The conservation of Silhouette Island, Seychelles

I. Plants

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Abstract: As the third largest of the granitic islands of Seychelles Silhouette supports a wide variety of localised plants and animals. The steepness of the terrain has prevented the extensive ecological damage by forest clearance that occurred historically on other Seychelles islands. Recent studies of the island's habitats have confirmed its great conservation value. The range and condition of habitats found on the island and the species found within them are outlined below. Specific conservation problems are described and proposals made to ensure its continued preservation.

Introduction

Situated in the western Indian Ocean, some 800km east of the African coast the Seychelles group of islands supports a wide range of habitat types, many of which have developed in isolation since the break-up of Gondwanaland. Silhouette is the third largest of the granitic islands, with a surface area of approximately 1600 hectares. It is approximately 19km north-west of the largest island, Mahé (see Map 1 insert), is the second highest in the group (maximum height 740m above sea level) and consequently is one of only two islands to support high altitude forests including extensive areas of primary montane forest. It is the least developed of the larger islands and has a population of fewer than 200 people in two small coastal settlements.

The island has important populations of rare animals, especially the Seychelles sheath-tailed bat (*Coleura seychellensis silhouettae*) (Nicoll & Suttie 1982), endemic Amphibia (Nussbaum 1984) and many endemic invertebrates. The flora includes several species that are now rare on other islands in Seychelles and a number of species are confined to Silhouette only, including a forest dominated by the endemic tree *Pisonia sechellarum* which was discovered in 1987 (Friedmann 1987). The steep slopes of the island and its rocky terrain have so far prevented development of the island and have served to protect its montane forests. The low altitude forests were extensively cleared in the 1930s but the forests above 400m are almost untouched, consequently Silhouette has the best remaining areas of montane forest in Seychelles.

In 1987 the Silhouette Marine National Park was established. This affords legal protection to the marine environment to a distance of 1km from shore, an area of 2,000 hectares. Within this zone only fishing for local consumption is permitted. The designation theoretically protects the off-shore zone from further ecological damage, although the effectiveness of this mechanism has not been documented. It appears from anecdotal reports

that the reefs around Silhouette have been extensively damaged, principally by coral formations being tangled in fishing and mooring lines. Whilst most coral heads are reported to be snagged by nylon lines it is probable that permanent damage may be prevented if further degradation from this source is stopped.

The terrestrial environment receives no official protection. The island is managed in a non-intensive manner that reflects the current management's (Island Development Company) interest in preserving the existing ecosystems of Silhouette. So far this has prevented extensive habitat destruction although the IDC's management objectives will be influenced by extrinsic economic factors which at times are likely to lead to a conflict with ecosystem conservation interests.

In 1990 the ecology of the *Pisonia sechellarum* forest on Silhouette was studied by the Oxford University Silhouette Expedition. This provided the first quantitative account of the ecology of the island. Observations made in 1991 and the findings of the expedition are combined in the following account of the status of habitats of Silhouette.

Habitats presently occurring on Silhouette

Although the geology of Silhouette differs from that of the other larger islands of Seychelles (being primarily comprised of syenite and microgranite instead of the more usual granitic rocks; Piggott 1968) the vegetation is broadly similar to that found on Mahe where the same altitudinal range occurs. The main habitats of Silhouette can be divided into 11 categories which are described below.

Although the flora of Seychelles is relatively well known, with extensive botanical collections dating back to 1931, few studies of ecological aspects of the vegetation have been undertaken. The first categorisation of definite habitat types based on floristics was proposed by Jeffrey (1962). This basic system of five natural habitats provides a general indication of habitat variation on the larger islands. Although subsequent accounts of the ecology of Seychelles do not explicitly use these habitat types and the precise nomenclature varies the five categories have been generally accepted (for example the account of the flora given by Friedmann, 1987, uses most of the categories described by Jeffrey). This was subsequently used as a basis for a more detailed classification by Proctor (1984).

Attempts to describe specific areas by the existing system of classification of the habitats of Seychelles (Proctor 1984), and to associate animal distribution with vegetation patterns, have revealed some shortcomings with the current habitat classification. Ongoing ecological research projects in the islands require a more detailed system that takes into account the extensive alterations to natural vegetation systems caused by human influences. In order to take these factors into account Proctor's system has been modified to draw attention to recently discovered vegetation types not previously included. Some of the names of the habitats used by Proctor (1984) have been altered to conform with more standard classifications applied to other areas such as those listed in White (1983). This system uses the categories provided by Proctor (1984) as a baseline, modifying and subdividing some categories to reflect localised habitat types of particular interest and un-natural habitats. Background information used in categorising the habitats is derived from personal observations (including unpublished data) and

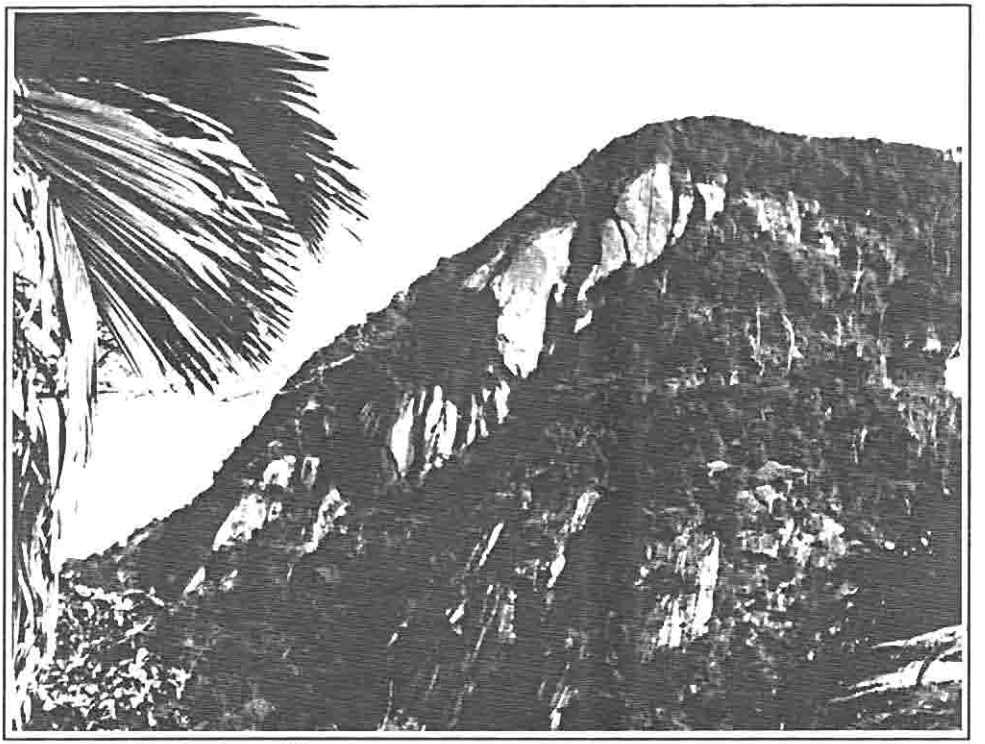


Figure 1. Mt. Dauban, Silhouette
(photo: J. Gerlach)

from several published sources (Friedmann 1986, Jeffrey 1962, Oxford University Silhouette Expedition 1990, Proctor 1984, Robertson 1987, Scott 1910).

The approximate distributions of the habitats are shown on Map 1. This map was prepared by outlining the main distinguishable habitats visible on the 1961 aerial survey photographs of the island, these were supported by characterisation of the habitats on the ground, using topographical features to confirm the location of the habitat boundaries. Habitat characterisation used the criteria described in the habitat descriptions below, on Silhouette all these areas are easily distinguishable. More detailed and accurate mapping is planned which will incorporate quantitative characterisation of the habitats.

1. Marsh habitats
   a). Mangroves.
   b). Lowland marsh - formed where the coastal plateau meets the base of the mountains. Largely drained or substantially altered by human interference. Naturally this habitat supports few aquatic plants (except algae and *Typha javanica* and the marsh fern *Acrostichum aureum*), marshes are usually bordered by lowland trees such as *Terminalia catappa*.

c). High altitude marsh - occurs in valleys at around 300-500m above sea level. These marshes have been drained and modified for agriculture. Marc aux Cochons on Silhouette was naturally an area of standing water with *Typha javanica, Gynura sechellarum* and *Melastoma malabathricum* (Scott 1910). It is presently a deserted *Coffea* plantation with areas of *Clidemia hirta*. This habitat was not listed by Proctor (1984).

2. Littoral zone - areas of strand debris and habitats influenced by direct action of the sea. The vegetation comprises salt tolerant algae along the high tide mark and common Indo-Pacific strand plants; *Ipomea pescaprae, Cocos nucifera, Calophyllum inophyllum, Casuarina equisetifolia, Hibiscus tiliaceus* and *Scaevola sericea*.

3. 'Glacis' - large expanses of bare rock exposed to wind and direct sunlight, with plant growth in sheltered soil pockets.
   a). lowland glacis - salt spray in this zone restricts the vegetation to xerophytic species except where sheltered valleys are present. Trees and shrubs include *Calophyllum inophyllum, Soulamea terminaloides* (this appears to have become extinct on Silhouette), *Mimusops sechellarum* and *Pandanus multispicata*. In sheltered valleys *Dracaena reflexa* and orchids (*Polystachya* spp. and *Angraecum eburneum)* may be abundant. On Silhouette such areas are being invaded by the introduced species *Bryophyllum pinnatum*.
   b). high altitude glacis - greater influence of clouds at high altitudes results in a habitat where *Nepenthes pervillei* is abundant. The commonest plant species in this habitat are *Pandanus multispicatus* and *Dicranopteris linearis*.

4. Scrub habitats - for the most part these are areas that have lost their native vegetation cover (category 4a. being the only exception), the main plant species in the secondary habitat are exotic weeds. A variety of indigenous plants do occur but at a low frequency. Scrub habitats were not considered by Proctor (1984) but should be recognised as they are usually highly distinct from surrounding habitats.
   a). *Cyathea seychellarum* patches - the dominance of small tree ferns (stunted or immature) at the head of boulder filled valleys could be considered a scrub habitat. These contain a variety of creepers and are gradually replaced by forest. This ranges from almost pure *Cyathea* and *Angiopteris evecta* stands (as on Silhouette) to mixed forest (eg. Morne Seychellois, Mahe).
   b). *Dicranopteris linearis* scrub - this is dominated by the exotic bracken fern which forms mats of dry fronds over 1m deep.
   c). *Chrysobalanus icaco* scrub - occurs on eroded red earth slopes following deforestation. The vegetation structure is dense and regeneration of trees very slow or non-existent. Some native herbs and creepers may persist in damper areas.
   d). *Clidemia hirta* scrub - *C. hirta* dominates a few small areas on Silhouette, its cover is variable in density; some palms do grow through and there are small numbers of herbs at ground level.

In addition to these areas of *Memecylon floribundum* scrub occur on Mahe, as yet this

has not been introduced to Silhouette (Gerlach 1993).

5. Coastal forests
   a). Typical coastal forest (now reduced to a few small patches) - this is a mixed forest type with a range of Indo-pacific trees, *Calophyllum inophyllum* and *Terminalia catappa* being the most abundant. *Intsia bijuga, Hibiscus tiliaceus* and *Cocos nucifera* are present, and, formerly, *Mimusops sechellarum.*
   b). Seabird island coastal forest - on islands with large seabird nesting colonies (eg. Aride and Cousin) coastal forest is dominated by *Pisonia grandis, Ficus* spp. and *Euphorbia pyrifolia. Rothmannia annae* is now restricted to coastal forest on Aride (with a few planted trees on Mahe). Only very small patches of this habitat ever occurred on Silhouette, all of these appear to have been destroyed earlier this century.

6. Agricultural areas (excluding tree plantations) - these areas are characterised by open vegetation with abundant and diverse growth of weeds. Lowland agricultural areas contain a variety of crop plants and invasive weeds.

7. Lowland forest - this is a largely exotic habitat type occurring on the plateaux of all islands. The natural forest would have been the coastal forest type. In its present form this is replaced by generally derelict plantations. Proctor (1984) combined lowland and coastal habitats, the separation of the two proposed here is intended to allow a distinction to be made between natural 'coastal' habitat and the 'lowland' habitat that has replaced it in most areas. The lowland forest in its present form is comprised of plantations of *Cocos nucifera* (or *Casuarina equisetifolia* on other islands), the understorey is invaded by *Cinnamomum verum, Leucaena leucocephala* and *Lantana camara.*

8. Mid-altitude forest - Proctor (1984) combined all forest habitats except lowland or costal forest in 'moist forest habitat'. Mid-altitude, high-altitude and montane forest are separated in the system proposed here to draw attention to distinguishable types that are obscured in Proctor's system. There is considerable overlap of the habitats in these categories, all the constituent habitats appear to be easily recognisable on *Silhouette.*
   a). Natural intermediate forest - this is an intermediate habitat between coastal and high altitude forests. Several lowland tree species occur (notably *Calophyllum inophyllum*), but the increasing humidity and decreasing temperatures with altitude allow the occurrence of a variety of other species. The dominant tree species is *Dillenia ferruginea* and historically *Mimusops sechellarum* was abundant, this species is now uncommon, most large trees having been felled for timber. *Northea sechellana* rarely occurs in such forests. In drier areas *Diospyros seychellarum* and *Memecylon eleagni* may be abundant. Very little pure mid-altitude forest persists.
   b). *Cinnamomum verum* forest - plantations of this species have replaced the

natural intermediate forest on most islands. *C. verum* has also spread from the plantations. *C. verum* forest has less diversity than the forest it has replaced although most species persist as isolated plants.

c). *Psidium littorale* forest - this has invaded some areas, becoming the dominant forest tree in parts of Silhouette, floral diversity remains high in *P. littorale* forest on Silhouette (this is in marked contrast to the very low diversity of such habitat in the Mascarenes, Gueho 1988).

d). Tree plantations - plantations of several species exist such as *Hevea brasiliensis, Santoricum koetjape* and *Swietenia macrophylla*. These are all very low in diversity and have little understorey.

9. High-altitude forest - plantations were not established in this zone but invasion by *Cinnamomum verum* is extensive. The natural habitat resembles natural mid-altitude *Dillenia ferruginea* forest but the dominant tree species is *Northea sechellana*. *D. ferruginea* is an abundant forest constituent.

10. Palm forest - this occurs in both mid- and high-altitude zones, corresponding to Proctor's dry forest habitats of slopes and valleys (Proctor 1984). Virtually all large trees in this habitat are Palmaceae (*Nephrosperma vanhouettarum, Roscheria melanochaetes, Phoenicophorium borsigianum* and *Verschaffeltia spelendida*) or Pandanaceae (*Pandanus hornei* and *P. sechellarum*). There are a variety of epiphytes and herbs, although the covering of dead palm leaves limits non-arborescent forms. This habitat is reduced in area but where it survives it is virtually intact, with relatively little invasion by exotics. There is one area of palm forest on Silhouette dominated by the palm *Lodoicea maldivica*.

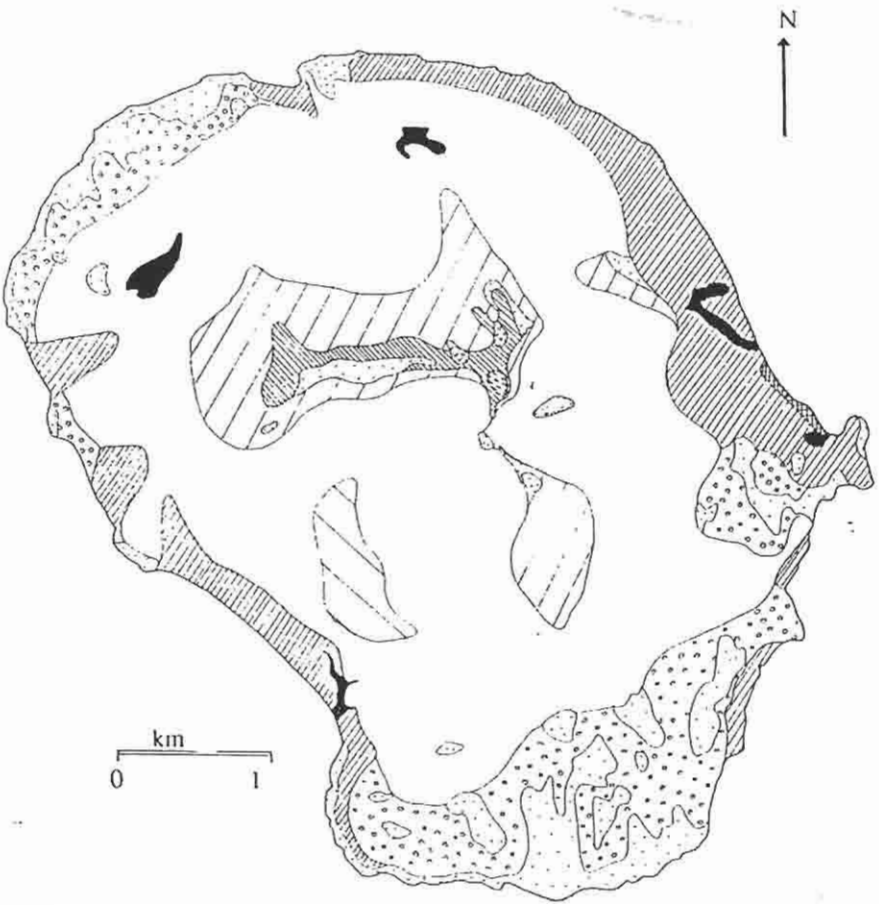
11. Montane forest - this is the most specialised habitat in Seychelles. It occurs in typical form only above 600m although local climatic conditions may result in the required extremely high levels of humidity occurring down to 500m in a few valleys.

a). Mossy montane forest - *Northea sechellana* remains abundant with the progression from high-altitude forest but is not dominant. At the lower limits of the habitat a variety of tree species may be abundant, including *N. sechellarum, Dillenia ferruginea* and *Gastonia* spp. At higher levels *Glionettia sericea* is dominant and is often the only abundant tree species where stunted individuals (2-3m high) grow on ridges. The high humidity allows the profusion of rare hygrophylic plants and epiphytic moss growth may reach over 1m in depth. The moss also carpets the rocky substrate. *Nepenthes pervillei* is common in this habitat.

b). *Pisonia sechellarum* forest - as with typical mossy montane forest this occurs in a zone of extremely high humidity. Suitable climatic conditions exist down to 500m in one valley on Silhouette where this very restricted (0.48 hectares in area) habitat occurs. The dominant tree species is *P. sechellarum, Ficus* spp. are common. The high levels of light at ground level result in an abundant ground flora with many localised species, especially abundant is the fern *Asplenium nidus*. 5 species of plant have not

been recorded outside the forest.

Map 1. Habitats of Silhouette



marsh
'glacis'
lowland forest
plantation
Dicranopteris scrub
Clidemia scrub

high-altitude forest
mid-altitude forest
palm forest (*Lodoicea*)
montane forest
Cyathea scrub
settlement (La Passe)

Status of selected native plant species

Some 66 of the 75 endemic plants of Seychelles have been recorded on Silhouette (Robertson 1989 and personal observations). This is a very high proportion of the Seychelles endemic flora, making Silhouette the most floristically diverse island of its size in the region as is shown by the comparative data in table 1. Of these *Justicia gardineri, Schefflera procumbens, Achyrospermum sechellarum, Carissa edulis* var. *sechellensis, Pisonia sechellarum, Psychotria silhouettae* and *Pseuderanthemum* aff. *tunicatum* are known only from Silhouette, with unidentified *Acacia* sp. and *Piper* sp. being possible endemics (the last 5 being restricted to one small boulder field 0.48 hectares in area). In addition Silhouette is one of only two islands to support *Seychellaria thomassetii* and *Nepenthes pervillei.*

8 of the recorded species appear to have become extinct on the island, these are *Impatiens gordonii, Soulamea terminaloides, Canthium carinatum, Rothmannia annae, Rapanea seychellarum, Coleus subfrutectosus* and *Bakerella clavata sechellensis.* Suitable habitat survives for the reintroduction of most of these species. The reasons for their extinctions are unknown but in the case of *Rothmannia annae* at least, it is most probable that clearance of all the larger lowland forests resulted in the loss of all trees. Many seedlings have been grown on Mahe and several of these should be available for replanting on Silhouette in the near future.

There is a small forest of *Lodoicea maldivica* at the source of the Grande Riviere. Although this is an unnatural forest type on Silhouette (having been planted in the 1950s, H. Dauban pers. comm.) it is of considerable interest as the only self-sustaining population of this palm outside of Praslin and Curieuse.

Table 1.

Island	Island area (km^2)	% Seychelles endemics	Endemics/area
Mahé	14.48	88	$4.56km^{-2}$
Praslin	4.04	40	$7.43km^{-2}$
Silhouette	1.60	88	$41.25km^{-2}$
La Digue	0.96	15	$11.46km^{-2}$

Conservation status of the island

The steepness of the island has prevented development of most areas above the coastal plateaux. Extensive areas of lowland forest were cleared in the early years of this century (H. Dauban pers. comm.) but the higher-forest regions have remained largely intact. The factors that protected these forests from agriculture and forestry in the 1920s and 30s still serve to prevent development of the island's interior. Although there has been some expansion of agriculture around La Passe it is unlikely that this will spread much beyond its current

boundaries. Degradation of Silhouette's ecosystems could come from two sources, tourism and invasion of habitats by introduced plants.

A large increase in the number of tourists visiting the island would cause damage if a significant proportion of them used the paths crossing over Jardin Marron. It is extremely unlikely that erosion on these paths will increase in the foreseeable future due primarily to the limited availability of tourist accommodation on the island. The concentration of the Silhouette Island Lodge Hotel on quiet, secluded holidays should help to safeguard against significant ecological damage being caused by tourism. The more sensitive paths such as along the ridge of Mt. Dauban are very susceptible to erosion but are fortunately too difficult to attract more than one or two visitors a year.

The most serious threat is posed by the ongoing process of vegetation replacement. Of the 270 plants presently recorded from Silhouette 104 are introduced species. Of these several have proved to be invasive on the island. Species that appear to be invading natural, or semi-natural, habitats but are presently uncommon or localised include *Cola nitida*, *Leucaena leucocephala*, *Chrysobalanus icaco*, *Syzigium carophyllus*, *Cinnamomum verum* (this species has invaded many habitats on other islands but is relatively insignificant on Silhouette), *Tabebuia pallida*, *Lantana camara*, *Hevea brasiliensis*, *Ananas comosus* and *Furcraea foetida*. Several species have spread widely over the island and dominate many areas, these are considered in more detail below:

Clidemia hirta

This species was recognised as a serious problem by the Oxford University Silhouette Expedition 1990. It dominates large areas and prevents natural regeneration through its dense foliage shading out seedlings. Its fruits are dispersed by birds and it spreads locally by shoots from creeping stems which attach to the ground by shallow surface roots. This allows it to grow on very shallow soils and germinate epiphytically. On Silhouette growth seems to be limited by light availability. It dominates areas where there is little shading caused by tree cover. Where trees occur but light penetrates, as on the summit of Mt. Dauban, it forms a dense undergrowth. It is distributed throughout Silhouette and its most important feature is that it will grow rapidly when a clearing is created by land-falls or tree-falls. Thus there is very little doubt that it will continue to spread. If unchecked there is no apparent reason why it should not eventually completely dominate the whole island. Its dispersal abilities mean that it will spread to other islands and continue the process. A survey in 1991 indicated that the problem was even more advanced than in 1990 and that complete eradication of *C. hirta* was impossible. Consideration of the alternatives leads to the conclusion that the only acceptable means of controlling the species is to uproot the main patches and to burn them in localised areas (Gerlach, 1993 in press).

Psidium littorale

This species is one of the most invasive plant species on Mauritius where it dominates forest habitat, excluding most other plants (Gueho 1988) and providing poor habitat for indigenous animals. The spread of this species may be facilitated by the presence of large, highly mobile dispersers such as monkeys and pigs. In the absence of these it appears to spread less rapidly and on Silhouette, although abundant, *P. littorale* forest does not seem to be spreading at a great rate. Observational records indicate that there is a relatively high

speci sity in *P. littorale* invaded areas and that indigenous plants persist. These forests shoul d dive nitored in the light of the potential threat this species poses.
be m itat restoration would primarily comprise planting and maintaining indigenous tree sapli Hat tting of established *P. littorale* trees or saplings would not be beneficial due to the h s. C nerative capability of this species, the resultant coppiced stands would probably creat h reg shade and occupy more space than the current growth forms, this would represent a mo tense ded habitat than presently occurs.
e degr

Para es falcataria

eriant characteristic large, flat topped trees are the distinctive feature of the island. The
The
speci reputation for being a highly invasive species. Whilst its invasive capabilities
s has
are n ubt it is certain that the significance of the threat it poses has been overstated.
ot in d
This view i confirmed by the forests of Silhouette which maintain a high diversity and
abund indigenous trees despite the apparent dominance of *P. falcataria*. The extremely
ance o
open nature of the canopy of these trees results in the shading effects of the foliage being
negligible. The trunks and roots do occupy a very large area and thus do compete for space
with other s ecies but this is rarely considered a major ecological limitation. On this basis
immediate c ntrol of this species is not a priority. As an abundant exotic species it would be
desirable to r educe its abundance. Felling the large trees would be excessively destructive with
extensive da nage caused to adjacent trees, it would be advisable to use a more gradual process
of ring-barki g selected trees, which would also reduce the problems of the rapid regeneration
of the specie s in clearings caused by felling. This form of management has recently been
initiated to re move some of the trees around the Grande Riviere in order to protect the water
supply of La Passe. The current management of Silhouette perceive the presumed high water
requirements of these large trees as a threat to the limited water flow in the Grande Riviere
(Revere pers. comm.).

Syzygium jar bos

Den se stands of this species do occur in small areas, the most apparent one being on
the west side just below the top ridge of Jardin Marron. There are no quantified data on the
diversity of *S. jambos* dominated habitat, the small areas concerned make observational
evide ce of doubtful value but it is worth recording that some indigenous species do occur but
that abundan ce appears to be very low, probably because of the very dense shade cast by the
low *S. jambo s* canopy at about 4-5m above the ground.

Ma agement of these habitats is unlikely to achieve complete eradication of the stands
due to the h igh regenerative ability of the species. The aim of management of *S. jambos*
should be to increase the abundance of indigenous species through planting, especially of taller
forest tree sp ecies which would eventually produce a canopy above the *S. jambos* canopy and
thus shade out the stands, causing a decrease in the density of *S. jambos* in the areas
conce ned.

Tabe ia pa lida

An area of *T. pallida* forest exists above Grande Barbe. This open forest appears to
low d
have iversity, it is not clear if this is a natural feature of the area or a consequence of
T. pa lida d minance. The excellent dispersal abilities of this species make it a potentially

serious invader. It does not tend to dominate large areas on other islands so is probably not an immediate threat. The small forest should be gradually replaced by planting indigenous species between existing trees and selectively removing the *T. pallida* when appropriate.

Hevea brasiliensis

The plantation of this species above La Passe is of no commercial value and is not utilised. It represents a very unnatural habitat with very little ground vegetation growing through the thick carpet of dead leaves. In the dry area in which it occurs this plantation may be a fire risk. Additionally the explosive dispersal mechanism of the seeds means that the presently small plantation is capable of rapid expansion. As for *T. pallida* the diversity of the area should be increased and the abundance of *H. brasilienis* gradually reduced.

Artocarpus heterophyllus

Although very abundant and widely dispersed the effects of this species are not clear. It is obviously a major component of the diet of fruit bats and as such may be of importance in the maintenance of Silhouette's large population of the species. The seeds and fruit are very frequently consumed by rats, its role in the rats' diet may be serving to reduce pressures on large seeded indigenous trees, such as *Northea sechellana* which appear to seed and germinate more frequently on Silhouette than on other islands. It is important that the diet of rats be determined to provide information on which plant species are suffering high levels of seed predation, whether any resident bird species are under threat and to determine if reducing the abundance of *Artocarpus heterophyllus* would lead to an undesirable increase in seed predation on other species.

The control of invasive introduced plants on Silhouette is the most important step that can be taken to preserve the ecosystems of the island. As the most natural and diverse of the granitic islands of Seychelles the preservation of Silhouette should be considered a high priority in the maintenance of biodiversity in the western Indian Ocean region. If the threats posed by these species can be minimised (through the implementation of at least some of the measures suggested above) the rare endemic plants and animals of Silhouette should not be at any serious risk of extinction. The security of this important island would be enhanced if the legal protection given to the off-shore zone around Silhouette were extended to cover the terrestrial environment. Whilst the current management practices do not endanger the currently existing habitats official legal protection would help to ensure their long term survival. It should be emphasised that protection of the forests of Silhouette would not conflict with the management practices currently being used by the Island Development Company on Silhouette.

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