## 2.0.Methods

### 2.1. General Methods and Techniques Used

This study is based on a systemic approach. The systemic approach is commonly applicable when the subject of a study can be singled out in a relatively explicit system (Blauberg et al. 1973). The main characteristics that define a system are: integrity, relative independence, structure, strong internal relations and hierarchy of relationships (Blauberg et al. 1973, Pistun et al. 1988). The subject of this study is treated as a part (subsystem) of hierarchically higher forestry system. The latter itself is a component of a societal system (see Figure 1).

The research process undertaken here can be broken into three successive stages: 1) preparation; 2) experimentation and 3) summarization. In the first stage, the original idea, the subject of investigation, the factors causing the subject specific characteristics and the objectives of the study were determined. Also, a literature search on related topics was conducted and the type and structure of available primary and secondary statistical data was uncovered.

The second stage – experimentation – includes application of analytical methods of data processing, interpretation and representation. A variety of methods were employed to examine survey data. These methods include: replacement value determination, cluster analysis, regression modelling, graphical and geographical representation, classification and others. In the third stage the results of the data analysis were reviewed and research-based conclusions prepared.

All the methods (groups of methods) used through the three stages of the research and their application are disclosed in more detail in Table 4.

**Table 4.** Methods used for the study of the household forest use in the Tanana Valley.

| # | Method(s) | Application and results | Stage when the use of the method was the most important (+) | | |
|---|---|---|---|---|---|
| | | | 1 | 2 | 3 |
| 1 | Search for data and literature | More than 32 publications were found useful and contributed to the study. The literature review helped to narrow down the subject of the study. The cooperation with the TVFUS team was established and the data from the TVFUS studied. Methods and techniques of the study were selected. | + | - | - |
| 2 | Historical | Historical patterns of forest resource usage in the Tanana Valley were studied using information obtained from interviews, surveys and the literature. The results from the previous TVFUS (2000) were analysed and compared with survey results from the TVFUS-2003. | + | - | - |

**Table 4.** Continued.

| # | Method(s) | Application and results | Stage when the use of the method was the most important (+) | | |
|---|---|---|---|---|---|
| | | | 1 | 2 | 3 |
| 3 | Sociological | A number of forestry professionals were interviewed (TVFUS steering committee members, faculty of SALRM and SOM of UAF, staff of ABFC, etc.). Participation in 4 forestry-related conferences, a number of discussions, teleconferences were undertaken. An active role in the development and implementation of TVFUS was taken. | + | - | - |
| 4 | Classification | The statistical database for the project was created. The data were structured into categories and groups based on the type of resource and/or species. The dataset included 324 rows, reflecting the number of respondents in the survey, and more than 50 columns, reflecting the criteria on which data could be sorted and classified. Both, Microsoft Excel and Microsoft Access were used to generate cluster tables. | + | + | - |
| 5 | Graphical | 27 graphs and figures were provided for better representation of the subject of the study and the results of the data analysis. | + | + | - |
| 6 | Economic | The replacement value for Tanana Valley forest resources utilized by households during the period from September 2002 to August 2003 was calculated. Preliminary collected market prices for different items or their most common substitutes were used for the evaluation (more detailed discussion is provided in Section 2.2). Linear regression modelling was considered (Section 2.5). | - | + | - |
| 7 | Statistical | Statistical techniques of confidence intervals and error calculation were applied to extrapolate the sample data for the whole Tanana Valley population and in regression simulations. | - | + | + |
| 8 | Mathematical | Simple and more advanced mathematical techniques were used through the whole data processing stage. | - | + | - |
| 9 | Geographical | A series of stationary geographical maps were created to reveal some rules of allocation of forest resource use by household and for better representation and visualization of the obtained results (Section 2.3). | - | + | + |

### 2.2. Minimum Replacement value

The replacement cost (value) method is one of cost-based methods used in natural resource and environmental economics. This method estimates values of natural resources or ecosystem services based on the cost of replacing these resources with similar resources or services (King et al. website, accessed 10/25/04). The replacement value method does not provide a complete measure of economic value (King et al. website, accessed 10/25/04). A complete estimation of natural resources' net benefits is based on estimating consumer and producer surplus. Estimation of consumer surplus and producer surplus would require the consideration of all monetary and non-monetary costs and benefits associated with resource use. There have been many studies of non-commercial values for specific Alaska natural resources (Herrmann et al. 2003, Duffield et al. 2001, Duffield et al. 2001a, Duffield et al. 2001b, Duffield et al. 2001c, McCollum et al. 1994, McCollum et al. 1994a).

The Tanana Valley forest use survey does not provide sufficient information for a complete estimation of the net benefits for various forest resources. Accordingly, a partial picture of economic value is presented here through estimation of replacement values. The replacement value method presents the value for a commodity assuming that direct consumption of the commodity is the sole source of benefits that harvesters derive and that if they did not harvest the resource they would purchase its closest market substitute. Furthermore, since the market price remains constant over all units of the harvested resource, this valuation method is based on an average value rather than the marginal value of the commodity. A question was included in the survey to inform the determination of substitute 'replacement' products for forest resources. The question was: "Does your household purchase substitutes for any of the above items when the harvest is less than desired? If YES, please tell us what is purchased to substitute for…" The source of prices used in replacement value calculation varied across resources. For many items, the price was based on records of local grocery stores that sold the substitute product at the time when harvest occurred. For other items the price established by local companies-buyers was used. In a few cases, online auction prices were used, since the appropriate information was not available from other sources.

Again, a note of caution is warranted when reviewing replacement values. We emphasize that the calculated replacement cost should be viewed as minimum value that represents only the resources' gross direct consumption value. It does not include other consumptive and non-consumptive values of forest resources and services that are substantial in many cases and it does not consider the costs associated with resource harvest. Such other values include aesthetic value, recreation value, life-sustaining value, scientific value, biological diversity value, spiritual values, intrinsic value, historic value, future value, therapeutic value, cultural value, etc. (Manning et al. 1999, Brown et al. 2000, Cordell et al. 2003). Key figures and characteristics used for replacement value determination on each harvesting section are presented in Tables 5 through 10 and discussed below.

#### 2.2.1. Per Unit Replacement Value

The weights of salmon, trout, grayling and pike were calculated based on the data gathered by the first TVFUS. Many respondents reported quantity of fish harvested

both, in number of fish and pounds, which allowed the calculation of the average weight of one fish. Because of space limitations of the survey, the subspecies of some fish species (salmon, trout, whitefish) were not specified. The weights of different subspecies were averaged to get an estimate for particular species. The information about average weight of burbot caught in Tanana River was obtained through interviewing experienced anglers. The weight of whitefish and sheefish was averaged together based on weight information from www.alaska.com and www.fishresource.com. The weight of cleaned fish (guts and head off) provided in Table 5 is approximately 90% of the whole body weight.

The whole fish per pound price was extrapolated to the replacement value for a single fish. Prices were obtained and/or derived from a local grocery store, Fred Meyers, and a local fish buyer (more information is provided in Table 5).

**Table 5.** Calculation of replacement values of harvested fish.

| # | Item | Price, $/lbs* | Substitutes used for price determination | Source | Average weight of cleaned fish, lbs | Replacement value for one fish, $ |
|---|---|---|---|---|---|---|
| 1 | Burbot | 3.74 | Mean chicken and cod | Fred Meyer | 2.00 | 7.48 |
| 2 | Grayling | 4.98 | Trout | Fred Meyer | 1.16 | 5.78 |
| 3 | Pike | 3.74 | Mean chicken and cod | Fred Meyer | 4.29 | 16.04 |
| 4 | Salmon | 1.15 | Chinook | Local buyer | 6.66 | 7.66 |
| 5 | Trout | 4.98 | Trout | Fred Meyer | 1.39 | 6.92 |
| 6 | Whitefish / Sheefish | 3.12 | Mean whitefish and cod | Local buyer, Fred Meyer | 2.50 | 7.80 |

* *August 2004 price.*

The prices fror replacemnt value calculations of harvested wood products in the Tanana Valley were taken from local sellers of similar items. Only prices for small spruce cones (typical for the study area) and birch bark (average size pieces of 16x20 inches) were obtained from ebay online auction (more details in Table 6) because no local price was available.

**Table 6.** Calculation of replacement values of harvested wood products.

| # | Item | Price | Substitutes used for price determination | Source |
|---|---|---|---|---|
| 1 | House Logs | $33.60/log | House Logs | Local Sellers |
| 2 | Firewood | $109.33/cord | Firewood | Local Sellers |
| 3 | Christmas Trees | $70.00/each | Christmas Trees | Local Sellers |
| 4 | Saw Logs | $37.20/log | Saw Logs | Local Sellers |
| 5 | Pole Logs | $4.91/pole | Pole Logs | Local Sellers |
| 6 | Birch Bark | $4.00/piece | Birch Bark | Ebay auction price |
| 7 | Cones | $0.20/each | Cones | Ebay auction price |
| 8 | Diamond Willow | $10.50/stick | Diamond Willow | Local Sellers |
| 9 | Spruce Burls | $6.00/foot | Spruce Burls | Local Sellers |

The calculation of replacement values for non-wood products was relatively straightforward since most of the products from this resource category can be directly substituted by equivalent products from the grocery store (Table 7). Replacement cost of landscaping plants was calculated based on the price of iris – the most popular landscaping plant according to survey responses. An average price for iris plants was obtained from the Holm Town Nursery Inc. (Fairbanks).

**Table 7.** Calculation of replacement values of harvested non-wood products.

| # | Item | Price | Substitutes used for price determination | Source |
|---|---|---|---|---|
| 1 | Birch Sap | $0.25/gallon | N/a | Local Buyer |
| 2 | Blueberries | $15.94/quart | Blueberries | Safeway |
| 3 | High-Bush Cranberries | $5.98/quart | Cranberries | Safeway |
| 4 | Landscaping Plants | $3.49/each | Iris | Local Nursery |
| 5 | Low-Bush Cranberries | $5.98/quart | Cranberries | Safeway |
| 6 | Mushrooms | $2.44/quart | White Mushroom | Fred Meyer |
| 7 | Raspberries | $5.86/quart | Raspberries | Safeway |
| 8 | Wild Strawberries | $3.54/quart | Wild Strawberries | Safeway |
| 9 | Rosehips | $2.51/quart | Dry rosehips | Ebay auction price |

To estimate a MRV for big game animals, ADFG estimates of boned-out carcass weights were used (see Table 8). The price of boned-out meat of the most common substitutes (beef and/or pork) was used in the replacement cost calculation for those animals.

**Table 8.** Big Game Weights.*

| Big-game species | Live weight of adults (pounds) | Carcass weight (pounds) | Boned-out carcass (pounds) |
|---|---|---|---|
| Moose | 750-1,650 | 375-835 | 250-600 |
| Caribou | 150-500 | 75-250 | 55-175 |
| Bison | 800-2,000 | 400-1,000 | 275-700 |
| Elk | 600-1,350 | 300-625 | 200-475 |
| Dall sheep | 110-230 | 55-115 | 40-80 |
| Muskox | 300-800 | 150-400 | 100-280 |
| Black bear | 70-350 | 35-175 | 25-125 |
| Brown bear | 375-1,250 | 185-625 | 65-215 |

** Source: Alaska Department of Fish and Game Hunting Regulations (pdf) and www.alaska.com*

*** The table shows the range of fall weights for both sexes 2 years of age and older, except bears. Bear weights are for animals 4 years and older; their weights can increase 25 percent from spring to fall. Carcass weight is the weight of the meat after the removal of viscera, head, hide and lower legs. Boned-out weight is the weight of the carcass after all bones except the ribs are removed.*

According to survey responses, when the harvest is less than desired people normally substitute small game animals with chicken (chicken or pork for snowshoe hare). This information was useful in calculating the MRV for small game animals. The price of a wolf pelt was used as an approximation of the replacement value for this animal (Table 9).

**Table 9.** Calculation of replacement values of harvested game animals.

| # | Animal | Price, $/lbs | Substitutes used for price determination | Source | Estimated Replacement value for one animal, $ |
|---|---|---|---|---|---|
| 1 | Moose | 2.63 | Average Beef and Pork | Fred Meyer | 1591.15 |
| 2 | Ptarmigan | 1.49 | Chicken whole | Fred Meyer | 1.68 |
| 3 | Caribou | 2.63 | Average Beef and Pork | Fred Meyer | 427.38 |
| 4 | Black Bear | 2.63 | Average Beef and Pork | Fred Meyer | 276.15 |
| 5 | Brown Bear | 2.63 | Average Beef and Pork | Fred Meyer | 1065.15 |
| 6 | Grouse | 1.49 | Chicken whole | Fred Meyer | 1.55 |
| 7 | Snowshoe Hare | 2.24 | Average Chicken and Pork | Fred Meyer | 6.72 |
| 8 | Water Fowl | 1.49 | Chicken whole | Fred Meyer | 1.52 |
| 9 | Dall Sheep | 1.78 | Beef | Fred Meyer | 151.30 |
| 10 | Wolf | $250.00/pelt | N/a | Local Fur Buyer | 250.00 |

Most animal traping is done to obtain furs, and hence pelt prices provide the best approximation of the replacement value for trapped animals. Pelt prices were obtained from the Alaska Raw Fur Company. The only trapped animal used mainly for food is snowshoe hare. Its replacement value was calculated from the price of its nutritional substitutes as reported by survey respondents (Table 10).

**Table 10.** Calculation of replacement values of trapped animals.

| # | Animal | Price, $/pelt | Substitutes used for price determination | Source | Estimated Replacement value for one animal, $ |
|---|---|---|---|---|---|
| 1 | Beaver | 21.77 | N/a | Fur Buyer | 21.77 |
| 2 | Snowshoe Hare | $2.24/lbs | Average Chicken and Pork | Fred Meyer | 6.72 |
| 3 | Fox | 25.00 | N/a | Local Fur Buyer | 25.00 |
| 4 | Lynx | 100.00 | N/a | Local Fur Buyer | 100.00 |
| 5 | Marten | 45.00 | N/a | Local Fur Buyer | 45.00 |
| 6 | Mink | 10.00 | N/a | Local Fur Buyer | 10.00 |
| 7 | Muskrat | 2.00 | N/a | Local Fur Buyer | 2.00 |
| 8 | Wolverine | 200.00 | N/a | Local Fur Buyer | 200.00 |
| 9 | Wolf | 250.00 | N/a | Local Fur Buyer | 250.00 |
| 10 | Otter | 100.00 | N/a | Local Fur Buyer | 100.00 |
| 11 | Coyote | 25.00 | N/a | Local Fur Buyer | 25.00 |

### 2.2.2. Total Replacement Value

Following the aforementioned rules and assumptions, the total minimum replacement value (MRV) of forest resources harvested in the Tanana Valley by its households was estimated. The estimates were first calculated for the survey sample and then extrapolated for the whole Tanana Valley population. The estimated September 2002 – August 2003 total MRV for household-harvested in the Tanana Valley forest resources was $27,460,796. More detailed information about the quantity and replacement cost of the various resources is provided in the Table 11.

**Table 11.** Estimated quantities and MRVs of the forest resources harvested in the Tanana Valley by its households (based on the 2002 TVFUS data).

| Category/ Subcategory | Quantity of the reported harvest | Total estimated quantity for the Tanana Valley | Estimated min. replace-ment value of the reported harvest, $ | Total estimated min. replace-ment value for the Tanana Valley, $ |
|---|---|---|---|---|
| **Fish** | | | | |
| Burbot | 185 | 20,786 | 1,384 | 155,483 |
| Grayling | 495 | 55,618 | 2,861 | 321,472 |
| Pike | 370 | 41,573 | 5,935 | 666,832 |
| Salmon | 416 | 46,742 | 3,187 | 358,040 |
| Trout | 509 | 57,191 | 3,522 | 395,762 |
| White/Sheefish | 139 | 15,618 | 1,084 | 121,820 |
| **Fish total:** | 2,114 | 237,528 | 17,972 | 2,019,409 |
| **Wood materials** | | | | |
| Birch bark, pieces | 500 | 56,180 | 2,000 | 224,719 |
| Christmas trees, each | 55 | 6,180 | 3,850 | 432,584 |
| Cones, # | 214 | 24,045 | 43 | 4,831 |
| Diamond willow, sticks | 461 | 51,798 | 4,841 | 543,933 |
| Firewood, cords | 387 | 43,483 | 42,256 | 4,747,865 |
| House logs, # | 505 | 56,742 | 16,968 | 1,906,517 |
| Pole logs, # | 267 | 30,000 | 1,311 | 147,303 |
| Saw logs, # | 565 | 63,483 | 21,018 | 2,361,573 |
| Spruce burls, # | 52 | 5,843 | 2,808 | 315,506 |
| Spruce roots, feet | 220 | 24,719 | * | * |
| **Wood materials total:** | N/a | N/a | 95,094 | 10,684,719 |
| **Non-Wood Products** | | | | |
| Birch sap, gallons | 27 | 3,034 | 7 | 787 |
| Blueberries, quarts | 964 | 108,315 | 15,358 | 1,725,618 |
| H/B cranberries, quarts | 172 | 19,326 | 1,026 | 115,280 |
| Landscaping plants, each | 192 | 21,573 | 670 | 75,281 |
| L/B cranberries, quarts | 449 | 50,449 | 2,685 | 301,685 |
| Medicinal plants, each | 78 | 8,764 | * | * |
| Mushrooms, quarts | 199 | 22,360 | 486 | 54,607 |
| Raspberries, quarts | 214 | 24,045 | 1,251 | 140,562 |
| Rosehips, quarts | 101 | 11,348 | 254 | 28,539 |
| Wild strawberries, quarts | 9 | 1,011 | 32 | 3,596 |
| **Non-wood products total:** | N/a | N/a | 21,767 | 2,445,730 |

**Table 11.** Continued.

| Category/ Subcategory | Quantity of the reported harvest | Total estimated quantity for the Tanana Valley | Estimated min. replace-ment value of the reported harvest, $ | Total estimated min. replace-ment value for the Tanana Valley, $ |
|---|---|---|---|---|
| **Game animals** | | | | |
| Black bear | 10 | 1,124 | 2,762 | 310,337 |
| Brown bear | 2 | 225 | 2,130 | 239,326 |
| Caribou | 15 | 1,685 | 6,411 | 720,337 |
| Dall sheep | 4 | 449 | 605 | 67,978 |
| Grouse | 528 | 59,326 | 818 | 91,910 |
| Moose | 43 | 4,831 | 68,419 | 7,687,528 |
| Ptarmigan | 233 | 26,180 | 391 | 43,933 |
| Snowshoe hare | 126 | 14,157 | 847 | 95,169 |
| Waterfowl | 680 | 76,404 | 1,034 | 116,180 |
| Wolf | 1 | 112 | 250 | 28,090 |
| **Game animals total:** | N/a | N/a | 83,667 | 9,400,787 |
| **Trapped animals** | | | | |
| Beaver | 54 | 6,067 | 1,176 | 132,135 |
| Fox | 33 | 3,708 | 825 | 92,697 |
| Lynx | 34 | 3,820 | 3,400 | 382,023 |
| Marten | 199 | 22,360 | 8,955 | 1,006,180 |
| Mink | 15 | 1,685 | 150 | 16,854 |
| Muskrat | 155 | 17,416 | 310 | 34,831 |
| Snowshoe hare | 78 | 8,764 | 524 | 58,876 |
| Wolf | 15 | 1,685 | 3,750 | 421,348 |
| Wolverine | 30 | 3,371 | 6,000 | 674,157 |
| **Trapped animals total:** | 613 | 68,876 | 25,090 | 5,638,202 |
| | | | | |
| **Total:** | N/a | N/a | **243,592** | **27,460,796** |

** Resource wasn't valued because of the lack of replacement cost information*

Pike accounted for the largest share of estimated MRV in the fish category, $666,832 (32% of total fish replacement value). The relatively large size of an average northern pike substantially contributed to this outcome. Trout (all kinds), salmon (all kinds) and grayling also accounted for significant shares of total fish MRV– 20%, 18% and 16%, respectively (Figure 4). Burbot and white/sheefish are less important in terms of MRV. These species account for 8% and 6% of the total fish MRV, respectively. In terms of the quantity of fish kept, trout, arctic grayling and salmon have particular prominence among the harvest fish species (see Table 11).

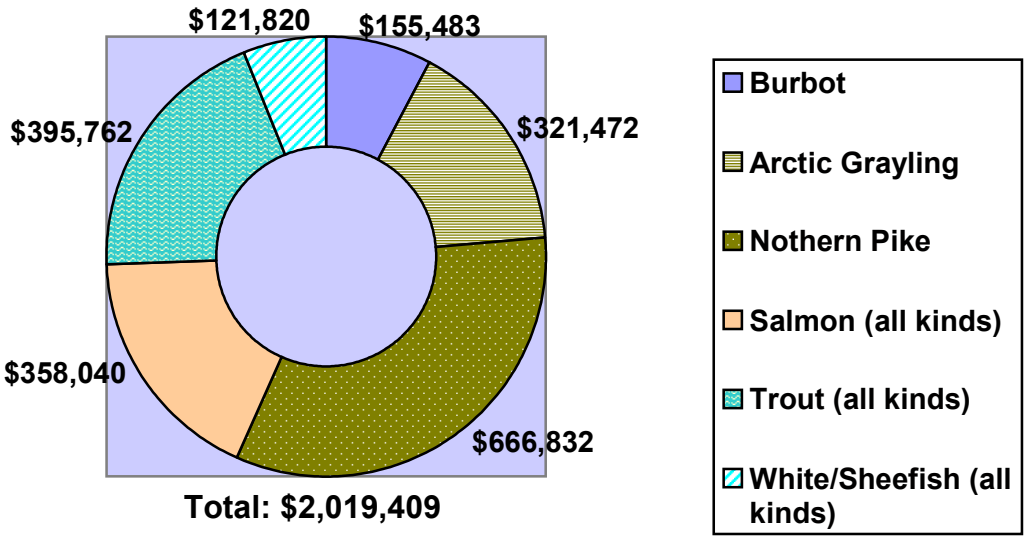


**Figure 4.** Estimated replacement value for fish harvested in the Tanana Valley by its households (by kind of fish).

In terms of MRV, wood materials have the greatest estimated value among the Tanana Valley forest-use natural resource categories. Firewood is the most prominent harvested wood material according to estimated MRV. Harvesting firewood is the most common wood resource harvesting activity in the region. Twenty-five percent of the TVFUS respondents reported harvesting firewood (in comparison, the next most popular activity – harvesting Christmas trees – had a 16% participation rate). Based on a local firewood price of $109.33 per cord, the replacement value for this forest resource was estimated to be $4,747,865 for the whole Tanana Valley region. Firewood accounts for 45% of the total wood materials replacement value (Figure 5).

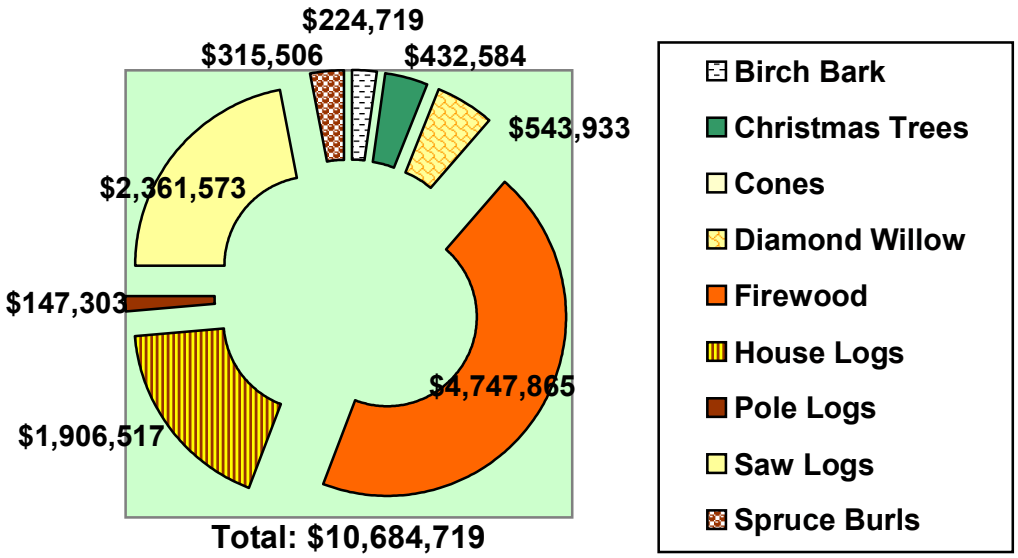


**Figure 5.** Estimated replacement value for wood materials harvested in the Tanana Valley by its households (by category).

Saw logs and house logs harvests are also important in terms of estimated replacement value. They account for 22% and 18% of estimated wood material total MRV, respectively. Other wood materials are less important across the region and none of their estimated shares of total MRV exceeding 5%.

Figure 6 shows the estimated total MRVs of non-wood products. Blueberries are the most prominent harvested non-wood resource, accounting for 71% of the total MRV for this category. Some other species of berries are also relatively important. In particular, low-bush cranberries, raspberries and high-bush cranberries have respectively 12%, 6% and 5% shares of the estimated total non-wood products MRV.

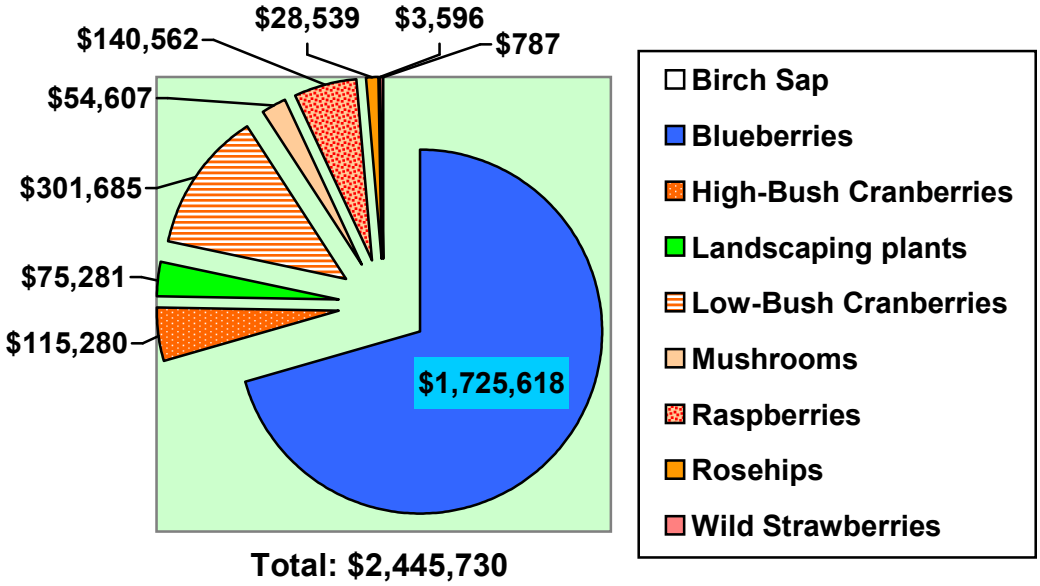


**Figure 6.** Replacement value for non-wood products gathered in the Tanana Valley by its households (by specious/category)

The estimated MRV for big game animals harvested by Tanana Valley households within the region is over $9,000,000. Moose, by a considerable margin, has the largest estimated replacement value for harvested big game animals ($7,687,528 or 85% of total big game replacement value). Caribou is the second most important harvested big game animal (based on estimated MRV) and has an 8% share of the estimated big game animals replacement value (Figure 7). Other big game animals may be of particular importance to particular regions, but their replacement values are small when considered across the entire Tanana Valley region. None of the other big game animals accounts for more than 3% of the estimated total big game replacement value. (For inner regional territorial differences of the big game harvests refer to section 2.3 of the paper).

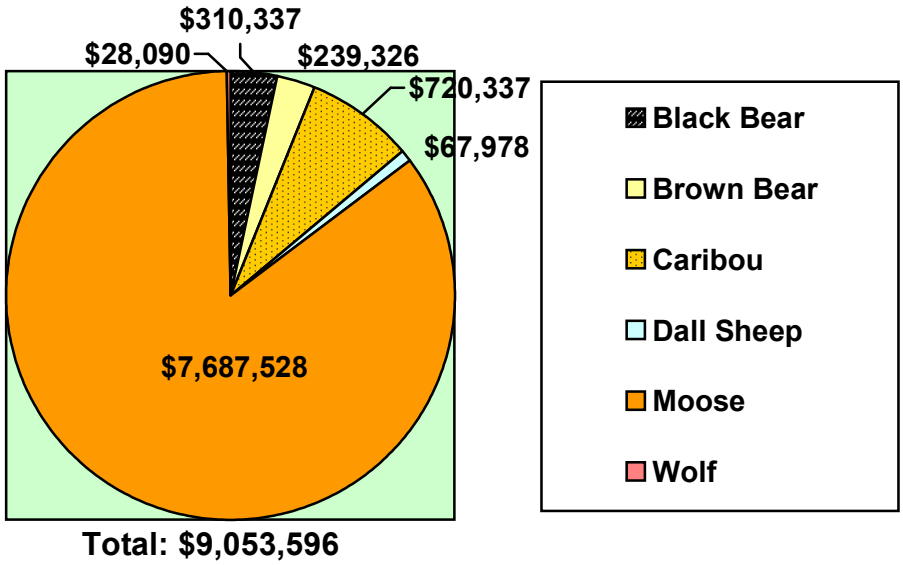


**Figure 7.** Estimated replacement value for big game animals harvested in the Tanana Valley by its households (by species).

The principal small game species harvested in the Tanana Valley according to survey results are grouse, ptarmigan, snowshoe hare and also various species of waterfowl. This latter group, waterfowl, has the largest estimated MRV—$116,180 (34% of estimated total MRV). However, snowshoe hare and grouse have only slightly smaller estimated replacement values. These later two species respectively account for 27% and 26% of the total estimated harvested small game MRV in the Tanana Valley (Figure 8). Ptarmigan account for a considerably smaller share of the estimated total small game replacement value.

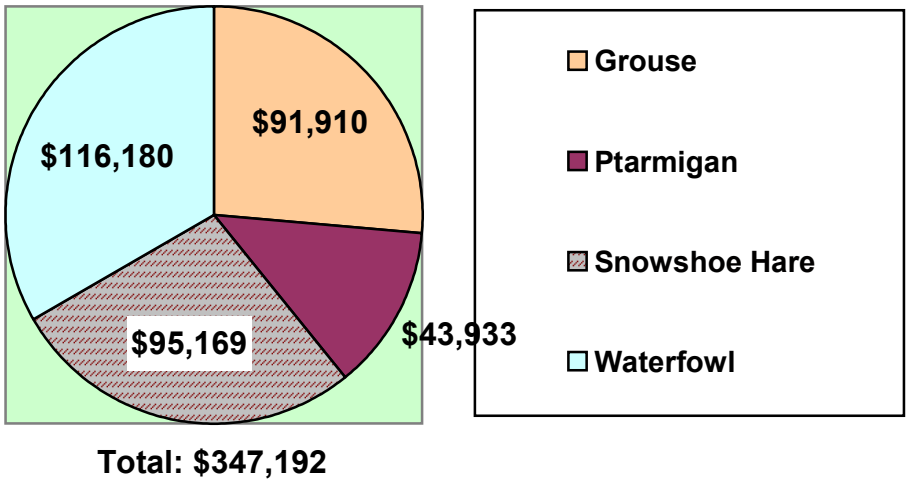


**Figure 8.** Estimated Replacement value for small game animals harvested in the Tanana Valley by its households (by species/category).

A variety of animal species are trapped in the Tanana Valley. As noted, they are principally trapped for their pelts, except for snowshoe hare, which is trapped mainly

for meat. Marten is the most prominent trapped species, with an estimated MRV of over $1 million across the region. Marten accounted for 35% of the estimated MRV for all trapped animals (Figure 9). Trapping for marten is the most geographically dispersed trapping activity. Several other species, in particular wolf, wolverine and lynx, also have significant estimated MRVs. Greatly contributing to the significance of these species is their highly valued furs (see Table 10).

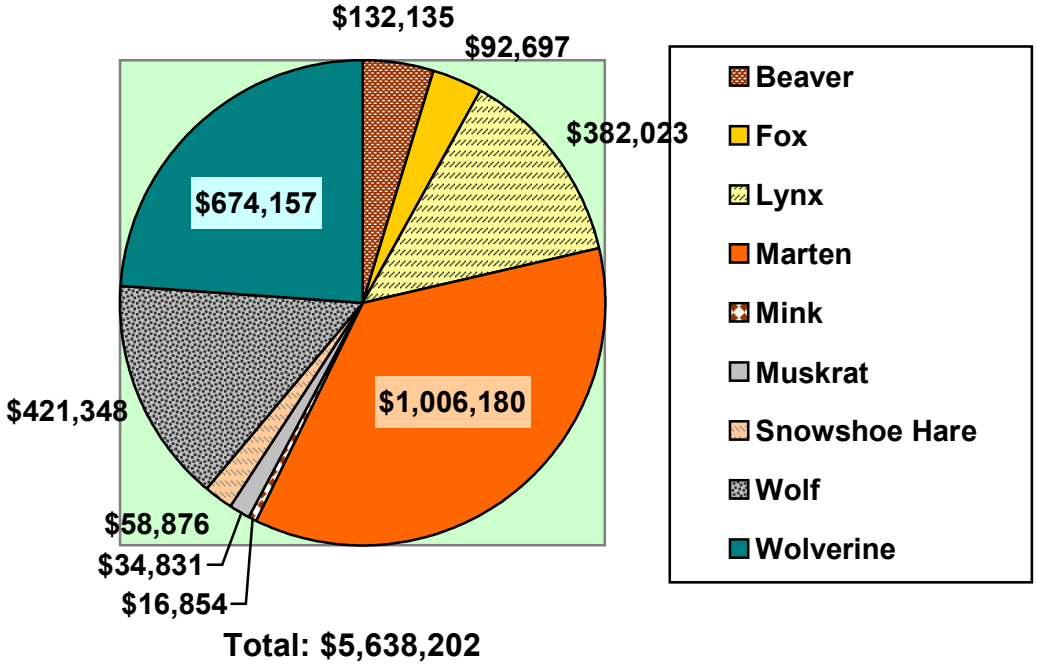


**Figure 9**. Estimated replacement value for animals trapped in the Tanana Valley by its households (by species).

The estimated total MRVs for all categories of forest resources harvested in the Tanana Valley by its households that were included in the TVFUS are presented in Figure 10. In terms of estimated MRV, wood products are the most important. The total estimated wood materials MRV of $10,684,719 represented 35% of total forest resources replacement value. Game animals and trapped animals also accounted for significant shares of total MRV (31% and 19% of total estimated MRV, respectively). Berries, plants and mushroom picking activities play a less prominent role in terms of replacement value. But, since non-wood products harvesting is relatively inexpensive, it may be an important part of household budget strategies. Fish harvest has an estimated replacement value of $2,019,409 and accounts only for 7% of the total estimated replacement value. This estimate may appear too low, but recall, the figure reflects only MRV for the fish meat, which is either low-valued or low quality for most fish species in the study region. The non-market value derived from the fishing experience is not captured in the replacement value.

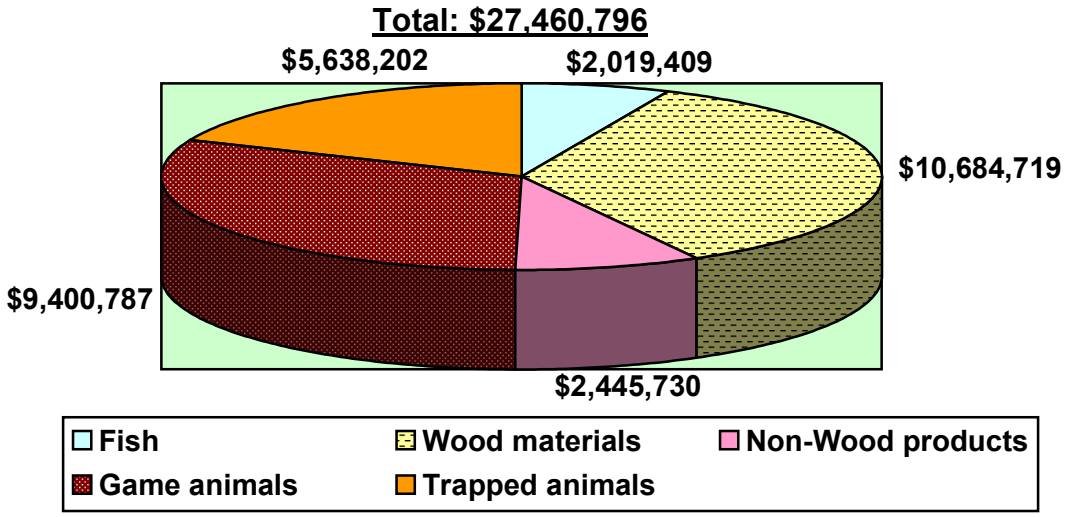


**Figure 10**. Structure of total estimated MRV for forest resources harvested in the Tanana Valley by its households (by category of resources).

Based on these estimated replacement values, the average MRV per household in the Tanana Valley is $874. Corresponding estimates from the TVFUS-2000 were lower - $679 per household (Bates 2001). The average of these two values, $780, may be used to represent the average annual MRV of various forest resources per household. This value represents approximately 1.3% of average income per household in the Tanana Valley region (estimated from the TVFUS data).

The relationships determined by the replacement cost analysis in this section are important to forest management. Changes in forest management policies and strategies can lead to shifts in the availability and accessibility of forest resources and thereby affect household well-being. The estimated MRVs for various categories of forest resources harvested in the region reflect only one dimension where these effects can occur. The MRVs represented in this section include only consumptive values households gain from the forest resources (in-coming effect). Recreational non-utilitarian in-coming effects are not discussed in this paper. Another important question is the out-going effect – time and costs people are willing to spend in order to undertake certain activities. These questions should be a subject of a more detailed study, especially when dealing with fishing, hunting and non-wood products harvest activities.

### 2.3. Structure and Allocation of Harvest: Geographical Approach

Mapping is a method used for research and illustrational purposes. Economic-geographical mapping allows the researcher to better visualize the quantitative and qualitative characteristics of the study subject. As a result, this method can open new perspectives in understanding space relations and processes, rules of resource allocation and territorial differentiation of particular activities and processes (Pistun 1996, Lutsyshyn et al. 2001, Topchiev 2001). Geographical mapping also serves as a

very good tool for presenting the collected statistical material and the results of investigation to readers.

In this study, maps were designed to demonstrate the amount and structure of the forest resources harvested by Tanana Valley households in various areas of the region. Usage of preliminary calculated replacement values of different categories of resources placed the resources in a common metric and allowed representing them in a single map. In addition, maps that represent data about the quantity and/or replacement value for different categories of resources (fish, big game animals, etc.) or single species were designed. Stationary economic-geographical maps provided in this section visually represent the areas where households more intensively harvested particular forest resources.

Generally accepted economic-geographical mapping techniques were employed for map designing (Shabliy 1992). Filling of different tones or patterning of different density were the techniques used to represent variation in relative values and characteristics (e. g., dollars per capita, quantity per sq. mile). The shapes of different sizes (scale) were used to demonstrate the differences among areas in some absolute quantitative characteristics (amount of forest resources harvested, replacement value for a resource, etc.). Diagrams of different types applied to each area within a map helped to structure and group the quantitative data for those areas.

For data representation and research purposes, there was one principle grid employed in the maps. The 21 survey grid areas used in the TVFUS for harvest allocation determination (see section 1.2) were aggregated into 10 larger geographical areas (Figure 11). This dimension was used to depict the Tanana Valley forest harvest allocation grid. The capital bold letters symbolize the 10 areas used in mapping. The letters in the parentheses refer to which of the 21 survey grids correspond to the new harvest allocation grid. For example, the new harvest allocation area “A” includes areas “A” and “E” from the survey grid and so on. The main purpose of the ad hoc grid manipulation was to increase the number of household respondents representing particular areas and, correspondingly, to increase a statistical significance of the extrapolation process.

The mapping procedure was conducted in several successive steps. First, the data was sorted by categories (species) of forest resources harvested. Households were segregated according to the harvest allocation grid, and replacement values (or, in some cases, quantities of harvested resources) were calculated for all the 10 harvest allocation areas. Since some respondents did not answer the question about the area(s) where the particular resource was harvested, the sample we could base the calculations on was decreased, though not significantly. The percentage of households reporting the harvest allocation information for a household among those reporting any harvest at all varied (depending on species or resource category) from 70% (the average for all fish species) to 93% (the average for all wood products gathered). The resources with location information falling below 70% were omitted from consideration and not included in the maps. This ad hoc adjustment allowed us to make statistical inference with a sampling error not more than ± 10% (in the absence on no-response bias) (Salant et al. 1994).

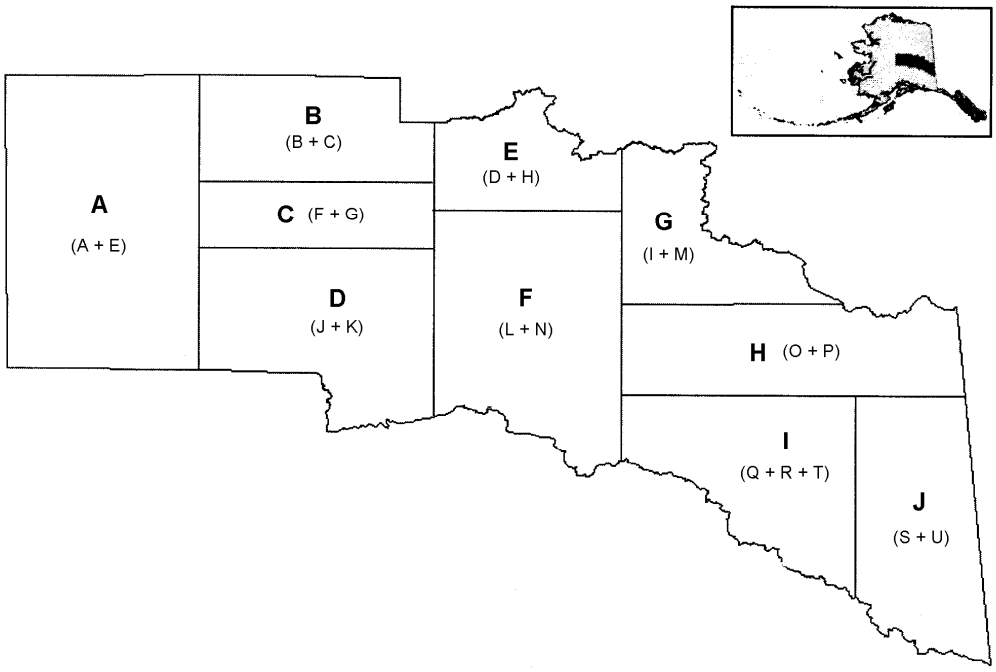


**Figure 11.** The Tanana Valley harvest allocation grid.

Finally, the data was extrapolated for all Tanana Valley households and the maps drawn (the data used to draw each map is provided in the Appendices D through J). In some areas of the Tanana Valley there was not enough information available about the quantity and/or structure of the harvest. Corresponding notes were made in the maps. To calculate the area of each of the 10 areas on the map a well-accepted geographical method was used (Yuzhaninov 2001). A transparent scale-paper marked out in square inches was placed on the survey map and squares (fractions) counted. Then using the scale of the map the areas in square miles and square kilometres were calculated. The technique had an average error of 0.01%.

Figure 12 shows the allocation of fish harvests within the Tanana Valley. Only four species (kinds) of fish, for which sufficient information were available, were considered in the map. The greatest quantities of harvested fish (all 4 species) occur in areas “F”, “C” and “E”, which are characterized by a proximity to population centres. Estimated total numbers of fish kept in these areas range from 25,437 in area “E” to 77,049 in area “F”. These three areas also lead the region in terms of harvested fish per square mile (Appendix D) and in estimated replacement value. Area “F” had the highest estimated fish replacement value of $591,527, followed by area “C” with a fish replacement value of $404,792. The smallest numbers of fish are harvested in areas “G” and “H”. These two areas also have the lowest estimated fish replacement value of $29,848 and $20,057, respectively.

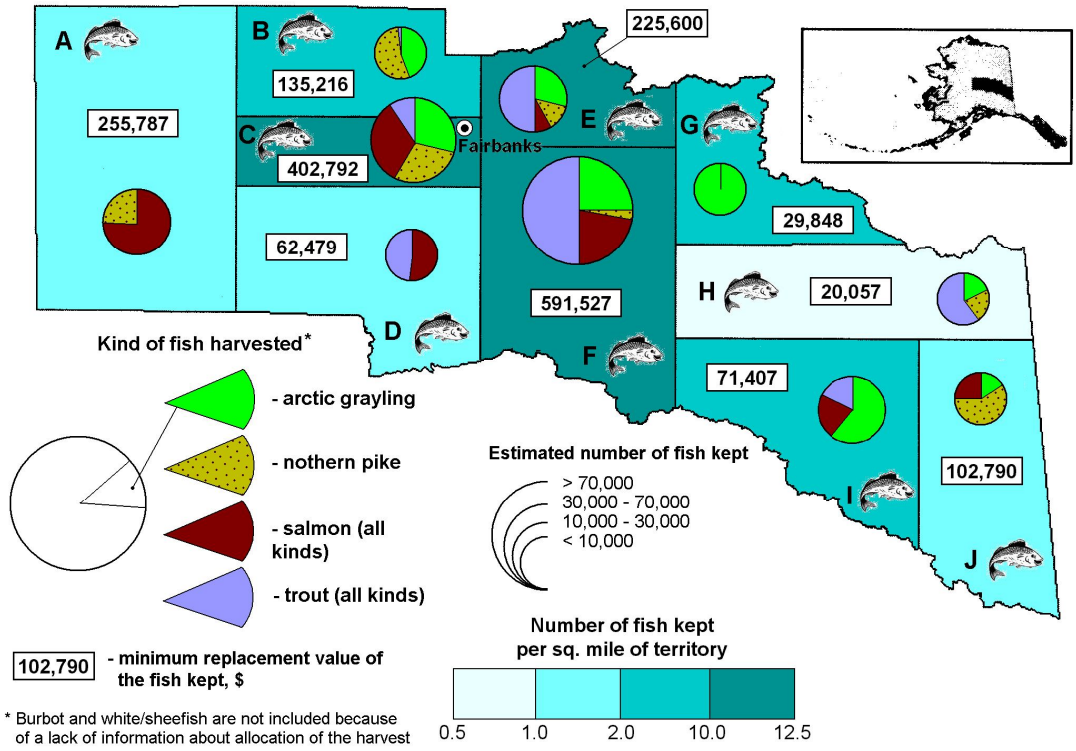


**Figure 12.** Estimated household fish harvested in the Tanana Valley (based on the TVFUS data).

The structure of the harvest significantly varies across the areas. Harvest of each of the four presented fish species occurs only in the three areas that are close to Fairbanks, "C", "E" and "F". Arctic grayling accounts for the greatest shares of estimated fish harvest in areas "G" and "I" (100% and 59%, respectively), and this species has a significant presence in most area fish harvests. Salmon is prominent in areas "A", "D" and "C" and is also harvested in all allocation areas, except areas "G" and "B". Trout (all kinds) accounts for the largest shares in areas "F", "E" and "H", accounting for 50% or greater of total estimated fish harvest. Northern pike plays a significant role in some areas as well, particularly in areas "J" and "B", where its harvest dominates over other species, and also in areas "C" and "A".

As noted previously, wood materials had the highest estimated replacement value among all resources harvested by Tanana Valley households. Inspection of Figure 13 shows that the wood resources are most intensively harvested in highly populated areas and in the areas with better access. In particular, the relatively densely populated area around Fairbanks led all of the Tanana Valley region in both estimated total wood materials replacement value and replacement value per square mile ($1,251). Areas "D" and "E", both close to Fairbanks, are notable for having high replacement value per square mile.

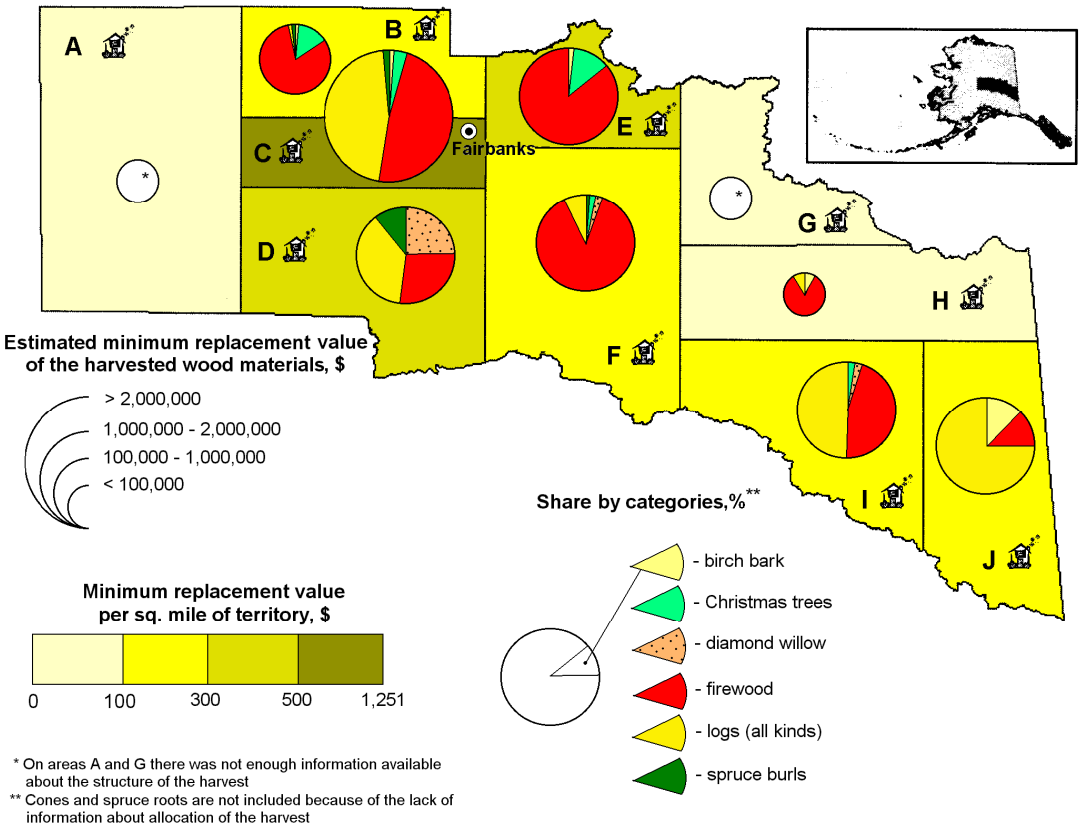


**Figure 13.** Estimated wood materials harvested in the Tanana Valley by its households (based on the TVFUS data).

As can be seen in Figure 13, in most areas firewood is the most common harvested wood material. Log harvest is also substantial in several areas. Firewood harvest is particularly noteworthy in areas "B", "E", "F" and "H" (more than 80% of estimated total wood harvest). The harvest of house log or saw log material is important for areas around Fairbanks, Tok and Northway (areas "C", "I" and "J" in the Figure).

Christmas tree harvest is concentrated around the highly populated Fairbanks area "C" and adjoining areas "E" and "B". The Christmas tree share of estimated total wood replacement values in areas "E" and "B" are 6.3% to 10.0%, respectively. Diamond willow harvest, as indicated by its estimated replacement value, is only significant in area "D". The share of total replacement value for this wood material is over 26% in this area. In the relatively remote area "J," birch bark harvest is particularly notable.

The geographical distribution of the Tanana Valley non-wood products harvest is also much diversified. Figure 14 shows that the non-wood forest products are most commonly harvested in, or close to, highly populated areas. In the Figure, the three areas around Fairbanks account for both, the greatest estimated replacement value and greatest replacement value per square mile (areas "B", "C" and "E"). The estimated MRV ranges in these areas from $608,801 in area "C" to $752,711 in area "E". The MRV per sq. mile is the highest in area "E" ($302) and "C" ($244) (Appendix F).

Lack of access as well as low populations appear to play a role in the low estimated harvests in areas “A” and “G”.

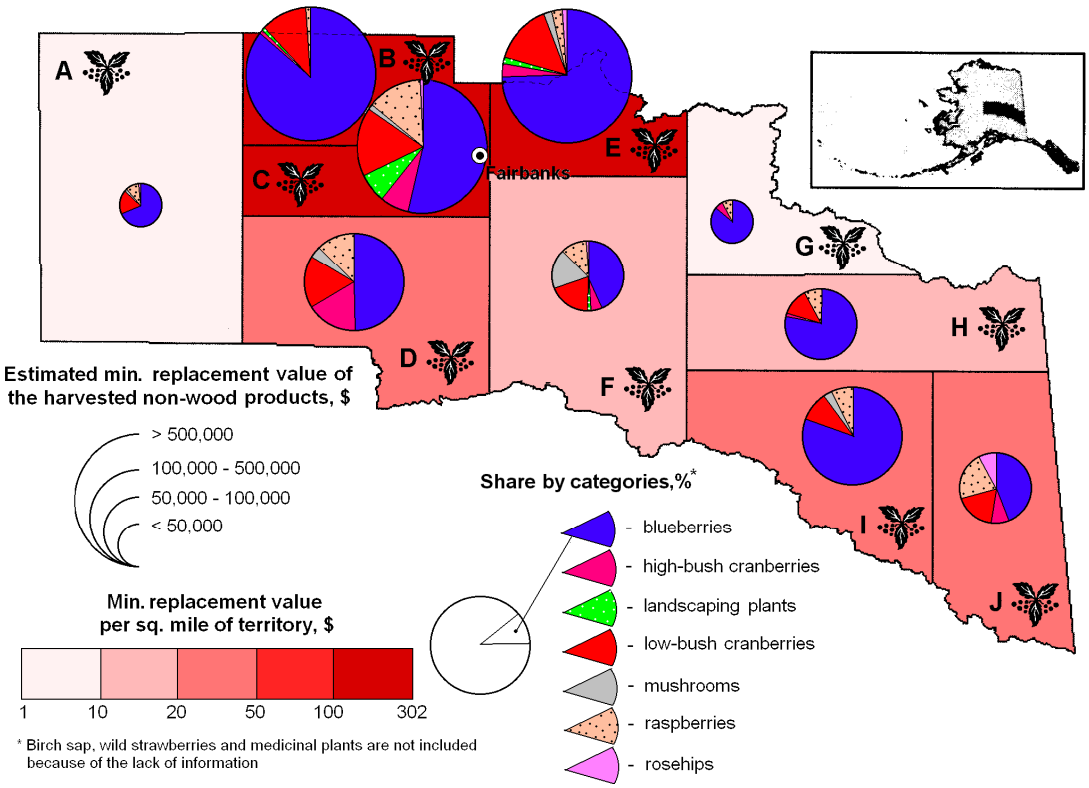


**Figure 14**. Estimated non-wood products harvested in the Tanana Valley by its households (based on the TVFUS data)

Some features of the structure of the non-wood products harvest are evident from the Figure. Blueberries are the primary non-wood product harvested in the region. Blueberries exceed 50% of the estimated total replacement value for the non-wood products harvested in almost all areas. Low-bush cranberries and raspberries also account for significant shares of harvested non-wood products in most areas. The harvests of several non-wood products are particularly noteworthy only in single areas. High-bush cranberries account for 17% in area “D”, whereas in the other areas its share is less than 8%. Rosehips have a share of almost 9% in area “J”; mushrooms more that 16% in area “F”; landscaping plants almost 7% in “C” area. The relatively large share of mushrooms in the area “F” may be explained in part by resident communities of Russians and Ukrainians (Delta Junction and Big Delta cities) who traditionally gather forest mushrooms for food.

Interestingly, Figure 14 shows that the higher populated areas are characterized by relatively diverse non-wood products harvest. In areas “C”, “D” and “F”, where most of the largest regional communities are located, non-wood categories other than blueberries account for significant shares of estimated total replacement value. An exception is area “J”.

Harvest from hunting activities were divided into two groups – big and small. Figure 15 shows the estimated quantity of big game animals harvested in the Tanana Valley by households and the structure and distribution of the harvest.

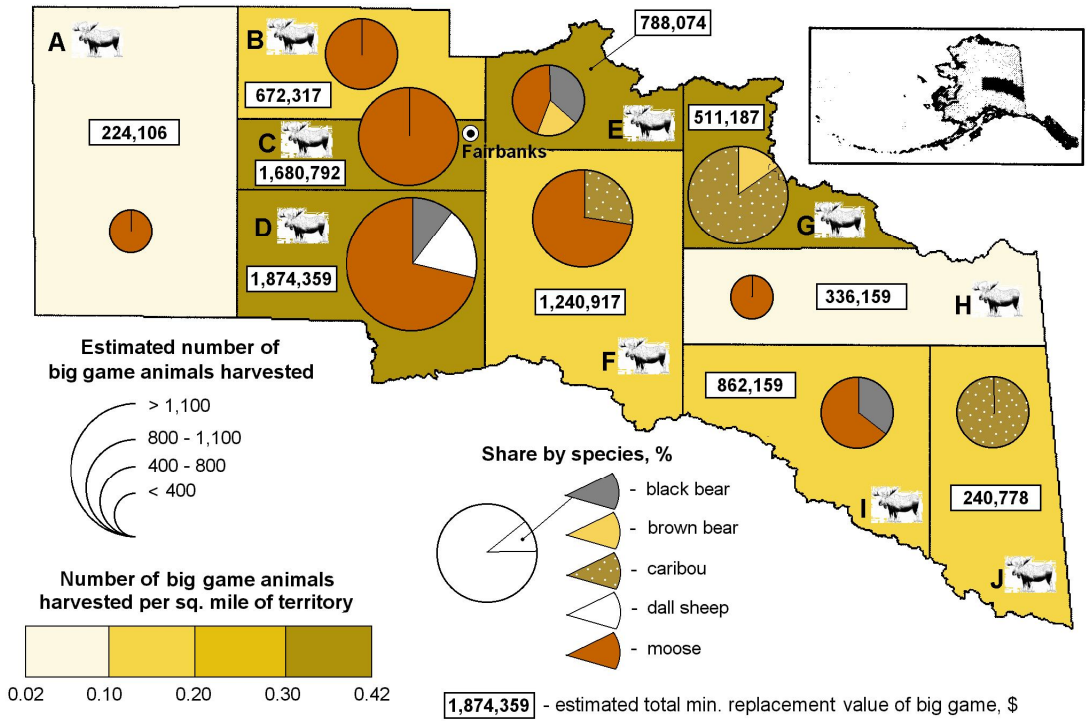


**Figure 15**. Estimated big game animals harvested in the Tanana Valley by its households (based on the TVFUS data).

It is clear from Figure 15, that proximity to population centers and good access play an important role in big game harvest, particularly with respect to moose. Area "C", which contains Fairbanks, has the highest estimated big game harvest per square mile. The highest estimated total number of big game animals is harvested in area "D" (1,549). Areas "A" and "H" are characterized by the lowest estimates of both, number of animals harvested per square mile and total number of harvested big game animals. Moose accounts for the largest shares of estimated big game harvest in all areas except areas "G" and "J". In the latter two areas, caribou is the dominant harvested big game animal. Dall sheep harvest is prominent only in area "D" within the Tanana Valley region. Black bear harvest is particularly significant in area "E", "I" and "D". Brown bear harvest is particularly significant in areas "E" and "G". More quantitative details about the big game harvest are provided in Appendix G.

The spatial distribution of small game harvest by the Tanana Valley households is illustrated in Figure 16. The harvests of grouse, ptarmigan and snowshoe hare are greatest in those areas that contain, or are proximate to, population centers and have good road accessibility. The harvest of these non-waterfowl species is geographically dispersed possibly due to the fact that landscape requirement for the species, forest thicket, is common throughout the region. Grouse is the primary non-waterfowl small game harvested in most of the areas. Ptarmigan represents a significant share of small

game harvest in areas “F”, “I”, “D” and “C”. Snowshoe hare is an important small game in areas “E” and “I” (for detailed figures see Appendix H).

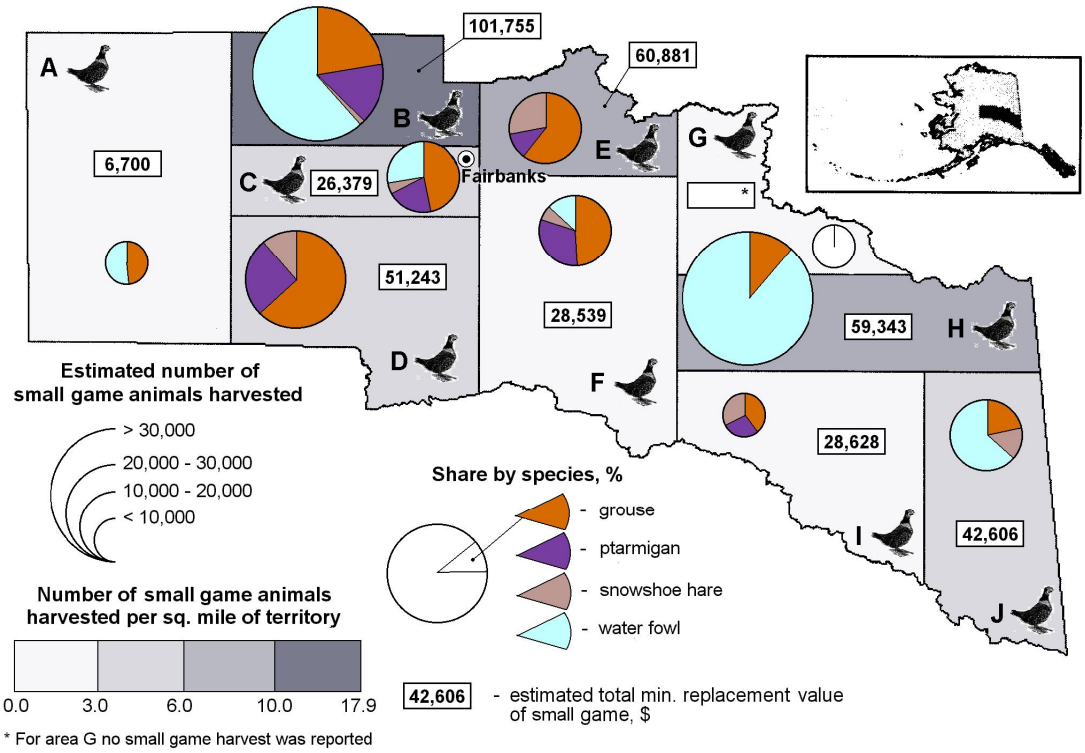


**Figure 16**. Estimated small game animals harvested in the Tanana Valley by its households (based on the TVFUS data).

Waterfowl hunting opportunities are highly dependent on the availability of suitable habitat. The largest regional waterfowl harvest occurs in area “H”. This area contains a vast wetland complex that offers extensive waterfowl habitat. Waterfowl harvest accounts for 90% of total small game harvest in this area. The second largest regional waterfowl harvest occurs in area “B”, which contains Minto Flats, a large wetlands complex located west of Fairbanks. Waterfowl accounts for 61% of the small game harvest in this area. Waterfowl harvest also accounts for a significant share of total small game harvest in areas “J” (62%), and “A” (52%). Inspection of Figure 16 and Figure 3 (Chapter 1) reveals, as expected, that waterfowl harvest is closely associated with available wetland habitat. Waterfowl harvest was not reported to occur in several areas that lack suitable habitat. It would appear from the survey results that waterfowl hunters are willing to travel long distances to gain access to better waterfowl habitat, which increased the share of waterfowl harvest occurring in relatively remote areas of the region.

It is difficult to provide generalities about trapping in the Tanana Valley region. Recall, only 3% of the survey respondents reported any household trapping activity. No trapping activity was reported in several areas (areas “A”, “E”, “G” and “H”). Area “J”, a remote area, has the greatest trapping activity both in terms of total

estimated number of harvested animals (over14,300) and number of trapped animals per square mile (3.3 animals) (Figure 17).

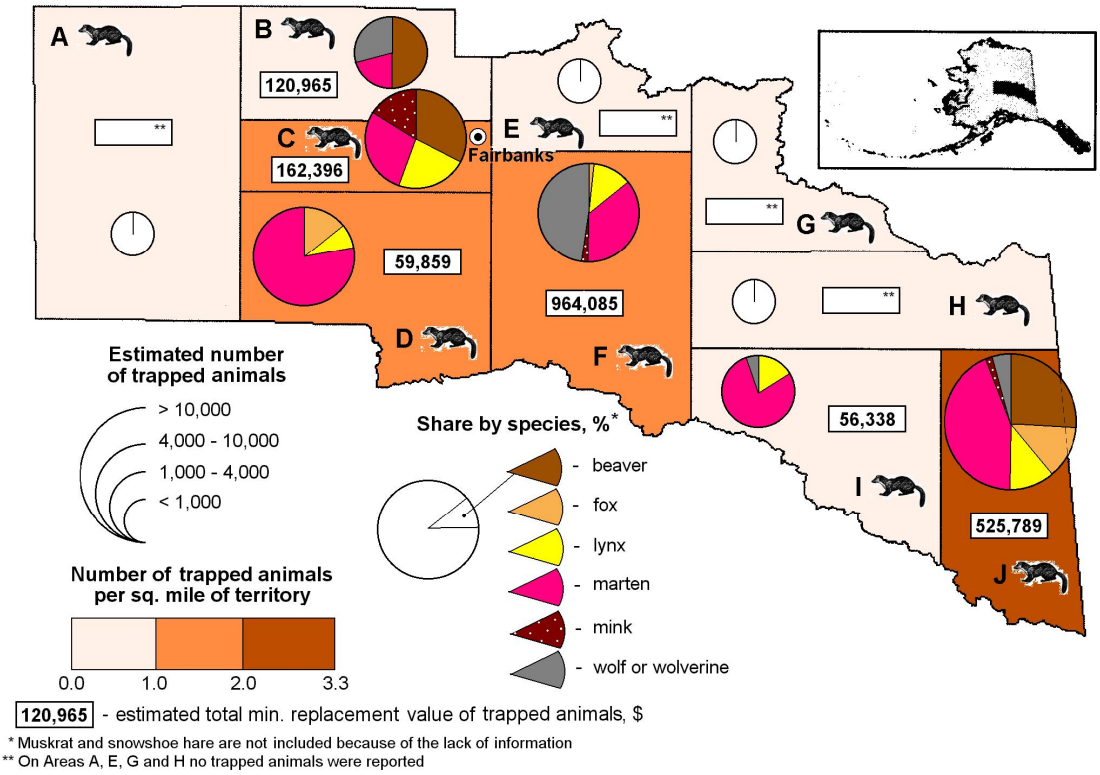


**Figure 17**. Estimated animals trapped in the Tanana Valley by its households (based on the TVFUS data)

The three areas below Fairbanks also have significant trapping activity as reported by the survey respondents. This may be related to population and accessibility factors. Area "F" has the highest estimated MRV for trapped animals. This is explained by a significant number of wolf and wolverine harvested (48% of total quantity of animals trapped). The pelts of those animals are high priced. Another area where wolf and wolverine harvest is important is area "B". Marten is the only animal trapped in all the represented areas. The second most common trapped animal is lynx. Fox, mink and beaver are present only in a few areas.

Figure 18 shows the distribution and shares of the various categories of forest resources harvested in the Tanana Valley by its households aggregated together on the basis of estimated MRVs. Inspection of the Figure reveals a few interesting relationships. The greatest estimated replacement values of total forest resource harvest occur around the relatively highly populated areas near Fairbanks (areas "C", "F", "E" and "D). Also notable, is that those areas jointly characterized by high population, better accessibility and river-lowlands landscapes, that have more abundant and diverse forest resource harvests.

The most prominent harvested resources in terms of replacement value across the region include game animals and wood materials. According to survey responses, the

two low-populated and "highway-less" areas "A" and "G" reported only game and fish in the structure of the forest resources harvested. This indicates that hunting and fishing are the most geographically disperse activities in the region. This may reflect that people are willing to travel much longer distances and, respectively, make larger investments in these activities compared to other forest resource harvesting activities.

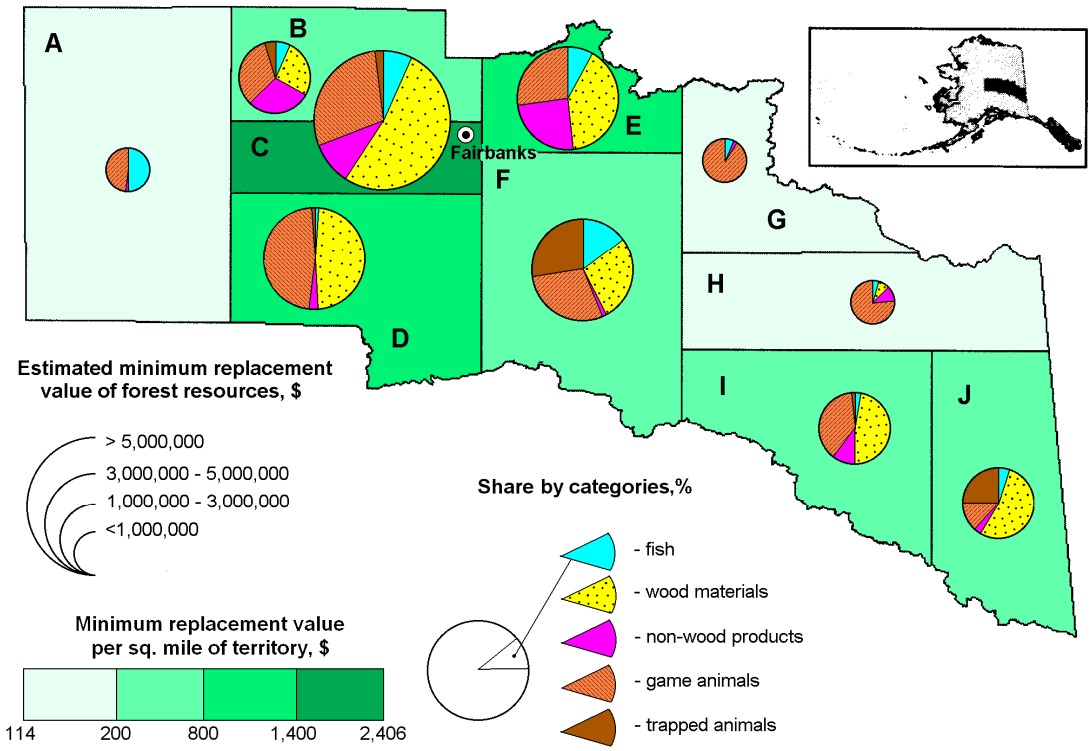


**Figure 18**. Estimated MRV for forest resources harvested in the Tanana Valley by its households: structure and allocation (based on the TVFUS data).

Trapping is locally significant in areas "F" and "J", but not elsewhere. Fishing is undertaken in all areas, but does not have significant shares in the estimated MRV for total forest resources harvests in any of these areas, except area "A". Non-wood products harvests are particularly significant around the Fairbanks NSB region (areas "B", "E" and "C"). The non-wood products harvest appears to be closely tied to proximity to population centers.

### 2.4. Cluster Analysis

The cluster analysis was employed to classify the TVFUS data. Cluster analysis classifies a set of observations into two or more mutually exclusive unknown groups based on combinations of interval variables (Stockburger, website accessed 10/26/04). This method helps to discover groups of objects based on common properties of those objects (Cluster analysis, website accessed 10/26/04). Cluster analysis shows if there is a relationship between the distribution of objects when interval variables change. In

this study, we use simple cluster analysis techniques. Advanced cluster analysis wasn't the purpose of the research.

In order to classify the data, cluster tables are created (Kotova 1999). A series of cluster tables, represented in this section, were constructed using quantitative and qualitative variables as interval variables. Among them: estimated MRV(s) for particular forest resource(s), quantity of harvested resources, income per household, size of household, etc. Household units were used as objects of the analysis.

In the tables given below, double-line borders outline the cluster table itself. Headings in columns and rows of each of the cluster tables represent the interval variables, either quantitative or qualitative. Such interval variables as household income, number of household members and education are discrete because only mean values could be derived from the survey data or possible options were exact numbers within a short range. Each cell in the cluster tables contains the number referring to the number of households in that particular cluster from the survey responses. The rest of the table contents shows some generalizing figures (sums, percentages) derived from the cluster table. Each table is followed by a graph (plot) providing better visual representation of the analysed relationship.

In Table 12, the Tanana Valley households are divided into 6 income groups and then segregated according to 3 levels of estimated MRVs of harvested forest resources. As can be seen from the Table, participation rates in the forest resource harvesting activities range among the household income groups from 54.5% in the less than $20 thousand income group to almost 72% in the $80-$100 thousand income group. The low-income households are less likely to harvest greater MRVs for forest resources. Households with estimated average MRVs greater than $2,000 account for slightly over 9% of all the surveyed households in the 0-$20 thousand, $20-40 thousand and $80-$100 thousand income groups. Greater than $100 thousand income group reported the highest percentage of households with greater than $2,000 MRV (13.8%), followed by the $60-$80 thousand income group (12.5%). Figure 19 reveals no clear pattern in the household income-household MRV relationship.

**Table 12.** Distribution of the TVFUS household (HH) respondents by income group and estimated MRV of forest resources harvested in the Tanana Valley.

| Income per HH, $ thousand / MRV harvested by HH, $ | 0-20 | 20-40 | 40-60 | 60-80 | 80-100 | >100 | Total # of HH |
|---|---|---|---|---|---|---|---|
| 0 | 15 | 19 | 25 | 17 | 15 | 11 | 102 |
| 0.1-2000.0 | 15 | 30 | 34 | 32 | 33 | 14 | 158 |
| >2000 | 3 | 5 | 7 | 7 | 5 | 4 | 31 |
| | | | | | | | |
| Total # of HH | 33 | 54 | 66 | 56 | 53 | 29 | 291 |
| >0 users | 18 | 35 | 41 | 39 | 38 | 18 | 189 |
| Share of >2000 in total # of HH, % | ***9.1%*** | ***9.3%*** | ***10.6%*** | ***12.5%*** | ***9.4%*** | ***13.8%*** | *10.7%* |
| Share of >0 users in total # of HH, % | ***54.5%*** | ***64.8%*** | ***62.1%*** | ***69.6%*** | ***71.7%*** | ***62.1%*** | *64.9%* |

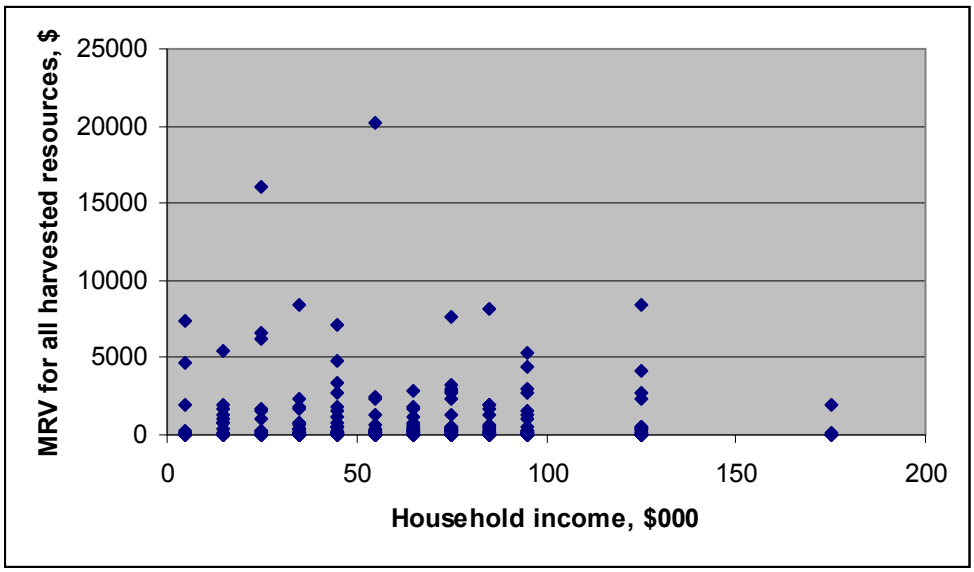


**Figure 19.** The relationship between surveyed household income and estimated MRV for harvested Tanana Valley forest resources.

Table 13 presents fish harvest by household income group. The fish harvest is divided into three ranges, households reporting no fish harvest, those reporting a harvest between zero and 20 fish, and those reporting a fish harvest greater than 20 fish. For the survey respondent households, 26.5% harvest fish in the region. Among these households, 68.8% harvest less than 20 fish annually while the remaining 31.2% of households harvest more than 20 fish each year. The relationship between the number of fish harvested by households and household income is not clear (Figure 20). The highest income group had the greatest percentage of households reporting some fish harvest and is followed by the lowest income group. The greatest percentage of households reporting harvest greater than 20 fish also occurred in the highest income group, but in this case the second highest income group, $80-$100, had the next highest percentage.

**Table 13.** Distribution of the TVFUS household respondents by income and number of fish harvested in the Tanana Valley.

| Income per HH, $ thousand / # of fish harvested by HH | 0-20 | 20-40 | 40-60 | 60-80 | 80-100 | >100 | Total # of HH |
|---|---|---|---|---|---|---|---|
| 0 | 22 | 43 | 53 | 40 | 39 | 17 | *214* |
| 0-20 | 8 | 7 | 8 | 14 | 7 | 9 | *53* |
| >20.1 | 3 | 4 | 5 | 2 | 5 | 3 | *24* |
| | | | | | | | |
| Total # of HH | *33* | *54* | *66* | *56* | *53* | *29* | *291* |
| >0 users | *11* | *11* | *13* | *16* | *12* | *12* | *77* |
| Share of >20.1 users in total # of HH, % | ***9.1%*** | ***7.4%*** | ***7.6%*** | ***3.6%*** | ***9.4%*** | ***10.3%*** | *8.2%* |
| Share of >0 users in total # of HH, % | ***33.3%*** | ***20.4%*** | ***19.7%*** | ***28.6%*** | ***26.4%*** | ***41.4%*** | *26.5%* |

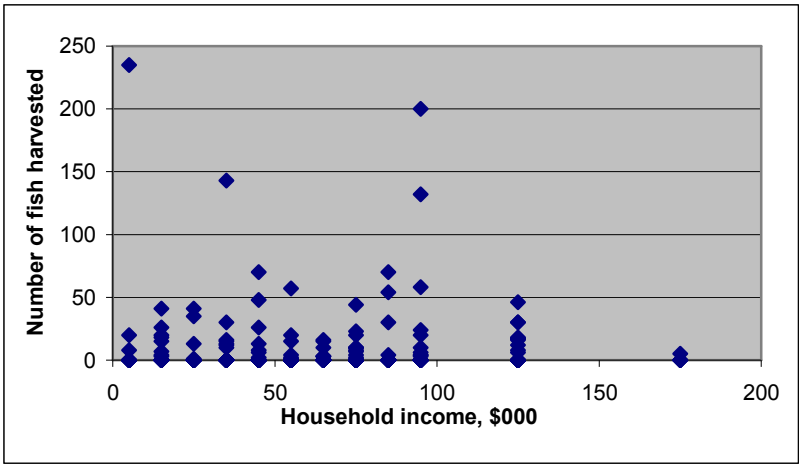


**Figure 20.** The relationship between surveyed household income and the quantity of fish harvested in the Tanana Valley.

The relationship between household income and MRV for harvested wood materials also does not display a clear pattern, as shown in Table 14 and Figure 21. Based on survey results, 80.4% of the Tanana Valley households are estimated to have a MRV for harvested wood materials of less than $1,000. Participation rates in wood material harvests are the highest among households with medium income. The shares of households harvesting over $1,000 of wood materials are highest in low and medium income groups.

**Table 14.** Distribution of the TVFUS household respondents by income and MRV for wood materials harvested in the Tanana Valley.

| Income per HH, $ thousand / MRV harvested by HH, $ | 0-20 | 20-40 | 40-60 | 60-80 | 80-100 | >100 | Total # of HH |
|---|---|---|---|---|---|---|---|
| 0 | 21 | 39 | 42 | 34 | 34 | 19 | *189* |
| 0-1000 | 9 | 11 | 20 | 17 | 16 | 9 | *82* |
| >1000 | 3 | 4 | 4 | 5 | 3 | 1 | *20* |
| | | | | | | | |
| Total # of HH | *33* | *54* | *66* | *56* | *53* | *29* | *291* |
| >0 users | *12* | *15* | *24* | *22* | *19* | *10* | *102* |
| Share of >1000 users in total # of HH, % | ***9.0%*** | ***7.4%*** | ***6.1%*** | ***8.9%*** | ***5.7%*** | ***3.4%*** | *6.9%* |
| Share of >0 users in total # of HH, % | ***36.4%*** | ***27.8%*** | ***36.4%*** | ***39.3%*** | ***35.8%*** | ***34.5%*** | *35.6%* |

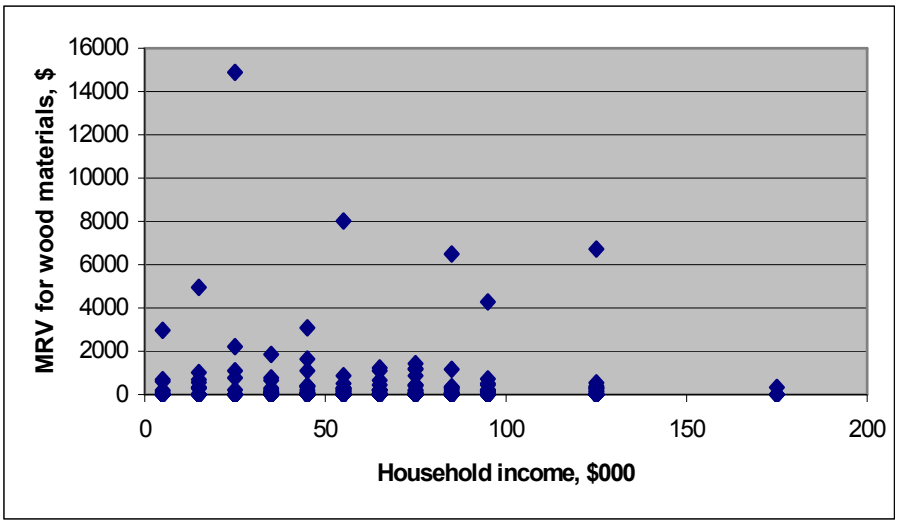


**Figure 21.** The relationship between surveyed household income and estimated MRV for wood materials harvested in the Tanana Valley.

Though participation rates in non-wood products harvesting is relatively high among Tanana Valley households (approximately 48%), the MRV for most households is small. Seventy eight percent of all participating households gather less than $200 MRV of non-wood products. Also, inspection of Table 15 shows that lower income households participate less in gathering activities than those in the medium and high-income groups. However, a higher percent of low-income households had estimated MRV greater than $1,000 than any of the other income groups (Figure 22).

**Table 15.** Distribution of the TVFUS household respondents by income and MRV for non-wood products harvested in the Tanana Valley.

| Income per HH, $ thousand / MRV harvested by HH, $ | 0-40 | 40-80 | >80 | Total # of HH |
|---|---|---|---|---|
| 0 | 51 | 59 | 42 | *152* |
| 0-200 | 28 | 46 | 35 | *109* |
| 200.1-500.0 | 4 | 12 | 5 | *21* |
| >500 | 4 | 5 | 0 | *9* |
| | | | | |
| Total # of HH | *87* | *122* | *82* | *291* |
| >0 users | *36* | *63* | *40* | *130* |
| Share of >500 users in total # of HH, % | ***4.6%*** | ***4.1%*** | ***0.0%*** | *3.1%* |
| Share of >0 users in total # of HH, % | ***41.4%*** | ***51.6%*** | ***48.8%*** | *47.8%* |

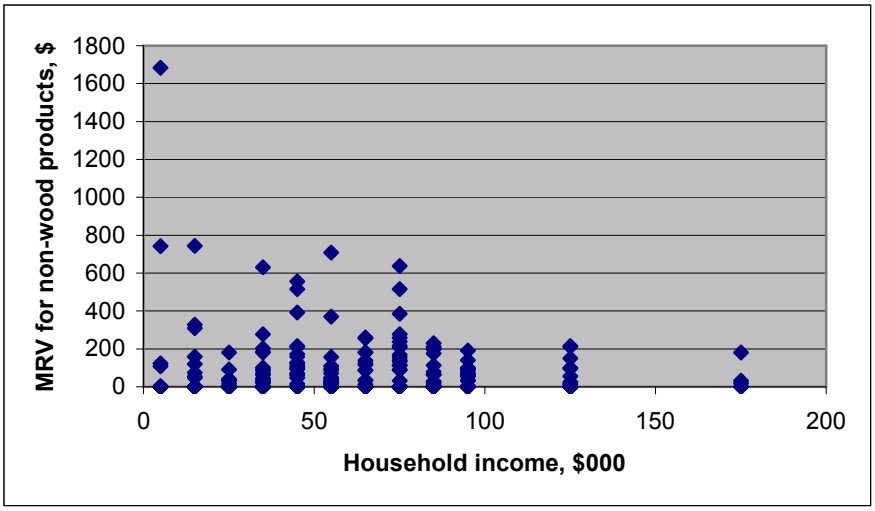


**Figure 22.** The relationship between surveyed household income and the estimated MRV for non-wood products harvested by the households in the Tanana Valley.

The relationship between hunting effort (hunting time) and household income is not readily discernible. Based on survey results, the majority of the Tanana Valley households do not hunt (about 74%). Among those surveyed households that do hunt, 88% spend less than 500 hours per year hunting. The participation rates by surveyed household income groups are fairly similar. Few households reported spending greater than 500 hours in hunting activities.

**Table 16.** Distribution of the TVFUS household respondents by income and hunting effort.

| Income per HH, $ thousand / Time spent by HH hunting, hours | 0-50 | 50-100 | >100 | Total # of HH |
|---|---|---|---|---|
| **0** | 80 | 98 | 19 | *197* |
| **0.1-500.0** | 22 | 33 | 6 | *61* |
| **>500** | 4 | 4 | 0 | *8* |
| | | | | |
| **Total # of HH** | *106* | *135* | *25* | *266* |
| **>0 users** | *26* | *37* | *6* | *69* |
| **Share of >500 users in total # of HH, %** | ***3.8%*** | ***3.0%*** | ***0.0%*** | *3.0%* |
| **Share of >0 users in total # of HH, %** | ***24.5%*** | ***27.4%*** | ***24.0%*** | *26.0%* |

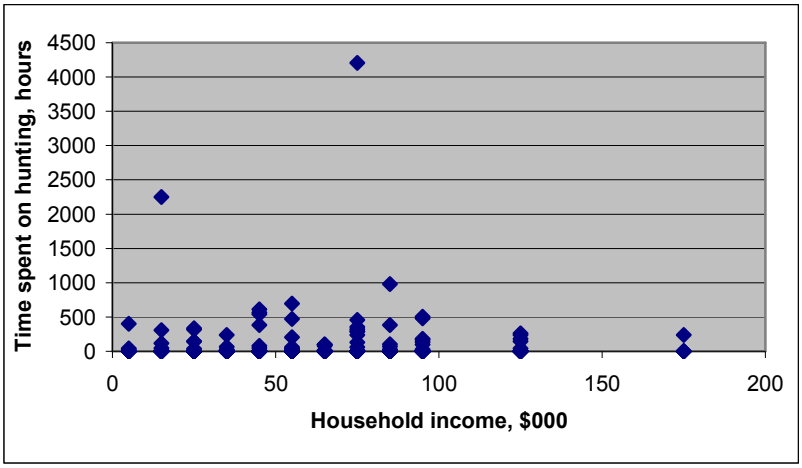


**Figure 23.** The relationship between surveyed household income and the number of hours spent by the households on hunting in the Tanana Valley.

Table 17 presents trapping harvest by surveyed households by income group. As noted previously, few surveyed households report any trapping activity. Inspection of Table 17 reveals that no trapping activity is reported for the highest income group. Increasing, but still low levels of trapping are reported for each of the subsequent lower income groups. The three survey respondents with the highest level of reported household trapping where in the middle-income group ($40-80 thousand). Caution is warranted in drawing inference from trapping information provided by the survey because of the low number of respondents reporting participation in trapping.

**Table 17.** Distribution of the TVFUS household respondents by income and MRV for animals trapped in the Tanana Valley.

| Income per HH, $ thousand / MRV harvested by HH, $ | 0-40 | 40-80 | 80-100 | >100 | Total # of HH |
|---|---|---|---|---|---|
| 0 | 81 | 114 | 51 | 29 | *275* |
| 0.1-1000 | 3 | 4 | 2 | 0 | *9* |
| 1000.1-5000.0 | 3 | 1 | 0 | 0 | *4* |
| >5000 | 0 | 3 | 0 | 0 | *3* |
| | | | | | |
| Total # of HH | *87* | *122* | *53* | *29* | *291* |
| >0 users | *6* | *8* | *2* | *0* | *16* |
| Share of >0 users in total # of HH, % | ***6.9%*** | ***6.6%*** | ***3.8%*** | ***0.0%*** | *5.5%* |

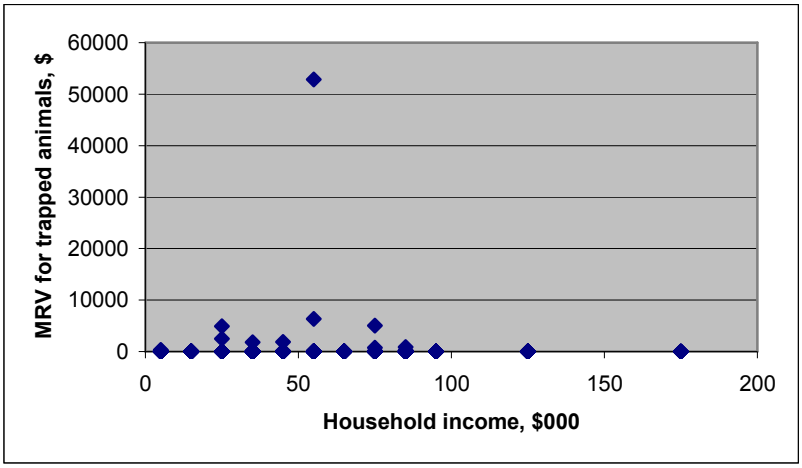


**Figure 24.** The relationship between surveyed household income and the estimated MRV for animals trapped by the households in the Tanana Valley.

Table 18 shows some interesting relationships from the survey results between average MRV and household size. Surveyed households with two or greater members are more likely to report having participated in forest resource harvesting than single member households. Also, surveyed households of three or more members are more likely to have had MRVs greater than $2,000.

**Table 18.** Distribution of the TVFUS household respondents by the household size and MRV for all forest resources harvested by the households in the Tanana Valley.

| Size of HH, # of people / Min repl. value, $ | 1 | 2 | 3 | 4 | >4 | Total # of HH |
|---|---|---|---|---|---|---|
| 0 | 33 | 37 | 18 | 17 | 9 | 114 |
| 0.1-2000 | 30 | 75 | 20 | 27 | 15 | 167 |
| >2000 | 6 | 7 | 8 | 6 | 5 | 32 |
| | | | | | | |
| Total # of HH | 69 | 119 | 46 | 50 | 29 | 313 |
| >0 users | 36 | 82 | 28 | 33 | 20 | 199 |
| Share of >2000 users in total # of HH, % | ***8.7%*** | ***5.9%*** | ***17.4%*** | ***12.0%*** | ***17.2%*** | *10.2%* |
| Share of >0 users in total # of HH, % | ***52.2%*** | ***69.0%*** | ***60.9%*** | ***66.0%*** | ***69.0%*** | *63.6%* |

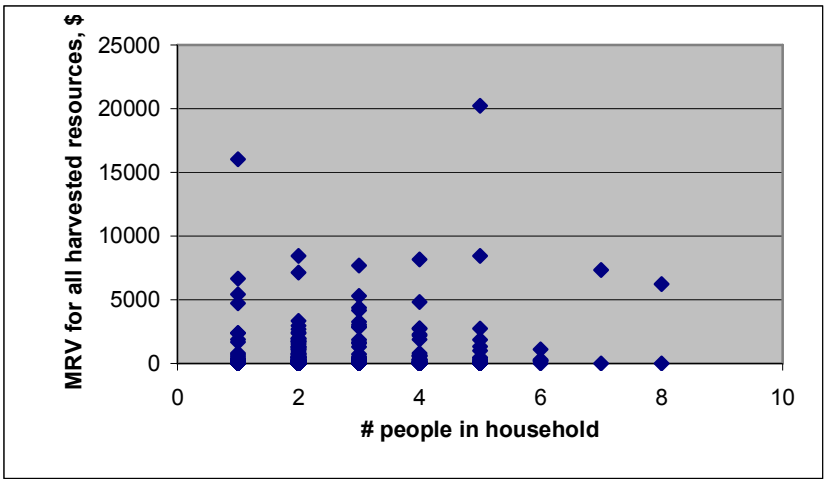


**Figure 25.** The relationship between surveyed household size and estimated MRV for forest resources harvested in the Tanana Valley.

Table 19 and Figure 26 illustrate the relationship for surveyed households between length of residence in Alaska and MRV for all harvested resources of the Tanana Valley Forest. Once again, no clear pattern emerges from the survey results. The highest average MRV-s are found for those households that report Alaska residence of greater than fifty years. But, the next highest average MRV is for those households with Alaska residence of twenty to thirty years, followed closely by those households reporting Alaska residence of 30-40 years. None of the time-of-residence groups has a participation rate less than 54%.

**Table 19.** Distribution of the TVFUS household respondents by the time of residence in Alaska and MRV for all forest resources harvested by the households in the Tanana Valley.

| Alaska residence, years / Min repl. value, $ | <10 | 10-20 | 20-30 | 30-40 | 40-50 | >50 | Total # of HH |
|---|---|---|---|---|---|---|---|
| 0 | 23 | 21 | 27 | 22 | 16 | 7 | 116 |
| 0.1-2000 | 25 | 35 | 47 | 26 | 19 | 14 | 166 |
| >2000 | 3 | 10 | 10 | 4 | 0 | 5 | 32 |
| | | | | | | | |
| Total # of HH | 51 | 66 | 84 | 52 | 35 | 26 | 314 |
| >0 users | 28 | 45 | 57 | 30 | 19 | 19 | 198 |
| Share of >2000 users in total # of HH, % | ***5.9%*** | ***15.2%*** | ***11.9%*** | ***7.7%*** | ***0.0%*** | ***19.2%*** | *10.2%* |
| Share of >0 users in total # of HH, % | ***54.9%*** | ***68.2%*** | ***67.9%*** | ***57.7%*** | ***54.3%*** | ***73.1%*** | *63.1%* |

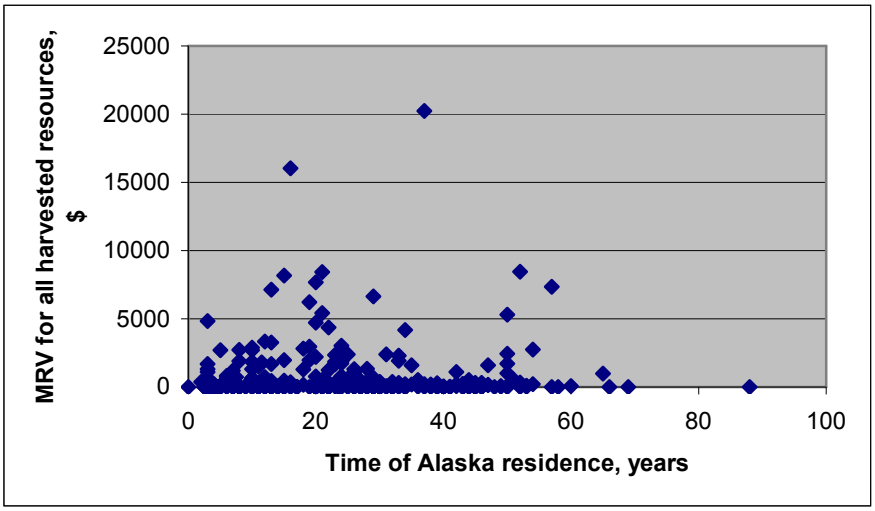


**Figure 26.** Relationship for surveyed households between length of Alaska residence and the estimated MRV for forest resources harvested in the Tanana Valley.

Table 20 and Figure 27 present the survey results for MRV by education cohort. The survey requested the educational level of the responder and does not reference the educational level of other household members. The results reported in Table 20 and illustrated in Figure 26 show that the vast majority of surveyed households reported at least some college education. This finding is consistent with results from the 2000 US Census for the North Star Bureau. Few households (5 households or 1.6% of the survey sample) reported less than at least some high school education. It is this group which reported the highest rate of participation in the harvest of the Tanana Valley forest resources. This group also has the highest proportion of its membership with MRV of greater than $2,000. The next highest participation rate in the Tanana Valley forest harvest is reported by households with at least some graduate school education

(66.7%). The participation rates in forest harvest then decline as the household education level decline. Those households with an undergraduate college degree or at least some undergraduate college level education reported the next highest participation rate in the Tanana Valley forest resource harvest followed by households with a high school degree or at least some level of high school education. These latter two groups, the high school education group and undergraduate college education group, have similar percents of members, approximately 11%, who had greater than $2,000 in MRV. By contrast the graduate school education group had only 6% of its members that achieved at least this level of MRV.

**Table 20.** Distribution of the TVFUS household respondents by education and MRV for all forest resources harvested by the households in the Tanana Valley.

| Education / Min repl. value, $ | Middle | High | College | Graduate | Total |
|---|---|---|---|---|---|
| **0** | 1 | 30 | 55 | 26 | 112 |
| **0.1-2000** | 2 | 34 | 82 | 47 | 165 |
| **>2000** | 2 | 8 | 17 | 5 | 32 |
| | | | | | |
| **Total # of HH** | 5 | 72 | 154 | 78 | 309 |
| **>0 users** | 4 | 42 | 99 | 52 | 197 |
| **Share of >2000 users in total # of HH, %** | ***40.0%*** | ***11.1%*** | ***11.0%*** | ***6.4%*** | *10.4%* |
| **Share of >0 users in total # of HH, %** | ***80.0%*** | ***58.3%*** | ***64.3%*** | ***66.7%*** | *63.8%* |

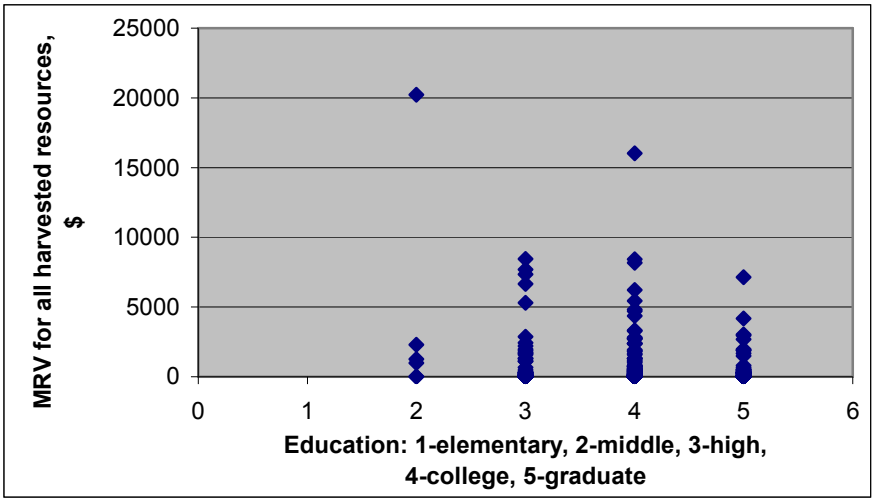


**Figure 27.** Relationship between surveyed households' education and the estimated MRV for harvested Tanana Valley forest resources.

Conclusions provided in this section underline some important peculiarities (relationships) of the forest resources use by the Tanana Valley households. However, many statements are open for discussions and further studies.

### 2.5. Application of Linear Regression Modelling

To provide further insight into the influence of various socio-economic factors to forest resource harvest activity regression analysis was considered. The hope was that the survey results could be used to develop the relationship between a particular resource harvest activity, as represented by the five overall harvest activities categories, and various variables, as provided by the forest-use survey. A more refined specification at the individual harvest species or specific type of activity within each harvest category was beyond the scope of this present work. Four general specifications were chosen for inspection, these were:

1) harvest replacement value;
2) harvest quantity;
3) time spent in harvest activities;
4) distance travelled to undertake resource harvest.

A variety of candidate explanatory variables were employed in the regression models, each of which expresses in someway the intensity of harvest activity. These variables included time of residence in Alaska, number of household residents, number of household children under 18, household income, time spent on other forest resource harvesting activities. It is important to recognize that there are numerous factors that effect household resource harvests that could not be included in the specified models because they are exogenous to the households and do not vary at the household level. For example, state regulations, market specificities, transportation and recreational infrastructure, etc. are exogenous to individual households. There are numerous other factors effecting resource use that do not lend themselves to quantitative expression. For example, cultural and personal preferences and lifestyle choices are important considerations in individual household resource harvest strategies. Accordingly, only certain explanatory variables were considered in the regression models.

Unfortunately, regression estimations were not revealing. This outcome is consistent with correlation analysis that was conducted to inform the regression model specification. As can be seen in Table 21, significant correlations between the resource harvest activities and candidate explanatory variables were not forthcoming. The only explanatory variable demonstrating a relatively strong relationship with harvest activities (i.e. with a correlation coefficient around 0.3) was time spent on other harvesting activities. The regression result shows almost uniformly low significance levels as indicated by the p-values of the explanatory variables, inconsistent signs on variables, and low explanatory power as indicated by low $R^2$ values. In no case, could we show significant relationships between the survey variables of either household size or its income and harvest activity.

The results were disappointing and perhaps due to several factors. They were consistent with survey responses to a question that asked why the respondent considered a particular harvest activity to be important for their household. Across

each of the forest resource categories, the most prominent motive for household resource harvest was recreation and personal enjoyment. Many residents of the Tanana Valley region live here for the amenity values offered by the natural setting, which includes forest resource harvest opportunities. The lack of significant results from the regression runs may simply be supporting the notion that resource harvest is affected principally by lifestyle and cultural preferences rather than by demographic factors. As noted, these preferences were not captured in the regression specifications.

**Table 21.** Correlations based on the TVFUS between the resource harvesting effort variables and candidate explanatory variables for 5 categories of forest resources.

| | Fishing | | | | Harvesting wood materials | | | Harvesting non-wood products | | | Hunting | | | Trapping | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MRV for harvested fish | Time spent on fishing | # of harvested fish | Miles travelled for fishing | MRV for harvested wood materials | Time spent on harvesting wood | Miles travelled for wood harvesting | MRV for harvested non-wood products | Time spent on harvesting non-wood | Miles travelled for non-wood harvesting | MRV for harvested game animals | Time spent on hunting | Miles travelled for hunting | MRV for trapped animals | Time spent on trapping | Miles travelled for trapping |
| **Household income** | -.05 | .09 | .02 | .06 | -.03 | -.02 | -.05 | .01 | .01 | -.10 | .07 | -.01 | .02 | -.03 | .00 | -.03 |
| **# of household members** | .17 | .07 | .19 | .08 | .02 | .11 | -.03 | .10 | -.02 | -.03 | .07 | .11 | .05 | .09 | .06 | .03 |
| **# of children under 18** | .13 | .04 | .16 | -.02 | -.00 | .12 | -.03 | .05 | -.04 | -.08 | .05 | .12 | -.02 | .11 | .08 | .01 |
| **Time of Alaska residence** | .06 | -.05 | .10 | .09 | -.05 | .01 | -.04 | -.04 | -.02 | .05 | .05 | .01 | .05 | .06 | .01 | -.01 |
| **Time spent on harvesting other forest resources** | .14 | .38 | .13 | .19 | .17 | .33 | .10 | .39 | .30 | -.02 | .48 | .12 | .17 | .61 | .43 | .32 |

The results may also be due to the design of the forest use survey, which may have lacked necessary specificity to yield meaningful regression results. For example, TVFUS covers only resources harvested within the Tanana Valley region. However, for certain resource harvest activities a significant amount of households harvesting effort could be undertaken beyond the geographical boundaries of the Tanana River Watershed. This can be very true for fishing and hunting, since hunting is a very mobile activity by itself and some kinds of fishing (i. e. fishing for good quality salmon or sea fishing) require travelling outside the region because they are not available in the Tanana Valley.

### 2.6. Sources of Errors and Uncertainty and Their Minimization

The TVFUS is an ongoing effort to understand the multitude of forest resource uses by households of the Tanana Valley. This is a noteworthy effort and as described throughout this paper, households are engaged in a range of harvest activities for timber and non-timber products. The survey was designed to capture forest uses by a random sample of the Tanana Valley households that could then be used to provide insight into the activities of all households of the region. However, in reviewing the

survey results and in rendering these inferences to the regional population the reader should be cautioned about potential error and uncertainty associated with the survey. These limitations to the interpretation of the survey results arise from the design of the survey and from the survey being non-stratified.

Potential limitations of the survey results are discussed below.

- The lower response rate of the second survey (36% versus 54% from the first survey) allows us to make statistical inferences about the general population of the Tanana Valley households with a sampling error of less than ±8% at 95% confidence level. However, this is only true if we assume that those households that returned the survey maintain the characteristics of the random sample. There is a possibility of non-response bias present in the survey results, i.e., if households that did not respond to the survey are different (non-random) from those households that did respond. For example, it is possible that households that more actively use the resources of the Tanana Valley were more likely to complete the survey than less active households, or that the likelihood of responding to the survey is related to various demographic characteristics such as age, income and education. This may explain why there are differences between survey-estimated fish and big game harvest for the region and those corresponding harvest estimates from ADF&G. In several cases, the ADF&G estimates are significantly lower than the TVFUS based estimates.

- The survey was not stratified by geographic region or by demographic characteristic. This may lead to large sampling errors when the results are presented according to various strata. For example, in this paper survey results are presented for various demographic groups, such as household income, education, and household size. The survey results were also evaluated based on location of harvest, which is closely related in many cases to location of households, particularly when dealing with resources such as non-wood products, firewood and some other wood materials and trapped animals. Many areas of the Tanana Valley have low populations and assurance of reasonable sampling errors in these cases would have required sampling a high percent of area households.

- Household harvest data was in some cases for broadly defined resource categories rather than more specifically defined resources. For example, salmon or trout harvest was not reported by species. Medicinal or landscaping plants were not specified by species as well. This may lead to large errors when calculating MRV for corresponding resources.

- There is a lack of information about the forest resources harvested by Tanana Valley households beyond the Tanana Valley region. If this information was available, it could provide much better insight on the behaviour of Tanana Valley households with respect to their harvesting effort; in particular, in determining relationships between household harvesting effort and possible factor variables.

To minimize uncertainties and limitations associated with the survey results the following recommendations could be considered:

- To adopt a methodology that mitigates non-response bias . In particular, a clear statement asking respondents to reply even if they do not use any forest resources could be included in the first section of the TVFUS. Other methods could be adopted to check and correct for non-response bias such as follow-up phone calls of non-respondents.

- To increase a representative sample size to minimize a sampling error;

- To give respondents an option to report the harvesting activities outside the Tanana Valley region;

- To undertake a stratified sampling approach in order to improve the statistical significance of geographical and cluster analysis. For instance, the sampling technique could allow for obtaining needed numbers of responses to make estimates for smaller geographical areas within the Tanana Valley region with acceptable sampling errors. In Table 22, we provide sample sizes that would be necessary to achieve given sampling percent errors for four forest management areas (derivation of corresponding numbers for finer areas was problematic due to unavailable information about the number of residential households). Four scenarios are offered in the table: ±10% error when there is substantial variation within the sample on a given characteristic, ±5% error when there is substantial variation within the sample on a given characteristic, ±10% error when there is modest variation within the sample on a given characteristic, and ±5% error when there is modest variation within the sample on a given characteristic. In the case of consumption allocation mapping the sample varies little (is relatively monotonic), since forest resources are mostly consumed at the places where households reside. Adopting this approach for *harvest* allocation mapping would significantly strengthen the statistical significance of the estimates as well;

- To combine the survey data with the US Census demographic data, a harvest allocation grid that better matches the residential zip code areas should be considered. This would be useful for undertaking more informative mapping, validation of the survey data at the local level, regression and cluster analysis.

**Table 22.** Sample sizes needed to make statistically significant inferences for resource allocation grids.*

| Forest management area | # of residential household units** | Necessary sample size for… | | | | # of available observations |
|---|---|---|---|---|---|---|
| | | Large variance in a sample (50/50 split) | | Small variance in a sample (80/20 split) | | |
| | | Less than ±10% sampling error | Less than ±5% sampling error | Less than ±10% sampling error | Less than ±5% sampling error | |
| **Kantishna** | 135 | 66 | 108 | 49 | 96 | 2 |
| **Fairbanks** | 30,841 | 96 | 381 | 61 | 245 | 290 |
| **Delta** | 1,239 | 93 | 333 | 60 | 224 | 9 |
| **Tok** | 746 | 85 | 254 | 57 | 185 | 10 |

** Compiled according to recommendations of Salant and Dillman, 1994.*

*** Derived from the 2003 US Census data for residential zip-code areas (Appendix K).*

## 3.0. Conclusions and Recommendations

With regard to the objectives of this study, the following conclusions and recommendations can be presented:

The Tanana Valley is a unique geographical region in the Alaska Interior. A complex combination of various environmental and socio-economic factors determines the use of the forest resources in the region. Minimum replacement value for forest resources harvested in the Tanana Valley by its households in the 2002-2003 season is estimated to be approximately $27,461,800, or $874 per household, or $614 per square mile of the territory. This numbers reflect only the consumptive (utilitarian) value of harvested forest resources.

Wood materials and game animals account for the largest percentage shares in the total minimum replacement value for forest resources harvested in the Tavava Valley. Firewood and moose are the principal resources in those two categories, respectively. Trapping is the third most important. Gathering and fishing play less important roles in terms of minimum replacement values. Among trapped animals, marten, wolverine and wolf are prominent. Blueberries are the main non-wood product harvested in the region. Northern pike, arctic grayling and trout (all kinds) account for largest shares in the minimum replacement value for all fish harvested in the Tanana Valley.

The allocation of forest resource harvests vary significantly within the Tanana Valley region. Various categories of forest resources have different harvest allocation patterns as well. In general, the greatest replacement values of total forest resource harvest occur around the highly populated Fairbanks area. Also notable is the fact that when the factors of high population, better accessibility and river-lowlands type of landscapes occur all together, the areas have more abundant and diverse forest resource harvests.

The most prominent harvested resources in terms of replacement value across the region include game animals and wood materials. The low-populated and “highway-less” areas are more likely to have game and fish in the structure of harvested forest resources.

No linear relationship between the household forest resource harvesting activity and such socio-economic household characteristics as income, time of Alaska residence, number of children, number of total household members was determined. At the same time, the cluster analytical approach reveals some relationships between certain socio-economic household characteristics and amount (value) of the forest resources harvested by the households. The study results, as well as the survey data, show that the stochastic factors of lifestyles and personal preferences play important (prominent) roles in household forest resource harvests.

The above listed findings can provide useful information to forest and land managers to inform their decisions more fully. In particular, the calculated replacement values can find important managerial implications when dealing with issues of timber versus non-timber forest use, resource versus conservation use of land; also on questions of informal labour and ecosystem services evaluation, etc. The

information provided about the minimum replacement value for different categories of forest resources can bring increased managers' attention to the role of some resources for households' lifestyles and budget strategies, particularly the importance of wood and non-wood products harvesting activities and trapping.

These findings and study methods could also find application in natural resource academic courses and in other areas of academic research.