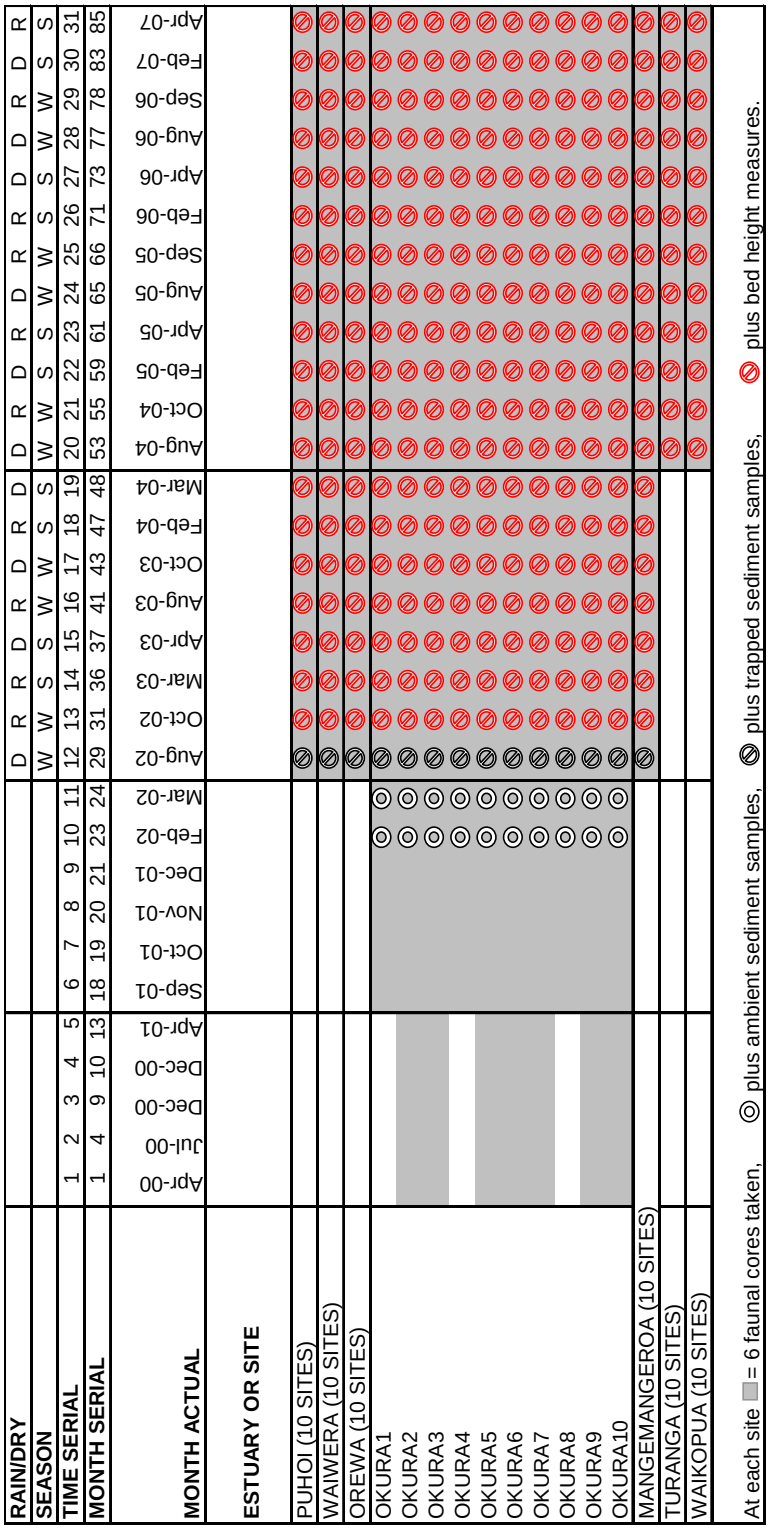
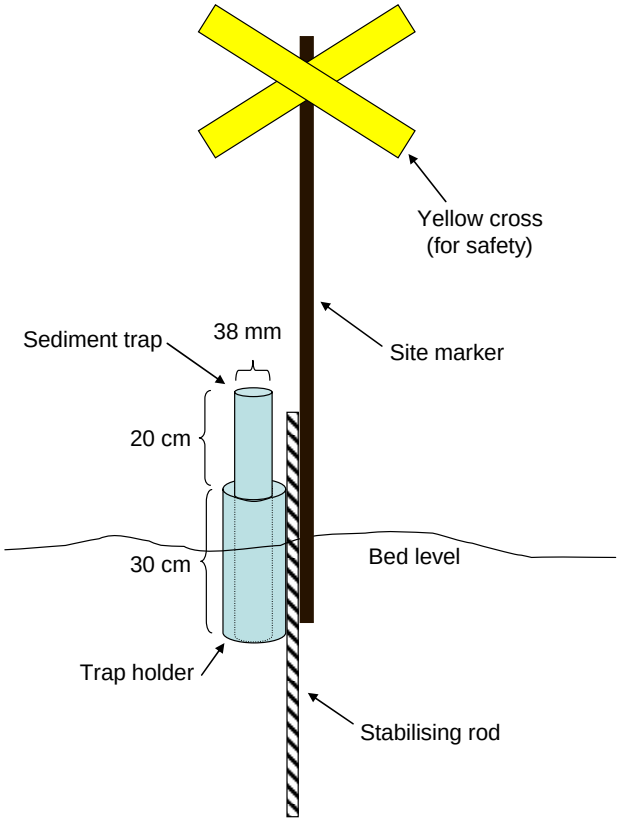
7.3 Appendix 3

Summary timeline of the monitoring programme. Season and rainfall factors are not indicated prior to August 2002, due to differences in sampling design.



7.4 Appendix 4

Schematic diagram of a site marker, showing design of sediment traps.



7.5 Appendix 5

List of taxa. The column labeled "ARC" indicates whether the taxon is one of the variables used for benthic health modeling (BHM) or is unique to this monitoring programme (U).

No.	ARC	Abbrev.	Name	Group	Phylum
1	BHM	Aglmac	*Aglaophamus macroura*	Nephtyidae	Annelida
2	BHM	Alphsp	*Alpheus sp.*	Decapod	Arthropoda
3	BHM	Amalsp	*Amalda sp.*	Gastropoda	Mollusca
5	BHM	Ampcre	*Amphibola crenata*	Gastropoda	Mollusca
4	U	Ampdae	Ampharetidae	Terebellidae	Annelida
6	BHM	Ampoth	Amphipod other	Amphipoda	Arthropoda
7	U	Aneoth	Anemone other	Anthozoa	Cnidaria
8	BHM	Antaur	*Anthopleura aureoradiata*	Anthozoa	Cnidaria
9	BHM	Antdae	Anthuridae	Isopoda	Arthropoda
10	U	Antisp	*Antiguraleus sp.*	Gastropoda	Mollusca
11	BHM	Aonoxy	*Aonides oxycephala*	Spionidae	Annelida
12	BHM	Aquauc	*Aquilaspio aucklandica*	Spionidae	Annelida
13	BHM	Aricsp	*Aricidea sp.*	Paraonidae	Annelida
14	BHM	Armmac	*Armandia maculata*	Opheliidae	Annelida
15	BHM	Artbif	*Arthritica bifurcata*	Bivalvia	Mollusca
16	BHM	Asyamp	*Asychis amphiglypta*	Maldanidae	Annelida
17	BHM	Ausstu	*Austrovenus stutchburyi*	Bivalvia	Mollusca
18	BHM	Barnac	Barnacles	Cirripedia	Arthropoda
19	BHM	Bulquo	*Bulla quoyi*	Opistobranchia	Mollusca
20	BHM	Capoli	*Capitella* spp. and oligochaetes	Capitellids + Oligochaetes	Annelida
21	U	Chaeto	Chaetognath	Chaetognath	Chaetognatha
22	BHM	Chiton	Chiton	Polyplacophora	Mollusca
23	BHM	Cirdae	Cirratulidae	Cirratulidae	Annelida
24	U	Cirssp	*Cirsonella sp.*	Gastropoda	Mollusca
25	U	Cirzel	*Cirsotrema zelebori*	Gastropoda	Mollusca
26	BHM	Colspp	*Colurostylis* spp.	Cumacean	Arthropoda
27	BHM	Comads	*Cominella adspersa*	Gastropoda	Mollusca
28	BHM	Comgla	*Cominella glandiformis*	Gastropoda	Mollusca
29	U	Commac	*Cominella maculosa*	Gastropoda	Mollusca
30	U	Comquo	*Cominella quoyana*	Gastropoda	Mollusca
32	BHM	Cordae	Corophidae	Amphipoda	Arthropoda
31	U	Corzea	*Corbula zealandica*	Bivalvia	Mollusca
33	BHM	Coscon	*Cossura consimilis*	Cossuridae	Annelida
34	BHM	Cragig	*Crassostrea gigas*	Bivalvia	Mollusca
35	BHM	Dilsub	*Diloma subrostrata*	Gastropoda	Mollusca
36	U	Diopsp	*Diopatra sp.*	Onuphidae	Annelida
37	U	Dorvil	Dorvilleidae group1	Dorvilleidae	Annelida
38	U	Dosspp	*Dosinia* spp.	Bivalvia	Mollusca
39	BHM	Edwasp	*Edwardsia sp.*	Anthozoa	Cnidaria
40	U	Epiten	*Epitonium tenellum*	Gastropoda	Mollusca
41	BHM	Euchsp	*Euchone sp.*	Sabellidae	Annelida

No.	ARC	Abbrev.	Name	Group	Phylum
42	U	Eundae	Eunicidae	Eunicidae	Annelida
43	BHM	Eurcoo	*Eurylana cookii*	Isopoda	Arthropoda
44	U	Evechl	*Evechinus chloroticus*	Echinoderm	Echinodermata
45	BHM	Exodae	Exogoninae	Syllidae	Annelida
46	BHM	Exospp	*Exosphaeroma* spp.	Isopoda	Arthropoda
47	BHM	Felaze	*Felaniella zelandica*	Bivalvia	Mollusca
48	U	Felzel	*Fellaster zelandiae*	Echinoderm	Echinodermata
49	BHM	Glyspp	*Glycera* spp.	Glyceriidae	Annelida
50	U	Gnathi	Gnathiidea	Isopoda	Arthropoda
51	U	Gnatho	Gnathostomulida	Gnathostomulida	Gnathostomulida
52	BHM	Gondae	Goniadidae	Glyceriidae	Annelida
53	BHM	Halspp	*Halicarcinus* spp.	Decapod	Arthropoda
54	BHM	Hamzel	*Haminoea zelandiae*	Opistobranchia	Mollusca
55	BHM	Harmsp	*Harmothoe sp.*	Polynoidae	Annelida
56	BHM	Helmac	*Helice*, *Hemigrapsus, Macropthalmus*	Decapod	Arthropoda
57	BHM	Hesdae	Hessionid	Hesionidae	Annelida
58	BHM	Hetfil	*Heteromastus filiformis*	Capitellidae	Annelida
59	U	Holoth	Holothuroidia other	Echinoderm	Echinodermata
60	U	Insect	Insect	Insect	Arthropoda
61	BHM	Isooth	Isopod other	Isopoda	Arthropoda
62	BHM	Lepdae	Lepidontidae	Polynoidae	Annelida
63	U	Leptsp	*Leptograpsus sp.*	Decapod	Arthropoda
64	U	Lignov	*Ligia novaezelandiae*	Isopoda	Arthropoda
67	BHM	Lumdae	Lumbrinereidae	Lumbrineridae	Annelida
65	BHM	Macdae	Mactridae	Bivalvia	Mollusca
66	BHM	Maclil	*Macomona liliana*	Bivalvia	Mollusca
68	BHM	Macste	*Macroclymenella stewartensis*	Maldanidae	Annelida
69	BHM	Magspp	*Magelona* spp.	Magelonidae	Annelida
70	BHM	Manshr	Mantis shrimp	Decapod	Arthropoda
71	U	Melasp	*Melagraphia sp.*	Gastropoda	Mollusca
72	U	Melcyl	*Melanochlamys cylindrica*	Opistobranchia	Mollusca
73	BHM	Micrsp	*Micrelenchus sp.*	Gastropoda	Mollusca
74	BHM	Minspp	*Minuspio* spp.	Spionidae	Annelida
75	U	Mite	Mite	Chelicaerata	Arthropoda
76	U	Modimp	*Modiolarca impacts*	Bivalvia	Mollusca
77	U	Mundae	Munnidae	Isopoda	Arthropoda
78	U	Murdae	Muricidae	Gastropoda	Mollusca
79	BHM	Mussen	*Musculista senhousia*	Bivalvia	Mollusca
80	U	Myastr	*Myadora striata*	Bivalvia	Mollusca
81	BHM	Mysida	Mysidacea	Mysidacea	Arthropoda
82	U	Mytadg	*Mytilus edulis galloprovinciallis*	Bivalvia	Mollusca
83	BHM	Nebala	Nebalace	Nebalace	Arthropoda
84	BHM	Nemert	Nemertean	Nemertean	Nemertina
85	U	Neogsp	*Neoguraleus sp.*	Gastropoda	Mollusca
86	BHM	Nerdae	Nereidae	Nereidae	Annelida
88	U	Nodant	*Nodilittorina antipodium*	Gastropoda	Mollusca
87	BHM	Notosp	*Notomastus sp.*	Capitellidae	Annelida
89	BHM	Notspp	*Notoacmea* spp.	Gastropoda	Mollusca
95	BHM	Nuchar	*Nucula hartvigiana*	Bivalvia	Mollusca

No.	ARC	Abbrev.	Name	Group	Phylum
90	U	Nucoth	Other Nuculidae	Bivalvia	Mollusca
91	U	Odospp	*Odostomia* spp.	Gastropoda	Mollusca
92	U	Onudae	Onuphidae	Onuphidae	Mollusca
93	U	Ophoth	Opheliidae other	Opheliidae	Annelida
94	BHM	Opisto	Opistobranch (Philine type)	Opistobranchia	Mollusca
96	BHM	Orbins	Orbinids	Orbiniidae	Annelida
97	BHM	Owefus	*Owenia fusiformis*	Oweniidae	Annelida
98	U	Pagsp	*Pagurus sp.*	Decapod	Arthropoda
99	BHM	Palaff	*Palaemon affinis*	Decapod	Arthropoda
100	BHM	Papaus	*Paphies australis*	Bivalvia	Mollusca
102	U	Papsub	*Paphies subtriangulata*	Bivalvia	Mollusca
103	BHM	Paramp	*Paralepidonotus ampulliferus*	Polynoidae	Annelida
101	BHM	Paroth	Paraonid other	Paraonidae	Annelida
104	BHM	Parspp	*Paracalliope* spp.	Amphipoda	Arthropoda
105	BHM	Pecaus	*Pectinaria australis*	Pectinarid	Annelida
106	U	Percan	*Perna cannaliculus*	Bivalvia	Mollusca
107	U	Phitar	*Philinopsis taronga*	Opistobranchia	Mollusca
108	BHM	Phoron	Phoronid	Phoronid	Phoronida
109	BHM	Phoxos	Phoxocephalids	Amphipoda	Arthropoda
110	BHM	Physpp	Phyllodocid	Phyllodocidae	Annelida
111	BHM	Pinnsp	*Pinnotheres sp.*	Decapod	Arthropoda
112	BHM	Platyh	Platyhelminth	Platyhelminth	Platyhelminth
113	BHM	Polyco	Polydorid complex	Spionidae	Annelida
114	BHM	Polyno	Polynoid	Polynoidae	Annelida
115	BHM	Ponaus	*Pontophilus australis*	Decapod	Arthropoda
116	U	Powesp	*Powellisetia sp.*	Gastropoda	Mollusca
117	U	Priapu	Priapulid	priapulid	Priapulida
118	U	Pycnog	Pycnogonid	Chelicaerata	Arthropoda
119	U	Risnae	Rissoninae	Gastropoda	Mollusca
120	BHM	Sabdae	Sabellidae	Sabellidae	Annelida
121	U	Scadae	Scalibregmatidae	Scalibregmatidae	Annelida
122	BHM	Scoben	*Scolecolepides benhami*	Orbiniidae	Annelida
123	BHM	Scospp	*Scolelepis* spp.	Spionidae	Annelida
124	U	Serdae	Serpulidae	Serpulidae	Annelida
125	BHM	Sipunc	Sipunculid	Sipunculid	Sipunculida
126	BHM	Solpar	*Solemya parkinson*	Bivalvia	Mollusca
127	U	Solsil	*Soletellina siliqua*	Bivalvia	Mollusca
128	U	Sphdae	Sphaerodoridae	Sphaerodoridae	Annelida
129	U	Sphguo	*Sphaeroma quoyanum*	Isopoda	Arthropoda
130	BHM	Spioth	Spionid other	Spionidae	Annelida
131	U	Spirsp	*Spirorbis sp.*	Serpulidae	Annelida
132	BHM	Syldae	Syllinae	Syllidae	Annelida
133	BHM	Tanaid	Tanaidacea	Tanaidacea	Arthropoda
134	U	Terdae	Terebellidae	Terebellidae	Annelida
135	U	Thashr	Thalassinoidia	Decapod	Arthropoda
136	BHM	Thelub	*Theora lubrica*	Bivalvia	Mollusca
137	BHM	Traole	*Travisa olens*	Opheliidae	Annelida
139	BHM	Troden	*Trochotodota dendyi*	Echinoderm	Echinodermata
138	BHM	Turbsp	*Turbonilla sp.*	Gastropoda	Mollusca
140	U	Tursma	*Turbo smaragdus*	Gastropoda	Mollusca

No.	ARC	Abbrev.	Name	Group	Phylum
141	BHM	Unbiva	Unidentified Bivalve	Bivalvia	Mollusca
142	U	Uncrab	Unidentified Crab	Decapod	Arthropoda
143	U	Uncrus	Unidentified Crustacean	Crustacean	Arthropoda
144	BHM	Ungast	Unidentified Gastropod	Gastropoda	Mollusca
145	U	Unpoly	Unidentified Polychaete	Polychaete	Annelida
146	BHM	Veniae	Venericardiae	Bivalvia	Mollusca
147	BHM	Waibre	*Waitangi brevirostris*	Amphipoda	Arthropoda
148	U	Xenspp	*Xenostrobus* spp.	Bivalvia	Mollusca
150	BHM	Xymsp	*Xymene sp.*	Gastropoda	Mollusca
149	BHM	Zealut	*Zeacumantus lutulentis*	Gastropoda	Mollusca
151	U	Zeaspp	*Zeacolpus* spp.	Gastropoda	Mollusca
152	BHM	Zegten	*Zegalerus tenius*	Gastropoda	Mollusca
153	U	Zenasp	*Zenatia sp.*	Bivalvia	Mollusca

7.6 Appendix 6

Changes in the methods for sampling and processing of ambient sediments over time

Sediment sampling began in September 2001 and used a 38mm diameter corer to a depth of 15cm adjacent to each faunal core (i.e., n = 6 per site). Sediment was then analysed using standard laser grain-size analysis, which provided the percentage volume in different size classes. Due to the unreliability of the laser grain-size analyzer available at the time, a decision was made, in consultation with the ARC, to use wet-sieving instead. Wet-sieving provides a weight of sediment in each grain-size class. This change in methodology occurred in August 2002 (sampling time 12).

Thus, from August 2002 onwards, sample processing was done using wet-sieving after pre-treatment with Calgon. Sediment samples were sub-sampled to obtain a representative known weight of dry material (approximately 60 g). Subsamples were then deflocculated for at least 12 hours and wet sieved on a stack of sieves (500, 250, 125 and 63μm) and each fraction (>500, 250-499, 125-249, 63-124 and <63μm) was dried, weighed and calculated as a percentage of the total weight. The fraction less than 63 μm was calculated by subtraction of all other dry weights from the initial dry weight due to the inherent difficulties in settling and drying these fine sediments.

In response to a review of methodology (Ford et al. 2003b), sample processing was changed again in August 2003 to include a pre-treatment of hydrogen peroxide. From this time onward, sub-samples were treated with 9% Hydrogen peroxide until fizzing ceased, to dissolve organic matter prior to the addition of Calgon. Calibration indicated that this change resulted in a small decrease (up to 8%) in the fine grain-size component of a sample (Ford et al. 2003b, pp. 14-16).

In August 2004, the field methods for sampling ambient sediments changed. One core of ambient sediment (20 mm diameter x 20 mm deep) was obtained adjacent to each faunal core and the contents of all six cores were bulked together to yield approximately 60 g wet weight prior to wet-sieving. This change was made in consultation with the ARC so that sampling would be: (i) consistent with the methods used by other ARC-funded programmes; (ii) more sensitive to surface fine sediment deposits than the previous methodology, (iii) integrating small-scale spatial variation within sites, and (iv) highly correlated with the previous sampling methodology.

As a consequence of the changes in sampling and processing methods outlined above, data on the texture of ambient sediments is only truly comparable from August 2004 (time 20) onwards.

7.7 Appendix 7

Glossary of statistical terms

AIC: "An Information Criterion", described by Akaike (1973), this is a value which is used to compare models of differing complexity which counter-balances the amount of variation explained (R^2) with the number of parameters (variables) used in the model. Smaller values of AIC indicate a better model for a given dataset.

ANOVA: "Analysis of Variance", a classical statistical method for comparing the means of several groups of samples, or examining the effects of treatment levels on a response variable.

Bray-Curtis: a dissimilarity measure, described by Bray and Curtis (1957), interpreted in ecology as a "percentage difference", calculated between two samples (*i* and *j*) on the basis of $k = 1,\ldots, p$ variables. If the value for variable k in sample i is denoted by y_{ik}, then the Bray-Curtis dissimilarity between samples i and j is calculated as:

$$d_{ij} = \frac{\sum_{k=1}^{p} \left| y_{ik} - y_{jk} \right|}{\sum_{k=1}^{p} \left(y_{ik} + y_{jk} \right)}$$

CAP: "Canonical Analysis of Principal Coordinates" (Anderson and Robinson 2003; Anderson and Willis 2003), a method of constrained ordination that finds an axis through a cloud of multivariate samples (on the basis of any distance or dissimilarity measure of choice) that is best at either discriminating *a priori* groups or at distinguishing positions of samples along a given (usually environmental) gradient.

central limit theorem: "CLT", a theorem stating that the distribution of sample means taken from a large population approaches a normal (Gaussian) curve with increases in sample size.

centroid: the multivariate analogue to an average or mean for a single variable. The centroid is a measure of the 'location' of a data cloud in multivariate space.

dbRDA: "Distance-based Redundancy Analysis" (Legendre and Anderson 1999; McArdle and Anderson 2001), a method of constrained ordination, which displays the relationships among sample points from a fitted model, on the basis of any distance or dissimilarity measure of choice. The ordination axes in a dbRDA are linear combinations of the predictor variables in the model that maximally explain variation in the data cloud.

df: "degrees of freedom": (1) *df of a model*: a value which indicates the complexity of a model. The greater the degrees of freedom of the model, the more parameters there are in the model and the more complex it is. (2) *residual df*: a value which indicates the number of pieces of information in a system that are free to vary. Generally, the greater the residual df, the greater the power of a test. Also, as model df go up, residual df go down.

dispersion: a measure of variability or how 'spread out' a set of points are in multivariate space.

distance (or dissimilarity) matrix: a matrix whose entries d_{ij} are the distance (or dissimilarity) values between every pair of N samples (i = 1, …, N rows and j = 1, …, N columns). This matrix is *square* (the number of rows equals the number of columns = N) and *symmetric* (because $d_{ji} = d_{ij}$) and each of the values along the diagonal, d_{ii} (denoting the distance from a given sample to itself), is equal to zero.

DISTLM: "Distance-based linear model" (McArdle and Anderson 2001), a method of fitting one or more predictor variables (usually environmental variables) to a set of response variables (usually biotic or species data) on the basis of a distance or dissimilarity measure of choice (e.g., Bray-Curtis). If the distance measure chosen is Euclidean distance, then the method does classical redundancy analysis (RDA). Although these models are linear in the predictor variables, they are generally non-linear in the responses (depending on the distance measure chosen as the basis for the analysis). DISTLM is a modeling tool, while dbRDA is a graphical tool for doing multivariate multiple regression on the basis of a dissimilarity matrix.

drafstman plots: a set of scatterplots, set out in a triangular fashion, where each pair of a set of variables on a single set of samples are plotted against each other in order to examine the patterns of relationship (correlations) among the variables and to look for outliers.

error rate: the rate at which a mistake is made when testing a null hypothesis using a given significance level. There are two kinds of error: Type I and Type II. A Type I error is the rejection of a true null hypothesis. A Type II error is the retention of a false null hypothesis.

Euclidean distance: the straight-line distance in Euclidean space between two sample points, i and j, where each variable k = 1, … , p defines an independent (orthogonal) dimension. If the value for variable k in sample i is denoted by y_{ik}, then the Euclidean distance between samples i and j is calculated as:

$$d_{ij} = \sqrt{\sum_{k=1}^{p} (y_{ik} - y_{jk})^2}$$

exact test: a test whose Type I error rate matches exactly the *a priori* chosen significance level (e.g., a test that rejects the null hypothesis at a rate of 5% when the significance level chosen is = 0.05).

family-wise error rate: the rate of Type I error (rejecting a true null hypothesis) when performing multiple simultaneous tests at a given significance level.

GAM: "Generalized Additive Model" (Hastie and Tibshirani 1990), a flexible modeling approach that modifies the usual linear regression model of variable Y versus a set of q predictor variables $X_1 \ldots X_q$, as follows:

$$E(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_q X_q$$

to something more flexible, by replacing the linear parameter terms, $\beta_i X_i$, with more general functions $f(X_i)$:

$$E(Y) = \beta_0 + f(X_1) + f(X_2) + \ldots + f(X_q)$$

GAMs are generally used for predictive modeling, but some caution is needed to avoid over-fitting.

homogeneity: equality of variances or dispersions.

MDS: non-metric "Multi-Dimensional Scaling", a method of ordination on the basis of a distance (or dissimilarity) matrix. The aim is to produce a pattern of points (samples) in a small number of dimensions (usually 2, but sometimes more), which retains the rank-order values of distances between those points as given in the original matrix. The relative proximity of the points on the resulting ordination diagram are interpretable as the relative similarities among the samples (e.g., sample A is more similar to sample B than it is to sample C, etc.).

percentile: see *quantile*.

PERMANOVA: "Permutational Multivariate Analysis of Variance", a method for partitioning multivariate variability on the basis of a chosen dissimilarity measure and performing tests of individual terms in ANOVA models, using permutation procedures (Anderson 2001, McArdle and Anderson 2001).

PERMANOVA+: an add-on package to the PRIMER computer program (Anderson and Gorley 2008), allowing the analysis of multivariate data in response to complex experimental designs or quantitative (e.g., environmental) variables and including routines for CAP, dbRDA, DISTLM, PERMANOVA and PERMDISP.

PERMDISP: "Permutational test of Dispersions", a method for testing the homogeneity of multivariate dispersions (the relative spread or variability) among *a priori* groups (Anderson 2006).

permutation test: a statistical test performed by calculating a test-criterion (such as *F* or *t*), then re-calculating its value after random re-allocation of observation units, either to groups in an experimental design or to values of a predictor variable (e.g., percentage mud) along a gradient, under a true null hypothesis of either no effect of groups, or no relationship with the gradient. Repeating the permutation procedure a large number of times allows a p-value to be calculated as the proportion of values of the test-criterion obtained under permutation that equal or exceed (are more extreme than) the original value.

PRIMER: "Plymouth Routines in Multivariate Ecological Research", a computer program by Bob Clarke and Ray Gorley from Plymouth Marine Laboratory, UK, specialising in the analysis of multivariate ecological data, including analyses based on Bray-Curtis and MDS ordination.

P-value: the probability, when the null hypothesis is true, of obtaining a statistical test-criterion (such as *t* or *F*) that is equal to or more extreme than the value of that test-criterion that was actually obtained for a given set of data.

quantile: a value for a variable that divides the total frequency of a sample or population into specified proportions. For example, the 0.25 quantile is the value that has 25% of the data below it and 75% of the data above it. A synonymous concept is the *percentile*,

which is expressed as a percentage, rather than a proportion (e.g., the 0.25-quantile is the 25th percentile). For more examples: (i) the 0.5 quantile is the median (middle) of a data set; (ii) five percent of the data lie above the 95th percentile.

quantile regression: an analysis of a variable's specified quantile in response to one or more predictor variables (Koenker 2005; 2007). Ordinary regression is the analysis of a variable's mean value in response to one or more predictor variables.

R: a language and programming environment for statistical computing and graphics (Ihaka and Gentleman 1996; R Development Core Team 2007).

R^2: coefficient of multiple determination, the proportion of the total variation in one or more response variables that is explained by a given set of one or more predictor variables. The value of R^2 increases monotonically with increases in the number of predictor variables included in the model.

significance level: commonly denoted by and used in testing hypotheses, a value which is set *a priori* (at the beginning) as the level of probability below which one is prepared to reject a null hypothesis. For example, if a significance level is set at = 0.05, then one would reject the null hypothesis for any *P*-value obtained that is smaller than 0.05 in value.

spline: a function defined by piece-wise polynomials that interpolates a smooth curve through a set of (X, Y) points. The higher the degree of the polynomial (i.e., the higher the degrees of freedom of the model), the more complex the spline shape will be, as a fit the data.

stress: a value used to assess the adequacy of an MDS plot to represent the relative dissimilarities among sample points in a reduced number of dimensions. As a rule of thumb: values of stress < 0.05 are excellent representations; values < 0.10 are very good; < 0.20 yields an interpretable plot, but values > 0.20 are suspect. A stress value as high as 0.30 indicates that the ordination diagram is really no better than a random smattering of points.

t-test: a classical statistical test for comparing the means of two groups of samples.

variance component: a measure of the amount of variation attributable to a given factor or a given spatial or temporal scale in an experimental design.

7.8 Appendix 8

Tables showing the top ten taxa in terms of rank proportional abundances (on average, through time) for each site, with a separate table for each of the estuaries. The names of taxa are given as abbreviations according to Appendix 5. Also provided are the averages (and ranges) for the number of taxa ("Avnosp") and the total abundance ("Avabund") at each site through time. The time points included in the calculations were the 20 time points from time 12 (August 2002) onwards for Puhoi, Waiwera, Orewa, Okura and Mangemangeroa, and the 12 time points from time 20 (August 2004) onwards for Turanga and Waikopua. The proportion of the total abundance accounted for by the top 5 and the top 10 listed taxa are also given, providing an indication of evenness for the communities at each site.

Appendix 8, continued.

PUHOI

Puhoi

	Rank proportional abundance												Total proportions	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Avnosp**	**Avabund**	**First 5**	**First 10**
P1	Papaus	Waibre	Colspp	Paroth	Ausstu	Exospp	Barnac	Eurcoo	Magspp	Maclil	18.2	112		
	0.530	0.205	0.083	0.046	0.039	0.027	0.019	0.005	0.005	0.005	(12-25)	(56-167)	0.905	0.967
P2	Cordae	Capoli	Coscon	Polyco	Aquauc	Ausstu	Helmac	Nerdae	Hetfil	Parspp	17.95	57		
	0.233	0.226	0.164	0.124	0.048	0.029	0.029	0.028	0.026	0.016	(10-26)	(10-132)	0.795	0.923
P3	Cordae	Capoli	Ausstu	Polyco	Orbins	Helmac	Aquauc	Nerdae	Hetfil	Maclil	20	49		
	0.263	0.157	0.152	0.146	0.075	0.030	0.022	0.021	0.021	0.015	(12-30)	(16-96)	0.793	0.901
P4	Barnac	Ausstu	Waibre	Papaus	Colspp	Nuchar	Exospp	Scospp	Maclil	Notspp	25.6	220		
	0.459	0.177	0.107	0.069	0.040	0.038	0.024	0.017	0.013	0.012	(19-34)	(81-491)	0.851	0.954
P5	Capoli	Coscon	Nerdae	Polyco	Aquauc	Hetfil	Orbins	Pecaus	Parspp	Cordae	20.9	91		
	0.207	0.182	0.181	0.145	0.111	0.032	0.023	0.021	0.017	0.010	(14-30)	(41-202)	0.826	0.930
P6	Ausstu	Aquauc	Hetfil	Exodae	Maclil	Polyco	Nuchar	Barnac	Antaur	Colspp	28.8	84		
	0.211	0.112	0.089	0.082	0.062	0.053	0.053	0.046	0.044	0.036	(24-34)	(49-141)	0.555	0.787
P7	Capoli	Polyco	Colspp	Aquauc	Ausstu	Maclil	Nerdae	Papaus	Hetfil	Magspp	25.9	80		
	0.236	0.177	0.102	0.087	0.067	0.057	0.045	0.045	0.026	0.025	(18-33)	(22-214)	0.669	0.867
P8	Capoli	Polyco	Cordae	Nerdae	Hetfil	Helmac	Aquauc	Ausstu	Pecaus	Parspp	17.6	51		
	0.322	0.242	0.120	0.058	0.044	0.040	0.038	0.018	0.016	0.013	(10-27)	(17-141)	0.787	0.911
P9	Cordae	Capoli	Polyco	Papaus	Nerdae	Waibre	Helmac	Ausstu	Colspp	Maclil	15.9	52		
	0.421	0.169	0.117	0.060	0.051	0.023	0.022	0.021	0.014	0.012	(6-27)	(10-141)	0.817	0.909
P10	Papaus	Cordae	Capoli	Colspp	Waibre	Ausstu	Nerdae	Maclil	Scospp	Polyco	18.2	55		
	0.248	0.160	0.148	0.117	0.063	0.055	0.043	0.027	0.027	0.025	(10-27)	(13-201)	0.735	0.912

Appendix 8, continued.

WAIWERA

Waiwera

	Rank proportional abundance												Total proportions	
	1	2	3	4	5	6	7	8	9	10	Avnosp	Avabund	First 5	First 10
W1	Capoli	Aquauc	Polyco	Cordae	Ausstu	Nerdae	Helmac	Hetfil	Maclil	Parspp	19.6	51		
	0.166	0.166	0.114	0.104	0.084	0.077	0.066	0.041	0.037	0.021	(12-28)	(11-102)	0.634	0.875
W2	Ausstu	Cordae	Capoli	Helmac	Nerdae	Polyco	Parspp	Eurcoo	Papaus	Artbif	13.5	24		
	0.364	0.191	0.130	0.069	0.037	0.035	0.034	0.017	0.013	0.013	(6-20)	(6-52)	0.791	0.903
W3	Papaus	Waibre	Colspp	Exospp	Barnac	Ausstu	Cordae	Mysida	Phoxos	Orbins	15.2	88		
	0.475	0.219	0.161	0.037	0.026	0.019	0.011	0.006	0.006	0.006	(8-27)	(26-196)	0.918	0.966
W4	Capoli	Cordae	Eurcoo	Parspp	Papaus	Helmac	Exospp	Scoben	Ausstu	Waibre	12.8	19		
	0.208	0.184	0.080	0.076	0.075	0.069	0.053	0.051	0.045	0.030	(8-20)	(6-56)	0.623	0.871
W5	Ausstu	Capoli	Aquauc	Exodae	Cordae	Nuchar	Polyco	Barnac	Maclil	Hetfil	27.2	107		
	0.281	0.135	0.127	0.080	0.060	0.044	0.044	0.039	0.032	0.030	(21-33)	(42-181)	0.684	0.873
W6	Ausstu	Papaus	Waibre	Colspp	Exospp	Maclil	Barnac	Nuchar	Nerdae	Aquauc	23.9	94		
	0.196	0.193	0.174	0.092	0.082	0.047	0.044	0.024	0.021	0.018	(16-36)	(59-167)	0.737	0.890
W7	Ausstu	Barnac	Capoli	Nuchar	Colspp	Maclil	Exodae	Orbins	Notspp	Aquauc	22.6	84		
	0.410	0.162	0.098	0.070	0.031	0.028	0.026	0.025	0.024	0.023	(17-29)	(45-133)	0.771	0.897
W8	Papaus	Colspp	Waibre	Ausstu	Exospp	Maclil	Nerdae	Barnac	Aquauc	Mysida	22.4	97		
	0.324	0.232	0.177	0.065	0.041	0.022	0.019	0.017	0.013	0.012	(17-29)	(54-239)	0.839	0.920
W9	Ausstu	Aquauc	Nerdae	Colspp	Capoli	Aonoxy	Maclil	Polyco	Hetfil	Antaur	28.9	100		
	0.180	0.156	0.112	0.085	0.073	0.051	0.051	0.043	0.036	0.028	(24-35)	(62-205)	0.607	0.816
W10	Ausstu	Capoli	Cordae	Helmac	Aquauc	Barnac	Polyco	Maclil	Nerdae	Orbins	18.6	52		
	0.325	0.248	0.117	0.047	0.042	0.041	0.031	0.024	0.020	0.014	(10-27)	(19-114)	0.777	0.906

Appendix 8, continued.

OREWA

Orewa

	Rank proportional abundance												Total proportions	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Avnosp**	**Avabund**	**First 5**	**First 10**
R1	Papaus	Exospp	Waibre	Colspp	Ausstu	Barnac	Eurcoo	Maclil	Aquauc	Nemert	14.3	156		
	0.547	0.179	0.154	0.037	0.034	0.014	0.010	0.008	0.003	0.002	(10-18)	(67-310)	0.951	0.989
R2	Barnac	Ausstu	Aquauc	Notspp	Maclil	Nuchar	Exodae	Orbins	Papaus	Aonoxy	28.8	215		
	0.453	0.219	0.122	0.034	0.033	0.014	0.014	0.011	0.010	0.009	(21-35)	(92-777)	0.861	0.920
R3	Barnac	Papaus	Ausstu	Waibre	Colspp	Aonoxy	Exospp	Notspp	Maclil	Eurcoo	22.1	246		
	0.393	0.354	0.072	0.045	0.039	0.024	0.014	0.012	0.009	0.004	(13-34)	(43-668)	0.903	0.966
R4	Waibre	Exospp	Papaus	Cordae	Eurcoo	Ausstu	Barnac	Colspp	Capoli	Helmac	13.3	72		
	0.374	0.190	0.182	0.110	0.054	0.031	0.016	0.011	0.005	0.004	(8-23)	(19-135)	0.909	0.975
R5	Ausstu	Aquauc	Barnac	Orbins	Maclil	Exodae	Nuchar	Antaur	Aonoxy	Notspp	25.8	107		
	0.382	0.135	0.069	0.056	0.055	0.049	0.044	0.037	0.025	0.025	(17-32)	(48-182)	0.696	0.877
R6	Aquauc	Orbins	Pecaus	Hetfil	Capoli	Parspp	Nerdae	Mysida	Maclil	Polyco	22.4	54		
	0.331	0.082	0.076	0.065	0.065	0.059	0.043	0.039	0.037	0.037	(15-27)	(19-150)	0.619	0.835
R7	Ausstu	Barnac	Maclil	Aquauc	Colspp	Nuchar	Capoli	Papaus	Hetfil	Nerdae	26.6	79		
	0.339	0.122	0.086	0.082	0.072	0.059	0.028	0.019	0.019	0.019	(19-33)	(27-122)	0.701	0.844
R8	Cordae	Orbins	Capoli	Aquauc	Maclil	Ausstu	Polyco	Parspp	Barnac	Antaur	21.5	49		
	0.191	0.150	0.149	0.088	0.078	0.076	0.025	0.024	0.023	0.020	(14-31)	(17-122)	0.656	0.825
R9	Cordae	Capoli	Orbins	Maclil	Ausstu	Aquauc	Nerdae	Parspp	Edwasp	Polyco	21.1	81		
	0.290	0.232	0.145	0.070	0.065	0.034	0.033	0.028	0.012	0.012	(11-26)	(30-282)	0.800	0.919
R10	Cordae	Nerdae	Polyco	Capoli	Aquauc	Parspp	Orbins	Maclil	Glyspp	Hetfil	20.9	75		
	0.252	0.163	0.136	0.121	0.095	0.073	0.043	0.015	0.014	0.014	(16-29)	(12-242)	0.767	0.925

Appendix 8, continued.

OKURA

Okura

	Rank proportional abundance												Total proportions	
	1	2	3	4	5	6	7	8	9	10	Avnosp	Avabund	First 5	First 10
O1	Ausstu	Aonoxy	Nuchar	Antaur	Papaus	Colspp	Parspp	Barnac	Phoxos	Hetfil	27.9	130.8	0.603	0.832
	0.252	0.119	0.084	0.074	0.074	0.057	0.053	0.048	0.037	0.034	(21-35)	(92-184)		
O2	Hetfil	Coscon	Aquauc	Nuchar	Polyco	Ausstu	Maclil	Nerdae	Glyspp	Pecaus	29.1	103.8	0.689	0.876
	0.210	0.193	0.138	0.083	0.065	0.061	0.047	0.035	0.023	0.021	(22-39)	(64-179)		
O3	Ausstu	Barnac	Colspp	Papaus	Sipunc	Hetfil	Waibre	Notspp	Maclil	Helmac	26.1	95.2	0.809	0.883
	0.459	0.229	0.062	0.040	0.019	0.019	0.017	0.015	0.013	0.012	(15-34)	(57-149)		
O4	Ausstu	Barnac	Colspp	Nuchar	Aonoxy	Phoxos	Antaur	Hetfil	Maclil	Aquauc	29.6	124.5	0.646	0.865
	0.199	0.148	0.138	0.103	0.057	0.057	0.053	0.041	0.039	0.030	(23-36)	(87-179)		
O5	Ausstu	Cordae	Hetfil	Nuchar	Aquauc	Capoli	Orbins	Colspp	Barnac	Maclil	29.0	80.4	0.563	0.777
	0.171	0.132	0.119	0.089	0.053	0.050	0.044	0.041	0.040	0.038	(19-39)	(42-136)		
O6	Ausstu	Barnac	Nuchar	Antaur	Aquauc	Hetfil	Notspp	Colspp	Maclil	Phoxos	33.0	190.0	0.693	0.890
	0.233	0.167	0.120	0.091	0.083	0.065	0.052	0.033	0.028	0.020	(27-44)	(125-275)		
O7	Ausstu	Barnac	Orbins	Aonoxy	Cordae	Colspp	Capoli	Aquauc	Nuchar	Maclil	24.9	56.7	0.536	0.764
	0.253	0.100	0.075	0.054	0.053	0.049	0.048	0.047	0.047	0.036	(19-31)	(31-152)		
O8	Hetfil	Orbins	Ausstu	Aquauc	Cordae	Capoli	Maclil	Nerdae	Polyco	Helmac	23.9	50.3	0.581	0.804
	0.170	0.141	0.102	0.096	0.073	0.070	0.062	0.036	0.030	0.026	(17-34)	(30-91)		
O9	Hetfil	Nuchar	Aquauc	Ausstu	Maclil	Capoli	Pecaus	Polyco	Nerdae	Coscon	27.1	80.6	0.587	0.809
	0.201	0.108	0.105	0.091	0.082	0.053	0.047	0.044	0.041	0.037	(15-37)	(40-171)		
O10	Hetfil	Capoli	Cordae	Polyco	Aquauc	Nerdae	Coscon	Pecaus	Glyspp	Maclil	20.8	55.5	0.594	0.861
	0.194	0.122	0.102	0.090	0.086	0.085	0.073	0.048	0.035	0.026	(14-28)	(30-110)		

Appendix 8, continued.

MANGEMANGEROA

Mangemangeroa

	Rank proportional abundance												Total proportions	
	1	2	3	4	5	6	7	8	9	10	Avnosp	Avabund	First 5	First 10
M1	Nuchar	Ausstu	Aquauc	Antaur	Maclil	Hetfil	Artbif	Orbins	Phoxos	Notspp	29.0	110		
	0.345	0.191	0.127	0.080	0.031	0.028	0.027	0.018	0.017	0.016	(24-34)	(71-144)	0.773	0.879
M2	Nuchar	Aquauc	Ausstu	Antaur	Aonoxy	Exodae	Notspp	Artbif	Hetfil	Maclil	31.1	126		
	0.250	0.152	0.132	0.102	0.100	0.049	0.021	0.020	0.020	0.017	(22-37)	(82-172)	0.734	0.861
M3	Barnac	Nuchar	Ausstu	Aquauc	Exodae	Artbif	Antaur	Notspp	Aonoxy	Hetfil	35.1	296		
	0.319	0.147	0.130	0.084	0.073	0.063	0.047	0.030	0.021	0.014	(29-42)	(147-652)	0.753	0.929
M4	Barnac	Aquauc	Orbins	Hetfil	Ausstu	Cirdae	Nerdae	Helmac	Artbif	Capoli	26.6	60		
	0.181	0.143	0.104	0.099	0.095	0.048	0.046	0.037	0.035	0.026	(21-36)	(22-152)	0.621	0.812
M5	Aquauc	Hetfil	Barnac	Ausstu	Orbins	Cirdae	Nerdae	Artbif	Helmac	Capoli	25.9	55		
	0.175	0.136	0.115	0.088	0.086	0.068	0.067	0.045	0.033	0.026	(22-32)	(24-103)	0.599	0.837
M6	Hetfil	Nuchar	Aquauc	Barnac	Ausstu	Nerdae	Exodae	Artbif	Coscon	Polyco	32.2	96		
	0.274	0.122	0.099	0.094	0.088	0.038	0.037	0.034	0.029	0.017	(25-47)	(54-222)	0.676	0.830
M7	Barnac	Hetfil	Aquauc	Ausstu	Nerdae	Nuchar	Artbif	Orbins	Antaur	Helmac	25.8	67		
	0.222	0.199	0.139	0.084	0.053	0.039	0.039	0.038	0.024	0.022	(21-36)	(36-125)	0.696	0.858
M8	Hetfil	Aquauc	Nerdae	Barnac	Capoli	Artbif	Helmac	Ausstu	Nemert	Polyco	21.9	51		
	0.399	0.194	0.062	0.040	0.039	0.038	0.034	0.031	0.023	0.018	(14-28)	(28-98)	0.733	0.877
M9	Hetfil	Aquauc	Cordae	Capoli	Nerdae	Helmac	Nemert	Ausstu	Artbif	Polyco	22.2	51		
	0.380	0.142	0.081	0.058	0.053	0.042	0.031	0.030	0.028	0.025	(16-29)	(27-113)	0.714	0.870
M10	Hetfil	Aquauc	Nerdae	Helmac	Capoli	Cordae	Artbif	Thelub	Nemert	Polyco	22.0	52		
	0.410	0.175	0.057	0.043	0.042	0.040	0.034	0.026	0.023	0.020	(17-32)	(27-93)	0.727	0.870

Appendix 8, continued.

TURANGA

Turanga

	Rank proportional abundance												Total proportions	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Avnosp**	**Avabund**	**First 5**	**First 10**
T1	Aquauc	Aonoxy	Parspp	Nuchar	Maclil	Ausstu	Orbins	Barnac	Antaur	Notspp	24.8	56		
	0.194	0.152	0.124	0.088	0.066	0.058	0.056	0.044	0.032	0.029	(20-29)	(20-90)	0.624	0.843
T2	Papaus	Parspp	Nuchar	Orbins	Aonoxy	Notspp	Ausstu	Maclil	Scospp	Aquauc	21.3	51		
	0.258	0.216	0.093	0.083	0.082	0.045	0.033	0.030	0.030	0.028	(17-27)	(14-83)	0.733	0.898
T3	Barnac	Nuchar	Notspp	Orbins	Parspp	Papaus	Aquauc	Aonoxy	Ausstu	Maclil	22.9	66		
	0.257	0.201	0.108	0.103	0.076	0.066	0.034	0.034	0.017	0.017	(14-29)	(44-97)	0.746	0.914
T4	Artbif	Aquauc	Hetfil	Nerdae	Ausstu	Helmac	Capoli	Polyco	Nemert	Nuchar	18.2	22		
	0.201	0.145	0.130	0.100	0.098	0.072	0.049	0.026	0.025	0.023	(12-29)	(11-50)	0.674	0.869
T5	Helmac	Hetfil	Aquauc	Capoli	Artbif	Ausstu	Nerdae	Nuchar	Nemert	Cordae	18.8	20		
	0.149	0.149	0.142	0.114	0.080	0.063	0.052	0.051	0.031	0.030	(8-27)	(7-38)	0.633	0.859
T6	Barnac	Nuchar	Ausstu	Aquauc	Hetfil	Artbif	Antaur	Nerdae	Polyco	Helmac	30.6	188		
	0.514	0.092	0.083	0.083	0.053	0.036	0.028	0.015	0.011	0.011	(17-38)	(16-307)	0.825	0.927
T7	Barnac	Ausstu	Nuchar	Aquauc	Hetfil	Artbif	Antaur	Polyco	Capoli	Nerdae	33.4	201		
	0.525	0.078	0.075	0.068	0.061	0.030	0.029	0.019	0.015	0.014	(25-37)	(68-328)	0.807	0.914
T8	Capoli	Hetfil	Aquauc	Cordae	Helmac	Nerdae	Thelub	Nemert	Artbif	Barnac	21.5	52		
	0.267	0.250	0.097	0.062	0.061	0.051	0.042	0.024	0.020	0.019	(15-27)	(20-115)	0.737	0.893
T9	Cordae	Capoli	Helmac	Aquauc	Hetfil	Nerdae	Polyco	Barnac	Nemert	Ampcre	10.3	38		
	0.531	0.207	0.171	0.021	0.016	0.011	0.009	0.007	0.005	0.003	(5-18)	(7-107)	0.946	0.980
T10	Cordae	Capoli	Helmac	Aquauc	Hetfil	Polyco	Nerdae	Macdae	Nemert	Parspp	11.9	55		
	0.606	0.182	0.127	0.014	0.010	0.010	0.010	0.007	0.005	0.003	(6-18)	(8-105)	0.939	0.974

Appendix 8, continued.

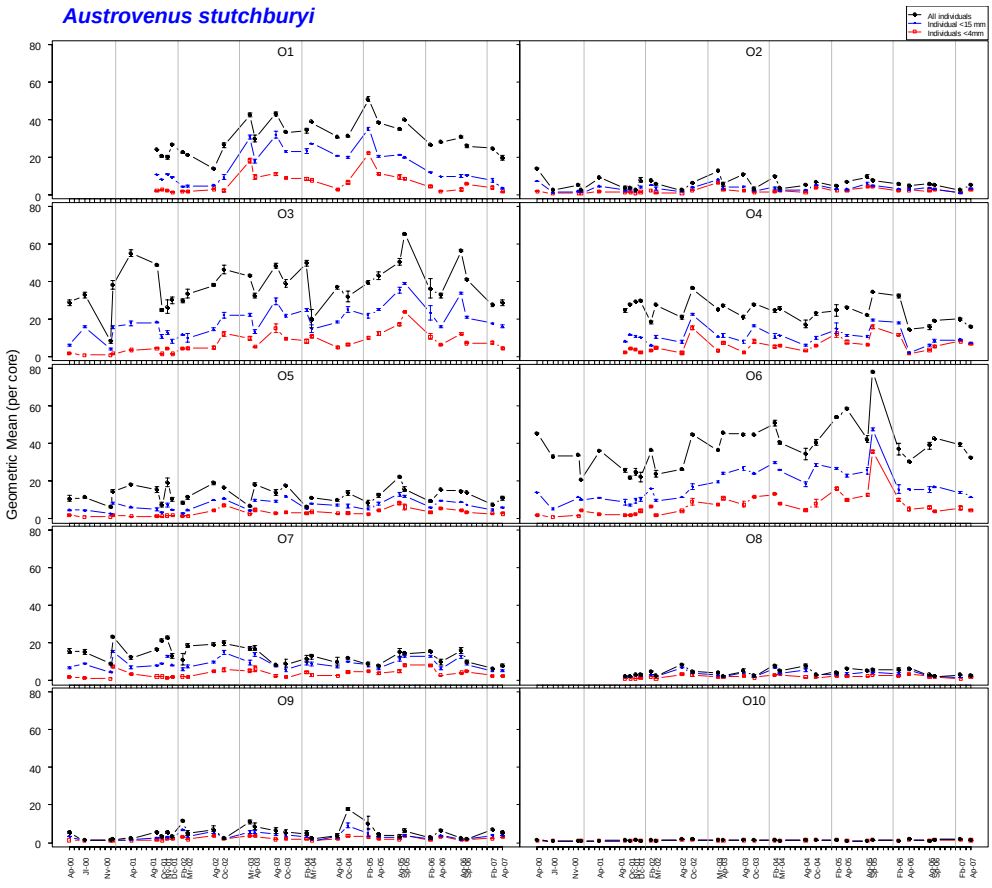
WAIKOPUA

Waikopua

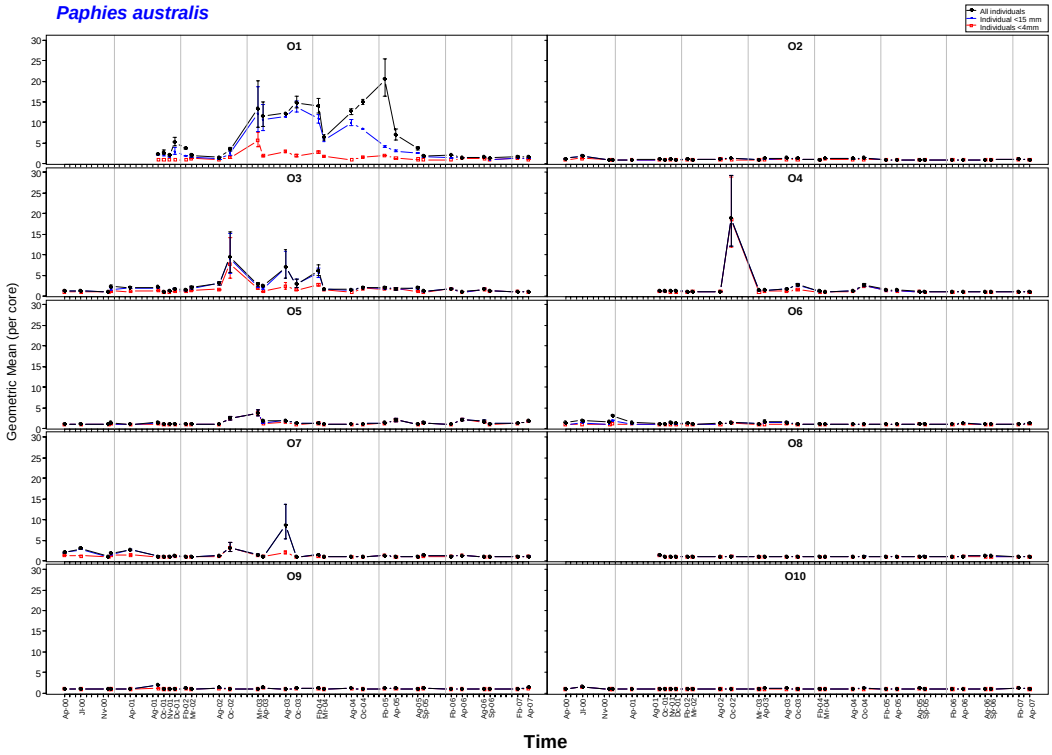
	Rank proportional abundance												Total proportions	
	1	2	3	4	5	6	7	8	9	10	Avnosp	Avabund	First 5	First 10
K1	Aricsp	Macste	Colspp	Parspp	Syldae	Ausstu	Nuchar	Aglmac	Sabdae	Exodae	30.0	27		
	0.113	0.093	0.083	0.064	0.058	0.049	0.037	0.037	0.036	0.036	(21-38)	(18-56)	0.411	0.605
K2	Nuchar	Aquauc	Ausstu	Hetfil	Exodae	Mussen	Nerdae	Maclil	Artbif	Orbins	37.1	110		
	0.294	0.096	0.078	0.066	0.053	0.052	0.052	0.050	0.033	0.027	(32-43)	(83-155)	0.587	0.801
K3	Nuchar	Hetfil	Aquauc	Ausstu	Artbif	Exodae	Nerdae	Nemert	Maclil	Macste	35.4	118		
	0.284	0.172	0.129	0.053	0.041	0.040	0.036	0.029	0.023	0.016	(28-41)	(80-176)	0.679	0.822
K4	Nuchar	Aquauc	Hetfil	Nerdae	Ausstu	Artbif	Exodae	Maclil	Nemert	Polyco	34.2	86		
	0.306	0.145	0.127	0.057	0.043	0.032	0.031	0.029	0.021	0.019	(27-41)	(59-134)	0.679	0.810
K5	Nuchar	Hetfil	Aquauc	Ausstu	Artbif	Nerdae	Exodae	Maclil	Macste	Polyco	32.7	109		
	0.226	0.203	0.151	0.052	0.045	0.044	0.042	0.029	0.020	0.020	(26-36)	(76-167)	0.676	0.832
K6	Aquauc	Nuchar	Hetfil	Artbif	Ausstu	Aonoxy	Nerdae	Orbins	Notspp	Parspp	29.9	84		
	0.281	0.227	0.066	0.055	0.053	0.051	0.031	0.028	0.022	0.020	(28-35)	(58-117)	0.681	0.834
K7	Aonoxy	Nuchar	Aquauc	Ausstu	Hetfil	Orbins	Maclil	Nerdae	Capoli	Colspp	28.2	100		
	0.357	0.212	0.107	0.040	0.037	0.028	0.025	0.023	0.021	0.020	(22-33)	(56-162)	0.752	0.869
K8	Orbins	Aquauc	Helmac	Capoli	Hetfil	Artbif	Ausstu	Nerdae	Cordae	Polyco	17.4	24		
	0.180	0.118	0.115	0.089	0.082	0.074	0.070	0.067	0.055	0.029	(14-21)	(17-57)	0.584	0.879
K9	Cordae	Capoli	Helmac	Artbif	Ausstu	Nerdae	Aquauc	Hetfil	Macdae	Parspp	13.9	15		
	0.169	0.161	0.147	0.109	0.107	0.070	0.049	0.033	0.021	0.018	(9-18)	(5-27)	0.692	0.883
K10	Capoli	Helmac	Cordae	Polyco	Artbif	Ausstu	Nerdae	Maclil	Macdae	Hetfil	11.6	19		
	0.390	0.223	0.097	0.064	0.038	0.024	0.023	0.022	0.021	0.017	(8-18)	(10-45)	0.812	0.919

7.9 Appendix 9

Time series of typical abundances of bivalves (*Austrovenus*, *Paphies* and *Macomona*, each shown separately) of different sizes classes at individual sites within Okura. The abundance of the smallest size class (individuals <4mm) is shown in red, the mid-size class (4-15 mm) is depicted by the distance between the red and blue lines and the largest size class (>15mm) is depicted by the distance between blue and black lines.



Appendix 9, continued



Appendix 9, continued