Fig. 45 Part of a fen on the Lammerlaw Range, Otago, where an upwelling of groundwater is producing a raised 'pustule', bright green from lush herbs and liverworts, that is more fertile and better aerated than the surrounding sedgeland. The soft peat of such sites can be a trap for animals, such as the cattle beast whose remains are visible in this pool.

Seepages occur in many different situations, ranging from drip-channels on cliffs, to the splash-nourished sides of steep streams and waterfalls (Fig. 46), and to all the places where water oozes from the ground because of a change in slope, a layer of impervious rock, or an iron pan. Many seepages occur in hill and mountain country. A snowbank is a site on a mountainside which accumulates snow, is usually late to thaw, typically has a predominantly mineral substrate, is fully saturated during the weeks or months of snow-melt, yet at other times may be dry (see Fig. 81). Many snowbanks feed seepages that merge with and nourish flushes and fens downslope.

Man-made channels include canals, irrigation channels, open drains, and ditches.

Fig. 46 Waterfalls produce gradations of habitats affected by water flow, splash, or spray; usually with herbfield or mossfield, and can mostly be classified as seepages, Tongariro National Park, Volcanic Plateau.

2.7 Structural classes

This classification level is concerned with the general growth form or structure (physiognomy) of the vegetation, or the leading type of ground surface. The structure of vegetation results from the spatial arrangement, stature, and relative abundance of plant growth forms. Structural classes are described without reference to particular plant species: this aspect of describing composition comes into play for the succeeding and lowermost level of the classification.

Most vegetation has several layers (or tiers), best displayed by forests where the uppermost continuous layer of foliage – the canopy – is formed by tree crowns which overtop subcanopy layers of small trees and shrubs, and layers of ground plants. In situations where the tallest layer of vegetation is not continuous and does not form a complete cover, the canopy is, in effect, shared between layers, as in many wetlands; it comprises that foliage which faces upwards to the sky and would be seen in 'bird's eye' view. Vegetation structural classes are distinguished on canopy cover, i.e. the percentage contribution of different growth forms to the total canopy area.

The main vegetation structural classes of wetland plants, plus the growth habits of aquatic plants are shown in Fig. 47. The following descriptions of structural classes are based on the diagnostic criteria developed by Atkinson (1985) for terrestrial vegetation, with some modifications and additions relevant to wetlands.

Forest Canopy cover of trees and shrubs >80%, with tree cover exceeding that of shrubs. Trees (including tree ferns) are those having a trunk ≥10 cm dbh (diameter at breast height).

Treeland Tree canopy cover 20–80%, tree cover exceeding that of any other growth form, but tree canopy discontinuous above lower non-woody vegetation.

Scrub Canopy cover of shrubs and trees >80%, with shrub cover exceeding that of trees. Shrubs are woody plants <10 cm dbh.

Shrubland Canopy cover of shrubs 20–80%, exceeding that of any other growth form.

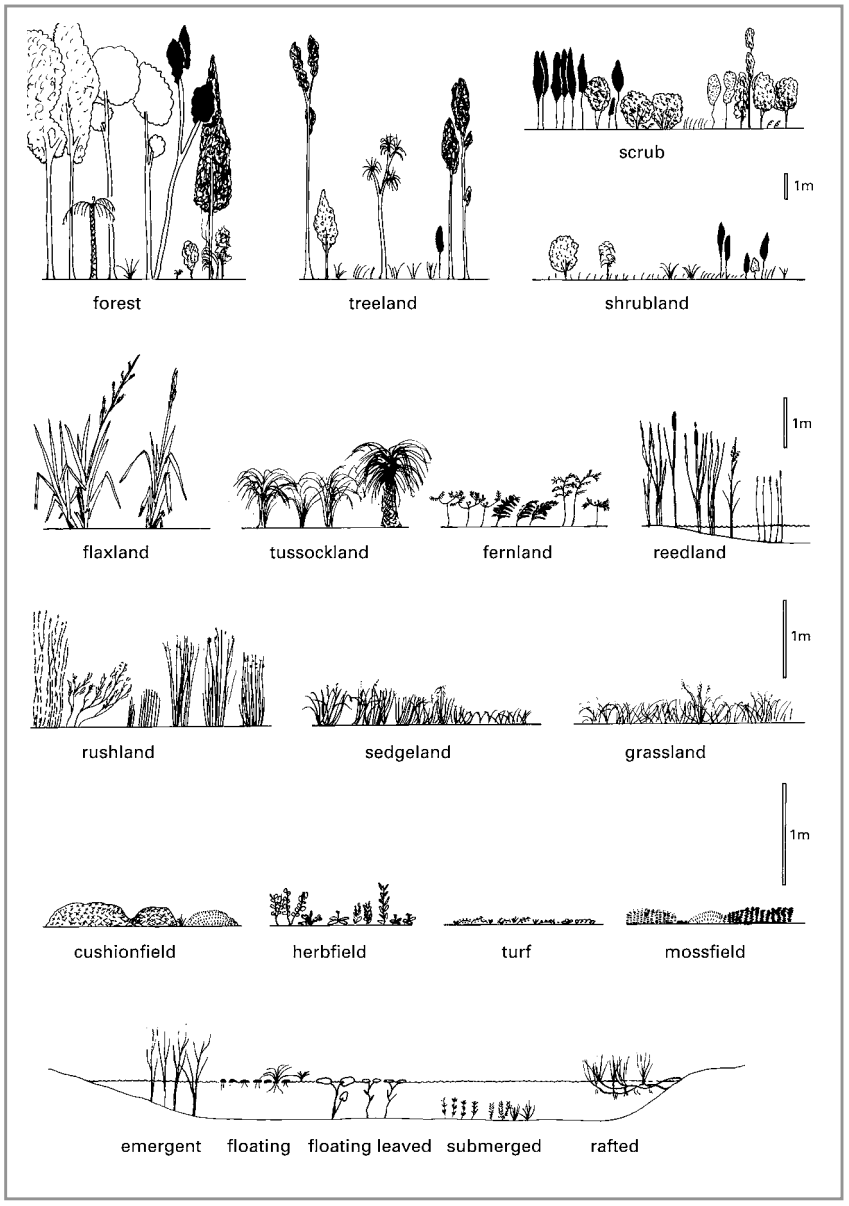

Fig. 47 Vegetation structural classes, and, at foot of diagram, growth habit of aquatic plants.

Flaxland Canopy cover of flax (*Phormium* spp.) 20–100%, exceeding that of any other growth form.

Tussockland Canopy cover of tussocks 20–100%, exceeding that of any other growth form. Tussocks include grasses and sedges >10 cm tall with fine linear leaves that arch upwards and outwards from a densely clumped base. Wetland tussocks include species of *Chionochloa*, *Cortaderia*, *Gahnia*, *Carex* (especially *C. secta*, *C. virgata*, *C. appressa*) and *Cyperus*, and *Schoenus pauciflorus*.

Fernland Canopy cover of ferns 20–100%, exceeding that of any other growth form.

Reedland Canopy cover of reeds 20–100%, exceeding that of any other growth form or open water. Reeds are tall erect herbs, emergent from shallow water, having unbranched leaves or stems that are either hollow or have a very spongy pith. Examples include *Typha*, *Bolboschoenus*, *Schoenoplectus*, *Phragmites*, *Phalaris*, *Zizania*, *Baumea articulata*, *Eleocharis sphacelata*, and *Glyceria maxima*.

Rushland Canopy cover of rushes 20–100%, exceeding that of any other growth form or bare ground. The rush growth form is characterised by those species of *Juncus* that have stiff, erect stems or similarly non-flattened leaves, but includes members of other genera (several *Baumea* and *Schoenus* spp., *Lepidosperma australe*, *Eleocharis acuta*, *Isolepis nodosa*) of similar growth form, and all species of the restiad genera *Sporadanthus*, *Empodisma*, and *Apodasmia*. The term restiad rushland may be used for vegetation dominated by these three genera, and wire rushland for that dominated by *Empodisma.*

Sedgeland Canopy cover of sedges 20–100%, exceeding that of any other growth form or bare ground. Sedges are members of the sedge family (Cyperaceae); the sedge growth form includes those plants having grass-like but usually coarser leaves, especially *Carex*, *Uncinia*, *Isolepis*, *Cyperus*, *Carpha*, and *Schoenus*. Note that several sedges belong in tussockland, reedland, rushland, and cushionfield.

Grassland Canopy cover of grasses 20–100%, exceeding that of any other growth form or bare ground. Tussock grasses belong in tussockland.

Cushionfield Cover of cushion plants 20–100%, exceeding that of any other growth form. Cushion plants include herbaceous, semi-woody, and woody plants with such dense branchlets and close-set leaves so as to form convex cushions. Cushion plants of wetlands include species of *Donatia*, *Gaimardia*, *Centrolepis*, *Oreobolus*, and *Phyllachne*.

Herbfield Cover of herbs 20–100%, exceeding that of any other growth form or bare ground. The herb growth form includes all herbaceous and low-growing semi-woody plants that are not separated as tussocks, ferns, reeds, rushes, sedges, grasses, cushion plants, mosses, or lichens.

Turf Herbfield of very low stature (generally <3 cm tall) of prostrate and tightly intertwined plants, typically composed of numerous species.

Mossfield Cover of mosses and / or liverworts 20–100%, exceeding that of any other growth form or bare ground.

Lichenfield Cover of lichens 20–100%, exceeding that of any other growth form or bare ground.

Algalfield Cover of algae 20–100%, exceeding that of any other growth form or bare ground.

2.7.1 Aquatic structural types

The growth habits of aquatic plants (Fig. 47) include those which are emergent, free-floating, bottom-rooted but with floating leaves, submerged, and rafted or sprawling (Coffey & Clayton 1988). These terms are all helpful when making a detailed description of aquatic vegetation structure. Wholly submerged vegetation attached to the substrate is often described in terms

of being on the bed of a water body, hence algal bed or macrophyte bed. Extensive and unbroken beds of dense submerged plants are often referred to as some form of aquatic meadow, for example charophyte meadow (see Fig. 95).

2.7.2 Non-vegetated substrates

Diagnostic criteria for wholly or predominantly non-vegetated substrates are provided by Atkinson (1985). The categories of rockland, boulderfield, stonefield, gravelfield, sandfield, siltfield, clayfield, loamfield, and peatfield are each distinguished by having a greater area of any one of these substrate materials than of plants. Rockland has a predominance of residual bare rock. Definitions of particle sizes of substrate materials vary both within New Zealand and overseas, but the following are based on Milne et al. (1995): boulders exceed 200 mm diameter; stones (= very coarse gravel) 60–200 mm; gravel 2–60 mm; sand 0.06–2 mm; silt 0.002–0.06 mm; and clay <0.002 mm (see Fig. 130). Additional types of substrate and ground surface that occur in wetlands include driftwoodfield, bacteriafield, shellbeds, salt crust, and mudfield (mud being an unconsolidated and wetted mix of silt- and clay-sized particles).

2.7.3 Heathland

This term requires explanation because it is in common use; it does not appear in the formal list above because it is, in effect, a combination of several vegetation structural classes. Heath plants are trees, shrubs, or dwarf shrubs, typically slow-growing and often stunted. The leaves are small, scale-like or needle-like, and hard with a thick, waxy cuticle. The foliage tends to be flammable, and is also resistant to decay, producing acid litter. Many heath plants have very fine roots and shallow root systems. Heathland occurs on many substrates (Burrows et al. 1979). Heathland which occurs on wet substrates ('wet heath', e.g. Wardle 1991) usually comprises a mixture of shrubland or treeland with rush-like sedges, wire rush, and ferns. Such heathland, very often fire-induced, is the typical vegetation of pakihi and gumland, many blanket peatlands, some bogs and fens, and some non-wetland sites.

2.7.4 Use of structural class terms

The suffixes '-land' or '-field', allow the above terms to be used as stand-alone names, but when used in combination with a wetland class, a herbfield, for example, will usually be referred to as, say, a herb bog or herb marsh. When the combination of a structural class with a wetland class results in a clumsy name, it is appropriate to include the suffix, e.g. herbfield, shallow water. In practical usage many of the terms for non-vegetated substrates can be amended to acknowledge their landform setting: mudflat, boulder beach, sand bar, etc.

2.8 Composition of vegetation

This lowermost level of the classification allows wetland types to be named from one or more of the dominant plants in the vegetation.

A full description of vegetation at any site would include data on plant composition of all tiers, but for naming vegetation types and for mapping them it is usual to rely on the dominant canopy plants, these being what one would see in 'bird's-eye' view. The system of Atkinson (1985) has gained wide acceptance (see Clarkson et al. 2003). It is designed to convey as much information as possible about what is being named or mapped without becoming difficult to comprehend. The first step is to recognise the extent and boundaries of the vegetation unit according to the desired scale of description or mapping. The second step is to allocate a structural class name. Thirdly, the compositional name is determined. A vegetation type can usually be named from those plant species having 20% or more cover, a level of composition which means that seldom more than three species need to be named. If two or more species qualify, they are named in order of decreasing abundance. When no species reaches the 20% level the name is derived from the two most abundant species at the 15, 10, 5, or 1% level, whichever is appropriate. When plant cover is less than 1% the name applied is solely the type of ground surface, for example gravelfield.

The naming system of Atkinson also provides a format to convey height relationships between the named species. A hyphen (-) links species of similar height hence for example 'manuka - pink pine scrub bog'. A solidus (/) links a tall species with one from a lower layer, both being part of the

canopy, as in 'cabbage tree / *Carex virgata* sedge swamp', indicating scattered cabbage trees within a sedge swamp dominated by *C. virgata*.

If required, a further degree of composition detail can also be incorporated in the vegetation type name using a format procedure to denote percentage plant cover ranges as in Table 10 of Atkinson (1985), viz. plant name underlined if >50% cover; without symbols if 20–49% cover; in round brackets ( ) if 10–19% cover; and in square brackets [ ] if 1–9% cover.

In some vegetation the presence of a plant species that is especially conspicuous will warrant its being included in the name for the vegetation type, in order to convey a realistic picture of the vegetation. Hence cabbage tree might be a conspicuous component of a flax swamp, yet present at only 15% cover, in which case the vegetation type can be named ('cabbage tree) / flax swamp'. It must be noted that although the Atkinson system for naming vegetation types is based upon canopy cover, there will be situations where it is desirable to distinguish and name a vegetation type by acknowledging a plant species which does not achieve 20% cover in the canopy yet is dominant and characteristic in one of the subcanopy layers. An example would be a desire to distinguish two types of closed-canopy manuka scrub fen, one having a dominant understorey of *Sphagnum* moss, and the other having wire rush. We suggest that by extending the Atkinson convention for conspicuous canopy plants to apply also to conspicuous or even dominant plants of the subcanopy, that the latter example could be named as 'manuka / [wire rush] scrub fen'.

Common names, when available, are ideal for brevity and are quite acceptable where their application to a plant species is unequivocal or explained. Scientific names are most accurately used by naming both genus and species, but naming the genus alone is equally clear when a genus has only one species in New Zealand, e.g. *Typha* (*orientalis*). If a plant can be identified only to the level of genus, then the uncertainty should be acknowledged (e.g. as *Baumea* sp. sedgeland). Situations also arise when relative abundance cannot be assessed for two or more similar species of a genus that are growing together, so the type must be named from the genus alone (e.g. *Baumea* spp. sedgeland; the abbreviation spp. indicating species in plural).

Section 5.1.7 expands on some issues commonly encountered when describing and mapping vegetation.

2.9 Wetland types

2.9.1 Examples of vegetation structure and dominant plants

The following illustrations of wetland types are described in a format that first emphasises the structural class (in bold type), notes the location (refer New Zealand map on inside front cover) and functional setting of the wetland, and then names the wetland type according to its dominant plants, structural class, wetland class, and hydrosystem.

Fig. 48 **Forest**. Arahaki Lagoon, Whirinaki, Volcanic Plateau; a depression upon volcanic ash (see soil profile, Fig. 131) where periodic ponding inundates the surrounding forest: kahikatea (*Dacrycarpus dacrydioides*) forest ephemeral wetland; palustrine.

Fig. 49 **Forest.** Waitangiroto, Westland; a lowland fen where sedgeland grades to a fringing zone of manuka scrub then silver pine (*Lagarostrobus colensoi*) forest bog; palustrine.

Fig. 50 **Forest**. Kaimai Range, Bay of Plenty; a hillside where mineral soils carry a flow of groundwater and surface water, evident from the wet sedgeland beside the vehicle track, and responsible also for the pale-green patch of pukatea (*Laurelia novae-zelandiae*) forest seepage; palustrine.

Continue to next file: WetlandsCOLOURf.pdf

Fig. 51 **Forest.** Kopuatai, Hauraki Plain, Waikato; a modified area of the Kopuatai Peat Dome, adjacent to one of the major encircling drainage canals: grey willow (*Salix cinerea*) forest fen; palustrine.

Fig. 52 **Treeland.** Lake Wahapo, Westland; lowland swamp close to a lake, where a high water table allows for the presence of only scattered and stunted trees: kahikatea / flax tree swamp; lacustrine. Note that in this example, tree cover is only marginally sufficient for this to be called treeland rather than flaxland.