Climate Change Impacts on **South Africa's Coastal and Estuarine Fishes**

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Understanding the risks or impacts of climate change on fish biodiversity and communities is important in planning for a future climate

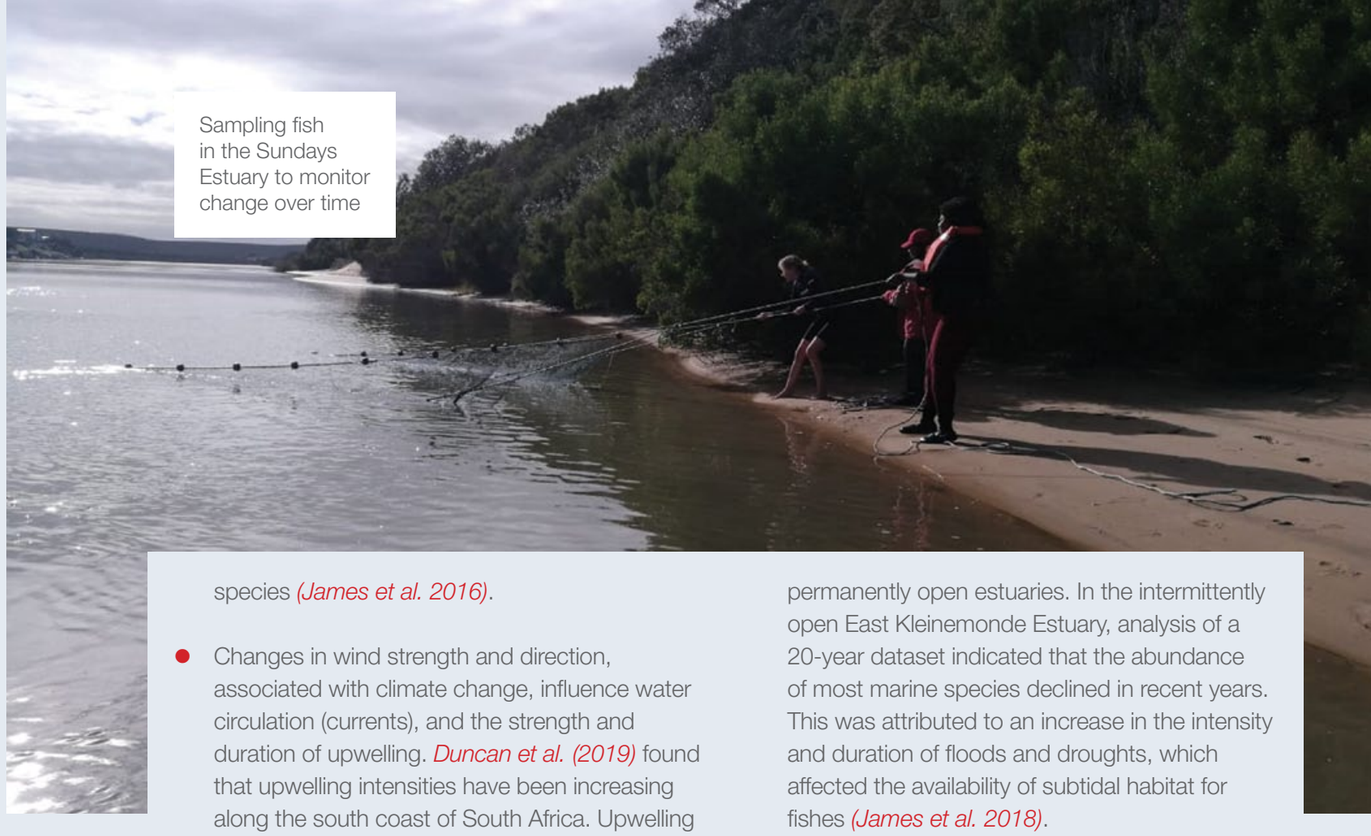
Climate change that is linked to the build-up of greenhouse gases and aerosols in the atmosphere has led to increases in the earth's surface temperatures over the last 50 years. As a result, the water in the world's rivers, estuaries and the sea is also heating up. In particular, climate change in the coastal environment (estuaries and nearshore) shows that there are changes in temperature variability; increasing winds and ocean currents; increased freshwater flow (rainfall); and other extreme weather events such as sea level rise and ocean acidification; all of which are having profound consequences for marine species.

Fish are often more susceptible to changes in temperature than many land-based animals. This is because their body temperature is the same as the water around them. Fish cannot maintain a constant body temperature, and cannot survive in temperatures too far out of their preferred range. Consequently, of all of the physical stressors associated with climate change, temperature is considered to have the greatest impact on coastal fishes. Researchers at the NRF South African Institute for Aquatic Biodiversity (NRF-SAIAB) and Rhodes University focus on understanding the implications that climate change will have for coastal fish species.

Key findings from this research

- The egg and larval phase of marine species takes place in the subtidal marine environment with juvenile fish migrating to shallow nursery areas (such as estuaries and rock pools) where abundant food and shelter allows them to grow rapidly before moving to deeper habitats as adults. In these highly dynamic nursery environments (estuaries and rock pools) where temperatures fluctuate on an hourly scale, juvenile fish are able to tolerate temperatures well above and below those to which they are currently exposed *(van der Walt et al. 2021)*.

- Despite the tolerance of juvenile fishes in their nursery habitats to extreme temperatures, the distribution of marine fishes may still be impacted by changing sea temperatures as the distribution of marine fishes is strongly linked to subtidal sea surface temperatures and temperature tolerance during the subtidal larval phase. The larval phase of most species are far less tolerant of extreme temperatures than the hardy juvenile stage. This was found to be true for southern African mullet species *(James et al. 2016)*.



Sampling fish in the Sundays Estuary to monitor change over time

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- Changes in wind strength and direction, associated with climate change, influence water circulation (currents), and the strength and duration of upwelling. *Duncan et al. (2019)* found that upwelling intensities have been increasing along the south coast of South Africa. Upwelling occurs when southerly winds drive cooler water from the deep towards the surface and can result in rapid temperature changes at the ocean surface. Extreme variability in temperatures is often lethal to fish.

- In estuaries where sampling was conducted after major flooding, flooding resulted in a decrease in the number of species recorded and density of fishes. Recovery of the fish community in estuaries to pre-flood conditions was fairly rapid in all systems studied, but when consecutive flood events occurred recovery was slower *(James et al. 2020)*. Unfortunately, the frequency and intensity of extreme events, such as droughts, sea storms and river floods, is already increasing along the southern African coastline and fish communities may not recover rapidly if these extreme events occur frequently *(James et al. 2013)*.

- The fish fauna inhabiting intermittently open estuaries may be less resilient to the effects of droughts and floods than those inhabiting permanently open estuaries. In the intermittently open East Kleinemonde Estuary, analysis of a 20-year dataset indicated that the abundance of most marine species declined in recent years. This was attributed to an increase in the intensity and duration of floods and droughts, which affected the availability of subtidal habitat for fishes *(James et al. 2018)*.

- Exploitation potentially alters the response of targeted species to climate change with marine protected areas harboring fish which are more resilient to climate change-associated marine heat waves *(Duncan et al. 2019)*. This is because fishing tends to remove stronger, more resilient individuals from the population.

Why this research matters

Research into coastal and estuarine fishes shows the risks or impacts that climate change has on fish biodiversity. At the same time, it shows the impacts that climate change has on the communities that rely on fish resources for food security. This research is timeous as the Intergovernmental Panel on Climate Change (IPCC) has recently published a report on changing oceans, marine ecosystems and dependent communities. Understanding the regional vulnerability of marine ecosystems to climate change is important in planning for a future climate and to highlight the potential that marine protected areas may have in increasing the resilience of targeted species to climate change. SM