THE HYDROSPHERE

The Great Southern reef is a marine environment influenced by

- hydrological conditions such as water temperature, depth, and clarity.
- hydrological processes including waves, tides, ocean currents and upwelling and extreme events such as marine heatwaves and floods.

Limiting conditions for kelp forests include cool, clear, shallow, nutrient rich water with the average pH and salinity levels of seawater. (Revisit details in 'Limiting conditions').

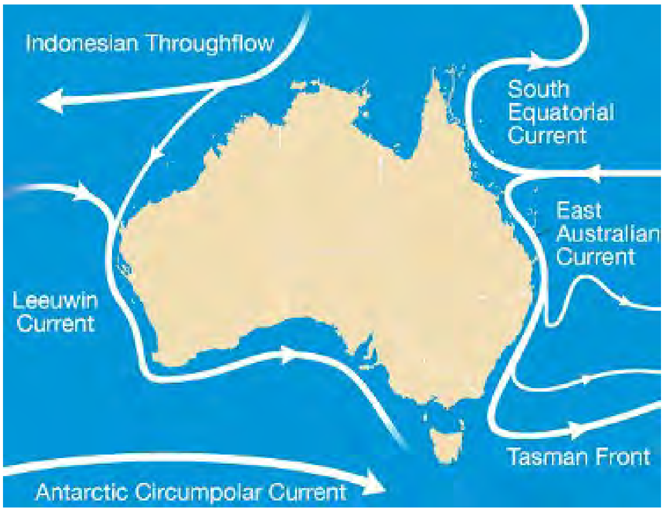
Two **Australian Ocean Currents**, the *East Coast Current* (EAC) and *Leeuwin Current* on the west and southern coasts impact the spatial distribution and functioning of GSR kelp forest ecosystems. These currents add several degrees of temperature to coastal waters.

Ocean currents also cause **upwelling**, a process that brings cold nutrient rich water to the surface, effectively fertilising surface waters and contributing to high primary productivity. **Figures 8 and 9**

WATCH this short trailer for Australia's Ocean Odyssey as an introduction to the EAC – https://www.youtube.com/watch?v=uINOSK2YE7Q

Learn more about these important ocean currents on the Bureau of Meteorology website.

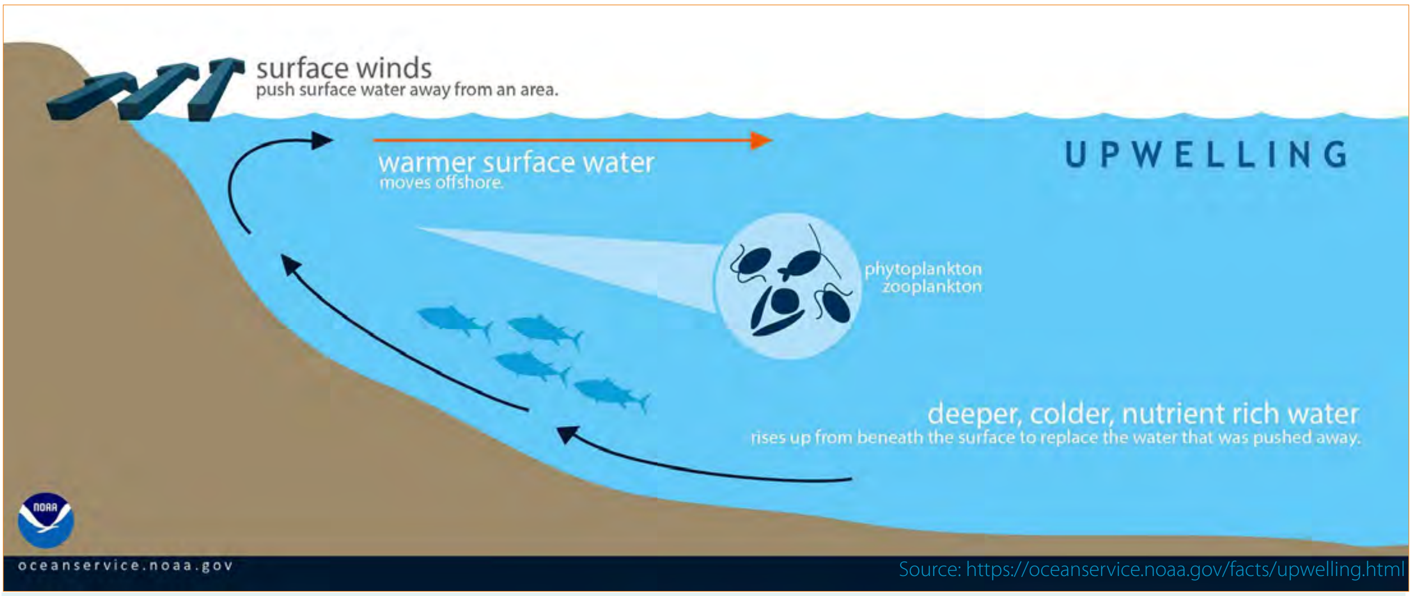
Figure 8: Australia's major ocean currents



Source http://www.bom.gov.au/oceanography/forecasts/forecast-help.shtml

Figure 9: Upwelling brings cold nutrient rich waters to coastal ecosystems

Displaced surface waters are replaced by cold, nutrient-rich water that "wells up" from below. Conditions are optimal for upwelling when winds blow along the shore.



Source: https://oceanservice.noaa.gov/facts/upwelling.html

WATCH these video clips to better understand upwelling:

Upwelling – real life visual from the Oregon Coast – https://www.youtube.com/watch?v=60_y6-CiUMA

What is upwelling (animation 50 secs) – https://www.youtube.com/watch?v=bp5UBuVD9e0

Hydrosphere and biosphere interactions

The hydrosphere is the determining factor for the spatial distribution of kelp and other species on rocky reefs. For example:

- The zoning of species on rocky coasts occurs due to changes in sunlight and water temperature through the water column. **Figure 7**
- Kelp reproduction requires the dispersal of spores in water.
- Different ocean conditions such as waves suit different consumer organisms. **Figure 3**
- A diversity of kelp and algae species thrive in different oceanic conditions. Giant Kelp grows in Tasmania's deeper colder waters while Sea Lettuce, a green algae, grows in shallow water on most rocky reefs.

Ocean warming

Warm currents are nutrient poor and if their influence increases or decreases there are implications for kelp productivity. The **tropicalisation** of species into temperate kelp forests has been associated with strengthening of the EAC. This has consequences for biodiversity as herbivorous tropical species feed on kelp and compete with for habitat and food.

The impact of warming

The ABC media report *'Hungry tropical fish, sea urchins marching south as kelp forests disappear'* identified the following impacts:

- Tropical fish numbers are increasing in usually temperate waters
- Migrating fish and sea urchins are eating kelp, leading to a decline in kelp forests
- over 1000 square kilometres of kelp forests have been lost in WA and sea urchins on the eastern coast are even cleaning up the turf algae that replaces kelp.

Resilience to natural stresses in the hydrosphere

High energy waves

Low to medium **wave energy** suits most kelps although some, such as Bull Kelp, can thrive on high wave energy coasts. Water movement circulates nutrients and oxygenates the water.

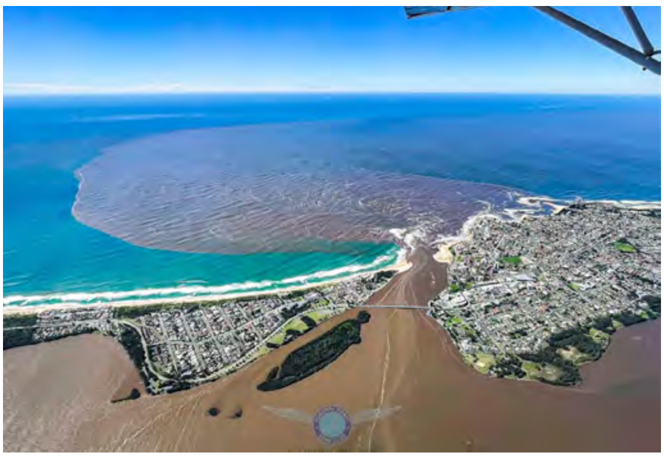
Storms created by weather events such as East Coast Lows and intense cold fronts, produce high energy waves that damage kelp during the duration of a weather event. This is evidenced by large amounts of **wrack** on the seashore after storms.

The natural resilience of kelp helps them to recover by recolonising exposed surfaces where kelp has been ripped off the surface and through high primary productivity as new blades grow. Kelp produces large amounts of spore for dispersal and fertilisation in the water. Kelp fertilisation to colonisation takes about six months. When kelp returns a new **primary succession** of organisms begins at the previously deforested site.

Floods

Flooding result in large amounts of sediment entering coastal waters where it increases turbidity and may smother smaller habitat species like seaweeds and sponge gardens through sedimentation. **Turbidity** impacts on ecosystem functioning by interrupting solar energy transmission through the water column where it plays an essential role in primary biomass productivity.

Flood waters also increase nutrient loads which can cause eutrophication. Once clarity returns however, normal functioning will resume, and the impacts will be short term unless successive flood events impede recovery.



The plume of sediment entering the ocean after floods on the central Coast of NSW in March 2021. Credits: Central Coast Aero Club and Andy Smith Photography.

Wrack on a beach and floating in the water after large seas in June 2021 Photo credit: L Chaffer