

# CATCHMENT TO REEF

WHAT WE DO IN OUR CATCHMENT AFFECTS THE REEF

## Are you Connected?

A guide to the processes linking  
Land, Sea and Reef

Niall Connolly, Russell Kelley,  
Richard Pearson & Tim Prior

## Catchment and Reef: linked by water

To protect the Great Barrier Reef we must also protect and manage the adjacent catchments, their land systems, streams, wetlands and estuaries, and the water cycle that sustains them.

When water evaporates off the sea and falls to land as rain, it flows through soils and aquifers, and then via streams and wetlands back into the sea. The water carries sediments and dissolved materials which deposit on floodplains, in estuaries and in coastal waters. Most importantly, water provides life-supporting pathways through the landscape.

The network of waterways is crucial to the movements of migrating animals that maintain the biological links between freshwater and the sea. Many familiar species, such as eels, mangrove jack and mud crabs, migrate through waterways. At different stages of their growth and development each of these animals utilises different habitats in the Catchment to Reef system.

Mature eels **(A)** migrate from catchment headwaters to the Coral Sea where they reproduce; their offspring, tiny elvers, then make the arduous return journey to fresh waters where they grow, eventually completing this extraordinary cycle.

Likewise, mangrove jack **(B)**, commonly found inhabiting mangrove creeks and freshwater streams up to 100 kilometres from the sea, need to migrate across the continental shelf to mature and reproduce on the reef.

## Biodiversity on land, in streams and in the sea

**Biodiversity** is the sum of all life. Between Catchment and Reef it comprises all the microbes, plants and animals that live in these habitats, and the interactions between them. Biodiversity provides the essential goods and services that maintain the health of the atmosphere, soils and water. As we change natural habitats and remove species, we reduce their ecological and economic roles. The interdependence of animals and plants in Catchment to Reef ecosystems is part of their natural healthy functioning. Changing any part can have dramatic effects elsewhere in this interconnected system.

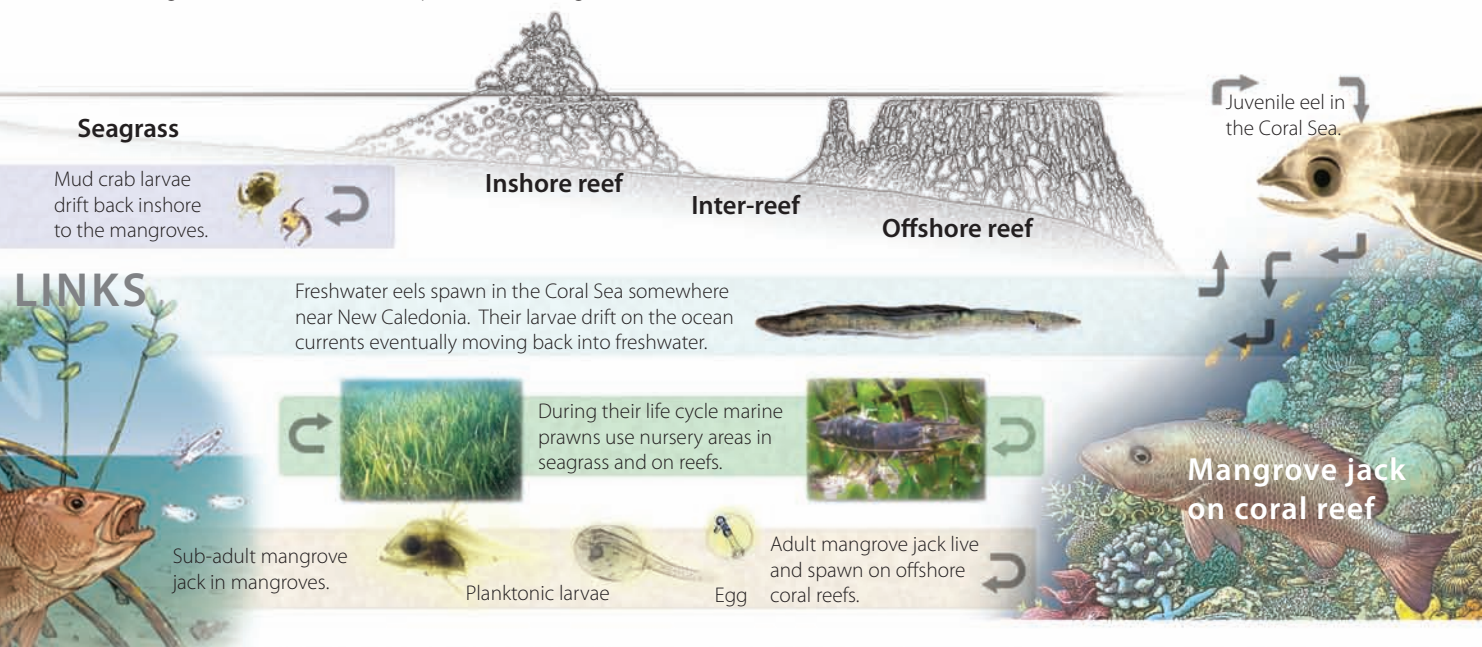




# WATER

## Connections, Cycles and the Original World Wide Web

This diagram illustrates just a few of the biological connections that exist between land, freshwater and sea, all of which rely on and contribute to, the ecological health of Catchment and Reef. Although sediments, nutrients and some chemicals are naturally found in waterways, the increased quantities we now see are upsetting the complex ecological processes in streams, rivers, wetlands, estuaries and coastal habitats such as seagrass beds and coral reefs. The connections between Catchment and Reef are being disrupted and some of their unique character is changing. In the following pages, we describe how the changes we make to the landscape are influencing Catchment to Reef connections.



Many of the Catchment to Reef connections support complex food webs of plants and animals in water and on land (**C**) e.g. crabs and prawns feed on algae and microbes; waterbirds feed on insects, frogs and fish in waterways; and crocodiles prowl estuaries, taking fish, crabs and shoreline animals. Strong connections to the land abound e.g. frogs and many insects have both aquatic and terrestrial phases in their lives, while waterbirds and reptiles require the land for breeding, roosting and basking. Breaking these connections disrupts these food webs, reducing biodiversity and productivity.

## Transporting materials

Water draining the landscape carries with it nutrients and sediments that support aquatic life. However, the amount of sediments, nutrients and other materials is increasing.

Today over a million people live in the catchment of the Great Barrier Reef, along with a similar number of vehicles, 5 million cattle, 4000 km<sup>2</sup> of sugar cane and 7000 km<sup>2</sup> of other crops. As a result, since European settlement, half of the Great Barrier Reef catchment area has been cleared or severely modified. Many Catchment to Reef habitats have been altered or removed, reducing water quality and the health of downstream ecosystems. Some important causes of change are:

**Sediments** – land clearing, overgrazing, cultivation and urban development all contribute to the four-fold increase in sediment reaching the Great Barrier Reef lagoon since European settlement. Excess sediments smother seafloor organisms and cut light penetration, affecting plants like seagrass and causing flow-on effects up the food web.

**Nutrients** – intensive fertiliser use, grazing and urban and industrial waste have doubled the quantities of nitrate and phosphate in rivers entering the Great Barrier Reef lagoon. Excess nutrients promote excess plant growth, causing major changes to water quality, habitats and the types of animals and plants living in them.

**Other chemicals** – we all use chemicals in daily life to wash cars, clean the house, kill pests or weeds in gardens or crops, and to manufacture goods etc. Many chemicals disrupt biological processes and can harm animals and plants.

## Living links in the landscape

Streams, rivers and wetlands are vital ecosystems in the landward half of the Catchment to Reef connection. These waterways have traditionally been viewed for what they can provide humans: 'swamps' were filled for crops; flows were altered to increase agricultural productivity; and water was harnessed for livestock, crops and towns.

Our waterways support rich and unique life. Human activities alter the movement and quality of water, disrupting habitats and the linkages crucial to the life cycles of plants and animals. Human activities in the landscape upset ecological processes and threaten the special biodiversity of these systems.

## Streams and rivers

Flows in streams and rivers are maintained by surface runoff and water seeping from wetlands and underground aquifers. In areas where the vegetation is cleared (**D**), the ability of the landscape to retain sediments, nutrients and other contaminants is reduced, so runoff waters carry greater quantities of these materials into waterways. Normally, stream-bank vegetation (the '**riparian zone**') can prevent some of this material entering the stream by capturing sediments and attached contaminants.

Livestock entering streams to drink and may trample vegetation and degrade stream banks, causing erosion. Gullies form and concentrate surface runoff, which by-passes vegetated banks. When this occurs, riparian vegetation no longer captures contaminants carried by overland flow.

Clearing stream-bank vegetation also reduces the natural leaf-litter input from riparian vegetation that naturally fuels the stream's food web. Diverting the flow of water with dams, weirs and gates (**E**), and channels (**F**) alters the character and size of streams and wetlands, disrupting the migrations of fish and other animals in the waterways, and ultimately breaking the connections between Catchment and Reef.

Land users, communities, industry and government are now conscious of the impact that human activities have on catchments, waterways and the reef.



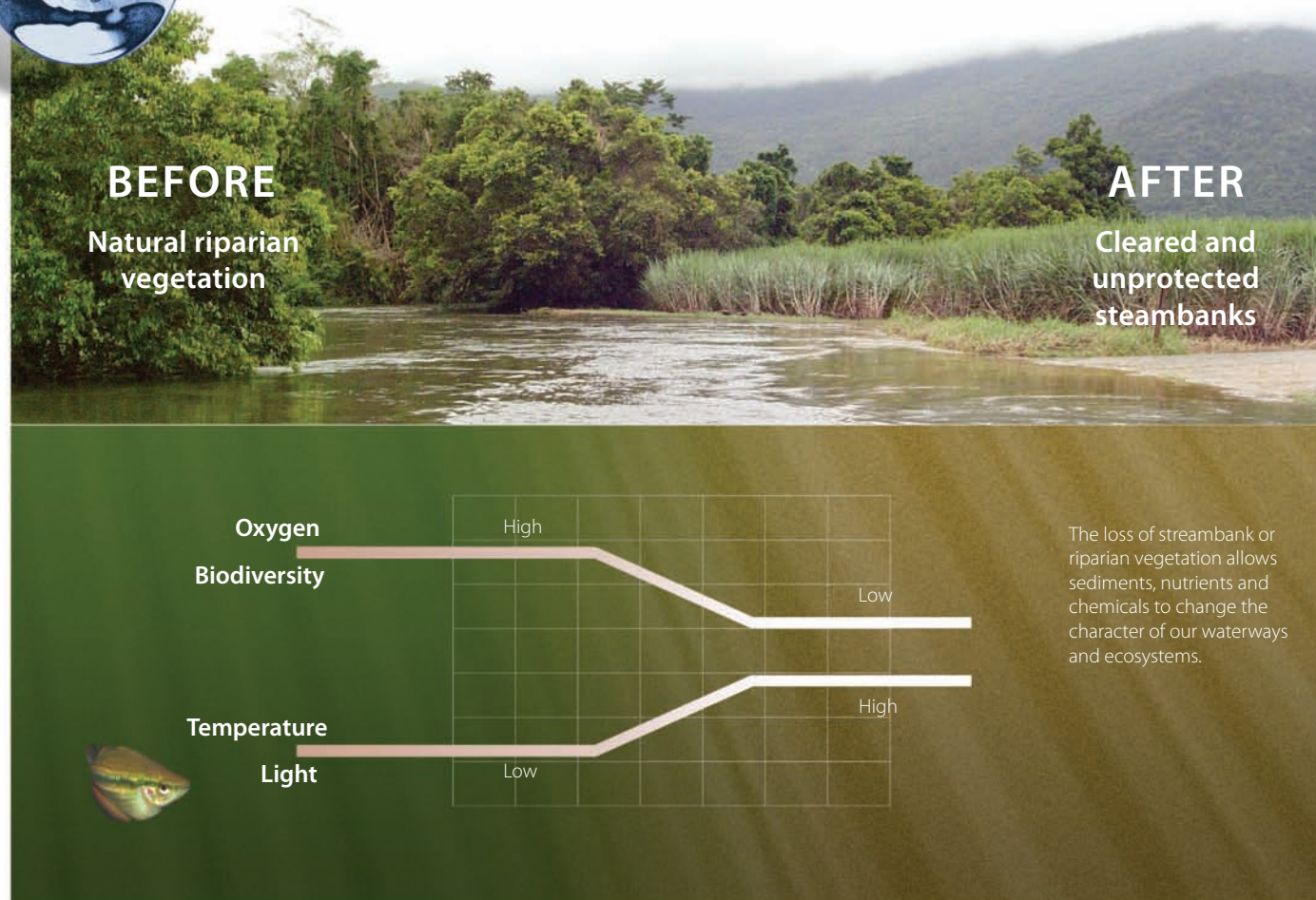
# STREAMS

## BEFORE

Natural riparian vegetation

## AFTER

Cleared and unprotected steambanks

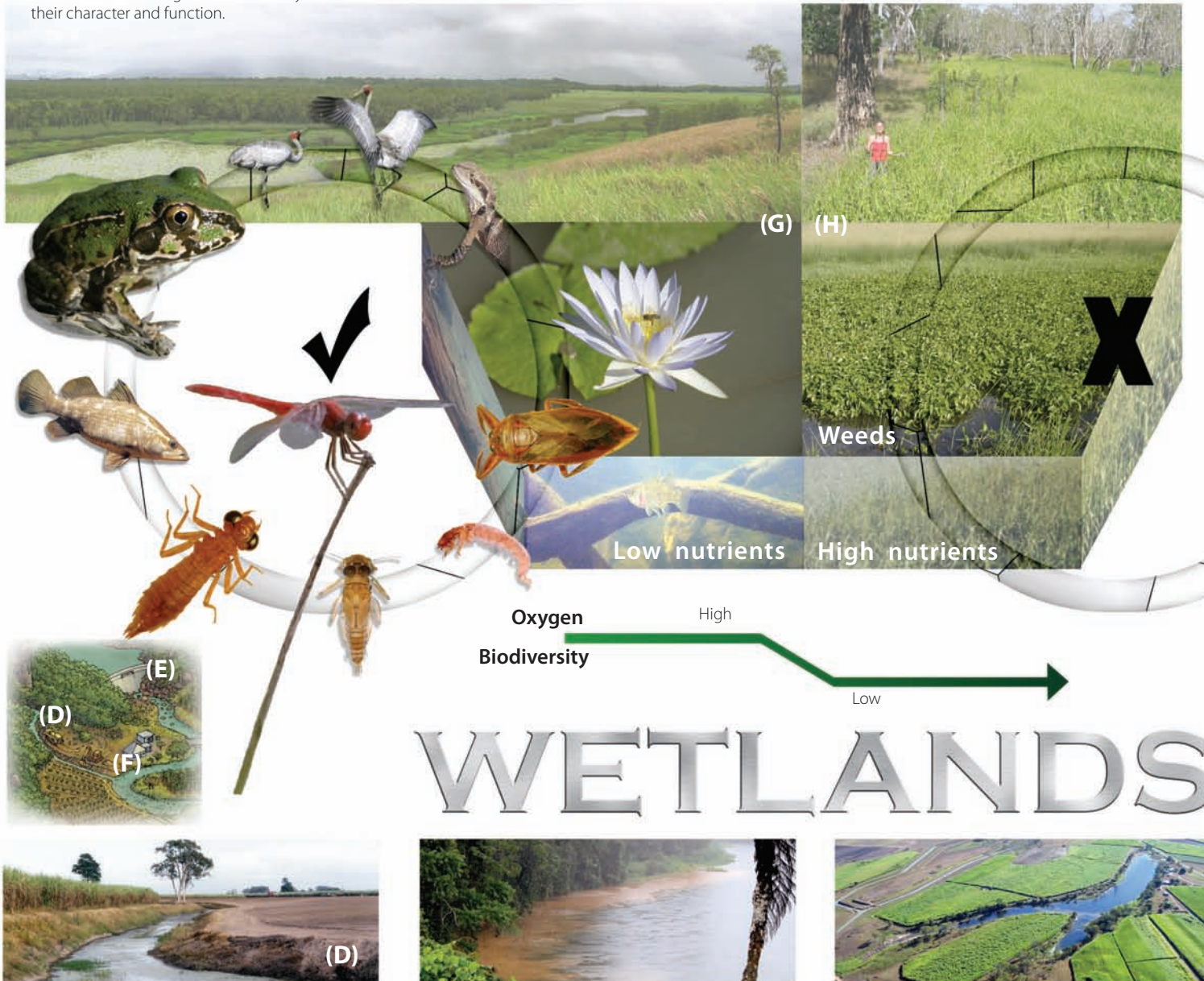




Altering the natural flows and the total nutrient load entering wetlands destroys their character and function.

## HEALTHY

## ALTERED



## Wetlands

Since Europeans settled in the Great Barrier Reef catchments, we have drained and filled around 90% of our freshwater wetlands and altered the flow of water that replenishes them. Wetlands form a unique transitional zone between dry land and aquatic environments that is regularly wet or flooded during the year. They support a huge diversity of life, some of which remains year-round, while some appears only seasonally.

Wetlands capture and store flood waters, allowing recharge of aquifers in the coastal plain and maintaining the flow of rivers during the dry season. At the same time, they trap sediments and nutrients that support diverse and productive biological communities.

Healthy wetlands **(G)** are rich in life and have complex water-based ecological linkages. These linkages are severely disrupted if natural landscape flows are disturbed. Once a natural wetland is altered its ecological functions often deteriorate **(H)**. Water levels can decline and sediments gradually fill the wetland; introduced pest plant species frequently invade and dominate; excessive weed growth reduces dissolved oxygen concentrations to critical levels; and excessive nutrients can cause blooms of toxic algae.

Ultimately, species are lost and the natural linkages between plants, animals and the environment that maintain these ecosystems are broken.

Wetlands provide important habitat for local and migratory waterbirds and are used as nurseries by fish and crustaceans migrating between Catchment and Reef. Wetlands are an extremely important link in the chain of habitats between Catchment and Reef and their removal can have lasting and serious consequences for natural ecosystems and for recreational and commercial human interests, including fishing and tourism.

Land and stream health can be maintained and improved by adopting best management practices in agriculture, grazing, industry and urban living. Turn to the back page for a link to resources on how to improve the waterways in your catchment.

## Not just a drop in the ocean

The Great Barrier Reef receives runoff from 30 major river systems extending up to 450 kilometres inland and draining 25% of Queensland. The quantities of sediments, nutrients and other contaminants reaching the Great Barrier Reef lagoon are proportional to the volume of this discharge.

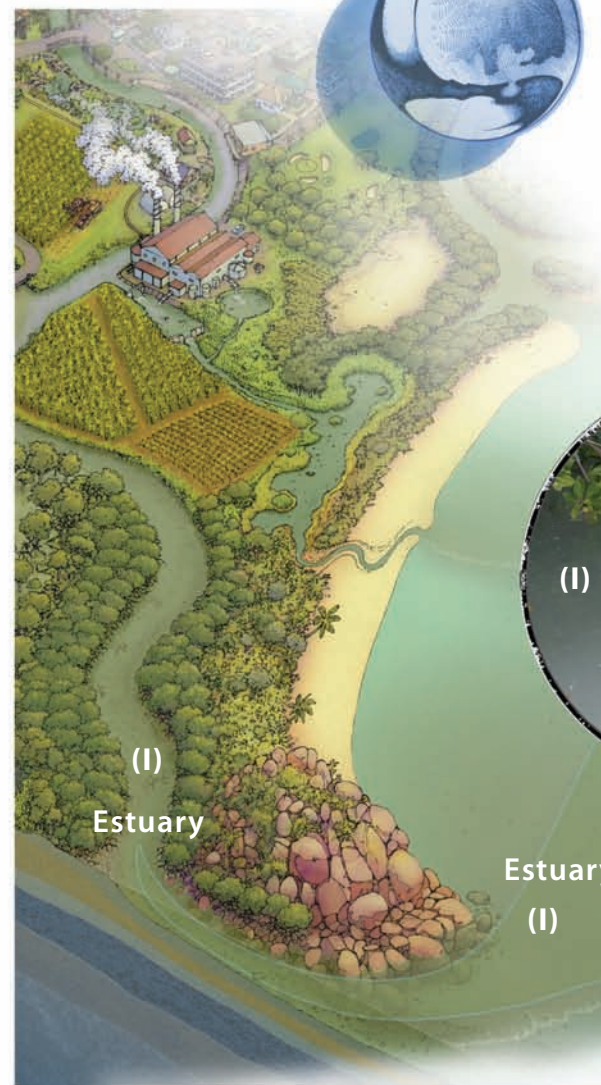
The greatest influence of these contaminants is close to shore. However, in some years floodwaters form a large proportion of the surface water in the Great Barrier Reef lagoon. For example, in 1974 Cyclone Wanda caused massive flooding of the Burdekin River, with 186 cubic kilometres of fresh water discharged - equivalent to 2/3 of the coastal water volume of the entire Great Barrier Reef (295 cubic kilometres). Material carried in such floods can directly influence offshore Reef environments.

## Estuaries and seagrass

Rivers change their character as they merge into the estuary, becoming tidal and progressively more saline as fresh and sea water mix. Large sediment particles fall from the water column to form the sandy or muddy bed **(I)**, while finer materials remain suspended, creating the murky estuary appearance.

Estuaries support specialised plants and animals, such as mangroves and mud crabs, and many marine animals spend part of their life cycle there. Typically, estuaries are very productive because of the nutrients funnelled into them from the whole catchment.

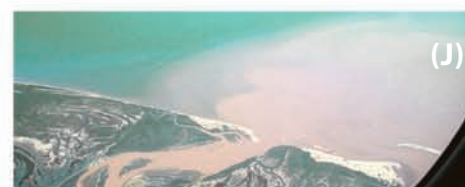
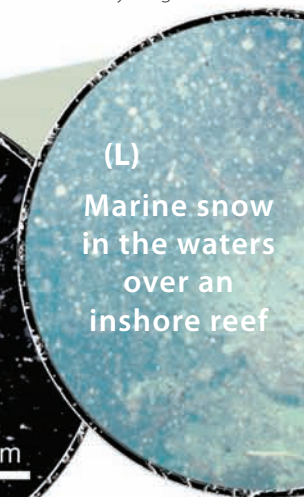
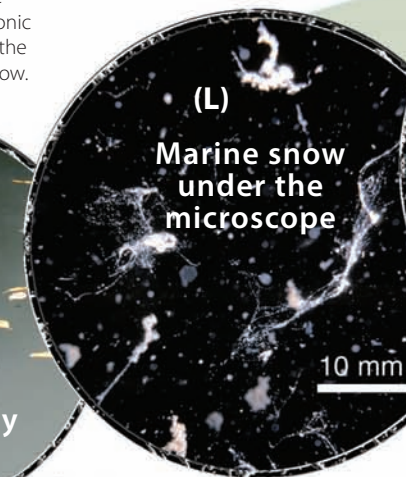
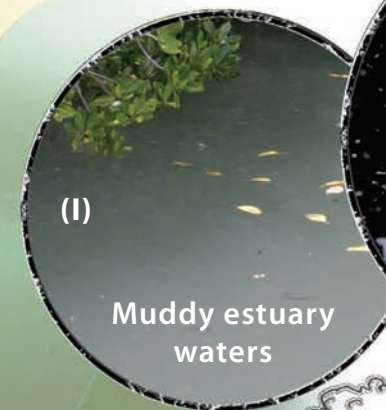
Agricultural chemicals from the catchment influence life in the estuary. For example, pesticides have caused dieback of mangroves in some estuaries, and can contaminate the flesh of crabs. Intensive land use has led to larger quantities of materials passing through estuaries and wetlands, forming huge brown flood plumes when they enter the sea **(J)**. Sediment and attached chemicals are continuously resuspended by currents and waves, reducing light penetration and, consequently, the growth of seagrasses **(K)**, affecting the animals that depend on them. Seagrass beds form nursery areas for many important species, such as tiger prawns and many fish, food for the iconic dugong and other species, and stepping-stones for migrating animals that connect Catchment and Reef.

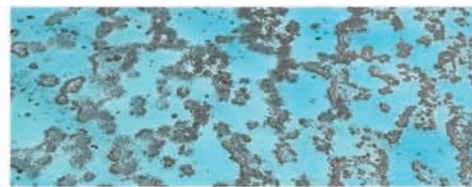
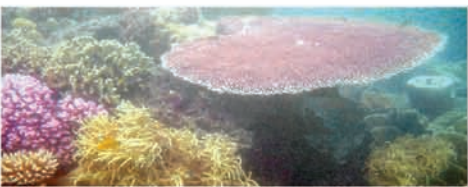


In muddy estuaries **plankton** naturally produce mucus known as **marine snow**. When excess **sediments** and **nutrients** are released into the tidal soup of the estuary, they fuel planktonic marine life and increase the production of marine snow.

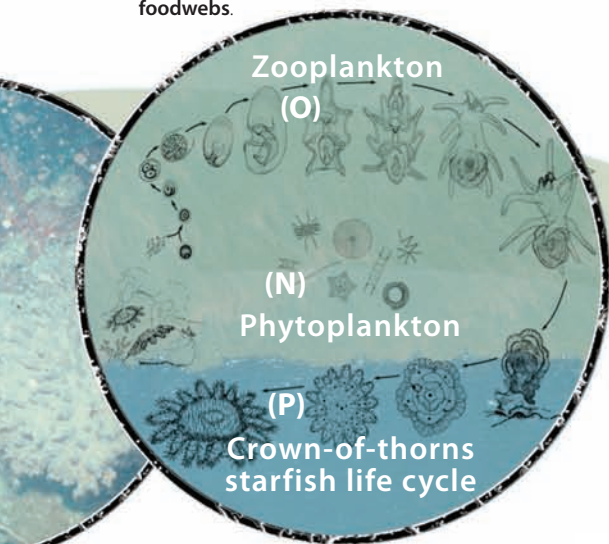
Wind and tide keep **marine snow** and **fine sediments** afloat - clouding the water - reducing light and changing the environmental conditions that control which creatures can survive.

**Marine snow** is sticky and eventually combines with sediment and organic particles to sink and **smother** small creatures on the seafloor, such as young corals.





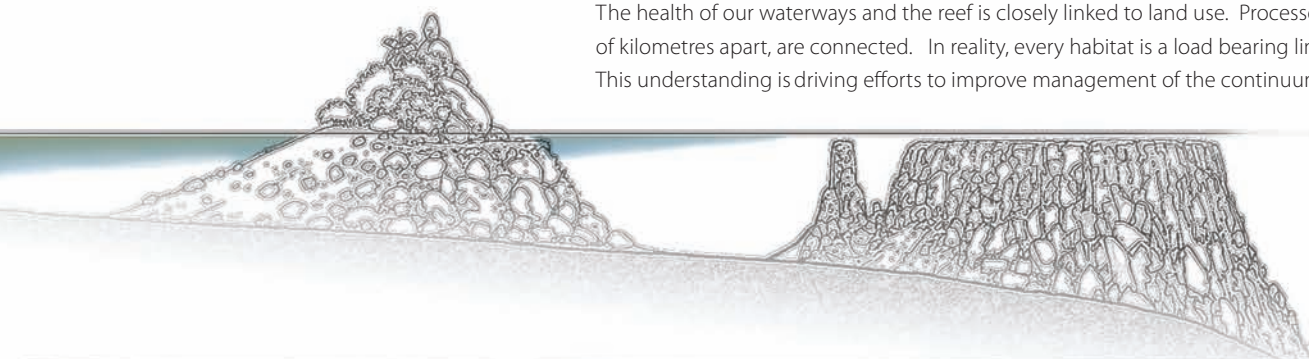
When nutrients penetrate further **offshore** they can distort coral reef **foodwebs**.



# PLUMES & PROCESSES

Marine environments respond to increased sediment, nutrients and contaminant loads.

The health of our waterways and the reef is closely linked to land use. Processes and events, hundreds of kilometres apart, are connected. In reality, every habitat is a load bearing link in a chain of connections. This understanding is driving efforts to improve management of the continuum - Catchment to Reef.



## Completing the connection

Flood plumes in the Great Barrier Reef lagoon are normal and have helped determine the distribution of reef types and the species that live on them. However, since intensive development of reef catchments, these plumes have carried much greater contaminant loads, causing major changes in the health and distribution of reefs.

A flood plume carries fine suspended sediment particles offshore, which become covered by mucus and plankton, forming 'marine snow' (L). This can smother settling juvenile corals on inshore and mid-shelf reefs. It also blocks the light, reducing the growth of tiny algae that live in and sustain coral tissues. While many corals have evolved to tolerate occasional sedimentation, most cannot cope with increases in the severity and duration of the sediment load.

Along with sediments, river plumes now deliver increased quantities of nutrients to the sea. Normally, nutrients are scarce on coral reefs because they are rapidly used by microbes and plants. Excess nutrients in flood plumes can promote fleshy algae that overgrow corals and degrade the reef (M).

Nutrients also fuel the food webs of the reef lagoon. Microscopic plants ('phytoplankton') (N), normally limited by a natural scarcity of nutrients, can have population explosions when exposed to nutrient supplements from a flood plume. Phytoplankton blooms can produce offensive 'red tides' and also boost the food chain by providing more food for microscopic animals ('zooplankton') (O), which in turn are fed upon by larger animals. Boosting food webs can severely disrupt plant and animal communities. Recent evidence suggests that even on offshore reefs, crown-of-thorns starfish outbreaks may be linked to nutrient pulses from flood plumes.

Starfish larvae feed on phytoplankton. As more nutrients produce more phytoplankton there is increased food for, and survival of larval starfish (P), and a surge in the adult population of starfish (Q). Thus, crown-of-thorns starfish, a natural member of the reef community, respond to changes in their environment.

In managing the Catchments and the Reef, it is vital to understand the natural connections between them, and human influences on them.

# RESOURCES

[www.catchmenttooreef.com.au](http://www.catchmenttooreef.com.au)

## Concept & communication design

russell kelley [russellkelley@mac.com](mailto:russellkelley@mac.com)  
<http://homepage.mac.com/russellkelley>

## Principal contributors

niall connolly, russell kelley, richard pearson & tim prior

## Production

russell kelley

## Illustration

gavin ryan [gavinryan@toadscape.com](mailto:gavinryan@toadscape.com)  
<http://www.toadscape.com>

## Aboriginal and Torres Strait Islander Sea Country

The Traditional Owners of the area covered by the Catchment to Reef program are recognised as its original owners and their entitlement to those ancestral lands and seas derive from customary lore which embodies the continuing role and responsibility that Traditional Owners have in looking after, caring for and managing country.

For them, land and sea country are considered as one. All aspects of social, cultural, traditional, spiritual and economic life are directly related to their land and sea country.

Recognition of Traditional Owner rights and involvement will be the key to the successful protection and management of the biodiversity of the region.

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## Community

### NRM Bodies

- Burdekin ([www.burdekindrytropics.org.au](http://www.burdekindrytropics.org.au))
- Fitzroy ([www.fba.org.au](http://www.fba.org.au))
- Burnett-Mary ([www.burnettmarynrm.org.au](http://www.burnettmarynrm.org.au))
- Mackay-Whitsunday ([www.mwnrm.org.au](http://www.mwnrm.org.au))
- Wet Tropics ([www.fnqnm.com.au](http://www.fnqnm.com.au))
- Cape York ([bruce.rampton@epa.qld.gov.au](mailto:bruce.rampton@epa.qld.gov.au))

### Landcare/Catchment Groups

- Landcare Australia ([www.landcareaustralia.com.au](http://www.landcareaustralia.com.au))
- Greening Australia ([www.greeningaustralia.org.au](http://www.greeningaustralia.org.au))
- Herbert Resource Information Centre ([www.hric.org.au](http://www.hric.org.au))
- Healthy Waterways ([www.healthywaterways.org](http://www.healthywaterways.org))
- The Wetlands Centre ([www.wetlands.org.au](http://www.wetlands.org.au))
- Wetlands Australia ([www.deh.gov.au/water/wetlands/](http://www.deh.gov.au/water/wetlands/))

## Science information

- CRC Reef ([www.reef.crc.org.au](http://www.reef.crc.org.au))
- Rainforest CRC ([www.rainforest-crc.jcu.edu.au](http://www.rainforest-crc.jcu.edu.au))
- CRC Coastal ([www.coastal.crc.org.au](http://www.coastal.crc.org.au))
- CRC for Catchment Hydrology ([www.catchment.crc.org.au](http://www.catchment.crc.org.au))
- Great Barrier Reef Marine Park Authority (GBRMPA) ([www.gbrmpa.gov.au](http://www.gbrmpa.gov.au))
- Reef Water Quality Protection Plan ([www.deh.gov.au/coasts/pollution/reef/](http://www.deh.gov.au/coasts/pollution/reef/))
- Australian Institute of Marine Science (AIMS) ([www.aims.gov.au](http://www.aims.gov.au))
- Reef Futures ([www.reeffutures.org](http://www.reeffutures.org))
- Australian Centre for Tropical Freshwater Research ([www.actfr.jcu.edu.au](http://www.actfr.jcu.edu.au))
- QLD Department of Natural Resources and Mines ([www.nrm.qld.gov.au](http://www.nrm.qld.gov.au))
- QLD Environmental Protection Agency ([www.epa.qld.gov.au](http://www.epa.qld.gov.au))
- QLD Department of Primary Industries and Fisheries ([www.dpi.qld.gov.au](http://www.dpi.qld.gov.au))
- Commonwealth Scientific and Industrial Research Organisation ([www.csiro.au](http://www.csiro.au))
- James Cook University (JCU) ([www.jcu.edu.au](http://www.jcu.edu.au))
- Griffith University ([www.gu.edu.au](http://www.gu.edu.au))
- Centre for Riverine Landscapes ([www.gu.edu.au/centre/riverinelandscapes](http://www.gu.edu.au/centre/riverinelandscapes))

## Selected publications

- Furnas, M. (2003) Catchments and Corals: Terrestrial Runoff to the Great Barrier Reef. AIMS, 346pp.
- Cappel, M. & Kelley, R. (2001) Connectivity in the Great Barrier Reef World Heritage Area - An Overview of Pathways and Processes. (In) Wolanski, E. Oceanographic Processes of Coral Reefs: Physical and Biological Links in the Great Barrier Reef. CRC Press pp. 161-187.
- Pusey, B., Kennard, M. and Arthington, A. (2004) Freshwater Fishes of North-eastern Australia. CSIRO Publishing 684pp.
- The Blue Highway (<http://www.abc.net.au/science/bluehighway/default.htm>)

