Coral reefs are in global decline, with seaweeds commonly supplanting corals and changing the character of the reef ecosystem. Much of the decline and lack of recovery relates to changes in fundamental biotic interactions that are mediated via bioactive secondary metabolites. Experiments on Fijian reefs demonstrate that a diverse assemblage of herbivorous fishes is critical for suppressing chemically-defended seaweeds that damage corals via allelopathic toxins. Of equal importance is how coral and fish larvae respond to chemical cues from overfished areas dominated by seaweeds versus no-take marine protected areas dominated by corals. These interactions demonstrate the importance of chemical signaling as a blue-print for biotic interactions that regulate ecosystem structure.