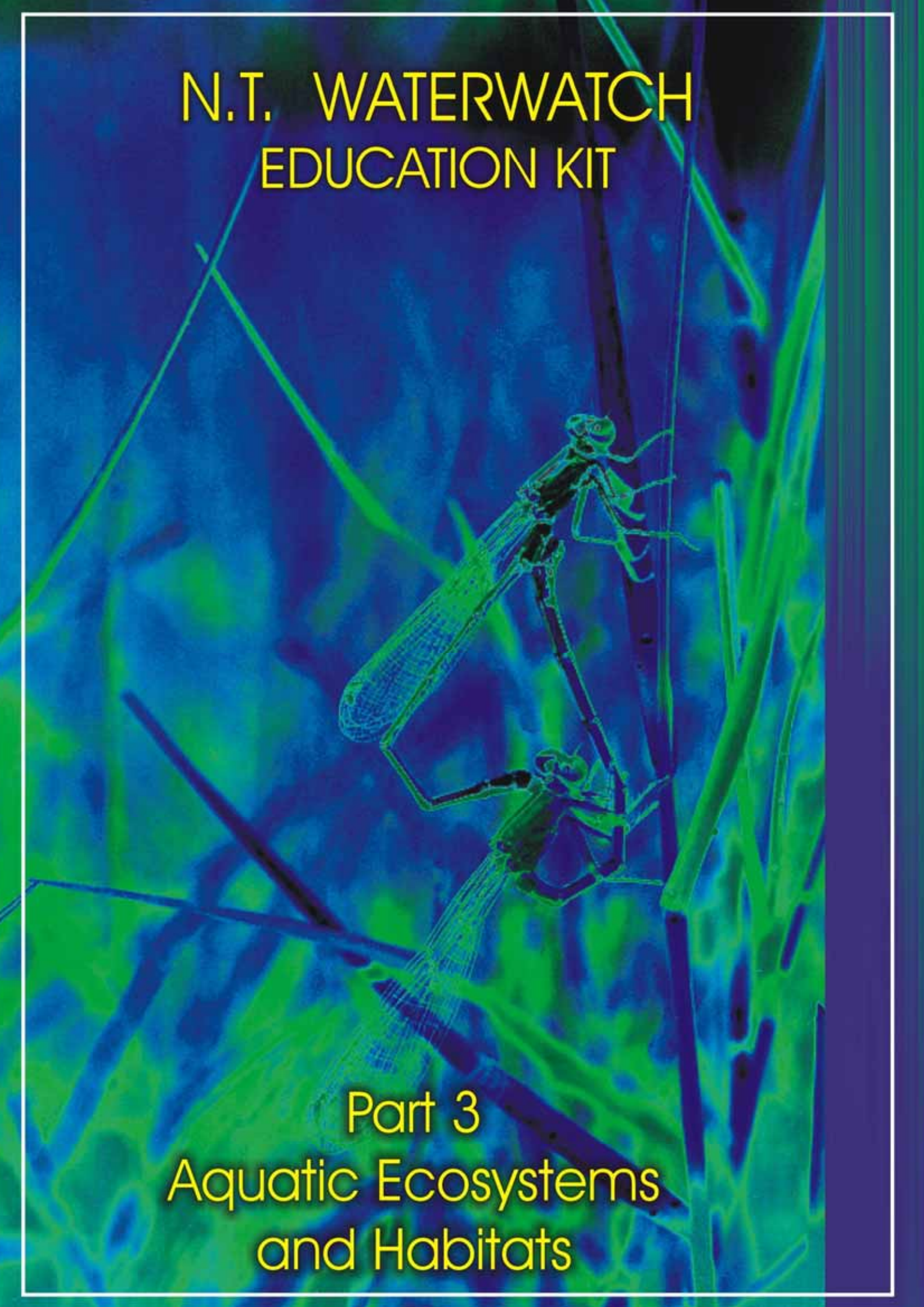
N.T. WATERWATCH
EDUCATION KIT



Part 3
Aquatic Ecosystems and Habitats

NT WATERWATCH EDUCATION KIT

PART 3:
AQUATIC ECOSYSTEMS AND HABITATS

A program of the Natural Heritage Trust

Northern Territory Government
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PART 3: Aquatic Ecosystems and Habitats

Introduction

The diverse aquatic ecosystems of the NT range from the clay pans, rock holes and ephemeral rivers of Central Australia to the lagoons and permanent river systems of the Top End. Each aquatic ecosystem provides different resources that make up the habitats within them.

In order to understand what impact human activity has on the environment we first need to understand what makes up the environment and what natural processes are taking place that may be altered.

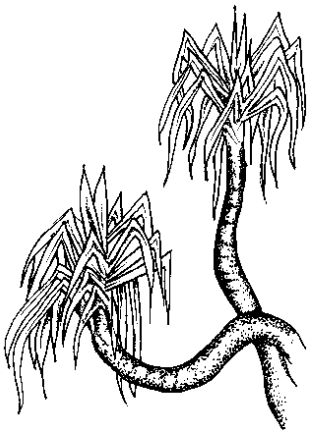
Plate 1 Sunset Upper Katherine River

Rationale

The Northern Territory (NT) has many varied wetlands, which are extremely important to Territorians from cultural, spiritual, economic and ecological viewpoints.

This section gives examples of the many wetland types in the NT. Examples are also given of the diverse range of flora, fauna and cultural uses associated with these waterways.

Students should be encouraged to determine the range of values which are placed on wetlands by using local examples.



Aboriginal Culture

Aboriginal communities have a rich tradition of environmental knowledge. Highlighted within this education kit is the Rirratjinu Language of North East Arnhem Land. Working together and sharing knowledge is how the Nhulunbuy Waterwatch Program and Yirrkala School has enriched this education kit (Schenkel pers. com).

Rirratjinu Language has been, where possible, incorporated into the activities and learning outcomes. We encourage teachers and schools in other areas to work closely with traditional owners and incorporate the local language and culture when learning about water resource monitoring and management (Schenkel pers. com.)

This is just one language group within an area which has many and by taking this first step we are able to keep culture alive, understand each other better and have a great time learning about our waterways (Schenkel Pers. com.)

Among Aboriginal people there is a belief of a special period of creation often referred to as 'Dreamtime'. During this time ancestral spirit beings, sometimes in the form of people or animals, roamed the featureless, flat earth creating everything that exists today including plants and animals, features in the landscape including waterways, language, law and tradition. Sometimes the activities of these creator beings are linked into 'Dreaming trails'. Special places where spirit beings were active or now reside are of great significance to Aboriginal people.

What is a Wetland?

One of the broadest definitions for 'wetlands' is that adopted by the Ramsar Convention, this being:

"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water to a depth which at low tide does not exceed six metres" (http://www.ramsar.org).

Plate 2 Katherine Gorge

Wetland habitats include billabongs, floodplains, creeks and streams, springs, sinkholes, swamps, estuaries, rivers, mangroves, flood-outs, salt pans and clay pans. These are rich ecosystems and show great biodiversity.

See Activity 1 (p 27)

What is an Ecosystem?

The terms ecosystem and habitat can become confused. An ecosystem is the combination of a community (biota) and its abiotic environment. Ecosystems are characterised by ecological processes such as the flow of energy and nutrients through food webs. The *ecotone* is the region lying between two ecosystems, often sharing some ecological features of both the ecosystems it is in between. A riparian zone, ie the land immediately adjacent to a river that may from time to time become submerged, represents an ecotone between water bodies and their catchments.

What is an Aquatic Habitat?

A habitat is a place that provides food, water and shelter for plants and/or animals that are occupying and using the space and resources. An aquatic habitat is one that an animal or plant uses to live or reproduce in, where water is the medium in/on which the organism lives. The water may be permanent or seasonal, fresh or saline water.

The habitat of a species may cross several ecosystems depending on resource availability. However an ecosystem can consist of a variety of habitats, for example a portion of a river may contain a riffle, pool, run, sand bed and riverbank.

Aquatic Ecosystems of the NT

Billabongs and Floodplains (*gu`un').*

Billabongs are waterholes which may form in the beds of drying ephemeral waterways, or when a river bend becomes cut off from the main waterway, or as seasonal floodplains recede to form discrete aquatic environments (Boulton & Brock 1999).

Plate 3 *Nelumbo* Lilies

The coastal floodplains of the NT contain Australia's largest areas of relatively unmodified wetlands, covering an area of approximately 10 000 km^2. The floodplains provide feeding and breeding grounds for a large number of waterbirds, and provide crucial dry-season refuge. The mudflats and coastal flats associated with the wetlands support thousands of shorebirds during annual migrations. The floodplains are also important habitats for crocodiles (*Crocodylus porosus*) and barramundi (*Lates calcarifer*), the premier target fish species of the recreational fishing industry.

See Activity 2 (p 28-29)

The Mary River wetlands are amongst some of the largest coastal wetlands in the NT, covering an area of approximately 1,300 km^2. NT floodplains are under increasing pressure from a range of threats including saltwater intrusion, weeds, improved pastures, grazing and feral animals.

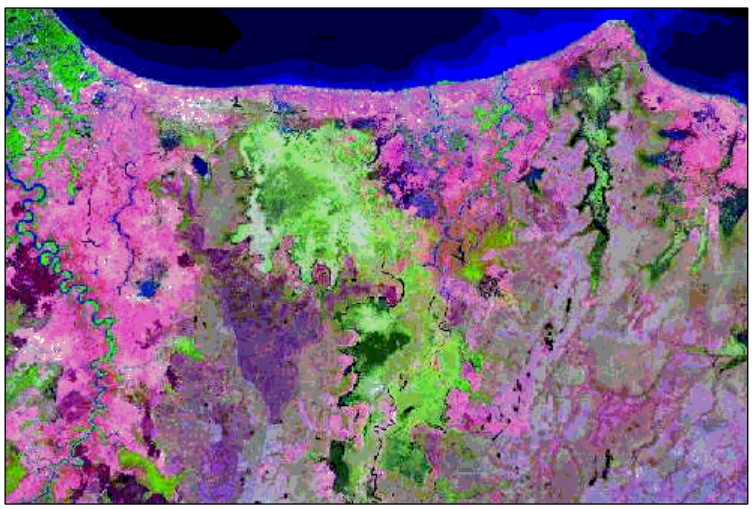


Plate 4 Satellite Image of Mary River Floodplains

Magpie geese (*gurrumattji*) are easy to find on the floodplains as they group in flocks of hundreds, sometimes thousands. Magpie Geese mate for life, although a male may choose two females. The family unit will share a nest and the responsibilities of tending the eggs. The nests are built of mats of floating vegetation on the floodplains (Serventy 1985).

Plate 5 Magpie Goose (*Anseranas semipalmata*)

Eleocharis dulcis and *Oryza* spp (wild rice). grass are important food sources for magpie geese. Adult geese feed on the bulbs of the *Eleocharis* , while fledgling geese are dependent on the seeds of *Oryza* for growth and development. Aboriginal people have traditionally hunted magpie geese for food (Serventy 1985).

The Lotus lily (*dhatam'*) has large pink flowers up to 25 cm across and giant leaves up to 75 cm across. The seeds and tubers (*burpu*) of this lily are edible raw. The seeds are also ground by Aboriginal people to make flour for bush bread (Brock 1988).

Plate 6 Lotus lily (*Nelumbo nucifera*)

Fish Kills

Fish kills are a regular occurrence in billabongs and receding floodplains in the NT. The timing of these kills generally correlate to the Build-Up Season (the season preceding the Wet Season) and are a result of natural occurrences. As water evaporates large numbers of fish become concentrated in small areas of water. Dissolved oxygen levels lower and temperatures increase. Fish deaths may also be attributed to naturally occurring toxins, which are more likely to concentrate as a result of run-off from the first rains (http://www.nt.gov.au/dbird/dpif/pubcat/newsletters/ahnnt.shtml)

See Activity 3 (p 30)

Creeks and Streams (*Riyala*)

Creeks and streams are waterways of various sizes which feed into larger water bodies. Streams can be identified by order in relation to the number of tributaries. Higher order streams have more tributaries (Boulton and Brock 1999).

Plate 7 Rapid Creek

Common archerfish (*nyinganyinga*) occur in many varied aquatic habitats of the NT, including marine and fresh water environments. These fish can generally be found patrolling areas shaded by riverine vegetation. The archerfish is not only capable of jumping out of the water to catch unsuspecting prey, usually terrestrial insects, but it can also spit jets of water, which knock insects into the water (Larson & Martin 1989).

Plate 8 Archerfish (*Toxotes chatareus*)

This distinctive, water-loving tree with spiky leaves is a common feature around Top End waterways (Brock 1988).

Although the fruit of this *Pandanus* species is inedible Aboriginal people can use the plant by creating paint brushes and rope from the roots (Brock 1988).

Plate 9 River pandanus (*Pandanus aquaticus*), Berry Creek

Springs

Springs are formed by water which flows naturally from underground, as a result of the water table intersecting the ground surface. Berry Creek starts from a number of springs, forms a small creek, then reaches Darwin Harbour through a mangrove lined estuary (http://www.nt.gov.au/paw/parks/berry.htm).

Plate 10 Berry Springs

Locally referred to as "thermal springs" the water at Mataranka Hot Springs emerges at 32 °C, an average temperature for groundwater in the region. The Springs are found at the point where the river bed is deep enough to intersect the watertable, allowing the aquifer to overflow.

Plate 11 Mataranka Springs

Damselflies (*mili mili*) are closely related to dragonflies. Because damselflies undergo metamorphosis, with an aquatic phase they are dependent on wetlands (Williams & Feltmate 1992).

Adult damselflies lay their eggs in the stems of aquatic plants. Once the eggs hatch the first part of a damselfly's life is spent as an aquatic nymph, which breathes using the pointed gills easily visible on the diagram below (Williams & Feltmate 1992).

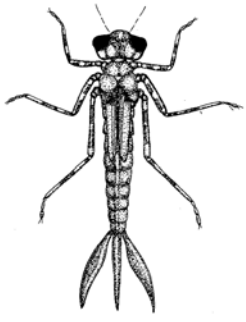


Plate 12 Damselfly adults (mating)

The presence of damselfly nymphs is an indication of good water quality. It is common for Waterwatch volunteers to catch and identify damselfly nymphs while doing macroinvertebrate surveys (Waterwatch Aust. 2000).

Sinkholes

A sinkhole is a localised sinking of the land surface, which may be shallow or deep and may occur either rapidly or gradually. Sinkholes may be formed if:

- changes occur in surface or sub-surface flow or drainage regimes;
- the water table is lowered;
- a major storm occurs; and/or
- a major drought occurs (Karp 2002).

Plate 13 Sinkhole, Katherine

The development of sinkholes requires a landscape underlain by soluble rock such as limestone or dolomite. While the formation of sinkholes can be naturally induced, they can also be induced by humans (Karp 2002).

Plate 14 Limestone Cave, Katherine

Sinkholes have significant cultural value, some being sacred sites. Sinkholes can also provide ecologically valuable temporary and permanent water sources.

Frogs (*garkman*) undergo a process called metamorphosis which means many frogs, including the Green Tree Frog (*Littoria carulea*) are dependent on water for breeding (Tyler & Davies 1986).

Plate 15 Green Tree Frog (*Littoria carulea*)

See Activity 4 (p 31-33)

Paperbark Swamps

Ephemeral paperbark swamps form vast wetland areas during the Top End's wet season.

Plate 16 Girraween Lagoon (close up of 'paper' bark)

The papery bark of *Melaleuca* trees is used by Aboriginal people in the creation of shelter, bedding, fish traps, watercraft and containers. It is also used when cooking food. Medicinally the infusion from the leaves of certain species can be inhaled or drunk to treat coughs, colds, congestion, fever and other ailments (Brock 1988).

Pandanus spiralis is commonly referred to as the screw palm. This distinctive tree with the bright orange fruits can be found in many different habitats, where water is a common factor. Habitats include swamps, creeks, billabongs, lagoons and floodplains (Brock 1988).

There are many cultural uses for *Pandanus*. The fruit is eaten raw or roasted. Medicinally the core of the stem is used in the treatment of diarrhoea, sores, ulcers and toothache. *Pandanus* leaves are used for weaving mats, baskets and dilly bags (Brock 1988).

Plate 17 Screw Palm (*Pandanus spiralis)* fruit and tree

Estuaries and Coastal Lagoons (*Dhulupun*)

An estuary is an area where saltwater from the sea mixes with freshwater from the land, examples include the mouths of a rivers, salt marshes and coastal lagoons. A *lagoon* is a broad, shallow estuarine system separated from the ocean by a physical barrier, generally close to the shore line (Mastaller 1997).

Both estuaries and coastal lagoons have water which is described as brackish, meaning it is salty. Brackish water ecosystems provide important habitats which are important to marine and terrestrial flora and fauna for shelter, food and reproduction (Mastaller 1997).

Plate 18 Amakwula River

Coastal wetlands support valuable mangrove or *gathul'* ecosystems. Mangroves in the NT cover approximately 4120km^2 of coast and river systems. This represents a third of the area covered by mangroves in Australia (Brocklehurst & Edmedes 1995).

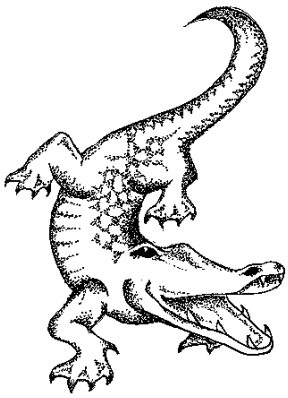
Plate 19 Mangrove Apple (*Sonneratia alba)*

Mangroves are important ecologically and economically in the NT. Many marine species, including those which commercially valuable, such as the barramundi (*ratjuk*) and mudcrab (*nyoka*), are dependent on mangrove ecosystems for food and for breeding habitats (Mastaller 1997).

Rhizophora mangroves are easily recognised by their arching prop roots. These roots enable *Rhizophora* trees to colonise the seaward edge of mangrove communities, despite constant tidal inundation and wave action. *Rhizophora* is used by Aboriginal people in the treatment of medical conditions, including chicken pox (Brock 1988).

Plate 20 Stilt Rooted Mangrove (*Rhizophora stylosa*)

Salt water crocodiles (*bäru*)



Salt water crocodiles (*Crocodylus porosus*) can be found in many coastal areas and river systems of the NT. It is very important to realise that these potentially dangerous animals also live in freshwater rivers, billabongs and swamps. Movement between habitats frequently occurs between seasons (http://www.flmnh.ufl.edu/cnhc/csp_cpor.htm).

Adult crocodiles represent the highest point of the food chain. They feed on animals including mudcrabs, turtles, goannas, snakes and shore and wading birds. Large adults occasionally take much larger prey include buffalo and cattle.

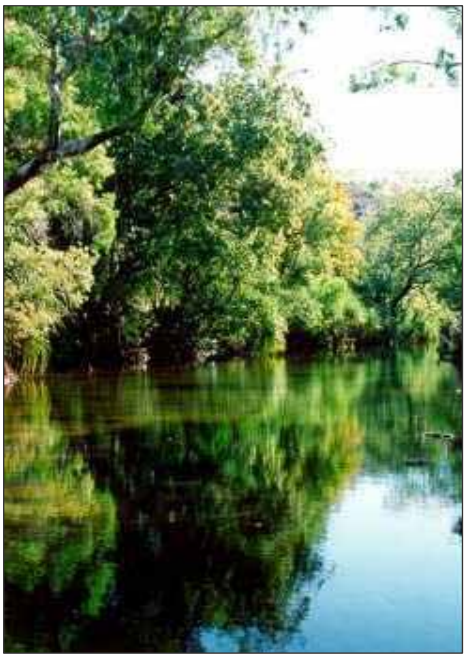
Breeding territories are established in freshwater areas. 40 to 60 eggs are usually laid in nests made from plant matter and mud. Nests are constructed between November and March and haltchlings emerge after around 90 days (http://www.flmnh.ufl.edu/cnhc/csp_cpor.htm).

Plate 21 Crocodiles on the Mary River Floodplains (notice the fishing lure).

Unregulated hunting, mainly between 1945 and 1970, dramatically reduced Australian crocodile populations. Conservation measures, including hunting bans, have been successful in protecting crocodiles, for this reason crocodiles should be viewed as dangerous. However tragic situations can be avoided with increased awareness and by taking care, whilst you are visiting crocodile habitats (http://www.flmnh.ufl.edu/cnhc/csp_cpor.htm).

See Activity 5 (p 34)

Rivers (*Gapu maya*)



A river is a large flowing water body which is often a final collection point for water within a catchment. Many tributaries, such as creeks, may flow into a river and contribute to its volume (Boulton and Brock 1999).

Plate 22 Flora River, Katherine

Plate 23 King River

Situated in north-eastern Arnhem Land the Goyder River is fed by spring discharge from an extensive dolomite aquifer. In November more than six months after the last rains, the upper section of the river maintains a flow of 1000 litres per second. This supports narrow patches of rainforest along the banks.

Plate 24 Goyder River

(http://www.lpe.nt.gov.au/advis/water/ground/Goyder.htm)

In contrast to Northern rivers the major rivers in arid Australia only flow after abundant rains. However the vegetation corridors which line the riverbanks provide essential shelter for the animals which live in arid environments (Davey 1983).

Plate 25 Todd River, Alice Springs

Arid Adaptations

Arid adapted animals have developed many strategies which enable them to cope with the harsh, arid conditions in which they live. These include (Davey 1983):

- sheltering above or below ground to reduce the time spent in the sun/wind;
- reducing water requirements, through lowered metabolic rates and aestivation;
- reduced excretion of water in sweat/urine;
- tolerance relatively high levels of dehydration;
- ability to absorb large amounts of water in short time periods;
- increased storage of water in body tissues;
- utilising water from plant and animal tissues when digested;
- utilising water from night dews;
- fabricating water from metabolic processes, including carbohydrate breakdown;
- life cycles suited for infrequent and short duration water supply; and
- tolerance of highly saline waters.

The water holding frog, native to Central Australia, appears above ground only after rain. During dry periods the frog burrows into the soil, where it creates an underground chamber. A waterproof lining is then produced, which together with the frog's bladder is filled with water, which acts as a reserve until the next rains (http://www.frogwatch.org.au).

Plate 26 Water holding frog (*Cyclorana platycephalus*)

See Activity 6 (p 35)

Flood-outs

Inland rivers obviously do not have opportunity to drain to the ocean. Instead river channels move towards landforms called flood-outs.

The geological features of an area will influence whether a flood-out may reform to become a concentrated channel of water. Flood-outs are flats which radially disperse water away from the end of a stream channel, across vast tracts of land (McDonald *et al* 1998).

Plate 27 Aerial photograph of a flood-out, Andado Station, NT.

Claypans and Saltpans

Pans, or playas are large, shallow, level-floored depressions. These basins flood after storms to form temporary lakes, which then rapidly dry out due to evaporation and infiltration of the water into the surrounding soil and groundwater aquifers. (McDonald *et al* 1998).

Plate 28 Clay-pan (dry), Central Australia

Salt pans form when trapped floodwaters evaporate, leaving a crust of salt. The high salt content of the soil limits plant growth to a few halophytic (salt tolerant) plants. http://www.lib.ttu.edu/playa/hydroact.htm

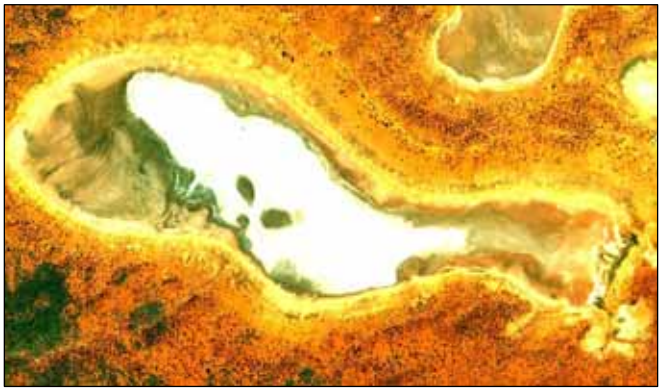


Plate 29 Aerial Photograph of a salt pan in Central Australia

Aquatic Habitats

Plants

Plate 30 Mangrove Apple (*Sonneratia alba)* flowers

Plants are an important part of the water cycle. Plants produce carbohydrates needed for growth and reproduction through a process called photosynthesis. This series of chemical reactions requires water in addition to light and carbon dioxide. Water molecules are absorbed from the soil into roots by the plant. Transpiration is the loss of water by evaporation from the leaves of plants. The water leaves plants as water vapour through the leaf surfaces (Knox *et al.* 1994).

Plants also influence the amount of water which is absorbed into the soil. Plant structures decrease the velocity (and therefore erosive potential) of rain droplets and channel them gently towards the ground. Stabilising root structures of plants further reduce the erosive potential of rain. Shade created by plants reduces evaporation levels (Knox *et al.* 1994).

Plate 31 Pandanus (*Pandanus aquaticus*) at Berry Springs

Riparian Vegetation

Vegetation that grows on the riverbanks is known as the riparian zone. This vegetation provides essential habitats for the animals living in and along the waterway. Riparian vegetation influences stream health by slowing overland run-off and trapping soil particles thereby reducing soil erosion. Riparian vegetation is often composed of plants which prefer moist conditions and are adapted to occasional flooding. Riparian vegetation includes native and introduced species which tend to form a corridor (riparian zone) along the edge of a waterbody (Waterwatch Aust. 2000).

Fringing vegetation is important in maintaining a healthy river system and preventing erosion of the river banks. It provides food and shelter for a variety of animals and acts as a filter to maintain the quality of water that enters the waterway. Fringing vegetation strips out sediment and takes up nutrients; it also stabilises (traps) and aerates sediments, and so prevents murkiness (Waterwatch Aust. 2000).

There is a variety of fringing and aquatic plants, different types of trees, shrubs, sedges and grasses can be found in salty, brackish and freshwater conditions.

Bank Vegetation

Bank vegetation provides much of the protection from erosion because its roots hold the soil together. Trees overhanging the stream keep the water cool. Leaves and branches can fall into the stream, as well as insects and other animals, and these provide food and protection for river animals. Examples of bank vegetation in the NT include freshwater mangroves (*Barringtonia acutangula),* Paperbark species (*Melaleuca sp.*), Pandanus (*Pandanus aquaticus* and *Pandanus spiralis*) and River red gums (*Eucalyptus camaldulensis*) (Brock 1988).

Aquatic Vegetation

Aquatic vegetation native to the NT has many diverse forms, all of are important in maintaining healthy aquatic habitats.

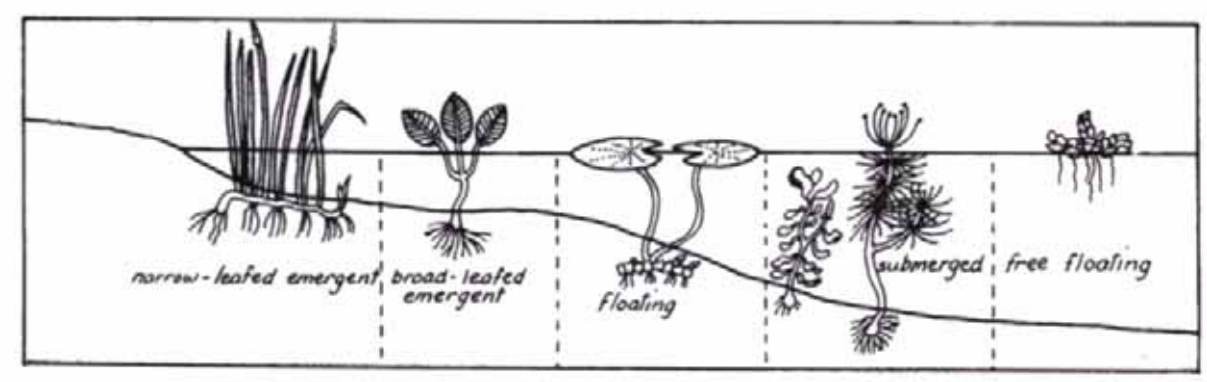


Figure 1 Types of aquatic plants

Free floating plant species which are generally not rooted into any substrate, but rather float on the water surface (Sainty & Jacobs 1988).

Plate 32 ***Eriocaulon setaceum***

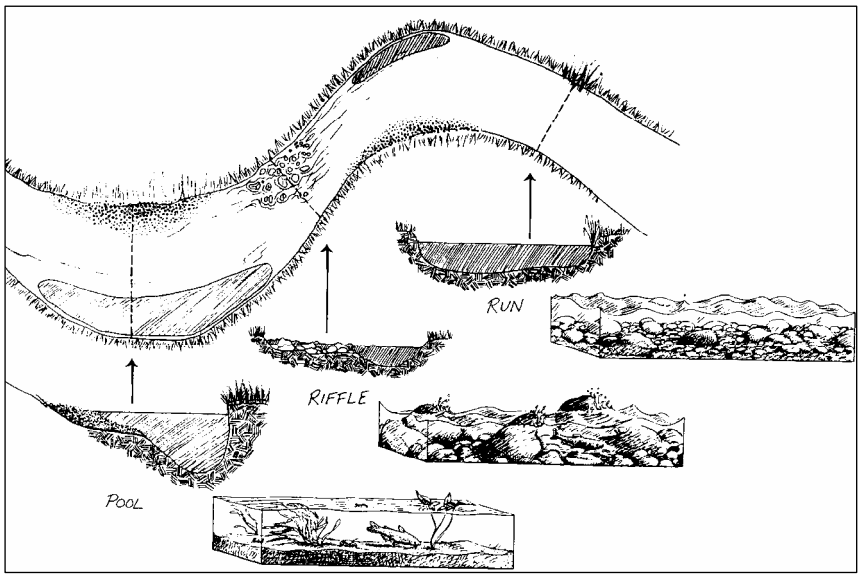
Floating attached plants species include the water lily *Nymphaea violacea* (Plate 33). Floating attached plants are rooted in the waterway substrate, but have at least the mature leaves floating on the water surface. These plants provide an important source of energy and play a significant role in the cycling of nutrients. They provide shelter and refuge for aquatic animals and a place for algae and invertebrates to attach themselves (Sainty & Jacobs 1988).

Plate 33 ***Nymphaea violacea***

Emergent plant species, such as the water chestnut (*Eleocharis dulcis*) are rooted in the substrate of the waterway, however their leaves protrude above the water surface (Cowie *et al* 2000). Trees and shrubs can also be considered emergents when they grow in seasonally inundated areas such as floodplains or swamps (Sainty & Jacobs 1988). Submerged plants remain below the surface.

Plate 34 **Melaleuca (paperbark) trees at Girraween Lagoon**

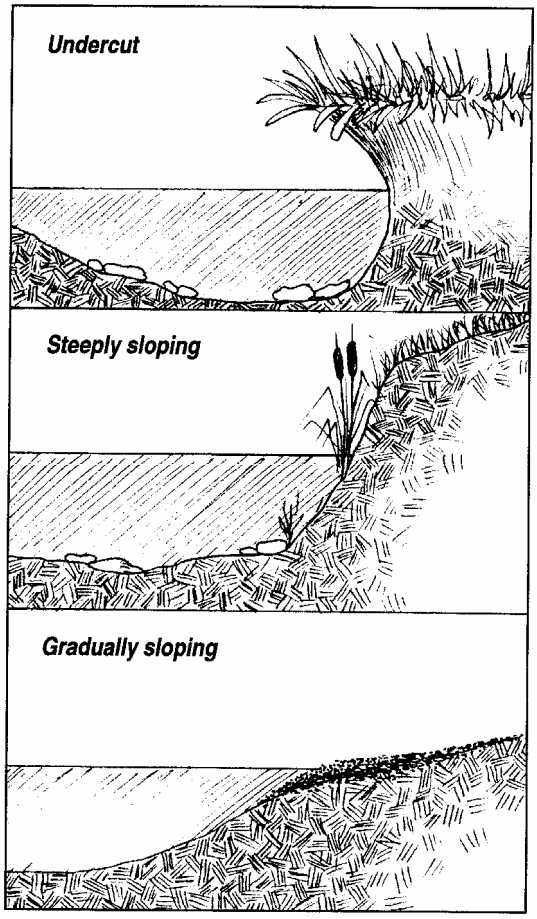
Habitat Types



Water flowing through a river passes through three physically different environments, these being riffles, runs and pools. Varying flows and depths create a variety of habitats for aquatic flora and fauna. Riffles are shallow, rocky and well aerated due to fast flowing turbulent water. Runs are deeper, slower and not as rocky as riffles and have some mud or silt among their rocks Pools are deep and have silt or mud bottoms (Waterwatch Aust. 2000).

Figure 2 Plain view/cross section of a pool, riffle and run (Waterwatch Aust. 2000).

River Banks



Vertical or undercut - a bank that rises vertically or overhangs the stream generally gives good cover for macro-invertebrates and fish and is resistant to erosion. The banks may be composed of solid rock or very fine sediment which is more resistant to erosion.

Steeply sloping - a bank that slopes at more than a 30 degree angle. This type of bank is very vulnerable to erosion if composed of sand or gravel.

Gradual sloping - a bank that has a slope of 30 degrees or less. Although this type of bank is highly resistant to erosion, it does not give much streamside cover.

Artificial changes to banks including the use of concrete or rock can stabilise eroding banks, however significant reductions in vegetation can negatively impact stream fauna. Concrete banks may also cause erosion upstream or downstream due to changed water velocity.

(Waterwatch Aust. 2000).

Figure 3 Stream bank shapes (Waterwatch Aust. 2000).

Why is Riparian Vegetation Important?

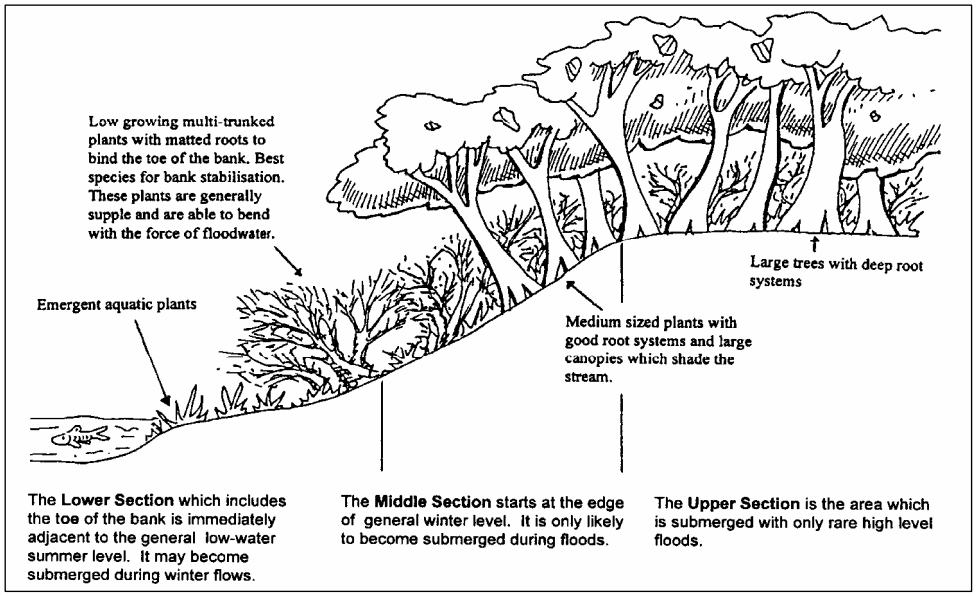


Figure 4 The riparian environment (Munks 1996 cited in Waterwatch Aust. 2000)

Riparian vegetation contributes to the quality of the aquatic environment as a source of food, shelter, habitat and shade: it stabilises stream banks and protects water quality (Waterwatch Aust. 2000).

Food and shelter

Riparian plants are a valuable source of food and shelter for birds, amphibians, reptiles and other animals. Leaf litter, insects, fruit and fallen branches from overhanging trees, give year-round food and shelter for native fish, invertebrates and turtles. Riparian vegetation can provide valuable refuges for rare and threatened plants and animals (Waterwatch Aust. 2000).

Woody debris

Riparian vegetation is a source of woody debris (fallen trees, logs and branches) which falls into the water and becomes a vital habitat for stream life. Logs and branches trap passing leaves and twigs so they can be used as food by aquatic animals. The rough surface of submerged native logs and branches forms micro-habitats for animals lower in the food chain. Woody debris creates valuable breeding places for macro-invertebrates and fish. Large pieces of woody debris slow the flow of small streams and help to form pools. De-snagging streams (removing woody debris) removes important habitats and should be avoided except where the stream is choked with debris and serious erosion is likely (Waterwatch Aust. 2000).

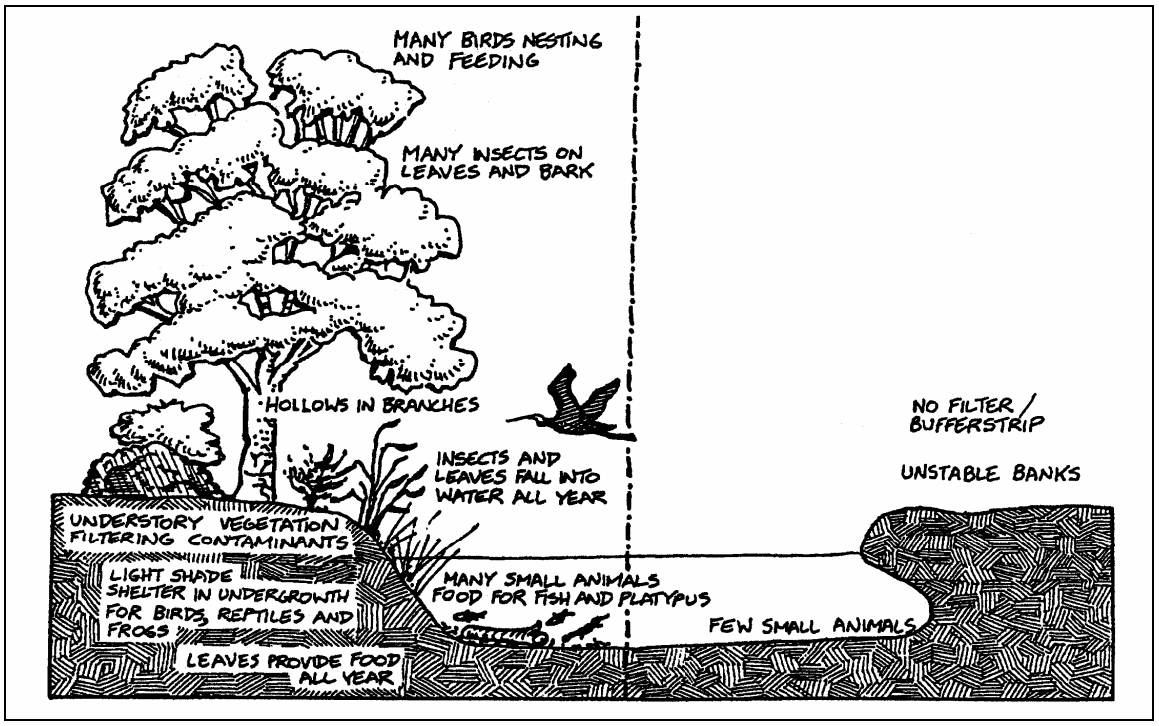


Figure 5 Comparison of vegetated and unvegetated river bank (Munks 1996, cited in Waterwatch Aust. 2000)

Shading

Riparian vegetation shades waterways and protects life from high temperatures which can be lethal to many aquatic plants and animals. Shaded parts of the stream are necessary for successful breeding by some aquatic animals, including fish (Waterwatch Aust. 2000).

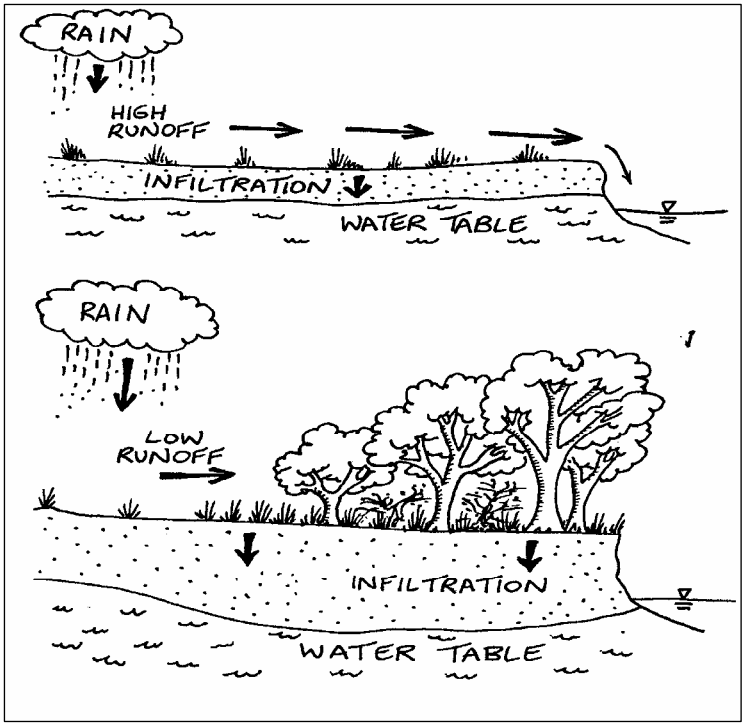
Bank Stabilisation

Roots of riparian plants bind soil particles together and prevent erosion, undercutting and bank collapse. Many Australian streams have highly variable flows which allow vegetation to persist on the toe of the bank. This helps to prevent scouring of the bank (Waterwatch Aust. 2000).

Water quality

Vegetation holding the bank together lowers the amount of sediment entering the water and can also trap silt and sand present in flood flows before it enters the waterway. The deep roots of shrubs and trees on the banks help to keep the water table low through extraction of ground water by evapotranspiration. This delays the onset of saturation of the river bank during heavy rainfall and reduces the incidence of bank collapse (Waterwatch Aust. 2000).

Vegetation within 40m of the waterway buffers the stream from activities on the land, eg: clearing and cropping is the most important part of the habitat to examine. It slows the overland movement of water into streams and traps sediment, nutrients, pesticides and herbicides from up-slope areas. Land is often cleared for agriculture, housing, roads and during forest harvesting, but this has led to large amounts of sediment (gravel, sand and silt) washing into our waterways. When streamside vegetation is removed there is less protection against soil loss, bank collapse and pollution, leading to poorer water quality and degraded conditions for aquatic plants and animals, both at the site and downstream (Waterwatch Aust. 2000).



Excessive nutrients entering streams encourage prolific growth of water weeds, particularly in disturbed areas. Dense aquatic weeds slow waterway flow causing sediment to settle, which in turn leads to a broadening of the channel and increased erosion of the banks. Additionally decomposition of large amounts of aquatic weeds by bacteria can lead to lower oxygen levels in the water (Waterwatch Aust. 2000).

Figure 6 Effect of riparian vegetation on runoff and water quality (Munks 1996 , cited in Waterwatch Aust. 2000).

See Activities 7 to 10 (p 36-41)

Animals

Plate 35 Katydid

Riparian ecosystems support a much higher abundance and diversity of animal species than in surrounding areas. Aquatic habitats and the associated vegetation of the riparian zones provide animals with food, standing water, nesting and roosting sites and shelter from predators. Water is also often a requirement for reproduction in both aquatic and terrestrial species (LWRRDC 1999).

See Activities 11 to 13 (p 42-48)

Macroinvertebrate Ecology

An aquatic macroinvertebrate is an animal without a backbone, that spends all or part of its life in water. The word ‘macro’ indicates these animals are large enough to be seen with the unaided eye (Waterwatch Aust. 2000).

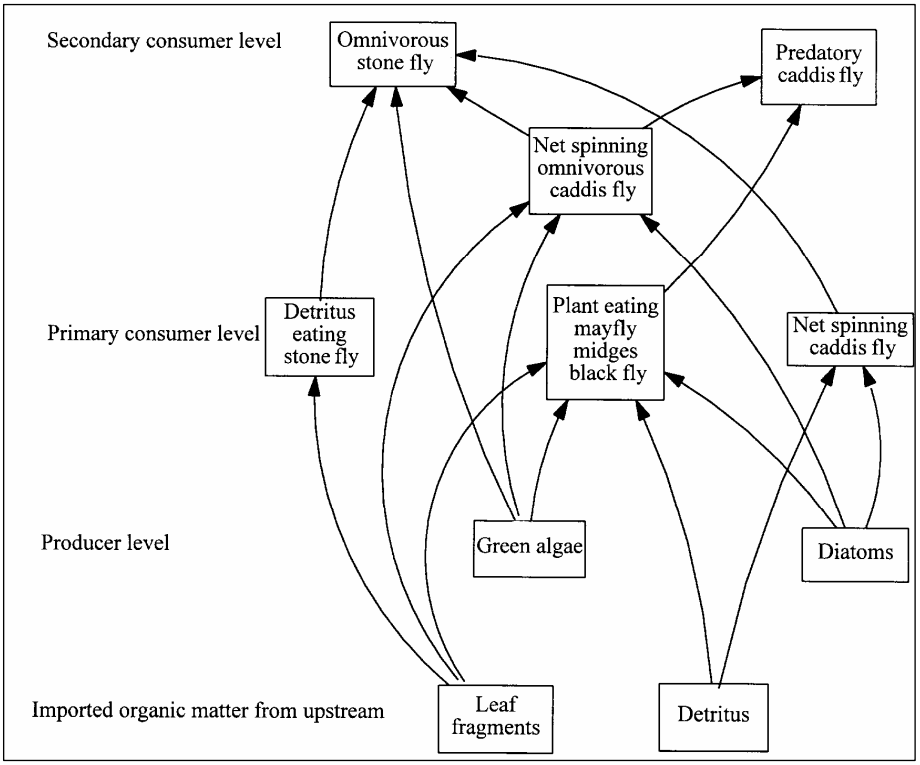
Figure 7 Dragonfly larvae

There are many kinds of macro-invertebrates in our waterways, including worms, snails, mites, bugs, beetles, dragonflies and freshwater crayfish. Our understanding of macroinvertebrates, in combination their abundance, the fact that they are easy to catch and relatively easy to identify at various levels either in the filed or later in a lab, are all factor which mean they make excellent biological indicators. A biological indicator is a living indication of how healthy a waterway is! (Waterwatch Aust. 2000).

The Aquatic Food Chain

Aquatic macro-invertebrates occupy a major role in the food chains of aquatic ecosystems. Macro-invertebrates consumers include herbivores (who eat algae and other aquatic plants) and carnivores (who eat other invertebrates) while macro-invertebrate decomposers are mostly detrivores (who eat dead plant and animal material). All these macro-invertebrates are in turn an important food source for fish, waterbirds and other fauna (Waterwatch Aust. 2000).

Macro-invertebrates can be grouped according to their eating habits:



- *grazers* - feed on algae attached to rocks or logs in the water, eg snails and mayflies;
- *shredders*- eat larger pieces of food (> 1 mm) such as wood and leaves that fall into the water, eg dragonfly larvae;
- *collectors* - feed on small bits of food (<1 mm) either by filtering the passing water or gathering it from the bottom, eg caddis fly larvae;
- *predators*- capture and eat other animals, eg water striders and damselfly larvae.

Figure 8 Feeding relationships of macro-invertebrates (Odum 1959, cited in Waterwatch Aust. 2000).

Other aquatic animals like fish, frogs and birds depend on macro-invertebrates as their main source of food. The greater the variety of waterbugs in a stream, the more chance that animals higher up the food chain will also be living there (Waterwatch Aust. 2000).

Metamorphosis

Some insects spend only a part of their life in fresh water. Insects such as mayflies, caddis flies and midges undergo a process called metamorphosis. This process dramatically changes body shape as the invertebrate grows from an egg to an adult. The transformation may take as little as two weeks, eg: mosquitoes, or up to four years for some dragonflies (Waterwatch Aust. 2000).

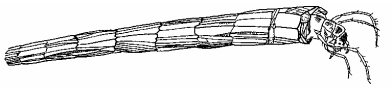


Figure 9 Caddis fly larvae

There are two types of metamorphosis, these being incomplete and complete. Incomplete metamorphosis is characterised by a nymph phase. Nymphs, such as a mayfly nymph, look similar to the adult, progressively becoming more similar with each moulting. Complete metamorphosis begins with a larval stage. The larva then pupates emerging as an adult with wings. True flies, beetles and caddis flies all undergo complete metamorphosis (Waterwatch Aust. 2000).

Other invertebrates spend all their life in water, eg: back-swimmers, water scorpions and water striders (Waterwatch Aust. 2000).

Table 1 Comparison between complete and incomplete metamorphosis (Waterwatch Aust. 2000).

Incomplete metamorphosis	Complete metamorphosis
egg	egg
early nymph	larva
late nymph	pupa
adult	adult

Macro-invertebrates habitats

Animals survive best in places that provide protection, camouflage, and food sources. Whatever your waterway, it will probably have several different habitats suitable for invertebrates. Macro-invertebrates are found in still water, riffles, runs and in pools of flowing waters such as creeks (Waterwatch Aust. 2000).

Riffles

Within faster flowing riffles rocks provide a variety of living places and a large surface area for macro-invertebrates to hold onto. Food is continually swept down in the current from upstream. Since riffles provide a variety of living places, current conditions and food, they often support a diversity of macro-invertebrates (Waterwatch Aust. 2000).

Runs

Runs are generally deeper and slower than riffles. Smaller particles like sand and gravel tend to settle on the bottom; limiting the variety of living places for macro-invertebrates. In addition, occasional floods will wash sand and gravel and any animals downstream. Food is suspended in the water, deposited on the bottom or may grow on the stream bed. This type of physical habitat limits the variety of macro-invertebrates (Waterwatch Aust. 2000).

Pools

Pools usually have sandy or muddy bottoms with fewer types of macro-invertebrates present. The habitat is less suitable so macro-invertebrates will attach to plant stems, roots, logs and other submerged items (Waterwatch Aust. 2000).

Macroinvertebrate Adaptations

Adaptations for life in fast-moving water

Animals living in moving water must be able to 'hang-on' and catch their food. You can often find examples of the following adaptations in Waterwatch macroinvertebrate samples (Waterwatch Aust. 2000):

- *streamlined bodies* (water pennies);
- *special hooks on legs*(mayflies and stoneflies);
- *suction body parts* (black flies and snails);
- *sticky secretions to attach themselves to the bottom* (caddis flies and midges);
- *structures to keep themselves in place* (caddis flies); and
- *specialised front legs and mouth-parts to filter the water or catch food moving past* (black flies).

Adaptations for life in slow-moving or still water

In contrast to fast moving water, animals in still or slow-moving water don't have to hang on and food is not brought to them in the current. They tend to have a wider range of sizes and shapes and be more mobile. Some have special adaptations to live on the surface, such as water striders, while others burrow into the soft sediments (Waterwatch Aust. 2000).

Table 2 Freshwater macro-invertebrate habitats (Waterwatch Aust. 2000).

Habitats	Macro-invertebrates that may be living there.
Edgewater includes overhanging vegetation from banks.	Fast moving bugs and beetles, freshwater shrimp.
Bottom - mud, sand, silt, gravel, rocks.	Worms, fly larvae, bivalve mussels.
Aquatic plants - plants under the surface as well as those growing through the water and floating.	Gripping insects, caddis flies, damselflies, shrimp, snails.
Flowing water - riffles, pools and runs.	Gripping insects, caddis flies, and beetle larvae that have burrowed into logs and under rocks.

Table 3 Estuarine macro-invertebrate habitats (Waterwatch Aust. 2000).

Estuarine (salt water) habitats	**Macro-invertebrates that may be living there.**
Seagrass and mudflats.	Whelks, cockles, shrimp, periwinkles, crabs, snails, amphipods, polychaete & squirt worms. Seagrasses are sensitive, slow growing and used by many fish as a breeding ground.
Saltmarsh.	Crabs, slugs, isopods, mosquito and midge larvae.
Mangroves.	Crabs, amphipods, isopods, prawns, shrimp, oysters, whelks, worms, barnacles and mussels.

See Activities 14 and 16 (p 49-52)

Local Surface Water Investigation B1-B5

Activity 1

Curriculum Links:

Science Concepts and Context / Life and Living CC 1.2, CC 2.2, CC 3.2, CC 4.2, CC 5.2

SOSE Environments / Natural Systems Env 1.3, Env 2.3, Env 3.3, Env 4.3, Env 5.3

Focus Question:

- **What are some different types of surface water in the NT?**

Aims:

1. To build on student's understanding of the aquatic ecosystems in the NT.
2. To examine how different ecosystems support different plant and animal communities.

Main Ideas:

- Surface water is freshwater that is visible above ground in waterholes, rivers wetlands, lakes, dams etc.
- Surface waters may be man-made, natural, permanent and ephemeral.

Need:

Internet access and local maps.

Consider:

Students research some actual examples of surface water bodies in their local region and label them man-made or natural, permanent or ephemeral.

Analysis:

Research animals and plants which are specific to the various water bodies which you have identified.

Analyse the various challenges which these animals and plants may face during the course of one year.

When do the different surface water bodies dry out (if at all) and for how long do they dry out?

Does the region flood?

Is the waterbody inundated with saline or brackish waters?

Extension:

Map these local water bodies on a photocopy of a local map of the region. Use the map determine where the flow into these water bodies has come from and where it goes.

Reflection:

How does the presence of a range of different surface water bodies in a region support biodiversity? (Biodiversity is the variety of living things that can be supported in a given area).

Lifecycle of the Barramundi

B3-B5

Activity 2

Curriculum Links:

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

SOSE Environments / Natural Systems Env 3.3, Env 4.3, Env 5.3

Focus Question:

- **What adaptations enable animals to live in aquatic environments?**

Aim:

To understand the concept that lifecycle strategies are a form of adaptation to a particular environment.

Main Idea:

- The barramundi (*Lates calcarifer*), is the premier target fish species of the recreational fishing industry.
- Barramundi spawn around river mouths early in the Wet Season. High tides wash the eggs and larvae into adjoining coastal swamps.
- Juvenile barramundi migrate upstream at the end of the Wet Season while mature males and females live mostly in tidal areas.

Need:

Student Sheet 3.1: Barramundi (below).

Consider:

Read the Barramundi student sheet. You may choose to do additional research on the barramundi's lifecycle.

Analysis:

What specific needs do the Barramundi require for a complete breeding cycle?

Draw a diagram which labels the various stages in the barramundi life cycle.

Investigate the reasons for the complicated life cycle of the barramundi.

Investigate your local area for suitable habitats.

Reflection:

Given the Barramundi is a popular fish to catch and eat, what is being done about protecting this fish from being overfished to the point that the population is being reduced?

Who is monitoring the fish numbers?

Student Sheet 3.1: Barramundi

Many fish species inhabit the protected waterways of Top End parks and reserves, most of them freshwater species. The Barramundi (*Lates calcarifer),* is by far the most prized target of recreational fishermen.

Barramundi thrive in both salt and fresh water. Barramundi spawn around river mouths early in the wet season and high tides wash the eggs and larvae into adjoining coastal swamps. Juvenile barramundi migrate upstream at the end of the Wet Season while mature males and females live mostly in tidal areas. One of the most fascinating biological aspects of this fish is that adult males turn into females to breed.

Fishing Controls

The Department of Business, Industry and Resource Development (DBIRD) has introduced a series of special controls to help minimise the impact of recreational and commercial fishing on the Territory's Barramundi resource. These controls cover fish size limits, bag limits, seasonal closures, gear restrictions in specified areas, and a ban on tethering of fish.

It is illegal to catch and keep Barramundi which measure less than 55 cm in length.

People fishing in the designated Mary River Zone are not permitted to take more than two Barramundi in one day nor to have more than two Barramundi in their possession at any one time. In other Territory waterways, the bag limits are five Barramundi in one day and five at any one time.

Tethering of fish is illegal in the Northern Territory.

Always release any fish that is not needed

Give released fish the best chance to survive by:

- removing the hook while the fish is still in the water;
- using a net to land, de-hook and weigh a fish before release;
- gripping the lower jaw, rather than placing fingers under the gill cover, when measuring a fish; and
- not leaving live fish on a hot deck or seat.

Design a poster which communicates some or all of these messages to fishermen

Fish Kills

B3-B5

Activity 3

Curriculum Links:

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

SOSE Environments / Natural Systems Env 3.3, Env 4.3, Env 5.3

Focus Question:

- **What factors can affect the health of aquatic habitats?**

Aim:

To gain a better understanding of the complexities surrounding the reasons for fish kills in the NT.

Main Idea:

- Fish kills may be natural or a result of pollution.
- Naturally occurring fish kills can occur as floodplains in the NT recede. As water evaporates large numbers of fish become concentrated in small areas of water. Dissolved oxygen levels lower and temperatures increase. Fish deaths may also be attributed to naturally occurring toxins.
- The timing of these kills generally correlate to the Build-Up Season.
- Fills kills can also occur as a result of toxic pollutants which have been introduced into waterways by humans, such as pesticides and toxic chemicals.

Need:

Research fish kills by contacting Government Departments such as the Department of Industry and Resource Development (DBIRD) and the Department of Infrastructure, Planning and Environment or the Internet.

Consider:

At what time of year are fish kills most likely to occur?

What are the mechanisms which cause seasonal changes in dissolved oxygen levels?

Analysis:

Write a detective story about two children who discover a major fish kill in the river and follow clues to find the culprit who had flushed old engine oil into a stormwater drain. Create a positive ending to the story.

Alternatively research and write a story about a fishy expedition where poison was used to stun and catch the fish to eat (indigenous methods).

Extension:

Discuss some of the naturally occurring toxins which can be found in the waterways of the Top End?

Research the precautions taken when using this method of fishing.

Katherine Region Sinkholes

B3-B5

Activity 4

Curriculum Links:

SOSE Environments / Environmental Awareness and Care Env, 3.2, Env 4.2, Env 5.2

SOSE Environments / Natural Systems Env 3.3, Env 4.3, Env 5.3

Focus Questions:

- **What is a sinkhole and how are they formed?**
- **How are ground and surface waters connected?**

Aim:

To gain a better understanding of groundwater and surface water interactions via the study of sinkholes.

Main Ideas:

- Sinkholes are a product of unconfined aquifers that can be considered wetlands when full of water.
- Sinkholes facilitate flow of groundwater to river systems.
- The processes of sinkholes need to be understood when considering nearby development of land. Appropriate management of sinkhole landscapes can minimise the risk of collapses.
- Sinkholes form a large part of the landscape in the Katherine region pastoral lands that overlie limestone substrates known as the Tindal formation (495km^2).

Need:

Student Sheet 3.2: Sinkholes (below),. Katherine Sinkhole Study poster (may be borrowed from your Regional Waterwatch Coordinator).

Consider:

The poster. An additional useful reference is Karp, D. Land Degradation Associated with the Sinkhole Development in the Katherine Region (Technical Report No 11/2002) DIPE, Darwin.

Analysis:

Students work as groups or individually to answer the questions listed on the student sheet.

Visit Cutta Cutta Caves or another sinkhole that is safe to access and visit. Study the rock formations and the fissures. Study the flora and fauna that exist in these locations. Investigate the cultural significance of this type of wetland. Write a report about your visit to the sinkhole wetland.

Extension

Design and create your own model of a sinkhole to demonstrate to other classes or visitors to the school.

Reflection:

Why is it important that these sinkholes are conserved as intact wetlands?

Why are water allocation plans important for the management of sinkholes and human structures that may exist near them?

EXCURSION

Student Sheet 3.2: Sinkholes

What type of aquifer is prone to sinkholes?

_____

1. Why are sinkholes significant biologically?

_____

_____

_____

2. Draw a labelled diagram of a typical sinkhole structure.

3. What factors can induce a sinkhole to collapse?

_____

_____

_____

_____

4. How might induced collapse of sinkholes be avoided?

_____

_____

_____

5. Investigate what makes groundwater green in colour and provide your explanation.

_____

_____

6. Looking at the rock structure on the surface around sinkhole country, what has caused the horizontal fractures, and what has caused the vertical fractures?

_____

_____

_____

7. What is the major land use of sinkhole country? Is this land use likely to cause sinkholes to form faster than they would naturally? If so why?

_____

_____

_____

8. Investigate the vulnerability of this type of water resource to pollution. Record your findings.

_____

_____

_____

9. Given the surrounding land uses, what might be some potential pollutants?

_____

_____

_____

Crocodile Ecology

B3-B5

Activity 5

Curriculum Links:

SOSE Environments / Environmental Awareness and Care Env, 3.2, Env 4.2, Env 5.2 / Natural Systems Env 3.3, Env 4.3, Env 5.3

Focus Questions:

- **What adaptations enable animals to live in aquatic environments?**

Aims:

1. To develop research/ report writing skills.
2. To learn about the ecology and distribution of crocodiles, including their adaptive features and interrelationships with their environment.

Main Idea:

- Saltwater crocodiles can be found in many coastal areas and river systems of the NT.
- Breeding territories are established in freshwater areas. 40 to 60 eggs are usually laid in nests made from plant matter and mud. Nests are constructed between November and March. Juveniles hatch after around 90 days.
- Crocodiles are often are viewed as man-eaters. Although many people have been injured and killed each year, many tragedies could have be avoided with increased awareness.
- Unregulated hunting, mainly between 1945 and 1970, dramatically reduced Australian crocodile populations.
- Conservation measures, including hunting bans, have been successful in protecting crocodiles.

(http://www.flmnh.ufl.edu/cnhc/csp_cpor.htm).

Need:

'Crocodile Features' and 'Crocodile Relationships' and 'Crocodile Appreciation' from the web site:
http://www.mesa.edu.au/friends/croc_kit/index.html

Consider:

Look at the information and follow the prompts on the web site.

Investigation:

Investigate the distribution of saltwater and freshwater crocodiles in the NT.

Analysis:

How have humans exploited crocodile populations in the past? Research the history that has resulted in laws that protect crocodiles.

Extension

Provide an extension into the arts, drama, games and music to develop an appreciation of crocodiles.

Aquatic Adaptations to Arid Ecosystems?

B3-B5

Activity 6

Curriculum Links:

SOSE Environments / Natural Systems Env 3.3, Env 4.3, Env 5.3

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

Indigenous Languages and Cultures Natural Environment

Focus Question:

- **What adaptations enable plants and animals to live in arid aquatic environments?**

Aim:

To gain an understanding of the wide variety of adaptations which enable aquatic animals to live in regions where very little surface water exists.

Main Idea:

- Many animals have developed strategies which enable them to cope with the highly seasonal conditions in which they live. These include (Davey 1983):
  - sheltering from sun/wind;
  - reducing water requirements;
  - reduced excretion of water;
  - tolerance to dehydration;
  - ability to absorb large amounts of water in short time periods;
  - increased storage of water;
  - utilising water from plant and animal tissues when digested;
  - utilising water from night dews;
  - life cycles suited for infrequent and short duration water supply.

Need:

Research material

Consider:

Discuss and research the many different adaptations animals in the NT have to seasonal water shortages.

Analysis:

Students choose a species to study, investigate its life cycle.

What body parts are involved in the adaptation, eg: skin, legs, feet, moth, behaviour, internal processes?

Students write a report, which includes a diagram, about the species that is chosen and then present this to the class.

Reflection:

What variations might there be in adaptations of Top End and Arid Zone species?

Extension:

Investigate indigenous stories which explain how or why the different animals have the body features that they do?

Plant Recognition Trail

B3-B5

(Adapted from the "Catchment Education Resource Book" NRE 1998 Vic.)

Activity 7

Curriculum Links:

SOSE Environments / Natural Systems Env 3.3, Env 4.3, Env 5.3

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

Indigenous Languages and Cultures Natural Environment

Focus Question:

- **How does water interact with plants?**

Aims:

1. To increase student appreciation of plants.
2. improve student identification skills.

Main Ideas:

- Plants form an essential part of the water cycle. Additionally many plants have important environmental, cultural and historical significance.

*If you need assistance in identifying your local trees, contact DIPE or Greening Australia.

Need:

Paper, pencils, cardboard and laminate.

Consider:

Select an area with a diversity of trees that students regularly visit.

Choose 10 distinctive and prominent trees from this area for use in the trail. Try to select a range of native species.

Photograph each tree so that your photograph shows the basic form of the whole tree.

Collect a sample of the leaves and bark from the tree (bark rubbings may also be taken using pencils and paper). If flowers, buds, or cones are available then they can also be collected and photographed or pressed in a plant press.

Make a permanent recognition card for each tree by placing the photographs back to back and laminating them.

The trail cards can be used in a variety of orienteering and recognition activities.

Analysis:

Research the natural habitats of each of your identified plants. What is the relationship between habitat, water saturation and plant type?

Extension:

Of the trees identified are any of these naturally found in riverine and aquatic environments? Examples include *Melaleuca* (paperbarks), *Pandanus* (screw palms) and *Eucalyptus camaldulensis*(River red gums)

Can you determine any physical features of plants which indicate the type of environment which they are best suited to?

Research some of the many indigenous uses of riverine and aquatic plants

Riparian Vegetation Study

B1-B3

Activity 8

Curriculum Links:

SOSE Environment / Place, Landforms and Features Env 1.1, Env2.1, Env 3.1 / Natural Systems Env 1.3, Env 2.3 Env 3.3

Focus Question:

- **Why is riparian vegetation important?**

Aim:

To understand the value of riparian vegetation.

Main Idea:

- Vegetation that grows on the riverbanks is known as the riparian zone.
- Riparian vegetation provides essential habitats for the animals living in the river.
- Riparian vegetation influences stream health by slowing overland run-off and trapping soil particles thereby reducing soil erosion.
- Riparian vegetation is often composed of plants which prefer moist conditions and are adapted to occasional flooding.

Need:

Transport, video (as below) excursion papers and pens.

Consider:

Watch the video's River Floodplains and Rivers, Streams and Billabongs. List some of the plants and animals associated with waterways.

Choose a river site to visit, guidance may be required from your Regional Waterwatch Coordinator.

Analysis:

Discuss what riparian vegetation is? Create a diagram with the class to explain it.

Discuss via a retrieval chart the value of riparian vegetation.

Talk about vegetation and animal interactions; vegetation and soil interactions, vegetation and water interactions – then relate this to the riparian situation.

Make observations on site: describe/draw the vegetation structure, i.e. types of plants; collect different leaf or flower or fruit types to represent the diversity of the vegetation.

While on site consider the question: is the riparian zone a dynamic system over time?

Back in the classroom, students create a brochure about the importance of riparian vegetation.

Reflection:

What would water quality be like without riparian vegetation? What factors might impact on riparian vegetation?

EXCURSION

Aquatic Plants

B1-B3

Activity 9

Curriculum Links:

SOSE Environment / Natural Systems Env 1.3, Env 2.3 Env 3.3

Science Concepts and Context / Life and Living CC 1.2, CC 2.2, CC 3.2

Focus Question:

- **What are the different plants types associated with waterways and why are they important?**

Aim:

To study the role of plants in an aquatic environment.

Main Idea:

- Riparian vegetation (vegetation that grows on the riverbanks) provides essential habitats for the animals living in the river. Riparian vegetation influences stream health by slowing overland run-off and trapping soil particles thereby reducing soil erosion.
- Bank vegetation provides protection from erosion. Trees overhanging the stream keep the water cool. Leaves and branches can fall into the stream, as well as insects and other animals, and these provide food and protection for river animals.
- Aquatic vegetation native to the NT has many diverse forms, all of are important in maintaining healthy aquatic habitats. Many of the plant types found in the water provide valuable food and habitat for aquatic fauna. Plants also assist in oxygenating the water through the process of photosynthesis.

Consider

Discuss how a combination of plant types can benefit aquatic and land animals.

Analysis:

What roles do plants play in the aquatic ecosystem?

Create a series of labelled pictures of plants which the students know to exist in nearby waterways.

Describe what happens in the process called ‘photosynthesis’?

Draw an aquatic food chain.

How are nutrients recycled? Why do you think this is an important process of wetlands?

Reflection:

Think about the role of the sun driving the energy cycle of the wetland.

How is heat energy transformed into organic matter?

Field Excursion to Identify Local Habitats

B1-B3

Activity 10

Curriculum Links:

SOSE Environment / Natural Systems Env 1.3, Env 2.3 Env 3.3

Science Concepts and Context / Life and Living CC 1.2, CC 2.2, CC 3.2

Focus Questions:

- **What are some of the aquatic habitats present in the NT?**
- **Why is riparian vegetation important?**

Aims:

1. To become familiar with the use and meaning of the term habitat.
2. To explore some local examples of aquatic habitats.

Main Ideas:

- A habitat is a place that provides food, water and shelter for plants and/or animals that are occupying and using the space and resources.

Need:

Transport, sketch pad, pens and writing paper. 'Stream Habitat Terms' Student Sheet (overleaf) Assistance from *Waterwatch*.

Consider:

Visit a range of aquatic environments within your local area.

Investigation:

Ask students to take note of the physical features of the site(s), eg: the water body cross section, the type of geology, soils, vegetation and animals present.

Can the sites(s) be divided into smaller habitats such as riffles, pools, banks, verges and river bends?

Record the different plants and animals present in each of these habitats. With the assistance of your local expert, you will also be able to sample the aquatic macroinvertebrates.

Analysis:

What were the different species found in each of these areas of the site(s)? Did some species overlap in their distribution? Were some specific to particular zones?

How many habitats were present at the site(s)? Draw and label a diagram showing the cross section of the site(s) and the various habitats present.

If possible, create a short video from the site visits explaining the difference between the different stream habitats.

Back in the classroom, as a class create a mural of the site(s).

Reflection:

Is it possible that the types of habitat present at a site can change over time?

EXCURSION

Student Sheet 3.3
Stream Habitat Terms

(Source: Waterwatch Education Kit, Waterwatch Vic and Barwon Water 1997)

A river is more than just water. It is a habitat for many different animals. The plants in and beside the water are very important parts of this habitat.

1. Label the 'verge', 'bank', and 'in stream vegetation' zones of a river on the drawing 'River Habitats'. Draw in the plants roots.

2. Water levels in rivers keep changing. Draw in 4 different water levels, and label them, to show likely water levels in different seasons.

3. Circle the correct answer and fill in the blanks below

Riffles are (deep / shallow), rocky sections of a creek or river. The water moves (faster / slower) as it bubbles over the rocks and stones.

Pools are (shallower / deeper) areas of the waterway. Here the water flows (slowly / quickly) and the streambed is usually of s ___ ___ ___ or m ___ ___ .

4. Fill in the blanks about riverside vegetation.

Overhanging trees provide s ___ ___ ___ ___.

Leaves fall into the water and provide f ___ ___ ___.and s ___ ___ ___ ___.___ ___

Insects living in riparian vegetation provide f ___ ___ ___ for aquatic animals.

5. Vegetation includes leaves, twigs, branches, roots and stems. How might the in-stream vegetation influence animal life in the river?

_____

_____

6. How might the river bank vegetation influence life in and around the river?

_____

_____

7. How might the river verge vegetation influence animal life in the river?

_____

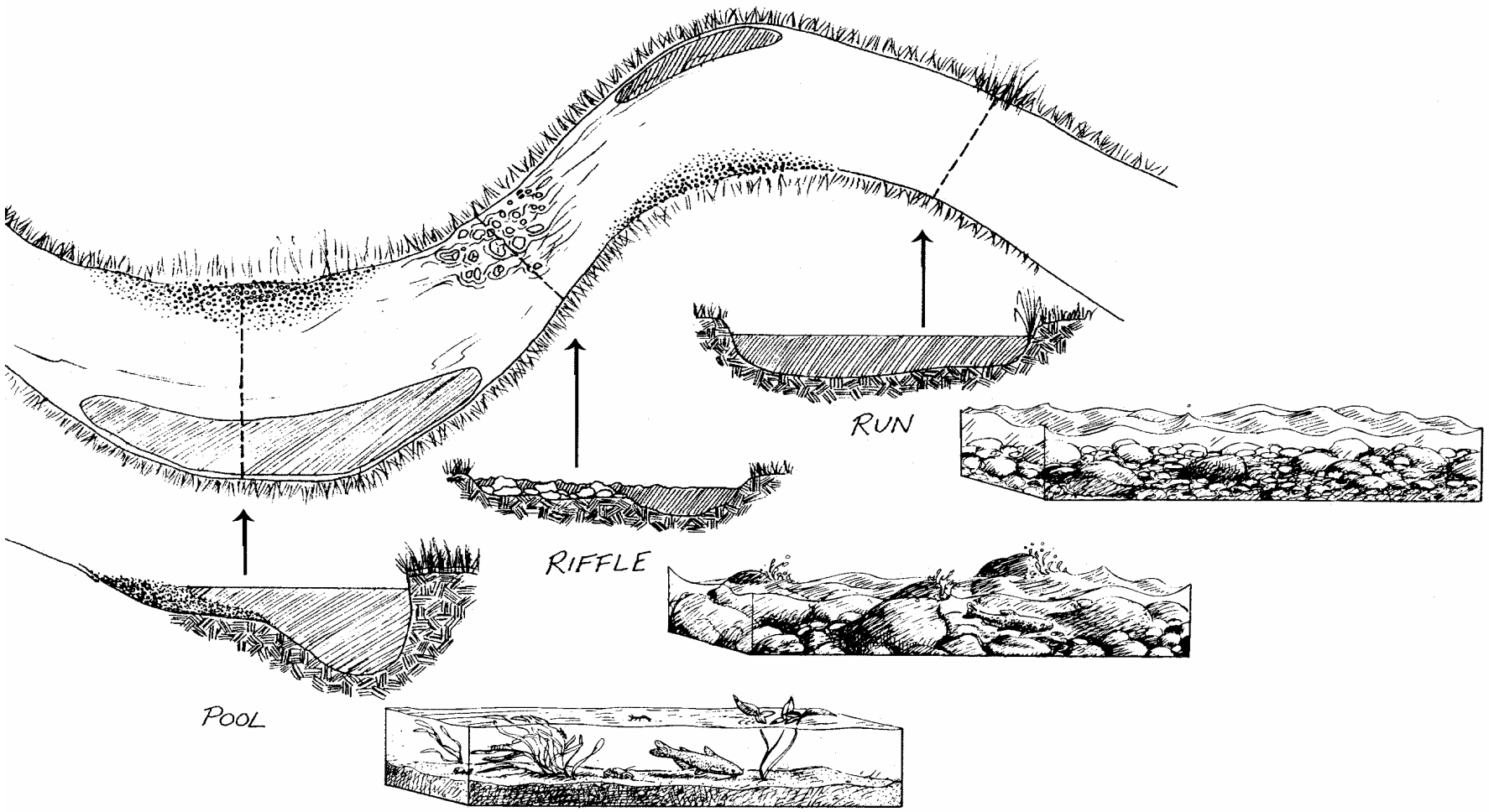


Figure 10 River habitats (Source: Adapted from the Tasmania Manual)

The Fresh Water Aquarium

B1-B3

Activity 11

Curriculum Links:

SOSE Environment / Natural Systems Env 1.3, Env 2.3 Env 3.3

Science Concepts and Context / Life and Living CC 1.2, CC 2.2, CC 3.2

Focus Question:

- **What is an Aquatic Habitat?**

Aim:

To learn about the basic needs of animals living in water through the use of an aquarium as a model of an aquatic habitat.

Main Idea:

- A habitat is a place that provides food, water and shelter for plants and/or animals that are occupying and using the space and resources.
- An aquatic habitat is one that an animal or plant uses to live or reproduce in, where water is the medium in/on which the organism lives.

Need:

Use an aquarium or fish bowl that has been set up in your classroom or somewhere in the school.

Consider:

What life is like in a freshwater aquarium?

Discuss:

The needs of the fish; these being oxygen, water, food, shelter and waste disposal.

How these needs are satisfied in an aquarium?

Other kinds of living things you can have in an aquarium.

Why plants are put in the aquarium?

Needs	How these are satisfied
oxygen	air pump, plants
water	Owner provided
food	Owner provided, algae on glass
wastes	filtered/ tank cleaned
shelter	plants, rocks, ornaments

Analysis:

What do all animals and plants need their habitats to provide?

Students write a story about what it is like to be a fish living in an aquarium. They might like to talk about the interaction required with humans in order to keep them alive.

Read Longneck's Billabong. Talk about Longneck's needs and how they are satisfied? Compare his needs with the needs of a fish in the aquarium and how its needs were satisfied.

Reflection:

Reflect on how aquatic animals in the real world do not require humans to maintain their habitats for them.

Surviving in Ephemeral Aquatic Habitats

B3-B5

Activity 12

Curriculum Links

SOSE Environment / Natural Systems Env 3.3, Env 4.3 Env 5.3

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

Indigenous Languages and Culture Natural Environment

Focus Question:

- **What adaptations enable plants and animals to live in ephemeral aquatic environments?**

Aims:

1. To introduce students to the concept of ephemeral habitats.
2. To review how organisms survive ephemeral habitats.

Main Idea:

- Ephemeral water bodies are those that only hold water for part of the year.
- These are usually small creeks, lagoons, rock pools or low lying areas in the arid zone.

Need

Research materials, art and craft materials.

Consider:

Read 'Wetlands' by Tricia Oktober and watch the very last few scenes from the video: 'The Call of Kakadu' or 'Our Living Deserts'.

How do plants and animals survive where the habitat is only seasonally under water? Talk about what happens to the plants and animals as the water disappears. Examples include:

- Migration of larger animals to more permanent waterways, such as rivers;
- Aestivation: Some animals, such as turtles and burrowing frogs dig into the mud to aestivate (sleep) through the dry times;
- Entering periods of dormancy: Some plants stop growing, but their roots remain protected in the soil until the next wet period.

Analysis:

As a class, research some examples of animals that use the mechanisms or strategies for survival over the dry period as discussed above.

Each student may like to create a poster about a particular type of aquatic animal and how it lives in the water. If the students work in groups, they may make up a play about the animal.

Extension:

As a class, create a mural of a billabong, including local animals and plants which you would expect to find in this type of waterway. Yolgnu Matha names have been included. You may like to research local indigenous languages for the labelling of your own mural. Discuss and illustrate where each animal would go if the billabong was to dry up

English to Yolngu Matha Translations

Water Birds

English	Yolngu Matha
egret	gany'tjurr or gomu`u
brolga	gu[urrku
magpie geese	gurrumattji
jabiru	nama'
kingfisher	djirrintiti (didi for short)
kookaburra	garrukal'
duck	muthali
crested terns	ŋurula

Water Plants

English	Yolngu Matha
water chestnuts	Rakäy
lotus lily	Dhatam
lotus lily bulbs	Nindan or Burpu
water lily	wäkwak or dhoŋgu
reeds	garriyak
Bullrush	Gulwani'
pandanus nuts	gunga
mangrove ferns	mayawarku
mangrove holly	banuminy
Leichart pine	Rulkarri
Cannonball mangrove	Gukawu
vines	gathurrmy
red flowered mangrove	milinyarr
swamp fern	garku
Flagellaria	Darwirr
grass	ritharr
mangroves	gathul'
yellow flowered hibiscus (Yirrkala creek)	mapadhurr
water lily bulbs	nin dan burpa
special grass	bulmirri

Water Animals

English	Yolngu Matha
macroinvertebrates	gapuwuy nhäŋiniŋ
snails	men duŋ
shrimp	marki
leech	djalŋiny
mussel	djarrwit
worm	mewirri (raypinpuy gapuwuy mewirri)
water mite	gapuwuy djuku
baby mozzie	borrutj yothu
sandfly larvae (midgee)	mindjirri yothu
water scorpion	dimidimi
tadpoles	wolkwulk
beetles	momu-ŋaniy
beetle larvae	miyiru
true bugs	yir'yirŋani
caddisfly larvae	momu-ŋani
dragonfly nymphs	dikarr-ŋani buku-warthunaya
file snake (live near Lotus Lilies)	djaykuŋ'
mangrove jack	Djembirri
crocodile	bäru
crocodile eggs	bäru mapu' or lanyarr
crocodile nest	ŋulurr or ngulwurr
small bandicoot	wan'kurra
big fish	balin
small fish	ratjuk
archer fish	watpirriyi or nyingagyina
black brim	matpuna
cat fish	wilitjwiltj
garfish	nyuŋula
crab (mangrove, red and yellow nippers)	ginybirk
pignose turtle	madalatj
long necked turtle	minhala
big freshwater turtle	ŋokawu
freshwater stingrays	guyapindi
bats	mattjurr'
owl	worr'wurr
frogs	garkman
buffalo	detuŋ or mewuŋ
pigs	norrŋ'norrŋ
feral	wakinŋu
water rats	nyiknyik

butterflies	bonba
olive python	wititj
water python	mokumilŋiny'mi (gatj)
eel	rangu'
cockroach	boduk (with white stripes)
green ants	ŋarmuk
honey bees (go looking for water)	dawurr
freshwater mussels	djarrwit
grey teal	muthali

Life in Our Waterways

B3-B5

(Adapted from Waterwatch Education Kit. 1997 Waterwatch Vic, Barwon Water)

Activity 13

Curriculum Links:

SOSE Environment / Natural Systems Env 3.3, Env 4.3 Env 5.3

Science Concepts and Context / Life and Living CC 3.2, CC 4.2, CC 5.2

Focus Questions:

- **What are some of the organisms that live in the aquatic habitats of the NT?**

Aims:

1. To become familiar with some freshwater plants and animals.
2. To develop an understanding of what aquatic animals eat, where they live and what adaptations they possess for life in an aquatic environment.

Need:

"What Am I" card template one copy per student. Safety pins.

Additional references:

Wetlands Wildlife: Gould League of Victoria.
Ponding: Gould League of Victoria.
Water Plants in Australia: Sainty & Jacobs.

Consider:

Explain the terms invertebrate, macro-invertebrate, crustacean, nymphs, larvae, detritus and carrion (see glossary).

Decide which local wetland plants and/or animals to include in this activity.

Analysis:

Students research and prepare the cards for the 'What Am I?' game.

Use the 'What Am I' to increase the students knowledge of aquatic plants and animals by holding a quiz session.

Students research and prepare posters to illustrate the aspects of the chosen species as listed for the 'What Am I' card.

Use the poster as part of a presentation to the class to explain how the support, transport or reproductive systems of their aquatic plant or animal helps it to survive in a wetland environment.

Use the cards or posters to demonstrate food chains.

Habitats:

Create a class mural of a cross section of a river scene, showing different kinds of micro-habitats. You could include fallen branches, pools, riffles, stones, and vegetation. Use the mural to review ways the river bank vegetation is important to aquatic habitats(shade, shelter and food supply). Students draw the plant or animal identified in their 'What Am I' card in the correct location.

Students research and write a story about a day in the life of an aquatic animal, describing how it lives and what type of habitat it needs. Explain how a change in water availability or quality could affect its survival?

Reflection:

How does Waterwatch monitoring involve the study of life in our waterways? Why do you think this monitoring is important?

Student Sheet 3.4
What Am I?

Plant/Animal name	
What it eats	
What eats it	
Preferred aquatic habitat	
Special features	
An illustration	

Adaptations for Seasonal Changes

B3

Activity 14

Curriculum Links:

SOSE Environment / Natural Systems Env 3.3

Science Concepts and Context / Life and Living CC 3.2

Focus Question:

- **What is metamorphosis and how does it enable survival in seasonal climates?**

Aim:

To understand the concept that lifecycle strategies are a form of adaptation to a particular environment.

Main Idea:

- An aquatic macro-invertebrate is an animal without a backbone, that spends all or part of its life in water.
- Many aquatic invertebrates undergo metamorphosis. The word metamorphosis comes from *meta* (change) and *morph* (shape) – a change in shape, not just size.

Need:

Research materials, macroinvertebrate survey equipment and the NT Guide to Macroinvertebrates (included in this education kit)

Consider:

There are two types of metamorphosis

Metamorphosis involving nymphs.

(Example:dragonfly)

The egg hatches into a small nymph which grows through a number of size stages (called instars). This is usually the long part of the animal's life. Finally, for an aquatic invertebrate like a dragonfly, it emerges from the water as an adult.

The adult dragonflies then mate on land. The female then lays her eggs on plants that grow near water. Often the eggs will not hatch for several months until the rains of the next wet season wash them into a waterway.

Metamorphosis involving larval and pupae stages.

A well-known example is the life cycle of the mosquito. Eggs hatch into larvae, which after a period of time will attach to a plant or rock and becomes a pupa. The pupa then splits to reveal the adult.

The *NT Guide to Macroinvertebrates* provides examples and pictures of nymphs and larvae which live in our waterways

Analysis:

Students prepare a poster depicting the various stages of aquatic macroinvertebrate of their choice which undergoes metamorphosis

Extension

Contact your regional Waterwatch coordinator to undertake macroinvertebrate sampling. Macroinvertebrates are considered to be biological indicators, this means sampling can reveal information about the health of a particular waterway.

Adaptations of Macroinvertebrates

B3

Activity 15

Curriculum Links:

SOSE Environment / Natural Systems Env 3.3

Science Concepts and Context / Life and Living CC 3.2

Focus Questions:

- **What adaptations enable animals to live in aquatic environments?**

Aim:

To recognise the different features of macroinvertebrates which have enabled them to adapt to a variety of environments.

Main Idea:

- Aquatic macroinvertebrates are an important part of aquatic environments and food chains.
- Many macroinvertebrates are sensitive to the condition of the water. Measuring their presence or absence is one good way to measure the quality of the water.
- Macroinvertebrates are found in greatest numbers in riffle areas. Stones provide places for attachment and predator evasion. These areas are oxygen rich environments and algae growing on the rocks can also provide oxygen, food and shelter.

Need:

Art and craft materials.

Consider:

Life in the fast lane:

Small animals living in moving water need to be able to hang on so they are not swept away. They often have special hooks or suction attachments to hold onto rocks or vegetation. They often have streamlined or flattened surfaces. Some build structures to keep themselves in place. Food is grabbed as it passes by in the water rather than being chased.

A quiet(er) life:

The animals in quiet waters do not have to hold on all the time. They have to chase their food so need to move more than riffle species. Some have special adaptations to live on the surface, some on the bottom. Some live in the leaf litter around the edges and others burrow into the soft sediment.

Worms that live in mud need to have ways to cope with the low oxygen levels in the mud. Some aquatic worms have blood pigments that are very efficient at picking up the oxygen that is present. Another way some animals cope with low oxygen levels is to increase the rate that oxygen passes over their gills.

Analysis:

Draw or create and three dimensional stream, which shows the different types of habitats that macroinvertebrates can inhabit.

Reflection:

What might happen to the total number of macroinvertebrates at a site if there was only one habitat type present – compared to a site that had several habitat types present?

Take Home Messages

B1-B3

Activity 16

Curriculum Links:

SOSE Environments / Environmental Awareness and Care Env, 1.2, Env 2.2, Env 3.2

Aim:

To share knowledge with family and friends, which emphasises the importance of looking after our planet's water resources.

Main Idea:

- Interesting facts about aquatic ecosystems and habitats can be shared by all.

Need:

Pens, scissors and card, magnets or double sided sticky tape/blue tack.

Consider:

Students may use the samples below or they may want to make up their own 'learnings'.

Analysis:

Cut the following cards out and use them at home. Students may pass onto a friend or family member.

Did You Know?

The coastal floodplains of the NT contain Australia's largest areas of relatively unmodified wetlands, covering an area of approximately 10 000 km^2

Did You Know?

An estuary is an area where saltwater from the sea mixes with freshwater from the land, examples include the mouths of a rivers, salt marshes and coastal lagoons.

Did You Know?

Inland rivers do not have opportunity to drain to the ocean. Instead river channels move towards landforms called flood-outs.

Did You Know?

A habitat is a place that provides food, water and shelter for plants and/or animals that are occupying and using the space and resources.

Did You Know?

There are twenty-nine varieties of fish, which occur in the harsh, ephemeral waters of central Australia. These species are well adapted to live in waters, which vary over a great range of salinities, temperature fluctuations, and oxygen levels.

Did You Know?

Adult barramundi males turn into females to breed.

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