

Supplementary Materials: Hyperspectral Shallow-Water Remote Sensing with an Enhanced Benthic Classifier

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The classification performance of the depth-specific classifiers from step 4 of the workflow was assessed using forward modeled R_{rs} spectra that were subsequently normalized and passed through the classifiers to generate an error matrix (Section 2.4). The error matrix for the 0–2 m depth classifier is given in Table S1. For each row of this matrix 30,000 R_{rs} were modeled using the benthic endmember of that row, normalized, passed through the classifier, then labeled as belonging to most likely output class. Thus for the second row of Table S1, 91.7% of the R_{rs}^M (Brown Algae) spectra were correctly classed as Brown Algae, while 2.0%, 1.8% and 4.6% were misclassified as Turf Algae, Brown Coral and Blue/Brown Coral respectively. The overall classification accuracy for the 0-2 m depth classifier was 98.5%. The error matrices for the 2-4 m, 4-6 m, 6-8 m, 8-10 m, 10-12 m classifiers are presented in Tables S2 to S6. With increasing depth, the overall classification accuracy decreases due to the reduction in the bottom signal. As such the overall classification accuracies for the 0-2 m, 2-4 m, 4-6 m, 6-8 m, 8-10 m and 10-12 m depth classifiers are 98.5%, 98.0%, 89.7% 84.8%, 69.6% and 53.5%, respectively.

Table S1. Error matrix for 0-2 m depth BSP-classifier. Bl/Br. Coral = Blue/Brown Coral and TA/BC = Turf Algae/Brown Coral. The diagonal elements of this matrix contain the correct classification rates for each class, while the off-diagonals represent misclassification rates. The overall classification accuracy for this classifier was 98.5%.

		Predicted Class						
		Seagrass	Brown Algae	Turf Algae	Calc. Algae	Brown Coral	Bl/Br. Coral	TA/BC
Actual Class	Seagrass	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Brown algae	0.0	91.7	2.0	0.0	1.8	0.0	4.6
	Turf algae	0.0	0.0	99.9	0.0	0.0	0.0	0.10
	Calc. algae	0.0	0.0	0.0	100.0	0.0	0.0	0.0
	Brown Coral	0.0	0.0	0.0	0.0	97.7	2.3	0.0
	Bl/Br. Coral	0.0	0.0	0.0	0.0	0.1	99.9	0.0
	TA/BC	0.0	0.0	0.0	0.0	0.0	0	100.0

Table S2. Error matrix for 2–4 m depth BSP-classifier with an overall classification accuracy of 98.0%

		Predicted Class						
		Seagrass	Brown Algae	Turf Algae	Calc. Algae	Brown Coral	Bl/Br. Coral	TA/BC
Actual Class	Seagrass	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Brown algae	0.0	91.1	4.2	0.0	0.0	0.0	4.7
	Turf algae	0.0	0.1	99.1	0.1	0.0	0.0	0.7
	Calc. algae	0.0	0.1	0.0	99.9	0.0	0.0	0.0
	Brown Coral	0.0	0.0	0.0	0.0	96.8	3.2	0.0
	Bl/Br. Coral	0.0	0.0	0.0	0.0	1.0	99.0	0.0
	TA/BC	0.0	0.0	0.1	0.0	0.3	0.0	99.7

Table S3. Error matrix for 4–6 m depth BSP-classifier with an overall classification accuracy of 89.7%

		Predicted Class						TA/BC
		Seagrass	Brown Algae	Turf Algae	Calc. Algae	Brown Coral	Bl/Br. Coral	
Actual Class	Seagrass	100.0	0.0	0.0	0.0	0.0	0.0	0.0
	Brown algae	0.0	48.2	16.5	0.0	0.1	0.0	35.2
	Turf algae	0.0	1.0	90.3	0.0	0.0	0.0	8.6
	Calc. algae	0.0	0.2	0.0	99.7	0.0	0.0	0.1
	Brown Coral	0.0	0.0	0.0	0.0	93.7	6.3	0.0
	Bl/Br. Coral	0.0	0.0	0.0	0.0	2.2	97.7	0.1
	TA/BC	0.0	1.1	0.0	0.0	0.2	0.1	98.6

Table S4. Error matrix for 6–8 m depth BSP-classifier with an overall classification accuracy of 84.8%

		Predicted Class						TA/BC
		Seagrass	Brown Algae	Turf Algae	Calc. Algae	Brown Coral	Bl/Br. Coral	
Actual Class	Seagrass	98.5	0.4	0.0	0.0	0.0	0.6	0.6
	Brown algae	0.0	41.7	3.6	0.0	0.2	0.6	53.9
	Turf algae	0.0	2.4	87.7	0.7	0.0	0.0	9.2
	Calc. algae	0.0	0.4	1.4	98.0	0.0	0.0	0.2
	Brown Coral	0.0	0.0	0.0	0.0	81.4	18.0	0.6
	Bl/Br. Coral	0.0	0.5	0.0	0.0	2.0	93.2	4.3
	TA/BC	0.0	4.7	1.0	0.0	0.3	1.1	92.9

Table S5. Error matrix for 8–10 m depth BSP-classifier with an overall classification accuracy of 69.6%.

		Predicted Class						TA/BC
		Seagrass	Brown Algae	Turf Algae	Calc. Algae	Brown Coral	Bl/Br. Coral	
Actual Class	Seagrass	92.1	2.6	0.0	0.1	2.4	2.0	0.9
	Brown algae	0.0	26.3	2.1	0.3	3.3	14.2	53.8
	Turf algae	0.1	3.2	78.4	5.7	0.6	1.5	10.5
	Calc. algae	0.0	1.1	14.5	81.6	0.2	0.3	2.3
	Brown Coral	0.0	0.3	0.0	0.1	66.1	33.0	0.6
	Bl/Br. Coral	0.0	2.4	0.3	0.2	5.6	71.0	20.5
	TA/BC	0.0	9.5	3.9	0.4	1.8	12.6	71.9

Table S6. Error matrix for 10–12 m depth BSP-classifier with an overall classification accuracy of 53.5%

		Predicted Class						TA/BC
		Seagrass	Brown Algae	Turf Algae	Calc. Algae	Brown Coral	Bl/Br. Coral	
Actual Class	Seagrass	78.0	3.1	0.0	1.0	6.7	7.9	3.3
	Brown algae	0.0	13.2	1.6	3.7	7.4	36.4	37.8
	Turf algae	2.7	2.6	60.9	8.3	1.8	5.3	18.4
	Calc. algae	0.1	0.9	36.8	52.5	0.4	2.3	7.1
	Brown Coral	0.0	0.3	0.0	1.2	53.7	42.9	2.0
	Bl/Br. Coral	0.1	2.1	0.3	2.0	10.3	63.1	22.0
	TA/BC	0.4	7.2	5.0	3.0	4.5	29.0	50.8