Streamlining zooplankton long-term monitoring in the CCE with ZooScan

Lauren A. Kittell-Porter & Mark D. Ohman

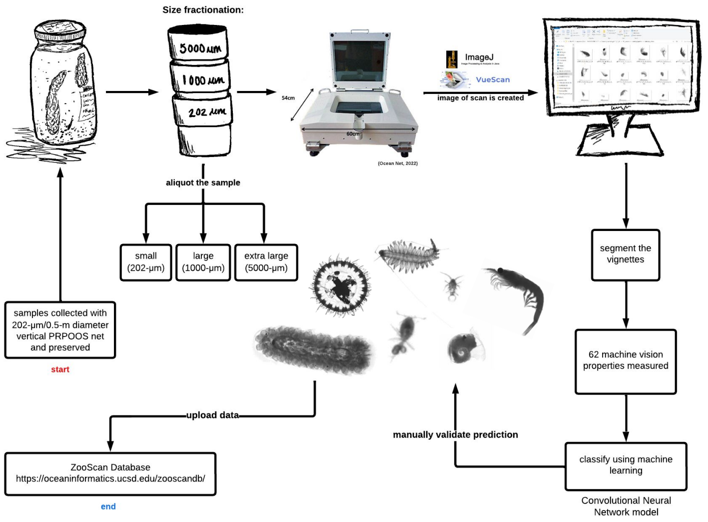
California Current Ecosystem LTER Site

Scripps Institution of Oceanography

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
- 62 machine vision measurements are made for each vignette
- Our data are made available on a public server under 'ZooscanDB'
- Representative results: We illustrate that Copepods represent expected patterns while Pyrosomes exhibit some surprising results

Ohman Lab ZooScan Workflow



Spatial Distribution

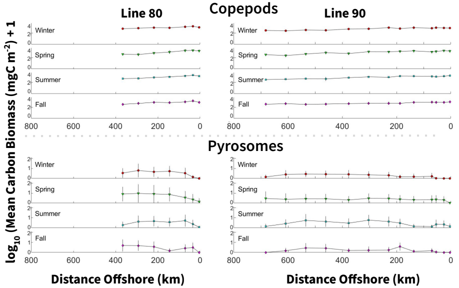


Figure 1. Figure 1. Copepod (top) and pyrosome (bottom) carbon biomass (mean ± 95%) versus distance to shore during four seasons along Line 80 (left) and Line 90 (right) from 0507NH - 2208BH (±95%). Note that copepod biomass decreases monotonically with distance from shore, while pyrosome biomass is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

Temporal Changes

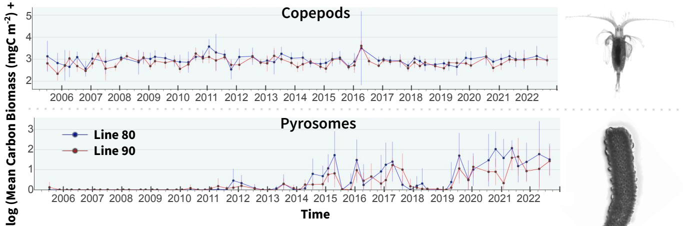


Figure 2. Copepod (top) and pyrosome (bottom) carbon biomass (mean ± 95%) versus time from Line 80 (blue) and Line 90 (red) from 0507NH - 2208BH. Note the pronounced increase in pyrosome biomass coincident with the Warm Anomaly starting in 2014.

Potential Covariates

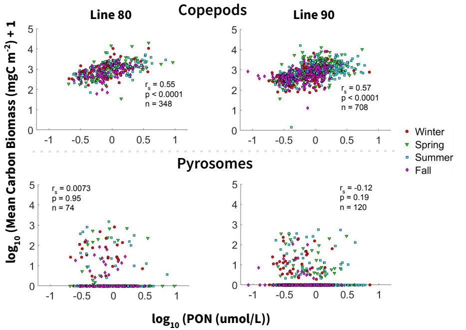


Figure 3. Copepod (top) and pyrosome (bottom) carbon biomass (mean ± 95%) versus Particulate Organic Nitrogen (PON) concentrations from Line 80 (left) and Line 90 (right) from 0507NH - 2208BH. Note that pyrosome biomass is independent of PON (and POC and Chl-a [not shown]) concentration, while copepod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

Key Points

17-year stability of copepod C biomass	***vs.***	A notable increase in pyrosome biomass beginning in 2013-2014
Nearshore elevation of copepod C biomass on both lines 80 and 90	***vs.***	A distinct offshore maximum of pyrosome biomass, in all 4 seasons
Copepods exhibit some relationship with PON concentrations	***vs.***	Pyrosome C biomass is independent of PON concentration

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 classifications.

California Current Ecosystem
Long Term Ecological Research

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CalCOFI Celebrating 70 Years