An Investigation of the Variability in Results from Application of the Water Framework Directive RSL Seaweed Monitoring Tool to a Single Shore by Different Workers

Compiled by Martin Wilkinson (Heriot-Watt University) using survey results collected by participants at the Estuarine & Coastal Sciences Association (ECSA) Seaweed Identification Workshop held at Heriot-Watt University, Edinburgh in March 2007

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1. Introduction

The tool devised for assessing ecological quality of intertidal rocky seashores in the British Isles for the European Water Framework Directive (WFD) using seaweeds is based on the numbers of species found (species richness) in a defined area of shore by a certain intensity of sampling effort (Wells et al 2007). It is unreasonable to expect all operatives in statutory agencies who have to apply this tool to have sufficient identification experience with British seaweeds to confidently identify all 630+ species recorded in the British Isles. So a Reduced Species List (RSL) of only approximately 70 taxa was devised to act as a surrogate for the full list. Richness of taxa from the RSL is currently used as the normal metric in assessing quality. "Taxa" is preferred to "species" in the RSL since a few entities are recorded only to genus level rather than to species level where specific identification might be dubious. Ecological quality assessment with the RSL also involves the use of supporting data on the composition of the seaweed assemblage by categorising the taxa list into colour groups, opportunists and ecological status groups (Orfanidis et al 2001) since the relative number of taxa found in each of these categories varies with ecological quality (Wells et al 2007).

In the form of the tool originally devised, shores could only be classified into 5 discrete quality groups as specified in the WFD. Subsequent to Wells et al (2007) the approach has been refined in accordance with the requirements of the WFD to give an Ecological Quality Ratio (EQR) which will vary on a continuous scale from 0 (worst ecological quality) to 1.0 (highest ecological quality – equivalent to reference conditions). This is achieved by the application of equations given in Wells (2006). In this, one of the metrics (shore description points) works in the opposite way to taxa richness to negate the effect that an increase in the habitat diversity will have on increasing taxa richness irrespective of ecological quality. A further refinement of the tool (Wells 2007) has involved a calculated "deshoring" factor to more precisely take account of the role of habitat diversity in taxa richness. The calculations of EQRs given in this report do not incorporate the deshoring factor which was not available when they were carried out.

An Excel spreadsheet was prepared by Robert Wilkes (Environmental Protection Agency, Republic of Ireland) based on Wells (2006) to calculate EQRs using Wells' formulae simply by entering presence of RSL taxa found on a shore into the spreadsheet.

It is unlikely that any two workers will find exactly the same species on a shore. Indeed Wells (2002) found that when she sampled the same shore in the same manner on three consecutive days she recorded a slightly different species complement although the richness was broadly constant. This suggests that any survey produces an incomplete taxa list which is only representative of the full list. Similarly a survey for the RSL will not necessarily detect all RSL taxa present but an artefact. The question therefore arises as to what variability will arise when different operatives sample the same shore for the WFD. Will there be such wide variation that classification of the shore will depend on who is assigned to sample it?

2. Methods

A subjectively rich, presumably high ecological quality shore was selected for simultaneous sampling by 10 groups each of 2 workers using the same sampling protocol. The taxa recorded from the RSL by each group were entered on Wilkes' spreadsheet and the EQR and supporting data were also obtained from this for each group of samplers. Samples were collected at the field site for laboratory examination and mainly worked up under similar conditions over two half days.

The sampling was carried out at Skateraw, East Lothian (NGR of starting point at Chapel Point NT739758) on Thursday 22 March 2007 between 0930 and 1115 when the predicted tide (0.6m 1029) was a spring tide. Although this site is close to Torness Nuclear Power Station, there is no evidence to suggest that it was adversely affected. The location of the sampling area is shown in figs. 1-3.

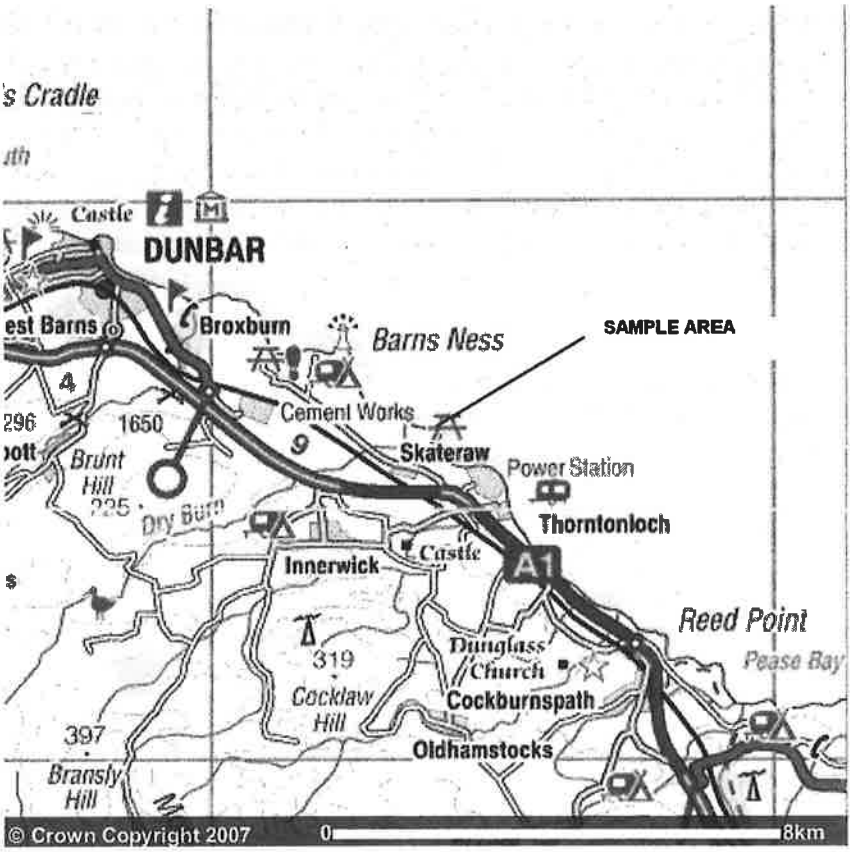

Fig. 1. General location of Skateraw

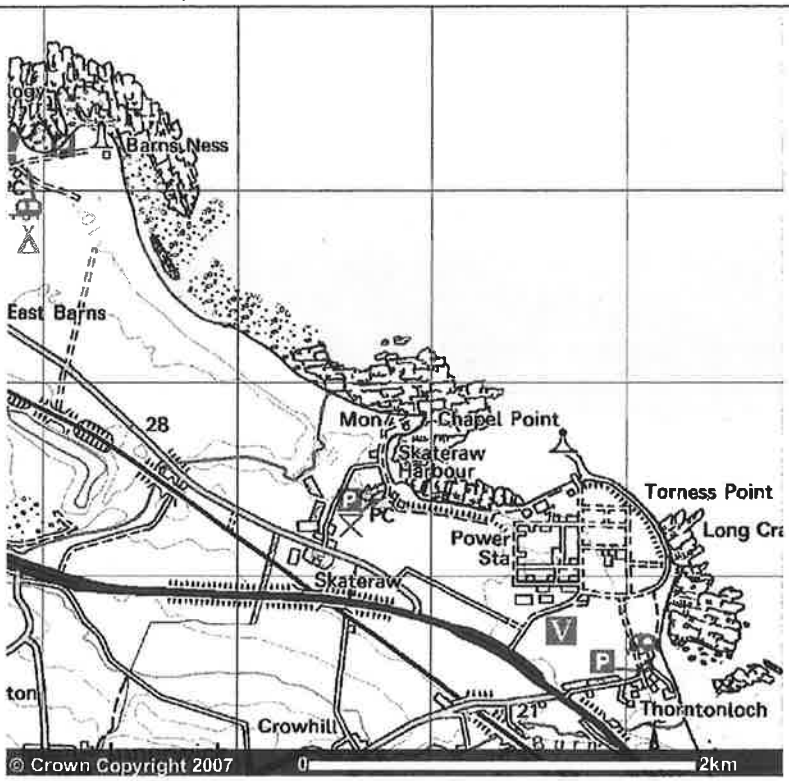

Fig. 2. Access to Skateraw as shown on the 1:50000 Ordnance Survey map.

Fig. 3. Boundaries of sampling area at Skateraw.

This was an extensive, gently sloping, shore composed of flat ledges with many rock pools of various sizes, covered in places with boulders and a well developed kelp zone easily sampled from the intertidal on the day of sampling which was a spring tide. (Figs. 4-8).

Fig 4. Bay at Skateraw looking east towards power station showing gently sloping extensive shore

Fig 5. Flat ledges forming shore at Skateraw seen from above the shore looking north

Fig 6. Mid shore at Skateraw showing boulders overlying rock ledges.

Fig. 7. Rich kelp zone exposed at low tide at Skateraw.

Fig 8. Boulders overlying bedrock on lower shore at Skateraw.

The teams of samplers were made up as follows:

1. Sarah Holt and Clare Scanlan – SEPA Aberdeen
2. Kirsty Dauros and Jeni Boyle – SEPA East Kilbride
3. Mhairi Wilson and Carol Milner – SEPA Dingwall
4. Lee Heaney and Laura Bush – SEPA Riccarton
5. Rolf Karez and Gesche Bock – LANU and Marine Institute, Germany
6. Ian Tittley and Phil Smith – Natural History Museum and Aquatonics
7. Tim Worsfold and Rachel Jacobson – UNICO Marine
8. Gillian Annett and Nuala McQuaid – EHS
9. Joe Skeats and Rebecca Aspden – EHS and St Andrews University
10. Alexia Chapman and Laura Cornick – Heriot-Watt University MSc students

Teams 1-5 and 8 are agency staff actively involved in WFD sampling while the other teams comprise a mixture of experts, students, researchers and environmental consultants of various levels of expertise. All had completed a minimum of 2.5 days intensive preparation on a training course in seaweed identification at Heriot-Watt University immediately prior to this exercise, although most had also been on previous courses and had other seaweed expertise.

3. Results and Comments

These results are not fully discussed and analysed here but are presented so that further discussion and analysis could be carried out if appropriate (e.g. at MPTT meeting in Belfast November 2007).

Table 1 shows the taxa from the RSL recorded by each group together with the numbers of taxa in each colour group and each ecological status group and numbers of opportunist taxa. From these are derived the proportions of red, green and opportunist taxa and ratio of the taxa numbers in the two ecological status groups. These are then used to generate scores shown in the lower part of the table which are used in the method given by Wells (2006) to calculate a single EQR value for the shore based on each sample on a sliding scale from 0 to 1.0 as detailed earlier. The points awarded for shore description are the same for all samples as all were working on the same shore. However, before the introduction of the deshoring factor (Wells 2007), not used in the present work, it was not clear what would be the best way to incorporate the shore points in the EQR calculation. In this table the shore description and species richness were firstly summed as equivalent measures so that 6 metrics were used in calculation of the EQR. An alternative treatment of this is then given in the shaded boxes where taxa richness and shore description are combined as a single metric so that 5 metrics in total are used in the calculation of the EQR.

Table 2 shows the fixed values entered in the spreadsheet based on the attributes of each of the five ecological quality classes as given by Wells (2006).

Table 3 repeats some of the summary data from the samples form Table 1 without the taxa lists but also gives estimates of the variation between the ten groups of samplers in each of the scores and metrics used in the EQR calculation and the EQRs themselves as maximum and minimum values and as standard deviations. This table also compares the EQR values found by the two different methods of incorporating shore description points (see above) and shows the effect on the EQR of reclassifying a single species, *Halidrys siliquosa*, between the two ecological status groups.

Table 1 shows that using all 6 metrics the shore was classified as good by 8 groups and high by 2 groups. but combining the shore description and taxa number as a single metric results in all the groups classifying the shore as high quality. At the time of writing the latter approach was\subjectively being favoured among Marine Plants Task Team members although this is now overtaken by the use of a deshoring factor (wells 2007). Subjectively one might expect this shore to be of high quality.

Within these EQR calculations from the ten groups there is variation since a final EQR of 0.800 to 1.000 would all classify as high. Groups 1-4 and 8 are in regulatory organisations. They gave arrange of EQR of 0.734 to 0.807 by the first method (3 good, 2 high) and 0.881 to 0.969 by the second method (5 high). Croups 1 and 6 might be regarded as seaweed professionals. They gave divergent values: 0.712 and .807 (1 good, 1 high) by the first method and 0.854 and 0.969 (both high) by the second method. A superficial conclusion might be that there is variation between workers but that it results generally in the same classification. Table 3 shows thatn the coefficient of variation (standard deviation as % of mean) by both methods is relatively low at 5.5%.

While some quite different values come into the same class on the sliding scale it is possible that only a slight variation could move a sample over a class boundary e.g. values of 0.806 and 0.807 by groups 1 and 3 on the first method would only require a variation of 0.007 or 0.008 to drop from high to good. Therefore it is necessary to quote the EQR value and not just the classification.

Table 1 Presence of RSL taxa and EQR Scores calculated for each of 10 separate pairs of workers surveying the same stretch of shore at the same time to study variation between workers. 1 indicates taxon was present.

Taxa found	Taxa on RSL for Scotland	colour	Opp	ESG	Sarah and Clare	Kirsty & Jeni	Mhairi & Carol	Lee & Laura B	Rolf & Gesche	Ian & Phil	Tim & Rachel	Gillian & Nuala	Joe & Rebecca	Alexia & Laura C
					SEPA Aberdeen	SEPA East Kilbride	SEPA Dingwall	SEPA Riccarton	Germany	NHM & Aquatonics	UNICO Marine	EHS	EHS & St Andrews	HWU MSc students
Blidingia sp.	1	G		2	1			1		1		1		1
Chaetomorpha melagonium	1	G		2	1							1		
Cladophora rupestris	1	G		2	1	1	1	1	1	1	1	1	1	1
Cladophora sericea	1	G		2	1		1	1	1	1	1	1	1	1
Enteromorpha sp.	1	G	1	2	1	1	1	1	1	1	1	1	1	1
Ulva lactuca	1	G	1	2	1	1	1	1	1	1	1	1	1	1
Alaria esculenta	1	B		1	1				1	1		1	1	
Ascophyllum nodosum	1	B		1	1	1	1	1	1	1	1	1	1	1
Cladostephus spongious	1	B		2	1		1	1	1	1	1	1		1
Desmarestia aculeata	1	B		1										1
Dictyosiphon foeniculaceus	1	B		1				1						
Ectocarpus sp.	1	B	1	1							1	1	1	1
Elachista fucicola	1	B		1					1					
Fucus serratus	1	B		1	1	1	1	1	1	1	1	1	1	1
Fucus spiralis	1	B		1	1			1	1	1	1	1		1
Fucus vesiculosus	1	B		1	1	1	1	1	1	1	1	1	1	1
Halidrys siliquosa	1	B		2	1	1	1	1	1	1	1	1	1	1
Himanthalia elongata	1	B		2										
Laminaria digitata	1	B		2	1	1	1	1	1	1	1	1	1	1
Laminaria hyperborea	1	B		2	1	1	1	1	1	1	1	1		
Pelvetia canaliculata	1	B		1		1				1			1	
Pilayella littoralis	1	B	1	2	1									
Ralfsia sp.	1	B		1	1	1		1	1	1	1		1	1
Scytosiphon lomentaria	1	B		1				1						1
Aglaothamnion/Callithamnion	1	R		2	1		1	1	1		1	1	1	1
Ahnfeltia plicata	1	R		2	1	1	1	1	1		1	1		1
Audouinella purpurea		R		1				1						

Calcareous encrusters	1	R		1	1	1	1	1	1	1	1	1	1	1
Ceramium nodulosum	1	R		1	1	1	1	1	1	1	1	1	1	1
Ceramium shuttleworthanium	1	R		1	1	1		1	1			1		
Ceramium sp.		R		1						1				
Chondrus crispus	1	R		1	1	1	1	1	1	1	1	1	1	1
Corallina officinalis	1	R		2	1	1	1	1	1	1	1	1	1	1
Cryptopleura ramosa	1	R		1						1				1
Cystoclonium purpureum	1	R		1				1						1
Delesseria sanguinea	1	R		1				1			1	1	1	
Dilsea carnosa	1	R		1		1	1							1
Dumontia contorta	1	R		1	1	1	1	1	1	1	1	1	1	1
Erythrotrichia carnea	1	R		1				1						
Furcellaria lumbricalis	1	R		1								1		
Hildenbrandia rubra		R		1						1				
Lomentaria articulata	1	R		1		1	1	1	1	1	1	1	1	1
Mastocarpus stellatus	1	R		1	1	1	1		1	1	1	1	1	1
Melobesia membranacea		R		1					1	1		1	1	
Membranoptera alata	1	R		2	1	1	1	1	1	1	1	1	1	1
Odonthalia dentata	1	R		1							1			
Osmundea hybrida	1	R		1	1		1	1	1	1	1	1		
Osmundea pinnatifida	1	R		1	1			1	1	1	1	1	1	1
Palmaria palmata	1	R		1	1	1	1	1	1	1	1	1	1	1
Phycodrys rubens	1	R		2	1		1	1						
Phyllophora sp.	1	R		1	1		1	1	1		1	1		1
Plocamium cartilagineum	1	R		2	1	1	1	1	1	1	1	1	1	1
Plumaria plumosa	1	R		2	1			1	1	1	1	1	1	1
Polyides rotundus	1	R		1	1		1		1	1	1			1
Polysiphonia fucoides	1	R		2	1	1	1	1	1	1				
Polysiphonia lanosa	1	R		2	1	1	1	1	1	1	1	1	1	1
Polysiphonia sp.	1	R		2	1	1	1		1		1	1	1	
Porphyra leucosticta	1	R	1	2					1				1	
Porphyra umbilicalis	1	R	1	2	1	1	1	1				1	1	
Ptilota gunneri	1	R		2	1	1	1		1		1	1	1	1
Rhodomela confervoides	1	R		2	1			1		1		1		
Rhodothamniella floridula	1	R		2	1	1	1		1	1	1	1	1	

Table 1 continued on next page

Table 1 continued

Number of green species	6	3	4	5	4	5	4	6	4	5
Number of brown species	11	8	7	11	11	11	10	10	9	11
Number of red species	25	19	23	25	25	22	23	26	21	21
Number of opportunists	4	3	3	3	3	2	3	4	5	3
ESG1	17	14	14	21	20	21	19	20	17	21
ESG2	25	16	20	20	20	17	18	22	17	16
Summary										
Species Richness	42.00	30.00	34.00	41.00	40.00	38.00	37.00	42.00	34.00	37.00
Proportion of Greens	14.29	10.00	11.76	12.20	10.00	13.16	10.81	14.29	11.76	13.51
Proportion of Reds	59.52	63.33	67.65	60.98	62.50	57.89	62.16	61.90	61.76	56.76
ESG Ratio	1.47	1.14	1.43	0.95	1.00	0.81	0.95	1.10	1.00	0.76
Proportion of Opportunists	9.52	10.00	8.82	7.32	7.50	5.26	8.11	9.52	14.71	8.11
Shore description										
SCORES	Sarah and Clare	Kirsty & Jeni	Mhairi & Carol	Lee & Laura B	Rolf & Gesche	Ian & Phil	Tim & Rachel	Gillian & Nuala	Joe & Rebecca	Alexia & Laura C
Species Richness	0.835	0.689	0.778	0.829	0.824	0.812	0.806	0.835	0.778	0.806
Proportion of Rhodophyta	0.816	0.833	0.853	0.823	0.830	0.809	0.828	0.827	0.826	0.803
ESG Ratio	1.271	0.943	1.229	0.752	0.800	0.610	0.747	0.900	0.800	0.524
Proportion of Chlorophyta	0.763	0.833	0.804	0.797	0.833	0.795	0.820	0.763	0.804	0.785
Proportion of opportunists	0.810	0.800	0.824	0.854	0.850	0.895	0.838	0.810	0.615	0.838
Shore descriptions	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350
FINAL SCORE	0.807	0.741	0.806	0.734	0.748	0.712	0.731	0.747	0.695	0.684
FINAL CLASSIFICATION	**High**	**Good**	**High**	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**	**Good**
Richness and Shore summed	**0.969**	**0.890**	**0.967**	**0.881**	**0.897**	**0.854**	**0.878**	**0.897**	**0.835**	**0.821**
	High	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**

Table 2. The values which were inputted to the spreadsheet used in the calculation of the EQR representing the values assigned to the boundaries between the five ecological quality classes.

Scores	bad	bad	poor	poor	moderate	moderate	good	good	high	high
EQR	**0**	**0.2**	**0.2**	**0.4**	**0.4**	**0.6**	**0.6**	**0.8**	**0.8**	**1**
Species Richness calculation	0	5	6	17	18	25	26	35	36	70
Proportion of Rhodophyta	0	15	16	35	36	45	46	55	56	100
ESG Ratio	0	0.2	0.2	0.7	0.7	0.8	0.8	1	1	1.2
Proportion of Chlorophyta	100	81	80	31	30	21	20	13	12	0
Proportion of opportunists	100	51	50	26	25	16	15	11	10	0
Shore descriptions	0	0	18	16	15	11	10	7	6	1
formula values										
EQR										
Species Richness calculation	6		18		26		36		70	
Proportion of Rhodophyta	16		36		46		56		100	
ESG Ratio	0.2		0.7		0.8		1		1.2	
Proportion of Chlorophyta	81		31		21		13		0	
Proportion of opportunists	51		26		16		11		0	
Shore descriptions	0		16		11		7		1	
Class widths										
EQR	0.2		0.2		0.2		0.2		0.2	
Species Richness calculation	5.0		11.0		7.0		9.0		34.0	
Proportion of Rhodophyta	15.0		19.0		9.0		9.0		44.0	
ESG Ratio	0.2		0.5		0.1		0.2		0.2	
Proportion of Chlorophyta	19.0		49.0		9.0		7.0		12.0	
Proportion of opportunists	49.0		24.0		9.0		4.0		10.0	
Shore descriptions	0.0		2.0		4.0		3.0		5.0	

Table 3. The values calculated by the spreadsheet for each component used in calculation of the EQR together with an estimate of variation between the ten groups for each of these measures.

STATISTICS															
	Sarah and Clare	Kirsty & Jeni	Mhairi & Carol	Lee & Laura B	Rolf & Gesche	Ian & Phil	Tim & Rachel	Gillian & Nuala	Joe & Rebecca	Alexia & Laura C					
	SEPA Aberdeen	SEPA East Kilbride	SEPA Dingwall	SEPA Riccarton	Germany	NHM & Aquatonics	UNICOM arine	EHS	EHS & St Andrews	HWU MSc students	mean	min	max	sd	sd as % mean
NUMERICAL TOTALS OF SPECIES IN EACH CATEGORY															
Number of green species	6	3	4	5	4	5	4	6	4	5	4.6	3.0	6.0	0.97	21.1
Number of brown species	11	8	7	11	11	11	10	10	9	11	9.9	7.0	11.0	1.45	14.6
Number of red species	25	19	23	25	25	20	23	26	21	21	22.8	19.0	26.0	2.44	10.7
Number of opportunists	4	3	3	3	3	2	3	4	5	3	3.3	2.0	5.0	0.82	24.8
ESG1	17	14	14	21	20	19	19	20	17	21	18.2	14.0	21.0	2.62	14.4
ESG2	25	16	20	20	20	17	18	22	17	16	19.1	16.0	25.0	2.88	15.1
SUMMARY OF TOTALS, PERCENTAGES, PROPORTIONS AND RATIOS NEEDED FOR CALCULATION OF CLASSIFICATION SCORES															
Species Richness calculation	42.00	30.00	34.00	41.00	40.00	36.00	37.00	42.00	34.00	37.00	37.30	30.00	42.00	3.97	10.6
Proportion of Rhodophyta	59.52	63.33	67.65	60.98	62.50	55.56	62.16	61.90	61.76	56.76	61.21	55.56	62.50	3.40	5.6
ESG Ratio	1.47	1.14	1.43	0.95	1.00	0.89	0.95	1.10	1.00	0.76	1.07	0.76	1.10	0.23	21.5
Proportion of Chlorophyta	13.95	10.00	11.76	12.20	10.00	13.89	10.81	14.29	11.76	13.51	12.22	10.00	14.29	1.63	13.3
Proportion of opportunists	9.30	10.00	8.82	7.32	7.50	5.56	8.11	9.52	14.71	8.11	8.90	5.56	14.71	2.41	27.1
Shore descriptions	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	na	na
SCORES FOR EACH METRIC CALCULATED ACCORDING TO SLIDING SCALE INSTRUCTIONS															
Species Richness	0.835	0.689	0.778	0.829	0.824	0.812	0.806	0.835	0.778	0.806	0.799	0.689	0.835	0.043	5.5
Proportion of Rhodophyta	0.816	0.833	0.853	0.823	0.830	0.809	0.828	0.827	0.826	0.803	0.825	0.803	0.853	0.014	1.7
ESG Ratio	1.271	0.943	1.229	0.752	0.800	0.610	0.747	0.900	0.800	0.524	0.858	0.524	1.229	0.24	28.0
Proportion of Chlorophyta	0.763	0.833	0.804	0.797	0.833	0.795	0.820	0.763	0.804	0.785	0.800	0.763	0.833	0.02	3.1
Proportion of opportunists	0.810	0.800	0.824	0.854	0.850	0.895	0.838	0.810	0.615	0.838	0.813	0.615	0.895	0.07	9.2
Shore descriptions	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	0.350	na	
FINAL EQR SCORE CALCULATED FROM AVERAGING OF ALL 6 METRICS ABOVE															
	0.807	0.741	0.806	0.734	0.748	0.712	0.731	0.747	0.695	0.684	0.741	0.684	0.807	0.04	5.5
	HIGH	**GOOD**	**HIGH**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**					
FINAL EQR SCORE CALCULATED FROM AVERAGING 5 METRICS ABOVE COUNTING ADDITION OF SPECIES RICHNESS AND SHORE DESCRIPTION AS ONE METRIC															
	0.969	0.890	0.967	0.881	0.897	0.854	0.878	0.897	0.835	0.821	0.889	0.821	0.969	0.050	5.5
	HIGH	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**					

Table 3 continued

The two sets of final scores below show the change in outcome that can result from changing the ESG status of just one species. *Halidrys siliquosa* is given on the formal RSL list as ESG1 but it can be argued that it should be ESG2. All the results above were obtained ranking this species as ESG2. The two outcomes below result from ranking it as ESG1. Only the final results are shown for *Halidrys* as ESG1 - none of the internediate values are shown.															
FINAL EQR SCORE CALCULATED FROM AVERAGING OF ALL 6 METRICS ABOVE															
	0.785	0.718	0.779	0.719	0.732	0.686	0.715	0.731	0.677	0.663					
	GOOD	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**	**GOOD**					
FINAL EQR SCORE CALCULATED FROM AVERAGING 5 METRICS ABOVE COUNTING ADDITION OF SPECIES RICHNESS AND SHORE DESCRIPTION AS ONE METRIC															
	0.941	0.861	0.935	0.863	0.878	0.823	0.858	0.877	0.812	0.795					
	HIGH	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**GOOD**					

The final lines in Table 3 show that a considerable change can result in the EQR and classification of the shores simply by recategorising a single species between ESG1 and ESG2. This shows the importance of being certain of the status given to each taxon on the RSL.

The sd as % mean of the scores used in EQR calculation in Table 3 shows that the ESG ratio gives rise to much greater variation between sampling groups than any of the other metrics. This could reflect some groups being biased in favour of more obviously identifiable perennial species. To further analyse this would require consideration of individual taxa recorded by each group rather than just the totals of taxa. An analysis of the taxa found by each group is given in Table 4.

Table 4. comparison of the taxa found by each group of 10 samplers sampling the same shore at Skateraw, East Lothian, on 22 March 2007 using the same sampling and identification effort.

TRIAL RSL SURVEY BY 10 GROUPS OF SAMPLERS AT SKATERAW 22 MARCH 2007									
Analysis of taxa found									
Full list of taxa on RSL for Scotland	taxa ranked as opportunist	ESG	taxa found at this site	number of times taxon found	taxa found by every group	taxa found by one group only	taxa found by 5 or more groups	taxa found by less than 5 groups	taxa not found at this site
CHLOROPHYTA									
Blidingia sp.		2	1	5			1		
Chaetomorpha linum	1	2		0					1
Chaetomorpha melagonium		2	1	2				1	
Cladophora rupestris		2	1	10	1		1		
Cladophora sericea		2	1	9			1		
Enteromorpha sp.	1	2	1	10	1		1		
Sykidion moorei		2		0					1
Ulva lactuca	1	2	1	10	1		1		
PHAEOPHYTA									
Alaria esculenta		1	1	5			1		
Ascophyllum nodosum		1	1	10	1		1		
Asperococcus fistulosus		1		0					1
Chorda filum		1		0					1
Chordaria flagelliformis		1		0					1
Cladostephus spongious		2	1	8			1		
Desmarestia aculeata		1	1	1		1		1	
Dictyosiphon foeniculaceus		1	1	1		1		1	
Dictyota dichotoma		1		0					1
Ectocarpus sp.	1	1	1	4				1	
Elachista fucicola		1	1	1		1		1	
Fucus serratus		1	1	10	1		1		
Fucus spiralis		1	1	7			1		
Fucus vesiculosus		1	1	10	1		1		
Halidrys siliquosa		2	1	10	1		1		
Himanthalia elongata		2		0					1
Laminaria digitata		2	1	10	1		1		
Laminaria hyperborea		2	1	8			1		

Table 4 continued on next page

Table 4 continued

Laminaria saccharina		2		0					1
Leathesia difformis		2		0					1
Litosiphon laminariae		2		0					1
Pelvetia canaliculata		1	1	3				1	
Pilayella littoralis	1	2	1	1		1		1	
Ralfsia sp.		1	1	8			1		
Scytosiphon lomentaria		1	1	2				1	
Spongonema tomentosum		1		0					1
RHODOPHYTA									
Aglaothamnion/Callithamnion		2	1	8			1		
Ahnfeltia plicata		2	1	8			1		
Calcareous encrusters		1	1	10	1		1		
Callophyllis laciniata		2		0					1
Ceramium nodulosum		1	1	10	1		1		
Ceramium shuttleworthanium		1	1	5			1		
Chondrus crispus		1	1	10	1		1		
Corallina officinalis		2	1	10	1		1		
Cryptopleura ramosa		1	1	1		1		1	
Cystoclonium purpureum		1	1	2				1	
Delesseria sanguinea		1	1	4				1	
Dilsea carnosa		1	1	3				1	
Dumontia contorta		1	1	10	1		1		
Erythrotrichia carnea		1	1	1		1		1	
Furcellaria lumbricalis		1	1	1		1		1	
Lomentaria articulata		1	1	9			1		
Lomentaria clavellosa		1		0					1
Mastocarpus stellatus		1	1	9			1		
Membranoptera alata		2	1	10	1		1		
Odonthalia dentata		1	1	1		1		1	
Osmundea hybrida		1	1	7			1		
Osmundea pinnatifida		1	1	8			1		
Palmaria palmata		1	1	10	1		1		
Phycodrys rubens		2	1	3				1	
Phyllophora sp.		1	1	7			1		
Plocamium cartilagineum		2	1	10	1		1		
Plumaria plumosa		2	1	8			1		
Polyides rotundus		1	1	6			1		
Polysiphonia fucoides		2	1	6			1		
Polysiphonia lanosa		2	1	10	1		1		
Polysiphonia sp.		2	1	7			1		
Porphyra leucosticta	1	2	1	2				1	
Porphyra umbilicalis	1	2	1	6			1		
Ptilota gunneri		2	1	8			1		
Rhodomela confervoides		2	1	4				1	
Rhodothamniella floridula		2	1	8			1		
total of taxa in category			57		17	8	39	18	13
percentage of Scottish RSL taxa			81		24	11	56	26	19
percentage of taxa found at this site			100		30	14	68	32	23

On this one shore while the ten groups as a whole found 81% of the taxa on the Scottish RSL only 24% of the RSL taxa were found by every group, 11% were found by one group only and 56% by over half of the groups. Clearly different groups do find different taxa even though they result in broadly the same quality classification of the shore from each group.

The list of taxa found by every group consists mainly of well known and usually very common and easily identifiable entities: *Cladophora rupestris*, *Enteromorpha* sp., *Ulva lactuca*, *Ascophyllum nodosum*, *Fucus serratus*, *Fucus vesiculosus*, *Halidrys siliquosa*, *Laminaria digitata*, calcareous encrusters, *Ceramium nodulosum*, *Chondrus crispus*, *Corallina officinalis*, *Dumontia contorta*, *Membranoptera alata*, *Palmaria palmata*, *Plocamium cartilagineum*, and *Polysiphonia lanosa*. Almost all of these can be identified with the naked eye.

The list of taxa that were found by one group only includes ones that require microscopic identification or which were not in the author's opinion very common on this shore: *Desmarestia aculeata*, *Dictyosiphon foeniculaceus*, *Elachista fucicola*, *Pilayella littoralis*, *Erythrotrichia carnea*, *Furcellaria fastigiata* and *Odonthalia dentata*. But they are otherwise common species which are not usually hard to identify.

It is useful also to consider the relative contribution by each of the two members of a single sampling group. Group 1 has kindly supplied their full set of recordings including RSL taxa taken fully to species level and also species which are not on the RSL since this group subsequently completed a full listing of taxa for this site (Table 5). They found 70 species of which 42 are RSL taxa. Of the two workers, Clare recorded 52 species and Sarah recorded 51 species. 46% of species were recorded by both; 27% by Sarah only and 29% by Clare only. However when RSL taxa only are considered the picture changes to 31 taxa found by both workers (74%), 6 taxa by Clare only (14%) and 5 taxa by Sarah only (12%). This gives support to the idea that RSL taxa are the ones more likely to be recorded by different workers.

These results are not fully discussed and analysed here but are presented so that further discussion and analysis could be carried out if appropriate (e.g. at MPTT meeting in Belfast November 2007).

Table 5. Taxa recorded by the two members of one group (Sarah Holt and Clare Scanlan). Taxa shaded in red were found by both workers. Taxa shaded in blue were recorded by Sarah only (also marked +) and taxa shaded in yellow were recorded by Clare only (also marked ++).

Chlorophyta	Phaeopyta	Rhodophyta
#Blidingia marginata (+)	*Alaria esculenta (+)	#Aglaothamnion hookeri (+)
#Blidingia minima (++)	*Ascophyllum nodosum	*Ahnfeltia plicata
Chaetomorpha mediterranea (+)	*Cladostephus spongiosus	Audouinella daveyii
*Chaetomorpha melagonium (++)	*Fucus serratus	Audouinella microscopica (+)
*Cladophora rupestris	*Fucus spiralis	Erythrodermis allenii (on Ph. truncata) (++)
*Cladophora sericea	*Fucus vesiculosus	Ceramium gaditanum (+)
#Enteromorpha compressa (intestinalis) (++)	*Halidrys siliquosa	*Ceramium nodulosum (virgatum) (+)
#Enteromorpha intestinalis (+)	*Laminaria digitata	Ceramium pallidum (++)
#Enteromorpha prolifera (++)	*Laminaria hyperborea	*Chondrus crispus
Entocladia flustrae (on bryozoan)	Petalonia fascia (+)	*Corallina officinalis
Entocladia perforans (+)	*Pilayella littoralis (++)	*Dumontia contorta (++)
Entocladia viridis (++)	*Ralfsia verrucosa	Gelidium pusillum
Monostroma grevillei (+)	Sphacelaria sp. (on base of Ulva)	Hildenbradia rubra (+)
Prasiola stipitata		#Lithophyllum incrustans (++)
Tellamia contorta (+)		#Lithothamnion glaciale
Ulothrix flacca (++)		*Mastocarpus stellatus
Ulothrix implexa (+)		*Membranoptera alata
Ulothrix speciosa (+)		*Osmundea hybrida
*Ulva lactuca		Osmundea osmunda
Urospora penicilliformis (++)		*Osmundea pinnatifida
		*Palmaria palmata
		*Phycodrys rubens (++)
		#Phyllophora pseudoceranoides (++)
		#Phyllophora truncata
		#Phymatolithon lenormandii (++)
		*Plocamium cartilagineum (+)
		*Plumaria plumose (++)
		*Polyides rotundus
		#Polysiphonia elongata
		*Polysiphonia lanosa
		*Polysiphonia nigrescens (fucoides)
		*Porphyra umbilicalis (+)
		Porphyra linearis (++)
		*Ptilota gunneri (drift only) (++)
		*Rhodomela confervoides (++)
		*Rhodothamniella floridula
		Titanoderma pustulatum
Total Chlorophyta 20	Total Phaeophyta 13	Total Rhodophyta 37

* indicates that this species is on RSL as an individual species
\# indicates that this species is part of a genus or larger grouping on RSL

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