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Traditional Plant Harvesting in Contemporary Fragmented and Urban Landscapes

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Abstract: *Ecosystem fragmentation and destruction can lead to restrictive administration policies on traditional harvesting by indigenous peoples from remaining ecosystem tracts. In New Zealand, concerns about endangered species and governmental policies that focus on species and ecosystem preservation have resulted in severely curtailed traditional harvesting rights. Although provision has been made for limited gathering of traditional plants from government-administered conservation lands, it is unclear how much harvesting is undertaken on these lands and elsewhere and what this harvest might consist of. We interviewed seven expert Maori elders from the Waikato, New Zealand, to identify plant species they currently harvested and from where. We compared these data with the data we collected on permits issued for plant collecting on conservation lands in the same region. We sought to gain information on indigenous plant harvesting to determine the extent of permitted harvesting from conservation lands in the Waikato and to identify issues that might affect plant harvesting and management. Elders identified 58 species they harvest regularly or consider culturally important; over 50% of these species are harvested for medicinal use. Permit data from 1996 to 2006 indicated no apparent relationship between species of reported cultural significance and the number of permits issued for each of these species. Currently, few plant species are harvested from conservation lands, although some unofficial harvesting occurs. Elders instead reported that medicinal plants are frequently collected from urban and other public areas. They reported that plant species used for dyeing, carving, and weaving are difficult to access. Elders also discussed concerns such as spraying of roadsides, which resulted in the death of medicinal species, and use of commercial hybrids in urban planning. Local government may have an increasingly important role in supporting native traditions through urban planning, which takes account of cultural harvesting needs while potentially reducing future harvesting pressure on conservation lands. We suggest that active participation by the Māori community in the development and management of urban harvesting resources will result in positive outcomes.*

Keywords: ethnobiology, indigenous plant conservation, indigenous, Māori, plant harvesting, TEK, traditional ecological knowledge, urban ecology

Cosecha Tradicional de Plantas en Paisajes Contemporáneos Fragmentados y Urbanos

Resumen: *La fragmentación y destrucción de ecosistemas puede conducir a políticas de administración restrictiva de la cosecha tradicional por indígenas en los remanentes de los ecosistemas. En Nueva Zelanda, la preocupación por las especies en peligro y las políticas gubernamentales sobre preservación de especies y ecosistemas ha resultado en la reducción severa de los derechos tradicionales de cosecha. Aunque se ha considerado la recolecta limitada de plantas tradicionales en los terrenos de conservación administradas por el gobierno, no está claro cuánto es cosechado en estas y otras tierras ni en lo que pudiera consistir esta cosecha. Entrevistamos a siete ancianos Maori expertos de Waikato, Nueva Zelanda, para identificar las especies de plantas que cosechaban y dónde lo hacían. Comparamos estos datos con datos que recolectamos de permisos emitidos para la colecta de plantas en terrenos de conservación en la misma región. Tratábamos de reunir*

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información sobre la cosecha de plantas nativas para determinar la extensión de la cosecha permitida en las tierras de conservación de Waikato y para identificar factores que pudieran afectar la cosecha y manejo de plantas. Los ancianos identificaron 58 especies que cosechan regularmente o que consideran culturalmente importantes; más de 50% de estas especies son cosechadas para uso medicinal. Los datos de permisos de 1996 a 2006 no indicaron una relación aparente entre las especies de significado cultural y el número de permisos emitidos para cada una de esas especies. Actualmente, pocas especies de plantas son cosechadas en los terrenos de conservación, aunque ocurren cosechas extraoficiales. Los ancianos reportaron que plantas medicinales frecuentemente son cosechadas en áreas urbanas y otras áreas públicas. Reportaron que las especies de plantas utilizadas para tinción, labrado y tejido son difíciles de obtener. Los ancianos también mostraron preocupación por la fumigación de caminos, que resultan en la muerte de especies medicinales, y el uso de híbridos comerciales en la planificación urbana. El gobierno local puede jugar un papel cada vez más importante en el respaldo a las tradiciones nativas mediante la planificación urbana que considere las necesidades de cosecha al mismo tiempo que potencialmente se reduce la presión de cosecha en terrenos de conservación en el futuro. Sugerimos que la participación activa de la comunidad Maori en el desarrollo y manejo de la cosecha de recursos urbanos tendrá resultados positivos.

Palabras Clave: conocimiento ecológico tradicional, conservación de plantas nativas, cosecha de plantas, ecología urbana, etnobiología, indígena, Māori, TEK

Introduction

Plant harvesting and plant use are fundamental ways that native peoples maintain connections to the wider environment and their distinctive cultural traditions. Research on harvesting by indigenous peoples to date has emphasized contexts such as intact traditional-gathering sites (Turner et al. 2000) and subsistence economies (Kaschula et al. 2005) and focused on issues such as sustainable use of nontimber forest products (Godoy & Bawa 1993; Schreckenberg 1999), opportunities for commercial trade (Gorman et al. 2006; van Andel & Havinga 2008), and management of threatened species (Anderson & Rowney 1999; Kala 2005; McGeoch et al. 2008). Nevertheless, in many countries, including New Zealand, ecosystem destruction and fragmentation has resulted in the reduced representation of many ecosystems, and urbanization has contributed to the existence of a significantly different landscape than that which existed a century ago. In addition, rapid urbanization of many indigenous peoples in the late 20th century has led to a dislocation of people from their traditional resources. For example, in New Zealand around 84% of the indigenous Māori people are now urbanized (Meredith 2009), whereas in the United States the 2000 census reported that 45% of Native Americans are urbanized and 64% reside outside their tribal areas (Harvard Project 2007). In Australia 42% of indigenous Australians were reported as residing in urban centers in 1996 (Jupp 2001). As yet, however, few, if any, researchers have addressed indigenous harvesting in an urban or nontraditional harvesting context. We considered contemporary harvesting where ecosystem fragmentation and destruction have strongly affected the traditional landscape and included urban dwellers among the target research group.

We focused on the Waikato region of New Zealand, where vegetation clearance and wetland drainage over the last 200 years have dramatically altered the landscape. The most radical changes have occurred in the lowlands, where forests, wetlands, and coastal ecosystems have been transformed into pastoral lands. Native flora remnants are fragmented and sparse (Leathwick et al. 1995; Clarkson et al. 2007), and concentrated in a few sizable tracts on the ranges or mountains. In the Waikato, this consists of around 270,000 ha of various types of ecosystems administered mostly by the Department of Conservation. The Department of Conservation is legally responsible for the conservation and protection of New Zealand's native flora and fauna. Thus, it administers many large areas of protected resources throughout the country, lands that now make up much of the remaining high-quality indigenous ecosystem areas in New Zealand. Throughout the Waikato, other scattered ecosystem fragments also occur, including small stands of coastal forest around the west coast harbors (Burns & Smale 2002). Most remnants, however, are no longer under the control of the indigenous Māori people.

Because of concerns about conservation of biodiversity, many countries, including New Zealand, enforce a restrictive approach to harvesting of the flora and fauna. Nevertheless, continued harvesting of natural resources may be critical to daily life (Agrawal 2005), the environmental philosophies central to indigenous world views (O'Flaherty et al. 2008), and the survival and expression of indigenous knowledge (Lyver et al. 2009). Historically, laws and guidelines relating to the preservation of indigenous flora and fauna have triggered fierce debate on the rights of Māori to access and manage these resources in New Zealand and rights to self-determination (Moller 1996; New Zealand Conservation Authority 1997), a situation that has also emerged elsewhere (e.g., Agrawal

2005). Some resulting paradigm shifts have led to increased community involvement and participatory decision making processes, including limited co-management and access to some resources for Māori. Traditional gathering of plants is allowed on conservation lands if a permit is issued, although this restriction is unsatisfactory for at least some, and perhaps for many, Māori communities. It is unclear how much traditional harvesting is undertaken on these lands and elsewhere, what this harvest might consist of, and what the effects of these policies are.

Although traditional knowledge generally is diminished in younger generations because of assimilation and environmental change, there is now a revitalization of many traditional practices, including the use of traditional medicines and making of arts and crafts. With this resurgence, it is timely to investigate the resource limitations and difficulties associated with these traditional practices. A key strategy of the Department of Conservation in the Waikato is to liase with local peoples to identify plant species that are important for traditional use and to consider which of these species may require conservation management (Brandon & Collins 2004). We sought information on indigenous plant use and harvesting from known Māori plant harvesters to identify plant species that are currently used and regarded as culturally important in the Waikato. Additionally, we analyzed permit data for the same region to determine whether patterns of plant-collection permitting on conservation lands are consistent with reported plant harvesting and to identify issues that might affect plant harvesting and management.

Methods

The western Waikato region in the central northern North Island of New Zealand has been populated by descendants of the Tainui tribal group since human landfall in about 1200 AD. The region today has one city (Hamilton, population approximately 130,000; Statistics New Zealand Census 2006), and the indigenous Māori population is about 20% of the total.

Interviews

We used narrative inquiry in semistructured interviews with seven research participants. This method addressed Māori concerns that research into their lives should be conducted in a holistic, culturally appropriate manner (Bishop 1996*a*, 1996*b*). These interviews allowed for more natural discussion and for unanticipated insights to emerge (Huntington 2000). We selected participants because they either used a range of native plants on a regular basis or were recognized experts in a traditional Māori discipline that relies on native plant use or were elders within their subtribes. The low number of participants reflects the system of expert specialization found in Māori and many other indigenous communities and the relatively small number of experts with detailed plant knowledge currently living in the western Waikato region. A large number of subtribes live within the wider Waikato Conservancy, so we focused on elders tribally connected to the western part of the Waikato Conservancy and resident either there or in the urban Hamilton area. All the interviews were conducted after discussion of our methods with staff of the Department of Conservation and in accordance with ethical guidelines for research with indigenous peoples. Thus, we provided participants with both oral and written information about the study and its aims (including proposed presentation in the public domain) prior to interviews and asked each participant to sign a consent form to ensure not only that the ethical obligations of the research were met, but that the rights of each participant (including the right to withdraw) were understood. We conducted most interviews on a one-to-one basis, although other extended family members were frequently present. Interview transcripts were returned to participants for final editing, prior to analysis of data. Intellectual and cultural rights to knowledge recorded in this study remain with the research participants.

The emphasis in interviews was on plants harvested, prepared, and used by the research participants themselves. Participants discussed harvesting purposes and locations, which plant parts they use, processing of plant material, and frequency of use. Participants also indicated whether it was easy or difficult to access particular plant material and discussed concerns related to harvesting. From interview data, we calculated the cumulative index of cultural significance (ICS) for each species identified as important by the participants to estimate the importance of species in the community (Silva & Andrade 2006): $\mathrm{ICS} = (p + u)\cdot i\cdot e\cdot c$, where p is the proposed use for a species; u the number of parts used (from 1 to 7; root, stem, leaf, flower, fruit, seed, whole plant); i the intensity which a species is used with (range 1–5; 5, intentionally maintained plant, primary production, commerce; 4, high use, moderate commerce; 3, medium use; 2, low use, most known medicinal plants; 1, minimal use, least known medicinal plants); e the exclusivity of use (2, species is preferred or is most important for a certain use; 1, species is a common resource for a certain use); and c, the contemporaneity of use (2, species is used currently; 1, species is no longer used).

Permit Records

The Department of Conservation issues permits for plant collection from the conservation lands they administer. Collecting from public or private land does not require permits, and therefore there are no formal records. Within the Waikato Conservancy, permits are issued for

the central and western region conservation lands by the Waikato Area Office, Waikato Central Office, and Kaupapa Atawhai Manager (a cultural liaison officer), whereas the Hauraki Area Office and Maniapoto Area Office issue permits for the eastern and southern part of the region, respectively. Permits allow collection of material from conservation lands for scientific research, cultural use, specimen collection for herbaria, restoration projects, and other reasons. We included collecting permits for peat cores, mud for dyeing purposes, leaves, seeds, and other plant material in the data set, but excluded requests for bird feathers, albatross bones, and other animal-related purposes. Permit records include information on the species, harvester, amount of material to be harvested, purpose, and site of harvest. We pooled permit records from the Waikato Area Office, Waikato Central Office, and Kaupapa Māori Manager from 1996 to 2006 for the analysis. Prior to 2000, permit records for purposes other than cultural were unavailable. We quantified the number of permits relating to cultural harvest issued each year; plant species requested; purpose of collection; and which areas are most frequently used by cultural harvesters. General information regarding cultural permits was also provided by the Maniapoto Office. Data exploration and analysis was carried out in Microsoft Excel and Minitab version 14.

Results

Interviews

Fifty-eight plant species were identified by research participants as being harvested or otherwise regarded as culturally important ($\bar{x} = 21$, range: 14–32). All the species identified by elders in these interviews, their habitats, and threat status are listed in Table 1. Thirty-six percent of species were harvested as medicines, 25% as food, and 19% each for weaving and dyeing. Similarly, of the 13 species that were identified by more than half of the elders, six were used medicinally and four were used for weaving, but only two were regularly used food plants. All the participants reported that they harvested and used medicinal plants, and all specifically reported regularly harvesting kumarahou (*Pomaderris kumeraho*) for medicinal use. Less common harvesting reasons included the use of leaves for female perfumes and insect repellent. Leaves were the plant part most commonly harvested (42%), with branches (19%), and bark (12%) the next-most harvested. Three tree species were reported as highly valued for timber. Plants with high ICS scores such as koromiko (*Hebe stricta*), kumarahou, and New Zealand flax (*Phormium tenax*), were spread across plant families. Although some plants had a higher final score than predicted by the partial score (which essentially refers to the frequency of reference), ICS scores were reasonably robust in predicting plants with high cultural significance in this research (Table 1).

Almost all reported harvesting was from uncultivated areas, including roadsides, scrub, and forested areas. Only three of these 58 species (hue [*Lagenaria siceraria*], riwai māori [*Solanum tuberosum*], and taro [*Colocasia esculenta*]) were almost exclusively cultivated. Although we did not identify harvesting sites for all species, all elders reported using public areas for harvesting. Elders living in rural areas used both remaining tribally owned forested fragments and publicly managed roadsides. Elders living in urban areas similarly used a mixture of public urban sites and home or communal tribal resources. Nevertheless, a majority of medicinal plant material was harvested from public urban areas and roadsides, so that, for example, four elders who identified their source of koromiko all gathered it from roadsides or public urban areas, and two-thirds of elders identified urban, publicly owned harvesting sites for kumarahou. Harvesting from conservation lands was not reported, with one exception.

Elders identified 13 species they were unable to adequately access, all of which are present on conservation lands. Eight are weaving and dyeing plants, and five are valued for their timber. Nine of these species are forest or shrubland trees. There was no apparent relationship, however, between plants described as hard to access and habitat type or plant family. Elders also discussed their concerns about harvesting within the fragmented and modified landscape that currently exists (Table 2). Five issues were of primary concern to them: contamination, hybridization, ecosystem destruction, incorrect harvesting procedures, and perceived administrative guidelines. Of these, only the last relates directly to the management of harvesting on conservation lands.

Permit Data

From 2000 to 2006, 99 permits were issued from Waikato Area Office and Waikato Central Office for the collection of organic material, including 80 for the collection of plant material and 19 for peat cores. Two requests for timber were not granted (in accordance with guidelines that timber is not to be removed from conservation-land forests if trees are intact and healthy except under exceptional circumstances). Otherwise, no requests for plant material were refused. Hauraki Office reported no permits were requested or issued for this period. Only 23 of the 80 plant material collection permits (29%) issued were for cultural harvesting (Fig. 1). Of these, weaving was the most commonly cited purpose for harvesting listed on permits (87%). During the earlier period 1996–1999, eight permits were issued to harvest four species, including five permits for weaving kiekie

Table 1. Plant species identified in interviews by expert indigenous elders in the western Waikato region, New Zealand, with their habitats and threat status.

Family	*Species, local name and threat status*[a]	*Habitats*	*Proposed use*	*Number of parts used*	*Intensity of use*	*Exclusivity of use*	*Contemporaneity of use*	*ICS score*[b]
Agavaceae	*Cordyline australis* (G. Forst.) Endl. (1833); tī, cabbage tree	coastal, lowland, submontane and montane forest margins	3	3	3	2	2	72
Araceae	*Colocasia esculenta* (L.) Schott (1832); taro	naturalized, cultivated	1	1	5	2	2	40
Araliaceae	*Raukaua edgerleyi* (Hook.f.) Seem. (1866); raukawa	lowland, submontane and montane forest	1	0	1	2	1	2
Araliaceae	*Schefflera digitata* J. R. Forst. & G. Forst. (1776); pate	lowland, submontane and montane forest	1	1	1	1	1	2
Araucariaceae	*Agathis australis* (D.Don) Lindl. ex Loudon (1829); kauri	lowland forest	2	2	3	2	2	48
Aspleniaceae	*Asplenium bulbiferum* G.Forst. (1786); pikopiko	coastal to subalpine, usually lowland forest	1	2	2	2	2	24
Asteraceae	*Sonchus* spp., including *S onchus asper* (L.) Hill (1769); puha	naturalized weed	1	1	4	2	2	32
Asteraceae	*Brachyglottis repanda* J. R. Forst. & G.Forst. (1775); rangiora	lowland, submontane and montane forest and shrubland	1	1	1	2	1	4
Bangiaceae	*Porphyra* spp.; karengo	marine species, but largely not west coast	1	2	3	2	2	36
Brassicaceae	*Brassica rapa* L.; Kōrou = pōhata = poneki	naturalized	1	1	1	1	2	4
Brassicaceae	*Nasturtium officinale*; watercress	naturalized water weed	1	2	4	2	2	48
Coriariaceae	*Coriaria arborea* Linds. (1868); tutu	lowland, submontane, montane and subalpine forest and shrubland	1	0	2	1	1	2
Corynocarpaceae	*Corynocarpus laevigatus* J. R. Forst. & G. Forst. (1776); karaka	coastal forest	1	1	2	2	2	16
Cucurbitaceae	*Lagenaria siceraria*; hue, gourd	cultivated	3	3	2	2	2	48
Cunoniaceae	*Weinmannia racemosa* L.f. (1781); kamahi	lowland, submontane, montane and subalpine forest	1	2	3	1	2	18
Cyatheaceae	*Cyathea medullaris* (G.Forst.) Sw. (1801); mamaku	lowland forest	1	1	2	1	1	5
Cyperaceae	*Eleocharis sphacelata* R. Br. (1810); kuta	lake margins	1	1	2	2	2	16
Cyperaceae	*Desmoschoenus spiralis* (A.Rich.) Hook.f. (1853); pīngao*	coastal sand dunes	1	1	2	2	2	16
Dennstaedtiaceae	*Pteridium esculentum* (G.Forst.) Cockayne (1908); bracken fern	cultivated	2	2	2	2	1	16
Dicksoniaceae	*Dicksonia* spp.,usually *squarrosa* (G.Forst.) Sw. (1801); ponga	lowland forest	1	1	3	2	2	24
Elaeocarpaceae	*Eleocarpus dentatus* (J. R. Forst. & G.Forst.) Vahl (1794); hinau	lowland, submontane and montane forest	2	1	2	1	2	12
Elaeocarpaceae	*Aristotelia serrata* (J. R. Forst. & G. Forst.) W. R. B. Oliv. (1921); makomako	forest, shrubland	3	3	2	1	2	12

continued

Table 1. (continued)

Family	Species, local name and threat status[a]	Habitats	Proposed use	Number of parts used	Intensity of use	Exclusivity of use	Contemporaneity of use	ICS score[b]
Fabaceae	*Sophora microphylla* Aiton (1789) *or tetraptera* J.S. Mill. (1780); kowhai	lowland, submontane and montane forest	1	1	1	2	2	8
Hemerocallidaceae	*Phormium tenax* J. R. Forst. & G.Forst. (1776); harakeke, flax	coastal swamp	4	4	2	2	2	64
Lauraceae	*Litsea calicaris* (Sol. ex A.Cunn.) Benth. & Hook.f. ex Kirk (1889); mangeao	lowland forest	1	0	1	1	1	1
Lauraceae	*Beilschmiedia tawa* (A.Cunn.) Benth. & Hook.f. ex Kirk (1889); tawa	lowland, submontane and montane forest	1	1	2	2	2	16
Loganiaceae	*Geniostoma rupestre* J. R. Forst. & G.Forst.; hangehange	lowland, submontane and montane forest and shrubland	1	1	5	1	2	20
Malvaceae	*Hoheria populnea* A.Cunn. (1839); houhere	lowland forest	1	1	5	1	2	20
Marattiaceae	*Marattia salicina* Sm. in Rees (1812); para†	forest	1	1	1	2	1	4
Meliaceae	*Dysoxylum spectabile* (G.Forst.) Hook.f. (1864); kohekohe	lowland, submontane and montane forest	1	1	2	2	2	16
Myrtaceae	*Syzygium maire* (A.Cunn.) Sykes & Garn.-Jones (1979); maire	lowland swamp	1	1	2	2	2	16
Myrtaceae	*Metrosideros excelsa* Sol. ex Gaertn. (1788); pohutukawa	coastal and lowland forest	1	0	2	1	2	4
Myrtaceae	*Kunzea ericoides* (A.Rich.) Joy Thomps. (1983); kanuka	scrub, regenerating forest	2	2	1	2	2	16
Myrtaceae	*Leptospermum scoparium* J. R. Forst. & G. Forst. (1776); manuka	regenerating forest, lowland swamp	2	2	3	2	2	48
Pandanaceae	*Freycinetia banksii var. baueraniana* A.Cunn. (1837); kiekie	lowland, submontane and montane forest	2	2	3	2	2	48
Phyllocladaceae	*Phyllocladus trichomanoides* D.Don; tanekaha	lowland, submontane and montane forest	1	1	2	2	2	16
Piperaceae	*Macropiper excelsum* (G.Forst.) Miq. (1843); kawakawa		2	1	4	2	2	48
Pittosporaceae	*Pittosporum eugenioides* A.Cunn. (1840); tarata, lemonwood	lowland, submontane and montane forest	1	1	1	2	1	4
Poaceae	*Cortaderia* spp. (native), including *C. toetoe*; toetoe, kakaho	freshwater swamps, damp places, riparian habitats, coast to subalpine	2	2	2	2	2	32
Podocarpaceae	*Dacrycarpus dacrydioides* (A.Rich.) de Laub. (1969); kahikatea	lowland swamp forest, also submontane and montane	2	1	2	1	2	12
Podocarpaceae	*Dacrydium cupressinum* Lamb. (1803); rimu	lowland, submontane and montane forest	1	1	2	2	2	16
Podocarpaceae	*Podocarpus totara* G.Benn. ex D.Don (1832), tōtara	lowland, submontane, montane and subalpine forest	1	2	2	2	2	24

continued

Table 1. (continued)

Family	*Species, local name and threat status*[a]	*Habitats*	*Proposed use*	*Number of parts used*	*Intensity of use*	*Exclusivity of use*	*Contemporaneity of use*	*ICS score*[b]
Polygonaceae	*Muehlenbeckia complexa* (A.Cunn.) Meisn. (1841); pōhuehue	coastal, lowland and sub-montane forest and shrubland	2	2	2	2	2	32
Rhamnaceae	*Pomaderris kumeraho* A.Cunn. (1839); kumarahou	lowland shrubland	1	3	4	2	2	64
Rosaceae	*Rubus spp.,* including *R. cissoides* A.Cunn. (1839); tataramoa = taraheke (Tainui)	lowland, submontane and montane forest	2	2	2	2	2	32
Rubiaceae	*Dodonea viscosa* Jacq. (1760); akeake	coastal forest	1	1	5	1	2	20
Rubiaceae	*Coprosma robusta* Raoul (1844); karamu	lowland, submontane, montane and subalpine forest	3	2	1	2	2	20
Rubiaceae	*Coprosma propinqua* A.Cunn. (1839); mingimingi	forest, shrubland, swamp	2	5	2	2	2	56
Rubiaceae	*Coprosma grandifolia* Hook.f. (1852); raurekau	lowland, submontane and montane forest	2	2	3	2	2	48
Sapindaceae	*Alectryon excelsus* Gaertn. (1788); titoki	lowland forest	1	0	1	1	1	1
Schizaeaceae	*Lygodium articulatum* A.Rich. (1832); mangemange	lowland to subalpine forest	1	1	1	1	1	2
Scrophulariaceae	*Hebe stricta* (Benth.) L. B. Moore (1961); koromiko	lowland, submontane and montane forest	3	2	4	2	2	80
Scrophulariaceae	*Hebe speciosa* (A.Cunn.) Andersen (1926); napuka, titirangi‡	open coastal areas	0	0	0	1	1	0
Smilacaceae	*Ripogonum scandens* J.R.Forst. & G.Forst. (1776); kareao	lowland, submontane, montane and subalpine forest	2	1	3	1	2	18
Solanaceae	*Solanum aviculare* G.Forst. var. aviculare (1786), *Solanum laciniatum* Aiton (1789); poroporo, raupeti	coastal and lowland forest and shrubland	2	2	2	2	2	32
Solanaceae	*Solanum tuberosum* L.; riwai māori	cultivated	1	1	5	2	2	40
Typhaceae	*Typha orientalis* C.Presl (1852) [1851]; raupo	coastal to lowland fertile wetlands	1	1	1	1	2	4
Verbenaceae	*Vitex lucens* Kirk (1897); pūriri	coastal, lowland, submontane and montane forest	1	2	2	1	2	12
Violaceae	*Melicytus ramiflorus* J.R.Forst. & G.Forst. (1776); mahoe	lowland, submontane and montane forest	1	1	2	1	2	8

[a]*Threat status: no symbol, unranked; *, gradual decline; †, serious decline; ‡, endangered.*
[b]*Calculation of index of cultural significance (ICS) score follows the method of Silva and Andrade (2006).*

Table 2. Concerns related to plant harvesting recorded in interviews with indigenous Māori elders.

Issue identified	*Species discussed*	*Other comments*
Contamination	*Nasturtium officinale* (watercress); *Sonchus* spp., including *S onchus asper* (puha); *Pomaderris kumerabo* (kumarahou)	Elders expressed concern about contamination of food plants such as puha and watercress, and several have now stopped harvesting from natural sites unless they can be sure the plants were uncontaminated by runoff from cows, sprays, and other substances.
Hybridization	*Hebe stricta* (koromiko); *Phormium tenax* (harakeke)	Some of the nursery varieties may lack the qualities valued in individuals in natural areas—a particular problem for medicinal plant users in urban areas.
Felling management guidelines and procedures	*Podocarpus totara* (tōtara); *Agathis australis* (kauri); *Dacrycarpus dacrydioides* (kahikatea); *Phyllocladus trichomanoides* (tānekaha)	There is a lack of available trees for timber. Elders perceived that administrators prevent windfall trees from being used.
Incorrect harvesting procedures	*Pomaderris kumerabo* (kumarahou)	Appropriate harvesting allows continued plant growth, but not all plant harvesters are aware of proper techniques.
Ecological fragmentation, inadequate habitat	*Pomaderris kumerabo* (kumarahou); bird–tree interactions, e.g., *Hemiphaga novaeseelandiae novaeseelandiae* (kererū) and *Dacrycarpus dacrydioides* (kahikatea)	Participants observed how some plant species grow best together and in particular habitats; others noted declining bird use of forest fragments as these became more isolated over time.

(*Freycinetia banksii* var. *baueraniana*). Only one additional permitted species appeared from 1996 through 1999. Thus, overall only nine species were harvested for cultural purposes by permit holders, with kiekie being the species for which the most permits were issued ($n = 23$; Fig. 2). No permits were issued for individual medicinal use. Regression results indicated no relationship between ICS scores, as a proxy for cultural significance, and permit frequency during 1996–2006. Although permits showed seasonal trends, with most weaving permits issued in summer and autumn, this trend was not evaluated statistically because so few permits were issued ($n = 23$ total for kiekie harvesting from 1996 to 2005).

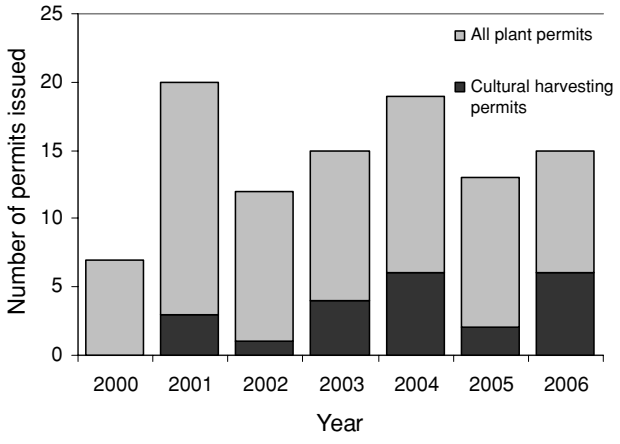

Figure 1. Number of permits issued in the Waikato Conservancy, New Zealand, for 2000– June 2006, for all plant material such as seeds and leaves, but excluding peat cores and animal material. One undated permit (for the cultural harvesting of kiekie) is not included. Two permits allowed for harvesting of more than one species. Permits issued 1996–1999 are not included as records because this period did not include plant material permits other than for cultural harvesting.

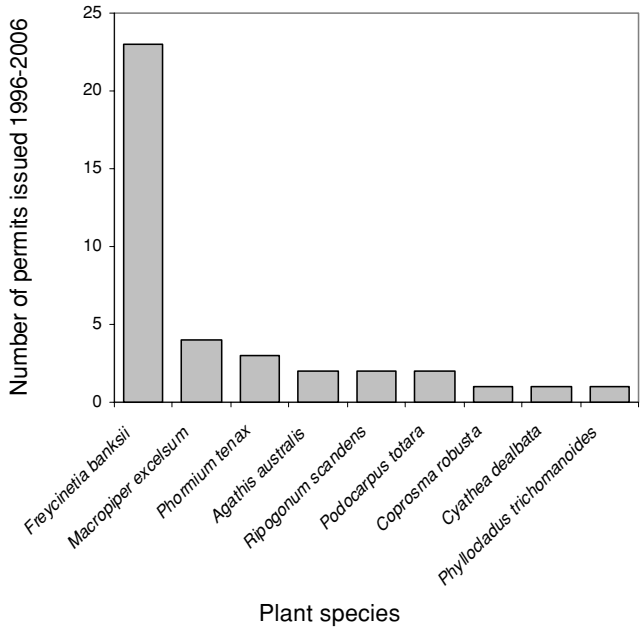

Figure 2. Number of cultural harvesting permits, categorized by species, issued by the Waikato Conservancy (excluding the southern Maniapoto Office) January 1996– June 2006.

Discussion

This study is the first that we know to identify plant species harvested by indigenous peoples within a first-world fragmented landscape and to consider this relative to both administrative procedures that restrict harvest and opportunities available to support cultural traditions. There are no contemporary data within New Zealand that address plant harvesting patterns, and to rely on historical accounts that were constructed within an essentially different landscape and society is inadequate. For example, *Phormium tenax* harvesting and management techniques have evolved with changing requirements and conditions (Wehi 2006, 2009; Wehi & Clarkson 2007). Future research needs to address harvesting needs within urban and changing landscapes. For urban dwellers, there are three likely scenarios that will allow individuals to continue practicing traditional plant harvesting: harvesters use urban resources (including resources they may create in their own or communal gardens); harvesters use resources from remaining traditional lands, although these are scarce; and harvesters apply for permits to harvest in national parks.

Our comparison of reported harvesting sites and permit data suggests that permits are not widely used to fulfill harvesting needs, with individuals currently using resources in the city and from other public areas such as roadsides, while also returning to remaining ancestral lands where possible. This suggests that urban site planning in association with local indigenous peoples may be vitally important to support future harvesting aspirations and the maintenance of cultural values and identity for urban migrants.

Despite the small size of this study, we consider that the expertise of the selected elders offered a good representation of harvesting knowledge within this region. The number of plants currently harvested by these elders may seem low in comparison with numbers in relatively intact tropical regions (e.g., in Brazil 372 species mentioned in 54 interviews across three communities [Silva & Andrade 2006]), but we suspect it is representative of temperate regions where harvesting patterns have been strongly influenced by forces such as colonization and ecosystem fragmentation.

Plant species identified in the permit data were all identified in interviews as culturally significant, which suggests a high degree of concordance between the two data sets. Nevertheless, there were many species identified by elders as culturally important that did not appear in the permit data, indicating that permit data cannot be used as a proxy to establish the cultural significance of plant species. Plant species used for medicinal purposes rarely appeared in the permit data, which infers that for this use (which generally requires small amounts of plant material) local, easily accessible plant populations may be preferred. There is regular use of plants from public sites, including roadsides, and plantings at colleges and universities within the city. Public sites thus have an important amenity value to native harvesters and supply plant species for a range of uses. In 1998 Moerman (Palmer 2004) hypothesized that plants traditionally used for medicine are those that are available, perennial, and widespread geographically, as well as easily noticed, large, and distinctive. Unpermitted harvesting from conservation lands has been reported as occurring regularly in one region of the Waikato district, mainly for food species such as pikopiko (*Asplenium bulbiferum*) and tī (*Cordyline australis*). Both these species were identified in interviews with elders, but were not reported as regularly harvested by most.

From both the interview and permit data, it is clear that native harvesters have difficulty accessing some species; weaving plants were especially prevalent in this category. Some of these species are difficult to propagate (e.g., kiekie, a forest liane), grow best in undisturbed environments, have low numbers of old-growth individuals, or are sparse because they are at the limits of their range. Kauri (*Agathis australis*) populations have been reduced by logging so that most remaining kauri have trunk diameters of <1 m (Burns & Smale 2002); hence, they are generally unsuitable for traditional purposes. No endangered plants are currently in high demand.

Elders in our interviews rarely discussed a number of native species highlighted in historical documents, which suggests that plant harvesting patterns have changed over the last century. For example, para (*Marattia salicina*) was previously a Māori delicacy (Cheeseman 1879) that now appears to be minimally harvested, if at all. Only one elder discussed this fern in relation to traditional foods and reported that he did not collect it. Other changes in harvesting patterns can be regarded as innovative. For example, watercress (*Nasturtium officinale*) was deliberately introduced to New Zealand in the 1840s. It became abundant in the Waikato (Clayton 2002) and replaced other native species as a staple food. This plant now has a long history of use by Māori. Similar substitutions of alien species for native plants has been recorded elsewhere, such as in Hawaiian traditional medicine, and illustrate how traditional harvesting can adapt to a changing biological and cultural environment (Palmer 2004). The loss of watercress harvesting sites because of contaminants therefore may affect many individuals.

Regulation of plant harvesting situations worldwide is variable on conservation or government-administered lands. Thus, contexts range from those where people depend heavily on harvesting in forested areas (e.g., Sri Lanka [Wickramasinghe 1997], India [Agrawal 2005]) to situations where extraction is not permitted, despite the reliance of locals on plant species (e.g., Karanth et al. 2008). Elsewhere, important plant harvesting sites may be retained within traditional territories (e.g., Canada: Trusler & Johnson 2008, Himalayas; Ghimire et al. 2004,

2005). There is, however, considerable concern worldwide that indigenous harvesting rights, as well as spiritual connections to traditional territories, not be unnecessarily disturbed (Brosius 2004). Within New Zealand, decimation of traditional harvesting sites because of ecosystem change suggests that creative solutions are needed. Evidence attests that transparent decision making that embraces a diversity of knowledge and values is best positioned to address complex environmental problems, such as harvesting in these situations (Reed 2008). Solutions to such complex problems include co-management with local user groups and indigenous peoples to produce flexible, multilevel governance systems (Berkes & Turner 2006). This approach is slowly being developed within New Zealand government agencies that administer conservation lands (e.g., Brandon & Collins 2004), although there is a continuing debate about the underlying politics and extent of this approach (Coombes & Hill 2005; Coombes 2007).

Currently, many public areas are not managed for cultural use. Yet there are many opportunities for planners to restore sites with input from indigenous peoples, such as in cities. An ecological stewardship approach increases the effectiveness of monitoring and assessment protocols and the conservation of urban biodiversity and has other positive spinoffs (Berkes 2004; Colding et al. 2006; Ballard et al. 2008). For example, widespread participation in self-regulation has occurred in Kumaon, India, because of a perception of scarcity and resulted in increased environmental action by local communities (Agrawal 2005). Innovative strategies may also prove important, such as the creation of urban insurance populations for species at risk from biological invasion, habitat loss, or overharvesting elsewhere in their range.

Although the number of plant harvesters in New Zealand is currently small, we expect the number to increase as part of a wider cultural revival. For example, the number of regular community and college courses on traditional plant use and the publication of popular books on traditional plant uses (e.g., Riley 1994) continues to climb. In addition, there are increasing numbers of nonindigenous people in New Zealand who are harvesting native plants for traditional processes such as weaving or medicine preparation, and they may have limited access to traditional harvesting grounds. Systematic recognition of harvesting needs through adaptive co-management would assist maintenance of cultural traditions and identity and may reduce pressure on plant populations on conservation-administered land.

The issues of access to, and management of, culturally important plants highlight the need for research on their distribution and ecology. These type of data are likely to become increasingly important as indigenous cultural traditions are revived. The data presented here also emphasize the role government agencies and local governments can play in enhancing access to plants by developing innovative solutions to their scarcity, such as restoration of urban sites that cater to cultural harvesting needs. We suggest that identification of, and discussion centered on, traditional plants that are in frequent contemporary use can lead to positive collaborations between government agencies and indigenous peoples and, in conjunction with an adaptive co-management approach, can create positive outcomes that support both cultural and conservation goals.

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