of freedom; the estimate for this term was the coefficient for using the whole spline, and there were other estimated parameters used in the spline itself which are not shown here. The term 'C(target species)1' means that target species was used as a categorical variable and the level was 1. There were three levels (species/codes) as one was absorbed into the intercept term. A factor was significant if the absolute *t* value was greater than 2.**

Variable	Estimate	s.e.	*t* value
Intercept	476.49	83.01	5.74
s(depth, 2)	0.01	0.002	5.65
s(longitude, 2)	-0.41	0.15	-2.83
s(month, 2)	-0.05	0.06	-0.77
C(Fset)	0.16	0.23	0.72
C(target species)1	1.02	0.63	1.61
C(target species)2	0.05	0.16	0.29
Fishing year	-0.19	0.04	-4.46

For the eastern part (Table 6), the simple regressions on both the observer and research data gave lower slopes than the model mean length trajectory. Although they were not statistically significantly different from the model slope, the estimated values were lower than those for the virgin biomass at the 80th percentile. Including mean lengths in the stock assessment could potentially affect the results from the current analysis. The GAM regression on the observer data had a positive slope that was significantly different from the model value (5% level), suggesting that the observer slope may be different from the model one, but in the same direction. The GAM slope was not statistically significantly different from the slope given by the simple regression.

Table 6: **Smooth oreo, eastern part. Slopes of length with fishing year and standard errors from observer (1989–90 to 1998–99) and research (1990–91 to 1995–96) data and those from model results at the estimated virgin biomass (B_0) and also at the 20th and 80th percentile of the distribution for the estimated virgin biomass. *, the slope was statistically significantly different from the corresponding model estimate (t-test, 5% level). 'Simple': simple regression where length was regressed against fishing year only. 'GAM': GAM regression where other variables were included, such as depth, time within the year, fishing sub-set, target species, and longitude. –, not estimated.**

	Research		Observer	
Type	Slope	s.e.	Slope	s.e.
Data, simple	-0.038	0.049	-0.023	0.073
Data, GAM	–	–	0.081*	0.046
Model, estimated B_0	-0.099	0.005	-0.113	0.004
Model, B_0 (20th percentile)	-0.125	0.006	-0.146	0.006
Model, B_0 (80th percentile)	-0.089	0.004	-0.101	0.003

Black oreo

For the observer data 50–60% of the black oreo tows were excluded. The western part had two fishery sub-sets; one that covered 75% of the total catch (Fset.2) and another that covered 20% of the catch (Fset.1). In constructing these sub-sets, the cells from the grid were ordered by the total catch in each cell so that Fset.2 covered the cells with the highest catch density and was compact in area. Fset.1 contained the lower density cells and generally surrounded the area covered by Fset.2 and was larger in area.

The eastern part had three fishery sub-sets; one that covered 50% of the total catch but contained the densest catch cells (Fset.3). Another had 25% of the total catch and covered the next densest catch cells (Fset.2), and the third covered the lowest density cells and had 20% of the total catch (Fset1).

The mean lengths for each year for observer and research data are given in Tables 7 and 8. The distribution of tows amongst the fishery sub-sets by year showed no clear trends, except for the eastern part where the number of tows declined over time.

For the western sub-sets, the expected proportions of tows by total catch were 21% (Fset.1) and 79% (Fset.2). This contrasts with the observed proportions of 47% and 53% (Table 7), but it was difficult to be conclusive because tow numbers were low. For the eastern sub-sets, the expected proportions of tows were 21% (Fset.1), 25% (Fset.2), and 52% (Fset.3) and were also close to the observed proportions, 14%, 23% and 63% (Table 8).

Table 7: Black oreo in the western part. Weighted mean total lengths (L, cm) and standard errors (s.e., cm) for research and observer data by fishing year. For the observer data, the number of tows observed (n, † = total) and the percentage of tows from each of the fishing sub-sets (Fset.1 and Fset.2) are also given (‡ = mean). –, no data.

Fishing	Research		Observer				
year	L	s.e.	n	L	s.e.	Fset.1	Fset.2
1986–87	34.4	0.8	–	–	–	–	–
1987–88	34.0	0.5	–	–	–	–	–
1988–89	–	–	4	34.0	1.0	75	25
1989–90	–	–	–	–	–	–	–
1990–91	34.6	0.9	1	30.0	2.0	100	0
1991–92	34.1	0.7	–	–	–	–	–
1992–93	34.7	0.7	–	–	–	–	–
1993–94	34.1	0.5	1	30.2	2.0	0	100
1994–95	–	–	–	–	–	–	–
1995–96	34.4	0.7	2	32.3	1.4	0	100
1996–97	–	–	–	–	–	–	–
1997–98	–	–	3	32.0	1.1	33	67
1998–99	–	–	2	32.1	1.4	50	50
1999–00	–	–	2	29.8	1.4	50	50
1986–00	–	–	15†	–	–	47‡	53‡

Comparison of the simple regression slopes for the research and observer mean length data with the expected slope from the model showed that there were no significant differences for both western and eastern parts (Tables 9 and 10). There were also no significant differences in slopes for the observer mean length data between the simple and GAM regressions.

Table 8: **Black oreo in the eastern part. Weighted mean lengths (L, cm) and standard errors (s.e., cm) for research and observer data by fishing year. For the observer data, the number of tows observed (n, † = total) and the percentage of tows from each of the fishing sub-sets (Fset.1 to Fset.3) are also given (‡ = mean). –, no data.**

Fishing	Research		Observer					
year	L	s.e.	n	L	s.e.	Fset.1	Fset.2	Fset.3
1990–91	37.1	1.2	11	36.8	1.0	9	18	73
1991–92	–	–	1	37.4	3.4	0	0	100
1992–93	35.3	1.7	15	37.5	0.9	0	47	53
1993–94	35.1	1.5	17	37.4	0.8	6	18	76
1994–95	–	–	8	30.8	1.2	63	0	38
1995–96	35.0	1.5	–	–	–	–	–	–
1996–97	–	–	1	37.6	3.4	0	100	0
1997–98	–	–	–	–	–	–	–	–
1998–99	–	–	–	–	–	–	–	–
1999–00	–	–	3	35.6	2.0	33	0	67
1990–00	–	–	56†	–	–	14‡	23‡	63‡

For the western part, there is potential for a signal from the observer mean length data because the slopes from the simple and the GAM regressions were both lower than those estimated using the virgin biomass at the 80th percentile (Table 9). In contrast, the research mean length data regression slope is within the slope values estimated using the virgin biomasses at the 20th and 80th percentiles and so is unlikely to have much effect on the results of the stock reduction analysis. For the eastern part, there is potential for a signal from the observer mean length data because the slope from the simple regressions was larger than that estimated using the virgin biomass at the 20th percentile (Table 10).

The short time series of observer data and large standard errors for the mean lengths implies that more data are needed before they can be used. The research mean lengths for the eastern part have a large standard error on the slope and so may not have a very large effect on results. However, it is greater than one standard error from the model value and so may possibly have a modest effect.

Table 9: **Black oreo, western part. Slopes of length with fishing year and standard errors from observer (1988–89 to 1998–99) and research (1986–87 to 1995–96) data ('Data') and those from model results ('Model') at the estimated virgin biomass (B_0) and also at the 20th and 80th percentile of the distribution for the estimated virgin biomass. *, the slope was statistically significantly different from the corresponding model estimate (t-test, 5% level). 'Simple': simple regression where length was regressed against fishing year only. 'GAM': GAM regression where other variables were included, such as depth, time within the year, fishing sub-set, target species, and longitude. –, not estimated.**

	Research		Observer	
Type	Slope	s.e.	Slope	s.e.
Data, simple	0.019	0.036	-0.030	0.117
Data, GAM	–	–	0.017	0.111
Model, estimated B_0	0.033	0.012	0.065	0.004
Model, B_0 (20th percentile)	0.033	0.012	0.065	0.004
Model, B_0 (80th percentile)	0.003	0.011	0.039	0.005

Table 10: Black oreo, eastern part. Slopes of length with fishing year and standard errors from observer (1990–91 to 1996–97) and research (1991–92 to 1995–96) data and those from model results at the estimated virgin biomass (B_0) and also at the 20th and 80th percentile of the distribution for the estimated virgin biomass. *, the slope was statistically significantly different from the corresponding model estimate (t-test, 5% level). 'Simple': simple regression where length was regressed against fishing year only. 'GAM': GAM regression where other variables were included, such as depth, time within the year, fishing sub-set, target species, and longitude. –, not estimated.

	Research		Observer	
Type	Slope	s.e.	Slope	s.e.
Data, simple	-0.402	0.179	-0.253	0.152
Data, GAM	–	–	-0.037	0.118
Model, estimated B_0	-0.153	0.018	-0.111	0.024
Model, B_0 (20th percentile)	-0.153	0.018	-0.111	0.024
Model, B_0 (80th percentile)	-0.134	0.015	-0.099	0.020

4. SUMMARY

Smooth oreo

Table 11 summarises the possible use of smooth oreo lengths in stock assessments. Only the western area had length data likely to be useful for stock assessment (See Table 2). However, using length data in the assessment would necessitate a more complicated model in which the population is split into a flat component that feeds fish into the seamount or feature component, where most of the commercial catch was taken. Initial recruitment might occur onto flat areas with a different rate of movement of recruited fish from the flat onto the seamounts. About 80% of recruit size fish occurred on the flat in the 1998 acoustic survey (Doonan et al. 2000) so that the population on the flat cannot be ignored. Alternatively, research data could be rejected if it could be shown that the relative catchability of small and large fish has changed over the survey series and there is a trend in mean length. For the east stock, length data are potentially useful.

Stock assessment modelling incorporating length data is required to determine if using the data will improve the assessment (compared to an assessment without length data). These results suggest that the OEO 4 smooth oreo length data are a good candidate for the extra modelling.

Black oreo

Table 12 summarises the possible use of black oreo lengths in stock assessments. Length data for the western (not research data) and eastern parts are potentially useful, but would need to be used in modelling before it can be concluded that they really are useful or not. The standard errors on the estimated slopes were relatively large so that data collected over more years (which will lower the standard error) are probably needed before being used in stock assessments.

Table 11: Classification of observer and research smooth oreo data for usefulness in stock assessments, and the hypotheses needed in the assessments to include the data. SSO, smooth oreo.

Stock	Data	Classification	Hypotheses/comment
SSO, west	Observer	Useful	Needs clarification on tows to include. Slope in conflict with that from research data. (1) Recruitment onto the flats is below average. (2) Growth has slowed so that fewer fish are moving into the recruited size class on the flat. (3) Movement onto the seamounts is above average. (4) Movement onto the seamounts is average or below average but fishing preferentially removes large fish first.
SSO, west	Research	Useful	See observer hypothesis. Slope in conflict with that from observer data.
SSO, east	Observer	Potential	(1) Below average recruitment. (2) Growth has slowed.
SSO, east	Research	Potential	See observer hypothesis.

Table 12: Classification of observer and research data for usefulness in stock assessments, and the hypotheses needed in the assessments to include the data. BOE, black oreo.

Stock	Data	Classification	Hypotheses/comment
BOE, west	Observer	Potential	Needs more years of data
BOE, west	Research	Not useful	
BOE, east	Observer	Potential	Needs more years of data
BOE, east	Research	Potential	Needs more years of data

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