

Supplementary Materials: Mussel Shells from Marine Aquaculture Act like Ecosystem Engineers: Legacy Effects on Benthic Communities

Table S1. Pairwise correlation among physicochemical variables (*Spearman* coefficient) by regions.

| Atlantic | | | | | |
|-------------------------------|---------|---------|------------------------------|-------------------------------|---------|
| | Redox | AVS | NH ⁺ ₄ | PO ₄ ³⁻ | OM |
| Redox | 1.0000 | -0.0714 | 0.3412 | 0.2024 | 0.0146 |
| AVS | -0.0714 | 1.0000 | -0.3296 | 0.2144 | 0.6254 |
| NH ⁺ ₄ | 0.3412 | -0.3296 | 1.0000 | 0.2240 | -0.7289 |
| PO ₄ ³⁻ | 0.2024 | 0.2144 | 0.2240 | 1.0000 | 0.1090 |
| OM | 0.0146 | 0.6254 | -0.7289 | 0.1090 | 1.0000 |
| Mediterranean | | | | | |
| | Redox | AVS | NH ⁺ ₄ | PO ₄ ³⁻ | OM |
| Redox | 1.0000 | 0.0078 | -0.3135 | 0.0718 | -0.1360 |
| AVS | 0.0078 | 1.0000 | -0.2070 | -0.1526 | -0.1826 |
| NH ⁺ ₄ | -0.3135 | -0.2070 | 1.0000 | 0.6278 | 0.4926 |
| PO ₄ ³⁻ | 0.0718 | -0.1526 | 0.6278 | 1.0000 | 0.3607 |
| OM | -0.1360 | -0.1826 | 0.4926 | 0.3607 | 1.0000 |

Table S2. Mean, standard deviation, minimum, and maximum values of physicochemical variables at the two regions by mussel shells treatment, by treatments NO= without mussel shells, YES = with mussel shells.

| Mussel shells | Atlantic | | Mediterranean | | Overall | |
|-----------------|--------------|--------------|----------------|---------------|---------------|---------------|
| | NO | YES | NO | YES | NO | YES |
| OM | | | | | | |
| Mean (SD) | 3.64 (0.223) | 4.64 (0.271) | 0.834 (0.112) | 1.03 (0.163) | 2.24 (1.44) | 2.84 (1.86) |
| [Min, Max] | [3.29, 4.11] | [4.28, 5.11] | [0.680, 1.02] | [0.820, 1.36] | [0.680, 4.11] | [0.820, 5.11] |
| REDOX | | | | | | |
| Mean (SD) | -404 (20.6) | -405 (17.4) | -20.2 (23.3) | -61.4 (43.1) | -212 (197) | -233 (178) |
| [Min, Max] | [-440, -355] | [-432, -382] | [-89.5, -1.60] | [-147, -7.10] | [-440, -1.60] | [-432, -7.10] |
| AVS | | | | | | |
| Mean (SD) | 188 (81.4) | 384 (151) | 16.5 (8.23) | 18.7 (21.5) | 102 (105) | 201 (214) |
| [Min, Max] | [90.1, 334] | [160, 707] | [7.62, 35.5] | [0.290, 69.3] | [7.62, 334] | [0.290, 707] |
| NH ₄ | | | | | | |
| Mean (SD) | 90.5 (1.32) | 87.4 (2.19) | 81.9 (47.2) | 129 (15.2) | 86.2 (33.0) | 108 (23.7) |
| [Min, Max] | [88.5, 92.4] | [83.6, 90.8] | [35.6, 217] | [107, 159] | [35.6, 217] | [83.6, 159] |
| PO ₄ | | | | | | |
| Mean (SD) | 37.5 (2.27) | 38.2 (0.883) | 9.71 (2.46) | 12.1 (3.43) | 23.6 (14.4) | 25.1 (13.5) |
| [Min, Max] | [32.2, 39.5] | [36.8, 39.4] | [4.55, 13.8] | [8.13, 17.5] | [4.55, 39.5] | [8.13, 39.4] |

Table S3. Mean \pm standard deviation (SD), median and minimum (Min) and maximum (Max) values of polychaete families abundances (ind m⁻²) in the Atlantic region, by treatments NO= without mussel shells, YES = with mussel shells.

| | NO | YES | Overall |
|-------------------|-----------------|------------------|------------------|
| Ampharetidae | | | |
| Mean (SD) | 6.95 (17.3) | 0 (0) | 3.47 (12.5) |
| Median [Min, Max] | 0 [0, 55.6] | 0 [0, 0] | 0 [0, 55.6] |
| Aphroditidae | | | |
| Mean (SD) | 0 (0) | 6.94 (24.1) | 3.47 (17.0) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 83.3] | 0 [0, 83.3] |
| Capitellidae | | | |
| Mean (SD) | 1630 (1880) | 1480 (782) | 1550 (1410) |
| Median [Min, Max] | 931 [111, 5920] | 1510 [139, 2420] | 1260 [111, 5920] |
| Cirratulidae | | | |
| Mean (SD) | 50.9 (60.2) | 64.8 (76.1) | 57.9 (67.5) |
| Median [Min, Max] | 27.8 [0, 194] | 41.7 [0, 194] | 27.8 [0, 194] |
| Cossuridae | | | |
| Mean (SD) | 2.32 (8.02) | 0 (0) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |
| Dorvilleidae | | | |
| Mean (SD) | 16.2 (32.3) | 6.95 (17.3) | 11.6 (25.8) |
| Median [Min, Max] | 0 [0, 111] | 0 [0, 55.6] | 0 [0, 111] |
| Eunicidae | | | |
| Mean (SD) | 0 (0) | 6.94 (24.1) | 3.47 (17.0) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 83.3] | 0 [0, 83.3] |
| Lumbrineridae | | | |
| Mean (SD) | 4.63 (10.8) | 16.2 (34.4) | 10.4 (25.7) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 111] | 0 [0, 111] |
| Maldanidae | | | |
| Mean (SD) | 2.32 (8.02) | 0 (0) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |
| Nephtyidae | | | |
| Mean (SD) | 2.32 (8.02) | 0 (0) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |
| Nereididae | | | |
| Mean (SD) | 48.6 (37.7) | 34.7 (41.2) | 41.7 (39.3) |
| Median [Min, Max] | 41.7 [0, 111] | 27.8 [0, 139] | 27.8 [0, 139] |
| Onuphidae | | | |
| Mean (SD) | 0 (0) | 4.63 (10.8) | 2.32 (7.84) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 27.8] | 0 [0, 27.8] |
| Orbiniidae | | | |
| Mean (SD) | 2.32 (8.02) | 0 (0) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |
| Paraonidae | | | |
| Mean (SD) | 71.8 (67.5) | 99.5 (63.2) | 85.6 (65.5) |
| Median [Min, Max] | 83.3 [0, 250] | 97.2 [0, 222] | 83.3 [0, 250] |
| Phyllodocidae | | | |
| Mean (SD) | 9.26 (18.1) | 18.5 (64.1) | 13.9 (46.3) |
| Median [Min, Max] | 0 [0, 55.6] | 0 [0, 222] | 0 [0, 222] |
| Poecilochaetidae | | | |
| Mean (SD) | 2.32 (8.02) | 0 (0) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |

| | NO | YES | Overall |
|-------------------|---------------|---------------|---------------|
| Polynoidae | | | |
| Mean (SD) | 0 (0) | 9.26 (24.7) | 4.63 (17.7) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 83.3] | 0 [0, 83.3] |
| Sabellidae | | | |
| Mean (SD) | 4.63 (10.8) | 2.32 (8.02) | 3.47 (9.38) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 27.8] | 0 [0, 27.8] |
| Scalibregmatidae | | | |
| Mean (SD) | 0 (0) | 9.26 (32.1) | 4.63 (22.7) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 111] | 0 [0, 111] |
| Sigalionidae | | | |
| Mean (SD) | 13.9 (32.4) | 0 (0) | 6.94 (23.5) |
| Median [Min, Max] | 0 [0, 83.3] | 0 [0, 0] | 0 [0, 83.3] |
| Spionidae | | | |
| Mean (SD) | 113 (125) | 50.9 (45.6) | 82.2 (97.4) |
| Median [Min, Max] | 55.6 [0, 444] | 41.7 [0, 167] | 55.6 [0, 444] |
| Syllidae | | | |
| Mean (SD) | 4.63 (10.8) | 16.2 (34.4) | 10.4 (25.7) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 111] | 0 [0, 111] |
| Terebellidae | | | |
| Mean (SD) | 2.32 (8.02) | 4.63 (16.0) | 3.47 (12.5) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 55.6] | 0 [0, 55.6] |

Table S4. Mean \pm standard deviation (SD), median and minimum (Min) and maximum (Max) values of polychaete families abundances (ind m⁻²) in the Mediterranean region, by treatments NO= without mussel shells, YES = with mussel shells.

| | NO | YES | Overall |
|-------------------|-------------|---------------|---------------|
| Ampharetidae | | | |
| Mean (SD) | 0 (0) | 2.32 (8.02) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 27.8] | 0 [0, 27.8] |
| Capitellidae | | | |
| Mean (SD) | 23.1 (40.7) | 81.0 (46.6) | 52.1 (52.0) |
| Median [Min, Max] | 0 [0, 139] | 83.3 [0, 167] | 27.8 [0, 167] |
| Chaetopteridae | | | |
| Mean (SD) | 9.26 (13.7) | 69.4 (85.0) | 39.4 (67.0) |
| Median [Min, Max] | 0 [0, 27.8] | 41.7 [0, 306] | 27.8 [0, 306] |
| Cirratulidae | | | |
| Mean (SD) | 4.63 (10.8) | 9.26 (18.1) | 6.95 (14.8) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 55.6] | 0 [0, 55.6] |
| Dorvilleidae | | | |
| Mean (SD) | 2.32 (8.02) | 20.8 (41.2) | 11.6 (30.6) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 139] | 0 [0, 139] |
| Eunicidae | | | |
| Mean (SD) | 2.32 (8.02) | 9.26 (18.1) | 5.79 (14.1) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 55.6] | 0 [0, 55.6] |
| Glyceridae | | | |
| Mean (SD) | 2.32 (8.02) | 4.63 (16.0) | 3.47 (12.5) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 55.6] | 0 [0, 55.6] |
| Hesionidae | | | |

| | NO | YES | Overall |
|-------------------|----------------|-------------|-------------|
| Mean (SD) | 2.32 (8.02) | 2.32 (8.02) | 2.32 (7.84) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 27.8] | 0 [0, 27.8] |
| Lumbrineridae | | | |
| Mean (SD) | 23.1 (28.6) | 2.32 (8.02) | 12.7 (23.1) |
| Median [Min, Max] | 13.9 [0, 83.3] | 0 [0, 27.8] | 0 [0, 83.3] |
| Magelonidae | | | |
| Mean (SD) | 0 (0) | 2.32 (8.02) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 27.8] | 0 [0, 27.8] |
| Maldanidae | | | |
| Mean (SD) | 0 (0) | 6.95 (12.6) | 3.47 (9.38) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 27.8] | 0 [0, 27.8] |
| Nephtyidae | | | |
| Mean (SD) | 9.26 (18.1) | 6.95 (17.3) | 8.10 (17.3) |
| Median [Min, Max] | 0 [0, 55.6] | 0 [0, 55.6] | 0 [0, 55.6] |
| Nereididae | | | |
| Mean (SD) | 13.9 (25.1) | 23.1 (33.1) | 18.5 (29.2) |
| Median [Min, Max] | 0 [0, 83.3] | 0 [0, 83.3] | 0 [0, 83.3] |
| Onuphidae | | | |
| Mean (SD) | 0 (0) | 4.63 (16.0) | 2.32 (11.3) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 55.6] | 0 [0, 55.6] |
| Opheliidae | | | |
| Mean (SD) | 0 (0) | 4.63 (16.0) | 2.32 (11.3) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 55.6] | 0 [0, 55.6] |
| Orbiniidae | | | |
| Mean (SD) | 4.63 (10.8) | 2.32 (8.02) | 3.47 (9.38) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 27.8] | 0 [0, 27.8] |
| Oweniidae | | | |
| Mean (SD) | 0 (0) | 4.63 (10.8) | 2.32 (7.84) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 27.8] | 0 [0, 27.8] |
| Paraonidae | | | |
| Mean (SD) | 23.1 (35.2) | 13.9 (22.2) | 18.5 (29.2) |
| Median [Min, Max] | 0 [0, 111] | 0 [0, 55.6] | 0 [0, 111] |
| Pectinariidae | | | |
| Mean (SD) | 4.63 (10.8) | 0 (0) | 2.32 (7.84) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |
| Phyllodocidae | | | |
| Mean (SD) | 4.63 (16.0) | 2.32 (8.02) | 3.47 (12.5) |
| Median [Min, Max] | 0 [0, 55.6] | 0 [0, 27.8] | 0 [0, 55.6] |
| Poecilochaetidae | | | |
| Mean (SD) | 23.1 (28.6) | 18.5 (24.7) | 20.8 (26.2) |
| Median [Min, Max] | 13.9 [0, 83.3] | 0 [0, 55.6] | 0 [0, 83.3] |
| Sabellidae | | | |
| Mean (SD) | 2.32 (8.02) | 0 (0) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 0] | 0 [0, 27.8] |
| Scalibregmatidae | | | |
| Mean (SD) | 4.63 (10.8) | 9.26 (24.7) | 6.94 (18.8) |
| Median [Min, Max] | 0 [0, 27.8] | 0 [0, 83.3] | 0 [0, 83.3] |
| Sigalionidae | | | |
| Mean (SD) | 0 (0) | 2.32 (8.02) | 1.16 (5.67) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 27.8] | 0 [0, 27.8] |

| | NO | YES | Overall |
|-------------------|---------------|-----------------|---------------|
| Spionidae | | | |
| Mean (SD) | 0 (0) | 64.3 (223) | 32.2 (158) |
| Median [Min, Max] | 0 [0, 0] | 0 [0, 772] | 0 [0, 772] |
| Syllidae | | | |
| Mean (SD) | 48.6 (44.5) | 127 (84.1) | 88.0 (77.1) |
| Median [Min, Max] | 41.7 [0, 111] | 125 [27.8, 333] | 83.3 [0, 333] |



Figure S1. Experimental units, with different type of sediment depending on the region and two treatments, with mussel shells and without mussel shells, were deployed on the sea bottom and collected after 35 days.

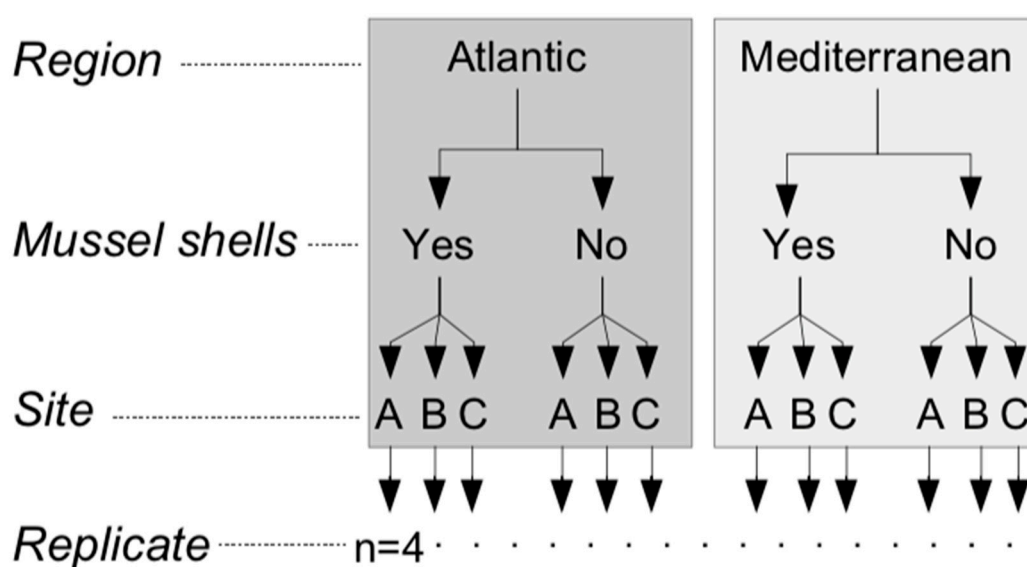


Figure S2. Experimental design for comparison of physicochemical variables and abundance of fauna. Polychaete families, due to the different assemblage structure, were analyzed separately by region.