CHAPTER SIX

Land dries in patches on the grey tide-plain,
rising smooth and abruptly
as a whale's back, assembling
soft carve-and-come-again islands

A NEW WAY OF LOOKING AT FLOODPLAIN RIVERS

Scientists struggling to understand how river systems work have suggested a new way of thinking about floodplain rivers; an intellectual framework they call the 'flood-pulse concept'. The flood-pulse concept is complementary to, but distinct from, the 'river continuum concept', which previously shaped ecological thinking.

The river continuum concept describes a river's long journey from its headwaters to the sea, observing the gradual changes in the qualities of its water and its mix of species along the way. Typically rivers collect litter, nutrients and sediment from their catchments, which drive life in their upper sections. However, as the rivers flow to the sea their downstream, slower-flowing reaches support increasing amounts of photosynthetic species — such as algae — which recycle the nutrients fed in upstream and which fix their own energy from the sun. Life in such rivers follows a continuum, from an upland ecology driven largely by decaying litter to a downstream ecology fed chiefly by algae and water plants.

WHY RIVERS NEED FLOODS

The flood-pulse concept, developed to describe floodplain rivers overseas, is quite different. It sees the inundation of floodplains as the main driving force behind river life, with the most important ecological processes happening across a river and its floodplain, not along it. In a flood-pulse river, the flooding cycle is more important than any gradual, downstream shift in ecology along a river's length — the river is more like a long, continuous ocean shoreline than a conduit carrying water from the mountains to the ocean.

The flood-pulse concept is still in its infancy in Australia, and has led to more questions than answers about how Australian rivers work. But already it has led scientists to think differently about floodplains, and to suggest new approaches to studying and managing them. For example, in a flood-pulse system, the interplay of organic matter, nutrients and energy between rivers and floodplains is enormously important. A major question for scientists is what materials floodplains supply to and receive from rivers — that is whether floodplains are 'sources' or 'sinks' for organic matter, sediments, chemicals and energy.

What feeds what: sources and sinks

Whether floodplains behave as sources or as sinks for different materials has enormous implications for riverine ecosystems, from the health of native fish to the control of blue-green algal blooms. Scientists believe that under natural conditions rivers supply water, nutrients and sediments to floodplains; while floodplains supply carbon (the main chemical building block of life), living organisms and water-treatment to rivers, and breeding grounds for riverine plants and animals. In short: floodplains rid water of excess nutrients and other pollutants, and supply rivers with food and life.

Ecologists now suspect that much of the carbon needed by river life is supplied by floodplains during floods, and is not taken up from the air in-stream by water plants and algae, or fed into rivers from their catchments. If so, rivers isolated from their floodplains may no longer be able to support large numbers of fish and other organisms. In such a scenario, floodplain waterbodies and vegetation are very important indeed — billabongs, swamps, lakes, marshes and flood runners may well be the main food supply for rivers.

Flooding is essential to maintain healthy rivers and floodplains. Most native fish species have evolved to take advantage of seasonal flooding, with the increase in food on the floodplain, to spawn. River regulation has reduced the numbers of small and medium floods, impacting on breeding opportunities. Photo: *David Eastburn, MDBC*

The golden perch is a highly migratory fish whose movement has been restricted by weirs and other barriers in waterways. Photo: *Gunther Schmida*

Above: Flood below Hume Dam, 1996.

Below: Flood at Wentworth, 1956. Photo: *MDBC*

Some researchers believe floodplain waters act like concentrated stock cubes, packed full of tiny living organisms and the chemical building blocks needed by river life. During floods, this 'stock' is diluted and spread far and wide, seeding life in floodwaters and the river, and providing food for newly hatched native fish, birds and other creatures (Chapter 10). If this stock cube model is correct, the longer the period between floods, the more impoverished river life will become.

However, scientists have not been able to trace the exchanges between rivers and floodplains in any detail, nor can they say with confidence how changes to the flooding regime might affect them. A complicating factor is that a floodplain may behave as a sink for certain materials under some circumstances, and as a source under others. For example, when a small, brief flood enters a red gum forest, it may pick up organic material and nutrients and wash them back into the river. But when a large, long-lasting, nutrient-rich flood rolls out onto the floodplain it may do the opposite — it may lay down enough silt and nutrients to feed the trees for years to come; nutrients which will gradually return to the river, as fallen leaves, in subsequent, smaller floods. Whether a floodplain behaves as a source or a sink probably depends upon the size, season, frequency and duration of floods; as well as the condition of its vegetation and soil; and the state of its waterbodies — all of which have been changed since European settlement (Chapters 11-13).

The season of a flood may be particularly critical. Because gum trees shed most of their leaves in summer, a late winter or spring flood will find a thick carpet of part-decayed (or 'conditioned') eucalyptus leaves, while a summer flood might find the leaves fresher, tougher and containing toxins which may be lethal to fish (Chapter 10).

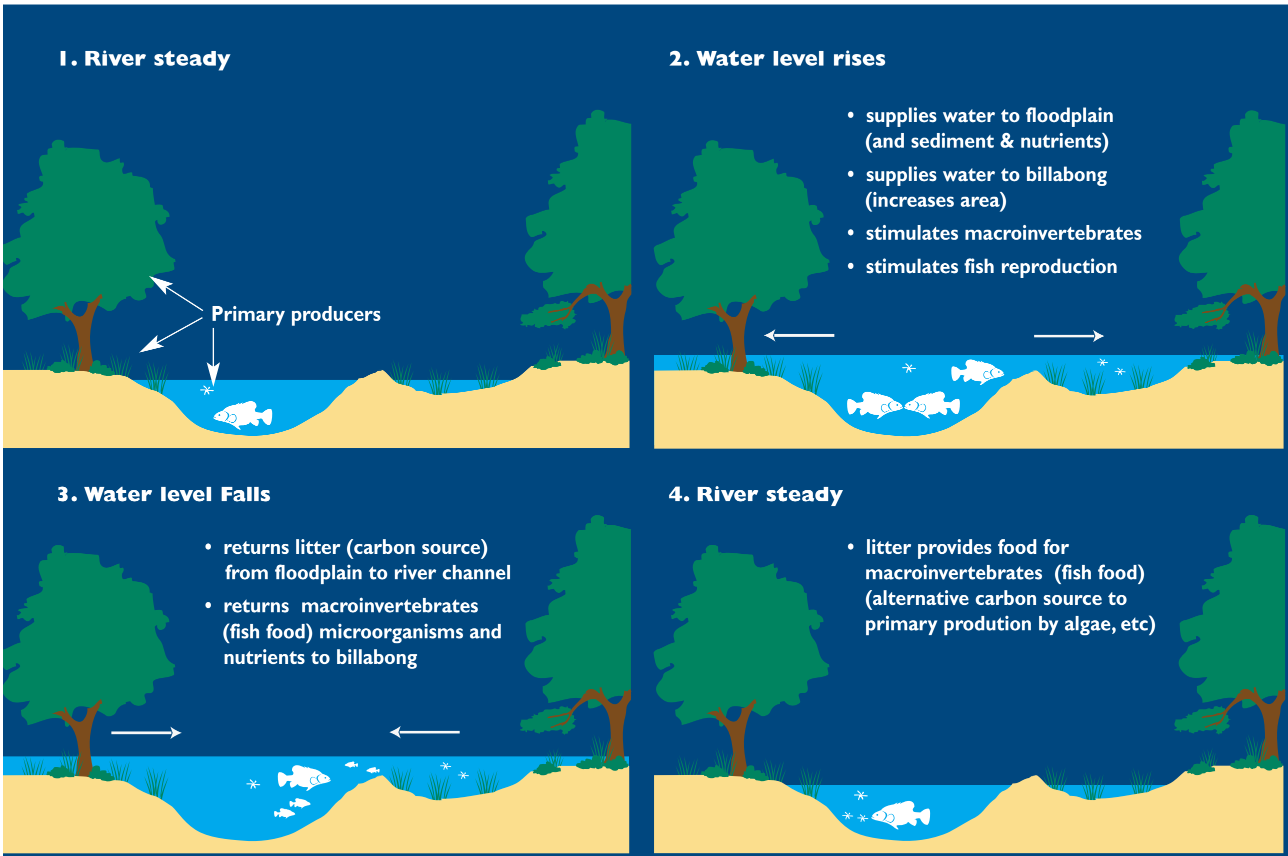
One very strong hint about the changeable behaviour of river floodplains is that over the past decade scientists have discovered that marshes and swamps can vary enormously in the amounts of nutrients they remove from floodwater. Recent research has found that intermittent wetlands can even sometimes add more nutrients to waterways than they remove, particularly when they are first wetted. The movement of groundwater through wetlands can also effect the extent to which they filter nutrients from surface water.

Flooding: the kiss of life

Wetting dry floodplain soil has multiple effects, all of which give a dramatic 'kick-start' to life in the water. This burst of sudden life, when water touches dry soil, is a short-term effect. The biological productivity of floodwaters peaks quickly, then slowly falls away until it reaches a new, lower plateau. Water that has been standing for a long time cannot support the same rapid biological growth as a fresh flood. Floodplain species are well-adapted to take advantage of this sudden surge of vitality.

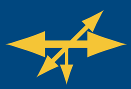
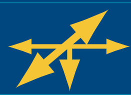
Wetting dry soil releases a surge of chemical nutrients. It also awakens the many different small, freshwater species that have lain dormant since the last flood. Wetting speeds up the breakdown of organic matter and cuts off the air supply to soil bacteria and switches them from aerobic to anaerobic forms (Chapter 8). It triggers breeding behaviour in plants and animals (Chapter 10); it attracts opportunistic species from afar; and it reconnects isolated pockets of water with each other and with the parent river. New waterborne species are introduced during the wetting process and large numbers of new living spaces created. The exchange of chemicals between the soil, the water and the air is also altered.

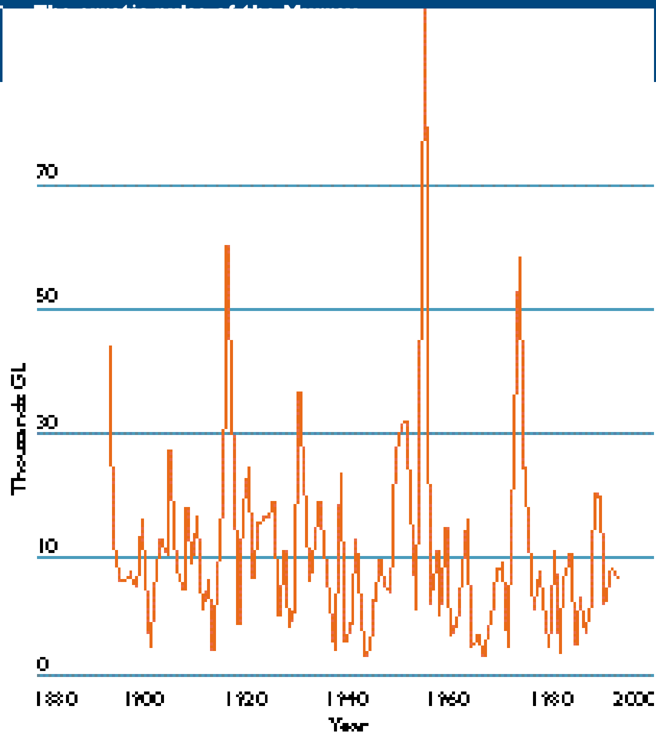
Within hours of wetting, floodplains teem with tiny aquatic animals, most too small to be seen with the naked eye. Within days



The flood-pulse concept emphasises the interplay of organic matter, nutrients and energy between rivers and floodplains.

Model river system

	Mountain headwater reach	Braided reach	Meandering reach
			
Channel pattern	single thread, straight	multiple braids	single thread, meanders
Channel stability	constrained	highly unstable	migrating
Floodplain development	little or none	moderate	expansive
Wetland vegetation	narrow riparian corridoor	pioneer community	pioneer to mature stages
Aquatic habitat	lotic (running water)	lotic, semi-lotic	lotic, semi-lotic lentic lentic (standing water)
Interactive pathways (movement of nutrients from river channel — floodplain)			

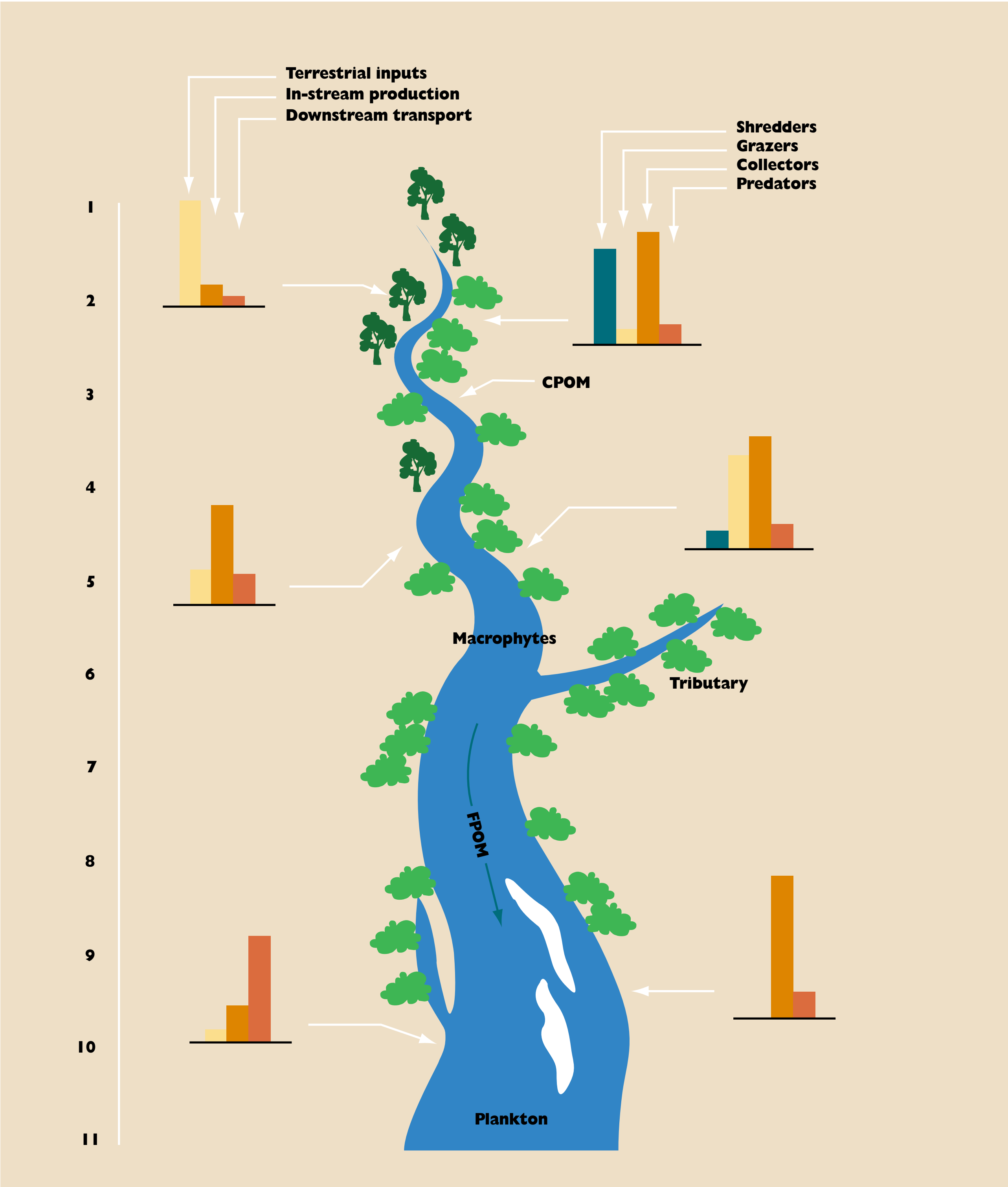


larger creatures — such as worm-like midge larvae — appear, feeding on the small animals and on decaying organic matter. These larger creatures, in turn, provide food for even bigger animals. Adult midges swarming just above the surface of the water, for example, are gulped down by newly arrived ducks (Chapters 9 and 10).

The reasons newly-wetted floodplain soils usually, although not always, give forth a sudden surge of chemical nutrients are complex. The surge is partly a legacy of the last flood, partly due to the physical and biological effects of wetting dry soil, and partly due to the rapid breakdown of the vegetation and organic matter which has built up between floods. When floodwaters recede or evaporate, the organic matter they carry is deposited on the floodplain soil. This is added to by leaf litter, grass, manure and other floodplain vegetation. This organic matter breaks down slowly when dry, and over time it accumulates. But when organic matter is wetted, its rate of decomposition accelerates, releasing nutrients into the water. Wetting also cuts off the oxygen supply to soil bacteria, switching them from aerobic to anaerobic production, which releases nutrients into the water in forms available to life.

The sudden spike of nutrients after wetting was first recorded in South African farm soils nearly 50 years ago, but has been little studied on Australian floodplains. However, it underlies much of the current scientific thinking about the role of floodplains in river ecology. Some native fish for example, breed successfully only in flood years, and appear to be highly adapted to take advantage of the surge in progressively sized food triggered by the wetting of dry floodplain soils (Chapter 10). In many ways the effect of flooding is similar to that of fire. The kinds of dry materials which might otherwise build up to fuel bushfires are quickly decomposed when they are wetted, and the carbon they contain is made available to river life.

River continuum concept



The river continuum concept depicting a river channel and riparian vegetation as the river grows from first order (top) to 11th order. Bar charts on the left indicate relative importance of energy sources and, on the right, relative abundance of invertebrates in different feeding groups. CPOM and FPOM are, respectively, coarse and fine particulate organic matter.