Outfall construction: Disturbance and recolonization of the marine benthic community

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- King County’s Environmental Lab
- Allan Fukuyama
Background: Brightwater

- King County’s newest regional wastewater treatment system
- Outfall constructed in 2008
- Discharges secondary treated into Puget Sound’s Central Basin
- Treated effluent discharged through outfall beginning in late 2012
Marine Outfall

- 84-in diameter pipe
- Splits into two pipes at 0 ft MLLW
- Pipes daylight at -80 ft
- Pipes lie on the seafloor extending ~ one mile offshore and terminating at -600 ft
- Terminate in 250 ft-long diffuser structures
Outfall Construction: The Trench

- Pipe was underground
- Sheeting was utilized for onshore to nearshore (-30 ft)
- Unsheeted trench construction from -30 to -80 ft
- Trench was 12 ft wide with an anticipated additional impact area of 4 ft on either side
- Sediments were stored on a barge until replaced in the trench
Trench Infauna Surveys

Sampling Events
- Pre-Construction Sampling
  - 2006 & 2007
- Post-Construction Sampling
  - 2009 & 2011

Methods
- Tandem vanVeen grab samplers
  - Sediment Conventionals
  - Benthic Infauna (3 reps)
Trench Infauna Surveys

Sampling Events
- Pre-construction sampling
  - 2006 & 2007
- Post-construction sampling
  - 2009 & 2011

Methods
- Tandem van Veen grab samplers
- 14 sites
  - 7 original - moved after 2006
  - Three “trench”
  - Four “edge”
  - Three “reference” (2009 & 2011)
Sediment Characteristics

- Top 10 cm
- Sandy (~97%)
- Minor increase in percent fines (clay)
- Some increases in gravel post-construction
  - Most significant at two edge stations (50 ft bathymetric contour)
  - 56% Gravel at one site in 2011
- Change in habitat could influence benthic community
The Fauna

- All individuals identified to the lowest practical taxonomic unit
- Sorted into major groups
  - Molluscs
  - Annelids
  - Crustaceans
  - Miscellaneous (e.g., echinoderms, nemerteans, etc.)
- Calculated benthic indices
Changes in Benthic Fauna - Indices

2009 (1 year post-construction)

Abundance →
Richness ↔
Diversity ↑
Biomass ↓
Abundance of stress-tolerant species ↑
Changes in Benthic Fauna - Indices

2011 (3 year post-construction)

Abundance

Biomass

![Graph showing changes in abundance and biomass over time with reference, edge, and trench categories.](image)
Changes in Benthic Fauna - Indices

2011 (3 year post-construction)

Abundance ↔
Biomass ↔
Richness & diversity ↑

Shannon's Diversity

Mean Shannon's Diversity

Reference • Edge • Trench

2006 2007 2008 2009 2010 2011
Changes in Benthic Fauna - Indices

2011 (3 year post-construction)

- Abundance
- Biomass
- Richness & diversity
- Abundance of stress-tolerant species
- Abundance of stress-sensitive species
Changes in Benthic Community

- Multidimensional Scaling (MDS)
  - Multivariate data (many taxa and abundances)
  - Visual tool to illustrates similarity/dissimilarity

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<tr>
<th>Year-Type</th>
<th>2D Stress</th>
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Transform: Fourth root
Resemblance: S17 Bray Curtis similarity
2D Stress: 0.16
Changes in Benthic Community

- Multidimensional Scaling (MDS)
- Cluster Analysis
  - Quantify degree of similarity
  - Groups samples based on levels of similarity
Changes in Benthic Community

- Multidimensional Scaling (MDS)
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![Image of data analysis and two-dimensional stress of 0.16](image-url)
Changes in Benthic Community

- Multidimensional Scaling (MDS)
- Cluster Analysis
- Groupings by Year
- Distributed by Depth
- Few Outliers
- 2011 Between Pre-Construction Samples

Transform: Fourth root
Resemblance: S17 Bray Curtis similarity

Year-Type
06R
09R
11R
07T
09T
11T
07E
09E
11E

Similarity
2D Stress: 0.16

2006 Grouping
2007/2009 Grouping
2007/2011 Grouping
Conclusions

- Some changes in sediment characteristics post-construction
- Sediments devoid of life after construction
- By 2009 many species had recolonized
  - Indices suggest a less robust community than historic/reference data
- By 2011 indices & MDS suggest that trench/edge benthic community was the same or more robust than historic/reference data
- Recovery appeared to be near completion after three years
Any Questions?