Ocean temperature predicts spread of marine species

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Scientists can predict how the distance marine larvae travel varies with ocean temperature – a key component in conservation and management of fish, shellfish and other marine species – according to a new study from the University of North Carolina at Chapel Hill.

Most marine life, including commercially important species, reproduces via larvae that drift far along ocean currents before returning to join adult populations. The distance larvae travel before maturing, called dispersal, is directly linked to ocean temperature, the researchers found. For example, larvae from the same species travel far less in warmer waters than in colder waters, said lead author Mary O'Connor, a graduate student in marine ecology in UNC's curriculum in ecology and the department of marine sciences in the College of Arts and Sciences.

"Temperature can alter the number and diversity of adult species in a certain area by changing where larvae end up," O'Connor said. "It is important to understand how a fish population is replenished if we want to attempt to manage or conserve it."

Using data from 72 marine species, including cod, herring, American lobster, horseshoe crabs and clams, O'Connor and her colleagues developed a model that predicts how far larvae travel at a certain temperature. The predictions appear to hold for virtually all marine animals with a larval life cycle.

"We can apply this rule to animals without having to go out and measure every species," O'Connor said. "Our general model gives us a powerful new way to study larval movement with knowledge about ocean temperature, which is much easier to come by. With models such as this, we can see what large-scale changes in ocean temperature may mean for adult populations."

The study appeared online the week of Dec. 25 in the *Proceedings of the National Academy of Sciences Early Edition*.

Knowing dispersal distance is a critical component for managing commercially important or invasive species, O'Connor said. "For many animals, the larval phase is the only chance for babies to get away from parents. Dispersal prevents inbreeding; for some species, this is a time to move from breeding ground to habitat where they'll mature," she said.

But less than 1 percent of larvae survive dispersal. They are consumed by predators, encounter harsh environments or never reach their destination and starve. For endangered species, survival of some animals may depend on whether offspring from parents in one protected area can get to another area where they are safe from harvest. "In warmer waters, marine protected areas may need to be closer together than in colder water, since in warmer water dispersal distances tend to be shorter," O'Connor said.

While a one degree increase in temperature at the ocean surface means larvae will travel a shorter distance in warm seas, the effect is more severe when temperatures are below about 59 degrees Fahrenheit (15 degrees Celsius), O'Connor said. Along California's coast, sea surface temperature may warm from 53 degrees to 59 degrees Fahrenheit during an El Nino year, when a warm ocean current appears in the equatorial Pacific Ocean. Larvae that travel 62 miles at 53 degrees Fahrenheit would disperse only 46 miles at 59 degrees.

"On the up side, shorter dispersal can mean greater survival because the larvae spend less time in the water, where they are at a high risk of death. On the down side, it could mean they won't travel as far and may not make it to their juvenile habitat," O'Connor said.

The researchers suspect temperature plays an important role in larval dispersal because metabolic processes in larvae are sensitive to temperature and similar among species. Consequently, larvae in cold waters develop more slowly and drift further before beginning their next development stage because colder temperatures cause sluggish metabolisms.

Source: University of North Carolina at Chapel Hill

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