Teaching Oceanography with Comics

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Rationale:

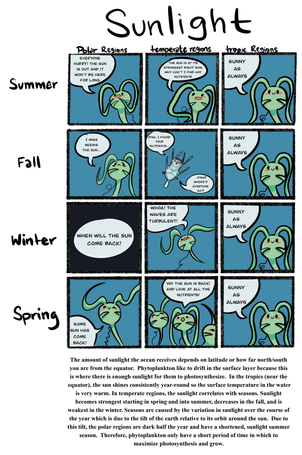
- Science communication is becoming increasingly more important in order to relay information to students and the general public because students can learn through a new medium (Sellars, 2017).
- Science comics are a great tool to use to communicate to all audiences because they are: motivational, visual, permanent, intermediary, and popular (Tribull, 2017).
- In oceanography courses, primary production is a topic that learners struggle with because they have to integrate concepts that are explored throughout the term of the course, like seasonal changes in sunlight and water column stratification, nutrient supply and cycling, ocean circulation and mixing, and predator-prey dynamics.

Methods:

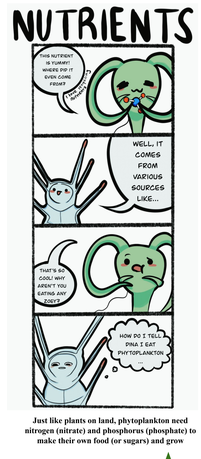
- Studied oceanography texts and course materials to identify concepts that learners (or students) struggle with. The seasonal cycle of primary production was selected as it integrates many basic oceanographic concepts and is fundamentally important in understanding how the ocean works.
- Interviewed scientific communication professionals with a specialty in oceanography to gain knowledge on what makes a good video/comic strip.
- Explored animation and comic presentation format for communicating these processes.
- Storyboarded, animated, scripted and drafted comic strips for review by oceanography instructors or oceanographers.

Educational Products:

Plankton are drifters or wanderers. That doesn't mean they can't swim, it just means that because of their small size they can't swim against ocean currents. Dina is a type of phytoplankton called a dinoflagellate, they are characterized by their two flagella that helps them move. There are different types of phytoplankton such as diatoms, cyanobacteria, and coccolithophores. Zoey, on the other hand, is a type of zooplankton called a Meroplankton. Meroplankton are marine organisms in their larvae stage, and Zoey is a sea urchin larvae! There is also holoplankton which is plankton that stays plankton for their whole lives. Although zooplankton grazes on phytoplankton, Zoey tries not to do that in front of Dina.



The amount of sunlight the ocean receives depends on latitude or how far north/south you are from the equator. Phytoplankton like to drift in the surface layer because this is where there is enough sunlight for them to photosynthesize. In the tropics (near the equator), the sun shines consistently year-round so the surface temperature in the water is very warm. In temperate regions, the sunlight correlates with seasons. Sunlight becomes strongest starting in spring and into summer, decreases in the fall, and is weakest in the winter. Seasons are caused by the variation in sunlight over the course of the year which is due to the tilt of the earth relative to its orbit around the sun. Due to this tilt, the polar regions are dark half the year and have a shortened, sunlight summer season. Therefore, phytoplankton only have a short period of time in which to maximize photosynthesis and grow.



Just like plants on land, phytoplankton need nitrogen (nitrate) and phosphorus (phosphate) to make their own food (or sugars) and grow

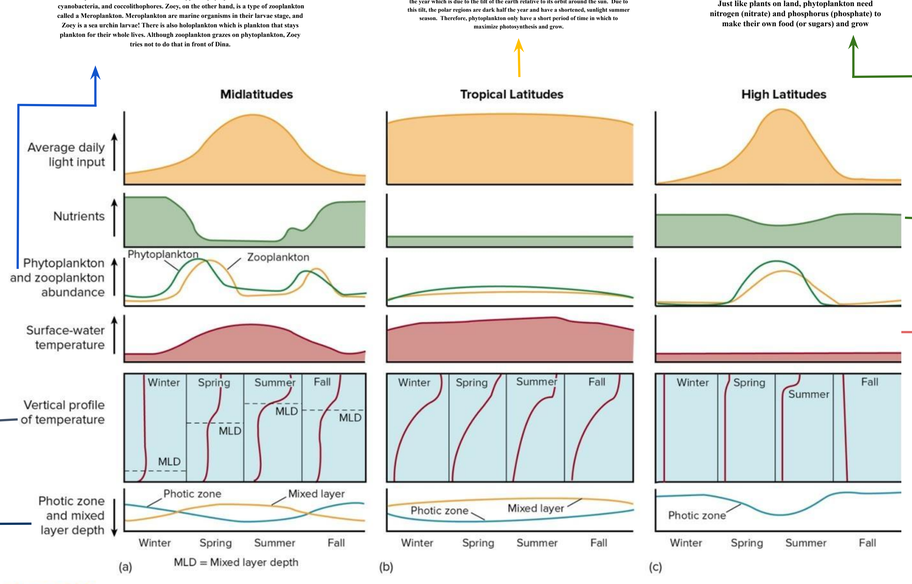
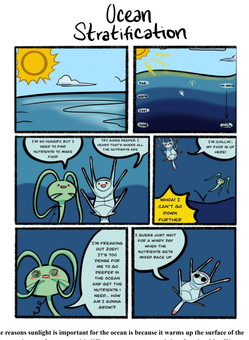


Figure 12.30 Vertical distribution of physical, chemical, and biological properties during the seasonal cycle in (a) temperate, (b)



One of the reasons sunlight is important for the ocean is because it warms up the surface of the water and creates layers of seawater with different temperatures and therefore densities. Warmer layers are less dense and tend to float, while colder layers are denser and sink. The sun is only able to penetrate a small volume of the ocean - the topmost layer called the photic zone. This topmost layer is where phytoplankton like to hang out since it is where they can photosynthesize. They have developed adaptations so they can be buoyant and stay afloat in this layer, but this limits their access to nutrients in the deeper, denser layers. This is fine if there are plenty of nutrients around in the upper layer of the water column, but as organisms die, get eaten and then pooped out by other organisms, these nutrients sink into the deeper, denser layers of the water column, where they tend to collect and increase in concentration. Without these nutrients, the phytoplankton are unable to grow.

There are a couple of ways nutrients can be brought back to the surface - all of them require some form of energy to mix deeper water up into surface water. Currents can flow over or around obstacles in the ocean and this will cause turbulence and mixing. Winds blow on the surface of the ocean providing energy to move water and mix a stratified or layered ocean water column vertically, bringing deeper water up into the surface layer of the ocean. Winds can also move water horizontally, pushing water away from some locations and piling it up in other areas of the ocean. Winds blowing over the surface of the water tend to move the water in the upper layer 90° to the right in the northern hemisphere and 90° to the left in the southern hemisphere due to Coriolis force which is caused by the Earth's rotation. This type of circulation is known as Ekman transport and often results in upwelling. Along some coastlines, and in other areas of the open ocean, winds push surface water away from the coast or each other, resulting in a gap that instantly gets filled with water from deeper in the ocean - it is upwelled. This brings up all the nutrients that have sunk through the water column (due to decay and fecal matter) up to the surface. Phytoplankton utilize these upwelled nutrients to grow.

Applications:

- The goal is to get any audience to understand science
- Integrating comics into the oceanography curriculum to engage students and facilitate learning
  - Comics are a powerful tool for organizing new information and useful assessment indicators for instructors
  - Comics can be used to introduce and explore oceanographic (or scientific) concepts
  - Using these comics along with or to replace lectures and readings benefits introductory students who struggle with these topics

Future Work:

- Integrate comics into Ocean Observatory Initiatives (OOI) Data Lab activities for introductory students and introductory courses
- Create a book out of the individual comics (with relevant background resources?) that can be distributed in print and electronically to instructors and learners of all backgrounds
- Further, explore animation tools to make comics live
- Animate a video on seasonal cycles of primary production in the ocean and post to YouTube

References:

Carly Melissa Tribull, Sequential Science: A Guide to Communication Through Comics, *Annals of the Entomological Society of America*, Volume 110, Issue 5, September 2017, Pages 457–466, https://doi.org/10.1093/aesa/sax046

Jabari Sellars, Comics in the Classroom, *Harvard Graduate School of Education,* December 2017, https://www.gse.harvard.edu/news/uk/17/12/comics-classroom

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