PAST AND PROJECTED FUTURE CLIMATE IMPACTS TO CORAL REEFS IN THE FLOWER GARDEN BANKS

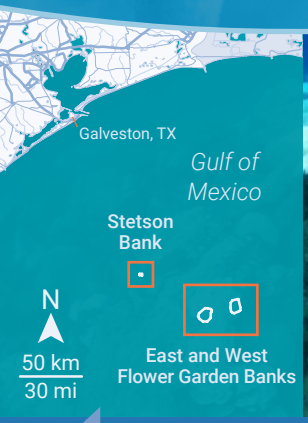


Image: FGBNMS/Hickerson

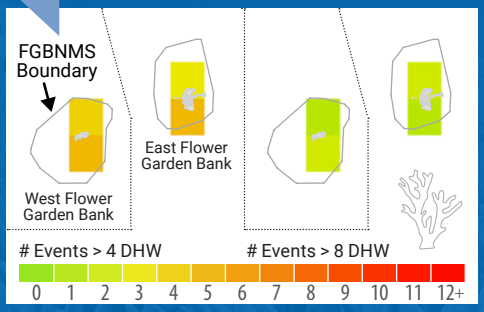
About

East Flower Garden Bank

Coral reefs in Flower Garden Banks National Marine Sanctuary (FGBNMS) contain over 300 species of reef fish, over 20 species of coral, a wide variety of crustaceans and sponges, and many protected and/or threatened marine mammals, sharks, rays and sea turtles. The reefs have been exposed to thermal stress severe enough to cause coral bleaching in the past (East Flower Garden Bank in 2016 on left), and are expected to in the future. Vulnerability to climate change is a function of both exposure of reef systems to climate pressures and the resilience of the system to those pressures. We can support reef resilience and reduce climate vulnerability by reducing the stress to reefs caused by human activities, such as discharge, fishing and anchoring.

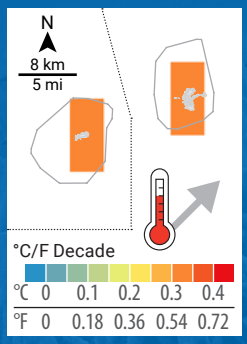
Past (1985-2012)

BLEACHING HISTORY



Frequency of exposure to thermal stress events that likely caused mild/moderate bleaching (4 DHW) and severe bleaching (8 DHW). Coloured boxes within sanctuary boundaries are 4-km pixels for which data are available.

TREND



Rate of increase of sea surface temperatures.

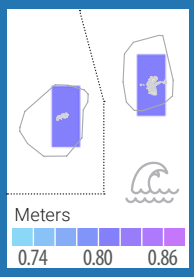
Reefs were exposed to thermal stress that likely caused mild/moderate bleaching (4 Degree Heating Weeks, DHW[1]) 5 times in the 27 year period and were exposed 2 times to stress that may have caused severe bleaching (8 DHWs). Coral reefs of the FGBNMS were exposed to moderate thermal stress in 2002 and severe thermal stress in 2005, 2010 and 2016. Reefs of the FGBNMS were exposed to moderate or severe thermal stress 3 times between 2002 and 2012. Reefs were not exposed to moderate or severe thermal stress at all between 1986 and 1996. This increase can be attributed to increases in sea temperature, which have averaged 0.35°C/decade (0.6°F/decade) in the FGBNMS.

Projected Future (2017-2100)

Climate models* suggest that all coral reefs of the FGBNMS will be exposed to severe thermal stress (8DHWs) every year by 2040 under emissions scenario RCP8.5 (assumes climate policy will not be effective). RCP4.5 is a stabilization scenario that requires greater emissions reductions than pledged under current climate policy. There is 15-20 years difference on average between RCP4.5 and 8.5 in the onset of annual severe thermal stress (a greater difference between scenarios than is projected for all other U.S. coral reef areas, except Florida). The projected change in aragonite saturation state (Ω_{arag}) between 2006 and 2050 is -0.48, which may cause a 7% decline in calcification (based on 15% declines for each unit of Ω_{arag}, Chan and Connolly 2006). Sea level rise is projected to increase 0.8 meters in the Flower Garden Banks area this century.

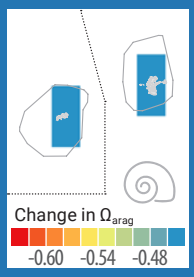
* Intergovernmental Panel on Climate Change (IPCC) fifth phase of the Coupled Model Interpolation Project (CMIP5) models (see van Hooidonk et al. 2015 for list of models for each scenario); projections shown are ensemble averages.

SEA LEVEL RISE



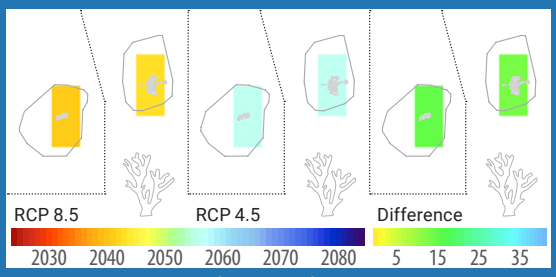
Sea level rise by 2100.

OCEAN ACIDIFICATION



Change in aragonite saturation state between 2006 and 2050.

ONSET OF ANNUAL SEVERE BLEACHING (YEAR)



Climate model projections of the onset of annual severe bleaching under RCP4.5 (stabilization scenario that requires greater emissions reductions than pledged under current climate policy), RCP8.5 (assumes climate policy is ineffective), and the difference in years between the scenarios.

These data and maps are adapted from these publications:

1. Heron, S. F., Maynard, J. A., et al. (2016). Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012. *Scientific Reports*, 6.
2. van Hooidonk, R., Maynard, J., et al. (2016). Local-scale projections of coral reef futures and implications of the Paris Agreement. *Scientific Reports*, 6.
3. van Hooidonk, R., Maynard, et al. (2014). Opposite latitudinal gradients in projected ocean acidification and bleaching impacts on coral reefs. *Global Change Biology*, 20(1), 103-112.

References:

Chan NCS, Connolly SR (2013) Sensitivity of coral calcification to ocean acidification: a meta-analysis. *Global Change Biology*, 19, 282–290.

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