

# PERMANOVA

## Permutational MANOVA

### Resemblance worksheet

Name: ITS2\_Sydney\_OTU\_rm1\_stand\_sqrt\_resem  
 Data type: Similarity  
 Selection: All  
 Standardise Samples by Total  
 Transform: Square root  
 Resemblance: S17 Bray Curtis similarity

Sums of squares type: Type III (partial)  
 Fixed effects sum to zero for mixed terms  
 Permutation method: Unrestricted permutation of raw data  
 Number of permutations: 999

### Factors

Name	Type	Levels
Site	Fixed	3
Habitat	Fixed	5
Season	Fixed	2

### PAIR-WISE TESTS

Term 'SitexHabitatxSeason' for pairs of levels of factor 'Site'

Within level 'Hard coral' of factor 'Habitat'  
 Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	1.0295	0.404	35
Site 1, Site 3	0.9331	0.519	35
Site 2, Site 3	0.80931	0.771	35

### Denominators

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	6
Site 1, Site 3	1*Res	6
Site 2, Site 3	1*Res	6

### Average Similarity between/within groups

	Site 1	Site 2	Site 3
Site 1	25.073		
Site 2	23.282	23.109	
Site 3	16.667	19.513	6.3322

Within level 'Hard coral' of factor 'Habitat'  
 Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	1.1648	0.214	35
Site 1, Site 3	1.8051	0.064	35
Site 2, Site 3	1.7205	0.115	35

### Denominators

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	6
Site 1, Site 3	1*Res	6
Site 2, Site 3	1*Res	6

### Average Similarity between/within groups

	Site 1	Site 2	Site 3
Site 1	45.026		
Site 2	45.825	50.795	
Site 3	11.898	17.54	18.43

Within level 'Soft coral' of factor 'Habitat'  
 Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	1.1013	0.273	35
Site 1, Site 3	1.2299	0.115	35
Site 2, Site 3	0.90652	0.606	25

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	6
Site 1, Site 3	1*Res	6
Site 2, Site 3	1*Res	6

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	35.284		
Site 2	18.741	7.3073	
Site 3	15.208	10.005	7.8999

Within level 'Soft coral' of factor 'Habitat'  
 Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 2, Site 3	1.7012	0.033	35

*Denominators*

Groups	Denominator	Den.df
Site 2, Site 3	1*Res	6

*Average Similarity between/within groups*

	Site 2	Site 3
Site 2	52.862	
Site 3	14.729	14.437

Within level 'Water' of factor 'Habitat'  
 Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	0.86551	0.479	35
Site 1, Site 3	2.2759	0.029	26
Site 2, Site 3	1.6015	0.033	35

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	6
Site 1, Site 3	1*Res	6
Site 2, Site 3	1*Res	6

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	40.562		
Site 2	28.827	18.484	
Site 3	0	10.288	34.565

Within level 'Water' of factor 'Habitat'  
 Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	1.8439	0.03	25
Site 1, Site 3	1.9138	0.028	18
Site 2, Site 3	1.1165	0.271	35

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	6

Site 1, Site 3 1\*Res 5  
 Site 2, Site 3 1\*Res 5

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	17.736		
Site 2	1.8952	35.219	
Site 3	0	36.544	43.311

Within level 'Sediment' of factor 'Habitat'  
 Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	1.1537	0.392	2
Site 1, Site 3	1.0186	0.361	35
Site 2, Site 3	0.88766	0.704	25

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	4
Site 1, Site 3	1*Res	5
Site 2, Site 3	1*Res	5

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	12.15		
Site 2	0	0	
Site 3	6.7522	6.0231	3.2852

Within level 'Sediment' of factor 'Habitat'  
 Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	13.466	0.333	2
Site 1, Site 3	1.0151	0.563	2
Site 2, Site 3	1.3088	0.271	11

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	1
Site 1, Site 3	1*Res	3
Site 2, Site 3	1*Res	4

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	0		
Site 2	0	91.433	
Site 3	0	9.683	0.95783

Within level 'Macroalgae' of factor 'Habitat'  
 Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	1.1866	0.059	25
Site 1, Site 3	1.2663	0.043	16
Site 2, Site 3	0.89508	0.746	35

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	6
Site 1, Site 3	1*Res	6
Site 2, Site 3	1*Res	6

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	5.6325		
Site 2	1	6.7132	

site 3            0 10.741 8.9715

Within level 'Macroalgae' of factor 'Habitat'  
Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Site 1, Site 2	0.98741	0.592	10
Site 1, Site 3	1.2472	0.021	32
Site 2, Site 3	1.0662	0.193	10

*Denominators*

Groups	Denominator	Den.df
Site 1, Site 2	1*Res	4
Site 1, Site 3	1*Res	5
Site 2, Site 3	1*Res	3

*Average Similarity between/within groups*

	Site 1	Site 2	Site 3
Site 1	4.7025		
Site 2	3.8515	0	
Site 3	0	4.0465	11.022

# PERMANOVA

## Permutational MANOVA

### Resemblance worksheet

Name: ITS2\_Sydney\_OTU\_rm1\_stand\_sqrt\_resem  
 Data type: Similarity  
 Selection: All  
 Standardise Samples by Total  
 Transform: Square root  
 Resemblance: S17 Bray Curtis similarity

Sums of squares type: Type III (partial)  
 Fixed effects sum to zero for mixed terms  
 Permutation method: Unrestricted permutation of raw data  
 Number of permutations: 999

### Factors

Name	Type	Levels
Site	Fixed	3
Habitat	Fixed	5
Season	Fixed	2

### PAIR-WISE TESTS

Term 'SitexHabitatxSeason' for pairs of levels of factor 'Habitat'

Within level 'Site 1' of factor 'Site'  
 Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Hard coral, Soft coral	2.1101	0.031	26
Hard coral, water	1.9451	0.029	35
Hard coral, Sediment	1.5845	0.046	25
Hard coral, Macroalgae	1.4797	0.032	35
Soft coral, water	2.336	0.028	26
Soft coral, Sediment	1.7922	0.02	25
Soft coral, Macroalgae	1.6996	0.027	26
water, Sediment	1.6035	0.087	35
water, Macroalgae	1.5182	0.056	35
Sediment, Macroalgae	0.92693	0.773	35

### Denominators

Groups	Denominator	Den.df
Hard coral, Soft coral	1*Res	6
Hard coral, water	1*Res	6
Hard coral, Sediment	1*Res	5
Hard coral, Macroalgae	1*Res	6
Soft coral, water	1*Res	6
Soft coral, Sediment	1*Res	5
Soft coral, Macroalgae	1*Res	6
water, Sediment	1*Res	5
water, Macroalgae	1*Res	6
Sediment, Macroalgae	1*Res	5

### Average Similarity between/within groups

	Hard coral	Soft coral	water	Sediment	Macroalgae
Hard coral	25.073				
Soft coral	0	35.284			
water	3.6362	0	40.562		
Sediment	0	0	5.016	12.15	
Macroalgae	1.0907	0	4.5104	10.608	5.6325

Within level 'Site 1' of factor 'Site'  
 Within level 'Bleaching' of factor 'Season'

Unique

Groups	t	P(perm)	perms
Hard coral, water	2.0476	0.031	35
Hard coral, Sediment	2.1286	0.183	5
Hard coral, Macroalgae	1.8001	0.038	35
water, Sediment	1.2199	0.209	4
water, Macroalgae	1.1904	0.26	25
Sediment, Macroalgae	1.0726	0.419	4

*Denominators*

Groups	Denominator	Den.df
Hard coral, water	1*Res	6
Hard coral, Sediment	1*Res	3
Hard coral, Macroalgae	1*Res	6
water, Sediment	1*Res	3
water, Macroalgae	1*Res	6
Sediment, Macroalgae	1*Res	3

*Average Similarity between/within groups*

	Hard coral	water	Sediment	Macroalgae
Hard coral	45.026			
water	2.7069	17.736		
Sediment	0	1.6165	0	
Macroalgae	2.3693	4.9783	0	4.7025

Within level 'Site 2' of factor 'Site'

Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Hard coral, Soft coral	1.5433	0.04	26
Hard coral, water	1.6448	0.028	35
Hard coral, Sediment	1.352	0.028	25
Hard coral, Macroalgae	1.5351	0.025	26
Soft coral, water	1.4653	0.036	26
Soft coral, Sediment	1.1188	0.247	7
Soft coral, Macroalgae	1.2434	0.051	16
water, Sediment	1.2587	0.089	35
water, Macroalgae	1.1581	0.174	35
Sediment, Macroalgae	1.112	0.244	7

*Denominators*

Groups	Denominator	Den.df
Hard coral, Soft coral	1*Res	6
Hard coral, water	1*Res	6
Hard coral, Sediment	1*Res	5
Hard coral, Macroalgae	1*Res	6
Soft coral, water	1*Res	6
Soft coral, Sediment	1*Res	5
Soft coral, Macroalgae	1*Res	6
water, Sediment	1*Res	5
water, Macroalgae	1*Res	6
Sediment, Macroalgae	1*Res	5

*Average Similarity between/within groups*

	Hard coral	soft coral	water	Sediment	Macroalgae
Hard coral	23.109				
Soft coral	0	7.3073			
water	4.3936	0	18.484		
Sediment	1.5202	0	2.1228	0	
Macroalgae	0	0	8.6729	0	6.7132

Within level 'Site 2' of factor 'Site'

Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Hard coral, Soft coral	3.6624	0.029	26
Hard coral, water	2.8364	0.035	35
Hard coral, Sediment	3.5351	0.059	11
Hard coral, Macroalgae	1.99	0.062	11

Soft coral, water	2.9117	0.036	26
Soft coral, Sediment	3.7085	0.051	11
Soft coral, Macroalgae	1.8719	0.063	15
Water, Sediment	2.5065	0.069	11
Water, Macroalgae	1.5064	0.055	15
Sediment, Macroalgae	1.7236	0.34	2

*Denominators*

Groups	Denominator	Den.df
Hard coral, Soft coral	1*Res	6
Hard coral, water	1*Res	6
Hard coral, Sediment	1*Res	4
Hard coral, Macroalgae	1*Res	4
Soft coral, water	1*Res	6
Soft coral, Sediment	1*Res	4
Soft coral, Macroalgae	1*Res	4
Water, Sediment	1*Res	4
Water, Macroalgae	1*Res	4
Sediment, Macroalgae	1*Res	2

*Average Similarity between/within groups*

	Hard coral	Soft coral	Water	Sediment	Macroalgae
Hard coral	50.795				
Soft coral	0	52.862			
Water	0.42236	0	35.219		
Sediment	0	0	0	91.433	
Macroalgae	0	5.6127	3.4841	0	0

Within level 'Site 3' of factor 'Site'

Within level 'Pre-bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
Hard coral, Soft coral	1.2406	0.029	15
Hard coral, water	1.6681	0.025	26
Hard coral, Sediment	1.1248	0.137	35
Hard coral, Macroalgae	1.2738	0.06	16
Soft coral, water	1.6652	0.024	25
Soft coral, Sediment	1.1912	0.024	15
Soft coral, Macroalgae	1.2613	0.06	25
Water, Sediment	1.4426	0.031	35
Water, Macroalgae	1.2149	0.288	35
Sediment, Macroalgae	1.168	0.134	25

*Denominators*

Groups	Denominator	Den.df
Hard coral, Soft coral	1*Res	6
Hard coral, water	1*Res	6
Hard coral, Sediment	1*Res	6
Hard coral, Macroalgae	1*Res	6
Soft coral, water	1*Res	6
Soft coral, Sediment	1*Res	6
Soft coral, Macroalgae	1*Res	6
Water, Sediment	1*Res	6
Water, Macroalgae	1*Res	6
Sediment, Macroalgae	1*Res	6

*Average Similarity between/within groups*

	Hard coral	Soft coral	Water	Sediment	Macroalgae
Hard coral	6.3322				
Soft coral	0	7.8999			
Water	0	0.70829	34.565		
Sediment	1.3946	0	4.8736	3.2852	
Macroalgae	0	0.84968	14.919	1.6351	8.9715

Within level 'Site 3' of factor 'Site'

Within level 'Bleaching' of factor 'Season'

Groups	t	P(perm)	Unique perms
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Hard coral, Soft coral	1.5532	0.028	26
Hard coral, Water	1.9811	0.037	35
Hard coral, Sediment	1.2488	0.121	25
Hard coral, Macroalgae	1.4821	0.061	35
Soft coral, Water	1.7635	0.03	35
Soft coral, Sediment	1.2329	0.092	15
Soft coral, Macroalgae	1.3939	0.055	35
Water, Sediment	1.5081	0.024	25
Water, Macroalgae	1.5525	0.092	10
Sediment, Macroalgae	1.1376	0.067	25

*Denominators*

Groups	Denominator	Den.df
Hard coral, Soft coral	1*Res	6
Hard coral, Water	1*Res	5
Hard coral, Sediment	1*Res	6
Hard coral, Macroalgae	1*Res	5
Soft coral, Water	1*Res	5
Soft coral, Sediment	1*Res	6
Soft coral, Macroalgae	1*Res	5
Water, Sediment	1*Res	5
Water, Macroalgae	1*Res	4
Sediment, Macroalgae	1*Res	5

*Average Similarity between/within groups*

	Hard coral	Soft coral	Water	Sediment	Macroalgae
Hard coral	18.43				
Soft coral	0	14.437			
Water	0	3.2314	43.311		
Sediment	2.2938	0.32778	2.593	0.95783	
Macroalgae	0	0	9.5658	1.3903	11.022



# PERMANOVA

## Permutational MANOVA

### Resemblance worksheet

Name: ITS2\_Sydney\_OTU\_rm1\_stand\_sqrt\_resem  
 Data type: Similarity  
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 Transform: Square root  
 Resemblance: S17 Bray Curtis similarity

Sums of squares type: Type III (partial)  
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### Factors

Name	Type	Levels
Site	Fixed	3
Habitat	Fixed	5
Season	Fixed	2

### PAIR-WISE TESTS

Term 'SitexHabitatxSeason' for pairs of levels of factor 'Season'

Within level 'Site 1' of factor 'Site'  
 Within level 'Hard coral' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	2.0626	0.032	35

### Denominators

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

### Average Similarity between/within groups

	Pre-bleaching	Bleaching
Pre-bleaching	25.073	
Bleaching	8.6394	45.026

Within level 'Site 1' of factor 'Site'  
 Within level 'Water' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.7006	0.03	35

### Denominators

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

### Average Similarity between/within groups

	Pre-bleaching	Bleaching
Pre-bleaching	40.562	
Bleaching	5.1218	17.736

Within level 'Site 1' of factor 'Site'  
 Within level 'Sediment' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.1713	0.459	2

### Denominators

Groups	Denominator	Den.df

Pre-bleaching, Bleaching 1\*Res 2

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	12.15	
Bleaching	0	0

Within level 'Site 1' of factor 'Site'

Within level 'Macroalgae' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.0357	0.368	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	5.6325	
Bleaching	4.4943	4.7025

Within level 'Site 2' of factor 'Site'

Within level 'Hard coral' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.9895	0.03	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	23.109	
Bleaching	14.559	50.795

Within level 'Site 2' of factor 'Site'

Within level 'Soft coral' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	2.0394	0.028	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	7.3073	
Bleaching	0.37209	52.862

Within level 'Site 2' of factor 'Site'

Within level 'Water' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.6841	0.057	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	18.484	
Bleaching	9.3068	35.219

Within level 'Site 2' of factor 'Site'  
 Within level 'Sediment' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.5442	0.121	3

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	3

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	0	
Bleaching	0	91.433

Within level 'Site 2' of factor 'Site'  
 Within level 'Macroalgae' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.1062	0.272	6

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	4

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	6.7132	
Bleaching	0	0

Within level 'Site 3' of factor 'Site'  
 Within level 'Hard coral' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.2393	0.058	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	6.3322	
Bleaching	5.5701	18.43

Within level 'Site 3' of factor 'Site'  
 Within level 'Soft coral' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.2024	0.182	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	7.8999	
Bleaching	4.4343	14.437

Within level 'Site 3' of factor 'Site'  
 Within level 'Water' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	2.2268	0.027	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	5

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	34.565	
Bleaching	4.8424	43.311

Within level 'Site 3' of factor 'Site'

Within level 'Sediment' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.0335	0.276	15

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	6

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	3.2852	
Bleaching	1.2855	0.95783

Within level 'Site 3' of factor 'Site'

Within level 'Macroalgae' of factor 'Habitat'

Groups	t	P(perm)	Unique perms
Pre-bleaching, Bleaching	1.31	0.066	35

*Denominators*

Groups	Denominator	Den.df
Pre-bleaching, Bleaching	1*Res	5

*Average Similarity between/within groups*

	Pre-bleaching	Bleaching
Pre-bleaching	8.9715	
Bleaching	0.45412	11.022