DIRECT AND INDIRECT EFFECTS OF CLIMATE CHANGE-AMPLIFIED PULSE HEAT STRESS EVENTS ON CORAL REEF FISH COMMUNITIES

Jennifer M.T. Magel, Sean A. Dimoff, and Julia K. Baum

Study Description

Climate change threatens the future of tropical corals, but less is known about how rising ocean temperatures impact reef fishes. We quantified reef fish communities in the equatorial Pacific (Kiritimati Island) before, during, and after an intense marine heatwave. Fish abundance and biomass around the atoll both halved during heat stress, presumably as fish migrated to deeper, cooler waters. One year after the heatwave, however, reef fishes had rebounded to pre-heatwave levels, with some notable exceptions: corallivores plummeted following the heatwave-induced mass coral mortality, herbivores increased as macroalgae proliferated, and reefs highly impacted by local human disturbance showed impaired recovery.

Magel, J. M. T., S. A. Dimoff, and J. K. Baum. 2020. Direct and Indirect Effects of Climate Change-Amplified Pulse Heat Stress Events on Coral Reef Fish Communities. Bull Ecol Soc Am 101(3):e01706. https://doi.org/10.1002/bes2.1706

Photo 1. Representative species from each of the eight trophic groups examined in the study (clockwise from top left): piscivores (peacock grouper, *Cephalopholis argus*), generalist carnivores (arc-eye hawkfish, *Paracirrhites arcatus*), invertivores (two-saddle goatfish, *Parupeneus insularis*), planktivores (yellowtail basslet, *Pseudanthias olivaceus*), corallivores (ornate butterflyfish, *Chaetodon ornatissimus*), omnivores (Dick's damsel, *Plectroglyphidodon dickii*), herbivores (bullethead parrotfish, *Chlorurus sordidus*), and detritivores (striped-fin surgeonfish, *Ctenochaetus marginatus*). In total, we counted 171,445 individual reef fishes of 245 species on our surveys before (2011, 2013), during (2015), and after (2017) the marine heatwave on Kiritimati. At the time of our July 2015 surveys, two months into the warming event, coral bleaching was still minimal and habitat complexity unchanged. This suggests the observed fish declines were the result of a direct physiological stress response to the increased water temperatures. Photo credits (clockwise from top left): Kevin Bruce (2019); Kristina Tietjen (2015); Kristina Tietjen (2019); Kristina Tietjen (2015); Kristina Tietjen (2016); Sean Dimoff (2019); Kevin Bruce (2018); and Kevin Bruce (2017).

Photo 2. Sean Dimoff lays out a transect line while conducting an underwater visual census (UVC) along the forereef at one of our long-term monitoring sites on Kiritimati (after the heat wave). During surveys, scientific divers swim along either side of a 100 m transect that is laid out along the reef's 10–12 m isobath. They identify, count, and size every fish observed, including the school of dark-banded fusilier (Pterocaesio tile) seen here ahead of Sean. Photo credit: Tyler Phelps (2017).

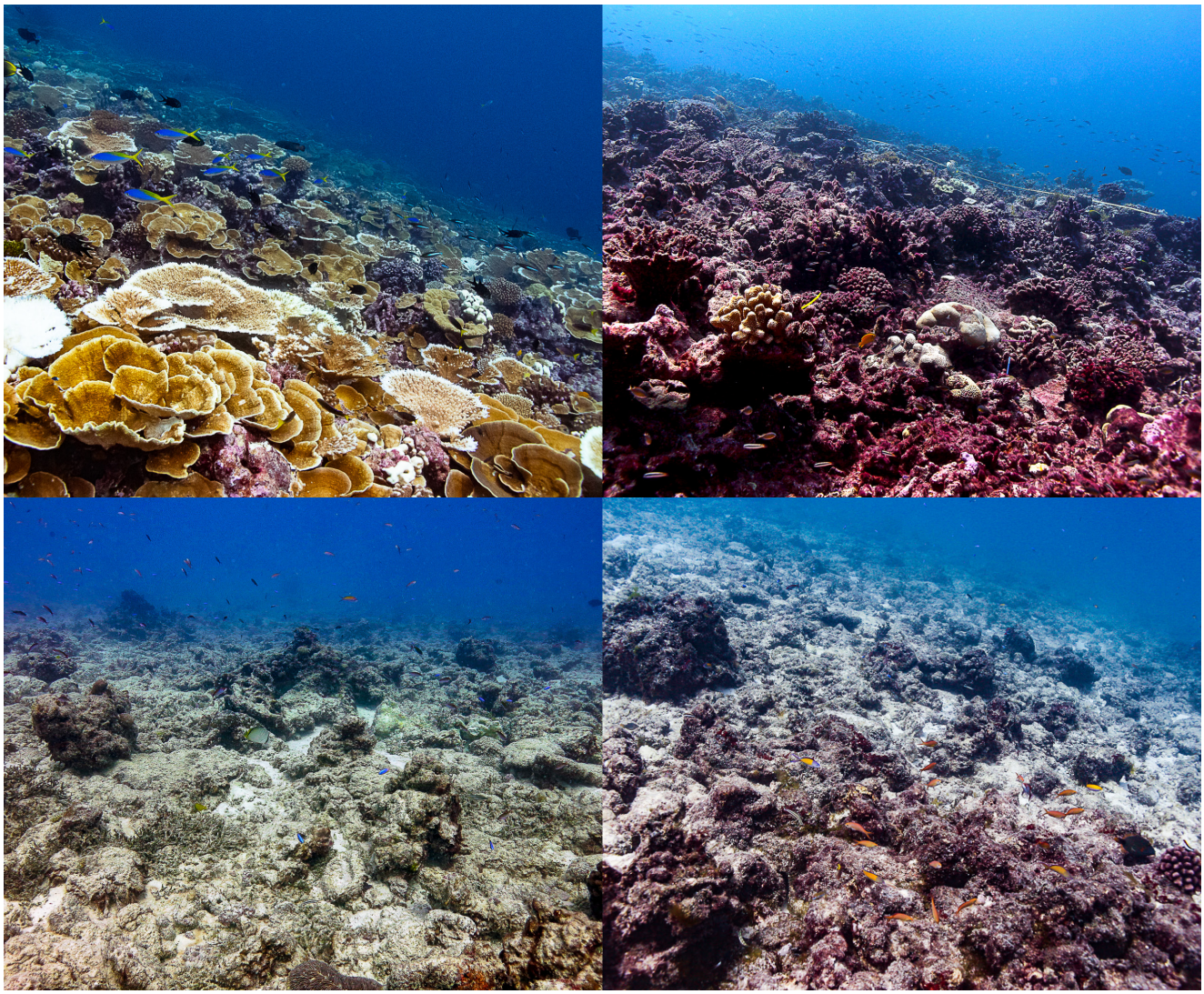

Photo 3. The 16 surveyed reef sites on Kiritimati (population ~6,500; Republic of Kiribati) span a gradient of chronic local human disturbance (sewage, fishing, infrastructure), from very low (top left) to very high (bottom left), that has arisen because of the concentration of villages on the atoll's northwest coast. Heatwave-induced mass coral mortality transformed sites across the gradient (right column, after photos of the same sites). Our analyses suggest that local disturbance may impair the ability of reef fish communities to recover following severe heat stress, possibly because these sites have less structural complexity, which reef fishes rely on as habitat. Photo credits: Kristina Tietjen (2015); Julia Baum (2017); Danielle Claar (2014); and Kristina Tietjen (2017).

Photo 4. Although the overall reef fish community had recovered to pre-heat stress levels one year after the event, the numbers of corallivores, including the Chevron butterflyfish (*Chaetodon trifascialis*; top), which feed on live corals, declined substantially. *C. trifascialis* has, in fact, not been observed since the heatwave. In contrast, numbers of herbivorous fishes, including Carolines parrotfish (*Calotomus carolinus;* right) increased, likely in response to increased turf algae and macroalgae cover at several of our sites. Photo credit: Kristina Tietjen (2015) and Sean Dimoff (2019).

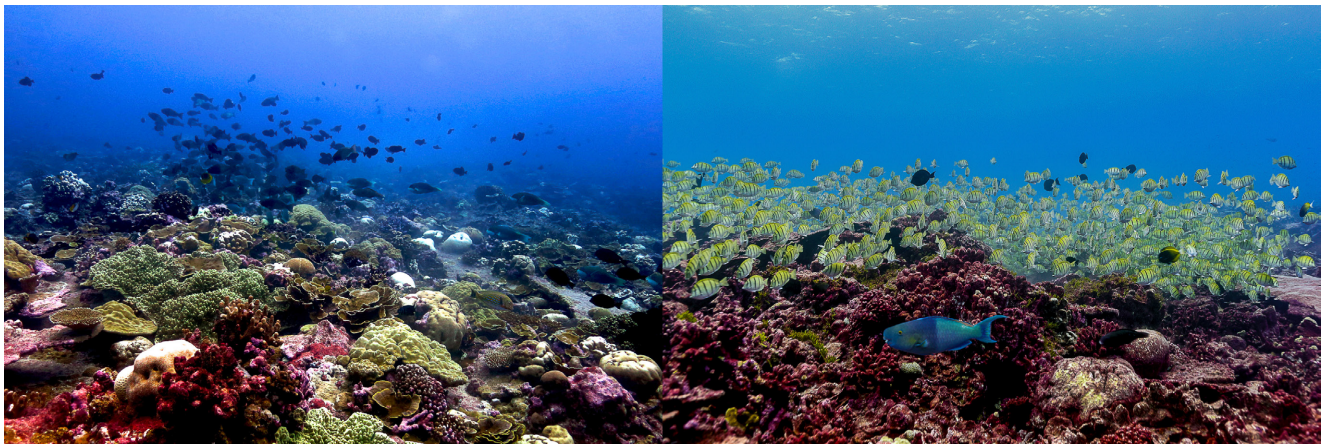

Photo 5. Large schools of reef fishes were observed before (blue-barred parrotfish, *Scarus ghobban;* left) and after (a lone ember parrotfish, *Scarus rubroviolaceus,* in front of a school of convict surgeonfish, *Acanthurus triostegus;* right) the marine heatwave, despite the mass coral mortality it inflicted on the reef. Although the heatwave's impacts on most of the reef fish community were short-lived, studying such events may foreshadow the more serious long-term consequences of future ocean warming. Photo credit: Kristina Tietjen (2015) and Kristina Tietjen (2017).

These photographs illustrate the article "Direct and indirect effects of climate change-amplified pulse heat stress events on coral reef fish communities" by Jennifer M. T. Magel, Sean A. Dimoff, and Julia K. Baum published in *Ecological Applications*. https://doi.org/110.1002/eap.2124