CHAPTER EIGHT

Rural People Continuing to Learn about their Environments

After relocating to a new place, or when experiencing accelerated environmental change, living things encounter new opportunities and challenges and must respond effectively to them if they are to survive. During the second half of the nineteenth century the publications of Charles Darwin influenced how the biological sciences dealt with this, but applications of his evolutionary thinking to human societies proved less successful. Early in the twentieth century the American anthropo-geographer Ellen Churchill Semple reacted to the intellectual strait-jacket of 'environmental determinism' and proposed the much less doctrinaire notion of 'environmental influences' acting on people. To Semple, 'the earth whispers solutions to our environmental problems'.[1] Six decades later, two North American geographers, Yi Fu Tuan and Edward Relph, proposed that people invest time, money and effort into creating places full of meaning and significance to themselves, their families, contemporaries and successors,[2] making them the principal agents of environmental change. These investments mean that present and future residents can enjoy the sense of being psychologically attached to a

particular place. Relph argued that people create landscapes of humanised places out of culturally neutral spaces by, amongst many such actions, building roads and houses, planting trees and shrubs, setting aside areas for recreation and exploration, passing on traditions and legends, and ensuring diverse opportunities for future generations to live and work happily there. In the words of the British geographer, Ronald Johnson, 'people make landscapes and landscapes make people'.[3] Relph distinguished between authentic and inauthentic place-making. The former involves the activities, legends and story-telling of successive generations of residents, enabling them and their progeny to feel native-rooted in a particular part of the world. In contrast, inauthentic place-making is often the consequence of organisations and powerful individuals deciding to erect structures to commemorate historical events without first involving residents. The first of these is evident in how successive generations of station families in the South Island high country have come to view and occupy their geographically isolated properties, a process that the American social anthropologist Michelle Dominy elegantly documented in her book about such a property in the mountains of Canterbury.[4]

Environmental changes trigger human responses, and throughout this book I have taken the stance that a landscape, farm or station can be viewed as a system: an organised suite of living things as well as pools of and channels for physical resources. The nineteenth-century German plant physiologist, Justus Liebig, investigated the mineral nutrition of plants, and his work soon became known around the world.[5] Its significance for New Zealand was evident to James Hector, who calculated that in 1891 the mineral nutrient content of exported meat weighed about one million pounds,[6] much more than was normally released during a year by nitrogen fixation and rock weathering in and immediately below the soil layer. Had he computed the average amounts of water needed to produce a side of mutton, a bale of wool or a bushel of grain, he would have been even more perturbed by the magnitude of environmental subsidies for the nation's exports.

During the 1930s the leading British ecologist Arthur Tansley popularised the word 'ecosystem' for the interactive web of living things in an area and the environmental resources that sustain them.[7] The American geographer Harlan Barrows implied much the same in his argument for geography as 'human ecology',[8] as did James Lovelock when he named the earth system after the Greek goddess, Gaia, and called for a new approach to the earth and

atmospheric sciences. Lovelock was especially interested in diagnosing and treating the earth's environmental problems, most of which have been directly or indirectly caused by people.[9] Ecology developed rapidly during the twentieth century and five of its core concepts remain important. The first of these concerns the close functional relationships between a living thing and its physical environment. The second is that the diverse living things of a mature ecological system cohere in recognisable ways – associations, communities, ecosystems and biomes – and are not simply random aggregates. The third stems from the field research of the British ecologist Charles Elton who proposed that each natural ecosystem can be represented by a pyramid assembled from distinctive layers: green plants, herbivores, carnivores and decomposers. Through his field work in the Canadian Arctic and Great Britain, he found that each of those layers is characterised by the number of individuals of all species present and the total biomass, which allowed him to represent an ecosystem by a pyramid of numbers or a pyramid of biomass, and to use this construction to compare ecosystems in different parts of the world. Fourthly, after an episode of environmental disturbance – whether caused naturally or brought about by people, their plants and animals – the ensemble of plant and animal species will spontaneously change, and this process will last until a stable system has developed. Plant ecologists term this process 'succession', and it happens wherever land plants grow. While we may be able to follow or infer the progress of successional change, it has proven difficult to predict which species will be involved or even how long the process will take. Fifthly, ecology encourages us to think holistically. Even if we touch only one element or modify just one function of an ecosystem, then our actions will have a further impact elsewhere in the system.

The roots of a closely allied discipline, plant geography, penetrate even deeper into our past, and from the eighteenth century onwards interest in this subject was spurred by gardening, fostered by botanical exploration in distant lands and enhanced by the scholarly publications of staff at the Berlin, Geneva, Kew and Paris botanical gardens. Strabo, a Greco-Roman scholar active in the last two decades BC and the first two AD, had described the vegetation cover of places around the Mediterranean basin,[10] but the foundations for the scientific study of plant distributions were laid in the late eighteenth century by Carl Linnaeus and his students, and a short time later by Alexander von Humboldt.[11] Charles Darwin knew about their findings and corresponded with such leading figures as Augustin and Alphonse de Candolle in Geneva, Joseph Hooker at

Kew Gardens on the outskirts of London, and Asa Gray at Harvard University in the United States of America.

A core principal of biogeography is that widely separated parts of the world are occupied by different ensembles of plant and animal species, and this was certainly evident to the British-born naturalist Joseph Banks when he visited New Zealand as a member of Captain James Cook's first expedition to the southern hemisphere.[12] He encountered a large archipelago that had long been geographically isolated from potential sources of plants and animals by broad stretches of ocean. That situation ended with the arrival of the first Polynesian people a millennium ago and, starting in the late eighteenth century, when people of European ancestry began to settle the land, bringing with them many species of living things. A little later, Darwin expressed concern that the indigenous biota would inevitably succumb to this tide of novel plant and animal species because the long period of geographical isolation had, he believed, increased the vulnerability of native New Zealand species to population decline, possibly even extinction, in the face of biologically superior newcomers. Although awareness of the findings of biogeographers increased amongst biologists and gardening enthusiasts in New Zealand as elsewhere, relatively little of that knowledge appears to have filtered down to pioneer farmers and station holders.

THE PIONEER PROPERTY AS A SYSTEM

The landscapes of southern New Zealand were mosaics of extensive and small-area environmental systems when the European settlers arrived. Some of these systems were not greatly affected as settlers moved in and began the process of environmental transformation; others ended up at different stages along the path to becoming productive economic units; and yet more soon became places where environmental transformation was virtually complete. The processes of transformation employed by pioneer landholders meant that on any farm or station, some environmental features were erased, some were in a state of flux, and the balance had given way to novel systems of plants and animals. Pioneer landholders diverted streams, drained marshy depressions, levelled surface irregularities and planted surveyed rows or clusters of trees and shrubs to modify atmospheric conditions near the ground and to ensure a more

Haldon Station homestead, hired men's quarters and out-buildings, 1868–78, with recently burned tussocks on the hill behind the housing. SOUTH CANTERBURY MUSEUM, TIMARU, 1888

congenial environment for people, garden and orchard plants, pastures, crops and livestock. Despite the scale and intensity of these activities, the principal topographic features remained largely unchanged. The greatest changes were to the topsoil, the climate near the ground, the hydrological regime of rivers and streams, and the geographical distribution of native plants and animals.

The dynamic environmental systems of a pioneer farm or station comprised crop and pasture plants as well as grazing animals, supported by stores of water and plant growth nutrients and inflows of water and solar radiation. Reservoirs and channels were key functional units in the environmental system of a pioneer property, and they mediated movements of energy, water and other material resources into and through it as well as beyond its borders. The soil layer was the primary reservoir for water and exchangeable plant nutrients, the

main channels for which were across and below the soil surface and thence into living tissues or transported away in large and small rivers.

Although it, too, was driven by shortwave solar radiation in the visible part of the spectrum, the environmental system of a pioneer farm differed substantially from the natural system(s) it replaced, notably with more biomass – in the form of meat, hides and wool, as well as grain and other plant tissues – and nutrients leaving the area for consumption elsewhere in the country or overseas. Trade in primary products was not environmentally neutral, but carried a cost in the currencies of the ecological resources of energy, water and nutrient ions. By the final decade of the nineteenth century, most lowland farms in southern New Zealand were dependent on supplements from external sources of nitrogen, phosphorus, potassium, calcium and other essential plant nutrients to remain economically viable. The energy cost might have been recoverable within a few weeks of harvest, and replacement of the water component would have taken from days to months, but access to new nutrient ions to make up for those lost through trade would have taken as long as was needed for minerals in the area's rocks to weather chemically and for nutrient ions to become available to green plants. Pioneer farms depended on a small number of plant species that could produce large amounts of palatable and nutritious tissues for as long as possible during the year, and this required inherently fertile soils. Most of the pasture plants that the first generation of European settlers introduced did best where water and nutrients were not in short supply or could be supplemented by irrigation and top-dressing with organic manure, guano and mineral fertilisers.

In an ecological system, negative feedback restrains flows of energy and materials and positive feedback enhances them. Furthermore, negative feedback tends to stabilise the system by moderating its responses to external forces and inputs. In temperate areas where a thin layer of fine sediment rests on hard rock, if evaporation is neglected then plant growth will be primarily governed by the balance between rainfall and runoff. As the vegetation cover develops, the rate at which rain water flows off a slope and into a stream will decline because the developing soil and vegetation cover will progressively retain more water on site. The net effect of this will be to make more water available to green plants for longer after rain, thus enhancing their prospects of surviving a spell of below average rainfall.

The deleterious effects of enhanced positive feedback to a pioneer farm or station are evident in areas subject to frequent burning and heavy grazing.

Depending on their size, herds of cattle and flocks of sheep can deplete the vegetation cover, trample the topsoil and expose the area to loss of fine sediment after moderate to heavy rain. Heavily browsed plants may die when declines in the amount of fine soil particles and dead organic matter reduce the potential for soil water storage. For as long as frequent burning and heavy grazing continue, relatively more precipitation will evaporate or run off the surface and into streams, carrying decayed organic matter and fine sediment with it. In time this will lead to further reductions in biomass and soil materials.

Any ensemble of plants and animals risks being set back to an earlier developmental stage by fire, disease, flood and erosion, and the specifics vary from place to place. Pioneer landholders lessened the environmental risks to their properties by damming small streams for water supplies, clearing stream and river channels to facilitate discharge of flood waters, planting hedges and trees for shelter, controlling stock numbers to safeguard pastoral land, growing sufficient animal feed during the frost-free season to set aside some for consumption during winter, using fire judiciously as a grazing management tool,[13] and ensuring safe areas on their properties for people and livestock. One environmental lesson that took settlers several decades to learn was that the economic benefits that flow from modifying the environment carry direct and indirect costs, so each landholder had to decide for himself if a particular development project merited the initial financial outlay over the long run. A new ecological system needs time to develop, form buffers that can stabilise it and become a substantially self-regulating entity. While they were establishing improved pastures for their livestock, few settlers took the long view of landscape transformation, and none of the diaries and letter books that I read contained explicit acknowledgement of the environmental price they might later pay for having failed to do so.

The transformational structures that settlers installed on their properties included hedges and shelter belts to protect people, plants and livestock from inclement weather; hedges and post-and-wire fences to control access by livestock to cultivated fields and pastures; areas set aside for seasonal grazing and haymaking; channels to distribute water to livestock and for irrigating pastures; drains to manage the amount of water stored in shallow water bodies and the topsoil; and trees planted alongside rivers and streams to regulate flow rates. Insofar as steep or other difficult terrain was concerned, few landholders saw merit in retiring it from grazing, encouraging reversion to native ecosystems, or planting it with timber and decorative trees.

Today, civil society requires social and environmental impact assessments before individuals can embark on large development projects. I did not find evidence of even the rudiments of such forward thinking in any of the nineteenth-century diaries and letter books that I read, although some landholders and managers, such as the Scottish manager of Ida Valley Station in Central Otago, had begun to sense that an adverse environmental event in only one part of the property could place the larger operation at risk.[14]

FROM COLONISED SPACES TO HUMANISED PLACES

The first two generations of European settlers on the plains and low hill country of southern New Zealand came to an expanse of grassy vegetation, peppered with wetlands, as well as large and small remnants of forest in well-watered valleys sheltered from strong winds. There were large as well as small tracts of native forest in the low hill country of Canterbury and Otago, and more extensive forested blocks in Southland. Much of the area had scant shelter from hot, dry northwest gales in spring and summer or from cold, wet southwest blasts in winter and early spring. For all its licence, Henry Sewell's description of the Canterbury Plains in 1852 as a 'howling wilderness' is an understandable response to the environmental conditions he encountered in the young settlement.[15]

In the plains and low hill country of southern New Zealand, geographical arrangements of hills, flat ground, depressions, rivers, lakes and ponds gave shape and structure to the landscape, and its physical form was elaborated by plants. On that grid, settlers demarcated fields and pastures with hedges and planted trees to provide shelter for people and livestock. They also modified or replaced indigenous tussock grass and shrub communities, drained wetlands, and sowed palatable herbs, grasses, root and grain crops for consumption on the property or for sale. In doing so, they were inadvertently creating ecological opportunities for introduced weedy plants and early successional native species to increase in number and occupy a larger area. Some of the plant and animal species that were deliberately brought into the country proved desirable additions in certain circumstances and at particular times, but unanticipated nuisances in others: gorse and broom, Yorkshire fog and yarrow, rabbits and red deer are six of many examples. The capacity of the New Zealand environment to

A successful pioneer family with their hired male and female labour, Team's farm, Otaio, south Canterbury, late nineteenth century. 2002-1026-00049, WAIMATE HISTORICAL SOCIETY AND MUSEUM

throw up surprise after surprise struck the first generation of European settlers just as it does us.

During the second half of the nineteenth century, settlers had begun to learn that the New Zealand environment is a mostly fine-grained mosaic of ecological patches, one that calls for close matching of pasture plants and livestock with prevailing physical conditions. The one-size-fits-all model of land development did not work during the colonial period, although it became more feasible later on with the advent of mechanised land preparation, extensive irrigation and widespread application of mineral fertilisers to correct nutrient shortfalls. Another early environmental lesson was the critically important role of extreme weather conditions in the seasonal round of activities of a farm or station. British experience was not a uniformly good guide to this, and settlers in southern New Zealand discovered the importance of casting their nets widely in the Old World as well as

in recently colonised territories around the globe for examples of good practice in farm management and stock rearing to show them how best to respond to a geographically variable climate and occasionally adverse weather.

Settlers not only transformed the landscapes of their properties but were also engaged in an experiment, albeit one without controls, carefully specified treatments or trial runs.[16] They were informed about international practice in agronomy, horticulture and pasture management, but were creating a humanised landscape inspired as much by theological thinking as scientific principles, which led them to act in ways that, in retrospect, strike us as deleterious. At the time of their introduction, few settlers would have imagined that the European rabbit and Douglas fir could become environmental pests: the first within a decade of its introduction and the latter a century later. Amongst settlers' strengths were their flexibility in responding to novel environmental problems. That trait was especially evident in the last three decades of the nineteenth century when individual landholders, government officials and administrators sought ways to control the innumerable rabbits then plaguing southern New Zealand. Even so it took until the 1930s, when soil erosion had become too widespread and severe to neglect, for the nation to recognise the many risks it had been running.[17] Ideally, settler society should have screened imported plants and animals, and allowed entry only to those that were unlikely to spread spontaneously from where they were planted or released. This did not happen for more than a century, and New Zealand is now home to more naturalised than native species of higher plants.[18]

Did settlers recognise the links between their transformative actions and accelerated erosion, physiological drought and flooding? Partial as well as complete vegetation clearance depleted reserves of decaying organic matter in the topsoil, altered soil structures, and reduced amounts of water retained after rain and snowmelt, thereby weakening those ecological buffers that can come into play when current rainfall is too little to satisfy a plant's water requirements. During the second half of the nineteenth century, southern New Zealand experienced extended episodes of meteorological drought, but entries in farm and station diaries and letter books did not allow me to distinguish between the effects of spells of below-average rainfall on the one hand and loss of water storage sites in the topsoil on the other. For that, I would have needed reliable measurements of precipitation, water loss by evaporation and transpiration, storage in the soil and through-flow. Even records of precipitation

received and water levels in wells sunk for household supply would have been useful, but out of the farm and station diaries and letter books that I read only those kept by Edward Chudleigh, the Cody family and the two Scottish managers of Ida Valley Station mentioned the latter.

Nor did I find documentary evidence that settlers were aware of the paradox in their dependency on native plants and animals at a time when they were busily eradicating them. Despite the advocacy of such well-placed individuals as Thomas Potts of mid-Canterbury,[19] entries in settlers' diaries and letter books implied that few amongst them envisaged native species having a permanent place in the humanised landscapes then under development in southern New Zealand.

Relph's notion of place-making is implicit in Max Nicholson's description of the southern New Zealand lowlands during the 1970s as 'a countryside in search of a landscape', to which he added these challenging words, 'and no doubt will find a worthy one'.[20] Settlers' achievements in learning about the environments of southern New Zealand were steps along the path towards the creation of an economically viable and congenial cultural landscape for themselves and their families. Technical education and opportunities to share good practice were essential in this, and on 14 October 1867 the *Otago Daily Times* published a short piece by its Tokomairiro correspondent about the likely benefits of a chamber of agriculture, allied with the farmers' clubs then in operation, 'to consolidate as it were the scattered intelligence throughout the southern portion of Otago in one focus for really practical purposes'. This call on farmers to share good practice drew a favourable response from the Otago Provincial Secretary and Treasurer, whose letter to agricultural and pastoral associations across Otago was printed by the same newspaper on 4 December 1867. Officials were invited to comment in writing on 'the present condition of the agricultural interest and the means by which encouragement and assistance may be offered to it'. The Board of Agriculture in the Australian state of Victoria was proposed as a model for the province of Otago, and respondents were asked to indicate their support for such a body, summarise their views on the establishment of a model farm, then identify new farm products, likely processors of farm products and the most important features of an Otago beet sugar industry. Even at this early date there was clear recognition of the importance of a scientific approach to agriculture and pastoral farming, and in its 29 January 1868 edition the *Bruce Herald* reprinted an article taken from the *Pall Mall Gazette* about science and

farming in Germany since the early 1830s. It included these key words: 'The great secret of the success of Prussian agriculture is diffused education and technical instruction.' In southern New Zealand, the 'Prussian model' was seen as a way to enhance the management skills and practical education of people on the land.

LEARNING IN THE SCHOOL OF HARD KNOCKS

Settlers progressively learned about the environments of their farms or stations by observing, reading, asking questions and listening, and the course of their learning is shown in Figure 8.1. That representational model shows how settlers learned about local, regional and national environments by making observations,

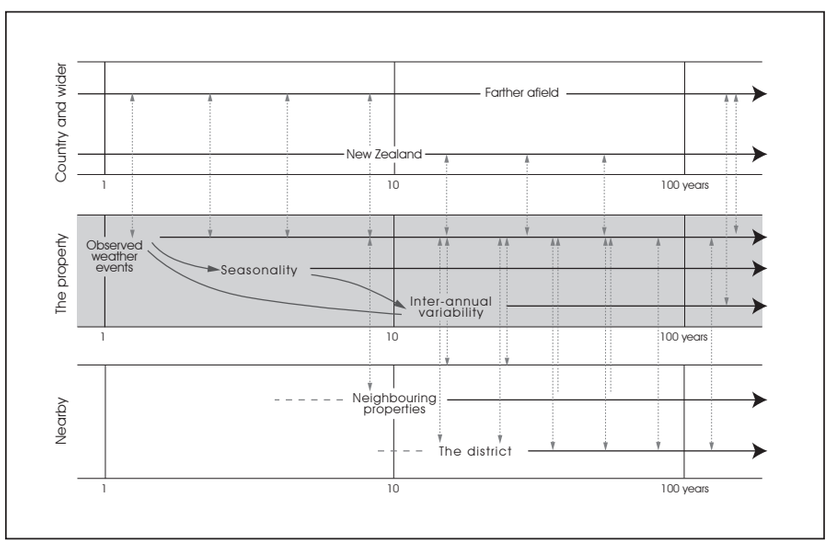

FIGURE 8.1 A representational model of environmental learning in early colonial times. Initially, rural settlers observed environmental conditions on their own properties (the shaded band) and compared them with what they had experienced elsewhere (the bands above and below the shaded band). As their awareness of seasonal effects grew stronger, they began to compare their experiences with those of people elsewhere in the district or farther away. Within a decade, they were more interested in discerning long-term variations on their properties and in the district. In time, rural people became adept at forecasting adverse weather events and drawing on that skill to manage their properties. SOURCE: SEE NOTE 21

discerning environmental signals, seeking and explaining patterns, calibrating particular environmental events against their own experiences as well as those of other people, and attempting to foretell weather conditions. The many geographical and historical comparisons recorded in farm and station diaries and other documentary sources justify the model.[21]

Entries in settlers' diaries also indicate more rapid discharge in streams and rivers after heavy rain and snowmelt towards the end of the nineteenth century than had been the case two or three decades earlier, which we can presume was a consequence of large-scale depletion of the vegetation cover, including conversion from geographically heterogeneous mixed tussock grass and shrubland ecosystems to extensive pastures of introduced grasses and broadleaf herbs. In the 1880s, Joseph Davidson of northern Southland started recording unusual flood events in his diaries:

> Came on to rain very heavy after dinner. Dome Creek rose very sudden – Creek falling [since then] as sudden as it rose. (14 May 1883)
> The [Dome] Creek still keeping very high. The stooks [of harvested grain] in the field has [*sic*] got a heavy drenching. If it [the weather] does not clear up soon it [Dome Creek] will get greatly discoloured. (25 February 1894)
> There was a very heavy hail storm passed over the Cattle Flat, hail stones very large – had the small gullys running full of water in a short time. (22 December 1898)
> Very bright and fine in forenoon – towards afternoon there was a heavy thunderstorm passed over – with heavy rain and hail. We seemed to escape the heaviest of it. It came down very heavy up Winding Creek and put it in flood. (15 January 1899)

Another indication of accelerated runoff after heavy rain or snowmelt is in a letter written by the manager of Ida Valley Station to the absentee landholder on 3 September 1895: 'In the last week of August we have had high winds and floods: most of the snow is gone and there are signs of grass [growth] . . . . Luckily the snow went away with wind and not with wet, and lately (except for sharp frosts at night) the weather has been mild . . . . During the late flood the creeks were higher than I have seen them, the Dovedale especially, and if it had not been for the heightening of the dam the flood must have gone right over it.'

Those experiences accord with observations of the McMaster family in the lower Waitaki Valley, where strong northwest winds followed by a southerly change early in the morning of 4 February 1894 brought persistent showers

that turned to heavy rain that evening and resulted in flooded creeks by the following morning. Three weeks later, after 24 hours of very heavy rain, flooding recurred. Light showers during the evening of 11 November 1899, followed by a day of humid weather and an evening thunder storm, caused overnight flooding. McMaster clearly understood that a sharp burst of heavy rain may be shed from, and persistent light rain infiltrate, bare dry soil: 'Lots of rain last night, and raining off and on all today, nice quiet penetrating [rain]; best [there] has been for years' (11 February 1899). On 16 June 1887 a member of the McMaster family recorded, 'A regular flood. Rain coming down in torrents. Everything and everywhere getting flooded. River rising rapidly'; and six years later, in September 1893, it was this sequence of adverse weather:

> Day fine; raining during last night. (10th)
> Weather blowy. Morning warm and dry. (11th)
> Weather wet . . . . Teams [of horses] idle; no work [done]. Fine evening. (12th)
> Day fine, raining during night. (13th)
> Raining all night from SE and NE. Too much rain. Awamoko very high. Heavy rain in evening. (14th)
> Weather still disgraceful, NE and SE rains. Teams all idle. Awamoko in flood. (15th)

Much the same is evident in the Cody family diaries for the Lime Hills area of central Southland.[22] Their property stretched from low-lying riverine swamps, over well-drained downs to low tussock-covered hills. The former had been almost completely drained, and the latter virtually cleared of tussock and low shrubs, for cultivation by the early twentieth century. In their diaries, family members referred more frequently to flooding in 1911, 1912 and 1913 than in the previous ten years, probably a consequence of the loss of wetlands that would have stored water and released it steadily into rivers and streams over periods of days or weeks rather than almost immediately after heavy rain, as described in this entry on 28 March 1913: 'Raining heavily all day. Pa went out for Tom and Dave but could not cross river bridge for water . . . . Big flood, lane washed away, etc.' Much the same happened three years later when, on 7 September 1916, the family had to take a different route home than the one they had followed that morning because the river had risen sharply in the interim.

Pioneers and their immediate successors were understandably interested in quick-fix solutions. Hedges of gorse, hawthorn and broom were effective in