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Comparison of catch efficiencies for King and Queen Scallops between the RV 'Prince Madog' and the commercial trawler 'Genesis'

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INTRODUCTION

To investigate if the Research Vessel Prince Madog could be used for future stock assessments instead of local fishing vessels a ship comparison trial was undertaken in October 2008.

In the past various relatively small research and commercial fishing vessels have been used for stock assessment work. As the Prince Madog is considerably larger in size, concerns existed that the Prince Madog could potentially exhibit significantly different catch efficiencies. These, if not quantified, could lead to a bias in stock assessment data. Similar ship comparison trials have been carried out by CEFAS in the English Channel to ensure commercial catches and catches made by research vessels can be compared (Dare et al. 1994).

There are several advantages to using a research vessel over commercial fishing boats. The Prince Madog has space for 10 scientists and can work 12 hour days without having to return to port in the evening, increasing not only the speed and number of stations (fishing grounds) which can be visited during a working day. The provision of additional personnel makes it possible to take additional biological samples which maximizes the amount and quality of data obtained. In addition, using a different fishing vessel for each survey makes direct comparison between surveys questionable due to 'ship' effects between different fishing vessels which cannot be quantified.

METHODS

Sampling procedures

For this ship comparison trial the 35 m purpose built RV Prince Madog and the 15 m commercial scallop trawler 'Genesis' were used (Fig 1). Trawling trials were undertaken at 5 different trawling grounds, East of Douglas, Laxey Bay, Maughold, Ramsey and Point of Ayre. At each ground three trawls were taken with vessels fishing in alternating order following approximately the same trawl lines but offset by c. 100m. Each vessel fished with one tow bar from its stern, equipped with 2 Newhaven Pecten (PD) and 2 Queen dredges (QD) in alternating order.

Catches onboard the Genesis were sorted and measured by 2 - 3 scientists kneeling on deck, while 8 scientists sorted and measured catches standing at sorting tables. To determine size frequencies of King

and Queen Scallops between c. 40 individuals of each species were measured from each dredge in each tow. Size frequencies were analyzed by fishing ground, pooling individual dredge and tow data.

Statistical analysis

To determine differences between the catch efficiencies of the two vessels, abundances of Queen and King scallops were compared by a two-way factorial ANOVA (GLM). The fixed factors were vessel (1,2) and the 5 fishing grounds (1, 2, 3, 4, 5). Three replicate samples (tows) were taken at each fishing ground. Data was Log transformed prior to analysis.

Catches made with the two gear types used, Pecten dredges (PD) and Queen dredge (QD) were analyzed separately.

Size frequency distributions of scallops caught by the two vessels with the appropriate dredge were compared by Chi-square analysis. The degrees of freedom (d.f.), number of categories, was determined by the range of sizes encountered on both vessels. Thus, the degrees of freedom varied between the different grounds and gears.



Fig 1 The commercial scallop trawler Genesis a) with scientific personnel onboard. b) Scallop dredges being recovered on the RV. Prince Madog.

RESULTS

King Scallops - Pecten dredges

Overall, there was no significant difference in King scallop catches between the two vessels (see ANOVA results, appendix Table 1). On average Prince Madog caught **1.14** S.D. ± 0.33 and Genesis **1.17** S.D. ± 0.49 individuals per 100 m². However, catches of King scallops did vary between grounds and vessels (Fig 2 and appendix Table 1). Post-Hoc multiple comparisons showed that Prince Madog caught significantly more King scallops than Genesis at East Douglas (**1.31** S.D. ± 0.45 versus **0.66** S.D. ± 0.09 individuals per 100 m²) and significantly less at Ramsey (**1.06** S.D. ± 0.10 versus **1.51** S.D. ± 0.21 individuals per 100 m²).

A summary of mean catches of both vessels for the different grounds and gears can be found in the Appendix Table 5)

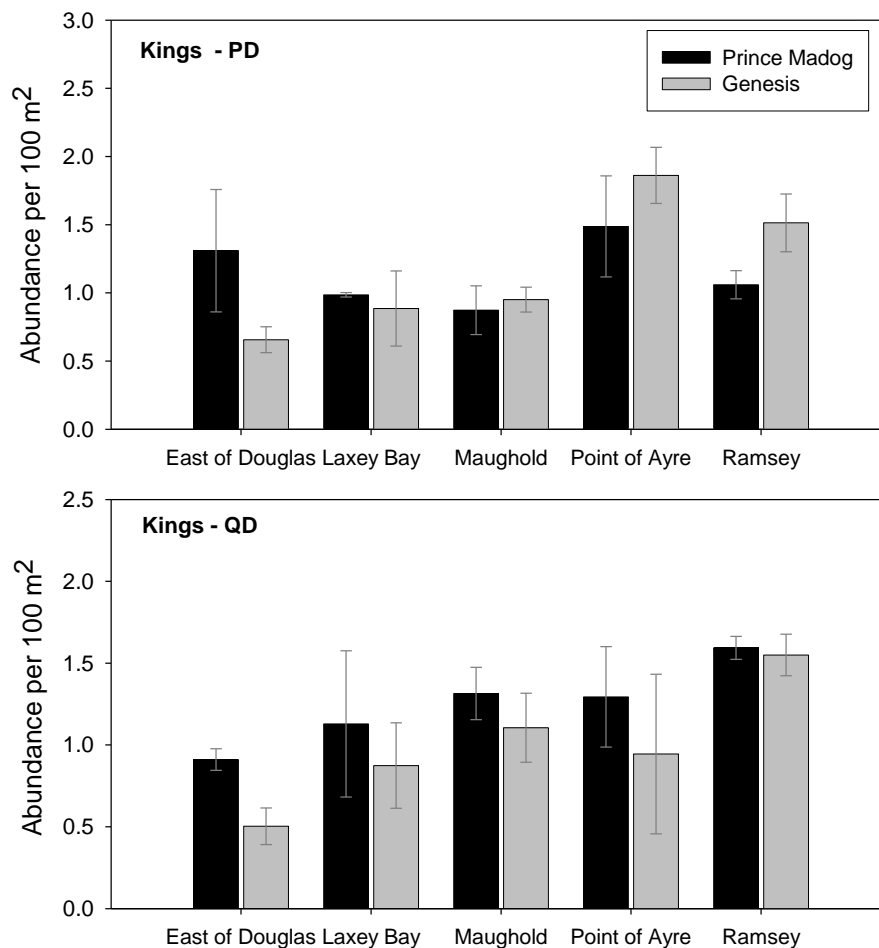


Fig 2 King scallop catches of RV Prince Madog and Genesis from five different fishing grounds made with different gears [Pecten dredges (PD), Queen dredges (QD)].

King Scallops - Queen dredges

A significant effect of vessel used was detected for King Scallop catches made with Queen dredges (see ANOVA results, appendix Table 2, Fig 2). Prince Madog consistently had higher catches than Genesis (**1.25** S.D. \pm 0.32 versus **1.00** S.D. \pm 0.42 individuals per 100 m²). Post-Hoc analysis showed that significant differences between vessels were apparent among fishing grounds but only at East of Douglas (Prince Madog **0.91** S.D. \pm 0.07 and Genesis **0.50** S.D. \pm 0.11 individuals per 100 m²)

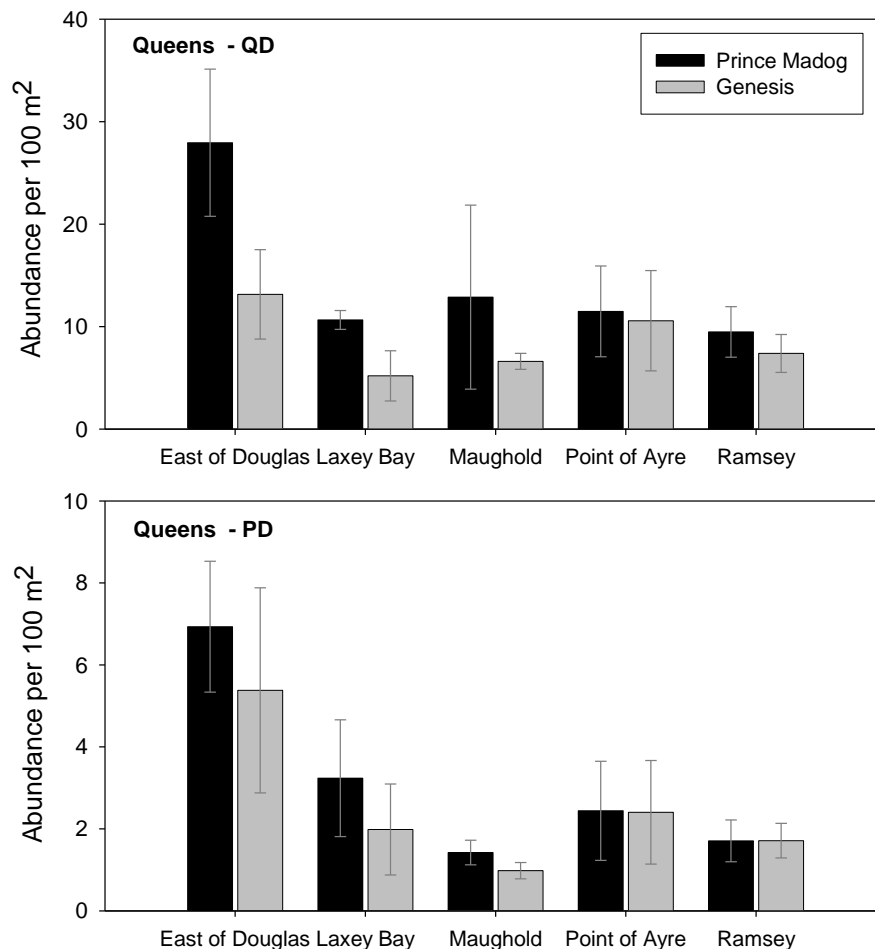


Fig 3 Queen scallop catches of RV Prince Madog and Genesis from five different fishing grounds made with different gears [Queen dredges (QD), Pecten dredges (PD)].

Queen Scallops - Pecten dredges

Overall, no difference in the number of Queen scallops caught by Pecten dredges was detected (see ANOVA results, appendix Table 4, Fig 3). Prince Madog caught on average **3.15** S.D. \pm 2.27 and Genesis **2.49** S.D. \pm

1.95 individuals per 100 m². Similarly, no significant differences were detected among fishing grounds.

Queen Scallops - Queen dredges

A significant difference in the Queen scallop catches made with Queen dredges was detected for the two vessels (see ANOVA results appendix Table 3, Fig 4). Prince Madog on average caught **14.48** S.D. ± 8.51 individuals per 100 m² while Genesis caught **8.58** S.D. ± 4.06 individuals per 100 m². Prince Madog catches were consistently higher at all 5 sites and the post-hoc analysis showed that significant differences existed for East of Douglas and Laxey Bay.

Correction factor

The significant differences in Queen scallop catches between the Prince Madog and the commercial trawler Genesis made with Queen dredges indicated that abundance estimates will need to be adjusted for this species if the Prince Madog is going to be used as the main survey vessel in future stock assessments.

To calculate a correction factor we used the vessel effect calculated from the following GLM model. Model and procedures were adapted from Dare et al. (1994).

Model

$$\ln(\text{catches}_{sv}) = V_v + S_s + \text{error}_{sv}$$

V_v is the effect of the vessel

S_s is the effect of the site (fishing ground)

The model was scaled so that $e^{V_{\text{Genesis}}} = 1$; that is $V_{\text{Genesis}} = 0$

The effect of the $e^{\text{Prince Madog}} = 0.481 \pm 0.167$

$$\ln(\text{catch}_{\text{Prince Madog}}) = \ln(\text{catch}_{\text{Genesis}}) + 0.481$$

By taking the antilog

$$\begin{aligned} \text{catch}(\text{Prince Madog}) &= e^{0.481} \times \text{catch}_{\text{Genesis}} \\ &= 1.617 \times \text{catch}_{\text{Genesis}} \end{aligned}$$

Thus to allow comparability of Prince Madog and past commercial catches the historic data needs to be raised by a factor of 1.6.

Size frequencies

Size frequencies of King and Queen Scallops in general did not differ between the two vessels. Only in two instances were Chi-square values statistically significant (<0.05) i.e. King scallops caught with Pecten Dredges (PD) near Ramsey and Queen Scallops (PD) caught in Laxey Bay (Table 1, Appendix Fig. 1-4). In both instances Chi-Square values were high because one 2.5 mm size class was absent in the Prince Madog data.

Table 1 Chi-square analysis comparing the size frequency distribution of Scallops caught by Prince Madog and Genesis

	Kings - PD		Kings - QD		Queens - PD		Queens - QD	
	Chi-square	df	Chi-square	df	Chi-square	df	Chi-square	df
East Douglas	20.0	36	42.4	34	9.0	30	12.8	23
Laxey	15.0	32	36.0	35	36.6**	19	16.1	21
Maughold	26.2	34	8.2	52	5.5	22	17.1	27
Point of Ayre	12.7	50	9.5	46	17.5	22	11.7	24
Ramsey	69.6***	33	14.7	37	13.4	29	7.5	22

CONCLUSION

The analysis showed that catches made with the Queen Scallop dredges for both Queen and King scallops differed significantly between commercial and research vessel. Despite these apparent differences in vessel performance we assume that these differences were unrelated to the catch efficiencies of the vessels used, but were linked to a more thorough sorting procedures onboard the Prince Madog. Most likely many of the smaller Queen and King scallops within Queen dredge catches were overlooked by personal working on Genesis due to a limit in personal, space and time, leading to a relatively consistent underreporting of abundances in the data.

If the Prince Madog were to be used in future surveys this bias would need to be considered within future stock assessments by adjusting historic records. Queen scallop estimates of the past would need to be raised by a factor of 1.6 following the results of this study.

The main concern that catch efficiencies of the Prince Madog would be lower compared to a commercial vessel could not be verified by this study. It can be concluded that the Prince Madog will be a suitable vessel

for stock assessment and that the bias introduced due to differences in sorting efficiency can be addressed.

RECOMMENDATIONS

Following this study we recommend that the RV Prince Madog should be used for future stock assessment work as there was little evidence of a significant vessel effect. Differences detected, with a high probability, were related to more precise measurements being taken by the scientists working on the Prince Madog, a reflection of the more appropriate facilities for this type of work on a research vessel and greater precision of processing material on-board.

Conducting stock assessments from the same vessel in the future should allow for the collection of more consistent and higher quality data. In the past various vessels have been used for stock assessments which inevitably will have introduced additional variability into past data.

BIBLIOGRAPHY

Dare PJ, Palmer DW, Howell ML, Darby CD (1994) Experiments to assess the relative dredging performances of research and commercial vessels for estimating the abundance of scallops (*Pecten maximus*) in the western English Channel fishery. MAFF Fisheries Research Technical Report 96, 9 pp.

Table 1 Results of the two-way factorial ANOVA for King Scallops caught with a Pecten Dredge (PD)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.694(a)	9	.299	6.490	.000
Intercept	.228	1	.228	4.953	.038
Ship	.003	1	.003	.071	.793
Site	1.736	4	.434	9.409	.000
Ship * Site	.955	4	.239	5.175	.005
Error	.923	20	.046		
Total	3.845	30			
Corrected Total	3.617	29			

a R Squared = .745 (Adjusted R Squared = .630)

Table 2 Results of the two-way factorial ANOVA for King Scallops caught with a Queen Dredge (QD)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.262(a)	9	.362	4.667	.002
Intercept	.057	1	.057	.739	.400
Ship	.638	1	.638	8.209	.010
Site	2.329	4	.582	7.497	.001
Ship * Site	.296	4	.074	.951	.455
Error	1.553	20	.078		
Total	4.873	30			
Corrected Total	4.816	29			

a R Squared = .677 (Adjusted R Squared = .532)

Table 3 Results of the two-way factorial ANOVA for Queen Scallops caught with a Pecten Dredge (PD)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.964(a)	9	.329	5.332	.001
Intercept	.503	1	.503	8.140	.010
Ship	.161	1	.161	2.606	.122
Site	2.688	4	.672	10.878	.000
Ship * Site	.115	4	.029	.467	.759
Error	1.235	20	.062		
Total	4.702	30			
Corrected Total	4.199	29			

a R Squared = .706 (Adjusted R Squared = .573)

Table 4 Results of the two-way factorial ANOVA for Queen Scallops caught with a Queen Dredge (QD)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5.703(a)	9	.634	4.585	.002
Intercept	157.900	1	157.900	1142.542	.000
Ship	1.734	1	1.734	12.546	.002
Site	3.389	4	.847	6.131	.002
Ship * Site	.579	4	.145	1.048	.408
Error	2.764	20	.138		
Total	166.367	30			
Corrected Total	8.467	29			

a R Squared = .674 (Adjusted R Squared = .527)

Appendix

Table 5 Mean catches of King and Queen Scallops made by the RV Prince Madog and the scallop trawler Genesis at different fishing grounds with Pecten dredges (PD) and Queen dredges (QD)

Species - Dredge / Site	East of Douglas		Laxey Bay		Maughold		Point of Ayre		Ramsey		Total	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Kings-PD												
Prince Madog	1.31	0.45	0.99	0.02	0.87	0.18	1.49	0.37	1.06	0.10	1.14	0.33
Genesis	0.66	0.09	0.89	0.28	0.95	0.09	1.86	0.21	1.51	0.21	1.17	0.49
Total	0.98	0.46	0.94	0.18	0.91	0.13	1.67	0.34	1.29	0.29	1.16	0.41
Queens-PD												
Prince Madog	6.93	1.60	3.24	1.42	1.42	0.30	2.44	1.21	1.71	0.51	3.15	2.27
Genesis	5.38	2.50	1.99	1.11	0.98	0.20	2.40	1.26	1.71	0.42	2.49	1.95
Total	6.16	2.06	2.61	1.33	1.20	0.33	2.42	1.11	1.71	0.42	2.82	2.11
Kings-QD												
Prince Madog	0.91	0.07	1.13	0.45	1.31	0.16	1.29	0.31	1.59	0.07	1.25	0.32
Genesis	0.50	0.11	0.87	0.26	1.10	0.21	0.94	0.49	1.55	0.13	1.00	0.42
Total	0.71	0.24	1.00	0.36	1.21	0.20	1.12	0.41	1.57	0.09	1.12	0.39
Queens-QD												
Prince Madog	27.94	7.19	10.65	0.92	12.87	8.98	11.48	4.43	9.48	2.47	14.48	8.51
Genesis	13.14	4.36	5.19	2.45	6.60	0.77	10.57	4.90	7.38	1.85	8.58	4.06
Total	20.54	9.69	7.92	3.42	9.74	6.65	11.02	4.20	8.43	2.26	11.53	7.21

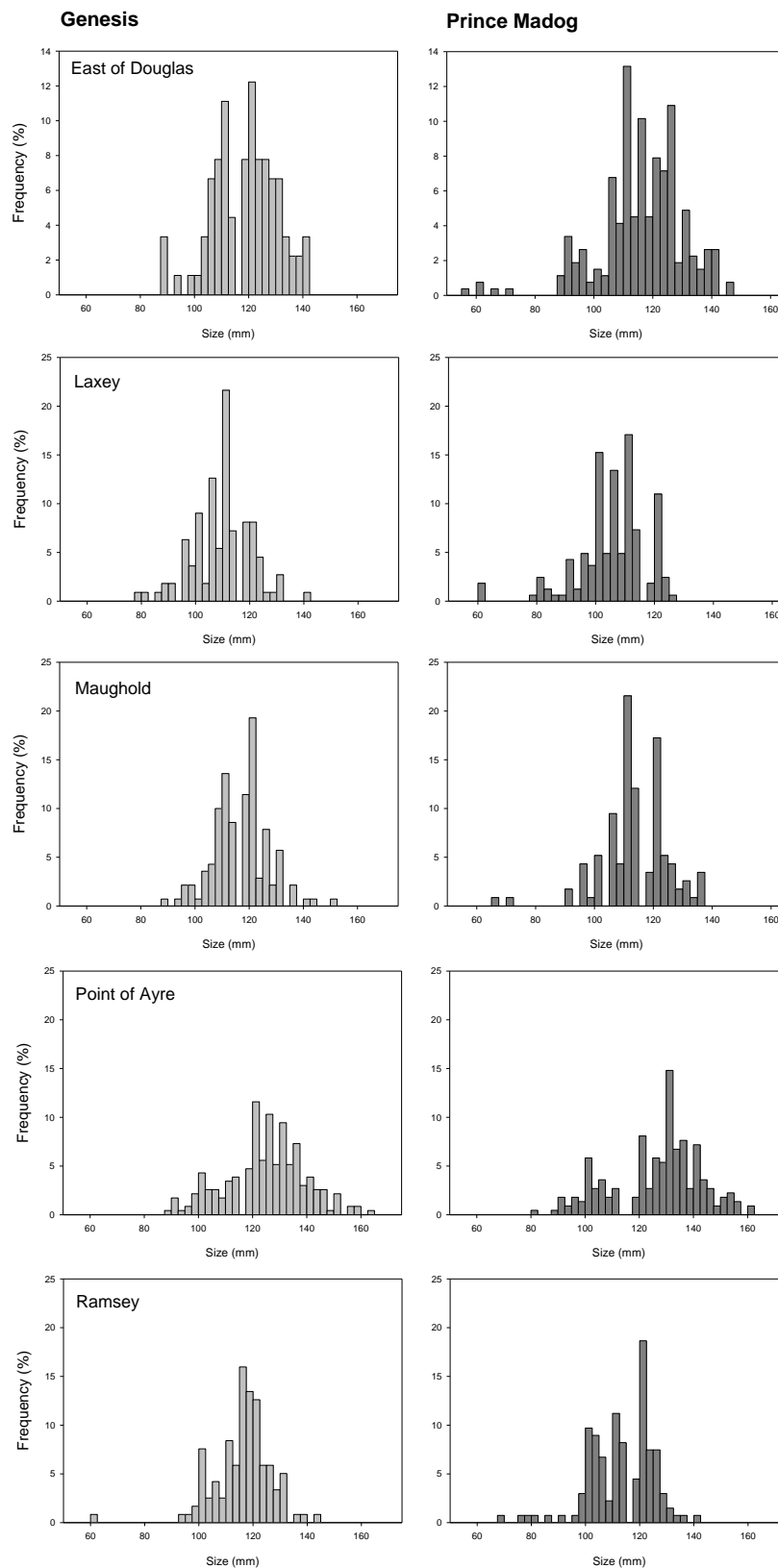


Fig 1 Size frequency distribution of King Scallops at different fishing grounds caught with Pecten dredges by Genesis and Prince Madog

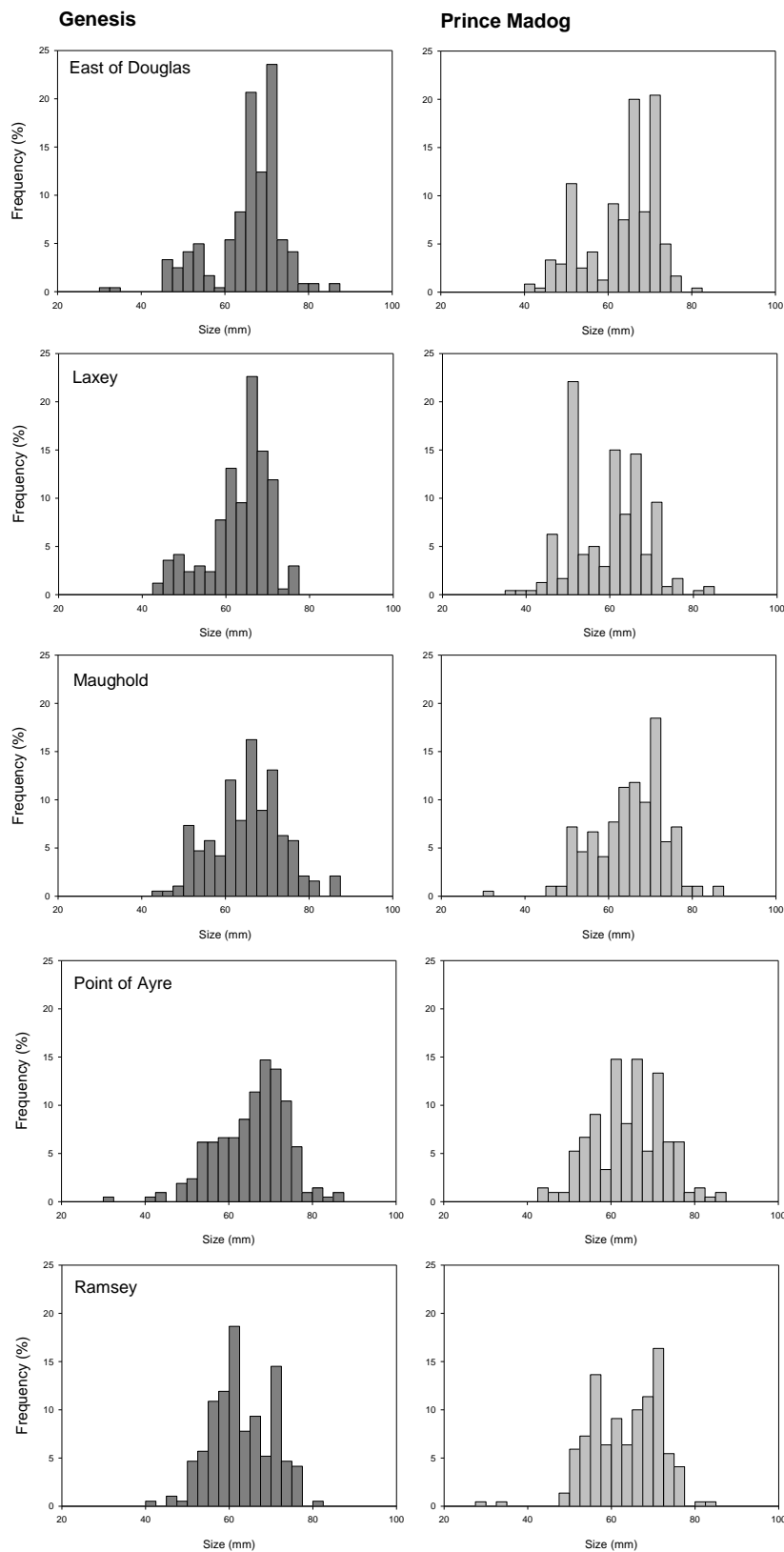


Fig 2 Size frequency distribution of King Scallops at different fishing grounds caught with Queen dredges by Genesis and Prince Madog

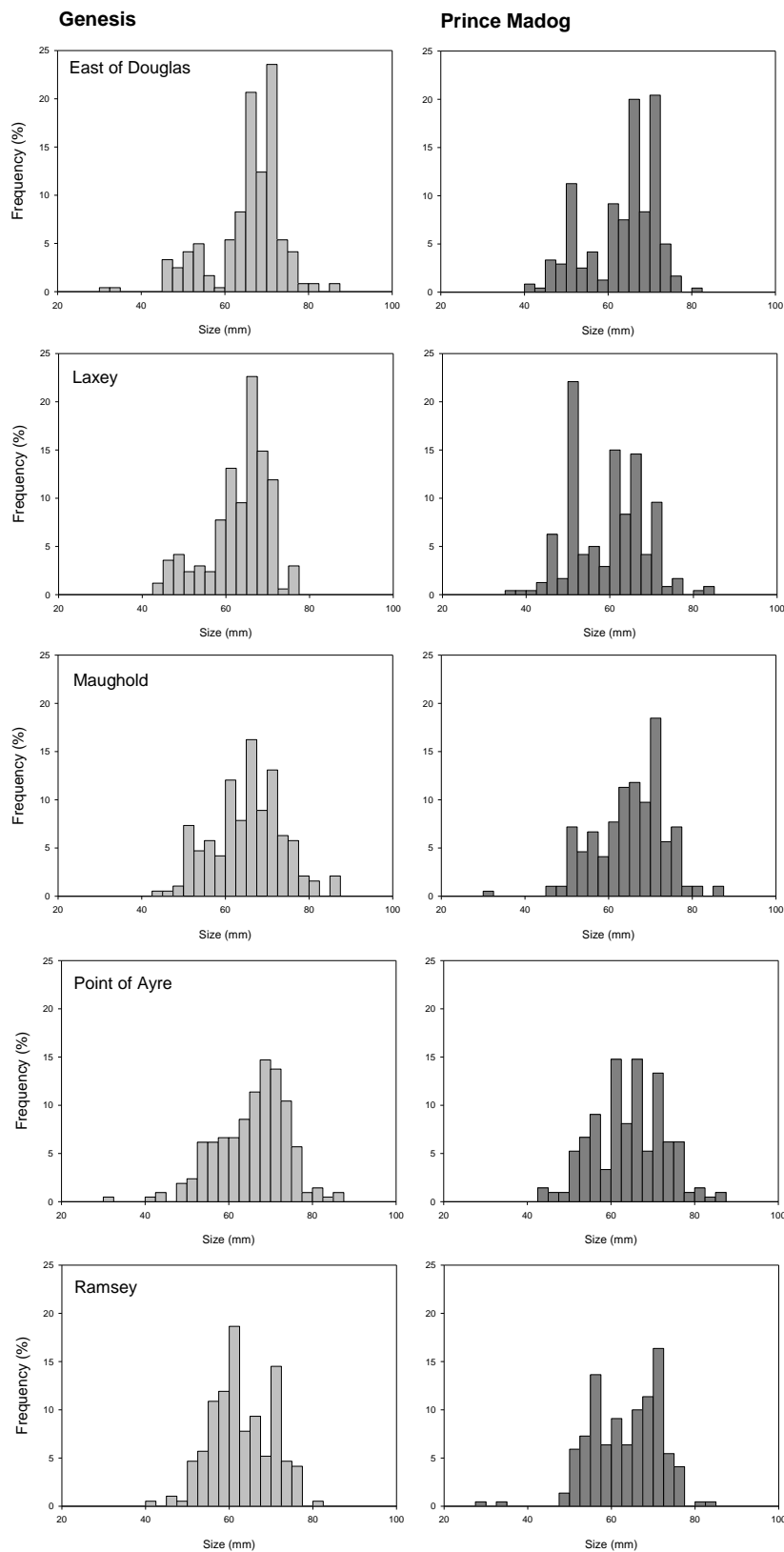


Fig 3 Size frequency distribution of Queen Scallops at different fishing grounds caught with Pecten dredges by Genesis and Prince Madog

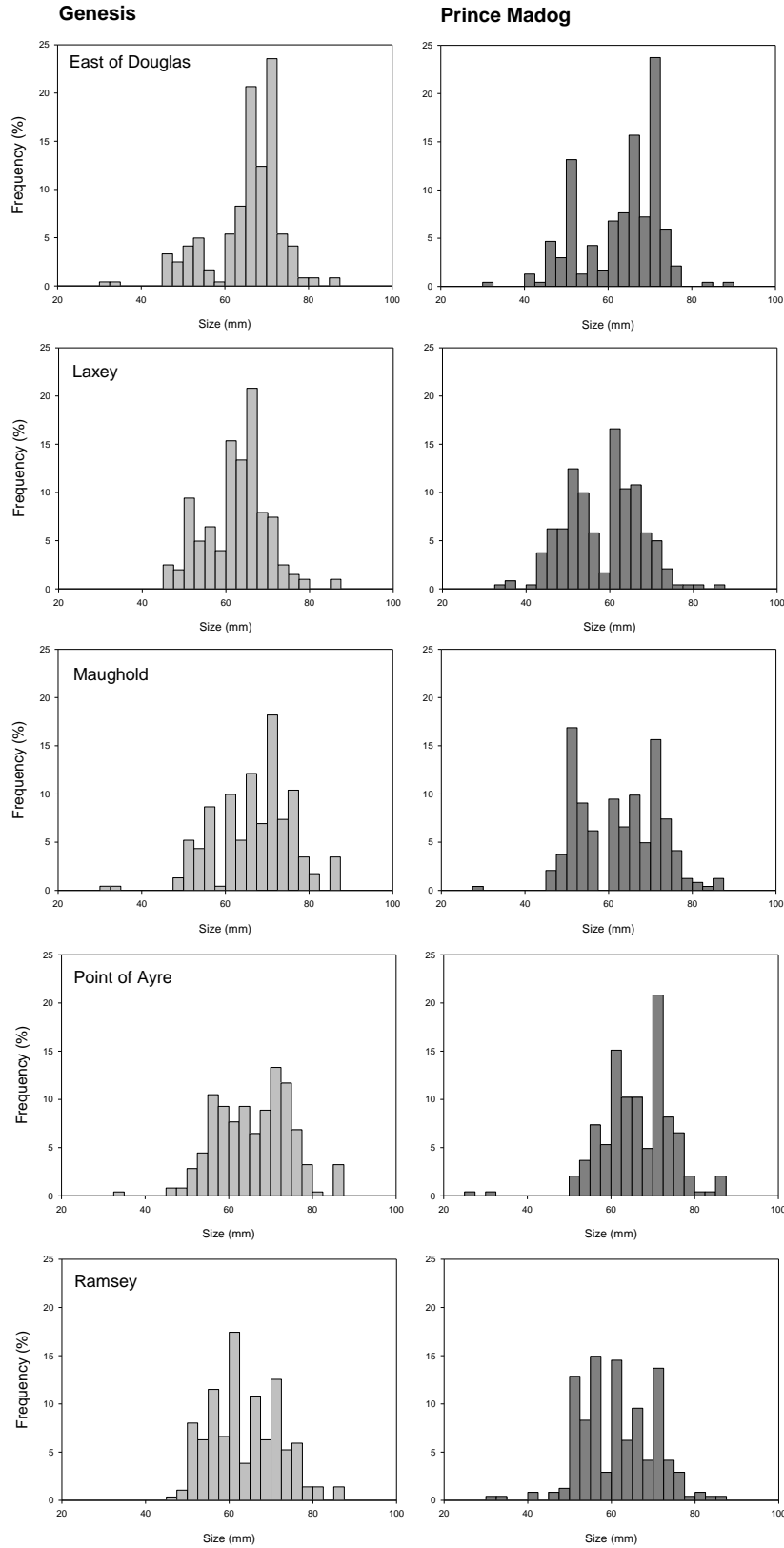


Fig 4 Size frequency distribution of Queen Scallops at different fishing grounds caught with Queen dredges by Genesis and Prince Madog