BIRCH, BERRIES, AND THE BOREAL FOREST: ACTIVITIES AND IMPACTS OF HARVESTING NON-TIMBER FOREST PRODUCTS IN INTERIOR ALASKA

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A

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Abstract

Harvesting wild berries, firewood, and other non-timber forest products (NTFPs) from the boreal forest in Interior Alaska is a common activity amongst local residents. NTFPs are harvested for personal use, subsistence, and commercial purposes. While these activities contribute to informal household economies and livelihoods, harvest of NTFPs are not well documented in Alaska. Availability of these ecosystem services may be altered under changing management and climate regimes. This interdisciplinary dissertation takes a look at the activities and impacts of current NTFP harvesting practices.

Survey results from a forest use survey provide insight into harvest activity in the Tanana Valley. Wild blueberries (38.5% of households with mean harvested amount of 7.7 quarts) and firewood (25.0% of households with a mean harvest amount of 4.7 cords) were reported harvested with greatest frequency, and harvesting activities were mostly concentrated around larger population centers.

Interviews were conducted with personal use and subsistence NTFP harvesters from Interior Alaska. Participants enjoy harvesting from the forest, and that the importance of harvesting is a combination of both the intangible benefits from the activity and the tangible harvested items. Harvested NTFPs were seen as high-quality products that were otherwise unavailable or inaccessible.

Birch syrup is a commercially available NTFP produced in Alaska by a small number of companies. Similar to maple syrup, producing birch syrup is a labor intensive process with marginal profits. Interviews were conducted with workers in the Alaskan birch syrup industry, who reported that they were seeking an alternative to the traditional employment.

The effects from mechanical damage from tapping for spring sap on birch's vigor are of concern to birch syrup producers and natural resource managers. This study compared the annual increment growth of Alaskan birch trees, *Betula neoalaskana*, between tapped and untapped trees. No significant difference was detected from tapping, but annual variability in growth was strongly significant. A temperature index accounted for nearly two-thirds of the annual variability. Pairing this index with two climate scenarios, birch growth was extended out through the 21st century. As temperatures rise, birch in Interior Alaska are projected to face a critical threshold, which may limit or extinguish their ability to sustain growth and yield a sustainable sap resource.

Integrating the survey, interview, and dendroclimatological data provides a richer picture of how NTFP harvesters actively use the forest and about the benefits derived. These findings can assist resource managers in balancing these needs with those of other forest uses on public land.

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Chapter 1: Introduction

Harvest of non-timber forest products (NTFPs) such as wild berries, mushrooms, and firewood has been described as "invisible" activities (Emery 1998, Shackleton, Shanley et al. 2007). Anecdotal evidence shows that harvesting NTFPs from the forest is a widespread activity among residents in Interior Alaska. Personal use and subsistence harvesting activities aren't systematically tracked in Alaska, so data documenting who is harvesting, what is being harvested, where harvesting activities take place, and why harvesters participate in these activities is quite limited. Without a baseline understanding of what activities are taking place and the benefits derived from these boreal ecosystem services, it's difficult to assess how these activities and benefits change over time. This dissertation looks at activities and impacts of harvesting non-timber forest products in Alaska through an interdisciplinary lens, using both quantitative and qualitative data from natural sciences and social sciences.

The concept of non-timber forest products (NTFPs) encompasses a wide range of products—each with unique characteristics, uses, and cultural values. NTFPs also have underlying similarities that tie them together as a field of research. The NTFP literature focuses on a range of topics including biology, economics, and rural development. Literature related to the biological aspects of NTFPs focuses on horticulture, harvesting impacts on wild plant population sustainability, and ecosystem conservation (Pierce and Shanley 2002, Vance 2002, Ticktin 2004, Belcher et al. 2005). Literature related to the economics of NTFP harvests and products includes assessing the market and non-market values (Godoy and Lubowski 1992, Pearce 2001). Literature related to rural development looks at the role of NTFPs in poverty alleviation (Belcher et al. 2005, Belcher 2005), empowerment of women (Osemeobo 2005, Paloti and Hiremath 2005, Shackleton et al. 2011) and other underrepresented populations (Hansis 2002, Belcher et al. 2010), and as a temporary alternative for when primary resources are in short supply (Emery 1999, Belcher et al. 2010). While the NTFP literature is not extensive, it is now well enough developed that meta-analysis studies and synthesis papers are able to make broad statements and to uncover unifying themes about biological sustainability of NTFPs and the role in NTFPs in economic and rural development. Papers focusing on synthesizing individual case studies have looked at the ecological impacts of NTFP harvesting (Ticktin 2004) and the impacts of NTFPs on rural development and poverty alleviation (Ruiz-Pérez et al. 2004, Belcher and Schreckenberg 2007).

Definition of Non-timber Forest Products (NTFPs)

Throughout the global literature on "non-timber forest products," the term "NTFPs" has common synonyms; "NTFPs" and its synonyms are defined in different ways with slight alterations to the definition resulting in different arrays of products included under the NTFPs umbrella. For instance, the United Nations Food and Agriculture Organization uses the term "non-wood forest product" (NWFP) and defines

NWFPs as "goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests" (United Nations Food and Agriculture Organization 2012). The United State Forest Service uses the term "special forest product" (SFP) and defines SFPs as "products or natural resources that are not the traditional timber and fiber products... they are products that are not converted into board foot or cubic measures" (United States Forest Service 2011). McLain and Jones (2005) define seven categories under the term of "non-timber forest products." These categories include: (i) foods; (ii) medicinal plants and fungi; (iii) floral greenery and horticulture stock; (iv) fiber and dye plants, lichens, and fungi; (v) oils, resins, and chemicals extracted plants, lichens, and fungi; (vi) fuelwood; and (vii) small-diameter wood used for poles, posts, and carvings (McLain and Jones 2005). Absent from this definition are non-biological forest resources and wildlife resources. The following is the definition adopted by the State of Alaska (AK DNR MLW 2013):

> Non-timber forest products are generally defined as products derived from biological resources. Some examples include mushrooms, berries, bark, burls, conks, cones, boughs, diamond willow, landscaping transplants, and sap. Not included are rocks, minerals, soil, water, animals, or animal parts. Timber products include saw logs, poles, house logs, firewood, and Christmas trees.

While NTFPs are managed by the AK DNR Division of Mining, Land, and Water, timber products are managed by AK DNR Division of Forestry.

For the purpose of this dissertation, I will use the State of Alaska's definition but also include poles, firewood, and Christmas trees as NTFPs, items also managed by AK DNR though the Division of Forestry, to reflect the definition set by McLain and Jones (2005). In certain parts of this dissertation (specifically in Chapter 4), I also incorporate small scale timber resources as well as fish and wildlife harvest data to give a broader view of forest activities.

NTFPs fall within the definition of an ecosystem service. Ecosystem services are ecological products and processes that benefit that society's well-being (Chapin 2009). NTFPs fall within two of the four categories[1] of ecosystem services: provisioning services and cultural services (Table 1.1). The two other categories of ecosystem services are supporting service and regulating services. Provisioning services, also called ecosystem goods, are the products from ecosystems that society directly uses such as fresh water, food, and fuelwood. Cultural services are products or aspects of ecosystems that contribute society well-being through different means such as cultural identity, spiritual benefits, and recreation opportunities (Chapin 2009). Harvesting wild berries provides food, a provisioning service, and may provide recreation or contribute to the harvester's cultural identity, a cultural service.

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[1] The two other categories of ecosystem services are supporting service and regulating services. Supporting services are ecological processes that are necessary for all other ecosystem functions such as maintenance of biological diversity and water, carbon, and nutrient cycling. Regulating services are ecological processes that regulate the climate and landscape such as pollination and control of pests and disease (Chapin 2009).

Management of NTFPs

Harvest of non-timber forest products (NTFPs), although practiced by peoples living in Alaska for thousands of years, is a relatively new management consideration for land and resource managers in the state. The Pacific Northwest areas of the US and Canada, on the other hand, have a slight advantage with respect to developing and implementing NTFP management regulations. The growing body of literature addressing NTFP management elsewhere may be able to point Alaska managers toward successful policies (Mahapatra and Mitchell 1997, Jones and Lynch 2002, Belcher et al. 2005). While non-commercial NTFP harvest is minimally managed in Alaska, if managed at all, the state has begun to streamline commercial harvest permits of NTFPs by offering over the counter permits through the Alaska Department of Natural Resource Division of Mining, Land, and Water's regulations established in 2005 and an accompanying "Non-timber Forest Products Harvest Manual".

Recent Increased Attention to NTFPs in Alaska

Three meetings since 2000 have brought together Alaskans interested in NTFP issues. The first state-wide conference addressing NTFPs in Alaska was the Hidden Forest Values conference held November 8-11, 2001, in Anchorage. The conference brought together subsistence NTFP harvesters, commercial NTFP operations, a variety of land managers, and researchers to discuss NTFPs resources, uses and management in Alaska. A second, smaller conference, Hidden Forest Values II, was held October 1-2, 2004, in Sitka. A third meeting, the Alaska Forum for Forest Practitioners, was held November 3-5, 2005, again in Anchorage, and was sponsored by the National Network of Forest Practitioners.

In the late 1990s, a review of market research for NTFPs in the United States was applied to Alaskan NTFP resources with the Alaskan Special Forest Products Market Research Report (Mater 1999). An Oregon firm hired by the US Forest Service compiled the report; due to budget restraints, however, primary market research for Alaskan NTFPs was not conducted. The resulting report provides valuable, although fairly non-place-specific, information about developing NTFP resources into products and bringing these products to market. Beyond the numerous illustrative examples from the contiguous U.S. states, the report outlines the assessed market demand for a number Alaskan NTFPs. While some of the NTFPs listed are fairly ubiquitous within the state (such as blueberries, rosehips, and characterwood[2]), a number of the species examined are specific to Southeast Alaska. This regional focus might be because the majority of Forest Service lands are in Southeast Alaska, and the US Forest Service funded the report. Alternatively this bias could be because preparers mainly relied on published data, and the Southeast Alaska ecosystem is fairly similar to the Pacific Northwest, where much of the NTFP research within the United States has been conducted.

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[2] Characterwood is the general term for wood with a distinctive appearance or grain such as burls, knots, diamond willow, or spalted wood.

The Alaskan Special Forest Products Market Research Report (Mater 1999) contains two sections that are particularly valuable: a section containing public and tribal comments on U.S. Forest Service draft policy on NTFPs, and a section outlining "Missing Pieces" for developing an Alaskan NTFP industry. Both community and tribal participants voice opposition to commercial use of NTFP resources from the national forests. The "Missing Pieces" section raises pertinent questions regarding biological sustainability and management strategies for NTFPs. Missing from the Alaskan Special Forest Products Market Research Report is an adequate consideration of post-harvest care and transportation challenges, a key component since improper post-harvest care and transportation can seriously impair future NTFPs values and production potential.

In Southeast Alaska, the Sitka Tribe of Alaska's Kayaani Commission formed in 1997 due to their concerns with a suggestion for the development of U.S. Forest Service monitoring guidelines for NTFP resources in the region. The Kayaani Commission has become a vocal group expressing their concerns over access issues and preservation of traditional Tlingit plants and plant uses. Interior Alaska does not yet have an equivalent organization, although individuals speak up about their concerns over infringement on their NTFP harvesting. In August 2007, the Fairbanks Daily News-Miner published a Letter to the Editor about a disrupted blueberries harvest (Beck 2007). The letter written by Joanne Beck of Eagle Village described her experience of heading out to go berry picking at her family's traditional patch along the Taylor Highway, and about the opposition that she and her mother ran into from a road construction crew working in the area. Her letter describes how twenty years after her grandmother's death she found her grandmother's cane at the patch, and about what an important role this location and blueberry picking plays in her life. Her letter further describes how a road construction worker "sneered" at her, with "I'm not going to slow down our $2 million project just so you could pick berries!" The experience by Beck shows that conflicts are already occurring between NTFP harvesters and others, in this case a road construction crew. Without documenting the importance of harvesting activities, the value of these activities may be trivialized.

NTFP management in Alaska

Because of the fractured ownership landscape in Alaska, current regulations over NTFP harvesting can be confusing. Regulations for harvesting activities depend on the land ownership of the specific place where harvesting is taking place, the purpose for harvesting (i.e. subsistence, personal use, or commercial), and the type of NTFP being harvested. Some federal and state land management agencies in Alaska distinguish between subsistence and personal use. Some agencies allow personal use harvest without a permit, while others require permits for personal use harvest. Regulations specific to commercial harvest of NTFPs complicate the picture even further.

Alaska contains approximately 375 million acres of land owned and managed by a variety of public and private entities. The federal government is the largest land owner in Alaska with 60% of the land (222 million acres). Federally owned land includes national parks, wildlife refuges, national forests, military reservations, and the National Petroleum Reserve on the North Slope (AK DNR DMLW 2002). The State of Alaska owns 28% of the land in Alaska totaling about 105 million acres. The state total includes land transferred to local governments, state forests, and land grants for schools, the University of Alaska, and the Mental Health Trust (AK DNR DMLW 2002). The vast majority of private lands in Alaska are Native lands. The Alaska Native Claims Settlement Act (ANCSA 1971) transferred 44 million acres of land to Native ownership. The Regional Corporations received a total of 16 million acres and 224 village corporations received a combined 26 million acres. Small villages, villages with less than 25 residents, also received land (AK DNR DMLW 2002). Less than 1% of privately owned land in Alaska is non-Native land (AK DNR DMLW 2002).

Management of NTFPs on Federal Land in Alaska

The piece of legislation most critical to subsistence harvest of NTFPs on federal land in Alaska is the Alaska National Interest Lands Conservation Act (ANILCA 1980). ANILCA was enacted on December 2, 1980 by the United States Congress. ANILCA was established to create conservation areas in order to protect natural landscapes and wildlife populations. Part of the purpose of ANILCA is also to "to provide the opportunity for rural residents engaged in a subsistence way of life to continue to do so" (ANILCA §101.c). Title VIII §810 addresses subsistence and land use decisions.

> In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands under any provision of law authorizing such actions, the head of the Federal agency having primary jurisdiction over such lands or his designee shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes.

Because of Title VIII, the U.S. Forest Service in Alaska does not require permits for subsistence harvest of NTFPs (ABFC 2003). A permit is also not required for personal use harvest of NTFPs on Forest Service land, although personal use is considered a secondary priority compared to subsistence. A Free Use permit is necessary for other educational or other non-commercial use; depending on the scope of the request, a National Environmental Policy Act (NEPA) review may be necessary before the permit is granted. A Forest Products Removal Permit is necessary for commercial harvest or bioprospecting on Forest Service Land. The process for approving commercial permits is slow and includes a NEPA review, with a mandatory consultation of local tribes and recognized tribal entities (ABFC 2003).

The Bureau of Land Management (BLM) does not require permits for subsistence or personal use harvest of NTFPs taken from BLM lands, with the exception of firewood, post, pole, and house logs which do require a free and easily obtained permit. Permits, also usually free, are necessary for research and bioprospecting on BLM land. Permits, however, are necessary for commercial harvest of NTFPs on BLM land (ABFC 2003). Similar to the Forest Service, BLM commercial permits take time for issuing and usually require a NEPA review to investigate the socio-economic and cultural effects from proposed commercial harvest. In a few cases, permits are issued with a "Categorical Exclusion," and do not require the full NEPA review (T. Hammond, personal communication).

The U.S. Fish and Wildlife Service allows for subsistence and personal use harvesting of NTFPs on all national wildlife refuges in Alaska. Commercial harvest requires a permit and is limited to the few small Intensive Management areas within specific refuges (ABFC 2003).

The National Park Service (NPS) generally does not allow for the removal of natural resources from any unit of the national park system (ABFC 2003). The major exception to this is subsistence harvesting of NTFPs by local rural residents who live in the vicinity. Subsistence NTFP harvest does not require permits and can include firewood, and sometimes even house logs. Park superintendents may allow for the personal use harvest of certain edible plants and fungi in their specific park, otherwise personal use harvest is not allowed on units of the national park system. Harvest of NTFPs for research purposes requires a research permit, and no commercial harvest is allowed on NPS lands (ABFC 2003).

In summary, although all these lands are held in trust for the public by the federal government, the specific agency in charge of managing the land determines what type of NTFP harvest is allowed. All federal lands in Alaska allow for *subsistence* harvest of NTFPs without a permit because of ANILCA Title VIII. All federally managed lands except for the national park system allow for *personal use* harvest of NTFPs without a permit as well. *Commercial harvest* of NTFPs on federal lands, if allowed, requires a permit and usually a NEPA review.

Management of NTFPs on State Land in Alaska

The Alaska Department of Natural Resources Division of Forestry (DOF) manages two state forests: the Tanana Valley State Forest and the Haines State Forest, with, respectively, 1.78 million acres and 286,208 acres. DOF also recently acquired the 360 acre Homer Demonstration Forest (AK DNR DOF 2007). The state, according to Alaska Statues Sec. 41.17.060 (1) manages its forest resources for multiple use, sustained yield, and sustainability:

> Forest land shall be administered for the multiple use of the renewable and nonrenewable resources and for the sustained yield of the renewable resources of the land in the manner that best provides for the present needs and preserves the future options of the people of the state.

According to Statute Sec. 41.17.200, the primary purpose of the state-owned forest is timber production:

> The primary purpose in the establishment of state forests is timber management that provides for the production, utilization, and replenishment of timber resources while allowing other beneficial uses of public land and resources.

However, non-timber uses of state forest lands are included in Statute Sec. 41.17.230.

> To the extent they are found to be compatible with the primary purpose of state forests under AS 41.17.200, the forest management plan must consider and permit uses of forest land for nontimber purposes, including recreation, tourism, mining, mineral exploration, mineral leasing, material extraction, consumptive and nonconsumptive uses of wildlife and fish, grazing and other agricultural activities, and other traditional uses.

DOF offers permits for personal use and commercial firewood harvest. Permits are also given for house logs (D. Hanson, personal communication). The Division of Mining, Land and Water (DMLW) is the branch of Alaska Department of Natural Resources responsible for "leasing and permitting state land for recreation, commercial and industrial uses" and therefore DMLW offer permits for commercial NTFP harvest on state land. In 2008, DMLW implemented an over-the counter commercial harvest permit for a wide range of NTFPs. The Division produced a "Non-timber Forest Products Harvest Manual" to accompany the permit process. A regular land use permit is still required for commercial harvest of items not in the manual or harvesting quantities that exceeds the levels allowed by the over-the-counter permit (AK DNR DLMW 2008). Harvesting berries, wild plants, and plant material for subsistence and personal use are considered "generally permitted activities" by DMLW and do not require a permit on state land (AK DNR DLMW 1989).

Borough governments may also regulate NTFP harvests. The Mat-Su Borough, for instance, issues two types of Land Use Permits: Personal Use and Commercial Use. Both permits are non-exclusive. Land Use Permits are necessary in order to access borough land for anything beyond using a historic or dedicated trail, public access right of way such as an RS 2477, or legally recognized easement. The Mat-Su Borough is interested in developing its NTFP resources (ABFC 2003).

Management of NTFPs on Private Land in Alaska

The majority of privately owned land in Alaska is held by twelve of the thirteen regional Native corporations[3] and the 224 Native village corporations set up by the Alaska Native Claims Settlement Act (ANCSA). Regional corporations were granted land by ANCSA (1971) in order to be for-profit corporations. For example, the regional corporation for Interior Alaska is Doyon, Ltd., which is the largest private landowner in Alaska with 12.5 million acres. The for-profit regional corporations may manage their lands according to their judgment of their own best interest, and as a result, some business decisions regarding management of corporation land conflicts with the shareholders' tribal government's desires. One case of this tension was the decision by Shee Atika Corporation in Sitka to harvest timber from Shee Atika corporation land around the town of Sitka where community members harvested NTFPs. Following the Shee Atika timber harvest, tribal government began to work with Shee Atika to demonstrate the value of the forest's value to the community (ABFC 2003).

[3] The 13th Regional Corporation was set up for Alaska Natives living outside Alaska and was compensated strictly monetary rather a combination of land and settlement money.

Native land owners can receive technical assistance with land management from non-profit tribal organizations such as Tanana Chiefs Conference (TCC) in the Alaskan Interior region, with Doyon the regional for profit corporate arm. TCC has a brief history of working with consortium members approximately twenty years ago to harvest spruce cones from Interior Alaska to ship to Germany for Christmas wreathes, but no record of this commercial harvesting was kept, nor was the harvesting activity regulated. The export of spruce cones ended when demand diminished (W. Putnam, personal communication). Doyon, Ltd. has an employee who addresses NTFP issues in the corporation's Lands and Natural Resources Department. Doyon, Ltd. was involved with a 2005 morel mushroom harvest and allows shareholders to harvest firewood and house logs on corporate land (G. Lee, personal communication).

Harvest of NTFP on private land, either Alaska Native or non-native lands, simply requires permission from the land owner. Alaska Department of Fish and Game require permits and licenses for fishing and hunting, even subsistence and personal use hunting and fishing, for people over the age of 16 when on private or public land because fish and game are considered property of the state. This is not the case with flora and fungi resources. Therefore, no permit from the state is necessary for harvesting NTFPs on private lands. Alaska also does not have any plants that are listed as Endangered Species, the listing that could prohibit a plant from being harvested.

Conflict and complementariness between NTFP harvest and other influences on the forest

In Alaska, for the most part, NTFPs are seen as non-rival[4] goods by land and natural resource managers as indicated by the lack of management regulating NTFPs harvest. Because the ratio of human population to the amount of land in Alaska is still fairly low, the harvest of NTFPs by one harvester is not seen as decreasing the ability of another harvester to participating in NTFP activities. However, because of the recent increased interest in biomass for energy production in Interior Alaska, competition among NTFP harvests may develop. The rapidly emerging large scale wood biomass harvest is likely to set up long-term conflicting goals between NTFP harvesters and commercial biomass harvest on a significant amount of forest land.

Planning for long-term timber sale for biomass in the Tanana Valley State Forest is underway by the Alaska Division of Forestry. The Best Interest Finding (BIF) for proposed 25-year timber sale biomass plan in the Tok region concluded the public comment period at the beginning of February 2013 (AK DNR DOF 2012). The proposed Tok biomass harvest area is contained within a 40 mile radius around Tok, and it was assessed as including a total of 3,370,00 green tons of biomass. If the 25-year biomass sale plan is approved and the timber sale is purchased, an estimated 35,000 green tons would be harvested each year. A benefit of biomass harvest would be the creation of

[4] "Non-rival good" is an economic term to describe resources in which one person's use of the good does not diminish the availability of the good to others or limit their use of it.

defensible space from wildfires around the community of Tok, with the initial five to 10 years of biomass harvest proposed (AK DNR DOF 2012). It is noted in the BIF that biomass harvest should benefit berry picking, as new berry patches are able to take root after biomass harvest (AK DNR DOF 2012).

A challenge for the state's management in forest products, both timer and non-timber, is enforcement of its regulations. The Division of Forestry doesn't patrol during evening and weekends when the majority of illegal firewood harvest occurs; additionally, Division personnel are not able to issue citations to those harvesting firewood without a permit, over their permit allotment, or outside the designated harvesting areas. When alerted to illegal harvesting, they contact state park rangers to issue citations, but most often simply contact the alleged illegal harvester to inform them of the regulations (Mowry 2013). One other method of decreasing illegal harvesting is to hinder access to the resources. In November 2012, the state closed a logging road outside of Fairbanks in response to illegal harvest of firewood; some of the illegal cut had been sold as part of a commercial firewood timber sale (Fairbanks Daily News-Miner 2012). Without effective ways to enforce management forest resources, the regulations merely become recommended practices.

Ecological challenges to future NTFP Harvest

Other changes in the forest such as climate change may also impact harvesting forest resources. Effects from climate change are already more pronounced in higher latitudes (Arctic Climate Impact Assessment 2004) such as Alaska's boreal forest. Projected ramifications from climate change include increased temperatures, changes in precipitation, thawing permafrost, shifts in vegetation zones, and increases in wildfires and insect infestations (Arctic Climate Impact Assessment 2004). Some of these impacts could decrease harvesting resources and opportunities, while others may increase resources and opportunities. For example, while wildfire is a natural disturbance in Interior Alaska, the frequency of large wildfires has increased dramatically beginning in the 1990's (Chapin 2008). Increased wildfire can benefit NTFP harvesting by returning forests to early successional vegetation such as berry patches. Wildfires can also invigorate berry production; post-fire berry patches have shown to increase fruit yield up to 2.6 times compared to unburned patches (Nelson et al. 2008). The severity of the wildfire influences the rate at which berry patches recover following wildfire. Berry production may peak around three years after light fires, but may take up to ten years to peak after severe fires (Nelson et al. 2008).

Using an interdisciplinary mixed methods approach

To examine management of NTFPs from different perspectives, this dissertation employs research methods from natural and social sciences, and it examines both quantitative and qualitative data sets. Through the integration of these research methods and data sets, the aim is to have a more holistic view of what is happening in the forest with the resource users and resources, and why. This approach is more informative than conducting a number of single disciplinary studies. Quantitative and qualitative methods can complement each other, although they typically have different goals and objectives. The analytical challenge is to integrate them in terms of a specific research problem. Quantitative research employs statistical analysis for deduction, confirmation, and theory/hypothesis testing, whereas qualitative research employs qualitative analysis for induction, exploration, and theory/hypothesis generation (Johnson and Onwuegbuzie 2004).

While quantitative and qualitative research use different frameworks and techniques, parallels for evaluating validity and trustworthiness exist between the two (Table 1.2). Quantitative research is conducted under positivist or a postpositivist framework that seeks to test a priori hypotheses to determine what is verifiable, or to at least narrow in on something approximating "truth" (Guba and Lincoln 1994). Some but not all qualitative research is conducted under constructivism/interpretivism, or the so-called critical theory framework that proposes to build understanding through the data collected without an a priori hypothesis. Typically this school of thought argues that truth is subjective and context specific (Guba and Lincoln 1994, Sale et al. 2002).

Chapter 2 examines who in Interior Alaska is harvesting, what they are harvesting, and what quantities they are harvesting, using the results from the 2003 Forest Use Survey. This chapter provides a picture of how Interior Alaska's boreal forest in is utilized for NTFPs and other forest resources.

Chapter 3 highlights the motivations for harvesters to participate in harvesting activities and the additional intangible benefits they receive from these activities. This chapter presents the results from semi-structured interviews conducted with experienced personal-use and subsistence-use NTFP harvesters throughout the Tanana Valley.

Chapter 4 looks at the reasons that people involved with the Alaska birch syrup industry choose to participate in laborious, seasonal work. This chapter addresses concerns regarding commoditization of NTFP resources and also takes a look at the history of the birch syrup industry in Alaska.

In Chapter 5, I examine the impact from tapping birch trees for harvesting spring sap has on annual increment growth of Alaskan birch trees. This chapter addresses concerns regarding sustainability when harvesting of NTFP resources and also includes a review of an overview of the history of birch sap harvest across the circumpolar north.

Chapter 6 summarizes the key finding from this dissertation and offers recommendations for managing NTFPs in Interior Alaska.

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Figures and Tables

Table 1.1. The four categories of ecosystem services and illustrative examples

Examples of ecosystems services which are non-timber forest product are indicated with an asterisk

Categories of ecosystem services	Examples
Supporting services	
	Ecosystem processes
	Diversity maintenance
	Disturbance cycles
Regulating services	
	Climate regulation
	Water quality & quantity
	Disease control
Provisioning services	
	*Food
	*Fuelwood
	Water
	*Fiber
	*Biochemicals
Cultural services	
	*Cultural identity
	*Recreation & tourism
	*Aesthetic & spiritual benefits

Note: Adapted from Chapin (2007)

Table 1.2. Parallels in criteria for evaluating rigor quantitative and qualitative research

Trustworthiness	*Criteria for evaluating rigor*	
	Quantitative research	**Qualitative research**
Truth value	credibility	internal validity
Applicability	transferability	external validity
Consistency	dependability	reliability
Neutrality	confirmability	objectivity

Note: Adapted from Rappaport (1990)

Chapter 2: Harvesting Non-timber Forest Products in Interior Alaska

Abstract

Harvesting non-timber forest products (NTFPs) such as berries, mushrooms, and firewood are treasured activities within the Alaskan boreal forest though there are limited data available on these activities. The state of Alaska allows harvesting on the 28% of state-owned land that is managed for multiple-use. Unlike hunting and fishing, permits are not needed for non-commercial NTFP harvest. As a result, harvesting goes undetected by resource managers. In 2003, a forest use survey collected data from households throughout Interior Alaska on their forest harvesting activities. Survey results provide insight into who is harvesting, what they are harvesting, quantities of harvest, and general areas of harvest activity. Wild blueberries (38.5% of households with mean harvested amount of 7.7 quarts) and firewood (25.0% of households with a mean harvest amount of 4.7 cords) were reported harvested with greatest frequency. Correlations of harvesting activities and demographic data were statistically significant for some demographic data (e.g. education level and residency in urban, ex-urban, or rural communities) but not others (e.g. age, number of years residency in Alaska, household size, and household income). Not surprisingly, harvesting activities were mostly concentrated around larger population centers. These findings can assist resource managers in balancing these needs with those of other forest uses on public

land such as a growing interest in new large-scale, long-term biomass timber sales for energy production.

Introduction

The Interior Alaskan ecosystem is dominated by the boreal forest; popular forest activities include hunting, fishing, trapping, recreation, and gathering of non-timber forest products (NTFPs) such as firewood and wild berries. Harvesting from the forest sustained aboriginal peoples' traditional societies, and it continues to contribute to modern culture's livelihoods throughout the United States (McLain and Jones 2005). In Alaska, harvested NTFPs are especially important as the informal trade and sharing of resources helps sustain social ties by serving as a means to connect urban Alaskan residents to rural communities. Harvesting activities also strengthens cultural pride and community identity (Lee 2002).

Anecdotal evidence shows that harvesting NTFPs from the forest is popular amongst residents in Interior Alaska, but there is little documentation on how extensive harvesting activities are. The purpose of this research is to explore an existing database from a 2003 Forest Use Survey to examine the demographics of harvesters, what they harvest, how much they harvest, and where they harvest. Additionally, this research sought to find patterns in both the demographics of harvesters and their harvesting activities.

Although there are many definitions of NTFPs, for the purposes of this paper I use the concepts found in the NTFP entry in the Dictionary of Forestry (Helms 1998):

> all forest products except timber, including resins, oils, leaves, bark, plants other than trees, fungi, and animals or animal products – *synonym* special forest products

The most widely acknowledged NTFPs are wild berries, tree boughs, mushrooms, and maple syrup. But more expansive definitions of NTFPs include fuelwood, fodder, bamboo, bushmeat, turtle eggs, and elephant tusks (Thadani 2001). McLain and Jones (2005) categorize NTFPs into seven groupings (Table 2.1). For the purpose of this paper, the term NTFP includes fuelwood but does not refer to any animal or animal product; however, the data set that I used for this research on harvesting activities in the Tanana Valley forest also included data on hunting and fishing activities. Therefore, as described in the Methods section, my analysis of the Forest Use Survey data includes results from other forest resources harvested in the Tanana Valley. Including these other forest resources give a broader picture of how local residents are using the forest. Beyond NTFPs, this paper also addresses the harvest of house logs, saw logs, fish, moose, and game birds.

Both Personal Use and Subsistence harvesting of NTFPS, except for firewood, are allowed on state and federal land without permits (AK DNR DMLW 2011, ABFC 2003a); NTFPs harvesting activity has largely been under the forest management radar in Interior Alaska thus far, although there is a lack of solid data about who is harvesting, what they are harvesting, how much they are harvesting, and where they are harvesting. This research addresses these questions.

Forest management in Interior Alaska

Interior Alaska has ten million acres of commercial forest land (Wurtz and Gasbarro 1996). The principal state land base dedicated to multiple-use and sustained yield forest production in Interior Alaska is the Tanana Valley State Forest (TVSF), covering 1.78 million acres (AK DNR DOF 2001). The Alaska Department of Natural Resources, Division of Forestry (DOF) manages the TVSF and is the main provider of timber sales in Interior Alaska. Alaska Statute Sec. 41.17.060.(1) states:

> Forest land shall be administered for the multiple use of the renewable and nonrenewable resources and for the sustained yield of the renewable resources of the land in the manner that best provides for the present needs and preserves the future options of the people of the state.

Alaska Statute Sec. 41.17.200 declares the purpose of the state-owned forest:

> The primary purpose in the establishment of state forests is timber management that provides for the production, utilization, and replenishment of timber resources while allowing other beneficial uses of public land and resources.

AS 41.17 clearly established a priority in utilization of the forests for economic gain. This intent is also demonstrated in the 2003 Forest Resource and Practices Act which focuses on providing jobs in both the timber and commercial fishing industries (AK DNR DOF 2003). The state is required to make areas of the TVSF available for timber sales. Other commercial activities permitted in the TVSF include mining, gravel extraction, oil and gas leasing, and grazing, although timber is the actual main commercial activity in the TVSF. The multiple use management strategy is echoed in Sec. 41.17.230, but the statute gives priority to timber harvest:

> To the extent they are found to be compatible with the primary purpose of state forests under AS 41.17.200, the forest management plan must consider and permit uses of forest land for nontimber purposes, including recreation, tourism, mining, mineral exploration, mineral leasing, material extraction, consumptive and nonconsumptive uses of wildlife and fish, grazing and other agricultural activities, and other traditional uses.

SB 180 could be interpreted as limiting Sec. 41.17.060.(3)

> To the extent its capacity permits, forest land shall be administered so as to provide for the continuation of businesses, activities, and lifestyles that are dependent upon or derived from forest resources

One hindrance to expanding forestry operations in Alaska is a limited road system and access issues, so expanding timber harvests is usually a costly endeavor because high value timber stand are often not economically feasible when the cost of road building is factored in to the calculation (Berman et al. 1999). Additionally, forest productivity is higher on national forests in Alaska (i.e. the Chugach National Forest in Southcentral Alaska and the Tongass National Forest in Southeast Alaska) than is the productivity on state forests such as the Tanana Valley State Forest (Berman et al. 1999). In the early 1990's, a proposed change to ramp up the level of timber sale on the

Tanana Valley State Forest resulted in local public outcry (Dawe et al. 1994). While these changes in forest management never panned out, new interest in biomass energy is now looking to revive the state's interest in offering large scale timber contracts. Currently, the planning process is underway for a proposed 25-year timber sale for woody biomass in the Tok region to harvest an estimated 35,000 green tons of biomass material each year. Public comment just ended at the beginning of February 2013 (AK DNR DOF 2012), so it is not yet known what the public response is to the proposed Best Interest Finding for the biomass timber sale.

The Alaska Department of Fish and Game (ADF&G) tracks harvest levels in the state each year, although data collected focuses mainly on fish and game resources harvested and harvest information of non-timber forest products is very limited. Some NTFP harvest information and ethnobotanical knowledge has been documented through ADF&G subsistence reports. These subsistence report focus on fish and game harvest, but a few (Martin 1983, Marcotte 1986) also mention NTFP resources harvested.

Marcotte (1986) documented plant use in the Interior Alaskan village of Huslia. Huslia, a predominant Koyukon Athabascan community, lies on the Koyukuk River which drains into the Yukon River from the north and is downstream from where the Tanana River enters the Yukon from the south. This technical paper includes data from 56 of the 57 households that were in the community at the time, and reports that seventy-five percent of households in 1983 used edible plants and an average six cords of firewood per year. The edible plants harvested included berries and rosehip (*Rosa acicularis* Lindl.). Six different types of berries were harvested, with a total of 276.5 gallons of berries for the community. The most common berry harvested was lowbush cranberry (*Vaccinium vitis-idaea* L.), with 34 households harvesting an average of 4.9 gallons of this type of berry. Seven households reported harvesting rosehips and averaged 1.9 gallons per gathering household.

A second subsistence report that also includes plants harvested, though in less detail. Martin (1983) looks at plant gathering activities during 1982 by the community of Dot Lake, a community consisting of 15 households in the Tanana Valley, approximately 160 miles southeast of Fairbanks. The report focuses more on fish and game but includes mention that households harvested firewood, berries, mushrooms, edible roots, rosehips, and edible greens (Martin 1983).

In 2008, the state began offering an over-the-counter permit over commercial harvest of some types of NTFPs through the Department of Natural Resources Division of Mining, Land, and Water (DMLW). State issued firewood permits, both for personal and commercial uses are handled through the Division of Forestry, which like DMWL is also under Department of Natural Resources. Prior to this over-the-counter permit, all commercial NTFP permits were handled as regular land use permits which were reviewed individually. The two objectives of the over the counter permit are to streamline the permitting process to minimize time requirements to issue permits and "better manage these natural resources to ensure a sustainable harvest for all Alaskans"

(AK DNR DMLW 2013). Permit holders are required to submit an "End of Season Report" in which they must list NTFPs harvested, location, harvest dates, quantity harvested, and uses of harvested products. Request for commercial harvest for items or harvest amounts not covered by the Limited Non-Timber Forest Products Commercial Harvest Permit must still go through the old process by applying for a Land Use Permit that requires a public review process (AK DNR DMLW 2013).

Forest Use Surveys conducted in Interior Alaska

A collaborative effort between the Alaska Boreal Forest Council, the Alaska Department of Natural Resources Division of Forestry, and the University of Alaska Fairbanks produced two Forest Use Surveys in order to assess annual harvest levels by households from the Tanana Valley in Interior Alaska. The first survey began in Fall 2000 and a second survey was administered in Fall 2003. Data from the 2003 survey are used in my research. These surveys looked at a wide range of harvest activities by households including non-timber forest products, fishing, hunting, and trapping.

The two surveys used a random sampling design with the aim to generate a generalizable representation of the communities within the Tanana Valley. Both surveys were mailed out to 1000 households throughout the Tanana Valley selected by a simple random sampling method that used different mailing lists so that each survey reached a different subset of the population. The 2000 Forest Use Survey (FUS) had a 54% response rate after taking into account the undeliverable surveys, while the 2003

FUS had a lower response rate of 36%. The 2000 FUS demographic data were compared to 2000 census data, showing that it was fairly representative, except for an under-sampling in the 20-30 age group and an under-sampling of females. Generally, the responses from both the 2000 FUS and 2003 FUS are fairly representative of the Tanana Valley population as a whole (Bates et al. 2004).

While a large amount of data was collected during both the 2000 FUS and 2003 FUS, the majority of the information collected was not made widely available. Prior to the study reported here, the analysis of 2000 FUS and 2003 FUS was limited to estimating total harvest from the Tanana Valley and then calculated replacement economic values. For example, the 2000 FUS determined that 35% of households harvested an average of two quarts of blueberries (*Vaccinium uliginosium* L.), with this extrapolated to a total of 112,182 quarts harvested for the entire Tanana Valley. Using the price per quart for which blueberries are sold in local food stores, the 2000 Tanana Valley blueberry harvest was estimated to be approximately $1.78 million (Bates 2002).

The Tanana Valley

The Tanana Valley lies in the Interior of Alaska, north of the Alaska Range. The Tanana River spans much of Interior Alaska—the headwaters are located just north of Northway, Alaska, and the Tanana River empties into the Yukon River. Most of the communities within the Tanana Valley are connected by a few main roads including the Alaska Highway, the Richardson Highway, and the Steese Highway. Fairbanks, the largest city in the Tanana Valley, serves as a focal point for shopping and other business, medical, and government services for residents in outlying communities around the Tanana Valley.

The Tanana Valley is part of the boreal forest, or "taiga", a circumpolar biome that extends across Canada and spans the area from the western coast of Alaska to the Canadian border. It is characterized by prolonged cold winters, short, cool summers, and nutrient-poor, cold soils often containing permafrost (Pojar 1996). Alaska's boreal forest has low species diversity but its wildfire regime creates a heterogeneous mosaic on the landscape (Chapin et al. 2006). Tree species present include black spruce (*Picea mariana* Mill.), white spruce (*Picea glauca* Moench), birch (*Betula neoalaskana* Sarg.), aspen (*Populus tremuloides* Michx.), poplar (*Populus balsamifera* L.), and tamarack (*Larix laricina* (Du Roi) K. Koch). There are large quantities of black spruce, hardwoods, especially birch, and mixed spruce-hardwood stands.

Interior Alaska does not support a large-scale timber industry, although the land is extensively forested. A number of factors contribute to the current low utilization of Interior Alaska commercial forest land, including economic conditions and landowners who decline or are reluctant to give long-term timber leases (Wurtz and Gasbarro 1996). A 1990s satellite mapping of 28.4 million acres of vegetation in the Tanana Valley showed only 2.1% (599,000 acres) as white spruce dominated forest, the principal desired species for timber harvest (Hammond 1996).

Methods

Data collection by the 2003 Forest Use Survey

The survey was conducted in 2003 by the non-profit organization the Alaska Boreal Forest Council in conjunction with the Alaska Department of Natural Resources Division of Forestry and the University of Alaska Fairbanks. The Alaska Boreal Forest Council ceased operations in 2005, and their database was subsequently transferred by the project manager to me for further analysis. The survey was designed by a team from the three partner organizations, and was carried out by the Alaska Boreal Forest Council.

The mail survey mailed out to 1,000 households across the Tanana Valley. Addresses were selected through a random sampling design using the 2002 Alaska Permanent Fund Dividend check mailing list. Addresses with zip codes within the Tanana Valley were extracted from the entire mailing list to form the pool from which addresses were randomly selected. Surveys were sent out in October 2003, and then reminder postcards and two additional copies of the survey re-sent in January and February 2004 to non-responders.

The survey inquired about the household harvests in five main categories: fish, wood and timber resources, non-wood resources, hunting, and trapping. Data collected includes quantity and general location. An 8.5 x 11 inch color map was provided which broke the Tanana Valley into 21 different labeled blocks so that survey respondents could identify where their harvesting activities took place (Figure 2.1). While the surveys were anonymous and do not identify survey participants, demographic data were collected including age, gender, zip code, years lived in Alaska, highest level of education, number of members in the household, and approximate household income.

Survey Data Analysis

Initially, the database (ABFC 2003b) went through an extensive quality control check process and verified with original survey forms to rectify data entry discrepancies. Approximately half of the hunting harvest data and all of the trapping data were set aside and not used for analyses due to their low reported harvesting occurrences. This allowed the analyses to focus on NTFP harvest activity and the prominent fish and game harvest activities. Fish and game included in analyses were grayling (*Thymallus arcticus*), salmon (*Oncorhynchus* spp.), trout (*Oncorhynchus mykiss)*, pike (*Esox lucius)*, burbot (*Lota lota*), whitefish (*Coregonus* spp.), moose (*Alces alces*), grouse (*Falcipennis Canadensis, Bonasa umbellus, Tympanuchus phasianellus*), ptarmigan (*Lagopus leucura, L. lagopus*), and waterfowl. The harvest data set aside includes hunting of black bear, brown bear, caribou, Dall sheep, snowshoe hare, and wolf and trapping of beaver, fox, lynx, marten, mink, muskrat, snowshoe hare, wolf, and wolverine. Statistical analyses were conducted using SPSS Statistical Package 19 to calculate descriptive statistics, Pearson correlations, and Analysis of Variances (ANOVAs) to look for patterns in harvesting activities and demographics of harvesters.

Results

Limitation of the survey

This survey was conducted in 2003 and provides data that illustrate harvest activity in the Tanana Valley during that year. Of the 1,000 Forest Use surveys sent out across the Tanana Valley, 296 surveys were returned. Taking into account the undeliverable surveys, the Forest Use Survey achieved a 36% response rate. That response rate is slightly higher than the response rates of mail surveys conducted for national forest planning in Alaska within the same time period (Brown et al. 2002). However, other natural resources mail surveys (spruce bark beetle community perspectives and moose hunting) conducted in Southcentral Alaska had response rates between 46-59% (Whittaker et al. 2001, Flint 2006). The Forest Use Survey's demographic data was compared to results from the 2000 US Census to evaluate how well the survey results represent the general population of the Tanana Valley (Table 2.2). The survey respondent population matched the general population fairly well for gender and household size, but the survey over-sampled older respondents. The survey over-sampled respondents with a bachelor's degree or higher, and under-sampled respondents with lower incomes.

Demographics of Survey Respondent

Descriptive statistics of the demographic data are presented in Table 2.3 and include respondent's age, the number of years that they have been residents in Alaska, education level, household size (number of adults and children in household), household income, and zip code. Correlations were calculated to investigate how different demographic characteristics align with each other (Table 2.4). Age was positively correlated with residency length in Alaska (0.503, $p \leq 0.001$) and negatively correlated with household size (-0.206, $p \leq 0.001$). Older survey respondents tended to have longer Alaska residency than younger respondents, and older respondents tended to have fewer household members.

Education level was slightly negatively correlated with years residency in Alaska (-0.124, $p \leq 0.05$), so survey respondents who have lived in Alaska fewer years tended to have slightly more formal education. Survey respondents with a high formal education level were more slightly likely to live in a more urban area (0.150, $p \leq 0.05$) and have a higher household income (0.299, $p \leq 0.001$). Higher income households were positively correlated with household size (0.238, $p \leq 0.001$) and positively correlated with urban zip codes (0.219, $p \leq 0.001$).

<u>Demographics and Non-harvesters, Personal Use harvesters, and Subsistence use harvesters</u>

Survey respondents were asked if they considered themselves as a Personal use or Subsistence use harvester. Since the survey collected data on five different resources categories (fish, wood and timber resources, non-wood resources, hunting, and trapping), response to this question may refer to any or all of these five resource categories. These two harvester-types were not exclusive, so respondents could identify themselves as neither, one, or both types of harvester. Self-identified non-harvesters totaled 136, while 146 respondents self-identified themselves only as Personal use harvesters, 2 self-identified themselves as Subsistence use harvesters, and 12 self-identified themselves as both a Personal use and Subsistence use harvester. For analysis, respondents that identified themselves only as Subsistence use harvesters and those that identified themselves as both and Personal use or Subsistence use harvesters were combined into one category of Subsistence use harvesters. Analysis of Variance (ANOVA) of non-harvesters, Personal harvesters, and Subsistence use harvesters shows that average Age ranged between 43.1 and 49.2, Years residency in Alaska ranged between 21.4 and 26.1, Education level ranged between 15.0 and 15.9, Household size ranged between 2.4 and 2.7, and Household income ranged between $42,857 and $57,931 (Table 2.5). Average for Age, Years residency in Alaska, Education level, and Household size for these three groups did not differ significantly. Household income differed amongst the groups ($p \leq 0.01$) and was lowest for Subsistence use harvesters

($42,857) (Figure 2.2). Household income was highest for Personal use harvesters ($68,094), and second highest for Non-harvesters ($57,931); these two groups were similar to the mean for all survey respondents ($62,398).

While the majority of non-harvesters, Personal use, and Subsistence harvesters live in urban zip codes, a larger percentage of Subsistence harvesters live in rural and ex-urban[5] zip codes (Figure 2.3) than the overall group, with 14.3% of Subsistence use harvesters claiming rural zip codes and another 14.3% claiming ex-urban zip codes. Still, 71.3% of all Subsistence use harvesters use an urban zip code. For Personal use harvesters, 81.3% use an urban zip code. A larger number of self-identified harvesters, both Personal use and Subsistence use, live in urban areas of the Tanana Valley.

Harvested amounts of NTFPS and fish and game

Surveys asked for the quantities harvested for a specific variety of edible NTFPs including berries, non-edible NTFPs, and fish and game harvested from the boreal forest. From the 296 returned surveys, 196 survey respondents reported harvesting some quantity of an NTFP or fish and game from the forest (Table 2.6). The most popular NTFP harvested was berries, with 131 household (or 44.3% of household) reporting harvesting berries. Blueberries (*Vaccinium uliginosium* L.) were the most common berry harvested with 114 households reporting blueberry harvest (38.5% of

[5] For the purpose of this paper, 'ex-urban' refers to communities that are not large enough to be designated as urban but are too large to be considered rural. See section 3.5 for a more complete explanation.

survey respondents). Households that harvested blueberries harvested a mean of 7.7 quarts of blueberries, with the largest quantities reported as 115 quarts. A total of 876.5 quarts of blueberries were reported harvested for the year. Low bush cranberries (*Vaccinium vitis-idaea* L.), wild raspberries (*Rubus ideaeus* L.), high bush cranberries (*Viburnum edule* Michx.), and wild strawberries (*Fragaria viriniana* Duchesne) were also harvested. The most commonly harvested non-berry edibles were rosehips (*Rosa acicularis* Lindl.) and mushrooms with 8.8% and 7.1%, respectively, reporting harvest of these items. The most common non-edible NTFPs that was harvested was Christmas trees with 13.2% of households reporting having harvested their Christmas tree from the forest.

Firewood was the second most commonly harvested NTFP with 74 households (25.0%) reporting having harvested firewood. The average amount of firewood harvested was 4.7 cords. A total of 350 cords were reported as harvested, with 25 cords of firewood as the largest quantity harvested by a household.

Fish and game, though not usually considered as NTFPs, were widely harvested by survey respondents. Fish were the most common item harvest with 85 households (28.7%) harvesting an average of 49.7 fish. The most commonly harvested fish was grayling with 15.2% of households harvesting and an average of 23.2 fish harvested. Salmon was the second most common fish with 13.2% of households harvesting and an average of 18.9 fish harvested. The least commonly harvested fish was whitefish with only 2.0% of households harvesting whitefish, but whitefish accounted 30.8% of fish harvested—the most number of fish caught of one species with 1,299 whitefish harvested out of a total of 4,223 total fish reported as harvested. The majority of whitefish was caught by one household which reported harvesting 1,200 whitefish.

Moose hunting was also a predominant activity with survey respondents. While only 12.5% of households reported harvesting a moose, more than twice that (26.4%) reported having participated in moose hunting trips. Seventy-eight households reported moose hunting trips. Participating households average 2.7 trip per household, and 36 of the 78 households reported harvesting moose. Successful moose hunting households reported harvesting an average of 1.1 moose. Birds were the second most commonly hunted animal with 45 households (15.2%) harvesting an average of 29.6 birds per harvesting household. Birch harvested included grouse (13.5% of households), ptarmigan (4.7%) and waterfowl (4.1%).

Relationships between demographics and harvest activities

ANOVAs were used to compare the mean quantity of NTFPs harvested by subgroups of harvesters (Table 2.7). Demographic data are used to categorize respondents into different grouping for this analysis. Age groups include: under 35, 35-64, and 65 and over. Years residency in Alaska groups include: less than 5 years in Alaska, 5-19 years in Alaska, and 20 or more years in Alaska. Education level groups include: less than a high school diploma, high school diploma, some college, college graduate, and greater than 16 years of formal education. Household size groups include: 1 adult household member and no children, 2 adult house hold members and no children, 1-2 adult household members with children, and 3 or more adult household members and children may be present. Income level groups include: less than $30,000, $30,000-$100,000, and greater than $100,000. Town size groups were classified by zip codes and include: rural, ex-urban, and urban. According to the 2003 Alaska State Statute AS 14.43.700 the definition of rural community includes:

> A community with a population of 5,500 or less that is not connected by road or rail to Anchorage or Fairbanks or with a population of 1,500 or less that is connected by road or rail to Anchorage or Fairbanks.

For this study, survey respondents from the following communities are considered rural: Cantwell, Denali Park, Minto, Nenana, Northway, and Two Rivers. Using the U.S. Census definition of an 'urbanized area', communities that are larger than 50,000 persons are labeled as urban. For this study, survey respondents from the following communities are considered urban: Eielson, Fairbanks, and North Pole. Communities that are too large to be considered rural and too small to be considered urban are labeled as ex-urban communities. For this study, survey respondents from the following communities are considered ex-urban: Delta Junction, Ester, Healy, Salcha, and Tok; Once again, Personal use and Subsistence use harvester categories include those survey respondents that self-identified themselves only as Personal use harvesters and survey respondents that identified themselves as Subsistence use harvesters (Subsistence use harvesters may have also identified themselves as Personal use harvesters).

No significant relationship emerged between harvesting activities and age of survey respondent. Nor did a significant relationship emerge between harvesting activities and years residency in Alaska. The one significant relationship between household size and harvesting activity was for harvesting Christmas trees ($p \leq 0.\ 1$) where on average, households with 3 or more adults harvested more Christmas trees per household (0.33 trees) than households comprised of 2 adults (0.17 trees). Households with just one adult and households with 1-2 adults with children harvested fewer trees (0.11 trees for both these types of households).

Households in the highest income group harvested statistically significantly larger quantities of wild strawberries ($p \leq 0.\ 01$) and house logs ($p \leq 0.\ 1$), although these NTFP items were harvested by only a small percentage of households, 3.7% and 1.7%, respectively. The average number of moose hunting trips taken by the lowest Household income group was significantly higher than the higher income groups ($p \leq 0.\ 01$); the low Household income group averaged 1.5 moose hunting trips whereas the mid and high Household income group averaged 0.6 and 0.5, respectively. The 22 survey respondents that reported harvesting landscaping plants were all part of the mid Household income group ($p \leq 0.\ 5$).

Compared with others, survey respondents of the lowest Education level group (those that did not finish high school) had significantly higher harvest levels of berries ($p \leq 0.001$), blueberries ($p \leq 0.01$), low bush cranberries ($p \leq 0.1$), raspberries ($p \leq 0.001$), rose hips ($p \leq 0.001$), mushrooms ($p \leq 0.001$), birch bark ($p \leq 0.001$), and spruce roots

($p \leq 0.001$). The lowest Education level group comprised of 3% of survey respondents; however, this group averaged a much higher harvest amount of some NTFPs than the average harvested amount for any of the other Education level groups. For instance, this group harvested an average of 21.6 quarts of berries whereas the other four groups averaged between 3.5 and 6.4 quarts of berries. Compared to the average amount harvested for all survey respondents, the lowest Education level group harvested 4.0 times the amount blueberries (12.1 quarts compared to 3.0 quarts), 2.9 times the amount of low bush cranberries, 8.2 times the amount of raspberries, 11.9 times the amount of rose hips, 9.7 times the amount of mushrooms, 16.0 times the amount of birch bark, and 21.6 times the amount of spruce roots than the overall average for these items. This pattern also holds for the number of fish and game items harvested, including total fish harvested ($p \leq 0.001$), salmon ($p \leq 0.001$), whitefish ($p \leq 0.001$), grouse ($p \leq 0.1$), and ptarmigan ($p \leq 0.1$). The middle Education level group, those with some post-high school education, harvested significantly more diamond willow[6] ($p \leq 0.1$) and took more moose hunting trips ($p \leq 0.01$) than the other Education level groups. Generally, firewood harvest had an inverse relationship with Education level ($p \leq 0.1$) where lowest Education level group had the highest average of firewood harvest (2.1 cords) and the highest Education level group had the lowest average of firewood harvest (0.6 cords).

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[6] Diamond willow is willow (*Salix* spp.) with diamond-shaped depression patterns on its stems. These depressions are believed to be caused by fungus, possibly *Valsa sordida,* or other fungi (Lutz 1958).

Like Education level, the survey respondent's zip code indicating the size of the town they lived in indicated statistical significance in some of their harvesting activities. Some NTFPs had highest average household harvest in rural zip codes and lowest average household harvest in urban zip codes. These included total berry harvest ($p \leq 0.01$), blueberries ($p \leq 0.01$), raspberries ($p \leq 0.05$), rosehips ($p \leq 0.01$), and diamond willow ($p \leq 0.001$). Fish and game harvest that follows this pattern, i.e. largest harvest in rural zip codes and lowest average household harvest in urban zip codes, is shown in moose hunting trips ($p \leq 0.001$) and for grouse ($p \leq 0.1$). Some NTFPs were harvested at statistically significant greater quantities by households in rural zip codes than for those households in ex-urban and urban zip codes. These include harvest values for birch bark ($p \leq 0.001$), burls ($p \leq 0.001$), and spruce roots ($p \leq 0.001$). Total fish harvested ($p \leq 0.001$), salmon ($p \leq 0.001$), pike ($p \leq 0.001$), and whitefish ($p \leq 0.001$) were collected in larger amounts by households in rural zip codes when compared to ex-urban and urban households. Three NTFPS that were harvested by very few households (1.7% or less of survey respondents) were harvested almost exclusively by households in ex-urban zip codes; these include medicinal plants, spruce cones, and saw logs. Households in rural and ex-urban zip codes harvested firewood in larger quantities than households in urban zip codes (Figure 2.4).

Household harvest of most NTFPs and fish and game was significantly higher by survey respondents who identified themselves as either Personal use and/or

Subsistence use harvesters than those who did not identify themselves as a Personal use or a Subsistence use harvester (Table 2.7).

Correlations among harvest activities

Results for Pearson correlations investigating if certain NTFPs and fish and game were harvested in tandem with each other are presented in Table 2.8. All berry harvest was grouped together to streamline this analysis. Similarly, different species of fish and different types of birds were also aggregated into a Fish category and a Bird category, respectively. The most significant correlations were among spruce roots, fish, birch bark, rose hips, and berries (Figure 2.5), where each of these harvested items were positively correlated with each other ($p \leq 0.001$). Other correlations worth noting are medicinal plants and spruce cones (0.786, $p \leq 0.001$) and diamond willow and tree burls (0.738, $p \leq 0.001$).

Geographic distribution of harvest activities

Harvest of NTFPs and fish and game was not spread evenly across the Tanana Valley (Figure 2.6). Harvest was concentrated near major population centers such as Fairbanks and North Pole, and to a lesser degree, Delta Junction and Tok. Compared to more remote areas, higher levels of harvesting also occurred along major roadways and waterways with access to the forest. For the most part, this trend of harvesting activities applies to harvest of different types of NTFPs including berry harvest (Figure

2.7), non-berry edible NTFP harvest (Figure 2.8), non-edible NTFP harvest (Figure 2.9), and firewood harvest (Figure 2.10). This trend also applies to hunting, both moose (Figure 2.12) and bird (Figure 2.13), but the epicenter of fishing activity was not centered on Fairbanks, the largest population center in the Tanana Valley. The most commonly used area for fishing is southeast of Fairbanks (Figure 2.11).

Discussion

Although the demographic data of the sample does not match 2000 U.S. Census data perfectly, the Forest Use Survey dataset provides a comprehensive look at how residents in the Tanana Valley utilize the boreal forest for their NTFP harvesting activities. The results of this research can be extrapolated to the Tanana Valley as a whole (Bates et al. 2004). Extrapolation would be more reliable by obtaining a sense of the harvesting activities of those households who received surveys but did not respond, in order to understand if their harvesting activities parallel results from the survey. It is possible that NTFP harvesters were more likely to return survey forms because they value NTFPs and their harvesting experiences. If non-responders had lower harvesting rates, extrapolating these results to a larger scale may over-estimate NTFP harvesting activities for the Tanana Valley. Nonetheless, this research begins to identify who is harvesting, what they are harvesting, how much they are harvesting, and where they are harvesting.

The "Who" of Harvesting

Analysis of the demographic data showed that the response to the survey was fairly representative of the population in Interior Alaska (Table 2.2). Older respondents tended to be long term residents of Interior Alaska. Younger survey respondents tended to have larger household sizes, which is logical since they are more likely to have children living at home.

Personal use or subsistence use harvesters are prevalent in all three types of zip codes classes: urban, ex-urban, and rural. In ex-urban zip codes, harvesters are equally likely to identify themselves as a subsistence use harvester as a personal use harvester. In rural zip codes, harvesters more likely to identify themselves as a subsistence use harvester than a personal use harvester. However, the majority of subsistence use and personal use harvesters claimed urban zip codes (Figure 2.3). These results demonstrate that no rural-urban divide was present in the data set. Subsistence use harvesters are found in urban areas and some rural residents identify themselves as personal use harvesters. Therefore, if regulations on managing either of these types of harvesting were to change, education outreach to inform the user groups would have to extend across the Tanana Valley to communities of all sizes.

Respondents generally accurately identified themselves as harvesters versus non-harvesters (Table 2.7); therefore, when survey respondents identified themselves as a harvester, it provided a clear indication whether their household harvested from the forest. Self-identified harvesters, whether they were personal use or subsistence use, were more likely to report harvesting berries, other NTFPs such as firewood and mushrooms, and many of the fish and game species than respondents who did not identify themselves as harvesters.

Education level and zip codes also are good indicators of harvesting activities (Table 2.7), but household incomes are not. Given generally high education level of the sampled population, a few very high harvest households with very low levels of formal education that were from rural zip codes contribute disproportionately to this result. Low entry barriers exist to this activity so a broad cross-section of population is able to participate. At the least, this shows that harvesting practices transcend some socioeconomic divides (additional and more in-depth insight into the motivations of harvesters is presented in Chapter 3). The widespread interest and participation in harvesting is consistent with the activities such as berry picking being seen as recreational and not a means to subsidize informal household incomes. Many of these activities can be done with limited investment beyond the harvester's time and transportation cost to the harvesting spot.

The "What" and "How Much" of Harvesting

Berries, especially blueberries, were the most commonly reported harvested NTFP with over one-third of household harvesting berries. An advantage of harvesting berries is that they are easy to identify, it does not take specialized knowledge or skills to harvest or utilize the berries, so it is perhaps not surprising that berries are a common and popular NTFP to harvest. Firewood was the second most common NTFP harvested with a quarter of household harvesting firewood. Fishing and hunting moose and game birds were also prevalent activities which shows that the "hunter and gather" lifestyle still plays a role in Alaskans' livelihood in the Tanana Valley.

To look for pattern in what specific NTFPs individual residents of the Tanana Valley are harvesting, Pearson correlations were calculated between all the different forest resources. Each NTFP was paired with all the other NTFPs and other included forest resources such as fish and game items. These pairings were tested to see if a household harvests one NTFP then that will indicates that they are also likely to harvest other specific forest resources. Out of 171 possible pairing amongst all the different NTFPs and forest resources in this data set, only 14 notable correlations emerged. Figure 2.5 illustrates ten of the 15 correlations that link the co-harvesting of birch bark, spruce roots, fish, rosehips, and berries. The additional five pairs with strong correlations that are not incorporated into Figure 2.5 include medicinal plants-spruce cones, diamond willow-tree burls, medicinal plants-moose hunting trips, spruce cones-moose hunting trips, and berries-Christmas trees. Some of these pairs make sense since birch bark and spruce roots are often used together when craft traditional-style birch bark baskets. Diamond willow and tree burls are similar NTFPs, so it's reasonable that a diamond willow harvester would also be interested in tree burls. The lack of any additional patterns in harvesting activities is notable, suggesting that resource managers must carefully consider which forest resources are aggregated for management into broader categories, because participation in harvesting of one item does not necessarily mean that additional similar items are of interest to harvesters.

The "Where" of Harvesting

While data on harvesters' modes of transportation was not collected, roads and rivers, and to a lesser degree—trails, provide access to harvesting spots. The type of forest resource being harvested determines where harvesters will travel for their activities. Harvesting areas closer to home may be preferable when taking short harvesting trips, such as an hour of berry picking or harvesting other edible NTFPs, in the evening after work. Other activities may inspire participants to travel longer distances from home. For instance, part of the appeal of fishing may include the experience of getting out of town to a serene environment.

Conclusion

This survey gives a snapshot in time of how residents in Interior Alaska were utilizing the forest for harvesting in 2003. Changes in the economy have been shown to change peoples' harvesting practices. As Emery (1998) documented, forest resources give rise to "invisible livelihoods" where people rely harvesting on NTFPs to make it through lean times by either providing supplemental income or through the consumption of edibles. Harvesting activities may increase as NTFP products are used, sold, or traded in informal markets/economies to supplement or stretch tight household budgets. Harvesting firewood is one way some residents in Interior Alaska combat rising heating and energy costs to get through cold winters (Mowry 2013). Another way that increased energy costs may alter harvesting activities is to shrink the distance that harvesters are willing to travel. This would further concentrate harvesting activities around population centers such as Fairbanks, potentially leading to overharvest in some areas or concentrating activities may increase conflict with other forest resource uses or land development projects.

Changes in forest management such as increasing timber harvest for biomass energy production could conflict with NTFP harvesters if biomass timber sales are adjacent to berry patches or overlap with firewood or mushroom harvesting areas. Alternatively, increasing timber sales may improve harvesters' access to the forest through new roads built, and clearing off biomass may benefit the NTFP resources by increasing their abundance on the landscape.

Managing for multiple use of the forest requires understanding the different user groups involved, and how their activities may interact to create conflict or possible benefit each other. To do so, it is critical to have knowledge of who is participating in what activities and where so that informed decisions may be made. This research documents how ubiquitous harvesting activities are across the Tanana Valley. However, since the survey analyzed here illustrates only one point in time, more research is need to keep current as changes in environment and the economy drive other forest uses particularly large scale wood biomass harvest for energy production.

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Figures and Tables

Table 2.1. Categories of NTFPs
Seven categories of NTFPs as defined by McLain and Love (2005)

	Categories of NTFPs
1	Foods
2	Medicinal plants and fungi
3	Floral greenery and horticultural stock
4	Fiber and dye plants, lichens, and fungi
5	Oils, resins, and other chemical
6	Fuelwood
7	Small-diameter wood used for poles, posts, and carvings

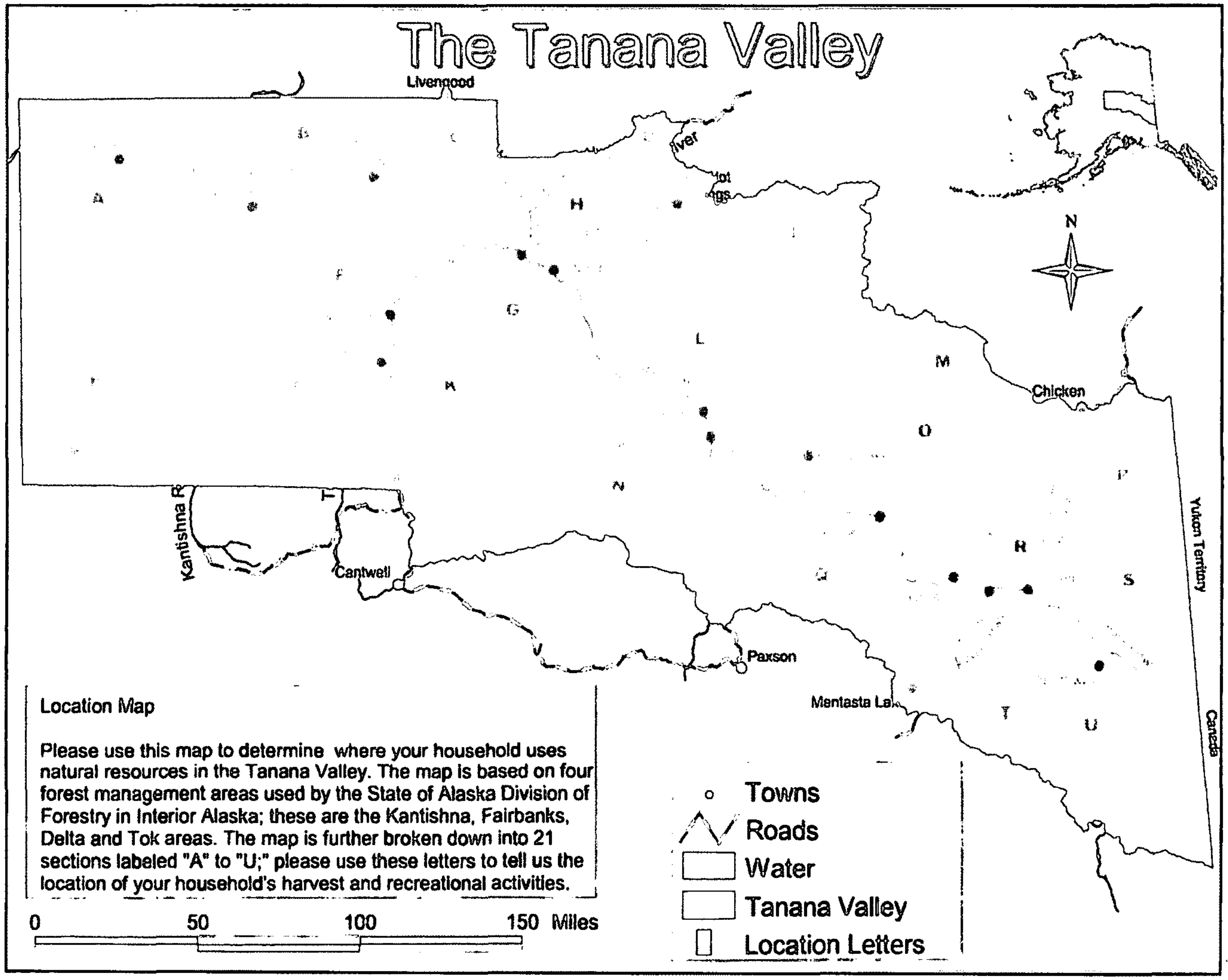

Figure 2.1. Forest Use Survey Map of the Tanana Valley

This map provide to survey respondents with 21 blocks to identify where their harvesting activites took place.

Table 2.2. Comparison of survey demographics with 2000 U.S. Census results

		Forest Use Survey	2000 U.S. Census
Age		48.4	29.5
Gender			
	male	52.4%	52.2%
	female	47.6%	47.8%
Education			
	Percent high school graduate or higher	96.9%	91.8%
	Percent bachelor's degree or higher	46.3%	27.0%
Household size		2.6	2.68
Household income		$62,398	$49,076

Table 2.3. Demographics of survey respondents

	N	Mean	Std. Error	Std. Deviation	Minimum	Maximum
Age	285	48.4	0.79	13.39	19	88
Years residency in Alaska	291	25.0	0.89	15.16	2	88
Education level	287	15.2	0.18	3.02	8	21
Household size	290	2.6	0.08	1.36	1	8
Household income	269	62,398	2,147	35,206	5,000	175,000

Table 2.4. Correlations of survey respondents' demographic data

		Age	Years residency in Alaska	Education level
Age	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	285		
Years residency in Alaska	Pearson Correlation	.503****	1	
	Sig. (2-tailed)	0.000		
	N	284	291	
Education level	Pearson Correlation	0.051	-.124**	1
	Sig. (2-tailed)	0.396	0.037	
	N	281	286	287
Household size	Pearson Correlation	-.206****	-0.072	-0.013
	Sig. (2-tailed)	0.000	0.221	0.822
	N	285	289	286

Household size	Household income	Residency in rural, ex-urban, or urban community[a]
1		
290		

Household income	Pearson Correlation	0.015	-0.009	.299****	.238****	1	
	Sig. (2-tailed)	0.811	0.882	0.000	0.000		
	N	266	268	267	268	269	
Residency in rural, ex-urban, or urban community[a]	Pearson Correlation	0.019	0.013	.150**	-0.038	.219****	1
	Sig. (2-tailed)	0.752	0.821	0.011	0.523	0.000	
	N	283	288	284	288	266	289

* $p \leq 0.1$; ** $p \leq 0.5$; *** $p \leq 0.01$; **** $p \leq 0.001$

[a]Town groups: 1= rural; 2= ex-urban; 3= urban (Rural includes: Cantwell, Denali Park, Minto, Nenana, Northway, and Two Rivers; ex-urban includes Delta Jct, Ester, Healy, Salcha, and Tok; urban includes Eielson, Fairbanks, and North Pole);

Table 2.5. Differences and similarities in demographics of self-identified harvester types
Demographics of self-identified non-harvesters, personal use harvesters, and subsistence use harvesters compared using Analysis of Variance (ANOVA)

	N	Age	Years residency in Alaska	Education level	Household size	Household income***
Non-harvester	116-133	49.2	24.3	15.0	2.4	57,931
personal use harvester	139-145	48.1	26.1	15.4	2.7	68,094
Subsistence use harvester	14	43.1	21.4	15.9	2.6	42,857
Total	269-290	48.4	25.0	15.2	2.6	62,398

*$p \leq 0.1$; **$p \leq 0.5$; ***$p \leq 0.01$; ****$p \leq 0.001$

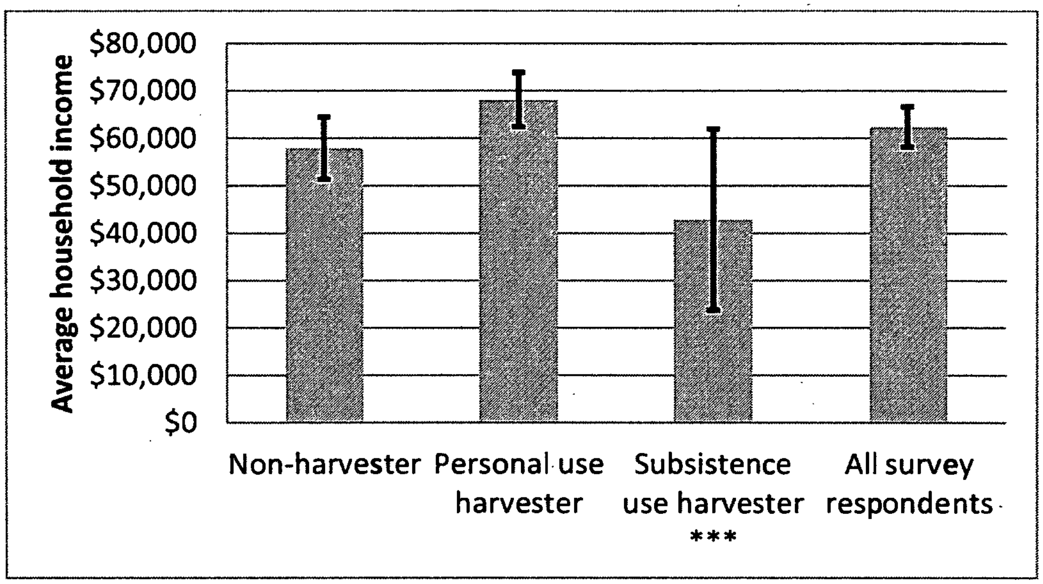

Figure 2.2. Income of self-identified harvester types
(*$p \leq 0.1$; **$p \leq 0.5$; ***$p \leq 0.01$; ****$p \leq 0.001$)

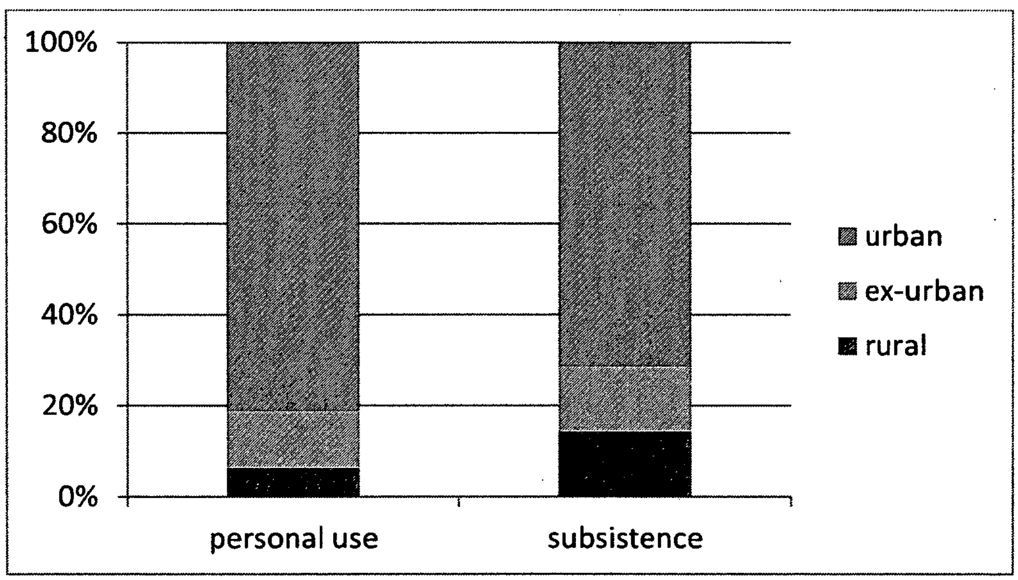

Figure 2.3. Geographic distribution of self-identified harvester types
Distribution of personal use and subsistence harvesters in urban, ex-urban, and rural communities

Table 2.6. Harvest of non-timber forest products and wild fish and game by survey respondents

	N % households	Mean	Unit	Std. Error	Std. Deviation	Range	Minimum harvest	Maximum harvest	Total amount harvested
Berries									
Total berries harvested	131 44.3%	12.2	quarts	1.29	14.73	114.5	0.5	115	1595.25
Blueberries	114 38.5%	7.7	quarts	1.04	11.13	99.5	0.5	100	876.5
Low bush cranberries	65 22.0%	5.8	quarts	0.56	4.52	19.5	0.5	20	378
Wild raspberries	51 17.2%	3.9	quarts	0.65	4.63	23.5	0.5	24	201.25
High bush cranberries	39 13.2%	3.3	quarts	0.39	2.41	9.5	0.5	10	129.5
Wild strawberries	11 3.7%	0.9	quarts	0.13	0.44	1.5	0.5	2	10
Other Edibles									
Rose hips	26 8.8%	3.3	quarts	0.92	4.7	24.5	0.5	25	85
Mushrooms	21 7.1%	9.9	quarts	3.02	13.86	59	1	60	208
Medicinal plants	5 1.7%	10.2	plants	5.58	12.48	29	1	30	51

	Birch sap	3 1.0%	5.5	gallons
Non-edibles				
	Christmas tree	39 13.2%	1.2	trees
	Landscaping plants	22 7.4%	8.2	plants
	Birch bark	16 5.4%	31.2	pieces
	Pole log	11 3.7%	23.5	logs
	Diamond willow	9 3.0%	14.8	sticks
	Tree burls	6 2.0%	7.5	burls
	Spruce cones	5 1.7%	42.8	cones
	House logs	5 1.7%	87	logs
	Spruce roots	3 1.0%	73.3	feet
	Saw logs	3 1.0%	175	logs
Fuelwood				
	Firewood	74 25.0%	4.7	cords

3.4	5.89	11.5	0.5	12	16.5
0.1	0.63	3	1	4	48
1.24	5.83	24	1	25	180
15.9	63.61	249	1	250	499
5.33	17.68	54	6	60	259
5.19	15.56	49	1	50	133
3.72	9.12	23	2	25	45
19.5	43.61	111	4	115	214
31.84	71.2	180	20	200	435
39.3	68.07	130	20	150	220
114.56	198.43	375	25	400	525
0.49	4.23	24	1	25	350

Fish and Game				
	Total fish	85 28.7%	49.7	fish
	Grayling	45 15.2%	23.2	fish
	Salmon	39 13.2%	18.9	fish
	Trout	34 11.5%	16.1	fish
	Pike	26 8.8%	16	fish
	Burbot	24 8.1%	7.5	fish
	Whitefish	6 2.0%	216.5	fish
	Moose	37 12.5%	1.1	moose
	Moose hunting trips	78 26.4%	2.7	trips
	Total birds	45 15.2%	29.6	birds
	Grouse	40 13.5%	11.5	birds
	Ptarmigan	14 4.7%	13.8	birds
	Waterfowl	12 4.1%	56.7	birds

18.79	173.26	1580	1	1581	4223
4.05	27.16	99	1	100	1046
7.54	47.07	299	1	300	737
3.63	21.16	99	1	100	546
5.67	28.9	149	1	150	415
1.16	5.68	19	1	20	180
197.02	482.61	1197	3	1200	1299
0.05	0.31	1	1	2	41
0.32	2.8	14	1	15	212
12.17	81.64	549	1	550	1332
1.59	10.06	49	1	50	459.5
3.37	12.61	38	2	40	192.5
40.5	140.29	499	1	500	680

Table 2.7. Harvesting activities by demographic groups

Analysis of Variance (ANOVA) results for non-timber forest products and wild fish and game harvest by demographic groups

	Age[a]	Years residency in Alaska[b]	Education level[c]	Household size[d]	Household income[e]	Residency in rural, ex-urban, or urban community[f]	Personal use harvester[g]	Subsistence use harvester[h]
Berries								
Total berries harvested			****			***	****	****
Blueberries			***			***	****	****
High bush cranberries							****	****
Low bush cranberries			*				****	****
Wild raspberries			****			**	****	**
Wild strawberries					***		***	
Other Edibles								
Rose hips			****			***	***	
Mushrooms			****				**	***
Medicinal plants						**		*
Birch sap								
Non-edibles								
Christmas tree				*			****	

Landscaping plants

Birch bark

Pole log

Diamond willow stick

Tree burl

Spruce cones

House log

Spruce roots

Saw log

Fuelwood

Firewood

Fish and Game

Total fish

Grayling

Salmon

Trout

Pike

Burbot

Whitefish

Moose

Moose hunting trips

Total birds

Grouse

***		***	****	****			*		****		***			****	****		****	*	****
****	*	**	**			*			****	**	***	*	**	*	***		****	**	*
	****		****	****	**		****	***	****	****		****		****		****		****	*
**						*												***	
	****		*				****		*	****		****				****		***	*

Ptarmigan	*	**
Waterfowl		

* $p \leq 0.1$; ** $p \leq 0.5$; *** $p \leq 0.01$; **** $p \leq 0.001$

[a]Age groups: under 35; 35-64; 65+

[b]Years residency in Alaska groups: less than 5 years in Alaska; 5-19 years in Alaska; 20+ years in Alaska;

[b]Education level groups: less than a high school diploma; high school diploma; some college; college graduate; post-college

[d]Household size groups: 1 adult household member, no children; 2 adult house hold members, no children; 1-2 adult house hold members with children ; 3+ adult house hold members, children may be present;

[e]Income level groups: less than $30,000; $30,000-$100,000; greater than $100,000;

[f]Town groups: rural; ex-urban; urban (Rural includes: Cantwell, Denali Park, Minto, Nenana, Northway, and Two Rivers; ex-urban includes Delta Jct, Ester, Healy, Salcha, and Tok; urban includes Eielson, Fairbanks, and North Pole);

[g]Personal use harvester: self-identified as a Personal use harvester

[h]Subsistence use harvester: self-identified as a Subsistence use harvester

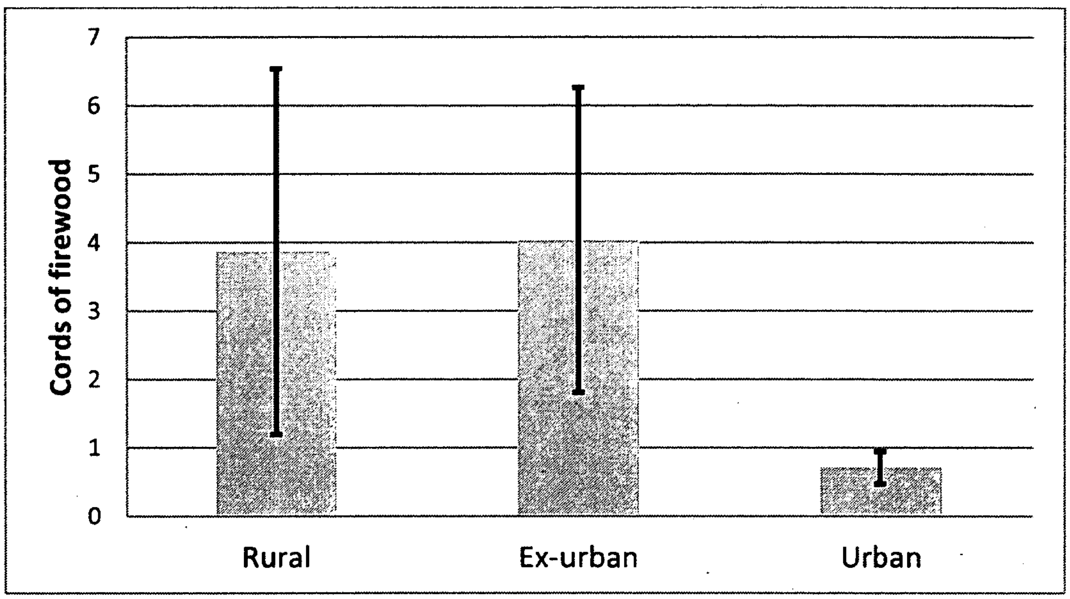

Figure 2.4. Average household harvest of firewood by zip codes

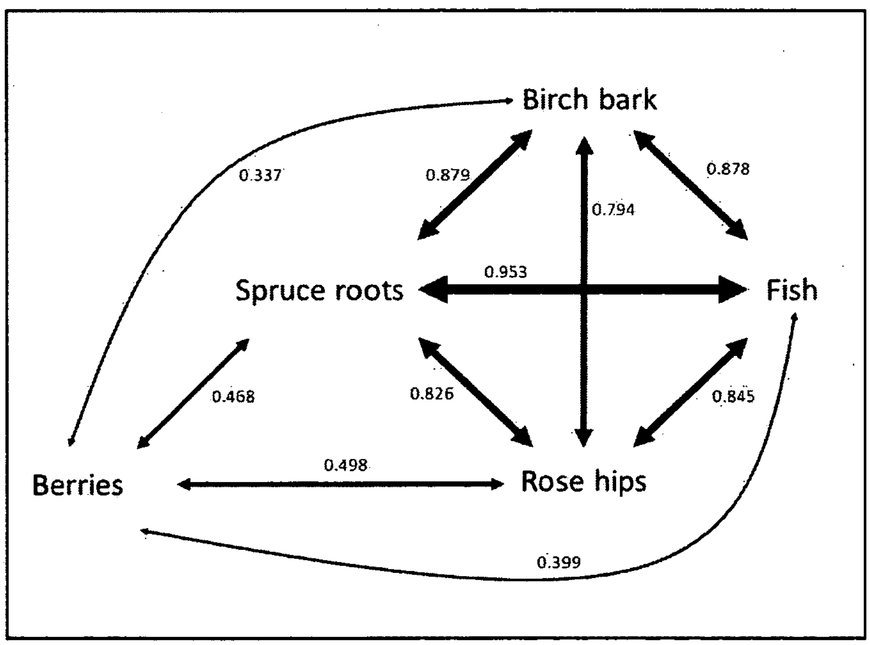

Figure 2.5. Pearson correlations between harvested items
($N = 296$, $p \leq 0.001$).

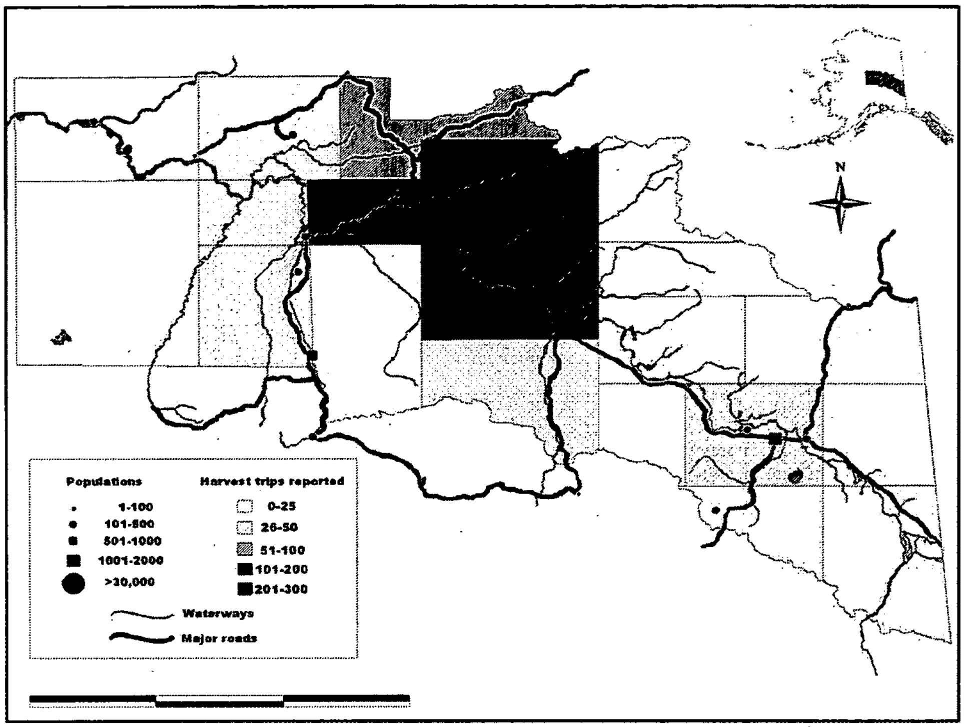

Figure 2.6. Geographic distribution of all harvesting activities in the Tanana Valley

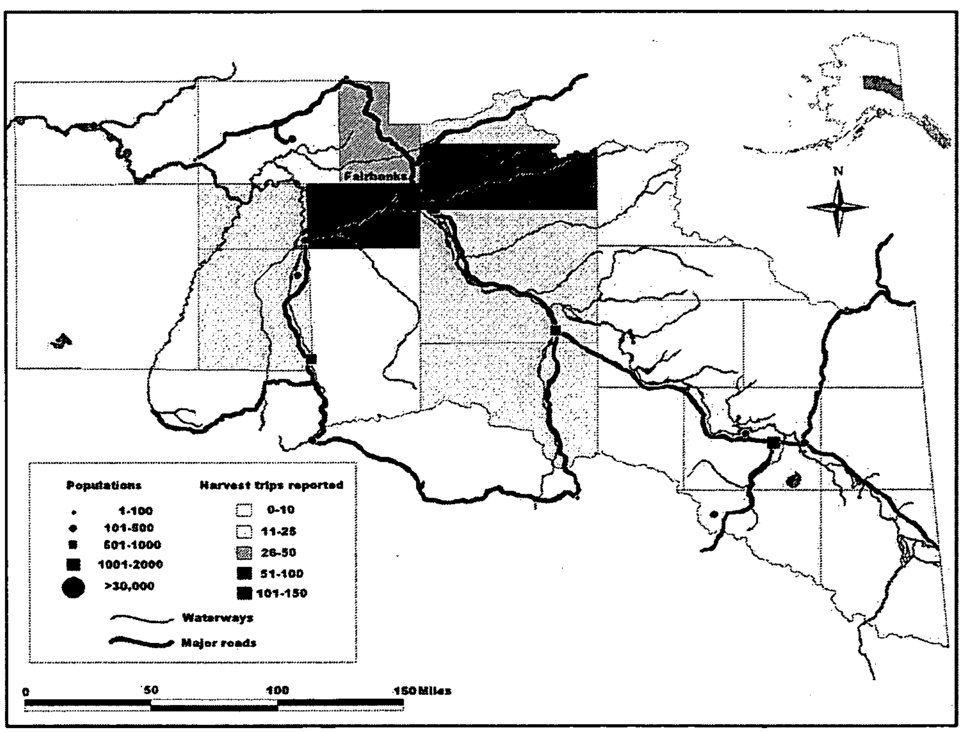

Figure 2.7. Geographic distribution of berry harvest in the Tanana Valley.

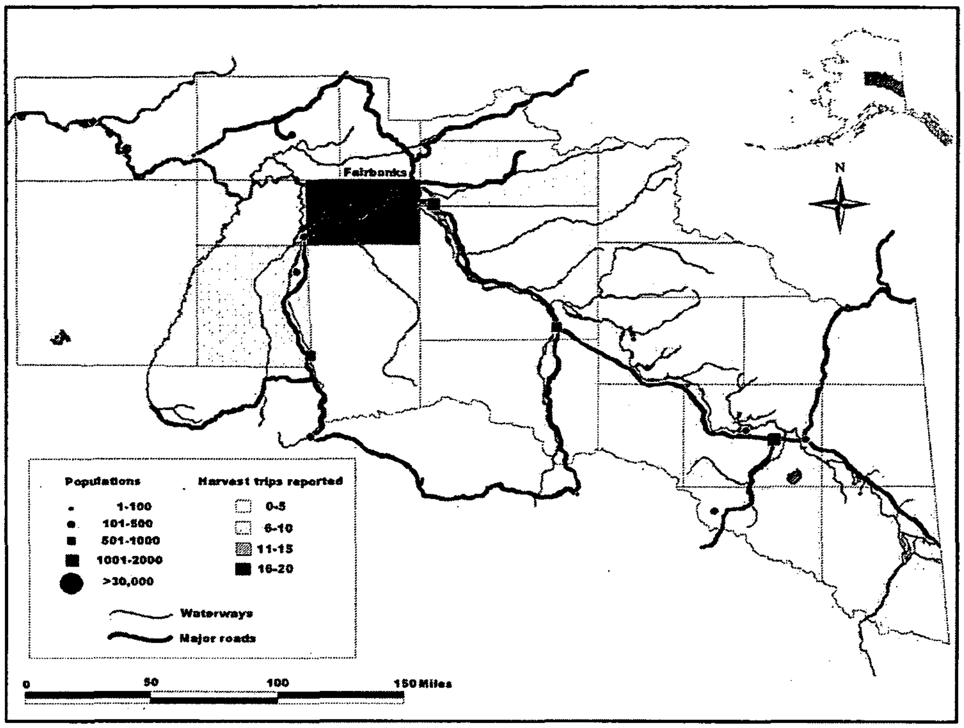

Figure 2.8. Geographic distribution of non-berry edible NTFP harvest in the Tanana Valley

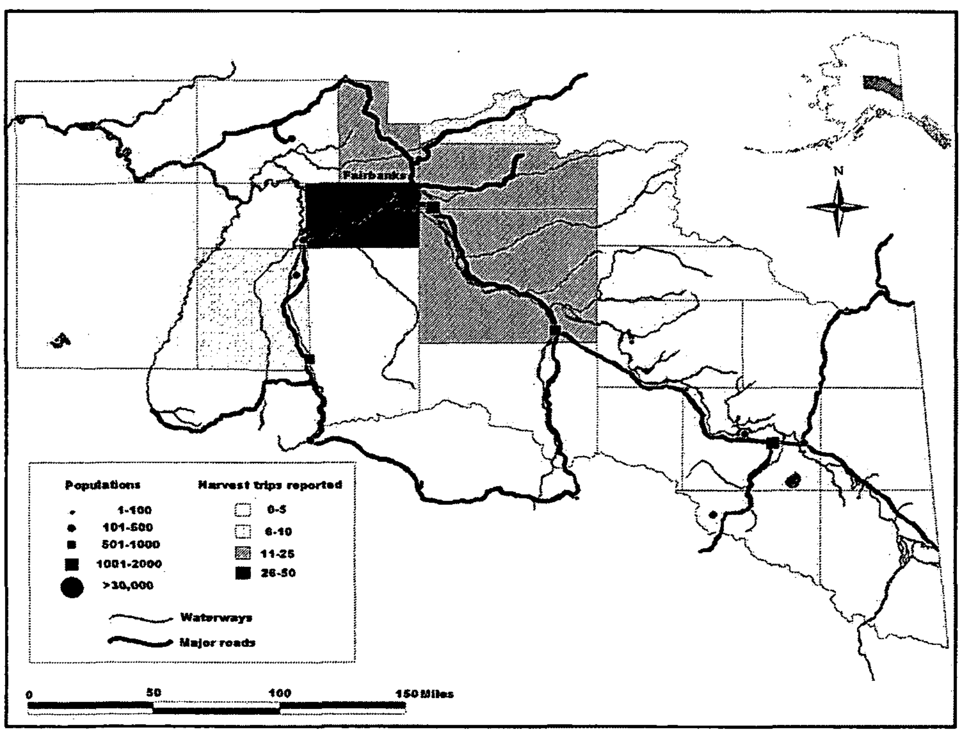

Figure 2.9. Geographic distribution of non-edible NTFP harvest in the Tanana Valley

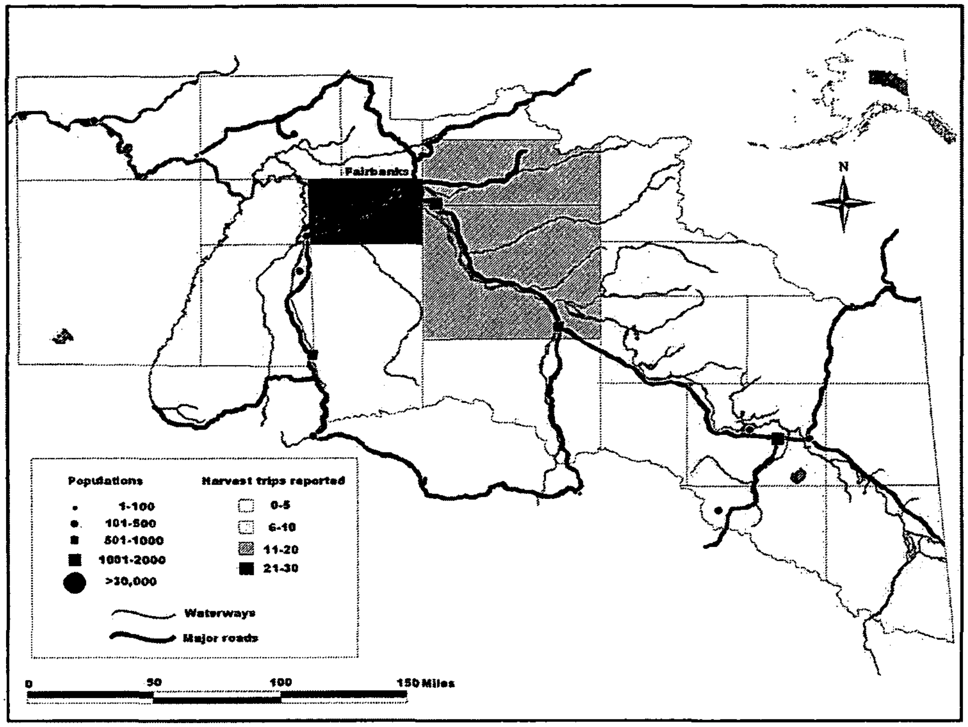

Figure 2.10. Geographic distribution of firewood harvest in the Tanana Valley

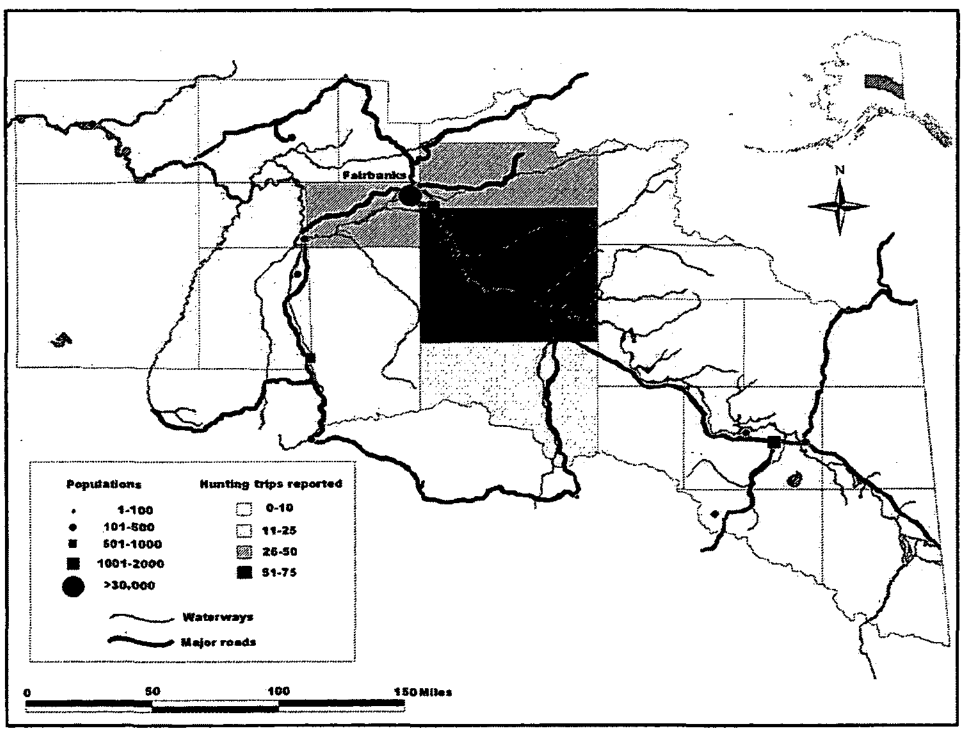

Figure 2.11. Geographic distribution of fishing in the Tanana Valley

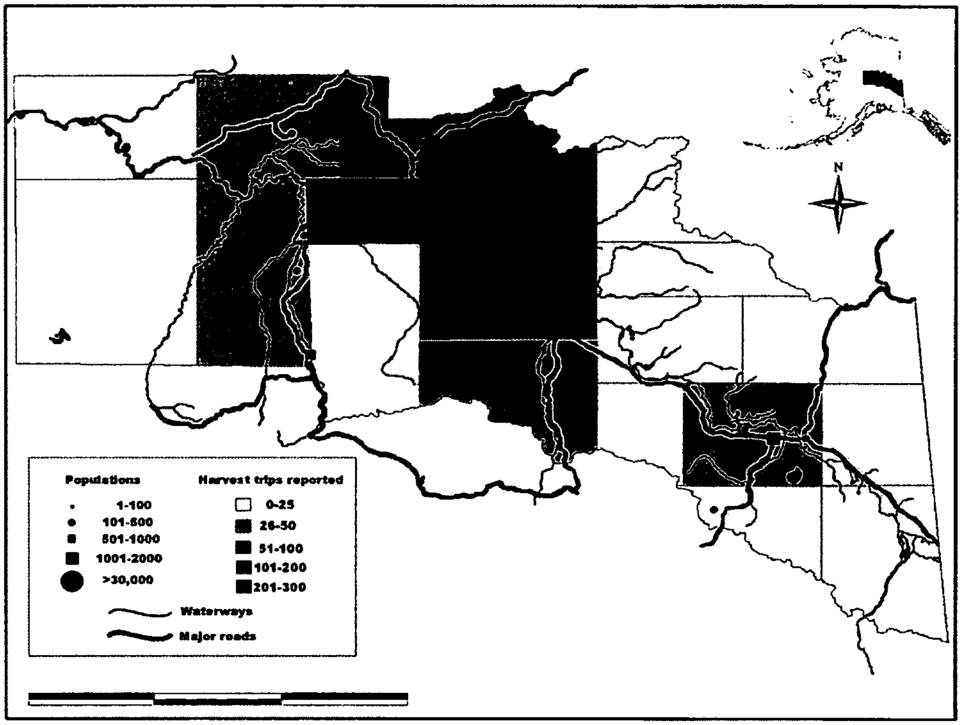

Figure 2.6. Geographic distribution of all harvesting activities in the Tanana Valley

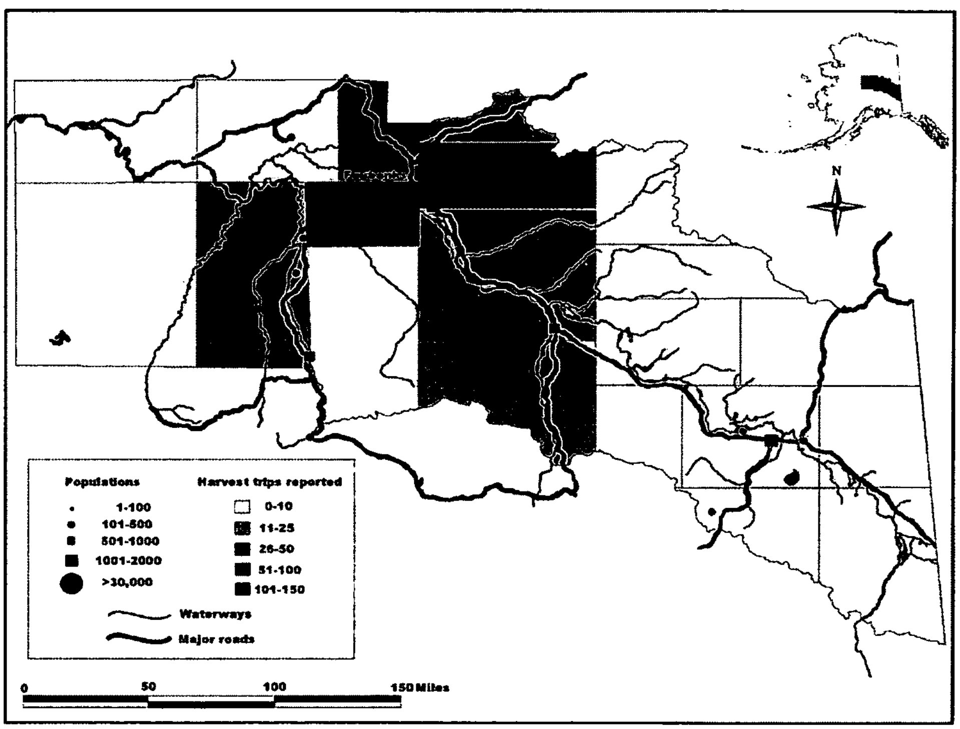

Figure 2.7. Geographic distribution of berry harvest in the Tanana Valley.

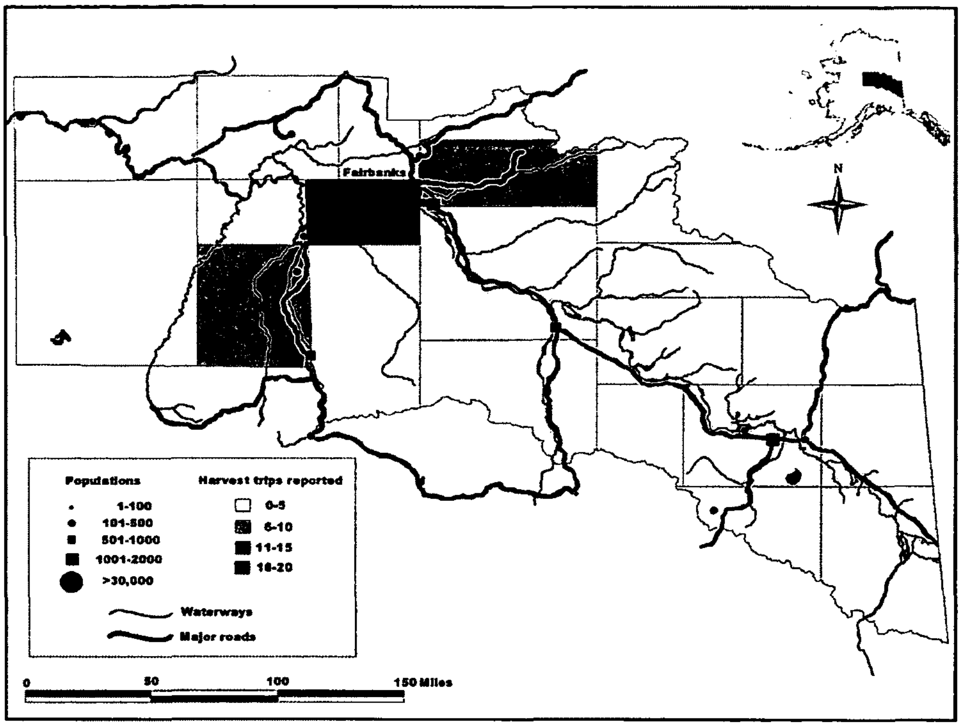

Figure 2.8. Geographic distribution of non-berry edible NTFP harvest in the Tanana Valley

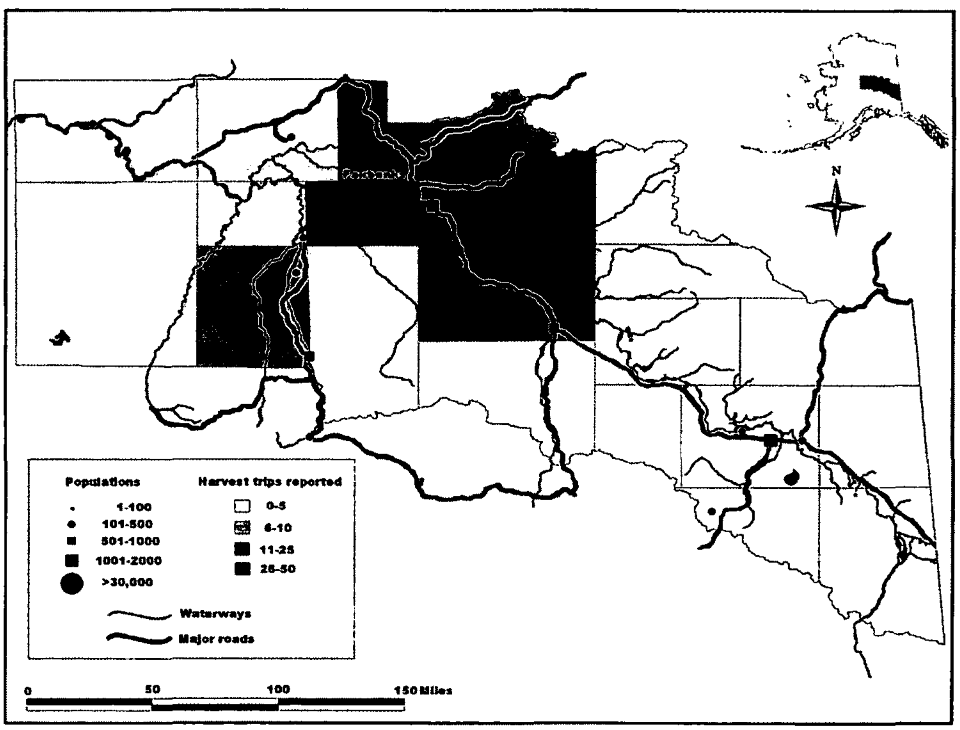

Figure 2.9. Geographic distribution of non-edible NTFP harvest in the Tanana Valley

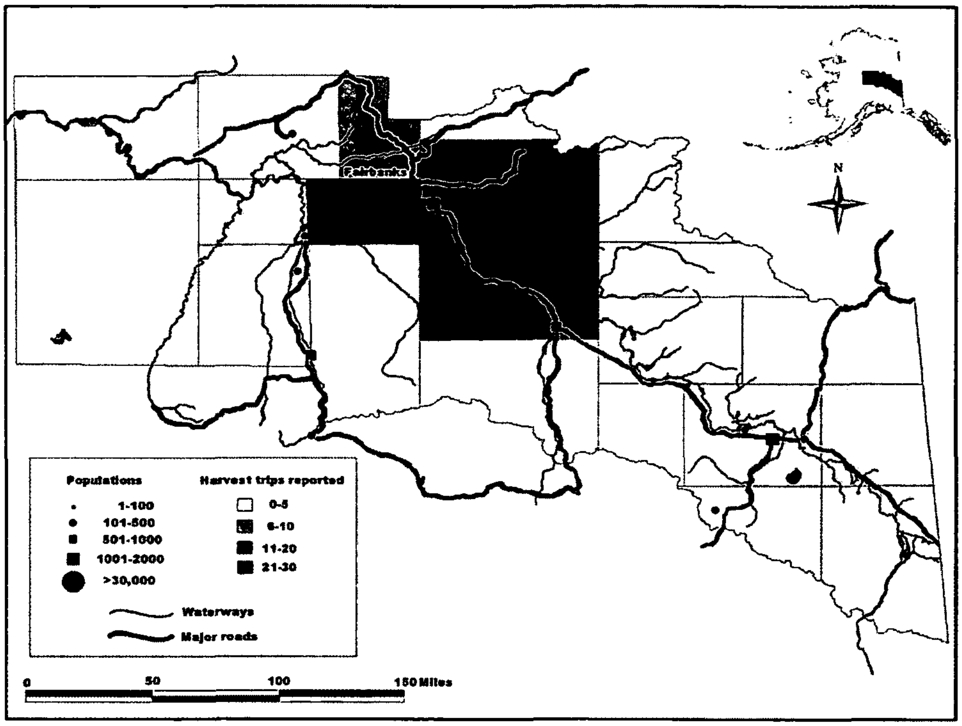

Figure 2.10. Geographic distribution of firewood harvest in the Tanana Valley

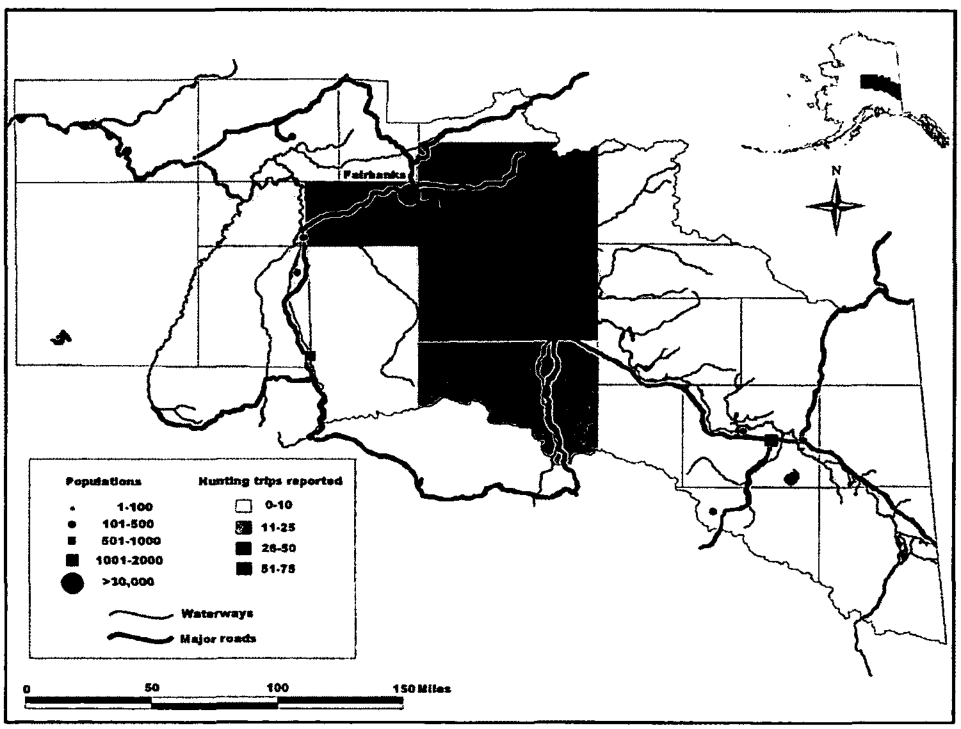

Figure 2.11. Geographic distribution of fishing in the Tanana Valley

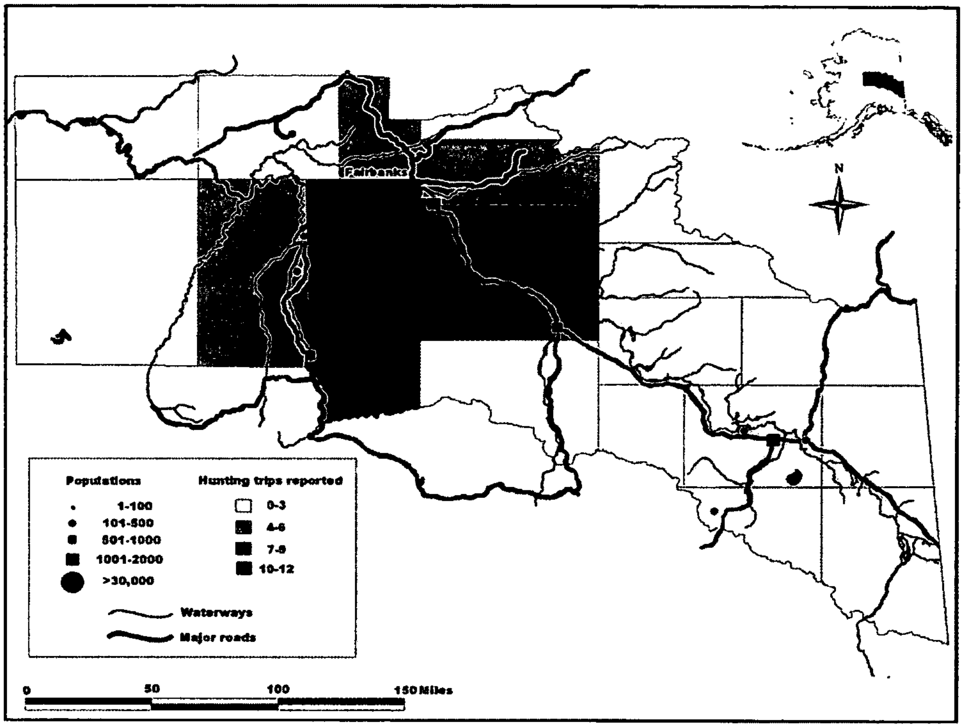

Figure 2.12. Geographic distribution of moose hunting in the Tanana Valley

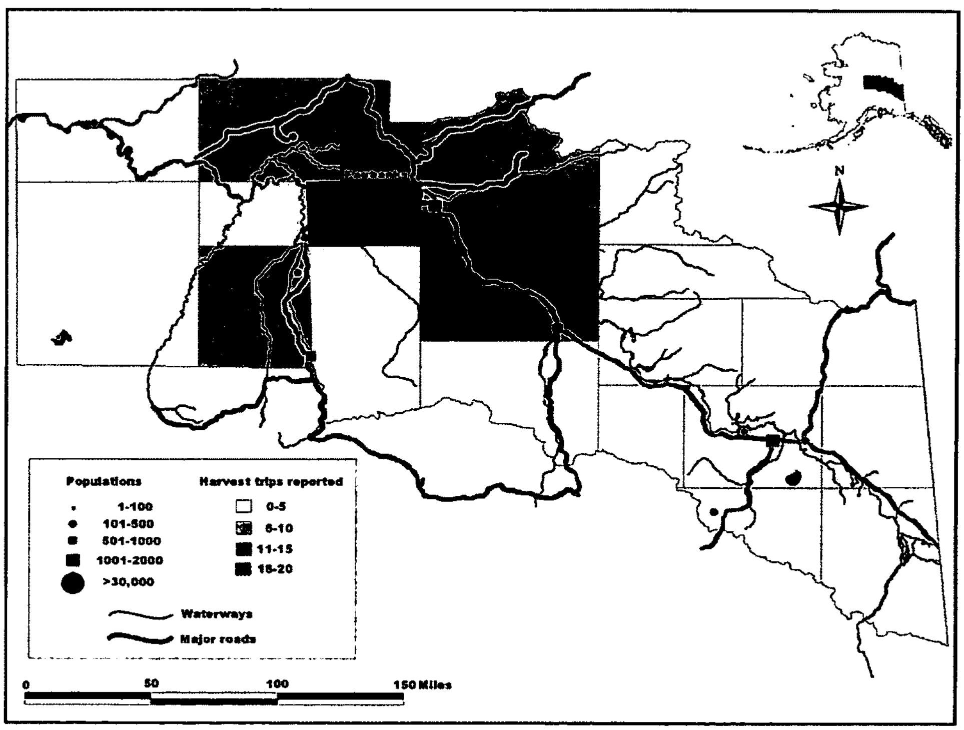

Figure 2.13. Geographic distribution of bird hunting in the Tanana Valley

Chapter 3: Motivations for Participation and Benefits from Non-timber Forest Product Harvesting in Interior Alaska

Abstract

Harvesting non-timber forest products (e.g. berries, mushrooms, and firewood) is a prevalent activity for residents living in Alaska's boreal forest region. This study employed semi-structured interviews with experienced NTFP harvesters in the Tanana Valley, and then used grounded theory techniques (Ulin et al. 2005) to analyze the transcripts. Harvesters are seeking complex experiences with multiple motivations for participating in harvestings beyond going out and filling their berry buckets and wood sheds. These motivations include spending time outdoors, and spending time with family and friends while harvesting. Harvesters receive both tangible and intangible benefits from their activities such as high-quality products that are otherwise unavailable or inaccessible, a contribution to their household economy, improved mental health, a spiritual experience, and developing connections to the land, nature, and their culture. These results offer land managers insight on what NTFP harvesting activities when they manage the forested lands for multiple uses.

Introduction

Subsistence and personal use harvesting of non-timber forest products[7] (NTFPs) are important activities by residents in the Interior Alaska boreal forest; this type of harvesting activity is one category of utilizing local ecosystem services. Such activities are protected under Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA 1980). Harvesting berries, wild plants, and plant material for subsistence and personal use are also considered "generally permitted activities" by Alaska Department of Natural Resource Division of Mining, Land, and Water (DMLW) and so do not require a permit on state land (AK DNR DLMW 1989). While fish and game resources are closely tracked and managed for the Alaska State Department of Fish and Game (ADF&G), only a limited number of ADF&G Division of Subsistence technical papers include plant gathering information (Marcotte 1986, Martin 1983). Beyond this dissertation and personal, anecdotal knowledge, little information is available detailing who is out harvesting NTFPs in Interior Alaska, what they are harvesting, what motivates harvesters to participate in harvesting activities, and what array of benefits are gained.

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[7] Definition of Non-Timber Forest Products: Throughout the literature on "non-timber forest products," NTFPs are defined in different ways with slight alterations to the definition resulting in different arrays of products included under the NTFP umbrella. For my research, I will refer to the definition laid out by the United Nations Food and Agricultural Organization which designates five categories under the term of "non-timber forest products." These categories include (i) foods, (ii) medicinal plants, (iii) floral greenery and horticulture products, (iv) fiber and dye plants, lichens, and fungi, and (v) oils, resins, and chemicals extracted plants, lichens, and fungi (McLain and Jones 2005). Absent from this definition are non-biological forest resources and wildlife resources.

The purpose of this study is to understand what role the harvest of non-timber forest products plays in the lives of active harvesters. Specific aims of this research include: (a) what items harvesters gather from the forest and how they are used, (b) what harvesters' motivations are for gathering NTFPs from the forest, and (c) the type of benefits that harvesters receive from their harvesting activities and how those benefits enhance their lives.

Valuing Non-timber Forest Products

Historically, the value of forests has mainly been calculated by looking at the potential for timber extraction (Thadani 2001). Costanza et al. (1997) take a broader view when calculating the value of ecosystems and incorporate ecological services such as carbon sequestration into their model. Pearce (2001) expands this further to include four categories of forests' economic value: direct use values (e.g. timber, fuel, NTFPs, genetic material, and tourism), indirect use values (e.g. carbon storage), option values (e.g. conservation for future opportunities of use), and non-use values (e.g. passive use values). The goal of Pearce (2001) is to measure forest values in terms of monetary units to promote forest conservation. The use of economic instruments to value forest resources such as NTFPs, however, does have limitations as many attributes may not be quantifiable, or are inadequately evaluated when taken out of context (Thadani 2001).

Gibson-Graham (2006) looks beyond the neoliberal capitalist economics view focused on "waged labor, the commodity market, and capitalist enterprise" to see a diverse economy which includes all the activities that govern how society functions, takes into account nonmarket and alternative market transactions, unpaid and alternative paid labor, and noncapitalist and alternative capitalist enterprise. This encompassing notion of the diverse economy acknowledges NTFP activities such as gathering NTFPs (nonmarket transaction), gift giving (nonmarket transaction), and bartering (alternative market transaction) that would otherwise not be included in neoliberal capitalist economics view of the economy (Gibson-Graham 2006) even though they may be important components of harvesters' livelihood.

This holistic view of the diverse economy seems applicable to developing countries (i.e. the "Global South"), but it can also be used in developed countries (i.e. the "Global North").

> The pressure to recognize that livelihoods are sustained by a plethora of economic activities that do not take the form of wage labor, commodity production for a market, or capitalist enterprise has largely come from the global "south", though there is increasing evidence of the variety and magnitude of noncapitalist transactions and nontransacted subsistence practices pursued in the developed economies of the "north." (Gibson-Graham 2006)

To understand the role that NTFPs and harvesting play in Interior Alaska's diverse economy, it is critical to understand how residents in Interior Alaska interact with the boreal forest. Therefore, this study researches the nonmarket and alternative market transactions from forest products and activities to assess how these transaction contribute to the livelihoods of NTFPs harvesters and the diverse economy of the Tanana Valley.

The Tanana Valley

The Tanana Valley lies in the Interior of Alaska, north of the Alaska Range. The Tanana River spans much of Interior Alaska—the headwaters are located just north of Northway, Alaska, and the Tanana River empties into the Yukon River. The Tanana Valley resides within the Alaskan boreal forest. The boreal forest, or "taiga", is a circumpolar biome that extends across Canada and spans the area from the western coast of Alaska to the Canadian border. It is characterized by prolonged cold winters, short, cool summers, and nutrient-poor, cold soils often containing permafrost (Pojar 1996). Alaska's boreal forest has low species diversity but its wildfire regime creates a heterogeneous mosaic on the landscape (Chapin et al. 2006).

The Tanana Valley Watershed is the most populated area of Interior Alaska (G.W. Scientific 2006). The major population center is Fairbanks. Two U.S. Census areas cover the majority of Interior Alaska; these include the Fairbanks North Star Borough and the Southeast Fairbanks Census Area (U.S. Census 2010). According to the 2010 U.S. Census, the population of the Fairbanks North Star Borough was 97,581 with the two most identified races as white (77.0%) and American Indian and Alaska Native (7.0%). Population for the Southeast Fairbanks Census Area was 7,029 with the two most identified ethnicities as white (80.4%) and American Indian and Alaska Native (11.5%). In comparison, the population for the entire state of Alaska is 710,231 with 66.7% identified as white and 14.8% as American Indian and Alaska Native (U.S. Census 2010).

Of Alaska's eleven cultures of Native people, the Athabascan people are the Alaska Native group most closely associated with the boreal forest region. The traditional Athabascan territory includes many linguistically and culturally similar and dissimilar groups in an area that extends north to the Brooks Mountain Range and as far south as the Kenai Peninsula. This expansive territory roughly corresponds with the boreal forest in Alaska and includes the Yukon, the Tanana, the Susitna, the Kuskokwim, and the Copper rivers (Alaska Native Heritage Center Museum 2011).

The Athabascan people are comprised of eleven linguistic groups. One of the linguistic groups, the Han, lives along the Yukon River on both sides of the Alaska-Canada border. While the Han traditional area is just north of the Tanana River Watershed, Mishler (2004) gives a detailed account of how the Han utilized boreal plant resources. Traditionally, the Han harvested an array of berries including blueberries (*Vaccinium uliginosum*), lowbush cranberries (*Vaccinium vitis-idaea*), gooseberries (*Ribes lacustre*), salmonberries (*Rubus chamaemorus*), and raspberries (*Rubus idaeus*). Along with caribou and salmon, the Han's diet also included cow parsnip, sometimes referred to as wild celery (*Heracleum lanatum)*, onions (*Allium* spp.), wild rhubarb (*Rumex* spp.), Labrador tea (*Ledum groenlandicum*), and alpine sweetvetch, sometimes referred to as Eskimo potato (*Hedysarum alpinum*). The Han also utilized non-food items such as moss, white spruce (*Picea glauca*), balsam poplar (*Populus* balsamifera), aspen (*P. tremuloides*), birch (*Betula neoalaskana*), and alder (*Alnus fruticosa, A. tenuifolia*) (Mishler 2004).

Fuelwood resources from the boreal forest were heavily used during the late 19th and early 20th centuries to support steamboat travel and mining activities. In 1869, the first stern-wheel steamboat, "the Youcon," made its way up the Yukon River. Many more steam-powered riverboats followed (Wurtz et al. 2006). Along the rivers in the Interior, steamboat traffic greatly increased the amount of fuelwood harvested and provided jobs and an important source of income for communities. Communities further down river in non-forested areas were able to collect driftwood and sell it for $3 per cord (Roessler 1997). During this period, as many as 250 steamboats would operate on the Tanana and Yukon rivers, with each steamboat consuming an estimated 4,400 cords of wood from along the river during the summer.

Interior Alaska's largest city, Fairbanks, was founded in 1903, creating a need for building materials and wood energy (Wurtz et al. 2006). With wood as its primary energy source, Fairbanks annually consumed 15,000-20,000 cords of wood for fuel (Rakestraw 2002). Mining activities required large amounts of fuelwood to thaw permafrost, and mining camps used wood to generate their heat and electricity (Roessler 1997). The early 20th century period of intense wood utilization ended abruptly, and by the time of statehood in 1959, only a modest demand for wood existed.

The Tanana Valley State Forest (TVSF), established in 1983, covers 1.78 million acres in several blocks of state ownership stretching across 265 miles from its eastern boundary near Tok to its western boundary near Manley Hot Springs, and it is dedicated to multiple use (AK DNR DOF 2001). Only a small percentage of the TVSF contains stands of trees dominated by white spruce, the species most frequently sought for commercial timber.

Interior Alaska does not have a large-scale timber industry, although the land is extensively forested. A number of factors contribute to the current low utilization of Interior Alaska commercial forest land, including economic conditions and landowners declining to give long-term timber leases (Wurtz and Gasbarro 1996). The forest is well utilized for other activities such as hunting, fishing, trapping, recreation, and gathering of wood products or non-timber forest products. One–third of households in the Tanana Valley picked wild blueberries and one-quarter of households harvested firewood (ABFC 2003).

Methods

This study was designed as a qualitative case study to examine knowledgeable NTFP harvesters' experiences of harvesting in Interior Alaska. A total of 18 interviews were conducted between May 2011 and October 2012, involving 22 participants. Interviews were semi-structured and were guided by a list of 18 pre-established questions (Appendix A) to focus the interviews. Participants were selected using a purposeful sampling design to recruit participants who actively harvest NTFPs from a range of backgrounds and age groups.

Participant Recruitment

Potential participants were identified through referrals from contacts at the University of Alaska Fairbanks (UAF) and at local natural resource-focused agencies such as the Alaska Division of Forestry, the Alaska Department of Fish and Game, and the Fairbanks Soil & Water Conservation District, and then referrals were contacted via phone or email and solicited for participation.

Data Collection

All interviews were conducted by the same researcher and lasted between 30 minutes and 2 hours, most were between 40 minutes and 1 hour. The majority of interviews were conducted in participants' homes, though some were conducted on the UAF campus. All participants signed a consent form. Participants were invited to archive a recording of their interview to the UAF Oral History Department, and a separate consent form was provided for those participants who chose to archive their interview. Participants were offered a $25 honoriarium for participation. Interviews were recorded electronically and I then transcribed the interviews verbatim. This study was reviewed and approved by the University of Alaska Fairbanks Office of Research Integrity (Protocol #225409-1). The interviews were not intended to document traditional ethnobotanical knowledge about how specific plants are used in medicinal and cultural practices, but rather these interviews were intended to give community members the opportunity to reflect on how their relationship with harvesting NTFPs from the landscape.

Data Analysis

Qualitative analysis was conducted using grounded theory techniques within an Interpretivist theoretical framework (Ulin et al. 2005). Grounded theory is one method of qualitative research, and defining characteristics of grounded theory include integrating the data collection and analysis process; using concepts as the basic unit for analysis and then grouping these concepts into high level categories; and focusing on process, including both phases or steps of a phenomenon or looking at actions or interactions that change depending on surround context (Corbin and Strauss 1990). Interpretivist research seeks understanding and insight into human behavior through a holistic approach, and it tries to answer questions of "why?," "how?," and "under what circumstances?" This framework sees reality as subjective and dependent on one's perspective, actions, and context. Within the interpretivist framework, interview participants have an active role in the research by consciously engaging in the interview process and sharing their perceptions, experiences, and behaviors (Ulin et al. 2005).

Transcripts were uploaded into ATLAS.ti 6 Qualitative Data Analysis software. Coding initially involved open codes; these open codes were then reviewed and organized into code families and next by themes (Appendix B). Codes included Animal interactions (harvester talks about a wildlife experience while out harvesting), Annual variability in resource—quantity (harvester talks about how the amount of a product varies from year to year; some years have lots available while other years are scarce), Quality of Life (harvester talks about how harvesting contributes to their quality of life), and Vitamin C (harvester talks about Vitamin C from a product). Code families include Benefits (e.g. diversity of the wild, forest management, mental health, physical activity), Connection (e.g. to nature, to the harvesting experience, to the land, to time past), Memorable (e.g. big bounty, epic experience while harvesting, interaction with animal, no berries to be had, people, trash in berry patches), Motivations (e.g. compulsion, create memories, harvesting the summer's sun, know where my food's coming from, need firewood to get by the winter, want to bring something home), NTFP (e.g. birch bark, blueberries, crowberries/blackberries, Labrador tea, rose petals, spruce roots, alpine sweetvetch), and Use (e.g. art & crafts, birch bark baskets, freeze and use, juice, tincture, wine/mead).

Conceptual maps looking at harvesting motivations and the attributes of a harvesting trip were constructed to organize information in meaningful ways (Ryan and Bernard 2003, Ulin et al. 2005, Giske and Artinian 2007). To verify the analysis, preliminary results were compiled in a letter and mailed to all interview participants for comment. A reminder letter was then sent out four weeks after the initial letter. Interview participants were invited to provide feedback either anonymously via a pre-addressed stamped envelope or provide feedback through email contact.

Results

Interview participants' demographics

A total of 22 people participated in interviews including 3 married couples, 15 women, and 7 men. The age of interview participants ranged from 32 to 79 years old, and average reported age is 52 years. While some of the interview participants have lived in Alaska their whole lives, mean years of Alaska residency for interview participants was 35 years, with 9 years reported as the shortest length of Alaska residency. Mean household income was reported as $65,000. Interview participants were primarily from Fairbanks and the surrounding area, though two interview participants live in Tok (202 road miles southeast of Fairbanks), one interview participant lives in Nenana (55 road miles southwest of Fairbanks), and another interview participant reported splitting her residency between Fairbanks and one of the more rural communities in Tanana Valley. Interview participants reported an array of backgrounds. The majority of interview participants were originally from outside the Tanana Valley—including rural Alaskan villages, other parts of Alaska, the Lower 48, and foreign-born.

NTFPs reported harvested

The most common items that interview participants reported harvesting include berries, which included blueberries (*Vaccinium uliginosium* L.), low bush cranberries/lingonberry (*Vaccinium vitis-idaea* L.), highbush cranberry (*Viburnum edule* Michx.), and wild raspberry (*Rubus ideaeus* L.). Other commonly harvested plants were rosehips (*Rosa acicularis* Lindl.) and birch bark (*Betula neoalaskana* Sargent). Firewood was also a widely harvested item— predominately white spruce (*Picea glauca* Moench) and birch (*Betula neoalaskana* Sargent). The main mushrooms harvested were boletes (*Boletus* ssp.) and morels (*Morchella* ssp.). An array of medicinal plants was mentioned by harvesters, including but not limited to Labrador tea (*Ledum palustre* Ait. Hult.) Other top items harvested included Christmas trees (*Picea* ssp.) and various landscaping plants.

Edible harvested items are eaten fresh, or are preserved through freezing, drying, or canning. Some wild greens are preserved in seal oil. Edibles, mainly berries, are frequently used to make jams, jellies, and sauces, or they used in baked goods. Edibles are also used to make beverages including tea, juice, wine, and mead. Birch bark is used for basketry and as a fire starter. Firewood is used to heat homes and saunas. Some harvested items are used for carving and other arts, décor, dog bedding, and ceremonial purposes.

Motivations and benefits for participating in harvesting activities

Participants' motivations for harvesting reached far beyond simply acquiring the NTFPs being harvested; likewise, benefits from harvesting were both tangible and intangible:

Respondents identified the driving force for their participation in harvesting as finding enjoyment in harvesting from the forest. The overwhelming message delivered was that people enjoy harvesting from the forest. As one participant aptly stated:

I enjoy it, and I would say that's why I go out and I do a lot of it.

For most respondents, the importance of harvesting from the forest is a combination of the harvesting activity itself and coming home with something. The desire to come home with a full bucket is usually only part of the reason that people go out to harvest; participating in the entire experience is also important. Harvesting provides opportunities to spend time outdoors, spend time with family and friends while harvesting, relax and gain mental health benefits from harvesting, have a spiritual experience, and develop connections to the land, nature, and culture. One participant noted:

Oh my gracious, coming home with something is just the final outcome (laughter) ... to me, it's the whole sum-the sum of it all, you know, you're going with someone, you bring a little bit snack *to share, you eat with someone, you're gathering... even when you go with someone, you're not even in the same space-you kind of drift away from one another and you just have that solitude and you're gathering, so when you're gathering, you're... you have to ...it's a process.*

it's a fun thing to do together and it's enjoyable, and it's fun to be out there with somebody, you know, if you can go with somebody or go yourself, I'd prefer to go with somebody and it just makes it more enjoyable, especially with you know, family.

the really important part of berry picking is also to be out there. I mentioned it was, you know, relieving stress and that kind of thing, but to be out and to pick the berries is... I don't call it a spiritual experience, but it's a very calm... I think it's a very centered experience and that's why I, for instance, don't like to go pick out... pick with a berry picker because it doesn't seem like picking berries when you use the berry picker. It just takes away the pleasure of it. I guess you feel like you're one with the earth when you do that. You just almost grow into the ground and that's what I like about it. It... I'm just so at peace when I there. In fact, I told my family that when I die, they should spread my ashes in the berry patches because that's where I'm happiest, so there's a certain kind of joy about it that I don't get with a lot of other things.

I couldn't say I've ever taken time off work to harvest anything edible, but they're very enjoyable later on when after they've been processed and you can enjoy them in any month of the year, really. And several months later and look at that jar and it has a date on it and like, 'Wow, we picked this clear back in October or September' and now we're enjoying it and it could be even two years later or more that you're enjoying those things. That's what I like about harvesting—that if you process it properly it will last years and years and years. If it's food or it could be like a diamond willow cane that you keep for 50 years that's your favorite diamond willow cane and you always use it when you go out and you just have this connect with it—you remember where you found it, where you cut it down, and then as it ages, it takes on this patina and it... you can remember all these different places that you've taken this cane.

Respondents described harvesting high-quality products that are otherwise unavailable or inaccessible. Store-bought berries were seen as vastly inferior to wild Alaska berries, or they were seen as something completely different than wild berries such as comparing apples to oranges. Most wild mushrooms, other types of edibles, and medicinal plants were either not available for purchase or cost-prohibitive to enjoy in the quantities that people harvest.

> *Lower 48 blueberries taste lithesome and really, you know, no comparison to Alaskan blueberry which has a very distinct, tart flavor and is probably much higher in Vitamin C*

If they were not able to go harvest these items, several participants indicated that they would just do without.

> *Generally, most of the things that we harvest I feel are commercially unavailable or outside my financial ability to purchase on a regular basis, so we'd probably just make do without a lot of these things.*

While participants did not heavily depend on the wild plants and mushrooms they harvest to have food to eat, these wild foods are an important component of their quality of life. Eating wild berries every day or incorporating wild mushrooms into a meal may not have add a significant amount of calories to people's diets, but these wild foods greatly enhanced people's lives.

> *I think that if we weren't able to harvest, it would not influence our sense of food security or our health. I think it would severely impact my quality of life.*

These foods seem to provide sustenance to their soul or as one participant explained, they are the "icing on the cake." Eating wild berries during the winter was described as a connection to the previous summer when they harvested the berries. As one participant explained:

> *Having a connection with summer in edible form is fantastic.*

Also, when they eat what they have harvested themselves, participants find satisfaction in knowing where their food comes from.

> *That just makes me happy because I know where it's coming from- where my food's coming from.*

Firewood is an item that respondents harvest with perhaps the greatest utilitarian goal - keeping them warm through the winter. Some of the participants described using firewood as their only or main source of heat in the winter;

> *For the last like 3 years I've heated exclusively with self-collected firewood.*

If participants who harvested firewood had to replace it with heating oil, it would add significant costs to their household budget.

> *If I didn't have it, my house would be awful cold and uncomfortable and expensive*

The items respondents reported harvesting from the forest are often shared with others, given as gifts, and used to reciprocate. Harvested items, especially berries and items made out of berries, are commonly shared with or gifted to friends, family members, and co-workers, as described by this participant:

> *I use them as gifts. Sometimes as Christmas gift, but mostly I... when I make it, I take a jar to my close friends, especially the older people that don't do it anymore, so I have about 3 or 4 people that... at least 3 or 4 people, maybe more (laughter) and so they go away, actually immediately, you know when I see them I give them a jar of... when I visit them, I give them a jar. And then if I go somewhere Outside, I take them. I've sent in the past when my mother was still alive, I would send her actually cranberries since she loved cranberries, so I would just send her them-cranberries in a box. And she always enjoyed them because they'd last long enough to get there.*

Harvested NTFPs are used to reciprocate when others share; for instance, some participants enjoy reciprocating with berries or mushrooms when their friends share wild fish and game meat with them.

> *usually we end up with 10-15 pint containers and then I store them in that format and usually they end up just travelling to people's houses or something, you know... bring something to us, not to have them leave empty handed, you know to take berries whenever they're available, I guess a lot of people end up leaving our house with a lot of mushrooms as well*

Sometimes harvesters are focused more on their harvesting activities than the harvested items, so they are willing to share what they harvest with complete strangers.

> *we had so many berries and we were getting tired of cleaning berries, but I wanted to go again ... and then I said, you know what, this is ridiculous, we have a lot of berries... we saw some*

> *people coming on the trail after we were berrying and thought OK, I'm not going to take more berries home, we have.... So I'm going to offer them berries. Of course they were about "Wow! This is nice" and then we saw the same family up there the following weekend and he had been hunting and he gotten a moose, so he was anxious to give us a piece of meat*

Spending time out in the forest gives harvesters an interest in and the opportunity to discover and learn about the local environment. Many participants indicated that they learn about the forest from spending time in the forest and observing what's there. They are interested in the plants that grow around them and want to learn more about what can be harvested, what is edible, and the medicinal properties of what is available.

> *I take a real sense of satisfaction just kind of developing a greater understanding of our natural surroundings and being able to interact with them in a way that feels like it's productive for us and sustainable for the environment.*

Harvesting wild foods was seen as part of a healthy lifestyle. Vitamin C, other vitamins, and antioxidants in wild berries and rose hips are seen as highly beneficial.

> *I don't have the scientific proof or anything like that, I just feel that it's probably a better product for what I need in my body. I just, you know, it's just providing... nature provides what I need. I just have an inherent belief about that.*

Many participants saw wild products as healthier than commercially produced agricultural crops. Wild foods were thought of as healthier than store-bought foods because they are seen as organic and do not contain chemicals.

I wouldn't buy commercial raspberries or blueberries. One for taste, and the other, raspberries have to be sprayed in order to make it through the transportation process.

I strongly believe that I have all these good berries—it's just better than the store bought brand and artificially raised things, you never know what's in it, so I know that this is where... I know where I picked it and it's good and, so for that reason, I really like to bring something home to have healthy food.

Some wild foods are seen as particularly beneficial for certain conditions, for example, eating wild rhubarb to improve blood sugar levels for diabetics.

When I go in for the checkup, my doctor was so surprised. He said 'what you've been doing? Your level went back to normal'. I said 'I started eating those wild rhubarb, about 2 or 3 times a week, or sometimes a little bit here or there, just keep it down'. Now they start putting it in the books... that's what they do. Help the diabetics. That's why long ago, the first people don't have no diabetics or anything because they eat from wild rhubarb, berries, fish, caribou and stuff like that. They were healthy.

Some participants believed that the activity of harvesting contributes to a healthy lifestyle. Three participants specifically mentioned harvesting as a physical activity when they exercise and stretch their legs.

[Harvesting] physically helps you as well—keeps you in shape.

It's fun, you get some exercise, you go hiking, and you're out in the fresh air.

I personally like the berries because it makes me stretch my legs.

Harvesters enjoyed utilizing local resources and find that harvesting from the forest provides a sense of self-sufficiency.

> *My mom—she taught my brother and I very early on that if you want to eat, you've got to pick. So, if you don't go and make the effort to collect it, you're not going to have anything to eat, so you... you have to go and gather so that you'll be able to eat.*

Participants seemed to value using local resources rather than relying on imports, and felt a sense of security or accomplishment when they fill their freezer, cupboard, woodshed, or are able to use something from their own property instead of having to run into town to purchase an item.

> *I always think if anything every happened that you couldn't get food for a while because of a disaster or whatever, no planes flying in, there would be enough here that I could subsist on for a few weeks at least, just, you know, eat blueberries and cranberries and maybe a few fish...*

<u>Other key themes discussed by interview participants</u>

Participants discussed additional factors that they find important about their harvesting activities, ones that go beyond motivations and benefits.

Some harvesters feel compelled to spend time harvesting. Respondents described an innate feeling that motivates them to harvest:

> *I have to do it every year; it's a compulsion.*

Additionally, some individuals talked about becoming obsessed with harvesting during the harvesting season, especially for berries—including dreaming about harvesting, constantly looking out for harvesting opportunities, and the difficulty that they have when stopping and leaving their harvesting spot.

> *Blueberries, for instance, I LOVE to go out pick blueberries, and it's not so much that I have all those blueberries, but yes, I dream about them at night. I see those blue... blue big orbs in my dreams*

> *I find myself particularly with cranberries, making it... it's really hard to stop because 'Oh, there's a...oh, there's a couple...Oh! Pick, pick, pick, Oh, there's another one... pick, pick, pick, pick, oh, there's another.' You know, so it's... you become kind of obsessed... at least I do once I get going. Oh just a few more, just a few more.*

People who harvest from the forest often participate in opportunistic harvesting when in the forest for other activities. People reported grazing on berries and rose hips while hiking, and they talked about picking up interesting objects that they find while out in the forest.

> *we graze on this stuff whenever we go out to walk... we tend to carry a plastic bag whenever we go out, just in case we see something.*

If they unexpectedly come across a bountiful patch, they may begin impromptu harvesting.

> *you're out for a drive or something and you see... oh—there's a really good rose hip spot. Stop the car! And go and pick.*

Respondents enjoy passing on knowledge and the harvesting tradition with others, including younger generations and people who are interested in learning about harvesting. While some respondents did mention their concerns that the younger generation is not going out as much to harvest, spending time harvesting with their children was one of the things that make harvesting trips memorable to some harvesters:

> *Since I've become a mother, it's been really, really fun for me to watch my daughter come out with me every year and watch her enjoy it, it makes me really, really happy that she runs through the woods and identifies plants and knows what to pick and knows what to avoid and ...she can just eat gobs and gobs of pretty sour berries because she has a taste for it, and so that makes me really happy... that's my favorite part of berry picking these days.*

Harvesting is part of the annual cycle of life in Alaska; some harvesters talked about how that cyclic pattern is what propels them forward through the seasons.

> *We were raised that way, so we go by the seasons. There's a gathering calendar. Around the circle we go. It's a circle of life.*

Harvesters often viewed the calendar and seasons in terms of the different items that are available for harvest at different times of the year—including birch bark in the spring, greens and wild rhubarb in the early summer, mushrooms at different times of the summer, different types of berries (blueberries, cranberries, etc.) in the late summer and early fall, and rose hips in the fall.

> *It's what you're supposed to do in the fall. You've got to go out and pick those rose hips because if you don't then they're... they're going to be gone and you're going to wish that you had them*

Opportunity to go out into the woods and harvest is a key component of why some people live where they do. Harvesting from the forest is one of the reasons that some people choose to live in Interior Alaska since harvesting is central to their lifestyle. Some of the participants saw harvesting from the forest as unique to living in Alaska.

> *this is a huge factor in what makes our life paradise here, and so far this is what we choose over a lot of other things that are important for us ... This is the essence. It's really at the core for why it makes sense for us to live here.*

<u>Verification of results by interview participants</u>

Preliminary summarized results were provided to all interview participants, with an opportunity to provide feedback. Five responses were received to the distributed summary, including three written and two verbal responses. Two of the written responses included comments from married couples who participated in the interviews. All responses to the summary were in agreement and confirmed that the summary represented a fair statement of their views.

> *Please count me and [name withheld] among the interviewees who share the perspective of your findings.*

The low response rate was not unexpected since interview participants were invited rather than required to provide feedback on the results. The unanimous agreement of the response comments with the summary of preliminary results confirms that the interpretations are most likely valid. One response received after the reminder letter was sent out indicates that interview participants did not feel compelled to respond to results they were in agreement with:

> *My reason for not sending back a reply was and is that I have nothing to add to your writing.*

Discussion

"Non-timber forest products" is a general term that is applied to wide array of products people harvest from the forest, and these products are usually lumped together for forest management purposes. Different categorizations of NTFPs exist. The United Nations Food and Agricultural Organization (FAO) designates five categories of NTFPs including (i) foods, (ii) medicinal plants, (iii) floral greenery and horticulture products, (iv) fiber and dye plants, lichens, and fungi, and (v) oils, resins, and chemicals extracted plants, lichens, and fungi (United Nations Food and Agriculture Organization 2012). McLain and Jones (2005) add two more categories to the FAO description with (vi) fuelwood and (vii) small-diameter wood used for poles, posts, and carvings. Kim et al. (2012) provides four categories of NTFPs including: (i) food and medicine, (ii) cultural products, (iii) ceremonial rites, and (iv) spiritual practices. The way in which NTFPs are categorized is highly dependent on what is available for harvest in the local ecosystem, how NTFPs are harvested, how they are used, and the purpose behind their use. In

Interior Alaska, the principal NTFP categories that stand out include (i) edibles, (ii) medicinal plants, (iii) non-edibles for artisan use or décor, (iv) cultural products, and (v) fuelwood.

Overlap between NTFP categories exists, and differentiation may depend on how an NTFP is used, or the purpose behind its use. For instance, birch bark harvested for basketry by some harvesters may be for artisanal use, while for other harvesters it could be used as part of a culturally-based activity; still others might use birch bark for a utilitarian purpose as fire starter; and others in the pharmaceutical industry are investigating the antimicrobial and antiviral properties of chemicals found within birch bark (Cichewicz and Kouzi 2004, Jäger et al. 2008). Another example of overlap in harvest use categories is provided by Labrador tea. Labrador tea can be described as an edible, a medicinal plant, or a cultural resource depending if it is being consumed as an enjoyable tea, it is being consumed to treat an ailment or for general health purposes, or is consumed as a part of a traditional Native Alaskan diet.

Biological properties of NTFPs separate them into different functional categories. These properties include reproductive strategy, growth, and life cycle. Differences in these properties dictate their availability, their uses, and the appropriate harvesting processes. For instance, Table 3.2 demonstrates some of the key characteristic functional differences between mushrooms, berries, and fire. Mushroom availability is highly variable between years and is sensitive to summer temperatures and the timing and amount of precipitation. Berry abundances also are impacted by weather;

harvesters indicated that there is variability among years—some years are good berry years while others are not—but seasonal variability in abundance is more moderate than for mushrooms. Firewood availability, because of slow rates of growth for trees, has a much lower level of variability between years.

The harvesting window differs for these three NTFPs as well: mushrooms must be harvested shortly after they appear to get them before they are infested with worms, berries can be harvested over a span of a few weeks, and firewood can be harvested anytime of the year, although there are preferential times during the year to harvest firewood.

The level of knowledge to harvest these three items also varies: harvesting mushrooms requires specialized knowledge of where mushrooms grow, and more importantly, which mushrooms are edible and which are poisonous. The knowledge level needed to harvest berries is less than that needed for mushrooms, since berry plants are easier to locate and differentiate. Knowledge for harvesting firewood is even more basic than that needed for harvesting berries, though one could argue that proper knowledge is need to safely use a chainsaw and fell a tree. These differences revolve somewhat around a temporal scale and it is their "distinguishability" that sets these products apart. Because of these differences it is to be expected that harvesters of these three NTFPs will view their harvesting experience differently.

Harvesting trips for different types of NTFPs such as mushrooms, berries, and firewood can have very different characteristics. Some harvesting trips may resemble a treasure hunt:

> *with the mushroom picking... it's like a treasure hunt. It's exciting because you don't know if you're going to find them or not. Blueberry picking is easy because you find a patch or you don't and it's pretty easy. But with mushroom picking, you can walk for hours without finding anything. And some summers you don't find anything. You go out several times and it's very frustrating, but when you find them and you find a lot, it's like "Wow." It's like gold mine; it's a treasure hunt; it's real exciting.*

other harvesting trips may be for enjoyment:

> *And I do it simply because I enjoy being out there doing it. I like to sit out in the forest on the moss and pick cranberries. I'll pick gallons and gallons of cranberries, and I'm not going to eat all the jam, and I have to give it away.*

others still may be focused on the utility of what's being harvested:

> *Firewood can be a fun activity, but this is an activity for survival.*

The different roles that harvesting experiences play depends on both the harvester and what they are harvesting; some harvesters may see the quest for the best berry patch as a treasure hunt while others may have a fairly reliable spot to harvest mushrooms and so harvesting mushrooms is predominately an enjoyable activity rather than a treasure hunt. These differences can be placed on different axes of a three dimensional graph to explore how some forest products may fulfill similar roles while other forest products fulfill vastly different roles (Figure 3.1). The placement of a given harvest experience or activity within the three dimensional graph is subjective based on the specific harvester.

For example, when harvesting mushrooms, one user might rate the experience high on the axes for enjoyment or treasure hunt, while a different user who has an established mushroom patch may experience the harvest more as utility as a food source.

Since multiple aspects meld together, a blueberry bush presents a helpful metaphor to illustrate the different components of a harvesting experience (Figure 3.2). The roots of the blueberry bush are analogous to the harvester's background, and provide the foundation for the experience. The leaves represent trip itself and the different characteristics specific to the process of harvesting. A dropped berry represents planting the seed of harvesting by passing on the knowledge or tradition. Finally, the flowers and berries can been seen as the outcome of harvesting, the intangible and tangible benefits, respectively, of the harvesting experience.

The findings from this research are not unique to Alaska and are reflected in geographically similar locations elsewhere. Crossing the Canadian border, research conducted with First Nation participants in the Yukon Territory demonstrated that community members attach intangible values to NTFPs, specifically spiritual and cultural values (Natcher and Hickey 2004). In Emery's (1999) work with harvesters in the northern forest of Michigan's Upper Peninsula, it was found that her research participants harvested for a range of reasons, including but not limited to personal consumption, barter and gifts, and for sales. She found that harvesters were able to use NTFPs as a means to diversify their livelihood strategies and to fill in income gaps in the Upper Peninsula, an economically challenged area. Even with a large focus on the sale of harvested NTFPs, personal consumption still accounted for a significant fraction of edible NTFPs harvested in the Upper Peninsula, with 94% of edibles harvested for personal consumption by harvesters over the age of 60, and 59% for personal consumption by younger harvesters (Emery 1999).

Much of the previous research on NTFPs has focused on how harvesting offers income opportunities to people on the periphery of the labor market due to location, age, gender, or disability (Emery 1998, Hansis 2002, Paloti and Hiremath 2005, Belcher et al. 2010). Harvesting also offers cultural, spiritual, and social values to harvesters' livelihoods (Emery 1999, Doble and Emery 2001). In addition to acknowledging NTFPs as a means to earn supplemental income, harvesters consistently report that part of the importance of their harvesting activities is sharing and gifting NTFPs as a means to build social relationships with friends and family members (Doble and Emery 2001, Belcher et al. 2010). The complex values that NTFPs contribute to household economies and harvesters' livelihoods documented in Interior Alaska are consistent with the consensus of findings in the U.S. and Canada.

As forest management in Interior Alaska evolves with changes in communities' needs for different ecosystem services and sources for livelihood, it is important for land managers to understand how the forest is already being used by specific users groups. NTFP harvesters seek complex experiences that blend multiple motivations along with tangible and intangible benefits.

This research produced rich data from the 18 interviews conducted. These findings add context to survey type findings, and indicate some of the principal motivations of the Interior Alaska harvester community. Within the group of participants interviewed, a number of motivations were identified, including motivations that interacted in a number of ways. The summary profile of harvester motivations developed from this study and offered to participants received a strong consensus as accurate.

A few limitations of this study should be noted. The findings of this study may not represent all harvesters in Alaska, specifically casual NTFP harvesters and harvesters outside of the Tanana Valley. Limiting the pool of potential interview participants to referrals from the university and natural resource organizations might have biased the results. As the primary researcher, and an experienced harvester, I brought strengths to this study in regards to my background knowledge about harvesting NTFPs; still this previous knowledge may have been accompanied with bias. Additionally, the results of this study represent interview participants' views at a specific point in time and context. Changes to external forces such as forest management practices, climate regimes, and energy costs could alter, emphasize, or weaken some of these conclusions. Future research is needed to see how prevalent the findings of this study are throughout the general population and how changes to Interior Alaska's socio-ecological system will affect the availability of NTFPs across the landscape.

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Tables and Figures

Table 3.1. Most commonly reported NTFPs harvested and their predominant uses

Key items harvested	Scientific name	Reported uses
Blueberries	*Vaccinium uliginosium* L.	Consume fresh, freeze for later use, jam, baked goods, juice, akutaq, wine, mead, kiefer
Low bush cranberries/ lingonberry	*Vaccinium vitis-idaea* L.	Consume fresh, freeze for later use, jam, sauce, baked goods, juice, akutaq, liqueur, mead
Highbush cranberry	*Viburnum edule* Michx.	Consume fresh, freeze for later use, jam, mead
Wild raspberry	*Rubus ideaeus* L.	Consume fresh, freeze for later use, jam, baked goods, vinegar
Rosehips	*Rosa acicularis* Lindl.	Consume while in the forest, jelly, dried, baked goods, ketchup, medicinal, tea, wine
Birch bark	*Betula neoalaskana* Sargent	Basketry, fire starter, ornamental
Firewood	Predominately *Picea glauca* Moench (white spruce) and *Betula neoalaskana* Sargent (Alaskan birch)	Fuelwood for homes and saunas
Mushrooms	Predominately *Boletus* ssp. (boletes) and *Morchella* ssp. (morels)	Consume fresh, dry, sauté and freeze for later use, can
Labrador tea	*Ledum palustre* Ait. Hult.	Tea, medicinal use
Christmas trees	*Picea* ssp.	Holiday decoration

Table 3.2. Harvesting characteristics for three NTFPs
A comparison of differing key characteristics for harvesting mushrooms, berries, and firewood

	Mushrooms	Berries	Firewood
Variability between years	High	Medium	Low
Harvesting window	Short	Medium	Long
Knowledge level required	High	Medium	Low

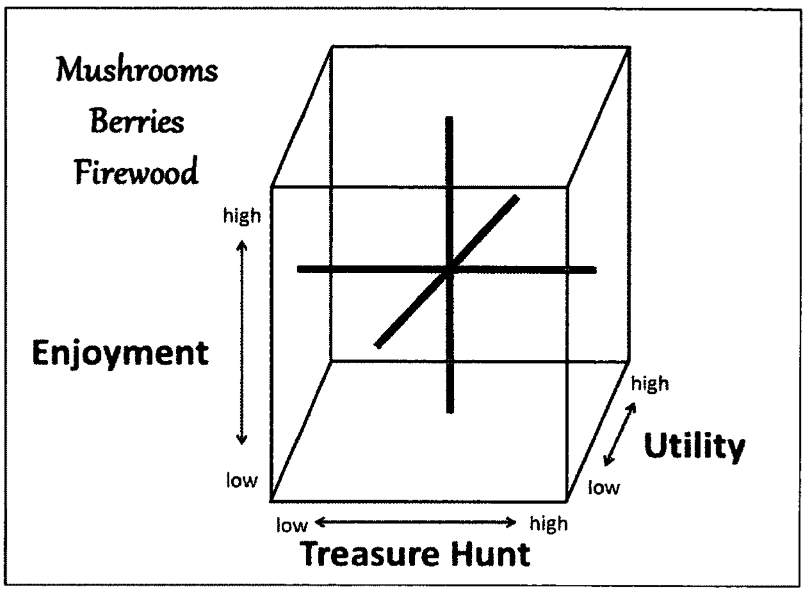

Figure 3.1. Spatial map to describe motivations for harvesting NTFPs
A 3-dimesional space to plot the motivations for harvesting NTFPs based on harvesters seeking a Treasure Hunt (*x*), Enjoyment (*y*), and/or Utility (*z*).

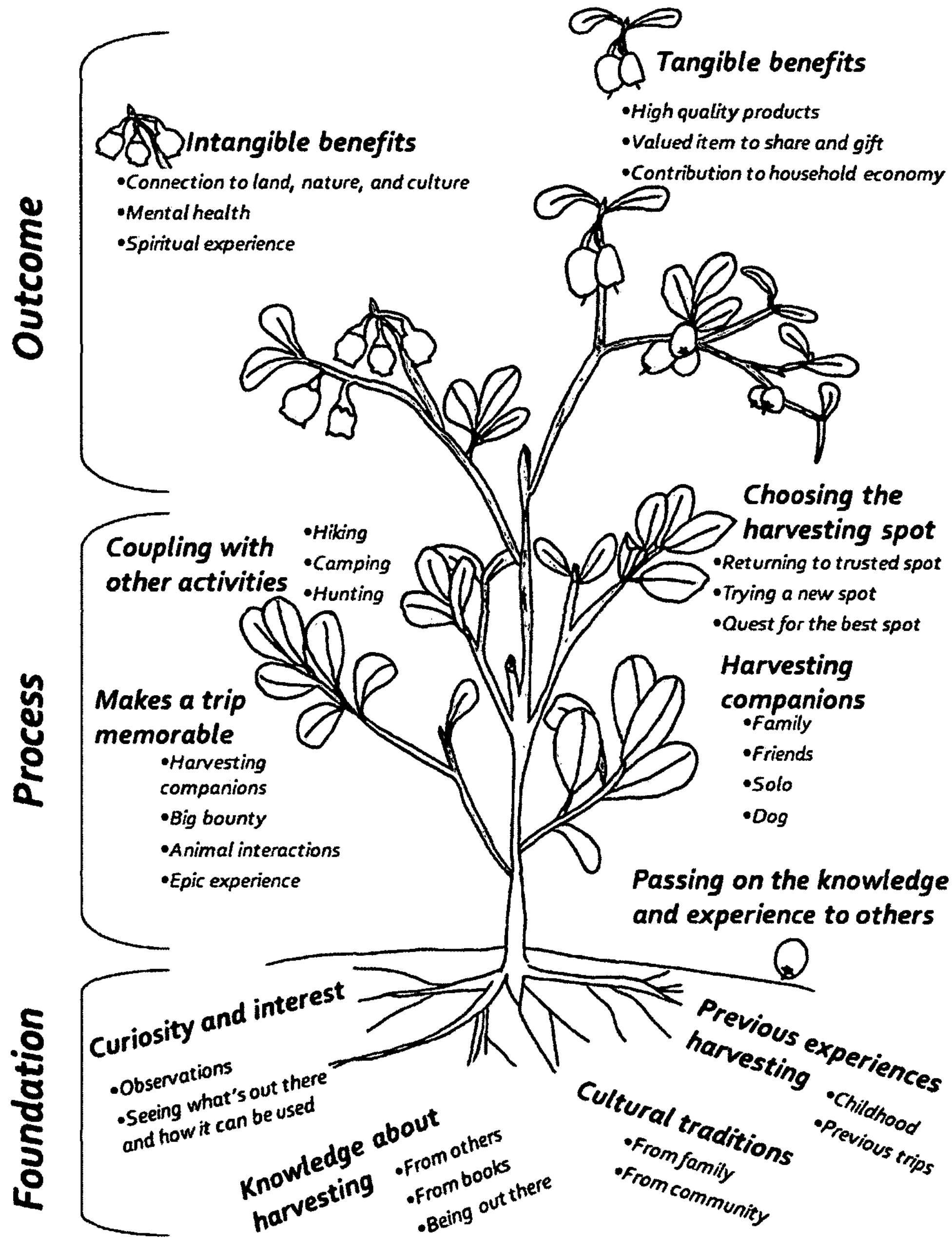

Figure 3.2. Anatomy of an NTFP harvesting trip
A blueberry bush serves as a metaphor for the describing different aspects of a harvesting experience.

Chapter 4: Working in the Woods: Birch Syrup Production as an Alternative Lifestyle

Abstract

Birch syrup is a commercially available non-timber forest product produced in Alaska by a small number of companies. While consumer interest in birch syrup continues to grow, the number of companies in Alaska producing birch syrup has decline over the first decade of the 21st century. Birch syrup is made from birch sap harvested in the spring in a method similar to maple syrup. Producing birch syrup is a labor intensive process with marginal profits. This study examined workers' motivations for participating in the Alaskan birch syrup industry during the 2007 sap season. On-site semi-structured interviews were conducted with workers, and then grounded theory techniques (Ulin et al. 2005) were used to analyze the transcripts. This study showed that participants in the birch syrup industry were seeking an alternative to or a break from the traditional workforce. Many of the workers held other seasonal positions and were drawn to birch syrup production as a way to fill in their off-season with a unique experience. The results from this study broaden the understanding of the role that commercial NTFP harvesting plays in rural development for forested communities in Alaska.

Introduction

Birch syrup is celebrated as one of Alaska's most recognizable commercial non-timber forest products (NTFPs), particularly because the media have identified it as a unique Alaskan product (Jackinsky 2001, Slow Food USA 2010). However, the Alaskan birch syrup industry is dwarfed in size by the North American maple syrup industry, which spans across much of Eastern Canada, New England, and parts of the Midwest. In reality, Alaska's commercial birch syrup production is a small, niche industry with a fluctuating number of participants over a relatively short history. Producing birch syrup is a labor-intensive process, and the birch sap season is a short window of opportunity dictated by weather and the arrival of spring. Despite these limitations, demand for birch syrup consistently has exceeded the current capacity of the industry, suggesting that there is potential for growth. The purpose of this study was to assess what draws participants into the Alaska birch syrup labor force and to document the benefits these seasonal workers perceive from their involvement.

NTFPs are defined in different ways by different groups but usually encompass what is harvested from the forest excluding dimensional lumber and animal products. Examples of Alaskan NTFPs include wild berries, firewood, mushrooms, and birch syrup. The United Nations Food and Agricultural Organization defines non-wood forest products, it's synonym for NTFPs, as "goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests" (United Nations

Food and Agriculture Organization 2012). Absent from this definition are non-biological forest resources and wildlife resources.

A review of birch sap and syrup

Birch trees transport important nutrients in the form of sap in the spring after breaking winter dormancy. These nutrients were stored in the roots over the winter, at the time of leaf senescence in the fall in order to prevent freeze damage and loss of moisture during the winter. In the spring, the stored sap is mobilized and transported upward into the canopy to the site of newly developing leaves. Like maple, birch trees can be tapped just before new leaves appear and the sap can be harvested. Birch sap is ~99% water and the remaining ~1% consists of small amounts of sugars, minerals, and other chemical compounds. Historically, the sugar in birch sap is one of the first carbohydrates that people could harvest in the spring—available before any other food from the new growing season appears.

Worldwide birch sap use

The most prominent use of birch sap throughout the circumpolar boreal forest is as a health tonic. Harvesting birch sap for consumption by humans has a long history and has been used for beverage, food, medicine and cosmetics (Saiguchi et al. 2005, Svanberg et al. 2012). Some European accounts of sap harvest date back to the early

10th century (Svanberg et al. 2012), and Asian traditions of harvesting sap date back to 600 BC (Woo 1995).

The sap is often referred to as "Aqua Vitae" or "Water of Life", and birch sap is part of traditional medicine of many northern countries including Japan, Korea, China, Finland, and Russia. People drink birch sap for general well-being and in the belief that it relieves an array of ailments including fatigue, gout, scurvy, and problems with the bladder or digestion. Sap has been drunk fresh as a beverage, fermented into wine, beers, and other beverages, incorporated into cooking, employed as a medicine, boiled down into syrup, and applied as a cosmetics for hair and skin (Buchholz 1943, Saiguchi et al. 2005, Svanberg et al. 2012). Birch syrup production outside of North America is quite rare. Buchholz (1943) documented birch syrup production in Eastern Prussia as one use of sap during the first half of the 20th century.

Birch sap has had limited use in North America compared with maple sap, which has a much higher sugar content (Saiguchi et al. 2005). In regions where maple trees were not available, the Cree Indians harvested birch sap and boiled it down into syrup; they used the birch syrup as a sauce for meat, fish, and bannock bread (Welsh 1972).

Birch syrup industry in Alaska

While harvesting birch sap is not a common activity in Alaska, over the past two decades, a number of companies in Alaska have commercially harvested birch sap for birch syrup production. Although the sap harvest and syruping process for birch are similar to techniques used to produce maple syrup, birch syrup has a unique taste and different texture than maple syrup (Cameron 2001).

The first commercial birch syrup producer in Alaska began operations in Fairbanks in 1968 and produced syrup for fourteen years (Maher 2005). It was a family run business, which sold syrup locally and was inspired by an article about birch syrup in a Canadian magazine that showed missionaries and First Nation people making birch syrup in the 1920s near Yellowknife, Northwest Territories (Maher 2005). The birch syrup industry in Alaska began again in 1990 when two companies started producing birch syrup. A third company began in 1991 (ABFC 2005). These companies were spread out across the state, located in Wasilla, on a remote homestead west of Trapper Creek, and Fairbanks. A fourth company in Haines began production in 1993 (Cameron 2001). The Alaska Birch Syrupmakers Association was founded in 1993 and activities included sponsoring an information and sales booth at the state fair in Palmer (Figure 4.1) and developing the Best Practices and Production Standards. The number of birch syrup producers in Alaska steadily grew, and in 2001, there were six companies involved in the Alaska birch syrup industry and producing an estimated 1400 gallons on birch syrup that year (ABFC 2005). Subsequently, the number of companies producing birch syrup in Alaska has declined, and in 2007, only two companies produced birch syrup. No new companies have joined the industry since.

ABFC (2005) surveyed the Alaskan syrup industry in 2001 about their production and practices. Six of the seven companies contacted responded. The 2001 survey provides a picture of the Alaska birch syrup industry at the period the Alaska Birch Syrupmakers Association was at its largest membership and most active period. At that time the main need that birch syrup producers acknowledged was assistance with business and financial planning. One syrup producer reported not producing syrup in 2001 because of financial difficulties. Starting a birch syrup company requires a significant financial investment. Startup costs ranged between $5,000 and $88,000. While four companies initially invested $20,000 or less, two companies initial investment exceeded $60,000. Four companies were started through personal funding sources; two of these four companies also used personal loans and the other two used business loans. The starting costs for one company were funded by grants, and one company did not specify the origins of its initial funding (ABFC 2005).

In the 2001 survey birch syrup companies employed from 1 to 3 year-round personnel, averaging slightly less than two (1.8) employees. All companies hired a seasonal workforce during the tapping season (ABSA 2005). One company purchased sap on the open market from local residents for 25 cents per gallon, which amounted to $2,000 paid to their top sap collector in 1999 (Jackinsky 2001).

In the 2001 survey, respondents reported low levels of competition amongst themselves. A bigger challenge was producing enough birch syrup to meet the market demand (ABFC 2005). One company, Cameron Birch Syrup and Confections, Inc. was named the "Made in Alaska Manufacturer of the Year" by the Make It Alaskan program through the State of Alaska's Department of Commerce, Community, and Economic Development (Jackinsky 2001).

Some of the value-added products ABSA members have sold over the last 20 years include pure birch syrup, birch-maple syrup, birch sauce and marinade, birch toffees, reindeer jerky made with a birch syrup brine, and birch caramel ice cream topping (Maher 2005). Other Alaska companies across the state have incorporated birch syrup into their commercially available products to add unique Alaskan flavor. For example, the Fairbanks-based Moosetard gourmet mustard company produces "Ginger Birch" mustard. Alaska Brewing Co. in Juneau has crafted an "Alaska Birch Bock". The Ring of Fire Meadery in Homer offers "Birch Syrup Reserve" mead. In Wasilla, the Alaska Distillery incorporates birch syrup into its "Birch Syrup Flavored" vodka. Anchorage chefs have also highlighted birch syrup in some of their recipes, including the Marx Brothers Café and the Crows Nest restaurant located at the Hotel Captain Cook. The success of these products demonstrates a growing interest in birch syrup which has been embraced by "foodies" and the Slow Food movement (Slow Food USA 2010, Day 2011, Canadian Press 2012).

<u>Birch syrup production elsewhere in North America</u>

While the total number of birch syrup producers in Alaska declined in the first decade of the 21st century, interest in birch syrup production grew elsewhere in North America. In 2007, the number of birch syrup producers in Alaska fell to two while

Canada had ten companies spread across six difference provinces and territories. While half of the Canadian producers are in Western Canada (four in British Columbia and one in the Yukon Territory), the other half are dispersed across Canada, including Northwest Territories, Alberta, Saskatchewan, and Ontario (Dixon-Warren 2007). Birch syrup production became a special project of the Quesnel Community and Economic Development Corporation (QCEDC) located in British Columbia. In 2007, the QCEDC published a birch syrup production manual (Dixon-Warren 2007).

Interest in birch syrup is growing in the Northeastern United States as a way to extend the syrup season. Birch sap flow starts after maple sap flow, and there is only a short window of overlap between the two sap flows (Kahrs 2012). Another attraction of birch syrup production is that it sells at a higher price than maple, around $300 a gallon for birch syrup (McGinnes 2013) versus $50-60 a gallon for maple syrup (Kahrs 2012). In 2008, a company in New Hampshire began commercial birch syrup production (Moore 2010), and a research project through the University of Vermont began investigating sap production by birch trees for potential syrup production in 2012 (Brown 2012). Vermont maple syrup producers have already begun to experiment with birch syrup production and are waiting for approval from the Vermont Agency of Agriculture to sell their product (Kahrs 2012). Research on sap yields by birch is also underway in New York at Cornell University's Uihlein Sugar and Maple Research and Extension Field Station. A recent birch tapping workshop attracted 100 syrup producers (McGinnes 2013). If birch syrup production proves to be a profitable industry in the Northeast, production appears likely to continue. The long history of maple syrup production in the area means that the syruping infrastructure is already in place, which lowers the initial investment for new participants in the industry.

Utilizing the Diverse Economy as a Framework

The "diverse economy" is a useful framework to look at NTFPs, such as birch syrup, since the economics of NTFP harvest includes a strong sociological component (Gibson-Graham 2006). In order to accurately understand the Alaskan birch syrup industry, research addressing the economics of commercial NTFP harvest should also address the role of NTFPs in harvesters' household economies (Alexander et al. 2001). The "diverse economy" looks beyond the neoliberal capitalist economics view and includes all the activities that governs how society functions, including activities such as nonmarket and alternative market transactions, unpaid and alternative paid labor, and noncapitalist and alternative capitalist enterprise (Gibson-Graham 2006). NTFPs can offer freedom from the formal market through the informal economy (Emery 1998). NTFP harvesting can offer an alternative form of employment to rural populations, including rural aboriginal residents, which may better suit their traditions and cultures (Belcher et al. 2010). NTFPs may also be an opportunity for rural residents not able to participate in the traditional workforce due to geography, socio-economic limitations, or cultural reasons. Small amounts of income from harvesting activities can be an important component of the overall household economy. While many of these participants in the informal economy tend to fall in the lower end of the socio-economic spectrum, the informal economy attracts a range of participants from different backgrounds and with different motivations (Emery 1998).

Methods

This qualitative case study was designed using the Diverse Economy approach as a theoretical framework to examine motivations for workers to participate in the Alaska birch syrup industry.

Interviews conducted

A total of ten interviews were conducted with individuals working at two different commercial birch syruping operations in April 2007. Interviews were semi-structured and were guided by a list of 12 pre-established questions (Appendix C) to focus the interviews Participants were selected using a purposeful sampling design to select participants who actively harvest NTFPs from a range of backgrounds and age groups. All interviews were conducted by the same researcher and lasted between 5 minutes and 17 minutes; interviews averaged 10 minutes. Interviews consisted of 12 questions that covered interview participants' harvesting background, participation in other forest activities, and the role of spending time in the woods in their life. All interviews were conducted on location during the birch tapping season. This study was reviewed and approved by the University of Alaska Fairbanks Office of Research Integrity (Protocol # 07-25). Participants provided written consent by signing a consent form.

Analysis of Interviews

Interviews were recorded electronically and I then transcribed verbatim. Transcripts were loaded into ATLAS.ti 6 Qualitative Data Analysis software. Transcripts were coded through an iterative process with open codes such as "fresh air" when interview participants discusses the importance of or their enjoyment of fresh air in their daily life. Other codes included "prefer country/woods over city" and "outdoor work as a priority" (Appendix D); these open codes were then reviewed and organized into themes shared in the Results section.

Qualitative analysis was conducted using grounded theory techniques within an Interpretivist theoretical framework (Ulin et al. 2005). Interpretivist research seeks understanding and insight into human behavior through a holistic approach, and it tries to answer questions of "why?", "how?", and "under what circumstances?" This framework sees reality as subjective and dependent on one's perspective, actions, and context. Under the interpretivist framework, interview participants have an active role in the research by consciously engaging in the interview process and sharing their perceptions, experiences, and behaviors (Ulin et al. 2005).

Results and discussion

Throughout the interviews, participants discussed their personal history of harvesting, how they become involved in birch syrup production, and why they chose this employment opportunity. Three interview participants were owners of birch syrup companies and the remaining seven participants were seasonal employees. Four interview participants were based in Alaska, one participant was from the East Coast, and five participants worked seasonal positions in Antarctica and then filled in the rest of their year with travel and other seasonal work. The time of interview was the first year that four of the employees had participated in the birch syrup industry.

In addition to commercially harvesting sap, harvesting NTFPs while in the woods is a common activity for this group. All but one participant reported harvesting other NTFPs. They harvest many other items for food, personal use, and as part of other income sources (Table 4.1). For two of the interview participants, harvesting was simply part of what they did while in the woods:

> *If we go for a hike, especially in August, which is when I'll tend to want to go to Hatcher Pass or something. Yeah, I'm always harvesting... always looking for berries... always harvesting, so yeah, it's something... it's part of, you know, it's part of what I enjoy doing, so... yeah...*
>
> *Whenever I'm in the woods, I see something that I can eat, I take it.*

Two of the ten interview participants had previous maple tapping experience, and two participants mentioned having visited a maple syruping operation in the past. One interview participant grew up making maple syrup:

> *I grew up on a farm so I started getting involved in maple back when I was in 7th grade*

whereas the other interview participant had a more limited experience with maple syrup production:

> *I did do a really small backyard syrup production with a friend and a friend of mine's parents who were really involved in it, so it was an old manure spreader as an evaporator bottom and a pan on the top and we... it was a small production but he sold some of his syrup and we collected by hand with a tractors and buckets.*

Interview participants had learned about birch syrup through word of mouth. Two interview participants had heard stories about homesteaders that had made birch syrup.

> *an old homesteader from Sweden and he use to tap trees in the spring for the... I don't know if he made syrup, but he did something with the sap...*

Many of the seasonal employees had vague knowledge of birch syrup prior to being hired, and all but one were recruited into their position through word of mouth. One seasonal employee responded to a posted flyer recruiting seasonal labor.

The reasons that interview participants said that they were drawn to birch syrup production labor were fairly similar and resonated throughout the group. Participants described the importance of spending time in woods and connecting with nature, their desire for working outdoors, and interest in trying something new.

Interview participants repeatedly acknowledge their need for spending time in the woods and the importance that natural setting plays in their lives:

> *I like to just observe what's going on out in the woods, you know. My little surroundings and everything. Cause around the, we don't live in town but we live in a ... not a big subdivision... it's kind of spread out, but there's sections of woods around the house and I'm always walking through them just to see what's there and what's to be found and anything's changed, you know. So, I always find myself just kind of attracted to the walking around wherever I live and whatever kind of woodlot there might be. Doesn't have to be a huge woodlot or have to have a hike for miles-just like to go walk in my little section kind of like Thoreau did. You know, a little microclimate.*
>
> *just being in the woods is just absolutely... it just feels good. It just... I just... it mellows you out; it probably lowers your blood pressure. And the woods has always been key to me, I mean as a kid that what I liked to do is go camping and canoeing and I just like being in the woods.*
>
> *Oh, it's just the most peaceful place to be. It's like everything about it... the smells...the sounds...I'm just way more at peace with myself when I'm at the woods than any place else.*

This interest in spending times in the woods spills over to what they desire for work, and participants explained their preference for jobs that allow them to be outdoors rather than in an office setting.

> *Any opportunity to get into the woods and do something neat, you know, like this, or build a cabin someplace, um to work and live... yeah... I'll do that anytime.*

> *Being in the woods is just feeds my spirit; I mean, I just love it. It makes me feel connected to nature which I feel very strongly. I tried an office job—I hated it. When I'm in town, I don't really... I really want to be in the woods. I feel very comfortable in the woods. And I love feeling like a part of nature and not apart from nature.*
>
> *one reason that I found making a living in the woods to be preferable to working, like a professional job or whatever is that it's really intensely satisfying to... to find that you can make a living from something that you harvest. And with that connection to the earth, it's just, it's just so much more fulfilling and satisfying than something that you're not... that doesn't connect you so much. So, I just think that that word-that it's fulfilling or satisfying is really important. That's all.*

Two interview respondents specified that the uniqueness of birch syrup and opportunity to come to Alaska was part of the draw to the position:

> *I'm drawn to kind of unique things, especially unique things that occur in remote regions. Yeah.*
>
> *Any opportunity to come to Alaska is worthwhile investigating. And, then birch syrup... I'd never heard of it before ... and I thought that was a pretty unique opportunity.*

The seasonal employees that came to Alaska to work in the birch syrup industry specifically wanted an "Alaskan" experience:

> *I don't want to go to a city if I come to Alaska*
>
> *I would feel like what would be the point in coming to Alaska if you're not going to spend time in the Bush or in the woods, you know, like, um, I think that's why most people probably come here*

is because it's so vast and there's so much land, and, um, want to explore it and be in it and, uh, get to know it

When I think of Alaska I think of big open spaces, wilderness and mountains and wildlife, so I wouldn't feel like I was in Alaska if I wasn't in the woods or outdoors

The contribution from forest-based work income to their annual income varied greatly among interview participants. Five respondents reported that birch syrup work constituted less than 5% of their annual income, two respondents estimating it as 20%, and three respondents estimating it as 80-100% of their annual income. None of the interview participants reported financial gains as their primary motivation for participating in the birch syrup industry. Even respondents who reported birch syrup as a high proportion of the annual cash income stated that lifestyle motivations were more important than the income provided. Two seasonal employees indicated that money was not a factor for their choice in travelling to Alaska to assist with birch syrup production:

I'm not doing it for the money, that's for sure.

No way, this is not a money making thing.

Over half (six of 10 respondents) spoke of living a transitory lifestyle that allowed them to participate in seasonal work.

I haven't got anything regular right now ... I've been kind of floating the past couple of years.

For the five interview participants who worked seasonally in Antarctica during the austral summer, the timing of birch syrup work corresponded with an off season which they could fill with other activities and jobs.

> *Seasonal work, yeah, so that basically means from mid-October if I do a summer season. The austral summer is, you know, middle of October to the middle of February, and then travel for a bit, and then try to find work.*
>
> *I'm a migrant worker, I guess, a seasonal worker. It varies. Yeah. South Pole. Bed and breakfast. Different stuff.*

Respect for the forest and appreciation for the trees that support their livelihood were also echoed by the interview participants:

> *Those trees sustain us, it's amazing when you think about it and you go out there and that sap is dripping in those buckets and you're like "This is how we live-these trees." That's why we like our trees.*
>
> *I just think that the harvest, especially the birch syrup harvest is a really amazing process and I'd like to see it stay, I'd like to see it just some lands being more available for it because I think it's a renewable resource, it's a sustainable agriculture, it's a good way for people to make a living, I think it's a great thing.*

Participants in Alaska's birch syrup industry in 2007 engaged in this employment to fulfill their lifestyle of choice. They repeatedly voiced their preference to spend time outdoors, not to be confined to an office job, and to be part of something unique. Most of the seasonal employees used this to experience something new, and one seasonal employee uses it as a break from his regular job:

> *They just submit to me leaving for 6-7 weeks in the springtime to come harvest birch syrup ... it gives me a chance to get away from all that for awhile. And they learn to appreciate me.*

Potential and challenges of NTFPs as income sources for rural communities

Commoditization of NTFPs has been championed as a solution for alleviating poverty in rural, forested areas while providing incentives for ecosystem conservation by creating revenue from sustainable harvest of NTFPs (Belcher et al. 2005). Much of the research in this area focuses on tropical forests and developing countries; vastly underrepresented are the United States, Canada, and Europe. For example, Belcher et al. (2005) conducted an analysis of NTFP commercialization using 61 case studies from Africa, Asia, and Latin America. They found commercial harvest of NTFPs are an important opportunity for supplemental employment and wage income to improve household economies and livelihoods; however, they also found regional patterns, demonstrating that some trends do not apply on a global level and may not apply to the unique cultures and livelihood strategies in Alaska.

A case study looking at rural development of NTFPs in Northern Manitoba examined the efficacy of the Northern Forest Diversification Centre (the Centre), an organization that served as a training, research, and trade center (Belcher et al. 2005). During its tenure of operation (2001-2006), the Centre was funded in part by the provincial and federal government, and it also generated profit through the revenue it received from its NTFP products (e.g. sweetgrass, Seneca root, and cranberry bark). The Centre was affective at training NTFP harvesters, but its rapid success may have led to its decline. It spread itself too thin while trying to perform an array of tasks. The Centre had a growing assemblage of harvesters to train and coordinate, and it served as the middleman to market their 435 different NTFP products. The Center's activities attracted attention from larger audiences outside of the region, this attention was accompanied with requests for presentations and collaborations. The Centre's trade of NTFPs was privatized in 2006, then its activities declined; by 2010, it no longer operated. Privatization made it difficult for the Centre to pass on most of the profit from NTFP sales to the harvesters and to serve as a financial buffer during inevitable ebbs and flows of the market. The Centre's successes include providing training and flexible employment opportunities. Interviews with harvesters indicate that they also benefited from "individual pride; self-sufficiency; re-connection with the land, with family, and with youth; and rediscovery/appreciation of traditions and traditional knowledge" (Belcher et al. 2010). The Centre was able to facilitate opportunities for important sources of supplementary wage labor that was flexible and non-traditional. This case study shows that a non-profit organization can provide a critical bridge that may be needed to support commercial NTFP harvesters and to connect them with viable markets for their products. Additionally, harvesters also gained non-monetary benefits from their work.

Turning to NTFPs to provide sustainable income for rural communities may be feasible, but a number of factors necessary for success must be considered (Belcher and Schreckenberg 2007). One way to investigate whether NTFP production does indeed generate income in rural areas and promote ecosystem conservation is to investigate the NTFP value chain, the 'production to consumption system', which tracks the stages a product goes through from being harvested, produced, transported, sold, and then consumed. With NTFP goods moving from rural areas into global markets, value chains can become quiet complex (Belcher and Schreckenberg 2007).

Developing an NTFP from a personal use product into a commercially available product has a number of obstacles starting with the harvest of the NTFP (Belcher and Schreckenberg 2007). Supply of NTFPs is variable since factors such as weather can disrupt a reliable quantity. Increased demand for the products often result in more intensive harvesting which often degrades the resource base. Alternatives to intensifying harvest practices are (1) extensive harvest of the product from a larger geographical region or (2) intensive management of the resource which may lead to cultivation (Belcher and Schreckenberg 2007). Domesticating NTFPs requires overcoming hurdles such as securing tenure to land on which to grow the product, developing the technical horticultural skills, and accessing investment capital. While wild-harvested NTFPs usually get a premium price compared to cultivated NTFPs, the cultivated product will fulfill part of the demand for the product and sell at a lower price. Additionally, when a resource develops or increases in value, the most powerful people—not the marginalized—usually are able to take control of the resources which limits the access and benefit to the marginalized people, possibly leaving them worse off than prior. These multiple factors affecting the harvest of NTFPs are initial stumbling blocks for poverty alleviation in rural areas (Belcher and Schreckenberg 2007).

Stable markets for NTFPs take time to establish and success is influenced by a number of factors (Belcher and Schreckenberg 2007). Once markets are established, they are subject to fluctuation since NTFPs are often luxury or faddish type goods. NTFPs also face competition from similar products, cultivated counterparts, and synthetic products (Belcher and Schreckenberg 2007). Birch syrup is categorized with similar edible products such as wild berry products.

Often, commercial harvest of NTFPs is seen as a means to provide supplemental income to rural residents or provide opportunities for marginalized people on the fringe of the workforce due to barriers from geography, skills, or language fluency (Emery 1999, Vaughan et al. 2013). This study showed that participants in the birch syrup industry were seeking an alternative to or a break from the traditional workforce. The "critical income supplement" model may hold true for other commercial NTFPs in Alaska, or possibly even apply to the birch syrup industry at a different point in time (e.g. local residents that sold sap for 25 cents a gallon to a birch syrup company that is no longer in syrup production). However, this study demonstrates that the range of motivations for NTFP commercial harvest in Alaska is more diverse.

This research examined the birch syrup industry during one sap season, and many of the workers were participating in the industry for the first time. However it's not clear what the turnover rate of seasonal employees is from year to year. Given the relatively large number of birch syrup companies that disappeared over the 2001-2007 period, questions remain regarding the population originally drawn into birch syrup production, why they joined the industry, and why they no longer continued syrup production if demand for birch syrup remains strong.

The strengths of this research are that it reached almost the whole population of birch syrup workers in Alaska in 2007 and interviews occurred on location while the participants where immersed in birch syrup production. One factor to consider in interpreting the results of this study is that some interviewees were visibly fatigued or reported low energy levels at the time of interview. Because the interviews were conducted during the sap season—a short, intense period— some interview participants were required to attend to a task and then come back to resume the interview. The data set is limited by the small population involved in birch syrup production and generally brief interview periods. The data set does begin to illustrate the motivations for producing birch syrup. Interviews were all conducted during the 2007 sap season which gives information on a specific point in time, but potentially limits its transferability. Due to birch syrup production work being a seasonal position for most of the people involved, the composition of the individual workers in the birch syrup operations have the potential to change markedly from year to year, so a long-term study is needed to give a more complete view. Finally, this research looked at birch syrup workers in Alaska, so the results do not necessarily provide insight to the birch syrup industry elsewhere such as Canada or other areas of the United States.

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Figures and Tables

Figure 4.1. The Alaska Birch Syrupmakers Association booth at the Alaska State Fair

Table 4.1. Forest resources harvested by commercial birch syrup workers

NTFPs and other forest resources harvested for personal use by commercial birch syrup workers and the reported uses

Harvested items	Uses
Birch bark	arts & crafts; fire starter
Cattail pollen	personal use
Devil's club	personal use
Fiddleheads	Food
Fish	food, recreation
Goldenrod	personal use
House logs	build cabins
Labrador tea	personal use
Lichen and moss	dyes for fibers
Mushrooms	food, sell
Nettles	personal use
Spruce tips	personal use
Wild berries	food, jam gifts
Wild game	food
Wood for carving	sell
Wormwood	personal use

Chapter 5: Effects of spring sap harvest on increment growth of Alaskan birch *Betula neoalaskana* and implications for the sustainability of the sap resource under a changing climate regime

Abstract

Birch sap has been harvested throughout the northern hemisphere for many centuries. Sap is harvested by drilling a hole into the sapwood during the spring. The effects from mechanical damage from tapping for spring sap on birch's vigor are of concern to birch syrup producers and natural resource managers, though research on tapping birch is limited. This study examined the annual increment growth of Alaskan birch trees, *Betula neoalaskana* Sargent, during three consecutive years of tapping and seven year post-tapping. A general linear model found no significant difference in growth between tapped and untapped trees, but annual variability was strongly significant. Tree growth was then correlated with climatic data. While no significant correlations were present with total monthly precipitation amounts, an index of eight mean monthly temperatures accounted for nearly two thirds of the annual variability in the growth. Using this index, birch growth was extended out using two general circulation models (GCMs) to generate Fairbanks climate scenarios through the 21st century. As temperatures rise, birch trees in Interior Alaska are projected to face a critical threshold, potentially by the middle of the 21st century, which may limit or extinguish their ability to sustain growth and yield a sustainable sap resource.

Introduction

Spring sap has been harvested from birch trees throughout the northern regions of the globe for many centuries (Terazawa 1995, Svanberg et al. 2012). Birch tapping literature is much more limited (Maher 2005) compared to maple tapping literature which is extensive and coordinated through the North American Maple Syrup Council; maple research is conducted in three research facilities, including the Centre Acer in Quebec, University of Vermont Proctor Maple Research Center, and Cornell University. Although harvesting birch sap is not as prevalent as harvesting maple sap in North America, interest in producing birch sap and birch sap products such as birch syrup is growing (Day 2011, Kahrs 2012, McGinnes 2013). If increased birch sap harvest is to be sustainable, it is necessary to understand how sap harvest affects the growth of birch trees. The purpose of this research was to examine if three consecutive years of spring sap harvest impacts the annual increment growth of Alaska birch trees. Additionally, this study looks at how changing climate may influence the availability of the birch sap resource in Interior Alaska through the 21st century.

<u>Sap harvest from birch tree</u>

Tree sap is defined as "the fluid contents circulating through dead xylem cells or canals" (Helm 1998). Sap transports nutrients including sugars, amino acids, and minerals. To conserve resources when losing their leaves in the fall, birch trees store important nutrients in their roots over the winter; in the spring, birch use sap to transport these nutrients back aboveground where the new leaves develop (Kozlowski and Pallardy 1997). Like maple, birch trees can be tapped just before new leaves appear and the sap can be harvested during a variable three to five week window (Saiguchi et al. 2005).

Harvesting birch sap for consumption by humans has a long history and has been used for beverage, food, medicine and cosmetics (Saiguchi et al. 2005, Svanberg et al. 2012). Historically, the sugar in birch sap was one of the first carbohydrates that people could harvest in the spring—available before any other food from the new growing season appeared. Some European accounts of sap harvest date back to the early 10th century (Svanberg et al. 2012). Asian traditions of harvesting sap date back to 600 BC (Woo 1995).

The currently recommended technique for harvesting sap from birch trees is to drill a tap hole 1½ to 1¾ inches deep with a drill bit into a healthy tree and insert plastic, nylon, or steel spiles (ABSA 2002). Other methods of sap harvest include harvesting sap from stumps of birch trees that had been cut down the previous winter (Roschin and Sultanov 1995) or by creating deep v-shaped cuts into the tree (Welsh 1972, Yoon and Jo 1995).

Chemical analysis of birch sap shows that it contains sugars, minerals, amino acids, proteins, and organic acids (Yagyu et al. 1995). The main sugars in birch sap are glucose and fructose (Yagyu et al. 1995, Maher 2005), but also lesser amounts of sucrose (Ganns et al. 1982) and galactose (Maher 2005). Potassium, calcium, and magnesium are the minerals present in highest concentration in birch sap (Ganns et al. 1982, Huldén and Harju 1986, Li and Gao 1995, Maher 2005). Minerals present in lower concentrations include manganese, sodium, zinc, iron, copper, and aluminum (Ganns et al. 1982, Huldén & Harju 1986, Yagyu et al. 1995, Li and Gao 1995, Maher 2005).

Health benefits from consuming birch sap are attributed to its chemical composition, especially the micronutrients present such as manganese, zinc, and copper (Drozdova et al. 1995). Birch sap is part of traditional medicine of many northern countries including Japan, Korea, China, Finland, and Russia. Birch sap has been drunk for general well-being and to treat an array of ailments including fatigue, gout, scurvy, and problems with the bladder or digestion (Drozdova et al. 1995, Terazawa 1995).

Birch sap is consumed as a beverage and health tonic in Asian countries including Japan, China, and Korea (Saiguchi et al. 2005). The "Namakje" sap festival in the Mt. Chiri region of Korean began in the 9th century. This festival brought people together to drink fresh sap, celebrate spring, and pray for a prosperous agricultural season. Now called "Chirisan Yakusuje," it has evolved into as a modern festival with sport and cultural competitions (Woo 1995). The Ainu people in Northern Japan continue to harvest sap and host a sap festival (Saiguchi et al. 2005). Bottled birch sap beverages are sold in China (Zhang and Shi 2005) and Japan (Yagyu et al. 1995).

Birch sap has a particularly rich history in many regions of Europe where it has been harvested and consumed in various ways in many different regions including Scandinavia, Germany, Britain, and the former Soviet Union countries (Svanberg et al.

2012). Sap has been drunk fresh as a beverage, fermented into wine, beers, and other beverages, incorporated into cooking, employed as a medicine, boiled down into syrup, and applied as a cosmetics for hair and skin (Buchholz 1943, Saiguchi et al. 2005, Svanberg et al. 2012). While its use has declined greatly in many parts of Europe, harvesting and consuming birch sap are still important activities in Russia, Ukraine, Belarus, Estonia, Latvia, and Lithuania (Svanberg et al. 2012).

Birch sap has had limited use in North America compared with maple sap, which also has a much higher sugar content (Saiguchi et al. 2005). In regions where maple trees weren't available, the Cree Indians harvested birch sap and boiled in down into syrup; they used the birch syrup as a sauce for meat, fish, and bannock (Welsh 1972). There is also limited documentation of birch sap use by the Thompson Indians of British Columbia (Turner et al. 1990) and the Tanaina Indians of Interior Alaska (Kari 1995). Mention of birch sap harvest and syrup can been found in 19^{th} and early 20^{th} century outdoor literature (Scientific America 1856, Kephart 1901).

While harvesting birch sap is not a common activity in Alaska, over the past two decades, a few companies in Alaska have commercially harvested birch sap for birch syrup production. Interest in birch syrup production is spreading to other parts of North America where birch trees grow. Ten companies throughout Canada also have begun syrup production (Dixon-Warren 2007). Maple sap researchers in New York and Vermont and a maple syrup producer in New Hampshire have begun experimenting with birch syrup (Moore 2010, Brown 2013, Shackford 2013). Although the sap harvest and syrup production process for birch is similar to techniques used to produce maple syrup, birch syrup has a unique taste and different texture than maple syrup (Cameron 2001).

Concerns regarding ecological sustainability of harvesting NTFPS

In order to address concerns about the potential sustainability of NTFPs, a recent meta-analysis examined 70 quantitative, empirical ecological studies that each assessed the ecological harvest of NTFPs for products primarily harvested from wild populations (Ticktin 2004). The vast majority of studies were focused on tropical NTFPs. Non-tropical biomes such as boreal forest are underrepresented or not represented at all in the literature to date. The results of Ticktin's (2004) meta-analysis recognize that harvesting NTFPs is often assumed to have a benign or negligible impact, but in reality harvesting can disturb biological processes at many different levels. Harvesting NTFPs can decrease or increase growth rates, reproductive capabilities, and vitality of the plants harvested or of neighboring plants. NTFP harvesting can shift the relative abundance of species in a plant community which in turn may alter biogeochemical cycles of important nutrients such as nitrogen. Harvesting can also shift the genetic distribution, especially when high-grading occurs. High-grading is the practice of removing plants with desired traits while less desired plants are left behind to reproduce and dominate the population. Ramifications from harvesting NTFPs may extend to populations of birds and other fauna that rely on the forest for food and shelter when harvesting improves or degrades habitat. The magnitude of these unintended consequences will determine the sustainability of NTFP harvesting (Ticktin 2004). Three broad ecological questions are given for a framework when developing harvesting management, specifically (1) What are the ecological impacts of harvest? (2) What are the mechanisms underlying these impacts? (3) What kinds of management practices may mitigate negative impacts and/or promote positive impacts? (Ticktin 2004).

Previous research on biological impacts of tapping birch trees

The majority of research examining the biological impacts from harvesting spring sap from birch has been conducted on *Betula verrucosa* in the Ukraine in the 1970's. Results of this research show that harvesting sap from a birch tree yields approximately 1/60th of the trees available sugar (Osipenko and Ryabchuk 1973). Intensive birch tapping over the course of 3-4 years did not lead to significant changes in the size or volume of the anatomical elements of the wood (Ryabchuk 1974). Changes in coloration of the wood from tapping were caused by biochemical changes in the injured cells. Changes in wood color extended farthest in the vertical direction, propagating up and down the xylem cells; color change extended far less in the radial direction, and was minimal tangentially (Ryabchuk 1975). Phenology of the trees was not significantly affected after tapping for 3-7 years (Ryabchuk 1979). Trummer and Malone (2009) conducted a pilot study to investigate stain and decay within trees that had previous been tapped in Interior Alaska at two different sites; half of the trees (Eva Creek site) had been tapped 17 years prior while the other half (Cache Creek site) had been tapped 6 years prior. They found staining associate with every tap hole in the 18 trees examined and average length of stain in the vertical direction extended 6.6 feet in the Eva Creek trees and 6.3 feet in the Cache Creek trees. Decay was present in 5 of 9 trees at Eva Creek and extended an average of 2.8 feet though compartmentalized within the stain. One-third of the Cache Creek trees had decay, all of which were less than 1 foot in length. It was also noted that most of the Cache Creek trees had decay present that was not associated with tapping (Trummer and Malone 2009).

Looking at growth rates after sap harvest, limited work in the Ukraine with *B. verrucosa* has shown that tapping did not produce a significant effect on diameter growth of trees (Osipenko and Ryabchuk 1973). Although tapping caused a slight radial growth reduction in some trees, other tapped trees showed greater growth than the controls. Osipenko and Ryabchuk (1973) concluded that lightly tapping a birch for a few years will not impact their growth rates, but they expressed concern that intensive tapping with multiple tap holes each year over a number of years would decrease growth.

<u>Response of birch trees to increment borers and other wounds</u>

The damage to a tree from increment boring, a common forestry practice, is analogous to damage from tapping. While there is very limited research that has investigated the impact on birch from harvesting birch sap is limited, research looking at the impacts of increment bores is more extensive and began in the 1930's after a surge of forest inventories were conducted (Hepting et al. 1949). This body of research focuses on discoloration of wood and fungal infection. Lorenz (1944) found that plugging holes from increment boring in hardwoods, including yellow birch (*Betula lutea* Michx.) and paper birch (*B. papyrifera* Marsh), did not decrease wood discoloration but did decrease the prevalence of heart rot. An early study looking at wounds from increment boring a mixture of 13 different hardwood and softwood trees in the Eastern United States included two species of birch: yellow birch (*B. lutea* Michx.) and sweet birch (*B. lenta* L.). Compared to the other trees, discoloration was the most extensive in the birch and 20% of the birches had decay present ten years after wounding. Also after ten years, of 13 species in the study, yellow birch had the lowest wound closure rate with only 50% of the holes closed, and the sweet birch had the second lowest wound closure rate with 81% of the holes closed (Hepting et al. 1949). Dujesieefken et al. (1999) examined the increment boring wounds on silver birch (*B. pendula* Roth) and found cambial dieback around the boring hole and discoloration of the wood stretching up to 200 cm in the axial (vertical) direction. Fungal hyphae were only found in the discolored wood which shows that the tree is able to compartmentalize the area damaged (Dujesieefken et al. 1999).

Neely (1988) compared wound closure rates on ten different hardwood trees including paper birch (*Betula papyrifera*) and found that the birch was one of the three slowest wound closure rates growth per unit of diameter growth. Dujesieefken et al. (1999) noted that wounds that occur in the spring and summer are less damaging to hardwoods than wounds that occur during fall and winter.

Climate change in boreal Alaska

Another potential challenge for the sustainability of birch sap production is climate change. Temperatures in Interior Alaska have been on an upward trajectory since the 1950's with air temperature having risen 0.4°C per decade and permafrost temperatures having risen 0.5°C per decade (Chapin et al. 2006). These trends are expected to continue and even become more pronounced with air temperatures projected to increase 0.4-0.7°C per decade during the 21st century (Chapin et al. 2006). Ramifications may include changes in evapo-transpiration rates, increased fire activity, reduced resistance to insect out-breaks, shifts in vegetation, changes in vegetation growth rates, and retreat of the permafrost extent (Chapin et al. 2006, Soja et al. 2007). Changes of this magnitude would impact social-ecological systems by altering the ecosystem services that the forest is able to provide to society (Chapin et al. 2006).

Methods

Study area

The study area was located just north of Fairbanks, Alaska at 64º 53′ 53.88″ N, 148º 10′ 37.75″ W. The forest composition in the study area is classified as an uplands site of Closed Paper Birch Forest (I.B.1.d) by the Alaskan Vegetation Classification (Viereck 1992) with 95% cover by birch (*Betula neoalaskana*). Other common species present include arctic rose (*Rosa acicularis*), high bush cranberry (*Viburnum edule*), and horsetail (*Equisetum pretense*). These sites were selected because of their southern exposure, proximity to each other, road accessibility, proximity to town since they were visited daily during sap seasons, and cooperation from the private land owners.

The study area is characterized by boreal forest climate with long, cold winters which can reach down to -50° C and short, cool summers which can briefly warm to 35° C (Shulski and Wendler 2007). Soils are cold and nutrient poor, and decomposition of organic material is limited by cool temperatures (Shulski and Wendler 2007).

Sampling design

A transect of 3 sites was established on south-facing slopes dominated by birch. Sites were located at top of slope, mid-slope, and toe slope. Ten birch trees were randomly selected at each site (a total of 30 trees) for tapping. Trees 15 centimeters diameter at breast height (dbh) or greater were determined eligible for tapping. This definition included canopy dominant and co-dominant trees. A rough sketch was created of all eligible trees in the stand (around 25 to 40 trees). Trees that were multi-stem were marked on the stem map as a single individual. A random table of digits was then used to select ten trees. If a multi-stem tree was selected the eastern- most stem was tapped.

Ten control birch trees were randomly selected at each site from the trees deemed eligible for tapping but not tapped.

Tapping procedure

Treatment trees were tapped in 2001, 2002, and 2003. Trees were tapped according to the Alaska Birch Syrupmakers' Association Best Practices (ABSA 2002). Tap holes were drilled prior to the start of sap flow, generally mid to late April when daily maximum temperatures reached near 50° Fahrenheit. Tap holes were drilled two inches deep approximately 1 meter high on the bole with a power drill and 7/16th inch ship auger drill bit. Tap holes were placed at approximately the same position on each tree during a given year (south side of the tree for 2001, east side of the tree for 2002, and west side of the tree for 2003) in a spot on the tree free of wounds, lenticels, or lichen. Plastic spiles, 5/16th inch plastic tubing, and food grade plastic buckets were used to collect the sap. At the end of the season, the spiles were removed, the tap holes were rinsed with water, and the holes plugged with corks.

Sample preparation

Tree cores the full diameter width of the tree and incorporating two full radii were taken from each of the tapped and control trees in October 2010. Tree cores were immediately glued to wooden trays in the field. Cores were then sanded using a series of progressively finer sandpapers, starting with a 120, 220, 400, and finally a 600 grit sandpaper for maximum ring boundary definition.

Measurement of samples

Initially, annual rings were counted and decades of growth were marked to assess age of the trees. Raw ring widths (RRW) were measured using a Velmex sliding stage at 0.001 mm resolution. The crossdating and measurement verification of RRW was assisted by the identification of key pointer years (Schweingruber et al. 1990) present in the record including 1993 and 1958. Measurement accuracy was verified by the crossdating program COFECHA (Grissino-Mayer et al. 1992), and very few dating errors were identified. Dating errors were corrected by examining and re-measuring the original specimen.

Analysis

Descriptive statistics were conducted on the entire arrays of the increment growth data using SPSS 19. Data for the last 21 years of measured tree growth were included in the statistical analysis comparing growth between the control (not tapped) and treatment (tapped) trees; statistical analysis focused on growth for the period prior to, during, and after treatment including 11 years of growth prior to treatment of tapping, 3 years of growth during treatment, and 7 years of growth post-treatment. Data series were detrended using a horizontal mean curve fit to produce a Ring Width Index (RWI). A uniform detrending method was applied because only a portion of the RRW chronologies were included in analysis, the sites were all co-located with 1.5 kilometers of each other, and trees were of similar age. As a result, all trees experienced similar climatic effects and were in a similar stage of their life cycle.

To test for effects of treatment, site, and year on growth rates, a general linear mixed model incorporating AR(1) autocorrelation was used in SAS 9.1 using the GLIMMIX macro; RWI data were transformed by a log function for use in the model. The model was run three times, once for each of the time periods (pre-tapping, tapping, and post-tapping). The model compared growth for each tree each year for two treatments (tapped and control/non-tapped) and mean growth between the three sites. Growth of tapped trees prior to tapping treatment was compared to control trees' growth to ensure unbiased sampling. Ring width increment values were summed for each tree for the seven years post-treatment (2004-2010), and an independent samples 2-tailed *t*-test compared the means of the sum of two treatments using SPSS 19.

To investigate the impact of climatic sensitivity on growth rates, detrended tree ring growth was correlated to Fairbanks weather record including both monthly mean air temperatures and total monthly precipitation from the combined University Experimental Station/Fairbanks International Airport (Wendler and Shulski 2009).

Results

Origin and growth of the sample

The first year of growth (FYOG) recorded in the tree core sample is 1929 and the youngest is 1957. All of the trees in the sample appear to have originated after the disturbances associated with the initial establishment of Fairbanks during the first two decades of the 20th century or later, with the great majority of the sample containing a FYOG from 1941 to 1950 (Figure 5.1). Mean FYOG for the entire sample was 1945 while the mean FYOG, and the distribution of FYOG did not vary greatly among the sites (Figure 5.2).

Average annual radial growth across all years and trees was 1.37 mm. The year with greatest mean growth with all 61 trees contributing was 1963, at 2.33 mm. Lowest mean growth averaged for all 61 trees occurred in 1998, at 0.40 mm. The 10 year period with the greatest mean growth was 1936-1945. The 10 individual years with the lowest mean growth include 1930, 1958, 1993, 1997-2000, 2003-4, and 2010.

Growth of tapped versus not taped population

Growth of the tapped population did not differ statistically from the control population at any of the three treatment periods, and site location did not have a significant effect on growth of trees during any of the treatment periods (Table 5.1). Consistently, annual variability significantly impacted the annual increment growth of trees with Pr <.0001 for 'Year' variable for all three treatment periods. Annual increment growth showed significant autocorrelation to the previous year (Table 5.1).

Mean total growth for the seven years after tapping showed no statistical difference between the control and treatment trees (Figure 5.4), confirming results from the general linear model.

Climate sensitivity

Detrended growth was significantly negatively correlated with 8 mean monthly temperatures at Fairbanks (Figure 5.3). The four months most correlated with included April, May, and June of the current year of growth and July of the prior year of growth. The other four significant months include April and June of the prior year and April and July of two years prior. Detrended growth was not significantly correlated with total monthly precipitation for any month of the current year of growth or two years prior.

A temperature predictive index for this population of birch (TI AKB) made up of the mean of the 8 monthly mean temperatures reproduces both the short term and medium term variability in the growth of the sampled birch population (Figure 5.5).

Both detrended growth and climate favorability were high in the 1960s and then declined to lower growth performance and less favorable climate in the 1990's. Some divergence occurred between the TI AKB and Ring Width Index (RWI). TI AKB over-predicted RWI with an underperformance by birch during the middle of the 1980s and the beginning of the 2000s; TI AKB under-predicted RWI with an over-performance of birch, most notably in the beginning of the both 1950s and the 1990s.

A disproportionate amount of the prediction error of TI AKB for birch growth is concentrated in four specific years. The maximum undergrowth (lower growth than predicted by TI AKB) occurred in 1986 and 2003. The greatest overgrowth (greater growth than predicted by TI AKB) occurred in 1953 and 1991. With these four outlier years removed, a simple linear regression of the TI AKB with detrended growth of the sample accounts for nearly two thirds of the variability in the growth of the sample from 1951 through 2010 (Figure 5.6).

Discussion

Birch trees are an abundant resource in Alaska's boreal forest with 1,801,000 acres in the Tanana River Basin that are dominated by hardwood forest (Hammond 1996). Economic studies conducted previously have shown harvesting birch sap to be a viable forest resource in Czechoslovakia (Kostron 1974), Belorussia (Sankovich 1984), and elsewhere in Soviet Union countries (Tomchuk et al. 1973, Shtogrin 1986). While the economic benefit for harvesting sap in China may not be large, the social benefit is a significant opportunity to provide employment (Nie et al. 1995). With increasing interest in birch sap and birch syrup products, birch trees may be able to contribute diversity to a sustainable forest economy for Interior Alaska.

From the general linear mixed model, no statistical difference was detected between the treatment group and the control group prior to treatment (Table 5.1) which indicates that no sampling bias occurred. Results from this study show that tapping *Betula neoalaskana* trees for short periods of time (i.e. three consecutive spring sap seasons) does not impact their growth patterns. These results agree with the previous research of Osipenko and Ryabchuck (1973) whose work showed that tapping birch led to insignificant changes in tree growth in *B. verrucosa* trees in the Ukraine in the 1970's.

No statistical difference was found among treatment groups or sites, and treatment and control trees responded similarly to climate (Table 5.7), so trees do not need to be separated out into different subgroups by treatment or site; therefore, the data set was consolidated for the correlations investigating climate sensitivity. Results of correlations of mean monthly air temperatures and total precipitation show that air temperature from eight key months (Figure 5.3) was predictive of annual growth; however, total month precipitation was not. This is consistent with Yarie (2008) who found that upland sites in Interior Alaska are not affected by a lack of summer throughfall limitations because the critical supply of moisture is received through spring melt from the winter snow pack. If the soil water content is not properly recharged by spring snow melt, then birch trees face moisture stress. Warm temperatures in April accelerate snow melt and decreases infiltration of water into the still-frozen soil. Summer temperatures regulate how rapidly that initial moisture supply is depleted. Birch has been shown to begin annual growth in early June and continue for a 45-day growing season which concludes in mid-July (Yarie 2008); therefore, warm temperatures between April and July and their effects on soil moisture and evapotranspiration rates constrain birches' capacity to grow.

An advantage that birch possesses over other trees in Interior Alaska is its adaptability to fluctuations in intraseasonal variability. While less favorable weather early in the growing season may limit birch growth, it is able to take advantage of favorable conditions that may appear later in the growing season to achieve multiple flushes of growth (Kozlowski and Pallardy 1997). This strategy is not available to all boreal trees in Alaska. If spruce, which are determinate growth species, experience unfavorable weather early in the growing season, their growth will slow or shut down and not resume even If conditions subsequently improve.

Changing climate could impact Alaska's birch resource through changes to growth caused by altered temperature and moisture regimes.

Climate sensitivity of other birch species

Birch ring width chronologies are limited in the literature, partly because ring boundaries are challenging to distinguish (Levanič and Eggertsson 2008, Doležal et al.

2010). A few previous dendroclimatological studies also demonstrate that birch species are highly sensitive to climatic effects, specifically temperature and moisture availability specific during certain months (Kuivinen and Lawson 1982, Levanič and Eggertsson 2008, Doležal et al. 2010) though the sensitivities differ by birch species, location, and elevation. Precipitation showed an overall greater influence on growth than temperature for Erman birch (*B. ermanii)* growth in shallow soils along treeline in Changbai Mountains in Northeast China (Yu et al. 2007).

Growth of birch *B. ermanii* in high altitude of the Mount Norikura region of central Japan are negatively affected by high temperatures in December and January and heavy snow in January and positively affected by warm temperatures during June, July, and August (Takahashi et al. 2005). Growth of birch at lower altitude on Mount Norikura were negatively affected by high August temperatures coupled with low precipitation which likely caused drought stress to the trees (Takahashi et al. 2003). In *B. ermanii* on Kamchatka Peninsula, Russia, radial growth was positively correlated with June and July temperatures and negatively related to precipitation. Trees at high elevations were more sensitive to climate than trees growing at lower elevations (Doležal et al. 2010).

B. platyphylla at higher elevations on Kamchatka Peninsula were positively affected by warm temperatures during July whereas *B. platyphylla* at lower elevations when growing on cool, wet site responded positively to warmer June temperature and when growing on drier sites responded negatively to warmer April temperatures and positively to June precipitation (Doležal et al. 2010).

In Northern Iceland, warmer June and July months have positive influence on the growth of *B. pubescens* (Levanič and Eggertsson 2008). *B. pubescens* in central Sweden had a positively correlated growth with high mean temperatures in July but showed no correlation of growth with either winter or summer precipitation (Kullman 1993).

In northern Michigan, *B. papyrifera* experienced a severe decline including widespread mortality after several years of climatic stress from increased growing season temperatures and decreased precipitation during the growing season (Jones et al. 1993). Trees showed a negative response to increased temperatures with decreased growth and increased susceptibility to pathogens, specifically the bronze birch borer (Jones et al. 1993).

Modeled future growth of birch trees in Interior Alaska

Climate scenarios based on General Circulation Models (GCM) downscaled for Interior Alaska produce an upward trend in temperatures (Chapin et al. 2006). Based on previous findings and the results of this study, such increased temperatures would likely reduce sap harvest. Birch produce higher yields of sap in cooler, wetter springs (Ganns et al. 1982, Maher 2005). Figure 5.8 presents the AKB Temperature Index (mean of eight monthly temperatures selected from Figure 5.3) for the dataset present in this paper and calculated projected growth for the 21st century by applying the linear regression of AKB Temperature Index (Figure 5.6) to two GCMs. The two GCMs used in this analysis were the HadCM3 from the Hadley Centre for Climatic Prediction and Research and CGCM2 from the Canadian Centre for Climate Modelling and Analysis (Kattsov and Kallen 2005). The HadCM3 GCM scenario indicates that birch would face severely growth-limiting conditions in the middle of the 21st century with the first negative RWI calculated from this model in 2058. Under this scenario, eight years display negative RWI (possible tree death) in the subsequent 20 year span, with consistently negative RWI beginning in 2080. The CGCM2 is projects growth-limiting conditions for birch in the immediate future, with the first negative RWI calculated by this GCM in 2014 and 3 additional negative RWI during the 2020's. Overall, the CGCM2 model produces 41 years with negative RWI during the 21st century. These scenario models results indicate that growth of birch on similar sites is likely to be so depressed or even nonexistent that future spring birch sap yields would either be severely diminished or not available for harvesting.

Beyond the reductions in growth and sap production, climate change has other ramifications for birch and sap harvest yields. Stressed trees are more vulnerable to insect outbreaks and other pathogens. Large wildfires in Interior Alaska typically consume spruce forests but under extreme conditions of heat and drought hardwood forest may become flammable. If elevated temperatures persist, eventually new plant species are likely to migrate into Interior Alaska which may be better adapted to the altered climate conditions and outcompete birch for soil moistures and nutrients.

This research has shown that short-term harvest of spring birch sap through standard tapping techniques does not significantly impact annual growth of Alaskan birch trees. More research is needed to investigate the longer-term impacts of harvesting spring sap from Alaska's birch trees, especially tapping over longer time periods (5 to 20 years). Additionally, long-term viability of a sap production system may be heavily dependent on factors exogenous to birch trees, specifically including a warming climate, altered moisture regimes, and increased forest disturbances by wildfire and pathogens.

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Figures and Tables

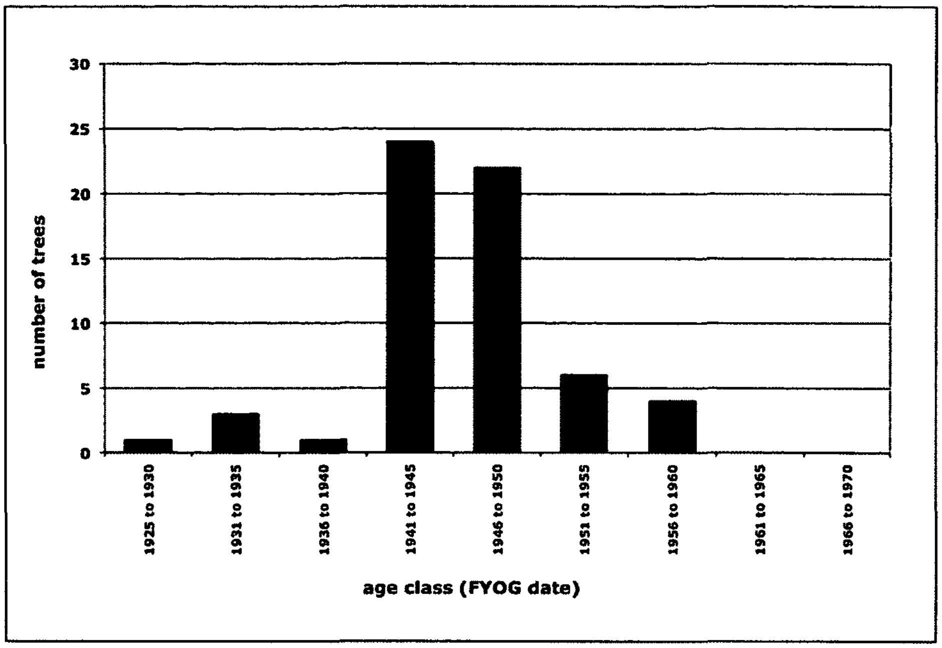

Figure 5.1. Distribution of ages for birch sample
First year of growth (FYOG) by 5-year age classes for combined birch sample.

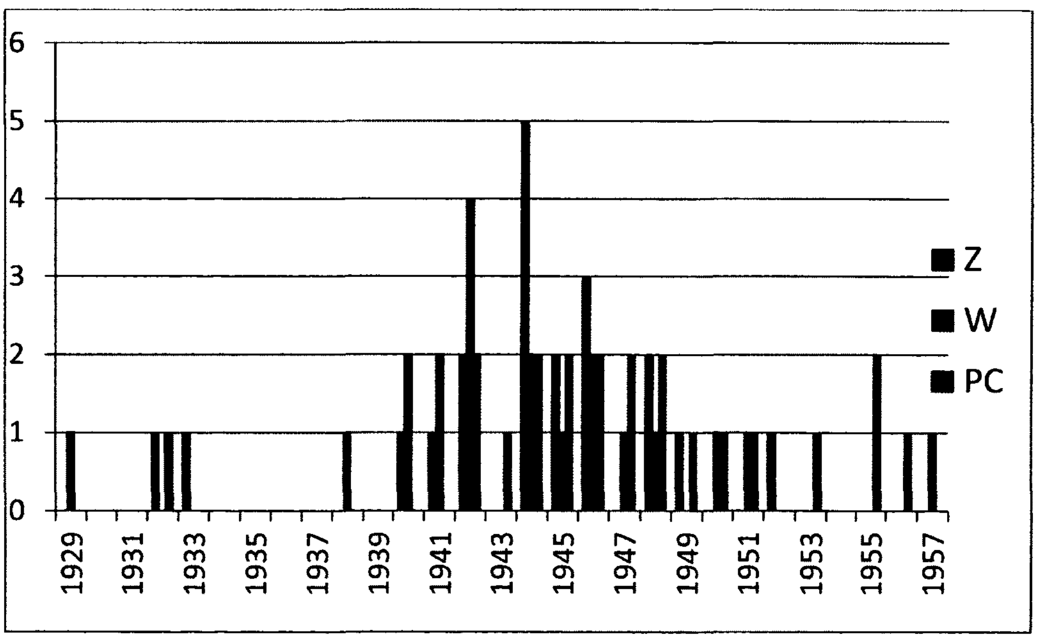

Figure 5.2. FYOG recorded in cores by site

Table 5.1. Results of the General Linear Model

Results for the General Linear Model comparing Year, Site, and Treatment of Tapped and Control Trees prior to, during, and after Sap Harvest.

		Type III Test for Fixed Effects					
		Year		Site		Treatment	
	AR(1)	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Pre-treatment years (1990-2000)	0.3903	127.63	<.0001	1.16	0.3220	0.34	0.5630
Treatment years (2001-2003)	0.3860	22.73	<.0001	2.09	0.1340	0.23	0.6344
Post-treatment years (2004-2010)	0.6359	63.07	<.0001	0.38	0.6886	0.96	0.3322

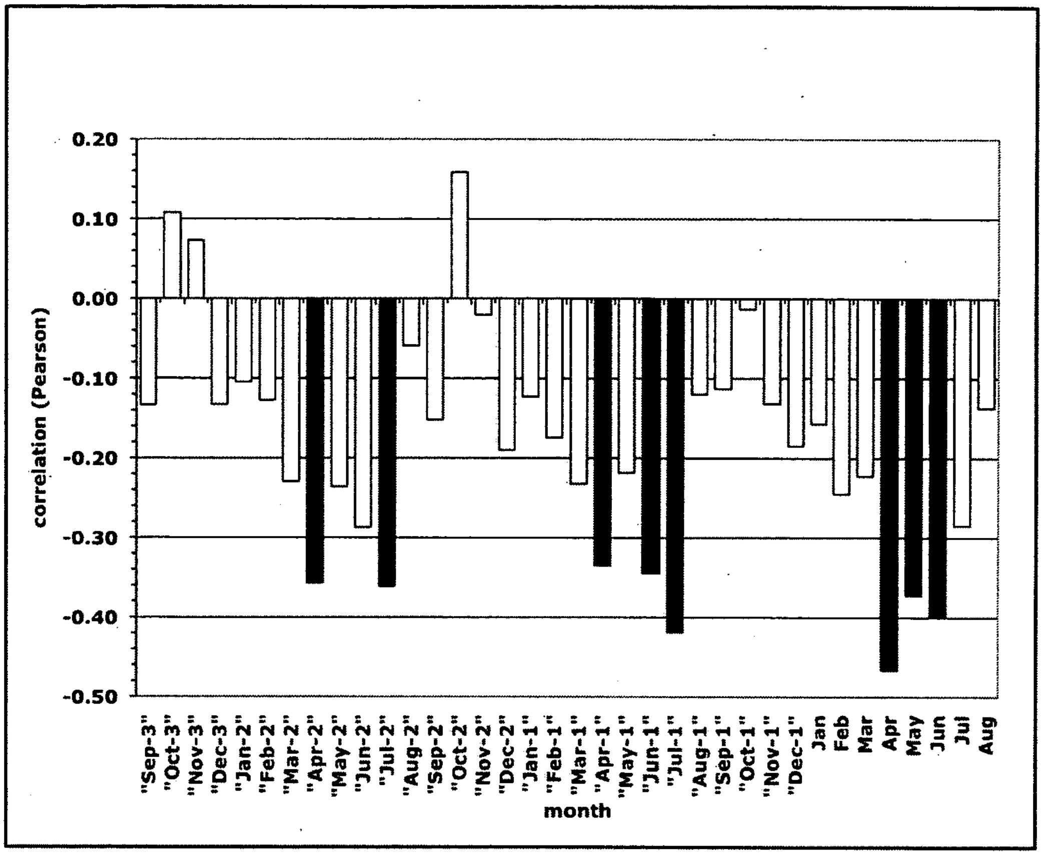

Figure 5.3. Correlation of mean monthly temperature at Fairbanks with mean sample ring width index, 1951-2010.

Black bars indicate months selected to construct temperature predictive index for growth of birch, based on correlation significant at the 99% confidence level.

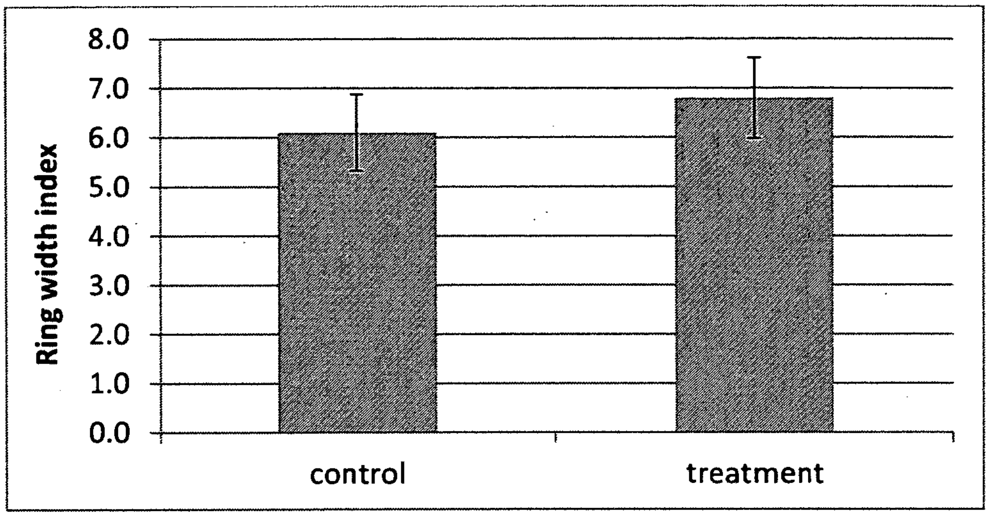

Figure 5.4. Mean post-treatment growth of control and treatment trees
Mean total growth of control (not tapped, n= 31) and treatment (tapped, n=30) trees during the seven consecutive years immediately following treatment (three years of spring sap harvest). Error bars indicate the 95% confident interval.

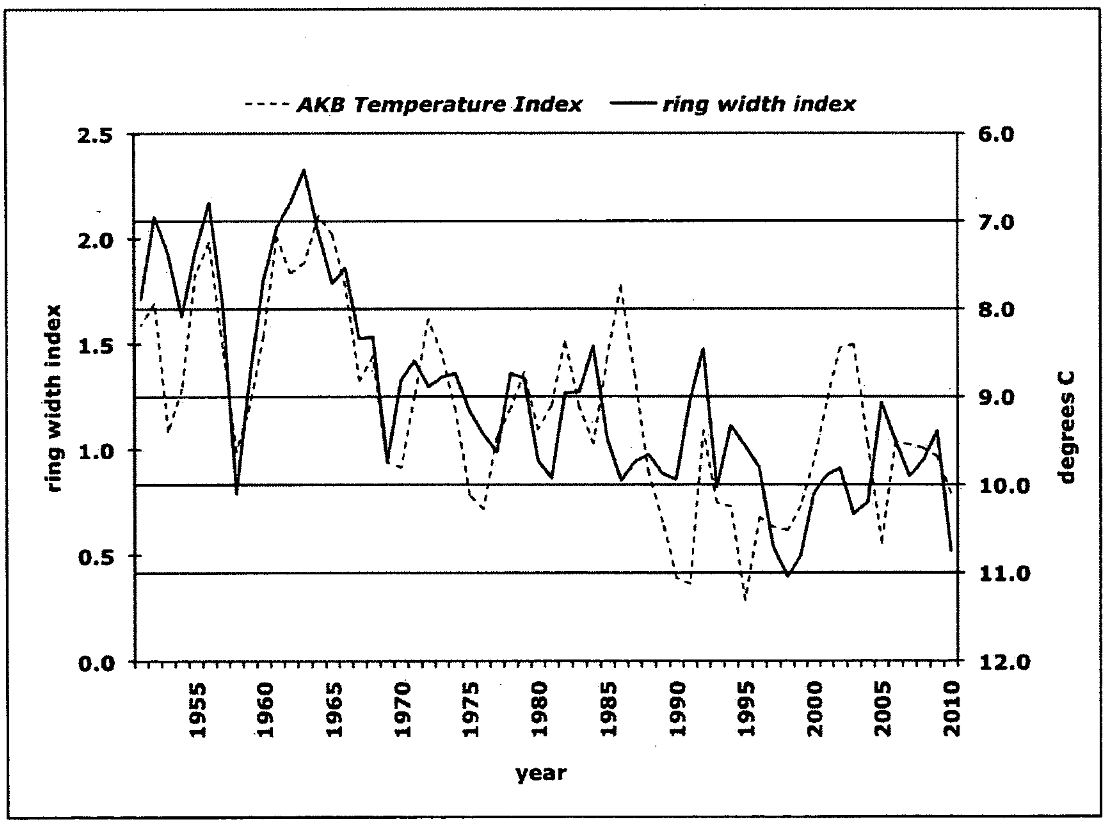

Figure 5.5. AKB Temperature index versus mean sample ring width index
The temperature index calculated from the mean of eight monthly temperatures selected from Figure 5.3 plotted against the mean sample (n = 61) ring width index.

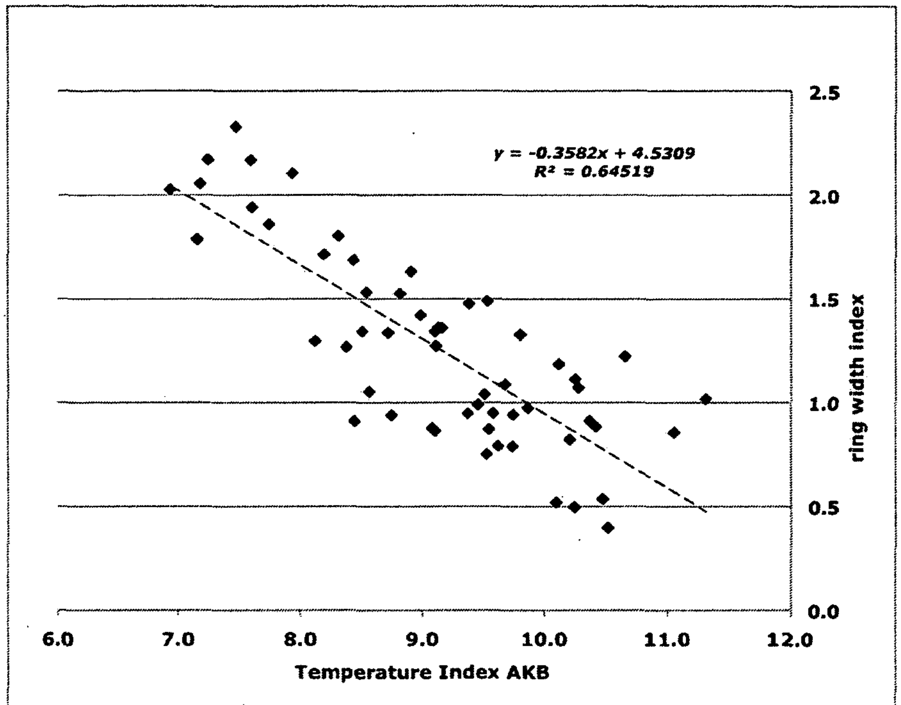

Figure 5.6. Linear regression of Temperature Index AKB versus mean sample ring width index

Linear regression of Temperature Index AKB with two highest (1953 and 1991, overgrowth) and two lowest (1986 and 2003, undergrowth) outliers removed.

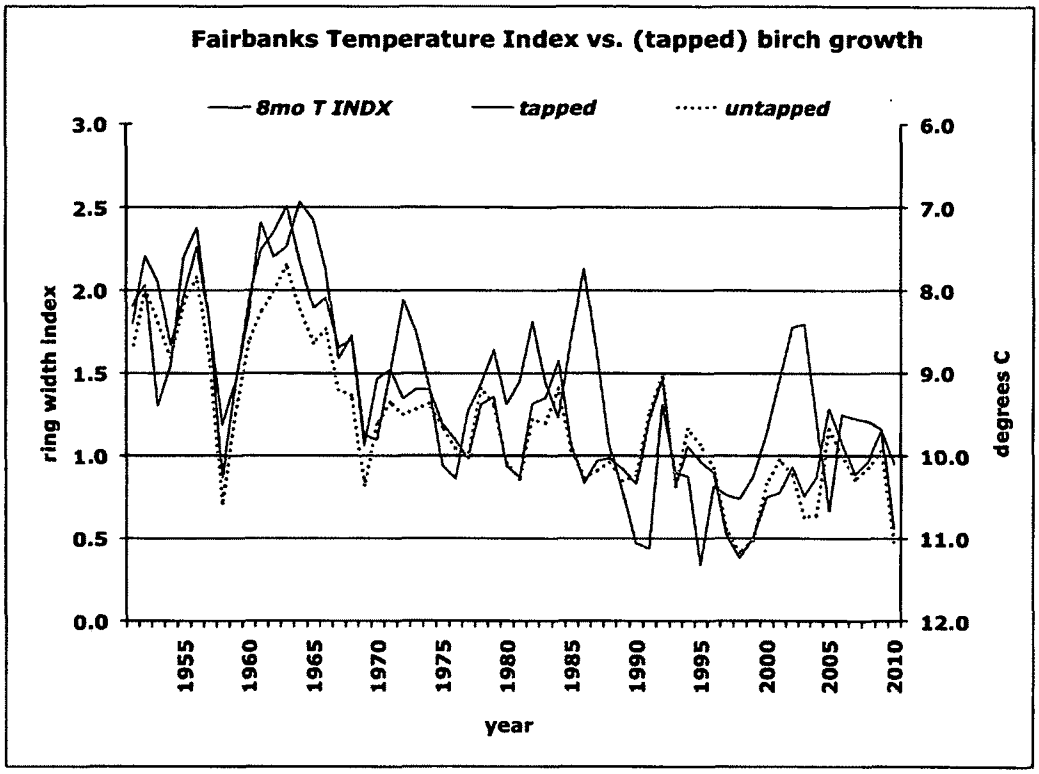

Figure 5.7. Growth of 30 tapped and 31 control birch trees versus temperature Index AKB.

Treatment birch trees were tapped for three spring sap season including 2001 through 2003.

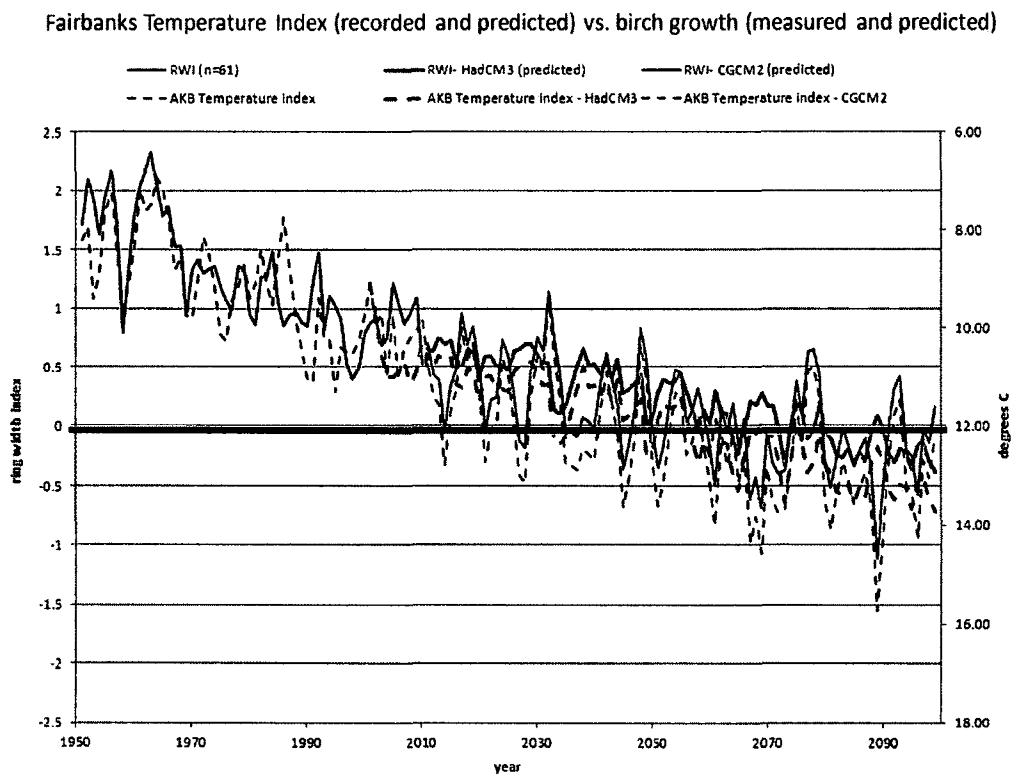

Figure 5.8. Measured and Predicted Ring Width Index of Birch 1950-2100
AKB Temperature index (mean of eight monthly temperatures selected from Figure 5.3) for recorded temperature for 1950-200 versus measure mean sample (n = 61) ring width index; AKB Temperature index calculated from two general circulation models (GCMs) used to generate Fairbanks climate scenarios of the twenty-first century versus modeled ring width indices based on the GCMs and Linear regression of Temperature Index AKB. (GCMs used include the HadCM3 from the Hadley Centre for Climatic Prediction and Research and the CGCM2 from the Canadian Centre for Climate Modelling and Analysis; Kattsov and Kallen 2005).

Chapter 6: Concluding Summary and Management Recommendations

This research investigated the activities and impacts for harvesting non-timber forest products (NTFPs) in Interior Alaska through the use of different research method techniques. Using an interdisciplinary approach, quantitative and qualitative data sets were collected, analyzed, and interpreted. These data sets include a forest use survey, interviews with personal use and subsistence NTFP harvesters, interviews with commercial birch syrup producers, and tree ring measurements of tapped and non-tapped birch trees. Linking these research components together begins to provide a comprehensive look at the role of NTFPs in Interior Alaska. Results from this research provide a basis for recommendations for management of NTFPs to maintain the benefits that harvesting currently provides to residents in Interior Alaska.

Key Findings from this research:

- NTFP harvest in Interior Alaska is widespread activity that transcends much socio-economic stratification. The majority of participants identified themselves as personal use harvesters and only a small percentage of harvesters identified themselves as subsistence harvesters.
- Wild berries, especially blueberries, are the most commonly harvested NTFP, and almost half of households (44%) reported

harvesting berries. Firewood is the second most common NTFP harvested, and one-quarter of households reported harvesting firewood. Other commonly harvested NTFPs included rose hips, mushrooms, and Christmas trees.

- Few patterns emerged in reported harvesting activities. Harvesters with lower formal education (less than a high school diploma) tended to harvest higher quantities of a number of NTFPs (e.g. berries, birch bark, spruce roots). Households in rural zip codes tended to harvest high quantities of some NTFPs (e.g. firewood, birch bark, spruce roots). Few correlations emerged amongst NTFPs harvested. The significant correlations were associated mainly with birch bark, spruce roots, rose hips, and berries.
- NTFPs harvest activities are concentrated around population centers.
- Personal use and subsistence NTFP harvest in Interior Alaska is an important activity to those who participate, and contribute to harvesters' informal household economies by providing products that are often otherwise inaccessible or unaffordable.
- Predominant motivations for harvesting NTFPS are spending time outdoors and spending time with family and friends while harvesting.

- For many harvesters, the importance of harvesting is the combination of the product harvested and the harvesting experience. Harvesters receive an array of intangible benefits while harvesting including improved mental health, a spiritual experience, and developing connections to the land, nature, and their culture.
- Commercial harvest of birch sap and the Alaska birch syrup industry provide forest-based employment. This work draws in workers seeking unique experiences and the opportunity to support their preferred livelihood.
- Short term (i.e. 3 year) harvest of sap from birch trees did not negatively impact growth rates.
- Warming temperatures over the 21st Century would increase moisture stress in birch in Interior Alaska and decrease their annual increment growth. If current relationship between temperature and growth continue, birch may cross a threshold which is very likely to limit or extinguish the ability of the species to sustain growth and yield a sustainable sap resource on the types of sites studied.

Recommendations for managing NTFPs in Interior Alaska

Based on the results of the research conducted, I've developed eight recommendations for preserving or enhancing the benefits received from harvesting

NTFPs in Interior Alaska. The recommendations presented are based on both suggestions that emerged from interview participants and from my application of the conclusions in the previous section. NTFP management is a broad subject; therefore some key areas of NTFP management are not addressed through these recommendations. For instance, illegal fuelwood harvest is a prevalent problem in Interior Alaska, but addressing that particular issue is outside the scope of this dissertation.

1. Recognize that the prevalent value of NTFPs is providing harvesting experiences. The likelihood of NTFPs becoming highly profitable is quite low, and these activities are not likely to generate large amounts of revenue for either land owners or harvesters. Whether harvesters are motivated by personal, subsistence, or commercial use, they are collecting unique products that are usually otherwise inaccessible and receiving intangible benefits to support their preferred livelihood.

2. Take an active role in disseminating information about NTFPs including proper harvesting techniques and practices. NTFPs can be used by management agencies as an avenue to reach constituents, because there is widespread interest among local residents in learning more about how to identify, harvest, preserve, and enjoy boreal plants and fungi. Information sharing should be

multi-directional since residents possess valuable local ecological knowledge. Since harvesters learn through a variety of ways, outreach efforts should be varied and can include websites, print material, and in-person workshops or plant walks.

3. Harvest activities should be systematically tracked to monitor what is being harvested, quantities harvested, and concentrated areas of harvesting activities. Additional data to track includes the role harvested items play in the informal household economy (subsistence, personal use, gifts, trade, or sell), conflict with other forest users, and if harvesters are meeting their harvesting goals.

4. Vegetation monitoring should include NTFP species to see how climate change is affecting their availability, production of harvested parts (e.g. berries, bark, leaves, roots, etc.), and reaction to harvest. Elevated stress from climate change may impact some plants NTFPs' availability or tolerance for harvest.

5. Consider setting aside land close to population centers to serve as harvesting parks. Many harvesters seek a more natural or wild experience and will not consider harvesting in a managed area, but some individuals expressed a need for a local spot to harvest in with elderly relatives or young children. Suggested

improvements include safe parking areas, navigable walking paths, trash receptacles, and restroom facilities. These types of areas would not serve harvesters looking to bring home large quantities of NTFPs, but they would be available for local residents who want a harvesting experience but aren't able to travel into more physically challenging or remote areas.

6. When creating new infrastructure, plan out the long-term use of the area. If a fire break is cut that will turn into a popular berry patch or a forest road is built to access a new biomass timber sale, consider how that will draw future users of the newly opened or accessible areas.

7. Consider establishing a user fee system to benefit the resource and harvesting opportunities. Harvesters indicated that they would be willing to pay nominal fees for permits if they saw the benefit from fees collected and the permit were easy to obtain. Facilities that harvesters were interested in include dedicated parking areas, trash receptacles, and maintained trails or boardwalks. Harvesters recognize that they already pay fees for parking and other services when harvesting in state-managed recreation areas. Model new fees after existing fee systems that public land users are already familiar with. Make the fee payment

process easily accessible for harvesters. Suggestions include an onsite payment drop box or a web-based.

8. If an area becomes a heavily used harvesting area, assess whether the area needs added management to prevent degradation of the harvest area. For instance, if a rural neighborhood becomes a popular berry picking area, assess if added infrastructure is need such as safe parking areas or trash receptacles.

9. Consider ecosystem management practices to stimulate NTFPs and other desired ecosystem services following land use or condition changes such as large scale forest harvest for biomass or fire. Forest managers have a number of tools available for influencing forest composition, vigor, or condition of stands and landscapes. A number of practices such as standards for retention of trees following harvest, distributing seeds, broadcast burning, site scarification, can be applied in a way that promotes NTFPs, or retains at least some NTFP opportunities.

Elements of these recommended practices are already applied by some organizations. For instance, the University of Alaska Fairbanks Cooperative Extension Service (CES) was identified by a number of harvesters as an important source of information and their website and print materials have extensive information about a number of NTFPs including berries, firewood, and morel mushrooms. CES also partnered with other organization to present in-person learning opportunities such as a mushroom identification walk with a mycologist in September 2012 and a birch tapping clinic in April 2013. While this is a promising start, still there are significant gaps in the availability of information needed by the NTFP harvester community.

Some of the recommendations in this section parallel practices that are already in place for other resource systems. The state of Alaska already provides recreation infrastructure and harvesting opportunities for other natural resources. The Alaska Division of State Parks charges $5-10 per vehicle for daily vehicle parking rates, and similar fees for use of boat launches. Additionally, fishing in state recreation areas is enhanced where ponds are stocked with fish for harvesting. Harvesting berries and mushrooms for personal consumption and household use is allowed in state recreation areas, but the harvesting opportunities are not actively managed or enhanced.

If a high demand for commercial NTFP permits develops, one option would be to increase access to other harvesting grounds through developing new trails and roads. It seems unlikely that roads will be built for commercial berry picking as they are for timber sales. However, coordinating different forest use activities can result in complementary, or perhaps even symbiotic, forest activities in which at least one of the forest resource user groups benefits from the other. While scenarios of coordinated management of multiple NTFPs may seem a distant prospect, the ultimate fulfillment of this goal will benefit from pro-active, long-term planning.

With large tracts of public land and resources available in Interior Alaska, the main management needs currently for NTFPs is (a) accessibility to the resource and (b) modulated behavior of people using the resources. Availability of NTFPs may change over time with changing climate and management regimes; therefore, the biological monitoring of NTFPs is a critical component of the overall management package. By balancing these various components of NTFP management, the tangible and intangible benefits will continue to enrich the livelihoods of residents in Interior Alaska.

Considerations for a management framework for NTFPs

Because of the multiproduct and interdisciplinary nature of NTFPs issues, research and management of NTFPs are spread across different government land management agencies, academic organization, and user groups. NTFPs are often grouped together as a single category of natural resources, but actually they represent a great diversity of biological characteristics and end uses. Some NTFP management recommendations and practices may not be universally applicable due to this diversity. When implementing management and new regulations, it is important to understand the specific NTFP being harvested, what part of the plant is removed, and how it will be used. For example, management practices necessary and/or feasible for berries may not pertain to fuelwood or mushrooms.

In Alaska, the term "subsistence" harvest carries with it specific legal connotations which have significant management implications. The Division of Subsistence is within the Alaska Department of Fish and Game, which obviously demonstrates its focus on fish and game resources. According to state statutes, subsistence is defined as "customary and traditional uses":

> Direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption, and for the customary trade, barter, or sharing for personal or family consumption (AS 16.05.940[32])

And the federal definition in the Alaska National Interest Lands Conservation Act (ANILCA 1980) defines subsistence as:

> The customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fur, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal family consumption; and for custom trade (Section 803 (16 U.S.C. 3113))

While these definition delineate what subsistence harvest is, individuals have their own concept of subsistence harvest and may simply use the term "subsistence" for their harvesting activities as even if they fall outside of the state or federal definitions.

Throughout this dissertation, I have specifically not differentiated between the terms personal use and subsistence use. The predominant harvest type reported in the forest use survey data (Chapter 2) was personal use (91% self-identified as personal use harvesters, 8% as both personal use and subsistence harvesters, and only 1% self-identified as subsistence harvesters). Categorizing harvesting into discrete types such as subsistence, personal use, and commercial since may be too simplistic since categories can overlap, as demonstrated by the 8% of harvesters in the forest use survey who identified themselves as being both personal use and subsistence harvesters. More generally, Saastamoinen (1998) demonstrated that a continuous spectrum exists between harvester types and the dichotomous division between "commercial" and "non-commercial" may be too simplistic.

Interviews with the commercial birch syrup producers within this research project (Chapter 4) established that all but one of interview participants also harvested NTFPs for personal use. Even within "commercial harvester" there is a spectrum of harvesters who base their livelihoods off NTFPs. For example, the owners of the birch syrup companies who spend the rest of the year producing value-added products and selling the products are a distinctly different type of harvester than those who dabble in commercial harvesting depending on their time availability and need for income supplements (the seasonal birch syrup workers). Harvest seasons in the boreal forest are quite short, so usually the majority of NTFPs jobs in this region only provide part-time work or income supplement rather than primary income (Saastamoinen 1998).

Huckleberry harvesters in the Pacific Northwest have been categorized into four groups (Carroll et al. 2003): Native Harvesters (people that have centuries of history harvesting in the area), Household Harvesters (non-Native American harvesters that harvest for use in their own households and to share with friends and relatives), Income Supplementers (people who usually pick for use in their household but harvest additional amounts for sale in order to supplement their income), and Full-Timers (people who spend their full-time during seasons harvesting, these people can be local or transitory). Harvesters readily shift between these categories depending on the year and personal circumstances (Carroll et al. 2003). An important consideration is how these different categories of harvesting should be managed and whether they should be managed in different ways or to different standards. Currently in Alaska, only commercial harvesting is actively managed.

Conflict between different user groups may arise if there are increases in commercial NTFP harvest or expansion of other forest use such as timber sales. Determining access to NTFPs is basically determining property rights[8] for NTFP harvest. The necessity to assign property rights, of course, raises questions about how those

[8] When the term "property rights" Is a used within the context of natural resource management, it defines which resources uses have the right to access to a defined resource or physical property and which resource users have the right to withdrawal the resource for their own use (Schlager and Ostrom 1992)

property rights should be allocated. An increase in the number of harvesters or a decrease in resource availability can turn a non-rival good into an exclusive good. In many places around the world, NTFPs are evolving into exclusive goods because of increased harvest or decreased availability, so land managers are now having to allocate harvesting rights to specific user groups where NTFP property rights previously did not exist (Alexander and Fight 2003).

Because of the low ratio of population to land in Interior Alaska, NTFPs in Alaska, for the most part, are still viewed as non-rival goods. Generally in boreal Alaska, the harvest of NTFPs by one harvester does not begin to exhaust the resource and decrease the ability to another harvester participating in NTFP activities. This low-conflict situation may change under (a) intensified forest management practices, (b) increased energy costs, or (c) ecological changes that decreases NTFP yields. The use of biofuels is increasing by households and school districts in Interior Alaska, and some entire communities are planning to decrease energy cost by utilizing local forest resources through fuelwood (cordwood, chips, and pellets). As vehicle fuel prices continue to rise, the distance that people are willing to travel for NTFP harvest may decrease, creating or increasing conflicts for NTFP resources around population centers. As human populations grow in Interior Alaska and new neighborhoods develop, favorable harvesting spots close to town are likely to be harvested at or beyond a sustainable level, resulting in reduced NTFP productivity and conflicts among users or closure to new harvesters. Finally, if temperatures continue to increase at current rates, plants in the boreal forest are likely to experience increased stress, hampering their ability to grow, or changing how they allocate growth resources to different structures and functions.

Four models describe how NTFP activities can interact with other forest uses such as timber or biomass harvest. These resources use models include Independent, Competitive, Complementary, and Symbiotic (Duschesne and Wetzel 2002). Independent Resource Use is characterized by little or no conflict between the two user groups since their activities, interests, and resource bases do not overlap. In a situation of Competitive Resource Use, NTFP resource users harvest areas that overlap the same land area or resource base that other forest users desire for their activities. In a variant scenario of Competitive Resource Use, activities on one NTFP user group negatively impact another group even if not in the same place or at the same time, for example an upstream or time-lagged impact. Complementary Resource Use occurs when no competition for resources exists, and one user group benefits from the activities of another user group. An example of Complementary Resource Use would be the use by NTFP harvesters of a forestry road constructed specifically for a timber sale. A second example would be the enhancement of an NTFP resource by a timber harvest. Symbiotic Resource Use occurs when both user groups benefit, and is often accomplished through co-management practices (Duschesne and Wetzel 2002).

Mitigating conflicts between multiple resource user groups may require new management practices and regulations in order to shift Competitive Resource Use in to Independent, Complementary, or, ideally, Symbiotic Resource Use. When new management policies are put in place, the benefits of those policies should outweigh the costs of implementation and enforcement of new policies. If not, the changes are not likely to be incorporated into people's behavior (Alexander and Fight 2003). In most case studies NTFP resource harvesters demonstrate low compliance with regulations which they do not recognize as legitimate (McLain and Jones 1998). Land managers need to educate harvesters on the rationale behind new management policies, and the regulations should be appropriate for what is needed to manage the resource and harvesters.

Two-way communication is necessary between harvesters and land managers in order to have success policies and compliance of regulations. Poor communication can result in a backlash against science and questioning of technical expertise of land managers (Love and Jones 2001). Exchange of information in both directions helps both land managers and NTFP harvesters understand each other's perspectives better and promote responsible harvest and management.

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Appendices

Appendix A: List of questions for Personal and Subsistence Use NTFP harvesters interviews (Chapter 3)

1. What do you harvest? (provide a list from the Forest Use Survey a sample list of berries, firewood, other botanical products, mushrooms, etc)
2. How do you use these things? What do you do with them? (Freeze them, turn them into jellies/jams)
3. Do you ever use these items for gifts or to trade?
4. How adamant are you about going out to harvest (take time off work, make time in your schedule, go if you have the opportunity)
5. How do you pick a spot where you'll harvest? Do you go to the same spot year after years or does your harvesting spot vary? How do you choose where you'll go pick?
6. Who owns the land where you go pick? Is access to the land ever an issue when you want to go harvest?
7. Who do you go harvest with? By yourself, friends, family
8. Do you have any particularly strong memories about a specific trip to go harvest?
9. Do you couple you harvesting with other activities i.e. hiking or camping?
10. How did you learn about what, when, and how to harvest? From other people or books?

11. If you're not able to go harvesting, how would you react? Would that change what you might buy from the store or try to trade for them?
12. If what you harvest is available from a store, how the store version different than what you harvest?
13. When you go out and harvest, what is your goal? Is it a certain about of something that you'll go out again and again until you have that much (i.e. 3 gallons of blueberries no matter how many trips it takes or a trip and get what you get during that trip)
14. Have you ever been to a U-Pick field to harvest anything? How do you see this as similar or different that harvesting 'wild.'
15. How important is it to harvest 'wild' products when you go out?
16. Would you like to see areas managed fro harvesting such as an area set aside for a blueberry patch? If so, who do you see managing these areas? Private or government (borough, state, etc.) Would you be willing to obtain a permit to go harvest in such an area?
17. How far are you willing to travel to go harvest? What is the furthest you've gone? What determines this? (time, cost of gas, want to get out anyways)
18. How does harvesting (or just having the opportunity to go harvest) contribute to you thoughts and identity of living where you do—in your community, in Alaska?

Appendix B: Code List for Personal and Subsistence Use NTFP harvesters interviews (Chapter 3)

AK berries-still buy berries from the store
AK berries are better
AK berries are different than store bought
animal interactions
annual cycle
annual variability in resource—quantity
annual variability in resource—temporal
begin harvest- child
begin harvest- when move to Alaska/Interior AK
being a part of nature
benefit-diveristy of the wild
benefit-forest management
benefit-mental health
benefit-physical activity
benefit-wild is healthier
benefits-healthy
berries
best 3 days of my year
carpool
collect interesting objects
concern for a clean environment
connection to nature
connection to the harvesting experience
connection to the land
connection to time past
constrained by cost
constrained by storage area
constrained by the seasonality
constrained by time
costs associated with harvesting- it's really expensive jam
couple-4 wheeling
couple-boating
couple-camping
couple-don't couple, focus on harvesting
couple-hiking
couple-hunting
couple-trip somewhere else

couple-U-Pick harvesting
curious of the local ecosystem
firewood
freezer full of food
gender-female
gender-male
gender-roles in harvesting
gifts
gifts-people who live Outside
gifts-Xmas
go-afterwork/evenings
go-any opportunity I can
go-important activity
go-opportunity arise
go-take time off work
go-weekend thing
God provides
grew up harvesting different types of things not in AK
harvest-family
harvest-friends
harvest-never alone in the woods
harvest-solo
harvest-with dog
harvest-with younger generation
hobby, not subsistence
hunter/gatherer
hunting
identity-Alaskan
identity-outdoorsy
identity-self
importance-activity of harvesting itself
imported food-unsustainable
invasive species
it's pleasant to me
jam-too much sugar!
just go without
land ownership-Native
land ownership-other private property
land ownership-own property
land ownership-public lands

land ownership-who knows?
learn-being out there
learn-books
learn-class
learn-Coop Ex
learn-family
learn-internet
learn-other people
life after death
life lesson via harvesting
Management
memorable-big bounty
memorable-epic experience while harvesting
memorable-interaction with animal
memorable-no berries to be had
memorable-people
memorable-trash in berry patches
missing feeling when living Outside
motivation-compulsion
motivation-create memories
motivation-don't want to run out
motivation-enjoy
motivation-harvesting experience is the whole sum-experience plus coming home with something
motivation-harvesting the summer's sun
motivation-icing on the cake
motivation-it's just part of life
motivation-know where my food's coming from
motivation-knowing what's out there
motivation-need firewood to get by the winter
motivation-social
motivation-spiritual
motivation-taste home
motivation-treasure hunt
motivation-try something new
motivation-utilize a local resource
motivation-want to bring something home
motivation-be outdoors
mushrooms
not dependent on harvest

Not harvest, something's missing
not replaceable with commercially available items
NTFP-birch bark
NTFP-birch sap
NTFP-blueberries
NTFP-bog cranberry
NTFP-burls
NTFP-chamomile, wild
NTFP-cloudberries
NTFP-cones
NTFP-cran, high bush
NTFP-cran, low bush
NTFP-crowberries/blackberries
NTFP-currants
NTFP-dandelions
NTFP-diamond willow
NTFP-fiddleheads
NTFP-fireweed
NTFP-firewood
NTFP-grass
NTFP-greens
NTFP-honey bees
NTFP-house logs
NTFP-Labrador tea
NTFP-landscaping plants
NTFP-lichen
NTFP-medicinal plants
NTFP-mushrooms
NTFP-nagoonberries
NTFP-other
NTFP-pole logs
NTFP-porcupine quills
NTFP-raspberries, wild
NTFP-rose petals
NTFP-rosehips
NTFP-salmonberries
NTFP-saw logs
NTFP-spruce pitch
NTFP-spruce roots
NTFP-spruce tips

NTFP-strawberries, wild
NTFP-wild potatoes/masu
NTFP-willow
NTFP-Xmas trees
opportunistic harvesting
pass on/share information with others
permits-already familiar with
quality of life
reciprocity
respectful harvesting
self-sufficiency
share
spot-changes
spot-changing ecologically
spot-find by being out in the woods
spot-land developed
spot-proprietary of it
spot-quest for the better spot
spot-same year after year
spot-searching for it
spot-secrecy
spot-share
spot-shift to new places that are more productive
spot-where you've been successful before
substitute goods
substitutes are too expensive
take time off work to harvest
trade
tradition-new
trapping
U-Pick
use-akutaq
use-art & crafts
use-baked goods
use-barter
use-birch bark baskets
use-canned
use-carving
use-ceremonial
use-dog bedding

use-dried
use-eat fresh
use-fire starter
use-freeze and use
use-home decor
use-jelly/jam/sauces
use-juice
use-liqueur
use-medicinal
use-reseeding project
use-salve
use-sauna/steam bath
use-sell
use-smoothies
use-store in seal oil
use-syrup
use-tea
use-tincture
use-vinegar
use-walking sticks
use-wine/mead
Vitamin C
void in my life if I couldn't pick
why we live in Alaska/Interior AK

Appendix C: List of questions for Commercial Birch Syrup Workers interviews (Chapter 4)

1. How did you get involved with tapping birch trees?
2. Did you ever tap maple trees growing up?
3. What else do you harvest from the woods?
4. How do you use these products—personal use, food, arts & crafts, sell?
5. With whom do you go harvesting these items? Is this usually the same people?
6. How did you learn about harvesting from the woods?
7. When did you start harvesting (how old were you)?
8. Do you often go out into the woods for recreation (camping, hiking, etc.)? Do you often harvest things from the woods when you're out do other activities?
9. What non-tangible benefits do you get from working/ spending time in the woods?
10. What kind of work do you do at the other times of the year?
11. Do forest-based products provide a majority of your annual income? What percentage of your annual income do you get from forest-based products?
12. How would your life be different if you didn't spend time in the woods? How important is it to your identity as an Alaskan to spend time out in the woods?

Appendix D: Code List for Personal Commercial Birch Syrup Workers interviews (Chapter 4)

age when start harvesting-- adult
age when start harvesting-- kid
age when start harvesting-- teenager
age when start harvesting-- young adult
Alaska weather
Alaskan identity
birch syrup-- grading quality
birch syrup-- organic certification
fresh air
harvest-- multitasking
harvest--club
harvest--elsewhere in AK
harvest--employees
harvest--family
harvest--friends
harvest--Outside
harvest--solo
harvesting other forest products--house logs
harvesting other forest products--wild fish & game
income from forest-based products-- 5% and under
income from forest-based products-- 6-25%
income from forest-based products-- 80-100%
inspiration-- learning to harvest NTFPs
inspiration-- to tap birch trees
intangible benefits
learn-- how to make birch syrup
learn--from books
learn--from others
learn--grew up with it
learn--on the job
learn--self-evident
lifestyle choice
maple
NTFP-- all other NTFPs harvested
NTFP-- does not otherwise harvest
NTFP-- lichens & moss harvest
NTFP-- pollen harvest

NTFP--bark
NTFP--berries harvest
NTFP--botanical harvest
NTFP--chaga
NTFP--devil's club
NTFP--fiddleheads
NTFP--firewood harvest
NTFP--goldenrod
NTFP--greens
NTFP--harvest for arts & crafts
NTFP--Labrador tea
NTFP--mushroom harvest
NTFP--nettles
NTFP--spruce tips
NTFP--wood for carving
NTFP--wormwood
NTPF-- maple experience
opportunistic harvesting
other forest use-- camping
other forest use-- hiking
outdoor work
outdoor work as a priority
prefer country/woods over city
previous experience in tapping
residency elsewhere in AK
residency in other states
resource sustainability
social ties-- getting involved with birch syrup industry
social ties-- harvest alone
social ties-- harvesting companions
spending time in the woods
use-- arts and crafts
use-- food
use-- gifts
use-- personal use
use--carve
use--commercial products
use--jam
use--sell
work-- Antarctica

work-- arts
work-- carpentry
work-- food industry
work-- hospitality
work-- research vessel
work-- sign as recruitment for birch syrup
work-- trade work
work-- trail crew
work-- transitory lifestyle
work--teacher
would like to get become more involved with harvesting