

Wetland craft plants in KwaZulu-Natal: an ecological review of harvesting impacts and implications for sustainable utilization

C.H. TRAYNOR*†, D.C. KOTZE** and S.G. McKEAN***

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ABSTRACT

In South Africa, wetland plants have been used for centuries and they continue to be harvested for subsistence and commercial purposes. Fibres for crafts are collected by cutting the aboveground parts. KwaZulu-Natal is one of the major basket-producing regions in southern Africa and at least twenty-two species of wetland plants are harvested for crafts. A literature review of the harvested species revealed that the impacts of cutting have only been extensively investigated for *Phragmites australis* (Cav.) Steud. and *Juncus kraussii* Hochst. The review suggested that, where plants display strong seasonal aboveground productivity patterns, cutting should take place after shoot senescence and before new shoot emergence to minimize damage to plants. Cutting in the short term could increase the density of green stems. However, in the long term in *Phragmites australis*, it may deplete the rhizome reserves and reduce the density of useable (longer and thicker) culms. The opportunity for sustainable harvests was investigated by considering the geographic distribution, whether species are habitat specific or not, and local population sizes of the craft plants. *Juncus kraussii* is of the greatest conservation concern. Ecologically sustainable wetland plant harvesting could contribute to the wise use of wetlands, an approach promoted nationally and internationally.

INTRODUCTION

Wetlands in South Africa are defined by the National Water Act (No. 36 of 1998) as 'land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil' (RSA 1998). Wetlands are valued as a habitat for rare flora and fauna, as part of a mosaic of ecosystems that maintain global diversity, for their provision of wetland products, for their functional values (Denny 1994; Dixon 2002; Dixon & Wood 2003), and as sinks for greenhouse gases (Brix *et al.* 2001).

Wetlands in the northern hemisphere, have a long history of use which has been relatively well documented (Smart *et al.* 1986; Van Wirdum 1993; Kiviat & Hamilton 2001). In Europe, many wetlands have been managed for centuries and the plant and animal communities are dependent upon this management (Haslam *et al.* 1998). Particular types of wetlands such as reedbeds are managed socio-economically for the reeds and sedges which are used commercially for thatching materials and also for nature conservation purposes (Hawke & José 1996). The long history of wetland utilization combined with an academic tradition of research concerning ecology and the impacts of use, mean that many wetland systems in temperate regions are relatively well understood and management is strongly influenced by science (Hawke & José 1996; English Nature 2006).

In Africa, the history of human disturbance and its effects upon ecosystems including wetlands is poorly understood (Macdonald 1989; Maclean *et al.* 2003). However, many African people 'depend *inter alia* upon wetlands for food, water, medicine, shelter, energy and waste disposal-wastewater treatment' (Denny 2001: 22). African wetlands provide a range of services and goods, particularly to local people (Terer *et al.* 2004; Bernard & Moetapele 2005; Cooper *et al.* 2006). However, wetlands have tended to be taken for granted (Denny 1994), and regarded as wastelands and are therefore not formally protected (Dovie 2003; Mmopelwa 2006). Some African wetlands have been modified (Richards 1995; Thenya 2001; Schuyt 2005) and in the past it was government policy to promote the drainage of wetlands for agriculture (Denny & Turyatunga 1992; Gichuki *et al.* 2001). Overexploitation and unsustainable use threaten many wetlands (Diop *et al.* 1999; Dixon 2002; Uluocha & Okeke 2004). Documented ecological and environmental knowledge of African wetlands is fragmentary; some systems have been investigated intensively but large areas of wetlands remain unrecorded. Furthermore, due to northern-driven global environmental activities, information tends to be within Europe and America rather than Africa itself (Denny 2001).

In South Africa, recovered artefacts show that wetland plants have been used for centuries; sedges were used during the Holocene Stone Age (Manhire *et al.* 1985), reeds by the Khoi San bushmen (Bassani 2000) and sedge mats to roof houses by the Khoi Khoi herders (Cunningham & Terry 2006). Use of wetland plants by the Bantu population has also been recorded, particularly for the Xhosa (Kepe 2003), the Tembe-Tonga (Pooley 1980; Liengme 1981; Cunningham & Gwala 1986) and the Zulu (Bryant 1949; Grossert 1978; Jones 2001). Wetland plants continue to be harvested in South Africa both for subsistence and commercial purposes (Cunningham 1987; Kepe 2003; Shackleton & Shackleton 2004). In some African countries excessive reed

* Wildlife and Environment Society of South Africa, P.O. Box 394, 3290 Howick, KwaZulu-Natal, South Africa.

† Corresponding author, Tel.: +27 (0) 21 887 6188; Fax.: +27 (0) 21 887 6189. E-mail address: ctraynor@ppf.org.za.

** Centre for Environment, Agriculture & Development, University of KwaZulu-Natal, Private Bag X01, 3209 Scottsville, Pietermaritzburg.

*** Ezemvelo KwaZulu-Natal Wildlife, P.O. Box 13053, 3202 Cascades, South Africa.

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cutting has resulted in local scarcity (Kgathi *et al.* 2005) and wetland degradation (Green *et al.* 2002). In South Africa, plant harvesting has been reported as a threat to grasslands (Cowling & Hilton-Taylor 1994). Within South Africa, investigations into the implications of utilization with regard to management and sustainability have tended to be species specific (McKean 2003) or site specific (Tarr *et al.* 2004; Dahlberg 2005). These investigations provide extremely useful information, but a broader understanding of species utilized, the impacts of use and implications for management is lacking for wetland habitats.

The aim of this paper is to consider wetland plants used for craftwork and to review the ecological impacts of utilization on these species. The province of KwaZulu-Natal in South Africa was selected as a case study area as it is one of the three major basket-producing areas in southern Africa (Cunningham & Terry 2006). During plant harvesting for crafts, the leaves and stems of wetland plants are typically removed by cutting. Therefore this paper will focus on the effects of cutting disturbance upon plants with reference to relevant aspects of physiology, biology and ecology. The effects of harvesting upon plant populations and the wetland habitat will also be elucidated. Finally, the implications of the review for the management of South African wetlands will be discussed with an emphasis on the ecological sustainability of these ecosystems.

METHODS

The main species of plants utilized for crafts within South Africa were determined from literature (Grossert 1978; Pooley 1980; Liengme 1981; Cunningham 1985, 1987; Cunningham & Gwala 1986; Heinsohn 1990, 1991; Heinsohn & Cunningham 1991; Moffett 1997; Christiansen 2000; Hennesey & Koopman 2000; Cunningham 2001; Krüger & Verster 2001; Simpson & Inglis 2001; Kepe 2003; Van Wyk & Gericke 2003; Tarr *et al.* 2004; Cunningham & Terry 2006; Traynor & Kotze 2007b; Kotze & Traynor in prep.).

Plants were classified using the wetland indicator status system of Reed (1988). This system assigns wetland plants to categories based upon their level of occurrence in wetlands (Table 1). This was carried out with reference to published work (Gordon-Gray 1995; Kotze & O'Connor 2000; Glen *et al.* in prep.) and examination of the habitat descriptions of specimens in the University of KwaZulu-Natal Herbarium. The current study focused upon obligate wetland species.

The names of the selected species were used in a literature search, the following general terms were also searched; craft plants, basketry, grasswork, wetland, reedbed, rush, sedge used in combination with management, cutting, harvesting, and Africa. The species names were searched using the Royal Botanic Gardens, Kew Electronic Plant Information Centre (<http://www.kew.org/epic/>). The ISI database at <http://wok.mimas.ac.uk> and Google 'scholar' (<http://scholar.google.com/>) databases were searched for manuscript references using the terms listed above.

The distribution of species within KwaZulu-Natal (KZN) was determined using records from the University of KwaZulu-Natal Herbarium (Pietermaritzburg Campus) and from the PRECIS species database of the South African National Biodiversity Institute (SANBI), Pretoria. The locality references were assigned to 1:50 000 map series and their distribution plotted.

RESULTS

Wetland species used in KwaZulu-Natal

The literature search of species used for crafts revealed 27 plants, 13 of these were obligate wetland species, and eight facultative wetland species (Table 2).

The species used belong to four plant families, Cyperaceae, Poaceae, Juncaceae and Typhaceae. Within South Africa, species within other plant families do provide a source of fibres for basketry, the most important of which are: *Hyphaene coriacea* and *Phoenix reclinata* of the Arecaceae family (Moll 1972; Cunningham 1988; Van Wyk & Gericke 2003), and the forest climber, *Flagellaria guineensis* of the Flagellariaceae family (Cawe & Ntloko 1997). However, these species are not classified as obligate or facultative wetland species and were, therefore, excluded from the current study.

The obligate and facultative wetland species listed in Table 2 provide plant fibres with characteristics suitable for crafts. These include tough fibres that can be twisted and bent without breaking; resilient fibres that can be dried and stored but that can also re-absorb moisture and retain flexibility for weaving; and sufficient length, so fewer 'ends' are produced during weaving; silica crystals or chemicals that reduce insect attack (Letšela *et al.* 2003; Cunningham & Terry 2006).

Individual plant response to harvesting

Plant physiology is an important factor that determines a plant's response to defoliation. The harvesting

TABLE 1.—Classification of plants according to occurrence in wetlands, based on US Fish and Wildlife Service Indicator Categories (Reed 1988)

| Wetland indicator classification | Habitat and occurrence |
|----------------------------------|---|
| Obligate wetland species | Almost always grow in wetlands (> 99 % occurrence) |
| Facultative wetland species | Usually grow in wetlands (67–99 % occurrence) but are occasionally found in non-wetland areas |
| Facultative species | Equally likely to grow in wetland and non-wetland areas (34–66 % occurrence) |
| Facultative dryland species | Usually grow in non-wetland areas but sometimes grow in wetlands (1–34 % occurrence) |
| Dryland species | Almost always grow in drylands (< 1 % occurrence in wetland areas) |

of leaves can be considered a low-impact harvesting activity, but the opportunity for sustainable harvesting is partially dependent upon plant physiology. Characteristics such as a rapid growth rate and asexual reproduction (clonal resprouters) produce high opportunities for sustainable harvesting (Cunningham 2001). Published information relating to the impacts of cutting was generally limited to the grass *Phragmites australis* (Cav.) Steud. and the rush *Juncus kraussii* Hochst. Therefore, these species are used to illustrate the relationship between plant physiology and response to cutting.

Phragmites australis, which is one of the most widely distributed plants on earth (Soetaert *et al.* 2004), is a rhizomatous and perennial grass, with annual shoots. In undisturbed reedbeds, the perennial rhizome produces shoots in spring, which grow in summer and die in autumn producing litter which can persist for several years (Schmidt *et al.* 2005). *Phragmites* is a long-lived clonal species, it colonizes by vegetative growth of aboveground runners and belowground rhizomes (Mau-champ *et al.* 2001). It can form dense, monospecific stands. The rhizomes have important storage functions, which largely determine the stability, survival capacity

and spread of the stand (Chapin *et al.* in Graneli *et al.* 1992; Karunaratne *et al.* 2004). Rhizome biomass and rhizome standing stocks of nonstructural carbohydrates and mineral nutrients have been shown to decrease early in the growing season and to increase later in the year. This seasonal pattern is attributed to mobilization of rhizome carbohydrate and mineral nutrient stores to support spring shoot growth, that takes place before any foliar structure has developed. Once the foliar structure has been established, basipetal transport of nonstructural carbohydrates and mineral nutrients occurs immediately (Graneli *et al.* 1992). The rhizomes can persist for several years, and Asaeda *et al.* (2006a) reported a clear variation between rhizome age-class in seasonal belowground resource translocation patterns; in late summer and autumn, translocation from shoots to rhizomes was concentrated in young rhizomes and older rhizomes shrank in size due to metabolic loss. In *P. australis*, the increase in above-ground biomass is a combination of new production, regenerated production and dissimilatory processes (Soetaert *et al.* 2004). The carbon budget for total reed growth was estimated to be 78–80 % photosynthesis, 17–19 % remobilization from rhizomes, and 3 % resorption of carbon from leaves. Half of all assimilates were transported belowground (Soetaert *et al.* 2004). In late summer and autumn and again in late winter and spring, the rhizomes produce buds from which shoots develop (Haslam 1969). The number and size of buds may be dependent upon the size and amount of newly formed rhizomes, which themselves may be affected by the reserves available (Mook & Van der Toorn 1982). The basal diameter of the bud is an important property, as once it is known early in the season, it can be used to predict the length and weight of the reed (Van der Toorn & Mook 1982). *Phragmites australis* stands are extremely productive communities and figures for peak aboveground biomass lie between 587–2 659 g DW m⁻² (Soetaert *et al.* 2004; Bedford & Powell 2005); belowground biomass values are larger with typical values between 2 806–3 346 g DW m⁻² (Soetaert *et al.* 2004). In natural reed stands, the dead leaves and stems accumulate at the end of the growing season. Stands are detritus-based ecosystems with litter accumulation and eventual drying out of the reedbed (Cowie *et al.* 1992; Bedford & Powell 2005).

Harvesting impacts vary according to the frequency and intensity of harvesting; frequent and/or intense harvesting of the vegetative parts, such as leaves, will deplete the carbohydrate reserves or disrupt water and nutrient flows (Cunningham 2001). In terms of management, the rationale behind cutting the aboveground parts of *Phragmites australis* is that it will retard subsequent growth and development of the stand because reserves produced during that season are exported from the system (Asaeda *et al.* 2003). Cutting also decreases oxygen transport to the root zone, which inhibits shoot regrowth (Weisner & Graneli 1989). Continuous nutrient removal could theoretically result in nutrient limitation. However Schröder (1987 cited in Ostendorp 1995) argued that harvesting dead aboveground material was beneficial because it limited the build-up of organic matter that could lead to oxygen depletion within the water body. Schmidt *et al.* (2005) suggested that cutting may reduce the natural silting-up process in *P. australis* reedbeds and therefore slow vegetation succession to scrub and woodland.

TABLE 2.—Wetland plant species used for craft in South Africa and their wetland indicator status

| Scientific name | Family | Wetland indicator status |
|---|------------|--------------------------|
| <i>Aristida junciformis</i> Trin. & Rupr. | Poaceae | F |
| <i>Digitaria eriantha</i> Steud. | Poaceae | FD |
| <i>Eragrostis plana</i> Nees | Poaceae | F |
| <i>Festuca costata</i> Nees | Poaceae | FD |
| <i>Miscanthus capensis</i> (Nees) Andersson | Poaceae | F |
| <i>M. junceus</i> (Stapf) Pilg. | Poaceae | FW |
| <i>Merxmüllera macowanii</i> (Stapf) Conert | Poaceae | F |
| <i>Phragmites australis</i> (Cav.) Steud. | Poaceae | OW |
| <i>P. mauritiamus</i> Kunth | Poaceae | FW |
| <i>Sporobolus africanus</i> (Poir.) Robyns & Tournay | Poaceae | F |
| <i>Cladium mariscus</i> (L.) Pohl | Cyperaceae | OW |
| <i>Cyperus esculentus</i> L. | Cyperaceae | FD |
| <i>C. fastigiatus</i> Rothb. | Cyperaceae | OW |
| <i>C. latifolius</i> Poir. | Cyperaceae | OW |
| <i>C. marginatus</i> Thunb. | Cyperaceae | OW |
| <i>C. natalensis</i> Hochst. | Cyperaceae | F |
| <i>C. papyrus</i> L. | Cyperaceae | OW |
| <i>C. sexangularis</i> Nees | Cyperaceae | FW |
| <i>C. solidus</i> Kunth (<i>Mariscus solidus</i> (Kunth) Vorster) | Cyperaceae | OW |
| <i>C. textilis</i> Thunb. | Cyperaceae | OW |
| <i>Schoenoplectus brachyceras</i> (A. Rich.) Lye* | Cyperaceae | OW |
| <i>S. scirpoides</i> (Schr.) J.Browning† | Cyperaceae | OW |
| <i>Juncus kraussii</i> Hochst. | Juncaceae | OW |
| <i>J. punctatus</i> L.f. | Juncaceae | OW |
| <i>Hyphaene coriacea</i> Gaertn. | Arecaceae | F |
| <i>Phoenix reclinata</i> Jacq. | Arecaceae | F |
| <i>Typha capensis</i> (Rohrb.) N.E.Br. | Typhaceae | OW |

* *Schoenoplectus brachyceras* was previously known as *Scirpus corymbosus* (Smith 1966). † *Schoenoplectus scirpoides* was previously known as *Scirpus litoralis* (Schr.) Palla. Reclassification of *Scirpus litoralis* identified two distinct species *Schoenoplectus scirpoides* and *S. subulatus* (Vahl) Klye. F, facultative; FD, facultative dryland; FW facultative wetland; OW, obligate wetland.

The harvesting time of *Phragmites australis* strongly affects regrowth (Karunaratne *et al.* 2004). In the United Kingdom, in mixed species stands, a summer cut is used to suppress the dominant, taller species and so promote plant species diversity and benefits to wildlife (Hawke & José 1996). The competitiveness of *P. australis* is reduced through removing the photosynthesizing parts and so the rhizome is deprived of energy. Summer cutting reduces shading, decreases competition for nutrients and creates space for other plant species to grow. Summer cutting is generally not used for commercial reedbeds but is commonly used for nature conservation purposes (Hawke & José 1996). Karunaratne *et al.* (2004) reported that summer cutting of *P. australis* decreased shoot height, increased leaf production and reduced the stem diameter and storage accumulation capacity of older rhizomes.

Asaeda *et al.* (2006b) compared cutting in Japan and its effect upon *Phragmites australis* growth in the subsequent year. They investigated two time periods: when shoot growth was rapid and rhizome reserve storage was near the seasonal minimum (June) against slower shoot growth and recharging rhizomes (July). They observed that cutting when shoot growth was rapid and rhizome reserve storage levels low, significantly reduced the aboveground biomass and it also reduced annual resource allocation compared to uncut stands. However, cutting when shoot growth was slower had less impact (Asaeda *et al.* 2006b). Karunaratne *et al.* (2004) also found that cutting when rhizomes were at their lowest storage level had the greatest effect on suppressing subsequent *P. australis* growth. They stated that the rhizome storage level at the time of cutting determines the response of shoots and rhizomes to disturbance. In these studies, the rhizome reserves were at their lowest 7–10 weeks after shoot emergence. Therefore, the timing of spring shoot formation can be used to determine the least appropriate disturbance time—the exact timing would depend upon local conditions.

Winter cutting in the United Kingdom removed dead stems, thus reducing litter-producing build-up and hence succession. It also promoted a better reed quality in terms of producing tall, wide-diameter, dense stems. Winter cutting favours *Phragmites australis* dominance, reduces plant species diversity (Wheeler & Giller 1982a, b), increases ground level temperature fluctuations and radiation, and may benefit wildlife by sustaining the habitat (Hawke & José 1996). Annual cutting removes the overwintering microhabitat for most invertebrates and can therefore be an efficient control method for insect pests of *P. australis*. However, certain species of reed-dwelling moths may not survive annual cutting (Hawke & José 1996). Biennial cutting allows reedbeds to 'rest', it provides uncut reeds for reed-dwelling wildlife, and enables biennial and perennial herbs to flower and set seed (Hawke & José 1996). Cowie *et al.* (1992) surveyed commercial reedbeds that had been regularly cut for twenty years in the United Kingdom. They reported that plant species richness and diversity were significantly greater and reed density was double that of uncut sites. In French Mediterranean reedbeds, Mauchamp (1998 cited in Poulin & Lefebvre 2002) reported that cut reedbeds had a higher density of green stems than uncut reedbeds ($238 \pm$

45 vs 137 ± 12 , $P = 0.02$); additionally, above a green reed density of 200 stems m^{-2} species richness declined. Van der Toorn & Mook (1982) stated that regardless of the cause of injury to *P. australis* (e.g. cutting, burning or frost damage) the most important factor determining the plant's response is whether the apical meristem of the shoot is killed. They found if treatments were applied before new shoots emerged, damage was minimal. However, killing of the shoot-growing point during harvesting resulted in replacement by several thinner shoots.

In South Africa, the effects of harvesting *Phragmites australis* were investigated in the Thembe Elephant Park, KZN. Reed harvesting typically occurred in winter (April to September) after the flowering period and once the reeds were mature (Cunningham 1985). Reed diameter was positively correlated with time since harvest, such that uncut reedbeds had a significantly larger diameter than cut reeds, which may indicate a larger rootstock and improved shoot production (Tarr *et al.* 2004). The long-term effects of winter cutting were investigated at Hluhluwe-Umfolozi Park in KZN where McKean (2001) compared annual cutting, biennial cutting and control treatments. He found that harvested treatments had higher total shoot densities than the control (uncut) treatment. As such, cutting appeared to stimulate new growth, a finding in agreement with Van der Toorn & Mook (1982). However, harvesting altered the reed size structure over time, and annual and biennial harvested areas showed reduced density of useable culms (length > 2.5 m and diameter > 10 mm) compared to uncut areas (McKean 2001).

Experimental cutting trials with perennial grass species in South Africa showed that regular cutting altered species composition through a shift in competitive hierarchy (Fynn *et al.* 2005b). Experiments demonstrated that summer mowing tended to decrease the abundance of taller species such as *Aristida junceiformis* and increase the abundance of smaller species such as *Themeda triandra*. Annual mowing during the dormant period favoured medium to tall grass species such as *Aristida junceiformis* (Fynn *et al.* 2005a).

The rush *Juncus kraussii* is a perennial, rhizomatous herb. In Australia, Congdon & McComb (1980) reported a lack of seasonality in standing crop as culms were produced in every month and reached their maximum length in two to five months. The highest nitrogen and phosphorus concentrations occurred several months before the peak standing crop, which was during the warm season. Nutrients may be translocated to rhizomes on senescence of the culms, which occurs throughout the year (Congdon & McComb 1980).

Juncus kraussii has similar morphology and occupies comparable positions in marshes as *J. gerardii* in Europe and *J. roemerianus* in the United States of America (Congdon & McComb 1980). In the warmer parts of the USA, the standing crop of *J. roemerianus* was reported to be seasonally constant (Williams & Murdoch 1972; Giurgevich & Dunn 1982). In South Africa, Heinsohn (1990) reported that during the rhizome lifetime of *J. kraussii* there is continuous culm production. An experimental field study indicated that annual and biennial cut treatments stimulated the growth of individual culms

(McKean 2002). In the related species *J. roemarianus*, primary net productivity increased by 21–48 % in the year following harvesting in the USA (De la Cruz & Hackney cited in Özesmi 2003). However, other studies in South Africa have suggested that in the long term, annual cutting resulted in a reduction in yield and plant vigour (Heinsohn 1991).

In KZN, cutting of *Juncus kraussii* within many protected areas is permitted from May each year. During April to July, the useable material as a percentage of total live material is the greatest (Heinsohn 1991). Culms are harvested through plucking or cutting with a sickle. Plucking has been observed in the north of KZN at Kosi Bay and may be possible due to the longer, more robust culms in this area (Taylor 1996). Plucking is regarded as the traditional method of harvesting *J. kraussii* but this method may damage the underground rhizomes (Heinsohn 1990). The sickle-cut method has been criticised for being wasteful as only 25 % of the cut culms are selected (Heinsohn 1990) and the unselected stems may be discarded and form a thick mat of litter, which impedes new growth by blocking sunlight reaching new shoots. *Juncus kraussii* rush harvesters tend to favour removal of all stems as it allows the new culms to grow uniformly (Christiansen 2000).

All wetland plant species harvested for crafts have a perennial life cycle. The morphology differs between families: the Juncaceae and Typhaceae are herbs, the Poaceae are graminoids and the Cyperaceae are grass-like herbs. Many of the species are rhizomatous such as *Cyperus papyrus*, *C. textilis*, *C. sexangularis*, *Schoenoplectus brachyceras*, *S. scirpioides*, *Aristida junciformis* and *Phragmites mauritianus*. Although the response of plants to cutting is likely to be species specific, morphological characteristics are an important factor influencing responses (Li *et al.* 2004). Thus, shared characteristics may increase the likelihood of similar responses.

Investigations of the response of plants to harvesting have largely been undertaken for only two plant species

that are used for craft production in South Africa, namely *Juncus kraussii* and *Phragmites australis*. An important question to address is: how applicable are the findings of these studies to other species that are harvested for craft production? Given that all of the other species, together with *J. kraussii* and *P. australis*, are vigorously growing rhizomatous perennials, in a general sense they are all likely to respond in a similar way. However, some differences are likely to be exhibited given that there is considerable morphological diversity amongst the species. In an attempt to account for this diversity, the species can be grouped according to shared morphological characteristics, and these groups of species will probably respond in a similar way to harvesting, although this requires further investigation. From Table 3 it can be seen that whereas some taxa, such as *Phragmites* and *Schoenoplectus*, are confined to one particular morphology, other taxa, notably *Cyperus*, have a diverse range of morphological characteristics.

Harvested plant populations: abundance, distribution and landscape level factors

The response of a species to cutting disturbance at the population level is determined by factors such as geographic distribution, whether species are habitat specific or not, and local population sizes. Species with a wide geographic distribution are not habitat specific and large local population sizes have a high potential for sustainable harvests (Cunningham 2001). Some of the landscape scale factors that influence a plant's population response to cutting disturbance are shown in Table 4. Species with a restricted geographic distribution that are habitat specific and with small local population sizes, have a low potential for sustainable harvesting. *Cyperus papyrus*, *C. textilis* and *Juncus kraussii* all have a restricted geographic distribution within KZN (Figure 1). However, they also all have large local populations at specific sites which increase their opportunity for sustainable harvests. Most of the wetland plant species are habitat specific as they tend to occur along rivers and streams, in pools,

TABLE 3.—Obligate wetland species used for craft production in KwaZulu-Natal, grouped according to shared morphological characteristics. All species listed are rhizomatous and perennial

| Morphological characteristic | <i>Miscanthus junceus</i> | <i>Cyperus latifolium</i> | <i>Typha capensis</i> | <i>Phragmites australis</i> | <i>P. mauritianus</i> | <i>Cyperus papyrus</i> | <i>C. sexangularis</i> | <i>C. textilis</i> | <i>C. marginatus</i> | <i>Schoenoplectus brachyceras</i> | <i>S. scirpioides</i> | <i>Juncus kraussii</i> | <i>J. punctatorius</i> |
|---|---------------------------|---------------------------|-----------------------|-----------------------------|-----------------------|------------------------|------------------------|--------------------|----------------------|-----------------------------------|-----------------------|------------------------|------------------------|
| Leaves | | | | | | | | | | | | | |
| basal, terete | x | | | | | | | | | | | | |
| basal, with blades | | x | x | | | | | | | | | | |
| terete | | | | | | | | | | | | | x |
| several sheathing full length of each tall culm, with blades | | | | x | x | | | | | | | | |
| single sheathing lower portion of each terete photosynthetic culm | | | | | | | | | | | | | x |
| reduced to small bracts | | | | | | x | x | x | x | x | x | x | |
| Culms | | | | | | | | | | | | | |
| terete, photosynthetic | | | | | | x | x | x | x | x | x | x | x |
| with very many terminal photosynthetic prophylls | | | | | | x | | | | | | | |
| with many terminal photosynthetic leaf-like bracts | | | | | | | x | x | | | | | |

swamps and dams. *Schoenoplectus scirpoides* and *J. kraussii* display more specific habitat requirements. *Schoenoplectus scirpoides* occurs mainly in estuarine areas and *Juncus kraussii* is most abundant in intertidal mud-flats. Although *J. kraussii* can grow in freshwater conditions, it may be out-competed, and it is more competitive in saline environments where it can form monodominant stands (Heinsohn 1991).

Implications of the findings

Most research concerning the biology and physiology of *Phragmites australis* was conducted in northern temperate regions (e.g. Mook & Van der Torn 1982; Karunaratne *et al.* 2004; Soetaert *et al.* 2004). The applicability of these findings to populations in South Africa needs to be considered. Experiments have suggested that *P. australis* displays differentiation of genotypes adapted to local geographical conditions, and that latitude can affect growth dynamics and biomass allocation patterns (Bastlovà *et al.* 2004). High phenotypic variation in morphology and life-history traits have also been reported (Clevering & Lissner 1999; Clevering *et al.* 2001). Although *P. australis* from different locations displays different growth rates in experimental cultures (Daniels 1991), the build-up of reserves in the rhizomes is a ‘strongly determined mechanism’ (Muachamp *et al.* 2001: 161).

In South Africa, as in the northern temperate regions, *Phragmites australis* shows a well-defined growing season in spring and summer with a pronounced senescence of aboveground parts in autumn/winter. Thus, the general trends in plant growth and resource mobilization outlined for the temperate regions are probably highly applicable to South Africa. Studies suggest that to maintain plant vigour, cutting should take place when rhizome storage levels are high and when shoot growth rates are slow. Cutting should not take place when new shoots are emerging, and should not remove the apical meristem, as this can lead to replacement by several smaller shoots. Therefore, cutting in autumn/winter is recommended. In fact, in South Africa, the timing of harvesting of *P. australis* occurs after flowering, once the shoots and leaves have begun to senesce. This timing is acceptable because the main uses in South Africa are for walls, screens (Van Wyk & Gericke 2003) and thatching (Cunningham 1985) as the stems do not have to be very flexible because they are not woven. The split stems can be used in basketry (Van Wyk & Gericke 2003), but this has not been widely reported in South Africa. Thus, in terms of the timing of cutting, current harvesting practices are in general agreement with recommendations from the published literature.

In contrast to *Phragmites australis*, the shoots and leaves of species used for weaving and basketry such as *Aristida junciformis*, *Eragrostis plana*, *Festuca costata*

TABLE 4.—Landscape scale factors which influence response to cutting of wetland species used for crafts

| Species | Geographic distribution within KZN* | Wetland system** | Habitat specificity** | Local abundance | Conservation information** |
|-----------------------------------|--|------------------|--|--|----------------------------|
| <i>Miscanthus junceus</i> | Limited to northern KZN, Midlands, coast | RPL | Riverbanks and vleis | | I |
| <i>Phragmites australis</i> | Widespread | RPL | Along edge of rivers, shallow water, margins of pools, swamps | Common or locally dominant (in riverbeds) | IC |
| <i>P. mauritanus</i> | Widespread | RPL | Along edge of rivers, shallow water, margins of pools, swamps, and dams | Common or locally dominant (in riverbeds) | I |
| <i>Cyperus latifolius</i> | Widespread | RP | Along edge of rivers and streams, freshwater swamps, wet depressions in grasslands | Locally common at specific sites | I |
| <i>C. marginatus</i> | Limited to Uplands and Midlands | P | Common along stream banks, usually rooted in shallow water, often among rocks; sometimes border isolated small pools | Can form locally extensive stands. | I |
| <i>C. papyrus</i> | Restricted to coast and Maputaland | RPL | Along edge of rivers, seasonal pools, swamps | Can form extensive stands at river mouths and flood-plains | I |
| <i>C. sexangularis</i> | Widespread | R | Along edge of streams or rivers, often in water | | I, En |
| <i>C. textilis</i> | Restricted to coast and Midlands | RP | Wet, marshy areas along coast, in shallow water along rivers/streams, marsh/vlei, brackish water | Locally common at specific sites | N |
| <i>Schoenoplectus brachyceras</i> | Limited to Uplands and Midlands | RL | Along edge of rivers, around edge of lakes and dams | | I |
| <i>S. scirpoides</i> | Restricted to coast and Maputaland | PE | Coastal marshy areas, saline pools | | I |
| <i>Juncus kraussii</i> | Restricted to coast and Maputaland | PE | Intertidal mud flats | Locally common at specific sites | I, NT |
| <i>J. punctorius</i> | Limited | RP | Along edge of rivers, wet, marshy areas around pools, swamps | | I |
| <i>Typha capensis</i> | Wide | RPL | Gregarious, along edge of rivers, around edge of lake, in marsh or vlei areas, ditches, dams | | I |

*SANBI PRECIS Database and herbarium records. ** Source: Glen *et al.* in prep. R, riverine; P, palustrine; L, lacustrine; E, estuarine; I, indigenous; C, cosmopolitan; En, endemic to southern Africa; N, naturalized; NT, not threatened.

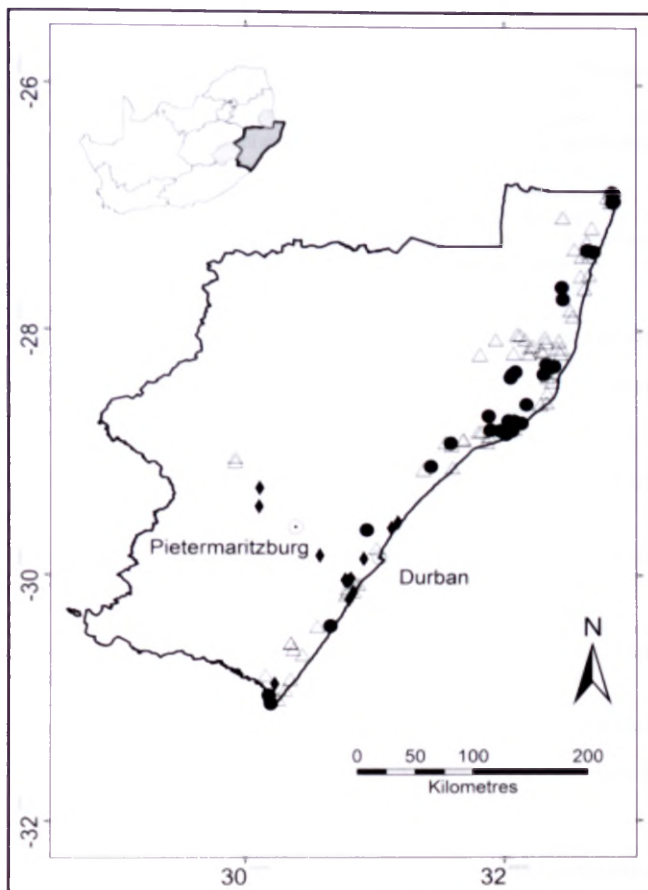


FIGURE 1.—Geographic distribution of *Cyperus papyrus*, ●; *Cyperus textilis*, ◆; and *Juncus kraussii*, △, in KwaZulu-Natal.

and *Sporobolus africanus*, must retain their flexibility. Therefore, the availability of these species is restricted to the spring and summer seasons (Cunningham & Terry 2006) as they are harvested before senescence in autumn/winter. Although their response to cutting disturbance has not been widely researched, the sharing of some key plant physiological traits suggests that these species may display a response similar to that documented for *P. australis*. Studies on *Glyceria maxima*, a perennial, rhizomatous aquatic species that belongs to the Poaceae family, showed that the amount of non-structural carbohydrates stored in rhizomes in autumn, has a strong relationship with the number of large-diameter shoots produced the following spring (Sundblad 1990).

Species within the Juncaceae may show a strong seasonality in growth at high latitudes but limited seasonality at lower latitudes where less extreme winter conditions exist (Congdon & McComb 1980). In *Juncus kraussii*, the main growth period is during the warm season. However, new culms are produced throughout the year in Australia (Congdon & McComb 1980), and South Africa (Heinsohn 1991). Thus, in South Africa, culms suitable for weaving and basketry are available during the entire year (Cunningham & Terry 2006). In terms of obtaining useable fibres for basketry and weaving, the timing of harvesting for the Juncaceae is less restrictive than for the Poaceae. Heinsohn (1991) investigated the timing of *J. kraussii* harvesting in South Africa, recommending that the period between April and July was best to obtain fibres for crafts, as the percentage of useable material

(long, green, non-flowering culms with limited signs of senescence) in relation to total live material, was greatest during this period. *Juncus kraussii* culms produced at any time of year, display an initial rapid growth, followed by a stationary phase with slow growth rate and slow senescence rate, and then finally a negative growth rate and increased senescence (Heinsohn 1991). The patterns of mineral nutrient and non-structural carbohydrate storage and movement between rhizomes and aboveground parts are unlikely to display seasonal trends as there is no single flush of growth. Rather, storage should be specific to the developmental stage of a particular plant. Thus, the timing of cutting disturbance, if it aims to maximize plant vigour, rhizome storage levels and culm diameter, will be determined by the developmental stage of the plant. As individual plant developmental stages vary throughout the year, no specific time of the year can be recommended for cutting from an ecological perspective. Investigations into the standing crop of *J. kraussii* in South Africa show that the amount of dead material peaks during August and September (Heinsohn 1991). Therefore, ecologically, this may be the most appropriate time for cutting disturbance.

The frequency of cutting has an impact on plant growth, and in the short term, cutting of *Phragmites australis* and species of *Juncus* may stimulate aboveground production (e.g. Cowie *et al.* 1992; McKean 2002). However, in *P. australis*, cutting in the long term may reduce the number of longer-length and large-diameter culms (McKean 2001; Tarr *et al.* 2004). Unfortunately, investigations of the long-term impacts of cutting upon species such as *J. kraussii* are limited. Crafters seek longer-length culms as it means there are fewer 'ends' produced in items. Additionally, culm length determines the width of sleeping mats, so long culms produce wide mats. Large-diameter culms have advantages over thin diameter culms in crafts, as it reduces the time required to construct items such as mats, as fewer culms are required. Furthermore, large culms are easier to handle. To obtain culms with these characteristics, biennial cutting has been suggested for both *P. australis* (Tarr *et al.* 2004) and *J. kraussii* (Heinsohn 1991; McKean 2002). Limited information exists concerning the other species harvested for crafts, but the precautionary principle and the above recommendations could be applied until further information is available.

From a resource management and conservation perspective, species with restricted distributions are important, especially if demand for their fibres is high. The results from this study suggest that *Juncus kraussii* and *Schoenoplectus scirpoides* are particularly important because of their restricted distribution and specific habitat requirements. Within KZN, demand for *J. kraussii* is extremely high. Although many species can be used to make sleeping mats, *J. kraussii* is the only species that is culturally acceptable for the production of bridal sleeping mats (Hennessy & Koopman 2000). Crafters have travelled up to 200 km to obtain supplies (Traynor 2008) and it was one of only two craft species where trade in unprocessed fibres away from the source was recorded (Cunningham 1985). Field studies within KZN have suggested that demand is greater than supply (Traynor & Kotze 2007b). Cultivation programmes have been established in KZN to meet the demand from crafts-

men (Traynor & Kotze 2007a). Information concerning *S. scirpoides* is limited, but this species does not have the same strong cultural associations as *J. kraussii* and it is used to produce fewer types of craft items (Kotze & Traynor in prep.). Thus, from a resource management perspective, *J. kraussii* is of primary importance.

For conservation purposes, it has been recommended that reedbeds are cut so that a mosaic of different-aged cut and uncut stands are produced within the landscape. These recommendations are applicable to South Africa. In fact, in many communal areas, wetland harvesting takes place on an *ad hoc* basis and individuals often walk to sites and harvest one bundle of fibres. Thus, cutting is often on a micro-landscape scale with small recently cut patches interspersed with regenerating patches and uncut patches. In some of KZN's nature reserves, the harvesting of *Juncus kraussii* is managed on a rotational basis (C. Beattie, Umlalazi, pers. comm.; S. Kyle, Kosi Bay, pers. comm.). Approaches such as these should be maintained as they are beneficial from a conservation perspective.

Wetland plant harvesting that is ecologically sustainable can contribute towards the wise use of wetlands. This requires maintenance of wetland ecological character and is achieved through the implementation of ecosystem approaches within the context of sustainable development (Ramsar 2006). The wise use concept is being globally promoted by international organizations such as Ramsar and Wetlands International. Within South Africa, local organizations such as Working for Wetlands and the Mondi Wetlands Project are developing wise use programmes for wetlands. These initiatives aim to support local livelihoods and increase economic empowerment of communities living near wetlands. Wetland plant crafting activities, if appropriately managed, could play an important role in such endeavours. Furthermore, support for harvesting and crafting may assist to enhance the perceived value of wetlands in their natural state and thereby reduce the pressure to convert the wetlands for alternative uses such as agriculture.

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