Streamlining zooplankton long-term monitoring in the CCE with ZooScan

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Background

- We process PRPOOS net samples collected from 2005 to present on quarterly CalCOFI cruises (0507NH to 2208BH) using ZooScan digital imaging and machine learning classification as part of the California Current Ecosystem (CCE) Long-Term Ecological Research (LTER) program
- Sampling along line 80 southwest of Point Conception (upwelling center) & line 90 crossing the Southern California Bight
- 20,000 to 40,000 vignettes obtained per cruise
- Sorted into 26 taxonomic categories using a Convolutional Neural Network/ResNet-152 model, followed by 100% manual validation
- Our data are made available on a public server under ‘ZooscanDB’

Key Points

- We process PRPOOS net samples collected from 2005 to present on quarterly CalCOFI cruises (0507NH to 2208BH) using ZooScan digital imaging and machine learning classification as part of the California Current Ecosystem (CCE) Long-Term Ecological Research (LTER) program
- Sampling along line 80 southwest of Point Conception (upwelling center) & line 90 crossing the Southern California Bight
- 20,000 to 40,000 vignettes obtained per cruise
- Sorted into 26 taxonomic categories using a Convolutional Neural Network/ResNet-152 model, followed by 100% manual validation
- 62 machine vision measurements are made for each vignette
- Our data are made available on a public server under ‘ZooscanDB’

Temporal Changes

- 17-year stability of copepod C biomass vs. Pyrosomes C biomass
- Nearshore elevation of copepod C biomass on both lines 80 and 90 vs. Pyrosomes C biomass
- Copepods exhibit some relationship with PON concentrations vs. Pyrosomes C biomass is independent of PON concentration

Spatial Distribution

- Distance Offshore (km) vs. Copepods and Pyrosomes on lines 80 and 90

Potential Covariates

- Log_{10}(PON (umol/L))

Despite decreased taxonomic resolution relative to human taxonomy, ZooScan increases sample throughput, provides excellent size and other morphometric data for each vignette, and allows for the retention of vignettes for future refined classification.

Figure 1. Copepod (top) and pyrosome (bottom) carbon biomass (mean ± 95%) versus distance to shore during four seasons along Line 80 (left) and Line 90 (right) from 0507NH - 2208BH. Note that copepod biomass decreases monotonically with distance from shore, while pyrosome biomass is more elevated offshore.

Figure 2. Copepod (top) and pyrosome (bottom) carbon biomass (mean ± 95%) versus time from Line 80 (blue) and Line 90 (red) from 0507NH - 2208BH. Note the pronounced increase in pyrosome biomass coincident with the Warm Anomaly starting in 2014.

Figure 3. Copepod (top) and pyrosome (bottom) carbon biomass (mean ± 95%) versus Particulate Organic Nitrogen (PON) concentrations from Line 80 (left) and Line 90 (right) from 0507NH - 2208BH. Note that pyrosome biomass is independent of PON (and POC and Chl-a [not shown]) concentration, while copepod biomass is proportional to PON (and POC and Chl-a).

Figure 4. Log_{10}(PON (umol/L)) with linear regression analysis for lines 80 and 90. Note the significant increase in PON concentrations coincident with the Warm Anomaly starting in 2013-2014.

Figure 5. Representative results: We illustrate that Copepods represent expected patterns while Pyrosomes exhibit some surprising results.

Ohman Lab ZooScan Workflow

- Size fractionation:
- Image analysis
- Machine learning classification
- Manual validation
- Data available on public server under ‘ZooscanDB’