ANALYSIS OF THE SCCWRP MEMBER AGENCY HISTORICAL BENTHIC INVERTEBRATE DATA

Presentation to the SCCWRP Commission

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BACKGROUND

- **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

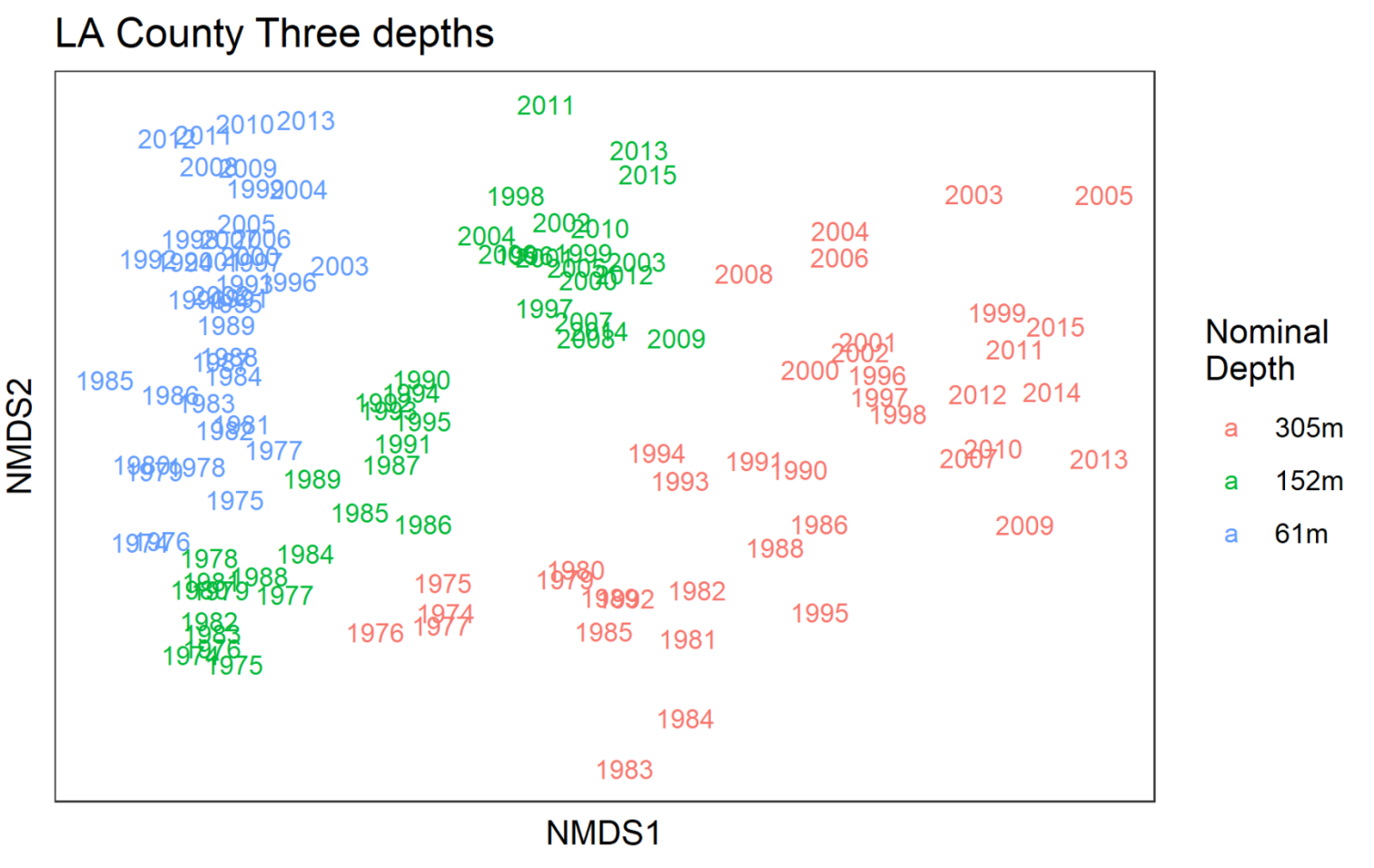
ANALYTICAL APPROACH FOR THE REGIONAL QUESTION

- **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

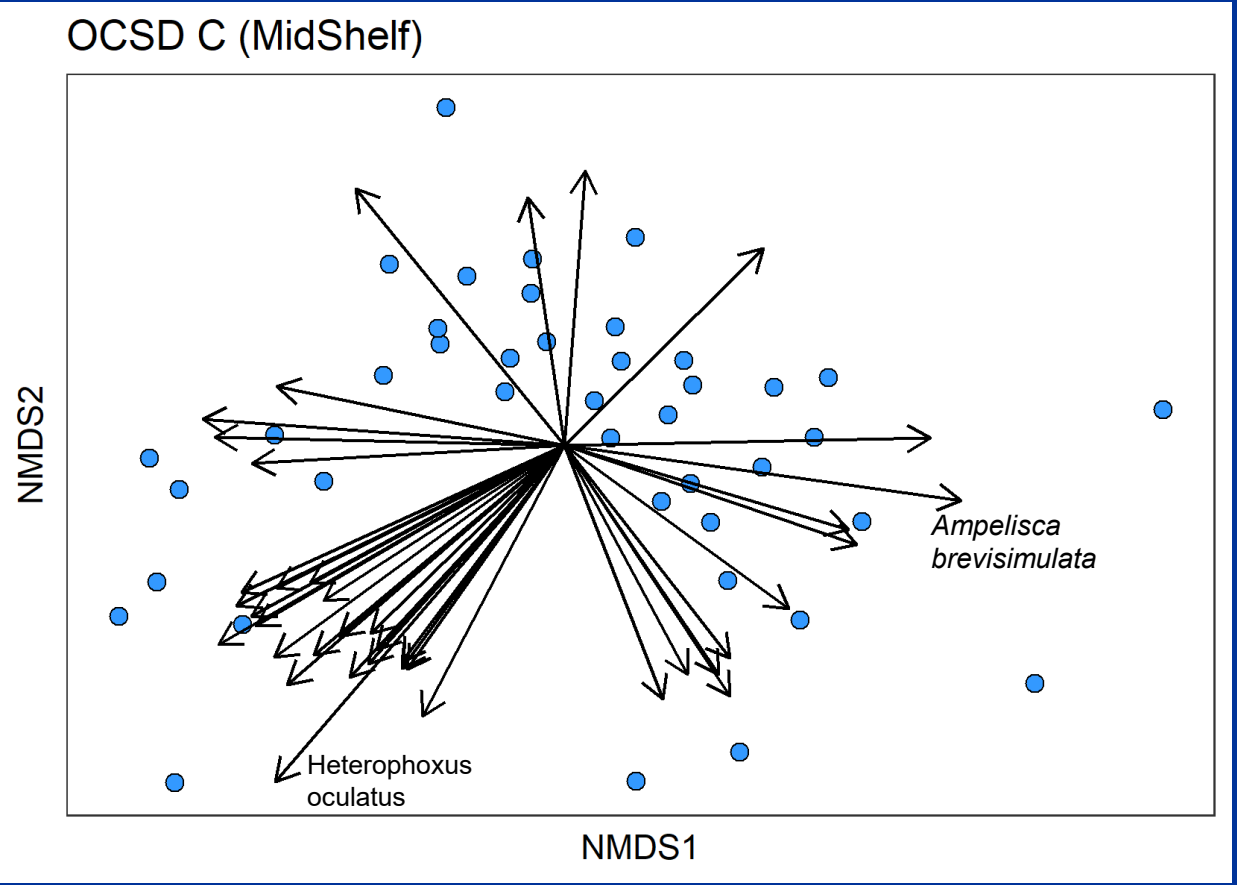
SELECTING DATA FOR THE REGIONAL SCALE QUESTION

- **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

TEMPORAL PATTERN DESCRIPTION



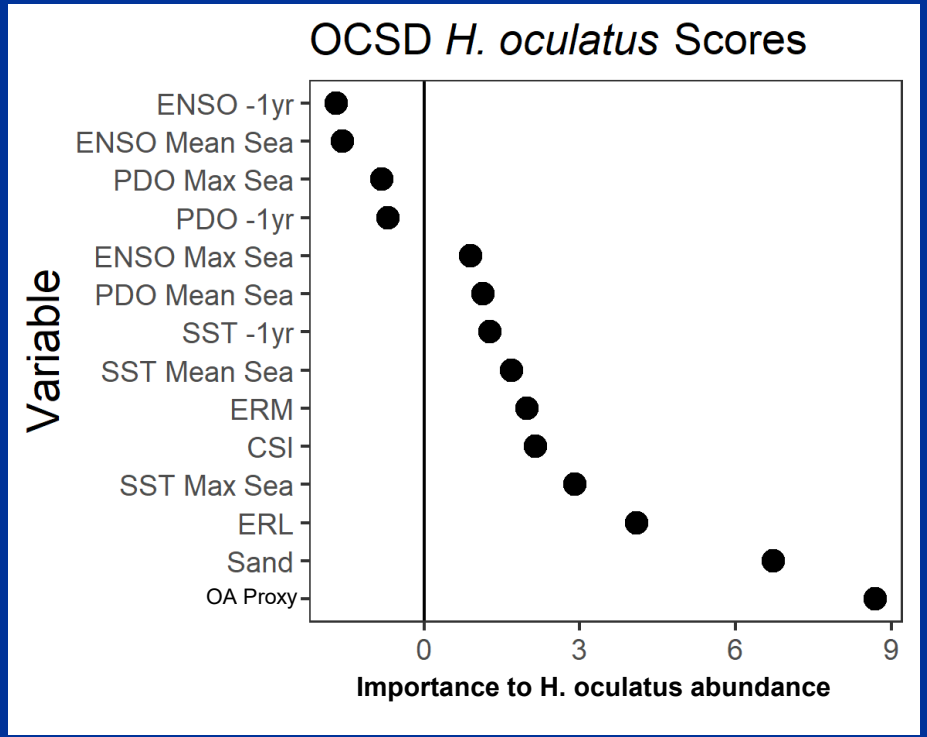
IDENTIFYING THE TAXA THAT CHANGE



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**

Variable Importance Plot



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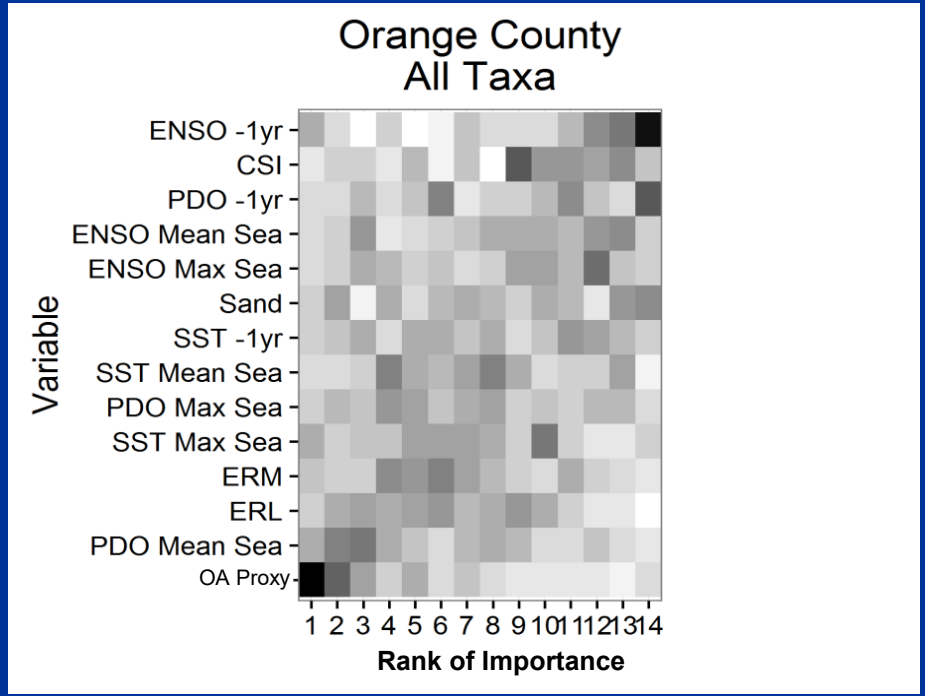
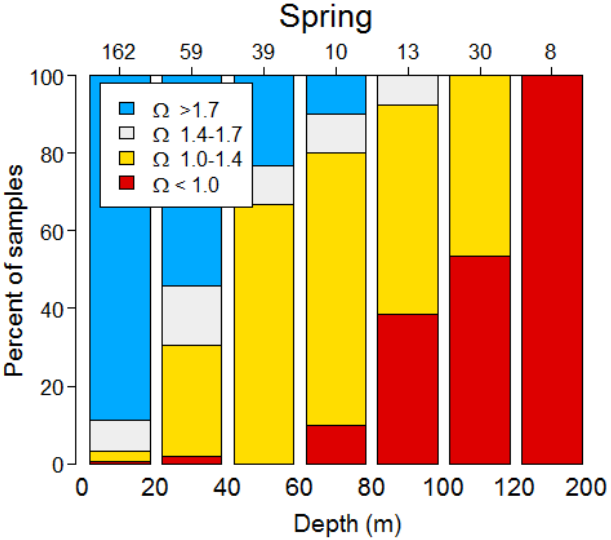
Importance of Variable to All Taxa



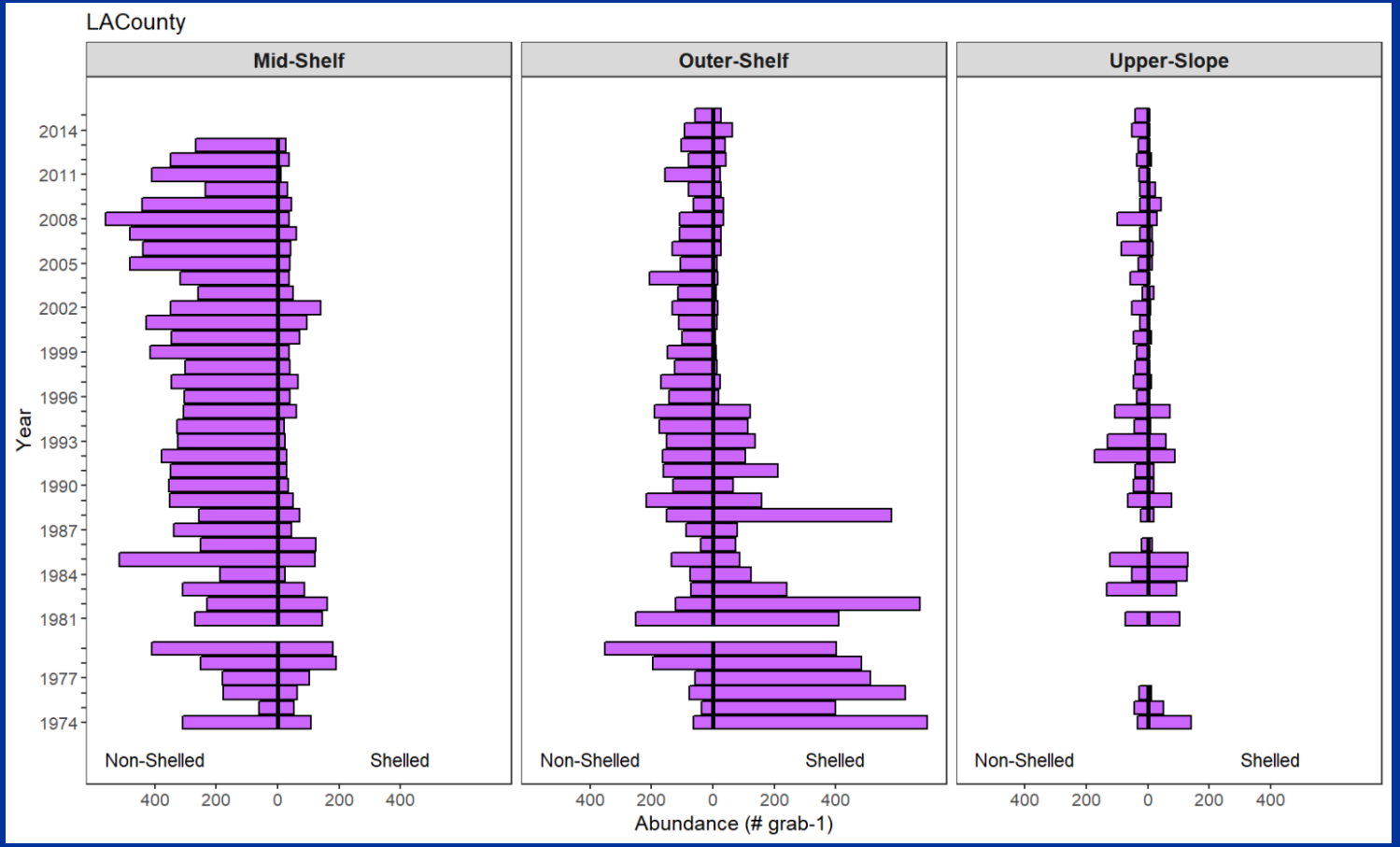
OA-RELATED HYPOTHESIS TESTING

- **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

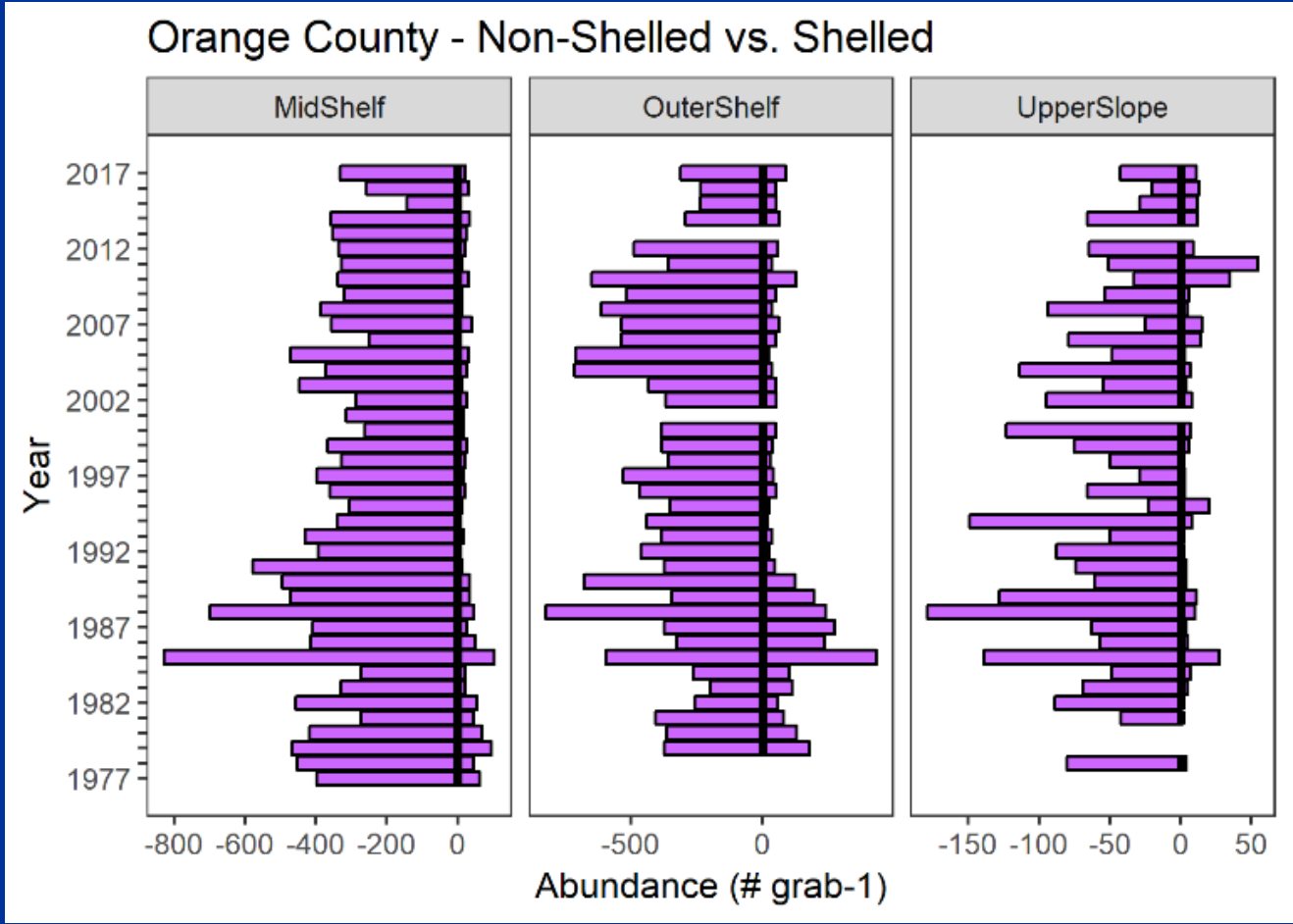
- **Hypothesis 2: Shelled organisms will be more affected in deep water**
  - Rationale: Deeper waters have greater exposure to corrosive waters
  - Approach: Compare rate of change in ratio of shelled organisms between shallow and deep waters



RATIO OF SHELLED:NONSHELLED 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

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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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POTW-EFFECTIVENESS ANALYTICAL APPROACH

- **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
  - Its 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