TWENTY-FOUR RIVERS

A basic vegetation survey

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Introduction and study area

The perennial Twenty-four Rivers system, which is fed by the Groot and Kleinkliphuis Rivers, drains the extensive high-elevation plateau of the Grootwinterhoek Wilderness Area, managed by Cape Nature. As well as a home to unique and species rich mountain fynbos, these uplands are an important water catchment area, directly supplying water for lowland agriculture in the vicinity of Saron, to the east of the Groot and Kleinwinterhoek mountains (Fig. 1). In addition, since the institution of a canal system in 1971, the Twenty-four Rivers system supplies Voëlvlei Dam to the south with yearly flows, including 100% of summer flows. Voëlvlei in turn supplies surrounding towns such as Riebeek-Kasteel, Riebeek-Wes, Morreesburg, Malmesbury, Darling and even Cape Town, as well as farms along these supply routes. The critical importance of the Twenty-four Rivers system is therefore underscored by the natural systems and number of people that rely on this mountain water. Regular monitoring of the state of health of the upper sections of the Twenty-four Rivers system is therefore necessary to ensure the continued supply of water of a high standard. This monitoring is especially important in light of projected warming and drying in the region and the ever growing agricultural and urban demand for water.

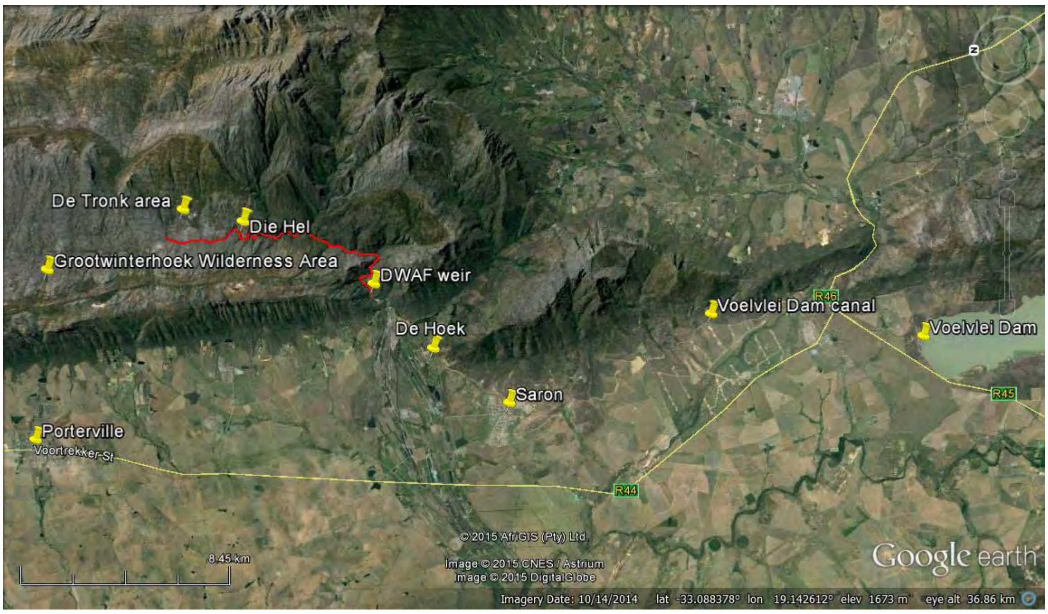

Figure 1. The surveyed section of the Twenty-four Rivers system is highlighted in red. Other areas or points of interest are shown as yellow pins. The map is oriented due east.

Objectives

Our aim was to conduct a basic survey of the riverine vegetation of the Twenty-four Rivers, commencing at the cement bridge crossing the Kleinkliphuis River to the NW of De Tronk and terminating at the Department of Water Affair and Forestry weir at the eastern end of the farm De Hoek (Fig. 2). The survey would include a cumulative list of all observed species, as well as an assessment of relative dominance of the most abundant species. Special consideration was given to the abundance of Palmiet (*Prionium serratum*) as a proxy for force of flow and accumulation of sediment, as well as occurrence of alien species. Accompanying these observations would be a series of repeatable panoramic photographs documenting the current state (composition and density) of riverine vegetation.

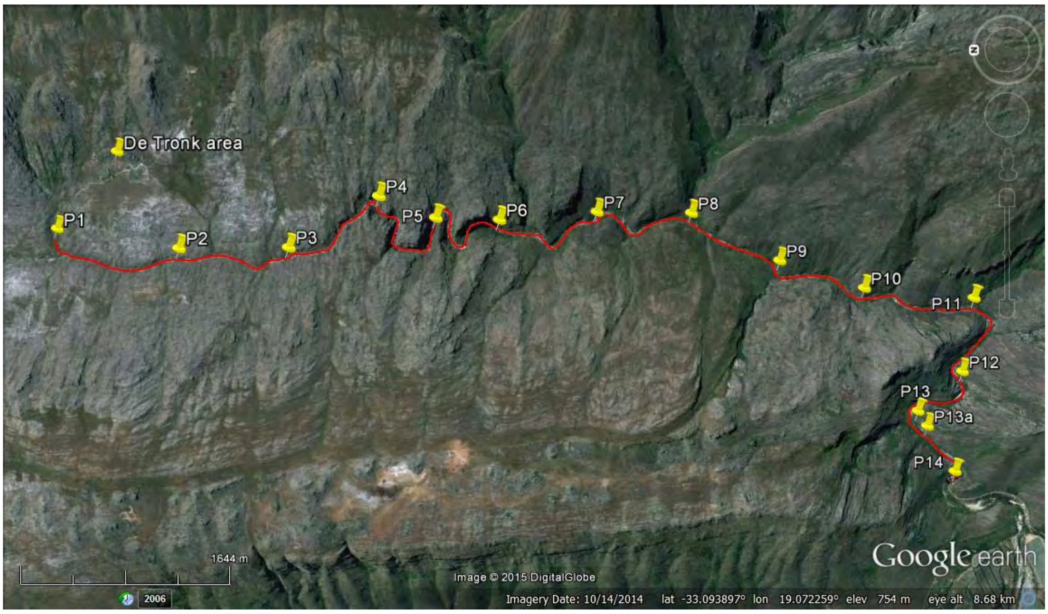

Figure 2. Surveyed section of Twenty-four Rivers indicating sampling stations at 1 km intervals.

Methods

The study was carried out between the 23rd and 25th March, 2015, during which time we hiked down the length of the Twenty-four Rivers. We marked our position at 1 km intervals (with the aid of a handheld Garmin GPSmap 60CSx), usually situated on an elevated rocky platform within the river channel, but sometime high up on the bank when vegetation was too dense/no suitable rock could be found. At each station we considered which three non-aquatic riverine species had been most dominant during the preceding kilometre. The most dominant species was then assigned a score of 1 and the ratio of the second and third dominant species (relative to the most dominant) was estimated. Abundance of Palmiet and area of burnt slope visible from the river channel was scored out of 5 for the preceding kilometre (1 = rare/very small; 5 = extremely abundant/extensive).

A pan-tilt tripod with a spirit level built into the tripod head was set up on the rock platform at the specified GPS location (Fig.3). The tripod legs were adjusted such that the head was as level as possible. A Nikon AW100 waterproof camera was mounted to the tripod using a square mounting plate and positioned facing up the river channel. The height from the rock at the centre of the tripod to the middle of the lens was recorded such that this height could be replicated in future. A central, left (rotated -30^o) and right (rotated +30^o) shot were taken (re-levelling after each rotation), after which the camera was rotated to face downstream, where the same procedure was duplicated. If more information could be gathered by tilting the camera up/down or continuing to rotate sideways at 30^o increments (+ re-levelling), then this was done. A photograph(s) of the tripod location was then taken in order to aid accurate repositioning of the tripod in future. A checklist of species was maintained between recording stations and, where possible, photographs of distinguishing characteristics taken. Individual photographs of the view up-river or down-river at each station were stitched together using the Photomerge function in Adobe Photoshop CS5. Unknown species were placed on Ispot (http://www.ispotnature.org/communities/southern-africa) for identification.

Figure 3. Tripod positioned on rocky platform. Tripod legs are set such that tripod head is as level as possible.

Results

The vertical profile of the Twenty-four Rivers suggested distinctive upper and lower sections with different channel and flow characteristics (Fig. 4). The upper section fell between the cement bridge crossing the Kleinkliphuis River and station 7, while the lower section ran from station 7 to the weir wall at station 14. (Please note, however, that the in-channel value for station 13 was used as the lowest elevation as station 14 was located on top of the weir wall). The upper channel was much steeper than the lower channel, dropping (on average) over 3 times as quickly at over 57 m per kilometre. It was characterised by very large boulders, visible bedrock, pot-holing, and a general absence of vegetation within the channel (Fig. 5a). The lower section was much less steep, more open and vegetated, with broader banks and often a braided channel (Fig. 5b). Rocks were much smaller too, and sediment had accumulated on the lee of rocks in the channel and formed islands on which vegetation (such as Palmiet) had taken hold.

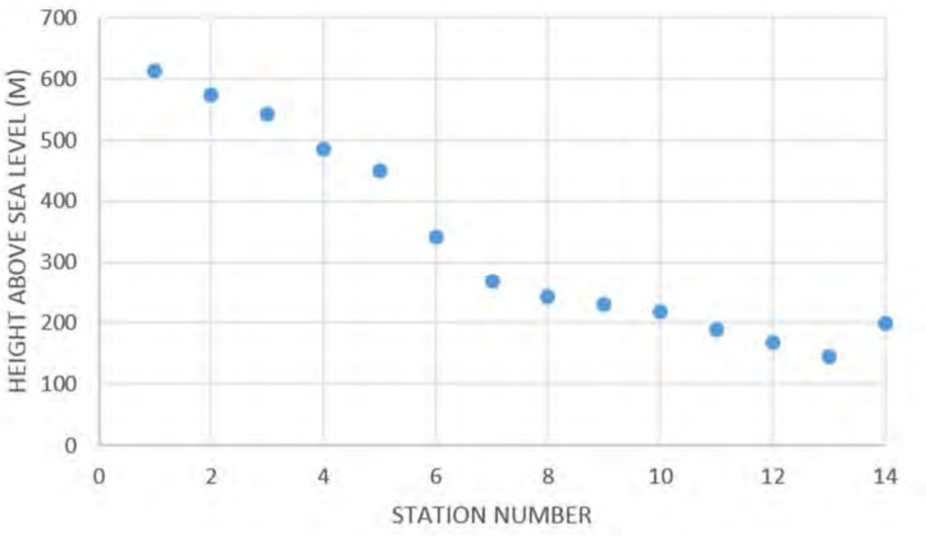

Figure 4. Vertical profile of the Twenty-four Rivers for the section studied.

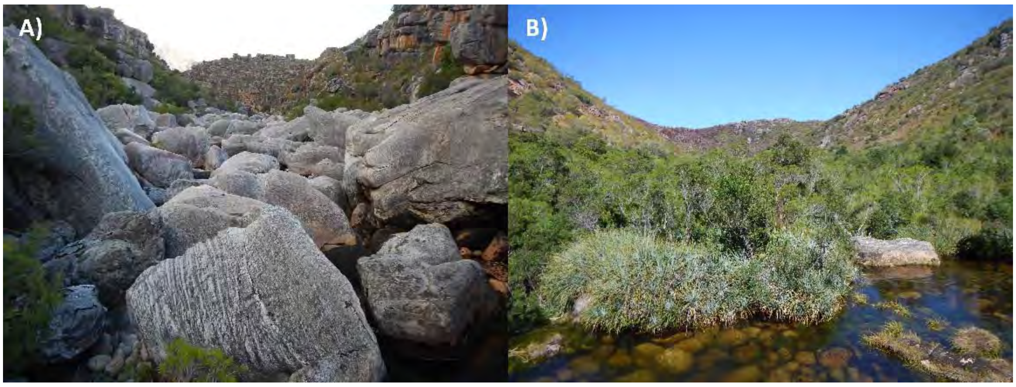

Figure 5. Typical upper (A) and lower (B) views of the Twenty-four Rivers, showing difference in channel characteristics.

A total of 31 different species were recorded, representing 22 different families (Table 1). It must be stressed that this is not a comprehensive list, but is likely to be representative of the most abundant species occurring within the river channel.

Table 1. Species list for the studied section of the Twenty-four Rivers.

Family	Genus	Species	Common name
Myrtaceae	Metrosideros	angustifolia	Cape gum/Smalblad
Asteraceae	Brachylaena	neriifolia	Waterwitels
Celastraceae	Maytenus	acuminata	Sybas
Myricaceae	Morella	integra	False-lance leaf waxberry
Anacardiaceae	Heeria	argentea	Kliphout
Thurniaceae	Prionium	serratum	Palmiet
Ebenaceae	Diospiros	cf. glabra	Bloubessiebos
Podocarpaceae	Podocarpus	elongatus	Breeriviergeelhout
Oleaceae	Olea	capensis subsp. capensis	Bastard ironwood
Cunoniaceae	Platylophus	trifoliatus	Witels
Cunoniaceae	Cunonia	capensis	Rooiels
Rutaceae	Agathosma	sp.	Liquorice buchu
Bruniaceae	Brunia	africana	River blacktip
Ericaceae	Erica	caffra subsp. caffra	Water heath
Pinaceae	Pinus	sp.	Pine tree
Proteaceae	Brabejum	stellatifolium	Wild almond
Stilbaceae	Ixianthes	retzioides	River bells
Aquifoliaceae	Ilex	mitis	Cape holly
Stilbaceae	Halleria	cf. elliptica	Tree fuschia
Fabaceae	Acacia	mearnsii	Black wattle
Restionaceae	Elegia	capensis	Fonteinriet
Restionaceae	Cannamois	cf. grandis	Bell reed
Blechnaceae	Blechnum	cf. tabulare	Mountain deer fern
Proteaceae	Leucadendron	salicifolium	Common stream conebush
Poaceae	Pennisetum	macrourum	Riverbed grass
Anacardiaceae	Searsia	angustifolia	Wilgerkorentebos
Salicaceae	Salix	mucronata subsp. mucronata	Cape willow
Anacardiaceae	Searsia	sp.	NA
Celastraceae	Maytenus	oleoides	Klipkershout
Ericaceae	Erica	distorta	NA
Celastraceae	Cassine	shinoides	Ladlewood
Asteraceae	Euryops	serra	Langbeenharpuis

Despite physical differences between upper and lower sections of the river, *Metrosideros angustifolia* was the overwhelmingly dominant riverine species throughout the studied section of the Twenty-four Rivers (Fig. 6). In all but one of the 1 km sections of river it emerged as the primary dominant species. In addition, when the ratio of the second and third most dominant species was averaged across all thirteen 1 km sections of river, the relative abundance of these categories (compared to the primary dominant) came in very low at a ratio of 0.32 and 0.15, respectively. The difference between second and third most dominant was generally much smaller. The composition of species making up the second most dominant position was also more varied (6 species). However, within the middle and lower half of the studied section, *Morella integra* was consistently second most dominant, with the exception of a single 1 km section occupied by *Brachylaena neriifolia*. The third most dominant category was again split between more species (7), although *B. neriifolia* occupied third place the greatest number of times (6/13).

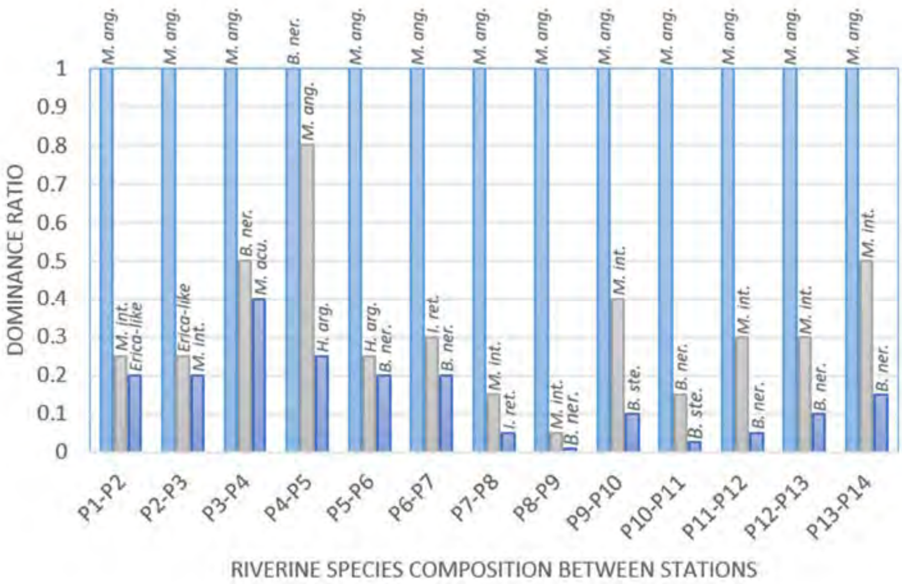

Figure 6. Graph indicating primary dominance of* M. angustifolia *and the degree to which second and third most dominant make up only a minor component of the vegetation.

Palmiet was relatively less abundant and followed first a declining trend in the upper section of the river, and then relatively more abundant and increasing in the lower section (Fig. 7a). The reason for the initial Palmiet abundance (within the first two studied sections of river) was likely due to initiating our recording effort in the slightly smaller Kleinkliphuis River, as well as the slightly gentler profile for these initial sections (remembering that the initial height was somewhat elevated as it was recorded on top of the cement bridge crossing the Kleinkliphuis River). Palmiet abundance was clearly well correlated to the vertical profile of the river in the sense that a steeper channel equated to less Palmiet, while a gentler channel meant more Palmiet (R^2=0.63) (Fig. 7b).

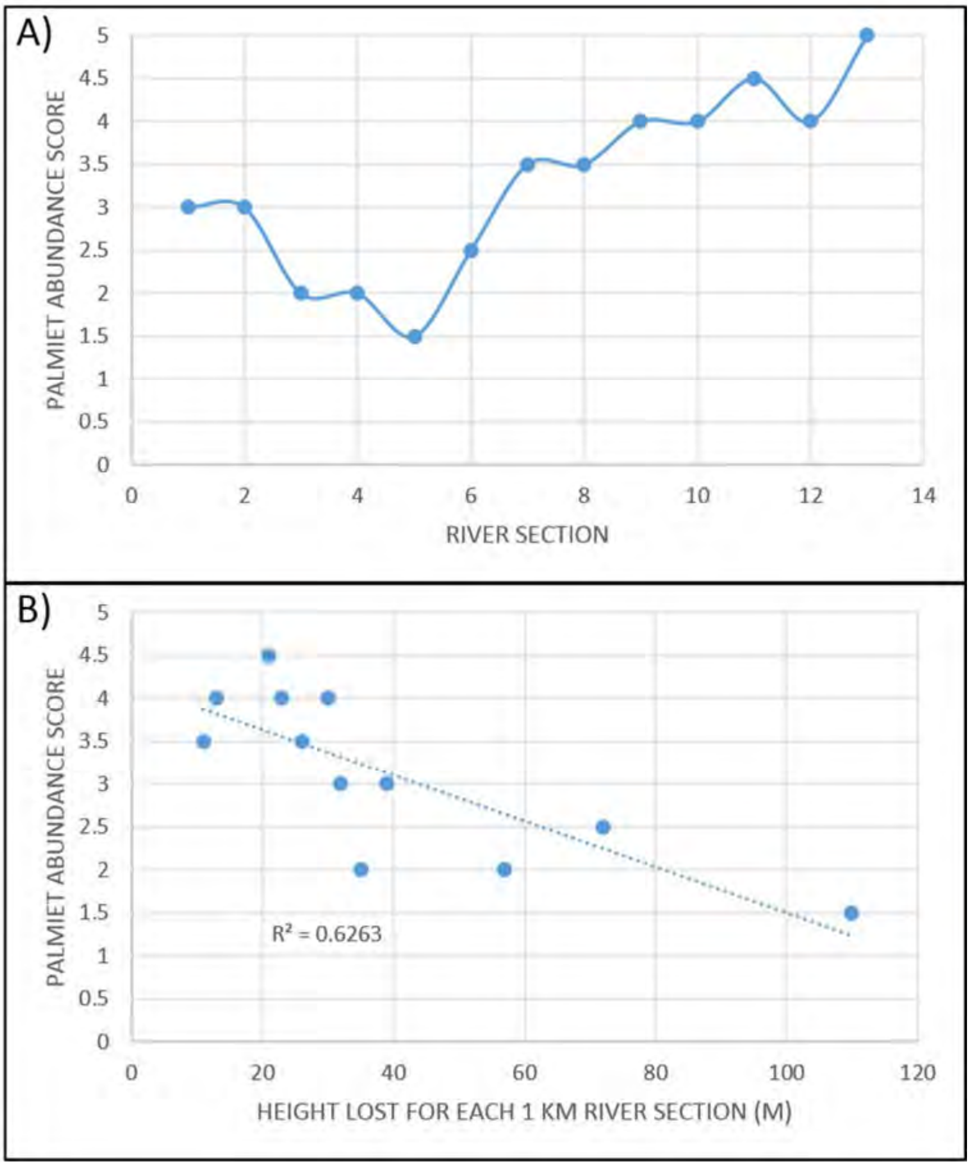

Figure 7. Graph A illustrating relative changes in Palmiet abundance for the studied section of the Twenty-four Rivers, and B showing the correlating between channel steepness and Palmiet abundance.

Exotic species were notably absent for most of the studied section of river, but where present as single individuals (*Pinus sp.*) or discrete clumps (*Acacia mearnsii*). A single *Pinus* individual was recorded between P2 and P3 (i.e. within the 2nd km) on river-right. At appeared to be reproductively mature. A clump of *A. mearnsii* were observed on river-left between P8 and P9 (8th km) and P11 and P12 (11th km). Several mature adults were present, as well as seedlings. A recent fire (earlier in the same year as this report) had burnt mainly the southern (river-left) slopes leading right down to the river for sections P9 to P14. As much as 50% of slope area visible from the river was burnt.

Panoramic photographs were taken at each station (facing up-river and down-river) and stitched together (Fig. 8a & b). This photographic collection represents a March 2015 (i.e. end of summer) vegetation baseline for the Twenty-four Rivers system. Repeating this series of photographs in the future will allow both direct assessments of change (e.g. shifts in dominant species, thickening or thinning vegetation, growth rates, exotic plant species abundance) and indirect assessments (e.g. changes in flow rates, nutrient loading, fires and consequently higher sediment inputs after rain, etc.).

Figure 8. An example of a stitched panoramic view up-river (A) and downriver (B). These particular views were from Station 3 on the upper portion of the Twenty-four Rivers.

Discussion and suggested management interventions

The general impression of the studied section of the Twenty-four Rivers was of a natural and healthy river system, almost entirely free of exotic species and with a high water quality (as judged by water clarity, aquatic flora, presence of fish, amphibians and invertebrates).

The upper section of the river was clearly subject to more powerful flows and frequent scouring, while the lower section was more depositional in nature. The classification of the river into an upper and lower section was well corroborated by the relative abundance (and trend of decrease /increase) of Palmiet and suggested that this species might serve as a useful proxy for energy or flow-force. As such, *changes* in Palmiet abundance might also prove to be a useful natural indicator of a *changing flow regime*. Changes in flow could be caused by factors such as changing rainfall, temperature, surface or groundwater abstraction or damming, changes in nutrient loading, grazing and fire frequency. Changing Palmiet densities could be used as an early warning sign of the changes listed above impacting on the riverine ecosystem. In order to be useful, however, absolute densities of Palmiet would need to be established at various points along the river of interest, and coupled to accurate rates of flow. An advantage of using Palmiet in this manner is its ubiquity in Cape river systems, which might provide scope for inter-river comparisons. In addition, Palmiet is likely to be relatively easy to differentiate from other riverine vegetation when identifying through remote sensing means such as high resolution aerial photography, as it is a distinctive grey-green colour and has tightly packed foliage.

While the dominance of *M. angustifolia* seems to be a natural condition and should not be flagged as an imbalance, it might be worth instituting monitoring to track any further increase/densification of this species. While *M. angustifolia* is indigenous, it is unusual in being the only example from its genus that is found in South Africa (the remainder being located on islands of the Pacific Ocean). While *M. angustifolia* is commonly found in river valleys where moister conditions prevail, its dominance within the Twenty-four Rivers system might (at a stretch) be due to factors such as an altered fire regime and/or altered grazing pressure. What is reassuring is that, despite its dominance, many species are able to co-occur with *M. angustifolia*, as can be seen from the biodiverse species list. In addition, the second and third dominant riverine groups contained numerous co-occurring species at lower densities than *M. angustifolia.* Notable among them was *M. integra*, which seemed to favour the gentler gradient of the lower reaches of the river, and *B. neriifolia* which occurred throughout.

A single *Pinus* individual and two clumps of *A. mearnsii* were the only observed exotic species within the studied section of the river valley. This was surprising since the situation is very different a short distance downstream of the Department of Water Affairs and Forestry weir and all along the lower course of the Twenty-four Rivers as it fans out on the lowlands. That section of the river is heavily infested with mature *A. mearnsii*, *Eucalyptus*, *Pinus* and other exotics. It is strongly recommended that the isolated exotics along the studied section are removed immediately while they pose little threat of spreading. Follow-up monitoring should be instituted for at least 2 seasons subsequent to removal and regular yearly monitoring of the lower reaches should be established to ensure that ingress of exotics does not occur from the weir upriver. The effectiveness of dealing with isolated patches of exotic trees before they spread their seed is well established and should spur management into swift action on the above measures.

In conclusion, a river system in good health with little intervention needed at this time, save for the removal of isolated exotic species. A more regular monitoring programme should be considered to help maintain the system in its current state.

Appendix to report

1) GIS folder containing
    a. GDB file to upload station points onto GARMIN device.
    b. Google Earth KML file.
2) Graphs folder containing
    a. Graphs as PNG files.
    b. PPTX document with graphs.
3) Images folder containing images used in report as JPEG files.
4) Photographs folder containing
    a. Subfolders from each site/station (1-14) including individual photographs up-river and downriver, tripod shot(s) and stitches panoramas.
    b. A species folder containing all photos taken of riverine species. Where possible, photo numbers were linked to species names in the XLSX file listed below.
5) An XLSX file containing the raw data from which the results were compiled.
6) This report as a DOCX document.