# Range Shifts: How Marine Taxa Track A Shifting Climate

Adapted from [Marine Taxa Track Local Climate Velocities](https://science.sciencemag.org/content/341/6151/1239)

## [Link to the visualization](https://huckley.shinyapps.io/RShiny_RangeShifts/)

## [Link to TrEnCh-Ed](https://trench-ed.github.io/#)

## Objectives

* Develop understanding of the global climate and microclimate forces behind range shifts.
* Analyze cause and effect plots and their biological reality.
* Gain an understanding of marine range shifts, climate velocities, and thermal envelopes.
* Use survey data to assess whether populations have tracked recent climate warming.

## Cross-cutting concepts -- *Next Generation Science Standards*

* Stability and Change
* Systems and System Models
* Patterns
* Cause and Effect

## Standards

Life Science Standards (LS)

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| --- | --- |
| HS-LS2-6 | Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively  consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new  ecosystem. |
| HS-LS2-8 | Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce. |
| HS-LS4-5 | Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in  the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of  other species. |

## Instructions & Questions

### Background

### First, read the introduction of the visualization and answer the following background questions.

1. Define range shift
2. What is the restricting factor of a population’s thermal envelope? (*Hint: it’s in the name)*
3. What are the three dimensions of a marine population’s thermal envelope?
4. How are thermal envelopes and climate velocities related?
5. Come up with a reason why a local climate velocity may be in an unintuitive direction.

### Thermal envelopes and taxon shifts

Ensure the taxa filter is set to “All.”

1. Think about the background information:
   1. What directions of depth and degrees North are the intuitive directions for populations to be moving due to climate change?
   2. Does the data support your intuitive guesses? Why or why not?
2. Look at the latitude (˚N/yr) plot and spot the datapoint at (0.04, 0.28). Hover over the point to retrieve species information and search online to learn a bit about the species (Wikipedia will work). What is its species name? Does what you learned about the species help explain its position on the graph? Briefly explain.
3. Look at the depth (m/yr) plot and spot the datapoint at (3.76, 0.48). Remember, a positive depth shift means a move to deeper waters. Again, hover over the point to retrieve species information and search online to learn a bit about the species (Wikipedia will work). What is its species name? Does what you learned about the species help explain its position on the graph? Briefly explain.

1. For each of the scenarios below, List the species names and xy-coordinates of a data point corresponding to each of the following scenarios on the Depth or Latitude plot:

a. A population that “overshot” its thermal envelope (i.e. a population that has a range shift greater than its climate velocity).

b. A population that is tracking its thermal envelope in the intuitive direction.

c. A population that is tracking its thermal envelope in the unintuitive direction.

1. What is a possible outcome of a population **not** shifting with the climate velocity of its thermal envelope?
2. What is a possible reason why a population is **not** shifting with the climate velocity of its thermal envelope?

### Taxa-specific shifting

Ensure you are on the depth plot for the following questions.

1. Set “Select taxa” = “Fish” and “Select fish” = “Sharks”. Leave “Region” = “All”. Take a screenshot of this plot.
2. Set “Select taxa” = “Brittle stars.” Leave “Region” = “All”. Take a screenshot of this plot.
3. Look up brittle stars to understand this data. What differences do you see between these two taxa groups? Hypothesize why this might be the case.

Now, switch to the latitude plot for the following questions. Set “Select taxa” = “Fish” and “Select fish” = “All”.

1. Set “Region” = “Newfoundland”. Take a screenshot of this plot. Are the majority of fish populations in the positive quadrant of the graph (top right) or negative quadrant of the graph (bottom left)? What does this indicate?
2. Set “Region” = “Gulf of Alaska”. Are the majority of fish populations in the positive quadrant of the graph (top right) or negative quadrant of the graph (bottom left)? What does this indicate?
3. Look up the locations of these two regions. Hypothesize why the climate velocity of these locations are shifting in different directions. What about the Gulf of Alaska might cause it’s fish populations to have southern climate velocities?