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# Incorporating Biocultural Approaches in Forest Management: Insights from a Case Study of Indigenous Plant Stewardship in Maine, USA and New Brunswick, Canada

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## ABSTRACT

Biocultural approaches promote consideration of diverse values and cultural practices into resource management. However, cultural inclusion in North American forest management is limited. Drawing on a case study of Wolastoqiyik and Mi'kmaq communities in Maine, USA and New Brunswick, Canada, we examine the practice of plant gathering, including associated values and cultural norms. Through interviews and participant observation, we find that gatherers value and care for plants and habitats that are not priorities for forest managers. Gatherers do not describe their actions in terms of management, with its connotations of dominance and control. Rather, they are guided by community-driven values and responsibilities. Our analysis suggests that their plant gathering activities align with a stewardship paradigm, which may be one useful way to characterize, legitimize and communicate approaches to caring for forests. We offer five suggestions for managers wishing to use biocultural approaches.

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Culturally significant plants; forest stewardship; Indigenous knowledge; Mi'kmaq; Wolastoqiyik

## Introduction

In the United States and Canada, forest management institutions must simultaneously maintain productivity and ecological health while also providing a suite of social benefits to various forest users (Neugarten et al. 2011). Among these priorities, however, cultural inclusion is often underdeveloped (Schelhas 2002). Specifically, Indigenous peoples, who have diverse relationships and values with forests are underrepresented in management processes and outcomes (Nenko, Parkins, and Reed 2019). Their forest stewardship systems are rich and complex, contributing to cultural continuity and offering important insights to other forest management approaches (Anderson 2005; Deur and Turner 2005; Waller and Reo 2018). However, ongoing processes of colonization have systematically displaced many Indigenous peoples from their lands and excluded them from processes by which those lands are managed (Lake et al. 2018).

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To address these dynamics, forest management institutions in both countries have developed approaches to include Indigenous priorities, knowledge, and perspectives (Booth and Skelton 2011; Beaudoin, Bouthillier, and Chiasson 2015; Dockry and Hoagland 2017; Emery et al. 2014; Lake et al. 2017). More broadly, federal trust responsibilities mandate nation-to-nation consultations for public forest management projects that may impact Indigenous rights (Beaudoin, Bouthillier, and Chiasson 2015, USDA Forest Service 2019). Additionally, consultation is required for certain private forest certification programs. Yet, meaningful application of such practices is uneven. Knowledge may be taken out of context or used to corroborate western scientific findings without benefit to Indigenous communities (Houde 2007; Reo et al. 2017). Species of interest to Indigenous peoples are not management priorities (Chamberlain, Emery, and Patel-Weynand 2018). While many of their actions are intended to promote the health of plants, animals and ecosystems they value (e.g. Turner and Berkes 2006), the inputs of Indigenous community members often go unrecognized because they are not carried out by professional “experts” (Berkes, Colding, and Folke 2000). Furthermore, Wyatt et al. (2013) note current consultation mechanisms employed by public and private forest institutions are not substantial enough to address Indigenous needs.

Biocultural approaches offer a framework to include Indigenous concerns, knowledge, and values in management processes (Ens et al. 2016). Biocultural approaches are an emergent area of study that conceptualize interrelationships between cultures and the environment. The term “bioculture” emphasizes “tightly intertwined and co-evolving social-ecological systems, cultural dimensions and implications in such systems” (Merçon et al. 2019, 2). It suggests that cultural diversity contributes myriad knowledge systems, stewardship practices, governance processes and innovations beneficial for environmental sustainability (Barthel, Crumley, and Svedin 2013). Biocultural approaches can be beneficial for conservation and resource management objectives, as well as cultural resilience (Gavin et al. 2015).

With this paper, we ask how biocultural approaches might be operationalized to provide effective outcomes for Indigenous peoples in a particular socioecological context who value, care for, and utilize plants from forested landscapes. Specifically, we argue that biocultural approaches can inform forest management by centering Indigenous values, practices, and knowledge. We report on an investigation and analysis of medicinal plant use by Indigenous communities in northern Maine USA and western New Brunswick Canada. Using ethnographic methods, we (1) characterize plant use and gathering practices; and (2) convey gatherers’ cultural values and norms related to plant use. We draw on our results to offer insights for public agencies and private forest operators, who have expressed interest in incorporating Indigenous priorities and knowledge into their management strategies (see, for example, Federal Register 2016; Irving Land Management personal communication 2011; USDA Forest Service 2019). Finally, we suggest explicit attention to biocultural approaches can create more inclusive and accurate basis for forest management and stewardship.

### ***Biocultural Approaches***

Biocultural approaches emerged two decades ago, in response to tandem crises of globally declining biodiversity and cultural diversity (Brosius and Hitchner 2010). The first

of these approaches was biocultural diversity. It recognized a growing deprioritization of cultural relationships with the environment, particularly contributions of Indigenous peoples to stewardship. Biocultural diversity proposes that Earth's biological diversity is inextricably linked to its cultural diversity (Maffi 2005). While recognizing that not all human activities are beneficial for life on Earth, this approach proposes multifarious relationships exist around the globe, many of which have resulted in the biodiversity we value and seek to conserve today. Early efforts often demonstrated a positive correlation between biological and cultural diversity by documenting their spatial co-occurrence (Loh and Harmon 2005).

Biocultural approaches have since multiplied, generating additional, interrelated areas of inquiry including biocultural “heritage,” “knowledge,” “cultural landscapes,” “ethics,” and “restoration” (Hanspach et al. 2020). This scholarship has identified factors key to the co-production and maintenance of biocultural relations, including: conservation of diverse knowledge systems and resource management practices; maintenance of Indigenous land tenure and governance structures; and context-specific, adaptive interventions, including opportunities for co-management (Gavin et al. 2015; Merçon et al. 2019). These recent approaches continue to value conservation of both cultural and biological diversity *in situ* as just (Ens et al. 2016) and offer models or options for future sustainability (Barthel, Crumley, and Svedin 2013, Merçon et al. 2019).

Many biocultural approaches share an emphasis on understanding cultural values, knowledge, and practices related to biodiversity (Hanspach et al. 2020). Examples of the importance of including such biocultural perspectives are evident in a range of resource management and policy settings including ecosystem management (Ens et al. 2015), fisheries management (Stephenson, Berkes, and Turner 2014), urban planning (Elands et al. 2019), and international conservation policy (Tengö et al. 2017). Relatedly, a well-established literature has documented knowledge and actions of Indigenous and other local peoples who have co-evolved, interacted with, and in some cases significantly shaped landscapes for thousands of years. These include deliberate landscape modification and tending of species guided by cosmologies, societal norms, and values (e.g. Anderson 2005; Deur and Turner 2005; Lariviere and Crawford 2013). Such cultural systems directly and indirectly promote land uses with distinct species assemblages, (e.g. Oberndorfer et al. 2020). Cultural values may further guide decisions about land care and use, which are evident on the landscape. For example, Menominee and Ojibwe tribal forestlands in Wisconsin contain older age classes, different resources, and suites of biodiversity than surrounding public and private forestlands (Waller and Reo 2018).

Recently, policymakers have employed biocultural approaches to create scalable policy frameworks that consider human and ecological wellbeing to be interrelated, rather than oppositional (Caillon et al. 2017). These approaches also support social equity in natural resource management by stressing the importance of Indigenous knowledge, resource stewardship, and participation in conservation actions (Ens et al. 2016). Our paper employs biocultural approaches to study how Indigenous values and practices may be mobilized toward equitable forest management. It is part of a larger study focused on medicinal plant use, Indigenous knowledge, and health sovereignty. We examine types of plants gathered, spaces of gathering, practices employed to care for plants, and values

undergirding these actions. We also explore how gathering permits might be received by community members.

## Methods

### *Study Context*

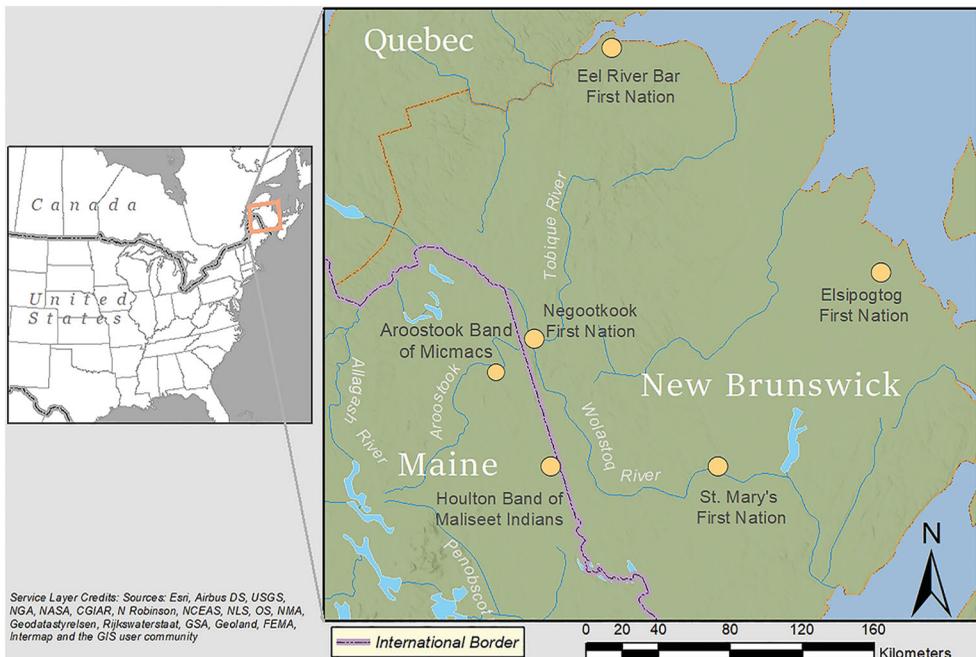
Our work engaged Wolastoqiyik (Maliseet) and Mi'kmaq communities of Aroostook County, Maine and western New Brunswick. Wolastoqiyiks and Mi'kmaqs, along with the Peskotomuhkati (Passamaquoddy), and Penawahpskewi (Penobscot) comprise the principal Nations of the Wabanaki Confederacy, a political alliance of closely related Eastern Algonquian Tribes (Pawling 2007). Wolastoqiyik and Mi'kmaq homelands span the Canadian Maritimes, the Gaspé Peninsula, and northern Maine. Their lands included a diversity of habitats, giving inhabitants access to inland forests, rivers, and coastal areas for hunting, fishing, and gathering opportunities. Wolastoqiyik peoples closely identify with the Wolastoq River. Both Mi'kmaq and Wolastoqiyik peoples engaged a seasonal round of travel to support cultural, physical, and spiritual needs (Speck 1915; Prins 1996).

Mi'kmaq and Wolastoqiyik communities were among the first to encounter Europeans in the 1600s. In subsequent processes of colonization, their experiences included disease epidemics, stolen land, and forced sedentarization, which altered life-ways and access to traditional foods and medicines. In the 1800s and 1900s, while some communities maintained strong fishing traditions, participation in agricultural labor became common, as did selling traditional crafts to burgeoning tourist markets. Assimilation politics and cultural repression, including boarding schools, discouraged transmission of Wabanaki languages and embedded knowledge, including plant relations (Bear Nicholas 2011; Prins 1996).

Wabanakis have maintained relations with plants as acts of resilience and resistance to these socioecological transformations (Greenlaw 2020). Within Wolastoqiyik and Mi'kmaq communities, historic relations with at least 130 species of plants and fungi for food, medicine, spiritual purposes and livelihoods have been documented (Arnason, Hebda, and Johns 1981 ; Moerman 1998). Gathering of plants and fungi continues to be an integral aspect of cultural expression and connectivity (Baumflek, Emery, and Ginger 2010). For example, Greenlaw highlights ash basketmaking as a livelihood resilience strategy that has emerged into a high artform while providing critical access points to Indigenous knowledge.

Our study area (Figure 1) is situated in a species-rich transition zone between coniferous spruce-fir and northern hardwood forest types. Forests cover a majority of the area and are therefore our main focus for management considerations. However, the forested landscape matrix contains diverse habitats including wetlands and old fields that are also given consideration here. The Maine Natural Areas Program (2013) recognizes 19 different natural communities regionally. Each natural community has an associated herbaceous layer, which is important to plant gatherers. Major land uses comprise industrial forestry and cold crop agriculture.

Tribal land base and forest ownership differ across the international border. Communities in New Brunswick have been situated on tribal reserves since 1790 (Pawling 2007), whereas Wolastoqiyik and Mi'kmaq communities in Maine have never lived on reservations. New Brunswick has 44,072 acres of reserve lands, approximately



**Figure 1.** Project study area, Mi'kmaq and Wolastoqiyik homelands in northern Maine, USA and western New Brunswick, Canada, with locations of participant's communities.

0.25% of the province. Reserve size varies from 69 to 10,887 acres (Government of New Brunswick 2019). In contrast, Wolastoqiyik and Mi'kmaq land holdings in Maine are 1,443.5 and 1,343 acres, respectively, 0.05% of Aroostook County alone. While Maine forests cover approximately 90% of the state, less than 5% is publicly owned (Ginger et al. 2012). Some 83% of the province of New Brunswick is forested, with 50% of that being public Crown Lands (Government of New Brunswick 2018). First Nations of New Brunswick can gather plants on Crown lands, including provincial parks. Noncommercial plant gathering on public lands is open to all Maine state residents (both Indigenous and non-Indigenous); permits are required to harvest certain species such as brown ash (*Fraxinus nigra*). However, gathering in state parks is prohibited, and highly limited in federally-operated Acadia National Park. Our study began as Acadia National Park, and industrial forest managers with Sustainable Forestry Initiative certification such as Irving Corporation, were considering mechanisms for Indigenous gathering, including permitting systems. These processes are slowly emerging now. Gathering on private lands is subject to varied arrangements, formal and informal, and in some instances occurs without any explicit arrangements. For some Indigenous communities in our study area, particularly New Brunswick, where forest governance does not provide mechanisms for full participation and realization of benefits, relations with the forest products industry remain strained (Wyatt, Kessels, and van Laerhoven 2015).

### **Data Collection and Analysis**

We collected data from 2010 to 2014 through semi-structured interviews, small group interviews, participant observation and archival research. Prior to beginning our study, we

appeared before the tribal councils of the Houlton Band of Maliseets and Aroostook Band of Micmacs, and gained permission to work in their communities. We then formed research agreements specific to each tribe. We also engaged two community researchers in our study team. Evaluated by the Cornell University Institutional Review Board, the project received exemption (protocol number 1008001595). The first author conducted the interviews, always accompanied by at least one community researcher, who helped ask questions and facilitate conversation. Prior to commencing an interview, we explained the purpose of our work, and participants gave written or oral consent to proceed. Upon interview completion, participants chose either to associate their name with the information they provided or to remain anonymous. We assigned a code to each interviewee, allowing their contributions to be identified while maintaining confidentiality.

We selected interviewees (26) through purposive snowball sampling methods, based on knowledge of plant gathering, and structured to ensure balanced gender and tribal representation. We determined the number of interviewees based on availability and our goal to attain a representative range of gatherer perspectives. Recognizing that the diversity within Indigenous knowledge systems makes full data saturation unrealistic, we stopped new interviews when information shared about gathering norms and values, and types of plants had plateaued. Participant ages ranged from 33 to over 80. They came from three Wolastoqiyik and three Mi'kmaq communities respectively: Houlton Band of Maliseets, Negootkook First Nation, St. Mary's First Nation, Aroostook Band of Micmacs, Eel River Bar First Nation, and Elsipogtog First Nation (Figure 1). We also interviewed two tribal natural resource personnel and one industrial forest manager.

Interviews ranged from 30 minutes to over three hours. Multiple interviews and repeated informal interactions enriched participants' contributions. Upon completing our initial set of interviews and preliminary data analysis, we conducted member checking, a process that seeks feedback from participants by sharing data and analyses and ascertains that their views are properly represented. Two participants were exceptions, one who passed away, and another who was in mourning. Interview questions focused on multiple aspects of plant gathering (SOM 1). Information we collected is not an exhaustive catalog of plant uses by these communities, but rather, represents the medicinal plants our interviewees currently value. We asked participants to describe their relations with these plants: their importance; and techniques used to gather them. We collected general information about use but did not ask interviewees to share specific preparation methods of plants. We also asked questions related to values, norms and preferences around plant gathering, including how interviewees would like to be involved in planning or management processes related to plants of importance.

During participant observations the first author accompanied gatherers to collect plants at least 18 times, and attended over 17 community functions including powwows, ceremonies, seasonal feasts and meetings. Our archival research focused on the extent of previously recorded Wolastoqiyik and Mi'kmaq plant use and established that few plant stewardship activities had been previously documented.

We analyzed interview data and field notes using NVIVO qualitative software (QSR 2013). Our iterative coding structure allowed us to examine a priori themes, and develop new codes and themes emerging from the data, including discrepant information (Boyatzis 1998). The first and second authors developed a preliminary codebook;

the first author conducted all coding (four rounds). A priori themes included norms and values related to plant use, plant gathering habitat, and traditional knowledge.

## Results

### *Plants, Plant Parts and Spaces for Gathering*

Interviewees discussed at least 54 taxa: 42 species and ten genera of plants, and two species of fungi they currently gather. The majority are herbaceous perennials; material from at least nine trees and ten shrubs are also gathered. None of these taxa are classified as threatened or endangered within our study area (SOM 2). Many are considered common, defined as locally abundant and capable of occupying a variety of habitats (Rabinowitz, Cairns, and Dillon 1986). Among these are seven introduced plants. Plant parts gathered include leaves, fruit, and rhizomes (SOM 3).

Gathering occurred in diverse habitats across the study area landscape (Table 1). While at least 19 plants and fungi are found in typical northern hardwood forest communities, a similar number can be found in what may be considered more marginal environments: roadsides and forest-field edges. Wetlands, both open and forested, are also significant sources of plants (19 total).

Gathering activities took place on personal, tribal, public, and privately-owned land. Gatherers living in New Brunswick often accessed plants on reserve lands; interviewees from Negootkook First Nation also mentioned group trips to a Provincial Park to collect certain plants. Important gathering locations in Maine included privately-owned but accessible land. Some gatherers communicated with landowners. Others described accessing plants from fields, roadsides, and riverbanks where land ownership was not determined. Some gatherers described losses of plant collection sites. For instance, one interviewee related the bulldozing of a field where she gathered sweetgrass (Wolastoqiyik: *welimahaskil*, Mi'kmaq: *kjimiskiku*, Latin: *Anthoxanthum nitens*), suggesting the landowner likely had no idea what they were destroying (Interview 0301).

### *Values Related to Plant Gathering*

Interviewees discussed a suite of values describing their relations and responsibilities with plants they gather, environments they visit, their community members, and the Creator. Data analysis revealed five broad categories of interrelated values. These recurring themes are discussed below, and listed in Table 2, accompanied by representative quotations.

**Table 1.** Number of reported plant taxa found in seven habitat types by growth form. The same species/genus may appear in multiple habitats.

	Herbaceous	Shrub/Subshrub	Tree	Fungi	Total
Northern hardwood forest	9	3	7	2	19
Forest edges	12	5	1	0	18
Dry areas/roadsides	9	8	1	0	18
Open wetlands	9	3	1	0	13
Old fields	6	5	1	0	12
Spruce-fir forest	4	1	6	1	12
Forested wetlands	5	0	2	0	7

**Table 2.** Mi'kmaq and Wolastoqiyik values related to plant gathering, exemplified by quotations from project participants and number of interviewees reporting.

Value	Representative quotation	Interviewees
Respect	If any of my brothers broke a branch off a tree, my grandmother would make them go and apologize to the tree, because you can't do that. How would you like it if somebody broke your arm? So we always were taught respect ... we had to take the earth, and touch it. My grandmother would always say <i>woliwon</i> for the <i>micuwakon</i> . Thank you for the food. So, we always had that respect for what we were using. (Interview 1302)	20
Reciprocity/Connections	It's not just the people that's going to be affected [by environmental degradation], it's every living thing here on earth, and she's alive, our Mother is alive, but she's hurting. So if she hurts, we hurt. The animals hurt, the plants hurt, everything hurts. (Interview 1202)	18
Thank the creator	You thank the Creator for the plants and everything from Mother Earth, and when I gather medicine, I say prayers for a certain person, prayers for that medicine to help them out. There's a connection ... I don't know how you can separate the two of them. You shouldn't, anyway. (Interview 1601)	17
Sharing	When we collected <i>kighaswes</i> last year, we wanted a little bit for us, but you always collect extra, right, so you can give it away. (Interview 1801)	20
Caring for Plants: take what you need	We don't pick any more than we really need. We always leave some behind, ... if there is an overabundance of medicine one year, then we don't bother going back the next year because we're just going to be going after something that we don't need anyway, so why not leave it right there until we do need it? (Interview 0105)	15

### ***Respect, Reciprocity and Connections to the Creator***

We describe these themes together because they were intertwined in interviews. Important qualities of gathering practices clearly emerged in our analysis, including how often they are rooted in concepts of respect, reciprocity, and interconnectedness. Many people we interviewed felt that plants are profound gifts from the Creator, and thus must be treated properly. The Wolastoqiyik phrase *T'an key utomonen* represents this. Meaning, "we must take care of plants", the phrase conveys people's responsibility to give care, and that, in return, plants will continue to care for people, by offering medicine. It is through these actions that gatherers recognize the life of the plant, and make a direct connection with the Creator:

It's not just the [blackberry] bush you are talking to, know what I mean? It's the Creator. (Interview 1601)

Gatherers also discussed the need "to be in the state of mind to pick medicines" (Interview 1701). A clear head and positive attitude are important to show respect for the plant being harvested, and to the people the medicines are intended for, based on beliefs that one's attitude affects the beneficial quality of the medicines.

### ***Sharing***

Twenty gatherers described sharing gathered plants. This is common within and across Wolastoqiyik and Mi'kmaq communities. Not everyone who uses these plants gathers

**Table 3.** Plant tending practices implemented by Wolastoqiyik and Mi'kmaq plant gatherers, with associated actions, examples, and number of interviewees reporting.

Tending strategy	Actions	Representative plants	Interviewees
Giving thanks	Prior to picking a plant or fungi, gatherers will say a prayer, offer tobacco or a song as a means of thanking the plant, and the Creator.	Implemented for all species	21
Leave some behind	Gatherers stressed the importance of never taking all the plants in a specific location to keep populations healthy and to leave some for other beings.	Most species	20
Pruning/coppicing	Selective cutting of branches and stems encourages vigorous vegetative regrowth, and in some case the promotion of fruit production.	Red willow (nepskihkamq, wjkulje'manaqsi, <i>Cornus sericea</i> ), high-bush cranberry (ipiminol, nipanmaqsi'l, <i>Viburnum opulus</i> ) and raspberry (minsosok, klitaq, <i>Rubus sp.</i> ).	5
Replanting roots and rhizomes:	After harvesting the below-ground parts of certain plants, gatherers will replant small rootlets and tubers to allow them to regenerate in coming years.	Muskkrat root (kiwhosuwask, kighaswes, <i>Acorus sp.</i> ) and goldthread (wisawkeskil, wisawtaqji'jkl, <i>Coptis trifolia</i> ).	11
Rotation of gathering sites	Gatherers will not return to the same site for a specific interval of time that is species dependent (weeks, months, up to several years), to allow plants to regenerate.	Most species	16
Scattering/sowing of seed	Gatherers report scattering the seeds of species prior to gathering, to encourage new plant growth.	Sweetgrass (welimahaskil, kjimskiku, <i>Anthoxanthum nitens</i> ), cow parsnip (paqolus, pako'si, <i>Heracleum maximum</i> ) and mullein (sahtiyil, pkumanaqsi, <i>Verbascum thapsus</i> )	8
Transplanting species	Gatherers will actively transplant species they utilize, placing them in locations that are more convenient to their homes.	High-bush cranberry, muskrat root and blueberries (sahtiyil, pkumanaqsi, <i>Vaccinium sp.</i> )	3

Plant names presented in the following order: common name (Wolastoqiyik, Mi'kmaq, Latin).

them; more often a few people will collect plants for many people's use. Gatherers discussed sharing plants with their families, emphasizing the importance of bringing plants to elders who greatly appreciate, but may not be able to collect, plants due to physical limitations. Additionally, gatherers share with each other to obtain plants they themselves do not collect.

### Caring for Plants

Caring for plants is a value that manifests through actions. Gatherers discussed ideas of care, and fifteen specified taking only what you need. All 23 gatherers described a suite of actions they implement to care for plants and fungi to ensure they will be available for future generations (Table 3). These were reiterated during interviews and demonstrated during plant gathering trips and ceremonies. The most prevalent form of care is

the practice of offering thanks to plants before harvesting them, including giving tobacco, prayer, or song. While some actions, including giving thanks and rotation of harvest sites are practiced with many different types of plants, other actions were specific, based on an understanding of that plant's biology. For instance, gatherers who harvest the roots of certain plants will wait to do so until seeds mature and can be scattered. Tending actions mainly focused on caring for individual plants, or plant populations.

Gatherers often implement several tending strategies simultaneously. For example, this quotation describes both leaving some behind and replanting roots:

A lot of times when I harvest some of my medicines, I'm supposed to pick the root and all, I'll take every other plant, I'll never take them all at once, ... and that way I get the good medicine, and the medicine will also be there next year. And a lot of times I'll take them [plants with rootlets] and go further away and shake out that root dirt. And, a lot of times, that will start growing again when you do that. (Interview 2201).

### ***Norms Related to Management and Permitting***

Interviews included commentary about cultural norms related to two important dimensions of forest management practice: use of the word "management"; and permitting to regulate use.

#### ***Avoiding the Language of "management"***

Gatherers we interviewed did not describe their interactions with plants nor their beliefs in terms of management, but rather care and kinship. Tribal natural resource personnel chose not to use the term "management" in species guidelines we co-developed for community use, feeling it inappropriately characterized tribal members' actions. Moreover, in describing relations with plants, one plant gatherer and community spiritual leader commented:

How to keep respect going for our ways...It's a different relationship [than management]...you need open-minded people [resource managers] on the other side. (Interview 1002)

Her response not only distinguishes her cultural practices from management, but also stresses the need for cultural sensitivity among forest managers, so that they might understand her beliefs and actions.

Additionally, gatherers expressed different ideas from forest managers about how harvested plants are measured. Harvest volume is a well-established metric forest managers rely on to inventory and monitor plants, understand intensity of plant harvests, and set management goals (McLain and Jones 2005). However, when we asked gatherers about how much they harvest, a typical sentiment was "I take what I need". One interviewee noted setting limits was unrealistic:

The way that [setting limits] operates is not real life ... people will come get what they need when they need it and putting hard numbers on that is not useful ... things would need to be more free-flowing than that ... (Interview 0901)

However, another interviewee noted established plant gatherers have their own systems to ensure sustainability, based on extensive ethnobotanical knowledge and cultural norms that promote limits:

A true medicine gatherer will not go in and destroy medicines because we know what to pick, what not to pick, how much to pick, and when to pick it... We pretty much self-regulate ourselves without even realizing, we don't grab what we don't need. If you don't need it, don't take it. (Interview 0109)

### **Permitting**

Gatherers we interviewed generally did not oppose the idea of implementing permit systems for plant gathering on private or federally-owned lands. What is significant is they stressed the importance of including community input into that process, including deciding who should be allowed to gather certain plants. This is tied to cultural norms related to spirituality, merit of an individual to be able to gather plants, and a view of plants as cared-for relations. Many gatherers we interviewed believe that, as a reinforcement of respectful relationships, community members under the influence of drugs or alcohol should not be allowed to gather medicines. Recognizing that plant knowledge is specialized, interviewees additionally stressed that only those with the proper skills and knowledge should be given permits:

A lot of [community members] know who the medicine people are and aren't. What they should do is let the elders, like ourselves, medicine people, go in and have a couple of people come in there and do certain medicine picking. Don't have a bunch of people come in there because they'd ruin it for everybody... if you have a bunch of people who don't know what's going on they'll demolish what we really need for ourselves. That's what I think we should do. (Interview 2201)

## **Discussion: Implications for Including Biocultural Considerations in Forest Management Practices**

Our results demonstrate Wolastoqiyik and Mi'kmaq gatherers maintain distinctive relations with plants and fungi important to them. These relationships offer guideposts for incorporating biocultural interactions into forest management. We synthesize and interpret our results in five subcategories, below.

### ***Herbaceous, Shrubby and Common Species***

A majority of medicinal plants Wolastoqiyik and Mi'kmaq community members gather are herbaceous or shrubby species. Interviewees value, and care for, common plants. The fact many of these plants are common may promote their sustained use (Thomas et al. 2009). As one interviewee expressed it: "You can't pick the rare [plants], cause they'd be extinct. You have to pick the common ones" (Interview 1601).

These findings, which echo results from research conducted with Indigenous communities elsewhere in North America (Lake et al. 2018), contrast with prevailing forest management practices. For example, interviews with industrial forest managers in northern Maine and western New Brunswick revealed their primary focus was wood

production for pulp and timber (Ginger et al. 2012). None incorporated herbaceous or shrubby species. As ecological integrity becomes an increasingly important concern for many forest managers, studies have explored the effects of timber management treatments on herbaceous understories in an effort to maintain biological diversity and ecological functions (e.g. Smith et al. 2008). Nevertheless, herbaceous species are not typically the primary focus of management efforts (Chamberlain, Emery, and Patel-Weynand 2018). When priorities for management or plant conservation efforts are set, plants without a pressing legal status, such as endangered or threatened, are unlikely to be identified as taxa of concern. Some introduced species gatherers find important, such as coltsfoot (*Tussilago farfara*), are the target of eradication programs.

This suggests incorporating Wolastoqiyik and Mi'kmaq cultural preferences into forest management will require directly considering understory plants. Further, a species' commonness does not preclude it from meriting attention. Common plants may become less abundant if their habitats shift. In our study area, as retired agricultural fields transition to forests, important gathering locations may be lost. Regionally, insect and pathogen outbreaks can quickly damage species. For example, the emerald ash borer has killed a majority of once-common ash trees (Herms and McCullough 2014). Climate change impacts are also predicted to reduce habitat for spruce-fir forests, and some northern hardwood species, including sugar maple (Wolastoqiyik: malsonaw, Mi'kmaq: snawey, *Acer sacharrum*) (Iverson et al. 2008), which may reduce the availability of products from these trees, as well as from their related plant and shrub understories.

### ***Spaces of Gathering Are Diverse and Spread across the Landscape***

In Maine and New Brunswick, plant gathering and tending activities take place across forested landscapes. Individual gatherers access and care for parts of their environment that may seem untended, such as old fields. Wetlands, which may be similarly overlooked, are sources of some of the most widely-gathered plants. Furthermore, we found Wolastoqiyik and Mi'kmaq plant gatherers implement small-scale techniques to take care of plants and fungi important to them, regardless of land ownership. This parallels examples of environmental stewardship and plant gathering in urban contexts where people also take care of interstitial spaces they do not own, such as highway medians (e.g. Svendsen and Campbell 2008).

This suggests the importance of collaboratively identifying locations on the landscape that hold biocultural value, which may include some unexpected places. For instance, plant gatherers affect land they do not own, albeit in seemingly small ways. They shape forested landscapes but have been largely overlooked. Recognition of this adds nuance to our understanding of how human activities can influence vegetation on private property.

### ***Gathering Practices Promote Sustainability***

Individual plant gatherers make it their responsibility to collect plants in ways they regard as sustainable. Their actions are a form of agency, by which they promote plants

important to them. These practices are guided by cultural values honoring plant life, and informed by rich traditional ecological knowledge that is both dynamic and multi-generational, key elements of biocultural conservation approaches (Gavin et al. 2015). Tending strategies include a mindset of giving thanks and specific actions (described in Table 3) that support sustainable relationships between human use and the ecology of the plants harvested. These activities reflect relationships gatherers have created with particular locations, plant populations, and in some cases, individual plants. We found the plant parts most gathered include leaves and fruits, which may not adversely affect plant populations (Ticktin 2004). For some species such as sweetgrass, harvesting has been demonstrated to enhance populations (Reid 2005). When below-ground parts of plants, such as rhizomes are harvested, gatherers take limited amounts and employ techniques to encourage regrowth and population health (Table 3).

The intimate scale at which gatherers interact with specific plant populations suggests the possibility of scale-complementarity with forest management practices that typically occur at the stand level, as well as opportunities for co-management. From a biocultural standpoint, the ability to begin with local cultural perspectives and then work across scales is essential (Sterling et al. 2017). Resource managers, for example, who begin with the Indigenous perspective that plant gathering is reciprocal and positive for both people and plants, are better positioned for co-management opportunities. Furthermore, respect for Indigenous knowledge is a key component of maintaining Native participation in environmental stewardship initiatives (Reo et al. 2017).

### ***Language for Shared Environmental Responsibility***

For Wolastoqiyik and Mi'kmaq gatherers, maintaining good relations with plants is an expression of connectedness and kinship-centered cultural beliefs. Individuals describe their actions as fulfilling a responsibility to their human communities, to the plants they interact with, and to the Creator. These ideas situate plant gatherers firmly within a complex system of relations, not outside or in control of nature. The beliefs and values expressed by Wolastoqiyik and Mi'kmaq community members, while unique, share common themes with descriptions of interactions with plants and animals amongst other Indigenous peoples of North America, including Ojibwe (Lariviere and Crawford 2013; Reo and Whyte 2012) and Lakota (Sherman, Van Lanen, and Sherman 2010).

One might interpret plant tending strategies we describe, coupled with a strong impetus toward conservation for future generations, as a readily recognizable form of resource management. However, institutions of resource management have origins in modernist scientific principles that emphasize control over nature through technically driven expertise (Kennedy, Thomas, and Glueck 2001). The fact that our interviewees did not self-identify their actions as “management” is significant, and suggests they view themselves as engaging with their surroundings in different ways. Consequentially, use of the term “management” may be an impediment to collaboration between government agencies, private industry and other land managers and Indigenous communities (Fazey et al. 2013).

“Stewardship” offers alternative language for translating between the knowledge systems of Wolastoqiyik and Mi'kmaq gatherers and resource managers. Environmental

stewardship concepts have long been incorporated into natural resources management, as conservation for future generations has been an implicit objective (Kennedy, Thomas, and Glueck 2001). Scholars and natural resource professionals are turning to the language of environmental stewardship to characterize and legitimize the diverse ways people care for their surroundings (Bennett et al. 2018).

In proposing the language of stewardship, however, we recognize that the Judeo-Christian roots of the term may be problematic in some instances. Ideally, co-production of shared language, inclusive of Indigenous concepts offered by community members, could become part of a collaborative management process that emphasizes respectful learning about values. Where this is not occurring, scholars have noted that the characteristics of a stewardship paradigm can be understood through a biocultural framework, and share many similarities with Indigenous worldviews and ideas about humanity's place in nature including: situating humans as one of many active participants within ecosystems rather than a dominant force outside them; a reciprocal responsibility to care for other beings that in turn sustain you; and concern for future generations (Lertzman 2009; West et al. 2018).

### ***Meaningful Community Engagement***

Plant gatherers indicated interest in participating in resource planning activities and would not be opposed to permitting processes for certain plants or fungi. Recognizing the inherent limitations and power asymmetries present in such arrangements, permitting is part of the current regulatory context for many forest management institutions. The success of such efforts will rest on shared understanding of the specific sociocultural context of gathering activities and creating mechanisms by which community voices are directly heard. Study participants identified two key biocultural considerations:

1. Sharing of plants and fungi across communities is widespread, particularly with those who are unable to gather for themselves. Should harvest limits be set on some plants, it will be critical to recognize that one gatherer may support many people, with limits set accordingly.
2. Permit processes for culturally important plants might include a Wolastoqiyik and Mi'kmaq advisory group that devises and monitors appropriate harvest practice.

In our study area, permitting systems informed in part by these considerations are currently being co-developed in several settings, including with Acadia National Park and industrial forests. Inclusion of Indigenous advisory boards provide a level of Indigenous governance. Such nested arrangements are a biocultural approach to incorporate multiple knowledge systems (Gavin et al. 2015). An Indigenous advisory board also promotes validation of knowledge systems from within the system, a key component of the multiple evidence base approach to ecosystem governance (Tengö et al. 2017).

These initial steps point toward more inclusive directions that forest managers can take in collaboration with Indigenous plant gatherers. Future actions based on

relationship building could go beyond permitting to include prescriptions or co-stewardship arrangements promoting plants of interest. We suggest that biocultural approaches facilitate identification of key considerations for these processes. Gavin et al. (2015) propose incorporating and respecting diverse knowledge systems as a biocultural approach that supports co-management/co-stewardship. We also find that biocultural approaches are an important precursor to co-developing such institutional arrangements. In our case, they can mobilize and translate knowledge embodied in values and practices, key tasks identified by Tengö et al. (2017) in bridging diverse knowledge systems.

## Conclusions

Biocultural approaches promote consideration of diverse values and cultural practices into resource management frameworks. As such, they can be a powerful lens through which to consider forest management and planning priorities originating from local cultural perspectives, and explicitly consider the needs of communities. In the U.S. and Canada, adopting a biocultural perspective may also promote greater Indigenous involvement in, and benefits from, forest stewardship activities.

Our findings suggest biocultural approaches, through their flexibility and focus on Indigenous knowledge and actions, can improve the inclusiveness and responsiveness of forest management. We recognize that our study's scope is restricted. Future Indigenous-led research efforts could highlight other impediments to and supports for biocultural practices. For example, environmental contamination, which was a concern voiced to us by plant gatherers. Nevertheless, this study highlights five actions that will be particularly useful to agencies, land managers and others interested in incorporating biocultural considerations into their management practices:

1. Explicitly consider herbaceous and shrubby species important to Indigenous communities, even if they are “common”.
2. Provide plant gathering opportunities in multiple habitat types.
3. Respect the traditional knowledges that inform gathering practices.
4. Adopt language that Indigenous forest users relate to.
5. Seek meaningful Indigenous community participation, including opportunities to exercise Indigenous governance, when creating regulations.

In this paper, we have outlined practical suggestions for forest managers interested in operationalizing biocultural approaches at local and regional levels. They are intended to enhance, not replace, collaboration and knowledge co-production with Indigenous peoples and other cultural groups. By recognizing the importance of individual actors, small-scale actions, complex connections, and community-held knowledge, biocultural approaches suggest spaces of complementarity with management. Engaging biocultural relations through a paradigm of stewardship offers a broad understanding of the relationships people form with plants and fungi. By valuing multiple ways of interacting with plants, forests and ecosystems, this stewardship lens has the potential to address uneven power dynamics implicit in management situations where expertise is narrowly

defined. We suggest a biocultural approach can be a powerful tool, offering more accurate and complete picture of the factors, and actors, shaping forested landscapes.

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