manifests at a broad level—with some reefs, or individual coral colonies on a reef, appearing to become more resilient than others from one event to the next. Lab studies have confirmed that sublethal levels of stress can indeed render corals more likely to survive high heat. It’s not clear, however, how long memory might last. An early study detailing work done in the 1990s suggests that corals might remember past exposures for a decade or more, but the timescale can also be quite short, limited to just a few weeks, supporting the argument that these changes reflect relatively rapid acclimation by long-lived coral colonies and not adaptation of corals over generations.

Increasingly, researchers are paying attention to the winners and losers of repetitive hardships to unpack the individual- and species-level differences in memory. “You see that variability across the reef, where some [corals] are totally pale and bleached and others look fully pigmented,” says Hollie Putnam, a molecular ecophysiologist at the University of Rhode Island. “I think that kind of natural variability sets up a really nice context to ask . . . mechanistic questions” about environmental memory. In recent years a panoply of new molecular tools has helped scientists determine how heat elicits changes in corals, and how exposures affect their algal symbionts, potentially preparing the animals for future harsh conditions.

Already, scientists are hoping to use coral memory to improve conservation and restoration strategies before corals tip irreparably toward extinction. Coral biologists are exposing corals in the lab to mild thermal stress to “harden” the corals, or fortify them against future heat waves and bleaching events. Teams are also breeding corals to have a higher capacity for memory, or inoculating corals with heat-resistant symbionts thought to play a role in memory. The ultimate aim is to one day outplant these corals to rebuild reefs that are losing the battle against climate change.

Agencies including the National Oceanic and Atmospheric Administration (NOAA) and the National Academy of Sciences have recently produced reports touting the promise of these memory-based approaches for improving coral resilience, while the National Science Foundation (NSF) and restoration groups are awarding grants to probe the genetic and epigenetic drivers of coral memory. Florida International University environmental epigeneticist Jose Maria Eirin-Lopez, a recipient of several NSF grants, says that this support underscores the relevance of this field of inquiry.

“Stress hardening has been highlighted as an intervention that can be incorporated into restoration, but we really don’t know quite enough to know how to do that efficiently,” he tells The Scientist. “It’s a glimmer of hope, and now we need to figure out how it’s working so we can actually implement this.”

**FEELING THE HEAT**

Coral reefs worldwide are exposed to increasingly frequent and severe warming events that can lead to catastrophic bleaching when coral organisms eject their algal symbionts. But scientists have noted that some reefs bounce back after such warming events and often fare better during subsequent temperature increases, even if they are hotter or longer than previous ones. This phenomenon—whereby an organism modifies its response to past abiotic stimuli—has been termed “environmental memory,” and researchers are working to understand how and why certain corals may have a greater capacity for memory than others.