Supplementary Material

**Spatio-temporal patterns in the coral reef communities of the Spermonde Archipelago, 2012-2014, II: Fish assemblages display structured variation related to benthic condition**

**1 Supplementary Figures and Table**

**1.1 Supplementary Figures**

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**Supplementary Figure 1**. Results of cluster analysis performed on fish abundances at sites within each year. Distance from shore (kms) is indicated in parentheses. Red lines indicate a group of sites that are significantly related (p < 0.05) based on SIMPROF analysis.

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**Supplementary Figure 2.** Eigenvector value, or loading, on the first three PCs of the PCA (Fig. S2) performed on the benthic assemblages (Table 2).



**Supplementary Figure 3**. Principal component analysis on the benthic community (Table 2) with colors indicating years (white = 2012, gray = 2013, black = 2014). Vectors indicate benthic groups (Rub = rubble, Algae = algae, ReefBuild = reef builders and OI = other invertebrates). Principal components one and two were used in subsequent multivariate GLM of fish communities (Table S1 & S2). Values in parentheses indicate percentage variation accounted for by that PC. Symbols indicate sites (up triangle = Laelae, diamond = Samalona, square = Barrang Lompo, circle = Bonetambung, hexagon = Badi, down triangle = Lumulumu, star = Karang Kassi, plus = Kapoposang)

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**Supplementary Figure 4**. Principal component analysis on water variables (Teichberg et al. accepted). Vectors indicate dissolved organic carbon (DOC), chlorophyll *a* (Chl\_ug/l), light attenuation (Kd), particulate organic matter (POM), ratio of Nitrogen:Phosphorus (N/P) and dissolved oxygen (HDO\_mg/l). The year of sampling also accompanies each site symbol. Values in parentheses indicate percentage variation accounted for by that PC.

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**Supplementary Figure 5**. Principal component analysis of fish community indices. Vectors indicate the total number of species (Spp), total abundance (Abund), total fish community biomass (TotBiomass), herbivore biomass (HerbBiomass), the slope of the community-wide size-frequency distribution (Slope) and its y-intercept rescaled to the mid-point (Int). The year of sampling also accompanies each site symbol.

**1.2 Supplementary Tables**

**Supplementary Table 1**. Fish taxa (indicated with ‘X’) contributing at least 0.1% of the total abundance across samples for each year. The total number of fish species, including those species that were removed before analyses, is given at the bottom. Significant relationships with either benthic PC1 or 2, as indicated from individual species GLMs, are listed below the species when significant.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | 2012 | 2013 | 2014 |  | Species | 2012 | 2013 | 2014 |
| *Acanthurus nigrofuscus* |  |  | X |  | *Hemiglyphidodon plagiometopon* | X | X | X |
| *Aeoliscus strigatus* | X | X |  |  | *Hemigymnus melapterus*  2014: PC1: 7.511, 0.010 |  |  | X |
| *Amblyglyphidodon aureus* | X | X |  |  | *Labracinus cyclophthalmus* |  |  | X |
| *Amblyglyphidodon curacao*  2012: PC1: 4.45, 0.044  2013: PC2: 9.388, 0.021  2014: PC1: 5.566, 0.034  2014: PC2: 6.839, 0.012 | X | X | X |  | *Labroides dimidiatus* |  | X |  |
| *Amblyglyphidodon leucogaster* | X |  |  |  | *Neoglyphidodon nigroris*  2012: PC1: 11.646, 0.002  2013: PC1: 6.986, 0.004  2014: PC1: 12.573, 0.001  2014: PC2: 4.592, 0.021 | X | X | X |
| *Amphiprion clarkii*  2014: PC2: 9.163, 0.003 | X |  | X |  | *Neopomacentrus filamentosus*  2013: PC2: 7.059, 0.022  2014: PC1: 5.319, 0.046 | X | X | X |
| *Cephalopholis boenak* |  |  | X |  | *Odonus niger*  2013: PC1: 9.712, 0.017 | X | X | X |
| *Centropyge vroliki* | X |  |  |  | *Ostorhinchus compressus* | X |  |  |
| *Chaetodon kleinii*  2013: PC1: 5.629, 0.039  2013: PC2: 10.421, 0.020 | X | X |  |  | *Oxycheilinus digrammus* | X |  | X |
| *Chaetodon octofasciatus* | X | X | X |  | *Oxycheilinus orientalis* |  |  | X |
| *Cheilinus fasciatus*  2012: PC2: 6.954. 0.019  2014: PC1: 3.99, 0.046 | X | X | X |  | *Plectroglyphidodon lacrymatus* | X | X | X |
| *Cheilodipterus singapurensis* | X | X |  |  | *Pomacentrus adelus*  2012: PC2: 8.942, 0.005  2013: PC2: 6.52, 0.041 | X | X | X |
| *Chlorurus bleekeri* | X | X | X |  | *Pomacentrus alexanderae*  2012: PC2: 7.635, 0.040  2014: PC2: 5.65, 0.047 | X | X | X |
| *Chlorurus sordidus*  2014: PC1: 6.695, 0.047 | X | X | X |  | *Pomacentrus amboinensis*  2013: PC1: 10.196, 0.004 | X | X | X |
| *Chromis margaritifer*  2012: PC1: 11.749, 0.017  2013: PC1: 8.729, 0.017 | X | X |  |  | *Pomacentrus aurifrons*  2013: PC2: 10.826, 0.004  2014: PC1: 8.097, 0.004 | X | X | X |
| *Chromis ternatensis* | X |  |  |  | *Pomacentrus auriventris* | X |  |  |
| *Chromis viridis* | X |  |  |  | *Pomacentrus bankanensis*  2012: PC1: 5.182, 0.057 | X |  | X |
| *Chrysiptera hemicyanea* | X |  |  |  | *Pomacentrus brachialis* | X |  |  |
| *Chrysiptera rex*  2013: PC1: 5.568, 0.008 | X | X | X |  | *Pomacentrus burroughi*  2013: PC1: 4.543, 0.037  2014: PC2: 3.561, 0.048 | X | X | X |
| *Chrysiptera rollandi*  2012: PC2: 10.21, 0.003  2013: PC1: 5.403, 0.011  2013: PC2: 7.808, 0.009 | X | X | X |  | *Pomacentrus lepidogenys*  2013: PC1: 13.605, 0.008 | X | X | X |
| *Chrysiptera talboti* |  |  | X |  | *Pomacentrus moluccensis*  2013: PC2: 9.01, 0.009  2014: PC2: 11.538, 0.001 | X | X | X |
| *Cirrhilabrus cyanopleura*  2014: PC1: 6.411, 0.035 | X | X | X |  | *Pomacentrus nigromarginatus* | X |  |  |
| *Cirrhilabrus ryukyuensis* | X | X | X |  | *Pomacentrus tripunctatis*  2012: PC1: 7.596, 0.009  2014: PC2: 23.392, 0.004 | X | X | X |
| *Coris gaimard*  2012: PC1: 4.951, 0.047 | X |  |  |  | *Pomacentrus vaiuli*  2013: PC1: 8.962, 0.017 | X | X | X |
| *Ctenochaetus striatus* | X | X | X |  | *Pseudanthias cheirospilos*  2012: PC1: 12.089, 0.013 | X |  |  |
| *Dascyllus aruanus* | X |  |  |  | *Pseudanthias dispar* | X |  |  |
| *Dascyllus trimaculatus* |  |  | X |  | *Pseudanthias huchtii* | X |  |  |
| *Diproctacanthus xanthurus* | X | X | X |  | *Scarus flavipectoralis* | X | X | X |
| *Dischistodus perspicillatus* | X | X |  |  | *Scarus ghobban* | X |  |  |
| *Dischistodus prosopotaenia*  2013: PC2: 8.471, 0.006  2014: PC2: 4.143, 0.040 | X | X | X |  | *Scarus niger*  2013: PC2: 9.26, 0.022 | X | X |  |
| *Epibulus brevis* |  | X | X |  | *Scarus scaber*  2013: PC2: 11.75, 0.005  2014: PC1: 11.644, 0.003 | X | X | X |
| *Halichoeres chloropterus*  2012: PC2: 9.814, 0.007 | X |  |  |  | *Scolopsis xenochrous*  2013: PC2: 13.399, 0.016  2014: PC1: 7.362, 0.013  2014: PC2: 5.806, 0.038 | X | X | X |
| *Halichoeres hortulanus* | X |  |  |  | *Siganus corallinus* | X |  |  |
| *Halichoeres leucoxanthus* | X |  |  |  | *Siganus doliatus*  2013: PC1: 10.606, 0.003 |  | X | X |
| *Halichoeres leucurus*  2013: PC2: 11.532, 0.004 | X | X | X |  | *Siganus vulpinus*  2014: PC1: 9.152, 0.005 | X |  | X |
| *Halichoeres melanurus*  2013: PC1: 6.713, 0.018 | X | X | X |  | *Thalassoma amblycephalum*  2012: PC1: 5.014, 0.036 | X |  |  |
| *Halichoeres prosopeion* |  |  | X |  | *Thalassoma hardwicke*  2012: PC1: 5.07, 0.032  2014: PC1: 5.962, 0.028 | X | X | X |
| *Halichoeres richmondi* | X |  |  |  | *Thalassoma lunare*  2012: PC2: 8.327, 0.006 | X | X | X |
|  |  |  |  |  | *Zebrasoma scopas*  2012: PC1: 5.406, 0.041 | X |  |  |
|  |  |  |  |  | **Total Species (n) at 0.1%** | **66** | **43** | **47** |
|  |  |  |  |  | **Total** | **125** | **111** | **117** |

**Supplementary Table 2**. The multivariate relationship between fish groups and the benthos. The first two principal components of the benthic assemblage (Fig. S2) were assessed against all species that make up a species group specific to a year. Significant p-values are given in bold and they are also indicated as subscripts to species groups in Figs. 3-5.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | 2012 | | 2013 | | 2014 | |
| Fish  group | PC | Resid. df and  df diff | Dev. | p | Dev. | p | Dev. | p |
| A | PC1 | 22,1 | 59.15 | **0.02** | 17.82 | **0.03** | 7.21 | 0.42 |
|  | PC2 | 21,1 | 68.42 | **0.01** | 34.01 | **<0.01** | 11.89 | 0.16 |
| B | PC1 | 22,1 | 3.64 | 0.64 | 28.37 | 0.14 | 92.79 | **<0.01** |
|  | PC2 | 21,1 | 13.71 | 0.15 | 92.86 | **<0.01** | 51.16 | **0.02** |
| C | PC1 | 22,1 | 23.14 | 0.10 | 9.05 | 0.18 | 12.90 | 0.09 |
|  | PC2 | 21,1 | 10.07 | 0.59 | 21.29 | **0.04** | 14.74 | 0.06 |
| D | PC1 | 22,1 | 10.58 | 0.19 | 7.47 | 0.19 | 25.44 | 0.11 |
|  | PC2 | 21,1 | 4.94 | 0.55 | 35.24 | **0.02** | 5.87 | 0.70 |
| E | PC1 | 22,1 | 1.41 | 0.79 | 21.84 | **0.00** | 1.34 | 0.52 |
|  | PC2 | 21,1 | 1.83 | 0.66 | 2.75 | 0.58 | 2.10 | 0.25 |
| F | PC1 | 22,1 | 53.47 | **0.03** | 48.82 | **0.02** | 6.75 | 0.08 |
|  | PC2 | 21,1 | 18.27 | 0.35 | 21.07 | 0.40 | 24.84 | **0.01** |
| G | PC1 | 22,1 | 10.13 | **0.04** | 4.64 | 0.61 |  |  |
|  | PC2 | 21,1 | 0.91 | 0.70 | 11.71 | 0.19 |  |  |
| H | PC1 | 22,1 | 5.28 | 0.16 |  |  |  |  |
|  | PC2 | 21,1 | 9.14 | 0.15 |  |  |  |  |
| I | PC1 | 22,1 | 2.36 | 0.75 |  |  |  |  |
|  | PC2 | 21,1 | 3.78 | 0.62 |  |  |  |  |