Fig. 33 Distinctive forms created by oioi restiad rushland, New River Estuary, Southland. These 'pikelets' are elevating themselves above the level of mudflats and tidal channels as the rushes trap sediment. They are 50–80 m across, but still actively expanding at their margins.

emergent foliage (see Fig. 94). Organic matter settles into the thick soup of underlying water, but may also accumulate as sedentary peat on the surface, eventually leading to a domed bog, yet still with a body of water beneath.

2.6.3 Forms of standing open water

Depending on their size and setting, bodies of standing (i.e. non-flowing) open water can be wetland hydrosystems or classes in their own right, or they can be inclusions within other wetland classes (Fig. 34). Lakes are the largest and they can be arbitrarily defined by having a major dimension of 0.5 km or more, the criterion used by Irwin (1975a) in his checklist of New Zealand lakes. Nevertheless, many smaller bodies of water, including some dune lakes, kettle lakes, and oxbow lakes, could be validly referred to as lakes on the basis of depth, permanence, or the operation of typical lake processes such as stratification and wave-action. Thermal stratification

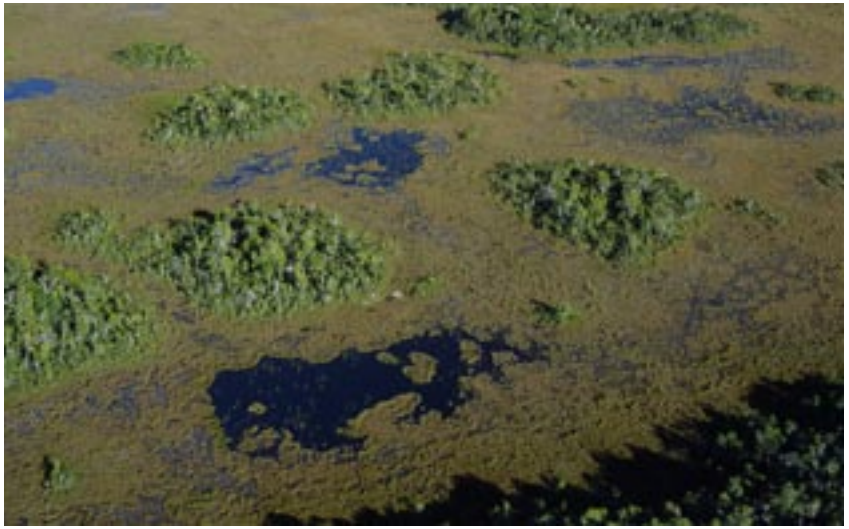

Fig. 34 Pools of shallow water are common in many palustrine wetlands, their shape, size, and distribution often being characteristic of particular wetland systems. These pools form part of a mosaic pattern with sedgeland, clumps and islands of reedland, and forested knolls in a Westland swamp system.

is the process whereby annual temperature cycles result in lake waters having horizontal layers of different densities. Monomictic lakes have a single period of stratification each year, generally in summer, alternating with a destratified period when mixing of the water layers, along with their nutrients and oxygen, is able to take place. Polymictic lakes have several periods of stratification and mixing each year. Amictic lakes are those which do not stratify.

A tarn is a small mountain lake (Fig. 35). A pond is an enclosed body of water, smaller than a lake, and often artificial, like the typical ponds of farmland. The term pool is applicable to an even smaller body of still water, often relatively stable in level, though it applies also, of course, to the deep and slow-flowing reaches of streams and rivers. The term peat pool is a useful one for pools within bogs and fens, these often having a characteristic rounded or oval shape, a relatively level base, and steep or overhanging peat margins.

A lagoon is a shallow lake, especially one that is permanently or periodically linked to a river, lake, or the sea. In New Zealand the term

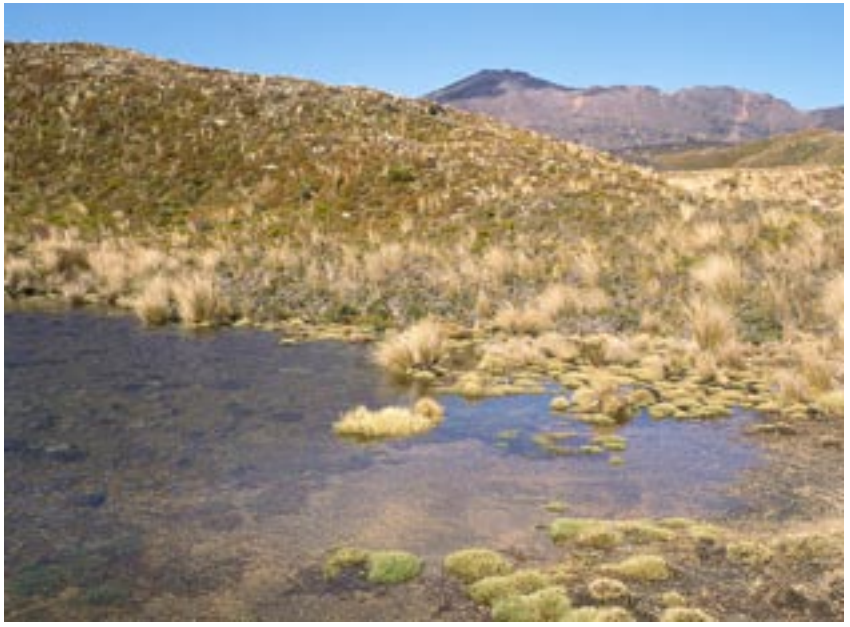

Fig. 35 An alpine tarn – or small lake – on the flanks of Mt Tongariro, Volcanic Plateau. This tarn has relatively little fluctuation, and is bordered by zones of cushion plants, tussockland, then shrubland.

lagoon is most often used for coastal lagoons (Fig. 36) but it is also used for inland examples. Coastal lagoons are separated from the sea by barriers of sand and gravel. They are usually shallow, often elongated parallel to the coast, with varying degrees of tidal prism and tidal mixing, and water that varies from fresh to brackish, and even to hypersaline where evaporation leads to salt concentrations (40‰ or more) exceeding than of oceanic water (c. 35‰). In the South Island, Kirk & Lauder (2000) recognise two distinct types of coastal lagoon: a 'hapua' type associated with the mouths of large braided rivers, having mainly freshwater but receiving some salt from spray and wash-over; and a 'Waituna' type (after Waituna Lagoon, Southland), more usually closed from the sea than open to it, having small inputs of river inflow, and with wind waves, currents, set-up, surge, and seiches as important mixing agents.

An estuary is a coastal body of water, partly enclosed by land but open to the sea, where seawater is diluted by land drainage, and where tidal effects

Fig. 36 Part of a coastal lagoon (Te Whanga Lagoon, Chatham Island) that is periodically open to the sea. In the background, beyond fernland and scrubland on blanket peat, are two coastal lakes, separated from the sea by dunes.

are evident. Many estuaries are located at the widened funnel-shaped mouth of a river, while others receive their freshwater only from streams (Fig. 37) and inflowing groundwater. Tidal rivers are those lowermost reaches of rivers affected by tidal flow or backwater, though these effects may have an influence further up-river than the inland boundary of the estuarine hydrosystem, defined by the place where marine salt concentration is 5‰. Harbours, inlets, and bays that are open to the sea have oceanic water and belong to the marine hydrosystem, but the deep and elongated fiords of high-rainfall Fiordland are distinctive as they receive considerable inputs of freshwater which persists as a permanent surface layer of low-salinity water buoyant above deeper seawater.

Man-made bodies of standing open water come in many forms, including hydro-electric lakes, reservoirs for irrigation or domestic water supply,

Fig. 37 A tidal creek in a bush setting, Stewart Island: an estuarine wetland with shallow water and a saltmarsh of *Puccinellia* grassland, influenced by gentle tidal ebb and flood flow, and by the mixture of freshwater and seawater.

farm ponds, ponds used for aquaculture, ornamental ponds, borrow pits, and ponds for the settling, treatment, or oxidation of discharges from stormwater, quarrying, mining, industry, and sewage.

2.6.4 Forms of flowing open waters and channels

Many wetlands either contain, are fed by, or are almost wholly composed of areas of moving water. Flowing waters within relatively permanent and well-defined channels will usually be classified within the riverine hydrosystem. Different portions of streams and rivers can be described by terms such as fall, cascade, rapid, riffle, run, glide, pool, backwater, bed, braid, and delta. Riparian habitats are those that occur along the margins of streams and rivers. Channels range in gradient from steep to gentle, and they may at one extreme be confined within a gorge (Fig. 38), or at the other extreme, free to spread laterally across a floodplain.

A braided river is one which carries a high sediment load, the ever-deepening shingle causing the river to follow numerous channels which

Fig. 38 A gorge (appropriately, Gorge River, south Westland) where extremes of flood discourage tall plants but encourage a broad zone of seepages.

repeatedly branch and rejoin, with an intervening pattern of low islands and shallow bars (Fig. 39). A meandering river or stream occupies a valley of low gradient, where the main channel is able to swing across the full width of its floodplain in sinuous turns called meanders (Fig. 40). As the channel shifts course the abandoned meanders (or oxbows when the cut-off river bend returns almost upon itself) can develop to marshes, ephemeral wetlands, swamps, or oxbow lakes.

Water channels that occur within palustrine wetlands are often too small or too slow to be called streams, but they can nevertheless display on a small scale many of the same sorts of adjacent features that can be seen on their larger counterparts. Much of the flowing water in palustrine wetlands is not channelled, but percolates as groundwater, or as a sheet of surface water (see Fig. 82).

As described earlier, the term seepage is here adopted for one of the wetland classes. A seepage (Fig. 41) is an area where groundwater percolates

Fig. 39 A braided river: one having numerous channels and carrying a heavy load of sediment, Waimakariri River, Canterbury.

to the land surface, the flow being less than that which would be considered a spring. A flush is a type of seepage that carries a periodic flush of water across the ground surface (Fig. 42). A spring is a stream emerging to the surface from underground at a point source (Figs 43 and 44). Both springs and seepages can emerge either upslope of, within, or at the toe of sloping wetlands. Their occurrence within a fen, for example, can be caused by an upwelling of groundwater through hydrostatic pressure, producing localised areas, sometimes as raised pustules, of enhanced aeration and nutrient status (Fig. 45).

Fig. 40 Stream meanders and oxbows of former channels are typical of a valley having a gentle gradient and a wide floodplain. This upland valley in the Garvie Mountains, northern Southland, holds a mixture of bogs and fens on the valley floor, and of seepages and pools on the opposite hillside.

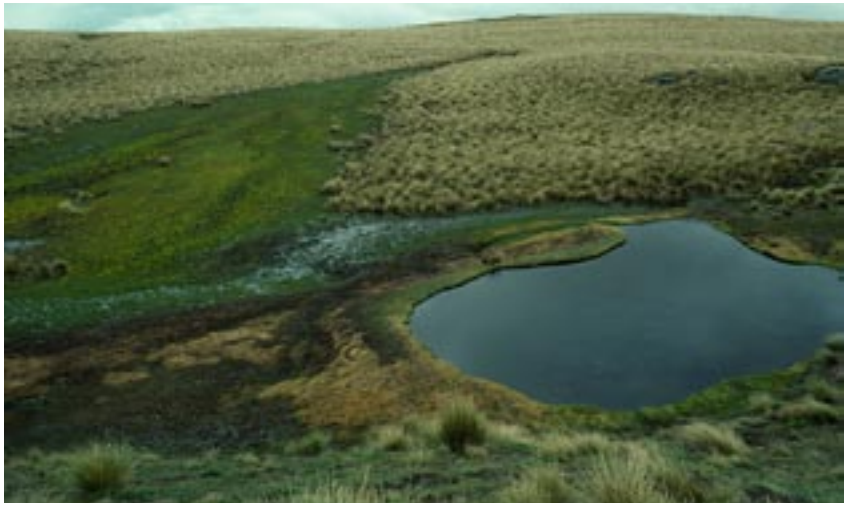

Fig. 41 A seepage complex on the Lammermoor Range, Otago, nourished both from the adjacent tussock grasslands and the peat-retained pool on right, showing how degrees of water movement and flushing have produced a fine-scale pattern of different vegetation types, distinguishable by their colours.

Fig. 42 A flush is a seepage that receives periodic pulses of water. This example, on a relatively steep mountainside, shows how heavy rain events have eroded a surface channel, and also deposited stones and gravel that are being incorporated in the peat, Garvie Mountains, northern Southland.

Continue to next file: WetlandsCOLOURe.pdf

Fig. 43 A spring, where water emerges from the ground as a point source (left) on the side of the Ahuriri Valley, northern Otago. The stable stream margin and the tufts of vegetation upon stream stones are indicators of constant flow and an absence of scouring sediments.

Fig. 44 A spring-fed stream near Twizel, inland Canterbury, where lush growth of herbs on the margins is indicative of a constant flow of well-aerated water and a moderate supply of nutrients.