# Methods

**Zoop 150 and Zoop 505 results not updated in this file!!**

Cross community correlations (previous results):

Linkages across communities were quantified using Mantel correlations and showed moderate to strong correlations among communities ([Table 1](#Table1)), consistent with Sigler et al. (2017). The strongest correlation was observed between benthic infauna (macrofauna) and epifauna (p=0.50). The observed association between zooplankton and bottom water characteristics was supported by a strong correlation between zooplankton and infaunal species composition (p=0.48). There was also a strong correlation between seabird species composition and zooplankton species composition, but not between the demersal fish community and either zooplankton or fish (Table 1). Key indicator species characterizing each community association were identified using statistical models linking each species in a given community to the ordination axes of another community. We used a generalized additive modeling approach with a Tweedie distribution to account for excessive zero observations in the data to assess the strength of the relationships and ranked species based on the resulting (Pseudo-)R2 values. species with an R2 value of at least 0.2 that were significantly related (95% significance level) to the community ordination were considered potential indicator species. As an example, we show the strong and unexpected associations between three epifaunal species and the zooplankton community ([Fig. 3](#Fig3)).

## Environmental data:

Water column and bottom water characteristics, sediment characteristics.

## Statistical analyses

NMDS ordination with environmental associations. Select environmental variables that are most strongly associated with the ordination using Mantel correlations (BIOENV). Select set of variables that had the highest Mantel correlation. Use those variables in PERMANOVA, along with ‘year’ to test for interannual differences that cannot be accounted for by environmental variables

Variables considered for pelagic communities (surface bacteria and protists, zooplankton and seabirds) included water and bottom temperatures and salinities, integrated chlorophyll, nutrient concentrations in near-bottom waters (phosphate, silicate, nitrite/nitrate) to account for a possible source of new nutrients, a simple stratification index, and the first sediment PC (which accounted for 51% of overall variability in sediment characteristics) to account for possible pelagic-benthic associations.

Variables considered for demersal communities () included all of the above and 2 additional sediment variables (PC 2 & 3).

Sediment PCA:

> summary(sed.pca)

Importance of components:

Comp.1 Comp.2 Comp.3 Comp.4 Comp.5

Standard deviation 2.2586574 1.4050749 1.1027854 0.82903085 0.62041547

Proportion of Variance 0.5101533 0.1974236 0.1216136 0.06872922 0.03849154

Cumulative Proportion 0.5101533 0.7075769 0.8291904 0.89791966 0.93641120

The first three principal components accounted for 83% of the variability in sediment characteristics with the first PC accounting for 51%. These three PCs were readily interpreted based on loadings

Loadings for sediment PCA:

> round(loadings(sed.pca)[,1:3],3)

Comp.1 Comp.2 Comp.3

phi.0 0.199 0.446 0.495

phi.1 0.319 0.330 0.384

phi.2 0.403 0.150 0.000

phi.3 0.391 -0.145 -0.125

phi.4 0.017 -0.491 0.180

phi.5 -0.422 0.082 -0.013

TOC -0.329 0.392 -0.167

TON -0.401 0.215 0.049

C.N.ratio 0.128 0.447 -0.482

delN15 -0.283 -0.010 0.545

# Results

## Bacteria

adonis2(formula = form, data = bact.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

SST 1 0.9272 0.08537 9.1811 0.0002 \*\*\*

SSS 1 0.3324 0.03061 3.2920 0.0050 \*\*

melt.sfc 1 0.2854 0.02628 2.8257 0.0128 \*

cruise 1 1.1249 0.10358 11.1394 0.0002 \*\*\*

Residual 79 7.9780 0.73460

Total 83 10.8602 1.00000

Three environmental gradients and interannual differences account for approximately 26.5% of the variability in the bacterial community. SST and differences between years account for most of the variability.

## Protists

adonis2(formula = form, data = prot.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

SST 1 0.7265 0.04598 5.1956 0.0002 \*\*\*

phosphate 1 0.3042 0.01925 2.1754 0.0140 \*

silicate 1 0.2684 0.01699 1.9197 0.0242 \*

cruise 1 2.0611 0.13044 14.7401 0.0002 \*\*\*

Residual 79 11.0466 0.69911

Total 83 15.8011 1.00000

Three environmental gradients (SST, bottom water nutrients?) and large interannual differences account for approximately 32.2% of the variability in the protist community but environmental effects are moderate with most of the differences due to year.

## Infauna

adonis2(formula = form, data = inf.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

sedPC1 1 1.409 0.04431 6.2370 2e-04 \*\*\*

Bsal 1 0.943 0.02966 4.1756 2e-04 \*\*\*

SST 1 1.015 0.03193 4.4952 2e-04 \*\*\*

sedPC2 1 0.766 0.02408 3.3894 2e-04 \*\*\*

cruise 1 0.663 0.02085 2.9352 2e-04 \*\*\*

Residual 113 25.526 0.80277

Total 118 31.797 1.00000

Four environmental gradients and small interannual differences account for approximately 19.7% of the variability in the infaunal community. Interannual differences possibly due to differences in station coverage.

## Epifauna

adonis2(formula = form, data = epi.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

BT 1 1.113 0.02592 4.9596 2e-04 \*\*\*

sedPC1 1 2.370 0.05519 10.5585 2e-04 \*\*\*

SST 1 0.639 0.01489 2.8491 6e-04 \*\*\*

Bsal 1 1.291 0.03007 5.7520 2e-04 \*\*\*

cruise 1 1.798 0.04187 8.0108 2e-04 \*\*\*

Residual 142 31.872 0.74224

Total 147 42.940 1.00000

Four environmental variables and interannual differences account for approximately 25.8% of the variability in the epifaunal community with sediment PC1 as the primary structuring gradient and moderate interannual differences after accounting for local environmental effects.

## Zooplankton (150 μm)

adonis2(formula = form, data = zoop150.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

BT 1 1.2553 0.06636 12.2957 2e-04 \*\*\*

Bsal 1 0.9823 0.05193 9.6221 2e-04 \*\*\*

cruise 1 1.3163 0.06958 12.8939 2e-04 \*\*\*

Residual 140 14.2926 0.75553

Total 143 18.9174 1.00000

Two environmental variables and interannual differences account for approximately 24.4% of the variability in the zooplankton community Primary gradients structuring the zooplankton community are bottom temperature and bottom salinity (rather than surface layer characteristics!) with fairly strong interannual differences.

## Zooplankton (505 μm)

adonis2(formula = form, data = zoop505.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

Bsal 1 0.8468 0.03400 6.2435 2e-04 \*\*\*

SST 1 0.4136 0.01661 3.0494 6e-04 \*\*\*

BT 1 0.6308 0.02533 4.6511 2e-04 \*\*\*

int.chla 1 0.3564 0.01431 2.6282 5e-03 \*\*

cruise 1 2.3820 0.09564 17.5632 2e-04 \*\*\*

Residual 137 18.5805 0.74604

Total 142 24.9054 1.00000

Four environmental variables and large interannual differences account for approximately 25.4% of the variability in the zooplankton community. Primary gradients structuring the zooplankton community are bottom water mass characteristics (including runoff fraction when using reduced data set, but not quite significant at 95%).

## Demersal fish

adonis2(formula = form, data = fish.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

BT 1 2.487 0.07108 13.2178 2e-04 \*\*\*

sedPC1 1 2.660 0.07601 14.1347 2e-04 \*\*\*

cruise 1 1.362 0.03893 7.2399 2e-04 \*\*\*

Residual 138 25.968 0.74213

Total 141 34.992 1.00000

Two environmental variables and interannual differences account for approximately 25.8% of the variability in the fish community. Primary gradients structuring the fish community are sediment size and bottom temperature with moderate 'additional' interannual differences.

## Seabirds

adonis2(formula = form, data = bird.env, permutations = 4999, by = "margin")

Df SumOfSqs R2 F Pr(>F)

BT 1 1.8056 0.11045 18.838 2e-04 \*\*\*

Bsal 1 1.0123 0.06192 10.561 2e-04 \*\*\*

cruise 1 1.2096 0.07399 12.620 2e-04 \*\*\*

Residual 130 12.4605 0.76217

Total 133 16.3487 1.00000

Two environmental variables and interannual differences account for approximately 24.8% of the variability in the bird community. Bottom water masses more strongly correlated with birds than surface water characteristics. Primary gradients associated with the bird community are bottom temperature and bottom salinity with substantial interannual differences.