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Review of CPUE from the bluenose (*Hyperoglyphe antarctica*) target line fishery in BNS 2, 1988–89 to 1997–98

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Final Research Report

Report title: Review of CPUE from the bluenose (*Hyperoglyphe antarctica*) target line fishery in BNS 2, 1988–89 to 1997–98.

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7. EXECUTIVE SUMMARY

This report reviews the raw and standardised CPUE series of kg/set and kg/hook from the bluenose target line fishery in BNS 2, for the period 1988–89 to 1997–98. The estimator of CPUE (kg/set) appears to be more robust against vessel level variability in gear, and to explain more variability in the data than the alternative estimator of CPUE (kg/hook).

Raw CPUE and the first order interactions for these estimators are examined to review the importance of the statistical area*fishing year interaction in this fishery. Whilst CPUE (kg/set) appears to be adequately described by a main effects model, complex interactions occur between vessels, months and fishing years for the CPUE (kg/hook) estimator, and the continued monitoring of raw CPUE by statistical area is suggested for this fishery. As data are sparse prior to 1989–90, it is suggested that subsequent analysis should be confined to the period from 1990–91 to 1997–98.

A decision is requested from the Ministry of Fisheries on which estimator to use in the subsequent MIAEL analysis of yield and biomass in this fishery.

8. INTRODUCTION

Bluenose supports a small target line fishery that represents on average 25–30% of the total BNS 2 landings from 1988–89 to 1997–98 (Blackwell 1999). Most of the remaining bluenose is taken as bycatch of the target midwater trawl fisheries for alfonsino (BYX 2) and gemfish (SKI 2) (Annala *et al.* 1999). The area covered by the QMA 2 bluenose fishery is shown in Figure 1.

Objectives:

This report addresses Objective 2 of the project BNS 9701;

To develop standardised CPUE indices (kg/hook) for the line fishery for bluenose in BNS 2.

Preliminary data for this objective for 1988–89 to 1995–96 were presented to the 18 February 1999 Inshore Working Group (IWG) meeting, together with additional data requested under Objective 3, "To develop standardised CPUE indices of bluenose from the target trawl fisheries for alfonsino in BYX 2 and gemfish in SKI 2". The Ministry of Fisheries subsequently amended Objective 5 of BNS 9701 to include data from bluenose target line fishery in BNS 2 only. Concerns were raised at the Inshore Working Group about the variability in line fishery CPUE between the statistical reporting areas in QMA 2. To address these concerns, the following additional analyses were requested by the Ministry of Fisheries:

(i) To derive a standardised CPUE series of kg/set for the target BNS 2 fishery
(ii) To review the fishing year*fishing ground interaction
(iii) To include data from 1988–89 to 1997–98

Additionally, the Ministry of Fisheries requested that the analysis methods include the loglinear model (Doonan 1991) and that use of the combined binomial and linear model of Vignaux (1994) be considered.

This report summarises this additional work required by the Ministry of Fisheries under this revised objective. It updates the original CPUE estimator of kg/hook evaluated under Objective 2 of BNS 9701 for the 1997–98 fishing year, and compares the use of both CPUE estimators for the period 1988–89 to 1997–98.

9. METHODS

Information available, data constraints and error checks

Data were extracted from the Ministry of Fisheries CELR database for fishing years 1988–89 to 1997–98, where method was line fishing and the target species was BNS 2. These data include three methods: bottom longline (BLL); dahn line (DL); and trot line (TL). Data for this fishery is reported on the Catch effort Landing Return (CELR) database only.

Data were accepted if the following constraints were met:

- catch weight was less than 7,000 kg/set
- number of hooks was between 50 and 7, 000 per set
- CPUE (kg/hook) was less than 10 kg
- number of sets was less than 10 per day

The data were examined and outliers were altered if the cause of the anomaly was apparent, or the observation was deleted. The number of hooks and the number of sets were transposed on a considerable number of records.

Statistical area was used as a proxy for fishing ground, as the CELR data contains this location data only. Raw CPUE (kg/set) was tabulated by statistical area. Effort was reported as the number of sets per day, and the number of hooks per day. This latter variable was treated as a categorical variable with four classes (1–799 hooks = category 1; 800–1499 hooks = category 2; 1500–1999 hooks = category 3; 2000–9000 hooks = category 4).

Variables

Variables used in the analysis were: vessel identifier; hook category; fishing year; month; statistical area; number of sets; method; vessel length; vessel breadth; vessel draught; vessel tonnage; year of construction (year built); and vessel volume (length*breadth*draught).

Models

Lognormal linear (LNL) model. A stepwise procedure similar to that used by Doonan (1991) was used to calculate LNL main effect models for estimators of kg/set and kg/hook. It is usual to apply a log transformation of catch effort data (I. Doonan, *pers. comm* 1999), and a small constant (c) was added to the data to avoid having to evaluate the log of zero. As the loglinear regression may be sensitive to the value of this constant, a sensitivity analysis was completed on the main effect model for each estimator.

The stepwise procedure of Proc GLM (SAS 1989) was used to calculate the LNL model and was continued until less than 1% improvement was seen in the value of the coefficient of variation (R^2). If the fishing year variable did not enter the model, then this was forcibly added, to allow annual indices to be determined. The fishing year indices were used to derive annual CPUE indices.

Loglinear interaction effects. As there are several alternative methods for analysis and interpretation of the fishing year*statistical area interaction term, statistical advice was received on the best approach to take (I. Doonan, NIWA, *pers. comm* 1999). It was agreed that the method used should be consistent with the stepwise approach taken with the main effect model, and should focus on the variables that entered the main effect model.

The model was re-evaluated to review the first order interaction terms for these variables. The variables were added to the model in the order that they entered the main effect model, using the stepwise procedure of Proc GLM, as described above.

For each variable that entered the model, the first order interaction terms were added to the full model until the additional variable or interaction explained less than 1% of the variation in the data.

Combined model. Where the data are highly skewed, typically as a result of a high number of zero catch records, the data are unlikely to comply with the model assumptions of normality and heterogeneity of variance (Snedecor & Cochran 1980). In such cases a log transformation may be insufficient, and the combined model (Vignaux 1994) may be more appropriate than the loglinear model. This method analyses fishing success separately, using a binomial model, then the successful catch data are examined using a loglinear model. The indices from the two parts of the model are then combined using the method described in Vignaux (1994). Statistical advice (I. Doonan, *pers. comm* 1999) indicated that use of the extended model is appropriate if more than 10% of the data represented zero catch records.

The number of zero catch records is very low in this target line fishery (Table 1), reaching a maximum of 5% of the data during 1993–94. This is less than the 10% threshold, and the combined model was not required in the data analysis. The percentage of zero catch does not seem to be related to trends in either the kg/set or kg/hook CPUE data (Figure 2).

10. RESULTS

Examination of raw CPUE

Fishing effort is unevenly distributed between statistical areas and fishing years (Appendix 1), and between fishing years and fishing methods (Appendix 2). Insufficient data are available to separately analyse trends in the dahn line (DL) and trot line (TL) data. Many statistical areas have been lightly fished and data were excluded from further analysis where fewer than 5 sets occurred per fishing year. Area 201 (*see* Figure 1) was also excluded as data from this area are available only for the 1990–91 and 1992–93 fishing years.

As only 10 years of CPUE data are available in this fishery, firm trends are difficult to determine. Raw CPUE for both kg/set and for kg/hook (Figure 2) appears to have increased from 1988–89 to 1990–91, remained relatively stable from 1991–92 to 1996–97, then declined in 1997–98.

Although CPUE (kg/set) by statistical area (Figure 3) follows this general trend, catch rate varies between statistical areas. In areas 11–14, CPUE increased from 1988–89 to 1993–94, with the highest rates of increase in area 13 and 14. CPUE in area 13 continued to increase until 1996–97, then declined to a similar level to that of areas 11 and 12 during 1997–98. For the southern areas (15 & 16), CPUE is much lower and variable, with a slightly increasing trend in area 15 and a decreasing trend in area 15.

The CPUE (kg/hook) data by area (Figure 4) are also consistent with these general trends, although the data appears to be more variable. This variability may be related in part to changes in fishing gear, within statistical areas (see Appendix 2).

Loglinear modelling

Loglinear (LNL) model

CPUE (kg/set) For the main effects model (Table 2), variables vessel ID and hook category entered the model, which explained 49% of the variation. The sensitivity analysis indicated that the model is not sensitive to levels of the constant (c) used in the analysis. The forcible addition of fishing year to the model to derive annual indices explained a further 0.9% of the variation. Trends in the main effect model indices are generally consistent with the trends previously described for raw CPUE (Figure 5).

For the CPUE (kg/set) estimator, addition of the vessel ID*hook category interaction (Table 2) to the full model explained 52% of the variability in the data. The forcible addition of fishing year into the model to derive annual indices explained a further 0.7% of the variability. The full model indices (Figure 5) are similar to the main effect model indices, although the s.e.'s are higher for the full model (Table 2).

CPUE (kg/hook) The variables vessel ID, hook category, number of sets, month and fishing year entered the main effects model (Table 3), and explained 28% of the variation in the data. Annual indices from the main effects model (Figure 6) show little contrast between fishing years. The sensitivity analysis indicated that the model is not sensitive to levels of the constant (c) used in the analysis.

From Table 3, the variables vessel ID, hook category, vessel ID*hook category, fishing year, vessel ID*fishing year and hook category*fishing year entered the full model, and together explained 47% of the variability in the data. Complex interactions occur between vessels and the amount of gear fished (number of hooks, number of sets), and these interactions differ between fishing years. Because the first order interactions between fishing year*vessel ID and fishing year*hook category entered the model, a single annual index may be inappropriate for the full model. As the annual indices of CPUE (kg/hook) may not adequately describe the variability within the data, these indices should be interpreted with caution.

11. DISCUSSION

Raw CPUE (kg/set) from the bluenose target line fishery appears to have increased from 1988–89 to 1990–91, remained generally stable until 1996–97, then declined slightly during 1997–98. Trends in raw CPUE (kg/hook) are consistent with these patterns, but the data are more variable. The data are too sparse to allow separate analysis of trends by fishing method. The percentage of zero catch records in this target fishery does not exceed the 10% threshold suggested for use of the combined model of Vignaux (1994) and CPUE analysis was confined to the loglinear model of Doonan (1991).

From the loglinear analysis of CPUE (kg/set), categorical variables vessel ID and hook category explained 49% of variability in the main effects model, and fishing year was added to derive annual indices. The full model which included the vessel ID*hook category interaction term explained 52% of the variation in the data. The

fishing year and statistical area terms and their interactions did not enter either model, which suggests that the data are adequately described by a single CPUE series. The standard errors are lower for the main effect model indices, and this model may be more appropriate for further analysis of trends in standardised CPUE.

The categorical vessel and gear variables explain a relatively large amount of the variability in the data, and annual indices are broadly consistent with the trends described for raw CPUE. Although the standardised CPUE series is higher than the raw CPUE prior to 1990–91, the *s.e.*s are also high, reflecting the low numbers of observations in the database for this period. It is suggested that subsequent modelling be confined to data from the 1991–92 to 1997–98 fishing years.

The main effects model for the CPUE (kg/hook) data explains only 28% of the variability and the model indices show little contrast between fishing years. The full model however, explains 47% of the variability in the data, and the first order interactions between vessels, fishing years and gear fished are complex. While fishing method and statistical area did not enter either the main effect or the full model, the CPUE (kg/hook) appears to be more sensitive to changes in the amount of gear fished between vessels, months and fishing years than the index of CPUE (kg/set).

12. ACKNOWLEDGEMENTS

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13. REFERENCES

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Table 1: Numbers of zero catches of bluenose in the target BNS 2 line fishery, in statistical areas 11 to 16, from 1988–89 to 1997–98

Fishing year	Number of observations	Statistical area							
		11	12	13	14	15	16	Total	Percent
1988–89	10	0	0	0	0	0	0	0	0.000
1989–90	54	0	0	0	0	0	1	1	0.019
1990–91	293	0	3	2	1	0	0	6	0.020
1991–92	350	1	1	0	0	0	0	2	0.006
1992–93	281	2	1	0	1	0	1	5	0.018
1993–94	259	1	3	0	0	9	0	13	0.050
1994–95	287	0	1	1	3	4	4	13	0.045
1995–96	185	0	0	0	0	1	1	2	0.011
1996–97	158	0	1	0	0	0	1	2	0.013
1997–98	228	0	1	1	0	0	0	2	0.009

Table 2: BNS 2 target line fishery. Loglinear (LNL) analysis of CPUE (Ln (kg/set+1)) 1988–89 to 1997–98

Values of R^2 in bold indicate the variable entered the model

Main effects model

Iteration	R^2 at iteration				
Variable	1	2	3	4	5
Vessel ID	**0.469**				
Hook category	0.262	**0.488**			
Fishing year	0.022	0.478	**0.497**		
Number of sets	0.130	0.470	0.490	0.498	
Month	0.017	0.475	0.495	0.497	0.505
Statistical area	0.325	0.470	0.489	0.498	0.499
Year built	0.288	0.469	0.488	0.496	0.498
Method	0.269	0.470	0.489	0.497	0.499
Length	0.110	0.469	0.488	0.497	0.498
Draught	0.101	0.469	0.488	0.497	0.498
Breadth	0.084	0.469	0.480	0.497	0.498
L*B*D	0.042	0.469	0.488	0.497	0.498
Tonnage	0.041	0.469	0.488	0.497	0.498
% increase in R^2	46.90	1.90	0.90	0.1	0.78

Model Log (Kg/set+1)= Vessel ID, hook category, fishing year
Note: Variable fishing was year forced into the model to derive annual indices.

Sensitivity analysis on the main effects model

Log ((kg/set)+c)

Level of c	R^2
0.01	0.448
1	0.497
10	0.518

Table 2: *–continued*

Full model

Iteration	R^2 at iteration			
Variable	1	2	3	4
Vessel ID	0.469			
Hook category	0.262	**0.488**		
Vessel ID*hook category			**0.521**	
Fishing year	0.022			**0.528**
Number of sets	0.130			0.521
Month	0.017			0.526
Statistical area	0.325			0.522
% increase in R^2	46.90	1.90	3.30	0.70

Model Log (Kg/set+1) = Vessel ID, hook category, vessel ID*hook category, fishing year
Note: Variable fishing was year forced into the model to derive annual indices.

Fishing year indices

Fishing year	Main effect model		Full model	
	indices	*s.e.*	indices	*s.e.*
1988–89	0.852	1.533	0.985	1.525
1989–90	0.758	1.250	0.904	1.246
1990–91	0.799	1.150	0.863	1.159
1991–92	0.961	1.131	1.053	1.137
1992–93	1.010	1.135	1.200	1.142
1993–94	0.907	1.139	0.959	1.145
1994–95	0.629	1.135	0.709	1.141
1995–96	0.938	1.145	1.087	1.153
1996–97	1.195	1.145	1.314	1.155
1997–98	1.000		1.000	

Table 3: BNS 2 target line fishery. Loglinear (LNL) analysis of CPUE (Ln (kg/hook+1)) 1988–89 to 1997–98

Values of R^2 in bold indicate the variable entered the model

Main effects model

	R^2 at iteration					
	1	2	3	4	5	6
Iteration						
Vessel ID	**0.205**					
Hook category	0.017	**0.239**				
Number of sets	0.008	0.218	**0.254**			
Month	0.011	0.220	0.251	**0.266**		
Fishing year	0.025	0.215	0.249	0.264	**0.277**	
Method	0.061	0.208	0.240	0.256	0.270	0.281
Statistical area	0.121	0.207	0.240	0.255	0.268	0.278
Year built	0.062	0.205	0.239	0.254	0.266	0.277
Draught	0.051	0.210	0.242	0.257	0.268	0.277
Length	0.034	0.205	0.239	0.254	0.266	0.277
L*B*D	0.023	0.205	0.239	0.254	0.266	0.277
Breadth	0.022	0.205	0.239	0.254	0.266	0.277
Tonnage	0.021	0.205	0.239	0.254	0.266	0.277
% increase in R^2	20.50	3.40	1.50	1.20	1.10	0.40

Model Ln(CPUE+1)= Vessel ID, hook category, number of sets, month, fishing year

Table 3: – *continued*

Sensitivity analysis on the main effects model

Log ((kg/set)+c)	Level of c	R^2
	0.01	0.278
	1	0.277
	10	0.245

Full model							R^2 at iteration
Iteration	1	2	3	4	5	6	7
Vessel ID	**0.205**						
Hook category	0.017	**0.239**					
Vessel ID*hook category			**0.322**				
Fishing year	0.025	0.215		**0.332**			
Vessel ID*fishing year					**0.439**		
Hook category*fishing year					0.358	**0.468**	
Number of sets	0.08	0.218		0.331			0.470
Month	0.011	0.220		0.331			0.468
Method	0.061	0.208		0.322			0.465
Statistical area	0.121	0.207		0.324			0.469
% increase in R^2	20.50	3.40	8.30	1.00	10.70	2.50	0.20

Model Log (kg/hook+1) = Vessel ID, hook category, vessel ID*hook category, fishing year, vessel ID*fishing year, hook category*fishing year

Fishing year indices

Fishing year	Main effect model indices	s.e.
1988–89	0.918	1.122
1989–90	0.897	1.061
1990–91	0.974	1.038
1991–92	1.031	1.034
1992–93	1.017	1.034
1993–94	1.026	1.035
1994–95	0.933	1.034
1995–96	0.965	1.036
1996–97	1.072	1.038
1997–98	1.000	

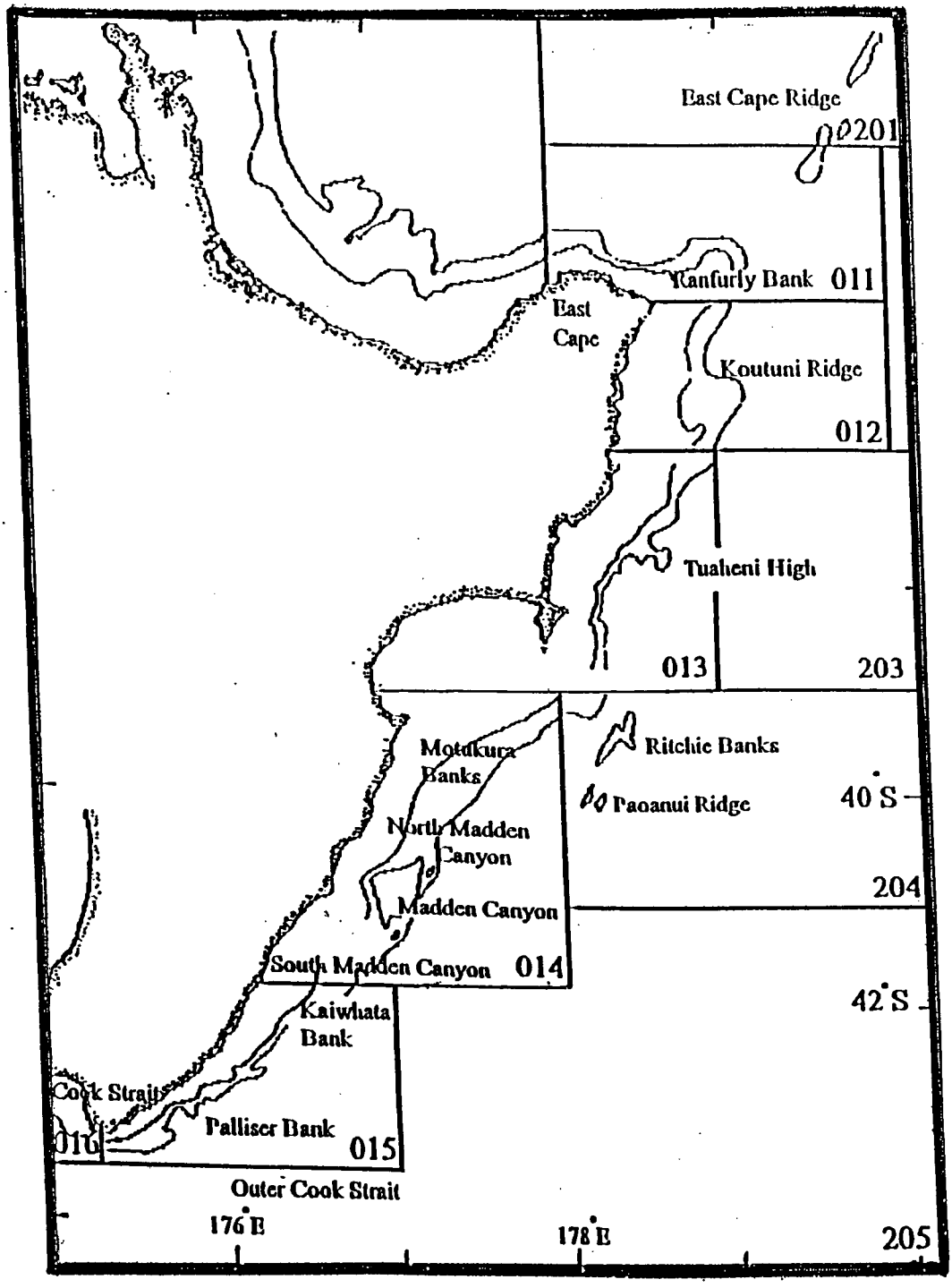

Figure 1: The area covered by the bluenose fishery in QMA 2 showing inshore (011–016) and deepwater (201–205) statistical reporting areas. Major fishing grounds are also shown.

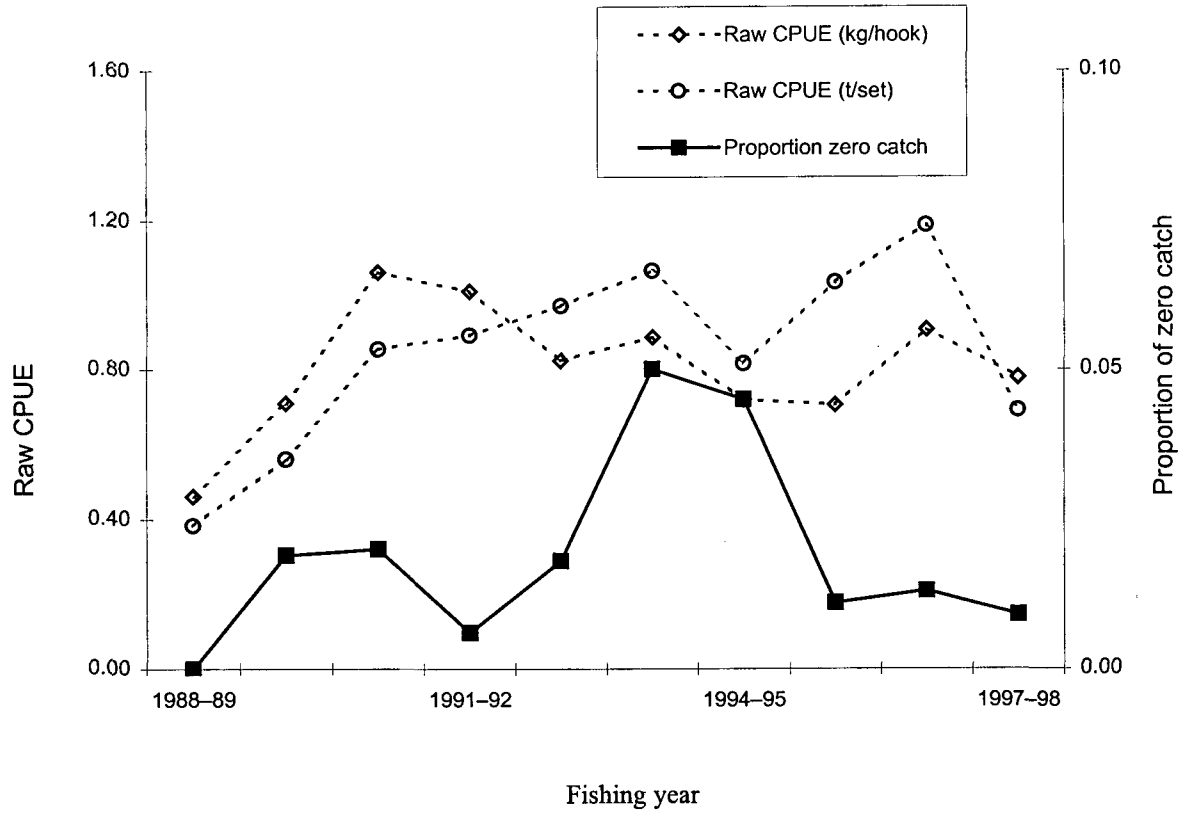

Figure 2: Bluenose target line fishery: Raw CPUE and proportion of zero catch 1988–89 to 1997–98

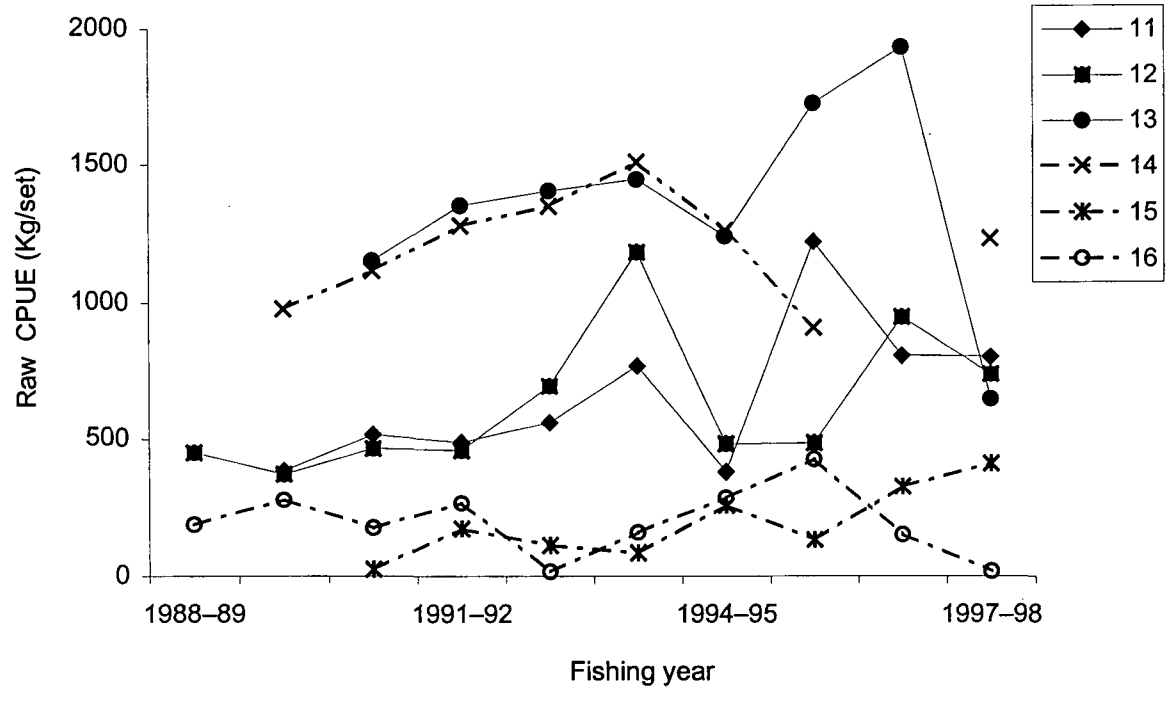

Figure 3: BNS 2 target line fishery Mean CPUE (kg/set) in statistical areas 11-16, All line methods, where number of sets ≥ 5

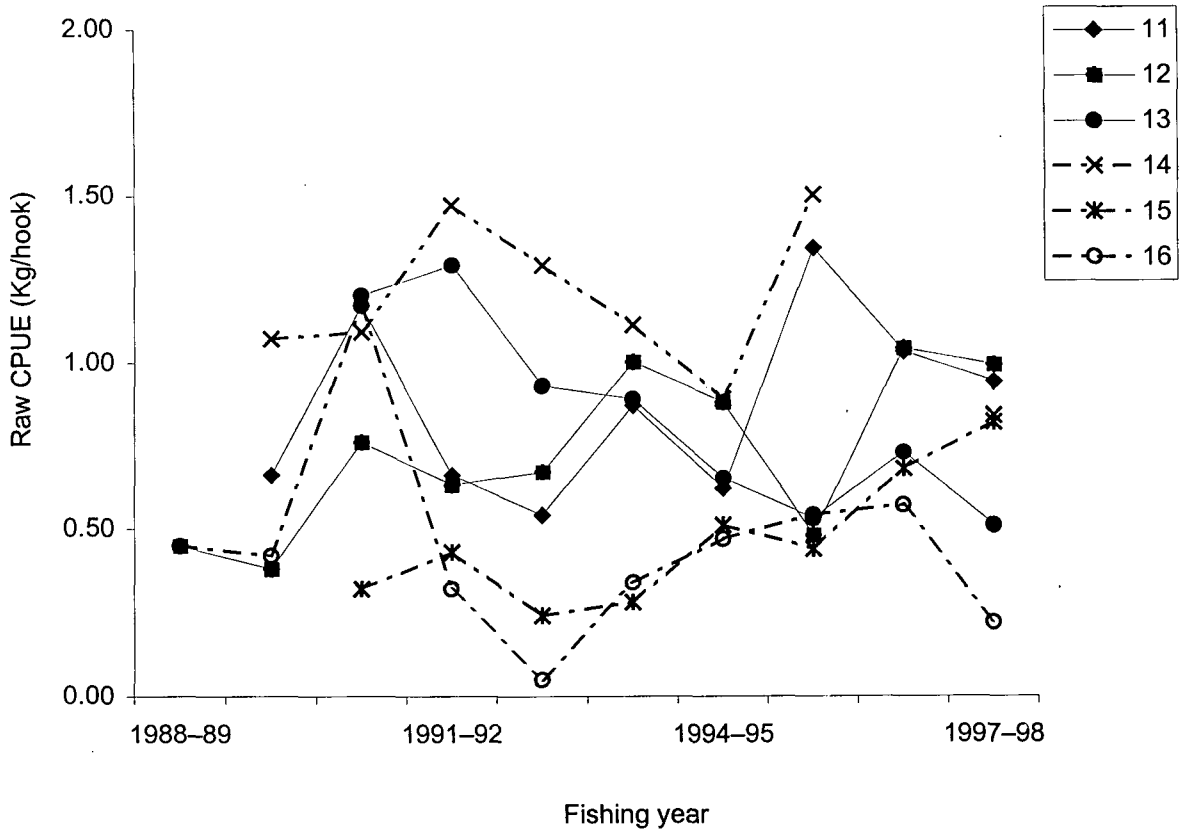

Figure 4: BNS 2 target line fishery Mean CPUE (kg/hook) in statistical areas 11-16, All line methods, where number of sets ≥ 5

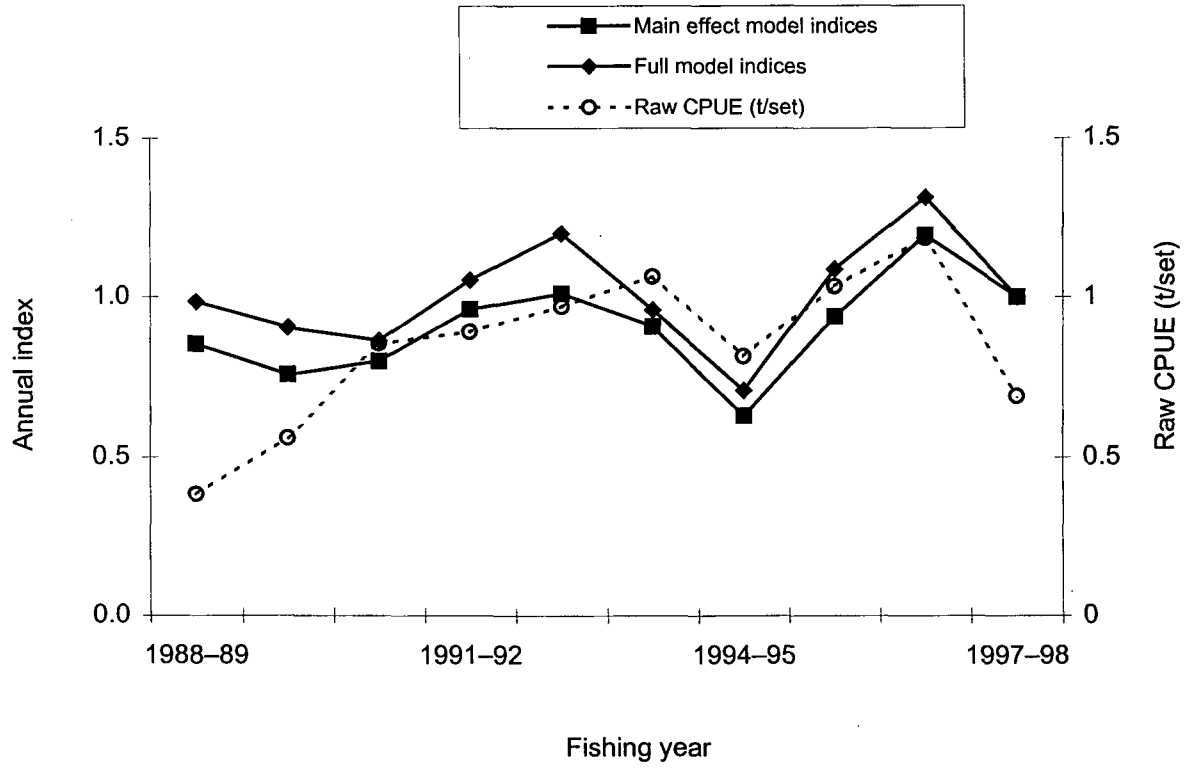

Figure 5: Target bluenose line fishery: Standardised CPUE indices (kg/set) from the LNL main effect model and raw CPUE (t/set) 1988–89 to 1997–98

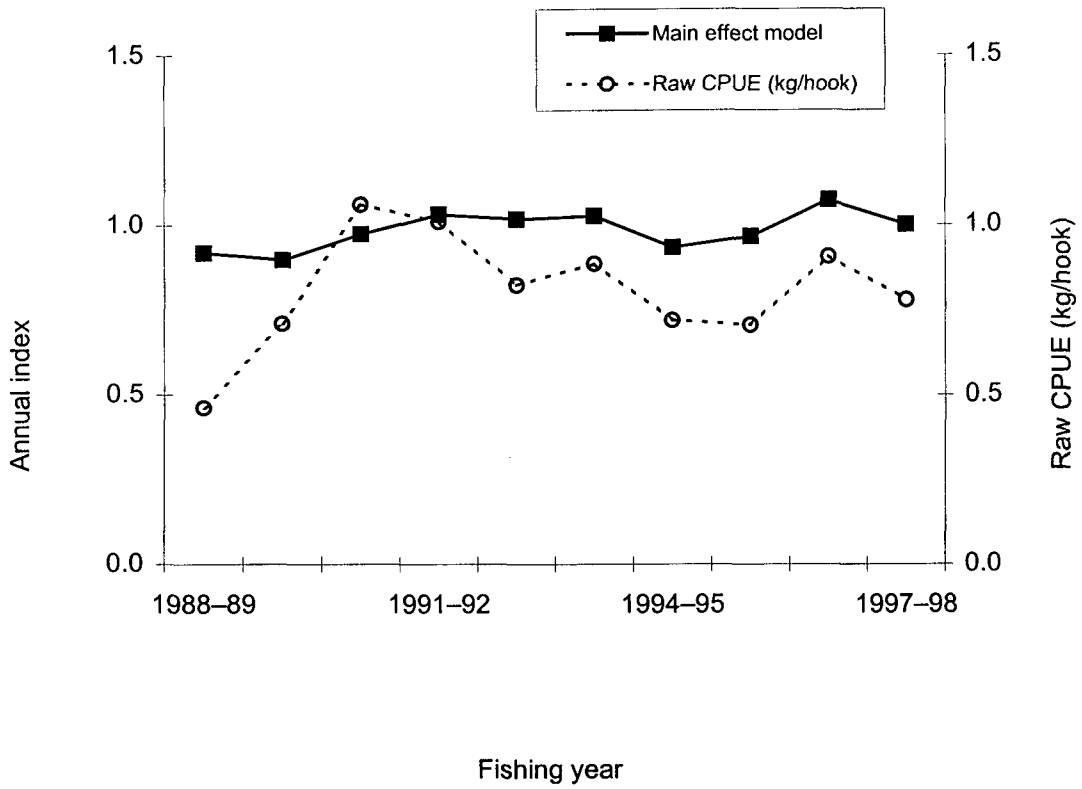

Figure 6: Target bluenose line fishery: Standardised CPUE indices (kg/hook) from the LNL main effect model and raw CPUE (kg/hook) 1988–89 to 1997–98

Appendix 1: BNS 2 target line fishery: Total estimated landings and mean CPUE (kg/set) and CPUE (kg/hook) by statistical area, 1988–89 to 1997–98

Fish year	Stat area	No. records	No. sets	No. hooks	Total estimated BNS (kg)	Mean Kg/set	s.e.	Mean Kg/hook	s.e.
1988–89	11	1	1	1,000	581	581		0.58	0.07
1988–89	12	6	6	6,000	2,706	451	81	0.45	0.07
1988–89	16	3	3	1,600	700	186	157	0.45	0.28
1989–90	11	16	22	13,350	8,070	386	80	0.66	0.16
1989–90	12	7	7	7,200	2,609	373	90	0.38	0.11
1989–90	13	2	2	550	150	75	5	0.29	0.06
1989–90	14	19	19	18,000	18,574	978	107	1.07	0.13
1989–90	16	10	12	6,750	2,842	278	81	0.42	0.09
1990–91	11	38	62	29,733	29,463	517	49	1.17	0.13
1990–91	12	45	57	34,950	25,544	468	63	0.76	0.12
1990–91	13	88	102	92,750	111,750	1,154	95	1.20	0.09
1990–91	14	94	131	120,200	129,230	1,117	75	1.09	0.07
1990–91	15	11	17	1,380	447	25	4	0.32	0.06
1990–91	16	17	20	8,000	5,222	175	43	1.17	0.87
1990–91	201	2	4	1,800	2500	625	75	1.39	0.17
1991–92	11	54	73	54,600	34,735	489	64	0.66	0.09
1991–92	12	77	96	66,830	40,330	460	43	0.63	0.06
1991–92	13	91	98	103,100	128,291	1,354	126	1.29	0.19
1991–92	14	94	140	104,010	144,530	1,282	93	1.47	0.08
1991–92	15	27	75	40,000	18,086	171	43	0.43	0.07
1991–92	16	7	18	12,600	5,326	266	89	0.32	0.08
1992–93	11	33	42	42,200	21,752	561	97	0.54	0.08
1992–93	12	62	68	65,100	44,800	696	74	0.67	0.06
1992–93	13	82	94	145,700	131,929	1,407	127	0.93	0.07
1992–93	14	68	92	90,800	117,252	1,352	114	1.29	0.09
1992–93	15	32	61	25,020	8,791	110	25	0.24	0.04
1992–93	16	4	23	2,850	169	16	9	0.05	0.03
1992–93	201	8	8	7,020	16,450	2,056	261	2.38	0.08
1993–94	11	21	27	26,900	20,635	770	148	0.87	0.20
1993–94	12	51	62	56,844	64,662	1,185	165	1	0.17
1993–94	13	65	71	117,680	97,412	1,448	153	0.89	0.09
1993–94	14	65	118	128,910	135,850	1,511	126	1.11	0.07
1993–94	15	29	69	23,260	10,278	84	24	0.28	0.07
1993–94	16	28	73	17,100	5,398	158	25	0.34	0.04
1994–95	11	6	12	7,750	5,415	383	102	0.62	0.13
1994–95	12	67	99	73,100	39,874	483	87	0.88	0.30
1994–95	13	79	84	138,425	99,592	1,244	135	0.65	0.06
1994–95	14	65	86	107,550	98,230	1,263	109	0.89	0.07
1994–95	15	32	72	34,025	14,309	258	67	0.51	0.11
1994–95	16	38	168	24,020	12,927	287	85	0.47	0.09
1995–96	11	32	45	34,480	42,278	1,224	175	1.34	0.21
1995–96	12	62	75	73,750	33,799	486	56	0.48	0.05
1995–96	13	62	70	181,860	107,996	1,727	222	0.53	0.04
1995–96	14	11	23	16,600	14,805	910	186	1.50	0.71
1995–96	15	9	16	5,450	2,065	131	42	0.44	0.16
1995–96	16	9	9	5,300	3,852	428	26	0.54	0.20
1996–97	11	28	33	30,060	26,179	808	171	1.03	0.22
1996–97	12	70	87	83,095	77,171	948	98	1.04	0.11
1996–97	13	50	50	159,800	96,685	1,934	173	0.73	0.09
1996–97	14	1	2	300	20	10	0	0.07	0.00
1996–97	15	2	5	2,000	1,950	329	304	0.68	0.58
1996–97	16	7	16	3,250	1,300	150	69	0.57	0.33
1997–98	11	34	36	33,720	27389	802.617	134	0.94	0.22
1997–98	12	87	129	101,290	85585	740.402	57	0.99	0.09
1997–98	13	43	59	74,200	37395	648.545	90	0.51	0.07
1997–98	14	29	44	51,200	45300	1233.62	115	0.84	0.08
1997–98	15	5	19	9,500	8120	412.4	55	0.82	0.11
1997–98	16	30	234	16,050	3443	18.01	5	0.22	0.04

			BLL		Total					DL		Total					TL		Total				
		No.	No.	No.	est.	Mean		Mean		No.	No.	est.	Mean		Mean		No.	No.	est.	Mean		Mean	
Fish year	Stat area	records	sets	hooks	BNS (kg)	Kg/set	s.e.	Kg/hook	s.e.	sets	hooks	BNS (kg)	Kg/set	s.e.	Kg/hook	s.e.	sets	hooks	BNS (kg)	Kg/set	s.e.	Kg/hook	s.e.
1988–89	11	1	1	1,000	581	581		0.58	0.07	0							0						
1988–89	12	6	6	6,000	2,706	451	81	0.45	0.07	0							0						
1988–89	16	3								3	1,600	700	186	157	0.45	0.28	0						
1989–90	11	16	22	13,350	8,070	386	80	0.66	0.16	0							0						
1989–90	12	7	7	7,200	2,609	373	90	0.38	0.11	0							0						
1989–90	13	2	0							0							2	550	150	75	5	0.29	0.06
1989–90	14	19	19	18,000	18,574	978	32	1.07	0.13	0							0						
1989–90	16	10	3	1,000	100	33		0.10		9	5,750	2,742	305	85	0.46	0.09	0						
1990–91	11	38	62	29,733	29,463	517	49	1	0.13	0							0						
1990–91	12	45	57	34,950	25,544	468	63	1	0.12	0							0						
1990–91	13	88	98	90,750	110,750	1,165	96	1.21	0.09	0							4	2,000	1,000	250		0.50	
1990–91	14	94	130	119,400	128,230	1,118	76	1.09	0.07	0							1	800	1,000	1,000		1.25	
1990–91	15	11	0							17	1,380	447	25	4	0.32	0.06	0						
1990–91	16	17	0							16	7,800	2,222	139	26	0.30	0.07	4	200	3,000	750		15.00	
1990–91	201	2	4	1,800	2500	625	75	1.39	0.17	0							0						
1991–92	11	54	73	54,600	34,735	489	64	0.66	0.09	0							0						
1991–92	12	77	96	66,830	40,330	460	43	0.63	0.06	0							0						
1991–92	13	91	98	103,110	128,291	1,354	126	1.29	0.19	0							0						
1991–92	14	94	140	104,010	144,530	1,282	93	1.47	0.08	0							0						
1991–92	15	27	57	36,500	14,470	244	60	0.36	0.07	17	1,500	616	37	7	0.42	0.08	1	2,000	3,000	750		1.50	
1991–92	16	7	15	10,000	4,605	284	158	0.37	0.14	3	2,600	721	240	70	0.26	0.05	0						
1992–93	11	33	42	42,200	21,752	561	97	0.54	0.08	0							0						
1992–93	12	62	64	64,950	44,680	707	74	0.67	0.06	4	150	120	30	0	0.80	0.00	0						
1992–93	13	82	94	145,700	131,928	1,407	127	0.93	0.07	0							0						
1992–93	14	68	90	89,800	116,945	1,370	114	1.30	0.09	0							2	1,000	307	154	0	0.31	0.00
1992–93	15	32	36	21,340	8,210	632	142	0.37	0.06	25	3,680	581	26	6	0.16	0.03	0						
1992–93	16	4	4	2,000	130	33	0	0.07	0.00	19	850	39	10	10	0.05	0.04	0						
1992–93	201	8	0							8	7,020	16,450	2,056	261	2.38	0.08	0						

Appendix 2: BNS 2 target line fishery: Total estimated landings, CPUE (kg/set) and CPUE (kg/hook) by fishing method (BLL=bottom longline, DL= dahn line, TL= trot line) and statistical area 1988–89 to 1997–98

			BLL		Total					DL		Total					TL		Total				
		No.	No.	No.	est.	Mean		Mean		No.	No.	est.	Mean		Mean		No.	No.	est.	Mean		Mean	
Fish year	Stat area	records	sets	hooks	BNS (kg)	Kg/set	s.e.	Kg/hook	s.e.	sets	hooks	BNS (kg)	Kg/set	s.e.	Kg/hook	s.e.	sets	hooks	BNS (kg)	Kg/set	s.e.	Kg/hook	s.e.
1993–94	11	21	27	26,900	20,635	770	148	0.87	0.20	0							0						
1993–94	12	51	62	56,844	64,662	1,185	165	1	0.17	0							0						
1993–94	13	65	63	116,000	92,812	1,505	161	0.76	0.07	8	1,680	4,600	575	25	2.74	0.12	0						
1993–94	14	65	118	128,910	135,850	1,511	126	1.11	0.07	0							0						
1993–94	15	29	36	18,400	9,713	237	47	0.64	0.15	33	4,860	565	16	5	0.11	0.04	0						
1993–94	16	28	3	2,200	230	90	40	0.35	0.30	70	14,900	5,168	164	27	0.34	0.05	0						
1994–95	11	6	11	7,550	5,265	429	111	0.60	0.16	1	200	150	150	0	0.75	0.00	0						
1994–95	12	67	99	73,100	39,874	483	87	0.88	0.30	0							0						
1994–95	13	79	83	138,050	99,492	1,259	136	0.65	0.06	0							1	375	100	100	0	0.27	0.00
1994–95	14	65	86	107,550	98,230	1,263	109	0.89	0.07	0							0						
1994–95	15	32	33	28,000	8,080	251	49	0.38	0.10	39	6,025	6,299	261	99	0.58	0.15	0						
1994–95	16	38	8	6,900	2,700	338	206	0.27	0.10	159	16,120	10,107	278	98	0.54	0.11	1	1,000	120	120	0	0.12	0.00
1995–96	11	32	33	33,480	41,278	1,261	177	1.35	0.21	12	1,000	1,000	83	0	1.00	0.00	0						
1995–96	12	62	75	73,750	33,799	486	56	0.48	0.05	0							0						
1995–96	13	62	70	181,860	107,996	1,727	222	0.53	0.04	0							0						
1995–96	14	11	23	16,600	14,805	910	186	1.50	0.71	0							0						
1995–96	15	9	12	5,000	1,740	171	47	0.41	0.12	4	450	325	81	73	0.46	0.35	0						
1995–96	16	9	0							9	5,300	3,852	428	261	0.54	0.20	0						
1996–97	11	28	33	30,060	26,179	808	171	1.03	0.22	0							0						
1996–97	12	70	87	83,095	77,171	948	98	1.04	0.11	0							0						
1996–97	13	50	50	159,800	96,685	1,934	173	0.73	0.09	0							0						
1996–97	14	1	0							2	300	20	10	0	0.07	0.00	0						
1996–97	15	2	5	2,000	1,950	329	304	0.68	0.58	0							0						
1996–97	16	7	1	350	0	0	0	0.00	0.00	15	2,900	1,300	175	76	0.66	0.38	0						
1996–97	Other	1	9	11,700	6,487	721	320	0	0.05	0							0						
1997–98	11	34	36	33,720	27369	802.617	134	0.94	0.22	0							0						
1997–98	12	87	129	101,290	85585	740.402	57	0.99	0.09	0							0						
1997–98	13	43	59	74,200	37395	648.545	90	0.51	0.07	0							0						
1997–98	14	29	44	51,200	45300	1233.62	115	0.92	0.07	0							0						
1997–98	15	5	19	9,500	8120	412.4	55	0.82	0.11	0							0						
1997–98	16	30	1	600	150	150	0	0.25	0.00	233	15,450	3293	13.46	2	0.22	0.04	0						
1997–98	Other	15	15	65,000	42992	2866.13	361	0.65	0.06	0							0						

Appendix 2:– ***continued***