Jellywatch: Examining the physical drivers behind onshore *Velella* jellyfish sightings through community science

Francesca M. E. Alatorre, Steve H. D. Haddock

University of California, Santa Cruz, Monterey Bay Aquarium Research Institution

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This summer, I spent my time as part of the University of California, Santa Cruz (UCSC) GEOPATHS and Monterey Bay Aquarium Research Institute (MBARI) online internship programs working on the largely self-directed Jellywatch project. This particular project is focused specifically on using community-sourced science as the primary dataset from the Jellywatch.org website to explore on-shore sightings of *Velella* jellyfish. Working together with my mentor, Steve Haddock, we focused on exploring the physical drivers behind *Velella* jellyfish wash-ups. *Velella* are blue colored hydroid polyps with a clear vertical stiff sail floats atop ocean's surface and are dependent on the wind and ocean currents for all travel. Spring seasonal storms over the ocean results in large "wash-ups" on coasts globally.

The project's goals were to use community sourced science as the primary datasets to discover correlations between wind vector data and *Velella* on-shore sightings; to find distribution patterns among the location and dates of on-shore sightings; and to use R language for all of the graphical and visual analysis of the datasets. Alongside the Jellywatch.org data, we supplemented the data with another community-sourced science dataset, iNaturalist.org *Velella* and *Physalia* (Man 'o War) sightings, which added more depth to our analysis due to its larger size and almost opposite sighting patterns. Then I looked at Planet.com satellite data to corroborate the larger *Velella* "wash-ups" from Jellywatch.org and iNaturalist.org. The location we focused on for the wind vector data came from a sensor at MBARI that recorded the direction, speed, and time of the current wind currents. This extremely sizable dataset made it possible to discover correlations between the prevailing wind currents and the onshore sightings of *Velella*.

On the technical side, I uploaded and worked on R language scripts out of a BitBucket repository through the use of the command line. I executed the graphical and visual analysis of the onshore sightings of both polyp species through use of the R language and various R packages. Through the use of these packages, I produced various timeseries, statistical plots, vector graphs, and global map projections of species distributions under the guidance of my mentor. Minor technical issues regarding the parsing of the Jellywatch.org data arose during the code writing process where an extra tab created an additional variable, shifting all of the definitions and creating 'N/A' data.

I began my analysis of the *Velella* onshore sightings through creating a global map projection with layer plotted over the coastlines showing the correct locations of sightings through the given coordinate data. This portion of the visual analysis took the most amount of time to flush out due to a rather steep learning curve of using multiple R packages I was unfamiliar with alongside getting back into the R language after some time. Next, I took the global map projections and created multiple that only plotted the data by year which demonstrated the significant increase in user data in the year following the brief pause in the Jellywatch.org website. The results of this visual analysis indicated global distribution of *Velella* sightings, most predominantly found along the United States (US) west coast and around the United Kingdom. One interesting result indicated almost out of phase sightings between the *Velella* and *Physalia* along the coasts of the US; *Physalia* is extremely dominate on the east coast while close to non-existent along the west coast. Then using the multiple graphs by year, I complied them into a gif file as a visually interesting way to digest the changes across the datasets.

Following the creation of the global maps, I did graphical analysis of the Jellywatch.org and iNaturalist.org datasets to find correlation between the seasons and when the highest frequency of "wash-ups" occurred. The results indicated *Velella* show seasonality in their onshore sightings, specifically the highest frequency of their sightings occur in the spring months independent of hemisphere. *Physalia* on the other hand shows an out of phase relationship to the *Velella* sighting seasonality, primarily found onshore during the fall months. I then combined all three datasets of both polyp species to layer their unique global distribution to make a more direct comparison of their sightings. This global map plot showed the significant difference in the number of sightings of *Physalia* versus Velella, where *Physalia* are spotted, *Velella* are unlikely to be seen there. Finally, I created a density line graph to demonstrate the increase of community science data entries in the last decade meant to show the growing interest and usability of crowd-sourced data.

Presently, my mentor and I are still working through the generating R language scripts of the wind vector analysis. For this analysis we have been exploring additional R packages for creation of a wind vector timeseries of wind speeds and direction from the MBARI sensors. Our next goal is to determine any correlation between the sightings in and around Monterey Bay and wind currents. Current plans for integration of wind vector analysis into the *Velella* includes producing timeseries examination of spring months, averaging the magnitude of the wind vectors by months for clearer analysis, and creating a vector field atop the global *Velella* distribution maps.

From these preliminary conclusions, I was able to present my findings of the Jellywatch project at the 2020 MBARI internship symposium through a virtual web meeting. In addition to the talk, I have also submitted an abstract to the American Geophysical Union (AGU) for a poster presentation for their online fall conference. For the second presentation I will be displaying the final results of the project that will include the conclusions and figures of the wind vector analysis.