Bookshelf

Connectivity in the Great Barrier Reef World Heritage Area – an overview of pathways and processes
Mike Cappo and Russell Kelley
In: **Oceanographic Processes of Coral Reefs: Physical and biological links in the Great Barrier Reef**
Editor: E. Wolanski
CRC Press 2000
The chapter by Cappo and Kelley looks specifically at the types of links between ecosystems mentioned on pages 4 and 5 and includes the illustration for *Bait, birds and billfish*. The colour version makes seasonal changes clearer.

Biodiversity: A Politician's Guide
Biological Diversity Advisory Council
Environment Australia

Pamphlets:
Protecting Biodiversity – an overview of the GBRMPA Representative Areas Program
GBRMPA (May 1999)
Update: May 2000
Update: September 2000
Bioregions of the Great Barrier Reef World Heritage Area (Draft)
Maps on pages 4 and 7 are based on the ones in this pamphlet, but to get an accurate picture of the bioregions in detail it is important to look at the original versions.
All available from GBRMPA, Ph: (07) 4750 0700, and from QPWS information centres.

Marine Turtles in the Great Barrier Reef World Heritage Area
Kirstin Dobbs
GBRMPA 2001
Section 4.1.2 deals with genetic stocks of turtles.

Australian Fisheries Resources
Patricia J. Kailola, et al.
DPI/ Fisheries Research and Development Corporation (1993)

Websites:
Environment Australia Biodiversity Group
www.biodiversity.environment.gov.au
• Biodiversity leaflets
www.environment.gov.au/library/pubs/pubs_subject.html
Australian Museum Biodiversity Exhibition
www.austmus.gov.au/biodiversity/index

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(For general information on the Wet Tropics World Heritage Area only.)
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CAIRNS QLD 4870
Ph: (07) 4052 0555

The Marine Animal Hotline number is **1300 360898**
Please call **urgently** to report injured, stranded or dead dugongs as well as dolphins, whales and marine turtles.

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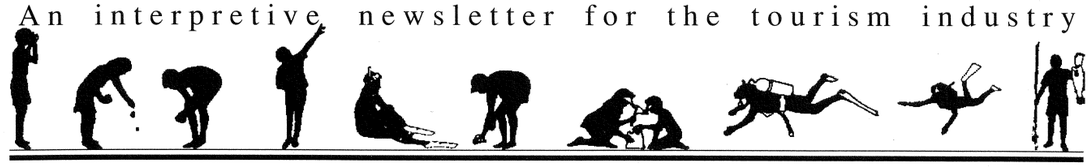
Tropical Topics

An interpretive newsletter for the tourism industry



Biodiversity in the GBR

No. 66 April 2001

Notes from the Editor

In a recent Australian survey, it was discovered that a number of people believed biodiversity was the name of a detergent. In fact, it is short for 'biological diversity', which means the variety of life, from tiny strands of DNA in a gene to the largest animals and plants. It also involves the complex relationships between the countless organisms. Although we take it for granted, biodiversity is essential for the health of the planet.

American social commentator and world-renowned scientist, Paul Ehrlich, provides a useful analogy. Imagine you are flying in an aeroplane and see someone crawling along the wing, removing the rivets one by one. The plane is able to fly without some of those rivets, but eventually the wing will fall off. Each rivet represents a species or biological function. We can survive without some, but not all, of them and if we continue to remove them, sooner or later, the processes of biodiversity will break down. Since we don't know which of the 'rivets' are essential, it would seem sensible to try to maintain them all.

This *Tropical Topics* looks at biodiversity in the Great Barrier Reef, at the types of diversity and the largely invisible links which connect ecosystems and organisms together. However, it starts with a bleak view of how our world might be without biodiversity, with an emphasis on the marine environment.

Acknowledgements
I would like to thank Russell Kelley, Watermark Films, and Jeff Miller, QPWS, for their help with this issue.

Imagine

a world without bio-diversity – a bleak world of the future created by unregulated human growth and development.

On the coast, all mangroves have been replaced with canal estates and resorts. Unfortunately, the acid-sulphate soils in these areas, following exposure to the air, began to poison coastal waters with sulphuric acid. This continued even after the developments were submerged by rising sea levels.

As a result, the commercial fishing industry has collapsed. An estimated seventy-five percent of commercially-important species used to spend some time in the mangroves, or were dependent on food chains which could be traced back to these coastal forests. With their habitat destroyed and their water poisoned their demise was rapid.

The death of extensive areas of seagrass beds exacerbated the situation, by affecting other fish and juvenile prawns. This catastrophe is blamed on extensive soil erosion from unchecked vegetation clearing as well as agricultural and urban development. Dugongs have not been seen for many years and turtles are a rare sight. Indigenous people lament the loss of these traditional foods and cultural icons.

Working with preserved sponge specimens from north Queensland, a scientist has discovered a chemical with exceptional anti-cancer properties. However, this sponge species, once discarded by the tonne from trawlers, cannot be found. The soft-bottomed lagoon floor where it once thrived is now a wasteland.

The Great Barrier Reef is but a shade of its former self. It has been badly affected by coral bleaching, caused by global climate change. In addition, unprecedented numbers of crown-of-thorns starfish, their larvae nurtured by increased human-sourced nutrients in the water and untroubled by overfished predators, have appeared in almost continuous outbreaks. As the corals died so did many of the organisms, such as reef fish, which relied on this environment for food and shelter. Increased numbers of cyclones are gradually demolishing the weakened reefs and the tourism industry, so long the economic mainstay of coastal towns in north Queensland, has gone into a serious decline.

Biodiversity is not just nice. It is necessary. Nothing, not least ourselves, can survive in isolation. Chains and webs weave different organisms and different ecosystems together in a pattern of interdependence. To break part of the web can have unforeseen effects elsewhere. We may resent controls aimed at regulating our activities, from no-take zones, and bag and size limits when fishing to rules on where and how we build our houses. However, these are necessary. Without controls, the embattled natural systems around us, on which we ultimately depend, would suffer – and so would we.

Where d'ya reckon all the fish have gone?

Marine Parks

Great Barrier Reef Marine Park Authority

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

Turtles and biodiversity

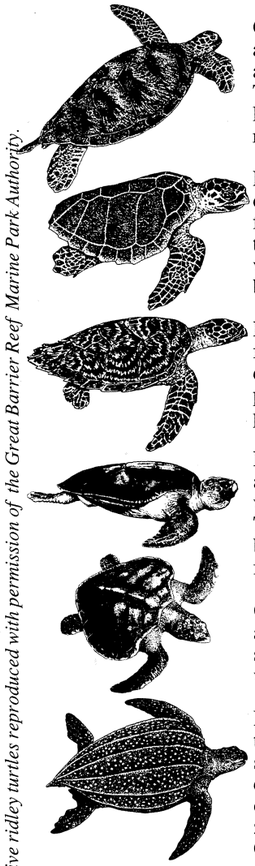
Biodiversity works on three main levels – species diversity, ecosystem diversity and genetic diversity. All three of these can be illustrated using one group of animals, the marine turtles.

Species diversity:

Six of the seven species* of marine turtle are found in the Great Barrier Reef World Heritage Area (see below).

Ecosystem diversity:

These different species of turtles have different diets and, as a result, inhabit different areas.



Illustrations of flatback and olive ridley turtles reproduced with permission of the Great Barrier Reef Marine Park Authority.

Green turtles are vegetarians and are found around seagrass beds and also wherever algae grows. This means they forage in open lagoon areas as well as around reefs and in inter-reefal areas.

Loggerhead turtles feed mainly on molluscs and crustaceans found in sandy areas. This means that they frequent coral reefs as well as bays, estuaries, seagrass beds and open lagoon areas.

Hawksbill turtles have a great fondness for sponges but also eat soft corals, other animals and plants. They are therefore found predominantly around reefs.

Flatback turtles eat soft-bodied animals such as sea cucumbers as well as sea pens and soft corals. They frequent shallow soft-bottomed sea bed habitats, away from reefs.

Olive ridley turtles like shellfish and small crabs found in the shallow softbottomed habitats which they frequent.

Leatherback turtles maintain their enormous size on a surprising diet consisting almost entirely of jellyfish. They frequent open waters, mainly in temperate zones, so are not often found in GBR waters.

As a result of their different habitat requirements, a wide variety of ecosystems needs to be preserved in order to protect all species of turtles. However, not only foraging zones must be considered. Different habitats are needed at different life stages. Hatchlings drift with ocean currents at the beginning of their lives and, at breeding times, many adults undertake long journeys through other areas to reach nesting sites where they add another habitat to their list of needs – beaches.

A diversity of beaches

Not just any beach will do. Different species nest in different areas and, importantly, the particular breeding biology of turtles adds further complications. For example, loggerhead turtles nest on islands in the Capricorn-Bunker group and on the adjacent mainland, near Bundaberg. If one of these areas was lost to the turtles, it would seem logical that the loggerheads nesting in the other area would maintain the population. However, the sex of a turtle hatchling depends on the temperature surrounding the egg during development (the middle of three distinct phases), higher temperatures producing females and lower temperatures producing males. It has now been discovered that the cooler coral cay beaches produce predominantly males while most of the eggs hatching in warmer mainland beaches result in females.

Similarly, in the southern GBR, those green turtles hatched on the warmer, more northerly beaches tend to be females while those in the cooler southern beaches are almost all males.

This variation in sex ratios of hatchlings, from different beaches, is true for all marine turtles. It stands to reason, therefore, that for each turtle population to remain viable, then they must be able to breed on a range of beaches – as well as having access to a variety of habitats in a number of different locations. For turtles of the GBR region (and the world) ecosystem diversity is the key to survival.

Genetic diversity:

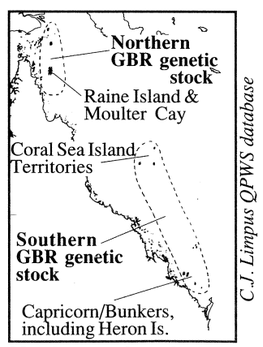
A green turtle nesting on Raine Island looks identical to a green turtle nesting on Heron Island – but they are not the same. Out of sight, hidden in the genetic code, are differences.

In fact, recent studies of green turtles have shown that there are three distinct nesting populations in Queensland which are genetically different from each other. One nests in the Gulf of Carpentaria and the other two within the GBR region, one in the north and the other in the south. The northern population, estimated at about 30 000 females, concentrates its nesting on Raine Island and Moulter Cay. The southern population nests in the Capricorn/Bunker group of islands and on Coral Sea Island Territories. A few of the estimated 8000 nesting females in this group occasionally lay eggs on islands between, such as Michaelmas Cay.

Although their nesting sites are far apart, these turtles move considerable distances between breeding episodes and frequently mingle with others at foraging areas. They may even roam as far as the nesting sites of others. However, they do not stay to breed and the genetics of the different populations remain separate.

This means that if one of the three distinct populations was to be wiped out, it would not be replaced by another. Preserving green turtles, therefore, involves treating each population separately from a management point of view and ensuring that all nesting and foraging habitats are preserved.

Green turtles are not the only turtles with genetic differences. Studies have shown that there are also genetically distinct Australian populations of loggerhead, hawksbill and flatback turtles. (Information is not available on leatherback and olive ridley turtles.)



C.J. Limpus QPWS database

Northern and southern green turtle genetic groups

*The seventh is Kemp's ridley, found only in the Gulf of Mexico.

The benefits of biodiversity

We need biodiversity. It is the source of all our foods and many of our medicines and industrial products, derived from domesticated or wild animals and plants. It is also important for our recreation and our psychological and spiritual wellbeing.

Biodiversity services include the maintenance of water, air and soil quality. In the marine situation, coastal plants, mangroves and seagrasses prevent erosion, stabilise sediments and trap pollutants. Phyto (plant) plankton removes carbon dioxide from the atmosphere, combating the greenhouse effect.

Biodiversity is the source of all our food, seafood being an obvious contribution from the marine environment. As we have seen (p4/5) this resource depends on many different ecosystems, from mangroves to reefs. Scientists searching for useful medicinally active compounds are increasingly looking to the most diverse regions such as rainforests and reefs. Intense competition between organisms living in close proximity seems to have resulted in the evolution of a vast range of chemicals. Many of these also have useful industrial applications.

Biodiversity is socially important. Thousands of visitors travel to Queensland each year primarily to enjoy the relatively pristine environments, which are often a stark contrast to the urban environments in which they live. The GBR is one of their main reasons for coming here and their presence underpins the economy of the region. The GBR is also appreciated by locals who periodically visit islands and reefs and go fishing for recreation.

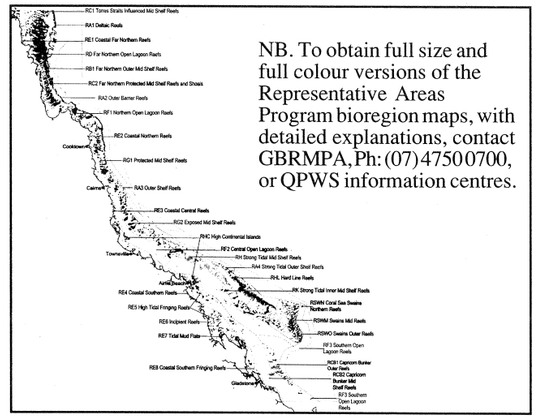
In addition to practical and economic values, a diverse environment has a profound aesthetic appeal to us all. We like to learn about it from TV documentaries and books and we like to explore it for ourselves. We know the world would be a poorer place for us all without biodiversity and we know also that we have a moral obligation not to destroy the plants and creatures with which we share the planet.

Biodiversity to the rescue

As we rely increasingly on monocultures to produce our foods, and reduce habitat containing wild plants and animals, we take a great risk. In the 1970s a new disease, the grassy stunt virus, appeared in the rice fields of India and South-east Asia, destroying vast areas of the crop. After testing 6273 varieties of rice, scientists eventually found one, from central India, with a resistance to the disease. An insignificant and otherwise useless wild plant, it had become extinct in its original habitat. All that remained were two seeds – but these were used to create a new resistant strain.

More recently, Chinese scientists who conducted an experiment in rice-growing techniques discovered that traditional methods of growing several different strains together, rather then vast plantings of just one type, led to an 18 percent increase in yield. In addition, the incidence of the destructive rice blast fungus, normally controlled with large amounts of toxic chemicals, decreased by 94 percent.

Representing biodiversity



NB. To obtain full size and full colour versions of the Representative Areas Program bioregion maps, with detailed explanations, contact GBRMPA, Ph: (07) 47500700, or QPWS information centres.

The Great Barrier Reef Marine Park Authority's Representative Areas Program aims to develop a network of highly protected areas which are typical of all the different habitats and communities within the GBR Marine Park. At the moment less than five percent of the area is highly protected – look but don't take zones – with a focus on coral reefs. However, in order to maintain biodiversity, the intention is to extend this high degree of protection to other ecosystems so that all bioregions will be represented.

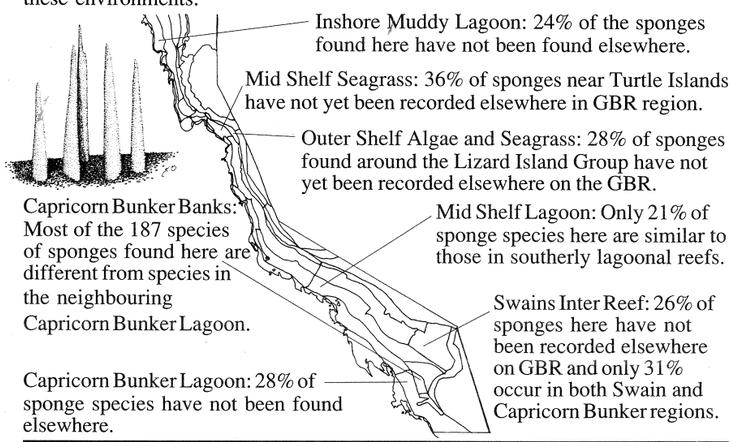
The first phase of this process involved classifying the different bioregions, with the production of the non-reef (p4) and reef (above) bioregion maps. This has been reviewed, and threats to these regions determined. Potential sites for protection will be selected after comments are received from the public. The launch of this phase is planned for mid-2001.

For more information contact Leanne Ferrnandes, GBRMPA, PO Box 1379, Townsville, QLD 4810; Ph: (07) 47500700; email: rap@gbrmpa.gov.au

Looking simply at sponges

Sponges are one of the most promising sources of biomedicines. Their main defence, as sedentary organisms which cannot flee, is to fight predators and competitors with chemical weapons. Collecting and modifying chemicals from the water filtered though their bodies, they produce an amazing array of compounds, many of which have proved to be of use in the fight against human diseases.

There are 2000 or more species of sponges in Queensland waters alone, with many found only in restricted habitats. This map gives an idea of the diversity involved, the limited range of many species and the importance of protecting all these environments.

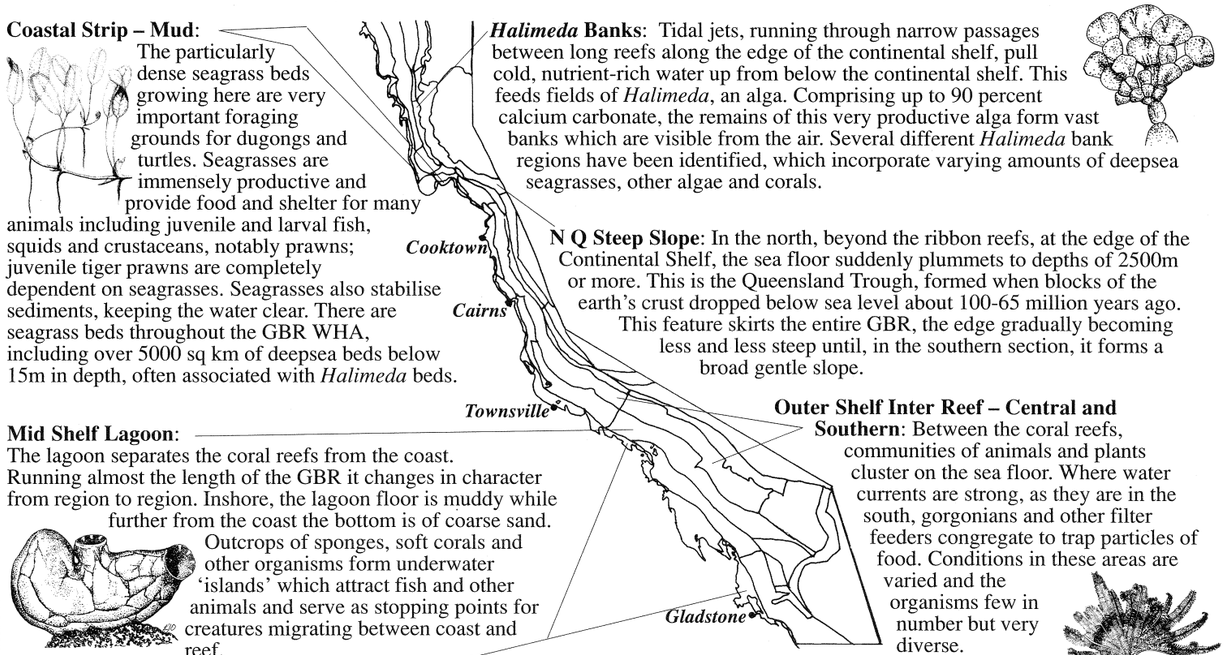


Ecosystems linked

The Great Barrier Reef World Heritage Area includes numerous types of ecosystems which are linked together in a multitude of ways by the organisms which inhabit them. Sometimes animals move across ecosystems. In other cases it is nutrients which move, as one organism eats another.

Diverse ecosystems

As part of the Representative Areas Program (see p7) panels of experts have identified 71 bioregions within the GBRWHA, each representing an area where the known animal and plant communities and the physical features are sufficiently different from their surroundings and from other areas of the GBR WHA. This has resulted in two maps, one showing reef bioregions and the other indicating non-reef bioregions. The diagram below is based on the non-reef bioregions map. Only a few of the 42 regions are labelled here since space is limited. The full colour version of these maps, with full explanations, are available from GBRMPA; Ph: (07) 4750 0700, and from QPWS information centres.



Coastal Strip – Mud: The particularly dense seagrass beds growing here are very important foraging grounds for dugongs and turtles. Seagrasses are immensely productive and provide food and shelter for many animals including juvenile and larval fish, squids and crustaceans, notably prawns; juvenile tiger prawns are completely dependent on seagrasses. Seagrasses also stabilise sediments, keeping the water clear. There are seagrass beds throughout the GBR WHA, including over 5000 sq km of deepsea beds below 15m in depth, often associated with *Halimeda* beds.

***Halimeda* Banks**: Tidal jets, running through narrow passages between long reefs along the edge of the continental shelf, pull cold, nutrient-rich water up from below the continental shelf. This feeds fields of *Halimeda*, an alga. Comprising up to 90 percent calcium carbonate, the remains of this very productive alga form vast banks which are visible from the air. Several different *Halimeda* bank regions have been identified, which incorporate varying amounts of deepsea seagrasses, other algae and corals.

N Q Steep Slope: In the north, beyond the ribbon reefs, at the edge of the Continental Shelf, the sea floor suddenly plummets to depths of 2500m or more. This is the Queensland Trough, formed when blocks of the earth's crust dropped below sea level about 100-65 million years ago. This feature skirts the entire GBR, the edge gradually becoming less and less steep until, in the southern section, it forms a broad gentle slope.

Mid Shelf Lagoon: The lagoon separates the coral reefs from the coast. Running almost the length of the GBR it changes in character from region to region. Inshore, the lagoon floor is muddy while further from the coast the bottom is of coarse sand. Outcrops of sponges, soft corals and other organisms form underwater 'islands' which attract fish and other animals and serve as stopping points for creatures migrating between coast and reef.

Outer Shelf Inter Reef – Central and Southern: Between the coral reefs, communities of animals and plants cluster on the sea floor. Where water currents are strong, as they are in the south, gorgonians and other filter feeders congregate to trap particles of food. Conditions in these areas are varied and the organisms few in number but very diverse.

High Nutrients Coastal Strip: These coastal areas, often fringed with mangroves, are dominated by mud which has come from the land. Wet season rains wash nutrients to this region, nourishing tiny planktonic plants and animals. With ample food and shelter, life thrives. Although not particularly attractive to humans, this is where the young of many reef, angling and bait fish get their start in life – see *mangrove supermarket*, right.

Note: Boundaries shown are artificially tidy. In fact, many bioregions grade into each other.

How seagrasses feed night herons

Green turtles feed on seagrasses in coastal areas and estuaries.

At breeding time, many then move offshore and lay eggs on island beaches.

In the case of Raine Island, a major rookery, this draws large numbers of sharks to feed on the adult turtles.

On nearby Moulter Cay several hundred pairs of nesting nankeen night herons feed their young on turtle hatchlings.

The mangrove supermarket

Mangrove plants are very productive, creating about one kilo of litter (leaves, twigs, bark, fruits and so on) per square metre each year. Much of this material is broken down by bacteria and eaten by crabs and other crustaceans, worms and molluscs. Converted into protein, these nutrients move along the food chains.

During summer, crabs and worms spawn. Eggs become floating larvae.

Many juvenile reef fish spend their youth in the coastal areas, taking advantage of this abundant food source and moving offshore as they mature.

Banana prawns spend their juvenile stages feeding in the mangroves where they are eaten by adult barramundi.

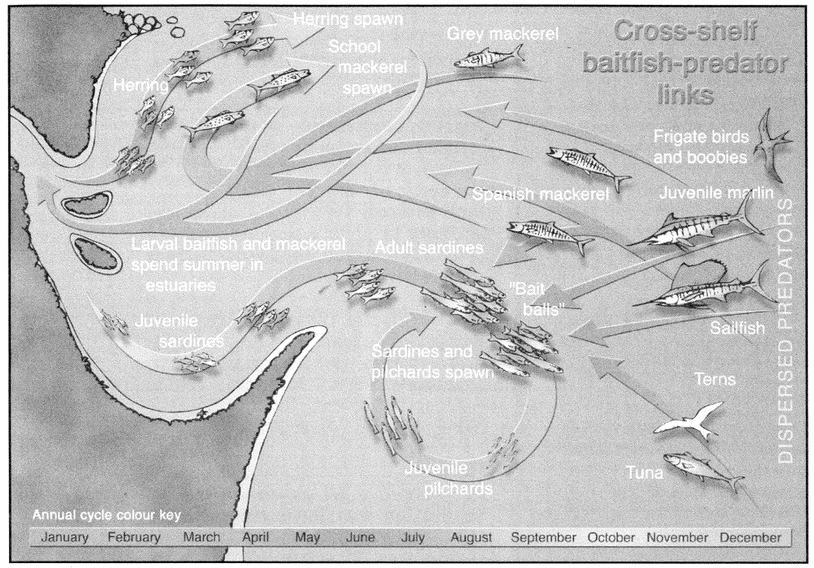
Mud crabs feed on mud whelks and other crabs. When ready to spawn the females migrate 30-50km offshore, to depths of 300m or more. Their larvae eventually drift back to coastal areas.

Shrimp are eaten by box jellyfish and by manta rays which appear in coastal waters at certain times of year, drawn by this abundance of food. They are thought to migrate up and down the coast.

Adult fish, including many angling species such as mangrove jack, sea perch and estuary rock cod, feed on adult crabs.

Bait, birds and billfish

This picture* neatly illustrates the connections between various organisms across the GBR region.

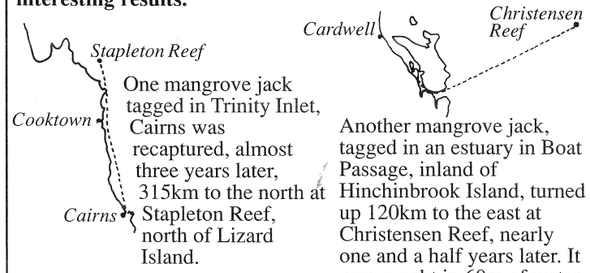


After spending summer feeding in mangroves and river mouths, maturing sardines and other baitfish move offshore, many of them forming 'bait balls' in the lagoon area. Their appearance, in winter, draws predators from deeper waters. Juvenile black marlin, moving south from spawning grounds in the north-east Coral Sea, feed heavily on sardines and pilchards. Spanish mackerel, moving in the opposite direction, join in and adult sailfish also appear for this bonanza. Dolphins, tunas and sharks are joined by birds — brown boobies and frigate birds diving in for their share in these hotspots of activity.

As summer approaches the remaining adult sardines and pilchards spawn. New predators, in the form of mackerel, appear while terns take over the aerial bombardment. Tunas target the larval and juvenile fish. By autumn Spanish mackerel have reappeared and the cycle begins again.

Tags tell tales

The 'AusTag' Sportfish Tagging Program has produced some interesting results.



One mangrove jack tagged in Trinity Inlet, Cairns was recaptured, almost three years later, 315km to the north at Stapleton Reef, north of Lizard Island.

Another mangrove jack, tagged in an estuary in Boat Passage, inland of Hinchinbrook Island, turned up 120km to the east at Christensen Reef, nearly one and a half years later. It was caught in 60m of water.

Mangrove jack are adaptable. They have also been found over 130km upstream in freshwater and can inhabit clear, rainforest streams.

The movement of maturing fish from coast to reef, where they will eventually spawn, is a relatively slow journey. During their travels they rely on the islands of life on the lagoon floor so it is important that we treat this area well. Trash fish and other creatures, discarded as unwanted bycatch by trawlers, are actually vital 'treasure' for these migrating fish. They are the hamburgers in the roadhouses along the highway to the reef.

Great movers

There is a steady traffic through the GBR.

Not only red emperors (see *Tropical Topics* 62) but also other sea perches as well as many tuna, mackerel, rock cods and emperors, spend their youth in the nutrient-rich coastal zone but, as they mature, work their way from coast to reefs to spawn. Their offspring then find their way back to the coast.

Eels take migration to extremes. After years of living happily in upland lakes and rivers the adults suddenly move downstream, through the mangroves, the seagrass beds, the lagoon, the reefs and out into the depths of the Coral Sea to spawn and die. The next generation then retraces its parents' steps.

A number of sharks move inshore to reproduce. Black-tip reef sharks and other whalers migrate to coastal areas in summer to give birth to live young among mangroves and seagrasses. Like so many young fish they take advantage of summer food abundances in these coastal areas.

Barramundi take another course. After spending their early stages in brackish water of coastal swamps they migrate inland to freshwater where they live until mature. Later they migrate to the coast for spawning – their eggs cannot develop in freshwater.

Ornate rock lobsters living on the north-east Queensland coast move south and east to spawn at the edge of the GBR near deep waters.

Humpback and minke whales move north in winter to give birth in northern GBR waters.

Mature black marlin congregate offshore in the Cairns-Lizard Island region to spawn between September and December. Many of the young fish move south, as far as the central NSW coast, feeding on pilchards and herrings.

Spanish mackerel gather to spawn in October and November around mid-shelf reefs. Afterwards, some of these fish may travel as much as 1000 miles to the south, many returning in the winter.

*Much of the information, as well as the illustration for 'Bait, birds and billfish', are derived, with kind permission, from **Connectivity in the Great Barrier Reef World Heritage Area** by Mike Cappo & Russell Kelley in **Physical and biological links in the Great Barrier Reef.** See Bookshelf for details.

Questions & Answers

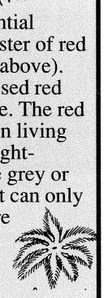
Q Are box jellyfish more common these days because of a decrease in sea turtle numbers?

A No. Although most sea turtles will eat a jellyfish if they come across it, these are not a preferred item in their diet. Leatherback turtles are an exception. These giants among turtles feed mainly on jellyfish – but they are more common in temperate Australian waters and are naturally much less abundant in tropical waters, such as the Great Barrier Reef region. In addition, box jellyfish are found fairly close to shore where turtles are less likely to be feeding.

Q What is the correct name of organ pipe coral? Why does it stay red when it dies?

A The correct scientific name is *Tubipora musica*. Although its skeleton is hard, it is not actually a true reef-building (Scleractinian) coral but a member of the soft coral group. The basic difference lies in the number of tentacles in each polyp – those of the soft corals have eight tentacles while those of hard corals have six, or multiples of six. The term 'soft' coral is a bit misleading, because many have numerous needle-like spicules (sclerites) in their tissues. Although similar in composition to the limestone skeletons of hard corals they are of a different crystal structure and are essentially internal structures whereas tissues of a hard coral colony lie on top of the skeleton.

The colour of hard corals is in the living tissue, usually provided by the zooxanthellae, or algal cells within it. The skeleton beneath is almost always white. The spicules of soft corals, however, can be quite bright in colour varying from red to yellow, pink and purple. This can lend colour to the entire colony where zooxanthellae are not present to mask it. In the case of organ pipe corals, this colony builds a substantial skeleton composed of a cluster of red tubes joined by flat plates (above). However, this is made of fused red spicules, not solid limestone. The red colour is usually obscured in living colonies by the feathery (eight-tentacled) polyps which are grey or greenish-brown in colour. It can only be seen when the polyps are retracted or damaged or in dead specimens, which retain the original colour.



Q How is beak and feather disease passed between parrots? Is it just from the parents to the young birds?

A Psittacine beak and feather disease is an extremely infection virus which impairs the growth of feathers, notably the flight feathers, and causes beak abnormalities. The virus also attacks cells of the immune system so infected birds are susceptible to other diseases.

The virus is easily passed from parents to the young, in which case the chicks, when launched from the nest, are unable to fly. However, the virus, which is present in the feathers and droppings of infected birds, also passes easily between adults. This often happens when wild birds are artificially attracted to feed together in people's yards and droppings become mixed with food. It is really not in the birds' interests to feed them – apart from problems with diseases, food offered is often inappropriate. It is much better to attract birds by providing them with a natural diet of suitable native trees and shrubs.

Tourist talk

ENGLISH	GERMAN	JAPANESE
biological	biologische	seibutsugaku teki na 生物学的な
diversity	Mannigfaltigkeit	soui 相違
to link	verbinden	tsunagu つなぐ
estuary	Flußmündung	irie 入江
species	Arten	shu 種
genetic	genetisch	iden no 遺伝の
ecosystem	Umweltsystem	seitaikei 生態系
to migrate	auswandern	iju suru 移住する
to protect	schützen	hogo suru 保護する
region	Gebiet	chiiki 地域

Facts and stats

So far scientists have described about one and a half million species worldwide but believe at least 30 million remain to be discovered – if they are not wiped out first. Some predictions are that 100 species are made extinct every 24 hours and at this rate, one quarter, or more, of life on Earth could be gone within 50 years. Other estimates put the rate of extinctions even higher, at eight per hour, or 70,000 per year.

Marine biodiversity is not as well understood as biodiversity on land. Indeed, it is estimated that about 75 percent of marine species are undiscovered! Nevertheless, while there are only 11 phyla (sub-kingdoms) of organisms on land, 28 are known from marine environments.

On a world scale, 12 countries have been recognised by scientists as being mega-diverse. They are Brazil, Colombia, Ecuador, Peru, Mexico, Zaire, Madagascar, China, India, Indonesia, Malaysia and … Australia.

However … in the last 200 years, about 70 percent of all native Australian vegetation has been removed or significantly modified. About 75 percent of rainforest, 90 percent of temperate woodlands and malee and about 60 percent of the coastal wetlands in southern and eastern Australia have been lost.

After just 200 years of European occupation, almost half of all Australian marsupials and monotremes are either extinct, endangered or vulnerable. Twenty mammal, nine bird and 97 plant species are known to have become extinct with a further 3329 categorised as rare or threatened. About one third of freshwater fish are either rare, endangered or vulnerable.

All Australian governments are implementing the National Strategy for the Conservation of Australia's Biological Diversity. This is a response to the international Convention on Biological Diversity which Australia, along with many other nations, signed in Rio de Janiero in June 1992.

Each year 1.8 million tourists visit Queensland's Wet Tropics World Heritage Area – a tourism industry worth about $400 million a year. This is 16 times the value of previous forestry operations.

An important substance, Prostaglandin E2, which could be important for the treatment of gastric ulcers was discovered in two species of gastric brooding frogs from Queensland. However, neither species has been sighted for some time and they may now be extinct.

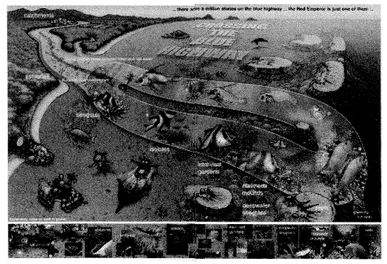
Out and about

The **Tourism Operator's Handbook** for the Great Barrier Reef is now available. This new resource has been designed as a reference guide for tourism operators currently working within the GBR as well as new entrants to the marine tourism industry. It explains the Marine Parks Permits and contains rules, regulations and guidelines that affect all tourism operators. These include Commonwealth and State Government legislation, Zoning Plans, Plans of Management and Best Environmental Practices. There is an 'A-Z' quick reference section and a detailed Section by Section guide to the GBR.

The Handbook is available from GBRMPA in Townsville and from QPWS centres in Townsville, Cairns, Cardwell, Gladstone and the Whitsundays. It is being sold at a special introductory price of $22 until the end of June, after which it will cost $39.85.

The Handbook has been produced in loose-leaf form for easy updating so purchasers are reminded to fill in, and post off, the enclosed form to receive regular updates on the latest management arrangements. For more information phone GBRMPA on (07) 47500700.

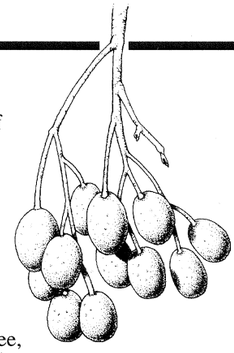
Butterfly illustration courtesy Gould League's Timelines News

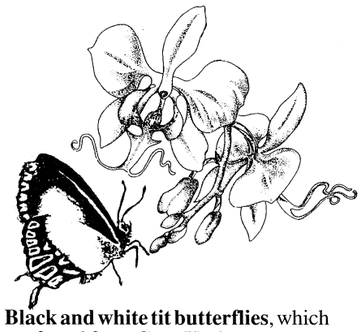


Connectivity is on the Web. The Australian Coral Reef Society's poster, ***Crossing the Blue Highway***, featured in *Tropical Topics* No. 62, can now be viewed on-line on the ABC website; http://abc.net.au/science/bluehighway/default.htm This on-line version supplies links to other resources, further reading and an address to contact for copies of the original poster.

The poster is also available, free of charge, from the QPWS office in Cairns, Ph: (07) 4046 6600 and from the GBRMPA office in Townsville, Ph: 4750 0700. It is an excellent resource, particularly for schools.

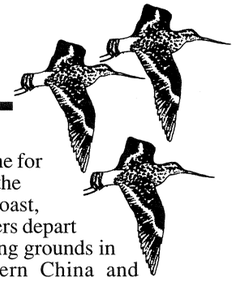
The globular yellow fruits of **white cedar** (*Melia azedarach*) ripen at this time of year to the delight of a number of birds, notably figbirds and orioles. This tree, which is sometimes known as Persian lilac, has a spreading lacy crown and sprays of delicate mauve flowers with a sweet scent which reminds some people of chocolate. A hardy tree, it often grows as a rainforest pioneer in disturbed sites. It is deciduous in winter, dropping all its leaves by June.





Black and white tit butterflies, which are found from Cape York to near Ingham, lay their eggs on epiphytic orchid buds, the developing caterpillars later feeding on the flowers. Not surprisingly they are unpopular with orchid growers who need to keep their plants in sealed shade houses. At this time of year, these butterflies target the Cooktown orchid (*Dendrobium bigibbum*) Queensland's floral emblem. Growing in scrubby habitats behind beaches and on rocky hillsides which are protected from fire, it blossoms at the end of the wet season with sprays of particularly attractive large purple flowers.

The **Museums Australia (Qld) 2001 State Conference** is to be held at the Righa Colonial Club Resort, Cairns, 15-16 September. The main theme is to be 'The New Museum' and will focus on museums and galleries either planned or recently opened in Australia as well as new developments in policy, practice and attitudes. For further information: contact MAQ; Ph: (07) 3250 1260 or email Chris Brophy on: cbrophy@maq.org.au



Autumn is a time for **birds** to be on the move. On the coast, migratory waders depart for their breeding grounds in Siberia, northern China and Alaska having spent the northern hemisphere winter probing our shores for food to fuel their return trip.

The last of the pied imperial-pigeons, which spent the summer breeding on offshore GBR islands and some coastal areas, are winging their way back to New Guinea. Buff-breasted paradise kingfishers take the same route during April, the adults leaving first and juveniles following a few weeks later. Dollarbirds depart for the same destination now and next month.

Many birds move within Australia. Flocks of rainbow bee-eaters, which heralded spring for people in southern Australia in September, have returned north to swell local numbers.

Less conspicuous migrants are rufous fantails. A proportion of the population breeds in south-eastern Australia but in February the adults fly north, followed by the juveniles in March and April. They tend to move discretely, individuals flitting from shrub to shrub, rather than in flocks. The juveniles have a different plumage with more orange-rufous on the upper parts and brown underparts rather than the black and white of the adult. They lose this by the next breeding season. These birds spend winter in northern Queensland and New Guinea. Rufous fantails which are resident in north Queensland move little, although they are generally absent from the uplands in winter and common in the lowlands. Leaden flycatchers follow a similar pattern.

Sacred kingfishers have started to appear. They are usually common around Cairns and Townsville in winter but disappear in October when they move south to breed.

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