CHAPTER

FOUR

The rival Billabong supermarket offers:
file-snakes, lily roots, spike-rush nuts,
long-and short-neck tortoise-meat
duck-and plover-eggs laid this morning,
and the price is always right.

MEETING PLACES

A river floodplain is one of the special places in the landscape where two very different environments, land and water, meet and overlap. Ecologists call such boundary zones 'ecotones', and they are invariably biodiversity hot spots. Ecotones harbour species from both neighbouring environments, and often — as with floodplains — many species unique to themselves. When two environments merge with each other in this way, the transition zone is usually rich with food and small-scale habitats. Because of this, ecotones provide crucial breeding and feeding grounds for species from both worlds. They also provide safe refuges in times of environmental stress, such as droughts.

Some animals will go to great lengths to make use of ecotones. Fish and birds travel enormous distances to breed in estuaries, mangroves and similar coastal wetlands, where swarming populations of invertebrates scavenge on the rich pickings of the shoreline and the shallow waters beyond — called the 'littoral' zone. Floodplains, and the water-bodies they support, appear to play a similar role in Australia's inland.

NATURE'S FOODBOWLS

Floodplains contain a great variety of different waterbodies, a few of which are permanent. All are replenished, regularly or irregularly, by floods. Such waterbodies include intermittent lakes, billabongs (or lagoons) and various types of flood runners (deep channels that only have water in them during high floods), as well as backwaters, anabranches and creeks. Equally importantly, river floodplains also contain swamps, marshes and other intermittently wetted areas, all of which play crucial roles in conserving river health. Indeed, the whole of a river floodplain can be considered a single, but extremely diverse, wetland. One recent study of the Murray and Edwards rivers identified 17 categories of riverine wetlands, 12 natural and five artificial. (6). Under natural flow, large floods periodically connect all the wetland components to each other and to the parent river, while more frequent, smaller floods connect only the lower-lying portions.

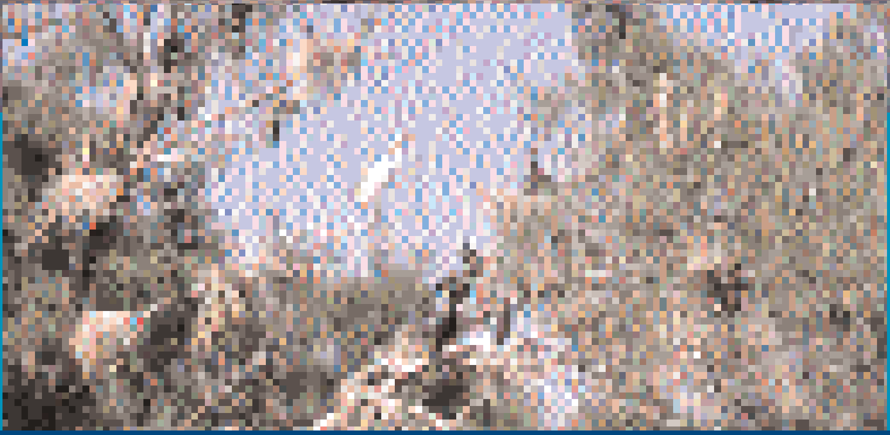
Typically, floodplain waters are shallow, still and clear — although often stained dark by tannins — with leaves and nutrients constantly entering them from the land. Flowing water in river channels is deeper, and often murky with suspended sediment, making it harder for light to enter and for water plants and algae to thrive. People often think of standing water as being stagnant and dead, and running water as clean and alive. In fact on floodplains the opposite is closer to the truth.

Plants are very important to aquatic life, as food and for habitat. In Australia's inland river channels, where relatively few water plants now grow, there are relatively few aquatic animals. Those animals that do live in river channels cluster around submerged snags and tree roots. On floodplains, where at least 100 times more species live, most aquatic animals live among the stems and leaves of water plants and algae. For example, scientists have found at least 65 species of invertebrate animals living among the dangling roots of azolla plants.

On floodplains there is frequent interaction, at all levels, between the land and the water. Creatures that live on floodplains have evolved to take full advantage of their changeable, dual environment. Creatures that live in river channels have also evolved to take full advantage of these exchanges, and to depend on them. For example: a large proportion of the insect food of native fish comes not from the water, but from the trees above. Drowned tree-dwelling insects are an important food source for river fish, just as decomposing leaves are an important food source for the bacteria which form the bottom of floodplain food chains.

Energy flows

Most life on Earth is solar powered. There are a few exceptions — such as the strange creatures that live around hot water vents on the bottom of deep ocean trenches, and those humans who use nuclear power. Even the filter-feeding mussels which use the energy of river



The wetlands of the Macquarie Marshes comprise a complex of braided channels, swamps and black clay floodplains on the lower Macquarie River in New South Wales.

Photos: *David Eastburn, MDBC*

Ibis rookery in lignum. Narran Lakes.

Wetlands in the Murray-Darling Basin that are of international importance & listed under the Ramsar Convention

See map page 25

State	Wetland	Area in ha
South Australia	1 Coorong and Lakes Alexandrina and Albert	140 500
	2 Riverland, including Chowilla Floodplain System	30 600
Victoria	3 Hattah-Kulkyne Lakes	1 018
	4 Lake Albacutya	10 700
	5 Kerang Lakes	9 172
	6 Gunbower Forest	19 450
	7 Barmah Forest	28 500
New South Wales	8 Macquarie Marshes Nature Reserve*	18 200
ACT	9 Ginini Flats, Namadgi National Park	125
Queensland	10 Currawinya Lakes National Park	151 300

* The full extent of the Macquarie Marshes is some 200 000 ha. Source: ANCA 1996.

currents to deliver food particles to their gills are really drawing on solar energy, because the sun drives the rain cycle which sets the water flowing. The fact that the sun drives nearly all life is one of the few certainties in ecology.

Many organisms are photosynthetic — they have their own ‘solar panels’ for capturing energy from the sun. But instead of generating electricity, as artificial photoelectric cells do, photosynthetic organisms store the energy they capture in special carbon-based chemicals, such as sugars. The sunlight-absorbing parts of plants, small lens-shaped lumps in leaf cells called chloroplasts, are coloured green. Other photosynthetic organisms, such as algae and many bacteria, contain other pigments as well as chlorophyll, giving them their red, brown, yellow and blue colours. As well as providing energy for (nearly) all life on Earth, photosynthesis also generates the oxygen we breathe and removes carbon dioxide from the air (Chapter 8).

Organisms which don’t catch sunlight themselves must get their energy by eating organisms that do, or by eating organisms that eat organisms that do — and so on. Ecologists trace the trade in energy as it passes up the food chain, from the primary producers that first catch energy from the sun, through various intermediary consumers to the top-order predators. A lot is wasted along the way. Organisms like plants and algae, which catch the sun, make up most of the living matter, or ‘biomass’, of any system. The top order consumers, although often individually quite large, account for only a tiny percentage of the total biomass.

Ecologists often talk about an energy pyramid, with photosynthetic organisms making up its bottom and large, flesh-eating predators at the top. In a freshwater ecosystem, for example, some of the sunlight landing on a photosynthetic organism (for example, a single-celled alga) is captured and stored as energy. When that alga is eaten by a microscopic grazing animal (perhaps a rotifer or a protozoan — Chapter 9), as little as 10 percent of the energy it has gathered in its lifetime might be passed on to the predator. And when that microscopic grazer is eaten in turn, say by an insect, only 10 percent of its energy may be passed on again. So a fish which eats the insect, just four steps up the pyramid, might collect only one 10th of one percent of the energy originally caught by the algae. Which means it takes an awful lot of algae to support just one fish. By the time a human catches the fish and eats it, the tip of the pyramid is getting very narrow indeed.

Of course the percentages quoted above are hypothetical. The energy passed on at each step, or ‘trophic level’, varies considerably. However, energy always dissipates rapidly up the food chain — most is used for moving around or is lost as heat; very little accumulates as digestible tissue. Because food chains are so energy inefficient, they cannot go up many trophic levels. There are seldom more than four or five steps between the primary producer at the bottom of the chain and the peak predator, such as the fish-eating human, at the top.

Of course the trophic flow doesn’t stop with the top-order predator; when the fish-eating human dies, bacteria and other decomposers recycle it back into the food chain. Indeed, most of the energy that drives life in floodplain waters comes from dead, rather than living, organic matter. The bottom of the food chain in a billabong is most likely to be a nearby river red gum, which sheds leaves, bark and twigs into the water, providing food for bacteria. The bacteria in turn are grazed by tiny animals, such as protozoans, and so on up the food chain. Vegetation and litter submerged by intermittent flooding is a major source of life energy for inland waters (Chapter 6).

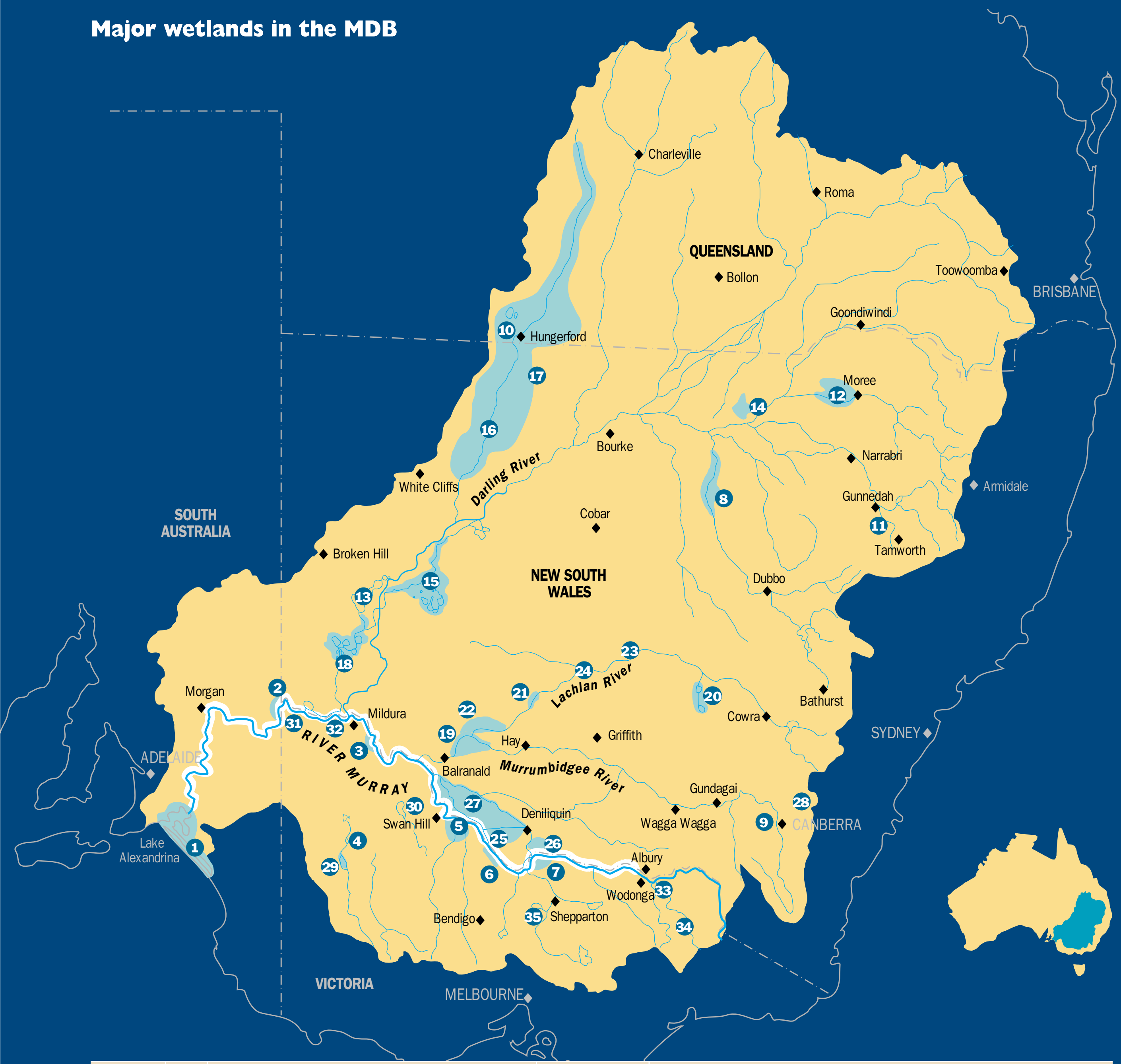
As well as energy, important chemical compounds — such as vitamins, — are also passed up the food chain. An animal that can’t manufacture its own supply of an essential chemical has to eat something that can. Some of these compounds are used up in life processes, others are excreted or passed on to the next level virtually unchanged. Indeed, some chemicals actually accumulate as they ascend the trophic ladder. The best known examples are heavy metals, and non-biodegradable pesticides such as DDT. Such substances might wash into floodplain waters at vanishingly low levels, in soil or in leaf litter. But because they can’t be degraded or excreted by organisms, the food chain acts as a kind of amplifier, in a process called ‘bioaccumulation’.

For example, in the first hypothetical billabong food chain described above, a toxin might be present at very low, safe levels in the algae at the bottom of the food chain. A microscopic grazer might eat and digest the algae, using the algae’s energy and excreting any waste,

Important wetlands of 5 000 ha or more in extent (excluding the Ramsar sites)

State	No	Name	Area in ha	Location
NSW	11	Lake Goran	6 000	Liverpool Plains
	12	Lower Gwydir Wetlands	102 120	Lower Gwydir River and Gingham Watercourse
	13	Menindee Lakes	45 000	Lower Darling River, near Menindee
	14	Narran Lakes	10 000	Terminal drainage of Narran River
	15	Talyawalka Anabranch & Teryawynia Creek	H /variable	Darling River between Wilcannia and Menindee
	16	Paroo Overflow	720 000	Paroo-Warrego Riverine Plains
	17	Yantabulla Swamp	37 200	Paroo-Warrego Riverine Plains
	18	Darling Anabranch Lakes	269 000	Darling River Plains on Great Anabranch
	19	Lowbidgee Floodplain	200 000	Murrumbidgee River between Maude and Balranald
	20	Lake Cowal-Wilbertoy Wetlands	29 000	Lachlan River Floodplain between Forbes & West Wyalong
	21	Booligal Wetlands	5 000	Floodplains of Lachlan River distributaries
	22	Great Cumbung Swamp	50 000	Lachlan River Floodplain near Oxley
	23	Lachlan Swamp	6 600	Mid Lachlan River

Major wetlands in the MDB



State	No	Name	Area in ha	Location
	24	Lake Brewster	6 114	Lachlan River Floodplain
	25	Koondrook and Perricoota forests	31 150	River Murray, between Moama and Barham
	26	Millewa Forest	33 636	River Murray, between Tocumwal and Barmah
	27	Werai Forest	11 234	Along Edward and Niemur rivers
	28	Lake George	15 000	Between Canberra and Goulburn
Vic	29	Lake Hindmarsh	15 600	North-west of Jeparit
	30	Lake Tyrrell	20 860	North-west of Sea Lake
	31	Lindsay Island	15 000	Near Mildura
	32	Wallpolla Island	9 200	Near Mildura
	33	Lake Hume	18 465	Near Albury-Wodonga
	34	Lake Dartmouth	5 990	On Mitta Mitta River
	35	Lower Goulburn River Floodplain	13 000	Below Goulburn Weir
		Source: ANCA 1996.		

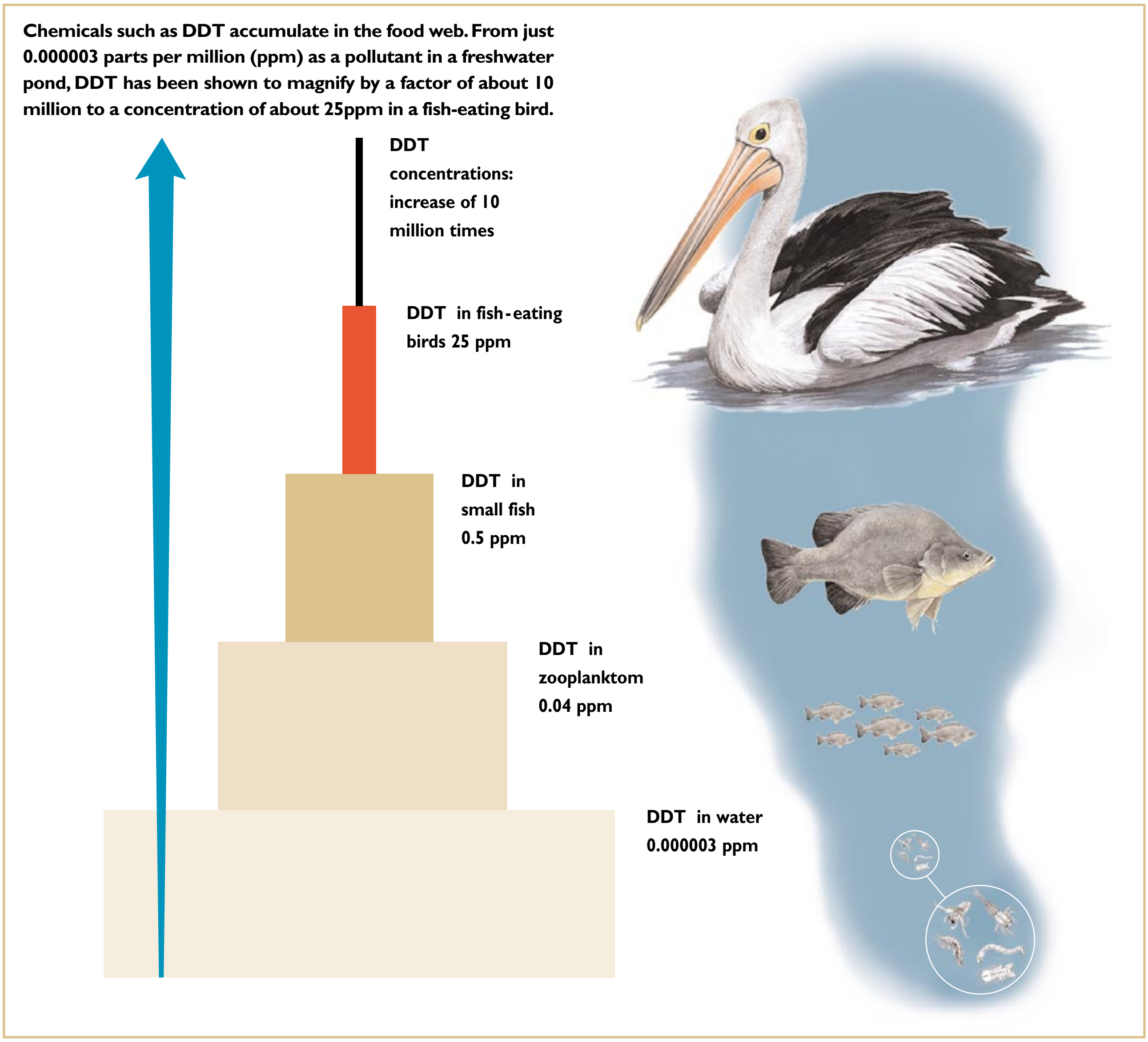
but the chemical would remain in its body. The more algae the tiny animal ate, the more of the toxin it would accumulate. If, over its life, it ate 10 times its own weight in algae, the microscopic grazer would end up with 10 times the background level of the chemical in its body. Similarly if the insect ate 10 times its weight in microscopic grazers, it would end up with 100 times the background level of toxin. The insect-eating fish, in turn, might end up with 1,000 times the original level. And any hapless humans who ate 10 times their weight in fish from the billabong — which they might do over many years — would end up accumulating 10,000 times the original level of the toxin.

There is a very important qualification to the pyramid model, particularly for aquatic food webs. At any given time the organisms at the bottom of a floodplain food chain, such as bacteria, may not in fact contain more biomass than the organisms at the top. For example, yabbies, which are quite high up the trophic ladder, nevertheless account for a large proportion of the biomass of inundated floodplain sediments. Similarly in some marine environments fish have been found to account for anything up to a third of the biomass. The yabbies and fish aren't breaking any laws of physics or ecology; the secret lies in what scientists call 'flux', or biological turnover.

Bacteria breed quickly. In theory a single bacterium dividing repeatedly could cover the entire planet with offspring in just a few days. But of course bacteria never get the chance; larger, slower-breeding creatures graze on them as fast as they appear. A protozoan might eat 1,000 bacteria over its lifetime, but at any one time there might be only 10 in the colony it is grazing on. As fast as the protozoan eats them, the bacteria reproduce. From the point of view of the protozoan, the bacteria are like a never-ending magic pudding. In an ecosystem that turns over very fast, as a floodplain waterbody does, a predator at any given moment might have more biomass than all its prey put together. But over the life of the predator, the prey will still weigh in with far more biomass — the pyramid still holds.

Of course food webs on floodplains, or anywhere else, aren't as simple and linear as the simplistic example given above. In real life they are very messy and complicated. But tracing the energy flows and the chemical pathways gives important insights into the way ecosystems work.

Biological magnification of DDT in a food chain



Chemicals such as DDT accumulate in the food web. From just 0.000003 parts per million (ppm) as a pollutant in a freshwater pond, DDT has been shown to magnify by a factor of about 10 million to a concentration of about 25ppm in a fish-eating bird.