PRECARIOUS PATH TO MATURITY

Stone crabs are vulnerable to environmental stressors at each stage of their life cycle. The more scientists learn about the impacts of these stressors, the better fishery managers can adapt their strategies to sustain the population. Here are the results of Mote's laboratory-based studies so far.

LEND A CLAW

You can help fight the challenges facing stone crabs—reduce your carbon footprint to help address climate change, use landscaping best practices to reduce nutrient-rich runoff, and support research focused on mitigating Florida red tide.

To learn more about Dr. Phil Gravinese and his research portrayed in this poster, including a list of peer-reviewed research citations, visit mote.org/gravinese.

THE CHALLENGES

Florida red tide (current stressor) is a higher-than-normal concentration of a toxin-producing *Karenia brevis* algae found in the Gulf of Mexico. Mote examined the impacts of high and medium red tide concentrations, which are each higher than the normal "background" levels.

Elevated temperature (current stressor projected to increase): Climate change is increasing average seawater temperatures, including in regions where stone crabs live. Mote examined the impacts of increasing temperature by 2 degrees Celsius (3.6 degrees Fahrenheit), which was based on one scientific projection of global climate change for year 2100.

Ocean acidification, OA (current stressor projected to increase): OA, part of climate change, is a worldwide decrease in seawater pH driven by increased carbon dioxide in the atmosphere. Some coastal habitats in Florida are also experiencing seasonal declines in pH due to organic runoff, which can decrease pH three times faster than the rate of OA anticipated for global oceans by the end of the century. Mote investigated the impacts of OA projected for year 2100.

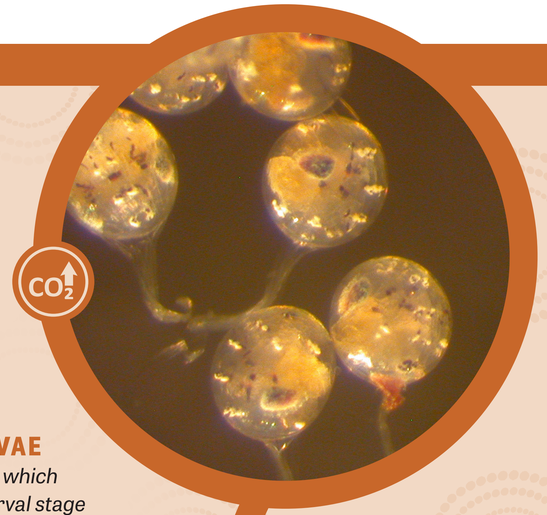
Low oxygen, or "hypoxia" (current stressor), can occur because of nutrient pollution in coastal waters and in the aftermath of a severe red tide. Both of these can cause increases in decomposing organic matter, reducing oxygen in the water. Mote examined the impacts of short-term low oxygen conditions comparable to those documented in shallow, nearshore environments along Cedar Key, Florida, where stone crabs were collected for the research.

MOTE MARINE LABORATORY

EMBRYOS

Stone crab embryos develop inside an egg for two weeks before hatching.

Ocean acidification (OA), exposure throughout embryonic development
28% decrease in hatching success
24% slower embryonic development



LARVAE

After hatching, stone crabs grow through five larval stages, which take 20–30 days to complete, before they molt into a post-larval stage that lasts about one week. In Mote's research, larvae were raised in each environmental condition throughout their entire larval development to monitor survival, development and swimming behavior.

Ambient conditions (pH = 8.0, temperature = 30 °C/86 °F):
About 25-26 days to complete larval development
Normal swimming behavior (80% of larvae swam toward the surface as expected.)

Elevated temperature (+2 °C/3.6 °F)
71% decrease in survival
13% faster development
Normal swimming behavior (80% swam toward the surface as expected.)

OA, (pH = 7.6)
37% decrease in survival
12% longer development in later larval stages
Abnormal swimming behavior (74% swam away from the surface at faster rate.

OA and elevated temperature combined
80% decrease in survival
Larvae developed at a similar rate to the elevated temperature condition. No changes in larval morphology (shape of body structures)
Abnormal swimming behavior (78% swam away from the surface at faster rate.)

Florida red tide, four-day exposure
100% mortality at high concentration (about 1 million red tide cells per liter of water)
30% mortality at medium concentration (about 100,000 cells per liter)
Abnormal swimming behavior (60% of larvae swam downward.)

ADULTS

Adult crabs can be "sublegal," with claws too small for harvest (roughly 1 to 1.5 years older than juvenile), or "legal," with claws that measure at least 2.75 inches from joint to end of the claw (roughly 1.5 to 2 years older than juvenile).

Florida red tide, nine-day exposure of sublegal crabs
67% decrease in eating
52% loss of reflexes
42% decrease in survival

JUVENILES

Young crabs that grow and molt repeatedly and are reproductively immature.

Hypoxia, two-hour exposure
80% mortality in small juveniles
12% mortality in large juveniles (but 35% of large juveniles showed immobility)

ILLUSTRATION BY: HAYLEY RUTGER | PATTERN BY: LIMOLIDA STUDIO / ADOBE STOCK