Projected Changes in the Distribution and Phenology of Nassau Grouper (*Epinephelus striatus*) Spawning Aggregations

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Most projections of how climate change affects species distributions are based on a species' most conspicuous life stage. However, not all life stages are equally sensitive to temperature. Among fishes, spawning adults often have narrower thermal tolerances than other life stages and may constrain population responses to climate change. We tested this hypothesis using data on Nassau grouper (*Epinephelus striatus*), a critically endangered top predator on Caribbean coral reefs. Species distribution models of spawning aggregations and non-spawning adults were used to determine which of seven environmental variables exerted the greatest influence on monthly fish distribution. Based on model output, we calculated thermal niche and ecological niche breadth of each life stage. An earth system model was then applied to project how species distribution and phenology shift under the RCP 8.5 climate change scenario. Sea surface temperature and seasonal temperature gradients affected the distribution of both *E. striatus* spawning aggregations and non-spawning adults, but these life stages differed in their preferred temperatures and reaction to oceanic currents. While the two life stages exhibited similar ecological niche breadth, the thermal niche of spawning aggregations was significantly narrower than non-spawning adults. By 2081-2100, potential spawning habitat was projected to decline by 82% relative to a 1981-2000 baseline, whereas suitable habitat for non-spawning adults decreased by 46%. Poleward shifts in latitude occurred >4 times faster for spawning aggregations than non-spawning adults. These changes were attributed primarily to rising temperatures, whereas changes in hydrography did not have a substantial impact. The narrow thermal tolerance range among spawning *E. striatus* confirms that this life stage is likely to serve as a bottleneck constraining responses to climate change.

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