

Part 2

While at the meeting, Joe listened intently as Dr. Marlin and others presented data about the fish Joe remembered as being abundant in the waters he fished over the years. The data described the shifts in species towards northern latitudes and deeper waters, although there were complications beyond these two movements.

Dr. Marlin presented his research first which describe the shift in location of summer flounder (*Paralichthys dentatus*, also called fluke), black sea bass (*Centropristis striata*), and scup (*Stenotomus chrysops*) towards cooler waters in the North Atlantic. He described these shifts as being related to climate velocity, which is the rate and direction that temperature shifts across space. "We are seeing overall shifts in species at a rate of 0.24–0.70° latitude/decade, or about 27–78 km/decade. However, our results also show that marine species shift at different rates and directions because they closely track the complex mosaic of local climate velocities." (see Figure 4)

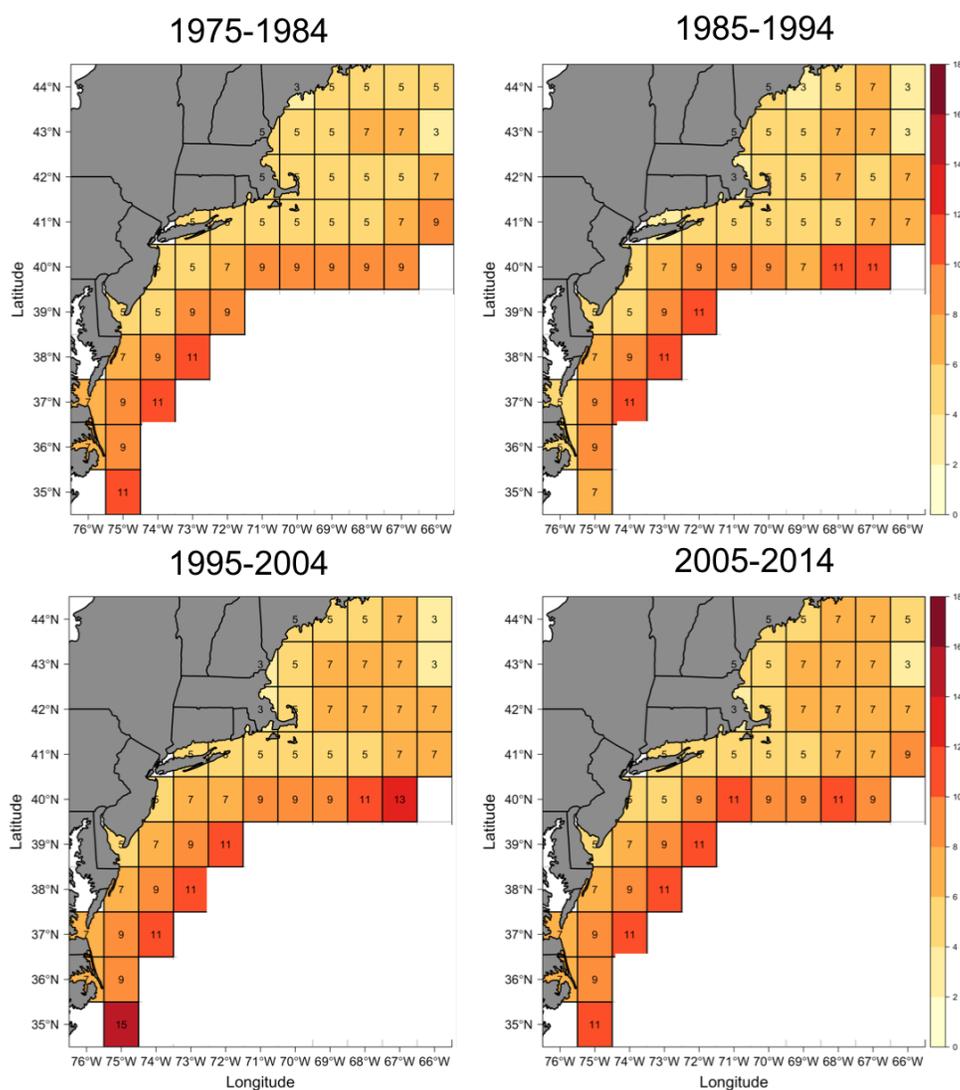


Figure 4: Bottom temperature data (degrees Celsius) collected from NOAA Fisheries vessels during their spring fish surveys in 10-year blocks.



Joe and other fishers in the audience were not surprised to hear about the shifts, but the concept of climate velocity was new. He raised his hand and asked, "Dr. Marlin, your data show locational shifts in a few species. Do you expect the shifts to be occurring in all marine species? What does it mean for the marine life that eat species living in different regions of the ocean?" Dr. Marlin replied, "Great questions! We know that not all marine species are shifting at the same rate; however, there are optimal survival temperatures for each marine species, and if temperatures are rising, they will likely shift to cooler locations if they can. Regarding your second question, I'll defer to Dr. Susan Baleen, a marine ecologist from the Marine Eco-Center of the Atlantic."

The next speaker was Dr. Baleen who has been studying marine ecosystems of the western Atlantic for more than twenty years. "When species shift location, it is like they are moving into a new home. The new location may or may not have what is needed for the guests to survive. If the location is suitable for the arriving species, the resources available for those already living there may be reduced. This is called competition. In addition, the food web may change as new species enter, begin eating new prey, and begin to be eaten themselves." She continued, "For example, we've seen this occur when black sea bass shifted north into lobster habitat and began to eat more lobster."

These two talks resonated with Joe as he thought about all the changes in his fishing waters. He is concerned about the status of the fisheries he relied on for more than 30 years, since he expected they would be sustained into the future. Even more, he is concerned about the marine ecosystem as a whole, knowing that one small change can have an impact throughout the entire ecosystem.

### Questions

1. In your own words, describe "climate velocity."
2. Note the data presented in Figure 4. Describe how marine species may respond to shifting temperatures as displayed in the figure.
3. Ecosystems are complex. Using a cause and effect frame, identify as many cause-effect relationships that may occur when species shift their locations.

