The Long and Entangled History of Humans and Invasive Introduced Plants on South Africa's Cape Peninsula

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Chapter 10
The Long and Entangled History of Humans and Invasive Introduced Plants on South Africa's Cape Peninsula

Simon Pooley

Abstract This chapter provides an environmental history of plant introductions and fire—and how their unintended consequences have been framed and managed—at the Cape of Good Hope, South Africa. The chapter explains why the plants which have proved invasive were introduced to the region, examines the effects of urbanisation on attitudes to introduced tree plantations, and describes the development of concern over the effects of fires and introduced plants on the indigenous fynbos vegetation. The chapter recounts the complex history of environmental management on the Peninsula, discussing the advantages and limitations of the powerful narrative linking invasive introduced plant control with fires and water supplies, and recent controversies between invasion biologists and commercial forestry managers.

10.1 Introduction

This is a history of fire, water and plant introductions, and the unintended consequences of how these have been framed and managed at the Cape of Good Hope, South Africa. In this chapter I explore why the plants which have proved invasive were introduced to the region, the effects of urbanisation on attitudes to introduced tree plantations, and the development of concern over the effects of fires and introduced plants on the indigenous fynbos vegetation. The chapter shows how a series of major fires ignited controversy over introduced plants and fire control, and recounts the complex history of environmental management on the Peninsula, drawing attention to economic, social, cultural and political as well as environmental influences on policy and management practise. Finally, there is a discussion of the advantages and limitations of the powerful narrative linking invasive introduced plant control with fires and water supplies, which developed after the unprecedentedly large fires of January 2000. Parallels—and differences—with the

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fire situation in the Mediterranean basin region, where fires have played an important role in shaping the biota for millennia, are explored in a panel 'Fires in Mediterranean-type ecosystems.'

10.2 Plant Introductions

Plants have been introduced to the Cape Peninsula at least since Europeans settled there in 1652. The first Dutch commander, Jan van Riebeeck, and his fellow Dutch East India Company (VOC) employees set out to establish a refreshment station for Dutch ships sailing between the Netherlands and Batavia, the capital of the VOC's territories in the Far East. They diligently investigated the possible uses and commercial potential of the local fauna and flora, introduced some early legislation in an effort to preserve scarce timber and firewood resources on the Peninsula, and introduced a wide variety of fruit trees, vines, ornamental trees, cereal crops and vegetables (Pooley 2009).

Over the ensuing 154 years of Dutch colonial rule at the Cape, the local landscape was transformed through wood cutting, the planting of numerous introduced plants, and sedentary farming including livestock raising (the Khoikhoi had used the Peninsula for seasonal grazing). There is no evidence to suggest that any of these introduced plants proved invasive, however. The only early records of problematic invasive plants are the scientific explorer Anders Sparrman's observations from the mid-1770s on the spread of the indigenous but unpalatable shrub renosterbos (*Elytropappus rhinocerotis*), on land used to graze livestock. This, he observed, was exacerbated by farmers' attempts to burn it out (Pooley 2014, p. 25). Most of the plants that ultimately proved to be invasive of the indigenous fynbos and renosterveld vegetation were introduced during the period of British colonial rule (1806–1910), from the mid-1800s. As the northern Peninsula developed from the mid-1800s, the sandy flats surrounding the Table Mountain Chain came to be seen as a major inconvenience and obstruction to development. A suite of hardy shrubs able to handle the harsh conditions in the nutrient-poor sandy soils, and adapted to the occasional fires which swept the undeveloped Flats and mountain slopes, were imported from Australia. Wattles (*Acacia* species), hakeas and casuarinas were imported from the 1840s to stabilise driftsands (Shaughnessy 1980; Bennett 2010; Pooley 2014).

The lack of firewood and timber had always been a problem for European settlers at the Cape, becoming ever more so as the town grew and railways were built from the 1860s. Private individuals established the first timber plantations on the lower slopes of Table Mountain; for example Van Breda had a full grown pine forest on his property Oranjezicht by 1861. In 1876, a Department of Forests and Plantations was established, run by a professional forester, Joseph Storr Lister. His father had overseen tree-planting and driftsands reclamation along hard roads on the Cape Flats, and after a spell in India and England, Joseph returned to work as Superintendent of Drift Sands Plantations on the Flats. He supervised the planting

of *Acacia saligna* and various eucalypts and pines across the Peninsula. In 1876 he established the first large plantation of trees in the Cape Colony, planting blue gum (*Eucalyptus globulus*) to drain swampy ground believed to be a source of fevers in the inland town of Worcester. The plantation was a success and repurposed as a commercial plantation, the first rotation being sold to the De Beers Consolidated Mining Company mining diamonds at Kimberley (Pooley 2014, pp. 35–36; Lister 1957).

State foresters subsequently set out to establish commercial plantations of imported trees on the Peninsula, efforts which gained significant impetus with the appointment in 1880 of a Superintendent of Woods and Forests, the French forester Count Médéric de Vasselot de Regné, who had been trained at Nancy. Cecilia, Tokai and Uitvlugt plantations were established on the Peninsula in 1884, and a nursery and an arboretum were established at Tokai by 1886. State forestry plantations were also established at Devil's Peak (1893) and Rifle Range/Ottery (1897). State foresters encouraged municipalities and private individuals to establish plantations, and in this period, German immigrants established wattle plantations on the Cape Flats. The City of Cape Town sponsored competitions to reward the planting of wattle plantations from the 1880s. In 1894 it established its first plantation at Kloof Nek, below Lion's Head, and then a large plantation at Newlands (Pooley 2014, p. 36; Bennett 2010; Sim 1907).

Pine trees were planted for timber (and initially to help encourage a moister local climate), and the main species (many more were introduced) included the Mediterranean species the Aleppo pine *Pinus halepensis*, the cluster pine *P. pinaster*, the stone pine *P. pinea*, the Monterey pine *P. radiata* which is native to California and Mexico (called *P. insignis* in the earlier literature), and the Scots pine *P. sylvestris* from Eurasia. Eucalypts were introduced from Australia for timber and to stabilise driftsands, the main species including the sugar gum *Eucalyptus corynocalyx* (*cladocalyx* F.Muell.), the karri *E. diversicolor*, and the blue gum *E. globulus*, and were planted in strips to protect pine plantations from wind and fire (particularly blackbutt *E. pilularis* and red mahogany *E. resinifera)*. The Australian wattles (*Acacia* species) were grown for timber (especially Port Jackson wattle *A. saligna*, mainly for poles, and Australian blackwood *A. melanoxylon*) and tannin (especially black wattle *A. decurrens* and golden wattle *A. pycnantha*), to stabilise driftsands (especially red-eye wattle *A. Cyclops* and long-leaved wattle *A. longifolia*) and to protect pine plantations from wind and fire (notably *A. decurrens*). Australian Hakea species were introduced to provide shelter, serve as hedges and stabilise driftsands (sweet hakea *H. drupacea*), of which three species have become particularly problematic in the long term (silky hakea *H. sericea,* rock hakea *H. gibbosa* and *H. drupacea*). A few of these plants, and the Australian myrtle (*Leptospermum laevigatum*) were introduced as ornamental plants and have proved invasive (Pooley 2014, p.164 and pp. 168–175; CGH 1900 G.39-1901, p. 12; CGH 1902, p. 17; CGH 1905, pp. 17, 19 and 25).

In brief, although fynbos plants are adapted to certain fire regimes, many of the introduced species are better adapted to exploiting post-fire periods, growing more

quickly and taller, establishing dense fire resistant stands which shade out understorey plants and exclude the indigenous shrubs. Although they ignite less easily than fynbos plants, they burn more intensely and are more harmful to indigenous ecosystem processes and structure than fynbos fires. The invasive plants can be grouped by dispersal strategy: the Australian myrtle, hakea and pines are serotinous, releasing winged seeds when their fire-proof cones or follicles are burnt by fires; the wattles drop hard coated seeds, forming seedbanks which are stimulated to germinate by fires (heat and smoke). They spread mainly along waterways (Richardson et al. 1992; Keeley et al. 2012).

10.3 The First Concerns Over Introduced Plant Species

The first major public debates over the desirability of introduced plants arose in connection with the provision of ecosystems services (or disservices) to the growing city. Two major issues for the expanding city and its satellite villages were: the suspected impact of tree plantations on water supplies from Table Mountain; and the inflammability of these trees and the threat this posed to surrounding settlements (and the natural beauty of the Peninsula).

Following the discovery of diamonds and gold in the interior in the 1860s and 1880s respectively, Cape Town grew from an estimated 45,000 residents in 1875 to 171,000 by 1904. By 1900 its satellite villages on the Peninsula were substantial municipalities, and new suburbs were being developed. Some of the forestry department's new plantations on Table Mountain were removed to make way for reservoirs (seven were built from 1896–1907), and Hutchins' claims in the mid-1890s that 'reafforesting' Table Mountain would increase water supplies and improve water quality were disputed. By 1896 tree planting atop Table Mountain was suspended, the City Council having convinced the Minister of Agriculture that tree-planting was adversely affecting the City's water supply. In 1904, the city was still running out of water in summer (Pooley 2014, pp. 43 and 126–27; Wall 2008; CGH 1896 G17-97).

The suspension of tree planting on top of Table Mountain, and residents' opposition to tree planting, were importantly influenced by fires on the mountain. Two big fires on the slopes above Cape Town and its suburb Rondebosch in 1892 and 1893 respectively resulted in fierce objections to plantations on the mountain, both because of the dangers posed by fires, and their disfigurement of the Peninsula's natural beauty. The forestry department lamented that private plantation owners were at fault for allowing their plantations to degenerate into patchy woods interspersed with rank understorey flora, and that properly run plantations characterised by dense planting and maintenance, firepaths and vigilant firefighters would solve the problem. Although the forestry department were allowed to continue to plant trees around the lower slopes of Table Mountain—providing they undertook

extensive safety precautions including building lookouts, clearing fire breaks and digging ditches around plantations—introduced trees had become a target of public disapproval (CGH 1892 pp. 27–93, p. 17; CGH1893, pp. 50–94, pp. 30–31) (Fig. 10.1).

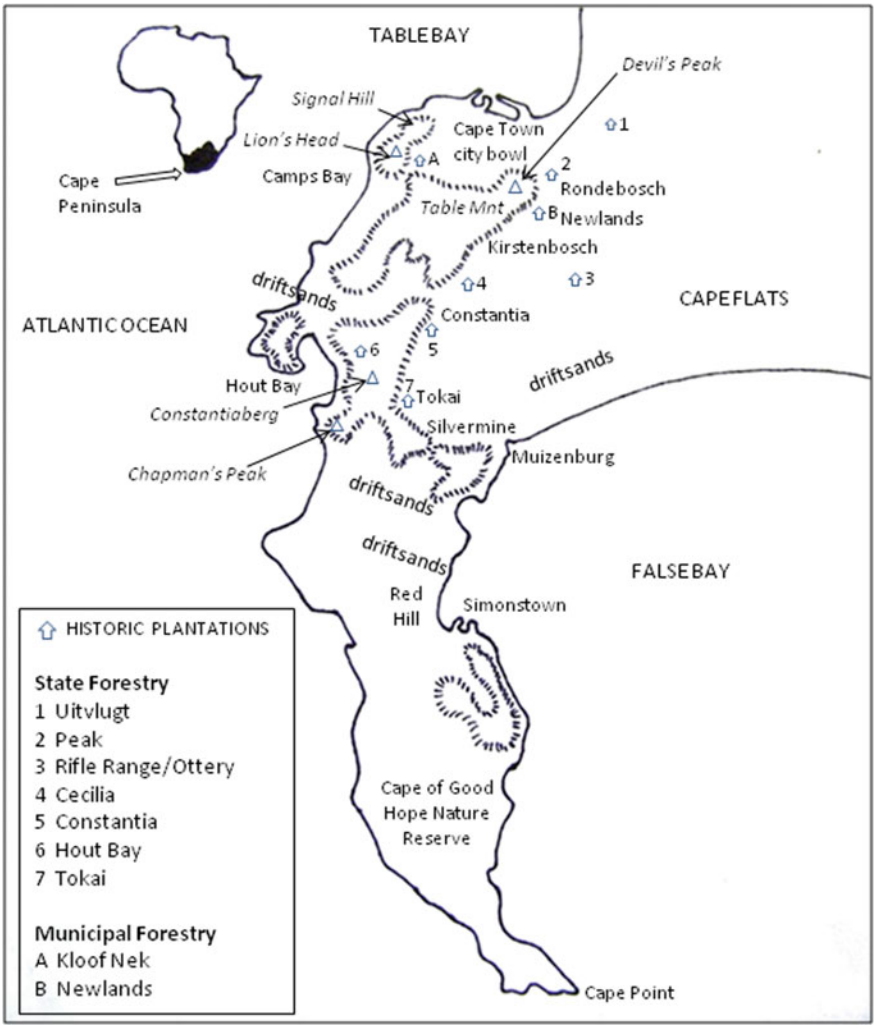

Fig. 10.1 Map of the Cape Peninsula showing historic plantations, sandrifts, key places and mountains. Most of these plantations had disappeared by the 1970s, and the Cape of Good Hope Nature Reserve has been incorporated into the Table Mountain National Park. *Credit* Simon Pooley

10.3.1 Concern for the Indigenous Flora

Concern that introduced plants would invade and overwhelm the indigenous flora of the southwestern Cape was remarked on from time to time from the mid-1800s, for instance in the region of Caledon in 1855, around Bathurst in 1863, in the 1880s by Cape botanist Peter MacOwan and in 1908 by another prominent Cape botanist, Rudolf Marloth (Van Wilgen et al. 2016). It became a sustained narrative in the 1920s, however, expressed prominently and consistently in the *Journal of the Botanical Society of South Africa* (*JBSSA*), which despite its title focused mainly on the Cape flora.

The 'floral nativism' developed at the Cape has been well described by Van Sittert (2003a, b), myself (Pooley 2010), Carruthers (2011) and Bennett (2015), and doesn't require lengthy reiteration here. What is important to recall is that the national botanical gardens at Kirstenbosch on the eastern slopes of Table Mountain was founded in 1913, not long after the creation of the Union of South Africa in 1910, and the chief instigator and first director Harold Pearson had explicitly argued for establishing a national botanical garden as an 'expression of the intellectual and artistic aspirations of the New Nation'. This he believed would 'encourage a proper appreciation for the rare and beautiful flora with which Nature has so lavishly endowed it' (Pearson 1910, pp. 1–4).

In the 1920s, Harold Compton (second director of Kirstenbosch, from 1913) and his fellow Botanical Society members developed a narrative of indigenous flora (they focussed on 'flowers') under dire threat from the ignorance, wilful destructiveness and callousness of some members of the public, including competitors in the many and popular flower shows, and the unchecked greed of commercial flower sellers and those in favour of commercial plantations over indigenous forests. Compton had instigated fire control measures including warning signs and safe barbecuing areas at Kirstenbosch following a large bushfire above the gardens in May 1923. In 1924, Compton (1924, p. 3) wrote that 'an attempt is also being made to get rid of the cluster-pines, hakeas and wattles which have been spreading so rapidly on the open slopes' [above Kirstenbosch].

Compton (1927, p. 3) urged people to garden with indigenous plants, arguing that 'apart from the natural beauty of our indigenous plants … these flowers have their intimate association with scenes of beauty: they carry memories of open-air days, among mountains and vleis and on the rolling veld. Lovely as they are, what associations have roses and sweet-peas that can compare with these?' Further, in the aftermath of the First World War, he argued that 'the other reason why we should grow South African flowers in our gardens is because they *are* South African. When love of country is linked with beautiful things like flowers, instead of with hideous things like war, then we shall have a truer patriotism than we know to-day' (Compton 1927, p. 3).

Compton (1928, p. 5) worried that much of Table Mountain was public land, and the Crown Land was 'administered by the Forest Department, which cares for its plantations but exercises little or no surveillance over the areas without timber'. The

Cape Town municipality managed its catchment area on Table Mountain, but planted introduced trees and '[favoured] the spread of that aggressive weed the Blackwood Wattle in Disa Gorge'. Compton urged the authorities to establish a nature reserve on Table Mountain, to enable the appointment of a ranger 'for fire-protection, for combating the spread of exotics, for the collecting of litter and for checking the depredations of flower pickers'.

In 1929, Compton published an article on 'The Vegetation of the South West Region' by a rising star on the local botanical scene, Robert Adamson, who had arrived in the country in 1923 to take up a professorship at the University of Cape Town. Adamson (1929, pp. 7–12) commented on the widespread invasion of the 'original' indigenous vegetation by the (indigenous) shrub renosterbos (*E. rhinocerotis*), which he attributed to 'interference with' and 'destruction of' the indigenous vegetation through burning and overgrazing. He also bemoaned the 'impoverishment' of the flora in the mountain regions, including Table Mountain, as a result of frequent fires. Drawing on his surveys of Table Mountain's flora (Adamson 1927), he argued (1929, p. 12) that 'the introduction of alien trees has brought about very marked changes…'. He commented that 'pines, and still more Australian species of Acacia have attained complete dominance over the native flora in places. Another Australian genus, Hakea, is locally ousting the indigenous bush'. When Sir Arthur Hill (1929), the Director of the Royal Botanic Gardens, Kew, visited the Cape in 1929, he complained of the domination of the vegetation of the Cape Flats by Eucalypts, pines, venothera (evening primrose, *Oenothera* species, from the Americas) and wattles.

10.3.2 Major Fires and Invasive Introduced Plants

Public opposition to imported tree plantations in particular re-emerged with a vengeance following a very big fire which broke out on the northern slopes of Table Mountain on 25 December, 1935, spreading into Peak Plantation. The foresters struggled to muster fire-fighters as it was a Christmas Day, and the fire raged for two days, finally requiring 700 men to bring it under control. The fire caused £4000 worth of damage to the plantation, and part of the reason it had been so difficult to fight was that it had spread into the pine-tree-invaded slopes of Devil's Peak, above the plantation. The City and the white sands of Milnerton Beach were dusted with gray ash. In the aftermath, there was a major public outcry in the newspapers against planting inflammable trees on the mountain slopes above the city, which dominated the headlines for three weeks after the blaze (Pooley 2014).

While a minority rallied to the defence of these introduced trees, bemoaning the otherwise shadeless windy slopes, and foresters defended the plantation for adding beauty to the naked slopes and for stopping soil erosion, the majority of correspondents to the newspapers focussed on the aesthetically displeasing aftermath of the fires and the threat to the indigenous vegetation. A vocal contingent championed by Lady Florence Phillips, a noted conservationist and wife of the Randlord Sir

Lionel Phillips, argued for fencing off the mountain from vagrants and other undesirables (ARFD 1935/36, pp. 6 and 16; *Cape Argus* 26 December 1935; *Cape Argus* 27 December 1935). Unruly and dangerous intruders, both human and floral, were to be excluded.

In the event, little came of calls to clear introduced species from the mountain. Some desultory efforts were made to clear invasive cluster pines in the immediate aftermath of the fire, and the municipality cleared a few hakea and *Acacia* in 1939 and 1940, but with the development of the Second World War, labour was not available for such work (Lückhoff 1951). Although there were few concerted management efforts to control invasive introduced plants in the first half of the twentieth century, there were important developments in research, conservation thinking and public perception in this period.

The period from 1921–1936 was an extended dry period, and the Great Depression had meant reduced resources for preventive control measures for fire and plant invasions. Fire incidence increased, and public concern increased over both of these interlinked threats to the landscapes and fauna and flora of the Peninsula. Alongside this, the opening up of the Peninsula through road building (in part to provide jobs during the Depression) and rising ownership of private cars was spreading the risk of anthropogenic ignitions, with very high fire incidence in 1938 and 1939. Capetonians worried that the scenic beauty of the Peninsula was under threat from quarrying on the mountain's slopes, the opening up of the Peninsula's mountains to the general public through road development, and the completion of the cable car link to the top of Table Mountain in 1929 (Pooley 2014, pp. 127–128).

For the first time the Peninsula was zoned into 11 fire control zones, and cooperative firefighting arrangements were set up between the Peninsula's municipalities and private estate owners. Propaganda efforts were funded to educate the public about the risk of veld fires and competitions held in schools (MM1940, CLFB, p. 41; Lückhoff 1951, p. 138). The Cape Town Municipality's Chief Forester Officer Hugo Brunt was praised for his efforts at overseeing a fire suppression campaign on municipal lands, and amid escalating fire incidence in the wider region, it was argued in the press that his fire-exclusion strategy should be expanded to the Western Cape's mountain regions (*Cape Times* 1942). This call provoked a memorandum to the Royal Society of South Africa from a retired forester John Henkel (1943), who worried that any such fire exclusion strategy would be impossible to achieve, dangerous, and ecologically harmful.

Henkel's memorandum came at a time of heightened sensibilities over national identity and protecting the country's natural heritage, as Prime Minister Jan Smuts led a divided country to war in support of the Allies (many Afrikaner nationalists supported the Nazis against their old adversaries the British). Smuts had appointed a committee to form a National Veld Trust in 1943 (*Cape Times*, 7 January), and land management issues had been militarised in the public discourse, with careless or deliberate fire starters being termed traitors in the newspapers. 'War' was declared on soil erosion, and on the Peninsula there was concern over invasive Argentine ants undermining the economy (*Cape Times* 1943, 20 November and 4 December). Smuts (1942) among others saw the country's natural heritage as a neutral and

hence valuable source of common identity for the country's divided European population, and thus its conservation took on nation-building political overtones (Van Sittert 2003b). There was also a sense (as there had been following the First World War) that Nature would provide a means of healing troubled spirits in the aftermath of war (Wicht 1945, pp. 7–9 and 53).

Amidst this period of political and environmental ferment, and in response to Henkel's letter, the Royal Society of South Africa appointed a committee to investigate the protection of the montane vegetation of the southwestern Cape. Chaired by the forestry researcher Christiaan Wicht, who was directing hydrological experiments at the Department of forestry research station at Jonkershoek near Stellenbosch, it published its report in 1945 (largely written by Wicht, with a chapter on 'characteristics of the vegetation' by Robert Adamson). This report (Wicht 1945) is now regarded as a landmark publication in the conservation of the region's flora (Van Wilgen et al. 2016).

Although the members of the Royal Society committee adhered to the received wisdom of the time that fire retards or interrupts the succession of vegetation to its 'natural' climax state, and can impact negatively on water supplies, they concluded that fire does have an important ecological role in fynbos and does not *necessarily* result in soil erosion or affect water supplies adversely. Poor burning practises—notably too-frequent burning over many years, followed by grazing—could result in such negative impacts, as could fires in areas with shallow sandstone soils on mountain slopes in areas with low rainfall (Adamson 1945, pp. 26–31, 38). From a management perspective, Wicht (1945, pp. 39–45) observed that attempts to exclude fire—ongoing since 1652—had all failed. He concluded that controlled burning in non-sensitive areas is preferable, supplemented by the creation of fire-belts, access paths, lookouts and labour for firefighting during the fire season.

Of the six processes identified in the report as major causes of vegetation deterioration, including conversion of the veld to other uses, erosion, flower gathering, pasturing, spread of undesirable species, and veld burning (Adamson 1945, pp. 22–23), the commissioners identified 'the spread of vigorous exotic plant species' as 'one of the greatest, if not the greatest, threats' to the fynbos. They noted the important role of fire in facilitating these biological invasions and advocated fire suppression as a key management strategy to control them. The Wicht Committee was sceptical that private landowners could handle dense stands of invasive species, and called on the government to take the initiative (Van Wilgen et al. 2016, pp. 32–33).

In the short term, nothing came of these expert proposals. Although the Department of Forestry formulated a policy for prescribed burning of fynbos vegetation in 1948, it was not implemented in the face of strong opposition to burning from the public and (largely) Department of Agriculture officials involved in soil conservation. There was also judged to be insufficient guidance on when to burn (which season, and how often) (Pooley 2014, pp. 83–86; Van Wilgen et al. 2016, p. 69).

On the Cape Peninsula, it is perhaps unsurprising that calls for prescribed burning (in part to prevent large dangerous fires resulting from a build-up of fuel

loads in the vegetation) came to naught. The war years had seen high fire incidence, partly due to a temporary population boom and increased ignitions, and the decline in fire prevention measures and available fire control personnel resulting from recruitment into the armed forces. A voluntary firefighters force had helped, but this was disbanded in 1945, and Hugo Brunt died in the same year. Amid an extended dry period from 1946–1949, fire incidence continued to increase steeply. The considerable anti-fire propaganda schemes had not had the desired impact, and in 1947 the Cape Peninsula Fire Protection Area was declared. The focus was on clearing inflammable vegetation, prohibiting veld burning and maintaining firebreaks.

10.4 Post-war Environmental Concern Over Invasive Plants

Concern over the situation on the Peninsula came together at a public meeting organised by the South African Association of Arts in 1948, where a resolution was passed requesting the appointment of a government commission to assess the situation (Hey 1978). Despite a wide range of measures from additional manpower to legislation in the period to 1949, fire incidence continued to rise, and in January 1950 a fire broke out on Table Mountain above the City and burned uncontrollably for four days. In another incident, two navy personnel were killed fighting a fire above Simonstown on the southern Peninsula. Following a public meeting, the Department of Agriculture donated funds to enable the Cape Peninsula Fire Protection Committee to greatly increase fire control work. This included efforts to control inflammable introduced plants (Pooley 2014, pp. 210–214) (Fig. 10.2).

Letters published in the *Cape Times* showed a similar range of opinions on introduced plants as evidenced in the aftermath of the Christmas Day 1935 fire. On the one hand some argued that indigenous vegetation was more effective at protecting the soil and used less water than pines. On the other hand, a Mr. R. Pothier asserted that the indigenous fynbos was highly inflammable, fires were easier to fight in plantations, and walking through shady pines was preferable to walking in 'sun-scorched, snake-ridden bush'. Singling out pines for removal because they were introduced species, he pointed out, should logically extend to removing oaks, gums, poplars and many other attractive introduced trees (*Cape Times* 1950, p. 8).

The called-for commission on the state of the mountain (the Van Zyl Commission) reported to the Minister of Lands in 1951. The report recommended the prevention and control of fires on the mountain, and 'eradication of noxious weeds and alien vegetation threatening the indigenous vegetation' to restore the mountain 'to its natural state of beauty' (cited Hey 1978, p. 17). The Commission motivated for the establishment of a Table Mountain Preservation Board to oversee this, which was constituted in 1952. Table Mountain was proclaimed a national monument five years later.

Common sight in Cape Town during dry summer. Veld and mountain fires anywhere in the Peninsula are a threat to public safety, to life and property, to the rich indigenous fauna and flora, to the conservation of the soil, and veld and water supplies.

CAPE CAMPAIGN AGAINST "FIRE BUGS"

Peninsula Inhabitants Draw Up Five-year Plan to Avert
An Annual Threat of Disaster to Mountains and Forests

Fig. 10.2 Feature story (1954) in the journal of *The National Veldtrust* (15(4): 6–7) on the five-year plan devised in 1953 'to make widespread forest and veld fires a thing of the past'

Carl Lückhoff, a well-known Capetonian plant collector and conservationist and author of *Table Mountain: our national heritage after three hundred years* (1951, p. 116), explained in this book that it was only after the January 1950 fire that the Forestry Department began clearing inflammable invasive species from the mountain above the Cape Town city bowl. These 'exotic' flora including pines, hakeas and wattles were, he argued, relentlessly advancing on the lower slopes and summit plateaus of Table Mountain, and the Table Mountain chain south to the Constantiaberg and Chapman's Peak.

Although well publicised in Cape Town since the 1920s, and following big fires in 1935 and 1950, it was only in the late 1950s that the issue of invasive introduced plants was formally tackled by a conservation body.[1] The Kirstenbosch Botanical Gardens' Wild Flower Protection Society Committee set up a Control of Alien Vegetation Committee in 1958, which published its findings as *The Green Cancers*

[1]The Wild Flower Protection Ordinance, No. 21 of 1957, set out to protect 'any plant indigenous to the Republic of South Africa, except noxious weeds' (cited in Hey 1963, p. 68).

of South Africa: the menace of alien vegetation (1959), which despite its title focussed on the Cape. The Committee's findings were amplified by the findings of University of Cape Town botanist Anthony Hall, who in 1959/1960 surveyed invasions along the Peninsula's mountains from Muizenberg Mountain in the south to Table Mountain. He recorded four *Acacia* species, three pines, and three Hakea, which he argued were shading out fynbos plants (Moll and Trinder-Smith 1992, pp. 135–137).

In 1962, an illustrated booklet *Bokkie the Grysbuck* (Bagnall and Louw 1962) was published promoting fire and invasive plant awareness. It narrates a heartrending tale of a small antelope orphaned by a bush fire set by careless picnickers. Rescued by firefighters, Bokkie is nursed back to health and released in a nature reserve, where he will be safe from 'the fires which ravage the mountain and destroy so many animals'. However, this Edenic landscape is threatened by hakeas and pines 'which are strangers and intruders in South Africa'. The denouement shows happy scenes of children chopping out invasive plants (Bagnall and Louw 1962, pp. 33 and 37). The iconic 'prevent bush fires' poster based on Bokkie was used throughout South Africa in ensuing decades, and was resurrected on the Cape Peninsula following the big fires of January 2000.

Thus, by the beginning of the 1960s, there was widespread concern over the impacts of alien invasive vegetation on the indigenous flora, with specific legislation in place to protect the indigenous flora (except for 'toxic weeds'). The position was summarised by the Director of the Department of Nature Conservation in the Cape Province, Douglas Hey, in an editorial in which he singled out several Hakea and Acacia species, *Pinus pinaster* and Australian myrtle as 'green cancers' and 'the greatest enemy of our natural flora' (Hey 1963, p. 69).

10.4.1 Management of Invasives on the Peninsula, c.1959–1978

Despite this public and expert concern over the state of the natural environment on the Peninsula, and despite education measures like the *Bokkie* book (sponsored by the provincial Department of Nature Conservation and the Cape Peninsula Fire Protection Committee), efforts to manage invasions, and research on invasive species, were slow to materialise.

The Table Mountain Preservation Board had managed to purchase and incorporate private land into the protected area, consolidating management to some degree, but lacked funds for conservation work and the authority to impose conservation measures on private landowners (Hey 1978). Colin Grohl, Director of the City Council's Parks and Forests department (also instrumental in the *Bokkie* pamphlet), discussed this situation with the Provincial Secretary of the Cape, W. J. B. Slater, and in June 1963 a meeting of all the major NGOs and provincial and municipal authorities was convened by the Administrator of the Cape, Dr. Nico

Malan, to propose the establishment of a large nature reserve on Table Mountain. Key issues included eradicating undesirable introduced vegetation and controlling veld fires and soil erosion. The Table Mountain Nature Reserve was duly proclaimed in November 1963, on City Council land (Hey 1978).

Annual reports show that the Corporation of the City of Cape Town's Department of Parks and Forests was clearing invasive plants (only Hakea are listed) from forest stations from 1959 onward, but only in 1964 was the programme of clearing and reclearing described as a 'vigorous campaign' (ARCE1979, Annual Report of the Parks and Forests Branch (ARPFB), p. 19). This mostly reflected expanded effort directed at clearing around its dams at the Wemmershoek and later (from 1967) Steenbras plantations, both distant from the Peninsula. *Pinus pinaster* was added to the list of cleared plants from 1967, and efforts at clearing 'alien vegetation' from nature reserves (Silvermine and Table Mountain, both established in the 1960s) were recorded from 1967–1970. From 1968, Port Jackson (*Acacia saligna*), *Pinus pinaster* and *Albizia* were listed as invasive introduced plants subject to control measures (ARCE 1958–79).

Invasive plant control was first recognised by the state Forestry Department as a discrete management goal in 1960, and department members attended a conference focussed on invasive Hakea management convened by the Department of Agricultural Technical Services in Stellenbosch in 1961 (ARFD RP20/1961, p. 12; RP80/1964, pp. 8–9). An interdepartmental action committee was formed which subsequently surveyed invaded areas and undertook awareness campaigns, and some gains were made in controlling Hakea (Van Wilgen et al. 2016, p. 71).

By the early 1970s (the years of the OPEC oil crisis), the Forestry Department acknowledged that invader control programmes were being scaled back as 'whenever funds have to be cut back these operations are rated a lower priority than others' (ARFD1972/73 RP38/1974, p. 9). This was particularly the case on the Cape Peninsula as the department had virtually ceased forestry activities: only Tokai, Devil's Peak and Cecilia plantations remained by the late 1960s, and Peak was phased out as a state plantation by 1971. Following big fires in 1973 and 1974 and post-fire clearing, the Municipality phased out commercial timber growing on the Peninsula in 1975 (ARFD and ARCFO c.1970–76; Shaughnessy 1980, pp. 260, 267 and 310). All of this resulted in reduced fire protection and invasive plant clearing activities on the Peninsula. The City Council was concentrating its efforts on the catchment areas of its Wemmershoek and Steenbras dams (ARCE 1963–76).

In 1974, a report on the status of Table Mountain published by the Cape Town Section of the Mountain Club of South Africa called for urgent measures to prevent the deterioration of Table Mountain, noting fire and alien vegetation control as priorities. In the same period, the Cape Divisional Council was under pressure to approve numerous applications for private development on the southern Peninsula, and a series of meetings were held to discuss comprehensive environmental planning on the Peninsula's mountains, with reports published in 1972 and 1975. An important report was prepared by University of Cape Town botanists Moll and Campbell (1976), which received the support of the Table Mountain Preservation Board. However, the authors' call for total eradication of alien vegetation was

judged unrealistic and too expensive, and the recommendation was rather to target sparsely infested areas of fynbos and protect them from future invasions, and aim for containment of other invaded areas (Hey 1978).

In 1976, McLachlan et al. resurveyed Hall's sample points from 1959/1960 and while they found a reduction in the distribution of some species (*Pinus pinaster* and *Acacia Cyclops*), they found increased distributions of *Hakea gibbosa*, *H. sericea* and *Acacia saligna* (Moll and Trinder-Smith 1992, pp. 137–139). There was clearly still cause for concern. The municipality's policy on invasive introduced plants at this stage was to clear all such plants from above the 300 m (984ft) contour line on the Peninsula's mountains. Below 300 m, non-invasive introduced species were to be left in place to provide shade for 'high usage nature-orientated recreation' (ARCE 1979, p. 19). In the opinion of Douglas Hey, Director of a one-man commission on the 'future control and management of Table Mountain and the southern Peninsula mountain chain' (1978, p. 62): 'despite all the good work on eradication which has been done over the past 15 years, the threat of aliens on the natural vegetation has not even been checked'. He identified impenetrable stands of hakea on private lands as a particular problem, and 'a great fire hazard,' also singling out *Acacia cyanophylla*,[2] *A. Cyclops*, *A. melanoxylon*, stinkbean (*Albizia futens*) and cluster pines as particularly problematic invaders (1978, p. 63).

10.5 Research on Invasive Plants, 1974–1989

With the proclamation of the Mountain Catchment Areas Act 63 of 1970, foresters were put in charge of the country's catchments. In recognition that plantations of introduced trees could have significant impacts on water supplies in catchment areas, the Forest Amendment Act, Act 40 of 1972, put restrictions on where afforestation could occur, controlled through a permit system (Van Wilgen and Richardson 2012a). The Department belatedly instituted a programme of prescribed burning. To work out how best to burn fynbos in these areas, and manage invasive plants, Gerrit Wagner and then John Fenn developed a system of coordinated working between researchers, planners and managers, which was implemented in many catchments until the terminal decline of state forestry as an active management institution in the late 1980s (ARFD RP18/1972, p. 9; Marais 2008; Kruger pers. comm. 2017).

In this period when management of invasive plants on the Peninsula was being called for, but scaled back for economic reasons, research began in earnest. Excluded from the International Biological Project (IBP) because of the country's Apartheid policies, South African researchers set up a programme of biome projects coordinated by The Cooperative Scientific Programmes secretariat of the Centre for Scientific and Industrial Research (CSIR). This included a Fynbos Biome Project,

[2]The blue-leaved wattle is no longer considered a problematic invasive in South Africa.

initiated in 1977, which included work on introduced invasive plants as a threat (Huntley 1992; Kruger 1978). The programme built on a scientific research programme initiated by state foresters in 1974 and led by Frederick Kruger at Jonkershoek, which drew in researchers who went on to become key figures in fynbos research and management including William Bond, David Le Maitre, David Richardson, Brian van Wilgen, and others.

An important international association which remained open for South African researchers was the MEDECOS network, a group of ecologists who had begun making comparative studies of Mediterranean-type climate regions in the late 1960s. The third MEDECOS meeting was hosted in Stellenbosch in 1980, where delegates were forcibly struck by the invasions of undisturbed fynbos ecosystems by introduced plants (disturbed ecosystems were supposed to be vulnerable; undisturbed ones not). The delegates motivated for an international programme to research and inform management of invasive species. The resulting Scientific Committee on Problems of the Environment (SCOPE) programme was launched in 1982, and the South African programme a year later, both resulting in books synthesising the available knowledge (Macdonald et al. 1986). This work included important discoveries on how such invasions impacted on fire regimes in fynbos, and on how key species invaded the fynbos (Van Wilgen et al. 2016, p. 33; Pooley 2014, pp. 98–101).

The control efforts of the 1950s and 1960s had proven relatively ineffective because little was known about the reproductive strategies of the invading plants. During the 1970s studies by Anthony Hall, Hugh Taylor, Eugene Moll and others resulted in more effective control measures, in particular, repeat treatments after initial clearing for invaded areas. A systematic invasive plant management plan was adopted in the Cape of Good Hope Nature Reserve in 1981, and by 1996, *Pinus pinaster* and *Acacia saligna* were judged no longer a threat, with only *A. cyclops* remaining an issue (Privett et al. 2001; Van Wilgen 2009, pp. 339–340). However, the fractured nature of land ownership outside of nature reserves made management very difficult on the Peninsula, as cleared areas could be easily invaded from adjacent privately owned properties which had not been cleared. It was realised that burning was a key control method, but prescribed burning was opposed by the public (Ibid.; *Cape Times* 1973).

10.6 Repercussions of the Collapse of Apartheid, c.1986–1994

The period 1978–1989 can be regarded as a golden era in research into fire and plant invasions in the fynbos, and certainly by the mid-1980s management was benefitting from these discoveries. However, as a result of international economic sanctions, internal strife and a war in Angola, by the late 1980s the Apartheid State was in a state of collapse. In 1986, the government set in motion a process of

devolution of state forestry which in 1990 resulted in the transfer of plantations to a parastatal, the South African Forestry Company Limited (SAFCOL), and placed the management of mountain catchments into the hands of provincial administrations ill equipped to manage them. Shortfalls in funding, experienced managers and labour, slashed budgets and (for prescribed burning) the fear of litigation from the expanding wildflower industry, contributed to a widespread abandonment of prescribed burning and invasive plant control. The Fynbos Biome Project terminated in 1989, and State Forestry ceased to exist as a powerful research, planning and management entity, with all research projects terminated by 1995 (Pooley 2014, pp. 110–112).

By the early 1990s, fire management on the Cape Peninsula was reduced to mainly firefighting, and invasive plant clearing to a minimum. At the same time, the City was booming, and informal settlements were springing up on the Peninsula. With the creation of the 'New South Africa' in 1994 international tourism thrived, especially with the hosting of the rugby World Cup in 1995. There were also important changes in the protected areas on the Peninsula: on 29 May 1998, President Nelson Mandela proclaimed the Cape Peninsula National Park (now Table Mountain National Park), in part the result of a sustained public campaign to better protect the Peninsula's flora and fauna stimulated by very large fires in 1986 and 1991. Importantly, this unified the management of most of the Peninsula's nature reserves under a single authority, South African National Parks (SANParks). Mandela (1998) looked to the striking natural landscapes and unique flora of the Peninsula for a symbol of national unity, as had Smuts and Pearson before him.

What hadn't been anticipated in the long-awaited creation of a National Park was that many of the experienced staff employed by the Municipality and Forestry Department on the Peninsula elected to take severance packages and not transfer to SANParks. Thus a great deal of experience of working to prevent and fight fires on the complex typography of the Peninsula was lost (Prins 2007; Pooley 2014).

Finally, the 1990s (with the exception of 1996) were to be a very dry period, and it is therefore unsurprising that there were major fires recorded in every year except 1996 and 1997. Forsyth and Van Wilgen (2008) found a significant increase in areas burning frequently in the period 1985–2007, in comparison with 1970–1990. Explicit links were made between fires and invasive introduced plants, as environmental threats. In February 1991, a big fire burned on Devil's Peak and in May, storms washed 400 m^3 (14,126 ft^3) of fire debris, mud and rocks down Tin Mine Ravine, flooding streets in the city below and costing millions of rands to clean up. Researchers concluded that the flood was caused when stormwater rushed over soil hardened by the intense fires resulting from the burning of introduced invasive plants (ARCE1991/92, pp. 7–8). Invaded sites carry as much as eight times more fuel than typical fynbos shrublands (Van Wilgen and Richardson 1985).

In this period of political turmoil and transition, state funds for research into invasive plants and fire had dried up, as had resources for control measures. In November 1993, former forestry researchers, conservation managers, university academics and others resolved to motivate for continued funding through focussing on ecosystem services. The management threat they focused on was the invasion of

catchment areas by introduced plants, and in 1994 they argued that unchecked plant invasions could reduce water supplies to the city of Cape Town by 30%. Guy Preston helped develop a proposal to combine invasive plant control with poverty alleviation through employing and training the poorest of the poor, and this was presented to the new Minister of Water Affairs and Forestry, Kader Asmal, in June 1995. The plan chimed well both with the political agenda of the new ANC-led government in South Africa which took power in 1994, and international developments in conservation and development thinking summarised in the Rio Declaration on Environment and Development in 1992. The result was Working for Water, a national water conservation campaign which included as a central component the removal of invasive introduced plants, creating jobs for the poor in the process (Preston 2007; Le Maitre et al. 1996; Van Wilgen et al. 1996, pp. 184 and 189).

The Working for Water programme was a great success, proving to be the only one of the government's new Reconstruction and Development (RDP) programmes to spend their budget. The pace at which the initiative grew raised challenges for management, and there were some important oversights in the early years. Working for Water workers were active on the Cape Peninsula, notably on the heavily invaded areas on the southern Peninsula where plants had escaped plantings intended to stabilise driftsands. These woody plants were cut and stacked on the hillsides, where they dried out, providing high concentrations of inflammable fuel (Preston 2007; Kruger et al. 2000).

10.7 The Great Fires of January 2000, and After

On Sunday 16 January 2000, two fires broke out on the southern Peninsula, one near the access road to the picnic site in Silvermine Nature Reserve, and one near the informal settlement at Red Hill. Weather conditions were extremely favourable to fire spread, with high winds and temperatures, and low humidity. The Silvermine fire spread quickly through fynbos invaded by introduced woody plants, and the Red Hill fire torched piles of cut invasive plants stacked by Working for Water workers, before tearing through mature fynbos. Continuous high winds and changes in wind direction made fire fighting even more difficult, and the fires were upgraded from a Code Red to a provincial emergency, with a Joint Operating Centre established to coordinate firefighting forces from four municipalities, South African National Parks, Heyns Helicopters, the forestry company SAFCOL (which had taken over Cecilia and Tokai plantations) and the South African Air Force and Navy. It took six days of firefighting to contain the fires, which together burned 8370 ha (20,682 acres) of the Peninsula, destroying eight buildings and damaging 51. The operational costs together with estimated costs of rehabilitation were in excess of R5 million, and the fires resulted in insurance claims of R40 million (Aupiais and Glenn 2000; Kruger et al. 2000).

It was the most serious fire event yet recorded on the Peninsula, and briefly made international headlines with footage of flames racing across the slopes above the capital city's suburbs. However, the ecological damage was slight, chiefly soil repellency caused by intense flames where invasive plants had burned (Kruger et al. 2000). In fact, the fires were arguably beneficial to areas of fynbos which had not been burned for decades, largely as a result of public antipathy to burning. Some fynbos species (notably the rare silver tree *Leucadendron argenteum*) may become senescent, i.e. show reduced vigour and reproductive capacity, if not burned for intervals of more than 35 years (Rebelo et al. 2006).

In the aftermath of these fires there was an outpouring of public support for improved fire control (as there had been following previous large fires), manifested as the Ukuvuka Operation Firestop Campaign. This campaign was importantly shaped by the goals and influence of Working for Water, and the first of its ten objectives was to 'secure full control over invading alien plants along the Table Mountain chain and adjacent areas' (Ukuvuka 2000). The campaign was heavily skewed towards controlling fire through controlling 'alien invasive plants'. Department of Water Affairs and Forestry billboards featured a dramatic scene of flaming fynbos towering over a house, proclaiming that 'every house that burned in the wild fires along Table Mountain in January 2000 was surrounded by invasive alien plants'. Thus for many members of the public, alien plants were held responsible for these huge fires. This was despite the official report on the fires being careful to state that these plants did not cause the fires; they exacerbated them in places where dense infestations existed (Kruger et al. 2000, p. 84).

Neely (2010, p. 880) argues that local scientists remained silent on this incorrect attribution of blame for the big fires to alien plant invasions, as from c.2003 their funding was derived mostly from Working for Water. Working for Water and Ukuvuka both advocated sustainable management programmes based on sound ecological science which were also ideally suited to the political climate of the new South Africa, linking biodiversity conservation and poverty relief. Another way of looking at this is to recognise a conjunction between a political imperative and a particular 'strong' strand within invasion biology, well represented at the Cape (discussed below).[3] Either way, the popular perception linking the fires with invasives was not an entirely helpful message on a Peninsula containing both the country's parliamentary capital, its suburbs and informal settlements, and a national park designed to protect the inflammable fynbos. It did not incline Capetonians to favour prescribed burning.

From the point of view of scientific research, this proved a fertile period, however. Once again concerns over introduced plants, fire and water had come

[3]For evidence of the vigorous debate on the impacts of bioinvasions within invasion biology see Russell and Blackburn's article, and the many responses, in *Trends in Ecology & Evolution*, January 2017, 32(1).

together in a powerful narrative about environmental degradation, and the need for research and scientifically informed management. An important symposium series sponsored by Working for Water was launched in 2003, generating a synthesis of scientific knowledge informing invasive plant management in the country, published in a special issue in the *South African Journal of Science* (Vol. 100, issue 1–2, 2004). In 2004, the Centre for Invasion Biology was established at the University of Stellenbosch, one of six Centres of Excellence created by the country's Department of Science and Technology. Under the initial direction of Prof. Steven Chown, and since of Professor David Richardson, the Centre has provided a focus for the many research efforts going on in different organisations, and has served as a catalyst for further research into bioinvasions (Van Wilgen et al. 2016, pp. 33–35; Neely 2010, pp. 884–885).

But what of invasive introduced plant management in the wider Cape Floral Region? An assessment of control measures in the Cape Floral Region (Van Wilgen et al. 2012) concluded that although there had been some progress with the control of some invasive introduced tree species, notably *Acacia cyclops* and *A. saligna*, and *Hakea* species had declined, significant control efforts and expenditure had failed to reduce the extent of invasions by *Acacia mearnsii* or *Pinus* species relative to 1996.

The 'invasive alien species strategy: greater Cape Floristic Region' initiated in 2007 was regarded as a useful exercise but a failure in that the recommended governance models had not been adopted, and the goals were neither measurable nor time-bound. Developed by the Cape Action for People and the Environment (CAPE) programme, the strategy was developed with funding from the Global Environment Facility and the World Bank, and in retrospect it was concluded that the external funding and origins of the strategy, meant senior South African officials decided to ignore it (Van Wilgen et al. 2016, p. 35).

10.7.1 Radical Narratives

Jean and John Comaroff (2001) have argued that the rhetoric of the anti 'alien' species campaign in South Africa is bound up with xenophobia in the new South Africa (prominent at that time). I have argued (Pooley 2010) that there are much stronger historical continuities in these debates over nature, nationalism and belonging than the Comaroffs allow, but their argument draws attention to the attempt to create a single voice, or normative position, on biological invasions. Certainly, the publicity campaign (8–15 October 2000) stimulated by the Department of Agriculture's regulations on invasive species proposed in 2000, entitled 'AlienBusters,' attempted this. It drew on images of evil extraterrestrials threatening planet earth to mobilise the public's fear (and fascination with) the 'other' to promote the eradication of invasive species (Lidström et al. 2015). The cohesiveness between political, scientific and management goals which Neely praises has provided a strong framework to motivate for programs to manage plant invasions in the region's unique fynbos vegetation.

Invasion biologists' narrative about the need to resist 'biotic homogenization' or the 'McDonaldisation of nature' has been remarkably effective internationally in recent decades. This narrative has succeeded in catalysing action against what Rob Nixon (2011) has called the 'slow violence' of complex environmental problems like biological invasions. These kinds of complex problems unfold slowly over decades or longer, and are the result of a multitude of ecological and anthropological causes. They are thus difficult to narrate as dramatic stories demanding immediate action (Lidström et al. 2015, p. 3).

A complication for such powerful narrative frameworks on the Cape Peninsula (as elsewhere) is that in fact there remains a significant diversity in attitudes to different species of invasive introduced plants and how they should be managed. The powerful narrative which has been developed at the Cape, linking scientific research, environmental management and social justice, tends to obscure and dominate the real diversity of views on what should be done (an ethical, not a scientific, question).

Environmental histories remind us that the Cape Peninsula has been inhabited by humans for millennia, and its fire regimes and vegetation have been transformed to varying degrees for at least 2000 years, beginning with the visits of Khoikhoi (or KhoeKhoe) herders and their vast herds of cattle and sheep. Transformations accelerated with European settlement from 1652. Modern vegetation maps do not show what actually grows on the Peninsula, but rather what their compilers' think potentially would grow on the Peninsula were it not for urbanisation and other human transformations and introductions. The underlying assumptions are that climate and fire regimes have remained essentially unchanged—despite indisputable evidence of anthropogenic climate change and changes in the temporal and spatial clustering of fires. In short, contemporary ecological conditions on the Peninsula tend to be measured against an idealised precolonial past (Pooley 2014).

In the strong versions of this narrative, supported for instance by SANParks on the Peninsula, introduced species are aliens and should be removed from all protected areas. All invasive introduced plants should be removed from the Peninsula. Ecologists in the region have contributed to this polarising narrative which tends to obscure the actual spectrum of introduced plants, suggesting that all are harmful whereas there are many examples which are not proven to be so (including some invasive ones).

Since the declaration of Table Mountain National Park in 1998, many of the Peninsula's smaller stands of pines and eucalypts have been cut down or burned and not replaced. Small local activist groups have emerged to protest against the removal of shade-giving trees in picnic areas. This was capitalised upon by Thomas Pakenham, when he launched his book *In Search of Remarkable Trees* (2007) in Cape Town. He accused white 'eco-fascists' of being a 'tree-Taliban' trying to ethnically cleanse the country of introduced trees (*Cape Times* 2007, p. 3; *Sunday Argus* 2007, p. 11). This was a misrepresentation: the campaign was focused on invasive species, carried out by poor non-whites, and funded by the ANC-led government (Pooley 2014).

The powerful narrative presenting invasive alien plant control efforts as a 'war on aliens' obscures a long and complex history of interactions between introduced and local species, and the complexity of human histories which have shaped the

Peninsula's landscapes for hundreds of years. As Lidström et al. (2015, p. 26) put it, this complex history is 'flattened' to present a simpler narrative about saving a 'threatened "now" defined against a static and idealised "then".'

More specifically, and problematically, this narrative pits conservationists and invasion biologists against commercial foresters, who since the winding down of state forestry in the 1990s have been major players in controlling (and some argue causing) the spread of the region's most important invasive plants. This is exacerbated by the rocky relationship that developed between the private forestry companies, and Guy Preston and others in the formative years of Working for Water (Preston 2007). In 2011, Preston took on responsibility for implementing the National Environmental Management: Biodiversity Act regulations on alien and invasive species.

The animosity between commercial forestry and conservation researchers surfaced publically in an ill-tempered exchange in 2012, following the online publication of a summary of a paper entitled 'Three centuries of managing introduced conifers in South Africa' by two prominent local conservation biologists (Van Wilgen and Richardson 2012a). Their paper argued that both in terms of the Conservation of Agricultural Resources Act (43 of 1983, amended 2001), and Forest Stewardship Council (FSC) certification, commercial forestry operators in South Africa were failing to fulfil their obligation to prevent the spread of invasive pines. These pines were negatively impacting on water resources, causing more intense fires and resultant soil erosion, and crowding out native species.

In a fierce rebuttal, the President of the South African Institute of Forestry, Ben du Toit (2012) disputed claims about water use by plantations, denied that plantations were resulting in most invasions (arguing good management, and the introduction of less invasive hybrids, were reducing invasions), and denied that plantations were having serious impacts on the biodiversity of the fynbos. He accused Van Wilgen, Richardson and the press release summarising their work of bias, pseudoscience, and perpetrating a socially irresponsible attack on an economically and socially important rural industry.

Van Wilgen and Richardson (2012b) responded with a point-by-point rebuttal, standing by their claims, most of which are reiterated in a recent paper (Van Wilgen et al. 2016). Commercial foresters in turn remain aggrieved that their efforts at what they call 'integrated weed management,' including their phasing out of highly invasive *Pinus pinaster*, planting of less invasive species like *P. elliottii* around the perimeters of plantations of more problematic species like *P. radiata*, and the use of biological control agents to combat plants like *Acacia mearnsii*, are not acknowledged by conservationists (du Preez 2017).

10.8 Conclusion

The Cape Peninsula harbours a wide variety of introduced plants including commercially important ones such as grapes. Among them are a remarkably persistent suite of invasive plants introduced by Europeans for a range of purposes: timber,

driftsand stabilisation and horticulture. These are valued differently by a range of interest groups. Well-to-do Capetonians living around the mountain slopes like the remaining pine plantations where they walk their dogs. They dislike the 'scruffy' wattles and hakea. The poor use these wattles and hakea for fuel for warmth and cooking, as building materials, and a means of earning an income (selling them to the well-to-do for their barbecues). For some conservationists, all of these plants detract from the ecological and aesthetic integrity of the Peninsula's landscapes. For some members of the public, stands of introduced trees bring welcome relief from the sun and wind in the otherwise treeless fynbos. Further, some trees have become engrained in the culture of the place, including the iconic stone pines below Devil's Peak and Lion's Head, the eucalypts on the flanks of Signal Hill, the palms of Camps Bay, and the camphor trees and oaks of Constantia (Pooley 2010).

In a long review and meditation on the history of scientific research and management of the Cape Floral Region from 1945–2015, some of the country's foremost ecologists, environmental historians and managers note that a strong emergent theme in invasion science has been the comparison of biological invasions in different regions and how they have been managed (Van Wilgen et al. 2016, p. 37). Although interdisciplinary in aspiration, comparative studies still tend to focus on ecological factors and quantified histories of management impacts, despite increasing acknowledgement of the importance of understanding the environmental histories of these social-ecological systems, and despite the realisation that environmental policy and management are influenced by much more than scientific knowledge and technical expertise.

As the example of the Cape shows so well, as important as control efforts are, they are unlikely to eradicate all introduced invasive species or to exclude all of the fires which favour them. By admitting more voices into the discussion of what to do about these plants, and toning down dominating and divisive narratives about fighting aliens, it may be possible to create space for a more nuanced discussion of the policies which should shape environmental management in the region. In the absence of a powerful state management agency with the political clout and managerial resources to enforce and implement sound environmental policies, collaboration between conservation and commercial forestry managers, scientific researchers and regulatory agencies, private landowners and the public—and the inclusive processes which this will require—seems a sound way forward.

It may be that what is required are management plans for hybrid rather than pure ecosystems, or a patchwork of the two. This will require formulating legislative and management responses which are implementable, and target actually harmful species identified in socially inclusive ways. The history recounted in this chapter suggests it may be advisable to take a triage approach, and prioritise some landscapes for protection, and some plants for management, rather than strive to restore unattainable idealised landscapes which not everyone aspires to inhabit (Fig. 10.3).

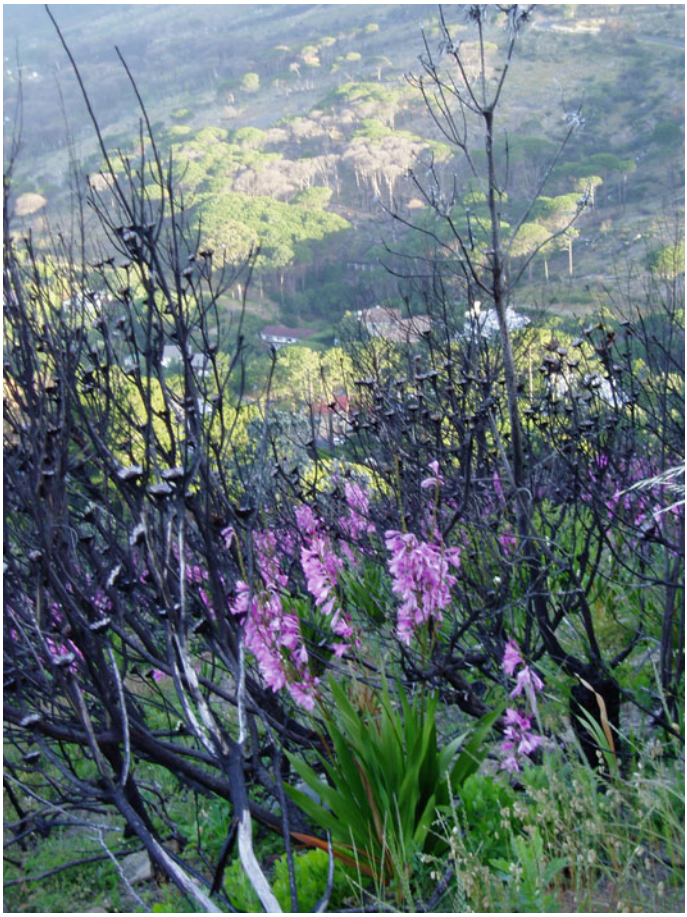

Fig. 10.3 Post-fire lilies spring up among charred protea shrubs after a fire on the slopes of Lion's Head, Cape Town. In the background are stands of non-invasive stone pines, on the slopes of Table Mountain above the city bowl. *Credit* Simon Pooley

Fires in Mediterranean-Type Ecosystems
Simon Pooley

Invasive grasses, shrubs and trees can profoundly reshape local plant communities and vegetation structure. The invasion of Mediterranean ecosystems by fire-adapted plants can be said to introduce a further, often very significant invasive 'beast': fire. Fire acts like a generalist herbivore, consuming all woody biomass whether alive or dead, toxic or

protein-deficient, so competing with biotic consumers for resources as well as facilitating vegetation change.

Fire regimes

Fire regimes are particular, prevailing combinations of frequency and seasonal timing of burning, fuel types, fire intensity and spatial distribution of individual fires. Plants adapt to particular fire regimes, developing strategies for coping with the prevailing rates of variation in fire regime parameters. Mediterranean climates, with wet and mild winters promoting vegetation growth, followed by long, hot, dry and windy summers, provide ideal fire conditions. However, natural ignitions (usually caused by lightning) are rare. Thus while Mediterranean plants are fire prone and well adapted to specific fire regimes, it is difficult to talk about 'natural fire regimes' (i.e. excluding human influence).

In the Mediterranean basin, fire regimes have developed in cultural landscapes where humans have deliberately (and accidentally) influenced the frequency and seasonality of burning. In turn, these anthropogenic fire regimes have selected for fire adapted plants. Further, over millennia, humans have brought about major transformations of the fuel, for example breaking up fuel bodies, clearing and protecting fields, or creating plantations of inflammable trees (Pyne 1997; Pausas et al. 2008; Keeley et al. 2012).

In some of the world's Mediterranean type regions, anthropogenic transformations of the landscape and ignition incidence have created fire regimes more favourable to introduced species than to the indigenous fire-adapted flora. For example, more frequent and more intense fires can favour introduced plants like quick-recovering, fire-resistant stand-producing wattles, or flammable grasses. Globally, Mediterranean-type ecosystems are spatially the most degraded (93%) in terms of having fire regimes falling outside of natural rates of variation. This is unsurprising considering their attractiveness to human development and their ecological fire dependence (Shlisky et al. 2008).

Fires are usually high-intensity crown fires which burn all the vegetation above ground. The plants of these regions are adapted to fire regimes of moderate frequency and variability of intensity, and have evolved an extraordinary array of strategies to cope with fire. The two major strategies are resprouting, and germination from a previously dormant seedbank, and individual species have evolved numerous approaches to surviving fires through these methods.

Plant responses to fires

Fires are followed almost immediately by an ephemeral flora which survives for only a year or two. They exploit the nutrient flush following fires, including the open space and sunlight produced when the usually dominant shrubs are consumed by fire. Geophytes like certain lilies and species of onion resprout from underground bulbs and corms after fire, flower profusely to form beautiful fields of colourful blooms, and set seeds which germinate when the winter rains arrive.

Suffrutescent species survive in dormant seed banks until stimulated by the heat of fires and germinate in the first rains after the fire.

The shrub flora also emerge following fires, but only begin to dominate after several years as they begin to form an overstorey, shading out the smaller plants, finally forming a closed canopy over them. The shrubs also regenerate either by resprouting after fire or from seedbanks, or in some cases, use both strategies. These woody evergreen shrubs form continuous bodies of well aerated fine vegetation which burns readily. Many Mediterranean pines have serotinous cones, where hot fires melt the waxy seals triggering seed release. Some fire-adapted species may experience local extinctions after very long periods without fire (senescence), but too-frequent fires are much more of a hazard. In most areas humans have so increased fire frequency that long fire-free intervals are unlikely (Pyne 1997; Keeley et al. 2012). In sum, the high biodiversity of this flora has been shaped, rather than threatened, by fires.

Fire history of the Mediterranean basin

The major difference between the fire histories of the Mediterranean basin, and those of the other Mediterranean type climate regions, is the antiquity of widespread and intensive land use in the former region. The first evidence of fire management in the Mediterranean Basin dates from the spread of crop farming and domestic grazing in the Neolithic period ($\sim$10,000–4500 BP), and during the Bronze Age fire was very widely used to improve pastures, dispose of waste and recycle nutrients in fallow fields, and clear forests and scrubland. By the late Bronze Age, extensive areas had been terraced and irrigated, and the economies of the Roman and Muslim empires in particular resulted in major land use changes, including logging to build large navies. Landscapes were cleared and opened, progressively from east to west. Anthropogenic activities created and maintained landscapes with low and fragmented fuel levels, through close cultivation and grazing, and fire regimes were fuel-limited (Pyne 1997; Keeley et al. 2012).

Pyne (1997) describes the immemorial practice of free-burning fire of nomadic (or transhumant) herders of livestock, and the tension between their seasonal burning habits and settled agriculturalists striving for closed ecological cycles in which labourers took over the tasks of unruly fire. There were naturally significant regional variations, encapsulated for Pyne in the divergent styles of pastoralism exhibited on the peninsulas of Iberia, Italy and Greece. In the 1700s, Enlightenment thinkers participated in an agricultural revolution informed by the ideals of classical agronomists, interpreting the region's physical and cultural landscapes as degraded ones ruined by imprudent land use, notably the destructive foraging and burning habits of shepherds. Pyne (1997) describes the attempts of French administrators to regulate and control fire policy nationally, legislated into the Code Colbert of

1669, and refined through the application of scientific expertise to guide national and later colonial forestry policy and management.

In the nineteenth century, industrialisation and urbanisation began to transform the primarily agricultural landscapes of the Mediterranean, emptying the countryside, leaving abandoned fields and vineyards. State foresters came to rival agronomists as shapers of these landscapes, and French forestry in particular, drawing on its domestic and colonial experiences on Mediterranean islands and in North Africa, implemented a military approach to fire control which proved widely influential and has had a lasting legacy in the region (Pyne 1997).

From the mid-twentieth century, rural depopulation and land abandonment along with reduced livestock grazing pressure has resulted in a shift in fire regimes along the northern rim of the Mediterranean basin. Old fields have been abandoned, become more shrubby, or been planted up with pines and eucalypts. Fuel beds have become large and continuous. Along the coastal areas development in response to tourism has increased the wildland-urban interface, resulting in increased fire ignitions. Together with hotter drier climatic conditions in recent decades, this has resulted in more frequent, and larger fires. While until recently continuing intensive rural land use in the southern and eastern Mediterranean rim has maintained fuels at low levels, resulting in relatively smaller areas burned annually, rural depopulation resulting from industrialisation and political instability is driving a similar shift in fire regimes to those occurring in the northern rim countries (Pyne 1997; Pausas et al. 2008; Keeley et al. 2012).

Fire and bioinvasions: the Mediterranean basin and other MTCs

For European botanists educated in the ecological orthodoxy of the early twentieth century, which regarded climate and soil as the chief determinants of vegetation, the fire-prone vegetation of the world's Mediterranean type climate regions was a puzzle. (Some plants, for instance juniper, rosemary and species of pine, even produce volatile substances which make them more inflammable.) It did not fit their linear conception of vegetation succession, where the vegetation progresses from pioneer communities colonising bare soil, through successive stages of increasing complexity, to reach a stable climax stage in equilibrium with prevailing climatic conditions. Botanical and forestry experts interpreted the dominant tree and shrub communities of Californian chaparral, Chilean matarral, Australian kwongan or mallee, Mediterranean-basin maquis or macchia, and South African fynbos and renosterveld, as a stage en route to mature forest—and not a climax community.

What confused botanists, was that this Mediterranean-type vegetation is autosuccessional, meaning the *climax* species are present in the *pioneer* communities. The structure and species mix of particular communities are shaped by time since the previous fire, and the nature of that particular fire. However, fire was interpreted as a disturbance to the 'natural' progression (or

equilibrium state) of the vegetation. It was often seen as destructive of biodiversity, whereas fire is a naturally recurring phenomenon in these plant communities, and is actually an important driver of their biodiversity. Into the 1970s, attempts were still being made by land managers to 'correct' this anomaly, either through excluding fire in the hope that the scrub would succeed to forest, or by planting trees (usually non-native species). This was especially the case in mountain catchment areas where trees were believed to best protect soils and water supplies.

Plant invasions by introduced species are a major problem in Mediterranean-type ecosystems, where altered fire regimes favour non-native plants including grasses and (introduced) shrubs and trees. Successful invaders usually exploit the post-fire invasion window more successfully than the indigenous flora, regenerating and maturing more quickly, and establishing dense fire-resistant stands which persist through subsequent fires. Although such stands of introduced plants (for examples of eucalypts or wattles) may be less easily ignited, once alight, they burn more intensely than the indigenous flora they have invaded, and can damage the soil and cause excessive runoff and erosion. Studies suggest that post-fire ecological damage of this kind usually occurs in transformed landscapes, notably pine plantations established on old fields (Pausas et al. 2008).

Keeley et al. (2012) argue that it is the long coevolution of Mediterranean basin plants with heavy human land use[4] (notably fire use) that has made them such successful invaders of other Mediterranean type climate ecosystems. These plants were introduced by European settlers in contexts of large-scale anthropogenic ecosystems disturbances, where settlers were clearing forests, cultivating crops, grazing livestock and deploying fires to aid them in these activities. Nearly two-thirds of invasive plants in California, Chile, South Africa and southern Australia come from the Mediterranean basin. Within the Mediterranean basin, on the other hand, the shrubs seem resistant to both local disturbances and invasions by introduced plants. An exception is areas with acidic soils and (relatively) high rainfall, where Australian Acacia and Hakea species are becoming invasive, notably in Portugal.

South Africa shares a number of characteristics with the more recent fire histories and current situations of the Mediterranean Basin countries, especially the 'fire club' comprising Portugal, Spain, France, Italy, and Greece. First, the depopulation of rural areas, particularly with accelerating industrialisation and use of fossil fuels following the Second World War, resulted in the decline of traditional biomass usage, the neglect of previously enacted

[4]See Pyne (1997) on the Mediterranean as an anthropogenic landscape, its biota sculpted by anthropogenic stresses, notably fire, browsing and grazing.

control measures, biological invasions by fuel-heavy inflammable plants, and a lack of labour for fire fighting.

Rapid urbanisation especially from the 1970s contributed to an extended wildland-urban interface, making fire control more difficult, and concentrating resources on fire fighting to defend dwellings and infrastructure rather than undertake fire prevention measures. Urban-oriented fire brigades have taken over fire control from forestry departments in wildland urban interface regions, and often lack the skills to prevent or adequately combat wild fires. Prescribed block burning along the wildland urban interface, or intermix, remains controversial and sporadically applied. The fractured nature of land ownership in such areas makes applying uniform or coordinated fire control measures difficult if not impossible. A shift in emphasis from plantation forestry to recreation and nature conservation in the last third of the century also resulted in a decline (or collapse) of fire control measures particularly in mountain regions (Anon 2007; Pooley 2014; Keeley et al. 2012; Doblas-Miranda et al. 2017).

European Mediterranean fires, c.1990–present

The perception is that in Europe, there was an upward trend in fire incidence and spread during the 1970s and 1980s, and some have argued this continues to the present.[5] This is despite the heavy investment in fire fighting capacity in the EU since the 1990s, which has managed to maintain the status quo in average years, but proved inadequate to contain megafires in years of difficult conditions with extreme fire weather. Despite the warnings of fire experts in the early 1990s, policy makers were slow to recognise the socio-economic determinants of this deteriorating fire situation. Major fires burned in southern Europe in 2000, with numerous fire disasters over the next decade, for example in Portugal in 2003 and 2005, Spain in 2006, Greece in 2007 and 2009, and Israel in 2010 (Xanthopolous 2009).

From 1998–2009, 35 major forest fires killed 307 people and caused losses of €6917 billion across Europe. On average, per annum, 70% of these fires occurred in the Mediterranean region, accounting for 85% of burned area. While 95% of ignitions were attributed to human causes, fire spread was attributed primarily to fuel levels and weather conditions. There was no overall trend either in area burned or number of fires, but it is asserted that fires are becoming more intense and difficult to control. They are also occurring at higher altitudes and in northern regions of the Mediterranean basin where they were uncommon in the past. The combination of increasing climate-driven fire risk, land abandonment and loss of grazers resulting in homogenous landscapes of fuel-heavy vegetation, and fire suppression rather than fire control policies led by urban-style fire services resulting in the accumulation of fuel, are shifting the fire regime towards large, frequent, intense fires (Anon 2010; Keeley et al. 2012).

[5]Data is incomplete and not always commensurable, and Turco et al. (2016) find an overall decline in area burned from 1985–2011, with the exception of Portugal.

At the time of writing, in 2017, forest fires had caused havoc in Portugal, Spain and Italy. Perhaps it is time, as Keeley et al. (2012) maintain, to move on from a fire management paradigm of fire suppression and a preference for dense forests, to one focused on sustaining natural ecosystems—which necessarily includes attempting to maintain the fire regimes the local biota have evolved to thrive in. In the case of the Mediterranean basin, this could mean restoring traditional agricultural land use practises. This approach would involve maintaining particular favourable fire regimes in landscapes, rather than trying to suppress all fires and treating those that do break out as natural disasters to be controlled through emergency responses. It would also involve controlling the spread of invasive, inflammable introduced trees and shrubs, and greater caution in where these are deliberately planted, avoiding close proximity to roads and homesteads.

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References

Anon (2007) Recommendations of session C: Europe, Southeast Europe, Mediterranean North Africa and Caucasus. In: Fourth international wildland fire conference. International Forest Fire News, vol 36, pp 1–3

Anon (2010) Mapping the impacts of natural hazards and technological accidents in Europe: an overview of the last decade. European Environment Agency Technical report No. 13/2010. EEA, Copenhagen

Doblas-Miranda E, Alonso R, Arnan X et al (2017) A review of the combination among global change factors in forests, shrublands and pastures of the Mediterranean region: beyond drought effects. Global Planet Change 148:42–54

Keeley JE, Bond WJ, Bradstock RA, Pausas JG, Rundel PW (2012) Fire in Mediterranean ecosystems: ecology, evolution and management. Cambridge University Press, Cambridge

Pausas JG, Llovet J, Rodrigo A, Vallejo R (2008) Are wildfires a disaster in the Mediterranean basin? A review. Int J Wildland Fire 17:713–723

Pooley S (2014) Burning Table Mountain: an environmental history of fire on the Cape Peninsula. Palgrave, London

Pyne S (1997) Vestal Fire: an environmental history, told through fire, of Europe and Europe's encounter with the world. University of Washington Press, Seattle

Shlisky A, Meyer R Waugh J, Blankenship K (2008) Fire, nature, and humans: global challenges for conservation. Fire Manage Today 68(4):36–42

Turco M, Bedia J, Di Liberto F et al (2016) Decreasing fires in Mediterranean Europe. PLoS ONE 11(3):e0150663

Xanthopolous G (2009) Wildland fires: Mediterranean. Crisis Response 5 (3):50–51

References

Adamson RS (1927) The plant communities of Table Mountain: preliminary account. J Ecol 15:278–309
Adamson RS (1929) The vegetation of the South West Region. J Bot Soc S Afr 15:7–12
Adamson RS (1945) Characteristics of the vegetation. In: Wicht WL (ed) Preservation of the vegetation of the South Western Cape. Report for The Royal Society of South Africa. Royal Society of South Africa, Cape Town
Aupiais L, Glenn I (eds) (2000) The Cape of flames: the great fire of January 2000. Inyati Publishing, Cape Town
Bagnall DG, Louw H (1962) Bokkie the grysbuck. Department of Nature Conservation & Cape Peninsula Fire Protection Committee, Cape Town
Bennett BM (2010) A global history of Australian trees. J Hist Biol 44(1):125–145
Bennett BM (2015) Margaret Levyns and the Decline of Ecological Liberalism in the Southwest Cape, 1890–1975. S Afr Hist J 67(1):64–84
Carruthers J (2011) Trouble in the garden: South African botanical politics ca. 1870–1950. S Afr J Bot 77:258–267
Comaroff J, Comaroff JL (2001) Naturing the nation: aliens, apocalypse and the postcolonial state. J South Afr Stud 27(3):627–651
Compton RH (1924) News and notes. J Bot Soc S Afr (JBSSA) 10:3
Compton RH (1927) News and notes. JBSSA 13:3
Compton RH (1928) News and notes. JBSSA 14:5
Du Preez B (2017) pers. comm. From Braam du Preez, Forestry Risk Manager for MTO Cape, 12 March
Du Toit B (2012) "No" to biased and pseudo-scientific reporting, says Forest Scientist. Available at: http://blogs.sun.ac.za/news/files/2012/05/Forestry-in-Fynbos-reply-BdT.pdf. Accessed on 9 June 2017
Forsyth GG, Van Wilgen BW (2008) The recent fire history of the Table Mountain National Park and its implications for fire management. Koedoe 50(1):3–9
Henkel JS (1943) Preservation of mountain vegetation of the South-West Districts of the Cape Province. Memorandum to the Royal Society of South Africa
Hey D (1963) The conservation of flora in the province of the Cape of Good Hope. Lantern 13:68–69
Hey D (1978) Report on the future control and management of Table Mountain and the Southern Peninsula Mountain Chain. Repub S Afr Pretoria, Government Printer
Hill (Sir) Arthur (1929) Personal diary. Kew Gardens Library and Archive, AWH/1/8 (1929)
Huntley B (1992) The Fynbos Biome Project. In: Cowling RM (ed) The ecology of fynbos: nutrients, fire and diversity. Oxford University Press, Cape Town, pp 1–5
Keeley JE, Bond WJ, Bradstock RA, Pausas JG, Rundel PW (2012) Fire in Mediterranean ecosystems: ecology, evolution and management. Cambridge University Press, Cambridge
Kruger FJ (1978) Description of the Fynbos Biome Project. National Scientific Programs Unit: CSIR, South African National Scientific Programs Report 28
Kruger FJ, Reid P, Mayet M, Alberts W, Goldammer JG, Tolhurst K (2000) A Review of the Veld Fires in the Western Cape during 15 to 25 January 2000. Department of Water Affairs and Forestry Report, South Africa, 145 pages
Le Maitre DC, Van Wilgen BW, Chapman RA, Kelly DH (1996) Invasive plants and water resources in the Western Cape Province, South Africa; modelling the consequences of a lack of management. J Appl Ecol 33:161–172
Lidström S, West S, Katzschner T, Pérez-Ramos MI, Twidle H (2015) Invasive narratives and the inverse of slow violence: alien species in science and society. Environ Humanit 7:1–40
Lister MH (1957) Joseph Storr Lister, the first chief conservator of the South African Department of Forestry. Journal of the South African Forestry Association 29:10–18

Lückhoff CA (1951) Table Mountain: our national heritage after three hundred years. AA Balkema, Cape Town
Macdonald IAW, Kruger FJ, Ferrar AA (1986) The ecology and management of biological invasions in southern Africa. Oxford University Press, Cape Town
Mandela RN (1998) Message from President Nelson Mandela on the occasion of World Environment Day. 5 June
Marais C (2008) Interview with the author. Cape Town, 3 October
Moll EJ, Trinder-Smith T (1992) Invasion and control of alien woody plants on the Cape Peninsula Mountains, South Africa 30 years on. Biol Cons 60:135–143
Neely AH (2010) 'Blame it on the weeds': politics, poverty, and ecology in the new South Africa. J South Afr Stud 36:869–887
Nixon R (2011) Slow violence and the environmentalism of the poor. Harvard University Press, Cambridge
Pakenham T (2007) In search of remarkable trees: on safari in Southern Africa. Weidenfeld & Nicolson, London
Pearson H (1910) Text of speech sent to Col. Pierie, Director of Kew. Miscellaneous Reports: South Africa; National Botanic Garden, 1910–1928, Kew Gardens Archive, 302, R6 (4 November 1910), 1–13
Pooley S (2009) Jan Van Riebeeck as pioneering explorer and conservator of natural resources at the Cape of Good Hope (1652–1662). Environ Hist 15:3–33
Pooley S (2010) Pressed flowers: notions of indigenous and alien vegetation in South Africa's Western Cape, c. 1902–1945. J South Afr Stud 36(3):559–618
Pooley S (2014) Burning Table Mountain: an environmental history of fire on the Cape Peninsula. Palgrave, London
Preston G (2007) Interview with the author. Pearson Hall, Kirstenbosch, Cape Town, 19 October
Prins P (2007) Interview with the author. Newlands Fire Base, Cape Town, 19 October
Privett SDJ, Cowling RM, Taylor HC (2001) Thirty years of change in the fynbos vegetation of the Cape of Good Hope Nature Reserve. Bothalia 31:99–115
Rebelo A, Boucher C, Helme N, Mucina L, Rutherford MC (2006) Fynbos biome. In Mucina L, Rutherford MC (eds) The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria, pp 53–219
Richardson DM, Holmes PM, Cowling RM (1992) Plant and animal invasions. In: Cowling RM (ed) Ecology of fynbos: nutrients, fire and diversity. Oxford University Press, Cape Town, pp 271–308
Shaughnessy GL (1980) Historical ecology of alien woody plants in the vicinity of Cape Town, South Africa. PhD thesis, University of Cape Town
Sim TR (1907) Forests and forest flora of the Colony of the Cape of Good Hope. Taylor & Henderson, Aberdeen
Smuts JC (1942) The Spirit of the Mountain. In Plans for a better world: speeches of field-marshal the right honourable J. C. Smuts. Hodder and Stoughton, London
Ukuvuka (2000) The Santam/Cape Argus Ukuvuka Operation Firestop Campaign draft business plan: 2000–2004. Ukuvuka, Cape Town
Van Sittert L (2003a) Making the Cape Floral Kingdom: the discovery and defence of indigenous flora at the Cape ca. 1890–1939. Landscape Res 28(1):113–129
Van Sittert L (2003b) The bourgeois eye aloft: Table Mountain in the Anglo urban middle class imagination, c.1891–1952. Kronos 29:161–190
Van Wilgen BW (2009) The evolution of fire and invasive plant management practice in fynbos. S Afr J Sci 105:335–342
Van Wilgen BW, Richardson DM (1985) The effect of alien shrub invasions on vegetation structure and fire behaviour in South African fynbos shrublands: a simulation study. J Appl Ecol 22:955–966
Van Wilgen BW, Richardson DM (2012a) Three centuries of managing introduced conifers in South Africa: benefits, impacts, changing perceptions and conflict resolution. J Environ Manage 106:56–68

Van Wilgen BW, Richardson DM (2012b) Fynbos forestry debate response. Available at: http://blogs.sun.ac.za/news/files/2012/05/Fynbos-Forestry-debate-response.pdf. Accessed on 9 June 2017
Van Wilgen BW, Cowling RM, Burgers CJ (1996) Valuation of ecosystem services. BioScience 46:184–189
Van Wilgen BW, Forsyth GG, Le Maitre DC, Wannenburgh A, Kotzé JDF, Van Den Berg E, Henderson L (2012) An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. Biol Cons 148:28–38
Van Wilgen BW, Carruthers J, Cowling RM et al (2016) Ecological research and conservation management in the Cape Floristic Region between 1945 and 2015: History, current understanding and future challenges. Trans R Soc S Afr 71(3):207–303
Wall K (2008) Water supply: reshaper of Cape Town's local government a century ago. In: van Zyl JE, Ilemonbade AA, Jacobs HH (eds) Proceedings of the 10th annual water distribution systems analysis conference, WDSA2008, Kruger National Park, South Africa
Wicht CL (1945) Preservation of the vegetation of the South Western Cape. Report for The Royal Society of South Africa. Royal Society of South Africa, Cape Town

Archives

State Forestry Department Annual Reports
Series reconstructed from personal copies and libraries as follows:
Rhodes House Library, University of Oxford
Republic of South Africa: Department of Forestry: Annual report 1951–67, Shelf No.610.44s. 5
Plant Sciences Library, University of Oxford
BN/South Africa/Department of Environment Affairs: Report, Annual–Forestry Branch; and on Microfilm, Bulletins, P3, BN/Rumania, Forestry and Environmental Conservation Branch Annual Report
(This library now rehoused in the Radcliffe Science Library)
Reports series (with abbreviations used in text) as follows:
Cape of Good Hope (CGH): Department of Agriculture, Reports of the conservators of forests, Cape Colony (to 1909)
Government of the Union of South Africa (UG): Forest Department: Report of the Chief CONSERVATOR of forests (ARFD), 1910–58/59
Republic of South Africa (RP): Annual reports of the Department of Forestry (ARFD), 1959/60–78/79
RP: Annual report of the Department of Water Affairs and the Department of Forestry and Environmental Conservation (ARFD), 1979/80–83/84
RP: Annual report of the Department of Environment Affairs (ARFD), 1984/85–94
ARFD (Annual Report of the Forestry Department). UG53-1936; RP20/1961; RP80/1964; 1972/73 RP38/1974; RP18/1972
CGH (Cape of Good Hope): 1900 G.39-1901; CGH 1902, 17; CGH 1905; CGH 1892 27-93; CGH1893 G.50-94; CGH 1896 G17-97

Municipal Sources

Chancellor Oppenheimer Library, University of Cape Town, Government Publications Department
Minute of His Worship the Mayor, Cape Town (MM): 1900–1953
Shelf Ref.: G682 VC2 s.2247
Incorporating Annual Reports of the:

Chief Officer of the Metropolitan Fire Brigade (ARFB)
Superintendent of public gardens and tree planting (ARPGTP), 1900–09
Superintendents of public gardens, and tree planting (separately), 1910–28
Director of Parks and Gardens (ARDPG), c.1928–53
City Lands and Forests Branch (CLFB), c.1939–53
The Corporation of the City of Cape Town: Annual Report of the City Engineer (ARCE), Shelf Ref. G 682 VC ED(ENGI), including
Incorporating the Annual Reports of:
Forests, Parks and Gardens (ARFPG) c.1954–60
Parks and Forests Branch (ARPFB) 1961–94/95

Newspapers

Cape Times and Cape Argus newspaper reports accessed on microfilm at the African Studies Library, University of Cape Town, Ref. BZA 76/72, MP 1025, and Rhodes House Library, Oxford, call number 620.18 t. 2
Cape Argus (1935) £250,000 havoc in great fire. 26 December
Cape Argus (1935) To safeguard mountain. 27 December
Cape Times (1942) Stop those mountain fires. Editorial, 27 November
Cape Times (1943) National Veld Trust. Editorial, 7 January
Cape Times (1943) Start of war on soil erosion. 20 November
Cape Times (1943) The enemy within. Editorial, 4 December
Cape Times (1950) Letters to the Editor. 1 February
Cape Times (1960) £1.2 million new science drives round Cape. 29 January, front page
Cape Times (1973) Fire could ruin flora. 18 April: 2
Cape Times (2007) 'Tree Taliban' ignores please to save green heritage. 3 February: 3
Sunday Argus (2007) Author blames 'eco-fascists' for tree-culling. 7 October, 11