Assessing Biodiversity with the Marine Biodiversity Observation Network (MBON)

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Djurhuus, Closek, Kelly, Pitz, Michisaki, Starks, Walz, Andrusziewicz, Olesin, Hubbard, Montes, Otis, Muller-Karger, Chavez, Boehm, Breitbart. Microbes to Mammals: Detecting Ecosystem Shifts Through Environmental DNA (in preparation)
Marine Biodiversity Observation Network
Environmental DNA (eDNA)
Questions

1. What taxa are we able to identify in Monterey Bay with eDNA?

2. How do the taxa identified vary over time?

3. Which environmental parameters correlate with changes in taxa?
Sampling Design

Environmental Samples:
- 8 time points

Control Samples:
- Collection Blanks
- Extraction Blanks
- No Template (x3)
- Artificial Communities

<table>
<thead>
<tr>
<th>Station</th>
<th>C1</th>
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<tbody>
<tr>
<td>Years</td>
<td>2015-2016</td>
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<tr>
<td>Depth (m)</td>
<td>0</td>
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<tr>
<td>Filter type</td>
<td>0.2um PVDF</td>
</tr>
<tr>
<td>Replicates (n)</td>
<td>3</td>
</tr>
</tbody>
</table>

Djurhuus, Closek, et al. (in preparation)
Sample Processing

Filter 1L of Seawater

0.2 µm PVDF

Djurhuus, Closek, et al. (in preparation)
Sample Processing

Filter 1L of Seawater

Extract DNA

0.2 µm PVDF

Qiagen DNeasy

Djurhuus, Closek, et al. (in preparation)
Filter 1L of Seawater

0.2 µm PVDF

Extract DNA

Qiagen DNeasy

Amplify & Sequence

Illumina MiSeq Paired End

12S rRNA

18S rRNA

16S rRNA

1391f, EukBr+Golay
Amaral-Zettler et al., 2009

mCOIinfF, HCO2198
Leray et al., 2013;
Folmer et al., 1994

MiFish_U: 5F, 5R
Miya et al., 2015

515F-Y, 926R
Apprill et al., 2015;
Parada et al., 2016

Djurhuus, Closek, et al. (in preparation)
Sample Processing

Filter 1L of Seawater

Extract DNA

Amplify & Sequence

Identify Target Organisms

12S rRNA

Vertebrates

COI

Invertebrates, some vertebrates, & phytoplankton

18S rRNA

Phytoplankton & invertebrates, some vertebrates

16S rRNA

Microbes (Bacteria & Archaea)

0.2 µm PVDF

Qiagen DNeasy

Illumina MiSeq Paired End

BLASTN / GreenGenes MEGAN 6

Djurhuus, Closek, et al. (in preparation)
Taxa Processing

Decontaminate

- remove non-targeted groups from each locus

Composite list

- all taxa identified across loci (n = 663)

Relative abundance

- for each taxon/locus (0-1)

Abundance index

- ensemble index for each taxon (0-1)

Trophic assignment

- taxon’s group & trophic level

Marine taxa

- down to Family-level (n = 348)

Correlations

- Kendall’s $\tau$ ($r > 0.70$, $p < 0.05$)

Network

- WGCNA of correlations relative to the taxon abundance index

Djurhuus, Closek, et al. (in preparation)
Monterey Bay Taxa Network

Djurhuus, Closek, et al. (in preparation)
Environmental Correlations

\[ r = 0.74 \quad p = 0.04 \]

\[ r = -0.76 \quad p = 0.03 \]

Djurhuus, Closek, et al. (in preparation)
Blue & Grey Subnetworks

- Bacteria, Archaea, and Fungi
- Primary producers
- Primary consumers
- Secondary consumers
- Tertiary consumers

Djurhuus, Closek, et al. (in preparation)
Subnetwork Key & Hub Taxa

Djurhuus, Closek, et al. (in preparation)
eDNA Detects Ecosystem Shifts

1. What taxa are we able to identify in Monterey Bay with eDNA?
   ✓ Taxa across the domains of life were identified in every subnetwork (Archaea, Bacteria, Fungi; Primary Producers; Primary; Secondary; and Tertiary Consumers)
   \[ n = 663 \rightarrow n = 348 \]

2. How do the taxa identified vary over time?
   ✓ Taxa co-occurred - subnetworks (specific groups of taxa) dominated during a time point

3. Which environmental parameters correlate with changes in taxa?
   ✓ Temperature and chlorophyll \( a \) correlated with two of the subnetworks

- eDNA metabarcoding is allowing us to gain new insights across the domains of life
- Highlight hub taxa that may serve as indicators of ecosystem states
Thank You

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Subnetworks over time

Djurhuus, Closek, et al. (in preparation)
Blue & Grey Subnetworks

Djurhuus, Closek, et al. (in preparation)

Primary producers (33%)
- Bacteria/Archaea/Fungi (11%)
- Tertiary consumers (1.2%)
- Secondary consumers (44.4%)

Primary producers (17.5%)
- Bacteria/Archaea/Fungi (22.8%)
- Primary consumers (10.5%)
- Secondary consumers (48.2%)
- Tertiary consumers (0.9%)