

A reconnaissance botanical survey of the Lower Orange River (Blouputs to Onseepkans) in the Northern Cape, South Africa

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In the past, the alluvial floodplains of the Orange River were covered with riverine shrubland and woodland. However, there are indications that this has changed and that this vegetation and habitat has been influenced by a number of factors, namely: expansion of irrigated crop farming; grazing pressure; and upstream dam construction. A botanical assessment was carried out along the Orange River between Blouputs and Onseepkans, in the Northern Cape to determine the nature and extent of the changes to the riverine vegetation, as well as to investigate the distribution of *Combretum erythrophyllum* and *Rhus lancea*. Only two specimens of *Combretum erythrophyllum* were noted whereas no *Rhus lancea* specimens were noted. There are indications that both the expansion of irrigated crop farming and grazing pressure has affected the vegetation of the plain and riverine area along the Orange River. Downstream from the farm Raap-en-Skraap (2819DA Skuitdrif), the natural vegetation of the riverbanks and islands is being replaced by alien plant species.

Key words: Orange River, vegetation, river changes, alien invasion.

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Introduction

According to Werger (1973), riverine forest and shrubland occurred along the Lower Orange River. The best-developed gallery forest was where flooding and subsequent deposition of alluvial material occurred most frequently. However, indications are that this has changed and that this vegetation and habitat has been influenced by a number of factors, namely, the expansion of irrigated crop farming, grazing pressure, and upstream dam construction.

The expansion of irrigated crop farming on the river banks has damaged or replaced riverine forest and adjacent vegetation units along the Orange River (Bezuidenhout 1996). The riverine vegetation upstream of the Augrabies Falls National Park (AFNP) has largely been cleared, to make way for intensively irrigated crops such as fruit (grapes & peaches), vegetables, cotton and

lucerne. It is not clear how much undamaged vegetation remains downstream of AFNP.

Grazing pressure on the riverine vegetation, through stock farming, has resulted in its invasion by mesquite (*Prosopis glandulosa*) and driedoring (*Rhigozum trichotomum*) (Hoffman 1996b). The extent of the invasion of riverine areas reported by Hoffman is unknown.

Before the Gariep (Hendrik Verwoerd), Vanderkloof (PK le Roux) and Boegoeberg dams were built, the Orange River was subjected to frequent flooding and deposition of alluvial material, and as a result a gallery forest developed. Statistically, the Orange River displays a one in 10 to 15 year episodic flood cycle, but floods can also occur every five to 10 years (Benade 1993). Twenty-three major dams have been constructed within the Orange River catchment between 1872 and 1993. Nine of South Africa's 30 largest dams occur within this catchment. Unfortunately

these developments have changed the flow regime of the Orange River, and the tributaries have dried up a number of times. Water regulation by dams has resulted in partial to total absorption of maintenance floods. The flood-buffering effect of the Gariiep and Vanderkloof Dams also resulted in short-lived, unnatural floods (Benade 1993). It is uncertain how the riverine forest has changed in response to the more frequent drying-up of the tributaries (Bezuidenhout 1996), and the changed flow regime.

The distribution of *Combretum erythrophyllum* and *Rhus lancea* within the riverine vegetation is phytogeographically interesting. Both species occur in AFNP, which is an enclave far from their normal distribution area (Werger & Coetzee 1977, Bezuidenhout 1996). Their distribution downstream from AFNP is unknown. Along the Upper Orange River these species are respectively absent or very rare (Werger 1973), but along the Vaal River they occur commonly in the riverine forest. Merxmüller (1966-1972) mentions that there is only one record of *Combretum erythrophyllum* in Namibia, reported by Dinter, who found a tree on the north bank of the Orange River at Gaidib in 1928.

A botanical assessment was carried out along the Orange River between Blouputs and

Onseepkans in the Northern Cape, to determine the nature and extent of the changes to vegetation along the river, as well as to investigate the distribution of *Combretum erythrophyllum* and *Rhus lancea*.

Methods

A five-day canoe trip was undertaken (February 1998) along the Orange River, from Blouputs to 2 km downstream of the town of Onseepkans (Fig. 1). Notes and photographic slides were taken along the River. Random stops were made and plant species names were recorded in the different vegetation units. Taxa names used here conform to those recommended by Arnold & De Wet (1993). The broad-scale structural classification of Edwards (1983) was used to describe the structure of the vegetation. Soil nomenclature follows the classification of the Soil Classification Working Group (1991).

Results

A. Literature assessment

Vegetation of South Africa, Lesotho and Swaziland

Hoffman (1996a) described the area as part of the Orange River Nama Karoo (Vegeta-

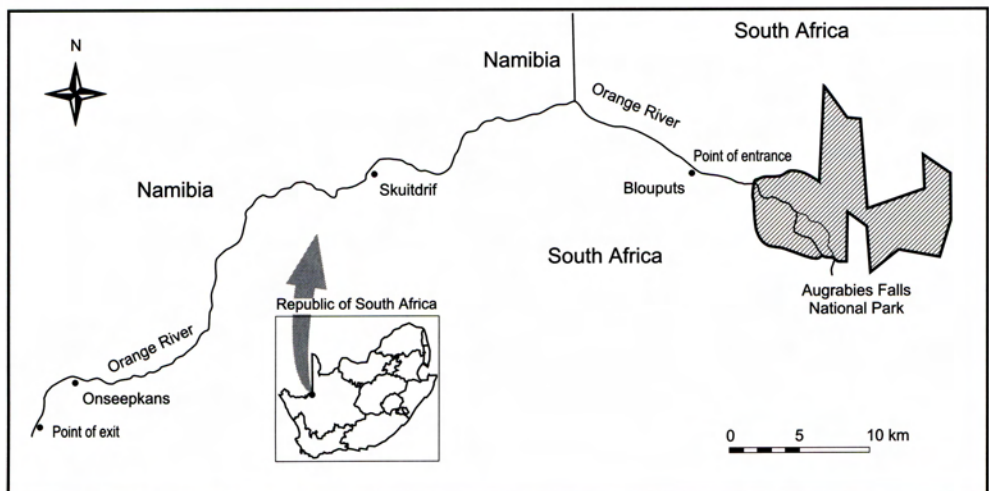


Figure 1: The location of the study area.

tion Type 51). According to Hoffman (1996a), the area is very rocky and possesses a "broken" topography with *Aloe dichotoma*, *Euphorbia avasmontana* and *E. gregaria* normally associated with the mountains and hills. On the pediments, *Acacia mellifera*, *Rhigozum trichotomum* and *Boscia albitrunca* are common shrubs whereas *Stipagrostis uniplumis* often dominates the plains.

According to Hoffman (1996b) the Bushmanland Nama Karoo (Vegetation type 49) occurs to the south of the area. The topography is generally flat and the study area is located in the most arid part of South Africa. Hoffman (1996b) described this vegetation type as being dominated by annuals and non-succulent shrubs. An interesting observation by Hoffman (1996b) is that this type has the highest proportion of annuals of all the Nama Karoo types. Annuals, such as *Pentzia annua* and *Zygophyllum simplex*, are common and together with geophytes comprise nearly 50% of the total number of species in the region.

To the west of the area lies the Upland Succulent Karoo (Vegetation type 56) (Hoffman 1996c). The topography ranges from gently undulating to steeply rolling, and large granitic boulders often dominate the landscape. Elevation ranges from 300 - 1700 m. According to Hoffman (1996c) *Aloe dichotoma* characterises much of this vegetation while other succulent species, particularly within the vygie family (Mesembryanthemaceae) are the dominant shrubs. Grasses are generally not common but many annuals occur in this vegetation type.

Conservation Status

The Augrabies Falls National Park is the largest conservation area within the Orange River Nama Karoo. The Orange River Nama Karoo comprises a total surface area of 537 081 km² of which only 1.47 % is conserved (Hoffman 1996a).

The Bushmanland Nama Karoo comprises a total surface area of 831 942 km² of which no

more than 0.03 % is conserved (Hoffman 1996b). This is far less than the internationally accepted minimum level for conservation, namely that at least 10 % of a vegetation type should be conserved. No major conservation areas occur in this vegetation type. Riverine areas are seriously invaded by *Prosopis glandulosa* and *Rhigozum trichotomum*, mainly in parts which have been heavily grazed (Hoffman 1996b).

The Upland Succulent Karoo comprises a total surface area of 386 727 km² of which more than 4.39 % is conserved. Several conservation areas such as the Goegap Nature Reserve and Richtersveld National Park occur in the Upland Succulent Karoo (Hoffman 1996c).

B. Description of the vegetation

Classification of the vegetation found on the broken, rocky terrain of the AFNP indicates nine plant communities associated with the complex geology (Bezuidenhout 1996).

The area along the Orange River consists of four main landscape units.

i) Hills

A hilly landscape is found adjacent to the Orange River. The dominant soil-rock complex is rocky outcrops, with the shallow (< 0.1 m) Mispah and Glenrosa soil forms subdominant (Land Type Survey Staff 1986).

In this landscape the following three vegetation units were observed following Bezuidenhout (1996): (1) the *Aloe dichotoma* Sparse Woodland; (2) the *Schotia afra* Open Woodland and (3) the *Ceraria namaquensis* Open Shrubland. The latter community is associated with rocky outcrops of mainly strongly weathered gneiss.

The most dominant trees recorded were the scattered tree-aloe *Aloe dichotoma*, *Schotia afra* var. *angustifolia* and *Adenolobus garipensis*. The most dominant shrub species were *Commiphora gracilifronsosa*, *Rhus populifolia*, *Sutera ramosissima*, *Cadaba*

Table 1
An alphabetically annotated list of plants recorded

Landscape unit	Hills	Drainage lines	Plains	Riparian areas and islands
Plant species				
<i>Acacia erioloba</i> E. Mey.			+	+
<i>Acacia karroo</i> Hayne				+
<i>Acacia mellifera</i> (Vahl) Benth. subsp. <i>detinens</i> (Burch.) Brenan		+	+	+
<i>Adenolobus garipensis</i> (E.Mey.) Torre & Hillc.	+		+	
<i>Aloe dichotoma</i> Mass.	+			
<i>Antherothamnus pearsonii</i> N.E. Br.	+			
<i>Arundo donax</i> L. *				+
<i>Barleria rigida</i> Nees	+			
<i>Boscia albitrunca</i> (Burch.) Gilg. & Ben. var. <i>albitrunca</i>	+		+	
<i>Boscia foetida</i> Schinz subsp. <i>foetida</i>	+		+	
<i>Cadaba aphylla</i> (Thunb.) Wild	+	+	+	
<i>Cleome angustifolia</i> Forssk. subsp. <i>diandra</i> (Burch.) Kers	+	+		
<i>Cleome foliosa</i> Hook. f. var. <i>foliosa</i>	+			
<i>Codon schenckii</i> Schinz	+			
<i>Combretum erythrophyllum</i> (Burch.) Sond.				+
<i>Commiphora gracilifrondosa</i> Dinter ex J.J.A. v.d. Walt	+			
<i>Dicoma capensis</i> Less.			+	
<i>Diospyros lycioides</i> Desf. subsp. <i>lycioides</i>				+
<i>Dyerophytum africanum</i> (Lam.) Kuntze		+		
<i>Enneapogon scaber</i> Lehm.	+			
<i>Eucalyptus camaldulensis</i> Dehnh.				+
<i>Euclea pseudebenus</i> E.Mey. ex A. DC.			+	
<i>Ficus cordata</i> Thunb. subsp. <i>cordata</i>		+		
<i>Forsskaolea candida</i> L.f.	+		+	
<i>Grielum humifusum</i> Thunb. var. <i>humifusum</i>			+	
<i>Hibiscus engleri</i> K.Schum.	+			
<i>Indigofera pechuelii</i> Kuntze	+		+	
<i>Indigofera pungens</i> E.Mey.	+			
<i>Leucophrys mesocoma</i> (Nees) Rendle		+		
<i>Lycium</i> L. species		+		
<i>Maerua gilgii</i> Schinz			+	
<i>Maytenus linearis</i> (L.f.) Marais			+	+
<i>Monechma spartioides</i> (T. Anders.) C.B. Cl.	+			
<i>Montinia caryophyllacea</i> Thunb.		+		
<i>Nicotiana glauca</i> R.C. Grah.*			+	+
<i>Nymania capensis</i> (Thunb.) Lindb.			+	
<i>Osteospermum microcarpum</i> (Harv.) T.Norl. subsp. <i>microcarpum</i>		+		
<i>Panicum coloratum</i> L. var. <i>coloratum</i>	+	+		
<i>Pappea capensis</i> Eckl. & Zeyh.		+		
<i>Parkinsonia africana</i> Sond.			+	
<i>Phaeoptilum spinosum</i> Radlk.			+	
<i>Phragmites australis</i> (Cav.) Steud				+
<i>Prosopis glandulosa</i> Torr. var. <i>glandulosa</i> *			+	+
<i>Prosopis velutina</i> Wooton *			+	+
<i>Rhus pendulina</i> Jacq.				+
<i>Rhus populifolia</i> E.Mey. ex Sond.	+			

Table 1
(continued)

Landscape unit	Hills	Drainage lines	Plains	Riparian areas and islands
	<i>Ricinus communis</i> L.*			+
<i>Salix mucronata</i> Thunb. subsp. <i>capensis</i> (Thunb.) Immelman				+
<i>Schotia afra</i> (L.) Thunb. var. <i>angustifolia</i> (E.Mey.) Harv.	+	+		
<i>Sisyndite sparteae</i> E.Mey. ex Sond.		+		+
<i>Stipagrostis ciliata</i> (Desf.) De Winter var. <i>capensis</i> (Trin. & Rupr.) De Winter			+	
<i>Stipagrostis hochstetteriana</i> (Beck. Ex Hack.) De Winter var. <i>secalina</i> (Henr.) De Winter			+	
<i>Stipagrostis namaquensis</i> (Nees) De Winter			+	
<i>Stipagrostis obtusa</i> (Del.) Nees			+	
<i>Stipagrostis uniplumis</i> (Licht.) De Winter var. <i>uniplumis</i>	+		+	
<i>Sutera ramosissima</i> Hiern	+			
<i>Tamarix usneoides</i> E.Mey. ex Bunge				+
<i>Tribulus</i> L. species			+	
<i>Trichodesma africanum</i> (L.) Lehm.	+			
<i>Ziziphus mucronata</i> Willd. subsp. <i>mucronata</i>				+
<i>Zygophyllum microphyllum</i> L.f.			+	
<i>Zygophyllum simplex</i> L.				+

* Alien species

aphylla, *Antherothamnus pearsonii*, *Boscia albitrunca* and *B. foetida*. Dominant grasses noted were *Panicum coloratum*, *Enneapogon scaber* and *Stipagrostis uniplumis*. The forbs *Cleome angustifolia*, *C. foliosa*, *Barleria rigida*, *Forsskaolea candida*, *Trichodesma africanum*, *Codon schenckii*, *Indigofera pechuelii*, *Hibiscus engleri*, *Indigofera pungens* and *Monechma spartioides* were also noted (Table 1).

ii) Drainage lines

Similar plant species that occur in the *Sisyndite sparteae* - *Schotia afra* Open Woodland (Bezuidenhout 1996), were recorded in the sandy drainage lines. The dominant soil-rock complex is the Dundee soil form while rocky outcrops are subdominant (Land Type Survey Staff 1986).

In the drainage lines, three tree species are dominant, namely *Ficus cordata*, *Schotia afra* and *Pappea capensis*. In the well-developed shrub stratum, *Sisyndite sparteae* is

dominant with shrubs such as *Cadaba aphylla*, *Lycium* species, *Montinia caryophyllacea* and *Acacia mellifera* also being recorded. Two dominant grasses were recorded namely *Panicum coloratum* and *Leucophrys mesocoma*, while the dominant forbs in this sparsely herbaceous layer are *Dyerophytum africanum*, *Osteospermum microcarpum* and *Cleome angustifolia* (Table 1).

iii) Plains

Two main soil types divide the plains landscapes into two different vegetation units.

1. The *Acacia mellifera* Open Shrubland (Similar to the plant community with the same name described by Bezuidenhout 1996) which is strongly associated with the slightly undulating, rocky plains. The habitat of this Shrubland consists of dorbank outcrops at many places and a very dense subendritic drainage and dissection pattern. The slightly undulating plains are dominated by the midslopes with dominant Hutton and Mispah soil

forms. The coarse sandy soil is shallow (0,1 - 0,3 m deep) and rocky (Land Type Survey Staff 1986).

The dominant tree species recorded are *Acacia mellifera*, *Maerua gilgii*, *Parkinsonia africana*, *Adenolobus garipensis* and *Boscia albitrunca* while the shrubs are *Cadaba aphylla*, *Boscia foetida*, *Phaeoptilum spinosum* and *Nymania capensis*. The dominant grass species are the typical Bushmanland Nama Karoo Vegetation Type grasses *Stipagrostis uniplumis*, *S. obtusa*, *S. ciliata* and *S. hochstetteriana*. The forbs such as *Dicoma capensis*, *Forsskaolea candida*, *Indigofera pechuelii* and *Tribulus* species were also recorded in this unit (Table 1).

2. The *Acacia erioloba* Sparse Woodland is not described in Bezuidenhout's (1996) vegetation description of the southern section of AFNP. This vegetation unit is strongly associated with deep alluvial floodplains adjacent to the Orange River.

The trees found here are the dominant *Acacia erioloba* and *Euclea pseudebenus*. The shrubs *Maytenus linearis* and *Maerua gilgii* were also recorded. Apart from some *Tribulus* species, *Zygophyllum microphyllum* and *Grielum humifusum* no other forbs or grasses were recorded. A small isolated patch of *Stipagrostis namaquensis* was noted on one alluvial floodplain. Unfortunately, declared exotic alien plant species were also recorded in this vegetation unit including *Prosopis glandulosa*, *P. velutina*, *Nicotiana glauca* and *Ricinus communis* (Table 1).

iv) Riparian areas and islands.

Four vegetation units were noted in this landscape namely, 1. *Tamarix usneoides* Open/Closed Woodland; 2. *Acacia karroo* Closed Woodland; 3. *Rhus pendulina* Forest; and 4. *Phragmites australis* Closed Reedland.

These units occur along a moisture gradient and this landscape is closely associated with the Orange River banks and islands. The dominant soil forms are Dundee and Oak-leaf. Also occurring is the intrusive rock

(mainly granite) of the Namaqualand Metamorphic Complex (Land Type Survey Staff 1986).

1. *Tamarix usneoides* Open/Closed Woodland

The *Tamarix usneoides* Open/Closed Woodland is associated with the alluvial deposits of the larger sandy drainage lines. The habitat of this vegetation unit is drier than any of the other habitats in this landscape.

The dominant tree *Tamarix usneoides* sometimes forms homogenous stands whereas the tall tree *Acacia erioloba* is scattered throughout this vegetation unit. The shrubs *Maytenus linearis* and *Acacia mellifera*, as well as the exotic invader shrub/tree *Prosopis glandulosa* and *P. velutina* were also recorded in this vegetation unit. The succulent *Zygophyllum simplex* was recorded as the dominant forb while *Sisymbrium sparteum* was also noted as sub-dominant forb (Table 1).

2. *Acacia karroo* Closed Woodland

The *Acacia karroo* Closed Woodland, dominated by *Acacia karroo*, is closely associated with the *Rhus pendulina* Forest. Both these vegetation units occur on the Riverbanks but the habitat of *Acacia karroo* vegetation is drier and more clayey than that of the *Rhus pendulina* Forest. Both these vegetation units occur on the large sandy islands (Table 1).

3. *Rhus pendulina* Forest

The *Rhus pendulina* Forest is the most prominent riverine vegetation along the Orange River. This vegetation unit occurs on the banks and on the large sandy islands of the Orange River. It is dominated by the three trees *Rhus pendulina*, *Ziziphus mucronata* and *Salix mucronata*. The shrub *Diospyros lycioides* and the robust reed *Phragmites australis* were also noted in this Forest. Sparsely distributed individuals, of the alien invasive shrubs *Ricinus communis* and *Nicotiana glauca* were also observed in this vegetation (Henderson 1995) (Table 1).

This Forest closely resembles the *Ziziphus mucronata* Closed Woodland described by Bezuidenhout (1996).

An interesting phenomenon, in this vegetation unit, is that only two specimens of *Combretum erythrophyllum* were noted, at the same locality (1 : 50 000; 2819 DA Skuitdrif) (Figure 1). No *Rhus lancea* specimens were observed.

4. *Phragmites australis* Closed Reedland

The perennial braided stream of the Orange River forms numerous small islands. The Closed Reedland occurs in the water on the edge of the Orange River or on relatively low-lying sandbanks in the River. The dominant vegetation unit on these islands is *Phragmites australis* Closed Reedland. It occurs as a dense stand and only two reed species were noted, namely *Phragmites australis* and *Arundo donax*. Note that the latter species is also an exotic plant (Table 1).

Concluding remarks

Comparison of the *Rhus pendulina* Forest in the study area with the *Ziziphus mucronata* Closed Woodland of AFNP, indicate that the *Rhus pendulina* Forest of the riparian and island vegetation is in a good to excellent condition along the Orange River in the study area. In contrast, the *Ziziphus mucronata* Closed Woodland, in AFNP is not in good condition. The Woodland has been opened up and aggressive invaders such as *Asparagus retrofractus*, *Prosopis glandulosa* and *P. velutina*, and pioneer succulent species such as *Mesembryanthemum crystallinum* and *Zygophyllum simplex*, have encroached this plant community in AFNP.

Downstream from the farm Raap-en-Skraap (2819DA Skuitdrif), within the study area, it was noted that the natural vegetation of the riverbanks and islands is being replaced by alien plant species (Figure 1). In some areas the invasive vegetation has completely replaced the natural vegetation. Near the town Onseepkans the *Rhus pendulina* Forest is replaced by the aggressive, alien plants

Ricinus communis, *Prosopis glandulosa*, *P. velutina*, *Eucalyptus camaldulensis* and *Nicotiana glauca*. The two *Prosopis* species are aggressive invaders, as was noticed nearer to Onseepkans where the riverine vegetation had been totally invaded and no original natural plant species are to be seen. The alien invader shrubs *Ricinus communis* and *Nicotiana glauca*, as well as *Eucalyptus camaldulensis*, are not aggressive, and although *Nicotiana glauca* is a perennial, it normally dies after two to three years, presumably because of a water shortage. In contrast to the observations of Hoffman (1996b), no *Rhigozum trichotomum* encroachment into the riverine areas was noted.

The two plain landscape vegetation units, *Acacia mellifera* Open Shrubland and *Acacia erioloba* Sparse Woodland, and the riparian and island vegetation units *Acacia karroo* Closed Woodland and *Rhus pendulina* Forest, appear to be threatened in the study area. If these vegetation units are not properly conserved and cared for, they will be increasingly threatened, particularly by expanding irrigation operations along the Orange River.

Upstream of AFNP the riparian and floodplains vegetation units have been almost entirely replaced by irrigated vegetable, fruit and lucerne crops, and there are very few patches of the natural vegetation remaining. Downstream of AFNP to Onseepkans irrigated table grape production is rapidly expanding. The best sites for irrigated vineyards are the alluvial plains close to the river, and the riparian and island zones. Here the natural vegetation is being cleared to make land available for grapevines which are irrigated from the Orange River. Further threats to the riparian and island vegetation units *Acacia karroo* Closed Woodland and *Rhus pendulina* Forest are posed by the drying up of tributaries and the lowering and constant level of the Orange River water-level (Benade 1993). This has been caused by the building of dams further upstream in the Orange River. Mining along the River has little to no impact on the riverine vegetation at this stage.

According to Werger & Coetzee (1977) the occurrence of *Combretum erythrophyllum* and absence of *Rhus lancea* in the *Rhus pendulina* Forest are of phytogeographical interest. This species is absent and very rare along the Upper Orange River (Werger 1973), but occurs commonly in the riverine forest along the Vaal River. Only two specimens of *Combretum erythrophyllum* were noted within the study area. No *Rhus lancea* plants were seen.

The length of the Orange River surveyed was just over 100 km. It is interesting that six or seven major fires (0.5 - 4 km long) have burnt down the riverine vegetation. Some of these fires could have occurred as long as three years ago, the others more recently. Some of these fires occurred far from any human activities and it is possible that the cause of these fires had been natural.

The re-growth of the *Rhus pendulina* Forest is vigorous, with only one tree species, *Salix mucronata*, not responding very well to fire. In the Richtersveld National Park the livestock farmers ("veeboere") sometimes burn the *Phragmites australis* Closed Reedland, because of various reasons e.g., safety and grazing stimulation. The fire sometimes spreads into the adjacent *Rhus pendulina* Forest, which is thought to be detrimental to the already fragile riverine Forest. It appears that fire could be part of the *Rhus pendulina* Forest ecosystem, and if this is the case, it may be that *Rhus pendulina* Forest is well adapted to fire.

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