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Insights From a Harvest Trip Model for Non-Timber Forest Products in the Interior of Alaska[1]

Kimberley Maher, Joseph Little, and Patricia A. Champ

Introduction

The harvest of non-timber forest products (NTFP) for personal uses such as hobbies and handicrafts, cooking and canning, and recreation is an important pursuit for many residents in Alaska (Pilz and others 2006). Five categories of NTFP have been designated by the United Nations Food and Agricultural Organization: (1) foods; (2) medicinal plants; (3) floral greenery and horticulture products; (4) fiber and dye plants, lichens, and fungi; and (5) oils, resins, and chemicals extracted from plants, lichens, and fungi (McLain and Jones 2002). As noted by Alexander and others (2002), interest in the harvest and use of NTFP has grown in the United States. Such products are harvested from forests throughout the United States (McLain and Jones 2002). While attention has been directed toward commercial aspects of NTFP use and harvest, cultural, religious, and social considerations are also important (Jones and Lynch 2002).

The harvest of NTFP in Alaska is largely unregulated outside of the Alaska National Interest Lands Conservation Act, which protects subsistence and rural harvesting rights at the Federal level, and a few State laws. However, within Alaska there has been some movement toward increased regulatory oversight. For example, the

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Authors:

Kimberley Maher, Ph.D. Student, IGERT Program, University of Alaska—Fairbanks.

Joseph Little, Associate Professor of Economics, University of Alaska—Fairbanks.

Patricia A. Champ, Research Economist, Rocky Mountain Research Station, USDA Forest Service, Fort Collins, Colorado.

Alaska Department of Natural Resources, Division of Mining, Land, and Water, the agency responsible for the permitting of commercial NTFP harvest on Alaska State land, has proposed regulatory changes and developed a "Non-timber Forest Products Harvest Manual" (AKDMLW 2008) to guide commercial harvest practices. Decisions about regulating (or not regulating) the harvest of NTFP should be grounded in an understanding of the extent of the activity as well as factors that influence the number of harvest trips.

Although there has been some research conducted about NTFP harvest and use practices in the state, much of the work has focused on southeast Alaska. Mater (1999) reviewed market research for NTFP in the United States and extended the analysis to Alaskan NTFP resources to assess the demand for the State's forest products. That study draws heavily on examples from the contiguous United States, which limits its applicability to the interior of Alaska. While some of the products examined are ubiquitous to the State (e.g., blueberries and rosehip), a number of the species detailed are specific to the southeast Alaska temperate rainforest. For studies related specifically to Alaska, Pilz and others (2006) examined the income generating potential and marketability of NTFP in southern Alaska. Drawing on survey data, Bates (2002) examined NTFP harvest and use in the interior region of Alaska.[2] Along with presenting descriptive statistics for a variety of forest products, Bates (2002) also used replacement costs as a measure of the potential economic value for a few key products such as mushrooms and blueberries. No formal attempt was made to model harvest trip taking behavior. To extend the analysis, a second Forest User Survey was conducted by the Alaska Boreal Forest Council, University of Alaska—Fairbanks, and Alaska Department of Natural Resources in 2003.[3] Like the first, the second survey asked respondents about their harvesting trips and quantities of products harvested. Additionally, the second survey also collected information about the respondents' personal characteristics and motivations for harvesting NTFP. The examination presented here draws on the data from the 2003 Forest User Survey to examine the harvest behavior of respondents who reported consumptive uses of NTFP in the interior region of Alaska. In this report, a model of NTFP trip taking behavior is estimated. Key factors related to number of harvest trips are identified and discussed.

This report is structured in three sections. The first section provides a background discussion of the study area and a brief review of State-level NTFP resource management institutions. The second section consists of the data analysis and modeling. This section includes a brief outline of the structure and administration of the 2003 NTFP user survey, the data analysis, and estimated harvest trip models. The report concludes with a summary discussion and suggests possible future research avenues.

[2] A preliminary forest use survey was conducted in 2000 by the Alaska Boreal Forest Council, University of Alaska Fairbanks, and Alaska Department of Natural Resources, Division of Forestry. The study by Bates (2002) is based upon the initial survey data. This paper focuses on the second forest use survey conducted by the same collaboration in 2003.

[3] A basic descriptive analysis of the data from the second survey is found in Bates and others (2004). The data from the second survey has been largely ignored because the Alaska Boreal Forest Council dissolved shortly after the survey was completed.

Background

Study Area

The Tanana Valley State Forest (TVSF) of Alaska (Figure 1) encompasses approximately 1.81 million acres and spans the Tanana River Basin located within the interior of Alaska (Pojar 1996). The population of the interior is concentrated in the Fairbanks-Northstar Borough, which had a reported population of 82,840 in the 2000 census. Located within the Fairbanks-Northstar Borough is Alaska's third largest city Fairbanks (population = 30,224). Outside of the Fairbanks-Northstar Borough are small villages and hamlets such as Tok (population 1,393), Fort Yukon (population 595), and Delta Junction (population 894).

The low population density and relative abundance of natural resources colors individual perspectives toward NTFP in the region. In general, the harvest of NTFP by one individual is not seen as decreasing the ability of another individual to participate in harvesting activities. While not specific to the Alaska NTFP context, Alexander and Fight (2003) discussed how management and property rights allocation choices depend upon the mosaic of social and biological factors present. Consistent with this thinking, NTFP in the interior are characteristically similar to other non-exclusive, open access resources where harvest access and use are guided by informal rather than formal rules.[4]

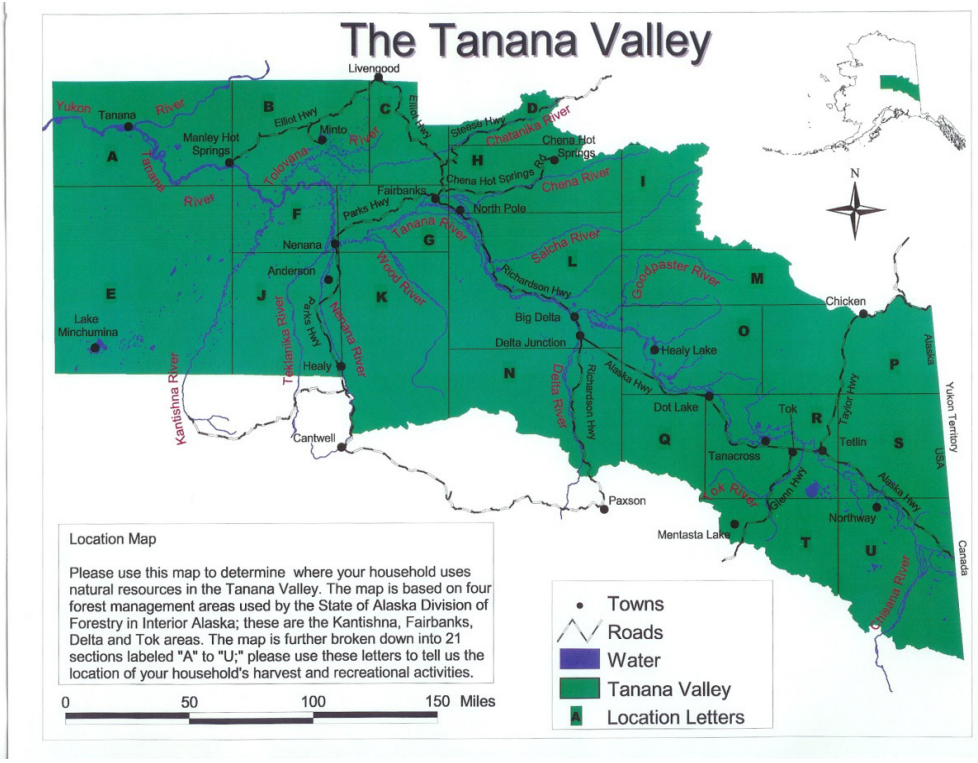

Figure 1. The Tanana Valley Watershed. Source: 2003 Forest Use Survey.

[4] Please see Schlager and Ostrom (1992) for a conceptual framework discussing access and use of common pool resources within the context of de facto and de jure property rights institutions.

Because harvest seasons in the interior are short, NTFP harvested commercially in the Tanana Valley usually provide only part-time work and serve as a supplemental income. Carroll and others (2003) examined huckleberry harvesters in the Pacific Northwest and presented four types of harvesters:

1. native harvesters—people that have centuries of history harvesting in the area;
2. household harvesters—non-Native American harvesters that harvest for use in their own households and to share with friends and relatives;
3. those who harvest to supplement income—people who usually pick for use in their household but harvest additional amounts for sale in order to supplement their income; and
4. full-time harvesters—people who harvest full-time, can be local or transitory.

Of course, individuals can also readily shift between these categories depending on the year and circumstances (Carroll and others 2003).

Management of NTFP on State Land in Alaska

Two State agencies within the Alaska State Department of Natural Resources have management responsibilities on the TVSF. The Division of Mining, Land and Water is responsible for the review and granting of permits for *commercial* NTFP harvest on State lands. Given that harvesting berries, wild plants, and plant material for subsistence and personal use are considered "generally permitted activities" by the DMLW, these pursuits do not require a permit. The other relevant State land management agency is the Division of Forestry (AKDOF). The AKDOF is responsible for the management of all State *forest* lands, including the TVSF. State law mandates that the AKDOF is to manage forest resources for multiple use, sustained yield, and sustainability; however, Alaska Statute Sec. 41.17.200 states that "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 resources (AKDOF 2003)." For fiscal years (FY) 1998-2005, the volume of TVSF timber offered averaged 14,509 million board feet (MBF) per year while the volume sold averaged 5334 MBF. An average price of $31.01/MBF for the region yields an average yearly sale value of $165,407.[5]

The AKDOF requires permits for some NTFP harvested on State lands. Individua ls must obtain permits for the harvest of firewood, house logs, and saw logs. Firewood permits cost $5 per cord and 157 permits for harvest on the TVSF were issued in 2003, generating $2355 in revenues for the State. Permit sales generated $2871 and $551 for house and saw logs, respectively.

[5] This information was provided to the authors in a spreadsheet from the AKDOF. The spreadsheet is no longer publically available. Timber volumes and prices are taken from the AKDOF Quarterly Cut and Sold Report. Average sale price is computed for Fairbanks, Delta, and Tok forest regions using AKDOF-computed prices for FY98-FY05.

Data Analysis and Modeling

2003 Tanana Valley Forest User Survey

The Tanana Valley State Forest Use Survey was administered in 2003 by the Alaska Boreal Forest Council, the University of Alaska, and the AKDOF. The purpose of the survey was to assess the annual household NTFP harvest levels from the Tanana Valley in interior Alaska. A broad spectrum of NTFP and recreational pursuits were included in the survey, but this report focuses on harvest and trip data for botanical and wood product categories. The array of botanicals included blueberries, raspberries, wild strawberries, high- and low-bush cranberries, fungi, rosehips, landscaping and medicinal plants. Wood products included firewood, Christmas trees, birch sap, saw logs, poles, house logs, diamond willow, and birch bark. Respondents provided information on the number of harvesting trips taken and quantities of NTFP harvested. In addition, respondents were provided a regional map and asked to identify approximately where they harvested (Figure 1). Finally, respondents answered a set of standard socio-demographic questions and provided their opinions on the NTFP management policies of various State and Federal agencies.

Bates and others (2004) provided additional detail of the survey design and sampling method used. To summarize, 960 individuals were randomly selected using contact information provided by the Alaska Permanent Fund. Addresses were cross-referenced with zip codes located within the TVSF region and mail surveys were sent. Two follow up contacts were used to enhance the overall response rate. A total of 292 (30.4% response rate) individuals returned completed surveys. Of these, 124 individuals indicated that they did not harvest a botanical or wood product NTFP from the study area, and 168 individuals reported harvesting at least one botanical or wood-related forest product, of which 16 failed to report a number of harvest trips. Respondents who failed to report trip and harvest quantities were identified in the data set. Descriptive statistics inclusive of all respondents reporting harvesting trips are presented in Table 1.

The gender of survey respondents (GENDER) was almost evenly split with 48% female and 52% male. The average respondent household size (HHSIZE) of 2.6 suggested that at least one child lives in the home. In general, the average respondent was somewhat older (AGE = 47.81), has received at least some college education (EDU = 15.67), and has lived in Alaska for over two decades (AKRES = 25.20 years). Respondent household income (HHINC) was collected using 12 income categories. Household income (HHINC) is treated as a continuous variable and the midpoints of each category are used for statistical calculations. Using this approach, the average household income of respondents was $65,055. URBAN is a dichotomous variable that indicates if the respondent lives in the cities of North Pole or Fairbanks—approximately 80% of respondents live in these areas. Very few respondents (8%) said they were harvesting NTFP for subsistence use; most respondents (90%) indicated harvest for personal use. Approximately 3% of the sample did not report an NTFP use category. Finally, two dichotomous variables indicated the proportion of respondents that made at least one harvesting trip in the general NTFP categories of botanicals (BOTBIN) and wood products (WOODBIN). Approximately 78% of respondents reported making at least one harvesting trip for botanicals; 59% of

Table 1. Descriptive statistics for 2003 Forest User Survey.

Variable	Definition	Mean (s.d.)
AGE	Respondent age (years)	47.81 (12.49)
AKRES	Years of AK residency	25.20 (15.22)
EDU	Years of education	15.67 (4.14)
HHSIZE	Number of individuals living in the household	2.60 (1.32)
HHINC	Annual household income	$65,055 (33,786.19)
GENDER	If reported as male = 1, 0 else	0.52 (0.50)
URBAN	If reported living in urban area = 1, 0 else	0.80 (0.40)
SUBSIST	If reported as subsistence = 1, 0 else	0.083 (0.28)
PERUSE	If reported as personal use = 1, 0 else	0.90 (0.30)
TOTTRIPS	Number of trips reported for all NTFP categories	13.83 (20.04)
BOTBIN	If reported taking at least one trip for any botanical = 1, 0 else	0.78 (0.42)
WOODBIN	If reported taking at least one trip for any wood product = 1, 0 else	0.59 (0.49)
Observations		168

respondents reported making at least one trip for wood products. Differences in the relative proportions of forest product categories are attributable to the presence of a few popular items. As just one example, blueberries are a common and readily available NTFP that many individuals harvest annually. Consequently, the mean proportion of the variable BOTBIN is heavily influenced by the presence of blueberries in this harvest category.[6]

Regarding the overall representativeness of the sample, it is difficult to draw comparisons among the sample, sample frame, and general population. Aggregate level descriptive statistics from the 2000 U.S. Census for the Fairbanks-Northstar Borough Metropolitan Statistical Area (MSA) provide one possible comparison; however, the MSA does not include all of the zip codes included in the survey sample frame. The relative proportions of men and women in the survey sample as well as the average household size of respondents are commensurate to the 2000 Census figure for the same variables. The survey sample with respect to gender reflects a relatively even split (52/48) between male and female. The 2000 Census figure is approximately 51/49 male to female. Average household size for survey sample is 2.6 persons compared to 2.56 for the Census. There are substantial differences between the average age and median income of survey respondents in comparison to the Census numbers. Survey respondents reported an average age of 47.8 years and average household income of

[6] Bates (2002, 2004) generalized statistical information to the Tanana Valley Watershed. However, in comparison to 2000 U.S. Census data for the Fairbanks-Northstar Metropolitan Statistical Area, respondents deviate from regional averages in the areas of educational attainment, age, and household income.

$65,055. Both figures exceed the reported Census figures of 29.5 years and $40,577. Given the limited amount of data available for comparison, it is difficult to make any final determination as to how well the survey sample represents the general population. In noting the relatively small sample size and the focus on adult NTFP users (as opposed to non-users), the findings presented here should only be generalized to the survey sample.

Harvest Statistics

The harvest quantities for each of the botanical and wood forest products are presented in Table 2. These statistics identify the mean quantities harvested for individuals who reported harvesting that specific product.

Table 2 indicates that survey respondents reported harvesting a diverse array of botanical and wood related forest products. While information about specific uses is limited, the raw counts of individuals reporting harvest are higher for those products that are most useful in either cooking or home heating. Specifically, blueberries, high bush cranberries, and raspberries have the highest number of reported harvesters for botanicals. The popularity of these berries is likely attributable to personal familiarity and to their usefulness as a recipe ingredient. In the wood products category, firewood was the most commonly harvested NTFP, with 74 respondents reporting and a mean harvest of 4.73 cords and 5.5 harvest trips on average. Very few survey respondents reported harvesting house logs (n = 5) and saw logs (n = 3), two NTFP activities that require a permit.[7]

Harvest Trip Model

A trip harvest model was estimated to provide insight into the factors that may influence the number of NTFP harvest trips made. The use of non-standard units of measurement between and within NTFP categories complicates any formal statistical modeling of the quantity of NTFP harvested. The reported number of harvest trips, however, is consistent across all NTFP categories. The general trip demand model is presented in equation [1]:

$$T_i = f(\mathbf{F}_i, \mathbf{H}_i, \mathbf{I}_i, \mathbf{S}_i) \qquad [1]$$

where T_i is the total number of NTFP harvest trips taken by respondent *i*, $\mathbf{F}_i$, is a vector of indicator variables representing the type of forest product harvested by respondent *i*, $\mathbf{H}_i$ represents whether the trip was for subsistence or personal use, $\mathbf{I}_i$ is the household income of respondent *i,* and $\mathbf{S}_i$ is a vector of other socio-demographic variables for respondent *i*.

[7] One respondent reported harvesting 1200 saw logs. This data did not appear to be a mis-entry and would subsequently upwardly bias mean harvest quantities in that category.

Table 2. Mean NTFP harvest quantities and trips for 2003 Forest User Survey. Respondents (n = 168).

Category	NTFP	Unit of measurement	Mean quantity harvested (s.d.)	Mean harvest trips (s.d.)	Number of harvesters reported
Botanicals	Blueberries	Quarts	7.72 (11.18)	2.53 (3.63)	113
	Low bush cranberries	Quarts	3.32 (2.41)	1.84 (1.76)	39
	High bush cranberries	Quarts	5.81 (4.52)	1.95 (2.33)	65
	Raspberries	Quarts	3.95 (4.67)	2.47 (3.71)	50
	Fungi	Quarts	9.90 (13.86)	3.67 (4.92)	21
	Medicinal	By type	10.20 (12.48)	2.2 (2.28)	5
	Landscaping plants	Number of plants	8.18 (5.83)	1.79 (2.18)	22
	Rosehips	Quarts	3.27 (4.70)	1.73 (2.01)	26
	Wild strawberries	Quarts	0.9 (0.46)	2.9 (6.03)	10
Wood product	Birch sap	Gallons	5.50 (5.89)	8.33 (6.11)	3
	Bark	Pieces	31.19 (63.61)	2.13 (1.86)	16
	Christmas trees	Single trees	1.23 (0.63)	1.00 (0.40)	39
	Cones	Number of cones	42.8 (43.61)	11.00 (21.80)	5
	Willow	Sticks	14.78 (15.56)	1.22 (0.97)	9
	Firewood	Cords	4.73 (4.23)	5.49 (7.51)	74
	House logs	Number of logs	87.00 (71.20)	15.00 (17.96)	5
	Poles	Number of poles	23.54 (17.68)	4.82 (8.77)	11
	Saw logs	Number of logs	175 (198.43)	15.33 (8.96)	3
	Burls	Number or burls	7.5 (9.11)	2.17 (1.47)	6
	Roots	Feet	73.33 (68.07)	2.33 (2.31)	3

To avoid problems with small sample size in some variables, forest products ($\mathbf{F}_i$) were grouped into broader categories of either botanical (BOTBIN) or wood (WOODBIN). The indicator variables PERSUSE and SUBSIST represent reported respondent use type ($\mathbf{H}_i$). Respondents who did not specify a use preference serve as the baseline. The continuous variable HHINC represents the natural log of household income. Finally, standard slate socio-demographic variables, including AGE, AKRES, GENDER, EDU, HHSIZE, and URBAN, are used.

Count data estimators such as Poisson or negative binomial are required given the presence of non-negative integers in the left-hand side variable. An additional layer of complication is added by the presence of a large number of zero counts (trips). To address the presence of zero counts, a zero-inflated negative binomial model was

estimated.[8] A second model excludes trip observations of zero and obtains coefficient estimates through zero-truncated negative binomial regression. Estimation results are presented in Table 3. Model 1 was estimated via zero-inflated negative binomial regression while Model 2 was estimated via zero-truncated negative binomial regression.

The parameter estimates and levels of significance are stable across all models. The only notable difference between the zero-inflated and zero- truncated negative binomial models is on the estimate on the PERSUSE variable. This could be due to the greater number of zero trip reports for respondents who did not specify a use type category. The relative influence a variable has on the trip demand function can be converted to an incident rate by taking $exp(\beta i)$, where βi is the estimated parameter. The incident rates are interpreted as the relative change in the number of trips that are predicted to occur for a one unit change in the explanatory variable. For each model, the likelihood ratio statistics indicate overall statistical significance at 1% levels. The difference in the number of observations is due to the exclusion of zero trip observations between the zero-inflated and zero-truncated negative binomial models.

Table 3. Estimated coefficients of NTFP harvest trip models.

	Zero-inflated ***Model 1***	**Zero-truncated** ***Model 2***
LNINC	-0.018 (0.13)	-0.033 (0.20)
GENDER	-0.116 (0.72)	-0.054 (0.29)
AGE	-0.015 (1.92)*	-0.017 (1.71)*
AKRES	-0.005 (0.74)	-0.008 (1.06)
EDU	0.004 (0.19)	0.003 (0.15)
HHSIZE	0.053 (0.92)	0.087 (1.28)
PERSUSE	0.561 (1.98)**	0.131 (0.34)
SUBUSE	0.356 (1.25)	0.415 (1.24)
URBAN	-0.721 (3.22)***	-0.702 (2.62)***
BOTAN	0.885 (4.01)***	0.822 (3.11)***
WOOD	1.211 (6.58)***	1.303 (6.04)***
Observations	168	151
Log- Likelihood	-496.74	-459.39
Likelihood Ratio (χ^2)	86.71***	67.59***
Alpha Statistics	0.951***	0.941***

***, **, *, Significant at the 1%, 5%, and 10% levels, respectively.

[8] The estimated alpha statistics significance indicates that the trip count data are over dispersed; thus, the negative binomial specification provides a better fit to the data. LNINC is the natural logarithm of the HHINC variable.

The estimated models illustrate a few interesting insights. A respondent's age is estimated to be inversely related to the number of harvest trips taken. Residents of urban areas (Fairbanks and North Pole, Alaska) take significantly fewer trips (approximately 50% less) than rural residents. Harvest trips are independent of income, a finding that supports previous research noting the few harvesters that try to use NTFP as a source of primary income. Estimates for the botanical (BOTBIN) and wood (WOODBIN) variables provide a general indication of how forest product type influences the number of trips taken by respondents.

If we compare individuals who solely harvest botanicals to those who harvest wood, the incidence rates tell us that those who pursue botanicals take an average of one less trip than those who exclusively harvest wood products. In all likelihood, more trips are needed to harvest and haul a winter's worth of firewood than are needed to haul a winter's worth of small and easily transportable blueberries. Unfortunately, it isn't possible to identify joint harvest with the available data. What can be said is that individuals who harvest both botanical and wood forest products are predicted to take more trips. Further research into the nature of specific harvesting behaviors with respect to joint harvesting is warranted.

Conclusion

Drawing on data collected through a mail survey, this study provides some insight about NTFP harvesting and trip behavior in the TVSF. Survey respondents reported harvesting a diverse array of forest products from the region. Most harvesters reported that the products they pursued were for personal use, which is consistent with the "household" harvester group described by Carroll and others (2003). A small proportion of respondents indicated they harvested NTFP for subsistence purposes. While the survey data cannot be used to assess the overall scale of harvest in the region, information collected from respondents indicates that the pursuit of forest products is important to many individuals.

A case can certainly be made for the development of future forest user surveys. Future surveys should be designed to further refine our understanding of harvester preferences and behavior. While the results from the estimated models in this study provide some insight into factors that influence the number of harvest trips taken by individuals, additional information about the spatial distribution of harvest patterns or the willingness to pay for specific products would enhance our understanding of motivations of local harvesters.

Harvesting NTFP in the TVSF remains an enjoyable pastime. Should the State decide to normalize management plans, there will be a need to educate harvesters on the reasons behind management policies and regulations. Given that the harvest of NTFP by local residents has both economic and cultural dimensions, future surveys can be used to examine what might follow from permitting NTFP for personal use. Such surveys can also be used to more fully develop the composite of the nature and purpose of NTFP personal use harvesting in the region. At the very least, understanding the critical role that NTFP harvest plays in the lives of local residents will further clarify the relative trade-offs of future land management decisions.

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Station Headquarters
Rocky Mountain Research Station
240 W Prospect Road
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(970) 498-1100

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