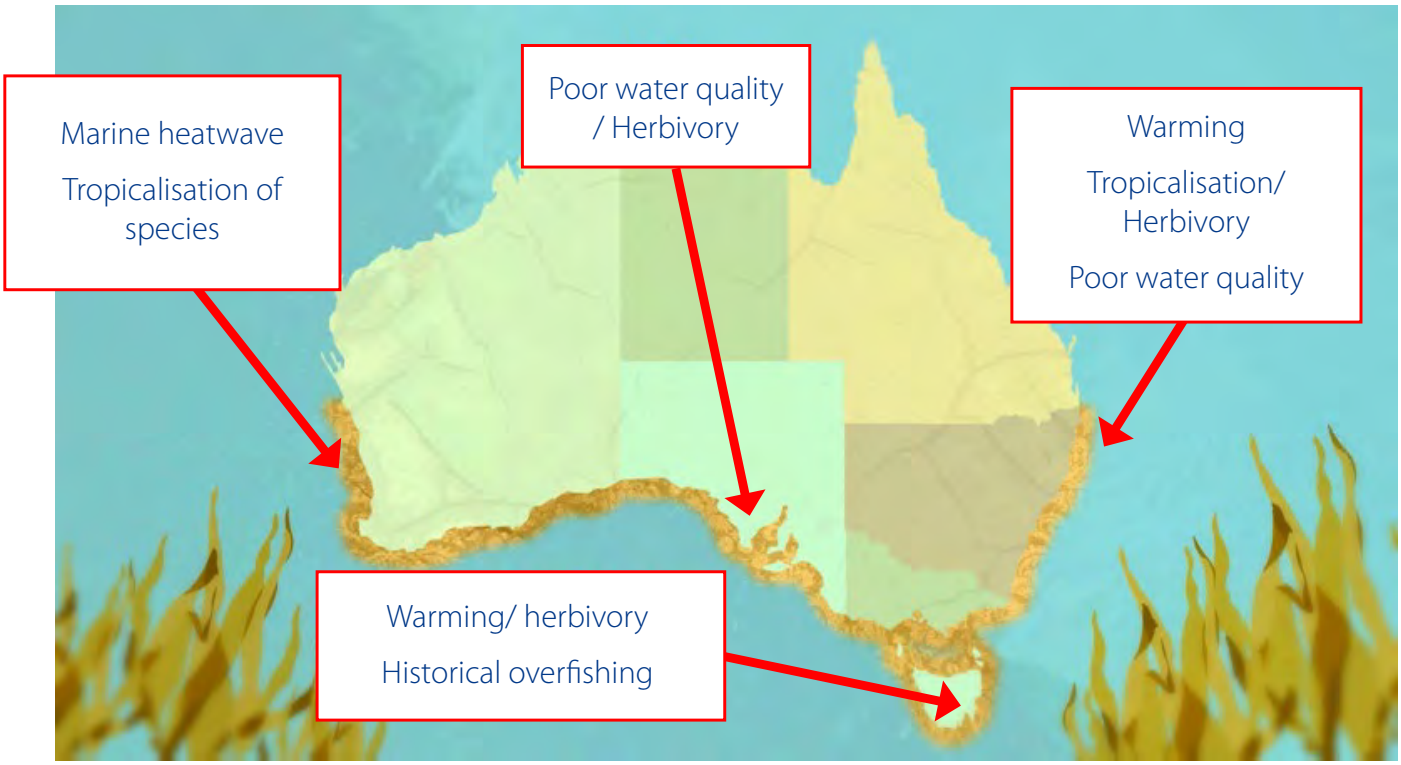
HUMAN IMPACTS AND ECOSYSTEM FUNCTIONING

Human impacts on kelp forests globally are well documented. Pollution / poor water quality, overfishing / overharvesting, sedimentation, invasive species /herbivory, changes to ocean circulations / currents and climate change have been identified as key causes of change. All can be linked to human activities from a local, regional and global scales.

On the Great Southern Reef, the main cause(s) of change differ by geographical location. See **Figure 14**.

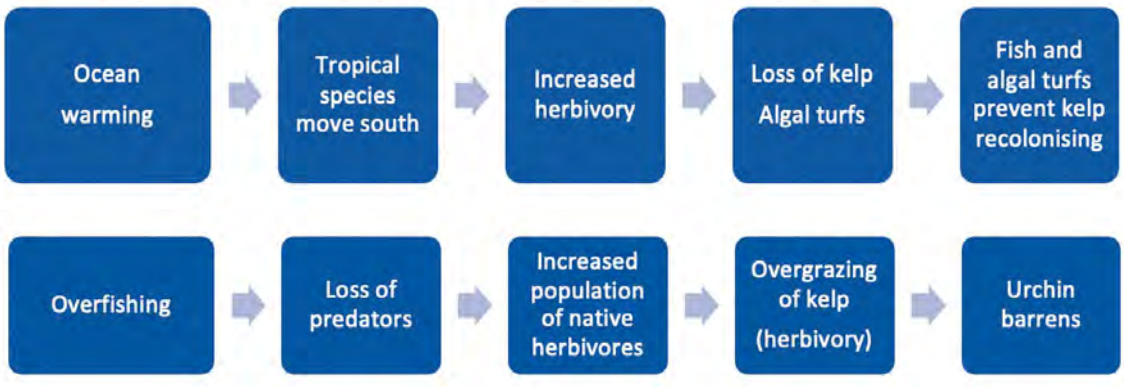
Figure 14: Causes of change to Great Southern Reef kelp forests.



Base map: Great Southern Reef https://greatsouthernreef.com
Adapted from GTANSW & ACT 2021 Annual Conference Presentation. *'Operation Crayweed. Engaging local communities and restoring underwater forests'* https://vimeo.com/560465469

The most significant impacts of change have been the loss and degradation of kelp forests, tropicalisation of species, the 'homogenisation' of kelp forest ecosystems, the replacement of kelp forests by algal turfs and urchin barrens and a loss of marine biodiversity. These impacts have economic, environmental and social consequences for the Great Southern Reef ecosystem and the communities that depend on it.

Some consequences of change



Climate Change and tipping points

Climate change projections and predicted impacts suggest that the kelp forests of the GSR will survive because they are resilient and adaptable, however they face permanent change in spatial distribution, characteristics and functioning.

Frequent impacts over a period of time have been shown to reduce ecosystem resilience and ability to recover. Further change associated with a warming climate e.g., an increase in storms and warming oceans, will increase the stresses on kelp forests and for some this will be the ***tipping point*** beyond which they will not recover. **Figure 15**

Measuring change

Historical data provides a baseline against which current and future change can be mapped. A 50-year global analysis by scientists showed a large variation in the magnitude and direction of change by species and geographic distribution with kelp losses in some regions and gains in others. There was evidence of decline in 38% of the kelp forests studied and an increase in the abundance of kelp in 25% of regions illustrating the influence of regional factors. Kelp Forests in the SE and SW Australia were in the declining category.

Longitudinal scientific studies of kelp forests in northern NSW (2002 – 2012*) and Western Australia (2001 – 2015*) by universities and research organisations are two studies showing that the causes and impacts of change on the Great Southern Reef vary geographically.

Organisations such as the Reef Life Survey Foundation are helping to fill knowledge gaps and provide access to quality, scientifically acquired data to record and monitor change, and to inform or evaluate management.

WATCH how quality data is obtained in the field:

1. Reef Life Survey makes the underwater visible
   https://www.youtube.com/watch?v=grq8dflbm8Q
2. Monitoring trends in marine life through citizen science
   https://www.youtube.com/watch?v=3I4V9iRKCBE

READ these reports to examine changes to kelp forests globally and in Australia:

Global patterns of kelp forest change over the past half-century
https://www.pnas.org/content/pnas/early/2016/11/09/1606102113.full.pdf?sid=b5c75459-7507-4cf9-93a8-1388e349a056

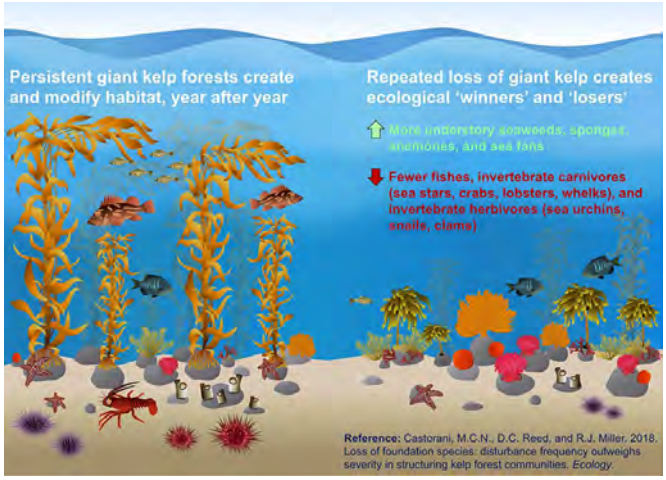
Underwater Health Check shows forests are declining around the world
https://theconversation.com/underwater-health-check-shows-kelp-forests-are-declining-around-the-world-68569

Tropical invaders, heat waves and pollution take toll on Australia's kelp forests
https://www.abc.net.au/news/science/2016-11-15/tropical-fish,-heat-waves,-pollution-threat-to-australias-kelp/8023634?nw=0

Multiple threats

Kelp forest ecosystems face multiple threats to their functioning with one change usually identified as a key driver or stressor. Frequent change over a period of time can reduce an ecosystems resilience and ability to recover as can increased stressors from natural events, human activities and climate change. **Figure 15**.

Figure 15: Impacts of frequent change on kelp forest biodiversity



LEFT: Increasing frequency of ocean storms alters kelp forest ecosystems
Source: https://www.nsf.gov/news/mmg/media/images/7_Kelp%20infographic%20(Max%20Castorani%202018-07-22).jpg

A. IMPACTS FROM TERRESTRIAL AND MARINE BASED ACTIVITIES

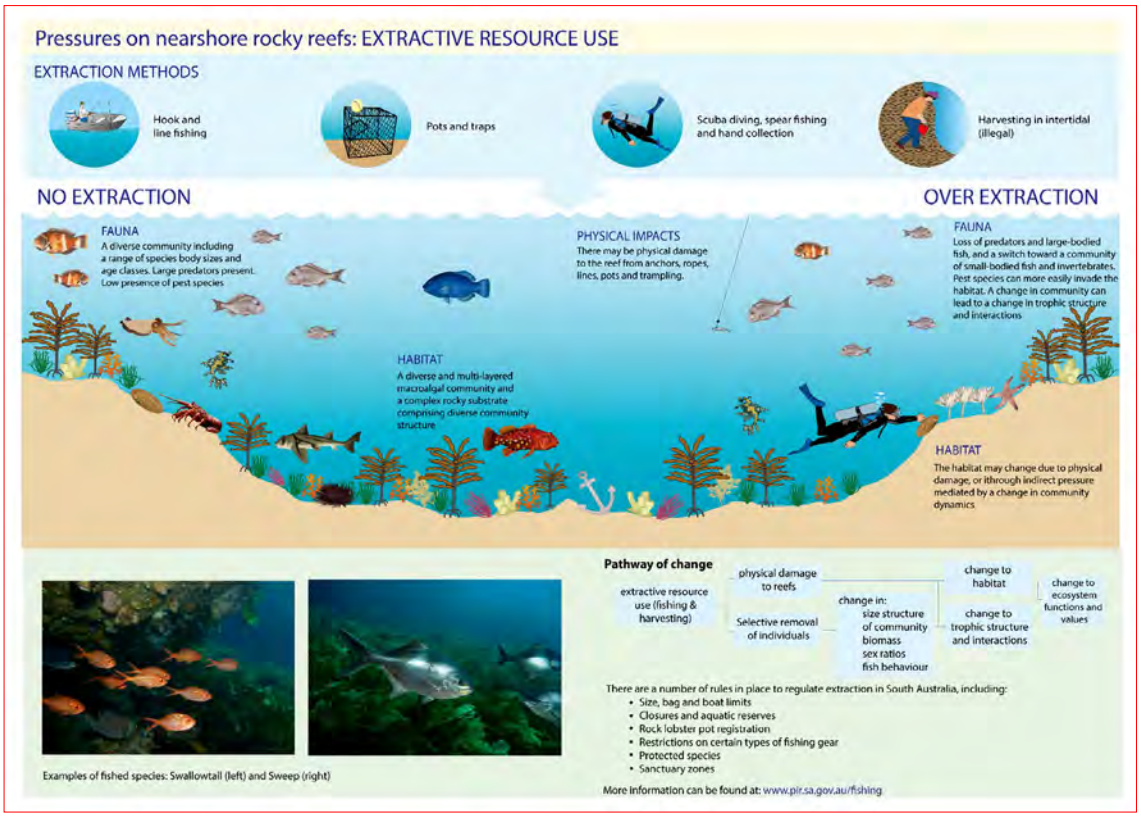
* Many of these impacts are detailed under the headings *Biophysical Interactions* AND *Vulnerability and Resilience*. Some examples are referred to in the *Illustrative Examples*.

HUMAN ACTIVITY	IMPACT ON ECOSYSTEM FUNCTIONING
Extracting resources / Commercial fishing See Figure 16	Loss of secondary and tertiary consumers / increased herbivory Example: Overhunting crayfish in Tasmania remove a natural predator of urchins and caused imbalance in the food web*
Pollution / Nutrients and chemicals See Figure 17	Eutrophication / algal blooms increase turbidity, fish kills Example: Sewage discharged into the ocean in Sydney in the 1970's caused the loss of Crayweed forests that could not tolerate the increased nutrient load*
Coastal development **Agriculture / urban / industrial / erosion / runoff** See Figure 18	Sedimentation – increased turbidity and reduced sunlight penetration / loss of baby kelp – smothering and reduced photosynthesis. Example: Coastal development and agriculture on Spencer Gulf in South Australia reduced water quality and increased turbidity that caused a shift from kelp to algal turf.
Tourism / boating / scuba diving	Damage / loss of species or primary biomass Example: Damage to seagrasses caused by boats anchoring in Cabbage Tree Bay Marine Reserve (Manly) led to calls in early 2021 to prohibit anchoring and extend the reserve.
Invasive species / marine pests	Competition / herbivory Example: Southward migration of fishes on the WA coast south of Kalbarri after the marine heatwave killed the kelp forests prevented the re-establishment of kelp.

Conceptual models

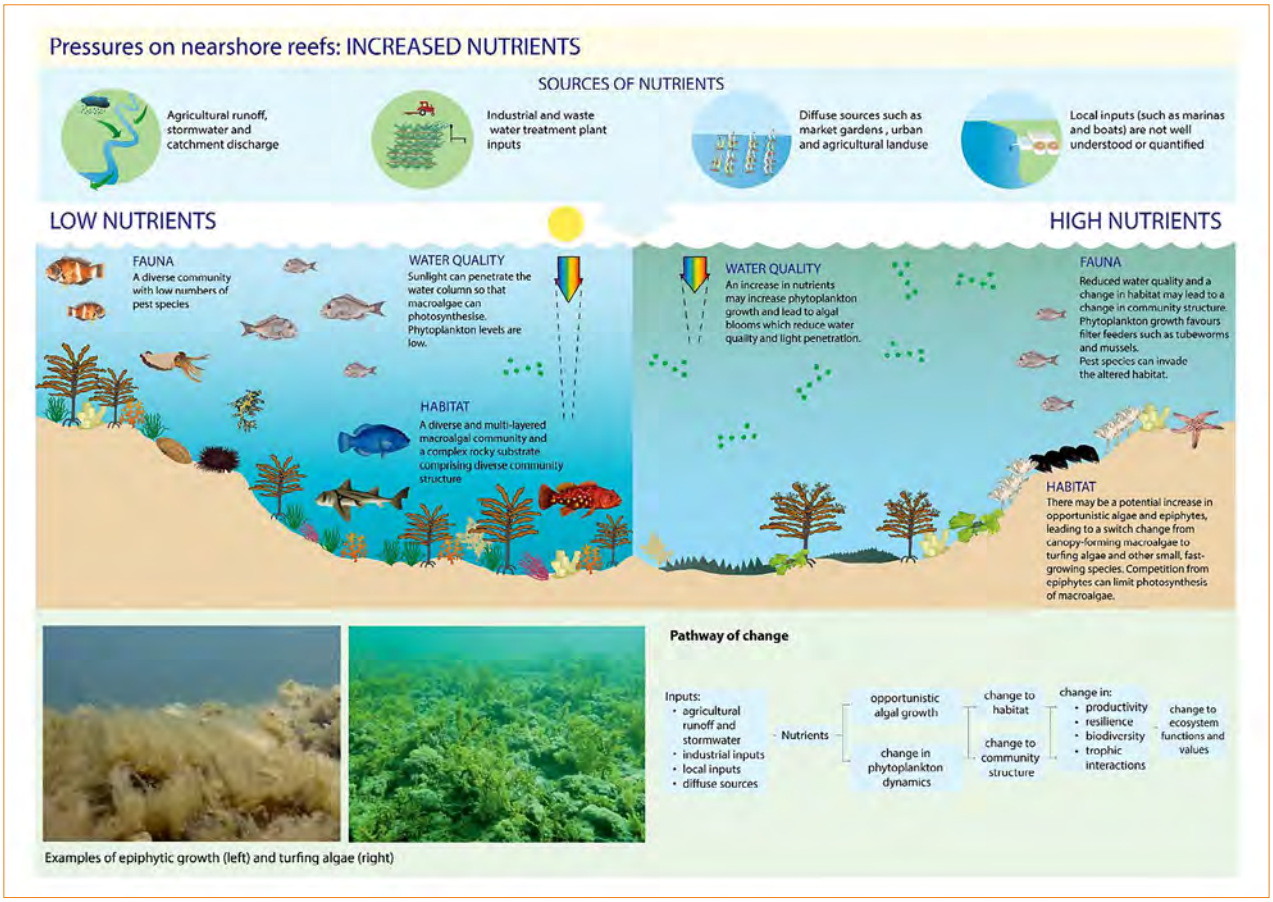
The following conceptual models were created for the South Australian Department for Environment and Water (2019) to summarise key threats and impacts on subtidal reefs. The three pressures illustrated are common to rocky reefs across the Great Southern Reef and useful for analysing the impacts of human activities.

Figure 16: Extractive Resource Use



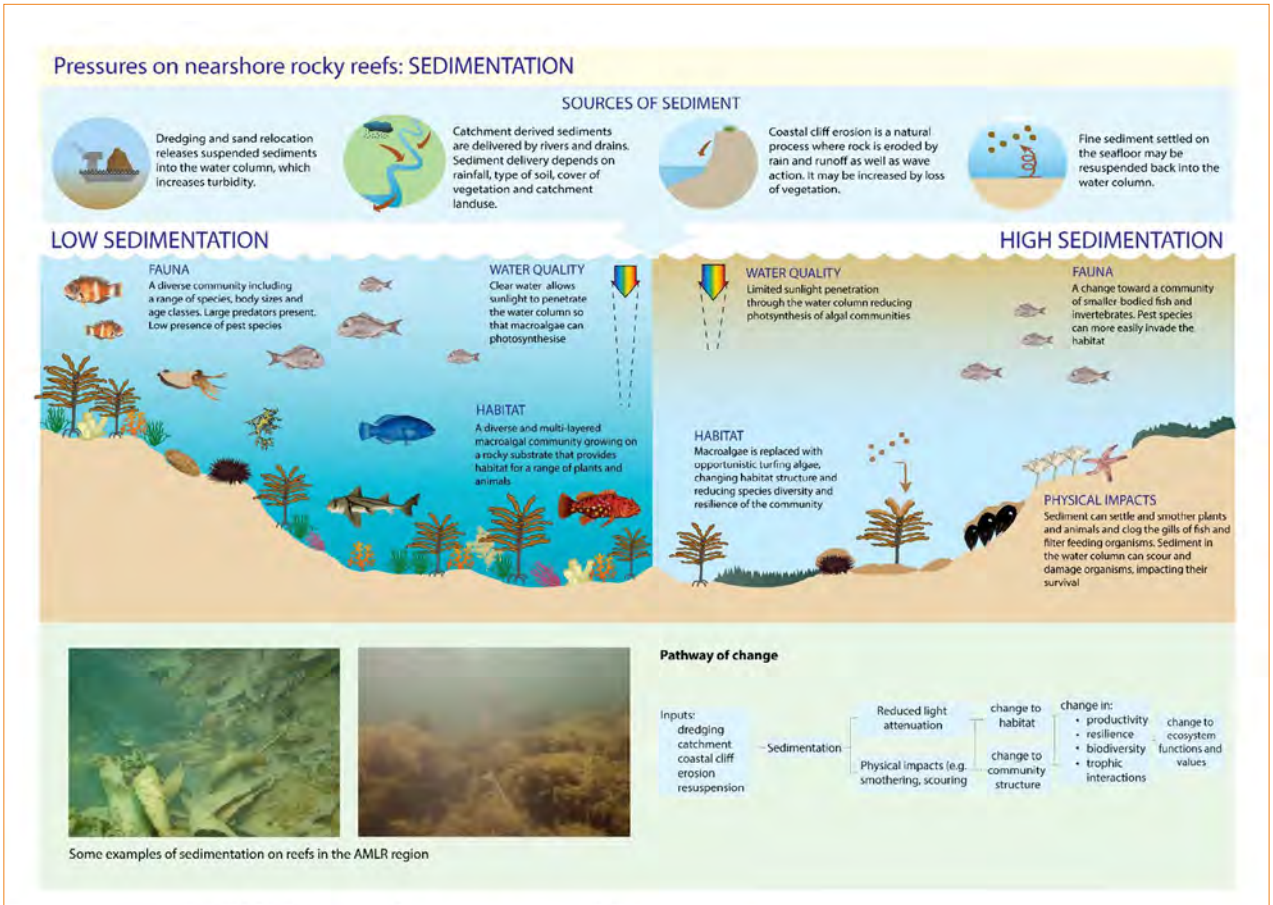
Conceptual models of nearshore reefs in the Adelaide and Mount Lofty Ranges region Department for Environment and Water 2019 https://data.environment.sa.gov.au/Content/Publications/AMLR%20Conceptual%20models-Technical-NOTE.pdf

Figure 17: Increased nutrients



Examples of epiphytic growth (left) and turfing algae (right)

Figure 18: Sedimentation



Some examples of sedimentation on reefs in the AMLR region

B. IMPACTS LINKED TO CLIMATE CHANGE

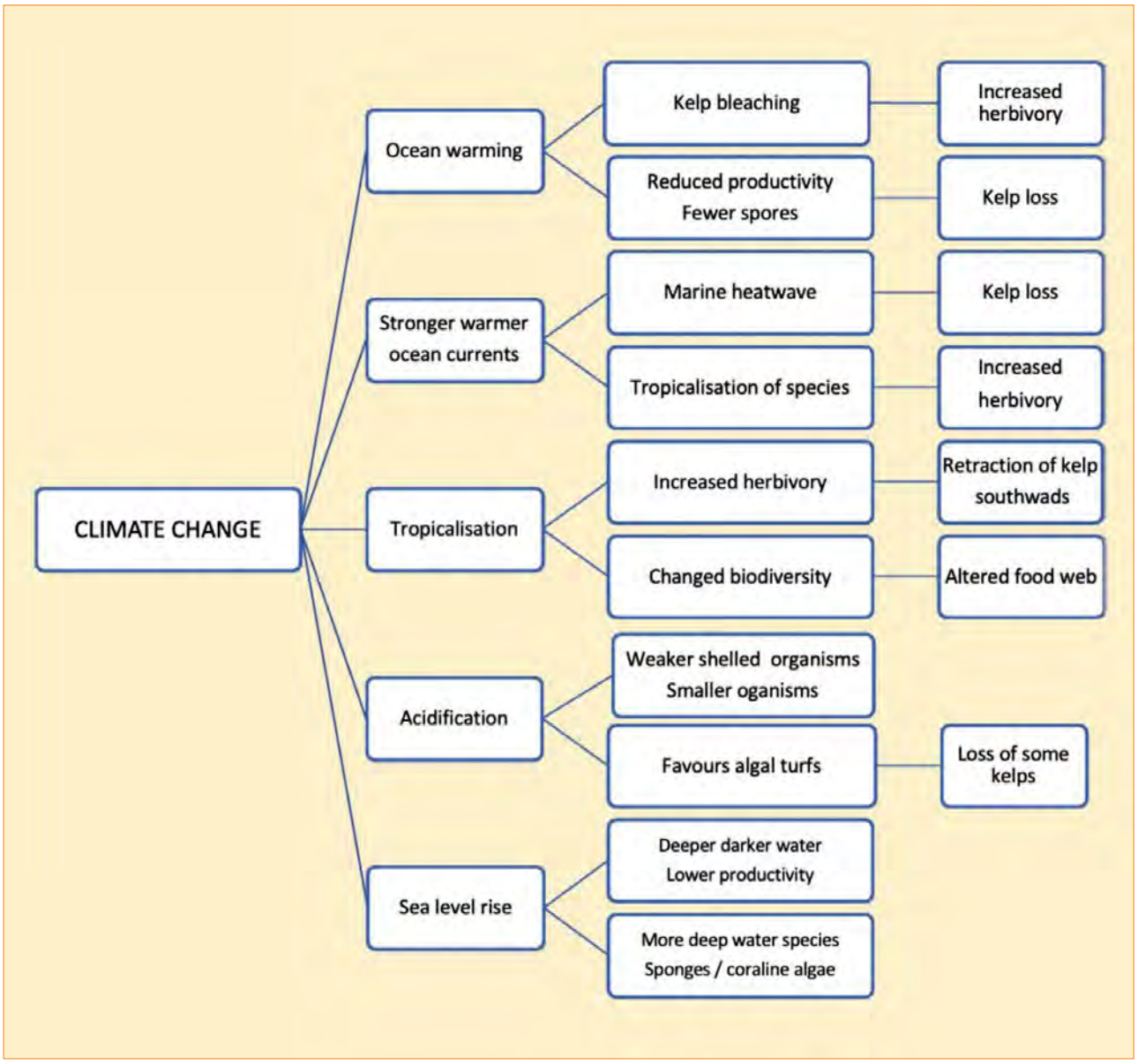
Carbon emissions from human activities are causing ocean warming, acidification and oxygen loss with some evidence of changes in nutrient cycling and primary production. The warming ocean is affecting marine organisms at multiple trophic levels, impacting fisheries with implications for food production and human communities.

'The loss of kelp forests is followed by the colonisation of turfs, which contributes to the reduction in habitat complexity, carbon storage and diversity (high confidence). Kelp ecosystems are expected to continue to decline in temperate regions driven by ocean warming and intensification of extreme climate events.'

Source: IPCC: Special Report on The Ocean and Cryosphere in a Changing Climate Ch5 https://www.ipcc.ch/srocc/chapter/chapter-5/

Figure 19 refers to many of the impacts of climate change on Kelp Forests referred to under previous headings and in the Illustrative Examples that follow.

Figure 19: Real and potential consequences of climate change for GSR kelp forests



Source: L chaffer

The Harlequin Fish is an iconic species in South Australia

The Adelaide and Mount Lofty Ranges Natural Resources Management Region:

- is ≈ 50% terrestrial and 50% marine
- supports iconic species and species of conservation concern such as the Harlequin Fish and Blue Groper
- provides critical habitat important for the lifecycles of commercially and recreationally fished and non-fished species
- is close to the large population area of greater Adelaide

See Conceptual models on pages 25 and 26

Harlequin Fish: Iconic GSR species on in South Australia
Source: Ocean Imaging | Great Southern Reef.

References

Tropical invaders, heat waves and pollution take toll on Australia's kelp forests https://www.abc.net.au/news/science/2016-11-15/tropical-fish,-heat-waves,-pollution-threat-to-australias-kelp/8023634?nw=0

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Extreme Marine Heatwaves Alter Kelp Forest Community Near Its Equatorward Distribution Limit https://www.frontiersin.org/articles/10.3389/fmars.2019.00499/full

SPECIAL REPORT: GLOBAL WARMING OF 1.5 ºC CH 03. Impacts of 1.5ºC global warming on natural and human systems https://www.ipcc.ch/sr15/chapter/chapter-3/