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A RAPID ASSESSMENT OF THE EFFECTS OF INVASIVE SPECIES ON HUMAN LIVELIHOODS, ESPECIALLY OF THE RURAL POOR

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1. INTRODUCTION

Invasive alien species (IAS) are one of the biggest threats to ecosystems and biodiversity worldwide (Sala *et al.* 2000, D'Antonio & Kark 2002), from the polar regions to tropical forests, and from wild lands and waters to agriculture and suburbia. Biological invasions are one of the most significant drivers of environmental change and degradation (Vitousek *et al.* 1997, Pimental 2002), affecting the delivery of ecosystem goods and services, and consequently human well-being. The recent Ecosystem Millennium Assessment (www.maweb.org) identified IAS as the single most important driver of ecosystem change (Petschel-Held *et al.* in press). Invasive alien species can have large detrimental economic impacts on human enterprises such as fisheries, agriculture and forestry. For example, Turpie *et al.* (2003) estimated that the negative economic impact of invasive alien plants on ecosystem services in Fynbos was in the vicinity of R 700 million per annum, and alien organisms threaten 55 % of South Africa's red data plants and up to 60 % of endemic freshwater fish species in the country. In South Africa's Gauteng Province alone, alien vegetation uses 25 million m³ of water annually, almost 50 % of the total use by the mining sector (Bohensky *et al.* 2004), whilst nationally alien plants use approximately 7 % of South Africa's annual runoff (le Maitre *et al.* 2000). Globally, the costs of damage caused by IAS has been put at US$ 1.4 trillion per year; close to 5 % of global GDP (Pimental *et al.* 2000).

While the negative impacts of IAS on ecosystem structure and function are undisputed, the picture is not as clear-cut when it comes to human well-being and livelihoods. This is especially so for the rural poor whose land and waters are most affected by IAS. It is tacitly assumed that the harmful impacts on ecosystem goods and services automatically translate into negative effects on human well-being. Yet, IAS are frequently integrated into the livelihoods of people, both as managed species, as well as through exploitation of wild invasive populations. Examples include the important role of brown trout in the livelihoods of some Andean communities in South America, the complete change in nomadic patterns of pastoralists in Madagascar to optimise use of invasive Prickly Pear (Kaufmann 2004), and the widespread use of invasive plants for construction and fuelwood worldwide (e.g. Shackleton *et al.* 2004). The recent controversy around the honey industry's resistance to the eradication of *Eucalyptus* in the southern Cape is another example of the conflicting value of invasive species to different stakeholders.

Many IAS are often 'adopted' into local livelihoods and cultures, and even given colloquial names. There is possibly a threshold density of IAS, beyond which people 'switch' from favouring indigenous species as their first choice to IAS. This may be because the former become too scarce and the latter abundant enough to warrant the 'switch', as the opportunity costs of use favour exploitation of the IAS over the indigenous species. This is conceivably also a function of how long the IAS has been a part of the landscape, and the reasons for its first introduction. There may also be other positive feedbacks, for example cultural changes, changes in human preferences, and changes in conventional practices and even institutions, which might drive the shift from indigenous to exotic species, for example the integration of Prickly Pear (*Opuntia ficus-*

indica) into livelihoods and cultures in Madagascar after its introduction by the French in the late 18th century (Kaufmann 2004). Another example of this type of 'switch' is the widespread use of *Araujia sericifera* (an alien invasive plant introduced from Peru) for medicinal purposes by traditional healers along South Africa's Wild Coast. Some of these 'switches' may even lead to the active management of invasive species, acting as a positive feedback on the invasion, for example the breeding of trout in Ecuador and elsewhere, and the cultivation of *A. sericifera* in home gardens. In other cases, people might simply be using aliens because they have resigned themselves to the presence of such IAS and are making the most of it, for example the use of *Prosopis* species for fuelwood and furniture in arid areas worldwide (e.g. Reid *et al.* 1990, Tewari *et al.* 2003).

Another scenario is that there is no threshold and switching, but simply a case of rural communities introducing, or accepting the introduction, of species with clear uses to them. The initial introduction is generally within a controlled, or farming type situation, e.g. introduction of new fish species for farming in ponds and dams, establishment of plantations or field-breaks of wood species useful for construction or firewood. Negative consequences may arise as these new introductions spread into the broader landscape away from the control of the local community.

The last scenario is that people simply have to live with the IAS, as the organism has no uses, and the rural poor typically lack the institutions, capital and/or techniques to eradicate it. In such situations the negative ecosystem costs ultimately undermine local livelihoods. Examples abound, including that of Triffidweed (*Chromolaena odorata*) in northern KwaZulu-Natal (South Africa) (Goodall & Erasmus 1996, Norgrove *et al.* 2000), or the invasion of coral reefs in the Caribbean by pathogens blown in with dust from the Sahara (Petschel-Held *et al.* in press).

In all these situations local communities have had to consider the trade-offs between, on the one hand, the negative impacts on ecosystem dynamics and goods obtained from the lands around where they live, and on the other, the potential positive benefits through use of the IAS. Whether or not the trade-off process will be deemed positive or negative will be influenced by a number of local and contextual factors such as extent and density of infestation, availability of alternatives, costs and mechanisms of alien control, land tenure, discount rates, severity of loss of ecosystem goods, etc.

There is much literature on and understanding of the negative impacts of IAS on ecosystem goods, services and behaviour (e.g. Murali & Setty 2001, le Maitre *et al.* 2002, Brooks *et al.* 2004). In comparison, there is relatively little work (although not a complete absence (e.g. Kaufmann 2004)) exploring the role of IAS in local livelihoods. This imbalance is telling because, with the increasing global awareness of the negative impacts of IAS, there is greater effort to control and remove them. This has essentially been deemed an ecological issue (e.g. McDonald *et al.* 1986, Chandrasekaran & Swamy 2002), and at times paired with an economic one (e.g. le Maitre *et al.* 2002, Pimental 2002, Turpie *et al.* 2003, Hosking & du Preez 2004).

When the economic costs of IAS have been considered, it has invariably been at the national or regional scale, considering losses of ecosystem services and impacts on the formal economy (e.g. papers in Pimental 2002). Seldom have the livelihoods and needs of rural people on whose land the IAS is located been taken into consideration. As with the biological and ecological dimensions of the problem, it is likely that there is a wide range of social and livelihood responses on behalf of rural communities to IAS, which are exceedingly variable in space and time.

Within the context of the above, the main objective of this study was to determine the effects of IAS infestation on human well-being, with a focus on the effects on poor, rural communities. Relevant questions in exploring this objective included:

?? *How important are IAS in human livelihoods?*

?? *What are the explicit and implicit trade-offs that rural people make in their use, management or attitudes towards IAS?*

?? *What are the long-term and short-term gains and losses for human well-being, from consumptive and non-consumptive use and ecosystem services, from IAS?*

?? *How do the impacts of IAS undermine livelihood opportunities and resilience?*

?? *What are the livelihood impacts of IAS eradication programmes?*

?? *At what point does an IAS become culturally 'internalized'?*

The study included two components. The first was a series (10) of desktop studies commissioned from around the world. The second was two rapid case studies conducted in the Eastern Cape province of South Africa. Both components aimed to gather qualitative and limited quantitative data on the effects that IAS have on rural livelihoods, quality of life and peoples' ability to fulfil their basic needs from the environment.

2. SCOPE OF WORK

The specific Scope of Work, as agreed with the Global Invasive Species Programme, was to carry out rapid surveys to gather qualitative and anecdotal evidence of the effect IAS have had on poor rural communities, their livelihoods, quality of life, and their ability to fulfil their basic needs from the environment. This would include two stages:

?? Stage 1. The contractor will develop a format on what information should be collated for the international summary case studies. This format is to be agreed with GISP staff. The contractor will commission ten desk-top summary case studies of the effect of invasive organisms on rural livelihoods from a number of different countries (to be confirmed with GISP). These summary case studies should draw on experience in the international Millennium Assessment project, involvement in community-based natural resource management (CBNRM), and non-timber forest product (NTFP) networks.

Contributing authors should be asked to rapidly identify key issues, with examples, and to put forward a number of hypotheses or propositions.

?? Stage 2. In order to investigate in more depth the key issues and hypotheses that emerge from Stage 1 the contractor should conduct field investigations in South Africa, in the Eastern Cape (at least two and possibly three localities to be confirmed with GISP). These field studies should take the form of a rapid survey to gather qualitative and anecdotal data on the effect that invasive species have on the livelihoods, quality of life and people's ability to fulfil their basic needs from the environment.

3. APPROACH

A four phase approach was adopted, each orientated to a specific aspect of the Terms of Reference:

?? We solicited a number of desktop briefs from international contacts from around the world. The purpose of the briefs was to use the best available information to develop a quick overview of the impacts of IAS on the lives of rural people. The authors were sent specific guidelines spelling out the information needs and format of the desktop brief (Appendix 1). The authors were given two weeks for preparation of the briefs, with emphasis on identification of key issues through review and interpretation of the existing literature. Once the desktop briefs were received they were used to (i) inform the development of two rapid empirical appraisals in South Africa, and (ii) a synthesis identifying commonalities and areas for further investigation. The briefs included:

Plant species	Fish species	Insect species
?? *Lantana* in India ?? *Eucalyptus* in Peru ?? *Mimosa* in Vietnam ?? *Prosopis* in Kenya ?? *Chromolaena* in Swaziland	?? *Tilapia* in India ?? *Tilapia* in Colombia ?? Salmon in Chile	?? Cassava Mealybug (and its biological control agent) in west Africa

?? Rapid appraisals of the impacts of IAS on rural livelihoods at two sites in the Eastern Cape of South Africa. One case dealt with Prickly Pear (*Opuntia ficus-indica* (L.) Mill.), and the other focussed on Black Wattle (*Acacia mearnsii* de Wild.). Both of these species are considered major invaders in South Africa (Robertson *et al.* 2003). In assessing the effects of invasive species on human well-being we drew upon the framework recently developed and tested by the international Millennium Ecosystem Assessment (www.maweb.org), in which we participated. Particular emphasis was placed on trying to capture not just a static picture of the current situation, but also the effects of IAS on the dynamic aspects of livelihood resilience and opportunities. Additionally, identifying and investigating community and household level trade-offs between the positive and negative impacts of IAS, as well as the different

vulnerabilities of varying sectors of the communities were central to our approach. Details of actual methods employed during the appraisals are provided in Sections 5.1.3 and 5.2.3.

?? Development of a proposal methodology for additional empirical studies internationally.

?? Feedback of the findings of the two rapid appraisals to the participating communities. This has not been completed at the time of writing, but will be completed soon thereafter. It will be in both written and verbal form.

4. SYNTHESIS AND LESSONS FROM THE INTERNATIONAL DESKTOP BRIEFS

The nine briefs received are provided in Appendix 2. They covered a range of organisms (five plants, three fish and one insect study) across three continents, all in the developing world. Given that they are based on desktop summaries, it is inevitable that the amount and precision of information varied from study to study. Nonetheless, they do, taken as a whole, represent a comprehensive compilation of information exploring the impacts of IAS on rural people in different parts of the world. As such it was possible to identify several recurring themes and key issues, which are outlined below. Not all of the briefs illustrate each issue to the same degree, but more than one does in each instance. Additionally, one needs to examine them all to appreciate different dimensions and perspectives on the same issue or theme. The briefs are dominated by examples from plant IAS. Undoubtedly, there is a need to balance this in future with more examples from animal species, including birds, reptiles and mammals which were not represented, as well as more insect species.

?? Definition of what constitutes an IAS is not universal. Whilst there are international definitions, authors of the different briefs have reported on a wide range of situations, in which some of the IAS are being farmed and rarely occur or establish outside the farming situation (e.g. some of the briefs on fish IAS; *Eucalyptus* in Peru), others are farmed but with frequent escapes that are used by rural communities which limits their propensity to establish out of the farming situation (e.g. alien salmon in Chile), and others still are wild invasives without any deliberate controls for introduction or eradication (e.g. *Mimosa* in Vietnam, *Chromolaena* in South Africa).

?? It is clear that there is a continuum of effects of IAS on rural livelihoods. At the one extreme there are some IAS that have no apparent direct or indirect uses to rural people, nor do they have any benefits to the local environment. Triffidweed (*Chromolaena odorata*) and Cassava mealybug (*Phenoacoccus manihoti*) typify such IAS. These are potentially the most serious of invaders as there is no positive reason to maintain them in the environment and harvesting by rural people will not be a means to keep them in check. At the opposite extreme are those IAS that play many and/or important positive roles in rural livelihoods. These include IAS used for household subsistence, commercial trade and medicinal or spiritual reasons. Removal of these species from the landscape would, in the short-term, have detrimental consequences for the people of that area, although they may well adapt to other species in

the longer-term. However, at appropriate densities these useful IAS do frequently serve as a substitute for indigenous species and thus mitigate the harvesting pressure on such indigenous species. The introduction of a biological control for Cassava mealybug, the parasitoid wasp *Anagyrus lopzei*, is an interesting example of an invasive species that has spread far and wide, with positive benefits for rural communities, although it is not actually used by them. Situated between these two extremes is a range of scenarios where the ratio between positive and negative impacts changes. Some species have minor uses, and overall, rural communities may prefer that they be removed. Some have important uses or impacts for only some sectors of the community. Others have been integrated in farming systems, either as a continuation of the original reasons for their introduction to that country, or as a new dimension. On the basis of the current suite of desktop briefs it is not possible to develop a typology or predictive capacity as to where a given rural community or IAS type might be most likely to be situated along this continuum. Such a typology is required, and perhaps a first start might to disaggregate what is an IAS into meaningful sub-classes based either on degree of aggressiveness, and/or broad taxonomic classes (i.e. is it useful to compare plants IAS with fish IAS?). Hardly any of the briefs had information that permitted presentation of a thorough evaluation of the relative magnitude of both the positive and the negative impacts, such as by means of cost-benefit analysis, or hours spent controlling it relative to hours spent gathering products from it. The brief on *Prosopis* in Kenya was informative in that regard. Whilst the authors presented such information, the results showed that for five of the seven villages, the losses in economic terms were greater than the benefits, but for the remaining two villages the opposite prevailed, where the density was lower. Moreover, even in those villages with net negative impacts, there were households that experienced net positive impacts, illustrating the value that some IAS represent for a proportion of households or actors, but not for all.

?? Most of the briefs were unable to present a dynamic picture of how the impacts of the IAS had evolved over time. Obviously it takes time for any IAS to invade, establish and become a feature of the landscape, and have measurable effects on ecosystems and rural livelihoods. One can hypothesise that the positive and negative impacts of any IAS, and the balance between them, will vary during the invasion, establishment and intensification phases (see Section 6.1). This needs to be investigated further. The case of *Lantana camara* in the Western Ghats of India is an interesting illustration of the importance of a temporal perspective. When first introduced as a garden ornamental it had aesthetic appeal. As it escaped and its abundance intensified in the surrounding landscape so it became to be vilified. But the balance has swung the other away again now that it has been found to be useful for the production of 'cane' furniture; so much so, that it is hoped by conservationists that it will reduce the harvesting pressure on indigenous rattan species which have traditionally fulfilled this purpose. Interestingly enough, there were fears about rattan invasions in the area three decades ago.

?? It is clear that IAS are rarely uniformly problematic or uniformly beneficial to entire geographic rural communities. This is because geographic communities are not homogenous and because infestations vary in density and extent. Households differ in a multitude of ways, significantly so on the duration of residence in the area, livelihood strategies, wealth, education, and adherence to cultural norms.

Consequently, an IAS that has negative consequences for one group of rural stakeholders may have either a neutral or positive impacts for others. Prickly Pear neatly illustrates this, but it is also evident from a number of the desktop briefs, such as *Tilapia* in Columbia and in India, as well as *Eucalyptus* in Peru. For some, mostly those with livestock, Prickly Pear has a negative impact by decreasing the area of land for grazing. But for another group, it represents a source of income from trade in the fruits at a vital time of the year (just after Christmas expenses, and the start of the new school year). For the majority, they have relatively neutral perceptions; they have few or no livestock, and they do not trade in the fruits, but they do enjoy eating the fruits when they come across them.

?? Several of the briefs illustrate the use of the IAS in question by rural communities. Yet the nature of use is very different between communities and within communities. Some households trade in IAS and therefore the benefits and losses experienced may be captured in local economic surveys and statistics. But for the large majority of cases, and the majority of people within each case, the uses are primarily at the household subsistence level or very local-level trade. Such uses are therefore rarely included in regional or local statistics. Thus, to many people on the ground and to regional and national officials, there is little evidence, and therefore appreciation, of the range of benefits rural communities do secure from IAS. Hence, the design and implementation of IAS control programmes are informed by the long-term costs of IAS for future generations and ecosystems and are rarely informed by the needs of rural people.

?? Rural communities display a remarkable adaptability and opportunism to IAS, which in some instances involves technological innovation. This is not to say that IAS represent only positive benefits for rural communities. Far from it. But several of the briefs illustrate how rural communities adapted to the presence of the IAS in order to optimise potential benefits or minimise potential negatives. This might be a small change in the calendar of seasonal events to allow time for harvesting and processing, or storage of a seasonal product from the IAS. Other strategies are the changing of landuse patterns to accommodate the IAS, such as using the IAS as boundary marker between properties or fields, or changing the location of arable fields, areas where livestock are grazed, or where fisherman set their nets or lines. On the technical innovation side, fishermen in the Columbia brief introduced a new type of trawl net to harvest Nile Tilapia and harvesters of Prickly Pear in South Africa have a number of wire tools for dealing with the prickles. In both these instances local names were made up for the new inventions. The case of furniture from *Lantana* in India demonstrates a whole array of technological adaptations and innovations. Clearly, any changes and innovations lend a temporal dimension to the study of IAS impacts on rural communities, especially as it is likely that such innovations only evolve after a period of time and exposure to the IAS. Thus, some studies may show little or no adaptation, but it may be only a matter of time.

?? From the information available to the authors very few of the briefs could offer much insight into how IAS influence household resilience and vulnerability. It is implicit that for those IAS with a direct use value, or in which trade is evident, that these activities will help increase resilience on the one hand (perhaps through accumulation of nutritional, physical or financial capital), and decrease vulnerability

on the other. However, it might well be that whilst one can document benefits to rural households from the use of a specific IAS, the relative magnitude of such benefits within the overall household portfolio of livelihood strategies is so small that it has little effect on the resilience or vulnerability dynamics of the household or community. This may be especially so when the ecological negatives are included in the analysis. The current suite of briefs has not allowed any conclusions to be drawn with respect to these two possibilities, and thus, this needs to be a priority in future research.

?? From the briefs very little evidence exists of local communities taking efforts to remove IAS from areas under their control. This is despite negative ecological impacts, which in many instances they had noticed and commented upon. Three postulates can be advanced with respect to this. First is that the benefits of the IAS substantially and equivocally outweigh the negatives. This may be related to the degree of infestation. The second is that the IAS did offer some direct use and/or trade benefits, and that given the often precarious nature of rural livelihoods and the limited opportunities open to them, rural households seek to optimise the current benefits rather than worry about the potential for ecological degradation which will occur on a longer time scale. This relates to the often survivalist modes of many rural people, and the discounting of future benefits. This seemed to be the situation presented in most of the briefs. The last is that rural communities appreciate the potential or real negative ecological impacts, but are relatively powerless to do anything about it. They lack the capital, information and/or institutions to initiate *and maintain* effective control programmes. The last is illustrated by the temporary local level attempts to control *Prosopis* in the broader landscape in Kenya, which were then abandoned after the cleared lands were flooded. yet, individual households continued to remove it from their own fields, presumably because the benefits of doing so (being able to cultivate the land) were sufficiently high to outweigh the costs (time) of removing it. Another example is the temporary efforts of the Tidbury community to remove Jointed Cactus (see 5.1.1.10).

5. RAPID FIELD APPRIASAL OF IMPACTS OF IAS: PRICKLY PEAR AND BLACK WATTLE

5.1. Prickly Pear

5.1.1. *A brief history*

Invasive alien plants have had a lengthy history in South Africa, and have shared the reputation of both friend and foe to a wide variety of people over the past two centuries. Prickly Pear (*Opuntia ficus-indica)*, known in Xhosa as **itdlofiya**, is an invasive, exotic cactus that occurs widely throughout the Eastern Cape (as well as every other province in South Africa). Prickly Pear was originally harvested and cultivated by pre-Columbian human populations in Central America for 9 000 years before the arrival of Europeans (van Sittert 2002). It was later taken to Europe where it spread south from Spain into North Africa by the Moors in 1610 as well as eastwards where it eventually arrived in India.

It's first appearance in South Africa was in the Cape via the Dutch East India company in the 1700's, were it became an ornamental plant in the homes and gardens of the Cape-Dutch colonists (van Sittert 2002). It was then transported by the 1820 settlers to the Eastern Cape were it found a stronghold. It then became an exotic import for the English and a seasonal food source for settlers and local inhabitants alike. According to van Sittert (2002) it became a major source of seasonal employment, "*Opuntia* allowed blacks and poor whites to elude wage labour for half the year by harvesting and selling the fruit crop". It then underwent fluctuations in status between that of a pest and danger to livestock by progressive farmers and an important food source for poor white farmers and black communities (van Sittert 2002). It grew prolifically in the Eastern Cape and large, impenetrable Prickly Pear thickets grew within agricultural fields and grazing lands, smothering the land upon which people relied. Measures were then taken to remove the plant.

First attempts were made to physically remove the plants and burn them; however this was a strenuous and labour intensive ordeal, leaving farmers desperately searching for alternative eradication strategies. Chemical removal was the next step, using mainly arsenic of soda. It controlled the plant, but was mainly the luxury of richer and more progressive farmers (van Sittert 2002). The hazardous nature of arsenic left many workers severely ill, and there were several fatalities. Later, around the mid-1950s, safer forms of control were introduced with the arrival of four different species of insects; the phycitid moth (*Cactoblastis cactorum*), the cochineal (*Dactylopius opuntiae*) and two borer beetles (*Archlagocheirus funestus* (Cerambycidae) and *Metamasius spinolae* (Curculionidae)) (Zimmermann & Moran 1991). The arrival of these biological controls has assisted governments and farmers alike in controlling the spread of Prickly Pear, so much so that current uses of Prickly Pear have become more valued, and the biological control insects are now regarded as the pests (Zimmermann & Moran 1991).

5.1.2. *Study area*

The Prickly Pear study site was the village of Tidbury (32°38.6'S & 26°39.5'E), in the Kat River valley, Mpofu district of the former Ciskei homeland. Details of Tidbury village are summarised from Shackleton *et al.* (2003). The Kat River valley is characterized by several different land uses. In the middle and upper reaches of the valley several communities are spaced approximately equidistant along the valley between the urban settlements of Seymour in the north and Fort Beaufort in the south over a distance of approximately 40 km. Tidbury village lies in the middle of the valley and is situated near the road that runs between these two towns. Rainfall within the valley decreases from the upper reaches in the north in a southerly direction (Motteux 2002). Mean annual rainfall at Fort Beaufort is approximately 500 mm. There is a corresponding change in vegetation from Eastern Thorn Bushveld dominated by *Acacia karoo* in the north of the valley, to more succulent thicket in the south, characterized by *Acacia karoo, Euphorbia spp., Diospyros dichrophylla* and *Olea europaea* (Low & Rebelo 1996). The Tidbury community is currently poorly mobilised and has received very little development; however recently a project has been linking them to other villages to communally manage the Kat river water use. The village comprises approximately 42 households, and is sandwiched between two orange farms, where seasonal employment from May to July supports several

households. Current infrastructure is poor, with no school, clinic or community hall. The majority of households rely on governmental children's, disability or old age grants and pensions. Almost 80 % of households had at least one person in the household receiving grants or pensions (Table 1).

Table 1: Household profiles at Tidbury.

Total number of households interviewed	24 (out of 42)
No. of permanent residents per hh	3.7 ± 2.0
Proportion of adult males (%)	24.40
Proportion of adult females (%)	35.40
Proportion children (<17 years old) (%)	40.20
Full time formal jobs per hh	1.0 ± 0.23
Government grants or pensions per hh	1.1 ± 0.8
Proportion of hh with at least one pension or gov. grant (%)	79.2

5.1.3. *Approach*

The data collection process for this study consisted of replicate, qualitative household interviews, workshops with specific user groups, interviews with different stakeholders, and density estimates in different areas of invasion of Prickly Pear.

5.1.3.1. Household interviews and participatory exercises

Household interviews were conducted randomly within 24 households who were available during the short period of this study. The interviews were approximately 30 minutes long, and were conducted in Xhosa (see Appendix 3 for interview schedule). The interview focussed on the use of Prickly Pear (amounts and by who), trade in Prickly Pear, alternatives to Prickly Pear, attitudes towards its presence in particular landscapes, and significance its significance in local culture and livelihoods. Within each interview a participatory exercise was used to determine the interviewee's preferred density of the IAS within their village and surrounding lands. They were presented with five different pictures of the same landscape at different levels of infestation of Prickly Pear (see Appendix 4). The cards were labelled A to E, with A having no infestation, B illustrating one tree per 100 m^2, C showing three trees per 100 m^2. D showed five plants per 100 m^2, scattered evenly throughout the landscape, and E showed a density of eight plants per 100 m^2. They then had to choose their preferred density as well as the density they would least like the IAS to be at. Finally they had to provide reason for their selections. The data collected were mainly qualitative, therefore basic frequencies were calculated. For the collection and selling of Prickly Pear, gross seasonal incomes were calculated. Volumes of Prickly Pear used were standardized as some people collected with buckets of known volumes, and others provided actual numbers of Prickly Pears; therefore 10 fruits were estimated to be the equivalent of 2.5 litres.

5.1.3.2. Discussions with major stakeholders

The stakeholder interviews consisted of informal discussions with other land users around the village. This included two farmers (a cattle farmer and a citrus farmer), an agricultural extension officer and a Nature Reserve manager.

5.1.3.3. Group workshops

The workshops were conducted after the household and stakeholder interviews. They were used to triangulate the findings from the interviews, and obtain get different user groups perspectives on the impacts of Prickly Pear and some other alien invasive species on their livelihoods. Aspects covered in each workshop included:

- Local understanding of current legislation surrounding the controls of Prickly Pear, and what their opinion was of the controls or lack thereof.
- Perceptions of other stakeholders in relation to Prickly Pear.
- Different words and names associated with Prickly Pear.
- New or alternative methods they have developed to collect or prepare the species.
- Listing of the major positive and negative factors associated with the presence of Prickly Pear in their area.

5.1.3.4. Density surveys

The Point Centred Quarter (PCQ) method was used to quantify the abundance of the IAS within the areas where people were harvesting. Using a square card with four quarters drawn on it, points were randomly selected by dropping it on the ground (Mueller-Dombois & Ellenberg 1974) (see Fig. 1). Within each quarter the distance (m) to the closest tree and its base diameter (cm) was recorded (Mueller-Dombois & Ellenberg, 1974). The distance between each sampling point was lengthened to 10 m to reduce the possibility of recording the same individual plant twice. Within Tidbury village the Prickly Pear plants were scattered in five small clumps around the homesteads. Therefore, five 50 m^2 quadrats were sampled in this area.

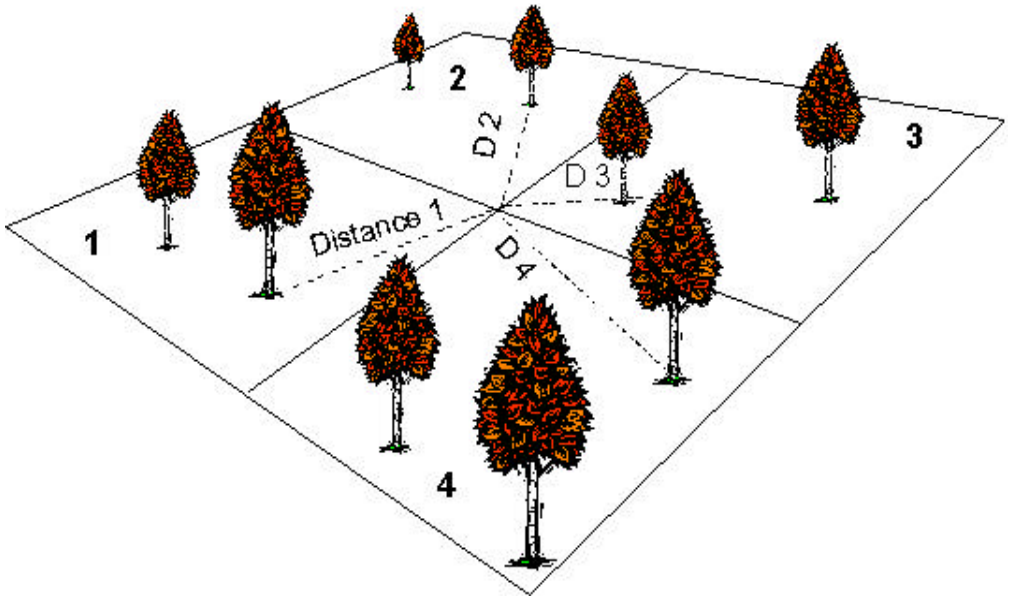


Figure 1: Schematic representation of PCQ method.

5.1.4. Findings: impacts on livelihoods

5.1.4.1. Size of the invasion

There were two key harvesting sites for Prickly Pear. The first site lays 2.02 km from the village and had 2.9 Prickly Pear stems per 100 m^2. The second site was 2.54 km away on the mountain to the south of the village and had more stems per area, with 4.2 stems per 100 m^2. The density of Prickly Pear around the homesteads and abandoned fields was 3.4 stems per 100 m^2 which was comparable to the density of the more distant populations in the communal lands. They used to also harvest from another large population to the north, but they no longer have access since it was fenced off to create a Nature Reserve. The density there was approximately 5.3 stems per 100 m^2.

5.1.4.2. Perceptions of invasion

Everyone interviewed said that Prickly Pear had been in and around the village before they were born. The oldest interviewee was 75 years old, and told us that his father used to collect it when he was young. In the group workshop, participants revealed that they were unaware that Prickly Pear was an alien species; so much so that one woman insisted that it was "the plant of my ancestors". Only 4 % (Table 2) of the people interviewed said that the abundance of Prickly Pear had increased over the recent past (last 5 – 10 years), while 67 % said that it has decreased. The most common reason people provided for the decrease was the higher harvesting pressure placed on Prickly Pear, since the other large population of Prickly Pear was enclosed into the Nature Reserve, which they could no longer access legally (although some admitted to still harvesting there without permission). Some other reasons provided were lack of rain and biological control introduced by commercial white farmers who occupied the area previously. People were accurate in their

perception of the extent of the invasion, with 67 % believing that the largest invasion was in the Nature Reserve. The mountains to the south were regarded by 25 % of interviewees to have the largest populations and the remaining eight percent did not know. Generally people perceived Prickly Pear to be at low densities.

Table 2: Perceptions of availability and change in Prickly Pear.

% of households perceiving an increase in abundance	4
% of households perceiving a decrease in abundance	67
% of households perceiving no change in abundance	25
% of households indicating they did not know	4

5.1.4.3. Direct uses

The majority of the villagers used Prickly Pear (Table 3); 23 out of the 24 households interviewed. Of these, 14 collected the fruit that they needed, two purchased Prickly Pear, and seven both collected and purchased the fruit. People collected and purchased Prickly Pear fruits during the fruiting season, which begins in mid-December and ends in March. Out of the 21 households that did collect, 18 collected from the mountains to the south of Tidbury. One household collected from their homestead, one from another farm, and one from the border of the reserve. The manager of the Nature Reserve said that people jump the fence to collect, which was later confirmed by the community representative, but obviously people were reluctant to expose such illegal harvesting activities.

Table 3: Percentage of households (hh) collecting and purchasing Prickly Pear.

Hh using Prickly Pear (%)	99
Hh collecting Prickly Pear (%)	58
Hh purchasing Prickly Pear (%)	8
Hh collecting and purchasing Prickly Pear (%)	29

During the Prickly Pear fruiting season one or two members of a household leave early in the morning to walk to the Prickly Pear population on the mountains. On average, a trip took about 3.2 $\pm$ 2.3 hours and the mean amount of Prickly Pear collected on each trip was 15.2 $\pm$ 8.3 litres (Table 4). The collectors made on average 3.2 $\pm$ 2.8 trips a month to collect Prickly Pear and according to the interviewees the fruiting season lasted about 2.5 $\pm$ 0.6 months (Table 4).

Table 4: Monthly consumption and time spent collecting Prickly Pear.

Mean amount used per interval (l)	15.2 ± 8.27
Mean no of times collected per month	3.2 ± 2.80
Average duration of seasons (months)	2.5 ± 0.59
Duration of collection trip (hr)	3.2 ± 2.30
Total time spent collecting per season (hr)	25.6 ± 3.81

Prickly Pear was also used to make wine, locally called **iQilika**. This word is not unique to Prickly Pear wine, and refers to any honey-based fermented drink. Four people were found to brew **iQilika** and two shared it with neighbours and relatives. Two houses also made Prickly Pear jam. The Prickly Pear cladodes can be denuded of thorns and fed to cattle and pigs. Four houses were found to be feeding their livestock cladodes.

Within the group workshop participants mentioned that people who collect for subsistence have priority over people who collect for the purpose of selling. This is an important local institutional arrangement to safeguard equity of access and household food security. In Limpopo Province similar local rules are to be found.

5.1.4.4. Economic use

There were only four active Prickly Pear vendors at Tidbury (Table 5). Within the group workshop it was raised that more people would be involved in selling Prickly Pear if there were higher abundances. They felt that the current densities were too low to support their subsistence requirements and the volumes needed to sell. All four vendors used the money earned from Prickly Pear sales to purchase groceries, and Vendor 1 said that sometimes she used it to buy school stationary for her children. Their earnings from trading in Prickly Pear are relatively low with a gross monthly income ranging from R20 to R100 (Table 5). Although there were only four people actively selling the Prickly Pear, four other people mentioned that they occasionally exchanged buckets of Prickly Pears for staple foods such as bags of maize-meal or samp (crushed corn). This was confirmed within the group workshop, where all the participants agreed that Prickly Pear was useful for barter and thus it was a useful currency to nurture reciprocal relationships within the community. Participants highlighted that those who shared Prickly Pear with others were more likely to be supported later on in times of need.

Table 5: Income from selling Prickly Pear.

	Vendor 1	*Vendor 2*	*Vendor3*	*Vendor 4*
Selling days per season	2	20	2	36
Volume sold per season (2.5 months) (l)	30	100	12.5	75
Unit price (R/l)	1.60 (R8 for =5 litres)	1 (R5 for 5 litres)	4 (R20 for 5 litres)	1.40 (R7 for 5 litres)
Gross seasonal income (R) (2.5 months)	48	100	50	105
Labour time collecting per day (hr)	8	2	4.5	6.5
Selling place	Roadside	Roadside	Home & Roadside	Roadside

5.1.4.5. Alternatives

Eight people could remember a time when Prickly Pear densities were very low, such that they couldn't any reasonable quantities of fruit. Two people out of the eight said that they used other wild species during this time. They both still used these wild indigenous species, although they preferred Prickly Pear, as the fruit is sweeter, readily abundant and "it gives us more energy". During the group workshop the participants said that although they can get other fruit, Prickly Pear was more substantial than wild fruits. They said that while walking in the hills they could rely on the other wild fruits for a snack, but they will make special trips to collect Prickly Pear, to bring it back home.

5.1.4.6. Optimal densities

At Tidbury village 91.6 % of people wanted Prickly Pear at the highest densities (density 'E' – Appendix 4), six people's reasons for having it so thick was simply that they loved it and wanted more, four said they could sell it at that density and two said that they would not have to travel too far to collect the fruit. Other reasons for having it at this density were that it was "beautiful to look at"; it supported their diet in summer; it was delicious and they wanted more; it was a healthy natural fruit and they needed more, it was scarce and thicker densities were needed; and finally that they all depended on it and wanted more around them. Only two people wanted it at lower densities; one suggested density 'B', their reason was that the current density is getting low anyway, and that they don't really need it, and the other proposed density 'D', as it must not intrude into their garden, or get too thick around the homes. When asked if there were areas in which they would not like Prickly Pear to grow 46.2 % of people did not want it growing within the homesteads and gardens; 33 % wanted it to grow everywhere; 12.5 % did not want it growing near rivers or sacred pools; and 8.3 % in fields and grazing lands. The most common reason amongst those who didn't want it growing around their homes was that the thorns were dangerous to children in those densities. Those who didn't want it growing in grazing lands felt there was not enough room for Prickly Pear in their limited grazing areas. One man said that he would prefer the Prickly Pear to grow in areas where there was erosion, as it protected the soil.

5.1.4.7. Cultural value

Only two people said that Prickly Pear had a cultural value, but they were unwilling to elaborate, other than saying it had a relationship with the spirits. In the group workshop a traditional healer mentioned it had a medicinal use, which was to help with chest pains. Six people said that Prickly Pear grew on the riverbanks near sacred pools, which is an important area and they did not want it there.

5.1.4.8. Development of new words and techniques

Besides the local name (**itdlofiya**) for Prickly Pear, people have developed some new techniques and terms associated with Prickly Pear. Amongst the 21 people who collected their own fruit, 20 used a specific technique to harvest Prickly Pear compared to harvesting other wild fruits. The technique was mainly adopted to avoid injury from the spines. The most common approach was using a piece of wire bent into a hook (called **umgwewe**) and is used to collect fruits high on up on the plants. The second most common technique was using an old soft drink can, with one of the sides cut off, to break off the fruits without getting their hands hurt. They called this 'can-harvester' **itanki**. Eight people used just **umgwegwe**, five people used **itanki**, and three people used both **umgwegwe** and **itanki**. In the workshop these techniques were discussed further. People were not sure how long they have used the word **umgwegwe**, however it is a tool developed for the unique purpose of harvesting Prickly Pear. One woman wrapped a plastic bag around her hands while she collected the fruit. Other strategies mentioned included harvesting after the rains as they believe the fruit grows bigger after rain and that it will be sweeter, and four people said that they go early in the morning, to see the fruits better in the morning light. One woman said that she left before the sun rose, so that she could collect before anyone else could.

5.1.4.9. Alternative stakeholder impressions

The Nature Reserve manager did not see Prickly Pear as a major problem in the reserve at its current densities. However, he felt that when villagers jumped the fence in order to collect Prickly Pear that they were in danger of being attacked by wild animals in the reserve, which could be a problem. He also claimed that they set up snares and traps for game while they were supposedly harvesting Prickly Pear. He had instituted a controlled permit system, as a means to monitor and manage people's use of resources within the reserve, and was only prepared to help those people who were willing to co-operate. Both the citrus farmer and the cattle farmer did not consider the Prickly Pear a problem, and stated that the current densities were to low to have any negative effects on the functioning of their farms. They said that Prickly Pear provided fruit to surrounding communities, many of whom were staff on their farms. They both felt that the Prickly Pear was an important social and economic resource and that it should be protected for the people in the valley. The orange farmer hires many people as casual labour during the picking season (winter); and felt that Prickly Pear provided a useful food alternative to oranges during the summer season. The agricultural extension officer was not aware that Prickly Pear was an alien plant. He mentioned that during his time working there he has never seen a problem with Prickly Pear and considered it a valuable resource to the communities in the Kat River valley. He felt that densities were currently too low due to the biological

control measures introduced by farmers in the past. He saw a need for higher densities of Prickly Pear to support poorer people, since it can be sold and used to supplement meagre incomes.

5.1.4.10. Other alien invasive species

A general impression from the interviews, group workshops, and discussions with alternative stakeholders was that Prickly Pear did not pose a major threat to alternative land-use options. However, during these interviews and discussions other alien species were continually mentioned as problems negatively impacts on local livelihoods. All the alternative stakeholders and the Tidbury community mentioned the Jointed Cactus *(Opuntia aurantiaca)* as a problem to livestock and people. They said that children were particularly prone to injury when they play barefoot in the fields, and also when it grows in soccer fields. Cattle, goats and sheep had also suffered injuries to their hooves, legs and mouths while they were grazing. Several individuals stated that some of these injuries were fatal to their livestock. At one stage they had decided to try and eradicate it. They had collected as much Jointed Cactus as they could and then burnt it. But after some time it was back at the pre-burning densities and they had given up trying to control it. Black Wattle was also seen as a problem in the Kat River valley. A community near the State plantations had sold their Black Wattle forests to a private contractor as they wanted other indigenous trees to grow there. The agricultural extension officer had mentioned a community who were struggling with a Black Wattle infestation along the river banks. There were two indigenous species that were pointed out by the farmers and the agricultural extension officer as an issue. The orange farmer and the extension officer both complained of *Acacia karoo* (an indigenous pioneer, and sometimes invasive, species) reaching large densities in abandoned fields. The cattle farmer was concerned with an indigenous *Aloe* species, as he was told that they provide environments that breed ticks.

5.1.4.11. Discussion

The people at Tidbury appear to rely heavily on Prickly Pear, although it is a seasonal fruit producer and so the major benefits could only be accessed for 2.5 months of the year. However, its role in providing cladodes as a form of fodder was available year round. Prickly Pear has been growing in the area for over 200 years (van Sittert 2002), and its adoption into everyday life at Tidbury is obvious. People in Tidbury were unaware of its alien status, and showed offence when this was suggested. The community has evolved a specific harvesting style and tools to collect Prickly Pear. They have created new products like a Prickly Pear wine and jams from the fruit. The fruit was also used economically, with four vendors identified as selling the fruit, which generated supplementary income for the households. People favoured Prickly Pear over wild species and use it more than the indigenous fruit species available in the area (Shackleton *et al.* 2003). The community felt that current densities were too low and they would prefer thick stands of Prickly Pear on the mountains, although they did foresee with thick densities around their homesteads. It was rumoured to provide medicinal properties and used in the treatment of certain ailments. Its role in supporting community relationships and nurturing reciprocity with the exchange of other food items for buckets of Prickly Pear is valuable, especially for the poorest household as it allows them to exchange their labour for

food in the absence of cash income. It thus acts as both a direct and indirect form of local security. Another indirect value of Prickly Pear was its aesthetic appeal. A young man of about 20 years old had lost both his parents to illness a few years earlier. He did not have a job or any governmental grants and relied solely on seasonal orange picking work in the surrounding farms. He was one of three people in the Tidbury community who had a home garden, and the only person who purposefully planted Prickly Pear around the border of his garden. He said that he thought it was beautiful and he likes looking at it. He also anticipates it becoming a reliable fence in the future. The positive effect Prickly Pear has on this individual's well-being is clearly significant. The trade-offs people have to make when allowing Prickly Pear to grow in their village are minimal. The potential costs associated with having Prickly Pear in higher densities are reduced grazing land, thorns endangering children, and possible constipation if large quantities of Prickly Pear are consumed. As a counter balance to these costs, people at Tidbury were provided with a reliable seasonal food source; economic and social safety-nets for 2 – 3 months of the year, and an aesthetic environment for a number of people. At current densities the plant poses little threat, and requires minimal sacrifice by other land users for it to persist in their environment. The challenges people face are not the possible reduction of alternative livelihood strategies and resilience, but are rather related to the low densities of Prickly Pear itself; the inaccessibility of larger populations in the Nature Reserve, and minor health problems if they eat too much. Prickly Pear has been integrated into local livelihood strategies during the summer, and the decrease of Prickly Pear seems to be the most problematic and worrying situation for Tidbury villagers. The biological controls that are infecting the populations of Prickly Pear may become more of a pest and problematic alien invasive people's current livelihoods, than the Prickly Pear itself.

Table 6: Positives and negatives of infestations of the Prickly Pear at Tidbury.

Positives	*Negatives*
Seasonal fruit that supports diets & nutrition	Thorns are possible danger to children
Fodder for cattle during difficult times	Not enough of the resource to support many sellers, biological control reducing productivity
Aesthetic value	Very far to collect, not enough prickly pear near the village
Monetary income from selling fruit during summer	Denied access to populations of Prickly Pear within game reserve
Resistant during dry times, and can support diets during these times	Eating too much causes constipation, therefore particularly dangerous for people who are lacking other food sources
Traditional wines and jams made from the fruits	

Positives	*Negatives*
Exchange of buckets of fruit for other forms of food	
Supports community relationships and nurtures reciprocity	
Some spiritual value, "plant of my our ancestors"	
The fruit is sweet and delicious, and people love eating it	
Unconfirmed medicinal value	

5.2. Black Wattle

5.2.1. *A brief history*

Black Wattle (*Acacia mearnsii*) has not undergone the same kind of lengthy and complicated journey through South African landscapes and societies as Prickly Pear, but its impact has been equally controversial. It is an invasive tree from the family *Fabaceae* originating from Australia where it is still a valued source of fuelwood and timber. Wattle arrived in South Africa in the 19th century, along with other exotic trees, where they were grown in plantations to accommodate the lack of readily available fast growing timber, and bark for the tanning industry (le Maitre *et al.* 2002). From these plantations invasions of pine species (*Pinus*), *Eucalyptu s*and other wattle species (*Acacia*) have left many areas surrounding the plantations coated in a monoculture blanket of young pioneering alien forests. Recently the effects of these alien trees on reducing surface water levels, due to their high water consumption, have become a national concern. The South African government and the forestry industry have taken an active role in eradicating Black Wattle and other high water-demanding alien invasives along rivers, catchment areas and other sensitive ecosystems. This is mainly carried out by a project named Working for Water (WfW), which has been active since 1995 (van Wilgen *et al.* 1995). It has been involved in the training and subsequent employment of local people to eradicate invasive plants.

5.2.2. *Study site*

Catha village is situated in the Amatola municipality in what was the former homeland of the Ciskei, approximately 20 km from Keiskammahoek (32°35.3'S & 27°07.4'E). It lies at the base of the Amatola mountains. It is surrounded on all three sides by hills, and five small tributaries meet near the base of the mountain to create the Catha River which runs through the middle of the settlement. It has very active and strong leadership, and community organizations. Like many rural settlements under the old apartheid

government people were resettled under the practice of "betterment planning" (de Wet 1995, 2001). However, currently much developmental activity is underway at Catha; roads are in the process of being built, there are two schools, a clinic, and a large recently built community hall. The Participatory Forest Management (PFM) committee is active and involved with monitoring and controlling indigenous forests and exotic timber plantations of pine, eucalyptus and wattle. Nearby, the Department of Water Affairs and Forestry (DWAF) has commercial pine and Black Wattle plantations which provide local people with employment. A small agricultural project has also recently been founded, where community members are cultivating larger areas of land along the floodplains for commercial maize production. Similar to Tidbury village, Catha village households also relied heavily on governmental grants and pensions, with 83.3 % of households receiving at least one pension or grant (Table 7).

Table 7: Household profiles at Catha.

Total number of households interviewed	30 (out of ± 300)
No. of permanent residents per hh	3.6 ± 1.5
Proportion of adult males (%)	23.8
Proportion of adult females (%)	37
Proportion children (<17 years old) (%)	29.2
Full time formal jobs per hh	0.2 ± 0.4
Government grants or pensions per hh	1.2 ± 0.7
Proportion of hh with at least one pension or gov. grant (%)	83.3

5.2.3. *Approach*

5.2.3.1. Household interviews and participatory exercises

Household interviews were conducted randomly within 30 households who were available during the short period of this study. The interviews were approximately 30 minutes long, and were conducted in Xhosa (see Appendix 3 for interview schedule). The interview focussed on the use of Black Wattle (amounts and by who), trade in Black Wattle, alternatives to Black Wattle, attitudes towards its presence in particular landscapes, and significance its significance in local culture and livelihoods. Within each interview a participatory exercise was used to determine the interviewee's preferred density of the IAS within their village and surrounding lands. They were presented with five different pictures of the same landscape at different levels of infestation of Black Wattle (see Appendix 4). The cards were labelled A to E, with A having no infestation, B illustrating one tree per 100 m^2, C showing three trees per 100 m^2. D showed five plants per 100 m^2, scattered evenly throughout the landscape, and E showed a density of eight plants per 100 m^2. They then had to choose their preferred density as well as the density they would least like Black Wattle to be at. Finally they had to provide reason for their selections.

Wattle wood was collected either by head-load bundles, cattle-pulled sleds, or light delivery vehicles (LDV). On average, nine head loads were found to equate to one cattle sled, and 2.5 cattle sled loads equate to one LDV load (this information was collected in a workshop). Unfortunately, due to time constraints head-load weights were not recorded. However, in a study conducted by Bembridge & Tarlton (1990) in the Amatola region, they recorded that the mass of fuelwood head-loads ranged from 10.0 kg to 36.0 kg, with an average of 24.3 kg; and lengths of wood per bundle ranged from 1.75 m to 3.3 m with an average of 2.5 m. These weights were then used to calculate the quantities of Black Wattle harvested or purchased over a given period.

5.2.3.2. Discussions with major stakeholders

The stakeholder interviews consisted of informal discussions with other land users, around the villages. At Catha Village, the Participatory Forest Management Committee (PFM), two tribal headmen, the oldest resident and a forestry official were interviewed.

5.2.3.3. Group workshops

The workshops were conducted after the household and stakeholder interviews. They were used to triangulate the findings from the interviews, and obtain get different user groups perspectives on the impacts of Black Wattle and some other alien invasive species on their livelihoods. Aspects covered in each workshop included:

- ?? Local understanding of current legislation surrounding the controls of Black Wattle, and what their opinion was of the controls or lack thereof.
- ?? Perceptions of other stakeholders in relation to Black Wattle.
- ?? Different words and names associated with Black Wattle.
- ?? New or alternative methods they have developed to collect or prepare the species.
- ?? Listing of the major positive and negative factors associated with the presence of Black Wattle in their area.

5.2.3.4. Density surveys

The Point Centred Quarter (PCQ) method was used to quantify the abundance of the IAS within the areas where people were harvesting. Using a square card with four quarters drawn on it, points were randomly selected by dropping it on the ground (Mueller-Dombois & Ellenberg 1974) (see Fig. 1). Within each quarter the distance (m) to the closest tree and its base diameter (cm) was recorded (Mueller-Dombois & Ellenberg, 1974). The distance between each sampling point was lengthened to 10 m to reduce the possibility of recording the same individual plant twice.

5.2.4. *Findings: impacts on livelihoods*

5.2.4.1. Size of the invasion

The Black Wattle occurred in three major areas. The first is a 57 ha stand of Black Wattle with a density of 19.1 trees per 100 m^2, which has been set aside and protected for a small development project controlled by the PFM committee. The second is a 27 ha plot, which borders the 57 ha plot and has been sectioned off for Catha village's daily use, with a density of 15.3 trees per 100 m^2. The third stand runs along the river for about 5 km, and creates a 50 m band on either side of the river. It had a density of 11.9 trees per 100 m^2. This Black Wattle forest is not managed and is believed to be increasing in density every year. Young Black Wattle plants can be seen in scattered densities in grazing fields and ploughed fields.

5.2.4.2. Perceptions of invasion

With respect to Black Wattle 77 % of respondents perceived Black Wattle to have arrived before they were born. The remaining 23 % said that the Black Wattle had arrived later. The dates of Black Wattle arrival varied considerably from 1926 to 1970. The oldest informant claimed the Black Wattle came from settlers from Cathcart over the mountains in the late 1920's. All the people interviewed at Catha were aware that Black Wattle was a foreign species. All interviewees claimed that Black Wattle had increased (Table 8); 73 % blamed the rapid expansion on the prolific dispersal of seeds by the wind; 13 % believed that the current extermination of Black Wattle by the Working for Water programme was actually assisting growth of Black Wattle, rather than reducing it. Other reasons suggested for the increase was that the area has rich fertile soils and high rainfall, which together promote the growth and spread of the plant. The riverbanks were perceived by 33 % of the people at Catha as having the highest densities. The 57 ha Black Wattle forests were seen as having the largest densities by 30 % of the interviewees; 16.7 % believed that both the riverbanks and the 57 ha site had the highest densities and 13.3 % were under the impression that both the 27 ha and 57 ha Black Wattle forests had the highest densities.

Table 8: Perceptions of availability and change in Black Wattle.

% of households perceiving an increase in Black Wattle abundance	30
% of households perceiving a decrease in Black Wattle abundance	0
% of households perceiving no change in abundance	0
% of households indicating they did not know	0

5.2.4.3. Direct uses

Collection of Black Wattle at Catha was high, with 29 out of the 30 households using Black Wattle, with 24 people collecting their own supplies, and only five purchasing Black Wattle (Table 9). Only elderly women, who all said that they were too old to collect, purchased Black Wattle. Wattle prices ranged from R80 to R200 per cattle load (one cattle-load is approximately 218.3 kg) with a mean price of R170 per cattle-load.

The amounts of Black Wattle collected and frequencies of collection were influenced by individual household needs. Fuelwood collection occurred more regularly than the collection of building and fencing poles (which were collected when people felt they needed to repair a house, or re-fence their garden). People's access to cattle or LDVs also influenced the amount they collected and the frequencies of trips they made, because ownership of these assets meant that they could collect and transport greater quantities, which obviously took more time. People who collected head loads collected 3.3 ± 4.5 times a month; whereas those collecting with LDVs and cattle collected 0.4 ± 0.7 times a month (4.8± 8.6 times a year; the standard error was skewed by one individual who collected three times a month with cattle) (Table 10). Collections trips lasted on average 2.6 ± 1.2 hours (Table 10). Black Wattle is available year round, but 30 % of the respondents said that they used more during winter, and one person said they used more during traditional ceremonies. Black Wattle was purchased yearly, with three women saying that they purchased it to prepare for winter and two said they bought Black Wattle loads for traditional ceremonies.

Table 9: Percentage of households (hh) collecting and purchasing Black Wattle.

Hh using the Black Wattle (%)	97
Hh collecting the Black Wattle (%)	80
Hh purchasing the Black Wattle (%)	17
Hh collecting and purchasing Black Wattle (%)	0

Table 10: Monthly consumption and time spent collecting Black Wattle.

	Head-load	Cattle-load
Mean amount used per interval (kg)	24.3 ± 12	218.25 ± 12
Mean no. of times collected per month	3.3 ± 4.5	0.4 ± 0.7
Average duration of seasons (months)	Year round	Year round
Duration of collection trip (hr)	2.6 ± 1.2	2.6 ± 1.2
Total times spent collecting per season (hr)	Year round	Year round

5.2.4.4. Economic use

Although there were five women purchasing Black Wattle, there were no sellers found amongst the 30 households interviewed. In the workshop, people admitted to offering their services to collect for others, usually men would collect for older women. Sometimes older women would pay, but people who helped did not expect payment and said that they usually did it for their relatives.

5.2.4.5. Alternatives

All the people interviewed claimed they were using Black Wattle because it was located reasonably close by and that there are restrictions on using indigenous species as they were under governmental control. Sixteen alternative indigenous species were identified, and two exotic alternatives. Half of the respondents spoke of

their preference between indigenous species and Black Wattle; 60 % preferred Black Wattle over the indigenous species. The reasons for this were that Black Wattle was closer to collect and they had open access to it. The remaining 40 % preferred indigenous species over Black Wattle, as they claimed that Black Wattle is a softer wood and that it doesn't burn as long as indigenous wood.

5.2.4.6. Optimal densities

The optimal densities preferred by the Catha village were varied. Density 'E' (the highest) was the most common preferred density, with 53.3 % wanting it at that density. The main reason was that the more there is the more people can use, and the second most common reason was that they could develop small businesses from Black Wattle when it is at a high density. Density 'D' was the next most preferred density with 23.3 %; reasons for this density were that it was difficult to walk around a forest at density 'E'. Other reasons were that it would invade grazing areas if at density 'E' and it was easier to manage at density 'D' and that criminals could hide in the thicker forests. The third most common density (10 %) was density 'A', which is no Black Wattle at all, as they were afraid of criminals hiding within the Black Wattle forests along the river. Stories of women and children being attacked when they go down to the river to collect water and wash, were common. One interviewee was raped several times while collecting water, and that the rapist had escaped under cover of Black Wattle. The remaining 13.4 % felt that a density of 'B' or 'C' was preferable having voiced similar concerns of wattle-covered crime.

5.2.4.7. Cultural value

The Catha inhabitants did not commonly view the Black Wattle as a cultural resource; however 26.7 % claimed they used it to build **abakweta** huts for young male initiates, for their coming of age ritual and circumcision camps. Another man said that it was culturally significant as they used the wood for fires for weddings, funerals and other ceremonies. One traditional healer was interviewed in the survey, and she stated that Black Wattle has no cultural value and that its presence near the sacred pools upsets the ancestors. However another individual claimed that Black Wattle covering sacred pools protected them from being over-used. The thick growth of the Black Wattle along the river and on the edges of forests has encroached on some sacred areas; 76.7 % were concerned with the growth of Black Wattle around sacred pools.

5.2.4.8. Development of new words and techniques

Wattle was not collected using a unique technique, however in the workshop it was discussed that it did make an excellent building wood as it is very straight and that they prefer it to indigenous trees for building. Wattle is also known colloquially as **plantaish** which is derived from the word 'Plantation'. In other villages **plantaish** is a common word for gum, pine, or any other tree grown in a plantation; however the workshop confirmed that this word in Catha village was unique to Black Wattle.

5.2.4.9. Alternative stakeholder impressions

The two headmen interviewed at Catha felt that Black Wattle should be removed, as its current densities were creating severe problems in grazing lands and fields. They also mentioned theft of cattle in Black Wattle thickets and confirmed the attack of women and children in areas of dense Black Wattle. They also mentioned that it was difficult to control and they felt that current controls by the government, instead of reducing Black Wattle were exacerbating the infestation. The PFM committee took a very different stand point; they felt that Black Wattle densities should be increased in woodlots. They were planning a potential development project reliant on Black Wattle timber sales. They felt that the criminal problem could be dealt with if Black Wattle was managed in set plots by community members. The oldest resident in the village provided some insight into the history of Black Wattle in the area. He felt that Black Wattle was a useful resource and that it supports many people in the village, however he feels that the priority should go to the concerns of the women and children who are at risk in the Black Wattle forests as well as cattle owners who face potential threat to cattle theft. The forestry official shared similar aspirations to the PFM committee and also felt controls were needed for Black Wattle growth.

5.2.4.10. Other invasive alien species

No other invasive alien species were identified as a problem within the area. Positive benefits were received from both eucalyptus and pine.

5.2.4.11. Discussion

Wattle densities were generally perceived to be too high, yet those who wanted higher densities thought that they could develop projects from it, or that the need to control high densities of Black Wattle creates potential jobs, through WfW projects. Black Wattle was viewed as a year round resource that was readily available and useful for fuel wood, building and fencing. Although people were aware of these benefits there were areas in the landscape where Black Wattle growth was undesirable; these included grazing areas, sacred pools, homesteads and riverbanks, as they either reduced the productivity, cultural heritage or safety of that particular area. The costs of these benefits were not only felt by those who used Black Wattle but also by other people in the village. Those carrying the most drastic costs for Black Wattle's persistence in the environment were women and children, who faced possible attack and even rape from criminals hiding in stands of Black Wattle. Cattle owners alike had mentioned cattle theft under the dense Black Wattle cover. The impacts on the cultural heritage of Catha was significant, with almost the entire river course clogged with Black Wattle infestation, making it difficult for cattle to drink, and rendering sacred pools inaccessible, not to mention reducing their surface water supply. Additional costs externalized onto peoples livelihoods were the increased effort people had to make in their fields in terms of removing Black Wattle and the reduced productivity of grazing lands. In light of these costs, the benefits of Black Wattle as (i) a year round resource, (ii) that is located reasonably close, and (iii) serving as a buffer to heavy harvesting of indigenous trees for similar uses, are important. Although its potential role in creating jobs and small business is not certain, it could make a significant financial difference to many households. The impact of Black Wattle on

people's livelihoods is multifaceted with a variety of benefits and costs. Within the village users and non-users of Black Wattle had to make trade-offs when dealing with the invasion. Those who used it had to either walk long distances to collect it, exchange goods and services, or pay money to obtain Black Wattle. But the costs, borne by everyone, including non-users, included possible attacks, theft, reduced productivity of fields and grazing lands and weakening of cultural and aesthetic value of sacred areas. However, for most people, the direct use benefits currently outweigh all the costs and the current thinking seems to be 'use now, worry about the consequences later'. Poor people are provided with short-term gratification and livelihood support; however the potential long-term costs may become more severe, and if Black Wattle is not managed effectively could possibly weaken their livelihood strategies by reducing available grazing land, soil fertility, cultural heritage and safety of the area.

Table 11: Positives and negatives of infestations of Black Wattle at Catha.

Positives	*Negatives*
Wattle forests are closer than indigenous forests, less distance to travel to collect	Wattle very invasive and growing within fields creating difficulties when ploughing
Wattle wood is used as alternative indigenous trees and is acting as a buffer to over harvesting of indigenous trees.	Very dense near river, creating an area to cover criminals, and making difficult for people to get to the river
Possible resource for a small development project selling timber	Growing in grazing lands and reducing available grazing areas
Resource available year round, large resource base	Wood burns quicker than indigenous trees (doesn't last as long)
Used to build traditional **abakweta** huts, for initiation ceremonies	Reducing cultural value of sacred pools
Favoured building material for housing and fencing as generally straight poles.	Reducing available surface water within the river
Used for firewood	
Used in traditional ceremonies like weddings funerals and initiations	
Protecting sacred pools from over use	

5.3. Issues from the field studies

The two field studies show that the effects of IAS on rural livelihoods are complex. Some households make extensive use of IAS and other do not; some use it to generate income and others turn to these species only in times of particular need. In each instance some stakeholders felt that current densities of IAS were too high and should be reduced, either for aesthetic or economic reasons, whereas others (the majority) would welcome greater densities because of the direct uses or potential cash that they represented. Consequently, from the findings at both of the case studies it is clear that the label of a "pest" for an IAS is a culturally, socially, and economically specific judgment, and that the difference between 'nuisance' and 'useful

resource' is perhaps a matter of perspective. This is an important reality as biological invasions of alien species are a historical process, which are not solely directed by the biology of the invader, but by shifting cultural values of the invaded society (van Sittert 2002).

The temporal dimensions and thresholds were not easy to elucidate from the approaches adopted, or within the time span of this study. It is noteworthy, however, that both species have been components of the landscape for decades, such that local people had become acclimatised to them, and viewed them as an integral, if not natural, part of the landscape. Thus, it is not a case of opportunistic use, but an adaptation to a permanent feature of the landscape, aesthetically, functionally and economically. Hence livelihoods will be affected if the IAS were to be removed. There did not appear to be too many obvious trade-offs, as perceived and reported by the rural people themselves, between the various direct, indirect and ecological benefits or impacts of either IAS.

6. PROPOSED METHODLOGY FOR ASSESSING IMPACTS OF IAS ON RURAL LIVELIHOODS

Based on the lessons from the international briefs and the two field studies in South Africa, it is possible to reflect upon and propose a common approach for similar studies in the near future. Clearly, time and budget available are crucial to methods and samples sizes employed in empirical data collection. We have assumed that a maximum of two weeks field time is available. So too is a conceptual framework to guide the questions to be asked and the different data sets required to best elucidate the impacts of IAS on rural livelihoods. Such a framework is necessary to unravel and interpret the complexity inherent in examining the effects of IAS on rural livelihoods. This complexity is a results of the (i) the varied nature of IAS and their uses, (ii) the diversity of livelihoods options in which rural households engage, (iii) the temporal dimension to invasions and hence people's reaction to them, and (iv) the local and national contexts that shape people options and vulnerabilities. The complexity is compounded when these different dimensions interact.

6.1. Conceptual framework for investigating and interpreting the impacts of IAS on rural livelihoods

6.1.1. *The baseline framework*

The framework is simplistic to make it adaptable for different types of organisms, situations and scales of measurement. Four curves are presented as trajectories through time since the IAS has been introduced (deliberately or accidentally) into an area. The first curve is one of increasing abundance of the IAS with time; it follows a density-dependent logistical function (sigmoid shape) in the absence of any control mechanisms. The second curve depicts benefits accruing to local livelihoods from the IAS. This will generally mirror the abundance curve. The more of the resource, the greater benefits. The third curve is one

relating to costs. This includes all costs, such as ecological costs, aesthetic costs, costs of control, etc. These costs compound as time and abundance of the IAS progresses, and hence the curve is exponential. The fourth curve illustrates livelihood vulnerabilities associated with IAS. We present is as cup shaped, with livelihood vulnerability being inherently high for most rural households at the start. This decreases as benefits of the IAS increase, and costs are still low. But as costs increase relative to the benefits then vulnerability is exacerbated once more. Whether or not it exceeds the starting point will depend upon the final ratio between costs and benefits. Whether or not the ratio of costs to benefits becomes, or remains, negative will depend upon the relative magnitudes and new uses or innovations (as in the case of *Lantana* in India). This baseline framework is presented in Figure 2.

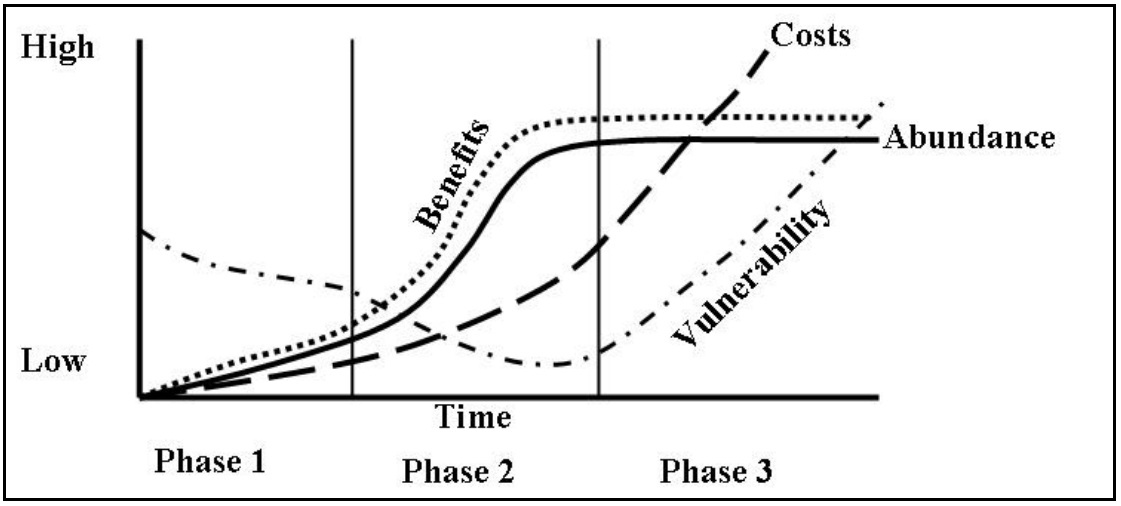


Figure 2: A conceptual framework to interpret impacts of IAS in rural livelihoods.

Two aspects of the framework are fundamental. Firstly, inherent in each of the curves are thresholds (Walker & Meyers 2004) - points at which the rate of response over time changes markedly. Additional thresholds are evident at intersections between curves. Identification of such thresholds in reality and the local community responses to such thresholds is important in developing a predicative understanding of the impacts of IAS on local livelihoods. Secondly, the temporal dynamic of IAS impacts is captured along the x-axis. Therefore, it is necessary that researchers and communities can verify where along this axis they are at any moment. For ease of interpretation and characterisation, we have divided the temporal axis into three phases, but in reality it is more of a continuum. Phase 1 represents the early stage of invasion represented by a low abundance of the IAS. In this situation the benefits are low, or small and direct, specifically for the reasons for which it was introduced, and perhaps accessed by only a small proportion of the community. There are no control attempts and ecological costs are still small. Livelihood vulnerability is defined more by other livelihood issues than by the IAS.

In Phase 2, the abundance has increased sharply, and continues to do so. Most people are now well aware of the presence of the IAS in the landscape, water bodies and/or people's fields and gardens. If it has beneficial uses (noting that not all IAS do have beneficial uses), many people are now accessing them. Costs are increasing. The ecological costs may be approaching or surpassing key thresholds of change. It is towards the end of this phase that management interventions may be considered. These interventions may be complex, and not always driven by local communities, but perhaps also by outside agencies, particularly conservation or State agencies. Livelihood vulnerability is reduced through the new options and benefits offered by the IAS in the landscape.

Phase 3 is the stage at which costs usually come exceed the current benefits, with the ratio moving further and further into a negative balance unless either the IAS is controlled (at a cost) or new and significant benefits are identified. People are now faced with either (i) controlling the invasion, (ii) living with it and hence also with impaired livelihood options and increased vulnerability, or (iii) move away. The final trajectories in Phase 3 will depend upon what intervention or strategies are adopted. If costs are not addressed then vulnerability will definitely be increased to levels above that of before the IAS was introduced.

6.1.2. *Accounting for IAS characteristics*

In any temporally dynamic model the shapes and steepness of the curves of costs, benefits and abundance will vary between species and between geographic localities. In terms of species characteristics they can be classed into four types based on a 2 x 2 matrix of (i) invasion aggressiveness, and (ii) presence or absence of desirable traits (such as edible fruits, wood for timber).

Table 12: Two-by-two matrix of species aggressiveness and usefulness.

		AGGRESSIVENESS	
		Low	**High**
BENEFICIAL TRAITS	**Low**	*Undesirable, docile species* It has negligible or low impact on rural people, because its invasivity is low. Hence, it is easily controlled, although such control does represent a cost. It currently has no known direct or indirect use and hence, no benefit curve in the conceptual framework	*Undesirable, aggressive species* The species has no or limited direct or indirect benefits to people. It invades rapidly, and is often difficult to control. Here the impacts on rural livelihoods will be most severe in the later phases of invasion. Rural communities frequently unable to control the species without external help. Examples from this project include Cassava Mealybug, Triffidweed, *Mimosa*.
	High	*Useful, docile species* Not very invasive, it is easy to manage. Benefits can be extracted from it and hence rural people with limited livelihood options will exploit it to maximum benefit. Such exploitation will be sufficient to keep it in check in most situations. Examples from this project include alien Salmon species in Chile, *Eucalyptus* in Peru, *Tilapia* in India.	*Useful, aggressive species* Such species invade the landscape or streams rapidly, and thus are often difficult to control. They are useful to the invaded society and hence there is resistance to its complete removal. However, harvesting by dependent communities is an inadequate control measure and so abundance and concomitant ecological costs increase with time. Various stakeholders come to condemn the species as abundance (and associated costs) increases. People would like to be able to control the species in a farming situation. Landscape invasion usually requires some external agency to assist in control. Examples from this project include Black Wattle, Prickly Pear, *Prosopis*, *Tilapia* in Colombia, *Lantana* in India

These four different species types result in four variations of the conceptual framework, which can then assist in analysing the current impacts of IAS on rural livelihoods, and people's responses to them (Fig. 3). The field methodology must then be orientated to determining in which phase along the time axis is each study community, as the impacts on rural livelihoods differ in each phase.

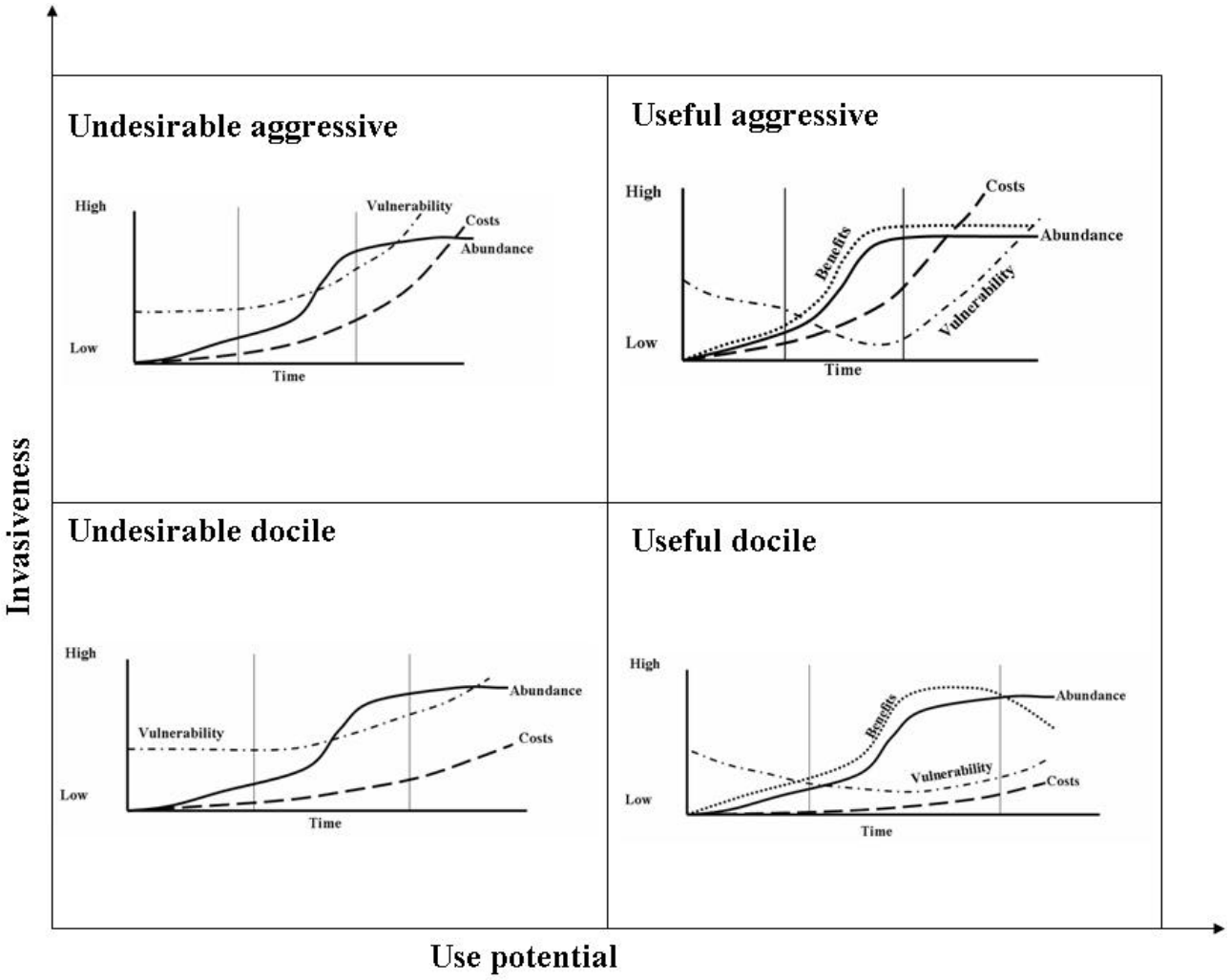
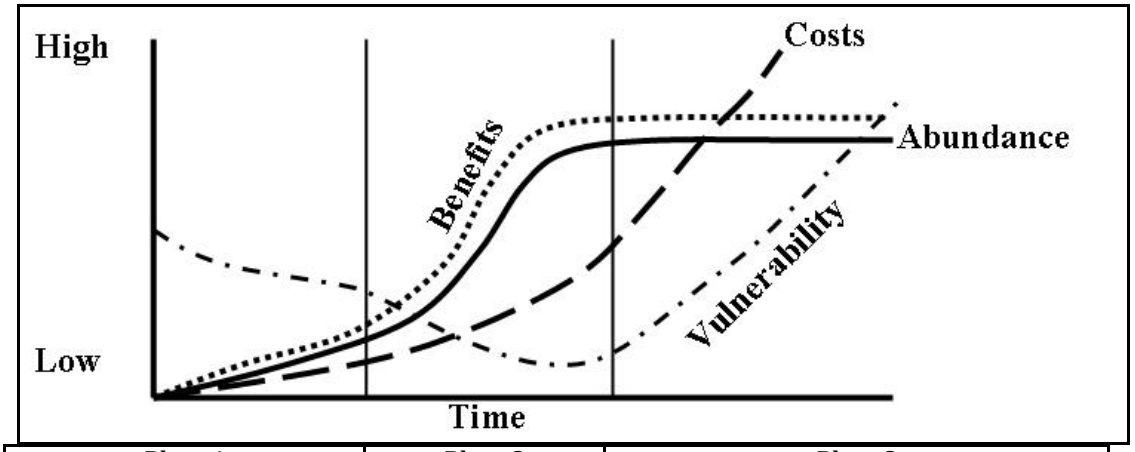


Figure 3: Variations of the conceptual framework for different species types. (Note that the x-axis is longer for docile species as it takes longer for effects to occur)

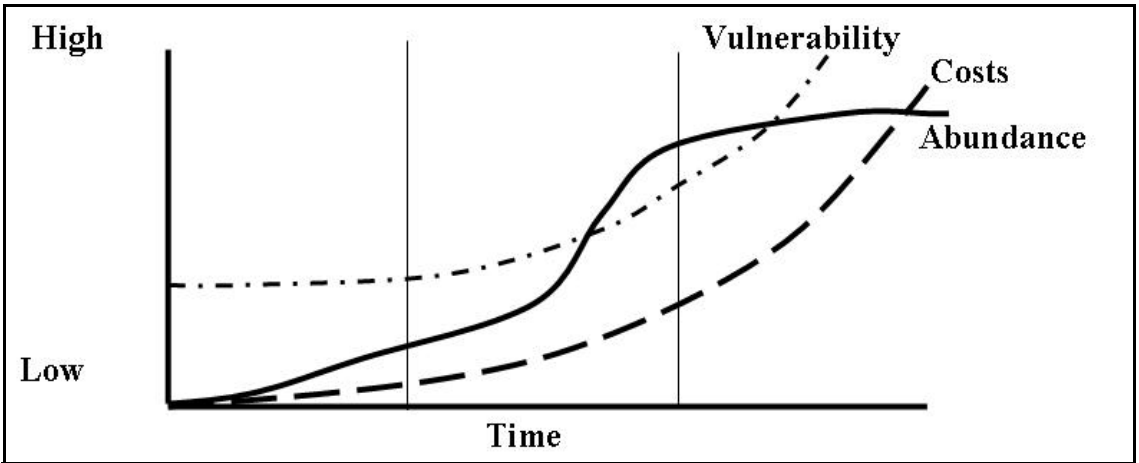
Each of these models is described in turn below. In each instance the temporal dimension is considered through examining the abundance, costs, benefits, and consequent livelihood vulnerability in each of three phases of IAS invasion.

6.1.2.1. Useful and aggressive species



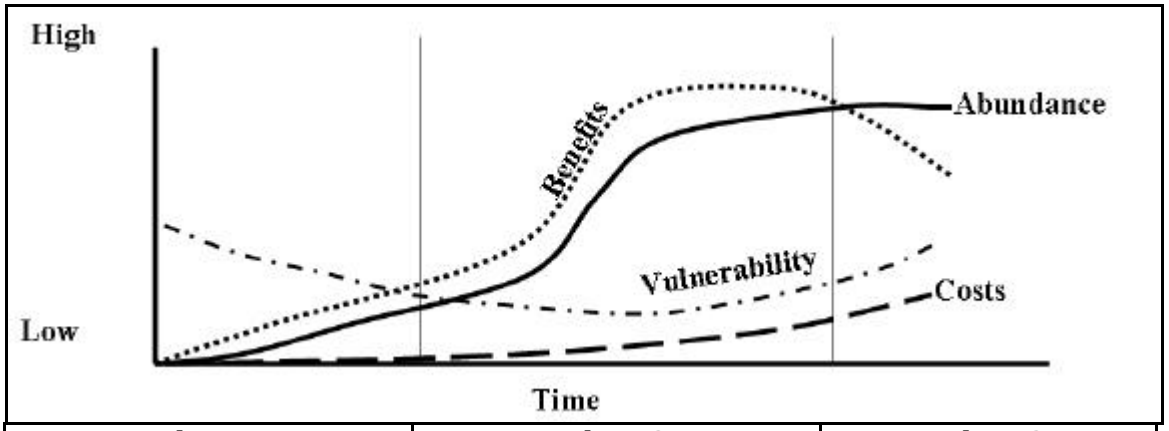
Phase 1	Phase 2	Phase 3
?? The abundance of the IAS is low; people are beginning to notice the foreign species in their environment. ?? Use of IAS is opportunistic and rare. Species is a rapid invader, therefore costs to surrounding environments increase quickly. ?? People may name the IAS in this phase.	?? Benefits rise with abundance of species. ?? People begin to increase their use of the species. ?? The IAS is adopted as a resource and possible livelihood strategy. ?? People develop new techniques to harvest or prepare the IAS. ?? Costs increase rapidly.	?? Benefits decrease as IAS adds further strain on other livelihood strategies, and environments ?? As costs keep rising and benefits decreasing, people begin to start controlling the plant usually with outside help) or changing land use patterns, or moving. ?? Depending on the interventions introduced in this phase benefits may increase, or decrease due to the cost of the intervention.

6.1.2.2. Undesirable and aggressive species



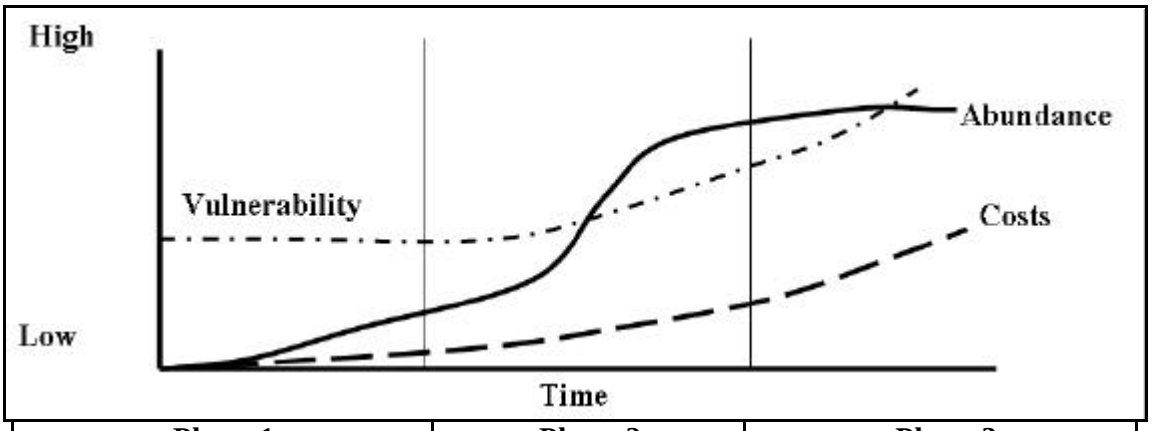
Phase 1	Phase 2	Phase 3
?? The abundance of the IAS is low; people are beginning to notice the foreign species in their environment, people don't use it and may only start noticing it due to problems it may cause ?? People may name the IAS in this phase.	??Heightened awareness of the species in their surroundings. ??There are no benefits. ??Costs increase quickly, slowly reducing the productivity of other resources, and hence vulnerability increases.	??The costs reach a negative threshold, and people begin to try to control the IAS, if it is in their means to do so. Control measures may occur earlier due to its lack of benefits, costs may become more obvious earlier on.

6.1.1.3. Useful and docile species



Phase 1	Phase 2	Phase 3
?? The abundance of the IAS is low; people are beginning to notice the foreign species in their environment. ?? Use of IAS is opportunistic and rare. Species is a slow invader, therefore costs to surrounding environment lag behind benefits. ?? People may name the IAS in this phase.	??Benefits rise with abundance of species. ??People begin to increase their use of the species. ??The IAS is adopted as a resource and possible livelihood strategy. ??People develop new techniques to harvest or prepare the AIS. ??Costs increase slowly levelling off the benefits. ??Vulnerability is improved as long as benefits outweigh costs	??Benefits decrease as IAS adds further strain on other livelihood strategies, and environments ??The invasion is more-or-less controlled by constant harvesting due to high benefits.

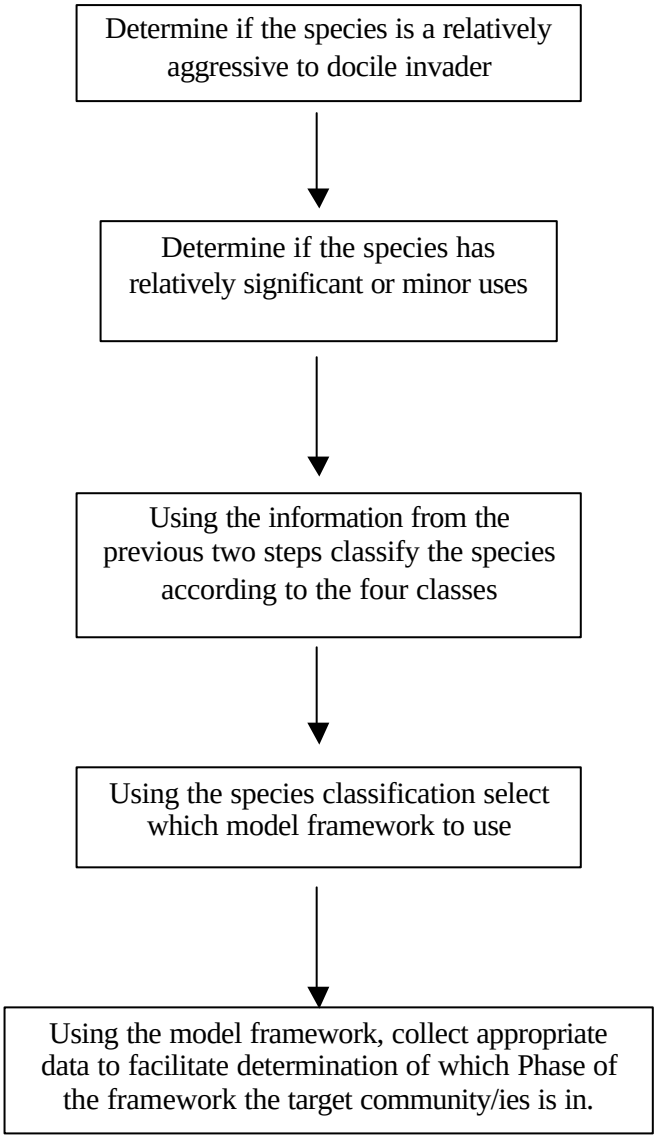
6.1.1.4. Undesirable and docile species



Phase 1	Phase 2	Phase 3
?? The abundance of the IAS is low; people are beginning to notice the foreign species in their environment. ?? No use of the IAS ?? People may name the IAS in this phase.	?? Costs slowly increasing, and since there are no benefits, vulnerability is also increasing.	?? People may take longer than usual to start controlling the plant, due to its slow rate of invasion.

6.2. Methodology

Using the conceptual framework the key steps in the proposed Methodology for future case studies are as follows:



?? Determine if the species is a relatively aggressive to docile invader

- Use existing literature from elsewhere in the country or world, or use expert opinion

?? Determine if the species has relatively significant or minor uses

- If no existing literature from the *specific study site* use direct observation or PRA.

?? Using the information from the previous two steps classify the species according to the four classes

?? Using the species classification to select which model framework to use

?? Using the model framework, collect appropriate data to facilitate determination of which Phase of the framework the target community/ies is in.
    - The necessary data and proposed methods are outlined in Table 13 below. The model framework dictates which of the curves need to be populated. For example, for an undesirable species, there is no benefit curve, and hence there is no need to collect those data in the field.
    - Using the data from the local situation, classify the local situation into one of the three Phases. This will then indicate the degree of vulnerability of the local community to the impacts of the IAS on their local livelihoods.
    - Ideally, if the project budget and time permits, then sample a number of field sites for a single IAS, across a continuum of increasing abundance.
    - The Framework and Methods can be applied at a range of scales. However, the preferred scale is at the level of a geographically defined community, but with provision for focus on particularly vulnerable sub-groups if such groups are identified during the PRA process to determine costs to other livelihood strategies.

Table 13: Proposed Methods and attributes to be collected.

CURVE	ATTRIBUTE	APPROACH
IAS Abundance	Current densities and extent of invasion	?? Stratify landscape into community-recognized units ?? Within each landscape unit conduct standard density counts appropriate to type of organism ?? Map/estimate patchiness and % of vulnerable landscapes currently invaded
	Past densities/rate of spread	?? PRA time lines/oral histories from key informants ?? Aerial photographic analysis for large visible organisms
	Preferred densities and extent of invasion	?? PRA picture ranking exercise of possible densities in each of key landscape types ?? PRA pie-charts to assess the patchiness and proportion of each landscape they would like to be covered at that density
Benefits	Direct use/household consumption	?? PRA at start to describe types of uses ?? Representative household interviews to establish: o % of people using/gaining o who they are o quantities o frequencies
	Local economic use	?? Household interviews to establish o proportion of people buying or selling o quantities o incomes and costs o harvesting areas o ranked estimate of contribution to livelihood o how long and why started trading o who they are

	Market orientated economic use	?? Market survey of vendors to get: o quantities o incomes and costs o harvesting areas o ranked estimate of contribution to livelihood o who they are o how long and why started trading o estimate of demand
	Indirect benefits (cultural, spiritual, aesthetic)	?? PRA at start to describe types of uses (including local terminologies, names and innovations)
		?? Representative household interviews to establish: o % of people using o who they are o quantities o frequencies
	Ecological benefits	?? PRA of local understanding of ecosystem benefits ?? PRA ranking of substitute species ?? Scenarios re response to potential increases of IAS, or decrease of IAS
Costs	Costs associated with direct use benefits	?? Representative household survey to determine: o time spent harvesting and processing o costs of inputs (e.g. transport, tools and ingredients) o health risk costs (e.g. snake bites, attacks, smoke inhalation)
	Costs associated with commercial use	?? Market survey of vendors
	Costs to other livelihood strategies	?? PRA session to identify negative effects of the IAS re: o % of people affected o who they are ?? Key informant interviews ?? Separate stakeholder PRA sessions to determine: o how affected o permanency of effect o magnitude of effect
	Cultural costs	?? PRA session to identify negative effects of the IAS re: o % of people affected o who they are ?? Key informant interviews ?? Separate stakeholder PRA sessions to determine: o how affected o permanency of effect o magnitude of effect
	Ecological costs	o PRA session to gauge community perceptions of ecological costs re: o nature o magnitude o effects o Expert interviews re: o nature o magnitude o effects
	Management costs	o PRA session to determine if management is/has occurring re: o when started (and ended?) o who involved o costs (time, tools, transport, etc.) o if no management, why not? o If external agency involved, then expert interview re: o when started (and ended?) o who involved o costs (time, tools, transport, etc.)
	Costs to society at large	o Expert interviews

7. CONCLUSIONS

In conclusion, this work has demonstrated that the effects of IAS on rural livelihoods are complex and spatially and temporally variable. There is a need for a larger suite of case studies using similar approaches and/or data to unravel some of the complexity and develop predictive typologies and capacity. Until that is achieved, it is important to accept that whilst the negative impacts of IAS on ecosystems are well recognised, one cannot assume that those negative impacts are automatically translated into detrimental impacts on rural livelihoods as perceived by rural people. In many instances rural people make extensive use of IAS and they perceive them to be a benefit to their own livelihoods. In some instances they prefer the IAS to locally available indigenous species. Provided that the ecological and other costs are less than these benefits then there would be some argument for maintaining specific IAS at specific localities, especially for the most vulnerable communities and households.

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9. ACKNOWLEDGEMENTS

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APPENDICES

Appendix 1: Guidelines to authors of desktop briefs

Appendix 2: Nine desktop briefs

Appendix 3: Interview schedule used at Tidbury and Catha for empirical case studies

Appendix 4: Pictorial density classes used for ranking preferred densities

Guidelines for preparation of desktop briefs on the impacts of alien invasive species on rural livelihoods and communities

INTRODUCTION

The objectives of the desktop briefs are twofold. Firstly, they are to provide a rapid overview of the impacts of invasive alien species on the lives of rural people by drawing on existing literature from a number of countries and across a variety of invasive species and taxa. Secondly, the desktop reviews should identify the most common data gaps, and the key issues that need to be explored in more detail in empirical case studies exploring the relationship between alien invasive species and their impacts on human well-being, specially of rural communities.

To facilitate collation and generation of generic issues across different invasive alien species (IAS), it is necessary that authors of the briefs follow specific guidelines with respect to the content, format and approach for preparing their individual desktop brief. Several key considerations in selecting IAS cases and study areas are outlined below.

?? *Existing knowledge* - authors need to select a species that is well known, at a site for which there exists a reasonable amount of information from one or more key reports or publications.

?? *Spatial scale* - it is obvious that information or lessons from different spatial scales may prove to be difficult to compare. Therefore, each brief should draw information primarily from local level case studies. Further information from other scales can also be considered, such as national level effects, as long as the primary information is based on solid local evidence.

?? *Temporal scale* – The short term and long term impacts of IAS differ. Some invasive species have negative impacts in the short term, but, as people find uses for them, they might become increasingly valuable. Other species might initially be beneficial to people, but as they increase in extent and density, they could have increasingly negative impacts. What are the common characteristics of the species belonging to the respective categories?

?? *Time of invasion* – Some species are recent invaders and others have been around for many generations. Species selected for inclusion in briefs should ideally not be recent invaders, because of time lags for impacts to become visible or measurable.

?? *Differential effects* - With respect to the effects of IAS on different sub-groups within a community, authors should refrain from extrapolating effects from one stakeholder group or one livelihood activity to all members of a community. Effort should be spent in identifying which groups of people (e.g. people with livestock, or the poorest members of a community, women, the elderly, etc.) are more likely to experience the greatest impacts of the presence of IAS, relative to others, or whether the impacts are experienced more or less uniformly.

?? *Positive and negative effects* – authors must consider both the positive and negative effects of IAS on specific sub-groups within the target community (e.g. people using edible fruits of the alien species may receive a net benefit, but if large portions of the landscape are invaded, people with livestock would experience negative effects because of loss of grazing land and fodder supply), as well as an overall assessment for the rural community as a whole. This information is important, because we would like to determine who loses and who gains from invasive species.

SUGGESTED STRUCTURE & CONTENT

NOTE: Below are a number of first and second order headings to guide authors in terms of the structure of the brief. Briefs should be written in narrative style, and not as a database. The bullets that we have below the headings are simply a checklist of the sort of information that we are seeking. Please do not use the same bullet style in preparation of your briefs.

1. Introduction

A short paragraph (2 – 4 sentences) that sets the scene for the rest of the brief and introduces the subject area - basically mentions the species (perhaps why it was chosen), the location and the existing research/studies that the brief has drawn-on. (For example: This brief assesses the livelihood and economic impacts of the invasive cactus *Opuntia ficus-indica*, commonly known as prickly pear, on a range of actors, including commercial farmers, poor rural and urban fruit traders, and subsistence farmers in the Makana district of the Eastern Cape, South Africa. It was introduced in the 1870s as a fodder plant for cattle. It was selected for study because # etc. This brief draws primary on the work of # (2000), # (2003), etc.).

2. Background Context

2.1. Species profile

This section focuses on a summary profile of the IAS in question, and provides a background to the characteristics of the species, or suite of species.

?? Taxonomy: taxonomic classification and description of the species.
?? Ecology: the basic autecology and life history strategies of the invasive species in question, characteristics that make it an invader, indication of the 'aggressiveness' of the invader.
?? Why was the species introduced to the region
?? Invasion Status: current intensity and extent of invasion in the study area.
?? Biological and ecological impacts of invasion: summary of the effects of the IAS on the supply of ecosystem goods and services.
?? Control attempts: control attempts imposed on the species currently and/or in the past, within the study district, including estimated expenditure.
?? Legal status: is there a legal obligation to control the species, or a law that prevents its cultivation?
?? When is the species product available: e.g. if a timber species it may be harvested all year, but if a fruit it may be available only for a few months.

2.2. Geographic location

Provide a basic summary of the geographic characteristics of the area including:

?? Location: country, latitude and longitude, district, size of the study area. It would be useful to have a map of the continent, country and area, either in the text or as an appendix.
?? Topography: mountainous, riverine, floodplain, etc.
?? Macro climate: mean annual rainfall and its seasonality and variability, summer and winter temperatures.
?? Biome/vegetation type

?? Fertility/suitability for intensive land use

2.3. People and livelihood profile

This section should focus on the people of the area and their dominant livelihood strategies.

?? Demographics: population size, density, gender and age profiles.
?? Social institutions: what key institutions operate and how active are they (e.g. forest management committees, traditional authorities, governmental bodies and NGOs).
?? Economics & poverty: how do most households gain cash income? (e.g. government grants, pensions, selling produce, local employment, distant employment, etc.) and what levels of poverty exist.
?? Main livelihood strategies: (e.g. are they a fishing society, agrarian, pastoralist, etc.).
?? Land use patterns: what are the dominant land use and resource use patterns (% of study area?).
?? Approximate annual returns per ha from agriculture (US$)

NOTE: avoid providing too much detail of demographics and socio-economics. Try to provide the relevant information regarding the species (or suite of species) and the area, i.e. remember the scale that we want to work at as pertinent to the species concerned, and the people affected by it. You will be able to elaborate under the "Effects of livelihoods" section below. This section should provide the context in which to interpret and qualify some of the findings covered in discussion of the effects on livelihoods. The Background Context section should be a maximum of three pages long.

3. Effects on Livelihoods

3.1. Direct use of the IAS

If the IAS has direct uses, then the following details need to be reported as far as existing information exists:

?? What part/s of the species is used? (e.g. the whole plant/fish; the fruits, the wood)
?? Domestic and/or commercial use. Is the IAS used for subsistence, to meet daily domestic requirements, or is it sold to provide income, or both? If both, what are the relative proportions between subsistence and commercial use?
?? When in the year is it available for harvesting? (give seasons and actual months).
?? Who uses the species: Describe the gender, socio-economic status, and livelihood group that uses the IAS (there may be more than one group). Also include which part of the community (sub-group) is most dependent or vulnerable to the loss of the species. Note whether it is used by humans directly or by the livestock belonging to community members.
?? For what is it used, and how is it prepared?
?? How often is it harvested? For example is it harvested daily in season, once a year during a defined season when it is ready/mature?
?? How much is used? (per day, or per week, or per month, or per year?)
?? Frequency and season of use? (e.g. daily in the fruiting season; all year when needed; once a week throughout the year; during harvesting season, which is June to October).

?? Variability in livelihood strategies: what variability do people have in their livelihood strategies and how does this affect the value of the species when it is used? In other words do they use a range of livelihood strategies that frequently change in relative importance of one against another, or is the mix and importance of the different strategies reasonably constant?
?? Safety-net uses: Is the species used as a safety net during times of hardship? (e.g. prickly pears can be used as an alternative fodder for cattle during times of drought; fuelwood is sold on the side of the road after retrenchment of the household breadwinner until s/he finds new employment).

2.2. Indirect impacts of the IAS

?? Effects on goods and services: How does this IAS affect the supply of other ecosystem goods and services which are important to rural livelihoods? (e.g. water provision, other useful species, loss of useful land, grazing, etc.). What is the magnitude of impact, either quantitatively or qualitatively?
?? Species substitution: Is the IAS a recognized (by the rural people) useful substitute species because
    ?? It saves people's time? (they do not have to walk as far to collect the useful product from this species as they would if they used an indigenous species, e.g. for fuelwood).
    ?? It saves other indigenous species from potentially unsustainable harvesting pressures?
    ?? It has replaced an indigenous species which is now in short supply
    ?? It has eradicated an indigenous 'counter-part' species
    ?? It has favourable qualities that people appreciate relative to locally available indigenous species (e.g. size, taste, productivity/yield).
?? Aesthetic impacts: Does this species have negative or positive aesthetic effects as perceived by local communities? (e.g. in South Africa some local communities oppose the control of some tree IAS because they perceive them to be aesthetically pleasing. In other areas there are local lobby groups and efforts to control them from spreading into montane grasslands because they block the view and are aesthetically displeasing).
?? Spirituality and culture: Does this IAS have positive or negative effects on spirituality or culture in the community? For example, it is adopted as a medicinal plant used in treatment around cultural ailments as opposed to physical ones. Another example might be dense IAS around pools of water may become to be regarded as preferential homes for water spirits, and people will resist attempts to clear the IAS.
?? Positive feedbacks on other invasive species: Does the IAS have positive effects and feedbacks on other invasive species, which might impact on livelihoods? (e.g. dense alien invasive plants in riparian areas might shade pools, thereby reducing the reflectivity and water temperature with the result that the pools become more suitable for invasive alien fish).
?? Future options: Has the presence of IAS in the area affected (increased or decreased) the options that rural people have open to them with respect to possible livelihood strategies?
?? Perceptions of invasiveness: What are the people's perceptions of the species as an invasive? (e.g. in Nqabara, South Africa communities consider invasive guava and bugweed trees as useful naturally existing plants, with the term "invasive alien" being a label given by 'scientists'.

2.3. Impacts of IAS management

?? Management investments: Do rural communities invest time/money in management? (management referring to the control of the species, or even the promotion of its growth such as fish farming).

?? Status of control: If control mechanisms have been or are introduced:
  - what is the attitude of local communities towards control actions? Does this vary between sub-groups within the community?
  - are there benefits for rural people from the control actions? (For example, direct employment, skills training, improved grazing).

?? Legal interventions: which legislation has been introduced to suppress the invasive species? How do local people respond to this?

3. Key information gaps and issues to be considered in future detailed empirical case studies

List here what are seemingly key information gaps for the particular IAS (or suite of) and locality covered in your desktop brief.

Detail any specific or generic issues that you feel will be key for future empirical case studies (not just yours) examining the impacts of IAS on rural livelihoods, distilled from either the prepared brief or your general intuition around IAS and rural livelihoods.

4. Discussion and Conclusions

Provide a final section that summarises:

- The positive and negative effects of the case study IAS (or suite of) on local livelihoods, in Table format (see below).

Positive effects on livelihoods	Negative effects on livelihoods
Readily available, nutritious fruits	Very invasive, can reduce grazing land
Potential marketable commodity, provide monetary income	May out compete important indigenous species
etc.	etc.

- Trade-offs that rural people make between the direct, indirect and ecological impacts of IAS.
- Differential livelihood impacts between specific sub-groups within a community.
- The uniqueness of the case study in terms of the interaction of location, species and people. In other words, the final evaluation of the impacts of the IAS needs be considered in the local biophysical and socio-economic context. If the context were different in some respect, would the impacts be different? For example, in a variable, arid environment a fodder producing IAS might assume a greater importance than in a highly productive high rainfall site. Another example is that an IAS with economic uses may be more important in livelihoods at a site with high poverty and few opportunities for earning cash incomes, than at a site where poverty is low and livelihood options many.
- At what level/intensity of invasion does the IAS become a problem, and to which groups within a community?

Overall, the concluding section must answer the key question based on the objectives, i.e. what changes in livelihood activities and options have occurred in the case study area, as a result of IAS? The corollary of this would be how would their livelihoods be changed if the IAS were removed?

5. References

Please provide full details of all references cited.

ESTIMATED LENGTH OF THE DESKTOP BRIEF

It is estimated that the desktop briefs will be a maximum of 10 - 15 pages at 1.5 line spacing.

FORMATTING OF THE DESKTOP BRIEF

It is required that all the briefs are formatted in the same manner. Formatting guidelines giving details of font type, size, referencing, etc. are provided in Appendix 1.

GISP Interview schedule

May-June 2005

Date: ____/___/____

Household No: _____

1. Size of invasion:

1.1. How long have you lived here?_____

1.2. How long has the IAS been here?_____

1.3. Has the abundance changed over the last 5-10years? Y [ ] N [ ]

If yes, how has it changed: Increased [ ] decreased [ ] both [ ]

1.3.1. Why do you think it's changed?

2. Role in livelihoods:

2.1. Do you use it? Y [ ] N [ ]

If yes:

2.1.1. What do you use it for?

2.2. Who in the household uses it?

2.3. Do you Buy or collect it or both? Buy [ ] Collect [ ] Both [ ]

2.4. If they collect:

2.4.1. How often?

2.4.2. How much do you collect each time?

2.4.3. Which months of the year do you collect it?

2.4.4. Who in the household collects it?

2.4.5. Where do you/they collect?

2.4.6. How long does a return trip take?

2.5. If they buy:

2.5.1. How often?

2.5.2. How much do you buy each time?

2.5.3. Which months of the year do you buy it?

2.5.4. How much does it cost?

2.5.5. Where or who do you buy it from?

2.6. Are there some households who use it more than others? Y [ ] N [ ]

If yes:

2.6.1. Who uses it more, and why?

2.7. Are there some households who use it less than others? Y [ ] N [ ]

If yes:

2.7.1. Who uses less it and why?

3. Economic use:

3.1. Do you sell it? Y [ ] N [ ]

If yes:

3.1.1 How often do you sell?

3.1.2. How much do you sell per day/week/month?

3.1.3. Which months of the year do you sell?

3.1.4. Where do you sell and/or to whom do you sell?

3.1.5. How much do you sell it for?

3.1.6.. What do you use the money you earn from selling for?

4. Alternatives:

4.1. What did you do before it was here?

4.2. Do you remember a time when this species was not here? Y [ ] N [ ]

If yes:

4.2.1 What other species did you use at the time?

4.2.2. Do you still use those other species?

4.2.3. Why did you change to the IAS?

4.3. Have you developed any new ways of collecting or preparing it compared to other plants you use for the same purpose?

4.4. Do you make any items from this plant that you cannot make from other species?

4.5. What would you do if the plant was not there anymore?

4.6. If there was a lot less, or very little of the species left, are there any other species you could use instead?

5. Optimal densities:

5.1. Present cards illustrating different densities of the plant. Ask them to rank the different cards according to which density they prefer the plant to be at:

A	B	C	D	E

5.2. Why did you rank it this way?

5.3. If the IAS were at density 'E' would you be happy? Y [ ] N [ ]

If Yes:

5.3.1. Why?

If No:

5.3.2. Why not?

5.4. What about other people, would they like it at density 'E'? Y [ ] N [ ]

I If Yes:

5.4.1. Why?

If No:

5.4.2. Why not?

6. Effects on land uses:

6.1. Are there areas in the landscape where this species is, most common or prefers to grow?

If Yes:

6.1.1. Where does it like to grow?

6.2. Are there areas in the landscape where you don't want this species to grow?

If Yes:

6.2.1. Where don't you want it to grow?

6.2.2. Why do you not want it to grow there?

6.3. Does this species cause any problems to you and your household? Y [ ] N [ ]

If Yes:

6.3.1. What problems does it cause?

6.4. Does this species cause any problems to other people? Y [ ] N [ ]

If Yes:

6.4.1. What problems does it cause?

6.5. Does this species have any benefits?

7. Cultural value:

7.1. Is this species used for any cultural or ritual purposes? Y [ ] N [ ]

If Yes:

7.1.1. What?

7.2. Does this species grow in areas of special cultural significance? Y [ ] N [ ]

If Yes:

7.1.2. Where?

7. Household profile:

7.2. Pls provide us with details of who lives in your house so we can examine patterns of IAS use to numbers of people, education and income.

Name	Year born	Still studying (#)	Sleep at home (*)	Eat at home (*)	Occupation	Money contributed/ month (grants, employment etc)

(#): P= primary; S= secondary; C= college, U= University (*): U= usually; W=weekends; M=month ends; R= rarely

7.3. What are the three most important sources of cash to your household?

1.	2.	3.

7.4 How many livestock do you own?

Cattle		Goats/sheep		pigs		Donkeys		Poultry	

8. Other comments:

8.1. Do you have any other comments about the IAS?