

Science and Land Use: The Kosciusko Primitive Area Dispute of 1958–65

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ABSTRACT

The Primitive Area dispute of 1958–65 is a seminal episode in the development of a nature conservation philosophy in Australia. Led by the Australian Academy of Science (AAS) and informed by detailed and growing understanding of the specifics of ecology in the Australian Alps, the debate was a turning point in thinking about land use in the mountain catchments.

This article examines the conflicts behind the scenes, within the AAS, between the AAS and the Snowy Mountains Hydro-Electric Authority (SMA), and within the SMA. It argues that the scientists' conflict with the SMA over plans for the summit area of Mount Kosciusko (now Kosciuszko) not only established ecology as a scientific basis for conservation thinking: it foreshadowed the current idea that management of healthy country involves recognition of the links between aesthetic *and* scientific thinking. In this respect science had and still has the capacity to offer alternative visions to the community about the relationship between natural resource management and land health.

An important element of modern environmentalism is community acceptance that broad ecological processes underpin sustainable landscapes. Growing concern about catchment health may well see renewed appreciation of the links between the ecological function of mountain catchments and their aesthetic and recreational value.

KEYWORDS

Australian Alps, ecology, land use, nature conservation, Snowy Mountains Hydro-Electric Scheme, Kosciuszko National Park

Visitors to the peak of Mount Kosciuszko today are inspired by the grandeur and wildness of the scene, by its apparent timelessness and unspoilt nature. Aesthetic appreciation is easy in such a place. But this landscape also is important in catchment and scientific terms: the source of significant rivers in south-eastern Australia and the habitat of unique plant communities. The adjacent ridgeline of peaks over 2000 metres contains the only evidence of recent glaciation in Australia, including glacial lakes and associated scoured cliffs, moraines and scattered debris.¹

Today national park protection is accepted for such places, and few visitors are aware that the view and the special qualities could well have been quite different. In 1958, the all-powerful Snowy Mountains Hydro-Electric Authority (SMA), established in 1949 and led by the engineer Sir William Hudson, planned extensive works here. The Authority was challenged by a group of scientists, who called for a 'primitive area' in the summit area or 'high tops' as they referred to it, rather than the Snowy Scheme plan for a 'landscape of power'.² By 1961 they had involved the Australian Academy of Science (AAS) in carrying their case.³

The battle was over the landscape around the headwaters of the Snowy River (Figure 1. Kosciuszko Summit Region showing proposed Primitive Area). Long-term official concern for soil conservation, pioneered in NSW by E. S. Clayton, was gaining strength from a growing body of alpine ecological study.⁴ Such study offered new knowledge, appreciation and authority about the scientific values and ecological processes of the mountains. Scientists shared this knowledge and their emerging vision with farming and nature conservation interest groups, thereby informing the idea that protection of areas for nature conservation was not only a justifiable land use, but also a wise one. Backed by public opinion, the scientists, amongst the most prestigious in the country although they are still largely unknown today, eventually defeated Hudson, until then an unchallenged hero of the development ethos of post-war Australia.

The dispute was the precursor to other, better known land use conflicts: Colong Caves, Myall Lakes, Fraser Island, Little Desert, Lake Pedder and the Franklin, the Daintree. However, it is rarely even listed amongst general conservation histories, and is the subject only of brief accounts in land use histories of alpine Australia by Hancock, Good, and Robin, although all three authors see it as a turning point in nature conservation endeavours.⁵

Libby Robin's two papers argue that the events established the credentials of ecology as a player in debates about conservation and science in the 1950s. These credentials, she observes, became sidelined by the emergence of radical environmentalism and the involvement of a lay community with non-scientific values in the 1970s. Although this analysis holds true in important ways, Hancock's interpretation also shows how charismatic individuals can communicate a vision of land use that is founded on science but expressed in terms of cultural values, especially aesthetic appreciation of ecological features and processes.

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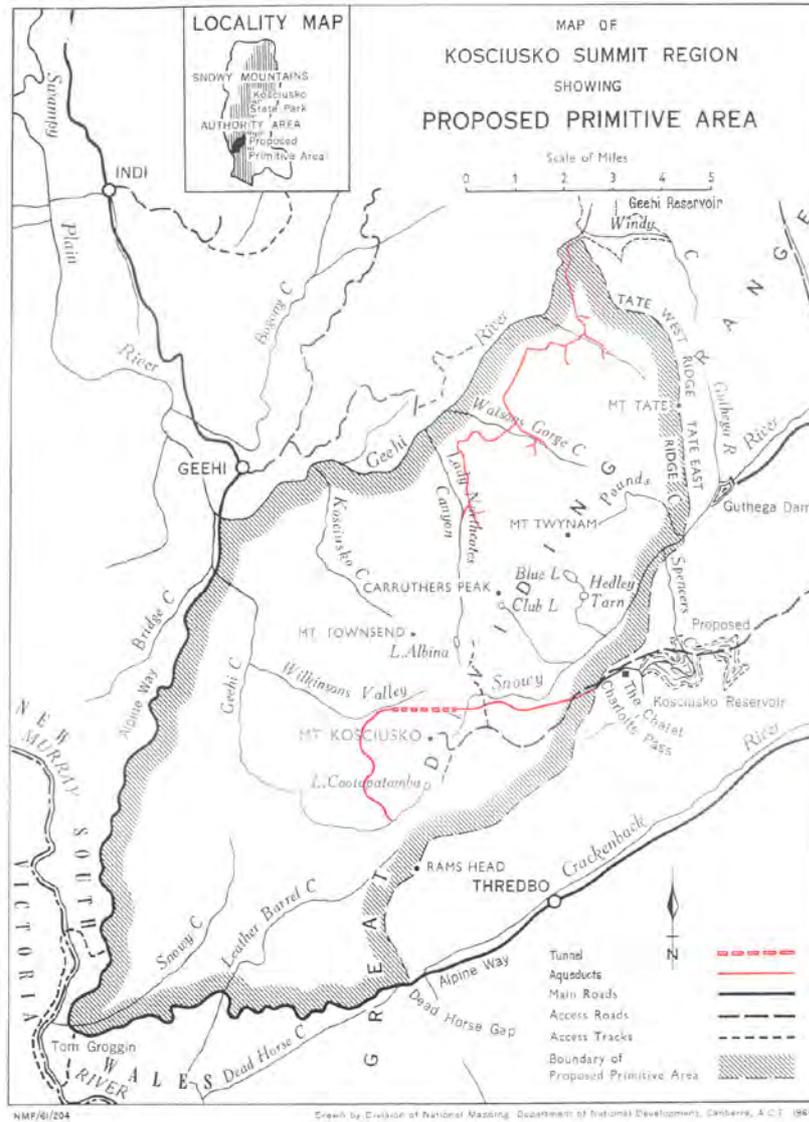


FIGURE 1. Kosciusko Summit Region showing proposed Primitive Area.
Source: AJS, June 1961, 393.

In Good's brief outline, this was the first environmental success for the concerned Australian public as well as for ecologists.

This article explores how non-scientific aspects of the debate were important, within the Academy, between the Academy and the SMA, and between the SMA and its political master, Senator Spooner of the Department of National Development. These attitudes and values predate the growth of popular environmentalism, when science became one voice amongst many in environmental issues.

The scientists initially assumed a 'wise use' progressive era belief that scientific rationality should determine land use decisions. They expected that the impacts of the project could be mitigated by application of sound professional and technological methods. But they became disabused of the adequacy of this position. They found that their fellow professionals, the engineers, saw in the landscape primarily their own short term works and were not really engaged by the long term question of ecological integrity. They became alert to the limitations of the 'embedded' science of the SMA, and began to question the wisdom of investing so much power in an agency that had wide powers and few control mechanisms, one that took on a life, a vision and moral purpose of its own. This and their developing understanding of the ecology of alpine Australia, led them to question the technological response, and to doubt the capacity of science alone to influence the dominant ethic of a major development entity.

In particular, the ecologist arguably at the centre of the dispute in the scientific community, Alec Costin, brought concepts into the argument that are now common in land use debates: of sustainability, ecosystem services and resilience, although then he did not use these terms. Although the Academy was constrained by Hudson's public demands that they should contain their arguments to pure science, it was the case for uniting aesthetics with respect for the ecology of the mountain areas that was taken up by the public. Costin argued that a deep understanding of, and empathy for, the unique ecology of the mountains was in itself an aesthetic judgment. Even more radical was his belief that respect for its beauty, and understanding of the way it functioned, would enable people to use the landscape more productively. This idea, of the union of knowledge, practicality and beauty, was a new social and moral vision for the mountains—preservationist rather than conservationist in the wise use sense. It is still a long way from being fully understood in the Australian context, and may well be Costin's most original contribution, entailing the incorporation of ecological understanding into general conservation thinking.⁶ It is in sharp contrast to Hudson's and Spooner's defence of the Scheme: that multiple use could be made to work for both ecology and water yield.

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THE EVENTS: KOSCIUSKO AND A 'PRIMITIVE AREA'

Bushwalkers, led by Myles Dunphy, had been arguing for 25 years for a 'primitive area', or wilderness zone based on American ideas. Dunphy's National Parks and Primitive Areas Council, a coalition of NSW bushwalking clubs, in 1931 proposed a vast Snowy-Indi Primitive Area straddling the NSW-Victoria border. In 1943, in response to Dunphy's persistent influence, NSW Premier William McKell's Kosciusko State Park Act empowered the new management body, the State Park Trust, to declare a primitive area of up to one tenth of the park, although the primary aim of the Act was catchment protection.⁷

Dunphy was a keen naturalist and appreciator of landscape, but his vision was not scientific in any detailed sense: he was primarily arguing for wilderness preservation for the fit and hardy few who could enjoy wild places. He fell out with the scientific community over an early attempt at primitive area protection in 1944 and 1945, being unable to agree with them or with Marie Byles, his bushwalking colleague and Secretary of the NSW Bushwalking Federation, on the question of rights of access. Byles, the Linnean Society and the Royal Zoological Society argued for exclusion of general use in favour of very tightly defined access for scientific purposes. The Trust, which was a weak and divided body, was unable to resolve these interest group differences, so after this early setback, the Primitive Area remained in limbo for another 12 years.⁸

The Academy of Science had clearly signalled that their concern about the poor condition of the mountains was more than scientific when they agreed to conduct an investigation in 1956:

... due in our opinion, to misuse and lack of understanding of the necessity to preserve what should be a very precious possession of the nation scenically, scientifically and as an economic asset.⁹

The subsequent 1957 *Report on the Condition of the High Mountain Catchments* had helped persuade the SMA, the public and the New South Wales Government that long established free range cattle grazing was causing disastrous erosion in the 'High Tops', with potential for damage to the Snowy Scheme. The SMA could have been forewarned that the scientists' alternative vision for land use in the mountains might also challenge their own. In Recommendation 5 the report's two principle authors, Professor John Turner and Costin, called for a re-examination of SMA's planned works above 6,000 feet (~1800m).¹⁰

Sources of electrical power are, or will be, available elsewhere, but the loss of the Kosciusko tops would be irreparable.¹¹

By 1958 the cattle had been removed from the High Tops, and Turner and Costin turned their attention to the SMA issue. In this new challenge they were energised by the unremitting efforts of the veteran geologist, W. R. 'Buster' Browne. Browne had been a key figure arguing for respect for scientific val-

ues in the earlier Primitive Area dispute. His efforts then had demonstrated the consequences of arguing against the Snowy Scheme. In his 1952 David Memorial Lecture he had referred to the SMA as a 'monster' and its works as 'desecration', making little attempt at scientific objectivity. This had provoked a sharp response from Hudson, defending the SMA's conservation practices.¹²

In early 1958 scientists, mainly from the CSIRO, and mainly Academy members, convened gatherings in Canberra and Sydney (both attended by Browne and Costin).¹³ These meetings set up the Canberra-Kosciusko Committee, which presented a roneoed 22-page submission to the Menzies Federal Government a few weeks later. It argued for a primitive area around the summit with exclusion and/or control of conflicting land uses: engineering works, tourism development and grazing. In particular it opposed the SMA's plans for engineering works above 6,000 feet, arguing that the superior values and fragility of this area required total protection. This work was a small section of the Scheme, but large in the place involved: aqueducts and tunnels would virtually encircle Mount Kosciusko, capturing the headwaters of the Snowy River and Lake Cootapatamba and directing this water to a dam near the junction of Spencer's Creek and the Snowy River. This was to be sited on part of the David Moraine flooding the valley below Charlotte's Pass. The submission also opposed an aqueduct along the steep rocky walls of the Lady Northcote Canyon and Geehi valley to a proposed Geehi Dam (See Figure 1).¹⁴

After a briefing by Hudson, Senator Spooner, Minister for National Development, rejected the submission.¹⁵ Hudson also alerted Spooner and Casey, Minister responsible for the CSIRO, to his displeasure with government employees speaking out about the project. He made sure Spooner knew that Costin's salary at CSIRO was paid for by SMA, funding for which was subsequently withdrawn. Both Hudson and Spooner were concerned that they were losing on the 'propaganda front' to 'extremists', although Hudson declined to engage directly in debate, finding the prospect 'distasteful'.¹⁶

The scientific views were promptly taken up: a sensational article in *Pix* magazine in September 1958 made clear to a wide audience the CSIRO's view that both the grazing and the SMA's works caused serious soil erosion.¹⁷ The national interest for the mountains was being recast in broader terms than utility for grazing *or* irrigation.

Over the next two years compromise was attempted through meetings and field trips between scientists and engineers. Some information was exchanged: details of works, erosion and sedimentation rates, hydrology, hydro-electric and irrigation benefits, findings about glaciation, the effects of climate, use of native and exotic plants and costs of rehabilitation programmes.¹⁸

By 1961, these efforts led to a modified AAS proposal, published in the *Australian Journal of Science*.¹⁹ Heeding criticism that scientists should stick to their science, its authors conceded the SMA's arguments on the arguable aesthetic effects of dams and aqueducts on scenery, and modified the earlier

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position on the Geehi aqueduct and dam. They softened their attack on the performance of the SMA and removed specific comments about damaging new recreational uses. But they argued on the original lines and with tighter scientific rigour about the need for a large primitive area. In particular they defined very tightly the scientific values of the alpine area in five succinct points stressing its uniqueness, the altitudinal sequence of ecology from foothills to peaks, the glacial features, the unique plant communities and the pristine streams.

The Academy's Press Release was given wide coverage, with little response from any opposition. By the early 1960s, the focus of skiing was changing: the old lodge membership model, which had suited the hardy few, was giving way to commercial accommodation supporting mass tourism. Alpine villages at Thredbo, Smiggin Holes and Perisher were established 'almost before anyone had had time to notice'.²⁰ The value of tourism and recreation was becoming the new justification for land use, overshadowing and even competing with the importance of irrigation and electricity. In time, this land use itself became problematic, but in the early 1960s the threat of tourism development to the values of conservationists still lay in the future. Both park protection groups and tourism interests believed that the park's future lay in protecting the aesthetic values of 'unspoiled' nature for visitors.

In 1959, the Trust had appointed its first Superintendent, Neville Gare. Gare was dynamic and determined to increase the standing of the park. With a certainty of belief and effective use of local media comparable to Hudson's own, he began to establish a commitment to park values in the Trust members, in other staff and in the public.²¹ His frequent newspaper articles explored natural but also social values.

The founding bodies of today's conservation movement were also gaining strength: both the NSW and Victorian National Parks Associations supported the scientists' case.²² The educational work that had continued from the earlier grazing campaign stood the scientists in good stead, and the media, Australian Primary Producers Union, River Murray League and others supported the primacy of catchment protection in the widest sense.²³

In 1962 the new Trust Deputy Chair Howard Stanley, an ally of Gare's, visited the First World Conference on National Parks in Seattle, USA. On his return he was widely reported as arguing for tourism in a national park context: the future value of the park was for low-key recreation and aesthetic appreciation in a 'pristine' landscape.²⁴ New Trust members had their own connections and alliances: for example K. G. Murray, an early developer at Perisher, was a friend of Stanley.²⁵ Other events had also changed: Costin's research influenced two Trust members, Baldur Byles and Garfield Barwick (Byles had been active in the scientist's campaign from the start, having attended the Sydney meeting of the Canberra-Kosciusko Committee). The trio took a three-day field trip in January 1958. After Barwick had been shown various study sites he changed his stance to guarded acceptance of scientific evidence, leading to the later majority

decision by the Trust to support the Primitive Area.²⁶ As a scientist Costin later saw the reason for this change as obvious. Barwick's professional training as a top lawyer gave him the habit of logically evaluating the evidence: he could not help but acknowledge a truth when it was demonstrated to him empirically and clearly.²⁷

By early 1963 the Trust found the numbers and courage to declare a Primitive Area, corresponding to that requested by the AAS. In the furore that followed, the public response was generally positive. But Hudson acted as though he had never heard of such an idea before. In an angry letter to the Trust, he claimed he was 'dumbfounded'. To the media, he said this was the first time the Authority had had an argument with anybody as to its work plans.²⁸

In April all the major local and State newspapers reported on a dramatic "'summit" conference on the roof of Australia' called by Hudson. Three Academy members supported the Trust members at the meeting. The parties failed to agree, and in fact dug in to their respective positions more deeply. Even the NSW Minister for Lands, Chairman of the Trust, continued to support its decision.²⁹ Minister Spooner also bought into the argument, using notes supplied by Hudson:

... the Authority ... is not opposed to the primitive area itself, nor has it ever opposed it. What the Authority does say is that its proposed works will not detract from the concept of the primitive area.³⁰

The matter was at a standoff. There was much debate internally and in the media about how it could be resolved. At the federal level it seemed that a cabinet decision would be needed: this would be difficult because Spooner and Barwick, by now a member of the Menzies Cabinet, were now on opposite sides. The NSW government argued that it would take agreement by the three governments involved to overthrow the Trust's decision.³¹ By mid-1963 the SMA had proceeded with the aqueduct along the spectacular wall of Lady Northcote Canyon to the Geehi Dam, but Hudson backed off a little by putting the aqueduct underground for the most visible part of its length.³² Hudson had earlier quoted a cost of £150,000 to achieve this but now in response to pressure from Spooner it emerged that this was 'a hurried guess'. The actual cost now was £30,000.

Spooner softened public opposition by announcing that in any case the summit works would not proceed for some years. His increasingly pointed requests to Hudson to supply detailed information on the SMA's plans reflected the political pressure he was under. Several dozen letters per week had been pouring into his office supporting the Trust and Academy, petitions and form letters were circulating amongst at least sixty conservation groups in NSW: the media was reporting the scientists' aesthetic and cultural arguments verbatim.³³

The NSW Cabinet continued to back the Trust. Soon afterwards, the NSW government changed and the new Minister Tom Lewis declared a National Park process for the State Park.³⁴ Hudson retired in 1966, and his replacement Howard Dann and the new Federal Minister, Fairbairn, let the matter slide into

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oblivion, finally announcing abandonment of the summit plans in 1968. Ironically, the Minister's reasons were similar to those argued by the scientists and conservationists, including 'the public interest'.³⁵

These events opened up debate about the nature of scientific participation at the time, as the analysis in the next section shows. Ecological science was only emerging as an accepted basis for action.³⁶ The detailed knowledge presented was unprecedented and its validity contested. Costin and his colleagues were using new, different principles to effectively build a local knowledge of place, one that rejected both the graziers' folk ecology³⁷ and the engineers' single minded focus.³⁸ The ecological case was authoritative, but it also inspired a broad moral authority about land use that appealed to the community conservation movement. This position, however, was unacceptable, not only to the SMA and the politicians, but even to some within Academy ranks.

WHAT ECOLOGY SHOWED ABOUT DEVELOPMENT

Costin had learned from local and international observations of transhumance grazing of the folly of importing land use practices from Europe to Australia. His experiments and data collection showed the impacts of disturbance on deep, fragile Australian mountain soils and associated plants at high altitudes.³⁹ This emerging ecological framework showed that such places could not easily be restored, and that costs of mitigation work and stabilising damaged areas were unacceptably high. Evidence was also growing that the limits of rehabilitation technology would be exceeded by work above 6,000 feet.

Browne's and Costin's notes to President Eccles, Turner and others in the Academy files inform them of new understanding of the relationships between precipitation, plant communities, soil and soil movement. Costin lucidly explains why the Kosciusko Tops are especially vulnerable, because they incur:

... an unusually large number of freeze-thaw cycles, Guthega for example, recording approximately 180–200 per annum ... [which] combined with heavy summer rains and strong winds ensures soil erosion debris is rapidly removed. The possibility of continued erosion is increased further by the unusual depth of the soils and weathered parent material beneath, and by the long unbroken slopes common in the Kosciusko area. This combination of deep soils and long slopes is not found to the same extent overseas where mountains are typically rockier and steeper.⁴⁰

By the early 1960s, Costin and his colleagues Dane Wimbush, Dave Kerr, Max Gray at the CSIRO's Alpine Ecology Unit were able to observe the NSW Soil Conservation Service programme to restore the shocking grazing damage in the Carruthers–Twynam area, where most of the soil had been lost. Assess-

ments showed that 'erosion ... had gone so far that economic reclamation seems to be out of the question.'⁴¹

A tenet of ecological logic was to avoid unnecessary damage, not to hope that it could be fixed up later. Costin argued further that the best guide to use was to observe and work for ecological integrity. This was a practical matter. If allowed, recovering ecological processes would maximise the mountains' value for sustainable water catchment *and* for scientific interest and study.

The need to prevent further damage perhaps gave an urgent edge to Costin's warning that the SMA could be working on the margins of disaster. A letter to Academy President Eccles looks quite prophetic in today's context of climate change. Costin describes his developing understanding of the recency of violent solifluction processes (movement down slope of semi-thawed rock, soil and slush over bedrock):

... if the SMA does go above 6,000 feet with its structures, it will be entering an environment which is on the knife-edge of natural stability, and there is no saying that solifluction instability could not return any time with just a small climatic shift.⁴²

MORE THAN A 'SCIENTIFIC' VIEW?

Emerging scientific knowledge supported an idealistic vision that was more than scientific. From the start, the scientists directly confronted the SMA's 'national interest' claims with their own. Their first, rejected submission begins:

The Kosciusko area is the highest and only extensive alpine landscape in Australia.

Progressive countries recognise that reservation and scientific management of outstanding natural features in order to preserve and enjoy their aesthetic, educational and scientific values is an essential form of land use, and is in increasing demand by the community. The rising tempo of development and population increase mean that the supply of such areas is rapidly diminishing.⁴³

They were uncompromising, even indignant, that unique natural features had been 'irreplaceably impaired': their protection was a matter of 'great urgency'. Increased access and use were causing new problems and exacerbating old ones; a planned approach was needed to prevent 'indiscriminate' development; the proposed works would add nothing to the irrigation value of the whole scheme and provide only a small additional electrical output.

The sheer pace and scale of developments of the Snowy Scheme were under attack. The 'mess' at one of the first major work sites, Guthega, was the beginning of the scientists' evident mistrust of the SMA.⁴⁴ They doubted its willingness to learn from or engage with their advice, or to manage impacts except for superficial aesthetic benefits. This judgement was to endure for the duration of the

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dispute, despite the SMA's repeated assertions that they were environmentally responsible and that damage at Guthega was caused by teething problems.⁴⁵ Foreseeing further damage at higher altitudes, the scientists demanded a considered planning process that included a range of values and impacts.

They also argued a political position against skiing development in the summit area. Two huts at Lake Albina and another below Mount Clarke were attracting increased traffic. Ever-deepening tracks were causing 'unsightly scars' five feet deep in places. They objected to the access to private huts as the 'virtual alienation of the choicest parts of a rare and irreplaceable landscape by individual groups'. Leaders in the skiing industry supported the SMA and had big plans for further developments around the High Tops.⁴⁶ For the scientists, a primitive area 'would be the most democratic way' of making the full benefits of Kosciusko available to everyone, without one person's use impinging on the values and enjoyment of others.⁴⁷

After three years of debate the AJS article of 1961 was more politically nuanced than the initial submission.⁴⁸ Its tone was careful, acknowledging some engineering, access and recreational benefits. But it tightened its case for primitive area protection as a superior form of land use: the widespread loss of native flora and fauna elsewhere made urgent the protection of remaining intact places. Nature conservation should not be seen as non-use of land. Protection could be a major purpose and value. In fact, the scientists were not primarily arguing for non-use, but for protection of undamaged or recovering ecological processes for sustainable economic and recreational value.

Scientists had supported the 'economy of nature' at least since Helms' famous conclusion about mountain grazing and associated practices fifty years earlier: land use should not involve more costs than benefits.⁴⁹ This was also a moral position: Costin, Browne, Turner and other scientists were ardent visionaries of land use in which aesthetics, ecological health and resilience, practical use, and human well being were intertwined. Recognition of ecological elements and processes led them to argue for an ethical relationship to nature. This was based on ecological rather than technological principles for land use, involving long time frames, localised interactions, caution about irreversible actions, respect for other species.

Their feeling for the aesthetic and spiritual value of the mountains underpinned their thinking:

We need such undisturbed areas more than the developments which are possible in them. If we cannot save a few of the best, it does not say much for our scientific, cultural and spiritual standards.⁵⁰

Several of the scientists wrote of their ethical responsibility late in the dispute:

We do not believe that scientists should speak only for what concerns science, and on all grounds – scientific, aesthetic, humanistic – we argue that our only

alpine sanctuary should not be entered by engineers for the sake of a very small and expensive increase in electrical power.⁵¹

CONFLICT WITH THE DEVELOPMENT ETHOS

This view of the public interest collided head on with that of Hudson, SMA engineers, and Senator Spooner who believed that the SMA's charter committed them to a great service to the nation. Development plans were also an expression of 'scientific, cultural and spiritual standards', and science should show how development *could* be best achieved, rather than to campaign against it.

Hudson's responses to the Academy's argument showed him to be amazingly ignorant of the particular values of the landscape for which he carried such great responsibilities, and very unreceptive to scientific argument about it. In a point by point response to the Academy's first Submission, SMA Chief Engineer Eric Warrell, acting for Hudson, argued that other areas would do just as well for a primitive area; that Victoria might offer a better alpine location for one; that specific 'items' of significance could be fenced off; that the works would only damage a little bit of the David Moraine; that Costin's knowledge of the plants and plant communities was flawed; that replanting would fix any damage.⁵²

In short, the engineers talked a different language, understood and valued different kinds of knowledge, had a different concept of value and utility. An SMA engineer showing a reporter around the contested area endorsed the scientists' private fears about engineers as land managers. This employee was puzzled by the fuss in a way that now reads as almost comic, especially when it is realised that the aqueducts would be 14 feet (4.5 metres) wide:

A couple of miles of aqueduct piping to be laid would be hidden eventually by imported snow grass, and spoil taken for the two and a half mile tunnel would be dumped out of sight behind a high knoll.⁵³

In reaction to such views, Turner raised the enduring public policy question of whose expertise should count. 'Decisions on such matters should not be left to *engineers only ...*' as they wanted to collect every particle of water.⁵⁴ Although the SMA employed respected soil conservation scientists Drs Mueller and later Raeder-Roitzsch and Phillips to research and remediate damaged areas, the Academy files show that the ecologists believed that the SMA's soil conservation efforts were inadequate and these scientists' work was compromised by the engineers' attitude to it. Turner, Max Day, Doug Waterhouse and Fred White believed that conservation-minded scientists or engineers left the SMA after short terms because their integrity was challenged by organisational attitudes, including the speed with which they had to produce solutions.⁵⁵ Long-term data collection was essential for natural resource management decisions. As Griffiths and Robin point out, the argument over land use in the mountains was one of

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the first that could be supported by the application of consistent data over time to a defined question.⁵⁶ Science was seen here as a continuing process, where the greatest risk is that evidence will be lost or damaged done before a site or question is fully explored.⁵⁷

An internal report of 1958 by Raeder-Roitzsch and Phillips presents an insight into SMA practices.⁵⁸ It is stamped *Top Secret: Never to be released*. Although the reasons for the secrecy are obscure, as the content appears to be workman-like rather than controversial, this prohibition suggests a culture adversarial to shared knowledge and peer critique or review, contrary to the customary openness and robust debate of natural science research.

This report echoes Costin's work in its experimental and observational comments about catchment deterioration, but it differs significantly in the way it considers water yield. It focuses on the SMA's specific objective, to capture as much water as possible. In sharp contrast with the Academy's interest in protecting catchment processes, the SMA scientists are concerned that any process that impedes or uses water flow is a problem, and any process that facilitates it is aspired to. The report challenges Costin's contention that native plants are most effective in restricting erosion, arguing that undisturbed native vegetation might limit water yield. To increase water flow, the report suggests the use of forest thinning to reduce evapo-transpiration, use of low water-consuming introduced plants, and draining 'swamps'. This emphasis on water flow *from* the system to dams and aqueducts rather than holding capacity *of* the system in soils, wetlands and plants is a crucial difference in attitude.

VISIONS IN CONFLICT: THE POLITICS AND THE SCIENCE

The two conflicting views sharpened as the conflict went on. Hudson, backed by his senior engineers, for whom it was said 'early conservation methods were extravagant and sometimes unnecessary',⁵⁹ saw the benefits of the great work as cancelling out marginal damage, which could in any case be decoratively concealed. Typically, in 1958 he appointed an Aesthetics Committee, which planned to plant exotic willows and poplars at the vast wasteland created by the borrow pits at Adaminaby. This kind of response seemed like a direct rebuff of ecological concerns, and indeed, the absence of any internal assessment as to the validity of the scientists' case is a striking feature of the SMA files. Hudson frequently used his successful media branch to rebut the scientists and rhetorically assert the SMA's high standards, persuading the Australian public that the mountains were in good hands. But the scientists Eccles, Turner and Day were not impressed by the standard SMA glamourising media strategies, politely requesting that a field inspection planned for them in 1960 should omit film viewing and visits to underground stations and research laboratories.⁶⁰

However, the scientists did not primarily question the SMA's integrity. They saw that Hudson was listening to a different drum, intent on carrying out the works that he was authorised to conduct. Hudson fought every inch of the way: a letter to the *Sydney Morning Herald* showed his effective use of what would now be called 'spin'. He reminded readers of the SMA's role in removing grazing, demonstrating that they were keen to preserve 'the natural flora' of the mountains. He saw little conflict between the proposed works and protection, arguing that rock spoil from the 4-mile long tunnels would be placed out of sight, and that the total works would be inconspicuous, well restored and maintained. He argued that the scientists had left their case too late, as the SMA was already committed to the works upstream through the building and design downstream of Guthega. In general the works would 'occupy an infinitesimal fraction of the primitive area'.⁶¹

Dissension broke out within the Academy when Professor Tom Cherry became the new President from 1961 to 1965. Like Hudson, Cherry thought the original submission was emotive and ill-considered, or unscientific. He was sceptical about the alarmist line on land degradation, and sought a diplomatic solution.

A mathematician and bushwalker, Cherry clearly didn't have specialised ecological knowledge. From his own brief 'inspection' of the High Tops, he argued that the damage was only a small part of the whole, that it couldn't be seen from the road, and that there were some good examples of rehabilitation. Here Cherry shows the skills of a good observer, or a naturalist, characteristically valuing personal observation and judgements, personal aesthetics and relying on commonsense rather than knowledge of detail or of processes.⁶² Cherry hoped that ecological science could develop techniques for remediating damage at high altitudes, rather than contesting their feasibility.⁶³ Interpretation of a landscape is also a matter of personal outlook: Cherry agreed with Hudson that high altitude lakes and exotic plantings improved the scenery; most people wouldn't know the difference anyway; and it was the SMA that opened up the country for scenic or recreational appreciation.⁶⁴

Cherry also thought that those in higher positions should decide these matters. Science should not be political. Unlike some of the others, he did not see the primitive area as a kind of absolute, in which compromise was loss, although he tried conscientiously to represent his fellow scientists' views. He thus aligned himself, possibly unconsciously, with Hudson's view that the default value in the debate was that of the Scheme: all else could be compromised. Needless to say, Cherry's cautious position did not go down well with the idealistic Costin. The President had effectively called Costin's science into question as well as his judgement. Scientific information can offer a fragile argument in a situation where only one or two people may have the detailed knowledge and understanding required to speak with real authority. Later, Costin was to tartly comment on Cherry's tendency to be easily satisfied by the window-dressing

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of the SMA: it was a waste of time talking to him about biology. Geehi could have been saved if it wasn't for Cherry, was his opinion.⁶⁵

It fell to the diplomatic Turner to mediate in this internal dispute. Although to the SMA he was a 'crusader' whose reluctance to be impressed was a problem, Turner agreed that perhaps the politics of the issue had been poorly handled. He lamented: 'It is a pity about Costin – he's extraordinarily good and likeable, but too impetuous and too young to handle such people.'⁶⁶ But unlike Cherry he endorsed Costin's science: he had his own detailed knowledge of alpine ecology, gained from work on the Bogong High Plains in Victoria with his and Costin's colleague, Maisie Fawcett.

Turner also recognised the personal and organisational culture they were dealing with.

Hudson is intransigent and says he will fight us all the way. If we give in he'll meet our wishes as far as possible on the new high-level construction work.

But:

They do not regard the primitive area proposal as meriting really serious attention. Engineers rule the roost there and they don't really understand what's needed.⁶⁷

Just as Hudson thought the scientists should restrict themselves to their science, Turner resented the fact that the engineers had exceeded *their* expertise: they had gone so far as to advise the scientists of the location of the 'rare' plants, the type of primitive area they should select, and had even taken sides with the skiing organisations.

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The vast multi-tiered infrastructure that is entwined with current environmental issues – laws, agreements, assessment processes, government and non-government organisations, campaigns and campaign skills – hardly existed in the 1960s, especially at the national level.⁶⁸ The scientists found themselves committed to the resolution of a problem that lacked forums or processes to resolve it. And to vigorously pursue a political agenda would exceed the limits of scientific authority or expertise.

Once the Academy's argument had been rejected twice in 3 years, this institutional vacuum made a stalemate inevitable. As early as 1955, the *Riverlander* (one of several journals of lower Murray farming and development interest groups) had pointed out the inadequate structure of the Snowy Scheme: 'a purely construction Authority' was empowered to carry out major works over a 3,000 square mile area without sufficient political and administrative machinery to deal with associated issues, foremost of which was now catchment management.⁶⁹ Although NSW managed the land under delegated authority to the State

Park Trust, the Snowy Scheme was a national matter. An agreement between the State and Commonwealth required that the Scheme manage the works in an environmentally sound way, but there was no precedent for intervention when this requirement was breached. In theory, State authorities were sufficient to see to the land management issues. But in practice, Kosciusko State Park Trust, the Lands Departments, Soil Conservation and Forestry authorities in NSW and Victoria were 'too conflicting, and their available resources too pitifully limited'.⁷⁰ There was no spokesperson for national parks or nature conservation at the Federal level. The interested Ministries, those responsible for National Development and for the CSIRO, had taken different sides in the debate, making any challenge to the SMA's plans at Cabinet level quite difficult.⁷¹ So, in the end, the matter petered out, overtaken by other political and land management agendas. In 1965, Alec Costin summed up the achievement:

As a milestone in public involvement in decisions affecting rational use of natural resources, the Kosciusko controversy is almost without precedent in this country.⁷²

Costin's use of the term 'rational' is arresting: it suggests that he still believed that the application of a scientific and technical process should offer an appropriate outcome. Yet throughout the dispute, Costin and his colleagues had emphasised ecology's capacity to underpin a moral and aesthetic sensibility towards nature. Letters and articles by their political supporters echo this view, suggesting that it was this sensibility that swayed debate for non-scientists.

This position echoed that of a growing environment movement internationally, in which trusting acceptance of technical and professional expertise was rejected in favour of an integrated view of various rationalities. Costin encompassed a 'land ethic' reminiscent of Aldo Leopold's contemporary position:

A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.⁷³

Cherry and his opponents in the Academy, Costin, Turner, Day, Waterhouse and White, concluded that such a conflict could best be resolved through a judgement made by democratic process, for the public good, not solely by internal experts. As Professor Cherry pointed out in a last letter to Sir William Hudson before his retirement in 1965:

The values attaching to the Primitive Area concept lie largely outside the objective sphere, while those values that are objective lie mainly in the province of specialists.⁷⁴

This understanding underpinned the growth of environmentalism as a social rather than a scientific movement, and it led to the acceptance of forums where argument over such matters was only partly technical.

WHAT IS THE LEGACY OF THE DEBATES OF THE 1950S AND 1960S?

Although people may now be even more sceptical about the capacity of science or technology as reliable sources of authority by themselves, acceptance of other ideas and values in tandem with science has grown. A radical shift in attitudes to land use will take more than fifty years, but since the 1960s cultural attitudes to land use in Australia have edged closer to Leopold's view that it is necessary to nurture both the tangible and intangible benefits of nature. From the triumph of 'primitive area' ideals this emerging rationality may have influenced the style and place of nature conservation in land management in the years since.⁷⁵ Protected places like Kosciuszko summit have become widely accepted, even though the popular rationale for protected area land use is probably more for aesthetic and experiential reasons than for scientific ones.⁷⁶ Perhaps the conflict had an effect on general understanding and support for the idea of catchment protection, which has been a slow growing story since. Over the last thirty years ecological ideas such as the value of headwaters, or that native species would work better than introduced plants in land restoration have begun to emerge more widely.

On the negative side, there is still an apparent incapacity for public debate to sustain attention to the detail of the problems at hand. Community consultation processes, which are now routinely pursued by natural resource management agencies, are not often informed by good education. In such processes, people's limited understanding of the ecological underpinnings of issues prevails, and their judgements are not often made on scientific grounds. These judgements may not improve the quality of management.

The outcome of the high tops conflict illustrates this perspective. The dam and related works were not built, but on the other hand, the work of restoring alpine catchment condition has never been completed. The 1960s work programme that Roger Good managed for the Soil Conservation Service of NSW aimed only to stabilise the landscape, to avert further erosion. This preliminary work has never been continued and has gone backwards in places, especially around Mount Twynam. Considering the vast quantities of soil that were lost during the grazing era, and the loss or alteration of entire vegetation communities, wetlands, soils and drainage systems, the catchment must still be well below its pre-European capacity for water retention and regulation. So an ecological solution has still not been applied to establish the greatest possible efficiency of the country's highest catchment, despite the current crisis over water in the three states dependent on the alpine catchments.⁷⁷

It is doubtful if many visitors to the Main Range are aware of this.

Consideration of the affair in 2008 suggests that the detail of this history has been forgotten, or at least has not entered the folk memory, as Griffiths and Robin hoped in 1994 when they suggested that science should not be seen as a narrowly instrumental offering:

The heritage of science in the Alps is undervalued in terms of its cultural significance, as a source of thoughtful and sensitive observation of nature, of creative and productive responses to landscape, of identity with place, of political and social courage. An understanding of Australia's scientific heritage might help prise open the grimly locked jaws of narrow-minded pragmatism.⁷⁸

The primitive area debate exposes the contested relationship between sound science and values, and may have entrenched incapacity to develop that relationship. As Robin lamented in 1998, 'deep suspicion' emerged between 'radical environmentalists' and scientific ecologists. Echoes of such suspicions of science still appear: the phrase 'so called scientists', which is currently getting a good outing in the climate change debate, was perhaps given its first national run in the conflict over the high tops dams. Good science, it seems, is destined to be ever in danger of offending groups radically at odds with, or embedded in, prevailing power systems.

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NOTES

¹ For general accounts of the geological formations and values of the mountains, see Roger Good, *Kosciusko Heritage* (Hurstville: The National Parks and Wildlife Service of NSW, 1992); Deirdre Slattery, *Australian Alps: Kosciuszko, Alpine and Namadgi National Parks* (Sydney: UNSW Press, 1998).

² Australian Academy of Science Archives, Kosciusko Tops File 1002. *Submission on Proposed Kosciusko Primitive Area* (unpublished report, undated, but probably March or April 1958).

³ Australian Academy of Science, 'The future of the Kosciusko Summit Area: A report on the proposed primitive area within the Kosciusko State Park', *The Australian Journal of Science* 23 (1961): 391–399.

⁴ Soil Conservation authorities had been established in both NSW and Victoria in 1938 and 1940 in response to a long history of concern about farming practices and soil erosion, and more recent concern about siltation of major new dams in both States. Alpine catchments were an obvious focus for scientific evaluation and protection. E. S. Clayton was the charismatic and determined Chair of the NSW Authority and a member of the Kosciusko State Park Trust from 1944 to 1961. He subsequently replaced A. B. Costin as soil conservation adviser to the SMA, when funding for Costin's salary was withdrawn after the AJS article appeared in 1961. More detail about Clayton's work can be found in Roland Breckwoldt and Soil Conservation Service of New South Wales, *The Dirt Doc-*

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tors: *A Jubilee History of the Soil Conservation Service of NSW* (Roland Breckwoldt, Sydney: Soil Conservation Service of NSW, 1988). Alec Costin's PhD Thesis, *A Study of the Ecosystems of the Monaro Region of New South Wales* (Sydney: NSW Government Printer, 1954), laid the foundation for his own and other research in the following years. Costin worked for the Soil Conservation Board in alpine Victoria from 1953 to 1955, as well as his NSW work.

⁵ For general conservation histories see: Tim Bonyhady, *Places Worth Keeping: Conservationists, Politics, and Law* (St. Leonards, NSW: Allen & Unwin, 1993); Libby Robin, *Defending the Little Desert* (Carlton: MUP, 1998); Drew Hutton and Libby Connors, *A History of the Australian Environment Movement* (Melbourne: Cambridge University Press, 1999); Martin Mulligan and Stuart Hill, *Ecological Pioneers* (Sydney: Cambridge University Press, 2001); William Lines, *Patriots: Defending Australia's Natural Heritage* (St. Lucia: University of Queensland Press, 2006, 28). For specific accounts of the primitive area dispute see: Keith Hancock, *Discovering Monaro* (Cambridge: Cambridge University Press, 1972); Roger Good, *Kosciusko Heritage* (Hurstville: The National Parks & Wildlife Service of NSW, 1992); Geoff Mosley, *Battle for the Bush* (Sydney: Envirobook, 1999); Graeme Worboys, Janet Mackay, Andy Spate and Roger Good: 'Protected area management in the Australian Alps: a case study: Kosciusko National Park' in L.S. Hamilton, D.P. Bauer and H.F. Takeuchi (eds.), *Parks, Peaks, and People* (Honolulu: East-West Center, 1993), 50–67; Libby Robin, 'Nature conservation as a national concern: The role of the Australian Academy of Science', *Historical Records of Australian Science* 10, 1 (1994): 1–24; Libby Robin, 'Radical ecology and conservation science: An Australian perspective', *Environment and History* 4 (1998): 191–208.

⁶ Thomas Dunlap, *Nature and the English Diaspora* (Cambridge: Cambridge University Press, 1999).

⁷ The Trust was entrusted with the 'care, control and management' of the park under the State Park Act in 1944. Chaired by the Minister for Lands, members were nominees of the Lands Department, Soil Conservation Service, Forestry Commission, Railways, Premier's Department and two community nominees. Later, two extra positions, one representative of cattle grazing lessees, and one local MP were added.

⁸ D. Slattery, 'Bushwalking and access: The Kosciusko Primitive Area debate 1943–6', *Australian Journal of Outdoor Education* 13, 2 (2009): 14–24; Mosley, *Battle for the Bush*; M. Harper, *The Ways of the Bushwalker* (Sydney: UNSW Press, 2007); P. Meredith, *Myles and Milo* (Sydney: Allen & Unwin, 1999).

⁹ Australian Academy of Science, Kosciusko Tops File 1001, 1956. *Letter from Fenner, Frankel, Wood, Clunies Ross and Browne, requesting the Academy to set up an enquiry into the condition of the mountain catchments* (Basser Library: AAS, Canberra).

¹⁰ AAS, *A Report on the Condition of the High Mountain Catchments of New South Wales and Victoria* (Canberra: Australian Academy of Science, 1957). Turner was Professor of Botany at Melbourne University. Costin was employed by the CSIRO's Alpine Ecology Unit. The SMA also contributed to his salary to advise their engineers on erosion matters. Drs Evans and Crocker were also members of the Committee that wrote the report.

¹¹ AAS, *A Report on the Condition*, 45.

¹² *Sydney Morning Herald*, 26 August 1952, 2; Hancock, *Discovering Monaro*; Mosley, *Battle for the Bush*; *Sydney Morning Herald*, 26 August 1952, 2.

¹³ AAS, Kosciusko Tops File 987, 25 March 1958.

- ¹⁴ AAS, Kosciusko Tops File 1002, May 1958.
- ¹⁵ National Archives of Australia, A2915/1, A5040, Spooner–Moore, 10 July 1958.
- ¹⁶ NAA, A1690/1, 1962/1695.
- ¹⁷ ‘Erosion – A threat to the Snowy Scheme’, *Pix*, 13 September 1958, 15–17.
- ¹⁸ NAA, A2915/1, A5040; AAS, Kosciusko Tops Files 987, 1002.
- ¹⁹ AAS, *The Future of the Kosciusko Summit Area*.
- ²⁰ Alec Costin, personal communication to author, 27 April 2007.
- ²¹ *Riverlander*, April 1961, 9; *Cooma Monaro Express*, 22 February 1963, 24 May 1963, 15 January 1964.
- ²² *The National Parks Journal*, 1960, 7.
- ²³ *Riverlander*, 1954, 1955; *Australasian Irrigator*, 1957.
- ²⁴ *Cooma Monaro Express*, 15 January 1964; *Daily Telegraph*, 14 June 1966.
- ²⁵ Neville Gare, personal communication to author, April 2007.
- ²⁶ Hancock, *Discovering Monaro*, 174; Byles, *Kosciusko State Park Trust: Notes on a three day tour*, dated 11 January 1958, Gare, Private Collection of Byles’ papers; Costin, personal communication to author, 2007; *Garfield Barwick, Interview with Neville Gare*, 22 July 1993 (Canberra: National Library of Australia, Oral History Recording); John Merritt, *Losing Ground: Grazing in the Snowy Mountains 1944–69* (Dickson: Turalla Press, 2007.)
- ²⁷ Costin, personal communication to author, April 2007.
- ²⁸ *Daily Telegraph*, 19 April 1963.
- ²⁹ *Sydney Morning Herald*, 29 April 1963.
- ³⁰ *Sydney Morning Herald*, 13 May 1963; NAA, A5628/2 1961/237 Part 3.
- ³¹ Victoria, New South Wales and the Commonwealth were the parties to the Snowy Mountains Agreement; Hancock, *Discovering Monaro*, 177.
- ³² NAA, A5628/2 1961/237 Part 3.
- ³³ NAA, A5628/2 1961/237 Part 3; AAS, Kosciusko Tops File 988, 18 April 1962.
- ³⁴ Hancock, *Discovering Monaro*, 178.
- ³⁵ NAA, A5628/2 1961/237 Part 3; Warrell–Dann, 26 February 1968. AAS, Kosciusko Tops File 989, Fairbairn–Burnet, 14 May 1968.
- ³⁶ Dunlap 1999; Hutton and Connors 1999; Mulligan and Hill 2001; Donald Worster *Nature’s Economy* (New York: Cambridge University Press, 1994).
- ³⁷ Scott Atran, *Cognitive Foundations of Natural History* (Cambridge University Press/ Editions de la maison des sciences de l’homme, 1990.)
- ³⁸ James Scott, *Seeing Like a State* (New Haven: Yale University Press, 1998). Scott describes the outlook and practices of institutional technical thinking.
- ³⁹ Scott, *Seeing Like a State*, describes the assumed transferability of project parameters from one place to another as one of the characteristics of modernist, high tech projects, especially in dam building and irrigation projects.
- ⁴⁰ AAS, Kosciusko Tops File 987, nd.
- ⁴¹ AAS, *The Future of the Kosciusko Summit Area*, 396.
- ⁴² AAS, Kosciusko Tops File 988, 27 February 1961.
- ⁴³ AAS, Kosciusko Tops File 1002, May 1958.

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- ⁴⁴ AAS, Kosciusko Tops File 988, Costin–Turner, 30 April 1962.
- ⁴⁵ Joyce Vickery, *Observations on Plant Regeneration in the Snowy Mountains Area*, 5. (Sydney: National Herbarium, Royal Botanic Gardens, 1964.)
- ⁴⁶ Charles Anton, Letter to the Editor, *Daily Telegraph*, 5 August 1961.
- ⁴⁷ AAS, Kosciusko Tops File 1002, May 1958, 4.
- ⁴⁸ AAS, *The Future of the Kosciusko Summit Area*.
- ⁴⁹ Richard Helms used this phrase in his 1893 attack on the ignorance and greed shown by the grazing practices in his ‘Report on the Grazing Leases of the Mount Kosciusko Plateau’, *NSW Agricultural Gazette* 4, 530–1. For a detailed lineage of the term in the changing ecological understanding of nature, see Worster, *Nature’s Economy*.
- ⁵⁰ AAS, Kosciusko Tops File 988, Costin–Turner, 30 April 1962.
- ⁵¹ AAS, Kosciusko Tops File 990, *Internal memorandum from Day, Turner, Waterhouse and White to President Cherry*, 17 May 1962.
- ⁵² AAS, Kosciusko Tops File 987. *Notes by the Snowy Mountains Hydro-electric Authority on the Academy Committee’s Draft Report* 25 November 1960.
- ⁵³ *Melbourne Herald*, 14 March 1963.
- ⁵⁴ AAS, Kosciusko Tops File 1002, Turner–Day, 29 August 1958.
- ⁵⁵ This was confirmed later by Clayton in E.S. Clayton, *The Fight for the Snowy Mountains: Personal Memoirs* (Unpublished: The late Sam Clayton, 1980, 206–7). AAS, Kosciusko Tops File 990, J.S. Turner, M. Day, D. Waterhouse and M. White, *Memo–Professor Cherry*, 28 July 1962.
- ⁵⁶ Tom Griffiths and Libby Robin, *Science in High Places: The Cultural Significance of Scientific Sites in the Australian Alps* (Canberra: Australian Alps Liaison Committee, 1994).
- ⁵⁷ AAS, Kosciusko Tops File 988, Costin–Turner, 30 April 1962.
- ⁵⁸ J. E. Raeder-Roitzsch and Marie E. Phillips, *An Analysis of Some Land Use Problems in the Snowy Mountains Area. Soil Conservation Report No. S.S. 20*. (Cooma: SMA, December 1958, 15).
- ⁵⁹ AAS, Kosciusko Tops File 987, Turner–Eccles, 4 October 1960.
- ⁶⁰ AAS, Kosciusko Tops File 987, Eccles–Hudson, 15 January 1960.
- ⁶¹ *Sydney Morning Herald*, 14 February 1962.
- ⁶² Atran, *Cognitive Foundations*.
- ⁶³ AAS, Kosciusko Tops File 988, Cherry–AAS, 8 December 1961.
- ⁶⁴ AAS, Kosciusko Tops File 1003, Cherry–Turner, 11 May 1959.
- ⁶⁵ AAS, Kosciusko Tops File 988, Costin–Turner, 30 April 1962.
- ⁶⁶ AAS, Kosciusko Tops File 1002, Turner–Day, 29 August 1958.
- ⁶⁷ AAS, Kosciusko Tops File 987, Turner–Eccles, 4 October 1960.
- ⁶⁸ Robin, *Defending the Little Desert*; Hutton and Connors, *A History of the Australian Environment Movement*.
- ⁶⁹ *Riverlander* ‘Crippled Catchment’. Murray Valley League and Murray Valley Development League 1955, 5.
- ⁷⁰ *Riverlander* ‘Crippled Catchment’, 5.
- ⁷¹ AAS, Kosciusko Tops File 987, Raggatt–Eccles, 19 May 1960.
- ⁷² AAS, Kosciusko Tops File 989, October 1965.

⁷³ Aldo Leopold, *A Sand County Almanac* (New York: Oxford University Press, 1949), 224.

⁷⁴ AAS, Kosciusko Tops File 988, Cherry–Hudson, 6 April 1965.

⁷⁵ Good, *Kosciusko Heritage*; Worboys, McKay, Spate and Good, *Protected Area Management*.

⁷⁶ Deirdre Slattery, 'Resistance to development at Wilson's Promontory National Park (Victoria, Australia)', *Society and Natural Resources* 15 (2002): 563–80.

⁷⁷ Good, personal communication to author, July 23, 2008.

⁷⁸ Tom Sharratt, quoted in Griffiths and Robin, *Science in High Places*, 5.