

### III. RESULTS

The Field Study ran for 36 days and 30 were used for data collection. There were 120 sessions planned, totalling 652 periods, of which 70 were completed, which produced 421 completed periods. A total of 210 seabird periods and 211 cetacean periods were recorded and there were 6957 observations made.

If there was no sign of any seabird or cetacean presence within a sector during a scan, the result was recorded as zero. For the purposes of differentiating observations with cancelled periods, zero values were recorded as 'NVI' (stands for 'Non-Visible') in the species category. This allowed the PRIMER software to calculate abundance of empty sectors during data analysis.

Table 7. Frequency of observations for each species by abundance categories, collected during seabird and cetacean observation periods.

Seabirds	Individual	Few	Some	Many	Abundant	Superabundant	Totals
NVI							3180
AUKS	22	375	357	342	52	14	1342
BLACK GUILLEMOT	71	22					93
GANNET	25	62	8	1			276
LARGE GULLS	315	17	31	2	4	2	479
SMALL GULLS	269	461	296	297	66	7	1396
SHAG	82	11					93
FULMAR	1						1
RED-THROATED DIVER	1						1
Cetaceans	1	2	3	4	5	6	
PORPOISE	53	23	16	5		8	105
MINKE WHALE	1						1
Totals	841	973	711	651	127	37	6967

Table 7 shows that Small Gulls and Auks were the most commonly observed species. Large Gulls follow with Gannet and Porpoise. Shags and Black Guillemot being observed on equal occasions and minke whale, Red-throated diver and Fulmar being clearly identified on single occasions. Their greatest numbers of observations recorded

were NVI's. 'Non-Visible' recordings were registered when there was no species clearly visible in the sector.

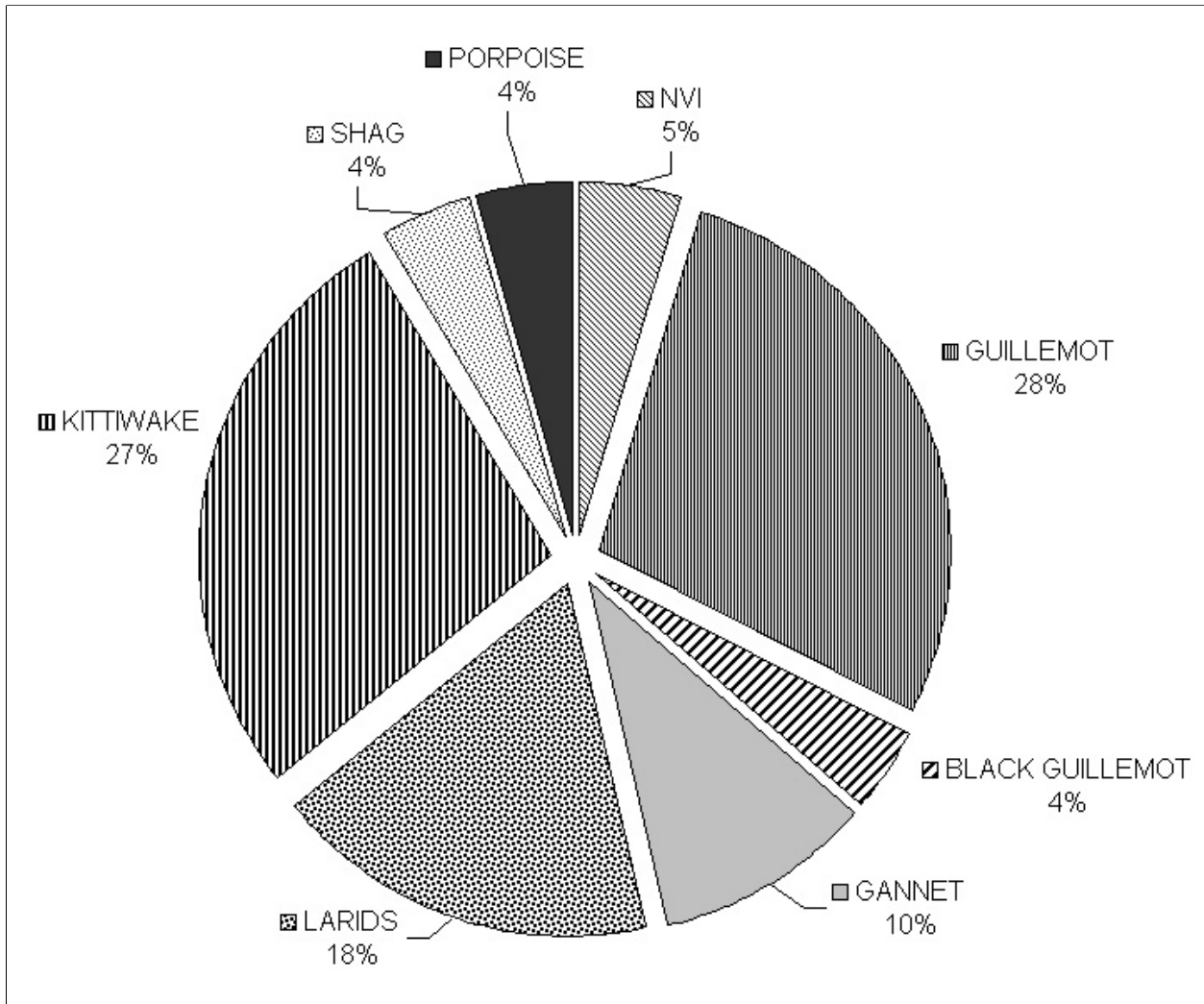


Figure 5. After all periods were pooled and species abundances averaged per session, the number of sightings of each species was calculated as a percentage of the total number of sessions.

Figure 5 shows the percentages of sightings registered of each species-group after the periods were pooled and averaged per session. Auks and Small Gulls account for over half of the total species observations. Large Gulls and Gannet make up a quarter with Black Guillemot, Porpoise, Shag and NVI's accounting for the remaining 17%.

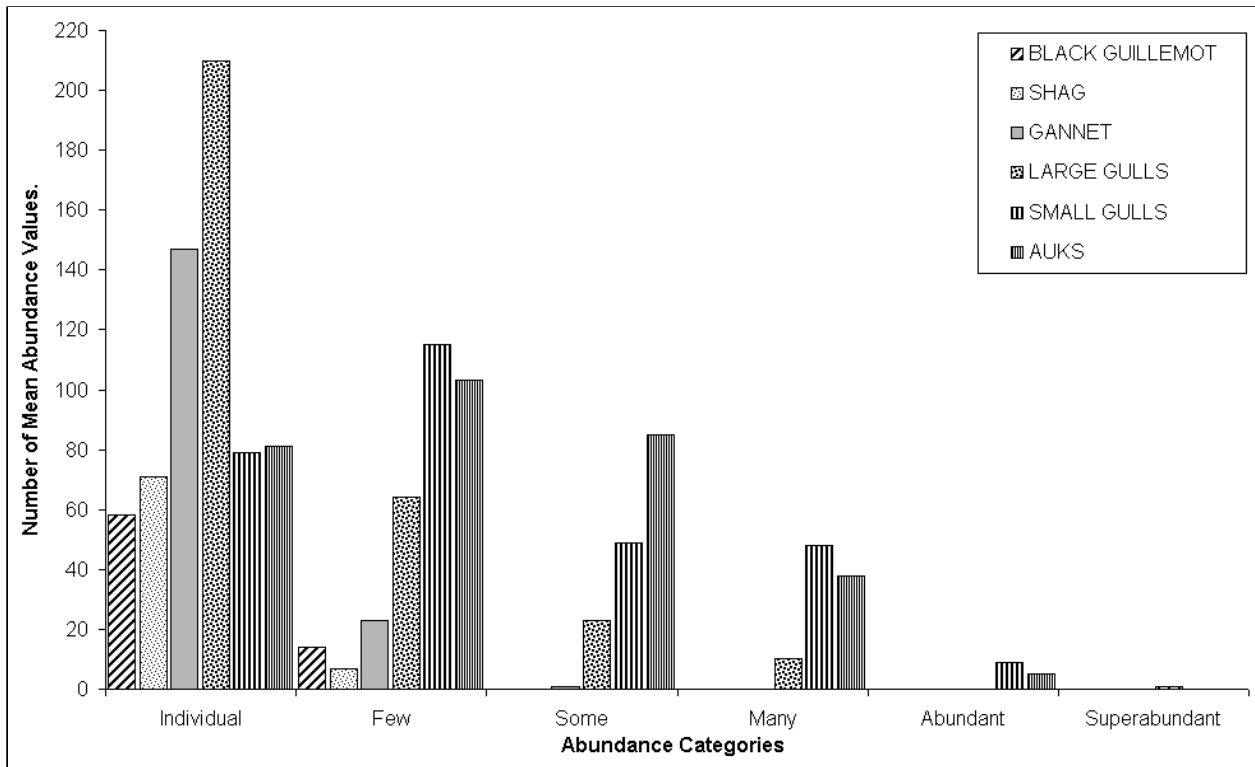


Figure 6-1. The numbers of mean values for seabird species-groups are arranged by abundance category.

Figure 6-1 shows that Large Gulls dominated the Individual abundance category followed by Gannet, Auks, Small Gulls, Shag and Black Guillemot, respectively. The number of observations in the Few abundance category is reduced, and Small Gulls and Auks dominate these sightings, followed by Large Gulls, Gannet, Black Guillemot and Shag. Shag and Black Guillemot are no longer present in high numbers, while Auks and Small Gulls are still recorded in Abundant numbers. There are recorded observations of large Gulls in Superabundant group sizes.

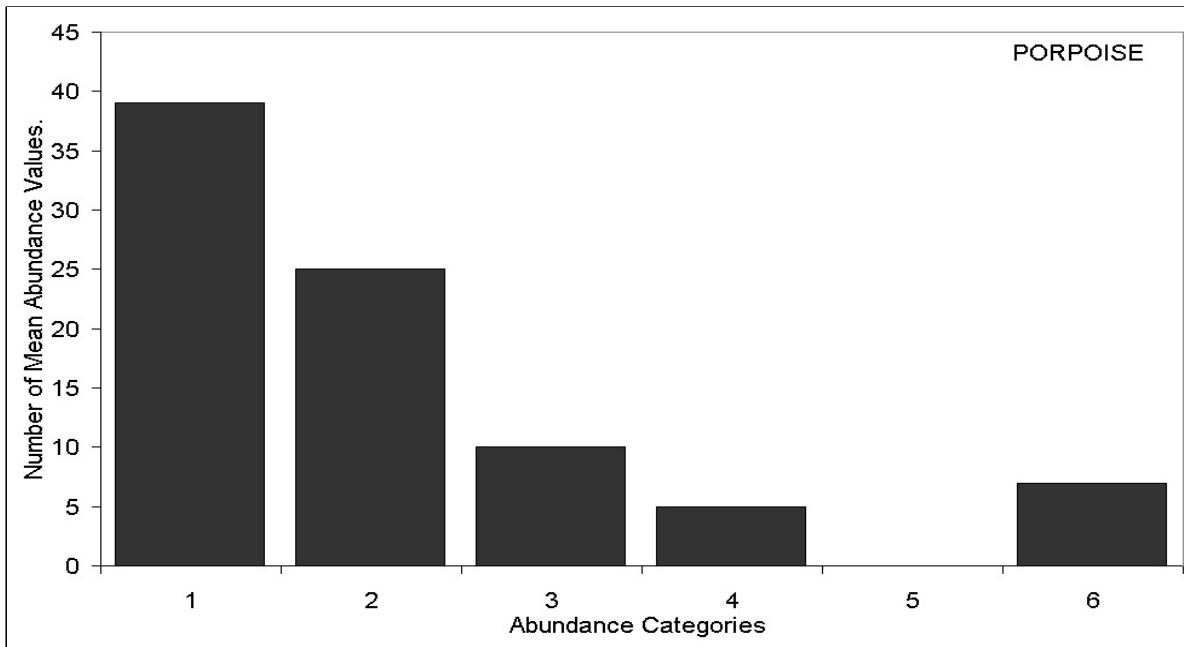


Figure 6-2. Because Porpoise were recorded as actual observed numbers, they are displayed in separate abundance categories.

Figure 6-2 shows the number of observations of Porpoise. These are illustrated separately as actual numbers of porpoise visible were recorded. Porpoise were recording with greatest numbers seen as solitary sightings. The numbers of sightings per category decreases with each increase in group size. There were no sightings of group size of five animals, but there was an increase to sightings of six individuals.

1. Tidal Direction

The results of the ANOSIM One-way test on the data categorised by Tidal Direction showed there was a strongly significant difference between categories (R= 0.024, Sample statistic= 0.1%).

Table 8-1. Results for the Pairwise test on Tidal Direction.

*Pairwise Tests:*

Comparison Groups	R Statistic	Significance Level %
WEST vs SLACK	0.038	0.1
WEST vs EAST	0.024	0.7
SLACK VS EAST	0.013	0.1

Table 8-1 shows the results of the Pairwise test associated with the ANOSIM result. There is a strong significant difference between each of the three comparisons as the significance levels are all clearly below 5%.

Table 8-2. Results of the SIMPER and Chi-squared test on Tidal Direction.

Species	SIMPER test			Av. Contrib%	$\chi^2$ test Asymptotic Significance
	Av. Abundance				
	WEST	SLACK	EAST		
AUKS	1.47	1.84	1.85	25.1	p<0.001
BLACK GUILLEMOT	0.02	0.14	0.16	4.5	p<0.001
GANNET	0.22	0.37	0.13	10.0	p<0.001
LARGE GULLS	0.66	0.79	0.5	17.4	0.005
NVI	0.14	0.06	0.34	7.9	0.03
PORPOISE	0.14	0.3	0.28	6.0	0.007
SHAG	0.07	0.11	0.12	4.6	0.057
SMALL GULLS	1.47	1.79	1.56	24.6	p<0.001

The  $\chi^2$  test and SIMPER test results are illustrated in Table 8-2. Auks and Small Gulls are seen to contribute the most to the SIMPER test including Large Gulls and Gannet. In the  $\chi^2$  test, only Shags are not significantly different between categories. These results are shown in Table 8-3 below.

Table 8-3. Chi-squared results for species with significant values on Tidal Direction test.

	$\chi^2$ Value		WEST	SLACK	EAST	TOTAL
AUKS	16.918	Obs. N	113	178	173	464
		Exp. N	154.7	154.7	154.7	
		<i>Residual</i>	-41.7	23.3	18.3	
BLACK GUILLEMOT	25.182	Obs. N	3	29	34	66
		Exp. N	22	22	22	
		<i>Residual</i>	-19	7	12	
GANNET	17.22	Obs. N	33	71	73	177
		Exp. N	59	59	59	
		<i>Residual</i>	-26	12	14	
LARGE GULLS	10.778	Obs. N	87	124	82	293
		Exp. N	97.7	97.7	97.7	
		<i>Residual</i>	-10.7	26.3	-15.7	
SMALL GULLS	18.45	Obs. N	110	183	160	453
		Exp. N	151	151	151	
		<i>Residual</i>	-41	32	9	
PORPOISE	9.852	Obs. N	15	28	38	81
		Exp. N	27	27	27	
		<i>Residual</i>	-12	1	11	

Table 8-3 shows the species-groups that showed significant differences in the  $\chi^2$  test and the associated frequencies. Negative residuals show that less observations were seen on a West-going tide for all species-groups. Large Gulls showed a negative residual on the East-going tide, while the other groups differed with Auks and Small Gulls showing greater frequencies on the Slack tide.

## 2.1 Tidal Phase

The results of the ANOSIM One-way test on the data categorised by Tidal Phase show there is no significant difference between categories ( $R = 0.014$ , Sample statistic = 18.4%).

## 2.2 Tidal Strength

The results of the ANOSIM One-way test on the data categorised by Tidal Direction showed there was a significant difference between categories ( $R = 0.018$ , Sample statistic = 0.1%) therefore Significance level is less than 5%.

Table 9-1. Results of the Pairwise test on Tidal Strength.

*Pairwise Tests:*

Groups	R Statistic	Significance Level %
WEAK vs STRONG	0.026	0.1
WEAK vs SLACK	-0.001	46.7
STRONG vs SLACK	0.028	0.1

Table 9-1 illustrates the results of the Pairwise test completed by the ANOSIM analysis. It shows that each comparison of 'Weak vs. Strong' and 'Strong vs. Slack' was significantly different, but the comparison test between 'Weak vs. Slack' was not significantly different.

Table 9-2. Results of the SIMPER and Chi-squared test on Tidal Strength.

Species	SIMPER test			Av. Contrib%	$\chi^2$ test Asymptotic Significance
	Av. Abundance				
	SLACK	WEAK	STRONG		
AUKS	1.85	2.02	1.36	25.1	0.041
BLACK GUILLEMOT	0.16	0.09	0.08	4.5	0.007
GANNET	0.34	0.43	0.18	10.3	$p < 0.001$
LARGE GULLS	0.5	0.75	0.72	17.3	0.085
NVI	0.13	0.06	0.12	7.6	0.009
PORPOISE	0.28	0.42	0.05	6.3	$p < 0.001$
SHAG	0.12	0.07	0.12	4.6	0.094
SMALL GULLS	1.56	1.8	1.51	24.3	0.322

Table 9-2 shows that Large Gulls, Shags and Small Gulls showed no significant difference between Tidal strengths. Auks, Small Gulls, Large Gulls and Gannets showed the greatest percentage contributions to the SIMPER test.

Table 9-3. Chi-squared results for species with significant values on Tidal Strength test.

	$\chi^2$ Value		SLACK	WEAK	STRONG	TOTAL
AUKS	6.366	Obs. N	173	161	130	
		Exp. N	154.7	154.7	154.7	
		<i>Residual</i>	18.3	6.3	-24.7	464
BLACK GUILLEMOT	9.909	Obs. N	34	15	17	
		Exp. N	22	22	22	
		<i>Residual</i>	12	-7	-5	66
GANNET	18.542	Obs. N	73	72	32	
		Exp. N	59	59	59	
		<i>Residual</i>	14	13	-27	177
NVI	9.333	Obs. N	32	12	28	
		Exp. N	24	24	24	
		<i>Residual</i>	8	-12	4	72
PORPOISE	18.296	Obs. N	38	34	9	
		Exp. N	27	27	27	
		<i>Residual</i>	11	7	-18	81

Those species-groups that showed significant differences are displayed in Table 9-3. Auks showed the greatest frequencies on a Slack tide, with fewer sightings on a Weak tide and negative residuals on a Strong tide. Black Guillemot were seen to prefer the Slack tide with negative residuals on the Weak and Strong tides. Gannet and Porpoise showed similar preferences as the Auks. The highest frequencies of NVI's were recorded on the Slack tide, with negative residuals on the Slack and a small number of observations on the Strong tide.



## 3. Area Sectors

The results of the ANOSIM One-way test on the data categorised by 'Sectors' showed there was a strong significant difference between categories (R= 0.096, Sample statistic= 0.1%).

Table 10-1. Pairwise test results between sectors.

Pairwise Tests	R Statistic	Signif. Level %	Signif. Diff. ?		Pairwise Tests	R Statistic	Signif. Level %	Signif. Diff. ?
AF vs. BF	0.031	0.8	YES		BN vs. DF	0.155	0.1	YES
AF vs. AN	0.032	0.9	YES		BN vs. EN	0.018	7.8	NO
AF vs. BN	0.107	0.1	YES		BN vs. EF	0.136	0.1	YES
AF vs. CF	0.035	0.6	YES		BN vs. FN	0.028	2.7	YES
AF vs. CN	0.152	0.1	YES		BN vs. FF	0.065	0.1	YES
AF vs. DN	0.161	0.1	YES		CF vs. CN	0.226	0.1	YES
AF vs. DF	0.004	26.3	NO		CF vs. DN	0.228	0.1	YES
AF vs. EN	0.176	0.1	YES		CF vs. DF	-0.004	60.8	NO
AF vs. EF	0.014	5.3	NO		CF vs. EN	0.244	0.1	YES
AF vs. FN	0.17	0.1	YES		CF vs. EF	0.016	5.2	NO
AF vs. FF	0.035	0.5	YES		CF vs. FN	0.227	0.1	YES
BF vs. AN	0.136	0.1	YES		CF vs. FF	0.058	0.1	YES
BF vs. BN	0.209	0.1	YES		CN vs. DN	-0.014	96.7	NO
BF vs. CF	0.016	8	NO		CN vs. DF	0.194	0.1	YES
BF vs. CN	0.258	0.1	YES		CN vs. EN	0.001	34	NO
BF vs. DN	0.255	0.1	YES		CN vs. EF	0.156	0.1	YES
BF vs. DF	0.019	4.1	YES		CN vs. FN	0.012	11.7	NO
BF vs. EN	0.276	0.1	YES		CN vs. FF	0.084	0.1	YES
BF vs. EF	0.039	0.1	YES		DN vs. DF	0.202	0.1	YES
BF vs. FN	0.247	0.1	YES		DN vs. EN	-0.004	59.4	NO
BF vs. FF	0.085	0.1	YES		DN vs. EF	0.171	0.1	YES
AN vs. BN	0.007	22.8	NO		DN vs. FN	0.01	16.4	NO
AN vs. CF	0.122	0.1	YES		DN vs. FF	0.092	0.1	YES
AN vs. CN	0.035	1.3	YES		DF vs. EN	0.221	0.1	YES
AN vs. DN	0.039	0.8	YES		DF vs. EF	-0.004	61.4	NO
AN vs. DF	0.079	0.1	YES		DF vs. FN	0.212	0.1	YES
AN vs. EN	0.054	0.4	YES		DF vs. FF	0.054	0.2	YES
AN vs. EF	0.068	0.1	YES		EN vs. EF	0.18	0.1	YES
AN vs. FN	0.062	0.2	YES		EN vs. FN	-0.005	59	NO
AN vs. FF	0.035	1.1	YES		EN vs. FF	0.09	0.1	YES
BN vs. CF	0.185	0.1	YES		EF vs. FN	0.167	0.1	YES
BN vs. CN	-0.003	51	NO		EF vs. FF	0.035	0.5	YES
BN vs. DN	-0.003	51.1	NO		FN vs. FF	0.084	0.1	YES



Table 10-2.  $\chi^2$  test results for each species-group, by sectors.

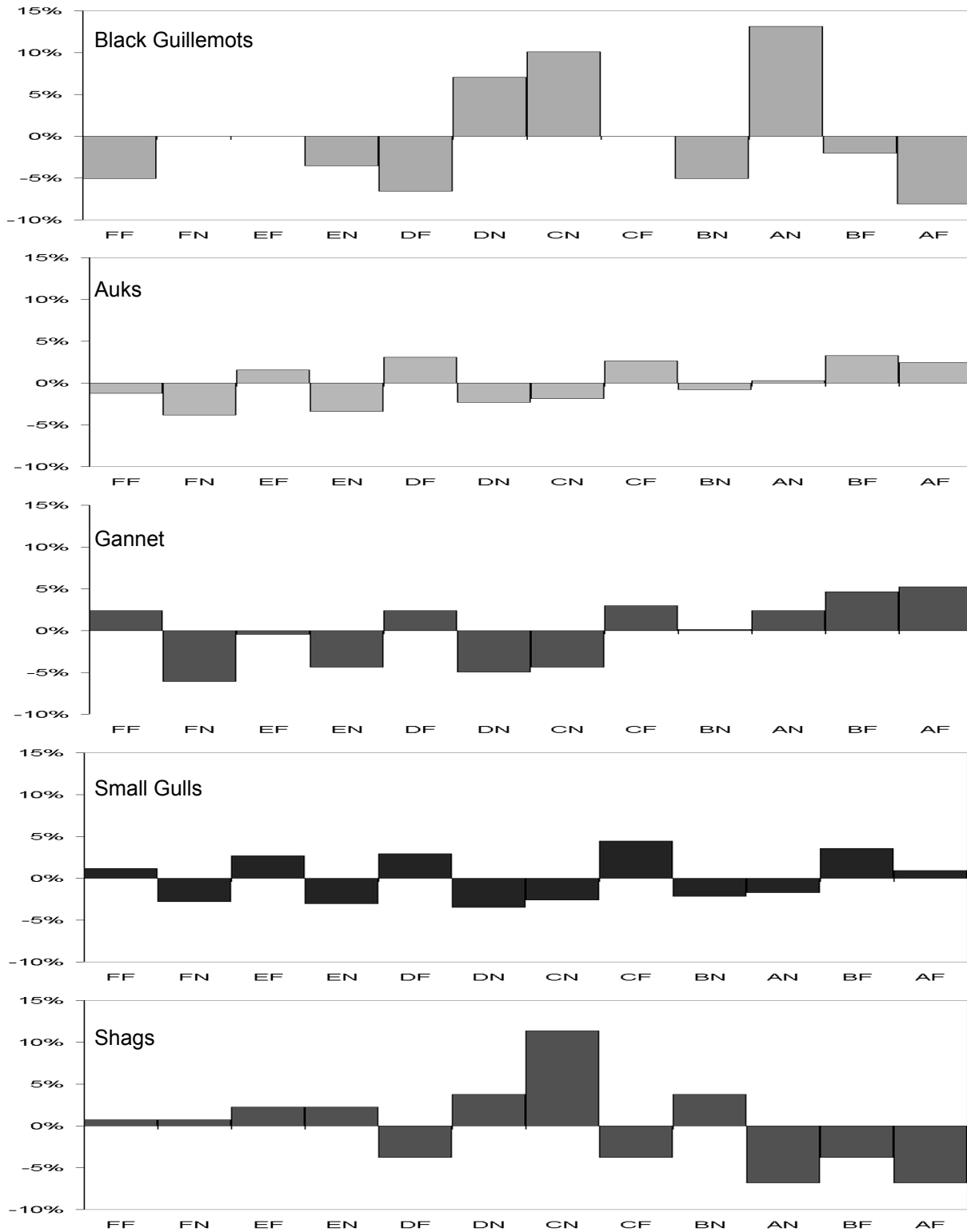
	Chi-Square Value	Degrees of Freedom	Asymptotic Significance
NVI	25.000	8	0.002
AUKS	40.569	11	p<0.001
BLACK GUILLEMOT	29.727	8	p<0.001
GANNET	37.169	11	p<0.001
LARGE GULLS	5.689	11	0.893
SMALL GULLS	51.344	11	p<0.001
SHAG	24.182	11	0.012
PORPOISE	10.938	10	0.362

Large Gulls and Porpoise were not significantly different between sectors, while all the other species-groups were less than 0.05.

Table 10-3. Residual values for Observed and Expected counts for species-groups, by sector. The Residual Index value is calculated by dividing the Residual with the Total of each species-group. This allows comparison of residuals between species.

CHI-SQUARED RESIDUALS:														
SPECIES		AF	BF	AN	BN	CF	CN	DN	DF	EN	EF	FN	FF	Total
BLACK GUILLEMOT	Residual Index	-5.33 -8%	-1.33 -2%	8.67 13%	-3.33 -5%	0.00 0%	6.67 10%	4.67 7%	-4.33 -7%	-2.33 -4%	0.00 0%	0.00 0%	-3.33 -5%	66
GUILLEMOTS	Residual Index	11.33 2%	15.33 3%	1.33 0%	-3.67 -1%	12.33 3%	-8.67 -2%	-10.67 -2%	14.33 3%	-15.67 -3%	7.33 2%	-17.67 -4%	-5.67 -1%	464
GANNETS	Residual Index	9.25 5%	8.25 5%	4.25 2%	0.25 0%	5.25 3%	-7.75 -4%	-8.75 -5%	4.25 2%	-7.75 -4%	-0.75 0%	-10.75 -6%	4.25 2%	177
HARBOUR PORPOISE	Residual Index	-1.36 -2%	1.64 2%	1.64 2%	2.64 3%	-0.36 0%	-3.36 -4%	-0.36 0%	2.64 3%	-6.36 -8%	2.64 3%	0.00 0%	0.64 1%	81
LARGE GULLS	Residual Index	-4.42 -2%	0.58 0%	-4.42 -2%	3.58 1%	3.58 1%	1.58 1%	4.58 2%	-0.42 0%	2.58 1%	-5.42 -2%	-3.42 -1%	1.58 1%	293
KITTIWAKES	Residual Index	4.25 1%	16.25 4%	-7.75 -2%	-9.75 -2%	20.25 4%	-11.75 -3%	-15.75 -3%	13.25 3%	-13.75 -3%	12.25 3%	-12.75 -3%	5.25 1%	453
SHAGS	Residual Index	-4.50 -7%	-2.50 -4%	-4.50 -7%	2.50 4%	-2.50 -4%	7.50 11%	2.50 4%	-2.50 -4%	1.50 2%	1.50 2%	0.50 1%	0.50 1%	66

Figure 8 below illustrates the Residual Index values for each Sector by Species. It shows how the Observed counts were higher than Expected in some sectors in comparison to others. Shags and Black Guillemot showed the greatest preferences to Sectors CN and DN, while Gannet, Auks and Small Gulls did not. Auks, Small Gulls and Gannet showed less specific difference between Sectors because the Index values are lower.



Figures 8. The Residual Index Values (sector residual by species ÷ species total) for each sector as in Table 10-3.