Plant Protection Research Institute / Navorsingsinstituut vir Plantbeskerming
Private Bag X5017 / **Privaatsak** X5017**,** *Stellenbosch 7599 R S A*
Vredenburg Research Centre / Vredenburg Navorsingsentrum
Polkadraai Road / **Polkadraaiwe**g, ***Stellenbosch 7600 R S A***
Tel: (021) 887 4690 (Int: +27 21) Fax: (021) 883 3285 (Int: +27 21)
E-Mail: *vredma@plant3.agric.za*
Web site: **www.arc.agric.za**

CONSULTANTS cc.[2002/066636/23]
38 Rhodes Avenue [South],
Stellenbosch, 7600, South Africa
Tel/Fax : 27 (0) 21 88 66 826
Cellular : 27 (0) 82 95 09 294
E-Mail : wek@iafrica.com
Website : http://www.agri-africa.co.za

An assessment of the impact on the Bee and Agricultural industries in the Western Cape of the clearing of certain Eucalyptus species using questionnaire survey data.

Mike Allsopp & Michael Cherry
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Final Report

EXECUTIVE SUMMARY

BACKGROUND

This report is the result of a joint commissioning of the Agricultural Research Council (ARC) and Agri-Africa consultants by the Working for Water Programme (WFW) and the South African Bee Industry Organisation (SABIO) to examine the impact of Eucalypt removal on the bee and pollination-dependant industries of the Western Cape.

The report starts by outlining the background to the impasse which had developed between the beekeeping fraternity and the Working for Water Programme as a result of the latter's intention to remove certain gums from the South African landscape and the formers' resistance to such removal on account of the importance of gums as a forage source for their bees. The gums in question are listed by category of environmental destructiveness in the Conservation of Agricultural Resources Act (CARA) and include seven species. One, *Eucalyptus lehmanni* or Spider Gum ('most destructive' category on the list), is regarded as sufficiently damaging to the environment to warrant its unconditional removal. The others, which include *Eucalyptus cladocalyx* or Sugar Gum, a major nectar source, may be retained in a non-sensitive ecosystem under permit ('demarcation') provided that the landowner assumes full responsibility for any environmental damage (invasion, fire, water removal) that could be caused by the trees.

The beekeepers' argument against the current policy stems from the view that the environmental benefits of gum removal do not match up to the disadvantage of the potential destruction of the bee population and the concomitant impact on the production of the most important industry dependent on bees, the deciduous fruit industry. They are concerned that most of the gum sites they use for foraging are not under their own control and that the landowners on whose properties the bees are sited would not be willing to be burdened by the responsibilities implied by demarcation. Whilst accepting that under certain landscapes and with certain species, gums are destructive of the environment, the beekeepers argue that this effect has been overstated.

METHODOLOGY

The methodology employed to determine the extent of the importance of the CARA listed gums to the beekeeping industry and at the same time gain some valuable insight into the perspectives of the beekeepers was to conduct a survey of beekeeping in the Western Cape by way of a posted questionnaire. After considerable and extended debate by the various role-players the questionnaire (appended to the report) was finally formulated to the satisfaction of the client parties, WFW and SABIO, and distributed to all available addresses of beekeepers, although not before a public dissemination programme had been undertaken prevailing on beekeepers to respond (or if unlisted to enlist). The address lists (extremely outdated, several beekeepers having died or lost interest in beekeeping in the interim) were supplemented by additional contact information from SABIO plus a very few 'unlisted beekeepers' requesting to be sent a questionnaire. In the final analysis it was felt that the great majority of beekeepers had received the questionnaire.

The degree of response and proportion of the response is discussed at some length in the report, as is the process of response validation, the latter being based on a physical inspection of ten per cent of each of three strata, according to size, into which the respondents were layered. In general, notwithstanding the dearth of information on the current size and makeup of the total beekeeper population, the consultants were able to conclude that *not less* than 20% of all beekeepers had responded. Subsequent analysis of the number of colonies showed the total number of colonies covered in the response *to be greater than or equal* to previous estimates of the total size of the managed honeybee population in the Western Cape. Back-calculating from pollination data and after due consideration, the consultants believed that about 80% of the

colonies are covered by the response and about 60% of beekeepers. Most of the non-respondents are believed to be small beekeepers with a minimal contribution to the industry as a whole.

Finally, the post-response validation exercise referred to, indicated that the questionnaire was in general conscientiously and accurately answered with the only notable misinterpretations being in some of the definitions of the environmental 'landscapes'. These resulted in some overstatement of the quantum of eco-sensitive landscapes.

SURVEY RESULTS

The survey results yielded some very useful information which is divided in the report into two subsections – 'quantitative' and 'qualitative'.

Quantitative profile

The quantitative information is intended to provide a collective profile of the beekeepers and how the industry is comprised. It is based upon estimates made by the beekeepers (like estimating honey produced from competing nectar sources) and is dependant on the familiarity of the beekeepers with their operations. An analysis of these estimates, however, including linkages between business characteristics (e.g. size of business with number of pollinations) shows consistency in its trends and expectations and is believed to produce outcomes of acceptable reliability. The pertinent quantitative findings regarding the response sample are the following:-

- The large commercial beekeepers (greater than 250 colonies) are 25% in number but own 75% of the colonies.

- Seventy six per cent of all 'colony months' spent on different sites are spent on gums, with 74% spent on CARA gums.

- Two thirds (66%) of all honey produced was produced on gums.

- Of the honey produced on gums two thirds is produced on Sugar Gum and about one fifth on Spider and Red River (watercourse) gums.

- Almost 60% of gums exist on land which is environmentally neutral – i.e. areas which are not riverine, nor mountain catchment, nor nature reserve, nor fire sensitive.

- The large beekeepers (75% of colonies) own only 7% of their gum sites, and where gum sites are not owned, the land-use agreements are mainly informal (58%) requiring payment in honey.

- Almost 87% of the colonies in the survey sample are from beekeepers that do pollination; each year about 50 000 pollinations are carried out at an average of 1.7 pollinations per colony.

- The main pollination requirement is in the Grabouw area where over 21 000 pollinations are carried out by the respondents, compared to over 12 000 and 9 000 respectively for the second and third largest pollination areas, Ceres and the Boland.

- The beekeepers' estimate of degree of negative impact of gum removal (scored out of ten showing 'small' beekeeper versus 'large' beekeeper) is: honey production - 5.8 vs 8.5; colony increases - 3.6 vs 5.9; colony build up - 4.0 vs 6.8. This illustrates the

increasing importance of gums as the size of the operation increases and illustrates differences in certain specific advantages assigned to gums.

- The bee industry employs permanently or seasonally in the ratio of 77 hives to one person employed.

In the body of the report all are discussed with other findings in the context of the study and appropriate conclusions drawn.

Qualitative profile

A few pertinent comments are required here on the responses of the beekeepers as to the likely effect of gum removal on their operations as well as some of the areas of responsibility and issues of strategy in the context of gum management.

On the matter of who should 1) be responsible for providing forage generally, and 2) responsible for replacing forage removed by WFW, the response in the former is 'all role players' in varying degrees, and in the latter, almost entirely 'government'. Not an unsurprising response in view of the origin of the CARA legislation and current gum removal policy.

As to whether beekeepers should be given special dispensation compared, say, to forestry which may not plant trees in environmentally sensitive areas, or nurseries who may not sell CARA-listed trees, the answers were inconclusive and of no particular value. Reasons supporting the special dispensation lobby were mainly to do with the value of the bee industry, especially in respect of the pollination of fruit.

Seeking views on who should carry responsibility for environmental degradation by way of water wastage, invasiveness and fire damage, the beekeepers identified the landowner as having to carry the most responsibility, although the government and beekeeper fraternity would have to accept a fair portion. In respect of water conservation, in particular, the government was seen to carry almost as big a share of responsibility as the landowner.

When asked whether the owners of bee sites situated in gums would be willing to demarcate the respondents indicated as many as two thirds would. Strategically speaking this is an interesting finding.

Of importance among the qualitative questions are those regarding the potential impact, business-wise, of gum removal. The information was garnered from similarly phrased questions seeking the impact of the removal of two classes of gums, namely all CARA gums and only the environmentally ''' gums (consisting mainly of Spider Gum and River Red Gum). In the first part, the beekeeper was asked to provide a 'percentage loss' (business reduction) should the removal policy be carried out and in the second to proffer realistic outcome scenarios. The results, discussed in greater detail in the report, are markedly different for the two gum classes. The average all-round loss if all CARA gums (containing 77% Sugar Gum measured in terms of colony-months) are removed is 66%, while it is 42% if only the 'extremely eco-sensitive'[1] gums are removed. The scenarios predicted by the beekeepers are consistent with this finding. For instance looking at the edges of the 'likely outcome' spectrum, with CARA gum removal, 55 businesses would close and 24 would be unharmed; with extremely eco-sensitive gum removal, 9 would close and 47 would be unharmed. This poses enormously important strategic issues.

[1] The term 'extremely (or highly) eco-sensitive' is applied to all gums on the Category 1 CARA list and gums which are on river courses and mountain catchments.

The penultimate question has to do with strategic adjustment. Given three time frames, 1 year, 5 years, and 10 years, beekeepers are asked to indicate how they will adjust to CARA gum removal. In general, the answers are in keeping with the same gloomy scenarios the beekeepers provided earlier. It is of significance that, given a ten-year programme, substantially more beekeepers believe they will survive, and (it would seem) believe this could be done with the development of alternative forage.

The last question on the questionnaire, seeking ways of collaboration with WFW, provided amongst other things an opportunity for beekeepers to make a political statement. Overwhelmingly the response confirms a wish for beekeepers to work together with Working for Water in some, as yet, undefined way.

DISCUSSION

To develop a sense of perspective the report opens its 'Discussion' section on the impact issue by reviewing the situation with respect to gum removal in the context of the role that gums play in the environment. Against the background of various articles written on the subject and the consultants' own observations during the validation process, the status of knowledge on the subject is evaluated, especially with respect to the issue of invasiveness and the specific conditions promoting invasion. It is concluded that some of the information is conflicting and requires further study, most specifically geared to Sugar Gum because of its importance to the commercial and wild bee populations.

The greater part of the 'discussion' section is devoted to the economic consequences of gum removal. Two approaches are adopted here. The first seeks to calculate an amount which is based on a 'total cut-off' cost based on the assumption that removal of the gums means removal of those bees affected, which, in turn, means loss of honey, loss of pollination revenue and, most importantly, loss of that portion of the crop which the gum-based bees pollinate. This is the methodology often used to calculate the contribution which bees offer to economic sub-systems. The method assumes there is no way whereby the industries involved can adjust to changed circumstances. Using this method (described in more detail in the text) the calculation of value lost under 'CARA listed' gum removal alternative is R1863 million of which R1834 is fruit production lost. Under the 'extremely eco-sensitive gums only' removal, R1177 million is lost, of which R1166 is fruit production. The problem with the 'total cut-off' approach lies in its assumption that no adjustment is possible; in the real world of entrepreneurial behaviour some adaptation seems more likely.

The second approach, 'realistic outcome', tries to predict a scenario for change. Here it is assumed that some form of artificial maintenance of the colonies is undertaken to be able to continue with (at least) pollination. This strategy will result in higher costs and the loss of gum-based honey, which it is assumed will be borne by the fruit growers whose risk in absolute terms is so very much higher. Notwithstanding the artificial means of bee maintenance proposed, the consultants believe that the pollination of fruit trees will still be seriously curtailed for reasons that the bee population will become weaker and substantially less in numbers, as will the wild bees from which genetic material is replenished. What the effect of diminished pollination will have is difficult to say but a reasoned estimate puts it at 10% of the crops actually pollinated[2]. Under these conditions the value lost would be R113 million for CARA gums of which R99 million is for fruit production lost and the balance (R14.4 million) is for added pollination fees (twice the existing fee) to cover the 'artificial' compensating strategy. Similar figures for extremely eco-sensitive gums are respectively R67 million and R63 million with R3.9 million added fees, an increase of 25%.

[2] Defined here as being crops which are pollinated by commercial bees - many orchards in the Koue-Bokkeveld area for instance (estimated at 45%) are currently not being pollinated by commercial bees (see page 41).

Two interesting points emerge from this 'realistic outcomes' methodology. Firstly, there is a substantially greater cost should all CARA gums be removed, compared to if only extremely eco-sensitive gums are removed. The compensating pollination fees for the former would have to be four times the level of the latter. Moreover, the potential fruit losses from curtailed pollination are double in the case of all CARA gums compared to gums. This factor must be seen in conjunction with the available information on invasiveness between the two classes of gums, as there is some doubt on the extent of destructive potential of Sugar Gum on the environment. Secondly, the likely scenario is that the fruit farmers will probably ultimately carry the cost of the removal of gums. This is because when faced with the reality of virtually no pollination they will have to offer their support and assistance to the beekeepers because of the magnitude of their potential losses to prevent disastrous crop losses. This means that the loss is really a transfer of cost from one industry to another, with the only destruction of value being crops lost if the artificial maintenance scenario results in curtailed pollination. Predicting the level of this eventuality is not easy, but it should be recognized that the stakes amongst the fruit growers are very high.

A corollary to the economic outcome above is that the best alternative to artificial feeding is to plant alternative non-invasive bee forage. To feed all the gum-dependent bees in the Western Cape, 6000 hectares of gums are needed. To create such a forage source would cost about R30 million in capital outlay, equivalent to an average annual cost of R4 million.

It is important to recognize that not only are the beekeepers and fruit growers affected. The report goes on to outline the more indirect issues involved in the event of the gum trees being removed. Several issues, directly linked to biodiversity and the maintenance of environmental balance through pollination, are brought to the reader's attention. It is felt within the decision-making framework that these are aspects which should form part of the strategic framework.

SYNOPSIS AND RECOMMENDATIONS

The synopsis brings together the core survey findings (mentioned above) and places these in the study context. The objective being to lead the reader to a set of recommendations as follows: -

1. Given the incompleteness of the evidence regarding gum invasion and the potentially significant lost value which the removal of certain CARA species will generate amongst beekeepers, the consultants recommend further evaluation of the invasive capacity of all species, excepting River Red Gum. The re-evaluation of Sugar Gum is especially warranted in view of its importance as a nectar source for bees at critical times.
2. As far as the ecological landscape is concerned eucalypt clearing should focus on riparian areas and nature reserves. Other regions should not being targeted until the invasive status of eucalypt species in these landscapes is determined with greater confidence.
3. The request by beekeepers for a fully consultative process is endorsed and should be followed up scrupulously.
4. Stakeholders should jointly and deliberately plan for and apply resources to replacing cleared gum with non-invasive alternate forage. This could be scheduled over a reasonable time period
5. A holistic approach by an extended constituency of interested parties to the broader influences and interactions of bees in the environment should be explored.
6. A peripheral recommendation (an appeal almost) outside the 'impact' issue but within the domain of bees and gums, is that nectar production be encouraged as a selection criterion in the area of eucalypt planting and breeding. Beekeeping is a low entry entrepreneurial activity that could go some way to alleviating poverty in some families, and is constrained by the lack of suitable nectar sources.

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1 BACKGROUND

Biological invasions are recognized as the second largest global threat to biodiversity, second only to human population growth and direct habitat destruction (Pimental 2002; Richardson & van Wilgen 2004), and erode natural capital, compromise ecosystem stability and threaten economic productivity. At least 120 000 non-native species have become established worldwide at a cost of some $314 billion annually in damage and control costs (Pimental *et al*. 2002).

Approximately 8 760 species of plants are reported to have invaded South African ecosystems (van Wilgen *et al*. 2002) and of these 161 are considered serious pest weeds. Most have been deliberately introduced as crop plants, for timber or firewood, as ornamentals, or to stabilize sand dunes or rivers, and have spread and become naturalized with serious consequences (van Wilgen *et* al. 2004). These invaders now occupy 10 million hectares of land in South Africa with resultant biodiversity and crop losses, as well as causing water shortages, increased soil erosion and increased fire threat. The annual cost of these invasives in South Africa is considered to be as much as R100 billion (van Wilgen *et al*. 2004).

The impact of invasive alien species on water resources, and the demonstration of the economic benefits of intervention (van Wilgen *et al*. 1997) led to the establishment of the Working for Water Programme (WFW), a multi-departmental government initiative aimed at managing the spread of invading alien plants and protecting water supplies in a manner supportive of the reconstruction and development of South Africa. The WFW Programme has grown enormously in the past seven years, with the emphasis on poverty alleviation and employment creation. R1.6 billion has been invested in clearing programmes in the first seven years of the programme (van Wilgen 2004). The emphasis in the Western Cape is sustainable water use for a growing population (van Wilgen *et al*. 1997) that has resulted in the removal of invasive alien vegetation, particularly in mountain catchment areas and along river courses.

An important component in the WFW battle with invasive alien vegetation is the recent (March 2001) amendment of the Conservation of Agricultural Resources Act (Act No. 43 of 1983) (CARA), under which landowners in South Africa are now legally responsible for the control of 197 listed invasive alien plant species. Species are placed in one of three categories. Category 1 plants in the regulations are prohibited weeds and must be removed. Category 2 species are plants with economic value and may be planted (or retained) in demarcated areas subject to a permit, provided that the permit-holder assumes responsibility for the spread and water usage of the species. Category 3 plants in the regulations are species that may be retained but no longer planted or propagated. Included in the list are seven species of eucalypts, six in category 2 and one (*Eucalyptus lehmanni*) in category 1. Eucalypts are reported to use large amounts of water with the afforestation of catchments in Mpumalanga resulting in the total drying-up of streams 6-12 years after planting (van Lill *et al*. 1980). Additional negative characteristics of gums are the reported ability of certain species to invade natural habitats, and as a fire threat. Eucalypts are, however markedly less successful as invaders than pines and acacias, both worldwide and in South Africa (Forsyth *et al.* 2004). The seven eucalypt species listed in CARA and their characteristics are indicated in Table 1.

There are at least 400 species in the genus Eucalyptus (Poynton 1979), all endemic to Australia or Tasmania, where they are suited to a wide range of climates. The first eucalypts were introduced into South Africa in 1807 (FAO 1979), and the mass planting of eucalypts in South Africa started with the establishment of a forestry industry in the mid-19th century, a direct result of the over-exploitation of natural forests earlier in that

Table 1**: CARA-listed species of eucalypt in South Africa (from Poynton 1979; Shaughnessy 1980; Johannsmeier & Mostert 2001).**

Species	Introduction into South Africa	Where planted in South Africa	Conditions for growth	Uses & purposes	Honeybee value (nectar & pollen scored out of 4)	Notes
Eucalyptus cladocalyx F.Mueller (Sugar Gum)	1865	Limited to the temperate winter rainfall of the Western Cape; only experimental plantings elsewhere.	Poor, sour, shallow soils	High quality and very hard timber; multi-purpose but mostly poles. Also used in tannin production, and for woodlots.	Only in the Western Cape. Very good nectar (4) and some pollen (1).	Very hardy to summer drought and poor soils. Only eucalypt that can deliver a viable timber crop in the Western Cape.
Eucalyptus camaldulensis Dehnhardt (River Red Gum)	1870 (repeated importation of seeds until at least 1972)	Most widely planted eucalypt in South Africa; mostly in dry to moderately-dry areas	Dry areas	Very good timber tree; used for structural timber. Also for woodlots and shelter-breaks.	Very good nectar (3) and good pollen (2)	Most dependable of all eucalypts in dry areas; very tolerant of drought, frost and heat. Most widely distributed eucalypt in Australia, along almost all rivers
Eucalyptus diversicolor F.Mueller (Karri)	1880 (repeated importation of seeds until at least 1979)	Best in temperate, winter-rainfall areas. Very susceptible to frost. Was widely planted in South Africa, now only in Cape	Only in good soils	Important timber tree in Eastern Cape. Used for logs, tool-handles and fire-breaks.	Good nectar source (3) but minor pollen (2)	Limited to temperate areas with consistent rainfall and good soil.
Eucalyptus grandis Hill ex Maiden (Saligna Gum)	1890 (repeated importation of seeds until at least 1980)	Best in warm, humid regions of KZN and Mpumalanga. Not in Western Cape because of summer drought and poor soils	Most soil types but only prospers in deep, moist soils	General purpose construction timber, mining timber, poles and posts; and for paper. Not great quality timber	Very good nectar (4) and good pollen (3)	Widely grown forest tree; most widely grown eucalypt in the world and most important in South Africa. Very fast growing, and mostly by private industry
Eucalyptus lehmannii (Preiss ex Schauer) Bentham (Spider Gum)	Before 1896	Only in the winter rainfall areas of the Cape, and only in sandy soils near the sea	Shrub-like in sandy coastal soils	Grown as shelter-breaks and as ornamentals, and for fencing material.	Good nectar (3) and good pollen (3)	Not of value as commercial timber.
Eucalyptus paniculata Smith (Grey Ironbark)	1878 (repeated importation of seeds until at least 1970)	Coastal tree; best in cool areas of KZN and Mpumalanga. Poor in the Western Cape.	Can do well on slopes with poor soil.	Very important commercial timber tree in South Africa; for telephone poles and railway sleepers.	Good nectar (3) but no pollen (0)	Very slow growing, therefore seldom planted in private plantations
Eucalyptus sideroxylon A.Cunningham ex Woolls (Black Ironbark)	1884	Mostly summer-rainfall areas. Needs cool regions. Grows well in some parts of the Western Cape	Ridges and slopes, poor and shallow soil.	Grown as shelter-breaks, woodlots and avenue trees; for timber (mining) and fencing; and for general use.	Very good nectar (4), no pollen (0)	Very drought resistant

century (Johannsmeier 1994). By 1940 approximately 149 species of *Eucalyptus* had been established all over South Africa (Forsyth *et al* 2004). Introductions took place through the actions of the colonial forest administration of the Cape Colony, and later through the Department of Forestry of the Republic of South Africa (Poynton 1979; Shaughnessy 1980), and by commercial forestry companies. The great advantage of eucalypt plantations was that they were very quick growing, and multi-purpose. Gums were introduced for structural timber, mining timber, poles, firewood, shelterbelts, fire-breaks, dune-fixation, the tanning of leather, and ornamentals (Poynton 1979; Shaughnessy 1980). The development of gum plantations in South Africa, by virtue of the abundant nectar and pollen that they provide, was also the beginning of a beekeeping industry in the country (Poynton 1979; Johannsmeier 1994).

Bee forage is critical for sustaining not only wild honeybee populations but also those honeybees kept by beekeepers. Nectar and pollen flows that are provided by various types of bee forage plants at different times of the year are crucial to the survival and successful reproduction of honeybee colonies, these honeybees being essential to the pollination and survival of indigenous flora, exotic garden plants and in particular many cultivated crops. It is for the latter aspect that the maintenance of bee forage plants is especially important. Commercial honeybees are used to pollinate at least 26 crops in the Western Cape in particular the deciduous fruit industry, an industry with export earnings of about R5 billion per annum and supporting 170 000 jobs. It is not an exaggeration that the economy of the Cape metropole is heavily influenced by the deciduous fruit industry, which in turn needs honeybees for the pollination of its crops.

The great value of gums to beekeepers is their dependability; regular flowering, constant nectar secretion and pollen production. "Only because more than half of the total honey produced comes from reliable eucalypts and only because eucalypts render it possible to maintain colonies for pollination, is commercial beekeeping feasible in South Africa" (Johannsmeier 1994). In the Western Cape the most important eucalypt is the Sugar Gum (*Eucalyptus cladocalyx*) which flowers between December and February (Johannsmeier 1994). Other Eucalyptus species of importance to beekeepers of the Cape are the River Red Gum (*E. camaldulensis*), the Spider Gum (*E. lehmanni*) and the Karri Gum (*E. diversicolor*). All four of these gum species are listed in CARA as invasive alien species and subject to control or removal. The targeting of eucalypts for invasive alien clearing in many parts of South Africa has led to dissatisfaction on the part of the beekeeping industry. The beekeepers have long raised concerns (McVeigh 1990; Post 1998) that the extensive clearing of gums for "ecological" reasons would have significant consequences as regards the amount of bee forage that would be available, and hence the sustainability of their industry and of those industries depending on commercial honeybees for crop pollination. As well as questioning the economic sense of the removals (weighing benefits as against costs), the beekeepers have also called into question the validity of the invasive status of some of the gum species listed under CARA.

There is a long history of correspondence and dialogue between the beekeeping industry and both the National Department of Agriculture (NDA) and WFW, but these interfaces appear not to have alleviated the concerns of the beekeepers. The first meeting between the beekeepers and WFW took place in October 1999, and subsequent meetings resulted in the June 2000 co-funding of a questionnaire and survey to ascertain the value of eucalypts to beekeepers in the Western Cape. This process was aborted when the two parties couldn't agree on the basis of the

questionnaire. The process was stalled until January 2002 when a “Gums in the Western Cape” workgroup was formed, comprising of all interested parties. A further series of meetings resulted in a Memorandum of Agreement (MOA) between WFW and the South African Bee Industry Executive (SABIO), committing them to a survey to determine the importance of gums to the beekeeping industry and related industries, and the development of an operational strategy regarding the removal of gums. Tenders for the survey were called for in June 2003, and the questionnaire and contract was approved in November 2003 for the work to be undertaken by ARC and Agri-Africa consultants.

At present, the Working for Water Project is involved with the removal of CARA listed eucalypt trees in the Western Cape, mostly from riparian areas. The immediate and critical question that now needs to be asked, and appropriately investigated, is what impact such an activity could have on commercial beekeeping in the region and on the crops reliant on bee pollination for their production. As will be seen in the report that follows and which attempts to find answers, the simplicity of the question belies the complexity of the problem.

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2 METHODOLOGY

At first glance the assessment appears straightforward; determine how much of a negative effect the removal of Eucalypts by WFW will have on the beekeeping industry in the Western Cape, and on the deciduous fruit industry that depends on honeybees for pollination. It is not, as mentioned, so simple and many difficulties present themselves.

Firstly, there are practically no studies that have examined the economic importance of a particular forage species in terms of its capacity to sustain the honeybee population, or even in terms of value due to honey production. The inherent difficulties to such analyses are obvious; it is practically impossible to allocate relative contributions to the multitude of melliferous species present in any patchy environment, and even very difficult to determine the biological origin of honeys. When the varied protein content of pollens, the different sugar concentration of nectars, and the importance of a host of trace elements are taken into account, it becomes impossible to accurately allocate value to any particular forage source.

Secondly, there have been extremely few analyses of the economic importance of honeybee pollination on commercial crops, and the required bee density at pollination, and even fewer on the importance of honeybees in the incidental pollination of non-commercial plants, and all rest on the same questionable assumptions.

Thirdly, detailed information regarding the beekeeping industry does not exist in South Africa where only a small percentage of beekeepers are registered or belong to any association. There are no significant records on how many beekeepers there are, how many colonies there are, where they are, or how much honey is produced.

Finally, it would be reasonable to expect that beekeeper submissions in response to any questionnaire will necessarily reflect “the importance of eucalypts to beekeepers” at a personal level. It is fair to assume that any beekeeper that fears for the loss of eucalypt forage will be sufficiently motivated to complete the questionnaire. Hence, these returns should approximate the “absolute loss due the eucalypt removal”. However, it is equally

fair to assume that a beekeeper that does not use eucalypt sites will be less motivated to submit a questionnaire. And without this information, it is impossible to determine the 'relative significance' of the eucalypt removal to beekeeping and agriculture in the Western Cape in the context of the total beekeeper population. In fact, it would be disingenuous not to note that it would be beneficial for the beekeepers (in their arguing for the importance of eucalypts) to report only eucalypt sites, or a disproportionate amount.

The latter concerns were addressed in the exhaustive development of a fair and accurate questionnaire (see appendix 1) for the beekeeping industry, a collaborative process with the consultants involving both WFW and SABIO, together with a process whereby the questionnaire might be disseminated in such a way as to gather responses from as many beekeepers in the Western Cape as possible. Built into the questionnaire were checks and balances to more accurately estimate the importance of various forage sources, and to estimate the importance of commercial crop pollination to beekeepers, and a validation process whereby the accuracy of beekeeper submitted information could be assessed.

The intent was a comprehensive survey of the importance of eucalypt trees to beekeepers in the Western Cape, with additional reference to the respective importance of the different species of gum as well as the various positions in the landscape that the gums might be found. In addition, the importance of gums with respect to the use of bees for commercial pollination in the Western Cape was to be determined.

3 BEEKEEPER SURVEY

3.1 Dissemination

To complete a thorough survey, as many as possible of the beekeepers in the Western Cape had to be contacted and prevailed upon to reveal sensitive information, such as where they keep their bees and what their production figures are. Such data is not routinely maintained in South Africa where beekeepers are traditionally not required to register, and there are no official records of the beekeepers in the Western Cape. Furthermore, many beekeepers choose not to belong to any beekeeper association, and often actively avoid contact with beekeeper groups.

Therefore, at the outset of the survey there was no way to know how many beekeepers there are in the Western Cape, where they are, how many honeybee colonies they possess, or how to contact them. The only available option was to contact as many as possible, and to estimate what fraction of the total complement this represented. It needs to be noted that it was emphasized that submitted questionnaires would be treated with the strictest confidence, with the details being revealed neither to SABIO nor WFW. Beekeepers are notoriously secretive about their apiary sites, and without this assurance, would have been extremely reluctant to complete questionnaires.

An effort was made to publicise the questionnaire and to attract the attention of beekeepers that were not members of beekeeping associations and were not on beekeeper lists that would be provided by these associations. A number of radio talks and radio announcements preceded the distribution of the questionnaires, and there

were also articles in trade magazines and newspapers. A total of eight people contacted the consultants and asked for questionnaires, these people being informed of the survey by the publicity campaign.

An initial list of 1156 beekeeper names and addresses was obtained from the Western Cape Bee Industry Association and from SABIO. [Note that this address list was an amalgam of beekeeper address lists from the past twenty years]. In consultation with both the Western Cape and Southern Cape beekeeper associations, ARC-PPRI was able to add the names and addresses of 58 additional beekeepers to the list. A questionnaire package was sent to all these addressees which contained an English and an Afrikaans copy of the questionnaire, a stamped return envelope and a request for the questionnaire to be circulated to any other known beekeepers in the Western Cape. Due to the limited response, a reminder letter was sent to all addressees (those that had not yet responded), extending the deadline for responses. In a final effort to elicit responses all non-respondents on the list with contact details were telephoned or e-mailed by the Western Cape Beekeeper Industry Executive (WCBIE) and asked to complete the questionnaire.

3.2 Responses

The total beekeeper list for the Western Cape was determined to be 1222 (1156 + 58 + 8) names. Of these 314 names could be removed due to there being duplicate names on the list, incomplete addresses, people on the list that were associated with the beekeeping industry but not actual beekeepers, people on the list that were no longer beekeepers, and beekeepers that had passed away. The final beekeeper list for the Western Cape was therefore concluded to be 908 names (1222 – 314). From these a total of 173 responses from active beekeepers were obtained. The percentage response was therefore calculated to be 173/908 = 19.05%. The number of colonies owned by these respondents was 33 836 (taking the median number where a beekeeper indicated a range of colonies).

In the final attempt to elicit responses, a total of 113 thus-far non-responsive individuals on the list were contacted and asked to submit responses; these individuals had been identified by SABIO as the “known” active beekeepers on the list that had not responded. Eighty eight (78%) of these purported beekeepers did not respond to messages left for them, and only one of those contacted eventually submitted a completed questionnaire. It was therefore decided that all those contactable beekeepers that were willing to respond to the questionnaire had done so, and that there was no point in trying to get further responses. It is worth noting that only three beekeepers indicated that they had not submitted a questionnaire because “it was too complicated”.

3.3 Survey Penetration

There have been only two other surveys of Cape beekeepers in recent times. A national survey in 1975 achieved a 40.4% return (702 positive responses) of which 271 were in the Cape Province (Anderson 1978). [Note: “Old” Cape Province rather than the Western Cape]. These 271 returns reported 15 650 colonies in the province. In 1995 van der Merwe and Eloff circulated 250 questionnaires to beekeepers in the Western Cape (bordered by Swellendam in the east and Clanwilliam in the north) from which they

received 57% returns. At first glance these figures would suggest that beekeepers in the Western Cape are presently less willing to participate in industry activities than was the situation in the past. However, in terms of the actual number of returns the surveys are pleasingly consistent. The 1975 survey of the whole Cape yielded 271 returns; this survey of the Western Cape province yielded 173 returns; and the 1995 survey of a truncated Western Cape yielded 142 returns. This consistency suggests that this body represents the active beekeepers of the Western Cape, and the vast majority of the non-responding addresses in the original list as not active beekeepers, and certainly not participatory in industry activities. The response from "active" beekeepers is therefore likely to be far greater than the 19% calculated, and is more likely to be in the order of almost 60% of the 1995 survey. The responses received are also considered to represent at least 80% of the managed honeybee colonies in the Western Cape.

Further support for this position, namely, that the survey reached the majority of beekeepers in the Western Cape and represents almost all managed colonies, comes from a number of factors:

1. Despite a concerted effort to publicize the survey in an effort to "catch" beekeepers not part of organized beekeeping, and therefore not on the beekeeping lists, only 3 submitted returns were from beekeepers not on the list (unknowns). Hence, the list can be considered to have been comprehensive.

2. The recalcitrant beekeepers (the 113 "known" beekeepers who did not submit a return), based on the knowledge of SABIO of them, represent only a small percentage of the total number of colonies in the region, thought to be less than 2000 colonies.

3. During the validation process (see below), a number of apiary sites with honeybee colonies belonging to beekeepers from off the list were detected. These beekeepers do not belong to any beekeeper body, did not fill in the questionnaire, and have no desire to do either. It was estimated a maximum of 3000 colonies are owned by approximately 30 beekeepers in this category.

4. The more than 33 000 colonies represented in the returns is greater than or equal to previous estimates of the total size of the managed honeybee population in the Western Cape (1975 census; WCBIE estimates).

3.4 Validation

The submitted returns were divided into three categories on the basis of the size of the beekeeping operation: 1-50 hives (hobbyist), 51-250 hives (semi-commercial) and 251+ (commercial). Approximately 10% of each group was randomly selected for validation of submitted results. A total of 17 beekeepers were identified to be validated. The validation procedure involved confirming the accuracy of reporting for apiary sites for all reporting beekeepers, for what could be reasonably expected in a normal year. For hobbyist beekeepers, all apiary sites were to be visited, while only randomly selected sites would be visited for semi-commercial and commercial beekeepers. In the validation process, 14 of the selected 17 beekeepers were successfully visited. One of the selected beekeepers was unexpectedly hospitalized on the day of inspection; another beekeeper

was overseas for the entire duration of the validation process; and the last beekeeper repeatedly failed to respond to telephone messages.

Of the 103 apiaries with 3215 honeybee colonies reported by the 14 validated beekeepers, 52 apiary sites and 1653 colonies were visited with the following results.

a. The carrying capacity of apiary sites was under-estimated by approximately 30%. That is, beekeepers were not over reporting the numbers of colonies that could be kept on apiary sites.

b. The forage type for sites was extremely accurately reported, with contribution of gum forage being very slightly (4%) under-estimated.

c. The species of gum was extremely accurately reported (approximately 95% accuracy).

d. The position in the landscape of the eucalypts was less accurately reported, with accuracy of approximately 80%. Both “gums in river-courses” and “gums in mountain catchment areas” were over-reported, sometimes because the beekeeper reported on the position of the colonies and not on the position of the forage. These categories are suggested to be likely to be over-represented in the survey results.

e. Where reported, the percentage of the gums that were planted was accurately reported.

The general conclusion of the validation process is that the questionnaire was well understood and accurately completed, and responses can be regarded with confidence.

3.5 Sample in Context

It also cannot be over-emphasized that it is not possible to precisely state how the sample of responding beekeepers represents the industry as a whole. Every effort, however, was made to disseminate the questionnaire to every beekeeper in the province and to facilitate the submission of a response.

For reasons already discussed, it can be confidently asserted that the survey respondents constitute at least 60% of all beekeepers in the province and a minimum of 80% of the economically active hives. What can also be said without fear of contradiction is that the sample contains all the beekeepers in the Western Cape that wish to make a contribution to the “Gums & Beekeepers Debate”, and as such should be regarded as the definitive response from beekeepers in the province.

4 SURVEY RESULTS

4.1 *Quantitative Profile*

The first section of the questionnaire sought to profile in a quantitative sense the beekeeping industry in the Western Cape. Beekeepers were asked to describe the

scale and nature of their industry, paying particular attention to the source of forage from which they produce honey and to the use of their colonies for commercial pollination. The results are intended to inform on the importance of eucalypts, and in particular, each category of eucalypt, on the beekeeping industry in the Western Cape. The results will be discussed by question and by issue raised. It is important to note that results pertain to the sample surveyed, and not necessarily the whole beekeeper population.

4.1.1 Size and demography

In all, 173 positive responses were received from beekeepers in the Western Cape, of which 77 were small beekeepers (1-50 colonies), 59 were medium beekeepers (51-250 colonies) and 37 were large beekeepers (> 250 colonies) (Table 2). These beekeepers recorded a total of 33 836 colonies for the Western Cape. As mentioned, these results correspond well with the results obtained for the Western Cape by van der Merwe and Eloff (1995), namely positive responses from 142 beekeepers, but contrast sharply with those collected in the 1975 census which records 271 beekeepers in the Cape Province (note, not the Western Cape) but only 15 650 colonies in the province (Anderson 1978). It indicates a likely decrease in the numbers of beekeepers in the province over the past 30 years, corresponding with international trends that show that beekeeping is an increasingly marginal profession, and has decreased by 50% in numbers since the 1950's (Hansen 2000). This conclusion is supported by data gathered by van der Merwe and Eloff (1995) indicating that only 18% of beekeepers in the Western Cape are under the age of 40. The numbers of colonies in the Western Cape appears to buck international trends (Hansen 2000), however, with colony numbers having more than doubled. The 73 000 colonies in the Cape estimated by Turpie *et al.* (2003) is clearly an over-estimate.

Table 2: Hive ownership in the Western Cape

	Number of beekeepers of each category	Percentage of all beekeepers	Total number of honeybee colonies	Percentage of all colonies
All beekeepers	173	100	33836	100
Small beekeepers (1-50 colonies)	77	45	1485	4
Medium beekeepers (51-250 colonies)	59	34	7113	21
Large beekeepers (>250 colonies)	37	21	25238	75

It is striking from Table 2 that commercial beekeepers, whilst representing only 21% of the total number of beekeepers, represent 75% of all the honeybee colonies in the province. Even more apparent is that the 45% that are small beekeepers constitute only 4% of the total colony numbers. Hence, from an economic viewpoint, these small beekeepers can be essentially disregarded. These data are again in sharp contrast to that obtained in the 1975 survey where only 10 out of 271 beekeepers where professional, and even the van der Merwe and Eloff (1995) study which reports that only 8% of beekeepers are fully professional. The most sensible conclusion is that, while the total number of beekeepers in the Western Cape seem to have dropped somewhat, the

number of commercial beekeepers and hence honeybee colonies appears to have increased in the past 30 years. This is probably entirely a result of the importance of bees to the commercial fruit industry in the Cape, and the revenue received by beekeepers from this industry (see later).

Honeybee colonies are maintained throughout the Western Cape (Table 3) but are concentrated in the Overberg and the Boland. Table 3 indicates a total of 40 842 colonies, hence 7006 (or 21%) are reported for more than one region. This is a surprisingly small percentage of colonies being moved between regions, and indicates that beekeeping in the Western Cape is essentially home-based.

Table 3: Number of colonies in each region

District	**Colonies**
Boland	9661
Ceres/Clanwilliam	4129
West Coast	4457
Overberg	13467
Little Karoo	2559
Swartland	3717
Peninsula	1867
Southern Cape	985
TOTAL	40842

4.1.2 Employment

A total of 440 people are employed in the beekeeping industry in the Western Cape (Table 4), although for many of those the employment will be part-time. The 1975 national survey (Anderson 1978) reports 1 616 people employed in the upkeep of 60 389 colonies, or 37 colonies per person. The 77 colonies per person indicated in the current survey further indicate the increasingly commercial nature of the beekeeping industry in the Western Cape.

Table 4: Direct Employment due to beekeeping activity.

	Average hives per person employed (includes owner)	Total employees
Small beekeepers	12	121
Medium beekeepers	49	144
Large beekeepers	144	175
All beekeepers	77	440

4.1.3 Honey production

The beekeeper responses indicate that approximately 454 tons of honey is produced annually in the Western Cape (Table 5). It is unfortunately impossible to compare these data with the 1975 or 1995 surveys as the first did not collect regional data for honey production, and the second did not collect any honey production data. The 1975 survey did, however, record honey production nationally of 31kg per hive, compared to the 13.4kg per hive reported in this survey (Table 5). This 57% decrease in honey production may reflect the increase pollination activity of beekeepers in the Western Cape, a decrease in suitable bee forage, and the increased numbers of colonies being supported in the province.

Annual honey production in South Africa has previously been estimated to be 3 500 tons (Johannsmeier & Mostert 2001) although the 1975 survey reported only 1 894 tons being produced (Anderson 1978). As in 2003 approximately 1 600 tons of honey was imported into South Africa (M. Holzhausen pers. comm.) whereas previously no honey was imported into South Africa (Anderson 1978), it is reasonable to conclude that honey production in South Africa is only about 50% of what is was in the 1970's, with possibly only 1 500 tons now being produced annually. This corresponds well with the honey production per colony reported in this survey.

Table 5: Average annual honey production in the Western Cape

	Total honey produced (kg)	Percentage of total honey produced	Average honey production per colony (kg)
Small beekeepers	17775	3.9	12.3
Medium beekeepers	93125	20.5	13.1
Large beekeepers	342982	75.6	13.6
All beekeepers	453882	100.0	13.4

4.1.4 Pollination

Perhaps the most striking change in the complexion of the beekeeping industry in the Western Cape concerns the commercial pollination of crops. In the 1975 survey 97% of beekeeper revenue was from honey production and only 1.2% from pollination (Anderson 1978). Only 2 260 colonies were reportedly used for pollination in 1975 (nationwide, but probably mostly in the Western Cape). If all 2 260 colonies were in the Western Cape, only 14% of colonies in the region were being used for pollination. The results of the present survey indicate a dramatic change in profile in the beekeeping industry with 29 316 colonies (87% of all colonies) being used in commercial pollination (Table 6). The numbers of beekeepers offering pollination services has also increased with 85 beekeepers (49%) offering the service. These figures have not changed much since 1995 when 44% of beekeepers offered pollination services (van der Merwe & Eloff 1995). Surprisingly, 17 (22%) small beekeepers offer pollination services, although their contribution to the total pollination pool is only 1%. Unsurprisingly, 35 (95%) large beekeepers offer pollination services. and these 35 beekeepers are responsible for 89% of the pollination services undertaken. Put another way, only 2 large beekeepers in the Western Cape do not make their colonies available for commercial crop pollination.

The implications of these data are considerable. Firstly, it is clear that almost all commercial beekeepers in the Western Cape depend on pollination revenue in their businesses. Secondly, and more importantly, the crop production industry in the Western Cape depends on almost 90% of managed honeybee colonies to provide the pollination services that it requires. The study by Turpie *et al.* (2003) estimates that 20 000 colonies (or 27% of their estimate of the numbers of colonies in the province) are used for pollination in the Western Cape, and fails to accurately identify the absolute dependence of the commercial bee industry in the Cape on crop pollination, and vice versa.

Table 6: The use of honeybee colonies for pollination in the Western Cape

	Beekeepers		Pollinations		Colonies		Number of pollinations per colony
	Number	%	Number	%	Number	%	
Whole beekeeper sample	173	100	50871	100	33836	100	
Pollinating sample	85	49	50871	100	29316	87	1.7
Small beekeepers pollinating	17	10	730	1	502	1	1.5
Medium beekeepers pollinating	33	19	5069	10	4426	13	1.1
Large beekeepers pollinating	35	20	45072	89	24388	72	1.8

93% of commercial pollination by beekeepers in the Western Cape is of deciduous fruit crops, divided almost equally between stone fruit (mostly plums) and pome fruit (apples and pears) (Table 7). The balance of the pollination is of vegetables and vegetable seed (Table 7). As deciduous crops and cultivars do not flower simultaneously, it is possible for beekeepers to use colonies to pollinate more than one crop. Table 6, which matches the number of colonies each beekeeper has with the number of pollinations he effects, indicates that on average 1.7 pollinations is provided by the 29 316 colonies used for crop pollination. (This ratio, it must be noted, assumes all hives owned by a pollinating beekeeper are used for pollination). A ratio of 1.7 pollinations per colony is in line with normal beekeeping practice (D Smit: pers. com.). These pollinations are distributed throughout the Western Cape, but concentrated in the fruit-producing areas of the Boland, Ceres and Grabouw (Table 8).

Table 7: Type of crop pollination in the Western Cape – number of pollinations

Stone fruit	Pome fruit	Vegetables	Vegetable seed	Other	Total	%
23043	24651	1021	1937	127	50780	100

Table 8: Area where pollinations are done – number of pollinations

Villiersdorp/ Grabouw	Ceres	Worcester	Karoo	Langkloof	Boland	Other	Total
21375	12345	2389	953	1530	9468	1604	49664

4.1.5 Income generated by the beekeeping industry in the Western Cape

Using 2003 values of R24 per kg honey and R260 per pollination unit, it is possible to estimate the relative financial importance of honey production and commercial pollination to beekeepers in the Western Cape (Table 9). In 1975 only 1.2% of revenue was from pollination (Anderson 1978). By 1995, the pollination beekeepers made 52% of their income from honey production, and 46% from pollination revenue. At present (this survey) the contribution of commercial pollination has increased to 55% for all beekeepers and 59% for commercial beekeepers. As well as representing an increased dependence of crop producers on commercial beekeepers, dictated by intensive farming practices and the need for top-quality fruit, these data may well also represent a decrease in the honey production potential of beekeepers in the Western Cape.

Table 9: Income generated by the beekeeping industry in the Western Cape (Rands)

	Honey value (at R24/kg)	Pollination value (at R260 per pollination)	Total	Percentage
Small Beekeepers	426 600	189 800	616 400	2.6%
Medium beekeepers	2 235 000	1 317 940	2 552 940	14.7%
Large beekeepers	8 231 568	11 718 720	19 950 288	82.7%
All Beekeepers	10 893 168	13 226 460	24 119 628	100%

4.1.6 Gums - relative forage value to the beekeeping industry

To estimate the contribution of eucalypts to the beekeeping industry of the Western Cape, beekeepers were asked to estimate their honey production resulting from different forage sources. Table 10 indicates the relative contributions for small, medium and large beekeepers. Sixty six percent of honey is reported to be produced from gums with the next most significant resources being fynbos with 18% and weeds with 7% (Table 10). Gums are therefore calculated to annually be worth approximately R7.2 million in honey production to beekeepers in the Western Cape (Table 10). The dependence on gums is slightly greater for the large beekeepers, with the other forage types slightly less important. As might be expected, “don’t know” is greatest for the small beekeepers.

Table 10: Honey production and value in the Western Cape from different forage sources (in kilograms with % in brackets)

	gums	weeds	citrus	canola	fynbos	Sub-urban	other	Don't know	TOTAL
Small beekeepers(%)	8734 (49)	1216 (7)	766 (4)	44 (0)	4515 (25)	512 (3)	1036 (6)	952 (5)	17775 (100)
Medium beekeepers(%)	51602 (55)	9259 (10)	1624 (2)	1434 (2)	22176 (24)	1052 (1)	5762 (6)	217 (0)	93125 (100)
Large beekeepers(%)	239546 (70)	21490 (6)	11159 (3)	10773 (3)	54442 (16)	500 (0)	2645 (1)	2426 (1)	342982 (100)
Beekeepers using gums(%)	299882 (69)	23255 (5)	133396 (3)	12211 (3)	71887 (16)	2061 (0)	950 (1)	2780 (1)	432797 (100)
Total (%)	299882 (66)	31964 (7)	13549 (3)	12251 (3)	81132 (18)	2064 (0)	9443 (2)	3596 (1)	453882 (100)
Monetary value (at R24 per kg, in R 000's)	7197	767	325	294	1947	50	228	86	10893

The contribution of gums to the Western Cape beekeepers is found to be considerably greater than the national estimate of 53% gum honey (Johannsmeier & Mostert 2001); eucalypts are obviously crucial to the viability of the industry in the province. Approximately 70% of honey produced by large beekeepers is gum honey, compared to 55% by medium beekeepers and 49% by small beekeepers (Table 10). Larger beekeepers are probably prepared in their own commercial interest to range further afield in search of gum trees than are beekeepers with fewer colonies. Similarly, the proportion of 'own forage' use is far greater amongst small and medium beekeepers (see later) than large. A full 83% of colonies in the Western Cape are reported to utilize gums at some point during the year, with this usage being equally shared by small, medium and large beekeepers (Table 11). Large beekeepers, however, indicate a greater reliance on gums for honey production, colony increases and colony build-up (Table 12). Of further interest and importance in Table 10 is that of the beekeepers using gums as a forage source, 69% of their honey is estimated to come from there. In practical terms this means that a hive using gums and delivering 14kg of honey per year would get approximately 10kg from gums and the balance from other nectar sources.

Table 11: Use of gums by honeybee colonies in the Western Cape

	Number of colonies that:		Percentage of total colonies that:	
	Use gums	Never use gums	Use gums	Never use gums
Small beekeepers	1232	253	4	1
Medium beekeepers	5442	1434	16	4
Large beekeepers	21242	3936	63	12
Total	27916	5623	83	17

Table 12: Importance of gums to different aspects of beekeeping (scored out of 10 for each category) (number of no answers = 11).

	Honey production	Colony increases	Colony build-up
Small beekeepers	5.8	3.6	4.0
Medium beekeepers	6.9	4.5	5.4
Large beekeepers	8.5	5.9	6.8

As expected, the dependence of beekeepers on different forage types varies across the regions of the Western Cape, but it is noteworthy that gums are the dominant forage type in all regions other than the Little Karoo and Southern Cape (Table 13). It is also apparent that, to a large extent, the other forage types are for colony build-up or maintenance, while gums are far more important in honey production. The presence of colonies on gums constitutes only 44% of the total presence of colonies on all forage types (Table 13), yet honey production from gums is 66% of total honey production (Table 10).

Table 13: Forage types for different areas (colonies that fully or partially use a particular forage source)

District	**Forage Source**							
	gums	weeds	citrus	canola	fynbos	suburb	other	don't know
Boland	7806	2592	182	763	3892	214	488	264
Ceres/Clanwilliam	3594	1269	660	50	904	3	340	55
West Coast	3802	1646	79	14	1915	150	197	112
Overberg	8015	2150	25	3658	6099	10	257	119
Little Karoo	1456	840	0	80	1579	230	549	120
Swartland	3152	1091	56	584	1004	250	21	21
Peninsula	1745	854	20	10	424	372	151	60
Southern Cape	825	283	143	30	853	101	227	175
TOTAL	30395	10725	1165	5189	16670	1330	2230	926

4.1.7 Land use agreements

Considering that eucalypt sites are so critically important, it is significant that relatively little is being done by beekeepers to secure these sites. In the survey, large, medium and small beekeepers indicate that they owned only 7%, 11% and 48% of eucalypt sites respectively, and together beekeepers had formal land-use agreements for only 26% of the non-owned eucalypt sites they utilized (Table 14), 91% of which are on private land (Table 15). Furthermore, cash payment for the use of eucalypt sites applies to only 17% of colonies (Table 16). In the 1975 survey, only 28% of sites were reported to be paid for by beekeepers (Anderson 1978). Of these, 50% of sites were paid for in honey, 30% in cash, and 20% in pollination services (Anderson 1978).

Table 14: Beekeepers' land use agreements for gum sites (as a percentage)

	Formal	Informal	No Agreement
Small beekeepers	22	57	21
Medium beekeepers	30	50	19
Large beekeepers	23	72	5
Average	26	58	16

Table 15: Ownership of non-beekeeper owned gum sites (based on positive responses)

	Number	Percent
Sites on state land	66	6.9
Sites on own land	16	1.7
Sites on private land	877	91.4

Table 16: Payment for non-beekeeper owned gum sites (number of colonies)

In cash	In kind	No payment
5039 (16.9%)	21410 (71.6%)	3455 (11.6%)

4.1.8 ***Eucalypts are important to the Beekeeping Industry****.*

Beekeeper responses confirm Sugar Gum to be the main eucalypt crop in the Cape (Johannsmeier 1994). The beekeepers in the survey sample collectively estimated that 66% of all gum honey is produced being from this species (Table 17). The next most significant gum species in the Western Cape are indicated to be the River Red Gum (*Eucalyptus camaldulensis*) and Spider Gum with 15% and 5% of the total gum honey produced respectively (Table 17). Non-CARA gums are responsible for only 3% of gum honey produced in the Western Cape (Table 17). [It is to be expected that the vast majority of the 6% of gum honey production that is recorded as being from “unknown” gums is in fact from CARA listed gums, as together these species constitute 97% of the “known” gums reported by beekeepers]. The direct monetary value (in terms of honey production) of the CARA-listed gums in the Western Cape is therefore calculated to be between R6.5 million and R7.0 million per annum, but is likely to be closer to the latter figure. The dependence on Sugar Gum is more marked for the large beekeepers (with 69%) than it is for the small beekeepers (48%), with the medium beekeepers being intermediate. A minimum of 90% of gum honey produced by large beekeepers is being produced from three species: Sugar Gum, River Red Gum and Spider Gum. In contrast, small beekeepers derive their honey from a wider range of gums, probably reflecting the more urban nature of their apiaries. Significantly, River Red Gum is a valuable resource

for both medium and large beekeepers, but not for small beekeepers, indicating this resource is essentially extra-urban and out of reach for home-based hobbyist beekeepers.

Table 17: Honey production and monetary value from different gum species (in kilograms of honey and Rands; figures in parentheses are the percentage of each gum species for the three categories of beekeepers)

	All forage	All gums	Sugar Gum	River Red Gum	Spider Gum	Grey Iron-bark	Black Iron-bark	Karri	Saligna Gum	Other gums	Un-known gums
Small beekeepers	17775	8734 (100)	4223 (48)	172 (2)	250 (3)	286 (3)	278 (3)	246 (3)	684 (8)	1076 (12)	1519 (17)
Medium beekeepers	93125	51602 (100)	28715 (56)	7033 (14)	1702 (3)	653 (1)	1646 (3)	1322 (3)	3728 (7)	3642 (7)	3160 (6)
Large beekeepers	342982	239546 (100)	165380 (69)	36354 (15)	12695 (5)	1873 (1)	3284 (1)	1600 (1)	649 (0)	4850 (2)	12862 (5)
Total	453882	299882 (100)	198318 (66)	43559 (15)	14647 (5)	2812 (1)	5208 (2)	3168 (1)	5060 (2)	9569 (3)	17541 (6)
Monetary value (at R24 per kg, in R 000's)	10893	7197	4760	1045	352	67	125	76	121	230	421

In addition to submitting basic information (amount of honey produced, amount of pollinations), respondents were also asked to submit site-based information, to allow for validation of their submission. It is instructive to compare these site-based data, calculated as colony-months spent by each category of beekeeper on gums and various types of gums (Table 18), with honey production data in determining the importance of eucalypts to beekeepers in the Western Cape. Honeybee colonies in the Western Cape spend 76% of the time on gum sites and 74% on CARA-listed gum sites (Table 18). Almost 60% of all the sites used in the Western Cape are reported to be Sugar Gum sites, further illustrating the pivotal role of this species to the industry.

Comparing the site-based information and the general honey information (Table 19) indicates that honeybee colonies spend more time on gum sites than would be expected from the honey produced from gums. This is particularly so for Sugar Gum (Table 19). This suggests that the gums, and especially Sugar Gum, play an important 'maintenance' role for beekeepers in the Western Cape, allowing them to sustain their colonies for lengthy periods as well as providing a honey flow. Given the known flowering patterns of the gums species, it indicates that beekeepers in the Western Cape position their colonies on Sugar Gum sites for most of the summer, slightly out of proportion to the honey yield from these sites. It is also interesting (Table 19) that 'unknown' and 'non-CARA' gums make up 6% of the honey production figures but only 2% of the site-information data. This indicates that beekeepers essentially place their bees on sites with 'known' gums as the major forage source, normally Sugar Gum, but often know that there are some 'other' gums around that make a contribution to the honey produced.

Table 18: Number of months honeybee colonies are kept on gum apiary sites in the Western Cape, indicated as colony-months

	Total colony-months	Total colony-months on gums	Total colony-months on CARA-gums	Total colony-months on Spider Gum or River Red Gum	Total colony-months on Sugar Gum	Total colony-months not on gums
All beekeepers	386351 (100)	295131 (76)	287287 (74)	71206 (18)	227800 (59)	91220 (24)
Small beekeepers	17454 (5)	14802 (4)	14164 (4)	3627 (1)	9051 (2)	2652 (1)
Medium beekeepers	75064 (19)	59318 (15)	55022 (14)	14428 (4)	38158 (10)	15746 (4)
Large beekeepers	293833 (76)	221011 (57)	218101 (56)	53151 (14)	180591 (47)	72822 (19)

Table 19: Comparison of site-based information and honey production information in determining the importance of eucalypts to beekeepers (*Note: Site information is based on the gum species being present at the site; no quantitative allocation is made. Some sites have more than one species present and hence the presence of individual species summated appear to contribute more than the overall total).*

	All forage	Non gum forage	Gum forage	Sugar gum	River Red Gum and spider gum	Other CARA gums	Non-CARA and unknown gums
Percent contribution to honey production in total honey produced (= 454 tons), based on beekeeper allocations	100	34	66	44	13	4	6
Percent contribution by forage in total colony-months (= 386 351), based on site information	100	24	76	59	18	2	2

An analysis of commercial pollination services provided by beekeepers of the Western Cape is even more illuminating as regards the importance of gums to the industry (Table 20). Almost 100% of pollinations are provided by colonies utilizing gums for some point of the year, and 96% of pollinations are provided by colonies utilizing CARA-listed gums (Table 20). Sugar Gum alone is utilized by 87% of the colonies used for commercial pollination in the Western Cape. Similarly, a combination of River Red Gum and Spider Gum is used for 61% of the pollination units. Clearly, the majority of honeybee colonies in the Western Cape that are used to provide commercial pollination spend part of the

year on Sugar Gum and either River Red Gum or Spider Gum. In contrast, practically none of the approximately 4500 colonies that are never on gums are used for commercial pollination, although there is no obvious reason why this should be the case. Within the survey sample only 200 pollinations could be linked to apiaries which do not involve gums at some point in the forage chain, in comparison with the more than 50000 colonies which forage on gums. The number of pollinations for different crop types with respect to the dependence of the colonies on different gum types is indicated in Table 21, and illustrates the dependence of all crop types on all of CARA-listed gums, Sugar Gum and a combination of River Red Gum and Spider Gum.

Table 20: The use of colonies for pollination with respect to the dependence of the colonies on gums for forage

	Beekeepers		Pollinations	
	Number	%	Number	%
Whole beekeeper sample	173	100	50871	100
Pollinating sample	85	49	50871	100
Beekeepers not on gums & pollinate	4	2	194	0
Beekeepers on CARA-listed gums and pollinate	74	43	48616	96
Beekeepers on non-CARA listed gums & pollinate	7	4	2061	4
Beekeepers on Sugar Gum and pollinate	65	37	44302	87
Beekeepers on River Red Gum and Spider Gum & pollinate	40	24	30863	61

Table 21: Number of pollinations with respect to the dependence on colonies on gums for forage and the type of pollination.

	Stone fruit	Pome fruit	Vegetables	Vegetable seed	Other	Total	%
Total	23043	24651	1021	1937	127	50780	100
Never on gums	62	120	0	0	11	194	0
CARA-listed gums	22383	23115	1017	1937	81	48534	96
Sugar Gum	21830	19991	730	1587	81	44220	87
River Red Gum & Spider Gum	12594	16402	679	1097	8	30781	61
Non CARA-listed gums	597	1417	4	0	35	2053	4

4.1.9 Position in the Landscape of Eucalypts used by Beekeepers.

The final quantitative questions asked of beekeepers in the survey were with regards to the position in the landscape of gums utilized by the beekeepers. Beekeepers were given three choices for landscape position: “rivers and wetlands” was defined as within 30m from the banks of a river-course or wetland; “mountain catchment” areas were steep slopes of mountains at least 500m high from top to base; and “other” was any other site. Within these three categories, beekeepers were further asked to distinguish, based on their opinion, between “environmentally-sensitive” such as nature reserves, “fire-sensitive” such as when close to buildings, and “other” when not judged to be either environmentally or fire sensitive. Beekeepers were also asked to record if honeybee colonies were maintained in nature reserves. The results of these allocations by beekeepers are presented in Table 22 and Table 23. Beekeepers reported that 28% of the gums that they use are found in rivers or wetlands, 8% are found in mountain catchment areas, and 64% in “other” areas (Table 22). Beekeepers further considered that only 8% of gums were in environmentally sensitive areas, and 6% in fire sensitive areas, clearly illustrating that in the opinion of the beekeepers, rivers or wetlands does not equate to “environmentally sensitive”. [It should be noted that the validation process which followed the survey suggested that both the “rivers and wetlands” and the “mountain catchment” categories might be slightly over-reported by beekeepers].

Table 22: Landscape and environmental sensitivity of gum forage

Natural Landscape	Fire and Environmental status	Honey production		Number of colonies	
		In kilograms	As percentage of all honey produced on gums	Colonies	As percentage of all colonies on gums
Riverine areas and wetlands	enviro-sensitive	20454	7	1532	7
	fire sensitive	2679	1	292	1
	not sensitive	60234	20	4343	20
	Total	83367	28	6167	28
Mountain Catchments	enviro-sensitive	286	0	30	0
	fire sensitive	7111	2	774	3
	not sensitive	17333	6	1343	6
	Total	24731	8	2147	10
All other areas	enviro-sensitive	3187	1	314	1
	fire sensitive	9837	3	763	3
	not sensitive	176627	59	12727	58
	Total	189651	64	13804	62

These data are further analysed in Table 23 which compares the position of the landscape with the different species of gum. The vast majority of gum reported as being in rivers and wetlands are River Red Gum or Sugar Gum. Surprisingly, very little of the River Red Gum recorded in this category is regarded as being "environmentally sensitive", with less than 1% of all colonies reported. Sugar Gum also makes up the majority of "mountain catchment" gums, but there are also surprising amounts of both River Red Gum and Spider Gum in this category. Fire-sensitive gums are well represented in this category, as might be expected. The bulk of "other areas" is also mostly made up of Sugar Gum, River Red Gum and Spider Gum, with 42% of all colonies utilizing gums being reported to use Sugar Gum in non-sensitive "other areas". 5% of all gums is reported to be River Red Gum in "other areas", presumably away from rivers and wetlands, 63% of the amount of the same species reported for rivers and wetlands. Beekeepers themselves are of the opinion that 95.1% of the gums that they use are planted, and that only 4.9% are invasive (based on a positive response to this question. The impression gained during the validation process was that the allocation of gums as self-propagating as against planted were for the most part accurate.

Considering the same question, that is, the position in the landscape of gums being used, by analysing the site information provided by beekeepers, indicates that 75% of all colony months spent by honeybee colonies in the Western Cape on gums, is spent on non-sensitive "other areas" (Table 24). The rest of the time spent by colonies is divided almost equally between rivers and wetlands, mountain catchment areas, and nature reserves (Table 24).

Table 23: Gums versus position in the landscape. (Colonies of bees in all categories, followed by percentage of all colonies on gums. Total number of colonies using gums is 22118.)

Position in the Landscape		Gum species								
		Sugar Gum	Red River Gum	Spider Gum	Grey Iron-bark	Black Iron-bark	Karri	Saligna	Other gums	Un-known gums
Rivers and wetlands	Eco sensitive	497 (2.2)	145 (0.7)	27 (0.1)	3 (0.0)	2 (0.0)	18 (0.1)	6 (0.0)	17 (0.1)	816 (3.7)
	Fire sensitive	155 (0.7)	19 (0.1)	1 (0.0)	0 (0.0)	10 (0.0)	20 (0.1)	42 (0.2)	17 (0.1)	29 (0.1)
	All other areas	1836 (8.3)	1648 (7.5)	216 (1.0)	84 (0.4)	113 (0.5)	82 (0.4)	54 (0.2)	148 (0.7)	162 (0.7)
Mountain catch.	Eco sensitive	12 (0.1)	0 (0.0)	1 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.0)	14 (0.1)
	Fire sensitive	384 (1.7)	118 (0.5)	3 (0.0)	3 (0.0)	35 (0.2)	15 (0.1)	67 (0.3)	56 (0.3)	92 (0.4)
	All other areas	783 (3.5)	145 (0.7)	265 (1.2)	25 (0.1)	24 (0.1)	14 (0.1)	45 (0.2)	34 (0.2)	7 (0.0)
Other areas	Eco sensitive	142 (0.6)	1 (0.0)	73 (0.3)	3 (0.0)	3 (0.0)	12 (0.1)	15 (0.1)	32 (0.1)	34 (0.2)
	Fire sensitive	474 (2.1)	0 (0.0)	159 (0.7)	2 (0.0)	31 (0.1)	14 (0.1)	10 (0.0)	19 (0.1)	54 (0.2)
	All other areas	9286 (42.0)	1095 (5.0)	457 (2.1)	123 (0.6)	238 (1.1)	162 (0.7)	237 (1.1)	502 (2.3)	626 (2.8)

Table 24: Colony-months on different landscapes

	River and wetlands only	Mountain catchment only	Nature reserve only	River & wetlands plus nature reserves	Mountain catchment plus nature reserves	Other plus nature reserves	Other
Colony months	21936	22969	20722	2544	228	1200	213372
Percent	7.8	8.1	7.3	0.9	0.1	0.4	75.4

4.2 Qualitative Profile – Beekeeper Opinions

In response to the request by WFW for some information on the opinions and attitudes of beekeepers, a number of questions were asked of them to enable knowledge to be gained on the subject. It was believed that by doing this, some solutions of practical value could be canvassed and in the process the beekeeping fraternity encouraged to assist towards workable solutions. Also it was felt that an understanding of the attitudes of the beekeepers would help to determine the best way forward for all parties.

Overall, the survey responses were generally disappointing, at least in their ability to generate creative solutions to the problem. But, in support of the quantitative and economic findings, the responses were usefully confirmatory and provide an insight into the views of the apiarists. The results will be discussed by question and by issue raised.

4.2.1 Responsibility for provision and replacement of forage.

The attempt to canvass views on who should be responsible for bee forage comes in two parts. The first seeks opinions of a general nature as to who should be responsible for ensuring the ongoing availability of forage for honeybee colonies. And the second asks specifically who should be responsible for replacing the forage which has been removed by the WFW gum programme. Table 25 gives the results of the first, and Table 26 the second. Answers in each are stratified according to the size category of the beekeeper.

Table 25: Share of responsibility to ensure bee forage is *generally available* (allocated score out of 100)

	Responsibility				
	Land owners	Bee dependent industry	Beekeepers	Government	Other
Small beekeepers	25	20	23	31	1
Medium beekeepers	19	15	32	33	2
Large beekeepers	12	16	30	42	1
Overall	19	17	28	34	1

Table 26: Share of responsibility to ensure forage is *available after CARA gum removal* (allocated score out of 100)

	Responsibility				
	Land owners	Bee dependent industry	Beekeepers	Government	Other
Small beekeepers	11	10	13	64	1
Medium beekeepers	8	8	12	71	0
Large beekeepers	2	9	12	77	0
Overall	8	9	13	69	0

There are only two major issues which need to be highlighted here, neither unexpected. The first that the *general* responsibility for providing forage should lie almost equally between the landowners, fruit industry, beekeepers and government; there is no obvious tendency towards any body. However, the replacement of forage *after removal of gums* by WFW is considered to be essentially the responsibility of government. The second point is that the larger apiarists (compared to the medium and small apiarists) lean more heavily towards government to resolve the forage problem generally. The likely reason for the this is that the larger apiarists, as full time commercial operators within a relatively important industry, feel more exposed to national directives and see intervention as a necessary ameliorative to these directives. The differences between larger and smaller apiaries are not marked however.

4.2.2 Should beekeepers have special dispensation in respect of water courses?

Table 27 indicates the views of the beekeepers regarding whether they should receive special dispensation allowing them to retain gums in watercourses, where the forestry industry is prohibited from planting trees. The medium and larger beekeepers suggest (in a ratio of 3:2 for medium and 2:1 for large) that beekeepers should receive special dispensation. The reasons given for seeking this 'yes-to-gums-on-watercourses' dispensation are almost all based on the overall economic value of bees in the Western Cape. Many of the comments, however, are qualified to allow the removal of gums from particularly sensitive water-courses. It is nonetheless surprising that a significantly large number of beekeepers (especially small beekeepers) do not consider that the bee industry should be especially privileged.

Table 27: Should the bee industry receive special dispensation with respect to the retention of gums in watercourses?

Size Category	Number responding:	
	'yes'	'no'
Small beekeeper	27	34
Medium beekeepers	30	19
Large beekeepers	23	12

4.2.3 Responsibility for environmental impact

The question is asked of the apiarists, who should be responsible for the environmental impact of the gums should they be allowed to stay. There are three categories of environmental impact (the *raison d'etre* of WFW policy on gum removal) which the beekeepers are asked to allocate responsibility for. The first is the question of invasiveness of natural biomes, the second, the problem of fire damage from the conflagration of the fuel load generated by gums, and the third, the issue of water conservation where gums are found to be adversely affecting the water courses. The response is to be found in table 28 which indicates an average allocated score out of 100 between the four role players – landowner, government, beekeeper and fruit industry.

Table 28: Environmental impact responsibility (score out of 100).

	landowner	government	beekeeper	fruit industry
spread of gums	44	22	29	6
fire protection	47	20	26	6
water conservation	39	35	19	7

The allocated responsibility for the 'spread of gums' and for 'fire protection' have similar profiles. The owner of the gums (first) and beekeeper (second) should, by average vote, bear responsibility for these areas up to a joint score of 73%. Government occupies a mere 20% of the 'responsibility' score, and only a few see the fruit industry as having any serious responsibility. The issue of water conservation, however, raises the government responsibility level up to 35%. This would seem to indicate that, in the beekeepers opinion, 'water' is more of a central and national concern than 'fire' and 'invasiveness'. In all impact areas, however, the landowner is expected to shoulder the greatest responsibility. What is perhaps surprising is the degree to which the beekeeper has allocated responsibility to himself for each of the above, between 20% and 30%.

4.2.4 Willingness to demarcate?

The CARA legislation allows for species in category 2 of the legislation to be demarcated, with the landowner taking legal responsibility for possible spread and for

water usage. The problem is that because the responsibility (and possible accompanying levies) automatically vests with the landowner in the case of demarcation, there is very little incentive to keep the gums on the property for the purpose of keeping bees. It is thought that for this reason beekeepers may not be able to persuade farmers to go through with the demarcation process. Respondents were therefore asked whether they believed their gum forage sources would be able to be demarcated. The answer is that the owners of two thirds of the gum sites used would, in the opinions of the beekeepers who house their hives there, be prepared to 'demarcate' their plantations.

The same question is not asked on a per site basis so that it is not possible to quantify the actual area involved in potential demarcation. As “large” beekeepers report that they own only 7% of their gum sites, the 66% of sites that they believe landowners are willing to demarcate on their behalf, clearly constitute a majority of the gum apiary sites in the Western Cape, and beekeepers believe that the majority of these sites need not necessarily be lost as a result of CARA legislation.

4.2.5 Dispensation for other industries dependent on harmful alien plants – eg nurseries.

Beekeepers were asked if, should the removal of CARA-listed gums be delayed or stopped, similar consideration should be given to other industries dependent on CARA-listed species. Of the 128 respondents 36% opted for the answer 'no' and the balance of 64% for 'yes'. There is little that can be concluded from this, except that the majority of respondents do not feel that the beekeepers should enjoy any special privilege, notwithstanding their argument (which appears in the reasons 'if no why not?') that they believe their industry carries especially significant economic weight, particularly through its pollination linkage.

4.2.6 Predicted effect of CARA gum removal vs ultra eco-sensitive gum removal.

Respondents were asked to predict the quantitative effect of the removal of all CARA-listed gum species on a) the number of colonies that they owned, b) the effect on the production of honey, and c) the effect on pollinations. Although speculative, the results do give a relative indication of what might happen if the policy of removal takes place. What is perhaps more valuable is to see how the 'damage profile' changes when the policy of gum removal shifts to River Red Gum and Spider Gum only. The information is contained in table 29 and estimates the negative effect (as a percentage) of gum removal on the numbers of colonies maintained by beekeepers, the amount of honey produced, and the numbers of colonies available for commercial pollination services. The sample is stratified into the three size categories of beekeepers.

Table 29: The average negative impact (percentage) on various components of beekeeping under different gum removal regimes.

	CARA-listed gum removal			River Red Gum and Spider Gum removal		
	Number of colonies	Honey production	Pollination	Number of colonies	Honey production	Pollination
Small beekeepers	65	52	69	53	39	56
Medium beekeepers	62	72	62	38	43	42
Large beekeepers	72	71	64	33	41	36
All beekeepers	65	68	66	41	42	45
Sample - all beekeepers:	using gums	using gums	pollinating	using gums	using gums	pollinating

Since the large commercial and medium beekeepers are economically the most consequential it makes sense to focus on those beekeepers for pertinent answers. If all CARA gums are removed, the potential losses in all the three above areas of beekeeping lie in the region of 60-70%. For these two categories of beekeepers the position changes significantly where only the River Red Gum and Spider Gum are removed. The number of colonies predicted to be damaged reduces from an average 67% to an average 36%. Honey production reduces from 71% to 42% and pollination reduces from 63% to 38%. The latter probably reduces less than the others because many apiarists would would strategise to keep swarms alive without expecting honey production to enable pollination to continue.

It is very interesting to compare the 'perceived losses' by the beekeepers (indicated as a percentage – Table 29) and the 'calculated losses' derived from the beekeepers own data submitted in the survey (Tables 17, 20 & 23). This comparison is presented in Table 30 and indicates that the beekeeper perceptions regarding the loss of all CARA-listed gums is relatively consistent with the production data, but their perceptions regarding the loss of the extremely eco-sensitive gums only is less so. Data submitted by the beekeepers suggest that they would lose more colonies than they expect if all CARA listed gums were removed, but less than they expect if only gums are removed. When it comes to the impact on pollination, beekeepers under-estimate the influence of both categories of gum removal. Of course it needs to be noted that these 'impacts' assume the colonies and the products are all lost if the gums are removed, an outcome not likely to be realized. It should also be noted that the "actual" figures in Table 30 should be slightly higher, to include "unknown gums" that are in reality either CARA-listed gums or extremely eco-sensitive gums.

The important message delivered by this table is that it illustrates in a quantitative sense the business concerns of the beekeepers that are exposed to the WFW felling policy. There is clearly a dramatic difference in the predicted damages between all CARA gums and the 'extremely eco-sensitive' gums. In general statements on the effect of the WFW programme, 105 beekeepers out of 173 respondents indicated that they would either close the business or continue at very high cost should all CARA-listed gums be removed, whereas only 63 beekeepers indicated a similar response should only River Red Gum and Spider Gum be removed.

Table 30: Predicted negative impact on beekeeping parameters by type of removal policy, compared to likely impact determined by results of the survey. The predicted impact of either CARA-listed gum removal or 'extremely eco-sensitive' gum removal (Table 29) is compared with figures extracted from beekeeper responses: Table 17 for honey production, Table 20 for pollination, and Table 23 for colony numbers. The comparison assumes that all gums of the particular category are removed, and that all colonies sited in those gums and their products (honey and pollination) are lost.

	Colony losses		Decrease in Honey Production		Reduced Number of Pollinations	
	Beekeeper prediction	Estimate from survey information	Beekeeper prediction	Estimate from survey information	Beekeeper prediction	Estimate from survey information
All CARA-listed gums removed	-65% = 14377	19458	-68% = 308640	272712	-66% = 33575	48616
Only "extremely eco-sensitive" gums (River Red Gum and Spider Gum) removed	-41% = 9068	4373	-42% = 190630	58206	-48% = 22892	30863

4.2.7 *Adaptation of bee businesses over different time horizons*.

The beekeepers were asked to indicate how they would adapt to the removal of all CARA-listed gum species. Their responses were to be in three parts, each assuming a different time frame for the eventual removal of the trees: one year, five years, and ten years. Table 31 provides the outcome after comments were categorised into different answer groups. There are four interesting aspects raised by the table, three of which lend value to a gradual approach, especially over the ten-year horizon. The first is that there is a marked reduction of beekeepers intending to close their business over that period, from 48 % planning to close in year one to 39% over ten years. Conceptually, nine per cent more beekeepers will plan to survive. The second result, similar though not in the same dramatic vein, is that the percentage of beekeepers planning to downsize reduces from 12% to 7%. Together this implies that an extra 14% of beekeepers foresee a solution to the problem of gum removal, provided that time is on their side. The final, key point in the table hints at the way in which this survival can be achieved. It is to plant more forage. Fifteen percent of beekeepers believe they can survive a ten-year removal programme by this approach, in contrast to only 5% who believe this option is viable in the shorter term.

The beekeepers, unfortunately, have little to offer as regards insightful suggestions as regards what this new forage might be (Table 32). Eighty six per cent of respondents either failed to answer this question, or said they had no idea or that there were no viable alternatives (Table 32). What suggestions that there were focussed on better usage of fynbos as bee forage, or the planting of non-invasive gums or other trees as bee forage.

Table 31: Adaptation strategy for beekeepers over different time frames (percentage of responses).

Expected strategy	Period for removal		
	1 yr	5 yr	10 yr
Close the business, can't adapt, go out of bees	48	43	39
Find new forage (eg fynbos)	17	20	20
Undecided, wait and see	5	4	5
Business will stagnate, erode	6	7	5
Create new forage	5	5	15
Downsize, consolidate	12	13	7
Continue as before	8	7	7
Re-adjust products or prices	0	1	2
TOTAL	100	100	100

Table 32: Alternative suggestions from beekeepers as regards forage sources.

No answer	76
No alternative	35
No idea	43
Fynbos/renosterbos	9
Plant other trees and non-invasive gums	13
Research	3
Other	1

Notwithstanding the optimism alluded to in Table 31 by a minority proportion of the beekeepers over the long term, the majority feel there is little they can do to save their businesses once the CARA-listed gums are removed. It is noticeable that the removal of gums has become ever more prominent in the concerns of beekeepers over the years. The removal of eucalypts was considered to be only the twentieth most significant risk to beekeepers in the 1975 survey (Anderson 1978). This had increased to the third most significant risk in the 1995 survey (van der Merwe & Eloff 1995), but still only 5% of beekeepers regarding it as a major problem. By 2004 (Table 31) between 50-60% of beekeepers believe that the loss of gums would prove fatal to their enterprises. The difficulty of creating or accessing new and valuable forage has equally been long a concern of beekeepers. Already in 1975, alternative sites and suitable forage was considered to be of great importance by beekeepers, and considered to be the second biggest problem after theft (Anderson 1978). The final interesting aspect in table 31 is

that practically no beekeepers believe that they can adjust to gum losses by increasing the prices for their services or products. This result suggests that beekeepers do not believe that the market would support an increase in price for honey, or that growers would be willing to increase payment for colonies rented for pollination.

4.2.8 Beekeepers and WFW working together.

An open-ended question was asked of the beekeepers: How best can Working for Water and the beekeepers work together to ensure sustainable management of gums? Again the answers were categorised into ten different answer types, which are shown below in Table 33.

Table 33: How can beekeepers and WFW work together?

Comment category	Respondents
Negotiate, communicate, consult	40
Remove only ultra eco-sensitive gums	24
Reconsider CARA legislation	12
Gradually replace with non-invasive gums	8
Control existing plantations and their spread	7
Use outside intervention, facilitation	4
Remove government owned gums only	1
Beekeepers should adapt	1
WFW unnecessarily immovable	7
Don't know	1
TOTAL	105

This last question on the questionnaire provided amongst other things an opportunity for beekeepers to make a political statement. In fact only seven of the 105 responding to the question believed that Working for Water was totally intractable in its approach. The remainder of the responses were generally constructive and often wide-ranging. Suggestions varied from 'planting large areas of bottlebrush for the bees' to ideas of 'conserving water by removing the Palmiet first'. Here is a brief review of the key suggestion categories, within which could lie some workable policy guidelines.

The most overwhelming response confirms a wish for beekeepers to work together with Working for Water in some, as yet, undefined way. The accompanying pre-amble to such requests often spoke of the importance of involving beekeepers in developing a solution and even suggested that at some stage WFW were not prepared to listen to the

beekeeping fraternity. The starting point for the future, voiced by the greatest lobby within the survey was to talk, consult, workshop, and generally communicate with WFW.

The second and third most important responses were for WFW and Department of Agriculture to: a) remove only seriously problematic gum trees (rather than indiscriminate felling); and b) reconsider the CARA legislation. They are taken together here because they both refer to similar things. Whilst a few respondents see trees as being less problematic if they are for instance in a non-sensitive watercourse, the main issue is with sugar gum where it exists outside a watercourse, mountain catchment or nature reserve. The plea ultimately is to make changes to the legislation to allow the controlled continuation of partially sensitive plantations so that the bee industry can continue to function.

Requesting greater tolerance could be regarded as a defensive strategy. More pro-actively the beekeepers suggest replanting for more forage and dealing with the gum issue in a more controlled way (eight and seven respectively out of the sample of 105). Other responses include seeking an objective arbiter or interventionist (the Minister of Agriculture was named by one) (4), complaining about WFW alleged intransigence (7), removing only government controlled gums (1), and don't know (2). Only one respondent believed that it was the beekeepers who should adapt.

5 DISCUSSION

The task of the consultants was essentially to determine how big the 'gum cake' that beekeepers and crop producers were reportedly feeding on was, and what would happen should that 'cake', or portions of it, be removed through the actions of the Working for Water Programme. This seemingly simple question was made difficult by a number of factors. Firstly, it is impossible to accurately determine the size of the cake as all parties in the debate had different ideas as to how it was constituted. The question then became: what would happen if slices of the cake of differing sizes (and impacts) were removed? A second problem was that it was impossible to determine exactly how many beekeepers (and crop producers) are utilizing bees using gums, because it was impossible to know how big the beekeeper pool is, or what percentage was represented by the survey. Finally, predicting what would happen should the 'cake' of gums be removed presents a host of alternatives, options and considerations that are daunting in their complexity.

5.1 Eucalypts – a perspective

Beekeepers have questioned the WFW gum removal programme on three grounds: 1) whether the species to be removed are really invasive; 2) whether they are unusually heavy water users; and 3) whether the negatives of keeping the species are not outweighed by the positives (cost versus benefit). The last question will be addressed in the remainder of the Discussion, but some clarification is needed regarding the first two concerns of beekeepers.

In respect of the invasive potential of the CARA-listed gum species, and gum species in general, there is some lack of clarity. A review of this issue therefore becomes relevant. While CARA lists seven eucalypt species as invasive in the Western Cape, Hall (1979) lists only *E. lehmanni* and *E. gomphocephala* as invasive eucalypts of Cape fynbos and Nel *et al.* (2004) list *camaldulensis* and *lehmanni* as major invaders, and *saligna* and *cladocalyx* as emerging invaders. Eucalypts, according to Lusk & Bellingham (2004) are in general very poor invaders, and despite massive propagule pressure, most cannot naturalise. Eucalypt seedlings are seldom able to compete with parents under plantation conditions but can invade pine plantations and denuded areas (Poynton 1979; Forsyth *et al.* 2004; the validation process of this survey).

In a recent rapid assessment of the invasive potential of eucalypts in South Africa, Forsyth *et al.* (2004) report that *camaldulensis* is a major and underestimated environmental weed in both Mpumalanga and the Western Cape, and that *grandis* is also invasive. In contrast, they report that Sugar gum is invasive only under certain conditions, notably after fires or in pine plantations (Forsyth *et al.* 2004), and that there is no indication that *diversicolor*, *sideroxylon* and *paniculata* are invasive in the Western Cape. It is significant to note that in their modeling of the cost of alien plants, van Wilgen *et al*. (1997) assumed that alien plants spread only after fires, supporting the contention of beekeepers that the gums are only invasive under local conditions and specific circumstances.

Impressions gained during the validation process of the survey are in agreement with the conclusions of both Forsyth *et al.* (2004) and van Wilgen *et al.* (1997). There is no doubt that *camaldulensis* dominates river-courses and is highly invasive all along the Berg River, and in many parts of the Breede River. Although many of the trees along the river banks are clearly planted the dispersal distance of the species is less apparent. It should be noted that this is similar to the situation in Australia where it is the most widespread eucalypt (Poynton 1979), and it probably should be expected to be invasive throughout South Africa. As *camaldulensis* is a very important eucalypt species across dry regions of South Africa, it is suggested to be important to determine the dispersal characteristics of the species, to determine how much of a threat these dry-country gums are to other river courses in South Africa, and what needs to be done to avert this threat.

It was apparent during the validation process, however, that the CARA-listed species found in farmlands (drylands) of the West Coast, Boland and Overberg are not invasive under normal circumstances, with no self-propagation being visible. One area of dispute with regards to the established literature is the status of Spider Gum, *lehmanni*, an 'uncontested invasive' on the Agulhas floodplain and the Cape Peninsula (Forsyth *et al.* 2004) and a category 1 plant under CARA. No dispersal could be seen from Spider Gum in these drylands, and as with the other gum species (excluding the River Red Gum), specific environmental conditions appear to be critical in determining if a gum species is invasive or not. It has to be noted that the few occasions during the survey that stands of invasive *sideroxylon*, *lehmanni* and especially *cladocalyx* were noted, all were in areas exposed to frequent fires or in pine forests, the latter clearly caused by eruptions of the previous gum species planted on the same ground.

Nonetheless, for the purposes of this report, all seven of the gum species listed under CARA are considered to be invasive and hence subject to removal or control under CARA legislation. On the basis of a preliminary view of the evidence, however, further

discussion on the invasive nature of the seven species is to be encouraged in the strategic phase to follow this economic assessment.

A final issue that requires consideration, in an estimate of the impact of eucalypt removal, is the total extent of the gums to be removed, and what proportion are utilized by the beekeepers. Marais *et al*. (2004) estimate the area of invasive gums in South Africa to be 63 000 hectares, and report the clearing of 5 761 hectares (initial and follow-up clearing) in 2002/2003 at a cost of R11.52 million. Le Maitre et al. (2000) indicate that less than 64 000 hectares is "condensed invaded area" but more than one million hectares of total eucalypt invasion exists. Of these, 606 599 hectares are in the Western Cape, including 12 112 hectares of the "condensed invasion" (Versfeld et al. 1998). In contrast to these figures, this present survey seems to indicate that beekeepers in the Western Cape place only 6167 colonies in riverine areas and wetlands (Table 23) which translates to only 1 000 hectares at the rate of 6 colonies per hectare, and that only 5% of the gums used (or 1 106 hectares) are considered by them to be self-propagating or invasive. Hence, there is a tenfold difference between what the beekeepers reportedly use, and the gums that are reportedly present. It is impossible to know which calculation is the more accurate but it should be noted that Le Maitre *et al.* (2000) themselves highlight the difficulties involved as their figures are based entirely on modeled data, without detailed mapping or spatial data, and "there are no data sets which can be used to assess the accuracy" of invasions of exotic species. It is certainly not credible that beekeepers in the Western Cape use only 10% of the gums present.

Finally, this assessment does not concern itself with the water-usage of gums as a reason for their removal. Although here it is interesting to note that the planting of eucalypts on Table Mountain in 1884 was motivated by a desire to increase water supply, "to replace the bleak and naked appearance" with trees to intercept moisture from summer clouds and secure a "bountiful supply of water" (Shaughnessy 1980). Dispute in this regard, the consultants believe, is more appropriately addressed in the strategic planning phase intended to follow this study.

5.2 Economic Impact of WFW Eucalypt Removal

There are two different methods by which the possible economic impact of eucalypt removal in the Western Cape might be assessed. The first method follows the standard, simplistic methodology, which looks at the current value of the gums to beekeepers and growers on the basis that this entire value is lost if the gums are removed. To facilitate the discussion this will be termed the 'total cut-off' cost. The second method seeks to anticipate a realistic scenario by considering what compensating reaction could be expected from beekeepers (and crop producers) should listed gums be suddenly removed from the bee forage chain. Industries sometimes unexpectedly find a way of adjusting when placed under serious pressure. This impact cost will be referred to as the 'realistic' (or 'outcomes') cost.

The economic impact of the removal of two versions of the cake are considered: (1) The highly 'eco-sensitive' gums (which are all gums in river-courses or wetlands, nature reserves and mountain catchment areas, and all Spider Gum); and (2) All CARA-listed gums.

5.2.1 Total cut-off cost assessment

At a cursory level, the task of determining the economic costs to beekeepers of the removal of gums by WFW programmes is relatively straight-forward: add the value of bee products produced on these gums, and the pollination value of colonies using these gums, together to establish the economic 'cost' created by their removal. This is very much the traditional method of bee-value assessments and has been used in most calculations of the 'value contribution' of bees and presupposes that the bees are removed as if by a stroke of a wand. Such attempts include the per annum value of honeybees of R3.5 billion in South Africa (Johannsmeier & Mostert 2001), R2.4 billion in the UK (Carreck & Williams 1998), and R106 billion in the USA (Morse & Calderone 2000). The Cape Action Plan for the Environment (CAPE) (CSIR 2000) was also largely based on this type of methodology, and concluded that "the entire Cape deciduous fruit industry is dependent on bees for pollination and these bees are almost totally reliant on fynbos in winter". Turpie *et al.* (2003) calculated that the value added by fynbos to honey and fruit production in the Western Cape was 40% of the total value of these products, or R580 million per annum. The rest of the value (in this analysis) was attributable to gums (Turpie *et al.* 2003); that is, R876 million per annum.

There are two general errors with this type of calculation. Firstly, this methodology does not take into account compensatory action on behalf of the beekeepers or the growers, such as moving the honeybee colonies presently on gum forage to alternative forage, or planting alternative forage, or crop producers using other (non gum-dependent) colonies for pollination.

Secondly, this methodology assumes the entire value of a pollinated crop, or at the very least that portion that is pollinated by honeybees, to be assignable to honeybees in the event of their removal. Thus, as apple production is reported to be 100% dependent on insect pollination, and as 90% of these insects are honeybees (Morse & Calderone 2000), the value of honeybees in apple production in South Africa in 2003 was R1.15 billion based on a total apple value of R1.28 billion (DFPT 2003). This form of calculation credits the full value of the crop to the honeybee pollinators, and nothing to the multitude of other factors: water, land, fertilizer, labour, pesticides, machinery, fuel. An appropriate analogy is to calculate the worth of the right front tyre in a motorcar race with prize-money of R1 million. It is true that if the tyre bursts the car does not win, but does that mean the value of the tyre is R1 million?

Using this basic methodology, the economic costs of the removal of all CARA-listed gums to beekeepers and crop producers of the Western Cape is calculated to be R1862.6 million per annum (Table 34). The economic costs of removal of 'ecological-sensitive' gums only (River Red Gum and Spider Gum) is calculated to be R1177.5 million per annum (Table 34). The vast majority of these economic costs are made up by a presumed stoppage of crop production resulting from (a presumed) loss of pollinators, at R1824 million and R1166 million for the loss of all CARA-listed gums and the loss of highly eco-sensitive gums respectively. Calculations for Table 34 are determined under the following assumptions:

- Honey lost. Calculated as the loss of all honey produced by beekeepers on CARA-listed or highly eco-sensitive gums (Table 17), at R24 per kg.

- Sundry products lost. Calculated as 25% of the value of honey produced by beekeepers on CARA-listed or generally eco-sensitive gums. Sundry products include wax, pollen, propolis, and products made from these raw materials.
- Colonies lost. Calculated as the loss of colonies presently maintained on gum sites, at R400 per colony, and based on colony numbers recorded in Table 23. All other calculations in Table 34 are annual costs; colonies lost is a once-off calculation.
- Pollination revenue lost. Calculated as the loss of pollinations presently provided by colonies maintained on gums (Table 20), at R260 per pollination.
- Crop production lost. The value of deciduous fruit crops in the Western Cape is reported to be R1995 million per annum, 90% of which (R1796 million) is reportedly due to the pollination of honeybees (DFPT 2003; Table 35). A proportional calculation of other crops pollinated by honeybees in the Western Cape adds a further R115 million to this total, giving a bee-related value of crops in the province of R1911 million per annum. As 96% of the colonies used for pollination utilize CARA-listed gums, the value of the gums in terms of crop production is calculated to be R1834 million per annum. A similar calculation for ultra eco-sensitive gums, based on 61% of colonies using these gums, yields a total of R1166 million per annum.

Table 34. The value of CARA-listed and highly eco-sensitive eucalypts to beekeepers and crop producers in the Western Cape, based on 'total loss' methods (in Rands).

		Cost of the removal of all CARA-listed eucalypts	Cost of the removal of highly eco-sensitive eucalypts
Beekeeper Costs	Honey lost	6.546 million	1.397 million
	Sundry products lost	1.637 million	0.349 million
	Colonies lost	7.782 million	1.749 million
	Pollination revenue lost	12.640 million	8.024 million
	TOTAL	28.605 million	11.519 million
Growers Costs	Crop production lost	1834 million	1166 million
TOTAL COSTS		1862.605 million	1177.519 million

5.2.2 Realistic outcomes-based assessment

In considering what the true economic impact of gum removal in the Western Cape might be, it is necessary to consider the outcomes, based on the actions of beekeepers and growers faced with economic survival in the event of gum removal. With this in mind let us review the economic consequences of gum removal in a more critical manner by examining some of the strategic alternatives which could be considered by the beekeepers in respect of honey production and pollination.

5.2.2.1 Honey production and other bee products

This a good place to make the following brief point about value, costs and margins. Should all the bees be destroyed and the apples and plums removed as a consequence,

say, of the WFW programme, there would arguably be a saving in costs (by doing less business) to offset against the loss of product value. The *net loss* to the grower and beekeeper would, on that basis, be the extent of the financial losses to which they would, as economic sub-sectors, be exposed. But it would be incorrect to use this *net* figure as the basis for calculating economic impact since other role players, from fertilizer salesmen to fruit marketers to hive makers, would be deprived of their share of *their value of the industry*, represented by the sundry input costs of beekeeping or fruit farming. It is therefore realistic to use product value and not profit margins as the standard for calculating broad-based economic impact.

Given the prospect of survival, could honey production losses resulting from gum removals be defrayed by beekeepers moving their colonies to alternative forage? In such a case, the gum removal would not result in actual production losses. The question being: what alternative forage is available?

In the survey, this question was asked of the beekeepers, but with no positive responses; no alternatives were offered. The reality of bee forage is that the vast majority of pollen and nectar collected by honeybees in the Western Cape during summer is from gums and assorted exotic weeds (Johannsmeier 2000). Indigenous honey sources in South Africa are essentially limited to spring flowering, which is strictly determined by the rain during the previous season and are highly variable (Johannsmeier & Mostert 2001). The best indigenous nectar sources in the country are *Acacia karoo* (sweet-thorn), *Acacia mellifera* (hook thorn), *Scutia myrtina* (cat thorn), *Ziziphus mucronata* (Buffalo thorn), *Combretum* spp., *Aloe* spp., *Euclea* spp. and *Erica* spp. (Johannsmeier 1994). None of these except Ericas are found in any number in the Western Cape, and none would be summer flowering and hence able to assume the importance of gums in the beekeeping landscape. Other viable honey sources in South Africa are cultivated plants such as sunflowers, citrus, lucerne and canola and weeds such as ramenas (wild mustard), *Echium* (bloublommetjies), dandelions and *Prosopis*. It is, however, not plausible that crop plants would be developed in the Western Cape to assist with the availability of honeybee forage, and clearly not suitable to develop weeds as a replacement for gums. That leaves only canola and fynbos as viable honey sources in the Cape (other than gums).

The canola planted in the Western Cape is sometimes mooted as an alternative to gums for beekeepers, but this is unlikely to be the case. The 42 000 hectares of canola in the Western Cape results, according to survey estimates, in only 3% of the honey produced (Table 10). And even if canola production increases to 100 000 hectares as is likely (Dirk Hanekom pers. comm.), this will make little difference to the potential of canola for honey production in the Cape. Furthermore, as an “alternative” to gums the canola flowers at precisely the wrong time of the year, being a winter crop as against the mid-summer sugar gum. In addition, using canola as a primary crop offers additional problems for beekeepers. The most obvious is the high degree of pesticide poisoning that occurs on canola, in common with all crops where beekeepers are not paid for pollination. There have recently been reports of poisoning in canola fields in the Western Cape, causing beekeepers to remove their colonies from the fields. The second problem is that canola is a very difficult crop for bees, and for Cape bees in particular. The sugar-rich nectar of canola (> 60% sugar concentration, Westcott & Nelson 2001) and the extremely protein-rich (> 20% protein, Kosonocka 1990) and lipid-rich (Singh & Singh 1996) pollen result in the crop being extraordinarily attractive to honeybees. Cape honeybee colonies on canola tend to immediately begin with colony reproduction and, if

not carefully managed, will swarm until there is nothing of the colony left (Allsopp unpublished results). This, together with the fact that canola honey granulates extremely quickly and is therefore of limited value to the beekeeper, has meant that most beekeepers in the Western Cape have tended to use canola as a 'shock' treatment: that is, they take colonies into canola for 2-3 weeks to allow for a rapid build-up but remove the colonies before honey is produced or problems are encountered. Under these circumstances it is difficult to see that canola might replace gums as a major honey source in the Cape.

The only other forage source listed by any number of beekeepers as an alternative (Table 32) is fynbos. The reality, however, is that accessible fynbos is presently heavily utilized by the beekeepers and expanding the contribution of fynbos to the maintenance of the industry would require access to fynbos presently off-limits to commercial beekeepers. Beekeeper associations in the Western Cape and in other parts of South Africa have recently attempted to gain access to nature reserves on the grounds of limited suitable bee forage being available elsewhere. Only by acceding to this demand is it conceivable that fynbos could make an increased contribution to beekeepers. In any event, and as with canola, the winter flowering of fynbos will have little impact as regards the availability of nectar resources during the dry summer months

An additional option would be for beekeepers to increase honey prices to make up for reduced production. South Africa traditionally produced approximately 3 500 tons of honey annually (Johannsmeier & Mostert 2001) but in recent years this has been drastically reduced, largely as a result of the Capensis Problem in the northern areas of the country. Honey imports into South Africa were also prohibited until 1990, but have increased since then to the level that a minimum of 1 800 tons of honey have been imported into the country in the past year, all of it on a rebate system allocated by the National Department of Agriculture. The consequence of this is that honey prices in South Africa are presently dictated by the international price and availability of honey and not by local production. Local beekeepers cannot therefore increase the price of honey to compensate for decreasing production figures as this would only serve to further encourage honey imports.

In conclusion, the beekeepers in the Western Cape would be unable to compensate for honey production lost due to the removal of CARA-listed gums, and would not be able to increase honey prices to compensate for reduced production. Accordingly, the 'apiary gate' value of honey lost for the sample is calculated to be R6.546 million for the CARA-listed gums, and R1.398 million for the ultra-sensitive gums. If the sample represents 80% of the total then these figures are R8.182 million and R1.747 respectively.

5.2.2.2 Pollination revenue to beekeepers and colony losses

If CARA-listed gums or ultra-sensitive gums were removed, would this necessarily mean the loss of the honeybee colonies utilizing these resources, and the loss of the revenue currently received through the use of these colonies from commercial pollination? It is difficult to rationalise a scenario that, in practice, will allow the kind of losses which little or no pollination would generate in the fruit industry. While the majority of beekeepers indicated that they would quit beekeeping in the event of large-scale gum removal (Table

31), the practical reality if all the listed gums were removed, is that it might not result in a substantial reduction in pollination revenue, or in colony numbers. Beekeepers would seek measures that would allow them to maintain colonies for pollination purposes, even if these colonies contributed little in terms of honey production. There is some scope for both canola and fynbos being better utilized to sustain and prepare the necessary numbers of honeybee colonies prior to commercial pollination, provided these colonies can be sustained financially as well as nutritionally for the rest of the season (mid- late summer). In addition, beekeepers have the option to feed colonies, simply to keep them alive during the gum foraging season from November to April, prior to the pollination season. Already many beekeepers feed colonies to prepare them for pollination.

Under certain conditions, the loss of gum forage *need not* cause a substantial decline in the numbers of honeybee colonies in the Western Cape that are available for pollination, or indeed, because of the dependence of the bee industry in the Cape on pollination (Table 6), on the total numbers of colonies in the province. A practical, anticipatory approach is to examine: (a) the increased cost to the fruit industry of a strategy for keeping the bees alive purely for the purpose of pollination; (b) the economic implications of such a strategy for the beekeepers and fruit growers; and (c) the impact it might have on the honeybee colonies in the longer term.

A beekeeping industry focused entirely on crop pollination would undoubtedly have implications in pollination prices, but these are not as significant as might be imagined. Let us take an example using the *ultra-sensitive* Red River and Spider gums. The survey respondents estimate that a honey crop valued at R1.397 million is produced on the *ultra-sensitive* gums (Table 17). If all of this honey was produced by the reported 30 863 pollination units (Table 20) that were kept at some stage on these *ultra-sensitive* gums, then an increase of R45 per pollination unit would compensate for this loss of honey production. Similarly, to compensate for the R6.566 million of honey lost from all CARA-listed gums, R135 extra would have to be paid for each of the 48 616 pollination units, again based on the total loss of the estimated CARA gum honey normally being produced by hives used for pollination.

Beekeepers would also have additional costs if colonies are maintained solely for pollination. These costs would be both in terms of direct costs for the additional supplementary feed, and also indirect costs for travel and time involved in the feeding process. In addition to the costs, there should also be concern as to whether colonies existing on supplementary diets will remain healthy in the long-term. Winston (1994) suggests that bees maintained on supplementary diets are of poorer quality, possibly courting disastrous long-term consequences. As colonies only produce the brood necessary for survival if sufficient pollen is available (Johannsmeier 1999) such feeding will have to include supplementary protein as well as carbohydrates. African bees appear not to respond well to commercially available supplementary protein diets (Johannsmeier & Mostert 2001; Allsopp unpublished data). Sustaining honeybees on supplementary diets is almost certain to stress colonies, make the population less robust and more susceptible to disease or other perturbation – all of which could result in additional colony losses for the beekeeper, and poorer pollination for the grower.

Notwithstanding, the costs, to be recouped from the pollination fee could be determined in a way that preserves the gross earnings per pollinating hive as follows:

	Gum forage	No gum forage
	Rand	Rand
Honey produced at say,10kg at R30 per kg (lost without gums)	300	0
Feed cost and transport at say, R24 per feed per month	0	(120)
Pollination fees at say,1.7 pollinations per hive @R257/poll	437	@ R**504**/poll 857
TOTAL	737	737

Note: The value of honey includes the byproducts at 25% of the value of the honey. The yield attributable to gums, 10kg - other forage 4kg - is derived from Table 10.

This means that pollination will cost the farmer R504 per pollination which is almost double the existing rate, that is R247 more. Furthermore, assuming that the survey sample accounts for, say, 80% of all pollinations, i.e. an industry wide total of approximately 63 000 pollinations, and CARA gums account for 95% or nearly 60 000 pollinations (based on table 20) then the added cost to the fruit industry could be reckoned at R14.82 million. (An amount of 14.42 million is calculated in Table 36 where the global quantities of the survey sample are used and upped on the basis that the sample represents 80% of all pollinating beekeepers, noting too that 80% is probably conservative.)

Looking at the apple costs at present, which are around R40 000 per hectare, the additional cost (or transference of cost) to the farmer of about R500-R600 per hectare for pollination does not seem to be insurmountable. However, margins in the fruit industry are under strain and the additional pollinating premium is a high proportion of the average profit. The situation for plums, albeit with higher per hectare margins is worse, since five to six hives are needed at an extra cost of about R1500 per hectare.

Should only the Red River and Spider Gums be removed, then the impact would be significantly less. Approximately 60% of all the pollinating hives use these gums in their forage chain (Table 20). The honey loss would be proportionally less because these gums do not give the same honey yield as say sugar gums which make up most of the CARA gum nectar source. Using the ratio of honey production based on survey estimates of ultra-sensitive gums to all gums, probably no more than about 20% of the *pollinating hives'* honey is derived from this source. Using this rationale the following would seem to be reasonable:

	Gum forage	No gum forage
	Rand	Rand
Honey produced at 10kg at R30 per kg x 1/5	60	
Feed cost and transport at R24 per feed per month	0	(48)
Pollination fees (1.7 pollinations per hive) @R257/poll	437	@ R **320**/poll 545
TOTAL	497	497

The premium which farmers could be expected to pay for the artificially generated pollination capacity in the case of the ultra-sensitive gum removal would be R63 per pollination or R3.78 million for 60 000 pollinations.

5.2.2.3 Production costs to fruit growers

We have argued that crop producers cannot afford to allow beekeepers to suffer crippling economic losses as a result of gum removals, and that growers will simply have

to meet the increased costs if they wish to have honeybee colonies for pollination purposes. But is this the only option available to growers? And what are the likely economic consequences to growers of having CARA-listed gums removed and having honeybee colonies sustained solely for pollination purposes?

The loss of natural vegetation and accumulated pesticide load that is associated with increasingly intensive farming practices have meant that the deciduous fruit industry is ever more reliant on commercial honeybees. In 1985 only 45% of pollinators in fruit orchards in the Western Cape were honeybees (Anderson 1985); by 2003 this had increased to 98% of all pollinators (Allsopp unpublished data). The viability of the fruit industry in highly developed areas is inextricably linked to the availability of commercial honeybees. In less developed areas this is less so, other wild pollinators playing a larger role. There are no alternative commercial pollinators such as leaf-cutter bees, blue mason bees or bumblebees in South Africa, and no practical likelihood that such alternative pollinators would be developed in the foreseeable future. Should they be developed, they too would require nectar and pollen, and hence would be no less threatened by the gum removal than are honeybees.

There are possible options other than honeybee pollination available to crop producers should commercial honeybee colonies become unavailable or too expensive. These options include the manual pollination of crop plants, the mechanized application of pollen by means of blowers or aerial spraying, and the development of self-fruitful crop varieties not requiring cross pollination. Whether any of these options are cost effective or even practical remains to be determined. What is certain, however, is that the development of these options would require a quantum shift on the part of the crop producers, and this could not be achieved in the short-term or without a great deal of research and expense.

Therefore, from a practical point of view, and certainly in the foreseeable future, the crop producers in the Western Cape are inextricably linked to the fate of the beekeeping industry. The crop producers will have no choice but to pay the additional pollination fees needed to keep commercial beekeepers afloat, should their gum honey revenue disappear. Crop producers would also be wise to take the approach that they need to do everything possible to ensure that there is enough natural forage available to sustain the necessary number of honeybee colonies needed for pollination, including the planting of bee-friendly forage wherever possible.

In the shorter term, what are the likely costs to be faced by growers resulting from the removal of gums and the likely change of strategy in the beekeeping industry? To begin with, Table 35 indicates that the threatened cost to growers in the 'total cut-off' simplistic assessment has been exaggerated. This is because the deciduous fruit industry should require over 88 000 pollinations (based on their crop types and hectarage), but according to this survey they only utilize 48 000 pollinations (Table 20), 54% of what should be required. This can only be because (a) lots of growers take fewer bees than recommended and (b) some growers do not take commercial bees at all, as they believe wild pollinators are sufficient. It is very interesting that the actual use in plums is 94% of what is expected, while that in pome fruit is only 38%. This suggests that growers find the value of commercial bees significantly higher in plums. That is not to say that all less-than-optimum numbers of bees are used in all pome orchards. In highly developed areas such as Grabouw it is likely that a full capacity of bees is used, and that in other areas such as the Koue Bokkeveld that practically no commercial bees are used. What

is clear, however, is that we can only allocate bee value for pollinations done by commercial bees. If commercial bees only are used for 54% of the orchards, only that proportion of the value (and the risk) can be allocated to these commercial bees. Accordingly, and using the same calculations as for Table 34, the value of bees for crop production threatened by the removal of CARA-listed gums is R990 million per annum. For the removal of ultra-sensitive gums only, the potential crop production losses are R629 million

Table 35: Deciduous fruit production and value, and the use of bees for commercial pollination, in the Western Cape in 2003 (P.Dall pers. communication; DFPT 2004).

Crop	Number of hectares planted in the Western Cape	Number of colonies required per hectare	Total number of pollinations required	Actual number of pollinations (survey results)	Honeybee contribution to fruit production	Total value of the crop (R million)
Apples	17877	2	35754	} 24651	0.9	1279
Pears	11370	2.5	28425		0.9	490
Plums	4084	6	24504	23043	0.9	226

However, as previously argued and notwithstanding the fact that most of the pollination of deciduous fruit crops is done by a relatively few large beekeepers who are almost all linked to listed CARA gum foraging, the availability of honeybee colonies for pollination is not expected to significantly diminish. As there are basically no non-pollinating beekeepers that could step in to fill the vacancies left by gum utilizing pollinating beekeepers (Tables 6 & 20), these colonies will have to be kept alive by artificial means. This is expected to result in additional colony losses and additional stress on the honeybees, resulting in reduced pollination availability. Pollination efficiency is also likely to be reduced by the high price that will have to be charged with the farmers opting to stretch their bees. The extent of this reduced value can only be guessed at. But because of the fruit industry's sheer size even small marginal losses reach significantly high amounts overall. For example a 10% reduction would imply that the actual losses in terms of unexploited crop production to growers in the Western Cape from gum removals are R99 million per annum for all CARA-listed gum removal and R63 million per annum for ultra-sensitive gum removal. It could be argued that the removal of gums would also affect wild honeybees and other pollinators, and hence would affect the pollination of crops presently not been serviced by commercial honeybees. But as this cannot be quantified, it is not included here.

5.2.2.4 Summarised costs

A summary of the expected 'real' impact costs of the WFW gum removal programme is presented in Table 36. The loss to the beekeepers of the gums is estimated to be R14.4 million per annum for CARA-listed gums and R3.9 million per annum for ultra-sensitive gums, but this shortfall is expected to be made up by increased pollination revenue from commercial crop producers. For crop producers not to pay for these higher fees is not in their short-term interests. Crop producers are expected to suffer substantial losses in terms of inadequate pollinator quality as a result of the gum removals, and the only long-term solution to the problem is the provision of adequate natural bee forage to sustain the numbers of colonies in the Western Cape needed for commercial pollination. This figure has already doubled in recent years, since the 1975 survey (Anderson 1978), with

these additional colonies essentially only being maintained for pollination purposes, and beyond the honey production capacity of the province. The removal of the gums will greatly exacerbate this process.

Table 36. The value of CARA-listed and highly eco-sensitive eucalypts to beekeepers and crop producers in the Western Cape, based on more realistic assessment methods (in Rands).

		Losses with the removal of all CARA-listed eucalypts	Losses with the removal of highly eco-sensitive eucalypts
Beekeeper Costs	Honey lost (table 17)	8.182 million	1.747 million
	Sundry products lost (25% of honey)	2.045 million	0.436 million
	Colonies lost at R400 each (pg 38)	1.556 million	0.350 million
	Supplementary feed cost R70/poll	4.200 million	1.694 million
	Extra pollination revenue (recovered)	-14.427 million	-3.877 million
	TOTAL	0.00 million	0.00 million
Growers Costs	Additional pollination costs (c/f)	14.427 million	3,877 million
	Crop production lost (10%)	99 million	63 million
	TOTAL	113.427 million	66.877 million

It is important to note that the scenario outlined above results in a transfer of some R14 million of the cost of gum removal from the beekeeper to the fruit farmer. In the broad economic sense this is not a destruction of value *per se* (good news, in fact, for the provider of bee feeds). It will however narrow the operating margins of the growers and collectively may make the difference on some farms between collapse and survival. In addition the growers will probably have to make do with less pollination and lose crop as a result, anywhere between R0 million and R 500 million. This last factor will be true value destroyed in the economic sense. As indicated earlier, the consultants believe a fair estimate of this loss to the grower to be of the order of 10% or R99 million, at least for the period it takes for the bee industry to consolidate and adjust, noting that estimates regarding the impact on crop of reduced bee density are not able to be supported with evidence.

The simple message is that the long-term financial viability of the bee industry in the Western Cape, and of the crop production reliant on the beekeeping industry, depends on addressing the nutritional shortfall brought about by the removal of the gums, and that means having dependable, high-yield summer nectar sources. Spring flowering indigenous trees would be of little use as they flower at the same time that the honeybee colonies are required to be in pollination. That leaves the option of planting gums to replace the gums that have been removed, and planting only non-invasive gums in areas of minimal impact to water resources. Special attention will need to be paid to which gum species are suitable as one of the CARA-listed species, sugar gum, has previously been considered to be the only high-yield species on the poor quality soils of the Cape (Poynton 1979; Johannsmeier 1994). The option of planting replacement gums would have to be financially viable. An approximate rule of thumb to determine forage capacity of gums is about 6 hives to the hectare (based on a census of six commercial beekeepers). If one assumes that forage for approximately 30 000 colonies is required

(75% of the total number of commercial hives) then about 5 000 hectares of gums would need to be planted. Given that the approximate cost of planting gums in the Western Cape is R5 000 per hectare (Ransom pers. comm..), including the cost of the land, then the total "new investment" would be about R30 million. This is a once off investment which if annualised at a rate of 12% per annum over 20 years would amount to an annual cost of R3 967 000 per year. This also gives an indication of an economic value of the gum trees earmarked for removal. A number of commercial beekeepers in the Western Cape have already followed this option, planting as much as 1 000 hectares of gums for their personal use.

5.3 Indirect impacts of WFW gum removal

The effect of honeybees on incidental pollination is inestimable (Free 1993), but certainly greater than their value in commercial pollination. That is, the pollination of wild flowers and trees, of gardens and fields, and particularly on nitrogen-fixing crop plants critical in fodder production. Approximately 15% of the total value of food consumed annually is in the form of meat and diary products depending on fodder production (Richards 1993) that has been valued at some $60 billion annually, the vast majority of that results from honeybee pollination.

Thus it can be seen that the removal of gum trees does not simply impact on commercial beekeepers. It reduces the amount of forage available for honeybees and all other pollinators, and therefore reduces the numbers of these pollinators available and effectiveness of the ecosystem service provided by these pollinators. Simply put, it reduces the size of the cake from which almost all pollinators must feed, thereby negatively impacting on this critical ecosystem function. Which means that reducing the gum forage in the Western Cape without replacing with an equivalent amount of suitable forage (nectar and pollen) cannot but reduce the number of wild honeybee colonies, the number of honeybee colonies that might be trapped by commercial beekeepers, the total amount of pollinators available in the province, and the robustness of the pollination service in general. Pollination is an ecosystem service that is directly linked to peoples' livelihoods (Gemmill 2004) and an issue recognized in the Convention of Biological Diversity (CBD) as critically important for conservation and sustainable agriculture. Reducing the amount of available forage in an ecosystem, albeit by the removal of alien species, could have unpredictable effects on the amount and diversity of indigenous pollinators, and on the plant species that they pollinate, and may well be contrary to CBD imperatives.

A reduction in the size of the forage cake, as would result from the removal of gums, would place severe pressure on the part of commercial beekeepers (and driven by the requirements of crop producers) in utilizing all suitable forage remaining in the Western Cape. This can only mean added pressure from beekeepers in gaining access to protected nature reserves, placing greater strain on all forage sites, and moving bees ever more frequently between forage sources to maximize the forage percentage collected by hived honeybees. This will add to the stress of the honeybees and on other pollinating insects and force them to exist on forage scraps remaining after the introduction and removal of commercial hives during the best weeks of the year. All of these factors have potentially serious consequences for wild pollinators, including wild honeybees, which support the pollination of the indigenous Cape flora (Whitehead *et al.* 1987). Economic pressure and the need to sustain a certain number of honeybee

colonies for commercial pollination could override environmental and conservation concerns, and result in changes in pollinator numbers, as well as species structure and biodiversity. The existence of eucalypt plantations in the Western Cape allows for the existence of a commercial beekeeping industry (Johannsmeier 1994), and essentially frees the natural ecosystem of that resource burden. Removing the resource but retaining the requirement for the honeybee colonies could force the resource burden to be acquired elsewhere - to the detriment of the indigenous fauna presently dependent on it.

5.4 A realistic scenario summarised

The removal of all CARA-listed eucalypts in the Western Cape is likely to have complex and largely unpredictable results, potentially ecosystem wide. It is impossible to determine exactly what these impacts will be, but there is clearly merit in beekeepers concerns.

Making reasoned forecasts on the information received during the survey, the following is a likely scenario should all CARA-listed gums be removed in the Western Cape.

- Most hobbyist, non-pollinating beekeepers will have substantially reduced honey production, and many of these individuals will give up beekeeping. The loss in honey production is estimated to be R0.2 million per annum.
- So too will medium-sized beekeepers not involved in pollination. The loss in honey production is estimated to be R1.1 million per annum.
- The larger apiarists will opt to specialize in pollination and in the absence of CARA-listed gums will adopt a strategy to keep the bees alive by supplementary feeding, or will give up beekeeping. The costs of additional feeding and lost honey production will have to be borne by the crop producers, and can be estimated at R14 million per annum. Failure to do so could result in the collapse of the beekeeping industry, and serious consequences for the crop producers.
- Crop producers could suffer production losses as a consequence of the decline in pollinator numbers and pollinator quality brought about by a shortage in high quality forage resulting from the removal of the gums. It is not possible to determine this loss but it could be of the order of 10% of pollinated crops or R99 million.
- Beekeepers and crop producers are expected to develop strategies designed to ensure sufficient forage to sustain the numbers of honeybees needed for commercial pollination in the Western Cape as a matter of urgency. The cost of such replacement could be about R30 million.

6 SYNOPSIS

In this section the key elements of the study findings are brought together to help an evaluation of the key issues for strategy formulation purposes.

6.1 Validity of the results

Validity here has two perspectives: the degree to which the sample of beekeepers represents the whole, particularly regarding the strategic issues; and the accuracy of the data given. As far as the question of representation is concerned, the sample covers between 70% and 80% of the total estimated hives in the Western Cape, an estimate reasonably in line with the literature and by back-calculating from the honey production and pollination estimates. In terms of number of beekeepers, the sample covers significantly less, probably no more than 60%, though it is impossible to know for reasons discussed earlier.

Regarding the second aspect of validity, the accuracy and conscientiousness of the response, a physical validation process was undertaken with ten per cent of randomly chosen respondents. The findings of this process revealed a high level of accuracy which, if anything, erred on the side of conservatism and which was supported by the sense of seriousness with which the questionnaire was answered by all but a very few people.

The important issue is that the information revealed by the survey is meaningful and can confidently be incorporated into the strategic process.

6.2 Stratification by size

An interesting and important characteristic of the bee industry is the size breakdown of the apiaries. Looking at the survey sample, about 20% of the larger beekeepers (greater than 250 hives) own 75% of the hives and produce over 75% of the honey. The same group carries out nearly 90% of the pollinations. The reason for this is the low barrier to entry into the bee industry and its attraction to hobbyist and part time participants. Essentially this means that from a strategic perspective the industry has a small but effective head and a long relatively inactive tail. In developing solutions to the gum problem, for instance, the major thrust lies with a relatively small number of influential operators.

6.3 Importance of gums in Western Cape beekeeping

The bee industry as we know it in the Western Cape is entirely dependent on both winter forage (primarily fynbos) and summer forage (almost exclusively eucalypt) for survival (Turpie *et al.* 2003). The role of gums in the Western Cape bee industry is critical. The main reason for this lies in the fact that gum nectar (especially Sugar Gum) is available at times when no other natural nectar is available. Here are some of the key statistics taken directly from the survey and which demonstrate the dependence of bees on gums. Seventy six per cent of colony months are spent on gum sites as distinct from other forage sites. Two thirds of all honey produced in the Western Cape is produced from gum nectar. Ninety six per cent of pollinating hives are in some way linked via the food chain to gums.

The survey has also enabled the different eucalypt species to be separately evaluated. All CARA-listed gums account for 90% of the honey production, and within this group,

Sugar Gum accounts for 66% and River Red Gum and Spider Gum together account for 19%. The balance of CARA-listed gums account for 6%.

The profile for pollination, which is based on linkages to the annual foraging (sometimes more than one site per year), is as follows. CARA-listed gums are responsible for 96% of the pollination, Sugar Gum for 87%, River Red Gum and Spider Gum together for 59%. The involvement of River Red Gum and Spider Gum at greater levels in pollination, compared to honey production, is due to a) the greater mobility of the (larger) pollinating beekeepers moving their bees more easily to river courses, and b) the early flowering of River Red Gum to help depleted colonies recover from the pollinating activity.

The important message contained here is that CARA listed gums are of paramount importance to beekeepers, especially Sugar Gum which flowers for an extended period and produces a high yield of nectar during an otherwise lean time of the year. Should the gums be removed, Sugar Gum in particular, an enormous forage source would be removed for both commercial and wild bees, upon the latter of which, it should be noted, the beekeepers rely for genetic enhancement. Inevitably, the number of hives in the Western Cape would be forced to decrease, or colonies would have to be maintained by artificial means. Maintaining honeybee colonies in such a manner in the longer term can only be considered to be ill advised, for the beekeeping industry and for the crop producers depending on these bees for pollination.

6.4 Views of beekeepers.

Much of the questionnaire is seeking narrative answers to requests for opinions, possible options, potential impact, working together and the like. An important outcome from this approach was that it gave the beekeepers an opportunity to reflect on and respond to the eucalypt/bee dilemma. The questions were deliberately phrased to encourage free-thinking answers. The detail of the questions and responses is given in the body of the report. It should be said here, however, that the overall picture emerging from gum-dependent beekeepers is one of fear for their businesses combined with a sincere willingness to be involved in the outcome of a communication process that this study, they believe, will have initiated. The amount of one-sidedly negative comment conveyed by these narrative answers was surprisingly little.

Whilst voicing their wish to participate in developing an acceptable solution, the beekeepers also felt that the perceived lack of pragmatism of the WFW gum programme was not consistent with the realities of the threat posed to the environment by the gum trees. Although not explicitly clear in the qualitative responses, the consultants feel there may be a lack of understanding amongst beekeepers of the requirements and conditions which govern demarcation, notwithstanding their view that gums under control are better than no gums at all.

6.5 Economic Impact

The economic impact of gum removal is determined by the reaction of the beekeepers, in particular the large beekeepers, to the removal of gums. The following scenario, as discussed in the main body of the text, would seem to best fit the circumstances and profile of the situation. Honeybee colonies of non-pollinating beekeepers would mostly

weaken or be disposed of. The balance would be kept partly artificially on feed, sacrificing the honey (which will be all but lost), and holding the hives for pollination. The additional cost and reduced honey flow would be recouped as an increased pollination fee. Based on considered estimates, the annual loss resulting from CARA-listed gum removals would be approximately R14.2 million. Possible losses in crop production due to lack of pollinator numbers or viability may reach R99 million per annum. Economic losses in all categories are greatly reduced if only ultra-sensitive gums are removed.

As gums clearly form part of the seasonal forage chain for the vast majority of bee colonies in the Western Cape, and their removal will have a significant effect on beekeepers and crop producers that use honeybees for pollination, to survive the beekeeper must aim to replace the lost forage in the long-term, and to maintain colonies solely for pollination purposes in the short-term, the crop producer bearing the extra costs. An artificial situation such as this reduces the stability of the system and makes it very susceptible to perturbations such as disease and genetic retrogression. For the crop producer, the effect could vary between the costly and the catastrophic.

7 RECOMMENDATIONS

1. This survey has gone a long way to illuminating the 'positive' attributes of the eucalypts in the Western Cape. We now have a good idea of the benefits of the various types of gums, and of the gums in various positions in the landscape. But only when we have better information as regards, in particular, the invasive nature of the various gums, can effective cost/benefit analyses be done. The WFW programme does not have a full understanding regarding the nature of invasive species and the threats they pose to the environment (van Wilgen 2004), and it is important that means are developed to deal with the conflicting views that arise from the programme.

   Accordingly, the consultants agree with Forsyth *et al.* (2004) that detailed studies are warranted to determine the true invasive status of eucalypts in South Africa. The invasion potential of the CARA-listed gum species needs to be carefully assessed, including Spider Gum, but excluding the River Red Gum. This is especially true of the Sugar Gum, upon which the overwhelming proportion of the Western Cape beekeeping industry rests. Special attention should be spent in determining under what circumstances the various gum species can become invasive, rather than having blanket prohibitions (Poynton 2003).

2. The consultants are also in agreement with the conclusions reached by Forsyth *et* al. (2004) that eucalypt clearing should focus on riparian areas and nature reserves, and that other regions should not be targeted until the invasive status of eucalypt species in these landscapes is determined with greater confidence. Until such time as better information is available, the removal of gums in the Western Cape should be limited to those circumstances where the disadvantages of retaining gums clearly outweigh their benefits. These gums represent approximately 42% of the gums utilized by beekeepers in the Western Cape (Table 23). Although it is likely that the true figure is less than that because some gums recorded in the questionnaire as "mountain catchment" or "river-course"

gums should have been termed “other areas”. In any event, there seems little argument that the disadvantages of gums in these areas outweigh the benefits, and that the majority of the beekeeping industry will survive their removal provided the other gums (especially Sugar gums) remain (Table 29). This particularly if the removal is over an extended period of time (Table 31).

3. Negotiations between WFW, the national and provincial departments of agriculture, commercial agriculture, and the beekeepers should begin urgently to map the way ahead. The process could be assisted by a previously mutually agreed to facilitator. Discussions should look to the identification of suitable areas for bee forage; suitable forage to be planted, including gums; and measures whereby these might be co-financed.

4. The negative impact of gum removal is likely to be significantly reduced if the various stakeholders were to invest resources and energy into assuring that there is sufficient forage available in the future to support the numbers of honeybee colonies necessary for commercial crop pollination.

5. In the longer term, beekeepers and growers in the Western Cape need to contemplate the future in a holistic manner and consider that very few gum plantations have been planted in the province in the past decade. The WFW gum programme should force all users of commercial honeybees to get together in ‘strategic mode’ and assess all factors (urbanization, habitat destruction, water usage, invasive aliens) to ensure that there are enough honeybees and other pollinators in the Western Cape not only for commercial crop production but also all other pollination. This is also a very positive wish emanating from the survey respondents. Partnerships will need to be built and options explored, to ensure the viability of beekeeping and bee-dependent crop production in the Western Cape.

6. Allied to the bee/gum issue (though peripheral to the impact of the WFW programme is the development of high quality forage for rural beekeeping programmes. This should be considered at the least by the Department of Water Affairs and Forestry, perhaps in conjunction with SABIO. [Options to be explored include negotiations with commercial forestry companies to ensure that future developments in eucalypt forestry consider forage value of the gums to be planted. This to compensate for the reduction in the level of ‘bee-friendly’ eucalypt planting that has taken place in recent years (Gardner 2004; Pott 2004). More than 90% of the commercial eucalypts in South Africa at present are grown as a short rotation crop for pulpwood or treated poles (Gardner 2004), and eucalypt species focus has shifted to faster growing pulpwood species that have sparse and irregular flowering and minimal nectar production. Negotiated efforts on the part of forestry and beekeepers to increase forage levels to sustain honeybee populations, brought into sharper focus by the need to utilise gums responsibly, could provide significant impetus in the efforts to use honeybees for social advancement.]

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10 APPENDIX 1 - Bee keeper letter and questionnaire

SURVEY

Impact of the Possible Removal of Eucalypt Trees on the Bee Industry in the Western Cape

Dear Beekeeper

The attached questionnaire is important. It is to establish the value of gum (Eucalyptus) trees to the beekeeping industry in the Western Cape province, particularly those gum species earmarked for removal under environmental legislation, and to canvass the views of beekeepers as to how the management of targeted gums could be tackled.

The questionnaire is being sent to all known beekeepers in the **Western Cape** province. Your name has appeared as a beekeeper on lists obtained from regional and national beekeeping organizations. If you are no longer are a beekeeper, please accept our apologies and return the questionnaire in the pre-paid envelope provided, filling in your name and answering "0 colonies" to *Question 1*.

The questionnaire stems from recent amendments to national environmental legislation (Conservation of Agricultural Resources Act = **CARA**; and other legislation) that has resulted in certain species of *Eucalyptus* (gum) trees being earmarked for removal in the **Working for Water Programme (WfW).** It is reasoned that due to their high water consumption and the propensity of some species to invade natural vegetation, that environmental degradation and water wastage can result. Gum trees, by adding fuel load, can also increase the risk of fire damage. In terms of policy, the gum trees subject to removal are:

- All gums in ecologically sensitive areas (= mountain catchments, nature reserves and along the flood plains or rivers, streams and wetlands).
- All Spider Gum (a declared weed) and undemarcated stands of Sugar Gum, Saligna Gum, Black Ironbark, Grey Ironbark, River Red Gum and Karri (declared invader species). These seven are the CARA-listed species of gum.

The **South African Bee Industry Organization (SABIO)** has pointed out that the listed gums are critically important to some beekeepers in many parts of South Africa, and to those sections of commercial agriculture that depend on honeybees for pollination of their crops. They contend that the removal of gum trees could have serious consequences for beekeeping and bee-dependent agriculture.

As a consequence of these conflicting positions, and the importance of developing an appropriate strategy for optimal gum management in the Western Cape, this questionnaire has been sent to you [1] to establish the value of gum trees to the beekeeping industry and [2] to canvass the views of the beekeeping fraternity as to how the various issues surrounding the management of listed gums could be handled. **The questionnaire/survey is commissioned jointly by WfW and SABIO, and supported by the National Department of Agriculture, the Western Cape Department of Agriculture and the Deciduous Fruit Producers Trust (DFPT). Please take the time to fill in the questionnaire, as it will assist the policy makers and other stakeholders in coming to a solution that is in the best national interest.**

In completing the questionnaire please note:

- The questionnaire should be completed by ALL beekeepers in the Western Cape Province, not only those who believe that they will be adversely affected by the removal of gum trees.
- Information is to be filled in as "an estimation of an average year". That is, what is **reasonably expected in a normal year**, and not only from actual records from past years.
- Data submitted will be subjected to a **validation process**. Beekeepers that submit returns may be asked to provide proof to verify their claims, requiring inspection of apiary sites and of records. Failure to comply will result in information submitted being discarded. Inspections will take place only with the consent of the beekeeper, and will seek to verify the numbers of colonies in apiary sites and the dependence of a site on a type of forage.
- All submitted questionnaires will be treated in the **strictest confidence**.
- Should further assistance be required in completing the questionnaire, please contact the co-consultants: Michael Cherry (021 856 1995; 082 804 6759; mcherry@telkomsa.net) or Mike Allsopp (021 887 4690; 083 288 5059; vredma@plant3.agric.za).
- Beekeepers may wish to arrange, through their local beekeeping association (Southern Cape or Western Cape), group Q&A sessions to assist in correctly filling in the questionnaire. The co-consultants will assist in these sessions, if requested.

The final date for the submission of the questionnaire is: 5 March 2004

Yours sincerely,

Dr P Van Rooyen, Head of Department, Western Cape Department of Agriculture, Private Bag X1, Elsenburg 7607,
*** Tel: (021) 808 5111 * Fax: (021) 808 5120 * Website: www.elsenburg.com**

Name			
Address			
Telephone	(h)	(w)	(cell)
Fax			
Email			

Question 1: How many **colonies of bees** do you have on average?	…….. colonies

Question 2: How many **beekeeping staff** do you employ?	Full-time …….	Part-Time …….	Total …….

Question 3: Estimate your average **annual honey production** (kg) (total production)	…….. kg

Question 4: Estimate the percentage of your total **annual honey crop** that is produced on the following **sources of bee forage (to total 100%).** *Gums = all species of Eucalyptus. Weeds = all common weeds of disturbed ground, including Vetch (wilde ertjie), Clovers (Klawer), Raphanus species (Ramnas), Echium species (Bloublommejies) and Cape Weed (Gousblom). Suburban = any mixture of garden flowers and trees. When a honey source other than those listed is known, specify under "Other". When the primary source of a honey crop is not known, indicate as "Don't know".*

Gums	Weeds	Citrus	Canola	Fynbos	Suburban	Other (specify) ……. ……...	Other (specify) ……... …….	Don't know
%	%	%	%	%	%	%	%	%

Question 5: During an average year, what percentage of your honeybee colonies **DO NOT use gums** as a major forage source (for honey production or for colony build-up)?	%

Question 6: On a scale of 0-10, **how important are gums** to these facets of your beekeeping business? (10 = most important)

Honey production		Colony increases (splits and trap-swarms)		Colony build-up	

Question 7: Of the **gums** (listed & other) that your bees use**, what** percentage do you estimate are the following? **(To total 100%)**

Sugar Gum *Eucalyptus cladocalyx*	River Red Gum *Eucalyptus camaldulensis*	Spider Gum *Eucalyptus lehmanni*	Grey Ironbark *Eucalyptus Paniculata*	Black Ironbark *Eucalyptus sideroxylon*	Karri *Eucalyptus diversicolor*	Saligna Gum *Eucalyptus grandis*	Other gums	Don't know which gums
%	%	%	%	%	%	%	%	%

Question 8: Can you make any suggestions as to **alternative forage** possibilities for the Western Cape to the above species of gums?

Question 9: Of the **seven gum species** listed above that are present at your apiary sites, what percentage are in the following **positions in the landscape (To total 100%)** ?

Riverine areas & wetlands (areas within 30 meters from a river course that physically flows during the wet season or from surface water that is present for at least part of the year)			**Mountain catchments** (steep mountain slopes of 30 degrees and more, at least 500m high from its foot to the ridge, and covered by natural vegetation)			**All Other Areas**		
Declared private and public nature reserves and other areas that you know are ecologically sensitive	Fire sensitive, contributing to and close to high fuel loads, **and** able to ignite valuable infrastructure or vegetation	Neither ecologically sensitive nor fire sensitive	Declared private and public nature reserves and other areas that you know are ecologically sensitive	Fire sensitive, contributing to and close to high fuel loads, **and** able to ignite valuable infrastructure or vegetation	Neither ecologically sensitive nor fire sensitive	Declared private and public nature reserves and other areas that you know are ecologically sensitive	Fire sensitive, contributing to and close to high fuel loads, **and** able to ignite valuable infrastructure or vegetation	Neither ecologically sensitive nor fire sensitive
%	%	%	%	%	%	%	%	%

Question 10a: What percentage of your **colonies that utilise gums** are kept in apiary sites **on land that you own**?			%
Question 10b: For **colonies utilising gums** that are kept on land that you **DO NOT** own, what percentage are subject to the following **land-use agreements** with landowners (to total 100%)?	Formal %	Informal %	None %
Question 10c: For **colonies utilising gums** that are kept on land that you **DO NOT** own, what percentage have the following **payment systems** with landowners (to total 100%)?	Cash %	"In-kind" %	None %

Question 11a: Estimate the average **annual pollinations** provided by your own honeybee colonies (managed either by yourself, or bees rented from you for pollination). The number of pollinations = number of paid pollination periods, or shifts, irrespective of how many times a single colony is used.	pollinations

Question 11b: Indicate as a percentage of your total pollinations the **crop types** that your colonies are used to **pollinate**.	Stone fruit %	Pome fruit %	Vegetables %	Vegetable seed %	Other %

Question 11c: Indicate as a percentage of your total pollinations **where you do pollination**.	Villiersdorp/ Vyeboom/Elgin/ Grabouw %	Ceres/Koue Bokkeveld/ Wolseley %	Worcester/ Klein Karoo/ Robertson %	Karoo/ N Cape %	Langkloof/ E Cape/ S Cape %	Boland/ Helder-berg/Piketberg/ Wellington %	Other %

Question 12: Provide the following information for ALL apiary sites that you use on a regular basis. For colonies placed in a number of sites in or around a single dominant forage source that is homogeneous in terms of species and position in the landscape, these sites may be recorded as a single site. Make as many additional copies of this page as necessary, indicating the page number.

Page Number:

Apiary **site** number	Site **name** (farm etc.)	**Number** of colonies	Nearest **Town**	**Distance** to nearest town (km)	**Months** of the year site is used. For eg (March –May) = (3–5).	Major bee forage present at the apiary site. Indicate the **forage type** ONLY if it is at least 10% of the total forage available at the site. Tick as many blocks as necessary.								For the gums that are present at the site, indicate which gum species are present. Indicate the **gum type** ONLY if it is at least 10% of the total gum forage available at the site. Tick as many blocks as necessary									For the gums that are present at the site, indicate the position in the **landscape**. Tick as many blocks as necessary				For the gums that are present at the site, estimate what percentage are **planted**.	Indicate the **ownership** of the gums present at the site: beekeeper-owned (B), state-owned (S), or privately-owned (P).
						Gums	Weeds	Citrus	Canola	Fynbos	Suburban	Other	Don't Know	Sugar gum	River Red Gum	Spider gum	Grey ironbark	Black ironbark	Karri	Saligna gum	Other gums	Don't know what gum	Riverine & wetlands	Mountain catchment	Nature reserve	Other		
1																													
2																													
3																													
4																													
5																													
6																													
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Question 13a: Accepting that bees are important to the Deciduous Fruit Industry (DFI) and other bee-dependent agriculture (BDA) in the Western Cape**, who should be responsible** for ensuring that there is **sufficient overall forage** available to sustain the necessary number of honeybee colonies? (For each category indicate a rating of how important, as in x%, to add up to 100%)

Landowners %	DFI & BDA %	Beekeepers %	Government %	Other (specify) %	**= 100 %**

Question 13b: Accepting that gums targeted for removal under current legislation are important in the maintenance of these bees, **who should be responsible** for ensuring that there is **sufficient replacement forage** available to sustain the necessary number of honeybee colonies if these trees are removed under the government legislation? (For each category indicate a rating of how important, as in x%, to add up to 100%)

Landowners %	DFI & BDA %	Beekeepers %	Government %	Other (specify) %	**= 100 %**

Question 14a: Considering that the forestry industry is prohibited by the National Water Act from planting trees in river-courses or streams, **should there be special dispensation** allowing beekeepers to keep gums in river-courses and streams?	Yes	No

Question 14b: If "Yes", **why**?

Question 15: In the case where certain species of gum have an **impact on the environment** under certain circumstances, but beekeepers wish to retain these gums for their use, **who do you think should be held responsible** for any environmental impact arising from the following? (For each category indicate a rating of how important, as in x%, to add up to 100% for each line)

	Landowner	Government	Beekeeper	DFI & BDA	
Spread of invasive gums					**=100%**
The risk of fire damage and protection against fires					**=100%**
Impact of gums on available water resources					**=100%**

Question 16: A landowner wishing to **retain** a stand of **CARA-listed gums** is required to demarcate these gums, and may be subject to levies in terms of water usage as well as fire management. Estimate what percentage of your colonies that utilise gums are situated on land where you believe the **landowner will be willing to demarcate** gums for your use, or will allow you to demarcate gums on their property.	%

Question 17a: If the **removal of CARA-listed gums is delayed or stopped**, should the same consideration be given to any other industry (eg nurseries) that has a vested interest in other CARA-listed species?	Yes	No

Question 17b: If "No", **why** should special consideration be given to the beekeeping industry?

Question 18: If all gums in ecologically sensitive areas (mountain catchments, nature reserves and along the flood plains of rivers, streams and wetlands) **AND** all CARA-listed gums were to be removed:
a: what **quantitative effect** would it have on your beekeeping business (as a % in each case, "+" for increase and "–" for decrease)?

Effect on number of colonies %	Effect on honey production %	Effect on pollinations done %	Effect on expenditure (travelling, feeding) %

b: how would it affect your overall beekeeping business (answer as a **general statement**)?

Question 19: If **ONLY** gums in ecologically sensitive areas **AND** Spider gum were to be removed:
a: what **quantitative effect** would it have on your beekeeping business (as a % in each case, "+" for increase and "–" for decrease)?

Effect on number of colonies %	Effect on honey production %	Effect on pollinations done %	Effect on expenditure (travelling, feeding) %

b: how would it affect your overall beekeeping business (answer as a **general statement**)?

Question 20: How would you **adapt your business** if all CARA-listed gums in the area you use are removed over a:

(a) 1 year period:

(b) 5 year period:

(c) 10 year period:

*Question 21:*How best can **Working for Water and beekeepers work together**, to ensure sustainable management of gums (use a separate piece of paper if necessary)?