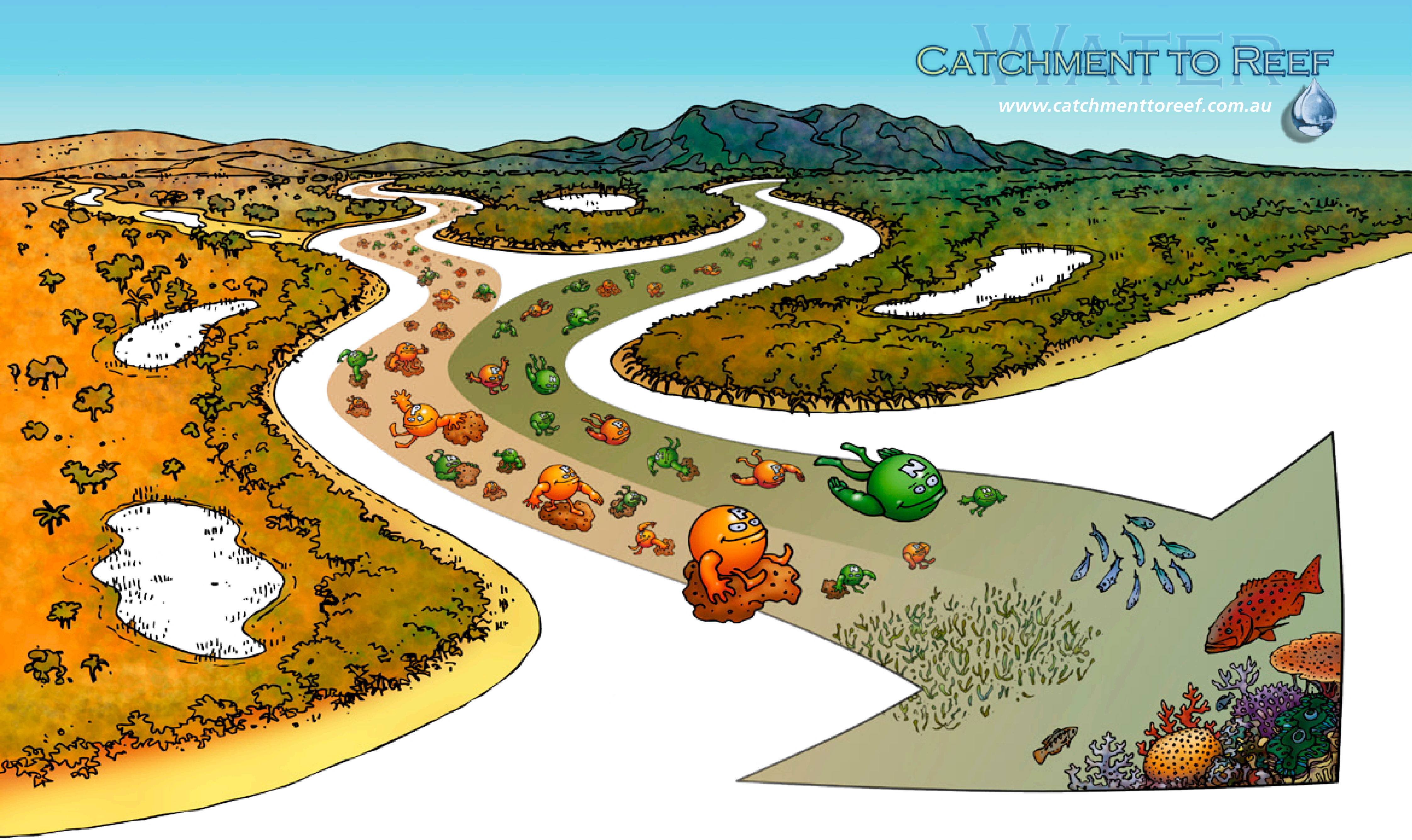


Nutrients, Catchments & Reefs

A guide to nutrients in your landscape

Nutrients in our environment

The Great Barrier Reef (GBR) and its catchments are an inter-connected system. *The waterways that connect land and sea transport the nutrients essential to maintaining a healthy environment and economy. This booklet introduces two of the most important nutrients in our environment – nitrogen (**N**) and phosphorus (**P**) – and shows the role and power of nutrients in natural processes. It also shows how human activities have changed the balance of these nutrients in the environment, and how best practice land use can improve both evironmental health and productivity.*

What are nutrients?

Nutrients are the natural chemical elements and compounds that plants and animals need to grow and survive. They are the 'fuel' of the natural engine in all ecosystems, the organic cycle (see right).

No escape

Every aspect of human society (no matter how urban) is directly dependent on the organic cycle to move and recycle nutrients through and between ecosystems.

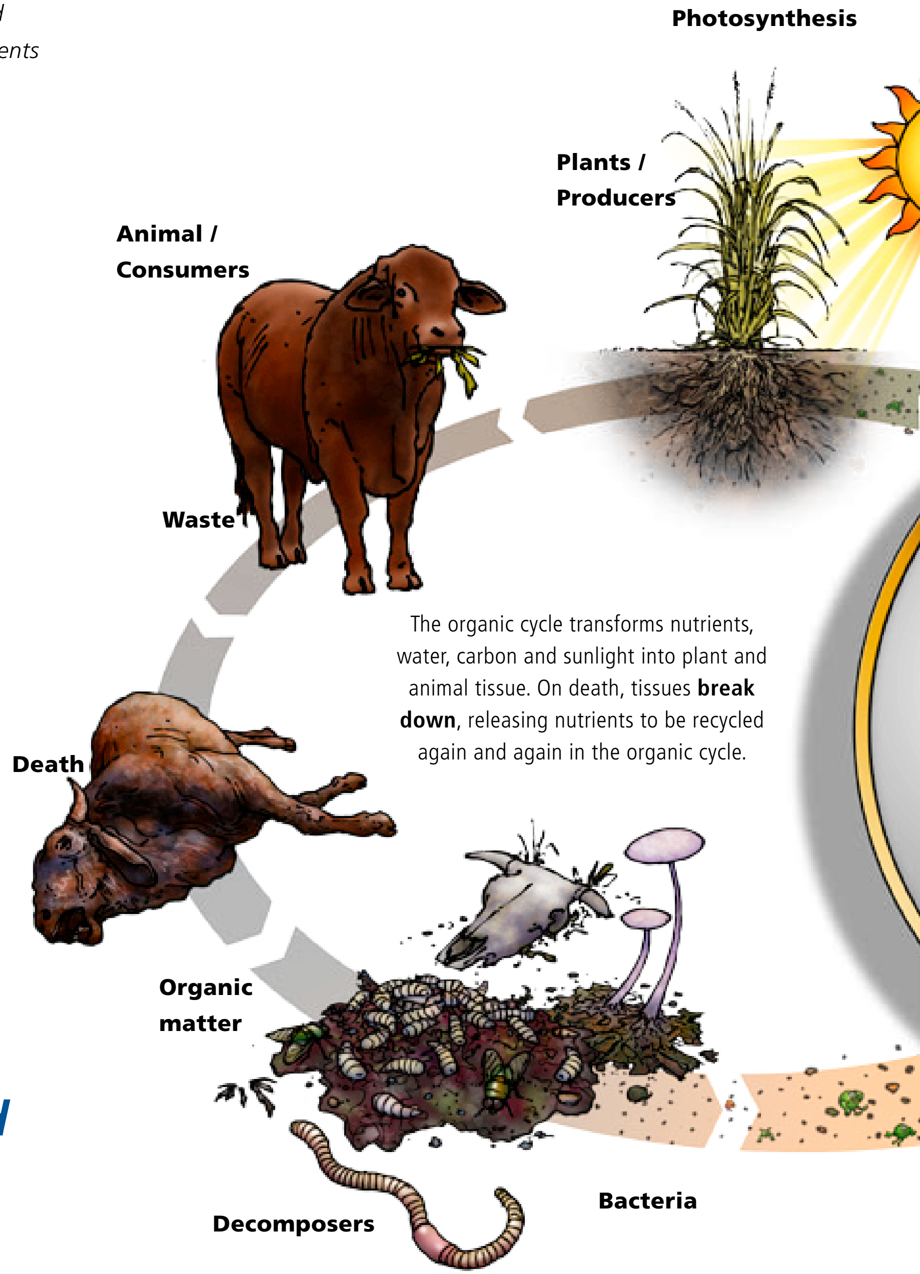
Without these processes waste would not decay and there would be no crops, livestock or fisheries.

The nutrient family

All living organisms require nutrients. Carbon, hydrogen, oxygen, nitrogen and phosphorus are needed to supply energy and support growth in plants and animals. Other elements such as potassium, iron, manganese, copper and zinc, are needed in small quantities for body maintenance.

For optimal growth plants and animals need specific combinations of these nutrients.

Nutrients are a potent biological fuel. They are essential to natural cycles and the growth of living organisms.

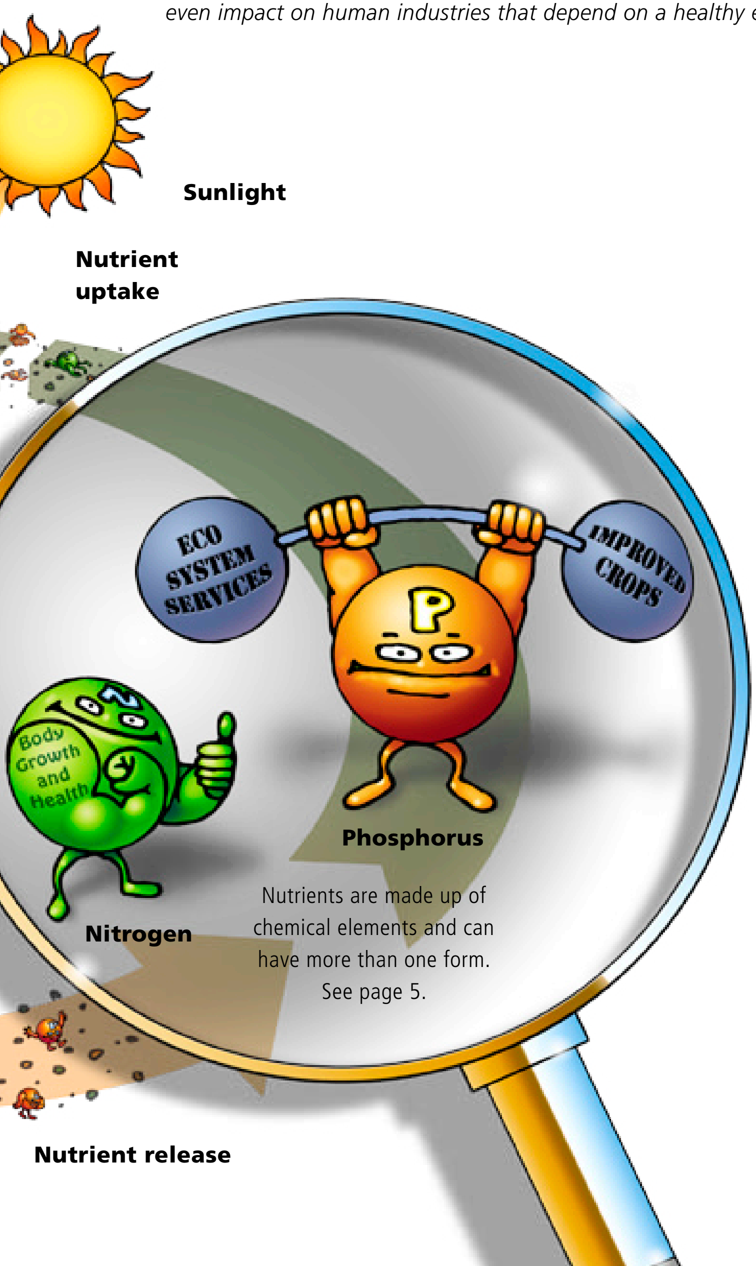


The organic cycle transforms nutrients, water, carbon and sunlight into plant and animal tissue. On death, tissues **break down**, releasing nutrients to be recycled again and again in the organic cycle.

N *= nitrogen,* ***P*** *= phosphorus*

The organic cycle

Nutrients are for recycling! *Nutrients flow around in an organic cycle at natural (normal) levels. Without nutrients plants and animals cannot grow or remain healthy. When nutrients are increased beyond natural levels there are ecological side effects, either locally or downstream. These side effects (see pages 12-13) can exclude species, change ecosystems and even impact on human industries that depend on a healthy environment, such as tourism and fishing.*



Watching your P's and N's

Carbon, hydrogen and oxygen are abundant nutrients in nature. But nitrogen (**N**) and phosphorus (**P**) are not always so freely available. When plants run out of **N** or **P** their growth slows and stops despite the availability of other nutrients. This is called nutrient limitation.

Think of plants and animals as living engines that need several different fuels to run properly. Sunlight and carbon dioxide are two fuels plants have in abundance. **N** and **P**, however, are special fuels that control the speed of the plant's growth 'engine'. Without the right amount of **N** and **P** plants won't grow optimally, so we sometimes need to add them as fertiliser to grow crops.

In the tropics

The organic cycle runs much faster in the tropics than in temperate environments. Intense sunlight, high temperatures and frequent rain favour year-round biological activity. Organic matter containing nutrients breaks down much faster, and nutrients (from any source) recycle at a greater pace.

Did you know

Acidity (pH) of soils affects the availability of nutrients for plants. When the soil pH is very high (alkaline) or very low (acid) all nutrients behave differently: some are locked away, while others can be released in excess.

The amount of clay and organic matter in the soil also affects its ability to hold nutrients.

Reference: Calcino 1994, Wilkinson and Grunes 2000

Contents

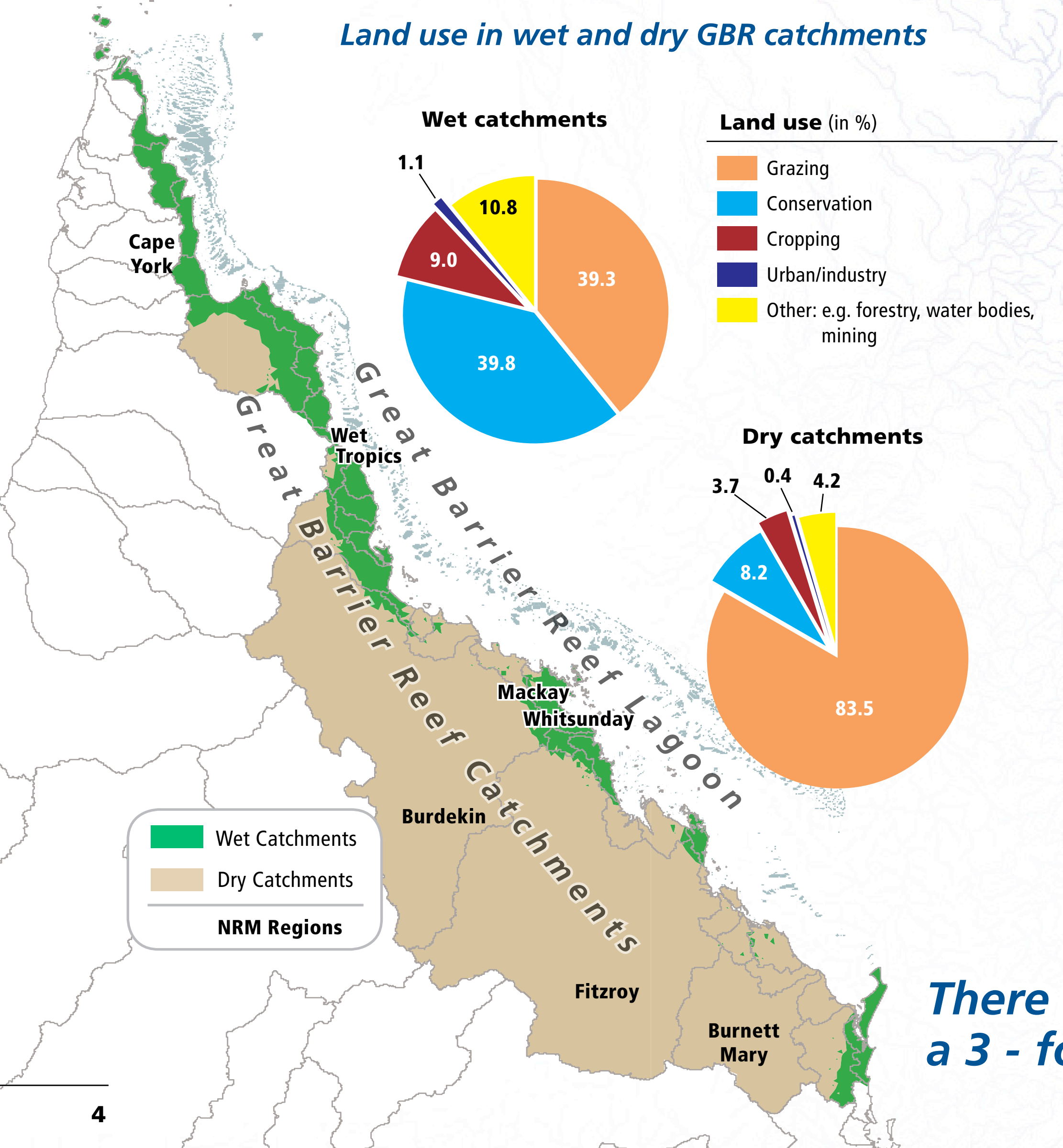
In this booklet

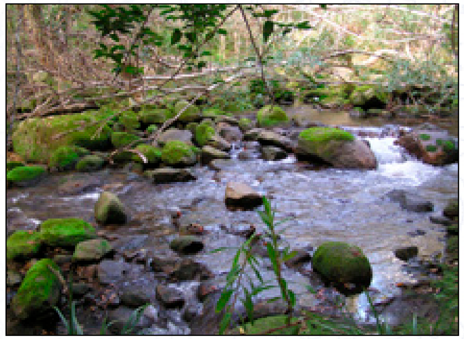
The organic cycle provides the essential ecosystem services we all depend on - clean air, clean water and clean soil.

Nutrients and the Great Barrier Reef

The Great Barrier Reef Catchment Area (412 000 km²) is made up of six Natural Resource Management (NRM) Regions, with over 30 catchments that drain into the Great Barrier Reef lagoon. *From the tip of Cape York in the tropics to Bundaberg in sub-tropical Queensland, the catchments span both the wet and dry tropics. Here we discuss the differences between these catchments, and their influence on the Great Barrier Reef lagoon.*

Land use in wet and dry GBR catchments





Wet catchments

Wet catchments (e.g. Wet Tropics, Mackay Whitsunday and Coastal Cape regions) have short, fast-flowing streams. Most of the rainfall occurs in the summer monsoon, with lighter falls throughout the year sustaining river and subsurface waters.

During flood events water can carry nutrients and sediments across the narrow coastal floodplain to reach the river mouth within 24 hours.

The clearing of coastal rainforest and the draining and filling of up to 90% of wetlands has combined with intensive agriculture and urban development to increase the sediment and nutrient load delivered to the marine environment.

Burnett Mary

The Burnett Mary Region differs from wet catchments by having lower average rainfall and a sub-tropical climate.

Dry catchments

Dry catchments (e.g. Burdekin and Fitzroy regions) are much larger, with more diverse landforms than the wet catchments. With lower, less consistent rainfall the landscape is drier and the ground cover more open.

Most streams are dry for much of the year except for disconnected pools and lagoons. In the wet season, streams flood quickly, carrying their nutrient and sediment loads down to the floodplain.

Grazing on savannah rangelands is the major land use and the land is prone to surface erosion. The floodplain has largely been cleared for irrigated cropping, horticulture, urban and industrial land uses.

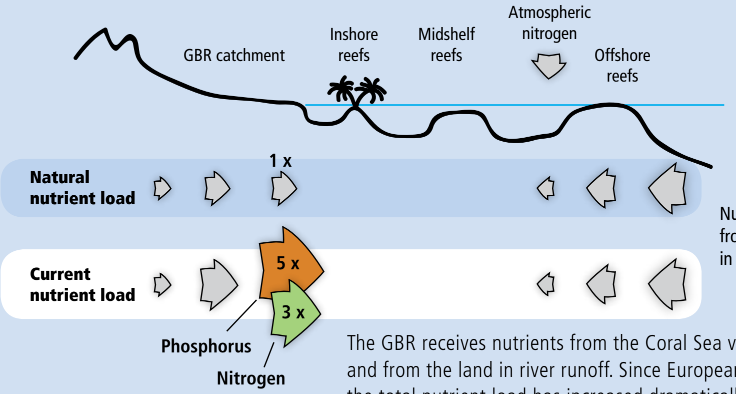
Dry catchment stream networks are much larger than the wet catchments. For example, the Burdekin River drains 130 000 km² and the movement of floodwaters from headwaters to river mouth can take days or weeks.

There has been a 5 - fold increase in phosphorus and a 3 - fold increase in nitrogen delivered to the GBR.

N *= nitrogen,* ***P*** *= phosphorus*

Water in every gully, creek and river adds to the total nutrient load heading downstream.

Nutrient loads & the GBR - natural and current



The GBR receives nutrients from the Coral Sea via upwelling and from the land in river runoff. Since European settlement the total nutrient load has increased dramatically.

Reference: McKergow et al 2005, Furnas 2003

At the end of the pipe

Nutrients accumulate as streams flow into each other. Ultimately freshwater streams mix with the sea in the estuaries of the Great Barrier Reef lagoon.

Excess nutrients encourage the growth of algae on inshore reefs and seagrass beds. They also feed plankton whose remains bind with sediment to form 'marine snow', reducing light and smothering the juvenile corals that renew inshore reefs, (reference: Fabricius 2005).

In nature nutrients occur in three basic forms:

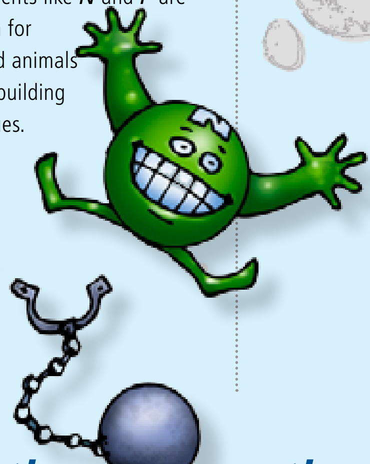
Tissue ▷ Particulate organic matter ▷ Dissolved organic matter ▷ Dissolved inorganic matter ▷ Cycle repeats

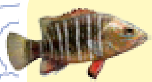
1. On death, decomposers (e.g. fungi, insects, bacteria) break tissue down into particulate organic matter (POM) - bits of leaves, bones and humus.

2. The next step of decomposition is dissolved organic matter (DOM). These large molecules are not easily used by plants or animals - think of them as being locked up until the next step in the cycle.

3. Finally bacteria break the dissolved organic matter into dissolved inorganic matter - the mineral form.

Now nutrients like *N* and *P* are free again for plants and animals to use in building body tissues.






Did you know

The Great Barrier Reef lagoon and its catchments are an inter-connected system of rivers, wetlands, mangroves, seagrass beds, islands, reefs and inter-reef habitats. Mangrove jack (above) depend on both reefs and freshwater habitats during their life cycle.

The GBR catchment is home to about one million people, a similar number of cars, about five million cattle, 4 000 km² of sugarcane and 7 000 km² of other crops.

Collectively, our activities (land clearing, grazing, agriculture, mining and urban development) have modifed over half of the total catchment area.

Reference: Connolly et al 2005

Decomposing tissue always releases N & P by the same pathway.

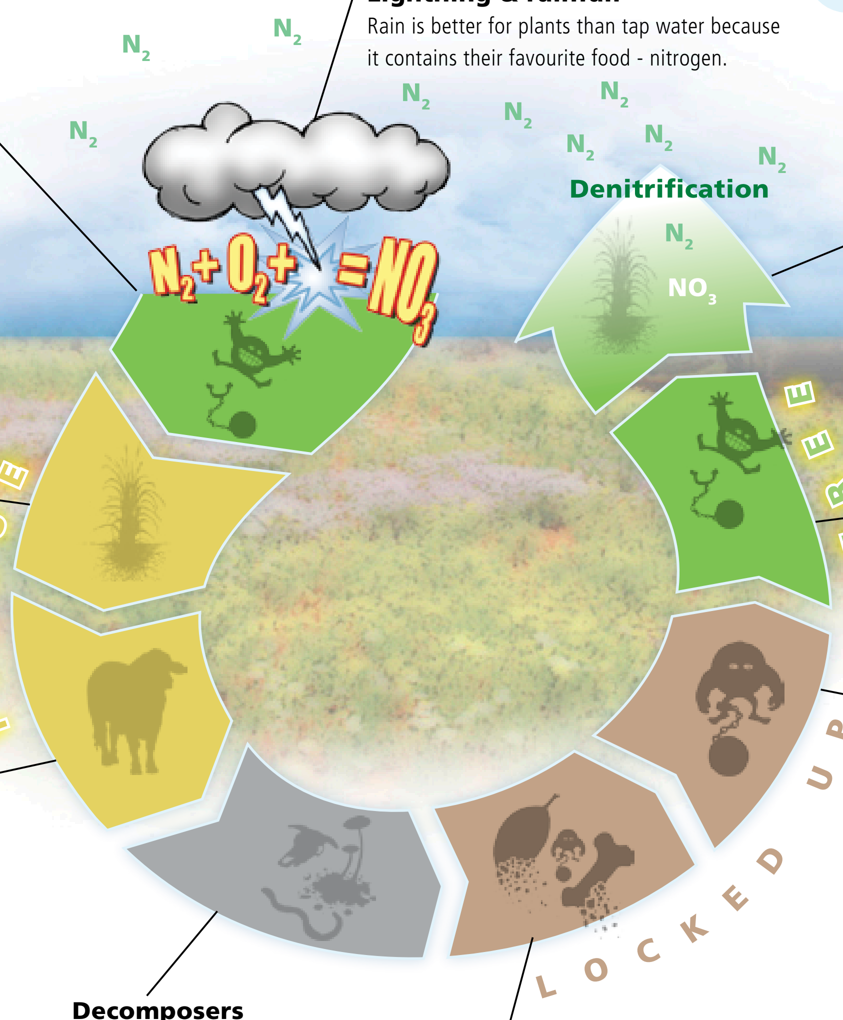
The nitrogen cycle

Despite being very abundant as a gas in our atmosphere most nitrogen (N) is locked away from the plants and animals which depend on it to build their bodies. *The nitrogen cycle makes life possible by recycling gas nitrogen (N_2) into a form friendly to living organisms - nitrate (NO_3) .*

Remember

Total nitrogen		
	Particulate organic nitrogen (PON) *Pieces of plants and animals*	**Nitrogen locked up**
	Dissolved organic nitrogen (DON) *Large unavailable molecules*	
	Dissolved inorganic nitrogen (DIN) *Small available molecules = mineral nitrogen in fertilisers*	**Nitrogen free to use**

*Meet **N**, or nitrogen. On his journey from catchment to reef he can take on different forms but the one of most use in natural cycles is NO_3 or nitrate.*



Lightning & rainfall
Rain is better for plants than tap water because it contains their favourite food - nitrogen.

NO_3
The atmosphere is nearly 80% nitrogen gas (N_2) which cannot be used by most plants. Useable or dissolved inorganic nitrogen is nitrate (NO_3) and is created by lightning and bacteria. Some bacteria can also fix **N** in the roots of legume plants.

NO_3
Towards the end of the cycle nitrate (NO_3), the useful dissolved inorganic form of **N**, is either recycled back into plant and animal tissue or escapes back into the atmosphere as nitrogen gas (N_2) - a process known as denitrification.

Plants
Nitrate, also known as inorganic (or mineral) nitrogen, is used by plants to grow. In the process, dissolved inorganic nitrogen is converted to organic nitrogen.

Dissolved inorganic nitrogen, NO_3
Finally, bacteria convert the dissolved organic nitrogen back into dissolved inorganic nitrogen - the form that most plants love.

Animals
Plants are eaten by animals and body tissues are built. In this way **N** moves around the organic cycle taking different forms as it goes.

Dissolved organic nitrogen
The particles further break down, releasing dissolved organic nitrogen. Found in soil and water, these are large complex molecules that are not readily accessible to plants.

From forests to fisheries, natural nutrient cycles make the world go round.

Decomposers
When plants and animals expel waste or die, decomposers recycle the organic nitrogen stored in their tissues. The process of decay has several steps before the **N** can again be easily used by plants.

Particulate organic nitrogen
Tissues are initially broken into particles e.g. leaf and bone fragments, and soil humus.

***N** = nitrogen, **P** = phosphorus*

Humans & the nitrogen cycle

Nitrate, or inorganic nitrogen, is delivered in rain and by bacteria, with an increasing amount also produced by human activities: *agriculture (fertilisers), aquaculture, intensive animal husbandry, urban and industrial discharge and the burning of fossil fuels.*

Extra nutrients are added to the environment to boost growth in crops and stock. At harvest, some of these nutrients are exported, but nutrients that escape (leak) into the surrounding environment will react with the plants and animals of the ecosystems they encounter.

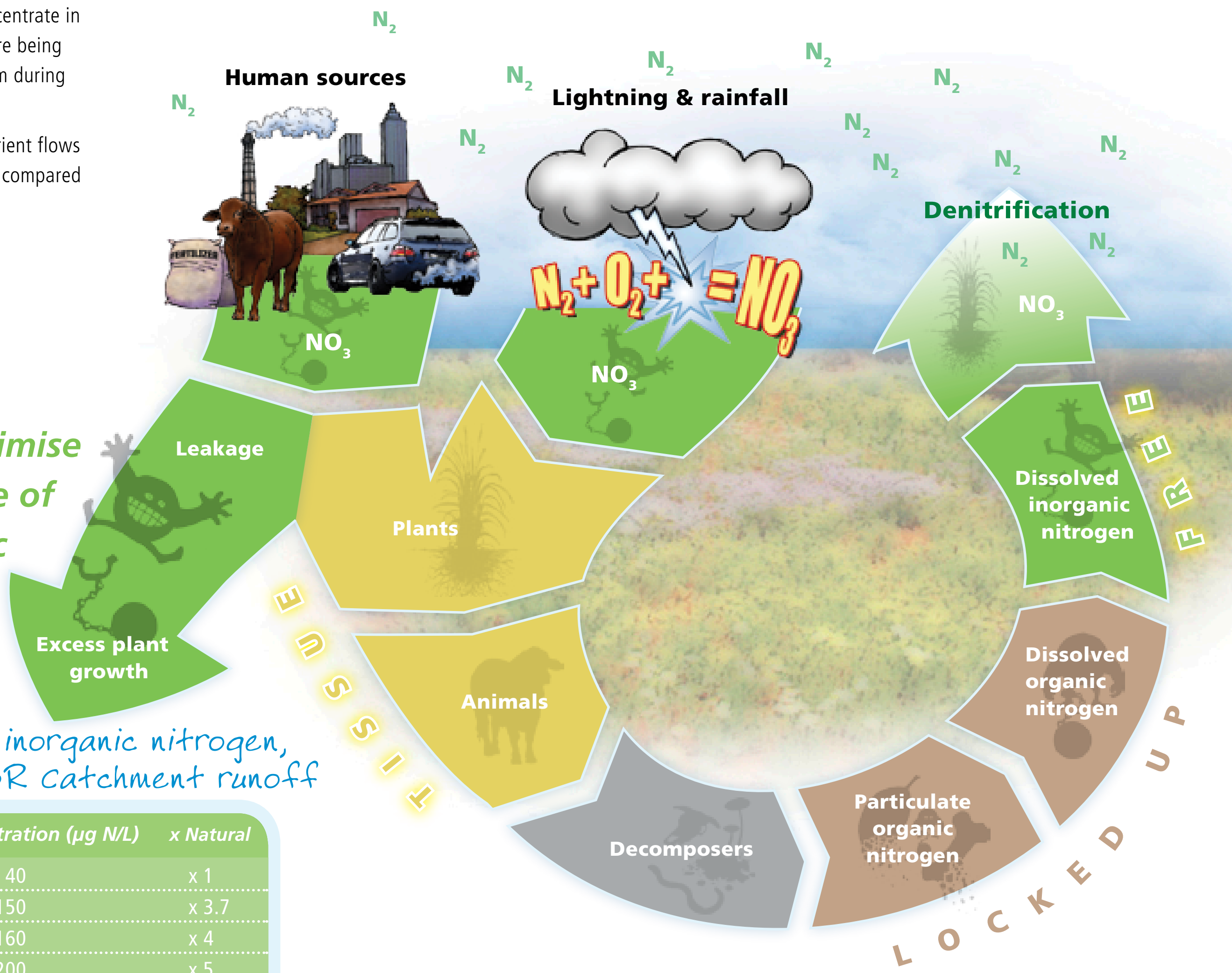
Half of the inorganic nitrogen (NO_3) applied to crops as fertiliser, can leak unused and untreated into the natural environment, (reference: Tilman et al 2002).

When more **N** is added to the environment than can be used in natural or modified cycles the excess causes nutrient pollution in waterways. This upsets the nitrogen cycle, causing serious problems associated with declines in water quality such as algal blooms, fish kills and loss of biodiversity.

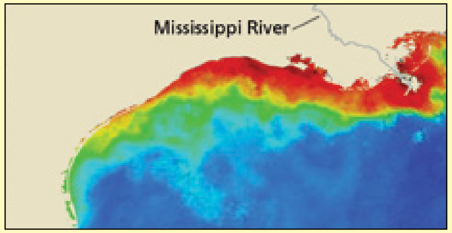
Nutrients in GBR catchments may concentrate in waterways during the dry season before being transported long distances downstream during high-flow wet season events.

The table below shows the typical nutrient flows ('leakage') from an undisturbed forest compared with low and high intensity land uses.

We need to mimimise the leakage of dissolved inorganic nitrogen.



Did you know



Nutrients can go wrong on a grand scale. Overseas for example, more than 15 000 km^2 of sea floor in the Gulf of Mexico is a 'dead zone', with no marine life. The human nutrient load from the Mississippi river causes a massive algal bloom which dies and sinks to the bottom. As bacteria break down the algae, they use up all the oxygen, killing other marine life. Turn to page 16 for a link to more about the Mississippi dead zone.

Typical values of inorganic nitrogen, nitrate (NO_3), in GBR catchment runoff

	Land Use	*Concentration (µg N/L)*	*x Natural*
Nitrate	Rainforest	40	x 1
	Forestry	150	x 3.7
	Grazing	160	x 4
	Urban/Industry	200	x 5
	Horticulture	500	x 12.5
	Cotton	700	x 17.5
	Bananas	1100	x 27.5
	Sugarcane	2000	x 50

Reference: Cogle et al 2006

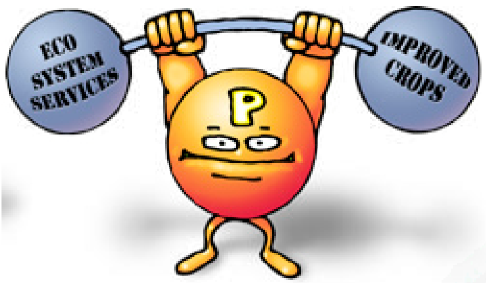
Dissolved inorganic nitrogen, Nitrate or NO_3, causes excessive plant growth in waterways.

The phosphorus cycle

Phosphorus (P) is an important component of DNA (life's building block) and is also part of the energy transfer system of plants and animals. *It is quite rare in nature and is rapidly used up by plants. **P** is rarely found dissolved in water.*

Remember

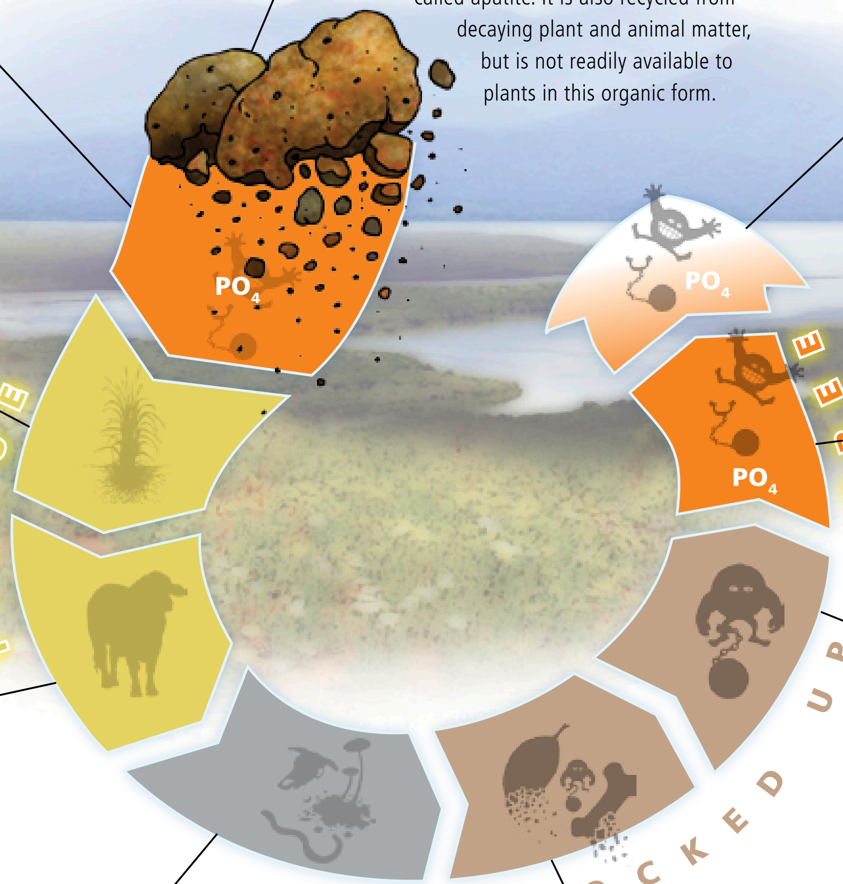
Total phosphorus		
	Particulate organic phosphorus (POP) *Pieces of plants and animals*	**Phosphorus locked up**
	Dissolved organic phosphorus (DOP) *Large unavailable molecules*	
	Dissolved inorganic phosphorus (DIP) *Small available molecules = mineral phosphate in fertilisers*	**Phosphorus free to use**



*Meet **P** or phosphorus. Like most nutrients he changes form as he moves through the landscape. Also known as PO_4^{3-} we'll call him $P0_4$ or phosphate - the form most available to plants.*

Weathering of rocks
P is mainly derived from the natural breakdown of rocks through weathering of a mineral called apatite. It is also recycled from decaying plant and animal matter, but is not readily available to plants in this organic form.

PO_4
Microbes help to extract **P** from rock particles, making it available to plants as phosphate (PO_4).



Mountains and marine sediments
The ultimate fate of **P** is either to be recycled back into plant and animal tissue or to be deposited into ocean sediments. Millions of years later this sediment phosphorus is returned to the natural cycle when mountain building uplifts and exposes the old seabed to erosion.

Plants
P travels attached to sediments and rarely in solution. Plants absorb mineral phosphate from the soil and water and convert it to organic phosphate to make DNA, proteins and cell membranes.

Dissolved inorganic phosphorus, PO_4
Finally, bacteria convert the dissolved organic phosphorus back into dissolved inorganic phosphorus - the mineral form that most plants love.

Animals
When animals eat plants (or plant-eating animals) they transfer organic phosphate around the food web.

Dissolved organic phosphorus
The particles further break down into dissolved organic matter. Found in soil and water, these are large complex molecules that are less accessible to plants.

P primarily travels attached to sediment, not dissolved in water.

Gully erosion - a major source of ***P.***

Decomposers
When plants and animals expel waste or die, decomposers recycle the organic phophate stored in their tissues. The process of decay has several steps before the *P* can again be easily used by plants.

Particulate organic phosphorus
Tissues are initially broken into particles e.g. leaf and bone fragments, and soil humus.

***N** = nitrogen, **P** = phosphorus*

Humans & the phosphorus cycle

Because P is a by-product of natural erosion, human activities such as land clearing, overgrazing and agriculture can increase the amount of P available to the biological cycles of the ecosystem.

The GBR and its catchment ecosystems have evolved with natural rates of nutrient supply. Much of the extra **P** added to the environment from human activities is taken up by crops and stock and is exported from the landscape as food. However, some escapes (leaks) into the surrounding natural environment and waterways.

As streams merge, nutrient loads increase downstream. Like **N**, the inorganic phosphorus is a potent fuel that promotes excessive plant growth and toxic algal blooms that cause fish kills. This reduces the number of species in streams and wetlands. Further downstream it promotes algal growth on reefs and seagrass beds.

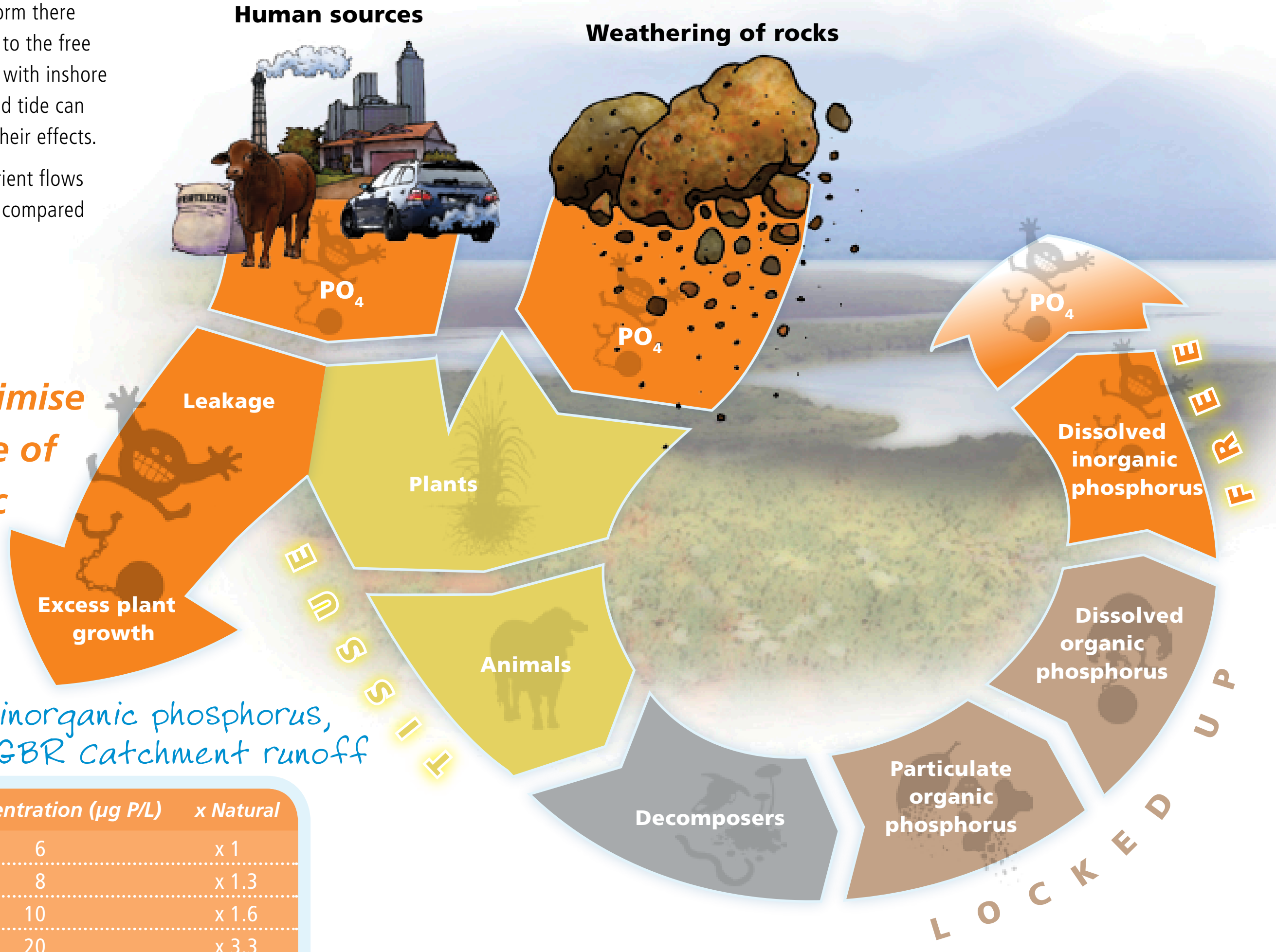
In large catchments with irregular seasonal discharge **P** tends to arrive in pulses attached to sediment. In this locked up (organic) form there is a lag time before bacteria convert it to the free (inorganic or mineral) form that reacts with inshore environments. During this lag, wind and tide can further distribute these nutrients and their effects.

The table below shows the typical nutrient flows ('leakage') from an undisturbed forest compared with low and high intensity land uses.

Did you know

In 1991, the longest blue-green algal bloom ever recorded stretched 1 000 km along the Darling River. A state of emergency was declared and the army was called in to transport drinking water to the riverside communities. Blue-green algal blooms occur in response to elevated levels of phosphorus. Typically, rivers that drain large catchments with high sediment loss have elevated phosphorus levels that promote algal blooms. Turn to page 16 for a link to more about the Darling River bloom.

We need to mimimise the leakage of dissolved inorganic phosphorus.



Typical values of inorganic phosphorus, phosphate (PO_4), in GBR catchment runoff

Phosphate: Land Use	Concentration (µg P/L)	x Natural
Rainforest	6	x 1
Forestry	8	x 1.3
Sugarcane	10	x 1.6
Grazing	20	x 3.3
Horticulture	30	x 5
Cotton	80	x 13.3
Bananas	80	x 13.3
Urban/Industry	230	x 38

Reference: Cogle et al 2006

Even a little extra P can cause a massive increase in weeds and blue-green algae in fresh waters.

The natural flow of nutrients in Great Barrier Reef catchments

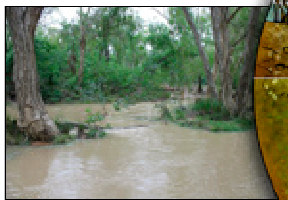
Nutrients in balance - they make the world go round

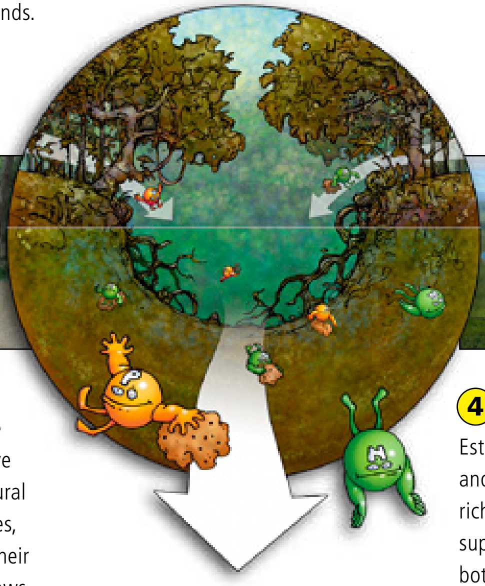
The environments of coastal tropical Queensland have evolved in balance with the natural supply of nutrients. Much of the N required by the natural system is delivered in rain and by soil microbes, while most of the P is produced by natural weathering. The natural levels of N and P are often low compared to temperate ecosystems.

Nutrients in their available (dissolved inorganic or mineral) form supply the needs of natural food webs. They are carried in surface and ground waters which flow into streams, rivers and wetlands.

In the tropics most nutrients are lost from the land in floods when sediment and nutrients are rapidly flushed downstream, forming visible flood plumes extending into the GBR lagoon.

Nutrients ***attached*** to suspended sediment in these plumes settle in the mud of tidal estuaries, close to the river mouth, whereas ***dissolved*** nutrients (particularly nitrate NO_3) are carried much further out into open water or along the coast.





1 Intermittent flows

In the dry catchments, rivers are often reduced to a series of disconnected pools. Nutrients naturally accumulate in slow flowing streams and pools, delaying their progress downstream.

2 Slow the flow

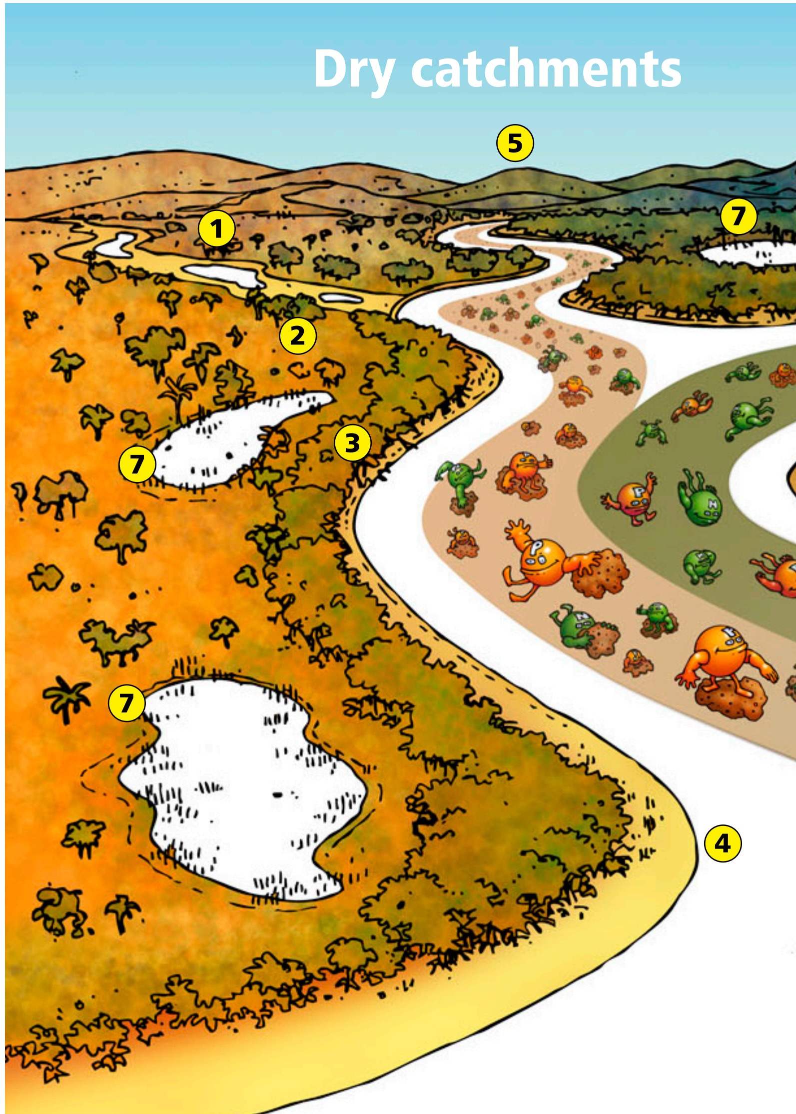
Nutrients and sediments are bound together as they move through the landscape. Natural vegetation, especially grasses, traps these sediments and their bound nutrients as water flows across the floodplain, building soils in the process.

3 Riverbanks

Riverbank or riparian vegetation stabilises stream banks, controls erosion and helps keep the amount of sediment and nutrients in waterways to natural levels.

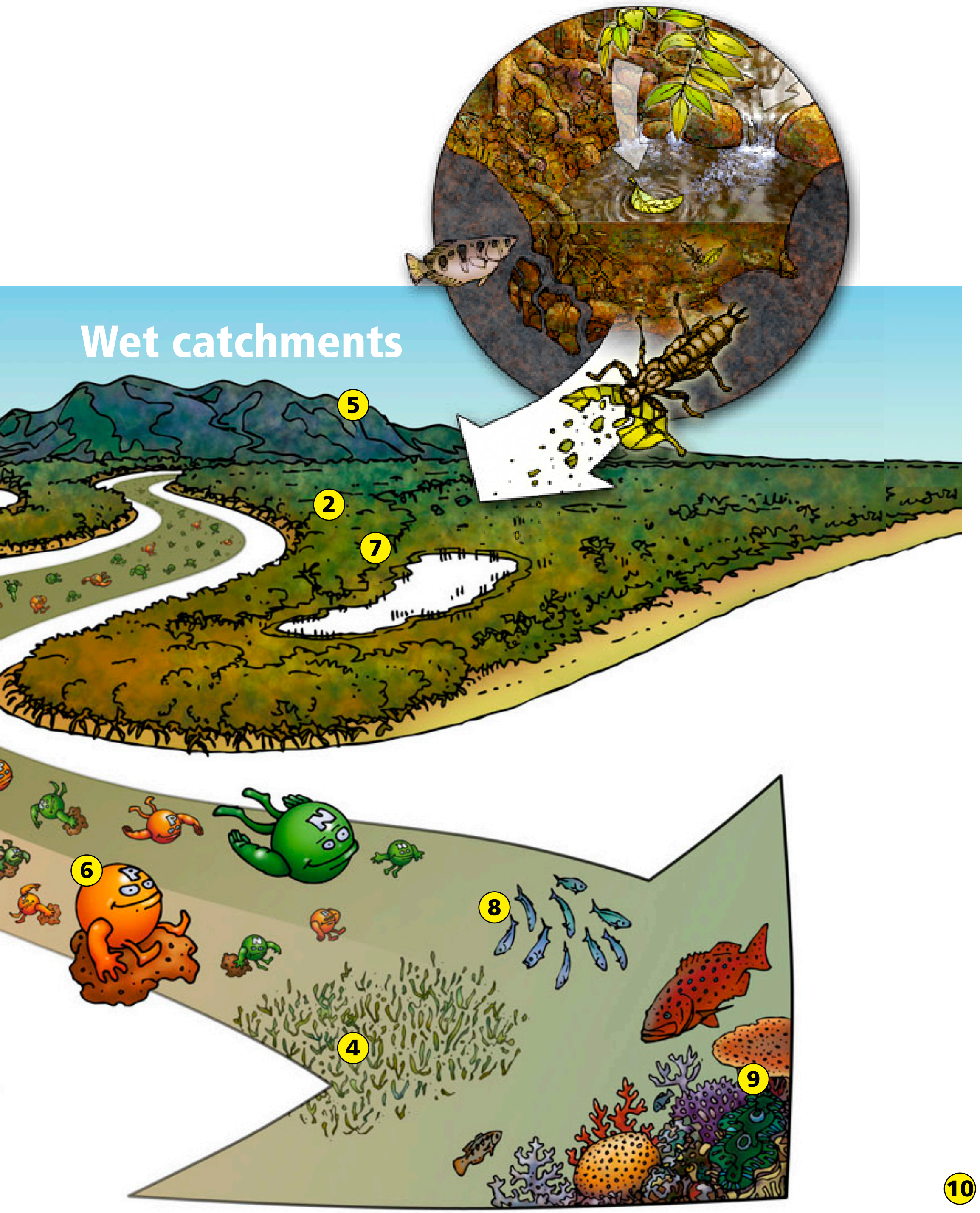
4 Estuaries

Estuaries trap some sediments and nutrients in their organically rich water and mud. They support food webs that reach both upstream into floodplains and downstream into mangroves, bays and seagrass nurseries. These food webs ultimately support the edible fish, crabs and prawns that underpin Indigenous, recreational and commercial fishing and tourism.



The natural flow of nutrients supports

N = nitrogen, P = phosphorus



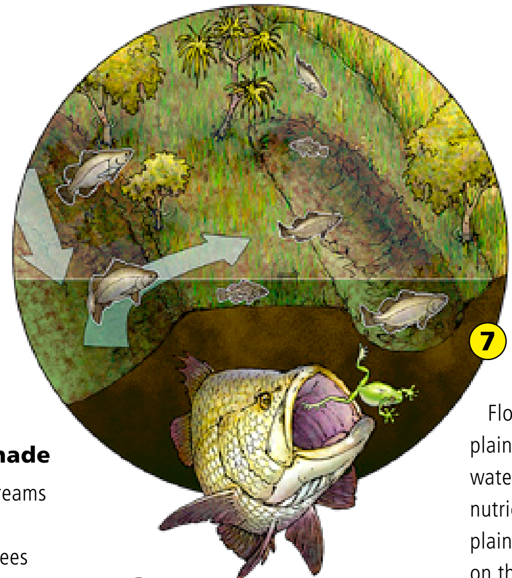
agriculture, forestry, fisheries and tourism.

5 Made in the shade

In their upper reaches, streams can be nutrient-poor, and overhanging river bank trees shade the water from the light needed by aquatic plants to fuel food webs. Nutrients are recycled from the leaf litter of overhanging trees. In upland streams entire food webs start from fallen leaves and the organisms that use them.

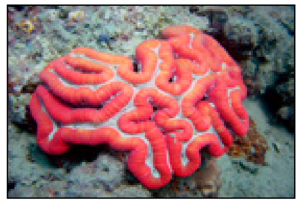
8 A balanced diet

Flood waters from the whole catchment are funnelled through estuaries into the ocean. The **available** nutrients are used by marine plants (phytoplankton) which in turn feed animal plankton, bait fish, larger fish and so on around the food web.



6 Flowing free

Nutrients are carried in flood waters attached to sediments or in their dissolved organic and inorganic forms. Only the dissolved inorganic forms of **N** and **P** are immediately available for plant growth.



9 A place to settle

At the end of the flow are the inshore reefs of the Great Barrier Reef lagoon. Here corals are naturally adapted to lower light and higher sediment levels found inshore. They can thrive under these conditions provided their larvae can find places to settle and there is not too much competition from algae.

7 Nutrients aren't just for humans

Flood waters flow on to flood plains, recharging wetlands and water tables. Here sediments and nutrients are captured by flood-plain food webs that depend on them.

During the monsoon floods many species move about the flood-scape e.g. adult barramundi leave floodplain lagoons and travel downstream to spawn.

10 Far out

The corals of offshore reefs grow in clearer waters. These corals suffer in nutrient-rich waters, preferring a low background supply of nutrients to sustain their growth. They are rarely directly influenced by catchment runoff.

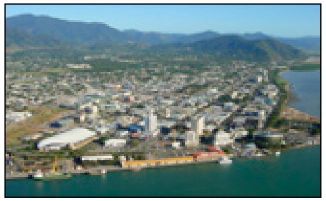
A healthy environment is a productive environment.

Effects of increased nutrients in Great Barrier Reef catchments

Nutrients out of balance make the wheels fall off natural processes

The dramatic increase in the amount of **N** and **P** flowing into the GBR lagoon has been caused by erosion, clearing, drainage, over-grazing and the direct addition of nutrients from human activities. Most of the natural vegetation on the rich floodplain soils, is now replaced with grazing, agriculture and urban development.

During heavy rainfall, excess fertiliser and free sediment are channelled into waterways through artificial drains. Nutrients at unnatural levels act as fuel to the natural system sending it into overdrive, causing biological pollution and disrupting the balance between plants and animals.



3 Why green slime...

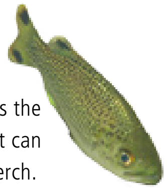
Nutrients combine from different sources and accumulate downstream at unnaturally high levels. As stream flow slows and wetlands dry out, nutrients concentrate, feeding massive blooms of microscopic algae and turning the water green - a process known as eutrophication. Excess nutrients also fuel the growth of water weeds, causing loss of habitat, oxygen and fish in waterways.

2 Urban inputs

Discharges from sewage treatment and industrial plants combine with urban wastes to raise nutrient and contaminant levels in urban waterways and inshore environments, further increasing the load from upstream.

1 Loss of riverbank vegetation

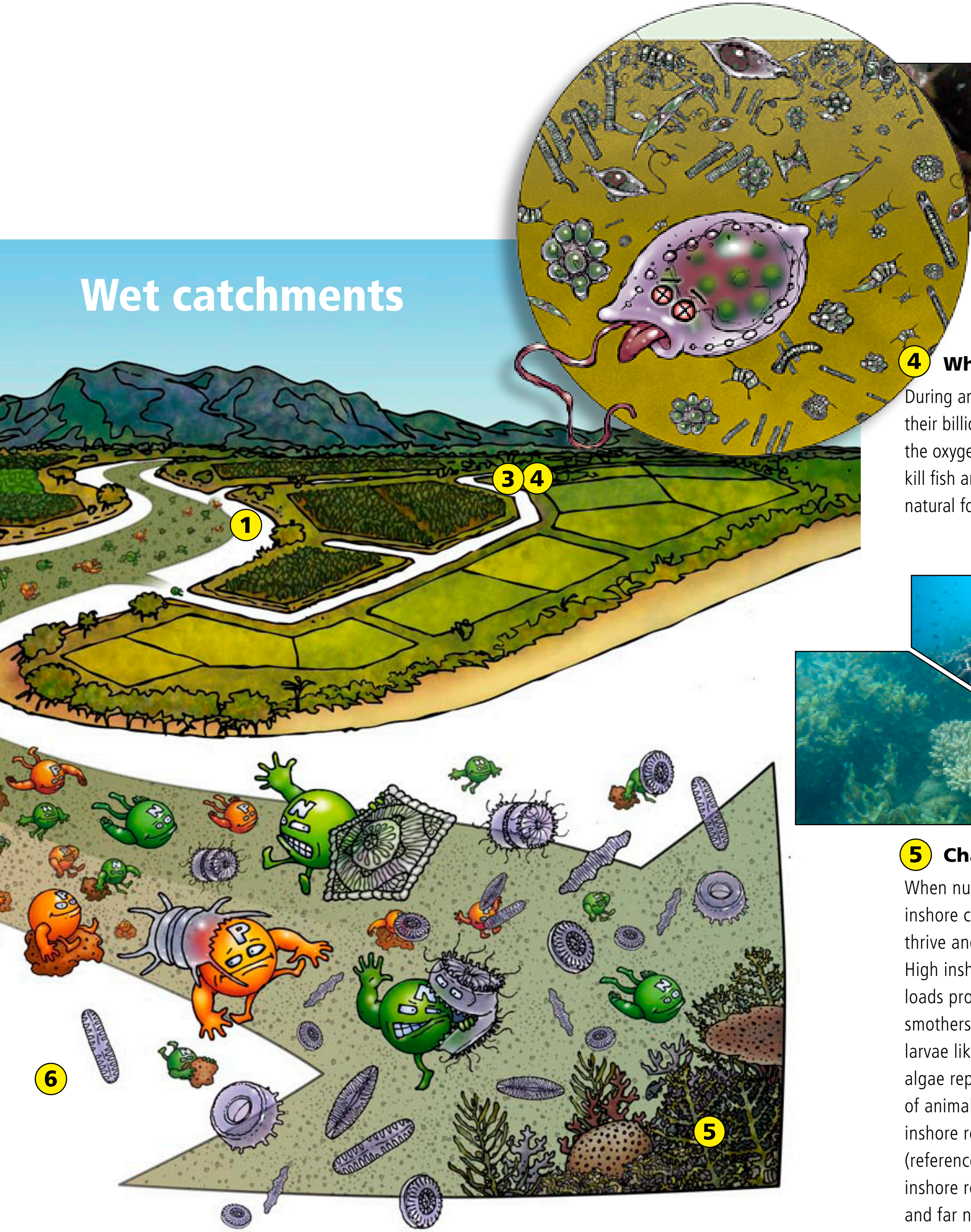
Clearing, overgrazing, removal of riverbank vegetation and the direct addition of nutrients from intensive land use radically change conditions in streams. The combined effect of extra sediment and nutrient, increased light (loss of shade) and higher temperature changes the kinds of animals and plants that can live there - e.g. loss of jungle perch.

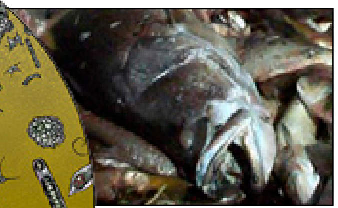


An algal bloom = eutrophication in action.

N *= nitrogen,* ***P*** *= phosphorus*

Wet catchments

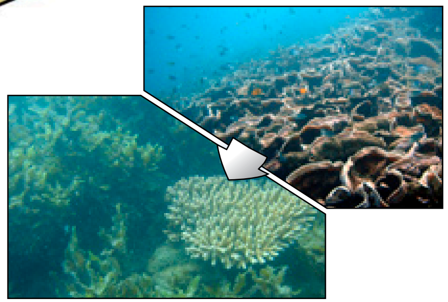




A freshwater fish kill.

4 Why fish die...

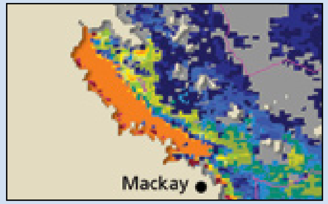
During an algal bloom, algae die in their billions. Their decay uses up the oxygen in the water which can kill fish and other important links in natural food webs.



5 Changes to coral reefs

When nutrient-rich water reaches inshore coral reefs, marine plants thrive and compete with corals. High inshore nutrient and sediment loads produce 'marine snow' which smothers the surfaces that coral larvae like to settle on. Eventually algae replace corals, and the types of animal and plants found on inshore reefs change with them, (reference: Fabricius 2005). Many inshore reefs on the Whitsunday and far north Queensland coast are degraded by excess nutrients and other stresses, (reference: Fabricius et al 2005).

A tale of two plumes



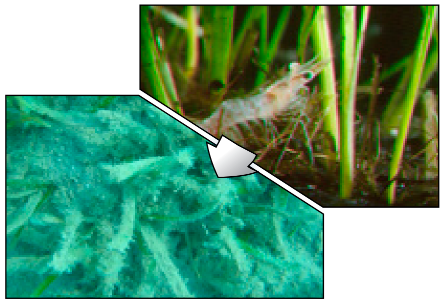
Burdekin flood plume

During floods the Burdekin River transports sediment from the erosion of every gully in its 130 000 km^2 catchment. Land clearing and grazing have increased the amount of sediment (with attached nutrients) carried to the river mouth. The distinct brown flood plume delivers sediments and nutrients to estuaries which are then distributed by wind and tide to inshore marine environments, sometimes travelling hundreds of kilometres.

Whitsunday flood plume

Mackay Whitsunday catchments are much smaller than the Burdekin, with higher rainfall and better ground cover. They discharge less sediment, but more dissolved **N** and **P** leaks from agricultural land use. Barely visible at sea level, the nutrient-rich Pioneer River flood plume is best seen in a satellite image which highlights microscopic plant growth (orange /red) in response to the dissolved nutrients. Wind and tide carry nutrients (and plants) away from the river mouths to other environments in the Great Barrier Reef lagoon.

Excess nutrients change the environment.



6 Seagrass under stress

As nutrient and sediment levels increase seagrass plants become coated with unwanted growth and sediment. This affects their role as nursery areas for fish and other species.

affect people's livelihoods.

Managing nutrients in the landscape

Rate of leakage x Area = Total Amount

All human land uses contribute to the total increase in nutrients entering the GBR lagoon. As a guide to the proportion each activity contributes to the increase in nutrients in GBR catchments, multiply the area of each land use by the rate of nutrient leakage (see tables on pages 7 & 9).

Grazing makes up 76% (315 000 km^2) of the GBR catchment, dominating the dry tropics, and can triple nutrient loads (especially **P**) where overgrazing and erosion occurs.

Combined cropping covers a smaller total area (14 000 km^2), but can release over 10 times the amount of **N**. Typically this is in the inorganic form most freely used by plants. Even higher concentrations of **N** (up to 50 times) are lost locally by intensive cropping and can have rapid impacts on the environment. One review has shown that only 30-50% of **N**, and ~45% of **P** applied in fertiliser, is taken up by crops, (reference: Tilman et al 2002).

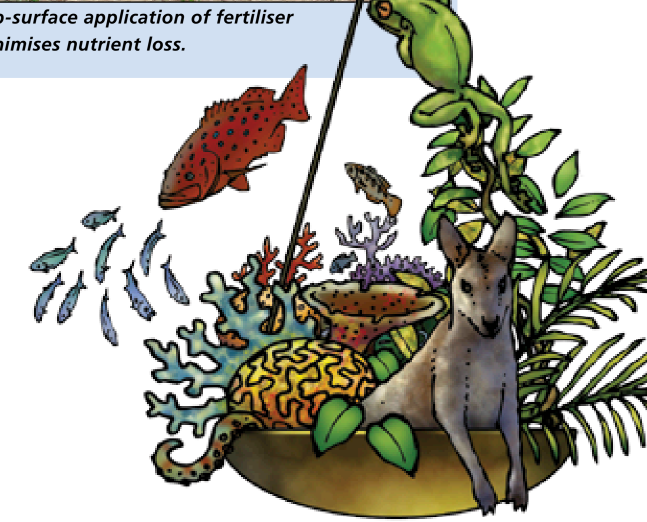
Urban and industrial land uses release high concentrations of both **N** and **P** into the immediate area. However, they make up a very small area (1 600 km^2) of the total GBR catchment and are heavily regulated.

We now know more about nutrients and how to reduce the amount of nutrient leakage into GBR catchments. Scientists, industries, managers and communities are working together to improve land and water management. Minimising the amount of nutrient and sediment entering the GBR lagoon will reduce impacts on the environment and our economy.

Smart farming: nutrient supply and demand

New research is helping growers match nutrient supply with the demand of crops. Adding only the nutrients needed is both a cost-effective and environmentally friendly approach to farming.

Sub-surface application of fertiliser minimises nutrient loss.



Improving water quality

Government programs provide the framework and funding for water quality and wetland management, while the regional NRM bodies are helping communities achieve improved water quality in local catchments by funding on-ground activities and training programs. Through the Coastal Catchments Initiative, regional NRM bodies are also preparing Water Quality Improvement Plans in key GBR catchments.

Hands on training

Queensland industry support organisations are providing training programs and workshops in land management to promote sustainable farming throughout the state.

Community monitoring

Landholders in all the GBR catchments are helping their regional NRM bodies to monitor water quality in their waterways, to identify and manage the source of nutrients and sediments.

New wetlands

Many farmers in the tropics have created artificial wetlands on their properties to replace lost habitat, providing a filtration system for the environment.

Turn to page 16 for links and resources

__N__ = nitrogen, __P__ = phosphorus

Nutrient management - a question of balance.

Urban cleanup

Coastal Councils can install pollution traps in stormwater drains, and improve the function of sewage treatment plants to minimise discharge of nutrients into local waterways and the GBR.

Best practice is the key

Nutrient leakage can be reduced, and money saved, through land management practices that reduce erosion and improve the efficiency of nutrient uptake. Ask your industry body, DPI & F, and regional NRM body for advice.

Trash blanketing improves the soil, protects it from erosion and reduces nitrogen requirements.

Inter-row ground cover, permanent plots and other techniques for minimising soil disturbance benefit the farmer, the environment and downstream users.

Riparian fencing, controlled cattle crossings and off-stream watering points improve water quality by reducing soil and nutrient loads. This also allows the stream to support wildlife and ecosystem services essential for a sound economy.

Trees for everyone

Community groups and landholders are replanting trees along riverbanks to reduce stream bank erosion, and provide wildlife corridors.

Understanding catchment and reef health

Scientists are studying the effects of increased nutrients on GBR catchments and inshore habitats. Their research will guide improved land and water management.

Resources:

Research

Australian Centre for Tropical Freshwater Research (ACTFR), James Cook University
www.actfr.jcu.edu.au

Australian Institute of Marine Science (AIMS)
www.aims.gov.au

Commonwealth Scientific and Industrial Research Organisation (CSIRO)
www.csiro.au

Centre for Riverine Landscapes Griffith University
www.gu.edu.au/centre/riverinelandscapes

School of Marine & Tropical Biology

James Cook University
www.biology.jcu.edu.au

NRM & Community

For connections to local landcare, catchment management and revegetation groups:

FNQ NRM Ltd (Wet Tropics)
www.fnqnrm.com.au

Burdekin Dry Tropics NRM
www.bdtnrm.org.au

Mackay Whitsunday NRM
www.mwnrm.org.au

Fitzroy Basin Association
www.fba.org.au

Burnett Mary NRM
www.burnettmarynrm.org.au

Cape York Peninsula Development Association
www.cypda.com.au

Greening Australia
www.greeningaustralia.org.au

Landcare Australia
www.landcareaustralia.com.au

Industry

BSES
www.bses.org.au

CANEGROWERS
www.canegrowers.com.au

DPI&F Grazing Land Management package
www.dpi.qld.gov.au/stocktake

Growcom's Water for Profit Program
www.growcom.com.au/land&water

Queensland Farmers' Federation Farm Management Systems
www.qff.org.au

Sustainable Agricultural State-level Investment Program AgSIP 05
www.dpi.qld.gov.au/AgSIP

Horticulture Australia
www.horticulture.com.au

Water quality / catchment programs

Australian Government Department of the Environment & Heritage

- **Coastal Catchments Initiative**
  www.deh.gov.au/coasts/index.html#cci
- **Reef Water Quality Protection Plan**
  www.reefplan.qld.gov.au
- **Wetlands**
  www.deh.gov.au/water/wetlands

National Action Plan – Queensland Water Quality Program
www.napswq.gov.au and www.wqonline.info

QLD Wetlands Programme
www.deh.gov.au/water/wetlands/qwp

Great Barrier Reef Marine Park Authority
www.gbrmpa.gov.au

South East Queensland Healthy Waterways Program
www.healthywaterways.org

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Fabricius K, 2005. Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. Marine Pollution Bulletin 50: 125-146.

Fabricius K, De'ath G, McCook L, Turak E, Williams D. 2005. Changes in algal, coral and fish assemblages along water quality gradients on the inshore Great Barrier Reef. Marine Pollution Bulletin 51: 384-398.

Furnas M, 2003. Catchments and Corals: Terrestrial Runoff to the Great Barrier Reef. AIMS, 346pp

McKergow L, Prosser I, Hughes A and Brodie J, 2005. Regional scale nutrient modelling: exports to the Great Barrier Reef World Heritage Area. Marine Pollution Bulletin 51: 186-200.

Tilman D, Cassman K, Matson P, Naylor R, Polasky S, 2002. Agricultural sustainability and intensive production practices. Nature 418: 671-677.

Wilkinson SR, Grunes DL, 2000. Nutrient interactions in soil and plant nutrition. D89 - D107. In Handbook of Soil Science. ME Sumner. CRC Press.

Case studies

Mississippi Dead Zone
www.nasa.gov/vision/earth/environment/dead_zone.html

Murray Darling Basin
www.mdbc.gov.au and www.dlwc.nsw.gov.au/care/wetlands/facts/paa/algae/index.html#BlueGreenAlgae

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For more information about the program and related products, go to: www.catchmenttoreef.com.au

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