ANALYSIS OF THE SCCWRP MEMBER AGENCY
HISTORICAL BENTHIC INVERTEBRATE DATA

Presentation to the SCCWRP Commission

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The SCCWRP Commission expressed interest in making better use of historical data sets
- They were hard to access when we prepared the Clean Water Act effectiveness document
- You invested a lot in collecting these data

You asked CTAG to develop a data archiving strategy
- That effort did not gain traction
- Too much time required with no defined end point to motivate the investment

We are now trying a new strategy: Focus on data sets for which there are defined questions we hope to answer
- Infaunal benthic invertebrates are a test case
WHY START WITH BENTHOS?

• They are one of the most relied on data sets you collect
  – The core of our Bight regional monitoring program
  – The primary data set used by POTWs for justifying 301(h) waivers

• They reside on the bottom where multiple stressors of management interest are prevalent
  – Can examine effects of sediment contamination, hypoxia, acidification and temperature change

• Yours is among the best such data sets in the world
  – The other best benthic data sets in the US are estuarine and don’t date back as far
  – Our taxonomic capacity is superior because of your investment in SCAMIT
  – You have an additional attribute: Four replicate data sets allow us to verify patterns across a geographic region
OUR APPROACH

• **Define the questions to be addressed before compiling the data**
  – Allows us to identify the data necessary to answer the questions
  – Lessens the data assembly burden, focusing on the most relevant data
  – Questions identified in concert with the topic area experts from the member agencies

• **Member agencies lead the data assembly for their own data sets**

• **The benthic group works collectively to achieve quality assurance**
  – Proving to be a great training and knowledge transfer processes
  – Quality assurance is even better when done in context of analyses

• **SCCWRP staff conduct most of the statistical analysis**
  – Manuscript writing assignments are shared (as is authorship)
THREE QUESTIONS THE GROUP PRIORITIZED

• How have macrobenthic communities in the region changed over the last 40 years?
  – Characterizing changes in relation to regional- and oceanic-scale changes

• How sensitive are our benthic assessment tools to interannual ocean temperature changes?
  – Does the BRI moderate natural interannual variations in species composition?

• Have macrobenthic communities at POTW-affected sites improved over the last 40 years?
  – Assessing whether reference and outfall stations have become more similar through time
  – How does the narrowing of that gap coincide with wastewater treatment enhancements
ANALYTICAL APPROACH FOR THE REGIONAL QUESTION

• Describe temporal patterns in the communities
  – Use multivariate analysis to characterize community composition through time
  – Identify the taxa that are changing

• Correlative analyses to assess possible explanations for change
  – Statistical modeling of individual taxa
  – Identify the relative importance of various local and oceanic-scale factors across taxa

• Hypothesis testing to further examine patterns observed in the correlative analysis
  – Look at faunal changes that we expect would respond to specific factors
SELECTING DATA FOR THE REGIONAL SCALE QUESTION

• **Focus on least-impacted reference stations**
  - Minimize the influence of local anthropogenic effects so we can examine oceanic effects

• **Select one site from each of three depths along a gradient**
  - Allows us to explore potential impacts of hypoxia and ocean acidification, which are more prevalent in deeper water

• **These choices only require data compilation/synchronization for 10 stations**
  - San Diego and Los Angeles City sampling is focused on two depths
IDENTIFYING THE TAXA THAT CHANGE

OCSD C (MidShelf)

NMDS2

NMDS1

Ampelisca brevisimulata

Heterophoxus oculatus
CAUSES FOR CHANGE

- Correlate response of individual taxa with 14 possible stressors
  - Oceanic factors such as temperature and acidification
  - Local factors, such as sediment quality
- Integrate results across species to look for dominant patterns
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Importance of Variable to All Taxa

Orange County
All Taxa

Variable

Rank of Importance

ENSO -1yr
CSI
PDO -1yr
ENSO Mean Sea
ENSO Max Sea
Sand
SST -1yr
SST Mean Sea
PDO Max Sea
SST Max Sea
ERL
ERL
PDO Mean Sea
OA Proxy
• Hypothesis 1: Shelled organisms should be affected by OA more than non-shelled organisms
  – Approach: Compare the ratio of shelled/non-shelled organisms over time

• Hypothesis 2: Shelled organisms will be more affected in deep water
  – Rationale: Deeper waters have greater exposure to corrosive waters
  – Approach: Compare rate of change in ratio of shelled organisms between shallow and deep waters
RATIO OF SHELLED:NON-SHELLED ORGANISMS
THE SAME PATTERN IN ORANGE COUNTY
NEXT STEPS FOR THE REGIONAL SCALE QUESTION

• **Continuing quality assurance of all the data**
  – Iterative process – we statistically identify patterns and your staff provide extra scrutiny of results to prevent spurious conclusions
    ○ Example: Disappearance of a species coincides with a change in taxonomists at a lab

• **Working to improve the stressor information used in causal analysis**
  – In particular, we want to strengthen the OA data
THREE QUESTIONS TO BE ADDRESSED

• How have macrobenthic communities in the region changed over the last 40 years?
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  – Does the BRI moderate natural interannual variations in species composition?

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INDEX TEMPERATURE SENSITIVITY APPROACH

• **Assess whether year-to-year changes in benthic indices correlate with changes in temperature**
  – Rationale: Changes in benthic condition should be slow and reflect decadal-level change in contaminant levels
  – Ocean temperature changes rapidly with El Nino and La Nina conditions
  – A well-performing condition index should not respond to annual temperature change

• **Compare index response to community response**
  – If the index is temperature insensitive, how much of that is attributable to index performance vs. temperature insensitivity of the benthic taxa?

• **What aspect of temperature does the biology respond most to?**
  – Which temperature parameter?
  – What lag period?
SELECTING DATA FOR TEMPERATURE QUESTION

• **Focus on minimally impacted stations**
  - Avoid confounding sediment quality improvements with ocean warming

• **Focus on the mid-shelf depth (~60m)**
  - We want to minimize OA effects for this question

• **No new data compilation necessary for this question**
  - The same subset of data used to address the previous question
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  – How does the narrowing of that gap coincide with wastewater treatment enhancements
• Have impacted stations gotten more similar to unimpacted stations over time?
  – Multivariate comparisons of communities at the paired sites through time
  – Assess whether the periods of greatest community composition change correspond with the temporal pattern of plant operation changes (1° treatment, 2° treatment, etc.)

• How have select indicator species changed over time?
  – Compare pollution indicative and sensitive taxa through time

• How have condition indices changed through time?
  – Track BRI and AMBI scores through time to provide an indication of condition
SELECTING DATA FOR POTW EFFECTIVENESS

• The minimally and maximally impacted stations from each utility
  – Allows for a paired comparison of change

• Focus on the mid-shelf depth
  – Minimizes OA confounding

• San Diego circumstance presents an interesting opportunity
  – They moved their discharge location 20 years ago
  – It’s almost like they did an experiment for us – Allowing us to look at the rate of change from the “ultimate clean-up scenario”
  – We can then compare the rate of change at other utilities with that rate of change

• Requires us to do additional data gathering and synchronization
  – But its only four additional (POTW-influenced) stations
THE TARGETED APPROACH TO HISTORICAL DATA APPEARS TO BE WORKING

• **Having specific data analyses in mind motivates the effort**
  – A relevant product at the back end leads to strong participation

• **Targeted analysis lessens the data compilation burden**
  – Focused only on the data needed to answer the questions posed
  – Individual facilities have the option to compile all their data, but it’s their choice

• **The data quality assurance process is more robust**
  – Connecting data QA to a use case leads to better QA queries

• **Great learning opportunity for your junior staff**
  – These historic analyses are a great way to pass the torch
NEXT STEPS

• Finish these benthic invertebrate products
  – Ensure that the enthusiasm I am reporting to you persists all the way to the finish line

• CTAG asked the benthic working group if they felt we should replicate this approach with other data sets
  – The answer was unanimously yes
  – They even provided a list of data sets they recommend doing next

• CTAG will prioritize which data sets to tackle next at their May meeting
  – George Robertson will report recommendations from the benthic working group