Ethnography of a Post-Soviet Landscape: Exploring the Dynamics among Forests, People, and Resource Use in Central Kamchatka

by

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Lingonberry (*Vaccinium vitis-idaea*)

Dedication

To my mother who planted the Russian seed and to my father who supported it, and to the memory of my Aunt Janie who loved lingonberries.

Acknowledgements

They say that it takes a village… This dissertation took six villages—Mil’kovo, Dolinovka, Lazo, Atlasovo, Krapivnaya, and Kozyrevsk—and two cities—Petropavlovsk-Kamchatsky and Elizovo. During my three seasons of fieldwork in Kamchatka in 2003-4, 2006, and 2008, I spent varying amounts of time in all of these villages and cities, collecting as many data, materials, and insights as I could on a place that never ceases to fascinate me. The people in this place are equally inspiring: they have truly been the wind beneath the wings of this project. Without the gracious hospitality and warm generosity of the people in Kamchatka, this project would never have gotten off of the ground. I am greatly indebted to all of these people who welcomed me into their lives and selflessly shared their time, energy, and resources. Below, I attempt to recognize all those who supported this work, city by city, and village by village.

As any traveler to the Kamchatka Peninsula knows, all journeys begin in the small town of Elizovo where the sole international airport on the peninsula is located. Most visitors also spend at least some time in Petropavlovsk-Kamchatsky—Kamchatka’s capital city. For me this city served as an important base prior to and in between extended trips to the central Kamchatka depression where my study site was located. My colleagues and friends at the Kamchatka Branch of the Pacific Ocean Institute of Geography extended to me invaluable scientific, logistic, and emotional support. I am also extremely grateful for the working and storage spaces that they offered to me while I was in the city and when I went away. Specifically, I would like to recognize: the late Robert Savel’evich Moiseev who served as the distinguished director of the institute and the current director, Aleksei Mikhailovich Tokranov; Tat’yana Robertovna Mikhailova, Valentina Petrovna Vetrova, Tat’yana Alexandrovna Pinchuk, Aleksandr Semenovich, Yul’ya, and Inga. I’d also like to extend a special thank you to the Vyatkin family—Pyotr Stepanovich, the late Alla Mikhailovna, and Marina Petrovna who have so graciously helped me in all aspects of my work and have housed me (and assisted me in finding housing.) Ol’ga Vladimirovna Lagutina has also been especially helpful in fieldwork logistics, including obtaining the proper invitations for visas.

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I spent the majority of my time in central Kamchatka in the villages of Atlasovo and Kozyrevsk. In Atlasovo, Tamara Stepanovna Demchenko was a faithful host, providing housing for me and field assistants, often on short notice. Ol'ga and Nikolai Zubchenko supported me and my work, providing everything from their expertise to a hot banya after a long day of fieldwork. In regards to fieldwork, Anatoly Ivanovich Krasnoshchekov was an invaluable source of knowledge and was instrumental in the fieldwork we conducted in the Atlasovo region. He generously provided transportation and housing for us, not to mention "five-minute" caviar after a long hard day of work on forest plots. Gennady Nikolaevich also kindly gave of his time and resources to transport us to our plots (in 2008). Oleg Alexandrovich Porshnev and Sergei Alexandrovich, the past director and head forester, respectively, at the former *leskhoz* (forest service unit) in Atlasovo gave me invaluable insights into past and current forest politics and resource use patterns. Sergei Aleksandrovich, the current head of the village administration, was exceptionally helpful during the 2008 field season, providing me with socio-economic data on the village and pointing me toward prospective interviewees. Finally, in Atlasovo, I'd like to recognize Anna Nikolaevna Boiko who gave me great moral support and encouragement as I pursued my work.

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Abstract

To understand natural resource use patterns in central Kamchatka (in the Russian Far East) I used an integrated geographical approach in which I wove historical, ecological, ethnographic, and spatial strands into an ethnography of landscape. Forming the core of the dissertation, this ethnography encompassed an examination of the complex landscape in central Kamchatka and the ecological processes defining it. It also included a study of the human communities inhabiting this region and how they interact with the natural world through their resource use. I explored this human-environment interface at a unique time juncture: the post-Soviet period. Marked by severe socio-economic and political crises, this period has distinctly influenced people's relationship with the environment.

I began this ethnography by tracing the current state of the landscape to large-scale industrial logging in the mid-twentieth century, which was the outcome of relationships among the Soviet state, the people in this region, and the forests. People have responded to ecological transformation, and to sweeping socio-economic changes in the post-Soviet period, through their resource use decisions and behaviors. One prominent strategy to support livelihood has been the gathering of non-timber forest resources (e.g. berries, medicinal herbs, and mushrooms). This study focuses on lingonberry (*Vaccinium vitis-idaea*), which is widely distributed throughout central Kamchatka and has strong economic and cultural value.

By linking ecological and ethnographic data to spatial data in GIS (Geographical Information Systems), I looked systematically at how land cover, distance, and accessibility shape lingonberry gathering patterns. Land cover was the most important determinant in gathering patterns: sites with high gathering intensity and marketing of harvests had larger proportions of early to mid-successional forests. These sites also tended to be located further from villages, which was expected given logging trajectories that radiated outward from these villages. These sites were, however, very accessible due to high road densities within them, and to the post-Soviet spike in individual car ownership. Overall, this linking of non-spatial and spatial data in an ethnography of landscape made people's interactions with the landscape explicit, thereby deepening our understanding of human-environment relationships during a time of great ecological, socio-economic, and political change.

Chapter 1
Introduction

Prologue:

"In Kamchatka we should not in the least live in want." –Resident of the village of Atlasovo.

Introduction

This dissertation explores the human-environment interface at a unique juncture in time. Situated in central Kamchatka, this wide-ranging study examines the transformation of landscape, livelihood, and resource use in the post-Soviet period. It dissects a complex natural landscape and the ecological processes occurring within it; it also studies the human communities inhabiting this landscape and how they interact with the natural environment through their resource use. Ecological and ethnographic data collected during three seasons of fieldwork (in 2004, 2006, and 2008), along with spatial data, form the building blocks of the "ethnography of landscape," (see Nyerges and Green 2000), which is at the heart of the dissertation. The integration of these various data in the ethnography of landscape allows human-environment relationships to be addressed in a more systematic way. This ethnography of landscape is foremost concerned with the following questions: What is happening to the landscape and what does it mean for the people? How do these findings play out over broader spatial and temporal scales? In posing these questions, the dissertation tells three main stories of forests, of people, and of the interactions between the forests and people.

A story of forests

The ethnography of landscape begins with a story of the forests within it, highlighting the unique force of volcanic activity in forming central Kamchatka. It also goes back in time to the peak timber production years in the mid- to late-twentieth century when expansive logging operations quickly consumed the timber frontier in Kamchatka's relatively small pocket of taiga forests dominated by larch (*Larix dahurica*). Relying both on historical scientific accounts and on empirical ecological data, this story considers the repercussions of logging through an in-depth discussion on successional processes in the forests following major disturbances. One of these repercussions has been the fragmentation of what was once termed 'Conifer Island,' which today has become a sea of deciduous growth interspersed with conifer (primarily larch) forests.

This striking transformation of vegetative communities has given rise to new resource-use opportunities, namely the gathering of non-timber forest products, including fruits (e.g. berries), mushrooms, and medicinal herbs. (In general, non-timber forest products encompass all items that are collected from the forest for human consumption and have no value as timber, or in this case, firewood).

A story of people

The story of forests is only a piece of the ethnography of landscape, which is also built on a story of the people who have inhabited this landscape. This story tells why they came to this remote outpost, and how they participated in large-scale logging operations mandated by the Soviet state. Its main focus, however, is on people's livelihood in the post-Soviet period when the collapse of industries and ecosystems forced them into subsistence lifestyles that were directly tied to the resources that they could extract and produce locally. Through these close interactions with the natural world to ensure their survival, people have honed ecological knowledge, which rivals what is known scientifically about the physical landscape. This knowledge includes that on non-timber forest product biology and ecology, and how they are affected by successional processes. The story of people in the landscape, like the story of the forests, is one of constant change in which people's relationship to the natural world shifts distinctly in sync with prevailing socio-economic and political conditions at both the national and local levels.

A story of people-forest interactions

Finally, this ethnography weaves together the stories of forests and people to paint a clearer picture of the human-environment relationship, which in this case is exemplified by the gathering and use of lingonberry (*Vaccinium vitis-idaea*). This species is well-distributed over the landscape, and is gathered in large quantities by local people for household needs, and as a commodity. This step was crucial in the research because the stories of forests and people alone could not explain precisely how people were interacting with the landscape through their gathering of lingonberry. These stories left unanswered the question of how the location of gathering sites and the land-cover types within these sites affected gathering decisions and behaviors. Yet, when these stories were merged with land-cover data derived from satellite imagery in spatial analysis, patterns of lingonberry gathering could be deciphered across the landscape that would not have been possible by relying on ethnographic and ecological data alone.

Integrated approach

To tell these stories, both quantitative and qualitative data from a variety of sources were used. Empirical data were collected through forest plot inventories, semi-structured interviews, and direct participant observation. Spatial data came from satellite imagery (Landsat TM), topographical maps, and GPS points recorded in the field. Other data sources included archival records, regional socio-economic publications, a dissertation written in 1963 on successional processes in central Kamchatka's forests, and a memoir on forest use by a long-time forester. These data were set in the theoretical context of historical, political, and behavioral ecologies. Thus, this dissertation has wide breadth, even as it is intensely focused on the central Kamchatkan landscape and the communities within it.

Spatial analysis in GIS (Geographical Information Systems) is a centerpiece of the dissertation. It provided a regional or 'synoptic' view of the landscape, facilitating the examination of questions raised by ethnography (i.e. how land-cover type influences gathering patterns) that otherwise would be difficult to answer precisely, especially considering funding, time, and personnel constraints (Behrens 1994, quoted in Nyerges and Green 2000). Overall, spatial analysis made the human-environment relationship explicit by showing precisely how landscape features, both natural (e.g. land-cover type) and anthropogenic (e.g. road networks) shaped where and how people chose to gather. Although this approach was valuable in detecting land cover across a landscape, it did not have the final say in the ethnography of landscape. For instance, it could not interpret land use, which as Nyerges and Green (2000) contend, "can be examined and understood only by application of the techniques and methods anthropologists have always employed—the hard work of local ethnographic and ecological fieldwork."

Temporal Context

These stories of people's interactions with the landscape are particularly relevant given the temporal context of the post-Soviet period. During the early part of this period local resource use in central Kamchatka acquired new meaning for households facing unprecedented socio-economic and ecological crises. In this respect, people in central Kamchatka were not alone. The deep economic recession that accompanied the ideological and material shift away from socialism towards capitalism translated into widespread poverty throughout the Russian population. The difficulties ensuing from this sudden impoverishment exceeded all expectations (Kuehnast 2000). Nonetheless, the situation in central Kamchatka was particularly dire due to the abrupt withdrawal of government subsidies that the former Soviet Union had earmarked for its far northern territories. For the people, and for the forest and agricultural industries in central Kamchatka, these subsidies provided relative plenty in a shortage economy. Moreover, people in this region faced serious ecological fallout after decades of unsustainable logging, which left insufficient resources to support the resumption of industrial-scale logging in this region. (The forestry enterprises were eventually privatized; however, they operated at a fraction of their former capacity.) Finally, the prices of raw goods, for instance, fuel and animal feed, soared following price liberalization, reflecting the true costs of shipping to Kamchatka.

This combination of socio-economic, political and ecological factors compressed the lives of people in central Kamchatka from the top down and bottom up, forcing those who remained in this region into subsistence lifestyles that were tied directly to the land, river, and forests that surrounded them. In this respect, the human-environment relationship was particularly well etched into the villages of central Kamchatka, making this connection easier to decipher than it would have been in a more complex and stable economy. Today socio-economic conditions are gradually improving for villagers in central Kamchatka, yet many households still pursue the subsistence strategies that they have honed as they continue to face few employment prospects. In sum, this ethnography of landscape is a story of transformation and adaptation, revealing how the human-environment relationship is shaped by the landscape, and by broader socio-economic and political factors at the local and national levels.

Overview of dissertation

This dissertation is divided into three main sections. Section I introduces the study site in central Kamchatka, depicting the physical landscape and forests in which it is located. It also takes an in-depth look at the past relationships between the Soviet state, people, and forests that gave rise to this landscape. Section II contains the heart of the ethnography of landscape, beginning with an ecological study of Kamchatka's successional forests and lingonberry yields within them. This piece is followed by a look at the people and their gathering of lingonberry. The third piece in this section is the most consequential: it is where people's relationship with the landscape is specified through the merging of ethnographic, ecological, and spatial data in GIS. Finally, the last section (Section III) explores livelihood in post-Soviet Kamchatka through both quantitative and qualitative assessments. Below, each separate chapter is briefly summarized.

Chapter 2 (Section I) sets a critical foundation for the dissertation by providing a comprehensive view of the forest communities in central Kamchatka and how they have been transformed through successional processes following major disturbances; it also looks at the traditional use of non-timber forest resources in Kamchatka. Chapter 3 in this section is premised on the concept of historical ecology that is primarily concerned with how the forested landscape of the central Kamchatka depression came to be the way it is today. At the far northern periphery of the former Soviet Union, this landscape is the product of past political decisions made by the centralized government concerning extractive resource use (see Eikeland and Riabova 2002). In its ambitious drive to tame and alter the natural world, the Soviet state relied on an expansive approach to development that necessitated great stretches of land where the resource frontier could be continually exploited (Gatrell 1999). This push for growth at any cost has had disastrous consequences for the forests and people of central Kamchatka (see Oldfield and Shaw 2001). To understand the scope of landscape transformation, this chapter employs a triangular model that offers a useful lens through which to interpret the collective outcomes of the state-people-forest relationships and what they meant for the landscape. By grappling with complex relationships between the state, people, and forests in the mid to late-Soviet period and the resultant landscape, this chapter builds upon the previous one, establishing the framework in which to place subsequent chapters of the dissertation.

Chapter 4 (Section II) is based on an empirical study of the relationship between features of forest structure and composition and lingonberry yields. Chapter 5 (Section II) is focused on the relationship between people in central Kamchatka and lingonberry gathering. This chapter integrates rich ethnography in the study of lingonberry gathering patterns, employing both a quantitative and qualitative approach to answer the fundamental questions of where, how, and why people are gathering. It also explores local ecological knowledge through people's perceptions of the forests where they gather lingonberry and through their explanations of variability in lingonberry harvests.

Chapter 6 (Section II) represents a critical point in the dissertation where non-spatial data from Chapters 4 and 5 are linked to spatial data in GIS to make quantifiable connections between people and the landscape. Similar to the previous chapters, the focus of this chapter is on lingonberry, the gathering of which represents people's interactions with the landscape. By looking at gathering patterns across the landscape through spatial analysis, the ethnography of landscape asks how ecological and anthropogenic processes determine where and how people are gathering. Another important part of this chapter is the underlying question of why people gather. Toward this end it considers the landscape through the eyes and actions of the people who depend on lingonberry for their livelihood. People's gathering decisions and behaviors were also examined through the lens of optimal foraging theory.

Chapter 7 (Section III) turns from the intense focus on lingonberry and gathering patterns that defined Chapters 4 through 6 to a more macro approach in which non-timber forest products are considered with other strategies that constitute household subsistence. This chapter analyzes how people have survived a crisis period. This core question was analyzed through Principal Component Analysis (PCA). This chapter is important in contextualizing the post-Soviet period and particularly, in underscoring why people gathered. It also helps position non-timber forest product gathering in the wider context, confirming that this activity was one of several that people incorporated into their household livelihood strategies.

The closing chapter, Chapter 8 (Section III) is the qualitative equivalent of Chapter VI. Whereas the former concentrates on overarching patterns of household livelihood, this chapter draws out people's voices of struggle and survival as they grappled with profound change and loss in the early post-Soviet period. This chapter is based primarily on responses to the following question posed in a semi-structured interview conducted in 2004, 2006, and 2008: "How do your gathering patterns today differ from those in the Soviet period and the early post-Soviet period (i.e. 1990s)?" The answers to this question clearly indicate the dynamic nature of the post-Soviet period; they suggest that the post-Soviet period actually be viewed as two distinct phases (1990s, and 2000 and beyond) instead of a continuous time block.

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Chapter 2
A Natural and Human History of the Central Kamchatka Depression

Introduction

At the heart of the Kamchatka Peninsula in the Russian Far East, the Central Kamchatka depression where this study is situated is an evergreen oasis amidst the fire and ice that characterize much of this northern volcanic land. (*Refer to Figure 2-1*.) Containing the easternmost pocket of taiga (or boreal) forest, central Kamchatka has long harbored human communities from otherwise inhospitable conditions. Thus, this area bears the heavy mark of human activity, in contrast to the rest of the peninsula that is still largely wild and pristine. Logging activity, which was commenced in this area in the early twentieth century to help supply the burgeoning fishing industry, and associated forest fires have dramatically transformed the forests in this region. Consequently, secondary deciduous forests are ubiquitous throughout central Kamchatka. The combination of volcanic activity and anthropogenic disturbances has turned this area into a fascinating natural laboratory in which to explore both ecological issues and those on human-environment interactions. This chapter lays the foundation for examining these interactions later in the dissertation by drawing upon historical scientific literature to present an overview of the forests in the central Kamchatka depression, and of the successional processes that have transformed them. It also takes a brief look at the historical relationships between humans and the environment that were first recorded with the earliest scientific descriptions of Kamchatka.

Human ecological history

The vivid history of people's interactions with the natural world in Kamchatka became more widely known beginning in the eighteenth century thanks to the efforts of Stepan Krasheninnikov and Georg Wilhelm Steller. These observant naturalists recorded rich descriptions of Kamchatka's natural world and the indigenous Itel'men that lived within it. In his classic volume, *Descriptions of Kamchatka,* Steller described his amazement of the people-plant interactions he so attentively observed (Falk 2003, translation by Margritt Engel and Karen Willmore):

> I can truthfully say that the curiosity of these people and their knowledge of the plants and their uses in cooking, medicine, and economics are so extensive and exceptional, as one would never suspect to meet up with in such an isolated, wild people, which they were a short time ago. The most civilized people could not have greater such knowledge. The inhabitants all thoroughly know their plants, according to names as well as their efficacy. They also know the efficacy of all plants according to various places where they grow and the time to collect them, to such a degree that I could not admire them enough. And above all, an Itel'men has this advantage over others: that anywhere and at any time he can live off his land, to the extent that no one could harm or cure him with any poison and medicinal plant that grows around him without his knowing. And although he has a more difficult life without commerce, he really does not actually need any foreign wares. He knows how to manage on his own and to make something out of everything, which the greatest philosopher and naturalist could not think of...Generally, nothing in this country is passed up without being tried to see whether it was edible.

Steller (Falk 2003, Polevoi et al. 1999) was also particularly struck by the Itel'men's robust health despite Kamchatka's harsh climate and constant dampness. In fact, he claimed that Kamchatka was one of the healthiest places in the world due to the Itel'men's extensive use of plants. For instance, by adding a mix of plant roots, shoots, and bark to their food, they managed to avoid scurvy. Their consumption of wild garlic (*Allium ochotense*), cloudberry (*Rubus chamaemorus*), and black crowberry[1] also helped stave off this disease. Wild garlic was especially useful to the Itel'men who harvested and stored it in large quantities to flavor fish over the long winter. They also highly valued fireweed from which they extracted sugar and made tea; they also used it to garnish fish and meat dishes. Other plants served as topical medicines, such as the needles and bark of the ubiquitous Siberian dwarf pine shrubs.

The Russian Cossacks who infiltrated Kamchatka beginning in the late seventeenth century established new traditions of forest use on the peninsula, logging coniferous forests for their fortresses, ships, and other needs. They came seeking yasaks (or iasaks), a tax in the form of furs collected as compensation from the Itel'men for living on the Tsar's land. The Cossacks also 'traded' their mélange of goods, including iron wares, with the Itel'men in exchange for furs. (Falk 2003, Polevoi et al. 1999). Thus, by easing the Itel'men's dependence on the plant world, they also directly influenced how the Itel'men interacted with the natural world. Still, the Itel'men remained closely connected to the natural world even through the early Soviet period. Their extensive ecological knowledge enabled them to amass and preserve sufficient reserves of plant resources (for example, forest berries) to last through long, harsh winters, and through periods of great upheaval and scarcity, including the World War II years. Beginning in the 1950s,

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[1] Refer to Table 2-1 for the Latin names of species not listed in the text.

however, Soviet assimilation campaigns largely severed the Itel'men's intrinsic ties to nature through forced relocations and the adoption of a more "civilized" way of life (f. 67, d.47: 1950-55).

The time-honored skills and knowledge of the Itel'men remain only as a memory in their descendents who are known today as Kamchadaly (plural), referring to people of mixed Russian and Itel'men descent. One Kamchadal woman, for instance, told how self-reliant her mother was in the forests, harvesting an array of healing plants, such as lingonberry leaves, hawthorn (*Crataegus chlorosarca*), fireweed, and marsh Labrador tea. Her mother was also skilled at crafting useful objects from birch bark. For instance, Kamchadaly mastered the preservation of various berries, such as honeyberry, mountain ash berry (*Sorbus sambucifolia*), and lingonberry that they collected from the forests, using the simple tools of birch bark containers, cold water, and stones. Another Kamchadal woman recalled how her ancestors once lived to advanced ages free of modern persistent ailments, citing the extensive use of plants as a primary reason for longevity.

Natural history

Rimmed by the Srednii (Middle) and Vostochnyi (Eastern) Mountain ranges, the central Kamchatka depression is a product of glacial and interglacial periods that occurred during the Late Pleistocene Epoch from 10,000 to > 55,000 years ago (Braitseva et al.2004). Owing to Kamchatka's overlap with the Pacific Ring of Fire, no less momentous influences are at work in this central region today; however, they are of a very different nature. Volcanic activity concentrated on the east coast of the peninsula continues to mold the landscape dramatically through ash fall, lava flows, thermal and geochemical forces, and the formation of strata cones. Volcanic material is carried in the air, and in the temporary streams flowing through the dry rivers that deposit proluvial fans. These fans are especially well-distributed throughout the Kamchatka River valley (*Lesa Kamchatki* 1969). Moreover, the processes of orogenesis (or mountain formation due to the folding and faulting of the earth's crust) are ongoing in this region, conditioning mobility in vegetative communities (Efremov 1973b, see also Turkov 1964). These major forces have also had a marked impact on the macroclimate, flora, fauna, and soils associated with this landscape (Efremov 1973a).

Vegetation, topography, and climate

The forest massif in central Kamchatka (or 'Conifer Island' in the vernacular) plays a key role in mitigating the region's sub-maritime climate characterized by short summers, and very snowy and long, harsh winters. It has also been invaluable in protecting the fragile soils in this region, and in regulating the waterways critical to salmon spawning (Turkov 1964). Historically, larch-dominated forests interspersed with birch, spruce, and to a lesser extent, aspen have filled the Central Kamchatka depression. Larch is a complex species with a range spanning an enormous area of northeastern Asia (Krestov 2003). This species has undergone several reclassifications at the species level due the high variability of its morphological features. For instance, larch in Kamchatka is commonly referred to as *Larix cajanderi* (including *L. kamtschatica*), which was one of the three species identified in the most recent taxonomic survey done by Koropachinskiy (1989, quoted in Krestov 2003). (The other two species were *L. olgensis* and *L. gmelinii*.) Still, according to Krestov (2003), the morphological and eco-biological boundaries among these three species are ambiguous, leading to the adoption of a broader interpretation of Larch species in northeastern Asia, as put forth by Tsveliov (1994, quoted in Krestov 2003). In this case all the aforementioned species were grouped into *L. dahurica* Laws. A more recent study based on molecular analysis, however, showed that the larch populations in Kamchatka differed significantly from other taxa based on the distribution of mitochondrial DNA diversity. At the same time, larch populations in Kamchatka shared specific chlorotypes with *L. cajanderi* and *L. gmelinii* (Polezhaeva et al. 2010). Also, nuclear data supported a close tie between Kamchatka larch and *L. cajanderi* (Khatab et al. 2008, quoted in Polezhaeva et al. 2010).

Larch and spruce forests signify zonal vegetation in the area (Krestov 2003). Turkov (1964) distinguished the following four zones based on elevation and forest association:

- *Zone I:* Larch-dominated forests in the plains and foothills of the central Kamchatka depression (up to 200 m);
- *Zone II:* Spruce-dominated forests in the sub-montane and foothill areas of the depression (200-400 m, and up to 750 m in places);
- *Zone III:* Subalpine sparse stone birch (*Betula ermanii*) forests mixed with alder (*Alnus fruticosa*) (400-800 m, and up to 1000 m in places);

- *Zone IV:* Larch forest tundra with Siberian dwarf pine (800-1000 m, and 1300-1500 m in places).

This study is concentrated in Zone I, encompassing the core part of the central Kamchatka depression dissected by the Kamchatka River. This zone has been further subdivided into two vegetative regions according to geomorphology and forest type (Turkov 1964). The first or eastern region has been highly influenced by volcanic activity (for example, ash falls and dry rivers). As a result, the forest association groups here have become acclimated to arid conditions and poor soils that are constantly being reconstituted with the addition of volcanic material, thereby precluding the accumulation of organic matter. The second, or southern region, is less affected by volcanic influence and thus, characterized by richer, moister, and relatively more mature soils that support greater biological productivity.

Table 2-1: Listing of scientific name, author of name, family, and common name of frequently encountered species in the coniferous forests of the central Kamchatka depression.

Scientific Name	***Author of Scientific Name***	***Family***	***Common Name***
Tree species: *Larix dahurica*	Laws.	Pinaceae	Larch
Betula platyphylla	Sukacz.	Betulaceae	Birch
Picea ajanensis	(Lindl. ex Gord.) Fisch. ex Carr.	Pinaceae	Spruce
Populus tremula	L. (Linneaus)	Salicaceae	Aspen
Shrub species: *Pinus pumila*	(Pall.) Regel	Pinaceae	Siberian dwarf pine
Juniperus sibirica	Burgsd.	Cupressaceae	Juniper
Lonicera caerulea	L.	Caprifoliaceae	Honeyberry
Vaccinium uliginosum	L.	Ericaceae	Bog bluelberry
Rosa amblyotis	C.A. Mey.	Rosaceae	Blunt-auriculate rose
Rosa acicularis	Lindl.	Rosaceae	Prickly rose
Spiraea media	Franz Schmidt	Rosaceae	Meadowsweet
Ribes triste	Pall.	Saxifragaceae	Swamp red current
Subshrub and herbaceous species: *Vaccinium vitis-idaea*	L.	Ericaceae	Lingonberry
Ledum palustre	L.	Ericaceae	Marsh Labrador tea

Calamagrostis purpurea, subsp. langsdorffii	(Link) Tzvel.	Poaceae	Reedgrass
Festuca altaica	Trin.	Poaceae	Northern rough fescue
Trisetum sibiricum	Rupr. s. str.	Poaceae	Siberian oatgrass
Chamerion angustifolium	(L.) Holub	Onagraceae	Fireweed
Geranium erianthum	DC.	Geraniaceae	Northern geranium
Carex sp.	--	Cyperaceae	Sedges
Linnaea borealis	L.	Caprifoliaceae	Twinflower
Pyrola incarnata	(DC.)Freyn	Ericaceae	Round-leaved wintergreen
Empetrum nigrum	L.s.l.	Empetraceae	Black crowberry
Rubus arcticus	L.	Rosaceae	Arctic raspberry
Equisetum sp. (arvense, pratense, scirpoides, sylvaticum)	L., Michx., L.	Equisetaceae	Horsetails (field, meadow, dwarf, and wood horsetail)
Maianthemum bifolium	(L.) F.W. Schmidt	Asparagaceae	May lily
Thalictrum minus	L.s.l.	Ranunculaceae	Small meadowrue
Hieracium umbellatum	L.	Asteraceae	Narrowleaf hawkweed
Galium boreale	L.	Rubiaceae	Northern bedstraw
Lathyrus pilosus	Cham.	Fabaceae	Marsh pea

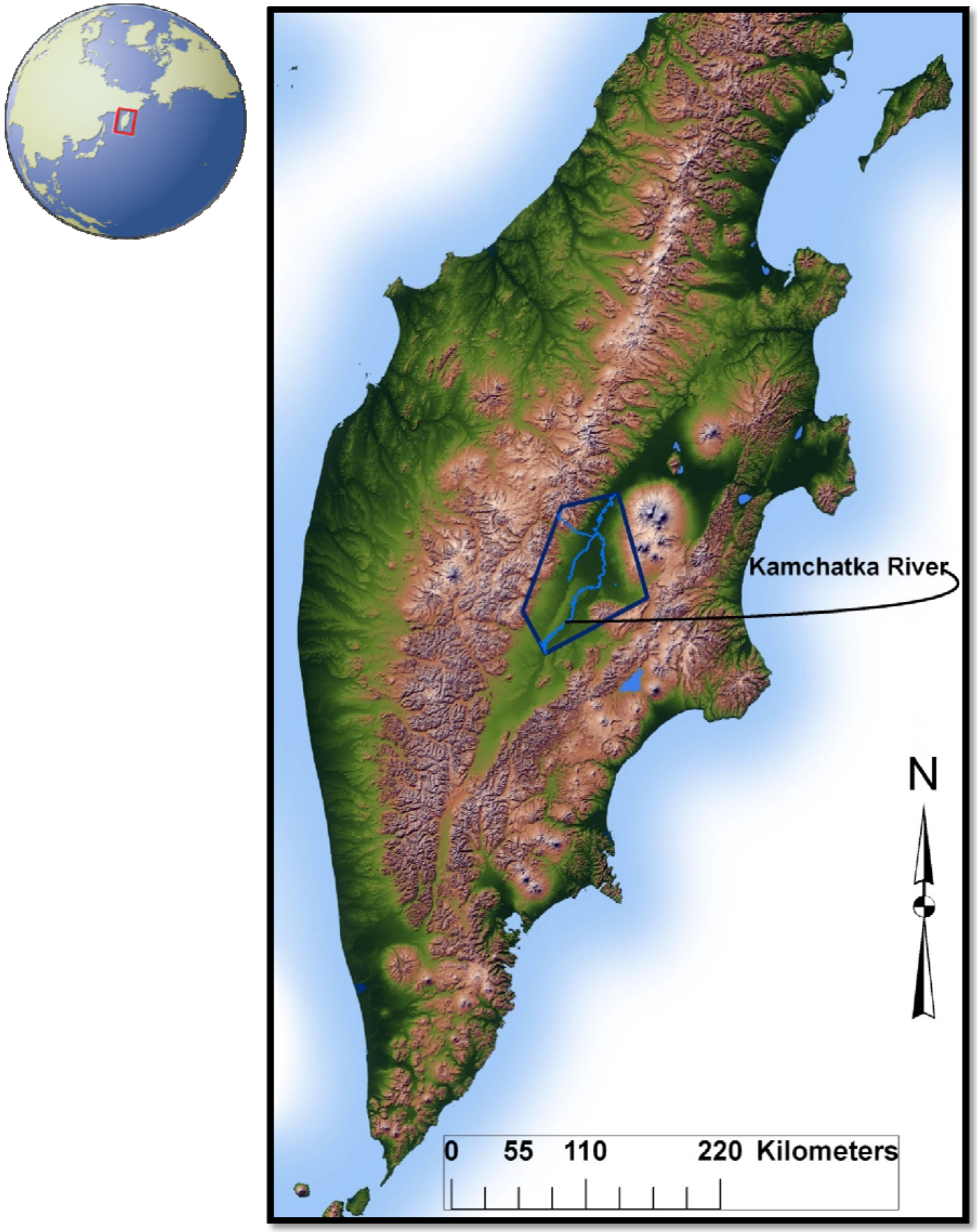

Image from NASA Visible Earth: http://visibleearth.nasa.gov/view_rec.php?id=16275.

Figure 2-1: Delineation of study site in the central Kamchatka depression.

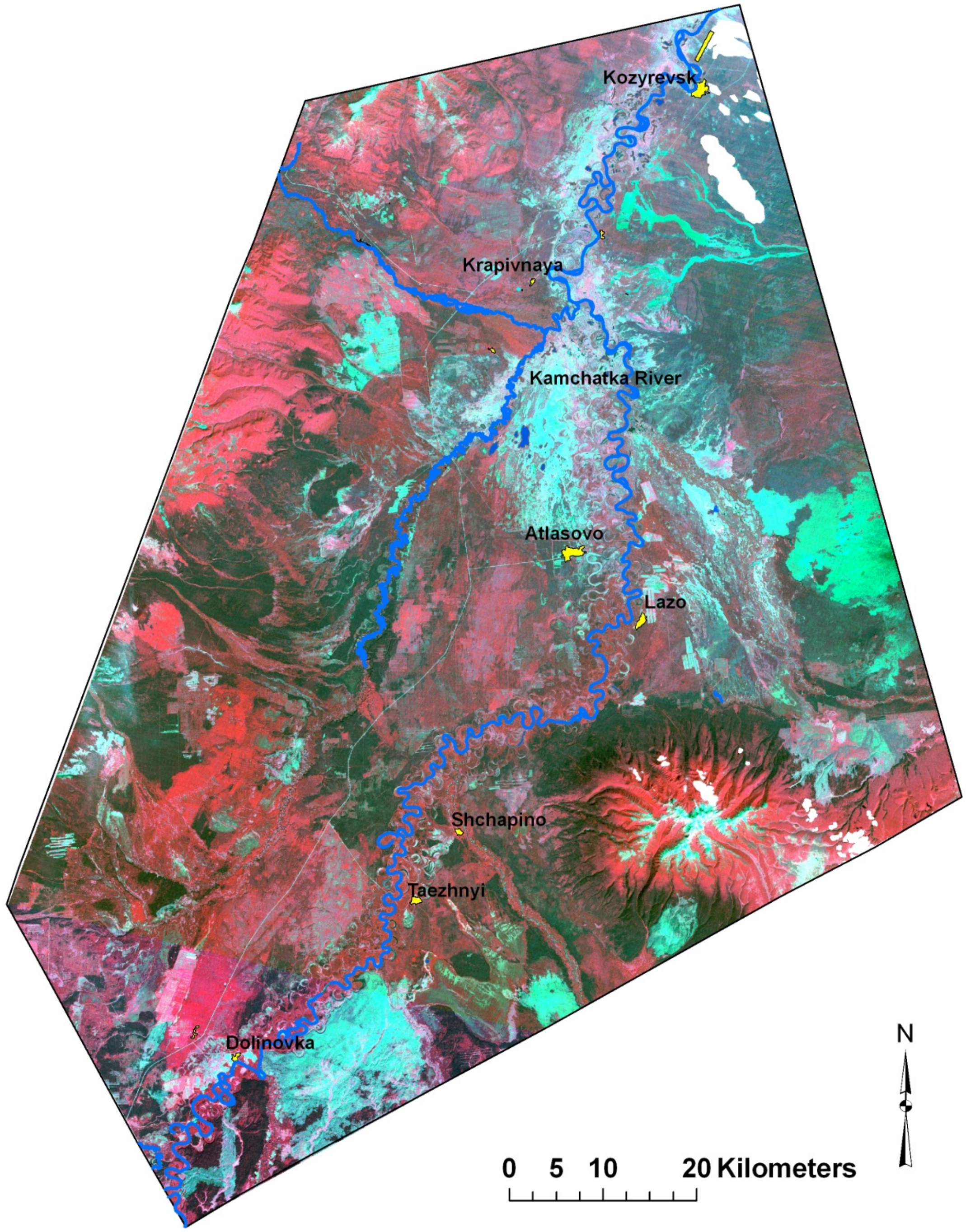

Figure 2-2: Landsat TM satellite image (July 23, 2007) of the study site, including villages of the central Kamchatka depression.

Forest structure and composition

Even in more productive sub-regions, species diversity is not a hallmark of central Kamchatka: only a relatively few and hardy plant species have adapted to the harsh conditions of this northern peninsula where the growing season is short and where there is permafrost for much of the year. Yet, this low diversity belies the intricate associations of species molded by volcanic activity, specific ecological conditions, and microclimate. Such associations differ distinctly from those found elsewhere in the Russian Far East (Efremov 1973b). These associations and the distinct niches that they occupy are discussed further in the next section.

Forest classification

An important outcome of early scientific research of central Kamchatka's coniferous forests was the first meticulous description of distinct forest communities or associations in this region accomplished through an ambitious research program organized by the Siberian Branch of the USSR Academy of Sciences from 1959 to 1962. This initial scientific classification of Kamchatka's coniferous forests served to ensure rational resource use, especially as logging activity intensified in this region. Researchers divided these forests into seven groups, which were then further broken down into distinct types within these groups (Kabanov 1963). These initial types varied in terms of moisture availability; however, they were differentiated primarily along the lines of geomorphology, which describes the internal and external processes forming the landscape, including tectonics and erosion, respectively (Efremov 1973b). Thus, a natural starting point for the classification of larch forests was along the landscape features of mountains, hills, plains, and plateaus. Most broadly, this division was between plain and mountain forests.

More recent geobotanical inquiry has attempted to harmonize the numerous local classification schemes, such as the one above, that have cropped up throughout the Russian Far East (RFE). The lack of coordination among these schemes and the failure of researchers in this region to abide by a main classification unit (for instance, association or forest type) have led to a highly confusing picture of vegetation classification in the RFE (Krestov 2003). Based on clarifications provided by Krestov (2003), the 'groups of forest types' specified by Kabanov (1963) are referred to here as forest association groups; the sub-category of 'forest type' in the original classification is labeled as 'association' throughout this chapter. According to Sukachov (1957, quoted in Krestov 2003): "The term 'association' (or forest type) unites communities similar in organization and habitat adaptations, or alternately, identical in main species and layer structure on similar habitats." In this sense, an association is an abstract grouping of plant communities sharing similar structures, dynamic processes, and location in different vegetation gradients (Shennikov 1935, quoted in Krestov 2003).

Today geobotanists working in the RFE define associations as: "several developing phytocenoses [plant communities] incorporating all stages of normal ontogenetic development of all determinant species of the forest community on biologically similar habitats" (Krestov 2003). In other words, associations have common attributes, such as dominant overstory species, and groups of indicator species pointing to similar habitats. At the next higher level, these associations are categorized into an 'association group' on the basis of analogous climatic, soil, and hydrological characteristics, and on the parallel composition of under and overstory layers. In addition, dominant species of the lower forest layers have similar stature and life-form (Krylov 1984, quoted in Krestov 2003). The next higher rung, or 'association class' is referred to as a "set of associations" with generally the same dominant species and features, indicative of adaptations to regional climatic conditions; at this level, climate is a main determinant in differences in vegetative cover (Krestov 2003). Finally, associations are joined into a 'formation' according to the ecological similarity of the dominant species (Dolukhanov 1957, Krylov 1984, quoted in Krestov 2003).

In central Kamchatka larch forests are broadly classified in the formation *Lariceta dahuricae*; the two most widely distributed larch association groups occur in the plains. The larch-forb (*Larix dahurica – Rosa amblyotis – Geranium erianthum*) association group is found in the flat, humid floodplain terraces of the Kamchatka River and its tributaries. The larch-marsh Labrador tea (*Larix dahurica – Ledum palustre*) association group is situated relatively higher on the dry and undulating interfluvial flanks of the Kamchatka River tributaries. Its habitat extends up to 300 m to the hills and ridges of moraine and volcanic origin, merging seamlessly with the densely vegetated foothills at the base of the two north-south mountain ridges that rim the central Kamchatka depression. Below, these two association groups, along with others pertinent to this study, are discussed in further detail.

Forest association group: Larch-forb (Larix dahurica – Rosa amblyotis – Geranium erianthum)

Spanning the eastern and southern vegetative regions of the Central Kamchatka depression, this association group is well-distributed, constituting up to 30 percent of the larch forests in this region (Efremov 1973b, Turkov 1964). In terms of growth and productivity, it is optimally situated in the aboveground dry river deltas that date to the Holocene period, and along the flat, terraced, or lightly undulating deluvial[2] and proluvial river floodplains. This association group occupies a range of 5 to 7 (and in some cases up to 10) km from the Kamchatka River, and 1 to 2 km from its main tributaries (Efremov 1973b). Besides high productivity, this group is defined by the following features: a complex structure and mixed composition in which birch makes up a considerable portion of the understory; uneven stands (although there are also distinct age groups); and a relatively well-developed and thick A-horizon soil layer where humus, sabulous, or lightly loamy and well-drained soils have accumulated. This association group contains six forest associations, the primary one of which shares the same name and major characteristics as the association group. (*Refer to Appendix A for a full listing of these associations.*)

Another prominent feature of this association group is a high percent coverage of the herbaceous-subshrub[3] layer, reaching 90 percent (Turkov 1964). The overstory and shrub layers are also relatively dense with a percent coverage ranging from 20 to 30 and 30 to 40 percent, respectively, although the latter can reach as high as 80 percent (Kabanov 1963, Turkov 1964). The deciduous shrub species of honeyberry, blunt-auriculate rose, and meadowsweet dominate this layer; coniferous shrubs are also present, including juniper and, more rarely, Siberian dwarf pine (Efremov 1973b, Turkov 1964, and Kabanov 1963). Finally, high species richness typifies the herbaceous-subshrub layer: reedgrass, fireweed, and northern geranium are dominant in the first tier of this layer; sedges and lingonberry are dominant in the second and third (i.e. shorter) tiers, respectively. Larch regeneration in these forests is generally unfavorable, although it does proceed on the decaying stumps and trunks of decomposing trees; it also responds to mild fires, resulting in an uneven-aged stand structure (Efremov 1973b). The full development cycle in this forest association group from growth of the herbaceous-subshrub layer to a fairly stable stage lasts from 400 to 500 years (Efremov 1973a).

Forest association group: Larch-marsh Labrador tea (Larix dahurica – Ledum palustre)

Filling in the widest part of the Kamchatka River valley, this forest association group was once the primary resource base for the former forestry enterprises (*lespromkhoz*) that operated in this region during the Soviet period. This forest association has developed on the well-drained

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[2]This term refers to deposits formed as a result of geomorphic processes (Baužienė et al. 2008).
[3]Sub (or dwarf) shrubs refer to low-lying woody plant species, such as marsh Labrador tea and lingonberry.

gentle slopes and interfluvial plains of the Kamchatka River tributaries. Overall, the soil composition in this association group differs noticeably from that of the previous group: as distance from the rich floodplain terraces increases (for example from 10 to 15 km), the A-horizon soil layer becomes comparatively thinner and drier, resulting in lower rates of soil decomposition, and subsequently, less productive forests. Four forest associations are delineated within this group (see Efremov 1973a). (*Refer to Appendix A for a full listing of these associations.*)

Even-aged and dense larch stands characterize this association group, attesting to its post-fire origin. These stands are primarily pure, although they are rarely intermixed with spruce and birch. (The expansion of birch into the overstory layer has been observed in old-growth and self-thinned forest stands [Turkov 1964].) Both birch and larch are present in the understory. Overall, there is a dearth of larch regeneration, and weak birch regeneration. The shrub layer in these forests is usually sparse, with a percent coverage ranging from 10 to 30 percent. The primary coniferous species in this layer are juniper and Siberian dwarf pine. The most commonly encountered deciduous shrub species is prickly rose; the shrubs honeyberry and meadowsweet are also present. In the herbaceous-subshrub layer, the subshrubs marsh Labrador tea and lingonberry dominate.

Forest association group: Larch-lingonberry (Larix dahurica – Vaccinium vitis-idaea)

This association group occupies a narrow range that stretches out along the dry river terraces and includes preserved sections of aboveground deltas and sand dunes dating back to the Holocene period. This group falls roughly at a midpoint in the successional trajectory beginning with the larch-lichen (*Larix dahurica – Cladonia stellatis*) and going toward the larch-marsh Labrador tea forest association groups. All three are highly related at the genetic level. Continued soil formation in the larch-lingonberry forests creates favorable conditions for new successional species, namely lingonberry. Given its extensive distribution and high fruit yields of lingonberry, this association group is highly relevant to this study. Moreover, in contrast to the larch-forb forests, the sparse shrub and herbaceous-subshrub layers characteristic of this forest association group make it easy to collect lingonberry.

Sparse growth in these layers is attributed to weakly developed and shallow soils of a sandy or sabulous composition and intermixed with pebbly material (Efremov 1973b). The overstory in this group consists almost exclusively of larch with singular occurrences of birch;

the coverage of this layer hovers around 50 percent (Turkov 1964). The shrub layer has an overall coverage of 20 to 30 percent where the dominant species is juniper. Siberian dwarf pine and honeyberry are sparsely distributed in this layer, while prickly rose and red current occur individually. Besides lingonberry, the minute twinflower can also be abundant in the herbaceous-subshrub layer; round-leaved wintergreen and black crowberry are less common. Reedgrass, fireweed, Arctic raspberry, and sedges are rarely observed. To conclude, the larch-lingonberry forests represent an important stage in a successional trajectory that begins in a denuded landscape following a major volcanic eruption and eventually leads to the development of the larch-marsh Labrador tea association group.

Disturbance dynamics

Before the rise of industrial forestry in central Kamchatka in the twentieth century, disturbances fit roughly into two categories: 1) those initiated by the plants themselves, for instance, by the gradual senescence of mature larch that created openings in the overstory and provided raised niches for larch regeneration; or 2) those spurred by external factors, such as sweeping forest fires or volcanic activity. The onset of industrial logging, however, signaled a cardinal shift in disturbance dynamics in which anthropogenic influences displaced natural phenomena as the root cause of disturbances. This shift markedly altered existing ecosystem dynamics, producing an unintended, yet inevitable outcome as state plans demanded ever-increasing timber output (Shamshin). (*Refer to Chapter 3 for a more detailed description of forest use history in central Kamchatka*.)

Logging

Initially, the highest quality—and economically most valuable—larch (i.e. those with a diameter at breast height, or dbh of >=28 cm) were selectively cut (Shamshin). This selective cutting, however, was not done to preserve the overall ecological integrity of the forest; instead, it was the default method given the primitive logging technologies used at that time. These trees formed part of the highly productive larch-forb forest association group growing in proximity to the Kamchatka River and its tributaries, which were the only conduits of timber transport at that time. This logging method reduced the initial overstory coverage by approximately 50 percent (Shamshin).

Advancements in the forestry sector were mirrored in the landscape: after the initial sweep through the larch-forb forests in the riparian zones, logging began to radiate further outward into the larch-marsh Labrador tea forests. Former logging methods were also replaced: conditional clear-cutting on a year-round basis became the norm whereby the most robust larch trees (or those with a dbh >= 12 to 16 cm) were removed from the forest cover, while thin (with a dbh from 4 to 12-16 cm) or diseased larch, along with all understory deciduous trees, were left standing (Turkov 1964).

This intensified logging level catalyzed large-scale landscape disturbance: by the 1960s from 15,000 to 20,000 ha of forest were cut annually (out of an estimated total of 617,480 ha of larch forests) (Turkov 1964). Logging was also tied closely to another main disturbance: forest fires, which were ignited through the burning of timber refuse. These culprits of deforestation and fragmentation left a deep imprint upon the landscape that ultimately led to the exhaustion of the resource base by the late 1980s. (*Refer to Table 2-2*).

Table 2-2: Forest inventory of central Kamchatka in 1961 and 2002.
The Department of Forestry in the Kamchatka oblast', and the timber branch of the organization Kamchatrybprom produced the 1961 data (in Turkov 1964); 2002 data were obtained from Shamshin 2005.

Total area in ha of:	***1.1.1961: Forest stock (in m^3)***	***1.1.2002: Forest stock (in m^3)***
Larch	109,000,000	69,080,000
Spruce	34,110,000	36,570,000[4]
Birch	559,370,000	NA
Aspen	149,400,000	NA

Forest fires

Well before the onset of logging, fires were an enduring and powerful element in shaping the forest massifs in central Kamchatka. For instance, age structure data on larch stands suggest a considerable wave of post-fire regeneration in the beginning of the nineteenth century (1801-1819) (Turkov 1963). Forest fires continue to be essential for the partial or full regeneration of larch, birch, and aspen (Turkov 1963, Kolesnikov, 1947, quoted in Turkov 1964). Fires enrich the soils and remove a major obstruction to seed regeneration by consuming the herbaceous-subshrub layer; at the same time, they spare separate trees and groups of trees that

[4]Shamshin (2005) attributed this mysterious increase to the observed spruce expansion into the lower boundary of Zone III (*refer to section on Vegetation, topography, and climate in the Introduction of this chapter*) under the overstory of larch and in the upper boundary of this zone under the overstory of stone birch. Spruce stands form after the logging of larch; these stands are of lower quality and are much less productive than the indigenous larch stands.

are critical in providing seeds for regeneration of the burned areas. In central Kamchatka fires have been directly or indirectly linked to volcanic activity, for instance they might be ignited through lava flows or intense lightening, respectively. Although industrial forestry and the accompanying efforts to control fire have considerably altered natural dynamics, fires continue to be a key disturbance in central Kamchatka, as was evident in the massive forest fire of 1949 that ravaged at least 200,000 ha before it was distinguished by rain. Even with better fire-fighting infrastructure, another fire scorched this region in 1976, consuming 12,000 ha (f. 722, o.2, d.6).

Post-disturbance forest succession

This section takes an in-depth look at the post-disturbance successional dynamics that have redefined central Kamchatka's forested landscape. To contextualize succession in time and space, it relies heavily upon the seminal research of V.G. Turkov (1964) on succession and its implications for forestry practices in central Kamchatka.[5] Similar to the development of the forest classification scheme (see Kabanov 1963), this research was driven by the practical need to address forest regeneration, which became especially apparent following the intensification of logging in the late 1950s.

Overview of successional processes

In the broadest terms, succession refers to changes in species composition, or the replacement of one biota on a site by another biota (Barnes 1998). An elemental successional trajectory of northern Larch-dominant forests proceeds in the following sequence: herbaceous cover—shrub cover—birch-dominant stands—larch-dominant stands (Chugunov 1955, quoted in Turkov 1964). In this scenario, there are favorable conditions for larch germination and the subsequent development of this species, allowing it to dominate the forest overstory again. This generalized successional path of post-disturbance forests has been widely observed in both tropical and temperate ecosystems; it is broadly categorized into two primary stages: 1) building (or upgrading), and 2) downgrading (or senescing) (Barnes 1998). These stages may be broken down into the following more specific phases that also apply to most ecosystems: 1) stand

[5]This research was the basis of V.G. Turkov's doctoral dissertation.

initiation or establishment; 2) stem exclusion or thinning; 3) understory re-initiation or transition; and 4) old-growth or steady-state (Barnes 1998).

Phase I can be very long-drawn-out, as is the case in central Kamchatka, lasting upwards of a hundred years depending on the type of disturbance, species regeneration strategies, or prevailing climatic conditions (Oliver and Larson 1990, quoted in Barnes 1998). The following sections examine how ecological, environmental, and climatic factors specific to central Kamchatka prolong (or curtail altogether) regeneration in successional forests, and how Phase I plays out in the two main forest association groups (larch-forb and larch-marsh Labrador tea) in this region following disturbances.

Barriers to larch regeneration

Soil specificities

Protracted larch regeneration is largely traced to distinct environmental and ecological conditions, foremost of which are the unusual soils blanketing this region (Turkov 1964). Evidence of volcanic activity permeates these soils, beginning with the C-horizon that is composed of volcanic remains and pyroclastic sediments, which give rise to the defining characteristics of the soil: exceptionally high porosity (for instance, pores >2mm) and an overall fragile composition (*Lesa Kamchatki* 1969; Turkov 1964). The A-horizon layers are thin due to continual ash depositions that contribute to a highly stratified soil profile with alternating humic and ash strata, resulting in the prevalence of sandy-loam or light-loam soils with a loose, granular structure.

The effect of volcanic activity on soil formation processes is so extensive that it has been compared to the influence of vegetative communities in these processes (*Lesa Kamchatki* 1969). High soil porosity makes the soils prone to extreme desiccation in the A-horizon layers. This phenomenon is especially strong during the second part of the vegetative period when the layer of seasonal frost, which served as an impermeable barrier to water drainage, melts. In the absence of this layer, soil moisture levels drop drastically from their former saturated state, prompting the widespread perishing of larch saplings (Turkov 1964). One reason for this loss is that severely desiccated soils are subject to very slow rates of decomposition, which inhibit the accumulation of organic matter and thwart nutrient uptake (Chizhikov 1951, quoted in Turkov 1964). This observation was confirmed by researchers at the Forest Experimental Station

(*Lesnaya Opytnaya Stantsiya*) that was formerly stationed in the village of Kozyrevsk to conduct locally relevant forest research. Soil desiccation is especially pronounced in logged areas due to earlier snowmelt, increased light exposure, and better ventilation than in undisturbed forests (Turkov 1964).

Insect infestation and competition from other species

A second grave, and unrelated, impediment to larch regeneration has been a relatively new phenomenon: the infestation of an invasive moth species responsible for the destruction of an estimated 80 to 90 percent of larch seeds (Turkov 1964). Some researchers traced the sharp drop in larch regeneration observed early in the twentieth century to the influx and subsequent widespread dispersal of the moth at this time (Kozikov and Rozhkov 1959, quoted in Turkov 1964).

Finally, another possible factor that greatly hinders larch regeneration is the extensive root system of birch with which larch cannot compete (Georgievsky 1962, quoted in Turkov 1964). Turkov (1964) observed that a large quantity of larch tended to die out en masse in secondary forests between the ages of 25 to 30 years, thereby allowing secondary deciduous regeneration to become a stable forest type following the traditional disturbances of fire and intensive volcanic eruptions (Kabanov 1963). Even in the absence of such disturbances, however, deciduous species could out-compete larch and expand into the overstory, particularly given their advantage of vegetative reproduction. Pervasive anthropogenic disturbances beginning in the twentieth century exacerbated existing slow rates of larch regeneration, thereby spurring the widespread replacement of larch-dominant forests with secondary, primarily deciduous species (Turkov 1964). The successional pathways behind this striking transformation of 'Conifer Island' are further explored in the following sections.

Secondary forests and the disappearance of 'Conifer Island'

On-going disturbances continue to transform the forested landscape in central Kamchatka, thereby initiating new successional trajectories across the landscape. Immediately following disturbance, rapid plant regeneration characterizes the initial building stage of succession, which is common to most forest association groups in central Kamchatka (Barnes 1998, Turkov 1963). As successional processes proceed, however, they are manifested differently depending both on association group (e.g. larch-forb and larch-marsh Labrador tea) and disturbance type. This section highlights the differential structure and composition of secondary forests arising from the initial association groups, and how specific disturbances (e.g. fire) have distinctly shaped these forests. Lastly, it looks at larch regeneration in the larger successional context, examining how processes in central Kamchatka diverge from those elsewhere (*refer to Figure 2-3*), with the effect that secondary forests have become permanent fixtures of 'Conifer Island.'

Figure 2-3: Successional trajectory for larch-dominant forests in Yakutia (Russia) over a period of 100 years (B.V. Chugunov, quoted in Turkov 1964)

Building Phase

The increased penetration of light, warmth, and moisture in the absence (or fragmentation) of the overstory cover is responsible for the first surge of re-vegetation following disturbance. Together these elements promote decomposition of organic matter and the subsequent nitrification of soil, a process through which nitrogen (in the form of nitrates) can be assimilated by plants, particularly herbs, explaining why this initial re-growth stage is concentrated primarily in the herbaceous-subshrub layer. In the taiga forests the sun-loving and nitrophilic herb fireweed flourishes in these conditions and predominates in the herbaceous-subshrub layer in the first years following disturbance.

Fireweed fulfills many crucial ecological functions, thereby setting the stage for subsequent successional phases. For instance, this species improves porous soil conditions, increasing water absorption and aeration; at the same time it raises the content of dissolved nutrients in the soil (see Danilov 1937, 1940: Stoyanov 1957, Protopopov 1959, 1960, 1962, quoted in Turkov 1964). This species also moderates surface soil temperatures through its own process of transpiration that intensifies during the heat of the day, thereby lowering soil temperature and increasing the relative air humidity. And, along with other herbs, it shields emerging larch seedlings from scorching sunlight. Without these interventions, sharp contrasts in soil temperature during the summer months would otherwise destroy larch seedlings. At this early regeneration stage, larch is still relatively shade tolerant; thus, there is little likelihood of fireweed out-competing larch for light (Dylis 1947, quoted in Turkov 1964).

Because it can either facilitate or thwart larch regeneration, the herbaceous-subshrub layer is singled out as a key element in determining further successional processes. To illustrate, the dominance of grass and sedge species instead of fireweed in the herbaceous-subshrub layer creates inhospitable conditions for larch germination and growth. Thus, the classification of early successional stages is based on this layer (Turkov 1964). Specifically, three distinct successional types[6] were identified in each forest association group according to specific species combinations (*refer to Table 2-3*). These types provide a snapshot of early successional processes at a given point in time. These few discrete categories reflect the comparatively small number of larch-forest associations in central Kamchatka (*Lesa Kamchatki* 1969). In actuality, species occupy disturbed sites in a variety of patterns and temporal sequences (Barnes 1998). Thus, these types are necessarily an oversimplification of continuous processes unfolding over a highly variant landscape. Nonetheless, they are useful in understanding basic successional patterns specific to the two main forest association groups in central Kamchatka.

Table 2-3: Initial successional phases in each of the main forest association groups following disturbances (i.e. logging).

1) ***Larch-forb***:	2) ***Larch-marsh Labrador tea:***
• *Fireweed*	• *Reedgrass—marsh Labrador tea*
• *Reedgrass-Fireweed*	• *Marsh Labrador tea—Juniper*
• *Shrub*	• *Lingonberry*

Secondary larch-forb forests

Two secondary forest associations form following disturbances in the larch-forb forests. They are classified according to the dominant deciduous species as: 1) birch-forb forest (*Betula platyphylla – Rosa amblyotis – Geranium erianthum*), or 2) aspen-reedgrass forest (*Populus tremula – Calamagrostis purpurea*) (Kabanov 1963). (The second type is much rarer than the first.) The structure and composition of these secondary forest associations clearly set them apart from undisturbed, or primary forests. In the secondary birch forests, for instance, birch dominates the overstory with a coverage ranging from 40 to 80 percent (Kabanov 1963). The initial increased light conditions in the absence of larch in the forest overstory stimulate the growth of birch and, to a lesser extent, aspen seedlings and saplings, which then cause distinct changes in the shrub and herbaceous-subshrub layers. Within an eight to ten year (or possibly

[6]In the literature, the term "types of cuts" (*tupy vyrubki*) was used.

more) gap following disturbance, the shrub species honeyberry and to a lesser extent, meadowsweet and blunt-auriculate rose expand to fill the opened niches. Juniper occurs only individually, or in small groups. At this point the extent of the shrub layer ranges from 40 up to 70 to 80 percent.

Weak shrub development has been observed following complete clear-cutting that typically precipitates a surge in grass and sedge growth (Turkov 1963, 1964). The subsequent sod formation on the forest floor inhibits larch regeneration. In the more common case of conditional clear-cutting, grasses and sedges have also been prevalent; at the same time, nitrophilic herbs (e.g. fireweed and Arctic raspberry) multiply, signaling the decomposition of organic matter. These improved soil conditions are favorable for larch regeneration (Turkov 1964). This successional stage would be categorized as the reedgrass-fireweed type.

Secondary larch-marsh Labrador tea forests

In its post-disturbance state, the larch-marsh Labrador tea forest association group becomes the birch-marsh Labrador tea-forb (*Betula platyphylla – Ledum palustre*) forest association group, which includes the association birch-marsh Labrador tea-lingonberry (*Betula platyphylla – Ledum palustre – Vaccinium vitis-idaea*) (Kabanov 1963, Turkov 1964). Frequent disturbances—often a mix of logging (conditional clear-cutting) and fire—greatly reduce, or completely destroy the initial forest stands. Particularly in the case of logging, the spared larch trees are largely inviable, with thin, dry trunks, making them susceptible to fire and insect infestation (Turkov 1964). Thus, here the effect of conditional clear-cutting is essentially akin to complete clear-cutting, despite the fact that a large quantity of trees may be left standing. The dearth of larch seed trees results in the dominance of birch in the overstory where it is sparsely intermixed with larch and aspen (*Lesa Kamchatki* 1969). In this case, birch reproduces primarily through vegetative propagation.

Unlike the relatively dense birch understory left in the larch-forb forests following logging, the sparse upper layers (i.e. overstory and understory) remaining in the larch-marsh Labrador tea forests are not sufficient to shield the topsoil from intensive sun exposure and subsequent desiccation of the forest leaf litter. The consequent delay in soil decomposition and nitrification creates a habitat less favorable for fireweed and other sun-loving and nitrophilic herbs (e.g. Arctic raspberry), which gives rise to the proliferation of reedgrass immediately following disturbance. As in secondary larch-forb forests, reedgrass in these forests also outcompetes shrub species, resulting in intensive sod-formation on the forest floor that proves extremely unfavorable for larch regeneration (Turkov 1964).

In the absence of reedgrass overgrowth, the shrub layer is typically well-developed, attaining an overall coverage of up to 70 percent. Juniper is predominant, interspersed with honeyberry, meadowsweet, and prickly rose; bog blueberry appears intermittently. As organic matter accumulates, it forms a layer of dry peat that is highly water absorbent. This layer allows for the growth and eventual dominance of marsh Labrador tea, a typical bog inhabitant, in the parched interfluvial plain inhabited by the larch-marsh Labrador tea forests (Turkov 1963). Besides marsh Labrador tea, lingonberry, reedgrass, fireweed, Arctic raspberry, and sedges are common in the herbaceous-subshrub layer (Turkov 1964, Efremov 1973b). Other species present include: round-leaved wintergreen, northern geranium, small meadowrue, and May lily; northern bedstraw, marsh pea, horsetails, and twinflower are sparse.

Differential effects of fire on successional processes

The strong presence of fire and its diverse effects on forests in central Kamchatka warrants a closer look at how it has influenced forest dynamics and specific successional processes. To begin, fire has played a more formative role in the larch-marsh Labrador tea forests, which are often distinguished by even-aged stands that indicate the one-time release of seeds on cleared soils. In some cases, however, there is clear variation in forest structure due to repeated fires and volcanic ash falls that have staggered successional processes. Observed variation is also attributed to gradation in the intensity, speed, and extent of the fire, all of which are affected by the structure and composition of the lower forest layers (understory, shrub, and herbaceous-subshrub layers). To illustrate, dense juniper and marsh Labrador tea coverage commonly found in the larch-marsh Labrador tea forests provide ample fuel for fires, which may burn much of the overstory in addition to the lower forest layers. In contrast, the larch-forb forests are less susceptible to intensive fires owing to their higher moisture content. Typically only light fires burn in these forests during the spring and fall.

This interplay of fire with specific habitats and forest associations has resulted in a high diversity of burns, making it difficult to draw a general pattern of successional processes. Nonetheless, two main groups of post-fire forests have been delineated on the broad basis of whether or not viable seed trees remain following a fire. In central Kamchatka most of the burns still contain seed trees. Within this group successional processes are divergent depending on the intensity of the burn, and on the forest association in which this burn occurred. All burned areas, however, go through the initial post-fire successional phase marked by the proliferation of fireweed in the second summer following fire (Turkov 1963). (This trajectory also applies to logged areas that have subsequently burned). Other early herbs are intermixed in this cover, albeit sparsely, including: reedgrass, sedges, narrowleaf hawkweed, horsetails, round-leaved wintergreen, marsh Labrador tea, and lingonberry.

Further, less intensive fires in the larch-marsh Labrador tea forests often result in complete larch regeneration, which tends to be thick the first years following disturbance; this growth surge usually tapers off within 20 years (Turkov 1964). Initially larch is dominant in the overstory, while birch clusters in the understory. In contrast, this type of fire in the larch-forb forests initiates regeneration of both deciduous and coniferous species that form even-aged stands in the first 10 to 15 years following a fire. As succession proceeds, however, larch regeneration becomes increasingly rare due in part to increased sod-formation and the accumulation of leaf litter on the forest floor, which preclude germination. Also, after the initial successional phases, distinct stratification occurs whereby birch dominates the overstory, while larch is relegated to the understory where it faces growing competition for scarce light and essential nutrients that are increasingly assimilated by birch's sprawling root system (Turkov 1964).

In the sites of more intensive fires, common in the larch-marsh Labrador tea forests with dense juniper (or Siberian dwarf pine) growth, the complete destruction of overstory and understory results in minimal to no larch re-growth. Consequently, deciduous species (birch and aspen) overtake these areas. In these forests, usually in the southern part of the central Kamchatka depression, the shrub and herbaceous-subshrub layers are uneven. Initially, the dense growth of fireweed is intermixed with the very sparse growth of reedgrass, sedges, horsetails, and several other species, including Arctic raspberry, northern geranium, small meadow rue round-leaved wintergreen, marsh Labrador tea, and lingonberry (Turkov 1964). As succession proceeds (specifically in the birch-marsh Labrador tea-lingonberry forests) marsh Labrador tea and lingonberry dominate the herbaceous-subshrub layers; juniper along with prickly rose, meadowsweet, and honeyberry are observed in the shrub layer.

Stalling of succession

According to the general successional model (*refer to Figure 2-3*), the post-disturbance secondary deciduous forests should have been a temporary link in the successive trajectory. For instance, the water-retaining qualities of the leaf litter that these forests produced should have prevented severe topsoil desiccation, which would favor the reappearance of larch (Turkov 1964). Yet, as previously demonstrated, the initiation of larch stands in early forest succession has been largely unsuccessful or prolonged, if not absent altogether, producing what has been deemed an irreversible change in forest cover. In actuality, the structure and composition of secondary forests has seemed to hinder larch regeneration (Kabanov 1963). The extensive expansion of the birch root system in tandem with intensive development of the shrub and herbaceous-subshrub layers depletes the soil of moisture and nutrients and produces a thick litter layer, both of which obstruct larch seeding and growth.

In isolated instances favorable larch regeneration has been observed, for instance, on the micro-niches provided by decaying tree trunks and stumps (primarily in the larch-forb forest association group) (*Lesa Kamchatki* 1969). The dearth of forest litter and other competing species on these raised spaces provides an ideal niche in which larch saplings can take root and survive. Such niches, however, are rare, especially following fires that burn through the woody debris layer on the forest floor. Thus, while scientists (including Turkov 1964) did not rule out the eventual re-colonization of larch in disturbed areas, they nonetheless acknowledged the overall picture of low and protracted larch regeneration rates. Although large-scale anthropogenic disturbance certainly exacerbated these rates, the origin of poor regeneration can be traced to the convergence of volcanic and climatic factors in the central Kamchatka depression that gave rise to unfavorable conditions for larch, including fragile soils that could not support the critical first years of growth. Against the backdrop of this vulnerable ecosystem, the consequences of extensive industrial logging were obvious: 'Conifer Island' became an obsolete term as it was increasingly encroached by deciduous species. In summary, this basic overview of vegetative patterns and successional processes in central Kamchatka provides an essential framework in which to situate analyses based on empirical ecological data that follow later in the dissertation (in Chapter 4). The next chapter turns from an overview of the forests to a detailed look at forest use during the Soviet period.

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Chapter 3
Persistent Ideology, Changing Landscapes, and the Transformation of Forests, People, and the Soviet State in Central Kamchatka

Prologue:
"We must not wait for benefits from nature, our task is to wrest them from her!"—widespread Soviet propaganda disseminated in the 1930s (Vorontsov 1992)

"There turned out to be a bottom in the forest 'bins'. The understanding of an island of coniferous forests in the Kamchatka River valley has gone into history as obsolete."—V.A. Shamshin (1994)

Introduction

This chapter explores the unique story imprinted upon the forested landscape of the central Kamchatka depression. This textured landscape tells of the people who settled in this far northern outpost, and of the former Soviet state that strove to build a thriving forestry sector here. It examines the interactions between the state, people, and forests through the lens of historical ecology, a discipline that advocates a holistic approach in addressing the multifaceted relationship between humans and their environment.

An integral part of the historical ecological approach is the use of past contexts in which to discern the present (Kidder and Balee 1998). Specifically, an understanding of former resource-use patterns is necessary to position effective environmental and cultural information at a range of temporal and spatial scales (Crumley 1994). Thus, by grappling with the complex relationships between the state, people, and forests in the mid to late-Soviet period, this chapter builds the essential framework in which to place the subsequent chapters of the dissertation that focus on people's livelihood strategies and their accompanying patterns of forest use in the post-Soviet period.

At the core of historical ecology is the idea of interdependence, such that people affect, and are affected by the natural world (Kidder and Balee 1998). This chapter is built upon a triangular model representing this notion of dynamic interchange among the state, people, and forests in past time and space in central Kamchatka (see Moran 2006). (*Refer to Figure 3-1.*) This model offers a useful lens through which to understand the nuances of these relationships, including how people influenced the state. Thus, this model breaks the conventional notion of a hierarchal and asymmetrical power structure with the state at the helm (Tasch 1999). Although the state was the initiator of large-scale timber operations in central Kamchatka, it was the collective outcomes of the state-people-forest relationships that dramatically transformed the landscape. The resulting patchwork of highly fragmented and degraded forests, in turn, profoundly affected how the state and the people related to these forests (Denecke 1992).

The core argument of this chapter is that the transformation of the forested landscape in central Kamchatka elucidates human-environment connections, or the ways in which the state and people shaped, and were shaped by, changes in the natural landscape. Situating the dynamic model within the context of a physical landscape allows for an in-depth examination of the following questions that guide this chapter:

- How did the Soviet state's ideology, as expressed in forest-use policies and practices, affect the forests and people in central Kamchatka?
- How did people relate to the state and to the forests? To what extent did the state dictate people's relationship to the forests?
- How were the outcomes of the state-people-forest relationships manifested in the physical landscape?
- What were the consequences of major landscape change for both the state and people?
- How did the state and the people respond to the landscape changes they had initiated?

To frame these questions, I first discuss the conceptual and theoretical underpinnings of historical ecology and institutional theory.

Theoretical Overview

Historical Ecology

Historical ecology is particularly applicable to this chapter because it addresses the core questions of how and why a landscape has been changed due to human-environment dynamics. The focus of historical ecology is on relationships: it is concerned with the wide scope of interactions between human societies and local environments, and the collective consequences of these relationships (Balee 2006). It emphasizes the connection between nature and culture as a dialogue—as opposed to a dichotomy (Ingerson 1994, quoted in Balee 1998)—where "humans are natural, and nature is human" (Kidder and Balee 1998).

Long-term processes that encompass spatial and temporal changes lie at the crux of historical ecology; these changes are what determine cultures and landscapes, both today and in the past (Balee 2006). The *outcome* of human-environment interaction that occurs at every period of history is a key element in this context (Balee 2006). In his view of history as particular to certain places, Karl Marx alluded to how landscapes were formed and recreated (see Baker 1992). Marx stated that the "material outcome" characterizing a certain period of history is "transmitted to each generation by its predecessor" and "on the one hand is modified by the new generation, but on the other itself prescribes its own living conditions and imposes upon it [*the new generation*] a definite development." This interpretation helps contextualize people's position in a physical place that is itself a product of previous human-environment relationships. This place acts upon people, just as they act upon it. Accordingly, different places and contexts confine and facilitate people's actions; at the same time, these actions build and maintain places, and thus, they involve questions of resource use and preservation (Tasch 1999). In this sense, the physical environment truly has become the "by-product of human conceptualizations, activities, and regulations—a nature, as it were, that is after nature" (Escobar 1999, quoted in Biersack 2006).

As both biological and cultural beings, people have always interacted with natural environments, modifying the structure, function, aerial coverage, and species composition of ecosystems over time (Kidder and Balee 1998, Moran 2006). Human activities, for instance, affect the vegetative patterns, including the dynamics of specific plant species (Gragson 1998). The concept of anthropogenic succession, or how people have altered the land through their resource use, imparts a clearer understanding of the human-environment connection. Human-induced disturbance is neither inherently destructive, nor unidirectional. In fact, anthropogenic succession to a certain degree reproduces ecological succession, or the 'naturally' occurring processes following any kind of disturbance (Gragson 1998). Today most ecologists accept disturbance phenomena, whether anthropogenic or ecological, as non-directional in that they do not always signal the end point of a process, but instead produce varied results (Gragson 1998). For instance, disturbances could lead to a decline in vegetative stature, diversity, or productivity; at the same time, they could also enhance the equilibrium structure and community composition of an ecosystem (Gragson 1998). These transformed ecosystems subsequently influence anthropogenic succession.

In central Kamchatka anthropogenic succession has dramatically changed the original vegetative communities: today deciduous species have come to dominate former coniferous ecosystems. Human-induced disturbance on a mass scale set into motion successional processes that continue to determine forest composition and use today. Although these disturbances were far greater in scope than naturally occurring ones, the end effects of both on ecosystems differ little. This intricate cause-and-effect dance between humans and nature is essential in understanding the dramatic transformation of the forests in central Kamchatka over a relatively short period of time (see Crumley 1994), and how people's resource-use patterns have fluctuated in step with both ecological and social processes (Pinedo-Vasques et al. 2002).

Centrality of landscape

In historical ecology the concept of the landscape as a biocultural phenomenon is paramount (Balee 1998). It captures the historical interrelatedness of humans and the environment that helped create the current world (Crumley 1994). Landscapes—past and present—mark human activities and ways of being, both subtle and dramatic. Specifically, they reveal the social practices and politically-based decisions, both conscious and unconscious, which have shaped human lives and livelihood, and the landscape itself (Harper 2006, Crumley 1994). In this sense, people's ecological relationships may be seen as "the embodiment of past activity" (Ingold 1992, quoted in Harper 2006).

Because human activities stem from specific behaviors, a landscape may also be seen as the product of mental attitudes; thus, a consideration of the ideological context is vital in the interpretation and recreation of landscapes (Baker 1992). Ideologies encapsulate the world in ordered and simplified terms, providing a cause to which people can align their thoughts, actions, and activities (Baker 1992). They are a crucial tool of state powers (often in the form of propaganda) seeking to assert authority and thereby transform the world and the people in it as they see fit (Denecke 1992). The resulting hierarchy in which the state's interests are elevated above others secures the state's domination (Thompson 1984, quoted in Baker 1992; Baker 1992). It also engenders power struggles between different groups (Baker 1992), which gives rise to conflicts that are reflected in the landscape.

The notion of ideologies as a powerful force in (re)creating and destroying landscapes is central to this chapter that traces extensive landscape change in central Kamchatka to political ideologies, and the contradictions inherent in them. Today central Kamchatka's landscape testifies to the region's past: it is a physical record both of large-scale ecological change, and of people's relationship to the state and the natural world that was predominantly dictated by centralized and idealistic ideology.

Institutional theory

Institutional theory emphasizes the importance of local institutions in accounting for forest use and conditions; thus, it is useful in sorting out the cause-and-effect actions of the Soviet state in resource use. A new body of literature is emerging on the forest-people nexus. This literature incorporates thinking from historical ecology; however, its extensive reliance upon the natural sciences to elucidate human-environment interactions makes it more comprehensive (Ostrom and Nagendra 2006). (*Refer also to Chapter 6*). This literature is founded on the concept that ecological systems are rarely exempt from human use, and argues that local institutions are the fundamental medium through which to understand forest condition and use. Put another way, a forest's condition may be traced to a particular type of institution that through its rules and incentives ultimately affects the behaviors of people in their resource use decisions (Gibson et al. 2000, Ostrom and Nagendra 2006).

Institutional theory integrates different temporal and spatial scales to understand forest change over time. Thus, as in historical ecology, the landscape—and its trajectory of change—are pivotal. This theory recognizes that previous human actions are often inscribed in the current landscape (Schweik 1999). At the same time, it is centered on what people are doing with forest resources in the present. Moreover, it recognizes that the impact of human behavior on the local environment is influenced by, and influences, both global and local physical factors; this behavior (and the incentives underlying it) are shaped by institutional as well as by socio-economic, demographic, cultural, and physiographic factors (Gibson et al. 2000, Schweik 1999).

Focusing on institutions and local actors in resource use in time and space, institutional theory is particularly apt to this chapter that focuses on the role of Soviet forestry institutions in large-scale landscape change. In a related study, Schweik (1999) explored the connection between local institutions, optimal foraging, and forest change in Nepal, showing how the spatial configurations of institutions shaped people's actions, which then led to changes in the geographic properties of the natural resource. Moreover, institutional theory acknowledges that local communities both modify and discard rules passed down from the central government; it also helps explain why they improvise their own rules (Gibson et al. 2000). Thus, in the case of central Kamchatka, this theory is useful in conceptualizing the former state-people relationship as more than a unidirectional one where people simply received preconceived orders.

Overview of chapter

This chapter has been divided into three main parts. Part I contextualizes the core components of the model, specifically: the state and its ideology, the people, the forests, and the state institutions. It also provides an overview of industrial forestry development in central Kamchatka. Part II examines the state-people-forest relationships as a sequence of movements beginning with state ideology and how it affected the people and forests, and ending with a look at the unintended outcomes of this ideology. Part III focuses on the consequences of major landscape transformation and how the people and the state responded to these significant changes in both new and traditional ways. Overall, this chapter strives to tell the intricate story of how the landscape in central Kamchatka came to be as it is today; thus, it relies heavily on knowledge that has been 'captured' (see Gunn 1994 quoted in Balee 1998; Balee 1998) in the archives, and in people's own observations and recollections as told through interviews and conversations.

Part I

Kamchatka in the greater geopolitical context

Lying on the extreme eastern periphery of Russia, the Kamchatka Peninsula has formed the country's last wilderness frontier since its inclusion as a territory in the eighteenth century (Sarkisov 1999). This remote area gained increasing attention as industrial development progressed through the Russian Far East (RFE) beginning in the early twentieth century. To understand the forces that have shaped modern-day Kamchatka, it is first situated within the regional context of the RFE. Then, the trajectory of industrial forestry in the peninsula during the Soviet period is outlined.

Although the colonization of the RFE predated Soviet rule, the rise of the Soviet regime consolidated the traditional colonial relationship that existed between the center (Moscow) and periphery (RFE). Recognizing the untapped natural resource potential (e.g. in forests and fisheries), along with the strategic location of this expansive region, the state launched large-scale industrial development in the RFE (Thornton and Ziegler 2002). These development plans were not unlike those targeted for other areas throughout the former Soviet Union. To implement these plans, the state concurrently set up an ambitious program to summon workers to the far, undeveloped reaches of the RFE, such as Kamchatka. The state invested heavily in this program, promising attractive salaries and other economic stimuli to help mitigate harsh living conditions and a lack of social infrastructure (Heleniak 2001, Mikheeva 2002). These costs were part of the extensive flow of funds to the RFE from Moscow that continued throughout the Soviet period. They were justified in light of the valuable raw materials, such as gold, diamonds, and timber in the RFE that were essential building blocks of the resource-intensive economy.

Besides contributing to the efficiency of the national economy, development of the RFE was grounded in political, military, and strategic interests that ultimately superseded economic plans (Mikheeva 2002). For instance, the RFE served as a repository in which to sequester political prisoners, and to dispose of other waste that tainted the center (Bassin 1991; Sinyavsky 1988, both quoted in Tasch 1999). Moreover, the state was well aware of the RFE's great geopolitical significance given its proximity to northeast Asia and the Pacific Ocean. Thus, an important part of its development scheme was the construction of naval bases for its Pacific Fleet (including one in Petropavlovsk-Kamchatsky, Kamchatka's capital city). This clear military presence helped bolster the state's authority in this geostrategic region (Bradshaw 2001). Later in the Soviet period a partnership with Japan, a key player in this region, had a momentous effect on the development of RFE forestry (Mathieson 1979). Similar to other industries, advancement in the forestry sector was grounded in a highly exploitative and inefficient approach that exacted a high ecological cost, as exemplified in the central Kamchatka depression where industrial forestry ravaged the once contiguous cover of coniferous forests in the valley. The extent of resource exploitation in this case was not unique: resources were systematically exhausted and landscapes were marred in similar scenarios that played out across the former Soviet Union. (One vivid example is the drying up of the Aral Sea due to the diversion of water for cotton crops.)

A brief overview of industrial forestry in central Kamchatka

The first tracks of industrial logging were made in Kamchatka in the early twentieth century as the newly-formed Soviet state proposed its grand vision to transform the USSR into a world industrial and military power (Vorontsov 1992). An important component of this vision was the development of Russia's rich forests reserves, which meant the geographical expansion of forestry throughout the country, including the RFE. In Kamchatka this movement occurred in four distinct periods (Shamshin 2005):

- **1927-1940:** Commencement of large-scale logging and timber processing, and forest inventories (for development purposes).
- **1941-1954:** Timber production and processing increased to meet the peninsula's needs for construction materials during the war and postwar years.
- **1955-1987:** Continued growth of timber production and processing; this period saw the dramatic rise of annual logging quotas based on highly subjective forestry science. Overcutting was further aggravated by round wood exports to Japan.
- **1988-2001**: Exhaustion of forest resource base and collapse of the forestry sector.

From 'chopping down' to 'felling' [7]

Initial phase of timber production (1927-1940)

The establishment of the Kamchatka Joint-Stock Company (*Aktsionernoe Kamchatskoe Obshchestvo*, or AKO for short) in 1926 and its growing demand for timber was the catalyst for large-scale logging in the peninsula. The founding of this company represented the first concerted effort to develop the rich natural resources in Kamchatka, which was the last remaining unindustrialized region in the former Soviet Union. This company oversaw the following economic sectors: fishing, logging, agriculture, housing, geological research, transportation, colonization (i.e. resettlement), fur production, and construction. In 1930, a forestry department was added to the AKO, which united all of the initial forestry enterprises in Kamchatka. This addition pushed logging from an intermittent activity to a planned, year-round operation.

Despite this momentum, the beginnings of industrial forestry were fraught with doubt surrounding the overall feasibility of timber production in the largely unsettled Kamchatka River valley (f.541, o. 1, d. 155a). Still, prospects existed even in the face of sizable natural and human

[7] This lexical shift reflects the progression of logging: the word 'chopping down' (i.e. by hand) (*rubka lesa*) gradually came to be replaced by the word 'felling' (i.e. with an electric saw)(*valka lesa*) (Shamshin 2005).

limitations, as articulated by the Russian botanist V.L. Komarov (quoted in Shamshin 2005): "New methods of collective labor and socialist management will undoubtedly overcome all hardships and make Kamchatka a settled and rich land." Komarov was the first Russian botanist to compile a systematic description of Kamchatka's flora (including woody plants) and the distribution of this flora in the volume entitled: *Flora poluostrova Kamchatki*, which was published in 1927 (Turkov 1964). His work overlapped with the Swedish botanist, Eric Hultén who published an analogous volume, *Flora of Kamchatka and the adjacent islands*, also in 1927.

Komarov's statement implied a cautious approach to resource use (Shamshin 2005). It reflected the threefold importance attributed to the forests at that time: 1) to protect fisheries and fur-bearing (and other) mammals; 2) to provide timber for local use; and 3) to serve as a limited export (f. 544, d. 75: 1928b). The initial Five-Year Plan (1928-1932) integrated these aims by specifying timber production sufficient to supply the peninsula's growing needs, which were primarily concentrated in the burgeoning fishing industry (also under the leadership of the AKO) whose rapidly rising demand for wood drums and containers set the pace for timber production at that time (f. 106, o. 1, d. 15: 1930a; Shamshin 2005).[8] These plans (*Pyatiletki*) were the cornerstone of the Soviet command economy that accelerated economic development in the Soviet Union. The first two Five-Year Plans (1928-1932, 1933-1937), in particular, were focused on advancing heavy industry (e.g. coal, iron, steel production) (Wikipedia contributors). The Soviet state became fixated on fulfilling these plans that specified quotas for all aspects of production in state enterprises and organizations, such as output and labor productivity.

The initial recognition of Kamchatka's coniferous forests as a finite resource solely for local use faded as economic interests in these forests grew. The AKO produced unprecedented data through extensive forest inventories in 1932 that supported the notion of the forests in the central Kamchatka depression sustaining "as much logging as was necessary and possible" (Shamshin 2005). This area became a natural target for timber production (Turkov 1964). Besides containing the peninsula's only commercially-valuable timber stands, the valley also provided an extensive river network made up of the Kamchatka River and its many tributaries (including Kozyrevka, Bystraya, Tolbachik, Urtsa, Shchapina, and Bol'shaya and Malaya Nikolki).

[8]Note that all documents cited in this chapter come from the State Archive of the Kamchatka oblast' (Gosudarstvennyi Arkhiv Kamchatskoi Oblasti) abbreviated as GAKO. The following abbreviations will be used throughout this chapter: f = fond; o = opis; d = delo. More detailed information on each source is found in the bibliography at the end of this chapter.

Large volumes of timber could be transported along these waterways, which were vital given the absolute dearth of roads in the region (f. 541, o. 1, d. 155b).

The first shipment of 18,000 larch was sent to the port city of Ust'-Kamchatsk by way of the Kamchatka River in 1928 (the first year that the AKO reported logging figures) (Shamshin 2005). Considering that the initial AKO forest inventory projected that up to 400,000 trees could be cut in a year, this amount shipped was quite modest (f. 544, d. 75: 1928a). The original logging operations, however, required enormous inputs of human and animal labor (horses and sled dogs). Loggers worked in small teams using two-handed saws, selectively cutting the most valuable larch that they loaded on horse-drawn sleds (f. 541, o.1, d. 155c). At this time logging was concentrated in proximity to the Kamchatka River, specifically, on its right bank in vicinity of the newly-formed logging villages Lazo and Shchapino (f. 541, o.1, d.155c). (*For location of villages refer to Figure 2-2*).

Logging also took place further north along the Kamchatka River, close to the village of Kozyrevsk where the Kozyrevsky state logging enterprise (further referred to as the *lespromkhoz*) was located. Commencing its operations in 1930, this *lespromkhoz* was one of the first in Kamchatka. Its main function was to supply the timber mill in the village of Kluchi (north of Kozyrevsk) that produced materials for the fishing and ship-building industries. In addition, it provided other local enterprises, including the *sovkhoz* (or state collective farm), with construction materials and firewood (f. 88, o.1, d.213a). And, it fulfilled the heightened demand for lumber to build new government headquarters in Petropavlovsk-Kamchatsky (Kamchatka's capital), as well as to accommodate the influx of new settlers (f. 106, o. 1, d. 15: 1930a). In this first stage of logging, yearly timber production never exceeded more than 100,000 cubic meters, yet this amount was sufficient to end Kamchatka's dependence on wood imports from the Russian mainland, and from Sakhalin Island.

Second phase (1941-1954)

This phase signified a clear turn in production that climbed up to 180,000 cubic meters in 1941 to help meet increased timber needs during the war period. To ensure steadily increasing output, successive Five-Year Plans stipulated the gradual integration of more advanced logging equipment and timber-hauling methods (f. 541, o. 1, d. 155d). By 1954 two types of electric saws had replaced handsaws and axes. These new, faster technologies greatly accelerated timber production, which led to resource exhaustion on the right bank of the Kamchatka River.

Third phase (1955-1987)

By 1955 the volume of timber produced in central Kamchatka (474,000 cubic meters) was almost exactly double its 1950 level (236,000 cubic meters) (Shamshin 2005). This increase was attributed in part to the stress placed on meeting, and exceeding the Five-Year Plans. Workers that went beyond plan goals on a quarterly, yearly, and five year basis were awarded cash bonuses. The upshot was accelerated resource depletion resulting from quotas that were wholly incongruous with the ecological conditions of central Kamchatka. There also rampant waste: workers felled trees that were left to decay on the forest floor all for the sake of meeting arbitrary plans. This practice fueled local resource exhaustion that eventually led to a full-fledged conservation crisis. For instance, due to resource exhaustion on the right bank of the Kamchatka River, the two original *lespromkhozy* (*plural*) that operated in this region (*lespromkhoz* "Lazo" in the village of Lazo and "Kamchatsky" in the village of Shchapino) were merged and reorganized into a new *lespromkhoz* that retained the name "Kamchatsky." Despite warning signs of problems with forest replenishment, the outlook for forestry operations still remained optimistic: projections based on available inventory data confirmed a minimum 30 year supply of mature forest stands to supply existing and proposed *lespromkhozy* (f. 474, o. 1, d. 6).

The following years—1958-59 in particular—represented a fundamental turning point in the integration of new logging equipment into the *lespromkhoz* (Kamchatsky in particular) operations. These were the years of Khrushchev's overambitious Seven-Year Plan that was intended to push the former Soviet Union to surpassing the U.S. in industrial output among many spheres. Fearing Stalinist-like reprisal, workers earnestly strove to meet overzealous plans, which had disastrous consequences throughout the country. In the remote outpost of central Kamchatka horse and humanpower had been fully phased out of logging operations by the 1960s in favor of a more sophisticated fleet of new tractors, trucks, and other heavy-duty vehicles. The modernization of the forestry sector coincided with the relocation of the Kamchatsky *lespromkhoz* in 1961 to the left bank of the Kamchatka River. From its new base in the village of Atlasovo, this *lespromkhoz* was poised to cut into 150,000 ha of forest that spread out before it. (This area had already been earmarked for logging a decade earlier in response to the disappearing forests on the right bank of the river [f. 649, o. 1, d. 1: 1952].)

This combination of new technology and a new timber frontier to exploit against the backdrop of the Seven-Year Plan had a dramatic effect on the Kamchatsky *lespromkhoz* where traditional ways of logging were changed. Larger worker brigades replaced the former small teams of two to three men, contributing to a pronounced increase in labor productivity (from 25 to 30 percent) (Shamshin 2005). Accordingly, timber volumes also rose to record highs: from 352,000 cubic meters in 1953 to 495,000 cubic meters by 1959 (Shamshin 2005). This spike in production set a precedent for ever higher (and unsustainable) output in subsequent plans, which the *lespromkhozy* under *Kamchatles* (the regional timber production association) met and exceeded. In fact, *Kamchatles* increased its timber output by 35.5 percent over four years (from 372,000 cubic meters to 450,000 cubic meters) (f. 88, o. 4, d. 168:1970). This feat was possible in part by removing the checks on protected (or Group I) forests, making them available for logging (f. 88, o.1, d. 877: 1966). In 1970, 591,000 cubic meters of timber were produced; by 1978 timber production nearly peaked at 677,000 cubic meters (Shamshin 2005). The Kamchatsky *lespromkhoz* emerged as the leader in timber production in Kamchatka, receiving national recognition for its achievements.

A shift in timber production from local to global

Sizable shipments of round wood to Japan helped spur these rising timber outputs (Shamshin 2005). These exports stemmed from a cooperative agreement between the Soviet Union and Japan to jump-start the snail pace of modernization in the Soviet forestry sector. This agreement also served to distribute timber production more equally across the country, including into the RFE (Mathieson 1979). Until the 1950s, logging in the Soviet Union was primarily concentrated in the European part of the country, including the north, northwest, and central regions, and the Urals, which resulted in severe overexploitation of the forest resources in these regions (Mathieson 1979).

In 1968, the two countries signed their first joint agreement on forest development in Siberia and the RFE that stipulated improved access to the forests with the end goal of increasing timber production. This compensatory agreement granted the Japanese concessions to a twenty-year supply of round wood and timber products in return for substantial investment in the Soviet forestry sector, which involved paying for the relocation of timber operations eastward. The Japanese agreed to outfit these operations with timber processing plants, and with new, modern equipment (for instance, chain saws, cranes, and powerful tractor-trailers) critical to the efficient cutting and hauling of logs out of the forests. They also supplied the necessary machinery to build forest roads, which opened up previously inaccessible areas (Mathieson 1979). The ensuing intensification in timber production and processing in the RFE was palpable: for the first time the growth of output in this region exceeded that in the western part of the Soviet Union (Mathieson 1979).

This new equipment eventually reached Kamchatka in the mid-1970s and was readily assimilated by the *lespromkhoz* workers, as one retiree recalled: "They gave me a truck—a new *Komatsu* from Japan. There were three of us who worked from January to April with the new vehicles and we did not have any problems" (*comment from interview*). On a larger scale, the state was also satisfied with the acquisition of new technology from Japan that was vital in transforming the Soviet forest industry (Mathieson 1979). Despite its high initial investment, Japan also clearly profited from this agreement, securing a promise of 7.6 million cubic meters of lumber and 200,000 cubic meters of sawn timber by the end of 1974 (Mathieson 1979).

The long-term parity of this agreement, however, was questionable, particularly in terms of ecological costs that were masked by proximate benefits. In Kamchatka, for instance, the development of a road network and the expansive logging that followed decimated the forests. In retrospect, early warnings against large exports of Kamchatka's forests foresight proved prescient, yet they seemed to be recognized too late. Moreover, after the lure of the new equipment wore off, the people stood to gain very little from this agreement, save the receipt of token consumer goods from Japan (Shamshin 2005). (A second agreement between the Soviet Union and Japan signed in 1974 earmarked 50 million dollars of a 550 million dollar loan from Japan for local expenses and consumer goods for Russian workers [Mathieson 1979]).

Introduction of model

The following sections provide background on each component of the triangular model, which is critical to the examination of the interactions between these components that forms this chapter's core.

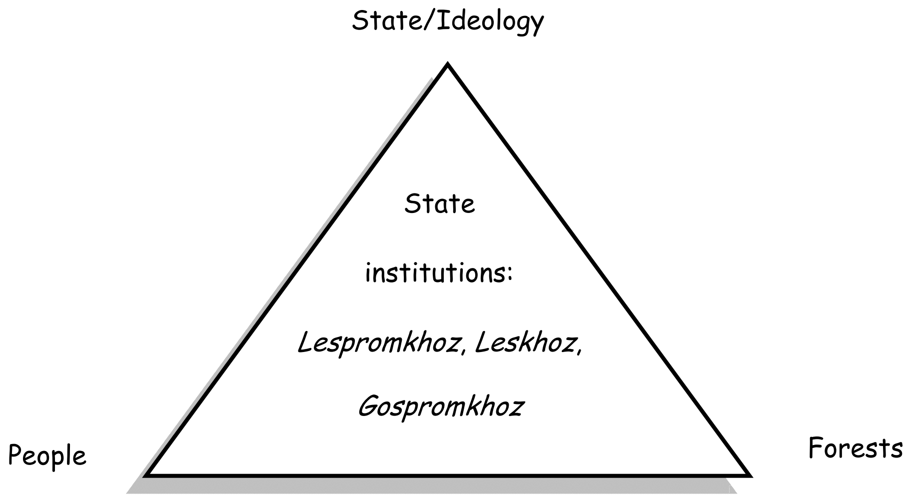

Figure 3-1: Simplified version of triangular model.

State

In this model the state represents the Communist Party of the Soviet Union (CPSU), specifically the *nomenklatura*, or the inner core of the elite groups associated with the party. Its position at the helm of the model symbolizes its place at the forefront of society. Like the head of a human body, the state orchestrated the whole people toward the ultimate endpoint of Communism (Casier 1999). In theory, it was supposed to act in the interest of the rest of the body, which, in turn, was to unite in upholding the party. This notion underpinned the Stalinist view of people as cogs in the enormous state machinery in which collective interests displaced those of the individual (Vorontsov 1992). This emphasis on the collective is clearly conveyed in the following address to workers at the Kamchatsky *lespromkhoz*:

> Comrades! Before our collective, before each honest laborer of the *lespromkhoz* is the task to apply maximum effort, to give your experience, knowledge and mastery to the business of heightening the quality and effectiveness of collective work (Doklad k 34-oi godovshchine Kamchatskovo *lespromkhoz*, 1985).

Soviet ideology rooted in the notion of Communism as the pinnacle of human existence was a cohesive force in this system, becoming a “central pillar of power” around which the state organized itself (Casier 1999). Thus, this ideology ultimately controlled the system, guiding such critical parts as the state’s Five-Year plans and its stance on resource production.

Ideology of nature transformation

Stemming from this fundamental ideology was the notion of reordering the natural world by any means necessary to meet growing economic needs. The Soviet ideologues I.I. Prezent and T.D. Lysenko popularized this idea by pitting unspoiled nature against human interests, giving rise to the Lysenko-Prezentist Ideology of Nature Transformation (Vorontsov 1992). This ideology prevailed during the Stalinist era and beyond, as conveyed pithily in the following slogan that became commonplace: "We must not wait for benefits from nature, our task is to wrest them from her!" ("*My ne dolzhny zhdat' milosti ot prirody, vzyat' ikh u nee—nasha zadacha*!") (Vorontsov 1992) This slogan was originally coined by the experimenter-gardener I.V. Michurin who died in 1936.

Three defining characteristics of the ideology of nature transformation and the concepts associated with it are significant in explaining the relationships in the model: 1) the reduction of complexity into an ordered view of the world, and the assurance of people's own place within the natural and social systems that make up this world; 2) the declaration of authority; and 3) the connection to a project of totalization (Baker 1992; Shils 1968, quoted in Baker 1992). This ideology proved powerful in rendering Kamchatka's intricate natural world as a simple entity that could be tamed and controlled through systematic natural resource exploitation. This pursuit exemplified the state's all-encompassing modernization project that necessitated the assertion of authority over both nature and people.

Within this broader ideology, the state employed the concept of rational resource use to promote economic development and advancement. This concept embodied the ideals of high output and labor productivity promoting the maximization of natural and human resources, and the minimization of inefficiency and waste. It became a catchall phrase in state discourse, as the following passage illustrates:

> The forests are one of the main natural riches in Kamchatka, occupying a considerable part of the peninsula. Each year their role in the development of the region's economy grows…Appearing at the November plenary of the Central Committee of the Communist Party, N.S. Khrushchev noted that the forests are a national treasure that needs to be protected and used rationally in every possible way (f. 147, o. 1, d. 63: 1963a).

In the state's eyes the fulfillment—and surpassing—of prescribed plans served as a benchmark for the achievement of rational resource use, although plans were often met in a way contrary to such use. In theory, rational resource use struck the perfect balance between exploitation and regeneration, ensuring the seamless continuation of resource production and economic growth. The country's vast natural wealth further reinforced this notion of resource inexhaustibility.   In reality, however, uninterrupted production proved wholly improbable, especially on Kamchatka where coniferous forest resources were limited and where regeneration was greatly prolonged due to the harsh northern climate and environmental specificities.

People

In an effort to overcome the labor shortages that hindered the initial development of Kamchatka's forestry and other economic sectors (e.g. agriculture and fishing), the Kamchatka Joint-Stock Company summoned workers from central European Russia (and to a lesser extent, from Siberia and the Russian Far East). The company was given ambitious orders: it had to bring no less than 70,000 people to Kamchatka in 1929-30. And, by the end of the first Five-Year Plan (1932) it was charged with the task of raising the overall population to 140,000 (f. 106, d. 485:1950-55). This influx of settlers typically had little work experience in the forestry sector, nonetheless they put forth a heroic effort in logging operations that required physically excruciating work in extreme climatic conditions (f. 541, o.1, d. 155c; f. 106, o.1, d. 15: 1930b; Shamshin 2005). Moreover, they faced extraordinary difficulties at first in securing essential provisions, such as food, clothing, and household goods (Shamshin 2005). The difficult life of these early settlers is conveyed in the following excerpt from a speech in honor of the Veterans of Labor (*Veterany truda*) at the Kamchatsky *lespromkhoz:* "You were the first to come to the Kamchatka outback. You had to lay the roads and build the bridges to develop the forest riches of Kamchatka with the help of the ax and barge." (*Memorial address to the Veterans of Labor in the Kamchatsky lespromkhoz—pamyatnyi adres Veteranu truda Kamchatskovo lespromkhoza*, 1980.)

Even after the initial wave of settlers to Kamchatka, the population remained extremely low, posing a chronic problem in developing the peninsula's industries, all of which experienced severe worker shortages (f. 67, d. 38). (Kamchatka had one of the lowest population densities of all the territories in the RFE.) These worker deficits prompted additional campaigns by national ministries to recruit people from the central part of the Soviet Union to work in the forestry sector. Stories of resettlement in central Kamchatka are ubiquitous, highlighting the region's relatively recent pioneer past. Of the thousands who risked venturing to Kamchatka, each has a unique rendition of how and why they came. One pensioner remembered with striking clarity the epic journey that she made as a ten-year old in May 1947 when she and her mother left for Vladivostok by train. After waiting nearly a month for a ship to Petropavlovsk-Kamchatsky (Kamchatka's capital city), they still had to make the arduous journey along Kamchatka's west coast to reach the northern settlement of Palana where her father had already been stationed for seven years. They finally arrived at their destination in a canoe-like boat built by the Koryak people.

Still, there is a common thread running through these stories. The promise of salaries that far exceeded those on mainland Russia beckoned many people here. To illustrate, a former schoolteacher compared her salary of 500 rubles a month to the 100 rubles she would have received elsewhere in Russia. This substantial pay difference broadened people's horizons, allowing them to pursue what otherwise would have been out of reach. Many planned on a temporary stint in Kamchatka (from three to five years) that would enable them to shore up sufficient wealth to buy an apartment or secure a comfortable retirement upon their return from Kamchatka. In addition to high salaries, generous governmental subsidies facilitated a level of relative plenty in Kamchatka, even in the remote forest villages. One woman from the Urals recalled her astonishment upon arriving in one of these villages: "You would go to a shop and there was a lot of everything. We never saw such so much in mainland Russia, at least not in our village." Also, the powerful *lespromkhozy* were able to invest heavily in village infrastructure. For instance, the Kamchatsky *lespromkhoz* underwrote the construction of a brand new school, new housing units, and a banya in the village (Atlasovo) where it operated. One Atlasovo resident reminisced about village life during this period of peak timber production: "The homes were equipped with big kitchens and hot water. There once was everything here: a dining hall, gym, club...There was everything. People were social; they went to the club and bonded."

Besides these tangible benefits, it was considered prestigious to live and work in Kamchatka, especially for teachers and doctors. Following graduation, these young specialists had to complete three years of service. The state sent them where it deemed necessary, reserving the most promising candidates for Kamchatka. Still others were drawn to Kamchatka by the call of adventure and discovery. For instance, one family was sold on coming when a relative sent them pictures of salmon that were nearly as tall as the people holding them. An aspiring young teacher came to Kamchatka from the Moscow region on her own because she wanted to experience Kamchatka's romanticism.

Besides directing some of its most qualified and well-educated young people to Kamchatka, the state also relocated prisoners to the peninsula to provide critical labor for forest exploitation, either directly or indirectly (see Pallot 2002). For instance, the prisoners were instrumental in constructing the infrastructure of logging villages, and performing other vital tasks, including building forest roads, baking bread, and doing routine maintenance (*comment from interview*). This support work allowed the state to channel the maximum number of new settlers immediately into logging operations.

Forests

An early explorer in Kamchatka, the geologist A. Erman in 1829 first recognized the coniferous forests clustered in the watershed of the Kamchatka River as a unique island. Despite its relatively small size, this island of forests has played a crucial ecological role in regulating central Kamchatka's microclimate, and in enriching and protecting its fragile soils. Its most important function, however, has been maintaining river conditions to support the prolific salmon runs that come to this region to spawn (f. 722, o. 2, d. 19). The strong interdependence between the forests and fish is visible in their biological rhythms: a change in one elicits a sharp change in the other (Kirpishchikov 1986b).

Pre-industrial forests

The coniferous forests that once formed a contiguous cover over the central Kamchatka River valley, and mountains adjoining it, primarily consisted of larch, and to a lesser extent, spruce, and mixed larch-spruce stands. Larch in the forest overstory could reach up to 33 m in height and 1 m in diameter, towering over understory species, including birch, spruce, and aspen. These species are common to the northern boreal forests (or taiga). On Kamchatka, however, they have undergone morphological differentiation, creating some confusion over whether to classify species like larch as a separate species or subspecies (Turkov 1964). These differences are attributed to Kamchatka's geographical isolation and to abrupt climatic changes at the end of the last Ice Age when these species began to colonize central Kamchatka.

Post-industrial forests

From the onset of large-scale logging larch was the targeted species with an initial supply estimated at 143 million cubic meters (f. 474, o. 1, d. 74: 1959). Spruce was also recognized as producing valuable timber, although its initial supply (approximately 35 million cubic meters), was considerably less than that of larch; thus, it was not as sought after by logging enterprises. Regeneration time for both larch- and spruce-dominated forests is protracted on Kamchatka, due in part to the specificity of the volcanic soil (Zhilin 1985). Consequently, the once-contiguous island of conifer growth has become a highly fragmented patchwork forest dominated by deciduous species (primarily birch). Lone thin trees still stand amidst heaps of logging refuge, telling of the former logging practices that took only the most robust trees.

State institutions

In the Soviet system the use and management of forest resources was highly stratified within specialized institutions and organizations that followed multiple chains of command (Eikeland et al. 2004). This section contains an overview of the institutions that were critical to the development of the forestry sector: the *lespromkhoz*, or state logging enterprise oversaw the extraction and basic processing of timber; the *leskhoz* managed the forests, undertaking protection and regeneration measures. The *gospromkhoz*, an organization that managed non-timber production (e.g., fish, game animals, forest fruits, mushrooms, and medicinal herbs) was established well after the forestry institutions, yet it, too, played an important role in forest use.

Lespromkhoz and leskhoz

The *lespromkhoz* and the *leskhoz* formed the locus of timber production in central Kamchatka. Outside of their main tasks in the forests, both institutions were also responsible for ensuring the overall welfare of the logging villages (Eikeland et al. 2004). The higher-profile *lespromkhoz*, however, assumed the lion's share of the work in constructing logging villages, and maintaining the infrastructure within them, including schools, daycares, clinics, stores, clubs, theaters, power plants, boilers, and streets (Shamshin 2005). The Kozyrevsky *lespromkhoz* administered worker living quarters, a public banya, laundromat, disinfection plant, cobbler, and a hotel in the village of Kozyrevsk (f. 88, o. 1, d.213b).

The work and responsibilities of the *lespromkhoz* and *leskhoz* were tightly interwoven, and in some cases became nearly inseparable. In central Kamchatka, for instance, the first *leskhoz* (Sredne [middle]-Kamchatsky, established in 1952) was officially part of the Kamchatsky *lespromkhoz*'s forestry department from 1961 to 1965. Even following the *leskhoz*'s reorganization as a separate entity, it continued to operate within the *lespromkhoz*, and even the employees were the same (f. 649, o.1, d. 33: 1965a). This close union between the two institutions was a trademark of the Soviet command economy where the exploitation and management of resources were practically indistinguishable because the enforcers and enforced were essentially one and the same (Welsh 1997, quoted in Turnock 2001). For instance, besides protecting forests, the *leskhoz* also participated in industrial logging, selling timber to the *lespromkhoz* to cover internal operations; the *leskhoz* then used this income to equip its sawmill so that it could meet production quotas (Eikeland et al. 2004).

On one level, both the *lespromkhoz* and *leskhoz* were created with a similar aim: to facilitate the broader national agenda of forestry expansion and increased timber production, particularly in more remote areas of the Soviet Union (Eikeland et al. 2004). Nonetheless, there were important distinctions between them. The *lespromkhoz* was founded exclusively to extract timber, including through the initial indiscriminate practice of “forest mining,” in which the only checks on production were available transport and labor capacity (Eikeland and Riabova 2002). In contrast, the establishment of the *leskhoz* immediately after World War II reflected the state’s growing recognition of biological and ecological concerns in natural resource use (Eikeland et al. 2004). Despite being subordinate to the *lespromkhoz,* the *leskhoz* brought a new dimension to forest use at the local level where it was supposed to keep the *lespromkhoz* in check by enforcing “the correctness and rationality of logging” (Sytnikov 1987; Eikeland et al. 2004).

Toward this end, the *leskhoz* was ordered to designate appropriate logging sites based on the detailed forest inventories and surveys it in theory conducted (Kupriyanov 1986; f. 474, o. 1, d. 74: 1959). Also, it had to enforce new logging methods mandated by the state (f. 474, o. 1, d.74: 1959). Other functions of the *leskhoz* included: protection of forests from fires, insect infestations, and other damage (primarily anthropogenic); fighting forest fires; undertaking intensive regeneration methods (including seeding and planting, and the designation of areas for this work); and conducting extensive sanitary cuts to ensure healthy forest stands, and to produce its own timber for processing into lumber (Kirpishchikov 1986b; Shamshin 2005; f. 474, o. 1, d. 74: 1959). It was also responsible for undertaking forestry research, devising a plan of socialist development for its collective, and organizing teachings on Communist labor (f. 649, o. 1, d. 167: 1974). Finally, it had to do public outreach on conservation and regeneration efforts, and establish a code of conduct in the forests for fire prevention (Kupriyanov 1986).

Gospromkhoz

Less prominent than the *leskhoz* or *lespromkhoz*, the *gospromkhoz* was still significant in shaping forest-use patterns in the villages of central Kamchatka. The first *gospromkhoz* (Ust' Kamchatsky) in central Kamchatka was established in 1963, followed by a second (Mil'kovsky) in 1967. Each was comprised of three branches (a headquarters and two satellites) that were established in villages in the *gospromkhoz*'s respective district. Initially, the *gospromkhoz*'s primary aim was fur production (f. 818, o. 1, d. 4:1966). Later, its activities included the harvesting and processing of fish, wild game, and non-timber forest products (mainly forest berries and mushrooms).

The non-timber forest product species that especially flourished in central Kamchatka's changing forest landscape were honeyberry,[9] bog blueberry, and lingonberry. They were interspersed with other species that also had potential for commercial harvesting, including: mountain ash berry (*Sorbus sambucifolia*), cranberry (*Oxycoccus palustris*), red current, grayleaf red raspberry (*Rubus idaeus subsp. melanolasius*), Arctic raspberry, and cloudberry (*Rubus chamaemorus*). Several edible mushroom species also proliferated in this region owing to the favorable climatic conditions for their growth, and to the new niches opened up by fires and logging. The *gospromkhoz* processed mushrooms by drying, salting, or marinating them, although drying was the method of choice, especially during abundant harvest years, since this method could accommodate increased gathering and processing (f.705, o.1, d.141: 1985). The *gospromkhoz* distributed its production (including the jams it processed from berries) to orphanages, preschools, boarding schools, and military bases throughout Kamchatka (*comment from interview with the former director of the gospromkhoz unit in the village of Atlasovo*). This production was also exported to Japan.

The *gospromkhoz* gradually expanded its repertoire to include other forest products, such as pine nuts, fern fronds (*Pteridium aquilinum*), wild garlic (*Allium ochotense*), and birch sap. Moreover, it began to collect and process medicinal plants (and plant parts) following an official directive ordered by the central *gospromkhoz* administration on the "measures to improve work on the collecting, processing, and distribution of medicinal plants to medical enterprises in 1979" (f. 705, o.1, d. 97: 1979). In accordance with this new direction, the Ust'-Kamchatsky *gospromkhoz* was obligated to supply regional pharmacies with 200 kg of dried rose

[9] Refer to Table 2-1 for the Latin names of species not listed in the text.

hips (f. 818, o. 1, d. 48: 1978e). The Mil'kovsky *gospromkhoz* was ordered to produce 1000 kg of marsh cudweed (*Gnaphalium uliginosum*), and 50 kg of lingonberry leaves. Yet despite this initial momentum, and the potential for commercial harvests of these and many other species, medicinal plants comprised just a fraction of the *gospromkhoz*'s combined non-timber forest product harvests and eventually faded from the Five-Year Plans.

Part II

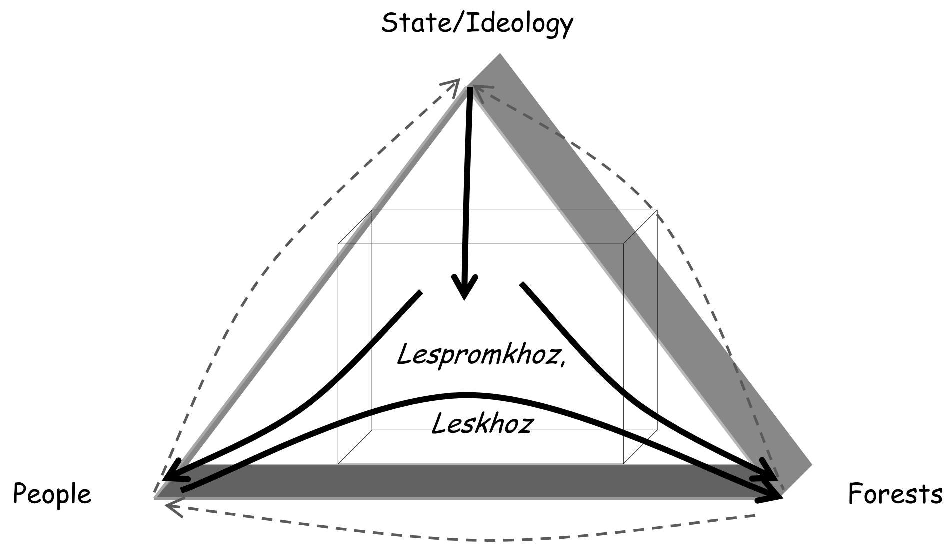

Figure 3-2: Dynamic triangular model (dashed lines represent feedback loops).

Introduction

In Part II, I use the model to explore the dynamics between its key elements—state, people, forests, and forestry institutions (*Refer to Figure 3-2.*) I begin by looking at the state and the development agenda it executed through the forestry institutions (*lespromkhoz* and *leskhoz*). Within this framework, I examine people's role in this agenda, and the extent to which they eventually shaped the state, just as they were formed by it. Lastly, I consider the outcomes of the state-people-forest relationships as they were manifested in the physical landscape, and what these outcomes signified for the state and people. The model provides a relevant starting point for dissecting the complexity of these relationships that are highly interconnected and fluid. The inherent tension within them is evident in archival material, and it is vividly expressed in people's lived experiences. Thus, in this part I often rely on personal accounts,[10] and make extensive use of the memoir by my colleague in Kamchatka, Vladimir Alekseevich Shamshin.

In *The Forests of Kamchatka: Past and Future (Facts, Reflections, and Letters of Scientists)*, V.A. Shamshin (2005) gives a fascinating and insightful account of Kamchatka's forestry sector as observed through his lifetime of work, first as a forester in the *leskhoz* and in the Forest Service administration, and later as an ecologist. Halfway through his career he felt compelled to pursue the path of science, recognizing that it was impossible to work creatively and inquisitively within the tight bounds of state forestry organizations, as he elaborated in his memoir:

> To work in the state Forest Service according to the dogma of departmental instructions is simple and comfortable, but boring and uninteresting. Those specialists who are capable of thinking already know that the demands specified by the instructions do not correspond to the nature [ecology] of the local forests, or they contradict sensible thought. No one is allowed to change the conditions of these instructions willfully… Working in production [the forest industry], I saw narrow-mindedness and the foolish conditions of the instructions, and transferring to a scientific institution I began to address problematic issues scientifically.

V.A. Shamshin walked a fine line as a forester who was obligated to produce forest data following rigid instructions that were unsuited to local forests, and as one who could see the inanity of the state bureaucracy. His perspicacious first-hand perspective on the evolution of Kamchatka's forestry sector has proven invaluable in piecing primary sources together in a coherent manner. Moreover, it has verified several of the trends I have been able to identify in these sources.

Shamshin's dual roles as a forester and researcher gave him a unique view of the logging footprint that steadily expanded throughout central Kamchatka in the twentieth century. He witnessed the advent of new logging technologies and equipment that transformed the forested landscape before his eyes, reducing the unbroken expanse of 'Conifer Island' to an archipelago of small forest islands. As seen through the lens of historical ecology, this highly fragmented landscape is the product of the interactions between the state and the people, and how the tensions and conflicts inherent within these interactions were or were not resolved (see Crumley 1994). Operating solidly on its ideology, the state did not adequately foresee, or react

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[10]These personal accounts are from the formal surveys I conducted, and from conversations and observations I recorded during fieldwork in central Kamchatka in 2004, 2006, and 2008.

to, this tension, which gave rise to unintended outcomes in the state-people-forests relationships. I look at these intricate relationships in a series of four movements to understand them—and their interconnectedness—better.

First Movement: The state and its ideology of nature transformation

In the state's quest to transform nature to its own end, the forests became a veritable factory of timber production, reduced to a non-living entity whose value was derived in discrete measurements (e.g. number of "industrial trunks" in a specified forest). Unlike an actual factory, however, central Kamchatka's coniferous forests contained a limited supply of timber and could not maintain uninterrupted production. To overcome this ecological constraint, the state promoted increased forest regeneration (particularly of the most valuable species), which would theoretically close the loop of resource exploitation in a cycle that could continue indefinitely (f. 147, o. 1. d. 63: 1963b).

The myth of inexhaustibility

By aligning ecological laws to its own ideology, the state created the myth of inexhaustibility. This distortion of the natural world to fit the state's utopian vision is evident in the passage below that articulates this myth:

> An unbroken conveyer of life would be realized: saplings, middle-aged, maturing, and mature stands would grow on the logged plots. While the mature stands were being logged, the maturing ones would become suitable [for logging], and as the plot was freed the young growth would already be rustling... (Sytnikov 1987)

The state used science to validate and disseminate its myth. In 1961 it established the Forestry Experimental Station in the village of Kozyrevsk as a branch of the Far Eastern Forestry Institute. The aim of this station was to generate locally specific information on the forests. Region-specific research was further expanded in 1973 when the Kozyrevsky *leskhoz* was reorganized to include an experimental component (f. 88, o.4, d. 168: 1970a). Yet, the station's recommendations seemed to defy Kamchatka's extraordinary landscape. For instance, despite evidence of protracted forest regeneration time (if extreme environmental conditions did not preclude it altogether), researchers at this station nonetheless concluded that following the first round of logging (in which the most valuable trees had been cut), the remaining trees would continue to grow until they, too, were ready for harvest (Kupriyanov 1986, Shamshin 2005).

Belief in the myth of inexhaustibility perpetuated destructive logging methods that ultimately undermined the entire resource base. The most prevalent of these methods in central Kamchatka was conditional clear-cutting. It involved logging the economically valuable larch (i.e. those trees that were mature and healthy); all other deciduous species (birch and aspen) and lesser quality coniferous species (spruce and diseased larch, which were more appropriate for firewood), were left standing (f. 88, o. 1, d. 607: 1961; f. 88, o.4, d. 168: 1970a). These remaining trees made up about one-third of the logged forest. Shamshin (2005) described this method as a masterpiece of bureaucratic casuistry that was employed in Siberia and the Russian Far East where there was a dearth of infrastructure to process lower-quality timber, including that used as firewood.

Conditional clear-cutting was particularly appealing in central Kamchatka where there was a very limited market for firewood, especially at the onset of logging (f. 541, o. 1, d. 155b). Synonymous with extensive development (f. 649, o. 1, d. 1: 1952), this method was likened to skimming the cream off of the forest: in the aftermath of such logging, thousands of cubic meters of timber were left behind. For example, in 1960 a total of 28,600 cubic meters of residual timber was reported left in logging plots, plus 7,930 cubic meters of high-quality timber that was never removed from the plots (f. 88, o. 1, d. 607: 1961; f. 147, o. 1, d. 60: 1962). Besides rampant waste, conditional clear-cutting resulted in large-scale ecosystem destruction over a relatively time short period, with the most accessible forested areas in proximity to rivers sustaining the greatest damage (f. 474, o. 1, d. 6: 1957). In these areas almost half of the trees that remained succumbed to drier conditions and windthrow (f. 649, o.1, d.64: 1966).

The advancement of logging technology further exacerbated the harmful effects of conditional clear-cutting. Heavy equipment destroyed much of the forest undergrowth that was not cut; it also precipitated abrupt changes in microclimate to which the remaining undergrowth could not adapt (Shamshin 2005). Moreover, the regeneration of such areas by coniferous species was very weak due to the rare occurrence of seed harvests, and widespread pest infestation of cones and seeds (f. 649, o.1, d. 86: 1966). Thus, the probability of natural forest regeneration, whereby the forest undergrowth would reach harvestable levels was slim to none, at least on a human time-scale.

The myth of abundance

Conditional clear-cutting was nonetheless integral to the economy of high production based on extensive development. This model of growth was one in which the resource frontier was continually exploited; it necessitated great expanses of land so that that population increase would not outpace the resource supply (Gatrell 1999). As this practice continued, the state had to prove that the raw material supply at its disposal was abundant (Shamshin 2005). To this end, according Shamshin (2005), the state invested much effort to confirm the belief that Kamchatka had sufficient forest resources to last a century. It again turned to science, employing forestry specialists to produce data that supported current and prospective demands of industrial logging (f. 722, o.2, d. 32: 1984). These specialists continued a well-established tradition of skewing science in favor of industrial forestry by devising groundless methods to justify an increased allotment of logging sites. For instance, Shamshin (2005) described how they came up with a formula that added an additional thirty to forty years to the age of forest stands, which indicated that they were mature (or "overmature") and therefore, ready to be cut.

Another deceptive device was instituted at the federal level in 1964 when state scientists and forest bureaucrats authored the national forest inventory protocol. This protocol mandated the classification of logged (or burned) areas with minimal forest cover (20 to 30 percent) as forested land (*lesistost'*), which was an important indicator of ecological well-being and the supply of local forest resources on a given territory (Shamshin 2005). The upshot was that disturbed areas were counted as forested even though they did not support viable forests (f. 649, o.1, d. 86: 1966). Also, logged areas covered with timber debris were considered part of the forest reserves, which furthered the illusion of forested land, and implied the occurrence of sound logging practices that did not need to be monitored.

In this way, the official percentage of forested land in Kamchatka remained high and stable from the first forest inventory onward (Shamshin 2005). It was the best of both worlds: the *lespromkhoz* logged thousands of hectares, and the state proved the continued abundance of its resource base (f. 649, o. 1, d. 173: 1973). The pervasive misclassification of forest types created an imaginary landscape that could sustain intensive timber production, as Shamshin (2005) described:

> The collective labor of scientists and practitioners [foresters] unnoticeably turned a mirrored reflection into an illusion: data from full-scale inventories were watered down, allowing [the scientists and foresters] to hand out that what was wished for in reality.

This illusion was striking: it was later found that these forest inventory methods overestimated remaining forest reserves in central Kamchatka by 30 to 40 percent (f. 722, o.2, d. 32: 1984). Accordingly, logging proceeded at approximately 30 percent above what should have been the established limit (Shamshin 1986).

This accelerated pace of logging quickly consumed the forest reserves in central Kamchatka, necessitating the adoption of new forestry practices. In 1972 the state finally outlawed conditional clear-cutting in favor of clear-cutting, or the complete clearing of a logging plot. The state viewed the latter as the only viable alternative to remedy the staggering waste in the forests, thereby ensuring “more rational use of the forest riches” (f. 147, o. 1, d. 60: 1962; f. 147, o. 1, d. 63: 1963a). There were other purported benefits to clear-cutting, including the maximization of increases in labor output and timber productivity (Shamshin 2005). Furthermore, clear-cutting had the potential to accelerate the completion of building projects, such as local plants and departments (i.e. within the *lespromkhozy* and other existing plants), specialized to process less-valuable coniferous and all deciduous species into firewood(f. 147, o. 1, d. 60: 1962; f. 147, o. 1, d. 63: 1963a). Yet, a demand for such production had to be created, which proved highly difficult (f. 147, o. 1, d.63: 1963b).

This shift in logging practices did not signal a change in the prevailing paradigm of forest use in which the best timber cut was regardless of ecological repercussions (Shamshin 2005). In fact, the state’s agenda continued to emphasize the task of supporting the uninterrupted, inexhaustible use of forests in Kamchatka (f. 722, o.2, d. 32). The state seemed unable or unwilling to let go of the myths it had spun, often in the name of science; thus, it insulated itself from the ecological truths of resource exhaustion, which jeopardized the basis of the forestry sector. This situation revealed a fundamental contradiction in the state’s ideology of nature transformation that concurrently espoused continuity and change (see Mitchell and Arrington 2000, Baker 1992). Just as the state could not develop the economy while simultaneously keeping the people as a homogenous whole (i.e. by preventing the rise of an educated class or “*intelligentsia*”), so too, it could not ceaselessly use natural resources and preserve the integrity of whole ecosystems. In the end, the state’s ideology became the “logical exposition of an idea” that was not aligned to reality (Casier 1999). It thus acquired a mythical quality that left the state baseless, as Casier (1999) explained:

> The Communist party has thus ascribed itself a central place in a self-made story, which is disconnected from the reality of experience. Take away the story and there is no ground left to legitimize the party's privileged role. In other words, its rule depends on the respect that people show for the myth.

Thus, to maintain its authority, the state had to convince the people to believe in its myths, which it accomplished through a combination of forced dependence on state institutions and propaganda distributed through these institutions, as discussed in the next movement.

Second Movement: The state and its relationship to people and forests

As the state expanded into Kamchatka, it undermined the forest's traditional role as nurturer and provider, and asserted itself as primary caretaker of the people. Consequently, people's lives in central Kamchatka were intrinsically tied to the state. Through the forestry institutions the state provided people with livelihoods and essential material infrastructure. In return, people were expected to acquiesce to state orders based on the ideology of nature transformation. The state's manipulation of the people through its institutions responsible for forest exploitation indicated the hegemony it sought through total conquest of the human and physical environment (see Baker 1992). In the transient culture of timber production in central Kamchatka, the people and forests seemed almost interchangeable:

> ...Everything is drawn out in dismal succession: they built a logging village (living quarters, power plant, boiler, school, preschool, club, dining hall, stores, garage), then cut down the surrounding forests—and abandoned the village, and went on to build anew, and to cut down a new forest. (Sytnikov 1987)

The state exhausted both people and forests, treating each as if they were at once disposable and limitless. Just as another swath of virgin forest could be cut, so could another settlement be erected, only to be abandoned with untold consequences for those who remained. In fact, the state never intended for the settlements to be permanent. Rather, they were envisioned as waypoints in the timber production process that could accommodate seasonal workers and become a temporary dwelling for full-time workers (f. 541, o. 1, d. 155b). They existed for as long as the local resource base remained viable. These settlements symbolized the subordinate position of both the forests and the people to the state's vision of nonstop production that necessitated both an endless resource base and workforce.

This story coincides with others on different continents, such as in the Brazilian Amazon, where people have cut forests for agriculture, logging, and infrastructure development. These people became the agents of large-scale landscape transformation that the Brazilian state had conceived and initiated toward its own end. The outcome of state-people-forest interactions in this region has been a large loss of forest cover over a relatively short period of time (Moran 2006). Similarly, the highly fragmented forest cover in central Kamchatka is a phenomenon of the relationship between the state, people, and forests. The people in this region also became, consciously or not, agents in forest transformation.

The culture of work and timber production

As agents of change, the people occupied a pivotal position in the state's agenda of production (and overproduction). The state institutionalized control over people, and the forests, by emphasizing the growth of labor productivity and of timber output in its Five-Year Plans, which were the blueprint for the *lespromkhoz* and *leskhoz*. The state maintained its leverage, especially at the onset, by engendering a culture of work where labor was valued not just for its own sake, but for the deeper sense of purpose it instilled within people. Namely, this purpose was to attain a bright collective future, especially for the next generation (Shamshin 2005). Ubiquitous propaganda in the forestry institutions promoted this higher calling: "We'll be all the better" ("*Chem luchshe budem"*). Or, consider the following call to action in a diploma honoring workers, entitled "*We are going toward the victory of Communist labor"* ("*My priidem k pobede kommunisticheskovo truda,*"1980):

> Work in such a way that all who look at you and at the work of your hands could say: "This is a working person!" Bravely and happily step into an independent life. Always be certain of our Socialist homeland, of the Communist Party. The collective and the country need your work.

There was also a wave of clever propaganda that hailed the industrialization of new lands and alluded to the vastness of the country's natural resource base (Vorontsov 1992). For example: "Kamchatsky lespromkhoz in the Five-Year Plans—they beat time" ("*Kamchatsky lespromkhoz v pyatiletke—oni operezhayut vremya*"). At least initially, such propaganda was influential, contributing to a palpable energy as the culture of timber production—and work—took hold in this remote outpost, as the following recollection of a long-time villager demonstrates:

> Our village [Atlasovo] once was brimming with activity: every morning large *Kamazy* (trucks) shook the village alive as they rumbled along the roads leading to the Kamchatsky *lespromkhoz*. Many workers had been up long before 7 a.m. to rev the large engines and to get the trucks going for the day. The streets were full of people on their way to work in various organizations, primarily the *lespromkhoz*, that ran full force during those days. People worked hard and earned money.

Many of these people embraced the culture of work and took their jobs very seriously, valuing hard labor as a means to live well. In this culture, work abounded due to steadily rising timber outputs. This high volume prompted by the mechanization of forestry dictated a breakneck pace at the *lespromkhoz* that ran three eight-hour shifts per day, seven days a week during peak timber production. Many vied for employment in the *lespromkhoz* that compensated its workers with high salaries, free trips to sanatoria, and ample vacation time (up to six months in some cases) for travel throughout the former Soviet Union. For instance, one former *lespromkhoz* worker recalled his difficulties in getting hired upon arrival in central Kamchatka in 1972. When he was finally taken on board as a driver, he put in twelve-hour workdays from October until April (mid or end, depending on the year), spending the weekends to repair the vehicles for the week ahead. Logging was undertaken during the winter months to avoid the washed out, impassable roads and swarms of mosquitoes that foiled productive work during the summer months; the most intensive period of work was from November to March (f. 541, o. 1, d. 155d).

Other employees appeared no less motivated. The collective at the Kozyrevsky *lespromkhoz*, for example, "sought out all reserves to accelerate the delivery of timber from the taiga," despite especially inclement weather (Suprunets 1986). Such assiduous efforts did not go unnoticed: the state paid special attention to high-achieving workers through bonuses and distinctions, such as Certificates of Merit (*Pochetnaya Gramota*) (f. 507, o.3, d.360: 1967). It also recognized "veterans of production" (*veterany proizvodstva*) who served in the *lespromkhoz* for more than 30 years with official rhetoric:

> The absolute majority [of the veterans of production] relate to their labor as their first social duty, honestly and conscientiously fulfilling their obligations. From year to year and from Five-Year Plan to Five-Year Plan, they exemplify heroic labor, strictly observe established order in production, do not allow breaches in the work regime, and train the young workers. (Excerpt from a speech given in honor of the 34-year anniversary of the Kamchatsky *lespromkhoz [Doklad k 34-oi godovshchine Kamchatskovo lespromkhoz], 1985*)

Willing collaborators

To raise and maintain worker morale the state staged socialist competitions (*sotsial'nye sovrenovaniya*). Intended to make life more interesting (see the diploma: "*We are going toward the victory of Communist labor,*"1980), these competitions typically occurred among the separate *lespromkhoz* and *leskhoz* branches (and sub-branches, such as the *lesnichestvo* within the *leskhoz*). Besides contests between collectives, there were also ones between individual workers in these collectives. These individual competitions were reminiscent of the Stakhanovite movement that began during the second Five-Year Plan in 1935 to urge workers to go beyond the quotas set for them. In all competitions, workers were urged to be active participants, motivated by the promise of quickly mastering skills for their work (see the diploma: "*We are going toward the victory of Communist labor,*"1980). The collectives and individuals that invested the greatest effort were acknowledged in the workplace where the competition results were prominently displayed, and they received material prizes (e.g. money, or goods and services in deficit) from the state. Besides mitigating boredom among the workers, these emulations served the state's ultimate ends of increased worker productivity and output.

On a deeper level, they served to steep the state ideology, including its myth of resource inexhaustibility and abundance, within the workers who were essential to the state in maintaining these myths. In the daily life of the forestry institutions, the people became willing collaborators in propagating the state's beliefs. In the *leskhoz*, for instance, foresters learned how to manipulate key indicators of overall forest condition (i.e. percentage of forested land) so that there was no evidence of decline from year to year, even though such a trend was obvious. An honest assessment of the forest condition was grounds for trouble that forest managers tried to avoid. In fact, being honest was akin to self-sabotage, and it could eliminate awards granted to the entire collective (Shamshin 2005). Thus, workers colluded to propagate the myth of resource abundance and inexhaustibility. Forest managers seemed to lose a sense of the forest as a living resource in need of protection and, serving the state, came to see it as the means of production, professing that, "as much as is needed [*referring to areas for logging*], is what it will be" ("*Skol'ko nado, stol'ko i budet*) (Shamshin 2005).

Inculcated in state ideology, the people acquired a sense of authority and power over the natural world that alienated them from the forests, and from the destruction that they had catalyzed within them, as the following description of forestry workers suggested:

> Someone once wittily described loggers as those who skim off the cream. It's mean, but true. They enter into forest stands with their powerful equipment, taking the best, and then they leave. They settled into the next plot, skimmed off the cream, cast off what they didn't need, and went on further…And so it was already many years—downcast, monotonous, and primitive. (Sytnikov 1987)

This divide between people and forests continued to widen as logging technologies became more sophisticated. People clearly became dominant over the forests, as one logger noted:

"Here we are on powerful Japanese forestry equipment going 60 km out from [the village of] Kozyrevsk where logging is underway. We are going still deeper into the taiga" (Kirpishchikov 1986a). Beneath its matter-of-factness, this simple description encapsulates the state's ideology of nature transformation, implying no limits in the conquest of the natural world. The state was able to overcome ecological constraints by asserting its power and control over the people who physically transformed the forests. Although the state-people-forest relationships initially appeared to be strictly hierarchal, a closer look at the dynamic model reveals a much greater degree of complexity in these relationships, as will be discussed in the following movements.

Third Movement: People's influence on the state

Undoubtedly, the state held great sway over nearly all aspects of people's lives, yet its ideology, and the orders, protocols, and policies that stemmed from it, were far from foolproof. Through their decisions and actions (or lack thereof), people came to shape the forestry institutions in which they worked. Such an unintended outcome forced the state to respond with new directives in an attempt to realign a wayward situation with the initial ideological vision.

Reconfiguration of state forestry institutions

According to institutional theory, local institutions both modify and discard centralized rules, and improvise their own (Gibson et al. 2000). This theory, therefore, is not solely top down: it recognizes that people are capable of influencing institutions. Within the context of this theory the state's ideological basis could be viewed as ultimately at the mercy of the forestry institutions, and those who worked within them (see Mitchell and Arrington 2000). Although the state may have been an imposing presence in people's lives, it was not solely an immutable force from above, or from the outside that constrained people (Greenhouse 2002, Wolfe 2000).

In this same vein, the forestry institutions (*lespromkhoz* and *leskhoz*) that mediated the state-people relationships were not rigid structures, but were malleable, fluctuating in response to people's lives in a remote, wild land. This fluidity granted people agency to affect the state, as indicated by the feedback loop in the model. Here the state-people relationship resembled one between the political and individual experience (Greenhouse 2002). Ensuing tension in this relationship revealed that the people could not be completely reined in as the state intended. People's uncalculated reactions to the state's agenda, and the acts, orders, and protocols that followed, inadvertently unleashed waves of ineffectiveness and inefficiency within the forestry institutions. Below I describe the unintended consequences of the state's effort to use people as its agents of forest transformation, beginning with people's wavering belief in the state system and ending with the unraveling of the strictly regimented production culture within the forestry institutions. The state reacted by attempting to reinstate its initial ideals, which only exacerbated the situation, and ultimately diminished the state's authority.

"Everything was good, but it didn't last for long"[11]

According to Shamshin (2005), initially people in the forestry sector thought that they were doing important and useful work, yet, it was the opposite. As timber production proceeded in central Kamchatka, the gap between the state's ideal and what actually transpired steadily widened. Neither the human nor natural resources in this region turned out to be as resilient and replaceable as the state first predicted. Beneath the veneer of fanfare and awards was the exacting nature of forest work, characterized by hard physical labor, long-term exposure to frigid winter temperatures, and a high accident rate. Together, these factors precipitated premature aging, disability, and even death for many of the workers (*comment from interview*).

Waning enthusiasm exposed a complicated relationship between the state and people. Despite the prominent propaganda extolling the merits of surpassing Five-Year Plans and working for the collective good, it was not clear whether people actually believed in the state's ideology or not. They may have continued to proclaim the party line out of obligation to the state and to the collective, yet this act did not necessarily indicate belief in the state system. Shamshin (2005), for instance, recalled how the foresters diligently spun ideological myths based on false forest inventory data; however, they did not actually believe in these myths. In this sense, they adopted the discourse of state ideology, compelling them to respect a certain set of rules (also referred to as a communication filter) when they spoke or acted in public so that they would be taken seriously (Casier 1999). In these filtered interactions everybody stated what they were supposed to, thereby becoming wrapped up in a power system in which they were "both a victim and a pillar" (Casier 1999 and V. Havel 1990, quoted in Casier 1999).

The centralized state sought to quell any sense of power coming from the people, particularly in the Russian Far East where a regional consciousness and frontier spirit often reigned (Thornton and Ziegler 2002). Through its conception of people and their work as cogs in

[11] Shamshin 2005

the machinery of centralized planning, which could be manipulated at will, the state unintentionally alienated people from their livelihoods (see Lampland 1991, 1995, quoted in Wolfe 2000). This rift created fertile ground for conflicts of interest between people and the state. In the end, people were much more willing to work for their own benefit than for that of the collective. Loggers' salaries, for example, were initially based on how many trees they cut during a shift, allowing them to earn handsome pay for their efforts (Kirpishchikov 1986a). Yet, no one bore responsibility for the ultimate fate of the cut trees, which translated into premium timber being left to rot on the forest floor (Kirpishchikov 1986a). Consequently, the production system became paralyzed by overproduction, with far more resources being consumed than could possibly be regenerated. In this case the state's ideology of nature transformation clearly undercut itself, as a former *lespromkhoz* worker testified:

> You did it well once, come on do it better still. We wanted to do as well as possible, but it turned out like it always does. People worked without any control. And, beginning with perestroika, everything was relaxed (turned loose) and people didn't work so well.

This frank assessment of work in the forestry sector seemed to encapsulate the story of the state-people relationship: people may have initially believed in their obligation to fulfill the state's plans and for the collective good, yet over time these beliefs waned, distancing them from the state and its original intent. This disconnect set the stage for haphazard and largely uncontrolled resource exploitation.

A sense of disillusionment among the workers seemed to go hand in hand with declining belief in the state and its system. At first, the people who arrived in central Kamchatka had favorable impressions of their new surroundings, as one villager recollected: "When we arrived [in the early 1970s], the *lespromkhoz* was wealthy." This seemingly propitious life, however, masked the deeper reality that the *lespromkhozy* administered the villages at a loss (Shamshin 2005). With the extra responsibility of maintaining an entire village infrastructure, their expenses always exceeded revenues. In fact, the *lespromkhozy* like other enterprises, such as the *sovkhozy* (pl.) were planned to incur deficits in Kamchatka's extreme conditions (Shamshin 2005). This shortfall was evident in the insufficient construction of housing and pre-schools, and in the lack of cultural and social services for the workers (f. 88, o.4, d. 168: 1970a). Also, such amenities as recreational rooms to help unify and support the collective were missing in the *lespromkhoz* quarters (f. 88, o.4, d. 168: 1970a).

Growing disillusionment and the accompanying loss of motivation stifled worker morale, giving rise to a culture within the forestry institutions that lacked the discipline necessary for effective work. For instance, the following scenario was not uncommon:

> Toward the end of the day the entire staff responsible for forest protection was drunk and playing hooky, which results in negligence at work. Instances of undisciplined behavior are systematically observed…all of which reflect on every forest management activity of the *leskhoz*: the crop of saplings became overgrown, and work on soil preparation [for planting saplings] and forest thinning was conducted without technical supervision by the *lesnichestvo* (subunit of the *leskhoz*), which leads toward low quality work. (f. 649, o. 1, d. 33: 1965b)

Other signs of a lax and haphazard approach toward work included *leskhoz* workers' use of "impermissible methods and ways of formulating results" in the logging records (f. 649, o. 1, d. 124: 1971). Such occurrences represented a significant deviation from the ideal of rational resource use, including that of human resources. This blatant disregard for one's work signaled rising tension within the state-people relationship, and the gradual erosion of the state's authority.

Unmitigated chaos in the forestry sector

The same system that ordered strict adherence to prescribed rules was also one hinged on subterfuge to maintain the myths of resource inexhaustibility and abundance that underpinned the state ideology of nature transformation. Forestry workers had to transform the natural world in a highly regulated and orderly manner, and then show that they had not done so to prove that the resource base was still sufficient to enable an uninterrupted and steadily increasing timber output. These aims were fully untenable, especially in central Kamchatka where geography severely limited the scope of logging. This clear contradiction, and the overall fragility of this system, did not escape the people. One former forester commented: "So, for what did we work? We worked for medals, for pay, and for Japanese-made shoes and umbrellas...but, we exhausted the forests."

The forestry workers committed countless infringements that likely stemmed from their growing disbelief in the state and the system in which they were entrenched. This collective disobedience engendered a free-for-all atmosphere in the forestry sector that implicated both the *leskhoz* and *lespromkhoz*. Whereas the *lespromkhoz* ignored the logging rules, the *leskhoz*'s insistence on high standards was minimal (f. 649, o. 1, d. 167: 1973). Although many of the workers within the forestry institutions sensed this deep dysfunction, it was not necessarily overt. In fact, the leading *lespromkhoz* (Kamchatsky) was widely recognized as a formidable actor in the forestry sector, and even rose to national acclaim (*comment from interviews and conversations with long-time residents of central Kamchatka, including former lespromkhoz workers*). This rise came on the heels of powerful new logging equipment that enabled all-out forest exploitation, and a subsequent spike in timber output. Such success, however, was fleeting. Other indicators portrayed a starkly different picture of serious shortcomings under the surface of increased production (Shamshin 2005). This situation exposed the extent to which the ideology of nature transformation had led the state astray from what was occurring on the ground. Thus, it was not surprising that the people responded to the state through widespread neglect of their assigned responsibilities within the forestry institutions.

Lespromkhoz: rules overlooked

From the first Five-Year plan, industrial forestry in central Kamchatka was not conducted "rationally" by the *lespromkhozy* as evidenced by operations at the Kozyrevsky *lespromkhoz*, which the state found to be in an "unsatisfactory" condition (f. 541, o.1, d. 155b). Specifically, the logging methods at that time were recognized as ineffective: selective methods of cutting meant that a large quantity of economically-valuable timber remained in the forest (f. 541, o.1, d. 155b). Although the mechanization of timber operations may have ameliorated this situation somewhat in terms of production levels, an inspection of the forestry sector by the Forest Service Administration on Kamchatka revealed a situation that was growing noticeably worse from 1959 to 1961 (f. 88, o. 1, d. 607: 1961). To begin, the *lespromkhozy* that were united in the organization *Kamchatles* did not allocate sufficient human and technical resources to meet their quotas as specified in the Five-Year Plan, resulting in the 1961 production plan fulfilled at only 84.2 percent (f. 88, o. 1, d. 607: 1962). At the same time, the *lespromkhozy* logged at will in protected riparian and other "green" zones (for instance, those buffering villages) (f. 88, o. 1, d. 607: 1961).

The *lespromkhozy* continued wide-scale forest destruction in clear disregard of official recommendations following the Forest Service's inspection (f. 88, o. 1, d. 607: 1962). They over harvested in a scenario of extensive development in which the timber frontier was continually pushed back while thousands of cubic meters (of timber) remained in the areas that were logged. Gross negligence characterized the *lespromkhoz*'s logging practices: rushing across the landscape, the *lespromkhoz* left in its trail piles of logging debris and timber strewn about over thousands of hectares, which, among other things, posed high fire hazards (Shamshin 1964; f. 649, o. 1, d. 56: 1967).

By 1970 the Kamchatsky *lespromkhoz* exceeded its specified logging quota by 17.8 percent, almost twice the permissible amount of 10 percent, which translated into 5,800 cubic meters of timber. In this same year it left 40,500 cubic meters of uncut timber in the forests (f. 649, o. 1, d. 124: 1971). These practices earned them the reputation of being “extremely thriftless” in their use of the forest resources (f. 88, o. 4, d. 168: 1970b). Despite early and recurring warnings on the ecological harm inflicted by conditional clear-cutting, this method continued unabated, even after its official ban in Kamchatka in 1972. The Kamchatsky *lespromkhoz*, for instance, still used conditional clear-cutting in 1973-74, seeming to have lost all sight of the fundamental rule underlying long-term forest use, namely leaving zero waste in a site (Shamshin 1964; f. 649, o. 1, d. 56: 1967).

Leskhoz: minimal standards

In central Kamchatka, forest management was described as being “left up for grabs,” a situation indicative of the *leskhozy* (plural) managing (or not) the local forests as they deemed appropriate (f. 88, o. 1, d. 607: 1961; Eikeland et al. 2004). The absence of a clear logging plan in the Atlasovsky *leskhoz* exemplified this management style; in fact, it was not until 1974 that this *leskhoz* compiled a plan for the Kamchatsky *lespromkhoz* operating on its territory and sent it to the Forest Service administration for confirmation (f. 649, o. 1, d. 167: 1974). By this time, however, the *leskhoz* had already become proficient in skirting the established rules for timber removal. In general, the *leskhozy* regularly made concessions for unauthorized logging. Specifically, they reformulated logging permits, using their legal right to switch logging sections. In some cases these exchanges were justified, such as when some sections were inaccessible due to fire or shifting volcanic sands. In other cases, however, over-harvesting well over the permitted amount in one territory was sanctioned in exchange for undercutting in another (Shamshin 2005; f. 88, o. 1, d. 607: 1962). In this way, the overall volume of timber removed did not change, giving the impression of everything proceeding according to plan. In actuality, however, the *leskhozy*'s slipshod tracking of logging activity and inventory of forest reserves precluded any objective measure of how much forest was cut annually, which contributed to the chaos unfolding on the ground (f. 649, o. 1, d. 124: 1971).

In this laissez-faire atmosphere the Kamchatsky *lespromkhoz* began to vie for the allocation of forest sections beyond the boundaries of its established logging area, which had largely been fragmented by the early-1970s due to widespread conditional clear-cutting (f. 649, o. 1, d. 167: 1973). These new allotments would make it possible for the *lespromkhoz* to keep exceeding the Five-Year Plan (Sytnikov 1987). In addition to granting extended logging rights, the *leskhozy* also largely exempted the *lespromkhozy* from fulfilling mandatory forest protection measures and general logging etiquette, such as clearing debris from logging areas (f. 649, o. 1, d. 56: 1967; f. 649, o. 1, d. 167: 1973). By failing to cleanup up to one-third of the total area they logged, the *lespromkhozy* created serious potential fire hazards (f. 88, o. 4, d. 168: 1970b).

Overall, the distinction between the *leskhoz* and *lespromkhoz* became increasingly blurred in this convoluted system as each enabled violations of the other. The following scenario was typical: the Atlasovsky *leskhoz* issued substandard logging permits that contained an "entire row of mistakes and corrections," and omitted some requisites (f. 649, o. 1, d. 124: 1971). At the same time, it did not have the proper resources, for instance, forest use data from the Kamchatsky *lespromkhoz* to formulate these permits accurately (f. 649, o. 1, d. 124: 1971). Yet, in the end, the *leskhoz* set itself up for this predicament by failing for several years to audit the *lespromkhoz* on the actual amount of timber it logged, and on the "rationality" of its harvesting methods (f. 649, o. 1, d. 124: 1971). These actions may be explained by the *leskhoz*'s high motivation to overlook the established state laws on which the logging rules were based (f. 722, o.2, d. 56: 1967). Specifically, the *lespromkhoz* allocated deficit goods (such as fuel) to the *leskhoz* in exchange for logging as it (the *lespromkhoz*) saw fit (Shamshin 2005).

Besides facilitating pervasive violations, the *leskhoz* workers also actively committed them. For instance, they began to log the forests that they were charged to protect in every possible way (including the best forests alongside the village) (Sytnikov 1987). There were also instances when they clear-cut in protected zones along waterways and around villages under the cover of "experimental logging" as approved by forestry science (Sytnikov 1987; f. 88, o.1, d. 607: 1961). Moreover, the data that they compiled on the forest reserves were deemed to be in a "very unsatisfactory condition" (f. 649, o. 1, d. 124: 1971). In two subunits (*lesnichestvo*) of the Atlasovsky *leskhoz*, for instance, data on logging plots were compiled arbitrarily, with some essential measurements overlooked, such as the number of trees with full or partial commercial value, and those suited for firewood (f. 649, o. 1, d. 124: 1971). To make matters worse, these subunits regularly neglected to transmit data to the *leskhoz*; the *leskhoz*, in turn, did nothing to correct this occurrence. Other violations of the *leskhoz* included failure to clear areas after logging, and to conduct sanitary cuts up to a year prior to actual logging (f. 722, o.2, d. 56: 1967).

Such haphazard activity and loose management at the *leskhoz* emboldened the *lespromkhoz* agenda to the point where it took clear prerogative. Even though the *leskhoz* had always been subordinate to the *lespromkhoz*, the growing power differential between these two bodies diminished the relevance of the *leskhoz*, and its ability to keep the system in check. Thus, as more violations slipped through the *leskhoz* management, the more authority it lost, giving rise to a situation that quickly spiraled out of bounds and was ultimately the precursor of an ecological crisis.

The state's reaction

The state was not unaware of the emerging chaos in the forestry sector. In particular, it was concerned with the growing gap between forest felling and renewal that threatened to undercut its ideal of rational resource use. To maintain the myth of resource inexhaustibility upon which this ideal was based, it became apparent that forest regeneration work—a primary task of the *leskhoz*—was starkly inadequate. For instance, from 1958 to 1961 regeneration measures, specifically those that facilitated "natural" forest successional processes through the maintenance of saplings and understory trees in logged areas, were applied to only 743 ha (f. 649, o. 1, d. 28). At the same time, 7,000 ha were logged in 1961 alone (f. 88, o. 1, d. 607: 1962). This approach was especially unfeasible in the context of mechanized logging operations and increasing timber output that transformed once-forested areas into desolate fields "sown with logging debris and abandoned tree trunks" (Shamshin 2005).

Clearly, more intensive forest replacement methods were needed. According to forestry science at that time, such methods would narrow the gap between the amount of forest cut and the amount growing back, thereby establishing an equilibrium within the forests. Most importantly, they would ensure a constant, high level of forest reserves that could support an uninterrupted cycle of production (Shamshin 2005). The state attempted to implement these methods through the reorganization of the *leskhozy* in Kamchatka (and throughout Russia) as (semi) autonomous units in 1965. (Formerly, in Kamchatka they had been part of the *lespromkhozy*). The primary mission of these reestablished *leskhozy* was to implement the state program aimed to close the gap between the area of land logged and that regenerated through seeding and planting efforts (Shamshin 2005).

Still, very little changed in regard to the urgent call for forest regeneration (f. 649, o. 1, d. 33: 1965b, d). The *leskhoz*, however, was not entirely to blame for this inertia. Its incompetence was explained in part by the state's own lapses, including an inadequate reforestation management plan for the *leskhoz*. This oversight made the comprehensive compilation of forest data extremely difficult and time consuming, thereby considerably compromising the quality of work done (f. 649, o.1, d. 48: 1966). Moreover, the *leskhozy* were under equipped to undertake intensive forest regeneration work. The head forester at the Kluchevsky *leskhoz* described the equipment at his disposal as "morally outdated, physically battered, and of weak capacity" (Motuzov**a** 1987). In comparison, the *lespromkhozy* were allocated the best and latest equipment—a clear sign of the state's overriding aim of production, with regeneration almost as an afterthought, which was manifested in *lespromkhoz*'s superiority over the *leskhoz*.

In addition to improper equipment, there were also insufficient or missing protocols on other tasks essential to the *leskhoz's* mission, such as forest protection and use, including the diversification of production beyond raw timber; and on fire and insect infestation prevention. These top-down omissions together with the endemic bottom-up violations had a strong negative effect on *leskhoz* operations (f. 649, o. 1, d. 33: 1965c). The state reacted to the growing string of violations in the forest sector by continually urging the *lespromkhoz*, along with the *leskhoz*, to orient their activities toward "the most rational use of the forest riches" (f. 88, o.4, d. 168: 1970a). Overall, the state's proclamations of high ideals, such as rational resource use, juxtaposed to the dearth of practical tools for implementing these ideals represented a striking contradiction in its agenda. It must also have confused the people who, on the one hand had to uphold these ideals, yet on the other, lacked the necessary means to accomplish this feat.

The root of this problem seems to have been the state's own unwillingness to think beyond rational resource, which seemed to perpetuate the cycle of negligence, resistance to change, and uncontrolled forest exploitation within the forestry sector (f. 147, o. 1, d. 60: 1962). Routine inspections of the institutions revealed these predicaments:

> …it is evident that the same shortcomings in the [*leskhoz*] work are indicated every year, both in the removal of timber, and in all aspects of forestry work. These tell of how carelessly the management of the *lesnichestvo* [*leskhoz* subunits] relates to work obligations: they do not take the comments from the higher leadership into consideration. Therefore, it has become systematized to allow the same mistakes that inflict great harm upon the forestry sector. (f. 649, o. 1, d. 33: 1965c)

Even when these lapses were made explicit, the workers chose not to amend their ways (f. 649, o. 1, d. 33: 1965c). This recalcitrance signaled a general sentiment of indifference within the workers that likely originated from distrust in the state. This ingrained cycle reveals the state-people relationship as one of high tension caused by expressions of power and control coming from both the people and the state. By choosing not to work, or not working as the state intended and thus, violating the state's rules and procedures, the people leveraged their own power over the state. A tight feedback loop appeared where the state's solution to negligence in the forestry sector was to tighten control through orders sent to the forestry institutions, which the people ignored in further defiance of the state. This cycle of action and reaction continued unabated until the physical exhaustion of resources ground it to a halt.

Fourth Movement: Ecological consequences of the 'transformation of nature'

The interactions between the state and people were complicated, yet the outcome for the forests was straightforward: it was unquestionably destructive, rupturing long-standing ecological processes that fundamentally transformed the coniferous forests of central Kamchatka. Extensive logging and forest fires (the vast majority induced by humans), interspersed with modest efforts to protect and regenerate forests, produced a highly patchy landscape in which more than eighty percent of this forested area had been disturbed; only thin threads of old-growth forests remained in the protected riparian zones of salmon-spawning rivers. By the year 2000, 80 percent of the forested area in the central Kamchatka depression had been fragmented. In more precise terms, from 1929 to 2001 25,971,000 cubic meters of timber had been cut, the lion's share (72.2 percent) occurring from 1955 to 1987 (Shamshin 2005). Satellite images of the central Kamchatka Depression from 1961 and 2000 provide a vivid validation of these figures, revealing a trail of timbering that arced across the central depression from the southeast to the northwest (Hitztaler 2003).

This landscape clearly testifies to the state's disconnect from the specific ecology of Kamchatka's forests, and from the experiences of the local people. Even if the people had worked exactly according to the state specifications, the coniferous forest ecosystems in central

Kamchatka were neither robust, nor abundant enough to sustain the ideal of uninterrupted timber production. Ecological vulnerability, in conjunction with unsystematic and unregulated logging that far outpaced forest regeneration, foreshadowed a system destined to collapse. These resource use patterns left an imprint upon the landscape that was increasingly deepened by advancing technologies and growing exports to Japan.

Despite clear evidence on the consequences of local resource exhaustion, most notably that on the right bank of the Kamchatka River that forced two *lespromkhozy* to close, the state clung to its ideal of uninterrupted forest exploitation and doggedly sought new ways to pursue its original agenda. The state seemed immune to the stark contradictions inherent in its ambitious, yet utopian ideology that both gave rise to a large and powerful forestry sector, and undercut it through the destruction of the resource base upon which it was situated. The egregious logging waste strewn across the landscape was a graphic depiction of this paradox. Proximately, it was an unintended consequence of the command economy: all timber—even that of high quality—cut above the specified amount was left on the forest floor (Kirpishchikov 1986a; f. 88, o.1, d. 607: 1961; f. 147, o.1, d.63: 1963a). These practices resulted in a quarter to a third of the cut timber ending up as waste before it even reached the next stages of production. (Typically, 100 to 160 cubic meters of timber were removed from one hectare of forest, while 30 to 90 cubic meters were left in the logging site [f. 147, o. 1, d. 63: 1963a]). Ultimately, this waste represented the state's detachment from—and subsequent loss of control and authority over—the forests and people.

The state's reaction to a changing landscape

The state remained indifferent to forest destruction (see Vorontsov 1992) until an impending ecological crisis could no longer be ignored. The first signs of this crisis were apparent in worsening work conditions at the *lespromkhozy*. The overall decline in forest quality necessitated logging in sites that were increasingly far—up to 80 km away—from the *lespromkhoz* bases (from materials on the Kamchatsky *lespromkhoz*). (For comparison, earlier sites were approximately 25 km from these bases.) Compelled to action, the state promoted measures to protect resources. This call, however, was pitched alongside orders to meet ever-rising quotas that would ensure constant production (and overproduction). This precarious—if impossible—balance between protection and production was embedded in messages admonishing workers to "be very careful in forest exploitation, so as not to violate the natural balance of the vegetative world," especially given Kamchatka's harsh natural conditions that stunted forest growth and regeneration (Kirpishchikov 1986b).

In this vein, regional governmental organs specified increased forest regeneration, and greater forest productivity through new logging practices, as the primary aims for Kamchatka's forestry sector in the Ninth Five-Year Plan (1971-1975). This decree followed a 1970 proclamation that emphasized Kamchatka's forestry sector as a very important, yet very backward, component of the peninsula's economy (f. 88, o.4, d. 168: 1970b). Specifically, they mandated the following from the *leskhozy*: maximal rational use and regeneration of forest resources; mitigation of losses from fire and insect infestations; and the organization of non-timber forest product harvesting and processing. At the same time, from the side of the *lespromkhozy* the state ordered an increase in timber production resulting from the integration of deciduous and lower quality wood into its operations (f. 88, o.4, d.168: 1970). Although it was couched in maximizing resource use, this call for heightened output seemed to suggest that production still took top priority. In fact, the state seemed to view plan fulfillment through rational resource use as a cure-all to subpar conditions in the forestry sector (Efimenko 1986). This sentiment was reflected in the voice of one forester: "To take care of the forests means to use its raw resources rationally" (Kupriyanov 1986).

In actuality, however, plan fulfillment and rational resource use were often incompatible: throughout the period of forest exploitation in central Kamchatka no substantial shifts were made toward rational resource use as the state intended, even as plans were met or exceeded (Shamshin 1986). The state's attempts to balance forest use often fell short in favor of plan fulfillment, as demonstrated in one case where it granted concessions to the Kozyrevsky *lespromkhoz* to log in ecologically sensitive sub-alpine forests that were officially off-limits. In the Soviet system these forests were classified as Group One Forests, meaning that they had special protected status; Group Three Forests were those designated for exploitation. This exception allowed the *lespromkhoz* to make up a deficit of approximately 225,000 cubic meters of timber, and thereby meet its production quotas (f. 88, o.1, d.877: 1966). After almost forty years of logging, the *lespromkhoz* had nearly consumed its resource base, which pushed it to the verge of liquidation (f. 88, o.1, d.877: 1966). This example underscores the state's myopic focus on the fulfillment (and exceeding) of plans that eclipsed the bigger picture of severe ecological damage and resource exhaustion. In the end, the utopian ideal of ceaseless production became mired in the complexity of the real world (Denecke 1992). Consequently, the state could not reverse the gaining momentum toward ecological crisis, even as it foresaw this outcome (f. 649, o. 1, d.7: 1961).

The influence of a changing landscape on the people

As the agents of landscape change, those who settled central Kamchatka were nearly entirely implicated in the state's scheme of forest exploitation. Thus, it was difficult to separate their role from that of the state in forest transformation, as both were highly interdependent. The landscape tells of people's outright neglect and carelessness on the job, and of their subsequent disconnection from the forests. Workers, for instance, adopted an "unforgivable indifference" to the forests and the natural systems supported by these forests, not giving a second thought to such destructive practices as logging in the headwaters of rivers, which threatened the integrity of hydrological systems (Efimenko 1986).

The eventual consequences of this profound forest change for the people, however, were markedly different than for the state. Whereas the state was sufficiently removed from these changes and even benefited from them (as in the case of raw timber exports to Japan), the people directly experienced the negative outcomes of a transformed landscape. To begin, the exhaustion of forest resources mandated the liquidation of *lespromkhoz* outposts, or the relocation of an entire *lespromkhoz* (for example, Kamchatsky *lespromkhoz*). Because the spatial configuration of resource exploitation and the *lespromkhozy* directly determined the spatial configuration of human settlement (see Schweik 1999, Shamshin 2005), these closings and transfers meant the abandonment of settlements in locations no longer strategic to timber exploitation, and the establishment of others in more propitious areas. People also had to contend with other consequences of forest exploitation, including local climatic changes, and the altered hydrology of salmon-spawning rivers (f. 129, o. 1, d.1). Salmon was especially important to the local economy, and served as a staple food source for individual households.

The people were not unaware of these changes. As Shamshin noted (2005): "The exhaustion of the raw resource base was obvious to everyone, but no one straightforwardly or openly said anything about it…There was the impression that the scenario of 'the worse, the better' suited everyone." Shamshin (2005) attributed this phenomenon to the illogical, yet stifling force of forestry science and the myths of forest inexhaustibility and abundance that it created. Moreover, because the *lespromkhoz* united the population in a common cause, and controlled nearly every aspect of village life necessary for survival in a remote, northern area, it quelled dissent. This situation mirrors Casier's (1999) description of people recognizing the "official truth" as a lie, yet in this process losing their capability to search out the truth.

Still, the voices of those who saw through the morass in the forestry sector to the unquestionable decimation of the resource base became more audible, particularly with the onset of *glasnost'*[12] beginning in the mid-1980s, as indicated in the excerpts below published in regional papers:

> The village of Kozyrevsk stood at the core of Kamchatka's forest sector. And, today the main activity of its population, and the sole source of its economic well-being [centers on] the forest. This source is rather threadbare after long years of irrational exploitation, founded upon the naïve belief in the inexhaustibility of the raw natural resource reserves…Gloom has already hung over the village for several years with the unforgiving and unrelenting question of: 'What to do next?' There are no prospects for the [Kozyrevsky] *lespromkhoz* as it is facing fragmented forest plots combined with losses from hauling loads over great distances, and from the upkeep of the village… Therefore, to save this village and provide its residents with prospective year-round employment over the long-term, a transition should be made from extensive logging methods to intensive ones that are well-thought out, reliable, and sustaining. This transition should not only be in words, but part of a multi-purpose use plan for forest resources. (Sytnikov 1987)

This insightful passage related that forest decimation was written into people's lives, yet it was not the final story. Here beneath the veneer of ideology something more profound and permanent was uncovered (Wolfe 2000), which shattered previously ingrained myths. People began to question what they had always heard as truth, as is evident in the revamped version of a well-worn propaganda piece (stated in the prologue to this part): "We must not wait for benefits from nature considering what we have done to it...have people not become so full of themselves, calling themselves nothing less than transformers of nature?"(Efimenko 1986) Moreover, an awareness of landscape change and people's role in it was articulated: "There is no point at which we will treat the taiga better, so it's getting worse every year. We are cutting everything in a row" (Kirpishchikov 1986a).

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[12]Shortly after assuming power in 1985, Gorbachev proposed the concepts of *glasnost'* and *perestroika*. Meaning openness or publicity, *glasnost'* was intended in part to open up horizontal communication among officials and specialists in the spirit of reviving technological innovation (Mitchell and Arrington 2000).

To conclude, landscape transformation in central Kamchatka clearly shaped the state and people, proving the complexity of relationships between the state, people, and forests. In the end, it was ecological change that dictated how the state and people used forest resources. A new stage of forest use evolving from this change is the topic of the third and final part of this chapter.

Part III

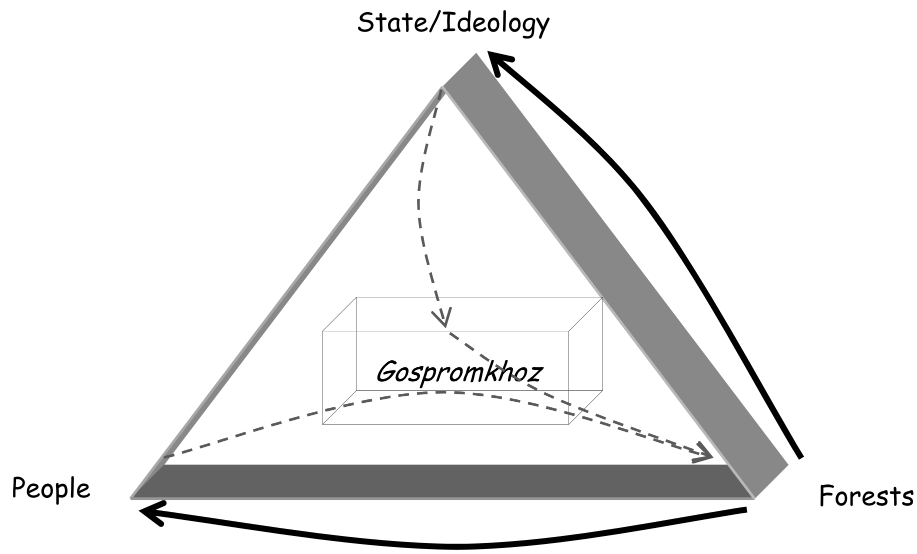

Figure 3-3: Dynamic triangular model (dashed lines represent feedback loops)

Introduction

This part marks a significant turning point in the chapter (and the model) where agency passes from the dominant state to the forests. By granting the forests agency, this model challenges the nature versus culture dichotomy that holds two polarized viewpoints: "nature shaping culture versus culture imposing meaning on nature" (Biersack 2006, Descola and Palsson 1996, Balee 1998). In central Kamchatka, the state, and the people it designated as agents of transformation, greatly affected the forests; however, their control over the natural world was not final. The forests also had a distinct effect on the people and state, which I examine in this last part. I focus on the *gospromkhoz*, a state organization that represented the state's response to the unanticipated consequences of a drastically altered forest landscape, and on people's interactions with the forests through this organization.

Seeing the forests beyond the trees

Despite massive disturbances from uncontrolled logging, and to a lesser extent, human-induced forest fires, the forests displayed a resilience that persisted even in a fragile northern ecosystem subject to severe climatic conditions and volcanic activity. These disturbances precipitated a cascade of successional processes across the landscape, which were the mechanism for natural forest regeneration following disruption (ecological or anthropogenic). The state had also envisioned this outcome; however, the actual pace at which these processes occurred diverged sharply from the state's truncated timeframe for the re-growth of commercial forests. In the window between disturbance and maturation (or earlier and later successional stages), the forests produced an abundance of non-timber forest products (e.g. forest fruits, mushrooms, medicinal herbs). Non-timber forest products also include other plant parts, such as sap and leaves, which can be extracted from the forests. In this sense the production of forest resources did continue uninterrupted, albeit in a very different manner than the state had initially envisioned.

Gathering of non-timber forest products

The forest surrounding the village of Kozyrevsk, one of the first areas in central Kamchatka where logging was initiated, acquired a reputation for an abundance of non-timber forest products. These resources were also colloquially referred to as the "gifts of nature" (*dary prirody*) (Tarasnyuk 1985). They were so copious in this region that the branches of honeyberry shrubs were purported to radiate a deep blue color from the succulent oblong-shaped fruits that made its branches droop to the ground (Tarasnyuk 1985). Lingonberry was also plentiful and drew people to these successional forests:

> Families with children spread out and began collecting lingonberry, such that each family had the impression that they were alone in the forest. When the evening began to set in everyone felt the urgency of returning to the tasks that awaited them at home. It was surprising to see so many people converge at about the same time on the main road that led us back to the village. The evening was warm and there was a hint of autumn in the air and we were singing, carrying lingonberries in all sorts of ways: in a pail hung over the shoulder, or in backpacks. (*A recollection of gathering in 1948 by a long-time villager in Kozyrevsk.*)

This early recollection of gathering non-timber forest products in central Kamchatka conveyed its rich meaning in people's lives. It was a release from their everyday lives and the tasks that filled them. Through this activity, people experienced the physical and spiritual sustenance of the forests, which dimmed their ingrained views of it as a production site that was merely the means to an end.

Ironically, as the state encompassed more and more of people's lives, it might have inadvertently prompted people to seek out the forests as their place of refuge where they could pursue what they wanted beyond the state's grasp (see Caldwell 2004 and Smith 2002). This idea of the forests as a haven, especially during scarce times, has been prevalent throughout Russia (Caldwell 2004). In the stark years following World War II, for instance, the state even looked to the forests for provision, outlining plans for the collection of mushrooms, berries, and medicinal herbs within them (f. 88, o.1, d.38: 1945; f. 88, o.1, d.103: 1946). Thus, it is likely that many of those who settled in central Kamchatka already had a established a connection to the forests where they previously lived; upon their arrival they honed these ties through their personal needs and lived experiences that fell outside of the state realm (see Crumley 1994). For those whose lives centered on forestry, retreating to the forests to regroup and spend leisure time became ingrained in the local culture. In this unofficial space people saw beyond the utilitarianism of the forests to a spiritual presence, which is traced back to ancient Slavic lore (see Paxson 2005; Kirpishchikov 1986b).

The harvesting of non-timber forest products epitomized the forests as a place where the economic, social, and spiritual spheres coalesce (Caldwell 2004). One villager in Kozyrevsk remarked: "Gathering mushrooms and berries has always been a revered activity for us." Another villager explained how small children and babushki (grandmothers) alike have taken part in the time-honored activity of mushroom gathering. Although gathering traditionally took place in people's private lives, the state's presence seeped into this activity through its organizations and institutions that arranged transportation to gathering sites for workers. The state also invested itself in this activity on a much larger scale.

The institutionalization of non-timber forest products

As non-timber forest products proliferated across the landscape in central Kamchatka, gathering acquired new status as an activity with economic potential. Beginning in the 1960s, the state began to diversify its resource use agenda in this region that had been solely focused on timber and agriculture (Tom I: 1976-77). To this end, it established the *gospromkhoz* to oversee the further development and regeneration of non-timber resources with the greatest economic promise, including: mammals (for fur and game), fish, and non-timber forest products (primarily forest and bog berries, and mushrooms) (f. 818, o. 1, d. 2: 1963; Tom II: 1976-77). The first *gospromkhoz* (Ust'-Kamchatsky) that covered the northern part of the central Kamchatka depression was established in October 1963; the Mil'kovsky *gospromkhoz* that extended over the southern part was created in April 1967.

These efforts reflected the broader national call at that time urging the comprehensive and rational use of natural resources to grow the economy in the Eighth Five-Year Plan (1966-1970). This course of action was clearly articulated in a directive of the Twenty-third Congress of the Communist Party of the Soviet Union in 1966 (*Rastitel'nye resursy v novoi pyatiletke,* 1966). Within this broad directive was the growing recognition of multi-purpose forest use that encompassed non-timber plant resources, including forest berries and mushrooms. These and other plant resources were deemed to have high potential as essential building blocks of the Communist society. Thus, the initiation of large-scale non-timber forest product harvesting and processing in central Kamchatka signaled a response both to the region's specific (and changing) ecological conditions, and to the overriding state directive for increased rational and multi-purpose resource use.

The production of non-timber forest products, along with fur, game, and fish, was distributed across central Kamchatka's landscape through the creation of satellite *gospromkhoz* branches that were situated in the logging villages that dot the Kamchatka River valley (*refer to Figure 2-2*). (There were two satellite branches each for the Mil'kovsky and Ust'-Kamchatsky *gospromkhoz* units.) On the territory of the Mil'kovsky *gospromkhoz* the three most abundant and economically valuable berry species (honeyberry, bog blueberry, and lingonberry) thrived in the northern part, which had a more continental climate than the southern part, meaning that late spring frosts were less likely to kill berry harvests. Also, this northern area was the site of intensive logging, specifically in the vicinity of the villages of Lazo, Shchapino, and Atlasovo (the first two villages were the sites of initial *gospromkhoz* satellite branches). These same berry species were also abundant in the southern territory of the Ust'-Kamchatsky *gospromkhoz* where large-scale logging also took place, for instance, around the village of Kozyrevsk (also the site of a *gospromkhoz* satellite branch).

Similar to the *leskhoz* and *lespromkhoz*, the *gospromkhoz* became an important mediator in the state-people-forest relationships. Even though the *gospromkhoz* operated in a different production mode than the forestry institutions, its primary aim was grounded in the ideal of rational resource use. The *gospromkhoz* also experienced many of the problems that seemed to be universal in the Soviet economy, including inefficient management and pervasive disregard for state orders. In the following sections, I trace how the state with its intent focus on rational resource use and heightened productivity responded to a changing environment through the *gospromkhoz*. In addition, I explore the interactions among the *gospromkhoz*, people, and the state, and finally, consider how the *gospromkhoz* affected people's gathering patterns and connection to the forests.

The gospromkhoz and the centrality of production

Situated in central Kamchatka's small logging villages, the *gospromkhoz* satellite branches and temporary drop-off and processing stations once hummed with activity during the summer months, especially in the evening when weary gatherers arrived to turn in their day's harvests. One gatherer recalled those days as a time when "we collected so many mushrooms." In the village of Atlasovo, *gospromkhoz* employees rounded up the daily berry harvests collected by industrious gathering brigades of four to six people stationed in the forests during peak season. The end of a gathering day in the forests meant a surge of work in the villages where it was not uncommon for the evening shift to stretch to 3 or 4 a.m., or until the urgent task of processing spoilage-prone berries and mushrooms was complete.

During the height of the summer gathering season that began in mid-to late July with honeyberry and ended in mid-to late September with lingonberry, work was in full swing everywhere, resembling a "constantly running conveyer belt" (*comment from interview with the former director of the Atlasovo gospromkhoz station*). Depending on the harvest conditions in a given year, between 50 to 80 tons of honeyberry and bog blueberry combined were delivered to a drop-off and processing station in the village of Atlasovo that was part of the Mil'kovsky *gospromkhoz*. (Honeyberry made up 25 percent of this volume, while bog blueberry made up the remaining 75 percent.) Jam production at this station peaked at 80 tons in a season; the average was 50 tons (*comment from interview with the former director of the Atlasovo gospromkhoz station*).

This snapshot of non-timber forest product harvesting that took hold in the increasingly patchy landscape of central Kamchatka verified that these resources were more compatible than timber with the ideal of uninterrupted resource use initially championed by the state. First, non-timber forest products were considerably more resilient than timber: it was possible to harvest them annually without a significant risk to their long-term viability. Second, when compared to the Soviet forestry practices, this activity was inherently less destructive to the forest ecosystems that supported it, enabling its long-term sustainability. Although timber production remained superior, particularly in terms of its economic and political pull, the rise of non-timber forest products in the aftermath of timber exploitation signaled a clear turning point in forest use, and revealed the forest's influence on the state.

The gospromkhoz in the Five-Year Plan

The integration of non-timber forest products into the economy, and as a target for rational resource use, seemed more a reaction of the state to changing ecological conditions than a proactive move to use exploit this resource. Nonetheless, the state applied the same ideology to non-timber forests products as it did to timber, viewing them as a utilitarian good that could be harnessed through the all-important Five-Year plans. The state obliged *gospromkhoz* directors to take all measures necessary for the unconditional fulfillment of the prescribed plans, which included the improved organization of non-timber forest product gathering and processing (f. 818, o. 1, d. 10: 1970). As in the forestry institutions, plan fulfillment stood as the single measure of success. The Ust'-Kamchatsky *gospromkhoz*, for instance, was awarded a cash bonus for the "competent organization of labor, the fulfillment of the production plan, and the improved quality of manufactured goods" (f. 818, o. 1, d.6: 1967). Such achievements supported the ideal of the *gospromkhoz* as an efficient and well-run organization. By its fifteenth anniversary, the Ust'-Kamchatsky *gospromkhoz* was portrayed in the official discourse as an organization whose work had matured and become stronger (f. 818, o. 1, d. 48: 1978a).

The same description could apply to the Mil'kovsky *gospromkhoz*: upon completing its tenth year of operation in 1976, it began to refine its agenda in respect to rational resource use. For instance, it sought to improve the processing of non-timber forest products that had abundant and dependable harvests and those that required minimal input of human and technical resources. Such resources included fiddlehead ferns and birch sap (f. 705, o. 1 d. 99: 1979; f. 705, o.1, d. 106: 1980; Tom I: 1976-77). It also began to process products prone to spoilage. Specifically, it ramped up its production of dried mushrooms, and jams from bog blueberry and honeyberry. Besides development of non-timber forest products, improvements were proposed for the organization of gathering activities, including: an additional collection station for fiddlehead ferns; the building of permanent drop-off stations in the areas of intense gathering activity; and a mobile jam-making station at one of the satellite branches (f. 705, o. 1, d. 106: 1980; f. 705, o. 1, d. 113: 1981; f. 705, o. 1, d. 120: 1982). The assessment of potential sites prior to harvesting was another suggestion for facilitating and refining the gathering process (f. 705, o. 1, d. 63:1974; f. 705, o.1, d. 67: 1975; f. 705, o.1, d. 78: 1976; f. 705, o.1, d. 113: 1981).

The archival records of the *gospromkhoz* do not make explicit the connection between logging activity and the growth of the non-timber forest product sector. Still, it does not seem coincidental that in 1976 toward the peak of timber production in central Kamchatka, an outside assessment of the Mil'kovsky *gospromkhoz* confirmed the high potential for large-scale non-timber forest product harvests due to the considerable quantities of berry and mushrooms on its territory (Tom II: 1976-77). Besides extensive logging, fires that typically originated from unsound forestry practices (i.e. burning timber refuse) opened up new niches for non-timber forest products in the forest cover. The expansive 1972 fire that broke out in the region of the village Krapivnaya is a prime example. It still evokes strong memories among the villagers who lived through it, as one Kozyrevsk resident recalled: "It was a very strong fire that burned for two and a half months. The first rains came only on August15th. A very large area burned, but somehow they saved the village." In the first years following this fire the lingonberry harvest was so abundant that it drew people from all regions in Kamchatka who collectively gathered around 40 tons in one season (*comment from the head forest ranger at a leskhoz branch office in the village of Krapivnaya*). At this same time, the former game manager of the Kozyrevsky satellite branch (of the Ust'-Kamchatsky *gospromkhoz*) recalled processing a record 25 tons of lingonberry jam.

Berry harvests on the territory of the Mil'kovsky *gospromkhoz* also rose considerably during these years: 11,200 kg and 10,100 kg were gathered in 1974 and 1976, respectively, which was a dramatic jump from earlier levels that averaged approximately 4,250 kg (f. 705, o.1, d. 63: 1974; f. 705, o.1, d. 78: 1976). The harvest of bog blueberry alone was two and a half times more in 1974 than in previous years (f.705, o. 1, d. 63: 1974). By 1978 the lingonberry harvest swelled to 13,030 kg, whereas in the eight years prior the average amount collected hovered only around 800 kg (f. 705, o.1, d. 91: 1978).

Unfulfilled plans

Auspicious harvest years facilitated meeting and even exceeding the set quotas. Abundant yields, however, did not occur yearly: Kamchatka's volatile natural environment and climate contributed to patchy harvests of non-timber forest products that varied greatly in quantity and quality (f. 705, o. 1, d. 148: 1986). Berries in particular were highly susceptible to climatic fluctuations, such as untimely summer frosts that precluded both harvests, and the fulfillment of annual quotas, regardless of all efforts otherwise (f. 705, o. 1, d. 56: 1973; f. 705, o.1, 120: 1982). These uncontrollable forces made it nearly impossible to predict harvests from year to year: an abundant or poor yield in one year gave little indication of what to expect the following year. For instance, in 1986 the collective at the Mil'kovsky *gospromkhoz* managed to produce only 1,500 kg of berries against a plan of 30,000 kg, owing to an exceptionally dry summer that caused extremely low yields of honeyberry and bog blueberry (f. 705, o.1, d. 148: 1986; f. 705, o.1, d. 151: 1987b; *comment from interview with the former game manager of the Kozyrevsky satellite branch*). This outcome negatively affected the entire production plan of the *gospromkhoz* (f. 705, o.1, d. 151: 1987b). Just a year later, in 1987 the records reveal overall auspicious conditions that were advantageous for the Mil'kovsky *gospromkhoz*" (f. 705, o.1, d. 155: 1987; f. 705, o.1, d. 158:1988b). The harvests for lingonberry and bog blueberry were particularly good in this year (f. 705, o.1, d. 154: 1987).

Owing to these great fluctuations, increases in berry harvests were not recommended in future annual plans, a move that was antithesis to the pervasive push for steadily rising production (f. 705, o. 1, d. 148: 1986). In this regard, non-timber forest production was clearly not conducive to the command economy, which may explain why, despite its potential, this production typically remained behind the *gospromkhoz*'s other primary activities of fishing and hunting that depended upon more stable resource bases. The inability of the command economy to adapt to varying harvest rates provided fertile ground for inefficiency. The Mil'kovsky *gospromkhoz*, for instance, surpassed plans for their mushroom harvest in 1980, which meant an increased plan for the next year. Responding to the plan, instead of the prevailing climatic conditions of that year, the *gospromkhoz* took exhaustive steps to ensure a successful gathering season. The plan, however, went unfulfilled due to a poor mushroom harvest that could not support large-scale gathering (f. 705, o.1, d.113: 1981).

The *gospromkhoz* also had to contend with the unusual phenomenon of volcanic activity, which often had detrimental effects on non-timber forest product harvests. The most evident example was the 1975 eruption of the Tolbachik volcano that produced major ash fall in the central Kamchatka River valley, thwarting the planned berry and mushroom harvests for both the Mil'kovsky and Ust'-Kamchatsky *gospromkhozy* (plural) (f. 705, o. 1, d. 70: 1975; f. 818, o.1, d. 36: 1976). There also appeared to be a residual effect on the territory of the Ust'-Kamchatsky *gospromkhoz* where there was a complete dearth of mushrooms in 1976 (f. 818, o.1, d. 36: 1976).

Erratic weather patterns and other environmental phenomena, however, were not the sole explanation for the collection of low to non-existent harvests: shortfalls within the *gospromkhoz* were also responsible. To illustrate, in 1975 the combination of frequent ash fall combined with the absence of drop-off and processing stations in areas of dense mushroom growth rendered plan fulfillment impossible (f. 705, o. 1, d.70: 1975). And, there were many instances when the *gospromkhoz* was ill-prepared to handle even abundant harvests, such as in 1972 when a good mushroom harvest was reported on the territory of the Ust'-Kamchatsky *gospromkhoz* (f. 818, o. 1, d. 16: 1972). An overall lack of preparation for the gathering season, and inconsistent management throughout this *gospromkhoz* (especially at the satellite branch in the village of Kozyrevsk) resulted in harvests that fell far below the given plans (f. 818, o.1. d. 20: 1973).

Several deficiencies within the *gospromkhoz* contributed to the commonplace situation described above. First, a shortage of supplies and equipment (including construction materials and vehicles) either due to poor planning, or to the inefficiencies of the command economy, were endemic in the *gospromkhoz* (f. 705, o.1: 1971; f. 705, o.1, d. 92: 1978). For example, when an organization higher in the hierarchy failed to return essential containers, the *gospromkhoz* had to scramble to obtain the proper supplies (f. 705, o. 1, d. 127: 1983; *comment from interview with the former game manager of the Kozyrevsky satellite branch*). Second, there was a perpetual dearth of essential infrastructure, such as temporary drop-off and processing stations, in the forests (f. 705, o. 1, d.78: 1976). Third, the *gospromkhoz* lacked storehouses and processing departments with modern equipment to handle large production volumes (f. 705, o. 1, d.67: 1975; f. 705, o. 1, d.127: 1983; f. 705, o. 1, d. 155: 1987; f. 705, o. 1, d. 169: 1989). Finally, there were acute labor shortages during peak gathering season due to the mobilization of nearly the entire local population to harvest fall crops, particularly in the agricultural villages within the territory of the Mil'kovsky *gospromkhoz* (these villages included Mil'kovo, Dolinovka, and Lazo). Because these harvests were given precedence over non-timber forest product harvesting, the Mil'kovsky *gospromkhoz* often had to lend both its employees and vehicles to support work in the fields (f. 705, o. 1, d. 63: 1974).

Unfulfilled workers

These challenges seemed to be overshadowed by steadily declining worker morale. Most managers at the *gospromkhoz* satellite branches, for instance, paid insufficient attention to their workers, and were indifferent to plan fulfillment (f. 818, o. 1, d. 24: 1974a). They also ignored the orders passed down from the main *gospromkhoz* director, and made chronic mistakes, such as late submission of reports. This recalcitrance shattered the production rhythm idealized by the state. It reverberated throughout the *gospromkhoz*, leading to endemic job laxity, which included high worker turnover, numerous days of lost work, and perhaps most pernicious of all, drunkenness on the job. The latter appeared to be the main contributor to what was described as extremely low discipline among workers (f. 705, o.1, d.79: 1976).

Although drinking was acknowledged as a major issue, little action was taken to counteract it. Those found guilty were rarely called to account, despite the promise of stricter measures to ensure better behavior (f. 705, o.1, d.79: 1976; f. 818, o.1, d. 40: 1977). The disintegration of worker morale in the *gospromkhoz* was reminiscent of that in the forestry institutions, and to a large degree, explained why plans were not always met, even in years of favorable harvests. To draw on one example, a 1974 analysis concluded that the harvesting of non-timber forest products was extremely inadequate within all three production units of the Mil'kovsky *gospromkhoz*; in fact, in one of the satellite branches no effort whatsoever was made to harvest these products (f. 705, o. 1, d. 72: 1975). Consequently, the plans for non-timber forest products went unmet for four years of the Ninth Five-Year Plan (1971-1975) (f. 705, o. 1, d.67: 1975).

Production of non-timber forest products was also a struggle for the Ust'-Kamchatsky *gospromkhoz*, as expressed in one directive: "For the duration of the *gospromkhoz*'s existence the harvesting and processing of non-timber forest products has been realized in an unsatisfactory way" (f. 818, o.1, d. 10: 1970). A subsequent investigation of the work at the Kozyrevsky satellite branch uncovered a situation in which nearly all production plans (with the exception of firewood) were unmet: only 67.7 percent of the plan for berries was realized and only 10.5 percent for mushrooms (f. 818, o.1, d.12: 1971a). This trend went from bad to worse, as described at the beginning of the following directive:

> In nine months, work within the Kozyrevsky branch of the *gospromkhoz* culminated in an extremely unsatisfactory situation in terms of fulfilling the production plan…This branch was completely uninvolved in the harvesting of such important resources as berries, mushrooms, and wild game meat. This situation occurred due to the director's irresponsibility in regards to his job obligations, and to his caving into the shortcomings at the branch—he does not want and is not able to organize work. An analysis revealed that the work at this branch is directed only at wringing out as much as possible from the organization [*gospromkhoz*] without the appropriate return. (f. 818, o. 1, d. 12: 1971b)

Morale within this branch continued to deteriorate, preventing plan fulfillment even in years of abundant harvest (f. 818, o. 1, d. 16: 1972). The situation at the other *gospromkhoz* satellite branch, Kluchevsky, was equally as dreary in regards to non-timber forest product harvests, attesting to the director's dogged refusal to pursue this line of work (f. 818, o. 1, d. 10: 1970).

To counteract this negativity, the state relied heavily on imposing a sense of personal responsibility within the *gospromkhoz* workers (the directors and branch managers, in particular) to maintain and increase production of non-timber forest products (f. 818, o. 1, d. 48: 1978c). The state extolled those workers within the *gospromkhoz* who went above and beyond the call of duty for the sake of the collective, declaring such commitment a "labor victory" within the *gospromkhoz* (f. 818, o. 1, d. 24: 1974b). Dedicated individuals were distinguished for their drive toward such a victory, which inevitably resulted in surpassing the plans (f. 818, o. 1, d. 6: 1967). And, there were others who took their personal responsibility for the success of the *gospromkhoz* very seriously, yet may not have been officially acknowledged. The main game manager at the Kozyrevsky satellite branch augmented non-timber forest product harvests at the *gospromkhoz* with her own to make up for shortcomings (*comment from interview*). This manager also logged long over-time hours during the primary harvest season to keep the entire operation running.

These accounts reveal the extent to which the *gospromkhoz* ran on the extraordinary energy of a handful of exemplary workers. These workers, however, seemed to be outnumbered by those who had become disillusioned and thus, lost all sense of personal responsibility. The resulting dysfunction within the *gospromkhoz* spoke of the deepening rift between the people and the state; it also underpinned serious problems. When compared to the forestry institutions, however, the *gospromkhoz*'s transformation of the forests was slight. First, the *gospromkhoz* was dependent on readily renewable resources, allowing it to harvest in the same place from one year to the next, depending on overall harvest levels (i.e. it did not steadily encroach upon and decimate new swaths of forest). Second, the harvesting of these resources took place on a much smaller scale and over a shorter time period every year when compared to logging.

Gatherers and gathering: interactions between the gospromkhoz and local people

Because the *gospromkhoz* clearly lacked the staff capacity and other resources to fulfill its plans for non-timber forest products, which stipulated (in most cases) progressive increases in harvest and processing levels, involving the local population became an essential component of its production strategy. Specifically, the *gospromkhoz* solicited potential gatherers by offering "live money," or immediate compensation for the non-timber forest products they collected and turned in to the *gospromkhoz* (*comment from interview with the former game manager of the Kozyrevsky satellite branch*). Besides the opportunity to earn additional income, in some years gatherers could also obtain various deficit goods in return for their harvests (f. 705, o.1, d.113: 1981). In short, gathering allowed people to obtain something that otherwise would not have been available to them. For example, one teenage boy earned enough money to buy outdoors equipment (for example, a sleeping bag and boat motor). Additional earnings enabled another villager to hire a tutor for her child at the university. It was rare, but possible for diligent gatherers to turn in enough berries (measuring in the tons) in a season to earn a car or motorcycle.

Typically those who held more prestigious posts, for instance, those in the *lespromkhoz* or *rybkop* (a local cooperative) did not gather, as they had neither the need, nor the time to do so. This activity, however, provided important opportunities for marginalized groups in the population, including women (especially those who did not work outside of the home) (*comment from interview*). Some villagers could earn the equivalent of their monthly salary after four or five full days of work in the forests. For instance, a former nursery school teacher in the village of Kozyrevsk told how she earned between 50-60 rubles a day gathering in the late 1960s and early 1970s. (On average, the *gospromkhoz* paid 1 ruble per kg of non-timber forest products received.) Considering that the average monthly salary at that time was approximately 170 rubles, and that basic goods, such as a loaf of bread and a liter of milk, cost around 20 kopecks (similar to U.S. cents), these earnings were respectable. Even the *gospromkhoz* employees gathered to make additional money.

A culture of gathering

The *gospromkhoz* recruited potential gatherers by disseminating information on its conditions and requirements through the mass media. It offered people two options: they could gather independently and turn in their harvests (including berries, mushrooms, and fiddlehead ferns); or, they could participate in gathering trips organized by the *gospromkhoz* throughout the week to collect berries (honeyberry, bog blueberry, and lingonberry) in the summer and early autumn. The latter option was especially appealing to people who were free during the summer, and who did not have other means to travel to distant gathering sites. Through these trips the *gospromkhoz* helped mold people's behaviors in the forests, for example, by teaching them fire prevention methods (f. 818, o. 1, d. 48: 1978c). It also encouraged people to gather in way that maximized productivity, including shaking honeyberry and bog blueberry shrubs to increase collection rates. This method resulted in large losses—up to 70 percent of the available harvest—and risked damaging the shrubs, yet it was still preferable to gathering by hand, which greatly lowered labor productivity (Tom II: 1976-77).

Before setting out with gatherers, the *gospromkhoz* investigated potential gathering sites to determine the number of gatherers, containers, and transportation type needed for a given season (Tom II: 1976-77). In particular, it sought out sites that could support large-scale harvests; these were typically in areas where the *lespromkhoz* had logged several years earlier. As logging radiated out further from the villages, gathering followed. Besides initiating disturbances in the forest cover that were critical to the growth and reproduction of non-timber forest products, industrial logging also laid down the road infrastructure necessary to transport large harvests from remote sites to the villages (Tom II: 1976-77).

Many people still harbor vivid memories of the *gospromkhoz* and the gathering culture it engendered within the villages. One woman in Kozyrevsk fondly recalled her participation in the *gospromkhoz* gathering trips as a teenager:

> People came to the *gospromkhoz* office early in the morning, at around 8 a.m. Everyone got together and we took off soon afterward, riding in the open back end of a large truck; there were mainly women—all with bandanas wrapped around their heads. Our containers were in the middle, or wedged under the benches on which we sat, or on our laps. We traveled fairly far from the village, a half an hour, or even an hour. When we

> reached our destination we were all covered in dust from the road. The *gospromkhoz* took us to areas that had been logged where the berry harvests [of honeyberry, bog blueberry, or lingonberry] were abundant enough to gather for the entire day. Upon our return to the village in the evening the *gospromkhoz* employees stood ready with their scales to weigh our harvests; they also inspected the quality of what we gathered. The berries that we collected were sent off to the main *gospromkhoz* branch for processing that day.

Another villager in Kozyrevsk shared some additional memories of these trips, explaining that two trucks with 25-30 gatherers departed from the *gospromkhoz* every day, weather permitting. She told how these vehicles filled up for every trip. She also emphasized the high participation in gathering lingonberry, which was greatly valued by the population (f. 705, o.1, d. 151: 1987c):

> They took a lot of people, including the village drunks and those who didn't want to work. They made trips every day, including Saturdays and Sundays, until the very end of September; sometimes they took gatherers 50 km beyond the village. A lot of people went on the trips to collect lingonberry, especially as there were no mosquitoes in the forest at that time.

Many villagers looked back on these trips with a fondness that went beyond the monetary benefit they collected at the end of the day. For instance, one woman reminisced how it was so wonderful to be in the forest, even if she was not able to collect enough to make substantial earnings. People also went for the camaraderie that they could share with close friends. And, people took advantage of the free transportation to gather for their own households, devising various ways to get their own harvests home without first passing through the *gospromkhoz*. One woman, for instance, asked the driver to drop her (and her buckets) off before they reached the *gospromkhoz* branch office; others turned in containers that they made to look full, but which were not. All of these tactics undermined the *gospromkhoz*'s underlying aims to increase production.

Gathering by all means necessary

Promoting gathering activity within the general population was a first step toward the *gospromkhoz*'s effort to meet its quotas, yet it was not sufficient, requiring the *gospromkhoz* to adopt a multi-tiered recruitment strategy. For instance, it targeted sub-groups within the general population, including sport hunters who had specialized knowledge of the surrounding forests. In exchange for berry, mushroom, and rosehip harvests, these hunters received access to the best hunting grounds and licenses to shoot the most valuable species (f. 818, o. 1, d. 48: 1978c).

In addition, the *gospromkhoz* actively recruited children at local schools and pioneer camps to help meet the specified plans, particularly those for rosehips, fiddlehead ferns, and wild garlic. Overall, children's contribution could not be overstated, as was evident in May and June of 1986 when one brigade of 22 schoolchildren collected 2,020 kg of wild garlic. This single input constituted over half of the total wild garlic harvest in the Mil'kovsky *gospromkhoz* for that year (f. 705, o. 1, d.144: 1986). (The total amount harvested in this year was 3,946 kg, which exceeded the plan by 158 percent [f. 705, o. 1, d.144: 1986].) In recognition of the children's participation, the *gospromkhoz* awarded cash prizes (ca. 100 rubles), and presented valuable gifts to those whose efforts were especially outstanding (f. 705, o.1, d. 123: 1983). The Mil'kovsky *gospromkhoz* even organized their own children's camps at the end of the school year to facilitate spring harvests of fiddlehead ferns and wild garlic (*comment from interview*).

Competing interests

The *gospromkhoz* took such measures because attracting gatherers proved complicated: even in small communities the *gospromkhoz* nonetheless had to vie for local gatherers and the non-timber forest products they produced. Its main competitors, so to speak, were the local goods cooperative (*rybkop*), and to a lesser extent, the *leskhoz*. (The *leskhoz* only began to accept and process non-timber forest products—lingonberry and mushrooms—beginning in the mid-1980s (f. 705, o. 1, d. 134: 1984). Similar to the *gospromkhoz,* both of these organizations paid gatherers on the spot, and facilitated outings to the forests, albeit on a lesser scale than the *gospromkhoz*. And like the *gospromkhoz*, their primary motive was to meet production quotas. For instance, the *rybkop* needed berries for its production of jams and wines (the latter which still lingers strong in the memory of many villagers) that it distributed throughout the region (*comment from interview*).

Because it handled merchandise, the *rybkop* could offer especially attractive incentives to gatherers, namely the opportunity to buy deficit goods, such as rugs or furniture. (The *rybkop* paid gatherers and gave them special coupons [*talony*] indicating what they could buy with the money; buying power increased with volume gathered [*comment from interview*].) And, before prices for non-timber forest product harvests were equalized in 1987 the *rybkop* garnered the majority of berry harvests by paying one and half times more per kilogram of harvest than the *gospromkhoz* (f. 705, o. 1, d. 85: 1977). Villagers still recall the long lines of people waiting to turn in their harvests outside of the *rybkop* (*comment from interview*). These lines clearly validated that immediate pay back, or "live money," was a major factor in people's decision to gather.

Socialist competitions

To win over more gatherers, and to increase harvest volumes, which lead to the ultimate goal of surpassing plans, the *gospromkhoz* was charged with organizing competitions among individual gatherers. In one competition held within the Ust'-Kamchatsky *gospromkhoz,* the most prolific gatherers could earn a first prize award of 100 rubles by turning in 1,000 kg of berries or 200 kg of mushrooms, or 30 rubles for 20 kg of rose hips (f. 818, o.1, d.48: 1978d). Such bonuses that nearly equaled a monthly salary, on top of regular earnings from harvesting, enabled a few ambitious gatherers to secure enough money in one season to live on for the rest of the year (*comment from interview*). These competitions also helped the *gospromkhoz* achieve notable successes in some years. The Mil'kovsky *gospromkhoz*, for example, more than doubled its quota for berry harvests in 1978, thanks to a competition it organized among gatherers (f. 705, o.1, d. 88: 1978). Competitions were even held at the local schools where each grade was challenged to produce a certain volume of non-timber forest products (for example, rosehips) (*comment from interview*).

The tactic of competition was also employed within the *gospromkhoz*, as it was in other state institutions (for instance, the *lespromkhoz* and *leskhoz*). The premise of these contests was the same: to spur overproduction through the maximization of resource production and to improve overall efficiency (f. 705, o. 1, d. 116: 1982). To this end, the *gospromkhoz* was ordered to deploy all material and moral means necessary in competitions among its satellite branches, brigades, and individual workers (f. 705, o. 1, d. 116: 1982). In one such competition within the Ust'-Kamchatsky *gospromkhoz*, the first place cash award of 250 rubles went to the satellite branch that produced at 150 percent of the plan, and that ensured quality processing and the timely delivery of production (f.818, o.1, d. 48: 1978b). (Second and third places went to the branches that surpassed the plans at 130 and 120 percent, respectively [f.818, o.1, d. 48: 1978b].) In the Mil'kovsky *gospromkhoz* workers were also recognized for major successes, which translated into overproduction, as was detailed in the directive to reward these workers:

> The following were produced for the state: 24,020 kg. of raw berries against the plan of 10,000 kg; 8,680 kg of processed mushrooms [salted and marinated] against the plan of 2,800 kg; 3,930 kg of unprocessed wild garlic against the plan of 2,500 kg and 87,380 kg of jam against the plan of 38,500 kg. (f. 705, o.1, d.158: 1988b)

Although much emphasis was placed on material rewards, these competitions had deeper meaning, especially in a command economy where buying power was limited. Engineered to surmount spreading inertia, these contests were symbolic of the state-people relationship. By providing people with material incentives, and reinforcing their worth as state workers and citizens, the contests became a means for the state use to control people to its own ultimate end of building a Communist society.

Gospromkhoz reformation

Although some plans were met or exceeded, they nonetheless could not hide the expanding problems within the *gospromkhoz*. By 1987 the Mil'kovsky *gospromkhoz* had achieved a six-fold increase in production output in its twenty years of operation (f. 705, o.1, d.151: 1987a). This achievement did not reflect the purported intensified rational use of natural and human resources (see f. 705, o.1, d. 63: 1974; f. 705, o.1, d.124: 1982). Rather, this achievement was the result of extensive development marked by the continued exploitation of remote areas, a growing workforce, and rising value of primary funds (f. 705, o.1, d.151: 1987a). Thus, even though production rose, it was inefficient and began to decline as the *gospromkhoz* chronically missed its target plans for revenue. Moreover, starting in 1982, labor productivity lagged behind salary increases, which was considered a violation of the fundamental law of socialism (f. 705, o.1, d.151: 1987a). These downward trends signified increasing stagnation within the *gospromkhoz* that was exacerbated by negligence on the job, and by the leadership's inattention to changing production conditions. These gave rise to the underutilization of the considerable reserves of non-timber forest products available to the *gospromkhoz* (f. 705, o.1, d. 155: 1987; f. 705, o.1, d.151: 1987a).

The inertia within the *gospromkhoz* was a drop in the sea of the languishing Soviet economy that received a jumpstart through *perestroika* beginning in the mid- to late 1980s. As part of this wider process to revitalize the country's sagging socio-economic development, and to shift to a model of intensive development, the *gospromkhoz* underwent a cardinal reorganization (f. 705, o.1, d.151: 1987a). In the Mil'kovsky *gospromkhoz*, for example, the three original branches were liquidated and replaced with two centralized ones to heighten the efficiency and intensity of production, and to promote rational resource use. One branch focused on hunting and non-timber forest products, and the other on fishing (f. 705, o.1, d. 158: 1988a). Reorganization, however, did not occur seamlessly: there was a clear imbalance in the workload, level of responsibility, and compensation between the branch directors, and the specialists who worked under them. Moreover, the formation of a permanent collective and the enforcement of discipline within it remained a challenge (f. 705, o.1, d. 158: 1988a). Still, some improvements surfaced, at least as reported in the *gospromkhoz*'s annual report for 1987:

> Owing to the measures taken to improve the harvesting and processing of non-timber forest products, and to the transition to negotiated prices, the gospromkhoz was able to increase considerably the volume of these products produced, thereby raising the economic efficiency in regards to this resource (f.705, o.1, d. 155:1987).

This emphasis on intensified use of non-timber forest products continued. Specifically, in 1988 the *gospromkhoz* came up with a new strategy to maximize the volume of lingonberry harvests that it received. A comparatively small amount of lingonberry was turned into the *gospromkhoz* in comparison to the other berries (honeyberry and bog blueberry): 5 to 7 tons in contrast to 50-80 tons, respectively (*comment from interview with the former director of the gospromkhoz unit in the village of Atlasovo*). This difference, however, was not attributed solely to biological harvest levels; instead, it was due in part to a sociological phenomenon. The former director of the *gospromkhoz* station in the village of Atlasovo recalled how people throughout the peninsula amassed in central Kamchatka during lingonberry season: "They came and came and came, even though the road was difficult, they still forged ahead." People arrived to spend time in the forests and to collect some of the valued lingonberry for their own households. As one Atlasovo resident recalled:

> Up until the 1990s, there were a lot of people arriving from the city (Petropavlovsk-Kamchatsky). They would gather 3-5 buckets for themselves. No matter when you went, there were people; they came in their own cars and on buses sponsored by the organizations where they worked, and on large freight trucks.

A portion of the non-locals also gathered to earn money, even taking vacation time to do so. While many did turn their harvests into the *gospromkhoz* drop-off stations, a high volume of lingonberry (up to 100 tons) nonetheless left the region (*comment from interview with the former director of the gospromkhoz unit in the village of Atlasovo*). In response to this situation, the *gospromkhoz* established patrols in conjunction with the local leskhoz to prevent non-locals from gathering for themselves, meaning either for their own household needs or to sell on their own (f. 705, o.1, d. 165: 1989).

Conclusion

The creation of the *gospromkhoz* testified to the state's widening perspective of forest use beyond timber and ultimately, to the influence of the forests on the state. The state may not have relinquished its fundamental ideology of nature transformation, yet it began to advocate for multi-tiered resource use that seemed more aligned with the natural world than previous policies that were in direct opposition to it. While the *gospromkhoz* signaled a changing relationship between the state and the forests, it also served a critical role in reconnecting people to the forests that had long been an intrinsic part of their lives. Unlike the forestry institutions that alienated people from the forests, the *gospromkhoz* created critical interstices in which they could interact with the forests in a minimally destructive manner through the gathering of non-timber forest products.

Although the *gospromkhoz* was bound to the state's production plans, there were no strict quotas imposed upon gatherers. In fact, this activity was voluntary (for all non-*gospromkhoz* employees) and lightly regulated, even at the official level: people could decide whether and how to interact with the forests, for instance, how much and how often to gather. This state-sanctioned activity gave people the choice to benefit directly and immediately from forest resources; thus, it was a profound departure from the frenetic timber exploitation that had previously defined people's relationships to the forests. Thus, even though the *gospromkhoz* itself was entrenched in many of the common ills inherent in the Soviet system, it became a unique link through which people could rediscover the meaning of the forests, and the extent to which the forests shaped their lives. The next chapters in Section II explore these forests, and the lingonberry harvests within them, from ecological, anthropological, and spatial points of view.

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Chapter 4
The Changing Ecology of 'Conifer Island' in Central Kamchatka: An Examination of a Disturbed Landscape

Prologue:
"Before my eyes occurred the exploitation, more precisely, the reduction of 'Conifer Island' in the Central Kamchatka depression, and the transformation of it into an archipelago of small forest groves. Now loggers and temporary workers are cutting and stripping away what remains."— V.A. Shamshin (2005)

"In Kamchatka there are a lot of forests—they will last us for a century."— V.A. Shamshin (2005)

Introduction

Grand disturbances, including forest fires and volcanic eruptions, have resulted in a distinctive contour of coniferous forests bounded by the central Kamchatka depression. Still, these pyrogenic forces could not rival the anthropogenic ones that swept through this region beginning in the early twentieth century. Today the ubiquitous fragmentation of this landscape marks the aftermath of a once prosperous logging industry; it also presents an unparalleled opportunity for the study of successional processes in the taiga, or boreal forests. The main focus of this chapter is an empirically-based ecological study that examines the relationships between features of forest structure and composition, and lingonberry (*Vaccinium vitis-idaea*). Lingonberry was chosen as the centerpiece of analysis in this chapter given its high ecological, economic, and cultural importance. This species is widespread and present in nearly all larch forest associations (Kabanov 1963); at the same time, it serves as an essential source of nutrition and healing for the people residing in this region. Thus, a clearer understanding of the interaction between lingonberry, and the structure and composition of successional (or disturbed) forests, is critical in augmenting existing knowledge of central Kamchatka's forests and their resource-use potential.

Guiding research question, hypothesis, and predictions

- *What is the relationship between lingonberry biology and ecology, and the composition and structure of successional forests in central Kamchatka?*

Based on the existing literature (*refer to Turkov 1964*), there should be a significant association of lingonberry with forest features, such as sparse overstory coverage and new regeneration, that indicate early successional, or recently disturbed forests. Specifically, lingonberry yields in these forests should be higher than yields in later successional forests. This chapter first provides an overview of lingonberry biology and ecology, which is followed by sections on the methods, results, and discussion of this empirical study.

Lingonberry biology and ecology

Biology

Lingonberry is a low-lying, evergreen woody subshrub with alternating, elliptically-shaped leaves that have a leather-like texture. The inflorescence of lingonberry is a raceme with a few white or pale pink flowers; it produces a small, globe-shaped, and bright red fruit containing between 5 and 31 seeds. This small perennial shrub has a well-developed, root system characterized by stolons that spread horizontally from the auxiliary bud near the base of the mother plant. Differing from typical vegetative shoots by their longer length and the formation of adventitious roots at the nodes, stolons produce immature ramets, or plantlets (Gibson). Thus, these stolons are responsible for the vegetative reproduction of lingonberry, and for the ability of this species to colonize an open area by forming a continuous cover. Lingonberry may also reproduce sexually, although this strategy is not as successful despite the large amount of seeds the plant produces. This occurrence may be explained in part by the high sensitivity of the seeds that require the right combination of moisture, sunlight, and accessible ground in which to germinate successfully. A recent finding has shown that the prevalence of clonal growth in lingonberry is likely to limit the numbers of fruit and seeds in this species (Nuortila et al. 2002).

Ecology

Lingonberry is distributed throughout the forest and Arctic zones, growing in pine and larch forests where it is a dominant species in the herbaceous-subshrub layer (Vander Kloet 1988). This species grows best in habitats that are well-penetrated (yet not inundated) by light and are moderately moist with loamy, humus, and moderately acidic (pH 4) soils. Lingonberry grows best and produces the most abundant yields in slightly elevated micro-niches (e.g., tree stumps or decaying trunks on the forest floor). Still, this plant has a fairly high tolerance for very dry or wet soils, and can even survive on waterlogged soils in highly acidic bogs. The full life cycle of a ramet typically lasts from six to seven years, although this number depends on the specific local conditions. The vegetative growth of lingonberry begins in early June and ends in August during which time the ramets increase their above-ground mass by 50 percent. A comparison of lingonberry growth in different climatic zones revealed that this plant develops best in niches with moderate moisture and shade (Yudina et al. 1986).

Besides vegetative growth, flowering and fruit production are also highly dependent on climatic and environmental conditions, resulting in considerable annual fluctuation in yields. Bud formation, for instance, responds directly to temperature and moisture levels: cold and rainy weather reduce it to a minimum, while it proliferates in warm, sunny conditions with adequate moisture. This process also depends on the amount of flowering buds from the previous year. Other factors that directly influence the fruiting of lingonberry include soil richness, micro-relief, and the composition of the plant community in which it is found. Once the plant has begun flowering, it enters into its most critical phase in terms of fruit production. Even slight frosts of -1.5°C to -3°C, which are common in central Kamchatka in the late spring and early summer, can damage between 70 and 85 percent of lingonberry's delicate flowers, especially in more exposed areas. Also, steady rain accompanied by cool weather (i.e. less than 15°C) considerably lowers insect (bee) pollination, leaving up to 85 percent of the flowers unpollinated. Fungal infestations pose yet another threat to fruit formation, and to other parts of the plant, such as the leaves; frequent rain and high humidity during the flowering period further exacerbate the occurrence of these infestations.

The fruits that do survive typically ripen sometime in August. (In the extreme climatic conditions of Kamchatka, however, lingonberry fully ripens only toward the end of August and the beginning of September.) Yields vary considerably depending on forest type and successional stage: for example, fruit production in a mature pine forest (in mainland Russia) averages approximately 80 kg per hectare (Yudina et al. 1986). In contrast, yields range from 500 to 1,500 kg/hectare in logged forests where there is good light-penetration (Yudina et al. 1986). Although major disturbances, such as logging and fire, spell proximate destruction of lingonberry (and most other species in the herbaceous layer), they also play a vital role in the plant's ultimate longevity by initiating the successional processes essential to its regeneration. Abundant harvests are most often traced to fire, and in other regions of Russia (e.g. in the northern part of the Primorsky Krai, the southern part of the Khabarovsk Krai, the Amur oblast', and especially in Yakutia) the origins of the larch-lingonberry forest association are bound to fire. This forest association in Kamchatka also appears to be connected to forest fires (Kabanov 1963).

Materials and methods

Forest inventory plots (N=43) served as the unit of data collection; they were disseminated throughout the study area (*refer to Figure 4-1*). Inventoried during the 2004, 2006, and 2008 field seasons, these plots were chosen on the basis of distance from nearest village, and disturbance history. Due to the study's focus on successional forests, and to issues of accessibility, especially in light of the study's limited budget, these plots were not randomly selected across the landscape.

Forest inventory plots

Notwithstanding the logistical challenges, every attempt was made to achieve a balanced sample of different forest association groups in varying successional stages in areas both closer to (< = 5 km) and further from (>15 km) the villages in the study site. Many of the areas sampled were chosen following careful consultation with materials provided at the local forest service branch offices, and with experienced local foresters. Besides distance and disturbance history, plots were also chosen with respect to their location in known lingonberry gathering sites.

With the exception of the first four plots from the 2004 pilot study[13], all plots were 20m x 20m; each plot was subdivided into 4 10m x 10m subsections to facilitate the inventory process. (*Refer to Figure 4-2.*) Once the general area in which to set the plot was decided, the actual location was determined by a random compass direction and randomly chosen number of steps in this direction from a (more or less) central point. The stopping point always served as the NE corner of the plot. The data collection protocol for the study of forest communities was based on the principles of vegetation classification defined by the Leningrad Geobotanical School developed by V.N. Sukachev and A.P. Shennikov (see Neshataev et al. 1994). The following general data were recorded for each plot: geographic location (determined by GPS); forest association group (before disturbance); administrative location (e.g. region and *leskhoz* district); macrorelief (e.g. floodplain terrace, wetland, etc.); microrelief within the plot; basic

[13] These plots consisted of 10 5m x 5m subplots that were evenly distributed throughout four different 1-ha experimental plots established by Japanese researchers from Hokkaido University.

drainage (e.g. fine, medium, or course soil); and type of leaf litter and average litter depth. (*Refer to Table B-1 in Appendix B for an overview of all plots.*)

Measurements of each vegetative layer are specified below (note that these represented a simplified variation of the Leningrad school methods):

1. *Over and understory layers:* percent coverage of overstory layer; total tree count; and diameter at breast height, or dbh (1.3-1.5 m from the base of the trunk) of each tree in both layers.

2. *Regeneration layer:* total count of all species; and height of specimens in each sub-plot representing mature, intermediate, and new regeneration (where applicable).

3. *Shrub layer:* overall percent coverage, and percent coverage of each species; height and diameter of haphazardly chosen specimens in each sub-plot (but not the largest or smallest); and length of main branch for coniferous shrubs (juniper and Siberian dwarf pine).

4. *Herbaceous-subshrub layer (including woody subshrubs):* species richness (i.e. count of all species in layer); abundance (*refer to Table 4-1 for abundance measures*); overall percent coverage, and percent coverage of each species (note that in 2008 the percent coverage was estimated for only the most abundant species); and height of haphazardly chosen specimens in each sub-plot (but not the largest or smallest).

5. *Woody debris (detritus) layer:* overall percent coverage; and total count of standing dead trees, trunks lying on the ground, stumps (plus diameter, where possible).

6. *Lichen-moss layer:* overall percent coverage; (very) approximate species count, plus brief description of observed species.

Note that the overall percent coverage was determined through visual approximation. Because this measure was quite subjective, the same researcher made these estimates in every plot to ensure consistency. (In some plots these estimates were compared to those made by other members of the field team as a way to gauge their general accuracy.)

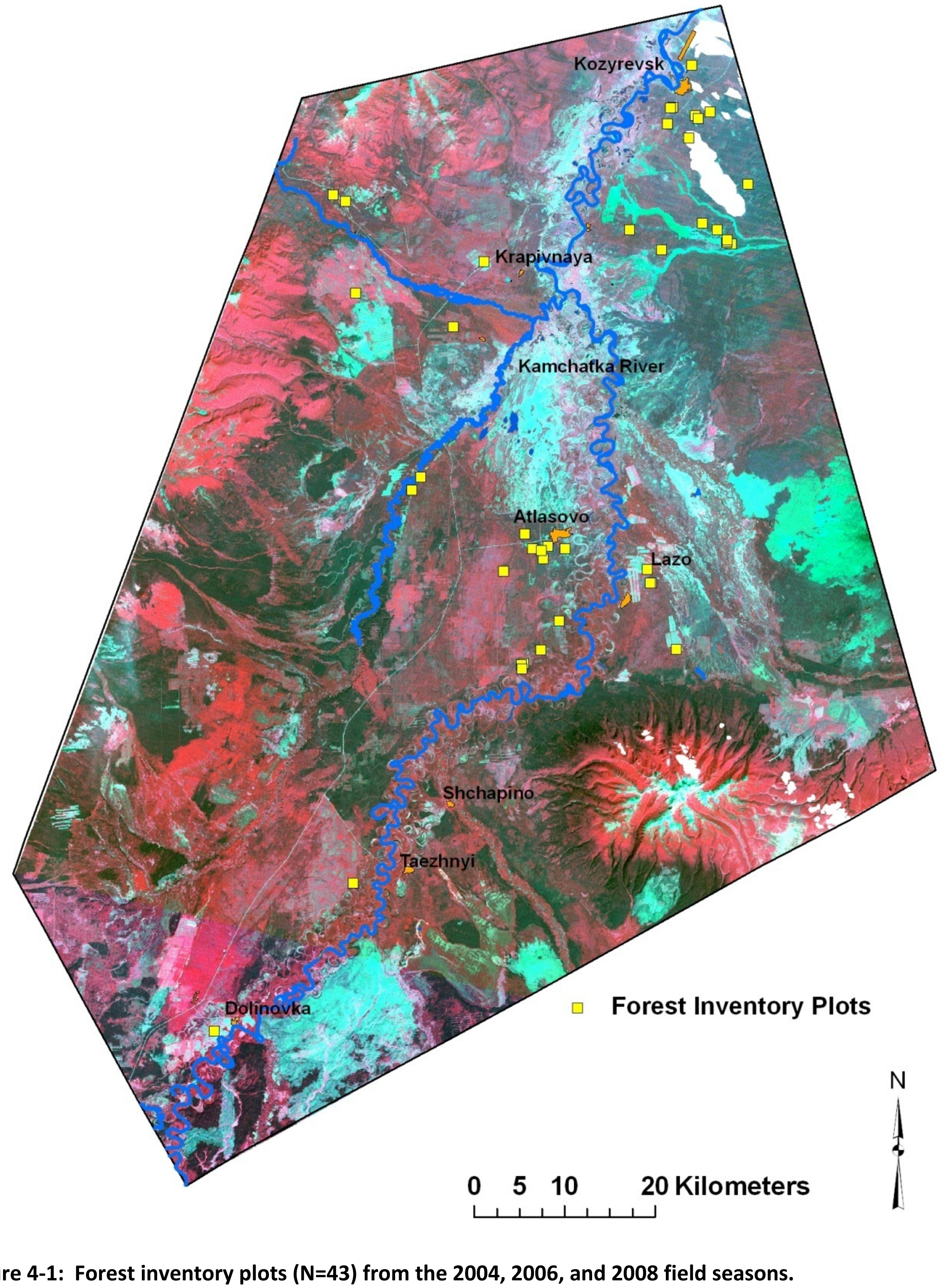

Figure 4-1: Forest inventory plots (N=43) from the 2004, 2006, and 2008 field seasons.

Measurement of lingonberry

In addition to the ecological data recorded for other species in the herbaceous-subshrub layer, one 1m x 1m plot was set up in each 10m x 10m sub-plot to study lingonberry ecology more closely. (*Refer to Figure 4-2.*) These 1m x 1m plots were randomly chosen based on a $100m^2$ grid.[14] (Note that if lingonberry was not found in the first random square, or there were fewer than five to ten fruits in this square, another random square was chosen. Typically, an appropriate square was found on the first or second try.) The following characteristics were recorded within each 1m x 1m plot: the total number of fruits present; diameter (in mm) of small, medium, and large fruits; plot topography; percent coverage of lingonberry; and other species present. To reduce variability, the same researcher did fruit counts and measured the diameter of the fruit.

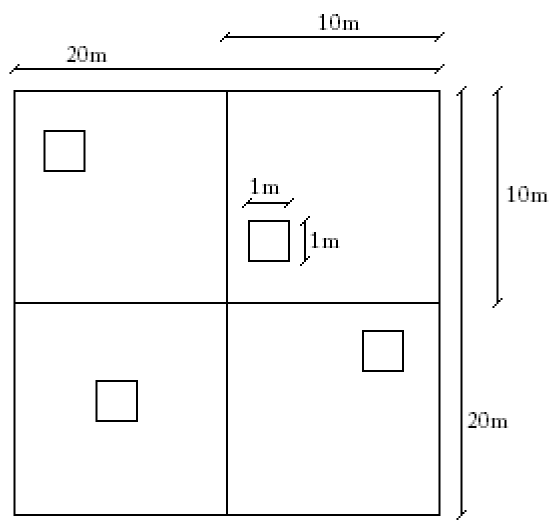

Figure 4-2: Drawing of sample plot with subplots.

[14]In the 2004 pilot season these 1m x 1m plots were haphazardly chosen.

Table 4-1: Drude scale used to measure abundance of herbaceous species.

Measure	***Scaled Measure***	***Definition***
Un. *(Unicus)*	***1***	*Species is observed only once on plot.*
Sol *(Solitarius)*	***2***	*Species is encountered more than once, but less than 5 times.*
Sp *(Sparsus)*	***3***	*Species is encountered ca. 5-7 times, but does not make up a large part of the herbaceous*
Cop 1 *(Copiosus)*	***4***	*Species is relatively well distributed.*
Cop. 2 *(Copiosus)*	***5***	*Species is very well distributed (its extent coverage can reach up to 50%).*
Cop. 3 *(Copiosus)*	***6***	*Species is clearly predominant; its extent coverage ranges from at least 70% up to 75%.*
Soc *(Socialis)*	***7***	*Species covers the plot almost entirely.*

Table 4-2: Summary of measured forest ecological variables.

Category	**Variable**
General	• Forest association group (prior to disturbance); • Disturbance history.
Overstory	• Percent overstory coverage; • Number of overstory trees; • Mean dbh (cm) of overstory trees.
Understory	• Number of understory trees; • Mean dbh (cm) of understory trees.
Regeneration	• Total count (all species); • Height (m) of mature, intermediate, and new birch regeneration.
Shrub	• Overall percent coverage; • Percent coverage, height, and diameter of the following common shrub species: o Juniper (+ length of main branch) o Honeyberry o Blunt-auriculate and prickly rose o Siberian dwarf pine (+ length of main branch)
Herbaceous	• Species richness (count of all species present on a plot); • Overall percent coverage; • Abundance, percent coverage, and height (vegetative and reproductive, where applicable) of the following common species: o *Lingonberry* o *Marsh Labrador tea* o *Reedgrass* o *Sedges* o *Fireweed*
Woody debris	• Overall percent coverage.
Moss and lichen	• Overall percent coverage.
Non-timber forest products	• Fruit count of *V. vitis-idaea* in 1m x 1m plots; • Mean diameter of fruit in 1m x 1m plots.

Data Analyses: Linear Models

In these analyses only data aggregated from the 29 plots inventoried in 2006 and 2008 were used; data from 2004 pilot study were excluded due to several missing values in the dataset from this year. Binary logistic regression was chosen to establish which elements of forest structure and composition affected the occurrence of lingonberry in a plot. In this model the response was coded such that 0 = fruit absence, and 1 = fruit presence. The following variables were tested in separate models:

1. Overstory and understory density (mean volume[15] x number of trees present).
2. Extent coverage of all individual shrub species only.
3. Extent coverage of all individual shrub species and the composite variable, or overall percent coverage of the shrub layer.
4. Extent coverage of all individual herbaceous and subshrub species only.
5. Extent coverage of all individual herbaceous and subshrub species and the composite variable, or overall percent coverage of the herbaceous-subshrub layer.
6. Abundance of individual species in the herbaceous-subshrub layer.
7. Extent coverage of woody debris layer.
8. Extent coverage of lichen-moss layer.
9. Shrub composite variable, herbaceous-subshrub composite variable, extent coverage of woody debris layer, and extent coverage of lichen-moss layer

(Note that none of the regeneration variables fit well in the model, so they were dropped.)

Next, linear models were fitted to test for possible associations between variables of forest structure and composition, and the abundance of lingonberry. Only data from the plots with fruit counts were tested in this model. Prior to fitting these models, the dependent variable (fruit yield) was changed using a square root transformation to normalize the distribution. The overall percent coverage of the lichen-moss, woody debris, and shrub layers, and the mean abundance of the herbaceous-subshrub layer served as independent variables in the models. A second linear model was fit with average fruit count for each plot (calculated from the individual counts for each of the four 1mx1m plots) to eliminate dependence in the fruit count variable. All regressions were modeled in the program R. Finally, box plots were used to compare lingonberry fruit count across the two categorical variables of forest type and disturbance history.

[15]Volume was calculated by using the formula for the volume of a cylinder, or $\pi r^2 h$, where r = dbh, and h was determined on the basis of dbh.

Results

Factors affecting the occurrence of lingonberry in a forest plot

First, an increasing percent of lichen-moss coverage seemed to raise the likelihood of lingonberry fruit occurring in a plot (up until a certain threshold). (*Refer to Table 4-3, and Figure 4-3.*) Second, a higher percentage of woody debris coverage also appeared to raise the likelihood of lingonberry fruit occurring in a plot. This likelihood was less than that for percent moss coverage, although it was still large. (*Refer to Table 4-4, Figure 4-4.*) Third, juniper had the largest effect on whether lingonberry fruit occurred in a plot. (This shrub had the largest eβ. *Refer to Table 4-5*.) Fourth, the percent of lichen-moss coverage gave the largest eβ, signaling that this forest layer most strongly influenced whether lingonberry fruit occurred in a plot (*Refer to Table 4-6*.) Lastly, the overstory and understory density did not affect the likelihood of lingonberry fruit presence in a plot (*Refer to Table 4-7*.)

Table 4-3: Summary of the binary logistic regression model where the percent lichen-moss coverage was a predictor of lingonberry fruit presence: *log odds (lingonberry fruit in a plot given lichen-moss coverage in a plot) = – 1.557 + 123.275x.* Here the odds of lingonberry fruit presence in a particular plot rose by a factor of $e^{123.275}$ for each one-unit increase in percent lichen-moss coverage.

	B	S.E.	Wald	df	Sig.	Exp(B)
Lichen-moss coverage	123.275	64.563	3.646	1	0.056	3.450E53
Constant	**-1.557**	**1.159**	**1.806**	**1**	**0.179**	**0.211**

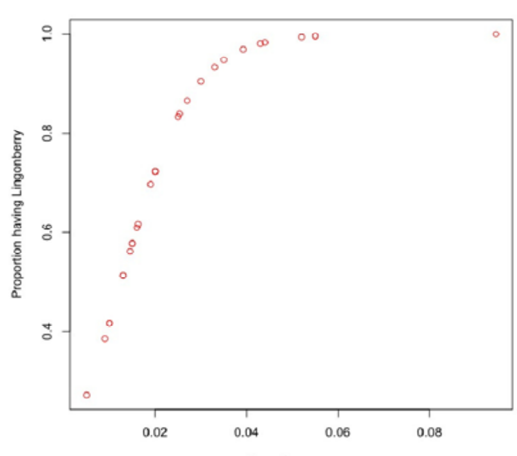

Figure 4-3: Plot of moss coverage versus likelihood of lingonberry fruit presence.

Table 4-4: Summary of the binary logistic regression model where the percent woody debris coverage was a predictor of lingonberry fruit presence: *log odds (lingonberry fruit in a plot given woody debris in a plot) = -0.814+25.093x*. The odds of lingonberry fruit presence in a particular plot increased by a factor of $e^{25.093}$ for each one-unit increase in percent debris woody coverage.

	B	S.E.	Wald	df	Sig.	Exp(B)
Woody debris coverage	25.093	17.559	2.042	1	0.153	7.903E10
Constant	**-0.814**	**1.223**	**0.443**	**1**	**0.506**	**0.443**

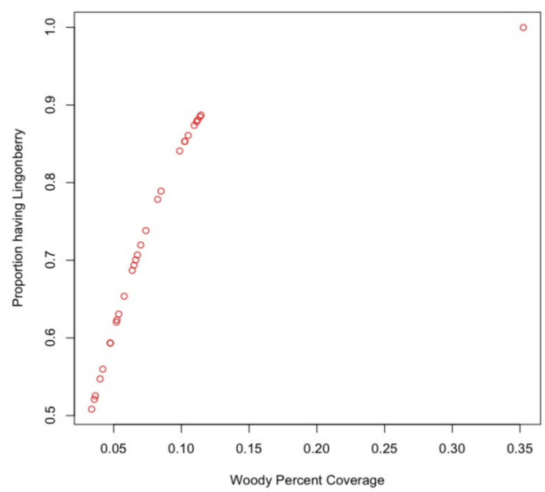

Figure 4-4: Plot of woody debris coverage versus likelihood of lingonberry fruit presence.

Table 4-5: Summary of the binary logistic regression model where percent coverage of the shrub layer was a predictor of lingonberry fruit presence. *Log odds (berries in a plot given several shrub species in a plot) =* $0.785 - 3.236x_{honeyberry} + 5.479x_{Juniper} + 2.595x_{Siberian\ dwarf\ pine}$. The odds of lingonberry fruit presence in a plot decreased by a factor of $e^{-3.236}$ for each one-unit increment in the percent coverage of honeyberry; the odds increased by a factor of $e^{5.479}$ for each one-unit increment in the percent coverage of juniper, and by a factor of $e^{2.595}$ for each one-unit increment in the percent coverage of Siberian dwarf pine.

	B	S.E.	Wald	df	Sig.	Exp(B)
Percent coverage—Honeyberry	-3.236	9.143	0.125	1	0.723	0.039
Percent coverage—Juniper	5.479	9.444	0.337	1	0.562	239.698
Percent coverage—Siberian dwarf pine	2.595	7.247	0.128	1	0.720	13.402
Constant	**0.785**	**0.846**	**0.862**	**1**	**0.353**	**2.193**

Table 4-6: Summary of the binary logistic regression model where composite variables of percent coverage of the following forest layers predicted lingonberry fruit presence: shrub, herbaceous-subshrub, woody debris, and lichen-moss. ***Log odds (berries in a plot given shrub, herbaceous-subshrub, woody debris and lichen-moss coverages in a plot) = $-10.443 - 2.326x_{shrub} + 2.255x_{herb} + 66.018x_{woody} + 292.078x_{moss}$.*** **The odds of lingonberry fruit presence in a plot decreased by a factor of $e^{-2.326}$ for each one-unit increase in percent shrub coverage; they grew by a factors of: $e^{2.255}$ for each one-unit increase in percent herbaceous-subshrub coverage; $e^{66.018}$ for each one-unit increase in percent woody debris coverage; and $e^{292.078}$ for each one-unit increase in percent lichen-moss coverage.**

	B	S.E.	Wald	df	Sig.	Exp(B)
Shrub coverage	-2.326	6.270	0.138	1	0.711	0.098
Herbaceous-subshrub coverage	2.255	5.671	0.158	1	0.691	9.533
Woody debris coverage	66.018	36.576	3.258	1	0.071	4.692E28
Lichen-moss coverage	292.078	195.537	2.231	1	0.135	7.043E126
Constant	-10.443	6.829	2.338	1	0.126	0.000

Table 4-7: Summary of the binary logistic regression model where overstory and understory density were predictors of lingonberry fruit presence. In this model, both factors of overstory and understory density have an eβ equal to 1.

	B	S.E.	Wald	df	Sig.	Exp(B)
Overstory density	0.000	0.000	0.314	1	0.575	1.000
Understory density	-0.003	0.001	2.981	1	0.084	0.997
Constant	1.815	0.684	7.048	1	0.008	6.139

Factors affecting the abundance of lingonberry in a plot

The percent woody debris coverage appeared to be associated with higher fruit yields; in contrast, the percent coverages of the lichen-moss and shrub layers, and the mean abundance of the herbaceous-subshrub layer, were associated with lower fruit yields. (*Refer to Table 4-8*.)

Table 4-8: Results of linear regression modeling data on fruit count. (Only data on the plots that had fruit counts were used). A square-root transformation was done on the dependent variable to ensure a more normal distribution.

	B	S.E.	T-Stat	Sig.
Intercept	12.46	2.99	4.15	0.001
Lichen-moss coverage	-54.84	29.41	-1.86	0.061
Woody debris coverage	30.86	12.28	2.51	0.014
Shrub coverage	-3.51	5.83	-0.602	0.549
Herbaceous-subshrub abundance	-0.138	0.4947	-0.281	0.7796

The second linear model was fit using average fruit counts for each plot. A square root transformation was also applied to this model; however, in this case it did not correct for non-normality due to what looked like a bimodal distribution of fruit. (*Refer to Table 4-9*.) This model produced results analogous to those in *Table 4-8*: all of the signs (negative, positive) were consistent (except those for herbaceous-subshrub abundance). The significance level, however, was very different. These results were most likely attributed to less variation in the predictors, and in the dependent variable, owing to the calculations of means. In both models, the R-squared (or the percent of variance explained) was approximately 0.10, which was not particularly high. In these analyses, however, the R-squared metric was less important as the emphasis was on identifying associations, instead of on prediction.

Table 4-9: Results of linear regression modeling data on mean fruit count for each plot. (Only data on the plots that had fruit counts were used). A square-root transformation was done on the dependent variable to ensure a more normal distribution.

	B	S.E.	T-Stat	Sig.
Intercept	15.61	5.68	2.74	0.014
Lichen-moss coverage	-53.29	54.53	-0.977	0.342
Woody debris coverage	4.26	17.43	0.245	0.809
Shrub coverage	-7.92	11.24	-0.705	0.490
Herbaceous-subshrub abundance	0.016	0.944	0.0 17	0.986

Graphical Analyses

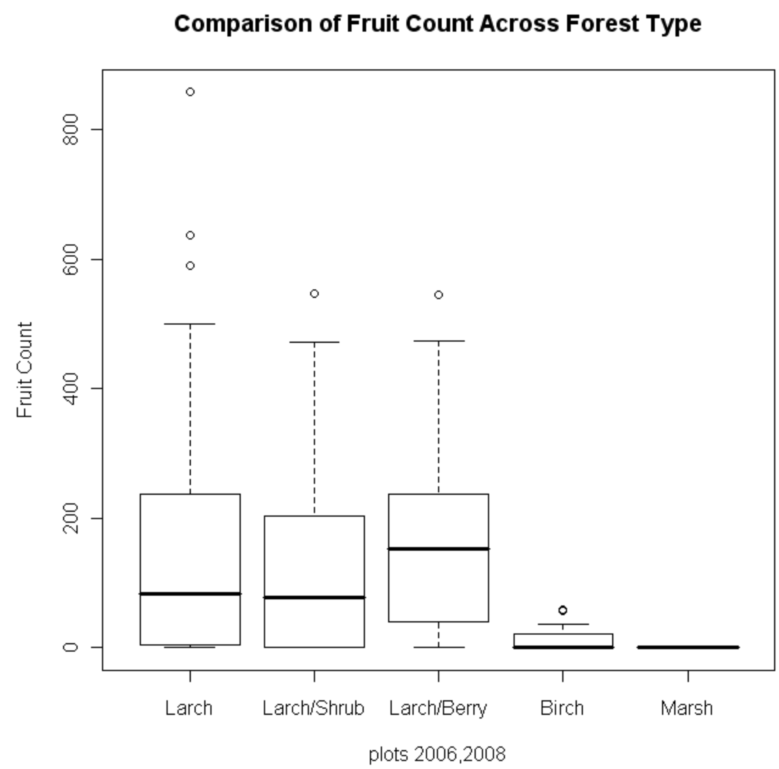

Figure 4-5: Side-by-side box plots for lingonberry fruit count by forest association groups. (Note that Larch = the forest association group of larch-marsh Labrador tea [*Larix dahurica– Ledum palustre*]; Larch-shrub = the forest association group of larch-forb [*Larix dahurica – Rosa amblyotis – Geranium erianthum*]; larch-berry = the forest association group of Larch-lingonberry [*Larix dahurica – Vaccinium vitis-idaea*]; Birch = maturing secondary deciduous forests in either the secondary Larch-forb [*Betula platyphylla – Rosa amblyotis – Geranium erianthum*] or secondary larch-marsh Labrador tea [*Betula platyphylla – Ledum palustre*] forest associations; Marsh = marshland with well-developed shrub and herbaceous-subshrub layers.)

In *Figure 4-5* the highest median fruit count occurred in the larch-lingonberry forest association group where lingonberry is the clear dominant in the herbaceous-subshrub layer; the greatest overall counts were noted in the larch-marsh Labrador tea forest association group. The minimal number of fruits in the maturing secondary deciduous forests likely reflected the poor harvests in 2008, the year in which this group was inventoried, i.e. it did not necessarily indicate unfavorable lingonberry habitat.

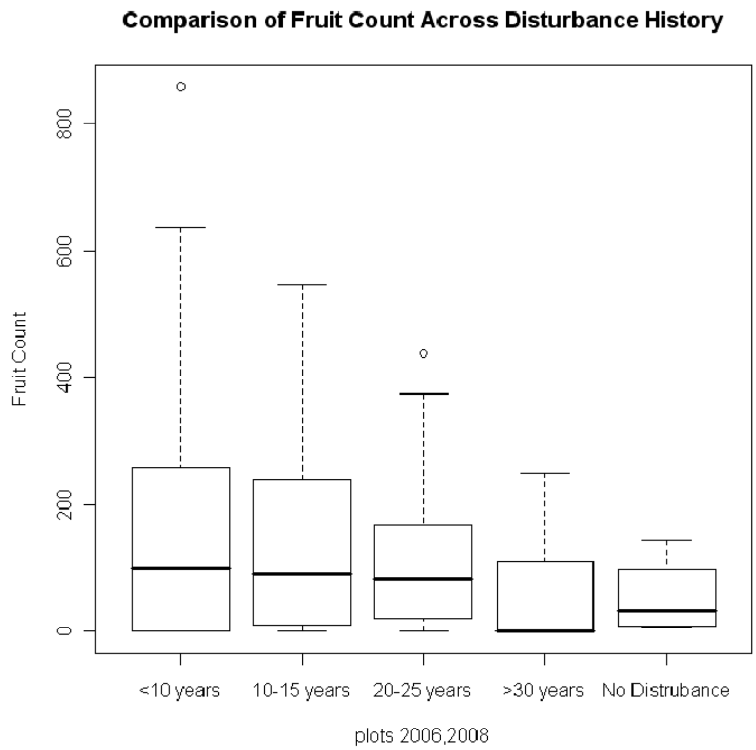

Figure 4-6: Side-by-side box plots for *V. vitis-idaea* fruit count by disturbance history.

Compared to *Figure 4-5*, lingonberry fruit counts with respect to disturbance history had greater variability; at the same time, the median fruit count was approximately the same across the first three disturbance groups (*Refer to Figure 4-6*.) There were, however, noticeably lower counts in plots where a disturbance occurred more than 30 years ago, or not at all.

Discussion

Regression analyses revealed associations between lingonberry fruit yields and variables describing forest structure and composition. The most influential variables in regards to fruit yields, however, differed from what was initially predicted. First, because lingonberry thrives in more open habitats, allowing for the penetration of sufficient sunlight, a lower percent overstory coverage was expected to be significantly associated with more abundant lingonberry harvests. The calculated variable of overstory density (related to overstory coverage), however, showed no association with the probability of lingonberry fruit occurring in a plot, meaning that the presence of fruit was equally likely in areas with both high and low overstory densities. This finding could be explained by relatively high overstory densities even following disturbance, owing to the many thin-trunked larch trees typically left standing, especially following logging.

This scenario allows for sufficient light to penetrate to the forest floor for the successful lingonberry growth and reproduction. The density of understory trees is less important to lingonberry ecology as this layer of primarily deciduous layer tends to be more light permeable. (Highly dense deciduous regeneration is an exception in this case.)

Second, regeneration variables were expected to be associated with higher lingonberry yields since re-growth is a strong indicator of recently disturbed forests. This prediction that also did not hold, which could be explained by the high variability in regeneration (categorized broadly as mature, intermediate, and young) from plot to plot, which made these variables challenging to measure. The variables that were significantly associated with lingonberry yields are examined below in more detail.

Lichen-moss coverage

This coverage had the greatest effect on the likelihood of fruits occurring in a plot; at the same time, it was associated with lower fruit yields. Both ecological and climatic conditions specific to central Kamchatka shed light on these somewhat counterintuitive findings. First, the presence of lingonberry fruits in forested areas with lichen-moss coverage has been documented in previous ecological research in this region (see Turkov 1964, Efremov 1973). This combination is primarily observed in the larch-lingonberry forest association group where lingonberry constitutes nearly the entire the herbaceous-subshrub layer in this species-poor association group. This group represents an intermediate successional stage between the larch-lichen and larch-marsh Labrador tea forest association groups. (The former association is the first to appear after major disturbances, namely volcanic eruptions.) Thus, the larch-lingonberry group is still interspersed with lichens. The relationship between increasing lichen-moss coverage and the likelihood of lingonberry occurrence tapered off past a certain point (*see Figure 4-2*), possibly indicating soils too poor and dry to sustain lingonberry growth. In contrast, where mosses dominate this layer instead of lichens, conditions may be too wet to support lingonberry.

Second, the association of the lichen-moss coverage with lower harvest yields was most likely explained by the unusually hot and dry climatic conditions in 2006 when all plots representing the larch-lingonberry forest association group (with the exception of one) were inventoried. This year saw a poor lingonberry harvest larch-lingonberry forests. Given more favorable harvest conditions, however, it is likely that the lichen-moss coverage would also be linked to higher fruit yields.

Woody debris coverage

Composed of remains from logging or fire, the woody debris layer clearly pointed to disturbed forests. The degree of decomposition in this layer indicated the approximate time lag since last disturbance; thus, a higher percent coverage generally corresponded to forests in earlier successional stages. Consequently, this layer's significant association with lingonberry fruit presence, and with higher fruit yields, helped support the association of lingonberry with early successional forests. Nonetheless, the effect of the woody debris layer on the presence of lingonberry fruit was less than that of the lichen-moss layer, suggesting that the larch-lingonberry forests provide the best lingonberry habitat. Figure 4-4 supported this idea, showing the highest median fruit count in larch-lingonberry forests, even in a poor harvest year.

Shrub and herbaceous-subshrub coverage

Both of these coverages had nominal effects on the occurrence of lingonberry fruit; they also corresponded to lower fruit yields (although not at the significant level). Of the three main shrub species analyzed (honeyberry, juniper, and Siberian dwarf pine), the percent coverage of juniper had the greatest effect on whether lingonberry fruit was present in a plot, which made sense in light of previous research showing juniper as the clear dominant species in the shrub layer of the larch-lingonberry forests. (It's possible that this shrub could have also been associated with higher fruit yields had harvest conditions been different in the year in which data were collected.) In other secondary forest associations shrubs (e.g. honeyberry), subshrubs (e.g. marsh Labrador tea), and herbs (e.g. reedgrass and sedges) out- competed lingonberry for scarce light and nutrients as they filled new niches following disturbances, explaining why the composite variables of shrub and herbaceous-subshrub percent coverage were connected to lower fruit yields.

Summary

Both the binary logistic and linear regressions were effective in modeling empirical ecological data. Specifically, they established distinct associations between lingonberry fruit yields and variables of forest structure and composition, namely the percent coverage of the lichen-moss and woody debris layers. Both layers had significant effects on the presence of lingonberry fruits, such that as the extent of these layers increased, the likelihood of fruit presence in plots rose; at the same time, increases in the coverage of the woody debris layer were significantly associated with higher fruit yields. Given that higher percent coverage of both layers indicated early successional processes, these results verified the connection between early successional forests and abundant lingonberry growth and reproduction. The association of the shrub and herbaceous-subshrub layers with lower fruit yields, although not significant, implied the pattern of waning fruit yields with progressing successional stages, thereby reinforcing this connection. Finally, graphical analysis (*see Figure 4-5*) further corroborated the link between lingonberry harvests and successional processes, showing no to very low fruit counts in the absence of disturbance or in late-successional forests where a disturbance occurred more than 30 years ago.

Conclusion

This chapter built upon the foundation laid in Chapter 2 with original research that showed the significant link between the lichen-moss and woody debris layers and lingonberry harvests. This result was unexpected: it was originally thought that the overstory and regeneration layers would have a significant effect on lingonberry fruiting. Thus, this research suggested that ground forest layers may be of greater consequence to lingonberry dynamics than the highest and middle layers. Moreover, this study helped confirm the association of early successional processes with higher lingonberry yields. These findings provide a starting point in understanding lingonberry gathering patterns, which is the focus of the next chapter.

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Chapter 5

Seeing Forests Through the People's Eyes: An Exploration of Non-Timber Forest Product Gathering Patterns and Local Ecological Knowledge in Central Kamchatka

Prologue:

"Beginning in the 1950s berries—lingonberry, honeyberry, and bog blueberry—appeared in the old cut areas as a result of industrial forestry practices. These berries were large and good. In the 1970s and 1980s there were big harvests [of berries]."—comment from a life-long resident of the village of Kozyrevsk, 2004

"Lingonberry—it's our wealth."("Brusnika—eto nashe bogatstvo.")—Long-time resident of the village of Kozyrevsk

"We make money on lingonberry." ("My delaem den'gi na brusniku.")—Long-time resident of Kozyrevsk

Introduction

In central Kamchatka the month of September has come to mark a time of frenetic activity: villagers expend considerable effort to gather, sort, preserve, and store harvests from both the fields and forests. Their ability to live through the winter is tied directly to what they manage to produce and gather during the summer and fall. These livelihood activities have become central to households during the post-Soviet period. (*Refer to Chapter 7*.) This chapter examines one of these activities, specifically the gathering of non-timber forest products, with a focus on lingonberry, a well-distributed non-timber forest product of high economic and cultural value. Within this overarching framework, this chapter seeks to explore the scope of people's ecological knowledge, and to clarify the fundamental questions of where, how, and why people are gathering. Based on extensive ethnographic fieldwork, this chapter is organized into two main sections, structured around the underlying aims of 1) examining local ecological knowledge (LEK), with a focus on how people perceive and explain variability in lingonberry harvests; and 2) answering where, how, and why people are gathering through quantitative and qualitative methods.

Guiding research question, hypothesis, and predictions

- *What factors affect where, how, and why people are gathering?*

Because people will harvest in ways that maximize the net rate of return per unit gathering time (Smith 1983), the following variables should significantly affect the gathering metrics of intensity, frequency, and number of gatherers and sites per household:

a. Distance from village to gathering site(s);
b. Transportation used to reach site(s);
c. Use of a special gathering tool;
d. Choice to market harvests.

Socio-cultural aspects of lingonberry gathering

In central Kamchatka, lingonberry gathering has simultaneously been a culturally- and profit-driven activity. Here gathering highly resembles gardening: on the one hand, people gather out of tradition and cultural obligation, for instance, there is a tacit expectation that lingonberry should be in every household; on the other hand, they engage in this activity out of necessity. This dual purpose has set lingonberry apart from other non-timber forest products, as evidenced in its consistently high rankings given by villagers. (Twenty-three of the 29 households that ranked non-timber forest products in the survey [in 2006 and 2008] distinguished lingonberry as the most valuable non-timber forest product; 4 households ranked it second; and 2 ranked it third.) In fact, some even described lingonberry as "red gold." Thus, nearly everyone—young and old alike—gathered lingonberry to one extent or another, at least everyone who was not lazy, as one villager pointed out.

This nearly undivided participation harks back to this region's historical dependence on forestry and the ensuing forest culture that brought the majority of people here into close contact with the forests on a daily basis. Gathering is still a prominent part of village culture today. For example, households stockpile lingonberry for the long winter months to provide essential nutrients in the absence of fresh fruits. (The naturally occurring benzoic acid in lingonberry prevents spoilage, making extended storage with minimal processing possible.) Lingonberry has also been part of an important exchange network between friends and relatives: villagers often ship lingonberry to those living outside of central Kamchatka. Finally, for many households marketing lingonberry is a viable way to earn extra income in a region plagued by chronic high employment. One respondent articulated the centrality of lingonberry to village life simply and emphatically: “So, what do you do? Really, how could you not gather lingonberry, if it is around?”

Local Ecological Knowledge

Local ecological knowledge (LEK) is described as “the knowledge and insights acquired through extensive observation of an area or species” (Huntington 2000). This knowledge has typically been attributed to a specific group of people in reference to local ecological processes (see Scholz et al., 2004, quoted in De Freitas and Tagliani 2008). People amass and hone this knowledge through direct and long-term interactions with the physical environment; often LEK is gained through trial and error and through learning based on negative and positive feedback loops (Berkes et al. 2003, quoted in Chalmers and Fabricius 2007). LEK has become an invaluable tool people use to make sense of and predict ecological phenomena upon which their livelihood (or even survival) depends (Huntington 2000). This dependence upon local ecosystems and all they provide, particularly in remote, rural areas makes LEK very valuable (Chalmers and Fabricius 2007). Beyond the communities in which it is honed, LEK has also contributed invaluable insights into local ecosystem processes and services, on which few or little comprehensive scientific studies have been conducted.

Although both LEK and systematic, scientific knowledge produced by a body of research experts (see De Freitas and Tagliani 2008) are rooted in an empirical foundation, they nonetheless have fundamental differences. For instance, whereas widely accepted rules and methods govern scientific inquiry, LEK is commonly relevant at the local level only (Gadgil et al. 2003, quoted in Chalmers and Fabricius 2007). Still, when merged together, these two knowledge bases can greatly enhance one another and expand the overall knowledge of a locality. Researchers (for instance, De Freitas and Tagliani 2008, Huntington 2002, Jiang 2003) have begun to tap into the high potential of LEK to understand ecosystem processes better and to institute more appropriate resource use policies. Chalmers and Fabricius (2007), for example, sought out local experts in a remote region in South Africa to compile LEK on land-cover change dynamics, which they then compared to published scientific reports on the same topic. This study stands out as one of the few that addresses both ecosystem changes and the drivers of these changes.

Despite its advantages, LEK is not foolproof, and is narrow in scope (Chalmers and Fabricius 2007). Its limitations arise from two factors: time and spatial scale (Jiang 2003). LEK tends to build up slowly over time; thus, an influx of rapid changes into an ecosystem, either natural or politically-based (or both), upsets this accumulation of knowledge. People simply do not have time to assimilate such drastic change. Another drawback is the uneven distribution of knowledge across a community due to variation in resource use. Also, LEK can simply be incorrect in some instances (Thompson 1989, quoted in Jiang 2003), owing to differential ability to understand ecosystem processes and their drivers. Despite its drawbacks, the emerging studies on LEK are still poised to make a strong contribution to scientific studies, especially in remote regions where ecological research has been minimal. While it should not be viewed as a surrogate for scientific studies, LEK can fill important gaps in existing data, thereby contributing to the production of "scientifically valid and locally relevant information" (De Freitas and Tagliani 2008).

LEK seemed particularly meaningful for central Kamchatka's rural communities where lingonberry gathering has been vital to the livelihood of many households, especially during the tumultuous early post-Soviet years. This urgency has required people to refine their basic knowledge of lingonberry biology and ecology, which has often coincided with general scientific descriptions of this species. LEK is especially relevant in this region where few (if any) scientific studies on lingonberry have been undertaken. An exploration of LEK, specifically as it related to lingonberry, provided a critical backdrop against which to situate the crux of this chapter on people's gathering behaviors and practices. It also set the stage for the juxtaposition of LEK with scientific knowledge in the Chapter 6.

Materials and methods

Survey structure

In frequent interactions with the natural world, people in central Kamchatka have acquired distinct ecological knowledge that has informed their harvest of local natural resources, including plant, wild animals, and fish. To capture this unique knowledge, a semi-structured household survey was conducted in a sample of households from five villages in central Kamchatka. This method of measuring the experiences and activities of individual households has proven useful in previous studies of people's interactions with the land (Axinn and Barber 2002). Difficulties with this method arise, however, due to the absence of an established definition of a household, and to fluid household composition (i.e. members joining and leaving) (Axinn and Barber 2003). In the central Kamchatkan sample, for instance, there were cases of extended families (e.g. grown children, grandchildren, and grandparents) that lived in physically separate dwellings, yet shared nearly all resources and the work necessary to gather or produce them. Despite such ambiguities, the survey elucidated prevalent gathering patterns, and people's accumulated ecological knowledge.

Wide in breadth, this survey included questions on household acquisition, processing, and use of common non-timber forest products. It also posed several questions specific to lingonberry gathering. Households were sampled haphazardly (in the 2004 pilot season), and systematically using local maps on which every house and apartment unit was delineated (in 2006). In 2008, the method of chain referrals (Huntington 2000, Bernard 2002) was employed to locate demographically and socio-economically underrepresented households in the 2006 sample. Thus, although the overall sample size was relatively small (N=109), due to time and labor constraints, it nonetheless was intended to be representative of the central Kamchatkan population, nearly all of which engages in gathering to one extent or the other.

Composed of open-ended and short answer questions, this survey elicited both qualitative and quantitative data on lingonberry, and on the gathering patterns and behaviors associated with it. The quantitative data were used to build a data table, which included the calculated variables of total time spent gathering (in hours) and overall gathering rate (liters of lingonberry/hour) for each household. (*Refer to Table 5-1 for a listing of variables*.) The qualitative data came from responses to the following inquiries: 1) Describe the forest where you collect lingonberry; and 2) What changes have you observed in lingonberry harvest rates throughout the time that you have gathered this resource in central Kamchatka?

Amassing the quantitative data from all collection periods proved challenging given its non-uniformity, which was due in part to a modification of the survey following the 2004 pilot season during which specific information was not collected on the total number of days and hours per day spent gathering as it was in subsequent seasons. Still, respondents in 2004 did cite general gathering rates (including those under differing harvest conditions, i.e. poor, average, and abundant), which in conjunction with total amount gathered were used to get a rough calculation of overall gathering rate. Also, variance in people's recall ability or way of answering questions, left gaps in the data set or produced information that required additional interpretation based on some general assumptions (see Moran et al. 2002). To illustrate, respondents often reported that they gathered for the "entire day," or for "half a day." These responses were assigned the more specific categories of 7 and 4.5 hours, which were based on direct observations of gathering. Finally, the variable of total time spent gathering per day was adjusted where reported gathering time included travel time to sites. In this case, a household's reported traveling time to sites was used; where travel time was not reported, mean travel times were calculated. These ambiguities underscored the importance of cross-checking responses with direct observations wherever possible, a method detailed in the following section.

Direct participant observation: gathering trips

An essential complement to the survey was participation in and direct observation of gathering activities and behaviors. These observations included: travel time to site and distance from village to site; total time spent gathering, exact amounts gathered by each person; and methods of gathering. These observations were critical in troubleshooting responses that seemed misreported (either intentionally or unintentionally). This method, however, was restricted due to the difficulty experienced in arranging trips, which could be attributed to several factors, including: 1) limited space—many people traveled to sites on motorcycle and were not able to take extra gatherers; 2) threat of competition posed by an extra person; 3) wariness in divulging one's 'own' gathering sites; and 4) spontaneously planned trips occurring in a narrow window of time during the very busy fall harvest season. Even though direct participant observation was not as widely employed as the survey, it nonetheless gave gathering activities a dimensionality that would have otherwise been missed.

Table 5-1: Summary of variables on lingonberry gathering.

Variable Type	**Description**
Basic Descriptive Variables:	• Household code and location (village); • Year in which gathering took place.

Categorical variables:	• Location of gathering sites from village (one way):
	    o 1= < 5km
	    o 2= 5-15 km
	    o 3= >15 km
	• How sites were reached (i.e. by which transportation mode):
	    o 1= foot, bicycle
	    o 2= motorcycle
	    o 3= car (or tractor)
	• How gathering was done (i.e. was a special tool used to expedite gathering?):
	    o 1= no
	    o 2= yes
	• Was all or part of the harvest sold?
	    o 1= no
	    o 2= yes

Continuous variables:	• Total amount of lingonberry harvest collected; • Total amount of harvest sold (where applicable); • Total number of adult gatherers in a given household; • Total number of gathering sites; • Gathering frequency or total number of hours gathered (per household) ([total gathering days] x [hours gathered per day]); • Gathering intensity (liters/hour) ([total amount gathered]/[total number of hours spent gathering]); • Approximate gathering rate (liters/hour) reported for average, below-average, and abundant harvests.

Data Analyses

Factors affecting gathering metrics

A general linear model was used to test the effect of four categorical variables on gathering metrics. The categorical variables of distance from village to gathering sites, transportation, tool use, and marketing were the fixed factors in this model; the gathering metrics of intensity, frequency, total number of gatherers (per household), and total number of sites (per household) were the dependent, continuous variables. Year was also added as a fixed factor to account for harvest variability. (Note that 2003 and 2006 were the years for which there was the most data; they indicated the timing of the surveys that were completed early in 2004 and late in 2006, respectively. Since there was virtually no harvest throughout central

Kamchatka in 2007, the survey done in 2008 actually recorded data on the 2006 season.) A custom model in SPSS was specified in which the main effects option was chosen for all factors entered. Parameter estimates and homogeneity tests were specified for each model (the latter ensured that the assumption of equal variances was not violated).

Descriptive Statistics

Descriptive statistics were compiled on all gathering metrics: intensity, frequency, total number of gatherers per household, and total number of sites visited per household. The total amount of lingonberry gathered (liters) and the total amount sold (where applicable) were also included. In addition, mean harvest rates for years of abundant, average, and poor harvests with and without tool use calculated. Independent t-tests compared the means of all these variables between 2003 and 2006. Frequencies were computed for the following categorical gathering variables: distance of gathering sites from village; transportation type; tool use; and marketing of harvests. Chi-square was used to test the relationships between the categorical variables.

Results

A time to gather and a time to search: LEK in central Kamchatka

Gatherers in central Kamchatka have become acutely aware of the strong environmental and climatic variability shaping and reshaping the landscape in this region, and the living systems within it, including lingonberry plantations. While some gatherers described lingonberry harvests as threatened, implying an imminent end to them, others expressed a more tempered view, acknowledging overall decline punctuated by abundant harvests. For instance, one lifelong gatherer remarked: "Lingonberry has decreased a lot, yet there are still abundant harvest years."[16] This observation revealed the intertwined nature of periodicity and overall decline in lingonberry dynamics. Both defined change; however, periodicity referred to proximate, or short-term (i.e. annual) changes, while decline entailed ultimate, or long-term changes. The majority of gatherers distinguished between these two interrelated, yet separate changes in their explanations of what caused them. Overall, periodicity seemed to be associated with natural phenomenon beyond the realm of human control (weather, for instance), while decline appeared to arise as a result of anthropogenic influences (e.g. logging

[16]Note that all direct quotations appearing in this chapter are my translations of responses to survey questions. (*Refer to Table C-1 in Appendix C for a full listing of surveys by date and location.*)

and gathering activity). In the absence of official data, the memory of gatherers—especially those with life-long experience—proved a powerful medium through which to explore the competing, and at times, complimentary, notions of periodicity and decline.

Periodic harvests

Variability in lingonberry yields seemed second nature to many gatherers. Periodicity in time and space crystallized in gatherers' observations, as articulated below:

> Not every year is a harvest year for lingonberry—maybe every other year. Harvests occur in different forest sections, so it's necessary to search for it [lingonberry].
>
> Sometimes there are very abundant harvests, sometimes none at all.
>
> In one year there are berries in one place, in another year—in another place. The forest also lives by its own laws.

Such insights were particularly evident in the words of those who earn income from this activity. These gatherers have culled a nuanced knowledge of lingonberry dynamics from their years of work in the forests, as embodied in the words below:

> Lingonberry harvests are not changing: if there is no harvest in the site where we gathered the previous year, it will reappear in two to three years.
>
> There is not a lingonberry harvest every year—the forest is very capricious: one year there is a harvest, and then there is no harvest for three years.
>
> There is a good harvest year, then two years of poor harvests. Then there will be a good harvest.

Climate and harvest dynamics

Some gatherers likened the cyclic harvest rhythms of lingonberry to those of agricultural crops, stressing the tendency of nature, specifically of forests and lingonberry plantations, to "rest." The vast majority, however, made explicit the connection between dynamic harvest patterns and prevailing weather conditions, as exhibited in the words of the following gatherer: "There are almost always very abundant lingonberry harvests once every four years. A lot depends on the wind, and on the amount of snow." This notion that lingonberry harvests depended on the weather was voiced countless times. Yet, local knowledge extended far beyond this general theme: many people could link specific aspects of climate to the success or failure of lingonberry harvests in a given year. For instance, the amount of precipitation was considered pivotal to good lingonberry yields. A simplified version associated rain or a "damp" summer with abundant harvests, and a lack of it (rain), or a dry summer, to poor harvests.

Snowfall, as indicated above, was also an essential element: above average quantities of it saturated dry soils in open habitats, thereby providing essential moisture during the fruiting period. Ample moisture in the soil during this period, and throughout the growing season, resulted in high lingonberry yields. According to another gatherer, a high moisture level also ensured large fruits at the time of harvest. Conversely, sparse snow cover and generally low precipitation levels were deemed to have a negative effect on harvests. Gatherers in Kozyrevsk observed these relationships firsthand in 2005 when wetter than normal conditions during the spring flowering period produced profuse fall harvests in the prominent gathering region referred to as "Kul'" in the vernacular. (*Refer to Figure 5-1.*)

In addition to precipitation, temperature was also described as a crucial factor influencing harvests. Although the role of sunlight in lingonberry development could not be understated, gatherers often told how it was clearly detrimental past a certain threshold. Intense sunlight during the flowering period caused the flowers to wither, thereby impeding pollination, and ultimately a good harvest. Many gatherers relayed how the combination of hot and dry conditions scorched (*vygorit'*) the berry, particularly in open areas where there was no buffer in the form of a dense herb and subshrub layer, which shields lingonberry from sun overexposure, and moderates temperature and moisture levels. In contrast, people told how late spring frosts during the flowering and pollination periods struck down harvests, with the immediate result that "everything was gone."

Additionally, characteristically strong winds during the flowering and pollination stages were frequently mentioned as forces that sabotaged harvests. Ash fall from volcanic activity also noticeably influenced harvests. While some held volcanic influence as a positive factor in harvest dynamics and fruit quality, others recalled its harmful effects. One keen observer and long-time resident of the region told how ash fall raises the topsoil temperature, causing "everything to burn." In contrast, another seasoned gatherer connected higher than average lingonberry harvests to heavy ash fall. This discrepancy may have arisen over the exact timing of ash fall: whereas it could be damaging in the summer, if it occurred in the winter it could enrich the soils with the spring snowmelt. Scientific research demonstrated that despite its nutrient rich properties, volcanic ash nonetheless negatively affected larch regeneration most likely due to the absence of humic elements (e.g. nitrogen and phosphorous) in the ash (Turkov 1964). The absence of these key elements was likely detrimental for lingonberry as well. Besides ash fall, dry rivers—another product of volcanic activity—have also proven detrimental to lingonberry harvests. For instance, the shifting sands of these rivers have literally buried gathering sites, for instance those near the former village of Kravche and Bobrovskoe ozero (lake) where people remember collecting copious harvests (*refer to Figure 5-1*).

In this highly volatile climate, gatherers stressed moderation as the key to abundant harvests: "If the summer is neither too hot nor too rainy, and if the frosts did not kill the flowers, then there will be a harvest." In just the right amounts, sun and rain can conspire to produce harvests where, as one gatherer put it, "it's possible to gather an entire bucket from the plantlets on one stump in about half an hour. The berry is very large and wonderful to pick and eat." Although such harvests do occur, the balance of light, moisture, and other elements in which they are cultivated is delicate and rarely occurs every year, a phenomenon of which gatherers are acutely, if not regrettably, aware. Overall, gatherer's keen knowledge of lingonberry biology and ecology very closely paralleled scientific descriptions of this species. (*Refer to the section on lingonberry biology and ecology in Chapter 4.)*

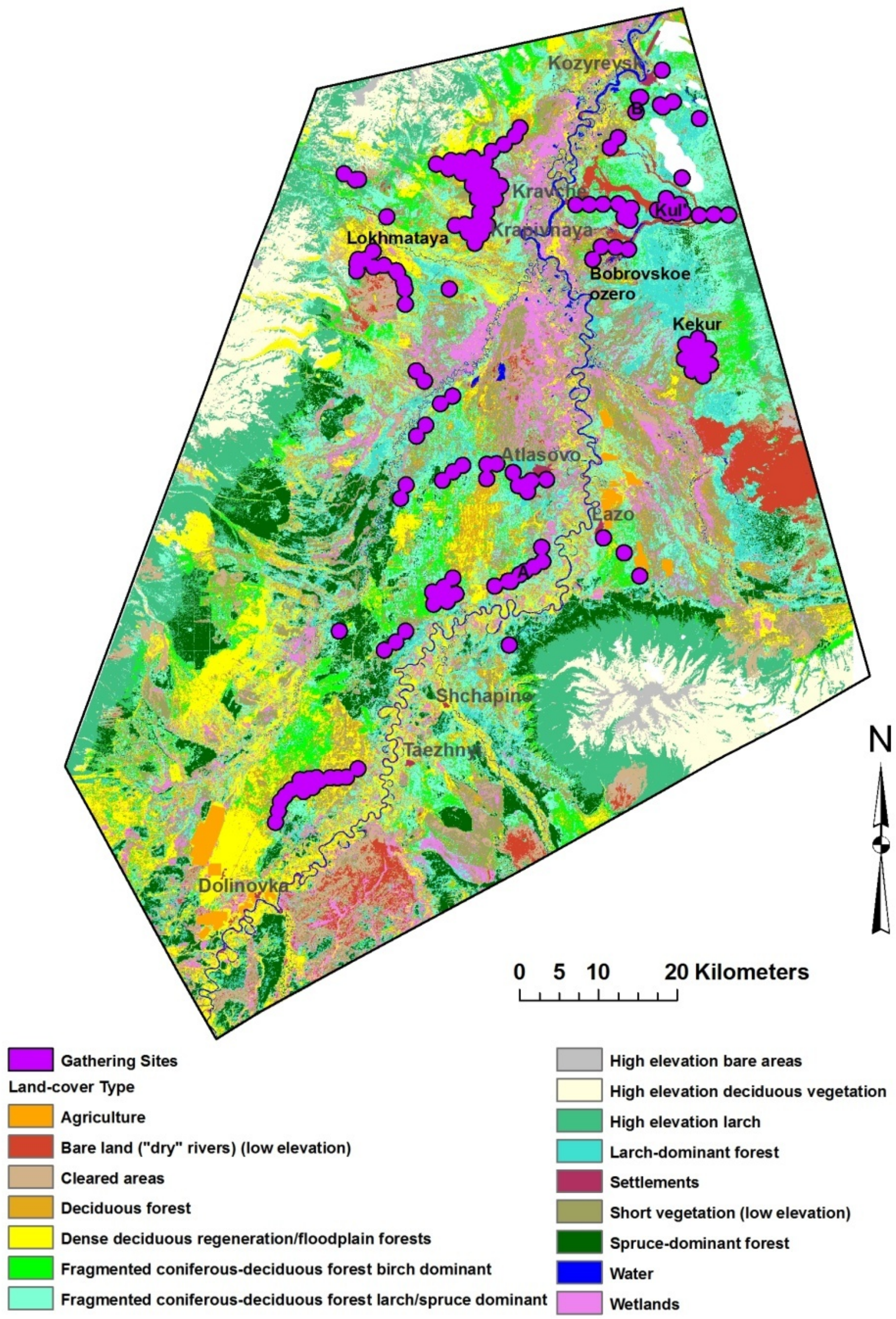

Figure 5-1: Land-cover map of the study site in the central Kamchatka depression. Gathering sites are delineated by polygons on the map; the names of key sites appear in black. (Villages, both former and current, are labeled in gray.)

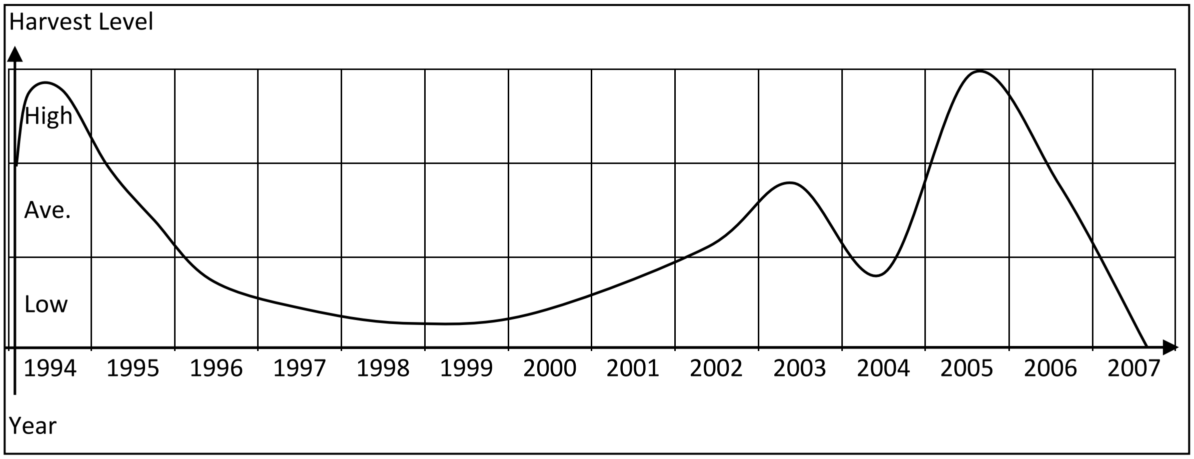

Figure 5-2: Lingonberry harvest trends from 1994 to 2007 in the region of Kozyrevsk.

Cyclic trends:

While a few gathering grounds (for example, Kul', or the area that adjoins the Kamchatka River south of Atlasovo, *refer to site A in Figure 5-1*) are renowned for their consistent harvests, periodicity in yields seemed to be the rule, instead of the exception, as demonstrated by a rough sketch of harvest trends in the region surrounding Kozyrevsk. Based on the collective memory of villagers, this diagram approximately depicts periodicity in harvests over a fourteen-year period. (*Refer to Figure 5-2*). Besides periodicity, this figure also suggested high unpredictability in yields, which was exemplified by the fairly long fallow period from approximately 1996 to 2001, and the rebound following it. Villagers attributed poor harvest years (for example, 1998 and 2004) to inopportune frosts during the flowering and pollination periods; at the same time they noted localized bumper yields, such as 2003 when, according to one knowledgeable gatherer, the “entire village of Kozyrevsk” gathered in a single region abutting the village (*refer to site B in Figure 5-1*). (This region was logged in the early 1990s.)

This same year marked a dry spell in Kul’, where there was essentially no harvest, as the berry “burned,” according to one villager. Yet, in 2005 there was a nearly unprecedented harvest in Kul’ that became legendary in the minds of many villagers. 2006 was comparatively disappointing, although there were decent harvests in proximity to the village (in the same area where people gathered in 2002 and 2003). Finally, according to some experienced gatherers, in 2007 the dearth of harvests throughout central Kamchatka was likely a consequence of heightened volcanic activity, including increased ash fall. In this year a few villagers managed to collect the bare minimum for household needs (for example, 10 liters), or they relied on reserves from the previous season, or simply went without lingonberry.

In the village of Atlasovo, approximately 50**)** km south of Kozyrevsk (as the crow flies), a different picture of gathering dynamics unfolded during the fourteen-year time period noted above, yet it, too, was spiked with the periodic highs and lows of plentiful and sparse harvests. One gatherer described a mental map in which he categorized general gathering regions based on which side (north or south) of the Kamchatka River they were found. He then explained the tendency of harvests to alternate between these two regions from year to year. This phenomenon attests to the landscape complexity of the central Kamchatka depression where favorable harvest conditions fluctuate noticeably within micro-regions. To illustrate, the mediocre harvest in 2006 in the Kozyrevsk region was dwarfed by exceptional lingonberry yields in the central and southern parts of the central Kamchatka River depression. During this season one collection point in Atlasovo alone took in over 16 tons of lingonberry, 3 of which were from the vicinity of the village of Dolinovka where an abundant lingonberry harvest occurred for the first time in eleven years. The perspective of local gatherers helped delineate the scope of this harvest:

> There were a lot of berries—there was nowhere to step; the berries were very large.
>
> There were such good berries in this year [2006].

In the absence of scientific studies on long-term patterns in lingonberry yields, LEK, albeit not entirely complete, nonetheless proved invaluable in discerning the nature of periodicity observed in central Kamchatka. Yet, as gatherers clearly referred to local ebbs and flows in harvest dynamics, the issue of a global decline in both the quantity and quality of lingonberry was also voiced.

Declining harvests

The following recollection by a life-long resident of Kozyrevsk painted the picture of lingonberry decline in large brushstrokes:

> Beginning in the 1950s as a result of the forestry industry lingonberry, honeyberry, and bog bilberry appeared in the old cut areas. The berries were large and good. In the 1970s and 1980s there were large harvests, but now the harvest levels are falling.

Other villagers who have lived and gathered in this region since their early childhoods have filed years of visual data in their memories by which they gauge current harvests. For instance, one woman recalled how harvests today are clearly less than those when she gathered for the *gospromkhoz* (the Soviet state organization that was responsible for non-timber forest product collection, processing, and distribution): "We went on gathering trips with the *gospromkhoz*. We crossed the dry rivers, and there were expanses full of lingonberry. [Today] you only come across it in places." Finally, one highly experienced gatherer confirmed this downward spiral of lingonberry harvests in more concrete terms: in one specific site where they used to gather 300 liters, they gather only 5 today. Another gatherer corroborated this decline based on her recollection of harvests in the mid-1980s, positing that this picture might be different if the *gospromkhoz* still existed and regulated lingonberry harvesting today.

Overall, evidence supporting global harvest decreases was rife. A younger woman, for instance, related how current harvests could not parallel those in the past, which allowed her grandmother to collect by hand (i.e. without a specialized tool used to accelerate gathering rate) up to 80 liters in one day in the mid-1970s to 1980. An elderly couple remembered "a lot more berries" even in the relatively recent past, or 10 to 15 years ago. And, another older woman stated emphatically that there used to be "patches and patches [of lingonberry] such that one couldn't tear oneself away from them." Finally, one woman who arrived in Atlasovo in 1968 shared this evocative account:

> It was like Switzerland here: a corner of paradise. There was taiga forest around, but now they have sawed down everything, and there is little rain…In those places where we used to gather, in the old logged areas, lingonberry is not there. In the new cuts people with special tools [*sovki*] tear out the plantlets by the root. Now there are no longer such large berries—they have snatched them all.

While there could have been lapses or inaccuracies, overall people's recollections seemed consistent, validating harvest decline. (*Refer to Table 5-2 for more expressions of decline.*) In fact, it was virtually indisputable among villagers that bountiful lingonberry harvests spilling out onto the forest floor have become remnants of the past. Besides quantity, many have recognized a marked decrease in the quality of harvests.

Table 5-2: Gatherers' observations of the declining state (in terms of both quantity and quality) of non-timber forest products, in general, and lingonberry harvests, in particular, in the central Kamchatka depression.

Decline of lingonberry harvests:	***Overall decline:***
"There is less lingonberry today." "The amount of lingonberry has been decreasing since my childhood." "Overall, in the past five years lingonberry and (honey berry) harvests have become a lot worse." "Formerly, there were much larger harvests [of lingonberry]." "People uproot the lingonberry plantlets in fresher cuts with tools [*pl. sovki*]. Now the berry is no longer as large as it once was."	"Formerly, there were larger harvests, now there are fewer." "Now, of course, harvests are less." "Berries and the forest—everything used to be better. For instance, berries used to be a lot larger in the past." "In general there used to be more non-timber forest products in the forests." "Harvest yields are decreasing from year to year."

Nostalgia notwithstanding, the collective memory highlighted some commonly accepted reasons why downward trends have occurred, including competition among gatherers for scarce resources combined with the increased use of technology (i.e. specialized tool and car). One gatherer voiced the following insight: "We are not the only ones gathering—many others are gathering, too. Perhaps it [decline in harvests] is due to resource depletion, gathering methods, or to weather." No doubt, it is difficult to isolate these interwoven causes affecting lingonberry harvests; however, a quantitative look at gathering practices reflected in mean harvest volumes collected and sold, and mean gathering intensity and frequency, proved a good starting point. (*Refer to Table 5-3.*)

Table 5-3: This model showed that the predictor variables of tool use and marketing had a significant effect on the dependent variable of gathering intensity. The B parameter estimates indicated that the variables of not collecting with a tool [Tool=1], or not selling one's harvest [Marketing=1], were associated with decreases in gathering intensity. Although there was a significant relationship between marketing and tool use, the latter had the strongest effect on gathering intensity. Year was also taken into account; however, year and the predictors of distance and transportation had no significant effect on gathering intensity. Statistics for corrected model: df=7; F=4.009, p = 0.001; R Squared = .260 (Adjusted R Squared = .195).

Parameter	B	Std. Error	T	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	8.082	.748	10.803	.000	6.593	9.571
[Tool=1—**not used**]	-2.039	.850	-2.400	**.019****	-3.730	-.348
[Tool=2—**used**]	0[a]	.	.	.	.	.
[Marketing=1—**not sold**]	-1.655	.786	-2.107	**.038****	-3.219	-.092
[Marketing=2—**sold**]	0[a]	.	.	.	.	.
[Dist=**<5 km**]	.402	.963	.417	.678	-1.515	2.318
[Dist=**5-15km**]	1.351	1.060	1.274	.206	-.759	3.461
[Dist=**>15km**]	0[a]	.	.	.	.	.
[Transport= **foot, bicycle**]	-1.401	1.365	-1.026	.308	-4.118	1.316
[Transport =**motorcycle**]	-.791	.913	-.866	.389	-2.608	1.027
[Transport =**car**]	0[a]	.	.	.	.	.
[Year=**2003**]	.533	.700	.761	.449	-.860	1.926
[Year=**2006**]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant. ******Significant at the 0.05 level

Discussion

To summarize, quantitative data analyses (*see also Appendix C*) marked the beginning in understanding post-Soviet gathering patterns in central Kamchatka. The univariate analysis (*refer to Table 5-3*) supported two of the original four predictions: tool use and marketing were significant factors in determining gathering intensity. Namely, the use of a tool in gathering, and the marketing of harvests were significantly associated with increases in gathering intensity. Higher gathering intensities translated into greater total volume collected. The difference in these volumes between those who do and do not gather for profit was highly significant (*Table 14*). It was also interesting to consider variation in total amount gathered by year. Those who marketed harvests gathered a much higher volume of lingonberry in 2006 compared to 2003, suggesting that 2006 was a more abundant harvest year. At the same time, the mean volume for those who gathered for household use only was higher in 2003 than in 2006, which possibly indicated a decreasing dependence on lingonberry gathering as economic conditions slowly improve in central Kamchatka.

Chi-square analyses were useful in establishing basic gathering patterns, specifically those dependent upon technology, for example, cars (or other large vehicles) and a specialized gathering tool. First, increasing distance to sites corresponded to traveling to these sites by car, which was expected. This analysis also revealed the extent of this relationship: most gatherers traveled 15 km or more by car to reach gathering sites; at the same time, cars were most often used to traverse shorter distances (5-15km), and it was not uncommon for cars to be used in a less than 5-km radius of the village. These results could point toward the novelty of car ownership in post-Soviet Russia that compelled people to travel by car if it was at their disposal. Second, transportation by car was significantly associated with tool use (in 2006 only). In this year nearly every gatherer who used a tool also reached sites by car. This finding could have reflected the abundant harvest levels in some areas of the central Kamchatka depression in 2006, demonstrating people's response to increased resource availability in which they employed the necessary technologies to maximize amount harvested. Third, the significant relationship between tool use and marketing of harvests seemed obvious: most gatherers who sold their harvests used a tool. In fact, the mean volumes gathered by those who sold harvests would likely not have been achieved without the use of a tool. (*Refer to Tables C-9 – C-11 in Appendix C.*)

Against this backdrop it appeared that gatherers have become increasingly differentiated along the lines of available gathering technologies: those with access to cars were able to travel further to sites that supported marketable harvests. Once at these sites, gathering tools allowed them to amass significantly higher volumes (in some cases nearly double) than gathering without a tool, regardless of harvest level in a given year (i.e. poor, average, or abundant). (*Refer to Table C-14 and Figure C-2 in Appendix C*.) Those without access to these technologies were greatly limited in where and how much they could gather. Consequently, these gatherers—most commonly the elderly—collected at subsistence level at best. There were also gatherers in the middle of this technical divide, for instance, those with motorcycles who did not use a tool, perhaps due to limited cargo space in which to transport large harvests.

Although these quantitative analyses were useful in delineating broad patterns, they nonetheless failed to capture many of the nuances in the people's gathering patterns. Here the ethnography is illuminative, offering keener insights into these patterns and how they are shaped. Many people clearly expressed a split between past and present patterns, suggesting new practices and behaviors that have punctuated previous ways of doing things. The four major influences on gathering—distance to sites, type of transportation used to reach these sites, use of a specialized tool, and the choice to market harvests—are further explored through the lens of ethnography in the next section to understand the guiding questions of this chapter more thoroughly, or where, how, and why people are gathering in the landscape.

Ethnography of gathering

Building upon local ecological knowledge and the basic gathering practices informed by this knowledge, this ethnography contextualizes people's interactions with the forests in central Kamchatka. Tapping into rich and textured accounts of gathering, it explores new dimensions of the core questions of where, how, and why people are gathering. Moreover, this section relates these accounts to the ecological, social, and economic factors influencing gathering. For instance, it considers how people have responded to the phenomena of periodicity and overall decline in lingonberry yields, and to a concurrent socio-economic crisis, in their gathering patterns.

Where are people gathering in the landscape?

In terms of place, gathering in post-Soviet central Kamchatka has been virtually unbounded by any political constraints. In fact, the geographical complexity of the region, as opposed to such features as private property (which is still non-existent), has been the primary limiting factor in where people can gather in the landscape. Even this barrier is diminishing as the population acquires more and better forms of transportation. Thus, given the numerous new possibilities, how have people settled on where to gather?

One's "own" gathering site

An obvious advantage of central Kamchatka's gathering culture has been exposure to a wealth of options, which along with accumulated experiences, has led to the designation of one's "own" sites. Although this sense of ownership is more conjectural than factual, people still exhibited strong attachment to "their" sites to which they return yearly. One gatherer described a deep bias toward her sites, which she clearly distinguished from unfamiliar gathering places in which she described feeling like a guest at someone's home. While such attachment may have been extreme, this gatherer was not alone: few people expressed staking out new gathering territories every year. At the same time, most gatherers had more than one site in their repertoire, which gave them recourse when their sites were fallow in a given year, or when they had already been picked over by other gatherers.

The concept of one's "own" site suggested stability within the landscape that was hardly the case in actuality. The patchy nature of lingonberry harvests often forced gatherers to part with familiarity and seek out new sites at the onset of each gathering season. The more perspicacious gatherers could gauge which sites to target depending upon the prevalent climatic conditions in a given year. For example, a hot, dry summer typically signaled better harvests in the larch-forb forests. (*Refer to site B, logged in the early 1990s, in Figure 5-1.*) A long-time gatherer relayed how he found very large lingonberries among the dense herbaceous layer characteristic of these forests, explaining that this cover protects the berries from scorching in the summer heat. In contrast, a cooler, wetter summer usually means that lingonberry will flourish in wide, flat open areas. This diversification in potential gathering sites verified the extent to which gatherers have adjusted to periodicity and decline in lingonberry harvests.

Perception of sites

Besides recognizing variability in harvests, people's awareness of a landscape in flux was obvious in descriptions of their gathering sites where they repeatedly recounted features indicative of disturbances, including: an open forest canopy; few trees in the overstory and understory layers; deciduous regeneration; and a high occurrence of woody debris. (*Refer to Table 5-4, part a*.) These descriptions added critical evidence to the link between high lingonberry yields and secondary forests in early successional stages. The following two depictions, in particular, further validated ecological relationships founded on quantitative data, namely the significant, positive association of percent woody debris coverage with the presence and abundance of lingonberry harvests. (*Refer to Chapter 4*):

> Lingonberry grows in logged areas in larch forests. Our forest—all of it is logs; it is littered where they left fallen timber.
>
> The forest is not so pure. There are a lot of dry logs and fallen timber.

Another significant association identified in the analysis of empirical ecological data, specifically the percent of lichen-moss coverage with lingonberry presence (*refer to Chapter 3*), was also echoed throughout people's descriptions of gathering sites. (*Refer to Table 5-4, part b*.) These sites were clustered within a unique area where successional processes and volcanic activity converge, thus warranting a closer look at this area called Kul' the vernacular and the gathering patterns particular to it.

Collecting in Kul'

Encompassing an expansive and distinctive landscape where swaths of forests alternate with dry volcanic rivers, Kul' (in the region of Kozyrevsk) is locally and regionally distinguished for its copious lingonberry harvests. Such harvests commonly attract scores of gatherers from the nearest village of Kozyrevsk, and throughout the region, despite its relative remoteness (it is a minimum of 20 km from Kozyrevsk). Made up of countless individual sites, this region was not an initial gathering ground: the residents of Kozyrevsk once gathered primarily in the environs of the village. Beginning in the 1970s, however, people began venturing to Kul', thereby commencing a practice that has become a well-ingrained cultural tradition in this region. Logging in the1960s literally cut the paths for these first journeys, which would not have been possible otherwise; it also provided the necessary disturbances for the proliferation of lingonberry harvests. A former *lespromkhoz* (forest enterprise) employee in Kozyrevsk recalled a striking scene of the arduous (and destructive) operations in this region: “Our tractor moved along bit-by-bit and we trampled [things down].”

Today logging only occurs in small-scale operations scattered throughout Kul’. Nonetheless, it still remains a place of pronounced disturbances. These are both on-going, in the case of perpetually shifting sands in the dry rivers, and fleeting, in instances of fire. Each has had a strong influence on lingonberry growth and harvest rates. One prolific gatherer attributed consistent harvests to this overall instability and the ensuing process of continuous re-vegetation. Gatherers often recounted harvesting in the open areas within this region; they also recognized unique features associated with these harvests, including lichens and moss, and a low herbaceous-subshrub layer dominated by lingonberry. These descriptions largely converged with scientific documentation of the larch-lingonberry forest association group, revealing a close overlap of scientific and local ecological knowledge. This juxtaposition of scientific research and local observations underscored the importance of larch-lingonberry forests in gathering endeavors. Further, it explained in more precise terms why Kul’, where these forests are well-distributed, has become such a sought-after gathering site. One gather succinctly summed up the ideal qualities of this place: “Lingonberry always grows [in Kul’], it is very large, like cherries—a deep dark red.” The 2005 season, in particular, stood out as one of unparalleled plenty: gatherers reminisced about the dense clusters of fruit that spread across the forest floor in this year: “There were so many berries. Almost half the village was in Kul’, there were enough berries for everyone.”

Table 5-4: Perceptions of gathering sites: a) general descriptions; and b.) descriptions of gathering sites in the region known as Kul'.

a. General Descriptions of Gathering Sites:

- *Open spaces or sparse forests in previously logged forests*

"[It is] an open place where there was a fire in the coniferous forests. [There] you just collect and collect lingonberry."

"…where there is a dense forest cover lingonberry doesn't fruit or its fruits are very small. Where there is an open forest there are very good berries."

"Lingonberry is found where fires and logging activity have been—in sparse forests, not in the taiga."

"They [lingonberries] are in logged areas—lingonberry loves open places."

"There has been logging—the forest is not dense, there are no timber stands."

"It's a miraculous place, usually the trees have been cut a little bit, there are good berries around stumps, and there are larch and birch. The trees are spaced sparsely apart—otherwise there will be no berry, and it does not grow in the grass. Lingonberry is found most often on the old [i.e. formerly] logged areas."

"Generally, there are many places where it is possible to gather lingonberry, including in logged areas where there is no beauty."

- *Secondary deciduous regeneration*

"Saplings grow there where they took so many forests. Birch, bog blueberry, moss, Siberian dwarf pine, and pine[17] also grow."

"There is beauty—juniper and rose shrubs, and a lot of birch and aspen. I love that place—there is such a scent, the air is so clean, the place is open.

"There is larch forest with plenty of birch; there are a lot of aspen."

b. Descriptions of gathering sites within Kul'

"There are endless forest openings. Everything is considered as a lingonberry plantation. Moss and crowberry grow there."

"In Kul' there are large depressions where only lingonberry grows."

"Lingonberry is found in open spaces, in sparse forests, coniferous growth is around. There is moss."

"There are forest openings where lingonberry grows. Siberian dwarf pine also grows there as do moss and different herbs. The herbaceous cover is not very tall."

"Lingonberry grows on the flat ground, and it grows on tree stumps. The lingonberry plantations love the lichens."

[17]This observation may be made in reference to the non-native pine trees that were introduced into this region as part of a largely unsuccessful re-planting effort during the Soviet period.

Retreating harvests

This link between plentiful yields and recently disturbed forests, as exemplified in Kul', has been intrinsic to where gathering occurs in the landscape; thus, as logging radiated steadily outward from the villages, so too have the most favorable gathering grounds. This phenomenon has unfolded in both of the main logging villages of Atlasovo and Kozyrevsk. In Kozyrevsk, for instance, a resident of 45 years expressed a tangible sense of loss in recalling the former abundance of lingonberry, and before that, the dense taiga forests in the environs of the village. In Atlasovo, a gatherer confirmed this trajectory, stating: "The forest is retreating from the village; the first cuts were in the region of the village, then they logged further and further from the village." Finally, one woman described what used to be a "solid cover of lingonberry" within walking distance of Atlasovo in 1968.

These observations helped frame a new dimension in gathering, namely the issue of accessibility. In the words of one villager gathering now requires "going into the deep," or traveling increasingly far to reach favorable sites. This situation stood in sharp contrast to gathering that occurred 20 to 30 years ago when prime sites were literally at everyone's doorstep, as one villager in Kozyrevsk remembered:

> We never drove anywhere to collect lingonberry—it surrounded the village. We didn't go further than 2 km from the village. We just walked with buckets. Now there is no berry in these places.

Another villager described an equally vivid memory of these former conditions, describing lingonberry harvests that once "studded" the village environs. While perceptions on the extent of lingonberry decline varied, the underlying notion of it "going far away," or receding further from the village with each year, was consistently expressed. Some attributed this phenomenon to the encroachment of village sprawl and trash into the surrounding forests. Cause notwithstanding, the effect of expanding distances between villages and gathering sites has been palpable for villagers who now must rely primarily on motorized transportation (cars and motorcycles) to reach these sites. The highly significant relationship between distance traveled to site and means of transportation exemplified this trend (*refer to Table C-9 in Appendix C*). It revealed that only a fringe group accomplished all gathering tasks, including seeking out and transporting harvests, on foot or bicycle, while the majority relied on some sort of motorized transportation in gathering.

How are people gathering?

Gathering technologies, including transportation type and a specialized gathering tool, have had a considerable impact on how people gather. The significant relationship between these two technologies (*refer to Table C-10 in Appendix C*) established that they were typically used in tandem, creating a distinct divide between low- and high-tech gatherers. Tool use proved the most important in determining gathering intensity (*refer to Table 5-3*). Qualitative data, however, suggested that the ways in which people reached their gathering sites were also consequential in influencing gathering metrics.

Motorized transportation and car ownership

Unprecedented individual mobility in the post-Soviet period, as manifested in climbing rates of car ownership, has fundamentally reconfigured gathering practices. One villager summarized the situation pithily: "Those who have a car and gas know the gathering grounds and drive to them [to gather] every day." Here emphasis should deflect from the technology itself (i.e. motorized transportation) to the individual ownership of this technology, and the free rein it has given people in deciding how they gather. By allowing people to gather on their own terms, individual car ownership marks a drastic turn from former confinement to state-sponsored vehicles (for example, those belonging to the *gospromkhoz* or *sovkhoz*). Now people can choose where, when, and how long they gather. Thus, it is not the technology itself (i.e. motorized transportation), but instead the application of this technology that has that has dramatically transformed the face of gathering in the post-Soviet period.

Individual car ownership has greatly widened the scope of gathering possibilities across the landscape. At the same time, this phenomenon is differentially distributed among gatherers, resulting in the clear stratification of gatherers, as one villager observed:

> If someone doesn't have [access to] transportation, they gather lingonberry ca. 3 km from the village; those who do [have access] try to go further. It seems fair to leave the non-timber forest products around the village for those who don't have the opportunity to travel far.

A clear difference in perspective has surfaced between these two groups, giving rise to the prevalent attitude of "the further away, the better" among car owners. For instance, one family who owns a car rhetorically asked: "Why would you gather on foot if you have a car and there are roads?" At the same time, they claimed that it was possible to gather "everything" within a 20-minute walk from their village, describing large quantities of berries in this range.

While such a scene might occur during an unusually good harvest year, it is rarely consistent, highlighting the vital role of transportation in locating gathering sites, especially during poor harvest years. Consequently, a lack of access to motorized transportation has posed a formidable barrier to resource acquisition, especially against the backdrop of overall decreasing harvests in proximity to the village. As one woman explained, “When we had a motorcycle, we gathered more. Now we gather in vicinity of the village, but not every year.” This predicament has particularly affected the elderly who like all people without transportation, must either forgo essential resources, or become adept at securing whatever transportation they might find. Arranging rides has been particularly challenging, as offers have become increasingly restricted to family members or close friends only. One elderly woman lamented that despite the proliferation of cars in her village, no has been especially eager to give pensioners a ride to gathering sites.

This widening gap between those who do and do not have transportation has become especially evident in the differential benefits conferred by car ownership, namely the ability to access larger and more favorable gathering sites, which has ultimately meant greater profit. One villager related that people with transportation could earn “decent” money by gathering. Another confirmed: “Those who gather to sell, they drive.” In this context, transportation most often implied a car. In contrast, use of a motorcycle was more commonly associated with gathering for household needs only; gathering on foot (and in proximity to the village) was almost always done for this same purpose, as confirmed by the following remark: “If people reach their gathering spot by foot, they gather 2 to 3 buckets [ca. 20 to 30 liters] to sell. If they drive, they typically gather 10 to 20 buckets [ca. 100 to 200 liters] to sell.” Here it is obvious how the stakes in gathering have risen with the onset of car ownership, which often justified selling harvests to make gathering profitable.

Besides transforming gathering patterns, car ownership has also left an unmistakable imprint on the forests, testifying to the post-Soviet way of gathering, which one gatherer called as “half wild.” Thus, what signaled freedom for some, evoked negative responses within others. For instance, one gatherer described popular gathering sites during peak season as parking lots; another shared how there were cars everywhere, just like in the city. Still another gatherer clearly made the connection between an influx of cars and ecosystem damage: “There are many cars in Kul’ that are destroying the local flora. Lingonberry once carpeted the forest floor; now it is only found in separate clearings due to heavy traffic." Other observations encapsulated similar scenes:

> If in one year there were many cars in one place, it means that in the next year there will be very little lingonberry in this place.
>
> [Gatherers] run over the plants with their cars and cause fires.
>
> In one year you notice faint motorcycle tracks, then you come again in a year and there is already a road there. When someone sees these tracks they know that another person has been there, and that it was necessary to investigate and to see what was along those tracks. The end result is that everything is smashed, and there are trash and cans.

In addition to damaging fragile ecosystems, some gatherers claimed that newfound access to gathering sites has resulted in over-harvesting by both locals and non-locals alike, subsequently causing a decline in lingonberry harvests. This increased access can be traced to the late Soviet period when the completion of the main road leading from Petropavlovsk-Kamchatsky (Kamchatka's capital city) to central Kamchatka in 1985 brought an influx of non-locals to the region. Today, increased access (including that facilitated by the dense network of forest roads) along with car ownership, has opened up the landscape to gathering opportunities in unprecedented ways. Besides road networks and motorized vehicles, the rudimentary technology of a gathering tool has been blamed for diminished harvest levels. Similar to motorized vehicles, this tool enables the acquisition of resources in less time, which warrants a closer examination of how people use it in their gathering.

Tool Use

Use of a handmade rake-like tool (*sovok*) typically doubles gathering intensity: in good harvest conditions an experienced gatherer can collect approximately 100 liters of lingonberry during a full gathering day (i.e. seven hours) compared to 50 to 70 liters without it. This advantage was particularly evident among prolific gatherers, many of whom marketed their harvests, leading to the common notion that tool use and selling were synonymous. The quantitative analyses substantiated this idea, showing a highly significant relationship between tool use and marketing (*see Table C-11 in Appendix C*), and a significant, positive effect of tool use on gathering intensity (*see Table 5-3*). Besides these strong statistical associations, gatherers often expressed polarized beliefs on tool use. For instance, tool use was preferable when collecting to sell, but not when gathering for household needs only. In addition, tool use was largely associated with the gathering habits of non-locals. Another divide in tool use was along gender lines: more men than women gathered with a tool. In this sense, gathering without a tool signaled a more careful and deliberate method, whereas its use implied speed, roughness, and short-sightedness, as articulated by gatherers:

> The berry is becoming still less and less due to tool use and to the fact that many people are trampling down the plantlets…Their eyes are burning, [asking], 'Who would like larger berries?' They damage the plant with the tool, which is why lingonberry harvests are decreasing. The lingonberry is no [longer] so large.

> Lingonberry [harvests] are diminishing due to gathering with tools. It's better to gather with [one's own] hands.

In these passages, hand-picking lingonberry was elevated above gathering with a tool. In fact, many held that the former was crucial to ensuring good harvests in the future. For example, one gatherer drew a connection between careful stewardship of a particular site and five consecutive years of yields in this site. In contrast, gathering with a tool was deemed unsustainable—a method adopted by one-time visitors in a particular site.

This clear dichotomy fell nicely in line with other perceived divisions around tool use. Namely, while hand-picking berries with one's own hands was aligned with organic notions of local and one's own household, gathering with a tool was associated with the idea of 'other,' for instance, with profits coming from unknown sources and with non-locals in search of local resources. It is not surprising then that non-locals, whom locals characterized as being "indifferent to nature" and "merciless" in their gathering practices, were often charged with the damage and decline of lingonberry. These viewpoints are unambiguously stated below:

> The lingonberry harvests are clearly decreasing due to over-harvesting. For the past five years people from Petropavlovsk-Kamchatsky [Kamchatka's capital city] and Ust'-Kamchatsk have been arriving; they come for a week and use tools, which cause a lot of damage to the plantlets, for example they uproot the plantlets, which require a lot of time to regenerate.

> Non-locals are mercilessly yanking out lingonberry. And, they pick the berry while it is still green, and with a tool. Lingonberry is becoming all the harder to find… People from Atlasovo gather lingonberry more carefully…If everyone (primarily non-locals) pulls up [the plantlets] to sell, then there will no longer be non-timber forest products… People are ruining, just ruining nature.

These statements encapsulated the polarities associated with tool use in gathering, including: local versus non-local; sustainable versus rapacious; and basic need versus profit. These sharp divisions, however, obscured the blurred lines of gathering along which locals also unsustainably sought profits. Here a more nuanced picture of gathering emerged: people endeavored to maximize their resource acquisition and minimize time and energy inputs; at the same time, they responded to social and cultural norms, and to local ecological conditions in their gathering practices.

Adaptive strategies to harvest variability

Variation in tool use depended to a large degree on the particular forest association group in which gathering occurred. For instance, a tall and dense herbaceous layer characteristic of the larch-forb forests often precluded tool use, as it proved time consuming to separate lingonberry from the other herbs and forest litter collected with it. Here it was evident how people have adopted multiple adaptive gathering strategies as they strive to maximize resource acquisition and minimize required inputs. For example, people respond to harvest conditions in a given year in quantity gathered. In years of above average to abundant harvests people reported collecting up to twice their normal amount, or approximately 60 to 70 liters per day; particularly proficient gathers could fill between 100 to 150 liters under such conditions. One woman even reported gathering up to 180 liters per day. To compare, during very poor, and below average and average harvests, quantities collected ranged from 5 to 20-50 liters per day, respectively. One villager described that such conditions necessitated "gathering on your knees." (*Refer to Table C-14 in Appendix C for mean harvest rates during poor, average, and abundant years.*)

To summarize, households that usually collected 10 to 20 liters of lingonberry during average years for their household needs, tended to acquire 50 to 60 liters (or even more) during good to abundant harvest years. This surplus was then sold, as epitomized in Kozyrevsk in 2005 following an extraordinary harvest: households in this village that normally do not sell lingonberry reported doing so in amounts ranging from 50 to 900 liters. For instance, one household gathered 320 liters in this year, the surplus of which they sold, compared to only 20 liters in 2006. The following response succinctly captured this phenomenon: "If it is a harvest year almost the entire village is in the forest gathering lingonberry because that is a way that people earn money. It is only during a harvest year [that this trend is observed.]" A budding entrepreneur building a business on non-timber forest products put the situation more pointedly: "If there is [just] a small harvest, then we earn less; we make money when there is a good harvest—we are surviving with quantities [of non-timber forest products] in the tons."

Why are people gathering?

For some people selling their surplus lingonberry harvest seemed like an instinctive response to a season of plenty; however, for others selling harvests has become integral to their household livelihood strategies. The latter group gathers to sell regardless of harvest levels (unless it is an exceptionally poor harvest year, as was the case in 2007). In fact, the chance to earn supplemental income seemed to be a primary driver in gathering practices. Certainly, collecting as a social and cultural activity, and as a way to meet some basic households needs, influenced where and how people gather, yet not to the same extent as when the resource was commodified. As one villager candidly put it, "people mainly make money on lingonberry."

Marketing of harvests

Ethnographic evidence drew out the importance of marketing harvests to earn income. Centered on the concept of "making a living" (*prozhivaniya*), a distinct gathering sub-culture has emerged in central Kamchatka during the post-Soviet period. People's estimates of those who gather to earn supplemental income ranged from as low as 30 percent to as high as 80 percent of all who gather. Quantitative survey data fell roughly in the middle, showing that 46.3 percent and 40.7 percent of gatherers pursued this purpose in 2003 and 2006, respectively. For some households in central Kamchatka's economically depressed communities, harvest income has provided a critical and relatively steady means of earnings, as one respondent pointed out: "Very many people live on account of it [income from lingonberry]. It's necessary to work and there are many without work." Another added: "If you don't have work, you still have to live, so a person goes to the forest to earn some bucks for himself." Even for those with salaries, selling lingonberry has provided the extra income necessary to feed and clothe one's family, or to supplement meager pensions, or to even purchase a "bottle" (of vodka). (*For more information on gathering as a part of household livelihood refer to Chapter 7*.)

Emergence of a consumer mentality

The upturn in economic trends beginning in the 2000s has mitigated people's financial predicaments. According to one woman, people have begun to live better and are not as avid gatherers as they were when they did not receive wages for months. Today a nascent consumer mindset has precipitated increased acquisition of goods and services—and the need of money to pay for them. Thus, many households that once gathered to ensure survival continue to gather to meet unprecedented expenses, for example, paying for a child's higher education. In fact, some see making money as the main aim of gathering. As families grapple with how to meet new and existing needs and wants, gathering both at the household level and for profit has become highly individualized, as one respondent observed: "Now it's every family for themselves trying to figure out how to manage [gathering]. All those who can sell do."

Striving to sell harvests is becoming increasingly associated with a "sense of bonanza" (*chuvtsvo nazhivy*), or a notion of "the more, the better." This emphasis on making money for purposes other than basic household survival seems to be pervading village life. Villagers elaborated upon this new phenomenon of people swarming to the forests to gather, mesmerized by the chance to earn money:

> The village [in 2006] was afire with lingonberry…It was like a holiday—people took off for the entire day, and everyone went to gather lingonberry. People wanted to collect more just to sell [lingonberry]… Dollars were in people's eyes…People forgot about everything else, it was as if they were collecting dollars.

> The amount gathered grows in volume with every year. Gathering—it's easy money. Now we are earning more money, but for everyone it's little, little, little and now what is gathered is more and more and more. When I arrived [in Atlasovo] I gathered for my household. At that time a barrel [roughly 50 liters of lingonberry] was enough.

In an essay exploring Russian narratives on money Nancy Ries (2002), observed this post-Soviet phenomenon, offering the following explanation:

> Where traditional boundaries of moral and group identification have been effaced, the flow of money can be cast as the primary agent of that effacement. Where it seems that personal integrity, moral limits, concern for the welfare of the larger community, and a desire to perform "honest work" have disappeared, the thirst for money can be invoked to make sense of that disappearance.

Yet, the push to make a profit did not completely overwhelm other cultural and social aspects of gathering that remained ubiquitous in village life. Many respondents—even some prolific gatherers focused on profit—mentioned gathering as a treasured opportunity to relax and recreate in the forests. The description of gathering as a way to combine "the useful with the enjoyable" was often repeated, revealing the difficulty in trying to tease apart the economic, social, and cultural reasons for gathering, which remain interdependent even as they are evolving.

Conclusion

This chapter contextualized LEK in central Kamchatka to understand little-studied lingonberry dynamics on a local scale, and what this knowledge meant in terms of people's gathering practices and behaviors. Seeing the forests—and lingonberry harvests—through local eyes revealed an intricate picture fluctuating over time and space. Nonetheless, distinct patterns emerged within this picture. On the one hand, there was a clearly articulated idea of periodicity in lingonberry harvests that was largely dependent upon environmental and climatic conditions. On the other hand, there was growing awareness of a global decline in harvests due to the changing scope of disturbance in the post-Soviet period. This overall decline was corroborated by regional forestry experts who told of the collapsed forestry industry and the ensuing near standstill of disturbance (in the form of logging) across the landscape, which has spelled a drop in lingonberry harvests.

Besides these broad brushstrokes, LEK also illuminated a more a nuanced understanding of the interactions between environmental and climatic factors, and lingonberry ecology. This degree of knowledge was particularly apparent among those who earned supplemental (and in some cases, primary income) from gathering. Although LEK wasn't foolproof, it was nonetheless a natural foundation upon which to build further analyses centered on the questions of where, how, and why people are gathering in the landscape. This approach synthesized quantitative analyses with an ethnography of gathering to gain sharper insights into current gathering dynamics. One notable finding that emerged was the prominence of technology in gathering practices, which has led to distinct differentiation among gatherers. For instance, those who employed technology (e.g. cars and a specialized gathering tool) were more likely to travel further, and to market harvests than those that did not. Both tool use, and the choice to market harvests, corresponded to a higher gathering intensity (liters/hour), and ultimately to significantly larger harvests when compared to households that neither used technology, nor sold harvests for profit.

While the relationships between use of technology and higher output might have appeared obvious at the outset, the ethnography drew out more subtle points embedded within them. It also drew attention to relationships that were not statistically significant or that may not have been as evident in the statistical analyses. In the case of car use, for instance, it was not the technology per se that has transformed the face of gathering in the post-Soviet period (cars and other vehicles were frequently used in the Soviet period to transport gatherers to sites). Rather, it was the new application of this technology at the individual level (even against a backdrop of pervasive economic decline) that has had a striking impact on gathering practices.

By opening up areas that were formerly off-limits to individuals, the dramatic rise in car ownership has created differential access among gatherers, or the ability to benefit from resources (see Pyhälä et al. 2005). To illustrate, cars afforded the opportunity to seek out and acquire the best resources; in contrast, those without access to this resource were limited to gathering in narrow ranges in proximity to villages, or they were dependent upon others with cars. Owning a car further enhanced benefits, as people could transport harvests themselves to larger markets in the south, thereby maximizing profits by avoiding middlemen in the villages. Thus, car use was synonymous with increased access, both to more abundant and easily acquired harvests, and to markets. Ultimately, this access signaled a greater payback from harvests. Besides cars, tool use was also an important part of the equation that equaled larger harvests and greater paybacks. While cars made a particular site accessible, tools made the resource on this site more readily available to the gatherer. The ethnography clarified tool use as much more than simply an implement to raise gathering intensity; it was simultaneously a marker of profit, and of unsustainable gathering done by the 'other' (or non-locals in this case). Moreover, tool use furthered the growing divide between high- and low-technology gatherers, the former who clearly reaped the greatest benefit from gathering.

In addition to elucidating quantitative analyses, the ethnography of gathering was also instrumental in corroborating a central premise of this study (and dissertation), namely, that people act in ways that make ecological sense, even without being fully aware of the science behind their actions. This phenomenon was readily apparent in people's descriptions of their gathering sites, which had a compelling ecological explanation (see Estabrook 2000). For instance, there were telling accounts of gathering in "broken" forests, littered with woody debris, which precisely coincided with the ecological finding that the woody debris layer was significantly associated with the presence, and higher yields of lingonberry. (*Refer to Chapter 4 for more detailed results of ecological analysis.*) This case exemplified how LEK accumulated through lived experiences closely mirrored scientific knowledge gained through empirical study, thereby helping to validate LEK. While it should not be viewed as a surrogate for scientific studies, LEK can fill important gaps in existing data, thereby contributing to the production of "scientifically valid and locally relevant information" (De Freitas and Tagliani 2008). The use of LEK in this capacity was the aim of this current study. Specifically, by juxtaposing LEK, ethnography, and quantitative analyses, this study presented a comprehensive picture of gathering dynamics that could not have been achieved by relying on the separate strands of qualitative and quantitative analyses alone. By establishing basic gathering patterns and how they relate to the forests, this study set the stage for Chapter 6 that takes a more exhaustive look at the interactions between people and the landscape.

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Chapter 6

An Ethnography of Landscape: Linking Spatial and Non-Spatial Data to Make Explicit Connections between People and Forests

Prologue:

"*Only in the surroundings of [Kozyrevsk] are the richest lingonberry stands preserved, and the mushrooms are so many that in a good harvest year you can cut them with a scythe, if you please…*"(Sytnikov 1987)

Introduction

This chapter represents a pivotal point in the dissertation where ecological, spatial, and human behavioral factors are merged using the analytic tools of remote sensing and Geographic Information Systems (GIS). This integrated geographical approach builds upon the previous chapters in the dissertation by making quantifiable connections between people and the landscape. Centered on the gathering of lingonberry (*Vaccinium vitis-idaea*), this ethnography of landscape asks how ecological and anthropogenic processes determine where and how people are gathering in time and space. It also considers the landscape through the eyes and actions of the people who depend on lingonberry and other non-timber resources. In this way it strives to clarify the underlying reasons for gathering, and to show that these reasons often made ecological, economic, and ultimately, evolutionary sense.

Within this overarching framework, the specific aims of this chapter are to:

1. Link ecological field data to spatial data derived from satellite imagery to establish relationships between land-cover type and elements of forest structure and composition indicative of successional stage; these elements included lingonberry fruit yields.

2. Link people and their gathering behavior to the landscape through mapping and managing of gathering sites in GIS;

3. Analyze spatial relationships between land-cover type and anthropogenic landscape features (e.g. villages and roads) to predict where gathering is occurring in the landscape.

4. Examine the factors of land-cover type, distance, and accessibility that influence people's gathering decisions and patterns to understand better how people are interacting with the landscape.

5. Briefly discuss findings in light of local ecological knowledge (LEK) and optimal foraging theory (OFT) to synthesize a multi-faceted view of gathering in central Kamchatka.

Guiding research questions, hypotheses, and predictions

The following guiding questions structure the ethnography of landscape that is the centerpiece of this chapter. These questions encompass a broad range of inquiry, from forest successional processes to the intersection of anthropogenic and natural features and how it shapes gathering patterns. They are all, however, grounded in the wider context of landscape and thus, give rise to an expanded understanding of the landscape unique to central Kamchatka, and the people and forests within it.

1. *What is the relationship between land-cover type and forest composition and structure?*

Hypothesis and Prediction I: Remotely sensed imagery is an effective tool in differentiating stages of secondary forest succession (i.e. early, mid, and late) (see Moran 1994). Thus, thus there should be significant differences in forest structure and composition among key land-cover types derived from satellite imagery.

2. *How do anthropogenic features interact with the landscape? Specifically:*

- *What is the relationship between land-cover types within gathering sites and distances to these sites from the nearest village and main road?*

- *What is the relationship between land-cover types within gathering sites and road density?*

Hypotheses and Predictions II: Given logging trajectories that have radiated outward from villages, increasing distances from the nearest village and main road to gathering sites are expected to correspond to higher proportions of land-cover types representing early- to mid-successional (i.e. more recently disturbed) forests within these sites. Also, given the extensive road network that supported these logging trajectories, higher road density within sites should be associated with increasing proportions of early- to mid-successional (i.e. more recently disturbed) forests.

3. *How are people interacting with the landscape through their gathering of lingonberry?*

- *What factors influence people's choice to gather in a particular site?*

- *What factors affect the gathering metrics of intensity, frequency, number of gatherers, and marketing of lingonberry harvests?*

Hypothesis and Prediction III: Ecological and anthropogenic elements shape how people optimize their gathering decisions and behaviors. Specifically, according to optimal foraging theory, people will gather in areas where they can maximize *the net rate of return* (of resource) *per unit foraging time* (Smith 1983).Thus, the factors of land-cover type, distance, and road density should influence people's choice to gather in a particular site. Moreover, the factors of land-cover type, distance, and accessibility should significantly influence gathering metrics such that:

a. Higher proportions of land-cover types representing early- to mid-successional forests in sites should be linked to increases in gathering intensity, frequency, number of gatherers, and marketing of harvests.

b. Increments in distance (from nearest village and main road to gathering site) should be associated with increased gathering intensity, frequency, and marketing of harvests, and with a decrease in the number of gatherers.

c. Higher road density within sites, which allows greater access within sites, should be associated with increases in all four gathering metrics.

Guided by these questions, this chapter is organized in the following manner: 1) introduction of theory to frame the study; 2) materials and methods accompanied by a brief rationale for their use; 3) question 1 results and discussion, including a section on LEK; 4) questions 2 and 3 results and discussion of, including a section on OFT; and 5) conclusion.

Theoretical framework

Ethnography of Landscape

The complex and non-linear interactions between people and the environment require an equally complex and integrated approach to their study, which is embraced by this work uniting ecological, ethnographic, and spatial data. This approach laid the foundation for an ethnography of landscape in which local ecological and ethnographic inquiries were expanded across a landscape deeply imprinted by anthropogenic disturbance (see Nyerges and Green 2000). Built using complementary methods—ethnographic and ecological fieldwork from the ground up and spatial analysis from the top down— this ethnography of landscape is a rigorous and inclusive way to study people's interactions with the environment. In this model neither type of data can be fully developed without the other. For instance, land cover may be clearly classified using remotely-sensed satellite imagery, yet these spatial data cannot explain the specific ecological or anthropogenic processes that produced such cover in the first place (Nyerges and Green 2000). Thus, even with continued advancements in remote sensing and GIS technologies, spatial analysis cannot replace time-honored ethnographic and ecological fieldwork. At the same time, it greatly augments anthropological studies, particularly those focused on cultural landscapes, or on the meanings and perceptions that people attach to land and land use, as one researcher (Jiang 2003) conveyed:

> Remote sensing images reflect the material basis of cultural landscapes that can only be understood through the meanings people assign to them and the perceptions people have of the environment. Furthermore, the reciprocal interactions between landscape and culture can be revealed in the analysis of remote sensing images: the material landscape not only demonstrates the consequences of cultural practices, but also carries messages about natural limitations on these practices. Therefore, remote sensing analysis has the potential to further inform us of the dynamics of the culture-landscape relationship.

Integrating spatial analysis with qualitative cultural studies is gaining momentum in different research communities and programs (Fox et al. 2003). Besides Jiang's (2003) research on cultural landscapes and the stories that remote sensing can reveal about these landscapes, other researches (Albert and Le Tourneau 2007) pioneered what they termed an ethnogeographical approach in their study of a classic issue in tropical anthropology: indigenous land and resource use in the Amazon. They used spatial analysis as a component in a multidisciplinary methodology to reconfigure the zonal models of land use established by previous studies. In this way they were able to draw out the nuances in indigenous natural resource practices and knowledge.

Moreover, new studies have endeavored to elucidate the human-environment relationship through the creation of spatial and temporal representations in which various spatial and non-spatial data (for example, biophysical and socio-economic, respectively) can be linked (Evans and Moran 2002). The incorporation of these data within spatial and temporal contexts is critical to understanding how socioeconomic and demographic factors are related to the landscape, namely how people as agents of landscape change shape, and are shaped by the landscape (Walsh et al. 2003). These studies have made important inroads; however, the emerging literature on this integrative approach is still sparse (Jiang 2003). Thus, this ethnography of landscape based on an integrative geographical approach is poised to make a distinct contribution to this growing literature.

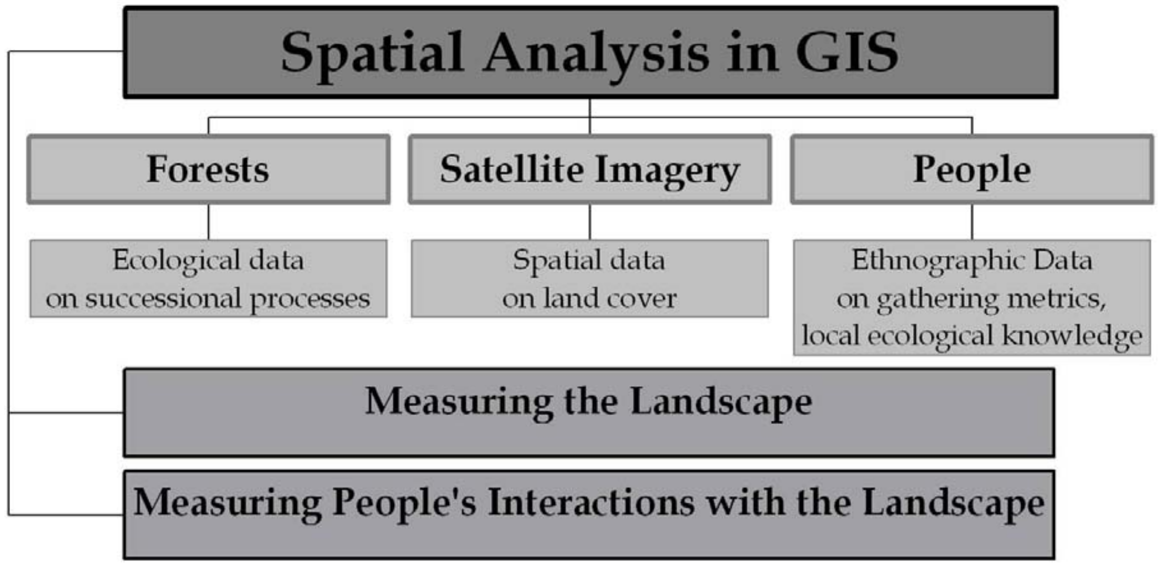

Figure 6-1: Graphical representation of an ethnography of landscape: to measure the landscape, and people's interactions with it, data from the forests, people, and satellite imagery need to be united in GIS.

Use of spatial analysis in the ethnography of landscape

A common challenge in examining human-environment interactions is that of scale: typically, most studies linking remote sensing observations and socioeconomic data have centered on large-scale analyses using nations or regions as spatial analysis units; or they have involved smaller-scale analyses, but with few observations (Evans and Moran 2002; Green and Sussman 1990; Skole et al. 1994; Geoghegan et al. 2001, quoted in Lambin 2003). More recently, analyses integrating data from the social, natural, and spatial sciences at the household and community levels have provided new insights into previously unexplored aspects of human-environment relationships.

These analyses raise the question of appropriate spatial and temporal scales. Namely, at what level or scale (for example, household or corporation) should the linkage occur? There is no straightforward answer to this question, as it depends upon both the research context, and on the particular social-biophysical process under investigation (Rindfuss et al. 2003b, Evans and Moran 2002). Another challenge in linking people to the land is that of multiplicity, as expressed, for instance, in the numerous ties between people and land in rural areas, and in people's varied responses to social change (Rindfuss et al. 2003a). Lastly, there is the difficulty of working with inherently different data (for example, human data versus land-cover data) gathered through a variety of methods (Walsh et al. 2003). While land is stationary, continuous, and quantifiable through remotely sensed imagery, people are mobile, discrete, and hard to capture using remote sensing techniques (Rindfuss et al. 2003b).

Consequently, there exists no one-to-one match between people and land, for instance between specific household units and pixels in satellite imagery, as they are represented by different units (i.e. discrete spatial points vs. continuous biophysical data values, respectively). It is, however, still possible to make such linkages by using specific geographic coordinates upon which to designate discrete areas in the landscape affected by people. Yet, this step assumes that people and their activities and behaviors are confined within specific bounds, which is rarely the case (Walsh et al. 2003). Innovative research has proposed new methods in response to these challenges (see Rindfuss et al. 2002, 2003b for their extensive study of individual households and land use patterns in Nang Rong, Thailand.) Nonetheless, the literature on linking specific household units to spatially-derived data is still in a nascent stage (Rindfuss et al. 2003a). This absence of an overarching theory or formula requires an individualized approach dependent upon the specific needs and conditions of the research project, and the setting in which it is situated.

Regardless of research protocol, there is a set of established spatial tools elemental in studying the relationships between people and land. These tools are part of the emerging Geographic Information Science, or GISci and include several spatial digital technologies, such as remote sensing, GIS, spatial analysis and statistics, and global positioning systems (GPS) (Crews-Meyer 2002). Together these tools represent significant advancements in the characterization and spatial representation of landscapes. They reveal more detailed texture of the landscape, especially over a broad and topographically complex area, than relying on field studies alone (Axinn and Barber 2003). The application of these tools, however, must be accompanied by an explicit understanding of both the phenomenon being studied, and of the software and methods necessary to measure that phenomenon (Crews-Meyer 2002). To illustrate, remotely sensed data have become indispensable in distinguishing secondary forest age classes (Moran 1994). Yet, to be effective, the researcher using these data must have a solid grasp of forest successional processes. Remotely sensed data can also reveal social processes, such as people's land-use patterns; however, the full interpretation of such patterns requires detailed knowledge of the people (e.g. demographics) and the factors (e.g. cultural and economic) driving land use (Rindfuss et al. 2002).

These spatial and non-spatial data are instructive alone; at the same time, understanding their interaction is especially powerful in discerning how humans influence the land, and how the land affects human activity. Such an analysis involves the integration of spatial (remotely sensed) and non-spatial (social) data through GIS. Although this approach involves numerous assumptions, it has nonetheless gained prominence in research aimed at linking people as agents of landscape change to the landscape (Evans and Moran 2002, Rindfuss et al. 2002, 2003b). For instance, the use of GIS technology enables the linking of household data to specific land parcels within the landscape, and to the land cover classes defining these parcels. Such linkages by spatial location are very effective when local populations are the main determinants of land use patterns (Axinn and Barber 2003). Although spatial analysis is far-reaching, it still must be contextualized to account for the influence of exogenous factors, such as national socio-economic and political dynamics that affect the study site (Evans and Moran 2002).

In the case of central Kamchatka, this integrative approach enabled the unprecedented study of a highly complex landscape and people's relation to it. This approach also facilitated a study of successional forests transformed by past logging, and by the natural processes of volcanic eruptions, fire, and seismic activity. The effects of these large-scale forces (fire in particular) would have been very difficult to detect based on ecological and ethnographic data alone, even as these data were vital in interpreting remotely-sensed imagery. In addition, this approach revealed spatial gathering patterns of lingonberry through linking people's gathering behaviors to the landscape. This representation of gathering hinted at the variability of lingonberry yields in both spatial and temporal contexts (see Aswani and Lauer 2006). Spatial analysis was useful in discerning gathering patterns across the landscape, yet it could not explain the behaviors underlying these patterns. Thus, the following section lays out the framework of optimal foraging theory that will be critical in answering the ultimate question of why people gather in particular places and ways.

Optimal foraging theory

People's gathering behaviors vary by household need and ability (*refer to Chapter 7*); at the same time these behaviors are predictable given particular ecological and socio-cultural constraints. Gathering patterns can be more deeply understood when interpreted through the lens of human behavioral ecology, a discipline that links evolutionary ecological concepts and models to inquiries of diversity within human societies (Winterhalder and Smith 2000). It has become common practice to examine different aspects of human foraging behavior through mathematical models designed to quantify cost-benefit trade-offs of these behavioral patterns (Bird and Bird 1997 and Smith 1991 quoted in Aswani and Lauer 2006; Krebs and Davies 1997). The pioneer in the development of cost-benefit models in ecology was Robert MacArthur. He was the first to apply the principle of optimal choice to foraging behavior (MacArthur and Pianka 1966, MacArthur 1972, quoted in Krebs and Davies 1997). The aim of this particular study was not to test foraging models. Rather, these models—and the theory backing them—provided an essential framework in which to examine people's gathering behaviors in central Kamchatka.

First, it is necessary to clarify terminology applied to the models, namely the differences in foraging and gathering. A critical distinction is that foraging does not imply amassing what has been picked or dug up from uncultivated sources into containers; instead, it refers to searching or moving from one source of food to another (Ingold 1986). Thus, the term gathering is more suited to central Kamchatka where people go to the forests with a clear idea of what they will procure, and then process for use through the long winter. It is far less common to collect for the next meal: gathering is primarily seen as an essential supplement to other forms of production (e.g. fish and garden resources), or to primary income. To illustrate, a loss of potato crop or fish catch would be catastrophic for many households, while a poor harvest of lingonberry is not as drastic.

Despite this distinction between foraging and gathering, at the basic level both involve resource selection and harvesting behavior, which are seen as production in the economic sense (Winterhalder and Smith 2000). In the ultimate sense, such productive behavior supports an individual's survival—and the chances of passing his or her genes to the next generation. Thus, the theory of natural selection is at the core of optimality models in which the most fit individuals, including those most efficient in foraging, avoiding predators, mate choice, and parenting, are those that persist (Krebs and Davies 1997). In other words, natural selection will favor the foragers whose behaviors capitalize the net amount of energy or nutrients procured per unit of time spent foraging (Smith 1983). In this context, natural selection is an optimizing force itself. Although these models are not a Panglossian conclusion of how the real world operates (see Maynard Smith 1978, quoted in Smith 1983), they are nonetheless viewed as the most compelling way to approach behavioral studies (Krebs and Davies 1997). One specific advantage is their combination of breadth and depth, making them applicable to a range of animal species; at the same time, they are sufficiently detailed to explain the specifics of individual foraging behavior (Smith 1983). Originally intended to study animal populations, anthropologists have begun to employ these optimality models, including those based on optimal foraging theory (OFT), in their examination of human behavior (Winterhalder and Smith 2000).

The following assumptions are at the crux of all optimal foraging models: 1) individual choices involve a proxy currency, for example, energy or prey type; 2) there is an evolutionary goal, such as attaining maximal foraging efficiency that is ultimately tied to survival and reproductive success; 3) there are constraints (e.g. searching speed)limiting the range of options. Smith (1983) emphasizes options, or choices left open to the actor as fundamental to the models applied to humans under several different conditions, including those where food or specific nutrients are scarce, and those where time is in short supply (as is primarily the case for gatherers in central Kamchatka). Regarding the latter, a dearth of time rivals the prospect of starvation in shaping efficient foraging (or gathering strategies) (Smith 1983).

The optimal foraging models most relevant to this study were: patch-choice, time allocation, and prey choice (see Smith 1983, Winterhalder and Smith 2000). The strategic goals of each model were, respectively, the optimization of: 1) set of habitats visited; 2) time allocated to foraging; and 3) set of resources to procure. In these models, a gatherer faces the choices of which site or set of sites to visit, of how much time to spend gathering in alternative sites, and which resources and how much to gather. The following sections take a more in-depth look at the defining parameters and assumptions of these three models. Note that the terms 'forager' and 'patch' have been replaced by 'gatherer' and 'site,' as the latter are more applicable in the given context.

Patch-choice and time allocation models

Patchy resources are defined as those that are "distributed and encountered in a spatially heterogeneous pattern" (Smith 1983). Lingonberry epitomizes this type of resource: its periodic yields are highly varied across the landscape in any given year. Given this unpredictability and instability, gatherers must contend with two interwoven optimization problems: 1) where to acquire this resource, and 2) how much time to devote to this activity in a given site (Smith 1983). These two problems are dealt with separately in the models of patch-choice and time allocation, respectively. First, the MacArthur-Pianka patch-choice model (named after those who introduced it in 1966) is premised on patch, or site selection according to the mean return rate for that site (Winterhalder 1981, quoted in Aswani and Lauer 2006). In this model, a gatherer will add sites to her repertoire until a decline in the mean rate of return for these sites outweighs saved travel time (Winterhalder 1981, quoted in Aswani and Lauer 2006). In other words, this model assumes a trade-off between reduced yields per unit time gathered and a decrease in time spent navigating between patches (Smith 1983). Here it is optimal to add sites until total time per unit gathered is minimized (Smith 1983). (Note that total time includes that spent both within and in between sites.)

This model, however, makes several oversights that have limited its broad application. First, it does not stipulate the amount of time a gatherer should stay in each site, or the influence of gathering on a resource (lingonberry in this case) within this site (Smith 1983). Rather, it assumes a constant rate of harvest over some time period, and that gatherers leave the site when the last resources have been collected at which point the expected or marginal harvest rate quickly drops to zero (Charnov; Charnov and Orians 1973, quoted in Smith 1983). Nonetheless, this model is applicable to specific situations, for instance, when the resource gathered is stationary and easily found, which describes lingonberry gathering in central Kamchatka. To illustrate, one gatherer relayed how people from throughout the region descended upon sites, gathering lingonberry by the ton. He specified that locals in contrast to non-locals gathered everything that they could find in one place before moving on to the next site. He also described intense searches for gathering sites. Considering the high variability in lingonberry yields, however, another model may be more applicable. This model accounts for the more likely scenario in which gathering within a site results in a steady constant drop in that site's return. Here is a classic case of diminishing returns to inputs of time or labor, which is considered in the marginal value theorem (Smith 1983).

Marginal value theorem

Centered on time allocation, this theorem optimizes gathering patterns in sites in terms of the highest overall rate of resource procured (Smith 1983). Unlike the MacArthur-Pianka patch-choice model, this model rests on the explicit assumption that gathering causes the gradual loss of resources in any given site, thereby resulting in an even decrease in the net return rate from that site as the resource (e.g. lingonberry) becomes harder to acquire (Smith

1983). Based on the assumption that people will strive to maximize net returns per unit gathered, several predictions stem from the marginal value theorem (Smith 1983). First, gatherers should move on to a new site when the return rate at the current one is low compared to that at other sites. In other words, a gatherer is expected to leave a site when the amount that can be harvested there per time unit time is less than elsewhere, even considering travel costs to another site. In this case, the marginal capture rate at the end of gathering in a particular site equals the overall mean capture rate, which is the average for the entire set of sites in which gathering took place (this rate includes travel time among patches).

Second, because time optimization in any site is a function of average yields across all visited sites, then time spent in one site should decrease with increases in resource abundance. Also, lower travel costs should be associated with greater abundance. In contrast, greater resource scarcity should increase optimal visit times in sites; it should also be tied to higher travel costs. Finally, new sites should only be added if the marginal rate of return is equal to or greater than the average for the existing set of sites (Charnov and Orians 1973, quoted in Smith 1983). According to Smith (1983) this last prediction implied using the marginal value theorem to delineate optimal patch choice based on a site's mean return rate.

Prey choice

According to Winterhalder and Smith (2000), the prey-choice model tests the assumption that gatherers strive to respond to a fluctuating environment by making choices that optimize net yield. This model is constrained by endogenous factors, such as available information, existing ecological knowledge, and technology, and exogenous factors, including distribution, density, and quality of resources (Winterhalder and Smith 2000). The general proxy currency is the net acquisition rate of energy, which can be easily measured. It applies to circumstances in which gatherers are both energy- and time-limited. In the former case, gatherers benefit more by collecting additional units of harvest, than from lessening gathering time; in the latter case, gatherers gain more by devoting time to other activities than they do by allocating additional time to gathering. An excellent example of this trade-off was encapsulated in the account of a couple who told how it was more profitable for them to spend two days gathering lingonberry during abundant harvest years than to spend that time tending garden crops. They reasoned that they could buy garden goods with the money they earned from selling lingonberry. In this case, the net acquisition gathering rate was clearly more time than energy-limited.

To conclude, these straightforward models, and the theory on which they are based, will be a meaningful lens through which to interpret gathering patterns, even as these models were not tested per se. Combining these models with empirical data helps to ensure a more comprehensive understanding of people's gathering, which may be eschewed by using either one alone (Smith 1983). This integrated approach takes into account that gathering behaviors are a product of both choice optimization, and of socio-ecological constraints, the latter which constitutes a major focus of this chapter.

Materials and methods

This section focuses on the methods specific to the processing and analyzing of spatial data, and to the integration of these data with ecological and ethnographic data in GIS. The methods for the collection of ecological and ethnographic data are detailed in Chapters 4 and 5, respectively.

Obtaining and pre-processing satellite imagery

The first step in this study was obtaining two Landsat TM (Thematic Mapper) images (p99r21 and p99r22) that encompassed the Central Kamchatka depression where this study was situated. These images had a spectral resolution of six reflective bands in the visible and near infrared electromagnetic spectrum (bands 1-5, and 7), and a spatial resolution of 30m x 30m. (Note that the thermal band 6 with a spatial resolution of 60m was not used in this study.) These images were chosen on the basis of their temporal suitability (both are from July 23, 2007) given the study's time range (2004-2008); moreover, these images contained strikingly little cloud cover, which is a rarity for this region. Nonetheless, image preprocessing required removal of the few clouds present.

Geometric and atmospheric correction procedures were done to ensure the spatial alignment of the images, and to remove both sun illumination and unwanted atmospheric effects from the imagery. In this step pixel digital number (DN) values were calibrated to remove the effects of solar illumination angles using the Chavez COST method (without Tau [t]), which is an image-based atmospheric correction procedure. This procedure was run through ERDAS IMAGINE 9.2 models created via the Website: http://earth.gis.usu.edu/imagestd/ (Leica

Geosystems, 2009). Following these corrections, images were reprojected into UTM-WGS 84 Zone 57 in ERDAS IMAGINE. The final stage of image preprocessing consisted of subsetting areas (one from each Landsat image) that together encompassed the study site in the Central Kamchatka depression.

Digital Elevation Model (DEM) and landscape differentiation

A DEM was used to account for the clear elevation gradations in the delineated study site, ranging from low floodplain to high alpine areas. Based on this model, both subset images were separated into two new layers containing pixels of upland (>500 m), and lowland (<500 m) (i.e. floodplain) areas. To create these layers, the DEM was used to mask out the area of interest (i.e. >500 m or <500m) from each original image. This landscape differentiation based on elevation ensured higher precision in the classification process, where the upland and lowland areas were classified separately.

Land-cover classification

Classification of upland and lowland, or floodplain and non-floodplain, areas was performed by running an unsupervised classification using the ISODATA algorithm in ERDAS IMAGINE (Tou and Gonzalez 1974). Fourteen land-cover classes were eventually identified on the basis of their spectral signatures. The varied—and highly disturbed—landscape of central Kamchatka made landscape classification difficult (and time-consuming), especially as it was not possible to distinguish all forest association group s spectrally. For instance, the larch-lingonberry group could not be differentiated spectrally; thus, it does not appear as a separate land-cover class, despite its importance to this study. (It was grouped into the category of fragmented larch, given the history of logging in the region where it is found.) Also, the two land-cover types of secondary deciduous forests (fragmented coniferous-deciduous birch-dominant forests and maturing deciduous forests) were spectrally very similar; however, they differed with respect to disturbance type. Whereas the former primarily occurred following logging, the latter typified post-fire vegetation. Other land-cover types with similar spectral signatures included short vegetation and wetlands. These similarities made some classification error unavoidable. In this case priority was given to ensuring the greatest possible accuracy in classifying the land-cover types representing forest successional stages, which were the most important in this study.

Final classification decisions were made using the spectral information content, empirical ecological data, ethnographic data, and the existing scientific literature on this region. (*Refer to Table 6-1; also, see Chapter 2 for an overview of the scientific literature on this region, and Chapters 4 and 5 for detailed descriptions of ecological and ethnographic data collection, respectively.*) Land-cover types of agriculture and settlements were not consistently identified through the clustering algorithm, but instead were delineated manually as polygons. These polygons were then rasterized and added to the final raster classification. Together, these steps helped ensure that the final classification reflected what is known scientifically of this region, specifically the presence of clear vegetative gradations in central Kamchatka. (*Refer to Chapter 2*.) Once the classifications of the lowland and upland areas for each subset were complete, all four were combined into one final image in ERDAS IMAGINE. (*Refer to Figure 6-2*.) Where overlap occurred between the areas of the two Landsat path/rows, the upland and lowland classifications of the more northerly and larger image (subset of p99r21) were favored.

Accuracy assessment of land-cover classification

An integral part of land-cover classification was the verification of final results done through accuracy assessment. To begin, the ratio of pixels (i.e. those representing forest inventory plots and known gathering sites with GPS coordinates compiled into a GIS point coverage) to land-cover type (in sq. km) was computed. Based on this ratio, additional pixels were added to land-cover types as needed such that the set of accuracy pixels was reasonably proportional to the relative expected frequency of a land-cover type on the landscape (i.e. more common land-cover types were assigned more accuracy assessment pixels). An independent analyst familiar with remotely sensed data, but not with the particular images used in this study, added these additional points through a visual interpretation of the original Landsat satellite image in either the 5-4-3 or 4-3-2 band combinations. Explanations of the land-cover classes (*refer to Table 6-1*) in conjunction with pictures of forest inventory plots (i.e. with known points in the landscape) aided the independent analysis in the interpretation and navigation of this image and in choosing pixels of very high known land-cover confidence.

Additional pixels were chosen and added to the existing GPS point coverage in GIS until the calculated target distributions were fulfilled. A typical standardizing procedure was then performed in which an expert analyst cross-checked all points to verify that they were in line with the representation of the initial points; modifications were made in the case of disagreement. Once these preparatory steps were complete, the matrix program was run in ERDAS IMAGINE against the classification; the outcome was summarized by overall and User's and Producer's accuracy in an output contingency table. (*Refer to Table D-4 in Appendix D.*)

Table 6-1: A brief description of land-cover types in the classification. The classification name and type is also given for primary and secondary forests. (*Refer to Chapter 2 for more information on forest classifications.*)

Land-cover Code	Land-cover Class Name	Color	Brief Description	Classification	Classification Hierarchy Level
1	Spruce-dominant forest	dark green	**Undisturbed forest:** Spruce (*Picea ajanensis*)-dominated coniferous forest, typically found at low elevations, i.e. along river tributaries, and mixed with larch.	*Picea ajanensis* forests	Formation
2	Larch-dominant forest	turquoise	**Undisturbed or minimally disturbed forest:** Larch (*Larix dahurica*) forests mixed with birch (*Betula platyphylla*) that have not been cut, or that were selectively cut ca. 70-80 years ago.	*Larix dahurica* forests	Formation
3	Fragmented coniferous-deciduous forest: *coniferous (i.e. larch, spruce) dominant*	aquamarine	**Disturbed forest I**: Mixed forests disturbed primarily by logging (conditional clear-cutting) or fire, or both (or by volcanic activity) ca. 15-30+ years ago; larch, or rarely, spruce dominate.	Secondary *Larix dahurica – Ledum palustre, Larix dahurica – Rosa amblyotis – Geranium erianthum dahurica* forests	Association group
4	Fragmented coniferous-deciduous forest: *deciduous (i.e. birch) dominant*	green	**Disturbed forest II:** Mixed forests disturbed through logging (conditional clear-cutting) or fire, or both (or by volcanic activity) ca. <=10-25 years ago; birch s dominant.	Secondary forests: *Larix dahurica – Rosa amblyotis – Geranium erianthum* forests in the region of Kozyrevsk; and *Larix dahurica – Ledum palustre* forests in the region of Atlasovo)	Association group

5	Maturing deciduous forest	mustard yellow	**Post-fire deciduous forest:** Primarily birch regeneration ca. 15-35+ years after a severe disturbance, typically fire, but also logging (clear-cutting), or more rarely, a volcanic eruption. Other deciduous species in this forest type include: aspen (*Populus tremula*), alder (*Alnus hirsuta*), and willow (*Salix sp.*). This land-cover type is typically less dense than that more recently burned (or logged) forests; it also signifies less dense deciduous growth in river floodplain and wetland areas.	Secondary *Larix dahurica – Ledum palustre, Larix dahurica – Rosa amblyotis – Geranium erianthum dahurica* forests	Association group
6	Dense deciduous regeneration/ floodplain forests	yellow	**Early successional deciduous forest:** Dense deciduous regeneration (birch, aspen, alder, and willow) ca. < =15 years following a major disturbance (i.e. fire). This class also includes floodplain forests occurring along river banks and sandbars, and in low-elevation wetland areas. Dominant floodplain species include: poplar (*Populus suaveolens*), willow (*Salix udensis*), and *Chosenia arbutifolia*	Secondary *Larix dahurica – Ledum palustre, Larix dahurica – Rosa amblyotis – Geranium erianthum dahurica* forests	Association group
7	Short vegetation (low elevation)	dark olive	**Initial to early successional forest:** Regeneration in the shrub and herbaceous layers following disturbance ca. < 20 years ago, but usually <=10; over- and understory are not present, or very sparse.	*Chamerion angustifolium, Calamagrostis purpurea, shrub phases of regeneration (refer to Table 2-3)*	
8	Cleared land	dark tan	**Initial successional forest:** Areas that have been cleared through intensive logging or fires (or both) within the past 3-5 years. Early colonizing herbs interspersed with bare patches are		

9	Bare land (low elevation), including "dry" rivers and sand banks	burnt orange	Land with no or little live vegetation, including very recently disturbed areas and some wetland areas. Also includes "dry" volcanic rivers, composed primarily of black sands that fill with seasonal runoffs, and the black sand deposits along the banks of the Kamchatka River.		
10	High elevation larch with Siberian dwarf pine	teal	Larch forests mixed with Siberian dwarf pine (*Pinus pumila*) beginning at 300 m; at 400-500 m (above timberline) Siberian dwarf pine forms a monodominant vertical belt.	*Larix dahurica – Pinus pumila* forests	Association class
11	High elevation deciduous vegetation	light yellow	Stone birch (*Betula ermanii*) forests mixed with alder (*Alnus fruticosa*) from 600-800m; closer to timberline Rhododendron (*Rhododendron aureum*) is common.	*Betula ermanii* forests	Formation
12	High elevation bare areas	gray	Rocky outcrops on mountaintops.		
13	Wetlands	violet	Lowland bogs and mires with sparse to no vegetation.		
14	Water	blue	Rivers, streams, lakes (including ox-bow lakes)		
15	Agriculture	orange	Fields actively used for crop or hay production, or those that are fallow.		
16	Settlements	maroon	Villages (inhabited and abandoned) and other human features, including local airports, landing strips, and winter cabins.		

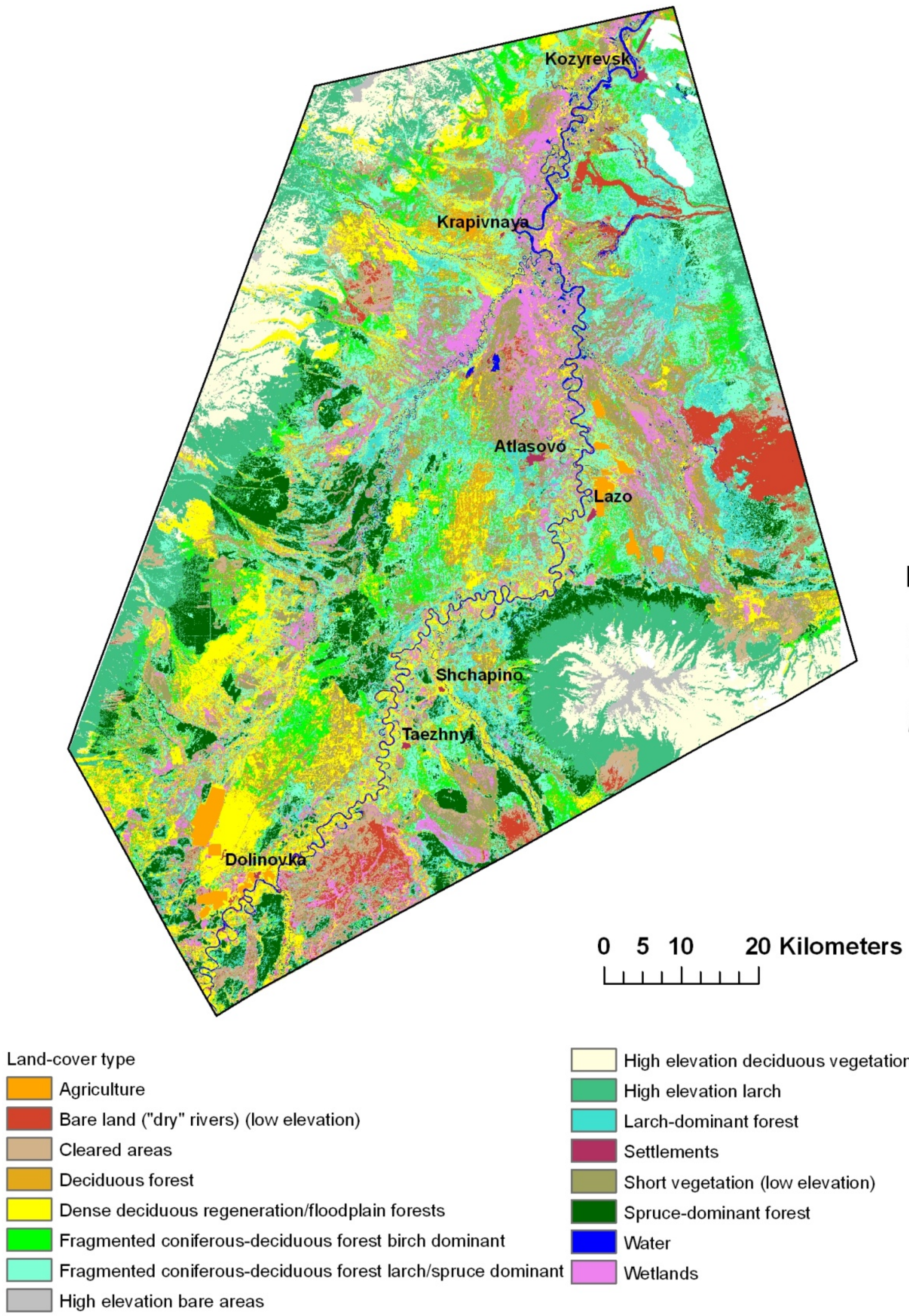

Figure 6-2: Land-cover map of study site in the central Kamchatka depression.

GIS Data Creation

In addition to land-cover data, vector data were a key component in spatial analysis. (*Refer to Figure 6-3.*) These data were created and stored in separate shapefiles in ArcMap (ESRI 2009), depending on their specific geometry (lines, polygons, and points). Because access to resources is an important factor in resource use (see Pyhälä et al. 2005), line data representing the extensive road network dissecting central Kamchatka were the most detailed—and critical—to this study. A product of prior industrial logging, roads in this network were differentiated into three classes, depending on amount of use and condition Lines were also used to delineate the equally extensive hydrologic network divided into major and minor river classes. (*Refer to Table 6-2*). Polygons outlined the following: lakes; villages and other human settlements (e.g. winter cabins) (both current and deserted); and agricultural fields (both fallow and those in current use). All vector data were digitized using 1:100,000 topographic maps (published in 2000 and 1985) and Landsat images. Lastly, a point layer contained the GPS coordinates marking all forest inventory plots, and other known gathering sites.

Table 6-2: Listing of types and classes for road and hydrology line layers. Class numbers are based on a modification of the Anderson et al. (1976) USGS classification scheme for use with remote sensing data.

Type	Class	Description
Roads:		
Primary (Type I)	1342	Unpaved; primary thoroughfares connecting villages in central Kamchatka to the Petropavlovsk-Kamchatsky, Kamchatka's capital city to the south.
Intermediate (Type II)	13425	Unpaved; arterial roads within forested area; that are traveled primarily by hunters and gatherers.
Forest (Type III)	1343	Unpaved; least traveled and maintained; a few of these roads are traversable only with specialized vehicles.
Rivers:		
Major	512	Kamchatka, Bystraya, and Kozyrevka Rivers
Minor	513	All tributaries of the major rivers, and other minor rivers.

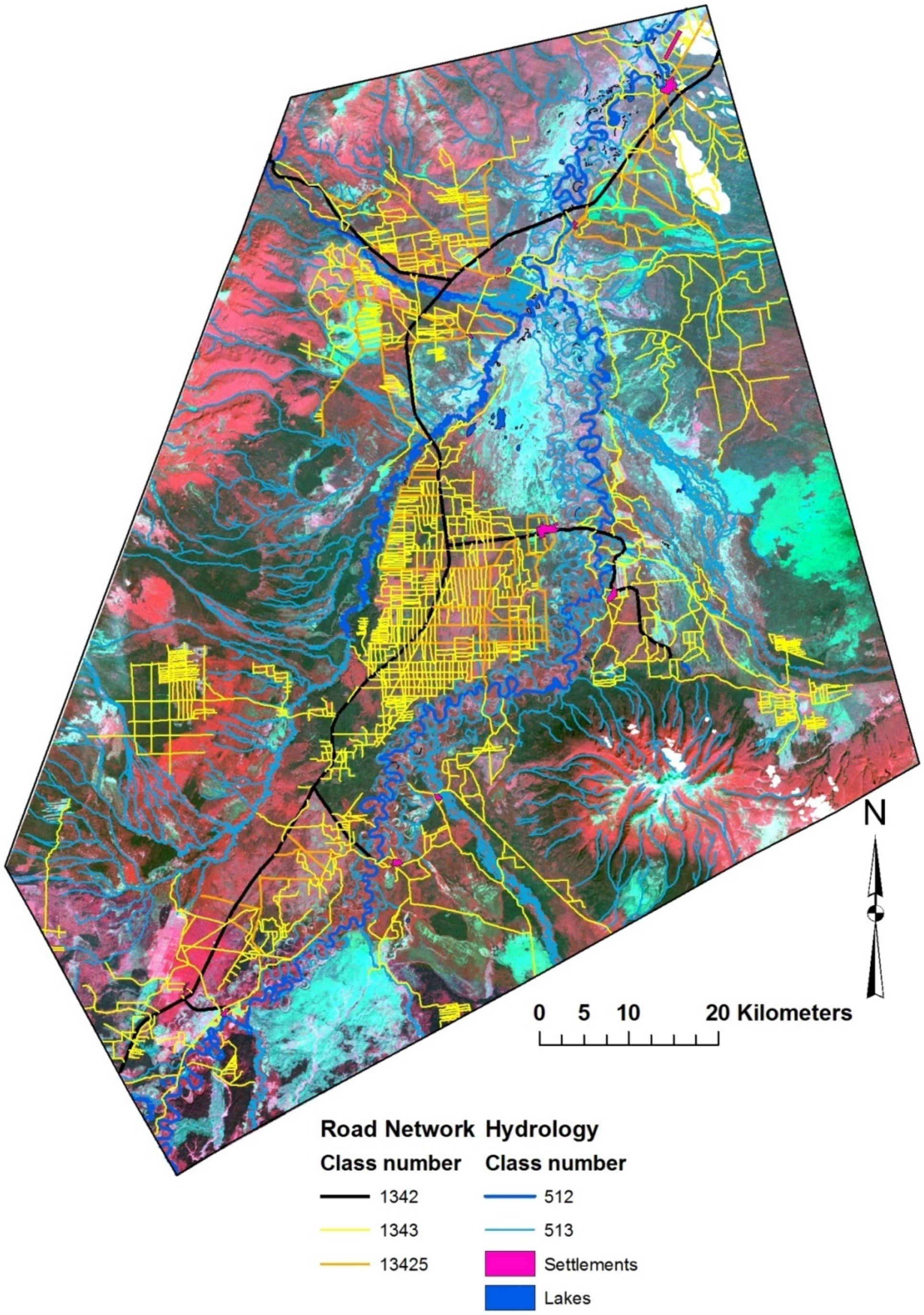

Figure 6-3: Depiction of vector data used in spatial analyses.

Relationship between spatial and ecological data

The relationship between land-cover type and forest structure and composition was first analyzed in a one-way ANOVA in PASW (SPSS) (IBM 2009). All forest inventory plots (N= 43) were assigned a land-cover type based on the classification. Due to the small sample size and the unequal spatial distribution of plots, only four land-cover types were considered. (Initially eight types were assigned; however, half of them represented three or fewer plots, which meant that they had to be consolidated with the other types that were most appropriate. For instance, maturing deciduous forests were grouped with fragmented coniferous-deciduous, birch-dominant forests.) These four land-cover types were: larch-dominant forests (Type 2); fragmented coniferous-deciduous forest, larch-dominant (Type 3); fragmented coniferous-deciduous forest, birch-dominant (Type 4); and short vegetation (low elevation) (Type 7). Levene's homogeneity of variance test was used to determine whether any of the variables violated the assumption of equal variances. The variables that violated this assumption were analyzed using the robust tests of equality of means with the Welch statistic.

The dataset was first tested as a whole with land-cover type as the independent factor and the variables of forest structure and function as the dependents; it was then sorted by year and tested using the same parameters. The significant results from these tests were further explored through the Tukey HSD (honestly significant difference) and Tamhane post hoc test to identify significant differences among groups. (The latter test was used when the assumption of equal variances was not assumed.) Box plot graphs depicted these differences for selected variables. (*Refer to Figures D-1 – D-4 in Appendix D*.)

Discriminant analysis was also used to test whether spatially-derived land-cover types differed ecologically (see Garson 2008). In this analysis land-cover type was specified as the dependent, categorical (or grouping) variable; all variables of forest structure and composition were entered as independent variables. Similar to the one-way ANOVA, only four land-cover types (2, 3, 4, and 7, *refer to Table 6-1*), were used in this analysis due to limitations in the ecological data (*refer to explanation under one-way ANOVA above*). The following options in creating the model in SPSS were chosen: 1) step-wise procedure; 2) use of the probability of F where the maximum significance of F to enter was 0.05, and the minimum significance of F to remove was 0.10; 3) scatterplots showing the relation of the first two discriminant functions. Eigenvalues were computed to show the extent to which each of the three discriminant functions in this analysis accounted for variance in land-cover class. Finally, Wilks' lambda was the default statistic used to test the significance of the discriminate function as a whole.

Linkage of non-spatial (ethnographic) and spatial data

Because the gathering patterns examined in this study were still primarily locally driven, it was appropriate to use GIS to establish linkages between households and gathering sites (see Axinn and Barber 2003). The first step in making these connections was to partition the landscape into discrete polygons that represented known gathering sites (see Evans and Moran 2002). This process began with a vector layer of GPS points in ArcMap. Representing the spatial unit of observation (see Walsh et al. 2003), these points collected during forest inventory work and on trips with gatherers contained known coordinates of lingonberry gathering sites. These points, however, were just a start: the highly variable and patchy nature of lingonberry harvests necessitated relating these point data to a wider spatial area, which was done by creating radial buffers around the points (see Rindfuss et al. 2002). These buffers had a 1-km long radius that extended from the points; this length was based on an assumption concerning the range of likely gathering activity. Considering that gatherers used a variety of transportation modes to reach sites (including car, motorcycle, bicycle, and walking), and that gathering sites typically contained roads that make them accessible, a 1-km radius seemed like a reasonable length that gatherers would be willing to travel within a site. (Although, it could have been an overestimate for those on foot, and an underestimate for those using motorized vehicles.)

Another assumption was that gathering sites occur in a circular shape (see Rindfuss et al. 2002). This representation seemed sufficient given that site boundaries were non-existent. In the cases where buffers encompassed terrain clearly not fit for gathering (e.g. rivers or volcanic dry rivers), the buffer was shifted accordingly on the basis of a topographic map (1:100,000). These initial buffers were supplemented with data collected in 2004 when some survey respondents sketched known gathering areas on topographic maps (see also Rindfuss et al. 2002). These sketches were redrawn in ArcMap and incorporated into the polygon coverage of the radial buffers. To ensure consistency in the coverage, 1-km radial buffers were created to fill in the respondents' mapped gathering areas.

In addition, other information on sites, including vernacular names, distance and direction from village, and roads traveled to sites, served as ancillary data. When added to the polygon coverage, these data often clustered together and coincided with the GPS points and the respondents' sketches of known gathering areas. When they did not, the geographical location of a gathering site was approximated based on all available and relevant information. (This documentation also proved important for later cross-checking ethnographic data, namely where people said they gathered versus where they actually gathered.) The final steps in creating the polygon coverage involved: 1) assigning distinct clusters a unique name and number; and 2) dissolving the radial buffers into 32 single polygons that represented the final gathering sites. One drawback to this approach was inconsistency in delineating sites due to the absence of precise geographic data for some of the sites (see Walsh et al. 2003).

Data integration in GIS

Managing data in GIS enabled the spatial linkage of these sites to both the landscape, and to the non-spatial data on gathering behavior. A challenge in connecting gathering behavior at the household level to sites was the absence of a clear one-to-one relationship (Rindfuss et al. 2002). One household, for example, might gather in several sites, while several households could frequent the same site. This complexity presented a "many-to-many" matching problem, or the issue of associating multiple responses to one or more gathering sites (see Walsh et al. 2003). In GIS "many-to-many" relationships are accommodated through the relate function by which spatial features are related to a non-spatial dataset based on a primary key, which in this case was the unique ID number for each gathering site.

The non-spatial data was contained in two separate datasets for the years 2003 and 2006 to account for temporal differences in lingonberry harvests, affect gathering metrics (e.g. gathering intensity and frequency). These two years were indicative of specific timing in fieldwork. (*Refer to methods section—data analysis in Chapter 5 for a more detailed explanation.*) Each dataset contained the following gathering metrics: intensity (liters gathered/hour); frequency (total hours spent gathering); number of gatherers per household; whether harvests were marketed; and ID number(s) of each reported gathering site(s). When a household reported more than one site, a new row was added to accommodate each additional site. All data on gathering metrics from the previous site were copied into the new row, assuming that gathering behaviors and patterns remained constant. These were broad assumptions, yet they were the only recourse as there were insufficient data on gathering metrics for each reported site. The one exception was frequency: it was adjusted for each added site according to increased or decreased travel time to this site. These datasets were then related to the attribute table of the gathering sites polygon layer in GIS through the unique site ID number that was common to both (*see also Walsh et al. 2003 for a study that employed a similar procedure*).

Analysis of linked non-spatial (ethnographic) and spatial data

Gathering patterns and land-cover

Although the relate function proved helpful, it still did not allow for the full incorporation of non-spatial data into GIS. To achieve this level of integration, the following variables were calculated for each gathering site in each dataset (2003 and 2006): sum of households gathering in site; sum of individual gatherers, and percent of all gatherers (figured using all sites); mean gathering intensity; mean frequency; and percent of households that marketed harvests. These aggregate data were added to new fields in the polygon attribute tables for 2003 and 2006. This step enabled the application of symbology to each polygon layer, which was then stacked in GIS along with the land-cover classification and other vector layers (e.g. roads, rivers, and settlements) to explore spatially the patterns of gathering intensity, marketing, and number of gatherers across the landscape. (*Refer to Figures D-5 – D-7 in Appendix D.*) Further, the area (in m^2) of each land-cover type within each gathering site was calculated by using the tabulate area tool in ERDAS IMAGINE. Then the proportion of each land-cover type relative to the area of the site in which it was found was calculated. These proportions were entered into the attribute tables for 2003 and 2006, which allowed for statistical analyses of the relationships between land-cover type and gathering metrics (see also Evans and Moran 2002). (*These analyses are discussed in detail below*.)

Additionally, proportions of land-cover types relative to the areas of four zones around villages were calculated. First, the mask function in ERDAS IMAGINE was used to create four concentric zones around the villages of Atlasovo, Dolinovka, and Kozyrevsk with the following parameters: Zone I = 0-4.9 km; Zone II = 5-14.9 km; Zone III = 15-24.9 km; and Zone IV = 25-35 km. Second, the total areas of each zone, and of each land-cover type within it, were calculated, allowing for the proportions of land-cover type to be compared graphically by zone. (*Refer to Figures D-8 – D-15 in Appendix D*.) These zones were also used to compare land-cover types and road densities within gathering sites versus those outside of these sites. This graphical analysis was important in substantiating the initial 32 gathering sites partitioned in the landscape. In other words, there should be clear differences between road densities and the proportions of land-cover types representing successional forests within and outside of sites. To perform this analysis, the total areas (in m^2) of gathering sites and non-gathering sites were summed for each zone. The total areas of land-cover types and total road lengths (of each road type) within these two categories were also summed; they were then divided by the total areas of gathering and non-gathering sites to calculate proportion of land-cover type and road density per site. The results were compared across zones and villages. (*Refer to Figures D-16 – D-26 in Appendix D.*)

Gathering patterns and distance

Road vector data were employed to understand the effects of distance and accessibility on gathering metrics. Least-cost distances from the nearest village to gathering site and from the main road to gathering site were figured as accurately as possible using the cost-distance and cost-path functions in ArcMap. In other words, they were determined based on actual routes that gatherers could take from the nearest village to site, as opposed to "as the crow flies" estimates. This process entailed the following steps:

1. Gathering sites were matched to the main villages of Atlasovo, Dolinovka, and Kozyrevsk (when there was overlap, i.e. when gatherers from two or more villages reported gathering at the same site, the site was assigned to the nearest village).
2. Each village polygon was converted to a raster; roads were also rasterized and assigned values dependent on their classification, such that main roads (class 1342) = 1; intermediate roads (class 13425) = 100; forest roads (class 1343) = 1,000; and all other non-road areas = 100,000. This weighting scheme reflected the increased costs as roads became less traversable, and thus, necessitated greater time and energy inputs. All non-road areas were assigned extremely high costs to ensure that they would not be considered in the distance calculations. On this basis, the cost-distance tool in ArcMap was used to create cost-distance and back link grids.
3. These grids were used in the cost-path function in ArcMap, which determined the distance and direction from the nearest polygon edge of villages to the nearest edges of gathering sites on the basis of the most efficient costs (in this case the gathering sites represented destinations).
4. These paths were converted back into a vector file where the length of each segment that constituted the route from the nearest village to gathering site was calculated in

meters. These segments were then summed to find the final length from the nearest village to gathering site. This same protocol was used to determine the least-cost distance from the main road to gathering site where the latter again represented destinations. (In the cases where the main road ran through a gathering site this distance was zero.)

Gathering patterns and accessibility

To determine accessibility within sites, the densities of all three road classes (primary, intermediate, and forest roads) were calculated within each gathering site. First, the intersect tool in ArcMap removed all roads outside of the polygons representing these sites. Road density was computed by summing the road lengths of each class within each polygon, and dividing these lengths by the total area of the polygon. These data, and the distance data, were then used in statistical analyses, as described below.

Statistical tests

Relationships between anthropogenic features and land-cover type

In examining these relationships, the focus was on correlation as opposed to cause or effect; thus, bivariate correlation models were run in SPSS to analyze the relationships between distance and land-cover type; and between road density and land-cover type. (Note that for these and subsequent models only the land-cover types 1-9 [*refer to Table 6-1*] were tested.) These models tested the predictions that increases in distance to sites (from the nearest village, and from the main road), and in road densities should correspond to higher proportions of land-cover types representing early- to mid- successional (i.e. more recently disturbed) forests within these sites. Because the measures of distance and road density did not change over time in this study, year was not considered in these models.

Factors influencing gathering choices

The first step in analyzing non-spatial (i.e. gathering metrics) and spatial data linked in GIS was establishing whether year land-cover, distance, and road density affected people's decision to gather in a certain site. Toward this end binary logistic models (a form of generalized estimating equations [GEE]) were run in SPSS on the basis of a dataset combining 2003 and 2006.In this model year was entered as the within-subject effect and gathering site ID number was specified as the subject effect. The dependent binary variable was gathering = 1 (if gathering activity was reported in that site in either year), and gathering = 0 (if this activity was not reported in either year). The covariates (continuous variables) were the following: proportion of individual land-cover type within gathering sites; least-cost distance in km from nearest village to site; least-cost distance from the main road to site; and road density (of all three road classes). Due to the small sample size (N=64), each of the covariates was tested separately in the model. For each model the option of main effects, and the statistical option of parameter estimates (including exponential parameter estimates), were selected. (These statistical options were added in addition to the default settings.)

Factors influencing gathering metrics

Linear mixed models were chosen to examine the effects of land cover, distance, and road density on the gathering metrics of intensity, frequency, number of gatherers, and marketing of harvests. Similar to the binary logistic models, these models run in SPSS also treated year (2003, 2006) as a repeated effect. Gathering site ID number was designated as the subject variable. In building the model, compound symmetry was chosen for the repeated covariance type. In addition, a fixed effect factorial model, and the statistical options of parameter estimates and covariances of parameters estimates, were specified. The gathering metrics were the dependent variables, while the covariates were the measures of land-cover type (individual proportions), distance (in km), and road density. As in previous models, the covariates were tested separately to account for the small sample size (N=64).

Results and discussion: Part I

Relationship between land-cover type and forest composition and structure

A one-way ANOVA established significant ecological differences among spatially-derived land-cover types, thereby validating the land-cover classification. There were significant differences in 14 (out of 49) variables among the 4 land-cover types tested (*refer to Table 6-3*). There were, however, no significant relationships in the one-way ANOVA between the lichen-moss and woody debris ground layers, and lingonberry fruit yields. This result was surprising in light of the regression models (*refer to Chapter 4*) that showed a significant effect of these two layers on lingonberry fruiting. This discrepancy could be due to the exclusion of 2004 data in the regression models. (Data from all three seasons, including 2004, were used in discriminant analysis and in the one-way ANOVA.) At the same time, it could point to the complexity of successional processes in central Kamchatka that could not be captured solely in one test. The ANOVA results, including those from the post hoc tests (*refer to Table 6-4*) are discussed below according to forest layer.

Table 6-3: All independent ecological variables that differed significantly among land-cover types.

Variable	***F***	***Sig.***
Overstory:		
Percent coverage^	17.137	**0.001****
Mean dbh	4.064	**0.013****
Total tree count^	5.720	**0.019****
Understory:		
Total tree count	3.904	**0.016****
Regeneration Layer:		
Height of intermediate class	5.041	**0.005****
Shrub Layer:		
Percent coverage (overall)	2.822	0.051*
Percent coverage of juniper^	3.753	**0.038****
Herbaceous Layer:		
Abundance of reedgrass and other grasses	2.595	0.066*
Height (cm, seed state) of grasses^	3.033	**0.019****
Percent coverage of grasses^	3.555	**0.037****
Abundance of sedges	3.735	**0.019****
Abundance of fireweed^	5.607	**0.018****
Height (cm, vegetative) of fireweed^	2.949	0.084*
Non-timber Forest Products:		
Max. height (cm) of lingonberry	3.080	**.038****
Total fruit count of lingonberry^	6.111	**.006****

*Significant at the 0.1 level. **Significant at the 0.05 level.

^Denotes variables that violated the homogeneity of variances assumption. They were tested in a robust test of equality of means where the statistic (Welch) was asymptotically F-distributed.

Table 6-4: Tukey HSD and Tamhane post hoc tests. (The latter was used in the cases when equal variances were not assumed.) Numbers in the paired comparison denote the following land-cover classes: 2 = primary or little-disturbed forest; 3 = Fragmented coniferous-deciduous forest, larch-dominant; 4 = Fragmented coniferous-deciduous forest, birch-dominant; 7 = short vegetation.

Dependent Variable	***Paired comparison***	***Mean difference***	***Sig.***	***95% Confidence Interval***	
				Lower bound	*Upper bound*
Overstory:					
Percent coverage^	2-4	0.414458	0.074*	-0.07518	0.90410
	3-4	0.157542	**0.047****	0.00169	0.01339
	3-7	0.165083	**0.030****	0.01400	0.31617
Mean dbh	2-3	19.609266	0.087*	-2.00980	41.22833
	2-4	28.845992	**0.009****	5.84069	51.85129
	2-7	23.714504	**0.023****	2.52358	44.90543
Total tree count^	3-4	13.48214	**0.048****	0.0892	26.8751
	3-7	12.96825	0.059*	-0.3634	26.3000
Understory:					
Total tree count	2-3	9.22905	0.056*	-0.1686	18.4076
	2-7	11.44444	**0.009****	2.3407	20.5482
Regeneration layer:					
Height of intermediate class	4-7	1.502834	**0.004****	0.40476	2.60090
Shrub layer:					
Percent coverage (overall)	3-4	0.216307	**0.034****	0.01259	0.42002
Percent coverage of juniper^	3-4	0.059804	**0.038****	0.00243	0.11718
Herbaceous-subshrub layer:					
Abundance of reedgrass and other grasses	3-7	-1.1964	0.061*	-2.433	0.041
Height (cm, seed state) of grasses^	2-3	60.702381	**0.013****	-109.45538	-11.94938

Table 6-4 (cont'd) Percent coverage of grasses^	3-7	0.030862	**0.042****	-0.18215	-0.00250
Abundance of sedges	3-4	-2.6094	**0.013****	-4.780	-0.439
Abundance of fireweed^	3-4	-1.9405	**0.008****	-3.468	-0.413
Height (cm, vegetative) of fireweed^	(no sig. pairs)				
Non-timber Forest Products:					
Max. height (cm) of lingonberry	2-7	8.979167	0.051*	-0.03637	17.99470
Total fruit count of lingonberry^	2-7	-684.472	**0.002****	-1141.11	-227.84
	3-7	-503.091	**0.030****	-971.41	-34.77
	4-7	-531.306	**0.022****	59.08	1003.53

*Significant at the 0.1 level. **Significant at the 0.05 level. ^Denotes variables that violated the homogeneity of variances assumption.

Overstory, understory, and regeneration variables

Significant differences among land-cover types in mean overstory dbh, percent coverage, and total tree count could be explained by logging operations that typically remove the largest and most robust trees and leave behind those of little economic value, i.e. with a dbh of less than 16 cm. (*Refer to Figure D-1 in Appendix D.*) Further, there were significantly more understory trees in primary, or little-disturbed forests (land-cover type 2) than in the recently disturbed short vegetation forests (land-cover type 7). (*Refer to Figure D-2 in Appendix D.*) There was a wide gap in disturbance history between these two land-cover types (less than 10 years for type 7 versus more than 30 years, or in rare cases, none at all, for type 2). The highly significant difference in mean intermediate height of regenerating deciduous species between fragmented, birch dominant and short vegetation forests also likely indicated differences in disturbance history: height was greater in the former due to the earlier occurrence of disturbance. It was uncertain why this variable was the only significant one for regeneration. Because regeneration proved difficult to measure systematically from plot to plot, a discrepancy in data collection could have accounted for this result.

Shrub and herbaceous variables

Both the overall percent shrub coverage and the percent coverage of juniper were significantly greater in fragmented larch-dominant than in fragmented birch-dominant forests, suggesting a longer period since last disturbance for the former forests. (*Refer to Figure D-3 in Appendix D.*) In other words, the fragmented larch-dominant forests were in a later successional stage than the fragmented birch-dominant forests. The dominance of juniper also indicated that the fragmented larch-dominant forests largely fell into the larch-marsh Labrador tea forest association group.

The abundance, or how many times a species is encountered within a plot, and percent coverage of grasses (primarily reedgrass) differed significantly between fragmented larch-dominant and short vegetation forests. (*Refer to Figure D-4 in Appendix D.*) This finding was not unexpected since reedgrass often proliferates in recently cleared areas. Also, the abundance of sedges and fireweed differed significantly between fragmented larch-dominant and fragmented birch-dominant forests. These three herbaceous species are usually the first to re-vegetate cleared forested areas following disturbances (*refer to Chapter 2*). Thus, these results further supported that fragmented birch-dominant and short vegetation forests were in earlier stages of succession than fragmented larch-dominant forests. These differences, particularly between fragmented larch-dominant and fragmented birch-dominant forests, could also be accounted for by the ecological distribution of these forests, which was the basis for classification into separate association groups.

Lingonberry variables

The difference in lingonberry fruit count was highly significant across the land-cover types: significantly higher yields occurred in short vegetation forests when compared with the remaining land-cover types. This result substantiated the association of abundant lingonberry harvests with early successional forests. (*Refer to Figure 6-4 and to Chapter 3*.) This result, however, should be qualified since year was not accounted for in this analysis due to the small sample size. When each year was considered separately, the only significant differences in mean lingonberry fruit count occurred in 2006 ($p = 0.057$) when the greatest number of forest plots were measured. Finally, the maximum height of lingonberry was significantly higher in primary or little-disturbed forests than in short vegetation forests, indicating more mature plantlets in the former, yet these plantlets often do not fruit, even during abundant harvest years.

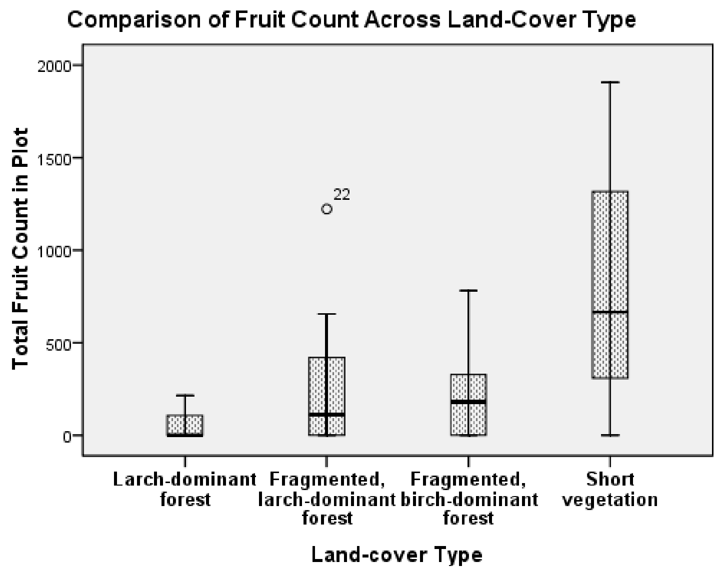

Figure 6-4: Side-by-side box plots for lingonberry fruit count by land-cover type.

Discriminant Analysis

Like the one-way ANOVA, discriminant analysis showed variance in land-cover types with respect to forest structure and composition; however, it took the one-way ANOVA test a step further by ordering the most important predictor variables of land-cover type. Discriminant analysis confirmed that the spatially distinct land-cover types in this study also differed ecologically: they represented distinct successional phases and forest association groups. In this analysis the first two discriminant functions captured 88.6 percent of the variance in land-cover types, attesting to the overall strength of the results that further validated the landscape classification. (*Refer to Table 6-5*.) Finally, a Wilks' Lambda tested the significance of the eigenvalue for each discriminant function. In this case, each function was significant; thus, the model was discriminating.

Table 6-5: Eigenvalues for the three discriminant functions in this model. The number of functions was figured by (g – 1) where g equaled the number of land cover types.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.522[a]	62.1	62.1	0.883
2	1.499[a]	26.4	**88.6**	0.774
3	0.647[a]	11.4	100.0	0.627

a. First 3 canonical discriminant functions were used in the analysis.

Discriminant functions

A step-wise procedure identified the seven variables listed in *Table 6-6* as the most important predictors of land-cover type; these variables ordered from most to least important were assigned a standardized coefficient whose absolute showed the partial contribution of each variable to the three discriminant functions in this model. Like beta weights in multiple regression, these coefficients indicated the relative importance of the independent variables in predicting the dependent variable. The variables that contributed most to the first discriminant function were (in order of greatest to least): mean percent overstory coverage, mean diameter at breast height (dbh) of overstory trees, and mean height of deciduous regeneration (intermediate class). This result meant that plots with higher measures of these three variables would also have higher scores for the first discriminant function.

For the second discriminant function, the variable of total overstory tree count was contrasted by variables representing mean percent coverage of overstory and herbaceous-subshrub layers. This finding meant that plots with high overstory tree counts and low percent coverages of the overstory and herbaceous-subshrub layers would have higher scores for the second discriminant function. Finally, for the third discriminant function, the variables of mean percent coverage of juniper and mean lingonberry fruit count were contrasted by the variable of mean height of intermediate regeneration. Plots with high scores for the third discriminant function would have high fruit counts and a high percent coverage of juniper, and a sparse to non-existent presence of the intermediate regeneration class.

Table 6-6: The standardized canonical discriminant function coefficients for the seven best predictor variables.

	Function		
	1	2	3
OVERSTORY: Mean Percent Coverage	**1.008**	**-.751**	.066
OVERSTORY: Total Tree Count	-.127	**1.202**	.352
OVERSTORY: Mean dbh (cm)	**.603**	-.077	.204
REGENERATION: Mean height of intermediate class of deciduous	**.500**	.323	**-.770**
SHRUB: Mean percent juniper coverage	-.022	.576	**.515**
HERBACEOUS: Mean percent coverage	-.139	**-.674**	.143
NTFP (Non-timber forest product): Mean lingonberry fruit count	-.404	-.311	**.394**

Discriminant labels

Structure coefficients (*refer to Table 6-7*) showed the simple correlations between the variables and discriminant functions. (Here all the other independent variables were not controlled for as in the case of standardized coefficients). These correlations resembled loadings in factor analysis in that the largest absolute correlations associated with each discriminant function suggested how to name each function (Garson 2008). The first (and most important) discriminant function was given the label of primary or little-disturbed forest since the variable with the largest correlation in this function was mean percent overstory coverage. (As this variable increased it indicated later successional forests.) The second discriminant function was labeled as fragmented forests: the variables with the largest absolute correlations in this function were total overstory tree count and mean percent coverage of the herbaceous-subshrub layer. These two variables were contrasting such that a higher tree count corresponded to a lower mean percent coverage of the herbaceous-subshrub layer. This combination of variables indicated disturbed forests.

The third (and least significant) discriminant function was labeled as larch-lingonberry forests. In this case the mean height of intermediate regeneration was most associated with this function; it was contrasted by the variables of mean lingonberry fruit count, mean percent juniper coverage, and mean dbh of overstory trees. In other words, increases in the latter three variables were associated with decreases in the height of intermediate regeneration. This combination seemed to describe the larch-lingonberry forest association group where juniper and lingonberry dominate the shrub and herbaceous-subshrub layers, respectively, and where there are commonly abundant lingonberry harvests. (*Refer to Chapter 2 for more information on this forest association group.*)

Table 6-7: **Structure matrix showing the correlations of each variable with the three discriminant functions. The first, second, and third discriminant functions were labeled based on the largest absolute correlation(s) associated with each discriminant function (in bold). Labels refer to successional stage (1 and 2); and forest association group (3).**

	Function		
	1 ***Primary, or little-disturbed forest***	2 ***Disturbed forests***	3 ***Larch-lingonberry forests***
OVERSTORY: Mean Percent Coverage	**.680***	-.019	.342
OVERSTORY: Total Tree Count	.251	**.456***	.332
HERBACEOUS: Mean percent coverage	-.019	**-.300***	-.002
REGENERATION: Mean ht. of intermediate class	.187	.166	**-.616***
NTFP: Mean lingonberry fruit count	-.259	-.154	**.388***
SHRUB: Mean percent juniper coverage	.128	.209	**.343***
OVERSTORY: Mean dbh (cm)	.246	-.174	**.281***

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

Variables ordered by absolute size of correlation within function.

*Largest absolute correlation between each variable and any discriminant function

Discriminant scores

The discriminant scores for each function (figured by multiplying the standardized function coefficient by the variable values for each forest plot) revealed distinct clustering of the four land-cover types. (*Refer to Figure 6-5.*) There was, however, some overlap between fragmented larch- and birch-dominant and short vegetation forests, indicating spectral similarity among these types, which presented difficulties during the classification process. Fragmented larch- and birch-dominant presented a particular challenge: initially, they were considered to differ primarily in composition of primary species. This analysis showed that fragmented birch-dominant forests are closer to short vegetation forests in terms of the predictor variables, suggesting that fragmented birch-dominant forests were at an earlier successional stage than fragmented larch-dominant forests. The disturbance history of these forests validated this finding, revealing more recent disturbances in fragmented birch-dominant forests in comparison to fragmented larch-dominant forests. A pair-wise comparison of individual land-cover types with respect to predictor variables revealed that fragmented birch-dominant forests and short vegetation forests did not differ significantly in percent overstory coverage or in total tree count; it was only when the variable of mean dbh was added that they began to show significant differences. (This variable was the third in a step-wise procedure identifying the key variables in predicting land-cover type. *Refer to Table 6-6 for a listing of these variables in order of importance [from highest to lowest].*) Fragmented larch-dominant forests and fragmented birch dominant forests showed significant differences across all variables.

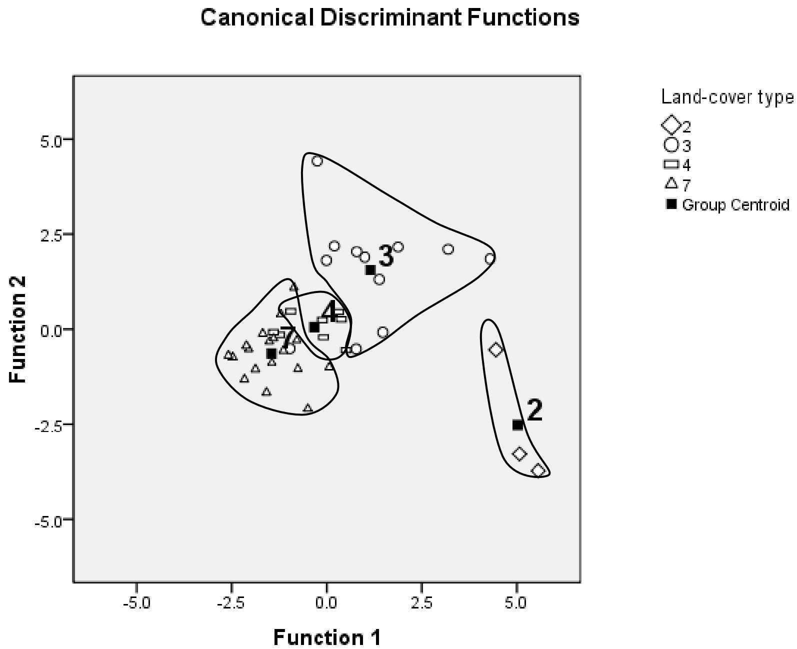

Figure 6-5: Graph of discriminant scores for all forest inventory plots categorized by land-cover type. Larch-dominant forests (land-cover type 2) had the highest scores for Function 1, fittingly labeled as primary or little-disturbed forests. Fragmented larch-dominant forests (land-cover type 3) had the highest scores for Function 2, also fittingly labeled as disturbed forests. Short vegetation forests (land-cover type 7) had the lowest scores for each function, indicating recent disturbance; Fragmented birch-dominant forests (land-cover type 4) appeared to be intermediary between the early successional forests denoted by type 7 and the mid- to later-successional forests denoted by type 3.

Summary of analyses

One-way ANOVA and discriminant analysis complemented one another in establishing that land-cover types differed significantly in terms of forest composition and structure. While discriminant analysis identified overstory variables as the most important predictor variables in land-cover type, the one-way ANOVA test revealed that other forest layers, namely the herbaceous-subshrub layer, could also distinguish land-cover types. In addition, the one-way ANOVA confirmed that these types could be differentiated on the basis of lingonberry fruit yields. The variables identified in these analyses as key predictors of land-cover type became by extension indicators of forest succession. Thus, these analyses were important in both validating ecological differences among land-cover types, and in understanding the successional processes that are currently shaping forests in central Kamchatka. These processes included lingonberry fruiting, which was associated with the land-cover types representing earlier successional stages. This connection is well recognized by the people in central Kamchatka for whom lingonberry has been a vital source of sustenance and income. People's ecological knowledge of the forests that support good harvests is explored in the next section.

Forest succession, lingonberry, and local ecological knowledge (LEK)

The previous analyses were just the beginning in understanding how forest succession affects gathering patterns. Here the discussion diverges from a data-driven examination of ecological processes to a look at the forests through the people's eyes. Local people often had an intuitive grasp of the connection between forest succession and lingonberry fruit yields, seeing the forests as a whole entity, instead of merely a set of variables. Overlap between scientific and local ecological knowledge was evident in people's descriptions of their gathering sites, in which they articulated the basic links between disturbance, forest succession, and lingonberry ecology. This resonance of LEK with scientific findings posited that people were acting in ways that made ecological sense, even though such ways seemed like second nature to them (see Estabrook 2000). Additionally, these ethnographic accounts enlivened the scientific understanding of forests, and they informed the questions of where, how, and why people gather, which lie at the core of the ethnography of landscape. Over a lifetime of lingonberry gathering, people have honed their knowledge of this species, and of the broader forest processes in which it is embedded. For instance, many gatherers were able to articulate the gist (and even details) of forest successional processes without formal scientific training. This next section explores the connections—both broad and intricate—that gatherers made between lingonberry biology and ecology and forest dynamics.

Disturbance and early successional dynamics

A general understanding of lingonberry biology and ecology permeated communities in central Kamchatka, as evidenced by the ability of many gatherers to link abundant lingonberry harvests to forest disturbances (e.g. logging and forest fires):

> When they cut the forest niches are open and berries appear. Or, after a fire, in two to three years there will be berries. Cycles occur. Fires are necessary.

> They cut down the forests and lingonberry grows at the beginning.

Additionally, one gatherer in Kozyrevsk recalled copious harvests for three consecutive years in the early 2000s in an area adjacent to the village that had been reopened to logging a decade prior (*refer to gathering site A in Figure 6-6*). In Atlasovo one woman described how lingonberry harvests have appeared on spurs branching out from the village two to three years following logging of primary forests on these spurs. According to her, these harvests were good as long as a thick grass cover did not form.

Although a general knowledge of lingonberry dynamics was widespread, it was not necessarily uniform, highlighting differential perception and experience among gatherers. For instance, some gatherers displayed nuanced knowledge of lingonberry cycles, as a long-term resident (and former *lespromkhoz*, or forest enterprise, employee) of Atlasovo demonstrated in the following passage:

> Lingonberry harvests appear about eight to ten years after logging in the forest; then for three to four years it is possible to gather this fruit in abundance before a recovery period that is followed again by fruiting. For example, in 1974 logging began in the larch forests [in an area near the village] and in 1984 there was the very best berry (*samaya yagoda*) observed there, followed by a fallow period. Then for three more years harvests were still observed there. Now the fruits there are small.

While this respondent claimed an eight- to ten-year time lag between disturbance and the first lingonberry yields, several others cited a truncated cycle in which fruiting occurred in as little as three years following logging or fire. Given the high variability of lingonberry harvests, and of disturbances, these observations likely marked the true range of first fruiting following disturbance. As implied in the passage above, gatherers preferred to gather in "fresher" cuts where lingonberry was purported to be larger than in older cuts. (*Refer to Table 5-4 for more descriptions of gathering sites.*) In these recently disturbed forests, the critical association of sunlight inflow through a fragmented forest overstory and lingonberry high yields was readily apparent to some, as revealed in the following observations:

> An abundant harvest will occur as long as a dense cover [of early successional species, for instance, aspen, poplar, and birch] does not form.
>
> There are more berries that grow on clear-cuts than in the forests because there is shade in the forests.
>
> Where there is a lot of sun, there is a lot of lingonberry, but it [the plantlets] are short and low.
>
> The harvest is really changing—lingonberry harvests are decreasing as the clear-cut areas are growing over and there is no longer adequate light.

Overgrowth and the fall of forestry

The concept of 'growing over' (as expressed in the last passage) was critical in understanding people's perceptions of forest succession. Judging by the contexts in which it was used, 'growing over' could indicate forests that were literally overgrown by dense re-growth of (usually deciduous) saplings. At the same time, this term could be used figuratively to describe the forest floor where the spread of species, such as the subshrub marsh Labrador tea displaced lingonberry. Both literal and figurative interpretations of 'growing over' specified a forest further along in the successional trajectory, or one with a longer lag time since last disturbance. Thus, people's extensive use of this term in reference to lingonberry harvests signified the prevalence of later successional forests in the landscape.

Current forestry experts in the region credited this phenomenon to the sharp drop in logging operations during the post-Soviet period; consequently, there have been far fewer niches for lingonberry colonization now than in the past. Many others made this fundamental connection between decreased harvests and the fall of the once robust forest industry in central Kamchatka, as encapsulated in the following explanations of overgrowth:

> Overgrowth is happening. There used to be a lot of logging that opened up the forest and the lingonberry plantations were large. Everything is growing over now.
>
> Lingonberry is overgrown quickly. Now they don't log as they formerly did, there is not such a *lespromkhoz* as there was formerly. There are few [lingonberry] plantations that remain.
>
> If they don't log it influences harvest levels—it means that gathering sites are declining, they are dying out because there is no help from people.

No doubt, the reforestation of large logging areas and some forest roads has been a visible testament to the collapse of the former *lespromkhozy* (plural for forest enterprises) in the region, and the subsequent cease of large-scale logging *and* gathering. One gatherer pithily summed up this situation: "There used to be a sea of berries, but gathering is related to where they are logging. They haul out logs only in the winter, and very little [at that]."

While logging has not come to a complete standstill, only a small portion of it now takes place in proximity to villages. The majority of current operations underway are situated in the foothills rimming the northwestern edge of the valley (*refer to gathering site B in Figure 6-6*). Although this activity is opening up new gathering opportunities, according to one gatherer, these higher elevation regions are simply not as conducive to lingonberry growth and reproduction as those in the valley. The clear reduction in gathering opportunities is symbolized by the overgrowth of what once were prime gathering grounds, including Bobrovskoe ozero (lake) and Sakharanaya (contains the subregion Kekur). (*Refer to Figure 6-6*). In addition, the region known in the vernacular as *Karpaty* (named after the Carpathian Mountains in Ukraine) located in the foothills of the volcanic massif east of Kozyrevsk,[18] stands out as a vivid example of declining lingonberry harvests. Following logging by the former *lespromkhoz*, gatherers descended upon the abundant yields in this region until the forests grew back. In other later successional forests, gatherers noted thick carpets of lingonberry that no longer produced fruit. One gatherer recounted recent gathering experiences as follows: "You arrive in one area where there was a good harvest for five years and now there is no harvest…With each year the harvest levels become worse and worse. Now it is hard to collect one bucket [10 liters]." Nonetheless, other gatherers still managed to find abundant harvests. For instance, during the auspicious 2006 gathering season in the region of Atlasovo "such great berries" (*takaya khoroshaya yagoda*) were reported in forest sections that start-up logging enterprises had logged a few years prior.

[18]Note that this area was shrouded by cloud cover in the satellite imagery; thus it was not included in the overall image of the study site.

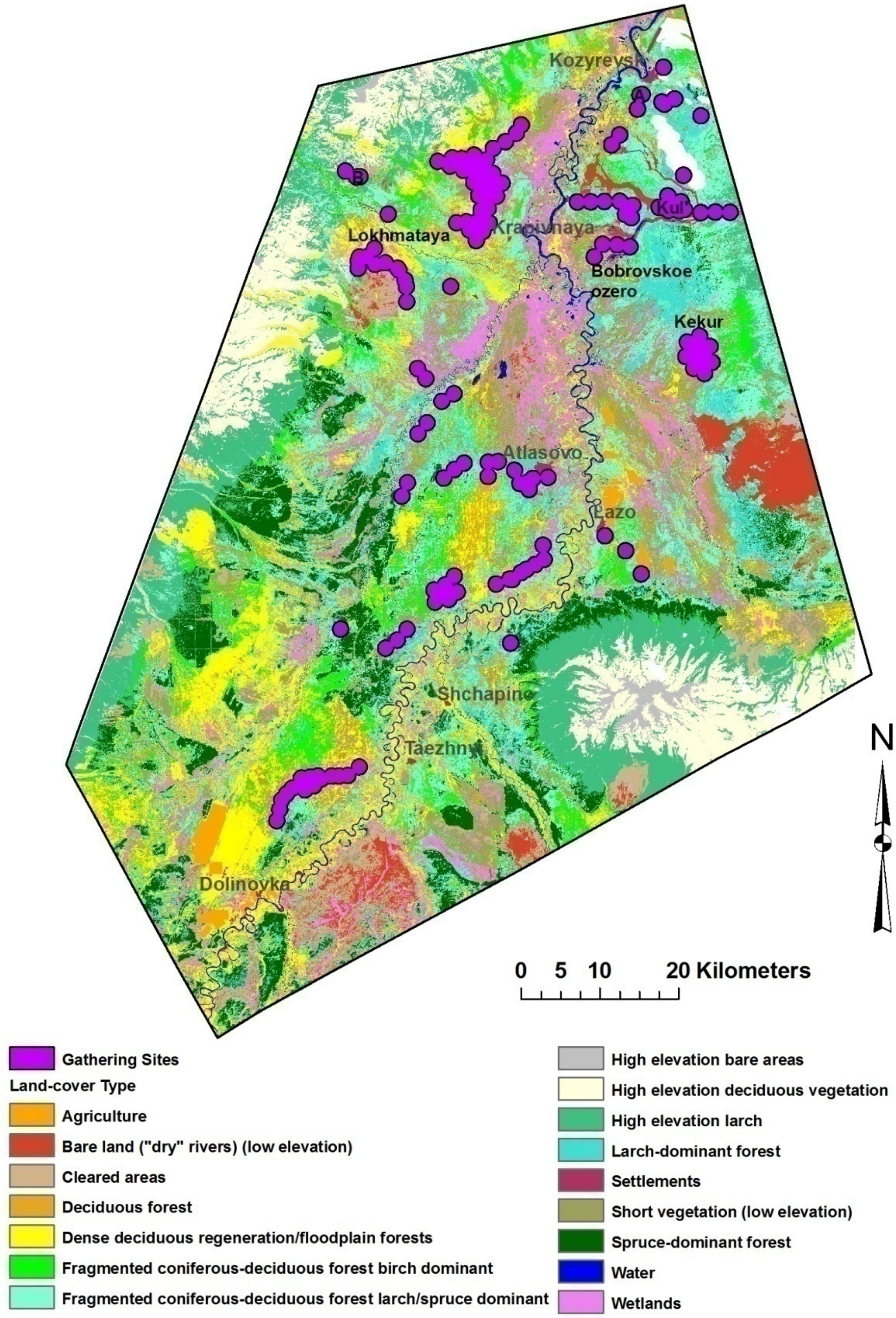

Figure 6-6: Land-cover map depicting gathering sites in the central Kamchatka depression (villages, both former and current, are labeled in gray).

Do people influence succession?

Even with a solid grasp of the tie between disturbance and sought-after harvests, gatherers denied conscious actions undertaken to spur yields: "…we won't cut down the forest for lingonberry, [even though] that it where the berry grows best." At the same time, gatherers could inadvertently create large disturbances, namely fires started through carelessness. A few keen observers noted that the actual practice of gathering, especially when using a tool, caused micro-disturbances vital for lingonberry growth and continued high fruit yields. Gathering was also cited as important in lingonberry seed dispersal; thus, fewer gatherers meant subsequent decreases in quality and quantity of harvests. (Here it should be noted that lingonberry primarily reproduces through vegetative propagation. *Refer to the section on lingonberry ecology and biology in Chapter 4*).

There is a dearth of research on the effect of gathering on lingonberry yields, yet a positive association between gathering and yields seemed plausible, given the observations of highly experienced gatherers, and existing scientific knowledge of this species. Nonetheless, this notion that gatherers could positively influence lingonberry ecology, even on a small scale, was unconventional. Some believed that lingonberry dynamics fell largely outside the realm of anthropogenic influence; thus, any perceived negative effect of gathering with a tool (for example, uprooting of plantlets) was minimal. More common, however, was the equation of tool use with smaller harvests and even the eventual demise of lingonberry. One woman, for instance, noticed where people had gathered with a tool, claiming that this practice damaged the plants, which then produced smaller berries.

LEK and scientific knowledge

In summary, the demonstrated recognition of the integral role disturbance plays in lingonberry dynamics suggested people's solid understanding of forest successional processes that were closely in line with—and could even rival—established scientific accounts, despite the simpler language in which they were articulated. The extent of this knowledge pointed to the importance of lingonberry to people's livelihoods. Because gathering has become a lifeline for many households in the post-Soviet period, gatherers are keenly aware of forest processes, especially as they relate to lingonberry yields, even though they have little formal or scientific knowledge of these processes. Rather, their knowledge has been wrought through repeated visits to and extended time gathering in "their" places. This well-ingrained habit of returning to the same places has attuned people to the ecological rhythms within these sites, specifically to how these processes affect gathering potential from year to year. LEK has also been sharpened by the search for new places to gather when preferred sites are fallow in a given year. Put another way, the greater one's knowledge of where lingonberry might occur in the landscape, the better their chances of acquiring this resource.

Results and discussion: Part II

Relationships between anthropogenic features and land-cover type

Bivariate correlation matrices showed associations of distance (from nearest village and main road to gathering site) and road density with land-cover type in central Kamchatka. They were an integral first step in gauging people's interactions with the landscape through lingonberry gathering. Each matrix summarized in *Table 6-9* is interpreted below in greater detail.

Matrix 1 showed that as distance from the nearest village to gathering site increased, 1) the proportion of larch-dominant forests in gathering sites significantly decreased; and 2) the proportion of cleared land in sites increased. These findings confirmed Prediction II, demonstrating the outward radiation of logging trajectories in this region that have markedly defined the spatial distribution of forests. The cleared areas further from villages testified to current logging operations situated in the last vestiges of exploitable forests those rimming the northwestern edge of the central Kamchatka depression. This spatial distribution of disturbed forests, and by association, lingonberry distribution, has had important implications for gathering, specifically by increasing travel costs as favorable sites move further outward.

Matrix 2 showed that with each 1-km increase from the main (Type I) road to gathering sites, the proportion of fragmented, birch-dominant forests in sites decreased. This negative correlation suggested that more recent disturbances have occurred in proximity to main roads, which was opposite of what was originally predicted. This correlation could indicate the recent phenomenon of resumed logging in the more intact forests surrounding villages. In the environs of Kozyrevsk, for instance, logging in the early 1990s produced fragmented, birch-dominant forests (these are in the birch-forb forest association) that are hemmed in by Type I roads, which might explain the negative correlation in this case.

Matrices 3 and 4 were highly similar, showing that increased densities of Type I and Type III roads in sites were significantly correlated with higher proportions of fragmented, birch-dominant forests and maturing deciduous forests in these sites. The strongest correlation was between Type III road density and the proportion of maturing deciduous forests in sites (Pearson correlation = 0.446), implying that sites with high proportions of this land-cover type were also very accessible given the density of roads (Type I and Type III) within them. Higher road densities in these sites could signify multiple disturbances within them that have necessitated additional road construction. Additionally, in Matrix 4 increased density of Type III roads was also correlated to decreasing proportions of bare land, which was not surprising as the road infrastructure in this region has been primarily confined to forested areas. Finally, there were no significant relationships between Type II road density and land-cover types, which could be due to the classification of this road type based on imperfect empirical knowledge. Still, the other significant correlations in these matrices upheld Prediction II that sites with high road densities also had higher proportions of early- to mid-successional (i.e. more recently disturbed) forests.

In sum, these results established the association of increased distance and road density with greater forest disturbance. These relationships highlighted a critical and paradoxical component in gathering patterns. Given the spatial distribution of disturbed forests and the highly developed road network that dissects these forests, gathering sites were at once found increasingly far from villages, yet in proximate terms, these sites were highly accessible, especially considering the rise of individual car ownership in this region. (*Refer to Chapter 5 for more information on this phenomenon.*).

Table 6-8: Summary of definitions for variables used in analyses. Note that all variables describe lingonberry gathering in delineated sites (*refer to Figure 6-5*). (*Also, refer to Figures D-5 – D-7 in Appendix D for graphical analysis of gathering metrics.*)

Variable	***Explanation***
Gathering Intensity	Mean Liters/hour
Gathering Frequency	Mean total number of hours gathered in one season (Here total time refers to actual time spent gathering only; travel time to and from sites was accounted for in calculating this variable.)
Number of Gatherers	Total number of gatherers who visited a site in one season
Marketing	Percentage of all gatherers at a site who marketed their harvests.
Type I Road	Main road artery
Type II Road	Intermediate road
Type III Road	Forest road

Table 6-9: Bivariate correlation matrices; distance and road density are the independent variables; land-cover type is the dependent variable.

Matrix	***Variable***	***land-cover type*** *(measured in proportion to gathering site)*	***Pearson Correlation***	***Sig. (2-tailed)***
1	Distance (km) (village to site)	Larch-dominant forest	-0.394	**0.026****
		Cleared Land	0.390	**0.027****
2	Distance (km) (distance from main road to site)	Fragmented birch-dominant forest	-0.346	**0.052***
3	Accessibility: Density of Type I Roads	Fragmented birch-dominant forest	0.314	**0.080***
		Maturing deciduous forest	0.315	**0.079***
4	Accessibility: Density of Type III Roads	Fragmented birch-dominant forest	0.298	**0.097***
		Maturing deciduous forest	0.446	**0.010****
		Bare land	-0.325	**0.069***

*Significant at the 0.1 level. **Significant at the 0.05 level.

People's interactions with the landscape through lingonberry gathering

Factors influencing gathering choices

Model 1 (*Table 6-10*) showed a significant effect of year on gathering activity: the parameter estimate of B (Beta coefficient) revealed that gathering was more likely to occur in 2003 than it was in 2006. The exponential parameter estimate of Beta (B =1.879—*refer to Table D-5 in Appendix D*) indicated that the odds of gathering in the designated sites (*refer to Figure 6-6*) in 2003 were 1.879 times greater than in 2006. This finding suggested improved socio-economic conditions that have reduced people's reliance on gathering as a livelihood activity, a phenomenon that was backed by several recent accounts of households curtailing gathering efforts as their household economic situation has improved. (*Refer to Chapter 7 for an in-depth analysis of household livelihood strategies.*)

In Models 2, 3, and 4 the proportion of primary, spruce-dominant forests, dense deciduous regeneration, and bare land influenced the likelihood of gathering. As the proportion of primary spruce-dominant forests increased within a gathering site, the probability of gathering in this site decreased. In contrast, higher proportions of dense deciduous regeneration and bare land in sites corresponded to a higher probability of gathering in these sites, corroborating early successional forests as favorable gathering sites. These results are explored below in more depth.

First, dense deciduous regeneration was representative of an early, post-fire successional forest, which is highly conducive to lingonberry growth and fruiting (see Kabanov 1963). Due to the differential effect of fire, this land-cover type occurred in a complex vegetative mosaic where it was interspersed with other land-cover types, including fragmented larch and birch-dominant forests, maturing deciduous forests, and low vegetation. Thus, the effect of dense deciduous regeneration on the choice to gather in an area needs to be interpreted from a wider (yet still localized) angle that encompasses the landscape mosaic in which this land-cover type is concentrated. An excellent example of such a variegated post-fire landscape where a high proportion of dense deciduous regeneration is intermixed with other cover land-cover types representing successional forests is the large gathering site of *Lokhmataya* (*refer to Figure 6-6*). Record lingonberry yields, for instance those in 2006, have been reported in this site where a major burn occurred in the early 1990s. One industrious gather described how he has harvested lingonberry "by the ton" in this region. This case implied that fire has been the major disrupting force in the post-Soviet landscape, which made sense against the backdrop of dramatic decline of timber production in this region.

Second, bare land did not affect the odds of gathering to the same extent as the other two land-cover types, yet it still had a significant positive effect (at the 0.1 level). This result was unexpected, especially as bare land represented areas where there was no to very minimal vegetation. It made sense, however, given the larger landscape context. Its positive effect was likely due to the prevalence of dry volcanic river beds (classified as bare land) partitioning the region of Kul', a very popular gathering destination. (*Refer to Figure 6-6, and to Chapter 5.*) The constant shifting of these black sand channels, along with intense forest fires, has given rise to specific forest association groups, including larch-lingonberry in which lingonberry proliferates and gives high yields.

Models 5 and 6 indicated that increments in distance from the nearest village and main road to gathering site corresponded to decreased odds of gathering in that site. Specifically, each 1-km gain signaled a 5.2 percent decrease in the likelihood of gathering. Clearly, distance influenced people's gathering decisions: as distance to sites increased, people tended to gather in them less. Overall, these binary models upheld Prediction III, showing that the factors of land-cover type and distance influenced people's choice to gather in a particular site. (Road density had no effect on this decision.) Specifically, the land-cover types of primary spruce-dominant forests and dense deciduous regeneration had the greatest impact on gathering decisions. These basic relationships formed the foundation for building a more nuanced understanding of how people gather.

Table 6-10: Summary of binary logistic models (Type III) in which the dependent variable was the response of gathering in a particular site: 1 = yes, or 0 = no. The covariates (or continuous independent variables) were: land-cover type (types 1-9, *refer to Table 6-1*) and distance (km) from nearest village and main road to gathering site. Each covariate was modeled separately, and year was controlled for in each model. (*Refer to Tables D-5 – D-10 in Appendix D for full results*.)

Model	***Covariate:***	***Beta***	***Wald Chi-Square***	***df***	***Sig.***
1	Year (2003, 2006)	0.631	2.943	1	**0.086***
2	Proportion of primary, spruce-dominant forest gathering site	-9.245	5.425	1	**0.020****
3	Proportion of dense deciduous regeneration in gathering site	14.720	4.748	1	**0.029****
4	Proportion of bare land type in gathering site:	6.707	3.619	1	**0.057***
5	Distance (km) from nearest village to gathering site	-0.039	3.309	1	**0.069***
6	Distance (km) from nearest main road to gathering site	-0.053	2.929	1	**0.087***

*Significant at the 0.1 level. **Significant at the 0.05 level.

Factors affecting gathering metrics

Land-cover type

An initial mixed model analysis (with the zero cases excluded—*refer to Figure 6-7*) showed no significant effect of year on the gathering metrics of intensity (p = 0.430) and marketing (p = 0.420). Year did, however, have a significant effect on frequency (measured in total hours gathered over a given season) (p = 0.023). (*Refer to Table D-11 in Appendix D for results.*) In 2003 people spent less time gathering than in 2006, which translated into an overall lower volume in 2003, even as people gathered somewhat faster in this year. (The mean gathering intensity in 2003 was 6.396 liters/hr compared to 5.871 liters/hr in 2006.) (*Refer to Tables C-12 in Appendix C.*) More abundant harvest levels in 2006 (at least in the region of Atlasovo) likely encouraged people to spend more time gathering, which in most cases led to extra income.

Linear mixed models 1 and 4 (*Table 6-11*) showed a negative relationship between the proportion of larch-dominant forests in a gathering site and gathering intensity and frequency: as the proportion of this land-cover type increased, both gathering intensity and frequency decreased. In contrast, Models 2 and 3 revealed that higher proportions of maturing deciduous forests and dense deciduous regeneration in gathering sites were associated with increased gathering intensity. These models built upon the binary logistic models that established a relationship between early successional stage and high lingonberry yields. Further, in Model 5 increments in the proportion of bare land affected increases in the total number of gatherers at a site. This positive association was likely attributed to the prominence of this land-cover type (primarily in the form of dry volcanic rivers) in the well-visited gathering region of Kul'. Thus, it was not this land-cover type *per se*, but instead its intersection with the larch-lingonberry forests, and the abundant lingonberry harvests that occur within them, that explained this result. This result underscores the importance of a landscape perspective, or a consideration of the relationships among land-cover types, instead of focusing only on discrete land-cover categories.

Model 6 showed that increments in the proportion of maturing deciduous forests at a site corresponded to an increased percentage of gatherers who sold their harvests. This result made sense in light of the positive association of maturing deciduous forests with gathering intensity, and the significant relationship between the choice to market harvests and gathering intensity (*for the latter refer to Table 5-3 in Chapter 5*). Dense deciduous regeneration did not have a significant effect on the marketing of harvests, even though it was also positively associated with gathering intensity. This discrepancy seemed to distinguish gathering sites with high proportions of maturing deciduous forests as the most productive in terms of lingonberry yields. Overall, these analyses showed that people gather more intensely in early- to mid-successional forests, and less intensely and frequently in later-successional (or primary) forests; thus, they verified Prediction IIIa. Of all land-cover types, maturing deciduous forests appeared to be the most favorable in which to gather, especially among those who marketed their harvests.

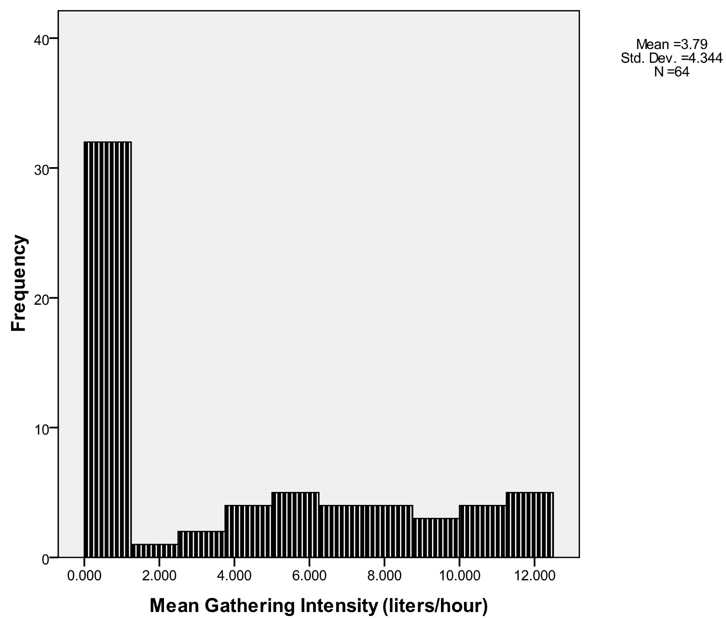

Figure 6-7: Histogram of mean gathering intensity (for both 2003 and 2006 combined). The high frequency of designated sites with no recorded gathering activity (i.e. where gathering intensity was zero) resulted in a highly skewed distribution of gathering intensity (and all other gathering metrics); thus, these zero cases were excluded from the mixed models.

Table 6-11: Summary of linear mixed models where the predictors were: land-cover types (types 1-9, *refer to Table 6-1*). The dependent variables were the gathering metrics of intensity, frequency, number of gatherers, and marketing (*refer to Table 6-8*). Each covariate was modeled separately, and year was controlled for in each model. *(Refer to Tables D-12 – D-17 in Appendix* D *for complete tables of fixed effects estimates.)*

Model	***Covariate*** *Proportion of land-cover type*	***Dependent Variable***	***Estimate***	***Std. Error***	***T***	***df***	***Sig.***
1	Larch-dominant forest	Intensity	-7.183	3.997	-1.797	20.934	**0.087***
2	Maturing deciduous forest	Intensity	13.472	5.700	2.363	15.499	**0.032****
3	Dense deciduous regeneration	Intensity	11.544	5.632	2.050	14.132	**0.059***
4	Larch-dominant forest	Frequency	-50.198	26.236	-1.913	16.712	**0.073***
5	Bare land	Number of gatherers	0.314	0.136	2.308	19.222	**0.032****
6	Maturing deciduous forest	Marketing	1.481	0.675	2.195	13.284	**0.046****

*Significant at the 0.1 level. **Significant at the 0.05 level.

Distance

The linear mixed models in *Table 6-12* revealed that increasing distances from the nearest distance from village and main road to gathering were significantly associated with rises in gathering frequency. There was also a significant relationship between growing distance from the main road to gathering site and an increase in the percentage of gatherers who sold their harvests. These findings supported Prediction IIIb, and made sense in light of other models showing a significant connection between increasing distances to sites and the prevalence of earlier successional forests in these sites. They were also in line with optimal foraging theory, holding that people will gather in sites where they can reap the greatest returns per unit time, even considering travel costs. In this case traveling further seemed to justify increased time and energy inputs to reach these sites; it also seemed to encourage spending more time at sites.

There was no significant association of distance with gathering intensity, possibly indicating that people are traveling further to desirable gathering sites and are spending longer at these sites; however, they are not necessarily collecting more. It was possible that higher gathering frequencies indicated longer stays at sites that were not entirely devoted to gathering. For example, many gatherers told of spending time at sites on other activities, such as making campfires. Also, it was not uncommon for people to embark on gathering trips primarily to escape their everyday routine and spend time in the forest. In this case gathering was almost an afterthought. (Note that travel times to and from sites were excluded from the frequency measure; however, breaks in the gathering day were not controlled for in the total tally of hours spent gathering.) This approach seemed to fit those who gathered for their household needs only. For those who marketed harvests, we would expect a strong association of increasing distances from nearest village and main road to sites with both heightened gathering frequency and intensity.

Table 6-12: Summary of linear mixed models where the predictors were distance (km) 1) from nearest village to site; and 2) nearest main road to site. The dependent variables were the gathering metrics of intensity, frequency, number of gatherers, and marketing. Each covariate was modeled separately, and year was controlled for in each model. *(Refer to Tables D-18 – D-20 in Appendix D for complete tables of fixed effects estimates.)*

Model	*Covariate* *Distance (km)*	*Dependent Variable*	*Estimate*	*Std. Error*	*T*	*df*	*Sig.*
1	Nearest village to site	Intensity	0.046	0.034	1.347	17.286	0.195
2	Nearest village to site	Frequency	0.536	0.210	2.551	14.441	**0.023****
3	Nearest village to site	Number of gatherers	0.005	0.004	1.281	15.918	0.218
4	Nearest village to site	Marketing	-0.001	0.001	-0.848	19.739	0.407
5	Nearest main road to site	Intensity	0.089	0.100	0.892	25.228	0.381
6	Nearest main road to site	Frequency	1.532	0.599	2.558	23.961	**0.017****
7	Nearest main road to site	Number of gatherers	-0.001	0.002	-0.107	21.051	0.916
8	Nearest main road to site	Marketing	0.020	0.011	1.813	24.975	**0.082***

*Significant at the 0.1 level. **Significant at the 0.05 level.

Road density

A linear mixed model showed that increases in Type II road density were significantly associated with increases in gathering frequency (Estimate = 0.109; Std. error = 0.039; t = 2.807; df = 20.125; and sig. p = **0.011**). (*Refer to Table D-21 in Appendix D.*) This finding only partially supported Prediction IIIc that higher road density (of all three types) should correspond to increases in all four gathering metrics. This result implied that Type II roads were better at facilitating access within sites compared to the rougher and less maintained Type III roads, and thus, they attracted a correspondingly higher number of gatherers.

Summary of analyses

Several distinct threads crystallized from these analyses. First, land-cover type and distance mattered in people's initial choice to gather in a site. Primary, or little-disturbed forests and increasing distances from villages to sites negatively affected this decision. In contrast, early successional forests that were generally concentrated further from villages had a positive effect on this decision. Second, land-cover type was also significant in how and why people gathered, such that higher proportions of early- to mid-successional (primarily post-fire) forests were associated with greater gathering intensity and marketing of harvests. Third, increasing distances from villages influenced people's decision to invest more time at sites without necessarily increasing their gathering intensity. Finally, the extensive road network in central Kamchatka opened up more remote, yet disturbed sites for gathering.

These threads wove together a complex picture of gathering patterns where people were gathering in proximity to villages (as might be expected given time and energy constraints); at the same time, they were traveling increasingly far to harvest lingonberry. There were both cultural and ecological reasons behind this phenomenon. The extensive road network in tandem with a spike in individual car ownership has facilitated travel to and within remote sites. These sites also contain higher proportions of early- to mid-successional forests due to the logging trajectories that have radiated out from the villages in this region. The analyses of ecological data showed a relationship between these early to mid-successional forests and higher lingonberry yields, thus justifying gathering further from villages in this landscape, even in light of increased time and energy inputs.

The land-cover type of maturing deciduous forests embodied this emerging picture of gathering patterns. These typically early to mid-successional, post-fire forests tended to be further away from the villages, yet were still highly accessible, given the significant association of Type III road density with this land-cover type. This land-cover type was also significantly associated with increased gathering intensity and marketing, signaling the presence of favorable lingonberry harvests. By showing that gathering is taking place in the most productive habitats, despite their relative remoteness from villages, these findings reinforced that people are responding to the landscape in their gathering patterns. In other words they are acting in ways that make sense ecologically, and, ultimately, evolutionarily (as is discussed in greater depth in the next sections).

Optimal foraging models

Derived from the integration of spatial and non-spatial data, these results greatly expanded the scope of where and how people were gathering in the landscape. Implicit in these results were the proximate and ultimate questions of why people gathered in the areas and the manner in which they did. For instance, if distance was a significant factor in people's decision to gather in a site, why did gathering nonetheless take place at sites further from the villages? What features, or combination of features, particularly in regards to lingonberry yields, of more remote sites made it profitable to gather in these sites? This section endeavors to make this underlying 'why' question explicit through the application of optimal foraging models. These models explained the intuitive decisions behind site choices and time allocated to gathering within these sites, and how these decisions varied in response to changes in harvests (see Smith 1983). Although they naturally simplified complex decision-making processes, these models as described below were nonetheless instructive in interpreting empirical data on people's gathering decisions and behaviors.

Response to abundance and scarcity of lingonberry yields

Patch or site choice

The marginal value theorem predicts that gatherers should leave a site when lingonberry harvests drop to the point where gathering in another site will result in greater returns per unit time, even considering travel costs (Smith 1983). Similarly, new sites should be chosen only when the marginal rate of return is equal to or greater than the average for the existing set of sites (Chartnov and Orians 1973, quoted in Smith 1983). In this case, the marginal value theorem could be used to delineate optimal patch (or site) choice (Smith 1983).

The high variability of lingonberry yields across time and space in central Kamchatka has forced gatherers to adapt their gathering strategies to fit the prevailing conditions for a given year. On a local level, gatherers have to make and remake gathering decisions continually, based on their specific surroundings, prevailing climatic conditions, and their main motives for gathering. One skilled gatherer conveyed his decision-making as follows: "You arrive [at a gathering site] and you see that there is no lingonberry at all, so, of course, you won't be collecting it." This gatherer has become adept at assessing a potential site in terms of marginal return rate before committing to gathering in it.

These foraging models seemed to be particularly applicable to those who marketed harvests, as was exemplified by the aforementioned gatherer who set aside cultural norms (i.e. having one's "own" sites) to focus explicitly on the task at hand: maximizing the net return rate from harvests. Another gatherer captured this mood: "Where there are more berries, and where a harvest will be—these are the most important [factors]." (Gatherers of this caliber reported single-handedly bringing in an average of 100 liters per day of lingonberry in above-average harvest conditions.) Doing so had handsome rewards, or as one gatherer explained, it was a way to obtain "free money" with minimal effort. These gatherers were clearly acting in accordance with the foraging models. At the same time, the models also encompassed the majority of gatherers who sought out sites where they could amass a harvest in a given year, despite the strong cultural preference among some for "their" sites. (*Refer to Chapter 5*.)

Even during abundant harvests, the marginal harvest rate could steadily drop toward the end of the harvest season, necessitating a more intense search for sites. One gatherer succinctly summed up this situation: "You have to run after the [lingon]berries, finding some here and some there." This predicament could also describe initial yields during a poor harvest season. Although there were gatherers willing to collect in this way, or to "look a little harder," for the purpose of providing their households with a minimum amount of lingonberry for the winter (i.e. approximately 20 liters), many clearly were not, as one woman bluntly stated: "What's the point of searching [for lingonberry]?" Another told how it just wasn't worth it to waste time and gas searching for berries. These attitudes fell directly in line with the foraging models predicting the marginal rate of return as a key factor in whether to gather in a site. This rate, in turn, was affected by factors of land-cover type, distance (from villages to site and from main road to site), and accessibility, as the previous analyses revealed. Environmental and climatic conditions specific to a given year were other factors that influenced this rate.

Time optimization

The marginal value theorem posits that time optimization at any site is a function of average yields across all visited sites, thus, time spent in one site should decrease as the overall productivity of a habitat rises, while decreasing productivity should increase optimal visit times in sites. Likewise, conditions of greater abundance exact lower travel costs, and conversely, scarcity signals higher travel costs. These premises were embodied in the straightforward account of one highly productive gatherer:

> If lingonberry is visible, if it is spread out [on the forest floor], then it is possible to gather approximately 2 buckets [20 liters] in one place. Somewhere you'll pass some of it up because you try [to gather] more and more quickly: there's a lot of lingonberry there, and there's lingonberry, so you need to move on.

This account seemed to speak for many gatherers, for instance, another equally prolific gatherer affirmed that it would not be worth his time to gather in a place with a sparse harvest; instead, he sought out those sites where he could remain in one spot and amass "a lot," meaning 1 bucket (10 liters) of lingonberry in 1.5 to 2 hours. Still another related how an abundant harvest with large lingonberry fruits allowed for the nearly instantaneous collection of this fruit, specifically, one bucket (10 liters) in as little as 20 to 30 minutes. These scenarios fall precisely in line with the marginal value theorem: dense concentrations of lingonberry harvests resulted in less time spent at any given site, and greatly lowered travel as gatherers could move quickly from one berry cluster (plantation) to the next. (Sparser conditions would be more costly for gatherers as they would have to invest time and energy to seek out favorable sites. One gatherer's recollection of the prodigious 2005 harvest in Kul' further illustrates this point: "There were just berries and berries. We gathered 20 liters just like that." Under these extraordinarily abundant conditions, the net rate of resource capture was especially high due in large part to the minimal effort required to locate the resource.

Many gatherers, including those with extensive experience, conveyed a sense of "diminishing returns" in their descriptions of time allocation for lingonberry gathering (even without explicitly saying so). For instance, it was common to report collecting three to four hours at a time over a course of a week (or a month, for serious gatherers). These responses indicated that it was more advantageous to gather in short stints as opposed to extended sessions (although a few gatherers reported spending up to twelve hours in the forests). Considered in terms of time optimization, it seemed plausible that shorter gathering stints meant relatively abundant harvest years, as gatherers devoted less time to gathering in a single site and had lower travel costs (in terms of going from site-to-site) on any given day. Alternately, these shorter stints could have signaled the heavy constraints on people's time during the busy fall season when they have to allocate time to harvesting both their garden crops and lingonberry.

Application of foraging models

These two predictions on site choice in terms of the marginal rate of return and time allocation seemed to blend together when applied to actual situations, as is demonstrated in the following section. This section looks at two distinct landscapes during seasons of abundance and scarcity and how they have influenced people's decisions of where and how to gather. To begin, the combination of high net return rates and time optimization has often been observed in the expansive gathering region known as Kul,' which annually draws hundreds of gatherers from throughout the region (*refer to Figure 6-5, and to Chapter 5*). This convergence has cultural significance, yet ultimately, people congregate here in large numbers due to the ease of gathering in the predominant larch-lingonberry forests. As predicted by the marginal value theorem, during abundant harvest years in Kul', people gather more in less time, and they minimize travel costs from site to site. This payback appears to justify the initial high travel costs to reach this region.

Many people seemed intuitively aware of these heightened gathering opportunities in Kul', which they attributed to the local ecology of the region, as expressed in their words below:

> The lingonberry is low—there are no shrubs.
>
> I was completely surprised. It was so clean in the forests, there were only lingonberry plantations, some trees, and endless open spaces. It was very easy to walk.
>
> It's necessary to gather in an open place. The berry does not grow in the forest—it is found in open spaces where you can pass through with greater ease and search out where the berry is large.
>
> Mainly there are burned sites where there is new regeneration of trees, and there is moss; there are no shrubs, so it is easy to gather there.

One villager suggested that such gathering has become the norm in her village (Kozyrevsk): "Our people are not used to such gathering [i.e. gathering where it is first necessary to search out a harvest]. They are used to stripping an open area that is overflowing with berries." Increasingly hot and dry summers, however, are threatening the extraordinary yields in Kul', which are prone to sun overexposure and subsequent desiccation. These conditions have caused gatherers to seek out harvests in the recently logged secondary forests adjacent to Kozyrevsk (*refer to gathering site A in Figure 6-6*). One villager asked rhetorically, "Why drive when the berry is surrounding you?" This question implied that the marginal rate of return in this particular year was higher in the sites adjacent to the village than it was in Kul'.

The marked differences between these two gathering regions were primarily ecological. In contrast to Kul', the secondary birch forests near the village had a dense, high, and relatively diverse herbaceous-subshrub layer that mitigated temperature fluctuations and water loss, thereby protecting lingonberry yields. These yields, however, were diffused among other species, which often precluded gathering with a special tool, and thus, slowed collecting times considerably. One man described gathering in dense herbaceous cover as "teasing out" lingonberries, adding that: "In the herbs you don't gather a lot." Consequently, gathering in this region was only preferable during years of scarce harvests in the larch-lingonberry forests.

Conclusion

In sum, this ethnography of landscape delineated people's gathering patterns across the landscape in post-Soviet central Kamchatka, making explicit how natural and anthropogenic constraints have led to unique configurations of gathering in time and space. The analytic results that narrated the storyline of this chapter were complex, integrating spatial and non-spatial data. First, these analyses confirmed that spatially defined land-cover types also differed ecologically. Several key predictor variables, including lingonberry fruit yields, differentiated these land-cover types. For example, higher yields corresponded to land-cover types representing early- to mid-successional forests. Further, these analyses established that successional stage, and distance of sites from village and from the main road artery, all mattered in influencing people's gathering decisions.

Other distinct relationships crystallized within these broad brushstrokes, revealing an intricate story of people's interactions with the landscape through their gathering activity. The highlights of this story included increased gathering intensity and marketing of harvests in sites with higher proportions of early- to mid-successional forests following major disturbances (primarily fire and, to a lesser extent, logging). Thus, land-cover emerged as a fundamental determinant of gathering patterns, reinforcing previous studies that identified vegetation type as a key factor in natural resource use (see Cocks et al. 2008). Distance and accessibility were also basic factors shaping gathering patterns: favorable gathering sites (in terms of land-cover type) also tended to be located further from the villages, yet high road densities made these sites very accessible, especially to villagers with cars or other motorized transportation.

This story makes sense in light of the Soviet forestry legacy that has intersected with the post-Soviet reality of dramatic declines in logging accompanied by increasingly limited means of fire protection. Thus, forest fires have appeared to supersede logging as the main type of forest disturbance in the post-Soviet landscape, creating new niches for lingonberry that proliferates following fire (Kabanov 1963). In this landscape high intensity gathering, motivated in large part by emerging free market forces, has been occurring in post-fire forests where abundant lingonberry yields justify longer travel times to sites. Besides fire, localized disturbances from volcanic forces have helped to ensure large harvests in some areas (e.g. Kul'), which have attracted many gatherers despite the distance required to reach this resource.

Although insightful, this story of gathering was nonetheless incomplete: it lacked the dimension of the people behind these gathering patterns. Therefore, this chapter made a critical departure from the production of scientific knowledge to explore local ecological knowledge (LEK) of successional processes and how they have influenced gathering patterns. Although people's descriptions of their gathering sites and activity were valuable alone, they proved especially insightful when analyzed through the lens of optimal foraging theory, which helped illuminate both the proximate and ultimate questions of why and how people gathered. Together, consideration of LEK and foraging models greatly enhanced the spatial analyses in this study, adding depth to the inquiry of where, how, and why people gathered. Moreover, in conjunction with spatial analysis, LEK and the foraging models demonstrated that people through their gathering behaved in ways that made the most ecological, economic, and evolutionary sense.

Still, the role of spatial analysis in linking people to the landscape to tell the story of gathering in central Kamchatka cannot be overemphasized. These analyses expanded what would otherwise have been a myopic view of the complex post-Soviet landscape, due to the limitations of on-ground fieldwork. Spatial analysis was most helpful in identifying disturbances across the landscape that may have been overlooked otherwise. For instance, it made explicit the connections between fire, successional forests, and increased gathering intensity and marketing in the landscape. Neither the ecological nor ethnographic data were comprehensive enough to draw out the land-cover type of maturing deciduous forests as a key determinant in shaping gathering patterns. (Only 2 out of 43 plots were set in maturing deciduous forests; thus, in the statistical analyses of ecological data, these plots had to be grouped with fragmented, birch-dominant forests (land-cover type 3), even though they have a unique structure and composition that was detected in spatial imagery.)

Rather, the ecological data pointed to the land-cover type of low vegetation as critical to gathering. This conclusion was not incorrect *per se*: it referred primarily to the relatively small areas logged by private forest enterprises in the post-Soviet period that have attracted gatherers. At the same time, this conclusion eclipsed the larger picture of disturbances across the landscape and the discovery through spatial analysis that it has been most profitable to gather in post-fire forests, even as people continue to gather in recently logged areas. Thus, only by merging on-ground and spatial data in GIS was it possible to delineate clear gathering patterns over a large landscape, and to relate these patterns to both natural and anthropogenic features of the landscape.

This combinatory approach to the ethnography of landscape followed in the footsteps of other innovative and integrative studies (Aswani and Lauer 2006, Fox et al. 2003), producing a richer dataset for analysis. At the same time, what was gained in breadth may have been sacrificed in depth, especially in consideration of the initial limited datasets. Focusing only on one topic, for instance, ethnography or ecology, would have allowed for more intensive data collection, and likewise more rigorous statistical analyses of these topics. Besides limited datasets, another major challenge in this study was the partitioning of the landscape into gathering sites through which to link people to the landscape. This step would have been difficult under the best of circumstances given highly variable and patchy nature of lingonberry harvests. For instance, in a below-average harvest year the set of sites where people gather can look very different from those during an abundant year. In fact, in any given year most gatherers are highly mobile, going from one site to another until they find harvests worth collecting. Prolific gatherers (i.e. those who gather to market harvests), in particular, tend to visit many sites spread across the landscape over a gathering season. This volatility and people's responses to it presented a major challenge in 1) the spatial delineation of gathering sites within the landscape; and 2) linking the social unit of observation (households) to the spatial unit of observation (gathering sites). As Walsh et al. confirmed (2003), it is unusual to isolate discrete territories where people's interactions with the landscape have occurred.

Given these challenges the radial buffer approach was deemed the best option; however, it was based on broad assumptions that made it less than ideal, leading to the high likelihood that delineated sites in this study encompassed too much (or too little)land. Consequently, the final set of gathering sites in this study was inevitably a simplified version of where gathering actually takes place across the landscape. Nonetheless, this approach based on gatherers' accounts, knowledge of local forestry experts, and direct participant observation seemed apt. Graphical analyses comparing land-cover types and road densities between gathering and non-gathering areas helped support the designation of polygons in this study that represented gathering sites, which were essentially unbound. (*Refer to Figures D-16 – D-26 in Appendix D*).

Still, there were several ways the methodology in this study could be improved. First, accompanying more gatherers to the forests and mapping their movement from site to site with a GPS unit could improve accuracy of site location and extent. (It proved complicated, however, to arrange such trips during previous fieldwork due in part to people wishing to protect "their" sites from being discovered.) Second, asking more detailed questions on where people gathered in a given year, including how much time they spent at a particular site and how much they gathered in that time, could increase accuracy in gathering metrics, assuming a fairly high level of participant recall level. (In this case a good system of cross-checking responses would have to be devised to detect inaccurate responses.) Overall, given the data limitations and the inherent challenges in linking people to the landscape, this study nonetheless was able to make a compelling case for the strength in bringing together ecological, ethnographic, and spatial data to produce an ethnography of landscape that in the end proved to be more than the sum of its parts.

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Chapter 7

Shifting Livelihoods and Social Differentiation of Households in Post-Soviet Central Kamchatka

Prologue:
"We are used to surviving on our own. Beginning in the 1990s we had to learn how to work…Everyone took nets and headed to the river to sell caviar for peanuts." –Long-time resident of Kozyrevsk

Introduction

The dissolution of the Soviet Union in 1992 ushered in sudden and extraordinary changes affecting nearly every aspect of people's lives, including their interactions with the natural world. Resource use in particular has undergone a distinct transformation during the post-Soviet period. This chapter examines how people have survived in rural, resource-dependent communities within central Kamchatka during this period marked by concurrent socio-economic, political, and ecological crises. It focuses on the resource-based livelihood strategies people have used to weather a period of great unpredictability and uncertainty.

Rural communities throughout the world rely directly on the environmental (largely plant) resources surrounding them, especially during periods marked by crisis and dramatic change (Cavendish 2002). Such transformation can be wrought by natural disturbances, such as drought or flooding, or by political and socio-economic upheaval. For instance, in regions experiencing great societal shifts (e.g. southern Africa), prevailing economic and political pressures have no doubt influenced the extent of forest-resource use (Rueff et al. 2008, Cocks et al 2008).

People in central Kamchatka have had to contend with both types of change concurrently: the nationwide socio-economic crisis in following the Soviet Union's dissolution overlapped with a local ecological crisis resulting from unchecked forest exploitation in this region during the Soviet era. This predicament forced the people who remained here to adopt subsistence practices based almost entirely on environmental and forest-related resources: garden and livestock production; and fish, wild game, firewood, and non-timber forest products (e.g. berries, edible fungi, medicinal plants, tree sap, and other parts of plants useful to people). In this sense, the people in central Kamchatka resemble those in other forest communities throughout Russia and the world that have had to resort to new sets of livelihood strategies in the wake of industrial shutdown (Metzo 2001; Nash 1994, quoted in King 2003). For instance, following the economic crisis in Venezuela beginning in 1983, the gathering intensity of natural, renewable resources grew considerably (Rodriguez 2000).

The broader socio-economic and ecological context notwithstanding, individual household socio-economic status (i.e. its overall wealth, economic opportunities, and educational level) is a fundamental determinant of livelihood activities (Cavendish 2002). Households tend to range from those that are nearly fully dependent on cash incomes provided by forest resources to those that do not use these resources at all (Vedeld et al. 2007). Seemingly homogenous rural communities in fact are not (McSweeney 2004). Within such communities Vedeld et al. (2007) identified three different purposes of forest income: 1) to supplement insufficient primary income; 2) to maintain current consumption patterns; and 3) to overcome poverty. Although these three functions overlap so that forest income many serve more than one purpose in a household at any given time, the role of forest income has seemed to shift in Kamchatka during the post-Soviet period. For instance, in the early 1990s, this income was a crucial surrogate for salaries that were often not paid for months at a time; at the same time, the forest harbored food sources essential for survival. With increasing economic stability, forest income is still vital to many households, but its utility is shifting as a means toward increased consumption of non-essential goods.

Roots of forest resource use

Socio-economic, political, and ecological factors have undoubtedly fostered dependence upon environmental resources in central Kamchatka (see Vedeld et al. 2007). This chapter goes further to examine the nature of socio-economic differentiation among households on a local level, posing the following questions: Where do the households in central Kamchatka settle on the continuum of forest dependency? What distinguishes households that are more and less dependent on these resources? The factors underlying forest resource use among rural dwellers are a recent research focus. Thus far, a correlation between primary socio-economic indicators, such as household income, and forest use has been identified (Mcelwee 2008). Household wealth, which includes income along with the factors of employment status, education, relationship to elites, and age, also accounts for high variability in resource use and environmental income among households in forest communities (Shackleton and Shackleton 2006, Pyhälä et al. 2005). The question remains, however, how exactly wealth and income affect forest resource use. To date, there are divergent findings (Cavendish 2002).

On the one hand, earlier research found that the poor are more likely to use forest resources to cope with poverty and to meet their overall needs (Arnold and Townson 1998, Arnold 2001, Rueff et al. 2008, Vedeld et al. 2007, Mcelwee 2008). Shackleton and Shackleton (2006) discovered that non-timber forest products are of greater value to poorer than to wealthy or middle-income households, and accordingly, poorer households consumed comparatively larger amounts of these products on a per capita basis. Further, in a meta-analysis of 51 case studies with data on household environmental income as well as other income sources, Vedeld et al. (2007) concluded that poor households had a greater reliance on forest income than wealthy ones within the same community. Such income helped to equalize the distribution of local wealth. Further, they found that high total income and greater income specialization were associated, implying that low-income households had to pursue a greater diversity of livelihood strategies to make ends meet. As dependence on forest income increased, so did diversification of strategies, up to a certain point. Other studies confirmed that as a household acquires greater wealth, the role of non-timber forest products (including as a source of income) within it diminishes (Pyhälä et al. 2005, Godoy et al. 1995).

On the other hand, recent research has begun to challenge the conventional notion that the forests are particularly significant for poor people who cannot afford other, more modern alternatives (Cocks et al. 2008, Chukwoune 2009). Wickramasinghe et al. (1996), for instance, did not identify a clear relationship between total household and forest incomes. They found that income may not be as important as originally thought in accounting for differences in the households that market non-timber forest products. This result suggested that non-timber forest product harvesting was pursued beyond subsistence purposes. This activity also enabled relatively better-off households to attain higher economic status (Wickramasinghe et al. 1996, Rueff et al. 2008). Further, Mcelwee (2008) discovered that the households in rural Vietnamese communities extracting the highest forest income in both absolute and relative terms were those in the middle of the economic spectrum and not the poorest. Finally, even a household's improved financial outlook did not correspond to a decline in forest resource use (Cocks et al. 2008).

Predictions

1. Income from primary employment should be the primary indicator of economic inequality among households.

2. If Prediction 1 holds, households with low income from primary employment should be more likely to:

    a. acquire inputs through secondary and environmental income (i.e. through other means than primary employment) than households with high income.

    b. pursue a more diverse set of subsistence activities (e.g. garden plots, fishing, collecting non-timber forest products) compared to households with higher income.

3. Larger households with more dependents should be less wealthy than smaller households with fewer dependents; thus, larger households should pursue secondary and environmental income to a greater extent than smaller households.

Study site

This study was conducted in five small villages in the central Kamchatka Depression. (*Refer to Figures 2-1 and 2-2 in Chapter 2*). Even with a sparse human population, this area is still one of the most populated parts of the Kamchatka Peninsula, otherwise renowned for its rugged, pristine wilderness and volcanic activity. Containing the easternmost pocket of northern boreal forests in the world, the low-lying central Kamchatka depression is clearly differentiated from the surrounding elevated landscapes. A distinctly continental climate distinguishes this depression. Larch was once the dominant species in this region; spruce also grows here, particularly along riverbanks. These dense forests drew people to this area during the latter half of the twentieth century when the Soviet state commenced industrial forestry. (*Refer to Chapter 3.*) This activity quickly transformed this area once known as 'Conifer Island' into a highly fragmented landscape colonized primarily by deciduous species (e.g. birch and aspen).

The five villages in this study have all been connected, either directly or indirectly, to the once burgeoning forest industry in central Kamchatka. Despite their relative proximity to one another, each village has a distinct microclimate and relief due to the complexity of the landscape. The natural features defining each village have been pivotal in defining socio-economic opportunities and people's livelihood strategies. For instance, the Kamchatka River separates some villages from the main north-south road leading to Petropavlovsk-Kamchatsky (Kamchatka's capital), thereby decreasing economic opportunities. Below is a succinct description of each village.

Kozyrevsk and Krapivnaya

Located furthest to the north, the logging village of Kozyrevsk is situated on the east bank of the Kamchatka River, making it accessible only by ferry; the village of Krapivnaya, originally a satellite logging community of Kozyrevsk, is located to the south (*Refer to Figure 2-2 in Chapter 2*). These villages are located in a narrow part of the Kamchatka River valley that is punctuated by volcanic activity, most noticeably in the form of dry rivers. The larch-forb forest association group dominates the moist floodplain of the Kamchatka River on which these villages are situated. (*Refer to Chapter 2 for an explanation of forest classification.*)

Atlasovo, Lazo, and Dolinovka

The villages of Atlasovo and Lazo are situated in the widest part of the Kamchatka River valley. Both were initially logging villages; however, after local resource exhaustion Lazo eventually became the site of a state collective farm. The larch-marsh Labrador tea forest association group is dominant in this drier region, which has made it more susceptible to forest fires. Typically, most fires occur in forests that have been previously logged. This high level of disturbance has given rise to the proliferation of secondary deciduous forests. Dolinovka lies at the southern edge of the central Kamchatka depression. This village surrounded by forests interspersed with wetlands was founded as an agricultural center in 1929, becoming the site of a large collective farm that once played a critical supporting role in the timber industry by sustaining the growing numbers of workers arriving in the region.

Common hardships

Underlying the ecological differences specific to each village is a shared struggle to carve out an existence following the collapse of the timber industry that was once the economic mainstays of this region. The ensuing socio-economic crisis have considerably quelled these once-bustling villages whose population numbers have plummeted in step with their economies (Hitztaler 2004). The village of Krapivnaya is an extreme example: it is essentially deserted today with the exception of a handful of families and a one-person branch office of the *leskhoz* (forest management unit). Even though this village was only intended to be a temporary settlement to facilitate logging efforts, at its peak it had a relatively large population and several amenities (e.g. school, theater, and stores). Today the remaining population continues to be dependent upon logging activity. Villagers in Kozyrevsk and Atlasovo work in recently reestablished forest regulatory organizations and in private logging enterprises. Yet, it is uncertain how long these enterprises can remain solvent due in large part to a region-wide ecological crisis resulting from prior years of extensive and unsustainable forest exploitation. Consequently, timber output in the region is a fraction of what it used to be (Hitztaler 2003).

Facing the same fate as the state forest enterprises, the collective farms in Lazo and Dolinovka also folded when the state withdrew generous subsidies that supplied them with everything from livestock feed to fuel (see King 2003). Upon the disbanding of these farms in the mid-1990s, former workers received redistributions of land, equipment, and livestock, which they used for subsistence, or to start up their own farming ventures. Mirroring the logging villages, both of these villages are a shadow of what they used to be, yet Lazo is in a more precarious position due to its isolation on the east bank of the Kamchatka River. In Dolinovka, villagers have found viable markets in Kamchatka's two cities to the south (Petropavlovsk-Kamchatsky and Elizovo), enabling them to earn livings from their small farms.

Although the predicament of each village in post-Soviet Kamchatka is nuanced, there has been an overwhelming shift to a subsistence-based lifestyle to ensure survival. Those who have remained—either by choice or necessity—now pursue various livelihood strategies that include garden production, livestock raising, gathering of non-timber forest products, hunting, small-scale timbering, and fishing, which have been vital sources of sustenance and income for villagers.

Materials and methods

Household survey

Data were gathered in the five villages through semi-structured surveys and direct participant observation in 2004, 2006, and 2008. These data were organized into two datasets for the following years: 2004 and 2006,8. The surveys included the collection of basic socio-economic and demographic data (*Table 7-1*), and data on people's livelihood strategies, particularly their acquisition and use of natural resources (e.g. non-timber forest products). The first year of fieldwork (2004) was exploratory, during which households were sampled haphazardly (Bernard 2002). Surveys in this year were concentrated in the villages of Kozyrevsk and Atlasovo; however, approximately one-fourth of the surveyed households were in the villages of Dolinovka and Lazo.

In 2006, households were chosen through a systematic sampling procedure guided by local maps delineating every house and apartment unit (*Table 7-2*). Each household was surveyed individually with the exception of three cases in which respondents representing two households participated in the survey together. Also, in this year surveys were conducted only in Kozyrevsk and Atlasovo (with one exception). In the final year of fieldwork (2008), surveys targeted the population subgroups of unemployed households and households with young children. These groups were underrepresented in the 2006 sample characterized by a high proportion of pensioners.

Table 7-1: Basic household socio-economic and demographic variables collected in the semi-structured survey.

Variables:
Total Number of Members in Household
Total Number of Adults in Household
Total Number of Employed Adults in Household (including pensioners)[19]
Total Number of Unemployed, or Seasonally or Temporarily Employed, in Household (including pensioners)
Total Number of Dependents • Number of Dependents in Household • Number of Dependents Outside Household

[19] Those who are officially employed, either full- or part-time; also includes self-employed adults, i.e. those who farm full time.

Table 7-2: Household sampling frame for 2006 and 2008. If the pre-selected household was abandoned, or if its members were not able or unwilling to participate in the interview, the next highest unit in the frame was selected. Kozyrevsk had more than twice the number of housing units as Atlasovo, which explains the difference in sampling intervals.

2006	***Atlasovo***	***Kozyrevsk***	***Krapivnaya*** [3]
Total Number of Housing Units (includes both single-family dwellings and apartment units) [20]	216	553	--
Number of Households in Sample	17 [21]	21	--
Sampling Interval (number of housing units)	14	28	--
2008			
Number of Households surveyed	3	10	2

Household Wealth Variables

Total employment income

The first step in determining household wealth was to measure income from official employment. Because it could be awkward and even inappropriate to solicit information on actual salaries and pensions during the survey (see also Pallot and Nefedova 2003), a proxy was assigned to measure income using an ordinal code for the following categories: place of work, employment position, and income supplements (*Table 7-3*).

The first category, place of work, referred to a position in either the private or governmental sector. Whereas job insecurity, longer and irregular hours, market

[20] In the case of a duplex housing unit, odd- and even-numbered units were alternately chosen.

[21] Two households appeared in the 2004 sampling frame and were re-interviewed for data verification purposes.

unpredictability, and unsteady pay characterized work in the private sector or in self-employed positions, jobs in the government service sector have become relatively stable, and offer decent pay (King 2003, and personal observations). The second category, employment position, concerned the skill level and responsibility required for a job (see O'Brien et al. 2004, Clark et al. 2003). The third category, income supplements, referred primarily to the monthly pensions of working retirees. (The retirement ages are lower in Kamchatka, which is still considered a region of hardship, than elsewhere in Russia; they are 50 for women and 55 for men.) Supplements also included disability payments, bonus pay due to exemplary work, or child support (for large families.) Thus, a pensioner still working in a specialized position within a government organization (i.e. local school or village administration) scored considerably higher than a non-pensioner in an entry-level position at a private, start-up enterprise. Scores for each category per adult household member were added; the sum of these sums was the proxy for total household employment income. A higher score indicated higher total income.

Table 7-3: Assigned ordinal scores for employment categories.

Income Variables	***Assigned Score***
Employment Status:	0. =unemployed 1. =pensioner (not employed) 2. =employed part-time, i.e. <40hrs./week 3. =employed full-time (or self-employed), i.e. =>40 hrs./week
Place of Work:	1. =private sector, or self-employed 2. =governmental sector
Employment Position:	1. =unskilled labor (e.g. custodial staff, security guard, laundress, or store clerk) 2. =skilled labor (e.g. forest ranger, secretary, or day care staff) 3. =professional (e.g. teachers, doctors, nurses, accountants, or local administrators) 4. =director, head of village administration
Supplements to salary:	0. =no additions to income received 1. = pension (if currently employed), or disability payment, or child support received 2. =two or more additions to income received (see 1)

Adjusted employment income

To gain a more complete picture of household economics, the proxy for total employment income was adjusted based on household of size and composition, taking into account the following factors (*refer to Figure 7- 1*):

1) The number of people present within the household. In this study dependents (primarily children and grandchildren) were grouped into two categories: those living within the household and those living outside of it. The latter referred almost exclusively to university students.
2) Nutritional needs of household members according to age and sex, i.e. children require fewer calories than adults; and women fewer than men.
3) Economies of scale: larger households were able to stretch inputs more efficiently so that a given welfare level per individual was attained with fewer resources than those required in smaller households.

- (proxy of total household employment income) / (adjusted household size) where,
  - adjusted household size = (household size) * (coefficient for economies-of-scale) where,
    - household size = ∑ [(coefficient for adult equivalent scale—a measure of a person's caloric needs per day)[1] * (dependent-weighted coefficient)[1]]

[1]This coefficient was 1.5 for dependents living elsewhere, accounting for the higher resource demand they place on the household. It was 0.5 for dependents who were not university students and only resided at a household for part of the year. In all other cases it was 1.

Figure 7-1: Calculation of Adjusted Employment Income (based on parameters taken from Cavendish 2002) .

Other Income

The variables grouped in this category included all other household inputs (both monetary and in kind) that did not come from primary employment. (*Refer to Table 7-4*.)

Secondary income

In central Kamchatka secondary income comes primarily from seasonal or temporary work, including: participation in international hunting expeditions; hosting, transporting, or leading groups of tourists; and winter employment in private forestry enterprises. Because such work is usually unofficial, or non-registered, and may be illegal in some cases (see Smith and Rochovská 2007), few people report or invest such income (Caldwell 2004). Thus, the variable of secondary income only indicates whether or not a household this earned this type of income in some way; it is not based on actual income amount. (*Refer to Table 7-4*.)

Environmental income—2004

In 2004 detailed environmental income data were only collected on non-timber forest products. Earnings ranging from 1 to 45,000 RUB were scaled on a 25-point continuum. (This range accounted for the highest total earned income of 43,250 RUB.) This scale score served as the variable of environmental income from non-timber forest product gathering.
Similar data were not recorded for the other types of environmental income (e.g. from garden production, livestock raising, fishing, hunting, timbering, and farming); thus, approximate income earned from these activities type was scaled on a 3-point continuum. The sum of scores became the variable of other environmental income (i.e. all such income not including that from non-timber forest products). (*Refer to Table 7-4*.)

Environmental Income—2006,8

More detailed data on environmental incomes in these years allowed for an aggregate measure of environmental income. These earnings were also scaled on a 25-point continuum to come up with the environmental income variable for this year; in this case earnings ranged from 1 to 250,000 RUB. (The highest total was 240,000 RUB.) Although every effort was made to ensure accuracy, environmental income totals for both the 2004 and 2006,8 datasets are at best approximations. Prices tended to fluctuate greatly even within one season, and were highly dependent upon the person to whom they were sold, for instance to a local or non-local (the latter typically offered higher prices). In the case of livestock (2006,8 only) the total profit reported was decreased by one-third to account for high production costs, i.e. cost of feed, which were very roughly estimated. Prices also depended on a respondent's recall ability, which may or may not have been accurate. When respondents could not recall actual quantities or prices of what they sold, or when they sold their production infrequently (i.e. every other year, every two years), they were assigned them the lowest amount earned by all other households in a particular category. Finally, in the case of fishing, it is very probable that respondents intentionally gave inaccurate or vague answers on the amounts of caviar they extracted and sold, as this activity was risky and illegal.

Subsistence activities

The following activities undertaken for household consumption only were also taken into account: garden production, fishing, non-timber forest product gathering, livestock raising, small-scale timbering, and hunting. Scores were assigned to each activity based on respondent rankings of each activity's importance, and its contribution (except for small-scale timbering) to the household food budget. (*Refer to Table 7-4*.) In the case of fishing, the amount of fish preserved (in kg) was scaled on a 10-point continuum was also added to the ranking score for this activity. While nearly all households used fresh fish caught in the spring, summer, and early fall, fewer preserved it for the winter, especially in sizable quantities, which could reach up to 650 kg/year. Thus, this step allowed for the differentiation of households that were more and less dependent upon this resource. (An analogous score was not added to the ranking for non-timber forest products since there was much less variability in the amount gathered for household consumption only.) Scores for each activity pursued by a household were then summed to produce the subsistence variable. A higher overall score indicated a more diverse repertoire of subsistence strategies.

Kin networks

In kind income was informally exchanged through social networks, which have played a prominent role in village life. In this case a subset of "practical kinship" (Bourdieu 1977 quoted in Caldwell 2004) was considered, specifically the exchange networks among related households (e.g. between parents and grown children, and among siblings) because they were the most obvious to identify. Nonetheless, the in kind income received through such networks was almost impossible to quantify as the exact nature of the exchange varied and was not always entirely reciprocal. Thus, the variable of in kind income only signified the quantity of kin relationships between households, typically those in the same or neighboring villages, and more rarely, those between village and city households (*Table 4*).

Table 7-4: Assigned ordinal scores for types of other income (for 2004 and 2006,8).

Other Income Variables	***Assigned Score***
Secondary Income:	1. =earned 2. =none
Environmental Income (not including that from non-timber forest products)(for 2004 data only):	1. = 1-10,000RUB 2. = 10,001-20,000RUB 3. = 20,001+ RUB
Subsistence Activities:	(*from least to most important*) 1. =hunting 2. =small-scale timbering 3. =raising livestock 4. =non-timber forest products 5. =fish/fishing 6. =garden plot
Kin Networks:	1. =household is related to one other household in the village (or surrounding villages or cities to the south) 2. =household is related to two or more households in the village (or surrounding villages or cities to the south)

Statistical Analyses

Owing to its high accuracy in assessing economic differences among households, Principal Component Analysis (or PCA) was chosen for data analysis. PCA has been shown to be at least as accurate—if not more so—as traditional measures of income and consumption (Filmer and Pritchett 2001, Gwatkin et al. 2007). The critical assumption in PCA is that the maximum variance in the set of variables is attributed to household economic status (Filmer and Pritchett 2001). Thus, one index is typically adequate to reveal economic variation among households (McKenzie 2003).

This index is based on a set of variables that allows for differentiation of wealth across all households (McKenzie 2003). The variables used to construct the indices in this study were: adjusted total household income from primary employment; total number of employed adults (including pensioners); total number of unemployed (or seasonally or temporarily employed) adults (including pensioners); total number of dependents; secondary income; environmental income, environmental income from the gathering of non-timber forest products (2004 only); subsistence activities; and in kind income.

Due to the division of environmental income in 2004 (i.e. that from the gathering of non-timber forest products and that from all other activities), there were nine original variables in the PCA of the 2004 data, and eight in that of the 2006,8 data. Besides environmental income, the remaining variables were consistent in both datasets. These variables had high standard deviations (i.e. they indicated uneven distribution, and therefore inequality among households), or the represented important household assets, or both.

Because the selected variables in this study were not all in the same units, and were not standardized, the option of correlation matrix was selected in running PCA analyses in SPSS. Also, the option of varimax rotation was selected to obtain a more definitive solution. The principal components derived were those with an eigenvalue greater than one, a common method in PCA. A wealth score was assigned to each household by multiplying its standard variable values (μ=0, standard deviation =1.0) by the coefficient of the first principal component, and then adding the results. Thus, a higher score implied better economic standing. The final wealth scores were dependent variables Y_1 (Vyas and Kumaranayake 2006).

The wealth index (first principle component) and the second principal component served as the variables in cluster analysis. This analysis (K-means, 10 iterations in SPSS) was used to delineate households in each dataset (2004 and 2006,8) into five distinct economic groups. These groups were depicted in graphical analyses in which households according to group were plotted on two-dimensional graphs with wealth index as the independent variable and the second or third principal components as the dependent variables.

Results and Discussion

Principal Component Analysis (PCA)

First principal component

In both datasets (2004 and 2006,8), the variable of total number of employed adults had the highest factor score in the first principal component, thereby associating it with wealthier households. (*Refer to Table 7-5*). In each dataset, the negative factor scores for the variable of the total number of unemployed adults highly contrasted this first variable. The variable of adjusted total monetary income also scored high in the first component (in the 2006,8 dataset only), demonstrating that income was also important in wealth differentiation. Assuming that employment status was indicative of household income such that households with full employment status had higher incomes than those with low employment status, these outcomes showed that income from primary employment was a strong indicator of economic inequality among households, thereby supporting prediction 1.

Second and third principal components

Previous studies using PCA established that only the first principal component was needed to measure inequality among households (McKenzie 2003). Nonetheless, the first component typically does not capture all of the available information in a dataset (Filmer and Pritchett 2001). In this study, the second and third principal components also had high variances (i.e. eigenvalues >1). In the 2004 dataset these first three components together accounted for 61.785 percent of the variability in the original variables: the first component accounted for 23.835 percent of the variation, while the second and third components explained 19.896 percent and 18.054 percent of the variation, respectively.

In the 2006,8 dataset, the first three components accounted for 66.202 percent of the variability in the original variables: the first component accounted for 27.854 percent of the variation in the chosen variables, while the second and third components explained 20.574 percent and 17.774 percent of the variation, respectively. To compare, the eigenvalues of the first principal component in analyses done by Vyas and Kumaranayake (2006) accounted for 16.0 percent, 14.9 percent, 13.4 percent, and 11.1 percent of the variation in their original data collected from four study sites.

More detailed data, in particular those on income-generating livelihood activities, gathered in 2006 and 2008 likely explain the higher accountability of variation in the 2006,8 dataset. Nonetheless, in both datasets the first and second principal components accounted for nearly half of the variation. These components were most associated with the variables of employment status and other income (e.g. secondary and environmental income, and in kind income through subsistence activities and kin networks), respectively.

Second principal component—2004

In this year the variable of environmental income from non-timber forest products was most closely associated with the second component, followed closely by kin networks and secondary income. (*Refer to Table 7-5*). The variable of subsistence activities also had a high factor score. The variable of other environmental income, however, did not have as high a factor score, due likely to the absence of sufficient data. The variable of total adjusted income received the lowest score for this component, which contrasted its high score in the first principal component, thereby verifying the second principal component as a valid measure of a different dimension in the data. At the same time, the second and third principal components are orthongonal to the first and therefore not completely unrelated (Filmer and Pritchett 2001).

Second principal component—2006,8

In this year the second principal component was most closely linked to the variables of subsistence activities and, to a lesser extent, secondary and environmental incomes. As in 2004, the variable of total adjusted monetary income stood in greatest contrast to these variables. (*Refer to Table 7-5.*) This component diverged from 2004, however, in that the variable of kin networks had a low factor score, precluding it from being considered a part of other income.

Third principal component—2004, 2006,8

Mostly uncorrelated to employment and other income, the third principal component explained yet a different dimension of the data. The factor scores in this component differed in 2004 and 2006,8. Whereas the variable of total number of dependents had the highest score in 2004, it scored the lowest in 2006,8. (In the latter dataset, the highest variable was kin networks.) (*Refer to Table 7-5.*) In order to conduct analogous graphical analyses of both datasets, the inverse of the total number of dependents (i.e. the absence of dependents) was interpreted as the variable most closely related to the third principal component in the 2006,8 dataset.

Relationships between wealth and other variables

Overall, PCA showed an unambiguous stratification of households in terms of employment status and other income. Moreover, it clearly established that household wealth was most directly linked to employment status, thereby substantiating the findings of previous studies (Shackleton and Shackleton 2006). At the same time, PCA captured the complexities of rural post-Soviet life, corroborating the substantial contributions of other income to households that have had to sustain themselves throughout a period of great uncertainty and insecurity.

Wealth and other income

Distinct patterns in household wealth and subsistence strategies were evident in each economic group of households plotted on the axes of the first and second principal components, representing wealth and other income, respectively. (*Refer to Figures 7-2 and 7-3.*) These patterns are discussed in detail, including in the broader the post-Soviet context.

Table 7-5: Results of principal components analysis for 2004 and 2006,8. In both 2004 and 2006,8 the first principal component was most closely associated with the variable of total number of employed adults; the second principal component was most closely linked to the variables of 'other' income. (NTFP = non-timber forest products.)

2004 Variable	Mean	Std. Deviation	Factor Score *1st Component*	Factor Score *2nd Component*	Factor Score *3rd Component*	**2006,8** Mean	Std Deviation	Factor Score *1st Component*	Factor Score *2nd Component*	Factor Score *3rd Component*
Total Number of Employed Adults (including pensioners)	1.27	0.819	**0.919**	-0.119	0.143	1.07	0.842	**0.902**	-0.111	-0.172
*Environmental Income (**2004**—from NTFPs only; **2006**—from all activities)*	2.38	4.897	0.237	**0.637**	-0.326	3.43	6.127	-0.257	***0.613***	-0.022
Total Number of Dependents	1.31	1.112	0.303	0.083	**0.869**	1.35	1.329	0.102	0.303	**-0.791**
Kin Networks	0.96	0.713	-0.078	***0.621***	0.053	1.25	0.398	-0.029	0.232	***0.597***
Secondary Income	0.21	0.412	-0.261	***0.620***	0.148	0.19	0.398	-0.155	***0.630***	-0.253
Subsistence Activities	15.06	2.906	-0.240	***0.578***	0.224	16.57	2.748	-0.077	**0.776**	0.358
*Environmental Income (**2004—** from all activities except NTFP)*	1.00	1.547	-0.332	0.451	0.354	n/a	n/a	n/a	n/a	n/a
Adjusted Total Household Income	2.25	1.619	0.446	-0.119	-0.719	1.86	1.466	0.766	-0.192	0.400
Total Number of Unemployed Adults (including those seasonally or temporarily employed; pensioners)	0.67	0.834	*-0.843*	0.205	0.163	0.98	0.935	*-0.848*	0.275	0.240

Household analysis by economic group—2004

Households in the highest economic group (*Figure 7-2—Group 1*), or those with the greatest mean wealth index score, also had a very high rate of employment (only 2 of 33 total adults in this group were unemployed). Group 1 households in this seemed to be split almost equally between those that acquired some form of other income and those that did not. For the latter, primary income was most likely sufficient to ensure household well-being; for the former other income, namely environmental income from marketing non-timber forest products was prevalent. Although the mean amount of environmental income earned was comparatively low, it was nonetheless noteworthy that more than half of these wealthiest households earned environmental income.

The second highest economic group (*Figure 7-2—Group 2*) was smaller and more diverse. The large quantities of non-timber forest products that were marketed by all households distinguished this group. (The two highest outliers of this group earned the most.) The outlier furthest to the right exemplified the power of other income in household economics. In conjunction with full employment status, environmental and secondary incomes, and inputs from kin networks, elevated this household to the highest economic position of all those in the 2004 sample. Clearly other income, namely environmental income, has helped these households achieve a higher economic status than they would have otherwise.

The middle economic group (*Figure 7-2—Group 3*) had a relatively lower mean wealth index even though it had a high rate of employment. In contrast to the first two economically better-off groups, the occurrence of other income was nominal in this group. Specifically, less than a third of the households earned environmental income from the marketing of non-timber forest products, and none brought in secondary income. Given the high level of employment in this group, it is plausible that these households chose to invest their time and effort into securing income from primary employment instead of from other income.

The unemployment rate was high in the second to lowest economic group (*Figure 7-2—Group 4*), which made sense as more than half of the adults were pensioners, the vast majority of whom did not work outside of the home. Employment was also low among the working-age adults in this group. Moreover, only three (out of eleven) households earned environmental income from selling non-timber forest products, and that was in comparatively nominal amounts; none of the households procured secondary income. This relative dearth of other income even amidst low employment status appeared to reflect a high dependence on pension payments. It also seemed to indicate the limitations particular to this group, including poor health and a lack of transportation, that have greatly curtailed the potential to acquire other income to build household economic status (see Pyhälä et al. 2006).

Finally, the bottom economic group (*Figure 7-2—Group 5*) had the lowest mean wealth index score in tandem with the highest rate of unemployment. Other income was a defining factor in these households. Half of the households marketed non-timber forest products, with a mean income that ranked second (after that in the second to highest economic group). All of these households procured environmental income from other activities (primarily fishing to obtain caviar). For two-thirds of these households, this income formed a substantial portion of their budget, substantiating the centrality of resource use in the absence of primary income. If only the wealth score mattered, this group would clearly be the most impoverished. Yet, the results suggested that other income has afforded households in this group a comparative advantage in relation to the second to lowest group where such income was considerably less prominent.

Overall, this analysis presented a complicated picture in terms of the relationship between household wealth and the acquisition of other income. On the one hand it upheld prediction 2a that households with high unemployment (and, likewise, low income) would be more likely to acquire inputs through other means than primary employment. On the other hand, these inputs—namely environmental income from non-timber forest products—were crucial to households in the second to highest economic group; they were also common in the wealthiest economic group, although in smaller amounts. Other income was least evident in the middle and second to lowest groups.

Thus, household employment status did not appear to be the sole determinant of the choice to earn other income. This finding called into question the notion that it is predominantly the poorest households in a community that pursue forest income (see Wickramasinghe et al. 1996). Rather, it confirmed the advantage of supplemental income from environmental sources in boosting household economic status (see also Wickramasinghe et al. 1996). Besides environmental income, the diversity of subsistence activities pursued was also the highest in the second to highest and lowest economic groups (Groups 2 and 5, respectively). The wealthiest economic group (Group 1) had a more modest repertoire of activities, whereas the middle economic group pursued the lowest number. This outcome supported prediction 2b that less well-off households would be more likely to integrate a greater number of livelihood activities into their household economy than wealthier ones; at the same time it revealed that the relationship between wealth level and set of subsistence activities pursue is complicated and non-linear.

Lastly, the contribution of in kind income received through kin networks proved more difficult to assess. Still, this type of income should not be overlooked given its cultural and socio-economic significance throughout Russia, especially during periods of hardship in which family and friends stand out as the most dependable source of immediate help in procuring essential resources (Caldwell 2004). Households in central Kamchatka seemed to be integrated differentially into kin networks regardless of economic status. The one exception was the middle group with a noticeably low level of involvement in these networks. The dearth of familial ties and support within this group may have fostered a greater sense of self-sufficiency, which could help illuminate the high rate of employment in this group.

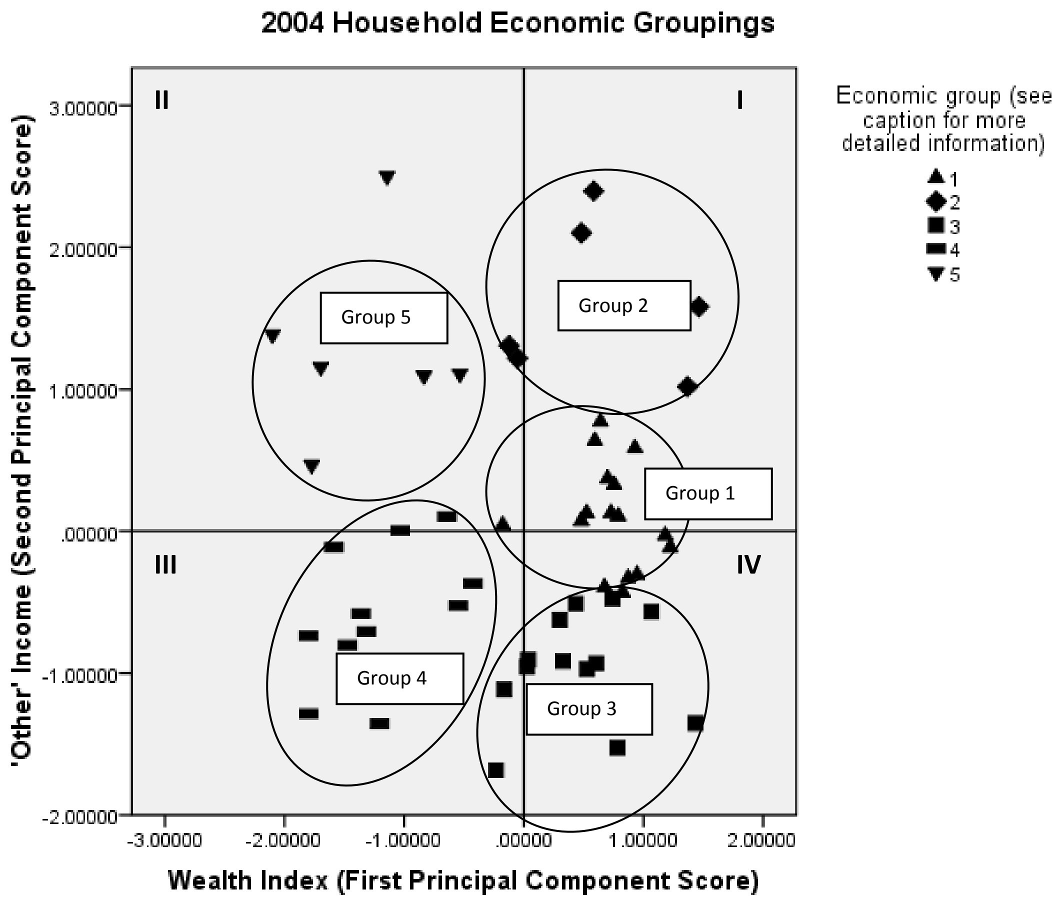

Figure 7-2: 2004. Households plotted on the axes of the first and second principal components, which are most closely associated with the variables of total number of employed adults and other income (i.e. environmental income from non-timber forest products, in kind income from kin networks, secondary income, and set of livelihood activities), respectively. Households are grouped as follows:

Group 1: High overall wealth, moderate other income.
Group 2: Moderate overall wealth (with the exception of two outliers), high other income.
Group 3: High overall wealth, little to no other income.
Group 4: Low overall wealth, little to no other income.
Group 5: Lowest overall wealth, moderate to high other income.

Household analysis by economic group—2006,8

Full employment status among all adults (including pensioners), accompanied by a very modest inflow of other income, characterized the wealthiest group of households in this sample (*Figure 7-3—Group 1*). Specifically, less than one-third of the households earned environmental income, giving this group the lowest mean for environmental income, and none posted secondary income. In contrast, in the second to highest economic group (*Figure 7-3—Group 2*) other income was much more prominent. In this group unemployment affected a little over one-third of the adults, possibly explaining why all households (except one) brought in environmental income (the mean of which was in the middle of the five groups); more than half earned secondary income.

High unemployment, primarily among pensioners, in tandem with modest earnings of other income characterized the middle economic group (*Figure 7-3—Group 3*). Similar to the second to lowest economic group in 2004, the prevalence of modest, yet regular pension payments have helped offset the need for supplemental income in this group. In contrast to 2004, however, nearly three-fourths of the households earned environmental income, albeit in small amounts. (This finding could be due to more detailed data collection of household livelihood activities in 2006 and 2008.)

Unemployment was pronounced in the second to lowest economic group (*Figure 7-3—Group 4*). Only 2 (out of 11) households brought in secondary income, yet nearly all earned environmental income. While six of these households earned very modest amounts, three brought in substantial profits (ranging from approximately 145,000-190,000RUB or $5,800-7,600 US). By maximizing the amount of resources that they could extract from the forests, rivers, gardens, and livestock, these high-earners have more than offset lost or diminished primary income.

This trend of high dependence on natural resources was clearly manifested in the lowest economic group containing three distinct outliers in this dataset (*Figure 7-3—Group 5*). What made this group unique, however, was intensive resource use coupled with full unemployment of all adults. The lack of official work explained why all households brought in high amounts of environmental income from a variety of sources (e.g. caviar, fish, and non-timber forest products). They also earned secondary income: the male members of each household undertook seasonal, low-paying work during the winter at small start-up forestry enterprises.

This strategy enabled them to concentrate their efforts on fishing and gathering of non-timber forest products in the spring, summer, and fall. Thus, low opportunity costs of time coupled with limited opportunities to procure income (see Lopez-Feldman and Wilen 2008) have pushed these households to invest heavily in resource extraction and forge a living directly from the forests and rivers. Their efforts have paid off, allowing them to gain a solid foothold in the natural resource markets, particularly in the lucrative and exclusive caviar trade.

Besides procuring monetary income, these households preserve non-timber forest products and large quantities of fish (165 kg on average) to feed their families. Thus, they represented exactly what might be expected in the aftermath of severe socio-economic and ecological crises plagued by chronic unemployment: a nearly total reliance on natural resources for income and subsistence. These households were nonetheless exceptions in a village where people have begun to receive steady pay and find employment as the region's economic conditions inch upward.

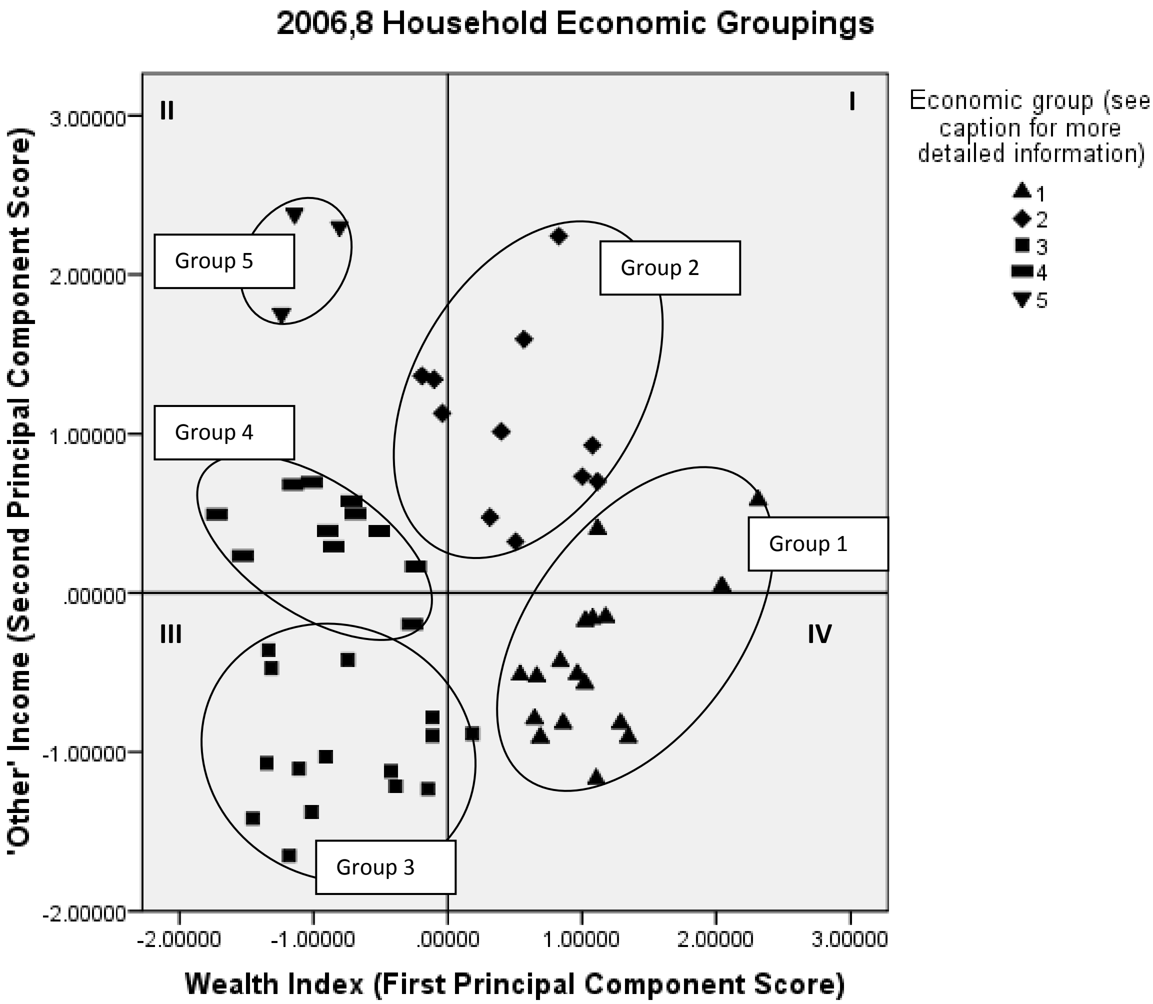

Figure 7-3: 2006,8. Households plotted on the axes of the first and second principal components, which are most closely associated with the variables of total number of employed adults and other income (i.e. environmental income from non-timber forest products, in kind income from kin networks, secondary income, and set of livelihood activities), respectively. Households are grouped as follows:

Group 1: Moderate, overall wealth (although a couple of outliers have high wealth), low or no other income (except for outliers).

Group 2: Moderate overall wealth, moderate to high other income.

Group 3: Low overall wealth, little to no other income.

Group 4: Low overall wealth, moderate other income.

Group 5: Low overall wealth, but high other income.

Shifting patterns in wealth and other income—a comparison of 2004 and 2006,8 datasets

The results for 2006,8 substantiated the basic patterns identified in the 2004 data; at the same time, patterns unique to each dataset were observed. In the 2006,8 dataset the wealthiest group was more in line with prediction 2a more than the analogous group in 2004: it earned modest environmental income and no secondary income. In contrast, other income did prove advantageous for the best off group in 2004. By 2006,8 the wealthiest households seemed to have moved beyond the need to supplement primary income. For these households, the costs of pursuing other income (i.e. lost work hours and pay) may well be higher than the benefits.

The lowest economic group in 2006,8 was most likely the upshot of targeting unemployed households during the last season of data collection (2008). This group seemed to represent an extreme example of how households may still stay afloat—and be profitable—in the nearly total absence of steady monetary income. It is difficult to draw any firm conclusions based on such a small group, yet there would probably be a low likelihood of sampling other such households, even given a larger sample size. First, most households do not have the stamina to depend solely on natural resources, which demands long stints in the forests or on the river. Concerning the latter, the caviar trade has become increasingly risky as local officials attempt to enforce stricter control over this illegal activity. Also, salmon spawning runs have thinned noticeably in recent years, making it harder to earn a living from the river. Second, improved economic conditions in Russia have trickled down to rural areas, somewhat easing the dire situation that forced the intensification of subsistence activities to earn income.

In summary, the 2006,8 data displayed a more convincing linear relationship between wealth and other income than the 2004 data, namely the wealthiest households also depended the least on forms of other income. Their high rate of employment—and the income received from it—allowed them to lessen their subsistence activities and the marketing of natural resources, or to forgo them altogether. Mcelwee (2008) also found that dependence on forest resources was least pronounced in households pursuing wage labor. The lowest economic groups also behaved as expected, intensely using forest resources in response to meager or no primary income. Still, these groups at either end of the economic continuum should not obscure the majority in the middle that have relied extensively, though not exclusively on other income (see Pyhälä et al. 2006). To illustrate, in both 2004 and 2006,8 households in the second to highest economic group appeared to gain substantially from other income. This income also proved especially beneficial to poorer households, boosting their economic status in comparison to households (i.e. those primarily made up of pensioners) that have largely chosen to forego other income. (*Refer to quadrants II and III in both Figures 7-2 and 7-3*.) Finally, similar to the results for 2004, those in 2006,8 could not support prediction 2b that a higher diversity of subsistence activities would be more evident among less well-off households. Mirroring the 2004 data, the lowest and the second to highest economic groups had the most diverse set of these activities. The wealthiest economic group pursued a low number of activities, and the middle economic group registered the least.

Wealth and household size

The third principal component in PCA was also important in explaining variation in the datasets. This component was most closely connected to the variable of total number of dependents indicating that household size and composition matter in regards to economic status.

Wealth and dependents

The relationship between wealth and total number of dependents in both datasets turned out to be more complex than the linear prediction (3) that household wealth would decrease as the number of dependents increased. (*Refer to Figures E-2 and E-3 and accompanying descriptions in Appendix E*). Specifically, some of the poorest households, i.e. those only receiving pensions, or those partially or fully unemployed, were also some of the smallest, while households in better economic standing tended to have more dependents. The sub-group of dependents outside of the household was also considered as they almost always imposed an increased financial burden upon households, typically in the form of tuition payments and extra rent. In both datasets the middle economic groups supported more dependents outside of the home than the wealthier groups, which was unexpected as the better off groups seemed most capable of bearing the high costs associated with these dependents. Overall, it was difficult to make a clear statement on the relationship between household wealth and dependents, as both less and more wealthy households had a high mean number of dependents, and the greatest number of the most expensive dependents (i.e. those outside of the household) was found in the middle group.

Other income and dependents

Although the relationship between dependents and household wealth proved ambiguous, there still remained the question of whether households with more dependents typically pursued other income to a greater extent than smaller households (prediction 3) (*refer to Figures E-4 and E-5 and accompanying descriptions in Appendix E*.)

Household analysis by economic group—2004

Here the second to highest economic group had the greatest mean total number of dependents. This group earned the most from non-timber forest product harvesting, and pursued the second to highest number of subsistence activities. The lowest economic group also had high environmental income (especially from sources other than non-timber forest products); however, its mean total number of dependents fell in the middle of all groups. The lowest mean total number of dependents was found in the second to lowest group, which was not unexpected as this group is dominated by pensioners; it is also characterized by low levels of other income. Thus, other income, especially environmental income, appeared to be of value in raising children. This finding reflected that from a comparative study of two Sri Lankan communities in which family size, in addition to access to a regional market, was identified as an underlying factor in the intensity of non-timber forest product collection (Wickramasinghe et al. 1996).

Nonetheless, a closer look at the subcategory of dependents outside of the household revealed that they were most prevalent in the middle economic group in which households earned no secondary income, and little to no environmental income (only one household brought in substantial income from non-timber forest products). This group, however, had high employment status (including among pensioners). These households most likely chose to invest their available time and energy in primary employment that could support children during their university and early post-graduate years. For example, one household in this middle group pursued full-time farming and marketing of crops, which enabled them to educate their child in mainland Russia. It also precluded the acquisition of other income.

Household analysis by economic group—2006,8

In this dataset the relationship between dependents and other income differed noticeably from that in 2004. The two lowest economic groups had the highest mean number of total dependents and were also the most highly dependent upon natural resources, thereby supporting prediction 3 that households with more dependents would be more likely to earn other income. Nonetheless, the differences in the mean total number of dependents between less and more wealthy households, and between those that rely to a greater and lesser extent on other income were not pronounced. Also, the lowest economic group was exceptional in its small size. Additionally, there was a notable difference in datasets regarding dependents outside of the household. In 2006,8 the wealthiest group had by far the highest mean of such dependents, whereas this mean was comparatively low in the groups where other income was prominent. These findings pointed to an emerging trend in a rapidly evolving economy in which the ability to support dependents outside of the home has become increasingly tied to income from primary employment. Such income has also begun to signify increased opportunities, for example in health care and travel, and it has bolstered spending power (see Shackleton and Shackleton 2006).

Conclusion

This study examined the livelihood strategies that rural households in central Kamchatka have adopted to survive the turbulent post-Soviet period. While all households have assumed some level of self-sufficiency, the extent of their dependence on forest and other natural resources for supplemental income and subsistence varied considerably. Thus, one of the main objectives of this study was to identify and understand the factors underlying household variation in villages where economic homogeneity was formerly the norm.

In this study PCA showed employment status, and the primary income it generates, as pivotal in sustaining households, and in supporting dependents outside of the home; however, it was not the sole means of support. Other income, particularly environmental income from the gathering and marketing of forest and other natural resources, has been essential for upper and lower income households alike during a protracted socio-economic crisis. Moreover, other income has enabled some households to achieve a higher economic status than they would have been able to do on primary income alone. This result defies the common notion that it is the poorest households in a community that mainly pursue the harvesting and marketing of natural resources (Wickramasinghe et al. 1996).

The results revealed different patterns than those originally predicted in terms of the relationship between household income from primary employment and the pursuit of other income. Even though the wealthiest households in 2006,8 appeared to depend the least on other income, those in the next highest economic group gained substantially from it. In 2004 other income was prevalent in the wealthiest group. At the same time, some of least well-off households in all years were highly dependent on other income. Besides wealth, dependents influenced the procurement of other income, which appeared to be valuable to households with dependents at home. These patterns underscored the importance of other (particularly environmental) income within households in these forest-dependent communities. Although the majority of these households are not solely dependent upon this income, it has nonetheless been critical in offsetting lost or decreased primary income (see Pyhälä et al. 2006).

These findings make sense in light of the broader socio-economic context in which even households with full employment status often did not receive salaries for months on end due to wage deferment in the early post-Soviet period. Moreover, there was rampant unemployment during this time as industrial production came to a standstill. Such conditions forced nearly all households into a subsistence lifestyle buffered by other income for basic survival. Although socio-economic conditions in central Kamchatka had begun to stabilize by 2004, the year in which this study commenced, the livelihood strategies that households honed to endure the dire years of the early post-Soviet period seemed to remain firmly in place. Other income has continued to be instrumental in meeting household needs, especially in the face of continued scarce employment opportunities.

At the same time, the relatively recent influx of governmental funding into local administrations, and rising entrepreneurial opportunities, has enabled more households to meet their needs through primary income, as more recent data (from 2006 and 2008) showed. Today households also have unprecedented consumer opportunities; thus, other income now serves a dual purpose, enabling households to acquire both essential (e.g. food and clothing) and non-essential (e.g. cars, new appliances, traveling) commodities. The latter has likely been a driving force in the continued use and marketing of natural resources, even in households with a steady flow of primary income (see Arnold and Townson 1998, and Cocks et al. 2008).

This study therefore challenges the established correlation between decreasing socio-economic status and increasing dependence on forest resources (McSweeney 2004, Mcelwee 2008). At the same time, it reinforces the concept of forest resources as a form of 'natural insurance' or a safety net that even in modest amounts greatly contributes to rural people's (especially the poor's) livelihood strategies (McSweeney 2004, Pyhälä et al. 2006).

Further, this study contextualizes the people-forest relationship in a unique spatial and temporal setting punctuated by concurrent socio-economic, political, and ecological crises. It diverges from typical studies of indigenous peoples in tropical and temperate forests to elucidate the experiences of primarily ethnic Russians in the northern periphery of Russia during the post-Soviet period. For the striking majority of these people the question of survival has been far from rhetorical: it has drastically redefined their lives and communities during a period of unprecedented and abrupt change. The same scenario of marginalization and reshaping of worldviews has played out in forestry regions throughout Russia, some at a distance of thousands of kilometers from Kamchatka, for instance those in the remote northwestern parts of the country or in the Buriat Republic in Siberia (Pallot 2002 and Metzo 2001). Thus, this study is vital in understanding the transformation of everyday rural life in the post-Soviet period (see Caldwell 2004, Smith and Rochovská 2007). It also sets the stage for the vivid portrayals in the next chapter of how people have made survival a reality in the midst of a far-reaching socio-economic and political crisis.

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Chapter 8
An Exploration of Resource Use Dynamics in Post-Soviet Spaces

Prologue:
"I want to ask you for forgiveness, because many of our dreams have not been realized, because what we thought would be easy turned out to be painfully difficult. I ask for forgiveness for not fulfilling some hopes of those people who believed that we would be able to jump from the gray, stagnating, totalitarian past into a bright, rich and civilized future in one go. I myself believed in this."—from the resignation speech of Boris Nikolaevich El'tsin on December 31, 1999 (Quoted in Ellman 2000)

"These tears did us good."—Resident of the village of Dolinovka in reference to surviving the 1990s

Introduction

This last chapter in the dissertation is wide-ranging in scope, providing a synthesis of resource use and livelihood in the temporal context of the post-Soviet period. This chapter serves as a follow-up to Chapter 7, presenting ethnographic accounts that complement the quantitative livelihood analysis. In this way, it endeavors to paint a more textured picture of the post-Soviet period by capturing the experiences of those who have lived through it. Within these narratives unmistakable voices of struggle, resilience, and hope emerge. Moreover, this chapter draws out distinctions within the post-Soviet period, portraying it as fluid and dynamic, instead of static. Changing resource use patterns, particularly in regards to non-timber forest products, highlight these dynamics, serving as a means by which to gauge and interpret the larger socio-economic and political processes in which these patterns are embedded. The guiding questions for this chapter are two-fold: How have non-timber forest product gathering and use evolved in the post-Soviet period? What have these changes signaled in terms of people's livelihood and their relationship to the natural world?

This chapter is structured around ethnographic accounts of non-timber forest product gathering (e.g. of fruits, medicinal herbs, and mushrooms), and other forms of resource use (e.g. garden production and fishing) in the post-Soviet period. This period is roughly divided into two parts: early 1990s to 2000 (early post-Soviet period), and 2000 and beyond ('post' post-Soviet period). This split is primarily politically based, marking a change in presidential power in 2000 (from Yeltsin to Putin) that has gradually led to improved socio-economic conditions throughout the country. To understand what these shifts have meant in terms of people's livelihood choices and resource use patterns, the following question was posed in a semi-structured interview conducted in central Kamchatkan villages in 2004, 2006, and 2008: "How do your gathering patterns today differ from those in the Soviet period and the early post-Soviet period (i.e. 1990s)?"

This chapter begins with an overall contextualization of the post-Soviet period, followed by a more detailed account of how this period has unfolded in central Kamchatka where dramatic changes have been particularly palpable. Here sweeping socio-economic and political transformation coincided with an ecological crisis, creating an especially stark situation for the people whose livelihoods were tied to the forestry industry. It then introduces the theoretical framework of political ecology in which the post-Soviet ethnography that forms the core of this chapter is situated. This ethnography features people's experiences of survival and securing a livelihood during the post-Soviet period.

Contextualization of post-Soviet period

Although the end of Communist rule was hailed as a breath of fresh air into a stagnant place, it also heralded the onset of tremendous uncertainty and insecurity for the people of the former Soviet Union. In the earliest days of the post-Soviet period beginning in 1992 what initially seemed hopeful and painless turned out to be excruciatingly trying. In fact, the ideological and material shift away from socialism toward capitalism in the former Soviet Union exceeded all expectations in terms of difficulty (Kuehnast 2000). The consequences of a long and deep economic recession translated into widespread poverty within a wide spectrum of the Russian population, forcing the vast majority to fight for everyday survival through the 1990s. Following the dissolution of the former Soviet regime, the majority of Russian households found themselves instantly impoverished with barely enough monetary income to cover the essentials; a full third of the population could not even provide for their basic subsistence needs (Clarke 1999).

The fall of socialism also signified the termination or deterioration of nearly all services and subsidies once provided by the state (Clarke 1999, Hann 2004). The subsequent vacuum was further exacerbated by the absence of social policy to complement economic reforms.

Consequently, the onus of meeting basic requirements once covered by the state, including higher education and medical services, shifted to households, further increasing their burden of rising expenses (Seeth et al 1998, Smith and Rochovská 2007). These sudden socio-economic and political transformations, and the unpredictability that accompanied them, stood in stark contrast to the relatively even-keeled life of the late Soviet era even despite daily uncertainties, for instance, whether bread would be available (Kuehnast 2000).

In response to these novel circumstances in which most workers were either unemployed or earned salaries below the official subsistence level (if they were paid at all), people employed unique sets of strategies, many of which had roots in the Soviet period (Clarke 1999, Caldwell 2004, Ries 2000). For instance, people relied on relatives, friends, and colleagues for mutual assistance, or they took up part-time, nighttime, or weekend work, and engaged in various sorts of trade to earn supplemental income. Moreover, they applied the "science of frugality" that they had honed over a lifetime (Ries 2002). Perhaps the most prevalent strategy was the return to household food production (especially by means of dacha gardening). Although this type of production was undertaken during the Soviet period, the factors upon which it depended, such as income, prices, available labor, access to land and capital, and the real or perceived risk of food unpredictability, changed fundamentally during the post-Soviet period (Seeth et al. 1998). By 2001 garden production from the household and personal sectors made up a striking 54 percent of the total value of Russia's agricultural production (Goskomstat, 2001a quoted in Pallot and Nefedova 2003).

Clearly, food production has been paramount in keeping the household afloat, particularly in rural regions where industries that were once the lifeblood of villages and small towns (e.g., state and collective farms, and forestry enterprises) were liquidated. Besides the loss of jobs, rural dwellers had to face the deterioration of infrastructure built by the state organizations and enterprises, including roads, schools, and health facilities (O'Brien et al. 2005). Thus, entire village populations, including pensioners and those employed in the cultural-social sphere (e.g. teachers) were forced to return to the household unit—and to a high level of self-sufficiency. This newfound centrality of the household signaled a radical departure from the previous order that had greatly diminished the household's relevance. This return to and increased emphasis on household production was a common theme uniting urban and rural dwellers in the post-Soviet period (O'Brien et al. 2005).

Although socio-economic differentiation has been less pronounced in rural than in urban Russia, the sudden stratification of rural households was nonetheless impressive given the homogeneity observed among households at the very end of the Soviet period (O'Brien 2004). This differentiation occurred along the subsistence-commercial spectrum, reflecting the varying levels at which rural households pursued small-scale subsistence activities (Pallot and Nefedova 2003). Throughout Russia, these activities (and combinations of them) have taken a variety of forms, depending on the specific region and locality (Pallot and Nefedova 2003 and Metzo 2001).

Central Kamchatka in the post-Soviet period

Subsistence strategies in central Kamchatka have closely resembled those in other rural communities throughout the vast Russian taiga: in the short growing season of this vegetative zone people are nonetheless able to pursue garden and livestock production, which they complement with the gathering of non-timber forest products in the forests. They have also begun to sell these forest products to generate additional income (see Pallot and Nefedova 2003). Together, these strategies of resource production, gathering, and marketing have been critical to household livelihood. In central Kamchatka the combination of subsistence strategies employed are unique, reflecting the region's rich natural resources, including its abundant salmon runs. The latter has provided an extremely valuable and bountiful food source; at the same time, this copious resource has also fueled a high-stakes caviar trade. Thus, salmon in this region play a complex role in households as both a source of nourishment and income.

This subsistence lifestyle has been a dramatic departure from the preceding order in which people's lives revolved around the state forestry enterprises and collective farms. These once thriving sectors were brought to a standstill when the central government that had propped them up dissolved. The abrupt withdrawal of generous subsidies meant the end of fuel, animal feed, and copious amounts of cash for the region's collective farms, all of which had formerly contributed to the abundant production of dairy products, eggs, vegetables, and meat (King 2003). It also spelled the end of food imports to the peninsula. This sudden termination of subsidies in tandem with the concurrent collapse of state enterprises and farms proved especially harsh for households in this region that were used to a relative abundance of goods in contrast to other areas in the former Soviet Union.

Although the economic situation in central Kamchatka is not as dire today as it was in the early to mid-1990s, household subsistence activities, such as gardening, fishing, harvesting of non-timber forest products, and hunting, still form the backbone of village life in central Kamchatka today. For many households these activities remain critical to everyday survival. Because these activities are pursued concurrently, it is difficult to consider them separately. Thus, this chapter discusses the livelihood activities of fishing, garden and livestock production, and non-timber forest product gathering in the post-Soviet period; however, its focus is on the latter given the centrality of this topic to the dissertation.

Ethnography of resource use

In the context of dramatic transformation from one way of life to another, such as occurred with the dissolution of the former Soviet Union in 1992, ethnography becomes "a methodology for exploring the zones (literally and figuratively) where people are entangled, abandoned, engaged, and altered by the reconfiguration of states" (Greenhouse 2002). Anthropologists who have explored these post-Soviet (and socialist) spaces through ethnography have uncovered a state of exhaustion and nervousness, and a strong determination to "make do" (Rethmann 1997, Caldwell 2004). The latter is described as a uniquely Russian characteristic that involves the ability to weave together a set of livelihood strategies to endure uncertain and difficult times (Caldwell 2004). This state of "making do" is born of crises during which people have had to "improvise with the elements of their social and political technologies and cope with a variety of unexpected disruptions and opportunities" (Greenhouse 2002)

The ethnography presented in this chapter captures people's response to socio-economic, political, and ecological crises, and how they have weathered novel circumstances through natural resource use. Whereas the quantitative data in Chapter 7 presented a concise picture of subsistence activities and their significance to households, this ethnography draws out stories in the spaces eclipsed by these data, exposing voices of survival, struggle, hope, and ambition that are intertwined throughout these stories. Through these accounts, it traces the extent to which people have pursued subsistence activities, and the importance they have accorded to these activities. On a wider scale, these resource use strategies act as a benchmark for gauging fluctuations in the socio-economic and political conditions that have defined the post-Soviet period.

Ethnography and political ecology

Given these socio-economic and political crises, and their implications for resource use, political ecology is an apt theoretical framework in which to situate this ethnography. Broadly, political ecology is concerned with the "relations between human society, viewed in its bio-cultural-political complexity, and a significantly humanized nature" (Greenberg and Park 1994, quoted in Biersack 1999). In this highly interdisciplinary field the issues are always geographical, historical, anthropological, political, economic, and sociological in nature (Biersack 2006). By bringing these separate strands together, political ecology bridges the social and natural sciences. A defining characteristic of political ecology is the recognition of human-environment relationships as reciprocal as opposed to one way (Odling-Smee 1994, quoted in Descola and Palsson 1996). Thus, it views humans and nature as being mutually influential over one another, thereby challenging the human/nature dichotomy (Kidder and Balee 1998). Put another way, political ecology is most concerned with issues of access to and control over natural resources, and the ecological implications of these issues (Watts 2000, quoted in Biersack 2006).

In this context, making connections between the local level and the nation-state is essential because these power relations affect how people interact with the environment (Kottak 1999; Moran 2008). Landscape change, for instance, can originate in changes made in national policies; at the same time, it can be rooted locally within a group of smallholders (Pinedo-Vasques et al. 2002). Both scenarios have been observed in central Kamchatka: whereas the former primarily occurred during the Soviet period when the state mandated extensive logging practices in this region (*refer to Chapter 3*), the latter has been more evident in the post-Soviet period with disappearance of the state and the emergence of small, local logging companies. This same pattern also applies to non-timber forest products. Centralized orders were once passed down to the *gospromkhoz* organizations (*refer to Chapter 3*) mandating the collection, processing, and distribution of non-timber forest products. In contrast, today this activity proceeds virtually uncontrolled by local authorities; instead, it has moved to the realm of households where individual gatherers determine the ecological impact of this activity. These examples reveal the aptness of political ecology in this ethnography, which allows for a more critical look at resource use and its consequences during a time of enormous socio-economic and political change.

Post-Soviet spaces

Dissolution of a former way of life

It's easy to write that people's lives in central Kamchatka were dramatically transformed with the onset of *perestroika* and the ensuing fall of the Soviet empire without truly understanding the extent to which these changes carved into and reshaped their lives in unprecedented ways. Thus, this ethnography begins by considering the impact of severe socio-economic and political crises on those who survived the early post-Soviet period. Through their recollections of resource use, people touched upon the hardships and the fears that they have endured during this period. Their accounts were often poignant, pointing to the profound effects of job and subsidy losses that have been rampant in this region. These sudden withdrawals left a vacuum that people filled with their own production, or with resources that they extracted from the rivers and forests. Grounded in the theoretical framework of political ecology, this ethnography documents these new patterns of resource acquisition and use, and how they have clearly fluctuated in sync with political decisions made thousands of kilometers away. It demonstrates how shifts in access to and control over resources have fundamentally changed people's interactions with the landscape, which, in turn, have had distinct ecological impacts.

To grasp the consequence of the Soviet Union's dissolution in central Kamchatka, it is necessary to portray first a glimpse of the former way of life, as articulated by one resident of the village of Lazo:

> There was such a *sovkhoz* [state collective farms], and there were such greenhouses! A lot of new people were arriving, primarily from Ukraine. At that time the *lespromkhoz* [forestry enterprise] was working—they were shipping logs down the river. The buildings in our village, for instance the cafeteria, were beautiful, but in a flash everything was destroyed.

An older couple in the village of Kozyrevsk echoed this sudden jolt, telling how their savings vanished in a heartbeat: "Everything was there, and then it all burned away." For them the 1990s took on an air of a "mad devaluation of investments." Such losses experienced throughout the villages were substantial in and of themselves; however, they also symbolized the disappearance of a way of life and work that had led to those savings. The outward destruction of village infrastructure created internal crises as people viewed years of their hard work disintegrate. One woman told of her distress in observing the decay of buildings she had designed during the Soviet years, concluding that all of her effort was wasted.

These material and immaterial losses—of savings, jobs, subsidies, and dignity—reverberated throughout the villages, causing people to retreat to the bounds of their households where they were forced to fend for themselves. This cardinal shift from the collective to individual unit reconfigured villages, and the people within them, to a point where they were barely recognizable. As people faced the issue of survival in the most literal sense, their perspectives narrowed and the mantra of living one day at a time assumed a heightened meaning. In the struggle to maintain their livelihoods, households turned to the rich natural resource base of central Kamchatka, which provided the basis for fishing, and gathering non-timber forest products; garden production also became central to a household's ability to survive. The significance of these activities is related in the following words of women from the villages of Dolinovka and Atlasovo, respectively:

> It was something else—gathering was essential in order to live. Farming and the forest helped us. There were mushrooms. We bartered some of the [mushroom] harvest and sold the rest somewhere. It was really difficult in 1996 and 1997—our children were growing and we had to feed them, but we didn't know how we would do so. At that time the forest rescued us—we were able to exchange our mushroom harvest for foodstuffs, for instance for vegetable oil, canned meat, and sweetened condensed milk. We waited for the mushroom-gathering season—the mushrooms were like manna from the sky. It was good that there was land around us—it saved us during a time of great hardship. Therefore people remain here. The land feeds us.

> Those were hungry years [the 1990s]. They didn't pay our salaries—it was difficult. We couldn't buy anything, so we ate fish and we had an assortment [of strategies]—fishing, forest [i.e. non-timber forest products], and potatoes. We learned to bake bread, and did whatever you can imagine with fish. Fish and mushrooms and berries (lingonberry) really gave us security. It wasn't clear how to survive. It was an awful time.

These two households were not alone: for many, the early post-Soviet days and the country's nascent democracy were synonymous with a time of fright in which families struggled to feed themselves on a day-to-day basis. The passages above vividly depicted how people made do by employing a suite of subsistence and commodity activities (i.e. marketing of garden production and non-timber forest products) in creative ways. This ability to make do and persist, however, did not assuage underlying insecurities that led to nostalgia for the past and apathy toward the future. Even as people were able to make it from day to day, these days were shrouded by intense worry (see King 2003). The upshot was that survival mode became the norm for people, as pithily expressed by one villager: “All these years we were just surviving.”

At the same time, this new order conditioned a staunch sense of self-survival as people took up nets and buckets to fish and gather non-timber forest products. People also began to expand their gardens in which they spent all summer to stockpile fruits and vegetables to last throughout the long winter, which was a clear departure from the Soviet period. During this time people also began to raise livestock. Former *sovkhoz* (state farm) workers, for instance, received these animals in lieu of a salary and upon the liquidation of the *sovkhoz*. With the disappearance of salaries and jobs the question of how to subsist (*prokormit’sya*) loomed large, leading people to concentrate on activities that they had once pursued at their leisure, as one former *sovkhoz* worker testified:

> We started to collect mushrooms and other non-timber forest products when the sovkhoz closed in 1995. We were unemployed; we used to have no time and gathered just for ourselves on our days off. Now, we’ve begun to sell berries.

Former *lespromkhoz* workers faced similar fates when the forest industry collapsed, which also meant the decline of critical infrastructure (e.g. schools, hospitals, theater, gyms) that once fell under the jurisdiction of the state-run *lespromkhoz*. This unraveling of the industrial and social fabric that had supported villages prompted an outflow of population (Heleniak 1999, Hitztaler 2004). Those who stayed faced a sharp decline in living standards. For instance, one woman admitted that her family has become poor, contrasting her situation now to that during Soviet period when she and her husband both worked, which allowed them to build their own home. “We lived normally [then]. Today those who run stores live well, but everyone else is supported by their garden and berries.”

These words were insightful, implying a connection between subsistence production and poverty. Moreover, they identified shifts in living standards and the subsequent differentiation of households during the post-Soviet period. Thus, while some households no longer rely on subsistence production, it is still important for the majority, especially in light of continued unemployment throughout the villages. (*Refer also to Chapter 7.*) In response to this socio-economic reality a villager in Kozyrevsk stated emphatically: “People have to live on something. Even if people do receive salaries or pensions, they [salaries and pensions] are miserly. How are people living? Someone turns to the river, and someone goes to the forests." Another villager echoed this same sentiment, and at the same time confirmed the differentiation that has occurred among households:

> For us the river and gathering—they are like hobbies, yet others are forced to go to the river and to collect non-timber forest products; they have to don their rubber boots and head to the river because there are not enough forests left to support our small private timber enterprises.

Similar to the others, this passage clearly stressed the blending of strategies necessary to maintain households in the post-Soviet period. Complementing one another both as subsistence and commodity production, these strategies were inseparable in most cases. The following sections, however, take an in-depth look at non-timber forest product gathering and use with respect to the early and later phases of the post-Soviet period. The activities of fishing and garden production are also considered given their centrality to household livelihood.

Gathering in the early post-Soviet period: "Only the forest fed us"

People gathered non-timber forest products long before the post-Soviet period and the onset of socio-economic hardship in this region. Yet, the nature of gathering, and the factors that drove it, changed profoundly in the post-Soviet period. In the absence of social security, this activity acquired a new dimension in the 1990s: instead of a leisure activity, gathering in the early post-Soviet days became a way to meet basic needs. As wage deferrals were prolonged, the role of non-timber forest products in households greatly expanded, as one villager succinctly expressed: "Non-timber forest products were fundamental—we lived on them." The following recollection of a young mother in the village of Atlasovo gives a more in-depth view of the growing recognition of and dependence upon non-timber forest products as a food source:

> We lived purely on account of non-timber forest products. At that time [in the early post-Soviet period] it was inconceivable not to gather mushrooms…We didn't see one kopeck for half a year. There were abundant non-timber forest product harvests of mushrooms, honeyberry, and wild garlic. We survived only on account of mushrooms—we fried and fried them. Formerly, it was not like this, but now the entire village is there in the forest.

Besides meeting immediate needs, forest resources were stockpiled resources for the long winter. For instance, one woman in the village of Kozyrevsk reported collecting an especially large quantity of mushrooms—up to 300 liters—in one season. This harvest acted as a surrogate for meat when money was short. Another woman in the village of Dolinovka remembered how her household, too, lived off of forest resources in 1994 when they had no money to buy anything, not even tea.

Although non-timber forest products directly provided vital nutrients, they also became a commodity that was bartered or sold food for food. One woman told how her family waited for the start of lingonberry gathering season, which signaled that they could feed themselves using the money they received from marketing lingonberry. Income earned from these harvests could also go toward the purchase of other essential items, such as clothes and shoes. Given this newfound significance of non-timber forest products in village life, there was almost unanimous agreement that people overall collected more at the beginning of the post-Soviet period in comparison to the Soviet period. To illustrate, one respondent told how approximately 10 liters of mushrooms and lingonberry apiece used to be sufficient for their household during the Soviet period. In the post-Soviet period, however, these volumes jumped to 70 and 300 liters, respectively.

This scenario was echoed by other villagers. One whose household began to market lingonberry in the early 1990s drew a sharp distinction between the Soviet and post-Soviet periods: "They used to pay money [salaries]; we lived well. Why would I have sold berries? People here did not harvest so much—no one needed so much." Another villager recalled not worrying about how to get food during the Soviet period: she and her husband were both working and they could buy everything from the local stores for mere kopecks. (Kopecks are to the Russian Ruble as cents are to the dollar.) They only began to gather following the dissolution of the former Soviet Union.

This association of higher volume and more intensive gathering with the early post-Soviet period, and its inverse, (or the association of lower volume and more relaxed gathering with the Soviet period), were not as linear as they might have initially appeared. Large-scale gathering also occurred during the Soviet period when there was a high local demand for non-timber forest products; people also earned money through their gathering efforts. (*Refer to Chapter 3, Part III for an in-depth account of gathering during the Soviet period.*) What then might explain the evident dichotomy between Soviet and post-Soviet gathering practices? The answer lies in the novel socio-economic and political conditions of which gathering was a critical benchmark. Whereas gathering had formerly been undertaken to supplement a household's table or paycheck, in the early post-Soviet period it became a mainstay of household tables and income. Also, it largely lost its status as a leisure activity, instead becoming an important form of work. Most significantly, it was done with an increasing sense of urgency and worry as households tried to stave off starvation and deprivation. Thus, the emergence of gathering as a means of survival was the most profound difference in this activity between the Soviet and early post-Soviet periods. The following words of one villager encapsulate this distinct shift: "People gathered non-timber forest products after *perestroika* to survive. They gathered before, so that they would have some additions to their diet. That was when they received their paychecks."

Responding to the absence of income and job prospects through gathering was critical to daily survival; at the same time, it signaled that people were no longer bound to the state norms and principles that had formerly dictated gathering locations and harvest prices. Rather, they could exercise unprecedented control over the non-timber forest products that they gathered, and how they used these resources. Many learned marketing basics, which were previously foreign. To illustrate, several households in the village of Dolinovka organized a small mushroom gathering and processing operation to fill orders from a larger town. The work was arduous and time-intensive, yet it brought in coveted income at a time when villagers didn't see money. In this stark scenario, it was at least something that people could do to improve their predicament. As the post-Soviet period wore on, these first seeds of marketing began to flourish in villages.

Gathering in the later post-Soviet period: "It's money"

The harsh predicament of the 1990s was not immutable: Russia's crawl out of dire economic straits meant the trickling of money into the remote villages of central Kamchatka. The return of wages mitigated the once pressing need to live off of the forests and the land to ensure day-to-day survival. These trends that began with a change of power in the federal government in 2000 were mirrored in gathering activities. For many households, gathering patterns fell back to their pre-crisis state, namely gathering was done for household use only, serving primarily as a supplement to the household food budget. This arc back to the past, however, represented only one facet of a multi-tiered picture. Many households remained dependent upon the additional income generated by non-timber forests product sales, contrasted by others that stopped gathering altogether and instead bought non-timber forest products from local gatherers.

Perhaps the most striking change in gathering from the earlier to later post-Soviet periods was its overall lessened importance to households, especially in comparison to other subsistence activities (e.g. fishing and garden production). For many households, non-timber forest products returned to their former role as a very useful, yet not essential supplement to the household food budget. In other words, they no longer served as a primary food source for households. In fact, villagers expressed were able to make do without them, if needed, as one villager explained: "We can live without berries and jam. If there is lingonberry, it's enough to gather it for compote; if there is none of this berry, it's nothing awful."

This diminished role of non-timber forest products could be due in part to sporadic harvests (e.g. of lingonberry) that could not be relied upon from year to year. More likely, however, it reflected improved socio-economic conditions in villages where more people were working and salaries had (for some) noticeably improved, especially with the expansion of administrative posts within the villages. (This trend was especially noticeable in 2008 during the final season of fieldwork.) One woman in the village of Atlasovo put this relationship between outside employment and gathering in plain terms: "While I didn't work, the necessity of gathering was very great. These earnings from lingonberry were primary, now there is not such a strong necessity [to gather]." This same scenario repeated itself in other Atlasovo households. For instance, one household that had devoutly sold lingonberry harvests throughout the post-Soviet period stopped doing so in 2006, opting to gather the minimal amount for household needs only. The financial situation of this household had visibly improved with new jobs, affording its members the option of not marketing harvests.

Some households were opportunistic gatherers, collecting and selling non-timber forest products (primarily lingonberry) only during years of abundant harvest. Earnings from these harvests went toward non-essential items, such as new appliances (e.g. washing machines). These examples revealed how people have acted in their best economic interest, which is dictated by the financial situation of the household. Thus, from a perspective of household economy, it made sense that some households chose not to invest the time and effort that they once did in gathering. Simply, they no longer needed this resource—and the income from it—to make ends meet.

Other households, however, have continued to struggle with unemployment, giving rise to distinct economic differentiation in villages. These households have not had the option of forgoing non-timber forest product marketing. Gathering for them was still one of few available options to earn income for basic necessities (e.g. food, childcare, clothing, and shoes). This income from gathering was particularly vital for households with children. One mother of four told how she would not gather and market harvests if she did not have children, explaining that the additional income they procured from gathering went toward clothing and school supplies. They were, however, able to feed themselves on their primary income, which was a clear improvement from when her husband worked at a start-up forestry enterprise in the village and received a pittance of a salary. Another young mother in Atlasovo admitted: "Times are tough, but people live very well on account of non-timber forest products. As long as there is lingonberry we'll have some financial backing."

Today this notion of financial support encompasses both needs and wants, which are becoming increasingly blurred, especially with the proliferation of goods and services that are now available in these remote villages. For example, some villagers have even been able to buy a car with their earnings from gathering. Thus, the evolution of this activity from a means to feed one's family and ensure basic survival, to a way to prosper is becoming more evident. One villager summed up the role of this activity very concisely: "its money." This prospect of earning a profit in whichever way possible has driven over half of all gatherers to sell harvests in increasingly greater volumes. A woman in Atlasovo gave this insight:

> People want more, and the more that they get the more they want…I'll only go to gather when my family needs exactly a kopeck, and not an extra kopeck. This year income from lingonberry was not necessary to anyone in our household, so we did not sell.

Finally, another made this perceptive observation: "Now the consciousness of people has changed. People are already oriented toward selling. For many lingonberry represents earnings that help the household budget…It is an income and not a bad one." This reorientation embodied the larger shift toward a market economy with increased consumption at its helm. People have learned how to be consumers, which has spurred large-scale gathering for profit

Evolution of gathering

This new consciousness has transformed how people relate to the landscape environment, and their impact upon it, as a woman from the village of Kozyrevsk described:

> Gathering occurs in a barbaric way. People rip up plantlets by their roots. Also, prior [to the post-Soviet period] people never began gathering before September 15th insomuch

> as that was the rule. Now people are gathering lingonberry already by August 15th. Now people live on this [resource].

Others expressed this same sentiment, tracing this barbarism to the great needs people faced when they did not receive their salaries and were forced to turn to the forests. This new attitude toward nature was symbolized by the use of a special gathering tool (*sovok*) that accelerates gathering rates, and eventually profit. (*For a more detailed discussion on the use of this tool, refer to Chapter 5.*) This unprecedented way of gathering was indicative of the severe socio-economic conditions beginning in the early 1990s.

A nearly complete lack of local regulation enabled and even facilitated this more exploitative relationship with the forest. In principle, the local *leskhoz* (forestry service unit) was to enforce established gathering quotas for each household to ward against over-harvesting of non-timber forest products. In actuality, however, gathering proceeded virtually unencumbered, rendering these rules irrelevant. Similar to the people, the *leskhoz* found itself in survival mode with scant government support and other pressing needs to address, such as fighting forest fires. To help secure its existence, the *leskhoz* accepted bribes in auctioning off long-term leases of forested land to start-up logging companies. In this free-for-all environment, gathering regulations could be easily broken, a situation of which both the people and the *leskhoz* were very well aware.

People were forthright in their assessments of the *leskhoz* in relation to gathering, stating that the *leskhoz* in no way whatsoever controlled gathering or took measures to protect gathering sites. *Leskhoz* employees themselves admitted as much, as expressed in the words of one forest ranger: “Sheer disorder [is occurring in the forests]. It’s mayhem—what person wants, that’s what goes on.” This outcome was due in part to the misuse of political power from above; from below it was tightly intertwined with the issue of survival. Both the *leskhoz* workers and villagers fully recognized that forest resources provided critical wherewithal for struggling households. One woman, for instance, openly admitted to gathering lingonberry before the official start date, explaining that it was impossible to compete for resources otherwise. This situation has spurred over-harvesting, which could be responsible, at least in part, for the overall decline of this resource. Gathering in increasingly larger volumes, both for the purpose of survival, and to earn money, have left a distinct mark on the landscape. This inscription of human activity speaks of local patterns that have evolved as adaptations to larger economic and political processes. Here the link between prevailing politics and landscape change is explicit.

Gathering culture

Socio-economic and political conditions have largely determined the evolution of gathering in post-Soviet Kamchatka; however, they do not tell the full story behind this activity. Long-standing cultural norms and beliefs are also responsible for observed gathering patterns, thereby adding a layer of complexity to this story. For instance, people have not simply started and stopped gathering in response to economic cues.   In this sense the meaning of gathering runs deeper than its function as a survival or money-making mechanism, even as these functions have been particularly visible in the early post-Soviet years. Here gathering resembles garden production that has also been vital to household livelihood throughout the post-Soviet period. In a study of household food production in ‘post-communist’ Slovakia, Smith (2002) argued that such production could not be interpreted as a response to austerity per se, but “as a practice with long-standing cultural and economic significance in the (re-) production of household economies.” The main premise here is that poverty is not at the root of garden production; instead, this activity can only be interpreted “in relation to the constellation of household, cultural/historical and economic (not only capitalist) forces” (Smith 2002).

This argument is very apt in terms of non-timber forest products that fill a specific niche in village life. Besides their utilitarian purposes, non-timber forest products are found in nearly all village households, even in symbolic amounts. (*Refer to Table E-1 in Appendix E*) They have also come to signify special occasions, such as birthdays, anniversaries, and New Year’s celebrations. This cultural and historical meaning attached to non-timber forest products elucidates why nearly entire village populations (including the elderly) continue to gather in one form or another, even as it might not make the most economic sense to do so. In fact, gathering has been so embedded in village life that some held it as a sin and shame to not go to the forests simply. Speaking on behalf of his household, one villager expressed this notion: “It's possible to live without non-timber forest products; for us there is no [monetary] advantage, yet they are still important to us.” This sense of importance could also be derived from the recognition of non-timber forest products as the source of essential vitamins and minerals that could promote good health. The act of gathering itself also appeared significant to villagers.

Many, for instance, recalled the sense of rejuvenation they experienced after a day spent gathering in the forests.

Other livelihood activities in the post-Soviet period

The focus on non-timber forest product gathering thus far should not overshadow other livelihood activities, such as garden and livestock production, and fishing, which have been of equal and (often) greater consequence to household livelihood. Similar to gathering, garden production has deep cultural origins, even as it has been central to household survival and livelihood in the post-Soviet period. None of these activities, however, stood alone: nearly every household employed its own combination of gathering, gardening, fishing, hunting, and livestock production to ensure its livelihood. Similar to gathering, these activities were also pursued during the Soviet period, yet they acquired special meaning in the post-Soviet period as they became mainstays in the household economy. The following profiles exemplify how households have tailored a combination of subsistence activities to suit their specific needs (and wants):

> This household is known throughout the village as one heavily engaged in the caviar trade from which, presumably, a large portion of its income originates; the fish from which they extract the caviar serve as an irreplaceable staple in their diet. They also have a garden plot and greenhouse where they produce a large potato crop and grow tomatoes and cucumbers. Finally, they also raise chickens and goats, and gather copious amounts of mushrooms.
>
> The woman who heads this household derives her livelihood from a variety of sources: she raises all vegetables herself, and salts the fish that she obtains. She used to keep a cow that was important in feeding her family. She also gathers mushrooms and berries, selling the latter if it is a good harvest year. Lastly, she also earns extra income by hosting foreign tourists.
>
> Today, this household employs a wide variety of livelihood activities. First, its members raise two cows and sell milk. Second, they sell part of their large potato harvest and other vegetables (when available). Third, hunting plays a major role in this household: moose, hare, and duck ensure a steady supply of meat in their household. Fourth, they participate in the caviar trade. And, finally, they market lingonberry during good harvest years. Essentially, they produce or obtain from nature everything they need for their household.

Garden production

Growing garden crops and tending a greenhouse have come to make up the lion's share of the food budget for many households in central Kamchatka. Even today nearly all households continue to raise their own food because, unlike city-dwellers, they have few opportunities to buy fresh fruits and vegetables. Moreover, the processed goods available in the villages are significantly more expensive than those in the city due to transportation costs (see also Metzo 2001). These rural households, however, have an advantage over those in the city in their proximity to garden plots, which surround most homes in the villages. Moreover, many of these households had already initiated garden production to some degree during the Soviet period. For instance, one villager in Kozyrevsk remembered how households in the village began the tradition of growing fruits and vegetables (e.g. tomatoes and cucumbers) in greenhouses in the 1970s. In the uncertain terrain of the post-Soviet period, however, the garden plot has assumed heightened importance in mitigating losses of jobs, livelihood, and social security. One villager captured the significance of garden production in straightforward terms: "We plant in the summer so that we can live through the winter." Another villager shared that as long as her household produced potatoes they could manage in any situation. This stalwart reliance on garden production as the main hedge against crisis resonated across households. For instance, one woman in the village of Dolinovka explained: "If you do not have money, it's still possible to live on what you grow in your garden plot…The main things come from the garden." Villagers, particularly those in Kozyrevsk, also plant to reap a surplus that they can sell for additional earnings.

This marriage of tradition and necessity has contributed to a pervasive garden culture in each village is, as one villager emphasized: "The main thing is that we live in a village—it [the garden plot] is our way of being (*byt'*)." So integral is the garden plot to the rural life that many villagers simply cannot conceive of living on the land without also cultivating a garden. They claim as their own the fruits of their toil: "Potatoes, beets, carrots, and cabbage—that is our food [diet]." Further, many invoked the word impossible in describing their relation to the garden plot: "Without our garden, it would be impossible to make it—it's what we eat, and it's what ensures that we have a full cellar." People also spoke of the garden plot as something that nurtured them (*vykarmlivat'*), implying its meaning beyond the physical provision of food. Undoubtedly, the dependence upon and even reverence for the garden plot attested to the centrality of this subsistence activity. In fact, it was nearly unanimously ranked as the most important of all activities in ensuring household survival. (*Refer also to Table E-2 in Appendix E.*)

Fish and livestock production

Just as nearly every household maintained a garden plot and gathered non-timber forest products, fish (salmon) and caviar were ubiquitous in the central Kamchatkan villages.

These villages are positioned within easy reach of the Kamchatka River that still supports relatively abundant salmon runs. In an effort to rein in the uncontrolled caviar trade, authorities have outlawed fishing; however, this legality has not stopped villagers from going to the river to set nets in which they hope to catch spawning salmon. The underground caviar trade is alive and well and remains lucrative for those villagers (including local law enforcers) willing to risk engagement in illegal and covert activity. This trade has supplied villagers with high-quality fish that they smoke and salt for use over the winter. The regional government also distributes fish to pensioners and villagers of indigenous decent. Particularly during the early post-Soviet period fish resources were an irreplaceable component in household subsistence, supplying income, and equally important, high quality protein that was not otherwise available. This resource is still vital to households; in fact, it was often ranked just below (or equal to) garden production in importance to household subsistence. (*Refer also to Table E-2 in Appendix E.*)

Besides fish, small-scale livestock production has been an essential source of protein and other nutrients for households. During the tumultuous early post-Soviet period the majority of households raised an assortment of cows, pigs, chickens, geese, turkeys, rabbits, and goats for their own consumption. Like other subsistence activities, this one could be harnessed to earn supplemental income through the sales of milk, eggs, and meat. In the later post-Soviet period, however, there has been a dramatic decline in the number of households raising livestock. Today, only a handful of villagers continue to pursue livestock production due in large part to the soaring prices of feed. At the same time, this trend is a clear testament to improved socio-economic conditions in the villages: the necessity to pursue this activity has diminished greatly since the early post-Soviet period. In fact, for many households this time- and resource-intensive activity no longer makes economic sense: now it is cheaper for them to buy what they once produced.

Conclusion: "We live with the forest"

By tracing non-timber forest product and other resource use patterns throughout the post-Soviet period this chapter revealed distinct dynamics of this period. It also showed how people respond to times of scarcity and relative plenty in their use of resources. In terms of non-timber forest product use, a distinct arc of gathering emerged. Beginning in the Soviet period, households generally collected non-timber forest products to procure supplemental food or goods in deficit. At this time gathering was also a prominent cultural activity undertaken as a form of recreation. This face of gathering, however, changed markedly in the early 1990s as villagers in central Kamchatka faced unparalleled economic hardship following the dissolution of the Soviet Union and the subsequent unraveling of their former way of life. In the wake of acute losses of jobs, livelihoods, and social security, non-timber forest products provided food for one's family; they were also a source of income that granted households some purchasing power to obtain essential items at a time marked by protracted unemployment and wage deferrals.

Many villagers vividly remembered the early post-Soviet period (or the 1990s) as the most difficult years when entire village populations fled to the forests and river to obtain all that they could for survival. It was not an exaggeration that people's continued existence during those years was directly tied to Kamchatka's natural bounty, as one villager professed: "If there wasn't the forest, I don't know how people here would have lived. Of course, we would not have lived through [the 1990s] without our garden plots and the forest." A change in presidential power in 2000 helped mitigate these dire circumstances. Accordingly, as people's financial situations gradually looked up and their lives began to turn around, gathering patterns harked back to those in the Soviet period. Some households have even stopped collecting altogether as they now have the wherewithal to purchase non-timber forest products that others have collected. One woman in Kozyrevsk encapsulated this trajectory in the following passage:

> From 1967 until the 1990s, we didn't use forest resources that much. We could buy a lot in the stores, things like jams. People had the money to buy such things. Everything changed in the 1990s when salaries were withheld, and it was necessary to have money for basic necessities. At that time I retired and we had to turn, like it or not, to the forest more often for help. We started to gather more berries; even if we didn't have sugar, we preserved the berries with cold water and aspirin. From 1990-2000 we never gathered and processed so many berries and mushrooms. You could eat mushrooms with sauerkraut and boiled potatoes and you would already not be hungry. It was a saving grace. Beginning the year 2000, things have become easier with money, it has become easier to breathe, but we still go to the forests—it has already become a habit. It is more economical. We already know how to use non-timber forest products.

No doubt, this arc of gathering patterns from the Soviet to later Soviet period (i.e. from 2000 and beyond), is a greatly simplified version: there are still many instances where households collect and sell in large quantities to meet basic needs. There is also the more recent phenomenon of people gathering to meet growing consumption and higher standards of living that go well beyond the basics. This evolution of gathering has had clear consequences for the local resource base: villagers have observed an overall decline in resources that is becoming increasingly pronounced as people continue to extract more from the landscape through gathering (and fishing and hunting), and as these activities continue to be loosely regulated. Some viewed this decline as symbolic of people's broken relationship with the natural world. Although this connection may be valid, it did not tell the whole story. Here the framework of political ecology was instructive in conceptualizing how political decisions at both the local and national level could leave a firm imprint upon the landscape by influencing people's gathering decisions and behaviors. Overall, by exploring gathering patterns spanning the post-Soviet period through villagers' accounts, this chapter gave voice to the people who have lived through these periods. At the same time it showed that the way gathering evolves depends greatly on the past, and on the appearance of new governance types with changing networks and social relations (Eikeland and Riabova 2002).

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Chapter 9
Conclusion

Prologue

"A good future should come, people should learn how to live—a lot depends on people, and also on the higher powers…Everyone sees our problems. Improvements in life are occurring, but slowly."—Resident of Atlasovo

"As long as we need forests we will harvest them in accordance with our need without any theoretical discussions."—Soviet National Board of Forestry, 1929

Introduction

This dissertation endeavored to discover many aspects of one big thing: the landscape of central Kamchatka. From this starting point, it covered wide ground by examining the forest and human communities inhabiting this landscape, seeking to illuminate how people used this landscape in the past and how their resource-use decisions continue to mold this landscape in the present. This link between people and the natural world has been particularly pronounced in the human communities of central Kamchatka where livelihood has been directly tied to forest resources. At the onset of the post-Soviet period in the 1990s, the people-forest relationship acquired heightened significance as households were forced to carve out subsistence livelihoods in the landscape. This dramatic shift in production from a collective to individual effort marked a momentous change in the way people used the landscape. It also underscored the importance of the temporal context in which the dissertation research is set. Within this post-Soviet context, the overarching aim of the dissertation was to make the human-environment connection explicit.

Toward this end, the dissertation united historical, ethnographic, and ecological studies that were both broad and focused, and quantitative and qualitative. These studies enhanced one another, presenting a more nuanced picture of past and present resource use. For instance, they revealed how past policies and practices profoundly transformed the landscape in central Kamchatka, and how these changes have, in turn, determined resource-use patterns today. In other words, people have responded to changes in the landscape through their acquisition of resources, even as they have caused the alteration of this landscape. Here it is evident how knowledge of past and present use of the landscape is essential in framing effective environmental and cultural information at various temporal and spatial scales (Crumley 1994).

Such knowledge set the stage for spatial analysis in GIS that revolutionized this study, transforming its historical, ecological, and ethnographic pieces into a comprehensive ethnography of landscape. This integrated geographical approach widened the landscape to an extent that would not have been possible relying on these separate pieces alone. The historical overview, for instance, clarified people's interactions with the landscape through use of the triangular model; however, it could not make these relationships explicit. The ethnography also elucidated people's connection to the landscape, yet it, too, lacked the necessary precision to define people's interactions with the landscape. The integrated geographical approach overcame these obstacles through the linkage of non-spatial to spatial data in GIS, which allowed for the direct connection of people's gathering decisions and behaviors to features in the landscape (e.g. land-cover type and road networks). Overall, this more systematic analysis of resource use revealed a complex picture of resource use that was affected both by local ecology from the bottom up, and by prevailing politics from the top down.

Overview of findings

This dissertation began with a background of people and place introduced in Section I, upon which the core stories of forests, people, and people-forest interactions were built. In addition to description, this section also contained critical interpretation. In Chapter 3 the triangular model proved instructive in understanding interactions among the Soviet state, people, and forests and how they gave rise to the landscape—and the resource use patterns within it—observed in central Kamchatka today. This section segued to more specific analyses in Chapter 4 (Section II) that started with a study of the relationship between forest structure and composition and lingonberry harvests. This study revealed a significant association between lichen-moss and woody debris layers, and lingonberry yields, suggesting that ground forest layers may be of greater consequence to lingonberry dynamics than the highest and middle forest layers. It also substantiated the connection between lingonberry harvests and forests in early- to mid-successional stages.

In Chapter 5 (Section II), the story of people and their resource use patterns was told through a quantitative analysis of lingonberry collecting, and through an ethnography of gathering. Together, these quantitative and qualitative methods drew out important nuances in people's gathering patterns, namely the distinct differentiation of gatherers with respect to technology (e.g. cars and a specialized gathering tool). These technologies were not novel to the post-Soviet period; instead it was their application that differed from the previous period. To illustrate, the dramatic growth of individual car ownership in the post-Soviet period has translated into unprecedented access to gathering sites and markets. This access has meant increased gathering opportunities, and ultimately higher payback for gatherers who could afford to buy a car. Those who could not make this investment, however, were limited to small-scale gathering opportunities in proximity to villages where they collected for their household needs only. Thus, a distinct divide along the lines of technology—and its consequences—has become prevalent among gatherers in post-Soviet central Kamchatka. At the same time, there also seems to be an emergent middle ground occupied by gatherers who have access to better sites, yet do not market harvests.

In Chapter 6 (Section II) an analysis of ecological data linked to spatially defined land-cover types to corroborated significant differences among these types in terms of key predictor variables. One of these variables included lingonberry fruit counts, such that higher yields corresponded to land-cover types representing earlier to mid-successional forests, further confirming findings in Chapter 4. Analyses of linked non-spatial and spatial data revealed complicated gathering patterns mirroring the complexity of the landscape that today bears the heavy imprint of past forest exploitation. To a large extent, this former activity, in conjunction with more recent disturbances (both logging and fires), has dictated the spatial distribution and abundance of non-timber forest resources, which, in turn, has affected where and how people gather these resources.

These analyses identified land-cover type (representing successional stage), distance, and accessibility as basic factors in shaping lingonberry gathering patterns. Gathering sites that supported increased intensity and marketing of harvests had higher proportions of early to mid-successional forests (i.e. those forests that have been recently disturbed). They also tended to be located further from the villages, yet internally they were highly accessible due to high road densities within them. Overall, land-cover type appeared as the most important factor in shaping people's gathering decisions and behaviors. Spatial analyses made clear connections between post-fire secondary forests and increased gathering intensity and marketing of harvests. These findings reinforced the importance of fire to lingonberry ecology and to gathering. They also suggested that forest fires—as opposed to logging—have been the largest cause of forest disturbance during the post-Soviet period. This outcome makes sense given the collapse of the timber industry in the post-Soviet period in tandem with drastic cuts made in fire fighting and prevention.

Local ecological knowledge (LEK) enhanced these spatial analyses, attesting to people gathering in ways that made ecological sense, even without being fully aware of the science behind their actions. People's descriptions of their gathering sites, for instance, overwhelmingly matched scientific classifications of secondary forests where lingonberry is found most abundantly. Spatial patterns also acquired deeper meaning when viewed through the lens of optimal foraging models, which were instrumental in answering the deeper question of why people gathered in specific places and ways. These foraging models were not tested directly; instead, they were applied to spatial patterns and gathering accounts, showing that people largely gathered in a manner that made economic, and ultimately, evolutionary sense.

Moving from an intense focus on lingonberry gathering, Section III was more global in its outlook, incorporating gathering patterns into the broader picture of household subsistence strategies during the post-Soviet period. Principal Component Analysis (PCA) in Chapter 7 verified the centrality of environmental income (i.e. that from forest and other natural resources) within a range of households during the post-Soviet period. This finding challenged the commonly held notion that it is the poorest households within a community that are most reliant upon natural resources. It also indicated the dire socio-economic conditions during the early post-Soviet period, including rampant unemployment and wage deferral, which forced nearly all households into a subsistence lifestyle buffered by other (i.e. secondary and environmental) income for basic survival. Even in the face of gradually improving socio-economic conditions, chronic unemployment still plagues the villages of central Kamchatka; thus, other income has continued to be instrumental in meeting household needs. Such income has elevated some households to a higher economic status than they would have otherwise attained.

The final chapter of the dissertation (Chapter 8) presented an ethnography of post-Soviet spaces, capturing the voices of those who have lived through this period in their accounts of livelihood. These accounts portrayed a clear evolution of resource use throughout this period, suggesting the delineation of the post-Soviet period into two distinct phases (1990s and 2000-present). Gathering changed markedly in the early 1990s as unforeseen economic hardship followed on the heels of the dissolution of the Soviet Union. People responded to this predicament in their resource use, turning to non-timber forest product gathering, garden and livestock production, and fishing to provide food and income for their households. With the upturn in the economy beginning in the 2000s, resource use has filled a different niche in household livelihood: today it helps support growing consumption and higher standards of living. Although there are still households that are largely dependent on environmental income to meet basic needs, more propitious economic conditions have gone hand in hand with a decline in resource use, especially in non-timber forest product gathering. Thus, today gathering seems reminiscent of that in the Soviet period when people's basic needs were met and gathering became a means to acquire goods in a deficit economy. Nonetheless, the socio-economic conditions in which these current gathering patterns are embedded have cardinally changed since the Soviet period.

Significance of research

One of the greatest strengths of the dissertation is its breadth that spans historical, ecological, ethnographic, and spatial inquiries; thus, it is able to contribute to many fields. First, by linking spatial and non-spatial data in a novel temporal and spatial context this dissertation is poised to make a distinct addition to the growing literature on the study of human-environment relationships through an integrated geographical approach. In addition, by including the voices, knowledge, and experiences of the people in relation to resource use in post-Soviet central Kamchatka, the dissertation is also in a position to augment the literature on ethnography of post-Soviet spaces. Finally, given that non-timber forest product species are virtually unstudied in central Kamchatka, this work makes an original contribution to the ecological literature on central Kamchatka.

Future prospects

Although decades of extensive, industrial logging have fractured the once dense massif of 'Conifer Island,' this landscape continues to be an important resource base of both timber, and non-timber forest products. In 2004, following the tumultuous years of the early post-Soviet period, one woman in Atlasovo offered that the village would exist as long as the *leskhoz* (forestry management unit) continued to anchor the village. By 2008, however, the *leskhoz* as the villagers had known it was no more. The federal government liquidated this former organization that primarily worked to replant and protect forests. In its place the government established three new organizations: one to replant forests following logging and fires; another to prevent and fight forest fires, and finally, one to handle administrative tasks.

Referred to as State Unitary Enterprises (*Gosudarstvennoe Unitarnoe Predpriyatie*), these new organizations have also been charged with generating their own funding. To this end they must promote their services (e.g. forest fire fighting or replanting) to logging companies that are now held responsible for taking care of the land they have leased from the government. In essence, these companies are renting former *leskhoz* employees to fulfill their legal obligations. By parceling out tasks that were once under the jurisdiction of the *leskhoz*, this fundamental reorganization has made the concept of the *leskhoz* irrelevant; it also appears to have eased the remaining checks and balances on forest use. In this sense, this overhaul of forest management has become a piece of the larger picture that is increasingly slanted toward the benefit of the timber industry. For instance, one forest manager explained that Russia's Forest Code has also been revised to accommodate the loggers at the expense of forest protection. The upshot of these new amendments was already evident by mid-2008 in the major logging operations that were slated for the last salvageable timber in central Kamchatka. For instance, approximately one million cubic feet of timber have been earmarked for logging in the same region (Shchapino) that marked the birth of industrial logging in central Kamchatka over five decades ago.

Villagers in this region reacted positively to the prospect of new positions that would accompany large-scale logging operations, especially following the loss of jobs that accompanied the *leskhoz* liquidation. For the villagers who have remained in this economically depressed region, news of potential redevelopment brought back vivid memories of bustling villages during the peak timber production years in the late Soviet period. Such images were sharply contrasted by the inertia that has blanketed these villages during the crisis years of the post-Soviet period. On the one hand, such a reaction is understandable, especially after a prolonged period of high unemployment and economic decline; yet on the other hand, the resumption of large-scale logging seems to be a short-term solution at best to the larger questions of wise resource use and economic stability in this region. The question of what will occur after the last marketable timber has been consumed inevitably arises. Will industrial logging today simply prolong the cycle of unsustainable resource use, leaving a new generation of villagers to face ensuing ecological and socio-economic crises?

This movement to reinstate large-scale logging operations through new logging concessions—some made to companies well beyond Kamchatka's borders—signals growing national and international awareness of Kamchatka's resource potential. It is further evidence of the wider push for all-out resource exploitation that prevails in Russia today. In Kamchatka this trend is strikingly apparent: besides logging, mining operations are being resumed and prospecting work is underway, forecasting more intensive development in the future. Moreover, natural gas development has already left an indelible mark on the landscape in western Kamchatka, and offshore oil drilling looms ominously on the horizon.

Although ecologists in Kamchatka have decried these latest developments, especially as Kamchatka harbors some of the last untrammeled wilderness in the world, their voices are becoming increasingly drowned out by those promoting unchecked development and the promises of short-term gain it holds. Thus, the same story of ecological loss and damage appears to be unfolding slowly before everyone’s eyes. At the same time, local people are lured by the prospects of instant money from intensive resource exploitation. The long-term benefits of such endeavors for Kamchatka, and especially for the small communities intrinsically tied to its forest and fish resources, are unclear at best.

Against such a backdrop, this dissertation is timely: it made human-environment relationships explicit, and it demonstrated the repercussions of unchecked resource use. This work, however, is only the first step in understanding an intricate landscape and the equally complex patterns of resource use within it. Today the predicaments, challenges, and potential opportunities people face in developing central Kamchatka’s resources underscore the need for continued study. One area to explore further is the development of non-timber forest products, considering the richness of these resources in central Kamchatka. The need to reinstate a structure reminiscent of the former *gospromkhoz*, which used to harvest, process, and distribute these resources, has been voiced (from the publication: *Lesnoe khozyaistvo nakanune XXI veka*, Forestry on the eve of the twenty-first century). The handful of enterprising individuals seeking to build a business on these resources gives hope that this vision could become a reality, which could lead to greater sustainability in one of the world’s greatest natural landscapes.

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Appendix A

List of associations within the Larix dahurica – Rosa amblyotis – Geranium erianthum (Larch-forb) association group

1. *Larix dahurica – Rosa amblyotis – Geranium erianthum*
2. *Larix dahurica – Juniperus sibirica*: found in the drier and hillier habitats in the southern part of the central Kamchatka depression, namely in the watersheds of smaller rivers where it borders *Larix dahurica – Ledum palustre* forests that occupy drier habitats; intermixed with aspen and spruce (Efremov 1973b).
3. *Larix dahurica – Pyrola incarnata*: found in moister habitats along the terraces of the Kamchatka River tributaries, on the periphery of volcanic remains; the evergreen species round-leaved wintergreen dominates in this association.
4. *Betula platyphylla – Rosa amblyotis – Geranium erianthum*: secondary birch forest appearing after disturbance (logging or fire), intermixed with larch and spruce; larch regeneration is weak.
5. *Populus tremula – Calamagrostis purpurea*: secondary aspen forest found in moist habitats only within the wider Kamchatka River floodplain; consists of nearly pure aspen stands that are rarely intermixed with birch, and dense growth of reedgrass abundantly interspersed with fireweed (Kabanov 1963, Efremov 1973b); larch regeneration is non-existent;
6. *Betula platyphylla – Juniperus sibirica – Ledum palustre*: secondary birch with juniper.

List of associations within the Larix dahurica – Ledum palustre (Larch-marsh Labrador tea) association group

1. *Larix dahurica – Ledum palustre*.
2. *Larix dahurica – Ledum palustre – Vaccinium vitis-idaea*: very closely related to the first association, distinguished by the clear dominance of lingonberry in the herbaceous-subshrub layer; other herbs are extremely sparse in this layer.
3. *Larix dahurica – Ledum palustre – Juniperus sibirica*: also very closely related to the first association, distinguished by a dense growth of juniper with a percent coverage reaching up to 90 percent.

4. *Betula platyphylla – Ledum palustre -- Vaccinium vitis-idaea*: appears only after intensive fires that have completely consumed the original forest stand; occasionally intermixed with aspen, marsh Labrador tea and lingonberry are dominant in the herbaceous-subshrub layer.

Description of forest association group: Larix dahurica – Cladonia stellatis (Larch-lichen)

This association group is the first to colonize a denuded landscape left in the aftermath of volcanic activity. Initiating the sequence of successional processes, it plays a vital role in transformating extremely poor and pebbly volcanic deposits into a life-supporting substrate. Specifically, as the lichens become established on patches of muddy deposits they act to anchor the mobile volcanic sands, and to enrich it with organic substances. Larch in this group grows in sparse and uneven stands of very low timber quality (Turkov 1963).

Description of forest association group: Larix dahurica – Pinus pumila (Larch-Siberian dwarf pine)

This association group from the *Larix dahurica – Ledum palustre* and *Larix dahurica – Vaccinium vitis-idaea* forests as elevation increases. Widely distributed in the interstices of plain and mountain forests, and in mountainous habitats, this association group is very complex, warranting its split into plain and mountain forests, classified according to elevation, and to the specific geomorphology of a habitat. The mountain forests are found in the foothills of the mountain ridges to the east and west of the central Kamchatka depression beginning at an elevation of 300 m. With rises in elevation (up to 500 m), the endemic species stone birch (*Betula ermanii*) becomes interspersed in the sparse larch overstory where the coverage is less than 40 percent (Efremov 1973b). A lichen cover also forms at these elevations, particularly where the forests are situated on thin and pebbly soils, as occurs in the Srednyi (Middle) Mountain ridge to the west of the depression. At higher elevations (500 to 1000 m), these forests become part of the sub-alpine larch forests, characterized by their location in harsh habitats. These forests are especially well-distributed in areas of current glaciation, or where snows remain for much of the year (Efremov 1973b).

Description of forest association group: Larix dahurica – Sphagnum sp. (Larch-moss)

Concentrated in the southern vegetative region of the central Kamchatka depression, this unusual association group of larch forests inhabits the valley slopes and the narrow terraces of the Kamchatka River tributaries, and grows on the slopes of ancient volcanic ridges. Mixed stands characterize this group: even-aged larch stands make up the overstory, while the understory is composed of colonizing spruce. These forests, however, are highly transient and patchy due to the complex interrelationship between spruce and larch in which the former ultimately supersedes the latter (Turkov 1964, Efremov 1973b). Even prior to its emergence in the forest overstory, spruce substantially alters the forest community in general, and the structure and composition of the lower forest layers, in particular. In the latter case, mosses begin to replace herb species; however, this occurrence is limited to a very narrow range distinguished by abundant moisture. Such habitats are an anomaly in the central Kamchakta depression where soil dessication, particularly in the summer months, is a major issue. Spruce spreads from the foothill zone to interfluvival habitats where it thrives in the moist, nutrient-rich conditions provided by the stream undercurrents running through these habitats (Turkov 1964). This phenomenon of vegetative mobility, and the relatively rapid and cardinal changes it produces in existing forest communities, has been especially apparent in the southern part of the central Kamchakta depression where soils tend to be moister (Turkov 1964). (*Refer to bibliography at the end of Chapter 2 for full references.*)

Appendix B

Table B-1: Overview of forest plots inventoried during the 2004, 2006, and 2008 field seasons.

Plot #	*Date*	*Location (District/leskhoz or lesnichestvo)*	*Forest Association Group*	*Disturbance history*	*Known lingon-berry gathering site?*
1	21-Jul-04	Ust'-Kamchatsky/ Kozyrevsky	Larch-lingonberry	<=10 years ago	yes
2	22-Jul-04	Ust'-Kamchatsky/ Kozyrevsky	Larch-lingonberry	>=30 years ago	yes
3	23-Jul-04	Ust'-Kamchatsky/ Kozyrevsky	Larch-lingonberry	n/a	yes
4	25-Jul-04	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	>=30 years ago	no
5	31-Jul-04	Mil'kovsky/ Lazovskoe	Larch-marsh Labrador tea	>=30 years ago	no
6	2-Aug-04	Mil'kovsky/ Lazovskoe	Bog blueberry marsh	>=30 years ago	no
7	3-Aug-04	Mil'kovsky/ Lazovskoe	Bog blueberry marsh	>=30 years ago	no
8	6-Aug-04	Mil'kovsky/ Lazovskoe	Larch-marsh Labrador tea	>=30 years ago	yes
9	25-Aug-04	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	20-25 years ago	yes
10	26-Aug-04	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	10-15 years ago	yes
11	27-Aug-04	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	20-25 years ago	no

12	28-Aug-04	Bystrinsky/ Bystrinsky	Birch-marsh Labrador tea	10-15 years ago	yes
13	28-Aug-04	Bystrinsky/ Bystrinsky	Birch-marsh Labrador tea	20-25 years ago	yes
14	29-Aug-04	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	20-25 years ago	yes
15	2-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	<=10 years ago	yes
16	4-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	<=10 years ago	yes
17	5-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	20-25 years ago	yes
18	7-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	>=30 years	no
19	8-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	Primary forest	no
20	9-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	20-25 years ago	yes
21	10-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	<=10 years ago	yes
22	11-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	10-15 years ago	yes
23	13-Aug-06	Mil'kovsky/ Atlasovsky	Larch-marsh Labrador tea	20-25 years ago	yes
24	16-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	10-15 years ago	yes
25	17-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-lingonberry	<=10 years ago	yes
26	18-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-lingonberry	>=30 years	yes
27	19-Aug-06	Ust'-Kamchatsky/	Larch-marsh	20-25 years ago	no

		Kozyrevsky	Labrador tea		
28	20-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	10-15 years ago	yes
29	22-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-lingonberry	>=30 years	yes
30	23-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	>=30 years	no
31	25-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	10-15 years ago	yes
32	27-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	20-25 years ago	yes
33	29-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-marsh Labrador tea	10-15 years ago	yes
34	30-Aug-06	Ust'-Kamchatsky/ Kozyrevsky	Larch-forb	10-15 years ago	yes
35	2-Aug-08	Ust'-Kamchatsky/ Kozyrevskoe*	Larch-forb	10-15 years ago	yes
36	3-Aug-08	Ust'-Kamchatsky/ Kozyrevskoe*	Larch-lingonberry	>=30 years	yes
37	6-Aug-08	Bystrinsky/ Krapivnenskoe*	Birch-marsh Labrador tea	<=10 years ago	yes
38	6-Aug-08	Bystrinsky/ Krapivnenskoe*	Larch-marsh Labrador tea	10-15 years ago	yes
39	7-Aug-08	Ust'-Kamchatsky/ Krapivnenskoe*	Birch-marsh Labrador tea	>=30 years	yes
40	9-Aug-08	Mil'kovsky/ Atlasovskoe*	Larch-marsh Labrador tea	<=10 years ago	yes
41	10-Aug-08	Mil'kovsky/ Atlasovskoe*	Larch-marsh Labrador tea	<=10 years ago	yes
42	11-Aug-08	Mil'kovsky/ Dolinovskoe*	Birch-marsh Labrador tea	10-15 years ago	yes

43	12-Aug-08	Mil'kovsky/ Dolinovskoe*	Honeyberry marsh	<=10 years ago	no

*Reflects new names after the liquidation of the former *leskhoz* units at the beginning of 2008.

Appendix C

Table C-1: Listing of semi-structured surveys conducted in 2004, 2006, and 2008. Surveys marked with a letter "a" or "b" indicate those conducted with two households at the same time. All direct quotations in Chapters 5, 6, and 8 are my translations of responses to the survey questions. No more information is provided in order to protect the confidentiality of the informants who participated in the survey.

No.	*Date*	*Location (Village)*	*No.*	*Date*	*Location (Village)*
1	2-Feb-04	Kozyrevsk	35	20,21-Apr-04	Atlasovo
2	3-Feb-04	Kozyrevsk	36	21-Apr-04	Atlasovo
3	3-Feb-04	Kozyrevsk	37	2-Jun-04	Dolinovka
4	5-Feb-04	Kozyrevsk	38	2,3-Jun-04	Dolinovka
5	5-Feb-04	Kozyrevsk	39	4-Jun-04	Dolinovka
6	6-Feb-04	Kozyrevsk	40	4-Jun-04	Dolinovka
7	6-Feb-04	Kozyrevsk	41	5-Jun-04	Dolinovka
8	8-Feb-04	Kozyrevsk	42	6-Jun-04	Dolinovka
9	11-Feb-04	Kozyrevsk	43	7-Jun-04	Dolinovka
10	12-Feb-04	Kozyrevsk	44	6,8-Jun-04	Dolinovka
11	12-Feb-04	Kozyrevsk	45	13-Jun-04	Kozyrevsk
12	12-Feb-04	Kozyrevsk	46	3-Aug-04	Lazo
13	13-Feb-04	Kozyrevsk	47	3-Aug-04	Lazo
14	16-Feb-04	Kozyrevsk	48	5-Aug-04	Lazo
15	16-Feb-04	Kozyrevsk	49	6-Aug-04	Lazo
16	20-Feb-04	Kozyrevsk	50	19-Aug-04	Dolinovka
17	21-Feb-04	Kozyrevsk	51	2-Sept-04	Kozyrevsk
18	23-Feb-04	Kozyrevsk	52	3-Sept-04	Kozyrevsk
19	25-Feb-04	Kozyrevsk	53	24-Oct-06	Atlasovo
20	26-Feb-04	Kozyrevsk	54	24-Oct-06	Atlasovo
21	27-Feb-04	Kozyrevsk	55	25-Oct-06	Atlasovo
22	28-Feb-04	Kozyrevsk	56	25-Oct-06	Atlasovo
23	4-Apr-04	Atlasovo	57	26-Oct-06	Atlasovo
24	5-Apr-04	Atlasovo	58	26-Oct-06	Atlasovo
25	6,7-Apr-04	Atlasovo	59	27-Oct-06	Atlasovo
26	7-Apr-04	Atlasovo	60	27-Oct-06	Atlasovo
27	8-Apr-04	Atlasovo	61a	31-Oct-06	Dolinovka
28	9-Apr-04	Atlasovo	61b	31-Oct-06	Dolinovka
29	13-Apr-04	Atlasovo	62	1-Nov-06	Atlasovo
30	13-Apr-04	Atlasovo	63	2-Nov-06	Atlasovo
31	15-Apr-04	Atlasovo	64	2-Nov-06	Atlasovo
32	16-Apr-04	Atlasovo	65	3-Nov-06	Atlasovo
33	19-Apr-04	Atlasovo	66	3-Nov-06	Atlasovo

67	20-Apr-04	Atlasovo	67	4-Nov-06	Atlasovo
68	5-Nov-06	Atlasovo	100	7-Aug-08	Kozyrevsk
69	7-Nov-06	Atlasovo	101	15-Aug-08	Atlasovo
70	7-Nov-06	Atlasovo	102	15-Aug-08	Atlasovo
71	14-Nov-06	Kozyrevsk	103	16-Aug-08	Atlasovo
72	15-Nov-06	Kozyrevsk			
73	15-Nov-06	Kozyrevsk			
74	16-Nov-06	Kozyrevsk			
75	16-Nov-06	Kozyrevsk			
76	17-Nov-06	Kozyrevsk			
77	17-Nov-06	Kozyrevsk			
78	14,21-Nov-06	Kozyrevsk			
79	20-Nov-06	Kozyrevsk			
80	21-Nov-06	Kozyrevsk			
81a	21-Nov-06	Kozyrevsk			
81b	21-Nov-06	Kozyrevsk			
82	22,24-Nov-06	Kozyrevsk			
83	23-Nov-06	Kozyrevsk			
84	23-Nov-06	Kozyrevsk			
85a	24-Nov-06	Kozyrevsk			
85b	24-Nov-06	Kozyrevsk			
86	25-Nov-06	Kozyrevsk			
87a	25-Nov-06	Kozyrevsk			
87b	25-Nov-06	Kozyrevsk			
88	26-Nov-06	Kozyrevsk			
89	26-Nov-06	Kozyrevsk			
90	27-Nov-06	Kozyrevsk			
91	27-Nov-06	Kozyrevsk			
92a	24,29-Jul-08	Kozyrevsk			
92b	24-Jul-08	Kozyrevsk			
93	24-Jul-08	Kozyrevsk			
94	25-Jul-08	Kozyrevsk			
95	28-Jul-08	Kozyrevsk			
96	29-Jul-08	Kozyrevsk			
97	30-Jul-08	Kozyrevsk			
98	1-Aug-08	Kozyrevsk			
99	5-Aug-08	Krapivnaya			

Descriptive statistics of gathering metrics

Table C-2: Summary statistics of gathering metrics for 2003.

Year: **2003**		*Gathering intensity (liters/hour)*	*Total hours spent gathering*	*Total amount of lingonberry gathered (in liters)*	*Total amount of lingonberry sold (in liters)*	*Total number of sites visited*	*Total number of gatherers per household*
N	Valid	50	50	54	50	55	55
	Missing	19	19	15	19	14	14
Mean		6.3957	21.4084	**129.4074**	**86.5000**	1.42	1.62
Median		5.0152	13.0600	**50.0000**	**.0000**	1.00	2.00
Minimum		1.98	1.75	10.00	.00	1	1
Maximum		23.53	125.00	1000.00	1000.00	3	2
Sum		319.78	1070.42	6988.00	4325.00	78	89
Std. Deviation		3.64134	26.19610	178.92314	178.50642	.686	.490

Table C-3: Summary statistics of gathering metrics for the years 2005.[22]

Year: **2005**		*Gathering intensity (liters/hour)*	*Total hours spent gathering*	*Total amount of lingonberry gathered (in liters)*	*Total amount of lingonberry sold (in liters)*	*Total number of sites visited*	*Total number of gatherers per household*
N	Valid	10	10	12	11	12	11
	Missing	6	6	4	5	4	5
Mean		8.9823	17.1620	**170.2083**	**110.4545**	1.42	1.64
Median		9.2063	12.3750	**85.0000**	**50.0000**	1.00	2.00
Minimum		.69	3.00	12.50	.00	1	1
Maximum		17.78	64.95	900.00	550.00	2	2
Sum		89.82	171.62	2042.50	1215.00	17	18
Std. Deviation		5.79954	18.59728	247.21278	167.48813	.515	.505

[22]Respondents in the 2006 survey were not specifically asked about 2005; however, because of the unprecedented lingonberry harvest in the vicinity of Kozyrevsk in this year many described their gathering patterns. For instance, people tended to gather and sell more, including those who did not typically market harvests.

Table C-4: Summary statistics of gathering metrics for 2006.

Year: **2006**		*Gathering intensity (liters/hour)*	*Total hours spent gathering*	*Total amount of lingonberry gathered (in liters)*	*Total amount of lingonberry sold (in liters)*	*Total number of sites visited*	*Total number of gatherers per household*
N	Valid	52	52	54	51	54	54
	Missing	12	12	10	13	10	10
Mean		5.8708	27.5152	**198.2593**	**126.5882**	1.70	1.70
Median		5.1250	9.2950	**45.0000**	**.0000**	1.00	2.00
Minimum		1.32	1.00	6.00	.00	1	1
Maximum		13.31	120.00	1300.00	1100.00	3	3
Sum		305.28	1430.79	10706.00	6456.00	72	92
Std. Deviation		3.48803	32.40194	321.40776	241.24769	.673	.537

Frequencies of main gathering predictors

Table C-5: Distance of gathering sites from village. These frequencies reflected the increased distances of gathering sites from villages: close to 50 percent (in 2003) and more than half (in 2006) of all trips to gathering sites covered distances of at least 15 km (one way) from the village to site. *Note that missing data in this and following tables indicate where there was duplicate data on a household for a given year, i.e. when a household reported gathering in two sites and all other variables remained constant, or when the data were not collected during the time of the survey due to lack of time, no response, etc.*

Distance (km)			Frequency	Percent	Valid Percent	Cumulative Percent
Year 2003	Valid	**1=<5**	20	29.0	31.7	31.7
		2=5-15	10	14.5	15.9	47.6
		3=>15	33	47.8	52.4	100.0
		Total	63	91.3	100.0	
	Missing	999	6	8.7		
	Total		69	100.0		
2006	Valid	**1=<5**	21	32.8	32.8	32.8
		2=5-15	8	12.5	12.5	45.3
		3=>15	35	54.7	54.7	100.0
		Total	64	100.0	100.0	

Table C-6: Types of transportation used in gathering. In both years over 75 percent of gatherers used motorized transportation to reach their gathering sites (namely, a motorcycle or car, or in rare cases, a tractor).

Mode of Transportation			Frequency	Percent	Valid Percent	Cumulative Percent
Year 2003	Valid	**1=foot, bicycle**	9	13.0	16.7	16.7
		2=motorcycle	18	26.1	33.3	50.0
		3=car	27	39.1	50.0	100.0
		Total	54	78.3	100.0	
	Missing	999	15	21.7		
	Total		69	100.0		
2006	Valid	**1=foot, bicycle**	8	12.5	14.8	14.8
		2=motorcycle	13	20.3	24.1	38.9
		3=car	33	51.6	61.1	100.0
		Total	54	84.4	100.0	
	Missing	999	10	15.6		

Table C-7: Use of tool in gathering. This basic, rake-like tool was typically used to accelerate gathering intensity; these frequencies show that less than half (40 percent) of the gatherers in both years used this tool.

Use of Tool			Frequency	Percent	Valid Percent	Cumulative Percent
Year 2003	Valid	**1=no**	31	44.9	60.8	60.8
		2=yes	20	29.0	39.2	100.0
		Total	51	73.9	100.0	
	Missing	999	18	26.1		
	Total		69	100.0		
2006	Valid	**1=no**	27	42.2	60.0	60.0
		2=yes	18	28.1	40.0	100.0
		Total	45	70.3	100.0	
	Missing	999	19	29.7		
	Total		64	100.0		

Table C-8: Marketing of harvests. In both years there were more households that did not market their harvests than those that did; however, this split grew in 2006 when 40.7 percent of households sold their harvests, compared to 46.3 percent in 2003.

Marketing of Harvests			Frequency	Percent	Valid Percent	Cumulative Percent
Year 2003	Valid	**1=no**	29	42.0	53.7	53.7
		2=yes	25	36.2	46.3	100.0
		Total	54	78.3	100.0	
	Missing	999	15	21.7		
	Total		69	100.0		
2006	Valid	**1=no**	32	50.0	59.3	59.3
		2=yes	22	34.4	40.7	100.0
		Total	54	84.4	100.0	
	Missing	999	10	15.6		
	Total		64	100.0		

Chi-square tests

Table C-9: Distance x Transportation. This test showed a significant relationship between distance and transportation, such that increases in distance traveled corresponded with more frequent use of motorized vehicles (i.e. car or motorcycle). Note that the years 2003 and 2006 are combined here. Initially the dataset was split by year: both years showed highly significant results, but in this case there were 5 and 6 cells for 2003 and 2006, respectively, that had expected count less than 5. Pearson Chi-square (for both 2003 and 2006): Value=42.757[a], df=4, p (asymp. sig. 2-sided) < 0.001.

[a]2 cells (22.2%) have expected count less than 5.

		Transportation:	**1=Foot, Bicycle**	**2=Motor-cycle**	**3=Car**	Total:
Distance	**1=<5 km**	Count	14	17	8	39
		% within Dist	35.9%	43.6%	20.5%	100.0%
		% within Transport	93.3%	58.6%	13.8%	38.2%
		% of Total	13.7%	16.7%	7.8%	38.2%
	2=5-15 km	Count	1	5	8	14
		% within Dist	7.1%	35.7%	57.1%	100.0%
		% within Transport	6.7%	17.2%	13.8%	13.7%
		% of Total	1.0%	4.9%	7.8%	13.7%
	3=>15 km	Count	0	7	42	49
		% within Dist	.0%	14.3%	85.7%	100.0%
		% within Transport	.0%	24.1%	72.4%	48.0%
		% of Total	.0%	6.9%	41.2%	48.0%
Total		Count	15	29	58	102
		% within Dist	14.7%	28.4%	56.9%	100.0%
		% within Transport	100.0%	100.0%	100.0%	100.0%
		% of Total	14.7%	28.4%	56.9%	100.0%

Table C-10: Tool x Transportation. This test showed a significant relationship between transportation and tool use. In 2006 (the only year for which there was a significant result), nearly all gatherers who walked (or biked) to their sites did not use a tool; nearly all those who used a tool also reached their gathering sites by car. Year 2003—Pearson Chi-square: Value=2.351[a], df=2, p (asymp. sig. 2-sided) = 0.309; Year 2006—Pearson Chi-square: Value=7.232, df=2, p (asymp. sig. 2-sided) = 0.027.

[a]2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.75.
[b]3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.80.

			Transportation:	**1=Foot, Bicycle**	**2=Motor-cycle**	**3=Car**	Total:
2003	Tool	**1=no**	Count	6	11	14	31
			% within Tool	19.4%	35.5%	45.2%	100.0%
			% within	85.7%	61.1%	53.8%	60.8%
			% of Total	11.8%	21.6%	27.5%	60.8%
		2=yes	Count	1	7	12	20
			% within Tool	5.0%	35.0%	60.0%	100.0%
			% within	14.3%	38.9%	46.2%	39.2%
			% of Total	2.0%	13.7%	23.5%	39.2%
	Total		Count	7	18	26	51
			% within Tool	13.7%	35.3%	51.0%	100.0%
			% within	100.0%	100.0%	100.0%	100.0%
			% of Total	13.7%	35.3%	51.0%	100.0%
2006	Tool	**1=no**	Count	7	7	13	27
			% within Tool	25.9%	25.9%	48.1%	100.0%
			% within	100.0%	70.0%	46.4%	60.0%
			% of Total	15.6%	15.6%	28.9%	60.0%
		2=yes	Count	0	3	15	18
			% within Tool	.0%	16.7%	83.3%	100.0%
			% within	.0%	30.0%	53.6%	40.0%
			% of Total	.0%	6.7%	33.3%	40.0%
	Total		Count	7	10	28	45
			% within Tool	15.6%	22.2%	62.2%	100.0%
			% within	100.0%	100.0%	100.0%	100.0%
			% of Total	15.6%	22.2%	62.2%	100.0%

Table C-11: Tool x Marketing. This test showed a strong relationship between use of the gathering tool and the selling of harvests: those who gathered for household use only tended not to use a tool, while those who gathered to sell tended to use this tool. Year 2003—Pearson Chi-square: Value=6.951, df=1, p (asymp. sig. 2-sided) = 0.008; Year 2006—Pearson Chi-square: Value=7.872, df=1, p (asymp. sig. 2-sided) = 0.007.

			Marketing:	**1=no**	**2=yes**	Total:
2003	**Tool**	**1=no**	Count	21	10	31
			% within Tool	67.7%	32.3%	100.0%
			% within	77.8%	41.7%	60.8%
			% of Total	41.2%	19.6%	60.8%
		2=yes	Count	6	14	20
			% within Tool	30.0%	70.0%	100.0%
			% within	22.2%	58.3%	39.2%
			% of Total	11.8%	27.5%	39.2%
	Total		Count	27	24	51
			% within Tool	52.9%	47.1%	100.0%
			% within	100.0%	100.0%	100.0%
			% of Total	52.9%	47.1%	100.0%
2006	Tool	**1=no**	Count	19	8	27
			% within Tool	70.4%	29.6%	100.0%
			% within	79.2%	38.1%	60.0%
			% of Total	42.2%	17.8%	60.0%
		2=yes	Count	5	13	18
			% within Tool	27.8%	72.2%	100.0%
			% within	20.8%	61.9%	40.0%
			% of Total	11.1%	28.9%	40.0%
	Total		Count	24	21	45
			% within Tool	53.3%	46.7%	100.0%
			% within	100.0%	100.0%	100.0%
			% of Total	53.3%	46.7%	100.0%

Independent t-tests: comparisons between years 2003 and 2006

Table C-12: Comparison of mean gathering metrics for 2003 and 2006. These data revealed some fluctuations in gathering metrics between 2003 and 2006, although these differences were not statistically significant, possibly due to the similarities in overall harvest levels for both years.

	Year	N	Mean	Std. Deviation	Std. Error Mean
Total amount of lingonberry gathered (in liters)	2003	54	**129.4074**	178.92314	24.34836
	2006	54	**198.2593**	321.40776	43.73806
Total amount of lingonberry sold (in liters)	2003	50	**86.5000**	178.50642	25.24462
	2006	51	**126.5882**	241.24769	33.78143
Total number of gatherers per household	2003	55	**1.62**	.490	.066
	2006	54	**1.70**	.537	.073
Total number of sites visited	2003	55	**1.42**	.686	.092
	2006	54	**1.33**	.673	.092
Total hours spent gathering	2003	50	**21.4084**	26.19610	3.70469
	2006	52	**27.5152**	32.40194	4.49334
Gathering intensity (liters/hour)	2003	50	**6.3957**	3.64134	.51496
	2006	52	**5.8708**	3.48803	.48370

Table C-13: Comparison of mean amount gathered by households that do and do not market harvests. In this t-test there were highly significant differences in household means for both years: 2003—F = 26.854, t= -4.985, df = 24.508, p = <0.001; 2006—F = 64.308, t = -5.077, df =21.065, p <0.001. ***Note that equal variances were not assumed, according to Levene's Test for Equality of Variances*.**

Year		Marketing	N	Mean	Std. Deviation	Std. Error Mean
2003	Total amount (l)	**1=no**	29	**31.1379**	23.46840	4.35797
		2=yes	25	**243.4000**	211.77681	42.35536
2006	Total amount (l)	**1=no**	32	**27.0313**	18.45218	3.26191
		2=yes	22	**447.3182**	388.01232	82.72450

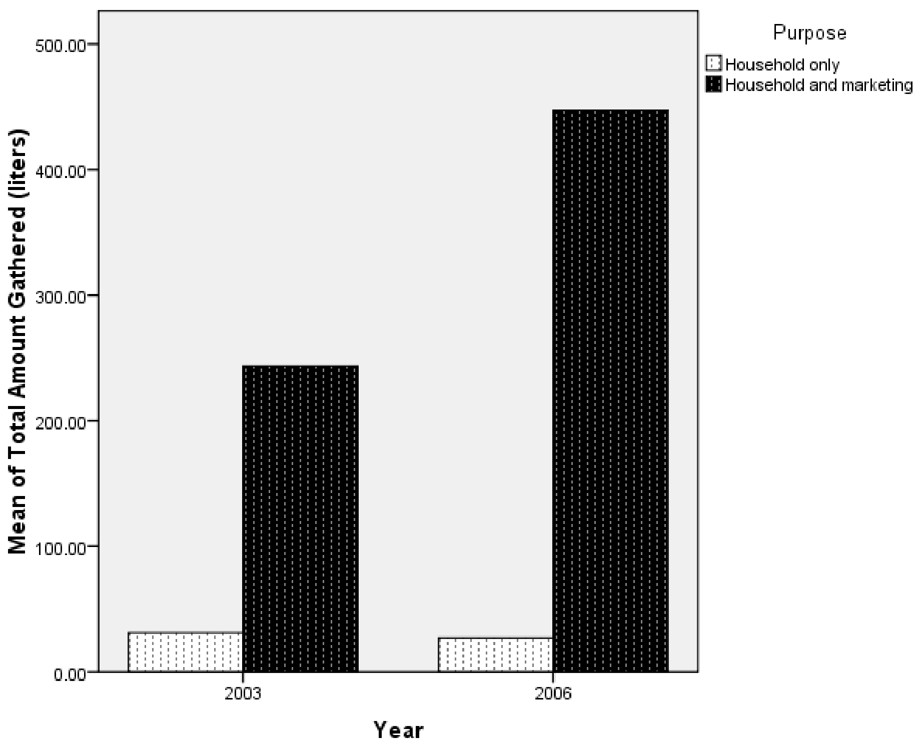


Figure C-1: Comparison of mean amount of lingonberry gathered (in liters) by households that do and do not market harvests.

Table C-14: Comparison of mean gathering rates (liters/hour) with and without a tool during years of poor, average, and abundant harvests. At each harvest level (poor, average, and abundant) there was a significant difference in mean gathering intensity when a tool was and was not used. This difference was particularly pronounced between average and abundant harvests. Average Harvest: F = 4.981, t = -5.011, df = 54.384, p = <0.001; Poor Harvest: F = 0.701, t = -3.264, df = 15, p = 0.005; Abundant Harvest: F = 5.446, t = -2.836, df = 38.890, p = 0.007. *Note that equal variances were only assumed for poor harvests, according to Levene's Test for Equality of Variances. Also note that year was not considered here as the majority of responses did not refer to one specific year, but instead reflected how much was generally gathered given the three harvest prognoses; thus, data from all years (1999, 2002, 2003, 2004, 2005, and 2006) were aggregated.*

	Tool use	N	Mean gathering rate	Std. Deviation	Std. Error Mean
Average Harvest	No	38	**4.81423**	2.116465	.343336
	Yes	32	**7.98243**	3.003096	.530877
Poor Harvest	No	9	**2.08907**	1.004131	.334710
	Yes	8	**3.98412**	1.381245	.488344
Abundant Harvest	No	23	**9.87651**	6.367946	1.327809
	Yes	25	**17.19518**	11.065980	2.213196

Figure C-2: Comparison of mean gathering intensity for poor, average, and abundant harvest year with and without the use of a tool. Besides tool use, harvest variability clearly influenced gathering intensity.

Appendix D

Spatial Statistics

Table D-1: Summary of vector line data in study site

Land-cover type	***Class***	***Total length (in km)***
Primary (Type I) roads	1342	227.73
Intermediate (Type II) roads	13425	415.97
Forest (Type III) roads	1343	3195.13
Major rivers	512	558.42
Minor rivers	513	3639.19

Table D-2: Summary of vector polygon data in study site.

Settlement name	***Total area (in km^2)***
Atlasovo	2.34
Dolinovka	0.49
Kozyrevsk	2.01
Krapivnaya	0.26
Kravche	0.31
Lazo	1.06
Shchapino	0.43
Taezhnyi	0.74

Table D-3: Summary of land-cover types in study area.

Land-cover type	***Total area (in km^2)***	***Percentage of total area***
Spruce-dominant forest	588.00	7.29%
Larch-dominant forest	456.95	5.66%
Fragmented coniferous-deciduous forest: conifer dominant	1473.79	18.26%
Fragmented coniferous-deciduous forest: deciduous dominant	458.44	5.68%
Maturing deciduous forest	625.33	7.75%
Dense deciduous regeneration/floodplain forests	830.02	10.28%
Short vegetation (low elevation)	1030.74	12.77%
Cleared land	285.17	3.53%
Bare land (low elevation), including "dry" rivers and sand banks	252.00	3.12%
High elevation larch with Siberian dwarf pine	736.38	9.12%
High elevation deciduous vegetation	616.87	7.64%
High elevation bare areas	58.97	0.73%
Wetlands	502.46	6.23%
Water	87.05	1.08%
Agriculture	59.09	0.73%
Settlements	9.87	0.12%
TOTAL:	**8071.12**	**100.00%**

Table D-4: Accuracy Assessment Matrix for the land-cover classification based on 2007 Landsat TM imagery.

		Land-Cover: Reference Map																		
	Land-Cover: Classified Map	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Col . Total	User's Acc.(%)	Com. Error (%)
1	spruce-dom.	**22**	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	23	95.65	4.35
2	larch-dom.	0	**11**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	13	84.62	15.38
3	frag. conifer dominant	1	4	**52**	2	1	1	1	0	0	0	0	0	0	0	0	0	62	83.87	16.13
4	frag. decid. dominant	0	0	2	**10**	0	0	0	0	0	0	0	0	0	0	0	0	12	83.33	16.67
5	maturing deciduous	0	0	2	1	**17**	2	1	0	0	0	0	0	0	0	0	0	23	73.91	26.09
6	dense decid. regeneration	0	0	1	0	1	**32**	0	0	0	0	0	0	0	0	0	0	34	94.12	5.88
7	short vegetation	0	0	1	0	2	0	**39**	1	0	0	0	0	0	0	0	0	43	90.70	9.30
8	cleared areas	0	0	0	0	0	0	1	**22**	0	0	0	0	2	0	1	0	26	84.62	15.38
9	bare land/ dry rivers	0	0	0	0	0	0	0	0	**19**	0	0	0	0	1	1	2	23	82.61	17.39
10	high elev larch	0	0	0	0	0	0	0	0	0	**23**	0	0	0	0	0	0	23	100.0	0.00
11	high elev deciduous	0	0	0	1	0	1	0	0	0	0	**30**	1	0	0	0	0	33	90.91	9.09
12	high elev bare	0	0	0	0	0	0	0	0	0	0	0	**14**	0	0	0	0	14	100.0	0.00
13	wetland	0	0	0	0	0	3	2	1	0	0	0	0	**30**	0	1	1	38	78.95	21.05
14	water	0	0	0	0	0	0	0	0	0	0	0	0	0	**14**	0	0	14	100.0	0.00
15	agriculture	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**15**	0	16	93.75	6.25
16	settlements	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	10	100.0	0.00
	Row Total	23	15	61	14	21	39	44	24	19	23	30	15	33	15	18	13	407		
	Producer's Accuracy (%)	95.65	73.33	85.25	71.43	80.95	82.05	88.64	91.67	100.0	100.0	100.0	93.33	90.91	93.33	83.33	76.92		Overall Accuracy (%)	
	Omission Error (%)	4.35	26.67	14.75	28.57	19.05	17.95	11.36	8.33	0.00	0.00	0.00							**88.45**	

Relationship between spatial and ecological data

Differences in key ecological variables by land-cover type identified on the basis of satellite imagery

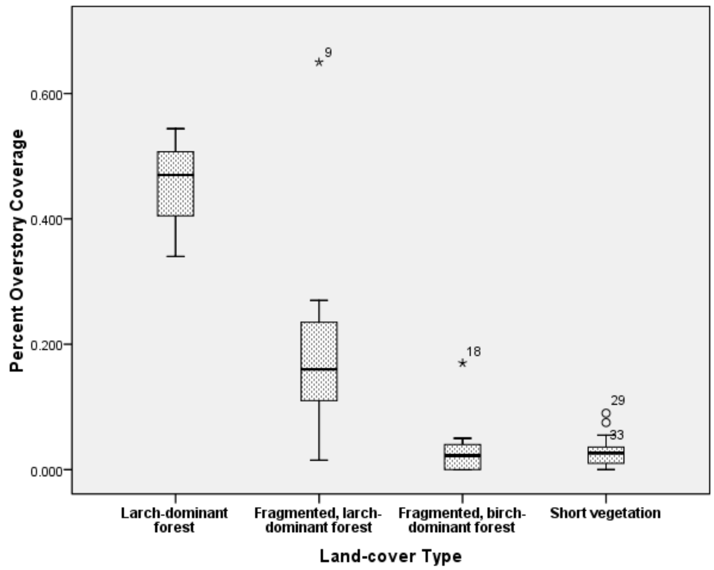


Figure D-1: Comparison of percent overstory coverage across land-cover type.

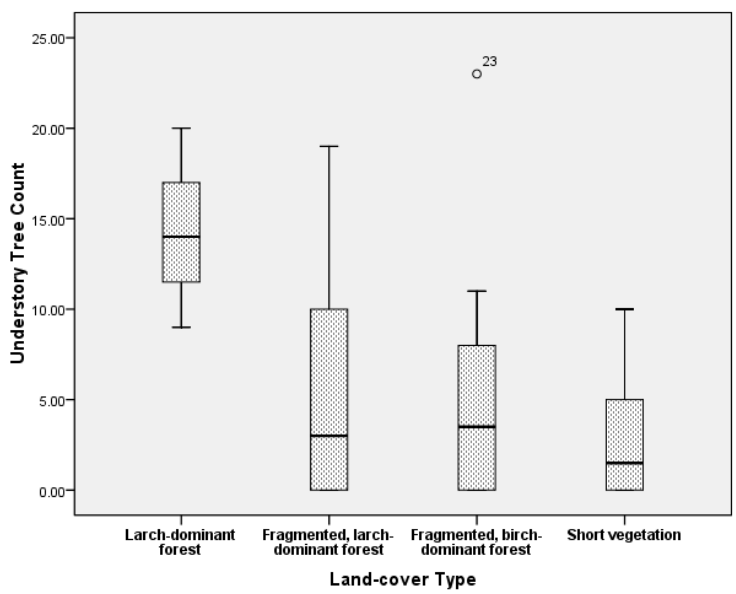


Figure D-2: Comparison of understory tree count across land-cover type.

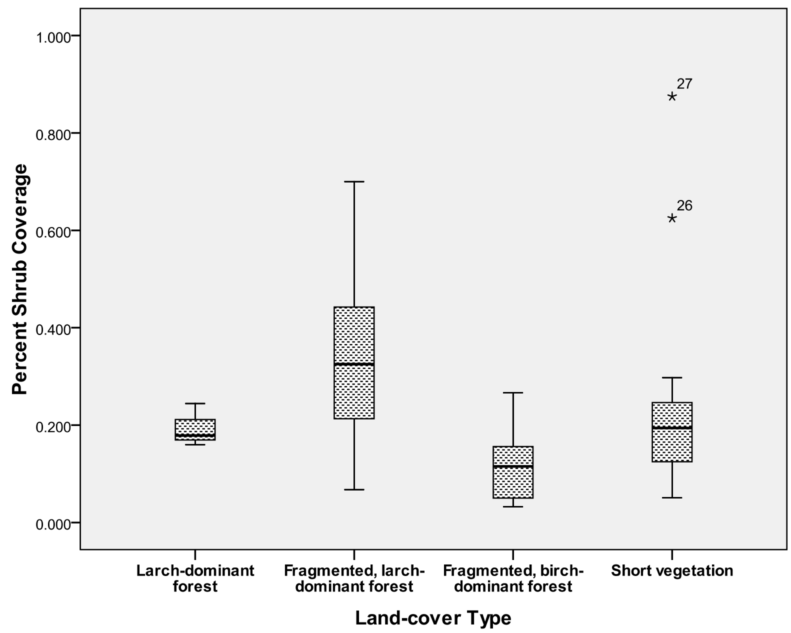


Figure D-3: Comparison of percent shrub coverage across land-cover type.

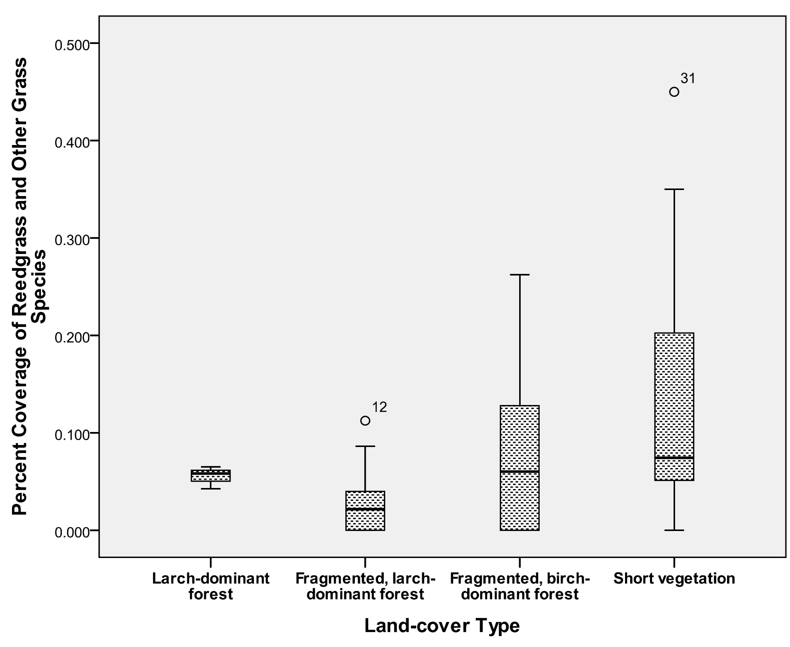


Figure D-4: Comparison of percent coverage reedgrass and other grass species across land-cover type.

People's interactions with the landscape through lingonberry gathering

Factors influencing gathering choices

Binary logistic models

Table D-5: Parameter estimates. Effect of year on probability of gathering.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-.251	.3563	-.950	.447	.497	1	.481	.778	.387	1.564
[Year=2003]	.631	.3677	-.090	1.352	2.943	1	**.086***	1.879	.914	3.863
[Year=2006]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	1									

a. Set to zero because this parameter is redundant. *Significant at the 0.1 level.

Table D-6: Parameter estimates. Effect of spruce-dominant forest on the probability of gathering, controlling for year.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-.074	.3829	-.825	.677	.037	1	.847	.929	.438	1.967
[Year=2003]	.662	.3843	-.091	1.415	2.966	1	.085	1.938	.913	4.116
[Year=2006]	0[a]	.	.	.	.	.	.	1	.	.
Spruce-dominant forest	-9.245	3.9692	-17.025	-1.466	5.425	1	**.020****	9.657E-5	4.039E-8	.231
(Scale)	1									

a. Set to zero because this parameter is redundant. **Significant at the 0.05 level.

Table D-7: Parameter estimates. Effect of dense deciduous regeneration on the probability of gathering, controlling for year.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-.756	.4197	-1.579	.067	3.244	1	.072	.470	.206	1.069
[Year=2003]	.698	.4073	-.101	1.496	2.934	1	.087	2.009	.904	4.463
[Year=2006]	0[a]	.	.	.	.	.	.	1	.	.
Dense deciduous re-growth	14.720	6.7551	1.480	27.960	4.748	1	**.029****	2470792.991	4.394	1.389E12
(Scale)	1									

a. Set to zero because this parameter is redundant. **Significant at the 0.05 level.

Table D-8: Parameter estimates. Effect of bare land on the probability of gathering, controlling for year.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-.461	.3888	-1.223	.301	1.405	1	.236	.631	.294	1.352
[Year=2003]	.661	.3837	-.092	1.413	2.963	1	.085	1.936	.913	4.107
[Year=2006]	0[a]	.	.	.	.	.	.	1	.	.
Bare land	6.707	3.5258	-.203	13.618	3.619	1	**.057***	818.440	.816	820621.404
(Scale)	1									

a. Set to zero because this parameter is redundant. *Significant at the 0.1 level.

Table D-9: Parameter estimates. Effect of distance from nearest village to gathering site on the probability of gathering, controlling for year.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	.590	.5302	-.449	1.629	1.239	1	.266	1.804	.638	5.101
[Year=2003]	.697	.4082	-.103	1.497	2.913	1	**.088***	2.007	.902	4.467
[Year=2006]	0[a]	.	.	.	.	.	.	1	.	.
Distance (km)	-.039	.0215	-.081	.003	3.309	1	**.069***	.962	.922	1.003
(Scale)	1									

a. Set to zero because this parameter is redundant. *Significant at the 0.1 level.

Table D-10: Parameter estimates. Effect of distance from the nearest main road to gathering site on the probability of gathering, controlling for year.

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	-.025	.4064	-.822	.772	.004	1	.951	.975	.440	2.163
[Year=2003]	.654	.3810	-.093	1.401	2.947	1	**.086***	1.923	.911	4.058
[Year=2006]	0[a]	.	.	.	.	.	.	1	.	.
Distance from main road	-.053	.0309	-.114	.008	2.929	1	**.087***	.948	.893	1.008
(Scale)	1									

a. Set to zero because this parameter is redundant. *Significant at the 0.1 level.

Factors affecting gathering metrics

Linear mixed models

Land-cover type

Table D-11: Estimates of Fixed Effects. Effect of year on gathering frequency (measured in total number of hours gathered)

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	40.102367	5.201872	30.884	7.709	.000	29.491463	50.713270
[Year=2003]	-15.417520	5.943725	12.701	-2.594	**.023****	-28.288999	-2.546041
[Year=2006]	0[a]	0	.	.	.	.	.

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Table D-12: Estimates of Fixed Effects. Effect of larch-dominant forest on gathering intensity, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	8.189539	.923910	29.092	8.864	.000	6.300190	10.078889
[Year=2003]	.632778	.952606	17.321	.664	.515	-1.374212	2.639768
[Year=2006]	0[a]	0	.	.	.	.	.
Larch-dominant forest	-7.182507	3.996717	20.934	-1.797	**.087***	-15.495740	1.130726

a. This parameter is set to zero because it is redundant. *Significant at the 0.1 level.

Table D-13: Estimates of Fixed Effects. Effect of maturing deciduous forest on gathering intensity, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	5.813775	.968983	27.773	6.000	.000	3.828174	7.799376
[Year=2003]	.921179	.932888	17.998	.987	.337	-1.038760	2.881118
[Year=2006]	0[a]	0	.	.	.	.	.
Maturing deciduous forest	13.471663	5.699922	15.499	2.363	**.032****	1.356572	25.586754

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Table D-14: Estimates of Fixed Effects. Effect of dense deciduous regeneration on gathering intensity, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	6.488383	.852555	29.680	7.611	.000	4.746445	8.230321
[Year=2003]	.938895	.956740	17.168	.981	.340	-1.078147	2.955938
[Year=2006]	0[a]	0	.	.	.	.	.
Dense deciduous regeneration	11.544384	5.631667	14.132	2.050	**.059***	-.523766	23.612533

a. This parameter is set to zero because it is redundant. *Significant at the 0.1 level.

Table D-15: Estimates of Fixed Effects. Effect of larch-dominant forest on gathering frequency, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	46.433365	5.994159	28.268	7.746	.000	34.160123	58.706606
[Year=2003]	-16.522905	6.023580	12.431	-2.743	.017	-29.596831	-3.448979
[Year=2006]	0[a]	0	.	.	.	.	.
Larch-dominant forest	-50.198467	26.236452	16.712	-1.913	**.073***	-105.625329	5.228395

a. This parameter is set to zero because it is redundant. *Significant at the 0.1 level.

Table D-16: Estimates of Fixed Effects. Effect of bare land on the total number of gatherers at a site, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	.046889	.015376	26.068	3.049	.005	.015287	.078491
[Year=2003]	-.013232	.010652	13.369	-1.242	.235	-.036179	.009715
[Year=2006]	0[a]	0	.	.	.	.	.
Bare land	.314077	.136098	19.222	2.308	**.032****	.029442	.598711

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Table D-17: Est. of Fixed Effects. Effect of maturing deciduous forest on marketing, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	.445722	.114881	27.096	3.880	.001	.210046	.681399
[Year=2003]	-.078126	.110906	15.873	-.704	.491	-.313388	.157137
[Year=2006]	0[a]	0	.	.	.	.	.
Maturing deciduous forest	1.481075	.674614	13.284	2.195	**.046****	.026816	2.935334

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Distance

Table D-18: Estimates of Fixed Effects. Effect of distance from nearest village to site on gathering frequency, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower	Upper
Intercept	30.62497	6.059097	25.262	5.054	.000	18.152598	43.097353
[Year=2003]	-	5.805938	13.903	-2.679	.018	-28.014922	-3.093586
[Year=2006]	0[a]	0	.	.	.	.	.
Distance (km)	.536289	.210259	14.441	2.551	**.023****	.086619	.985960

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Table D-19: Estimates of Fixed Effects. Effect of distance from nearest main road to site on gathering frequency, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower	Upper
Intercept	34.89544	5.201446	28.635	6.709	.000	24.251401	45.539498
[Year=2003]	-	5.629336	15.224	-2.801	.013	-27.751384	-3.784756
[Year=2006]	0[a]	0	.	.	.	.	.
Distance from main road	1.532400	.599132	23.961	2.558	**.017****	.295744	2.769055

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Table D-20: Estimates of Fixed Effects. Effect of distance from nearest main road to gathering site on marketing, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	.537061	.097969	28.917	5.482	.000	.336667	.737455
[Year=2003]	-.095723	.107962	16.692	-.887	.388	-.323823	.132377
[Year=2006]	0[a]	0	.	.	.	.	.
Distance from main road	.020368	.011237	24.975	1.813	**.082***	-.002775	.043512

a. This parameter is set to zero because it is redundant. *Significant at the 0.1 level.

Road density

Table D-21: Estimates of Fixed Effects. Effect of intermediate (Type II) road density on total number of gatherers at a site, controlling for year.

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	.030766	.017453	27.111	1.763	.089	-.005037	.066569
[Year=2003]	-.010959	.010499	13.999	-1.044	.314	-.033477	.011558
[Year=2006]	0[a]	0	.	.	.	.	.
Density of intermediate roads (Type II)	.109493	.039008	20.125	2.807	**.011****	.028156	.190831

a. This parameter is set to zero because it is redundant. **Significant at the 0.05 level.

Graphical Analyses

Variation in gathering metrics

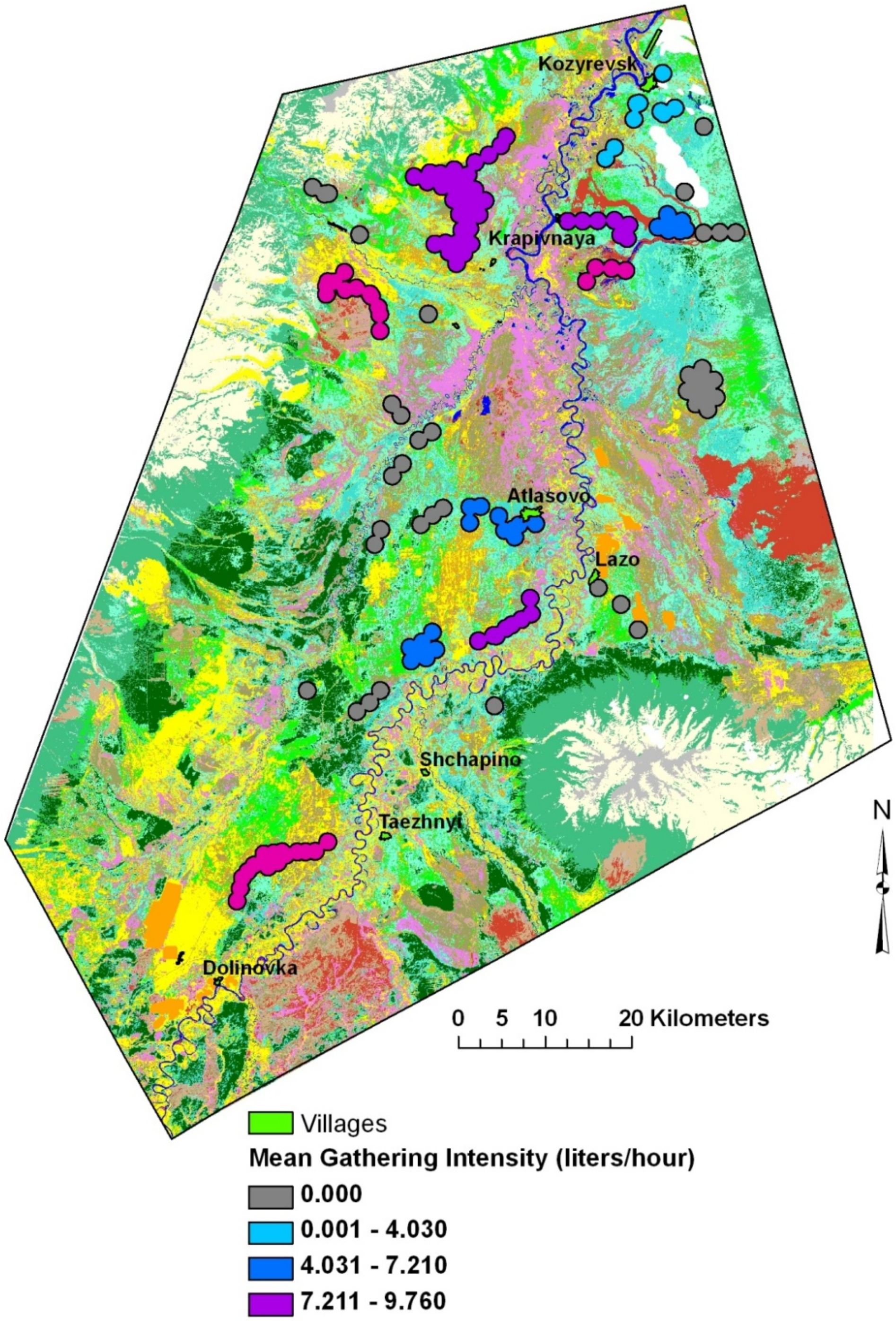


Figure D-5: Variation in gathering intensity (of lingonberry) across the landscape. (Polygons represent gathering sites.) Higher intensity gathering tended to occur further away from villages. (Map based on 2006 data.)

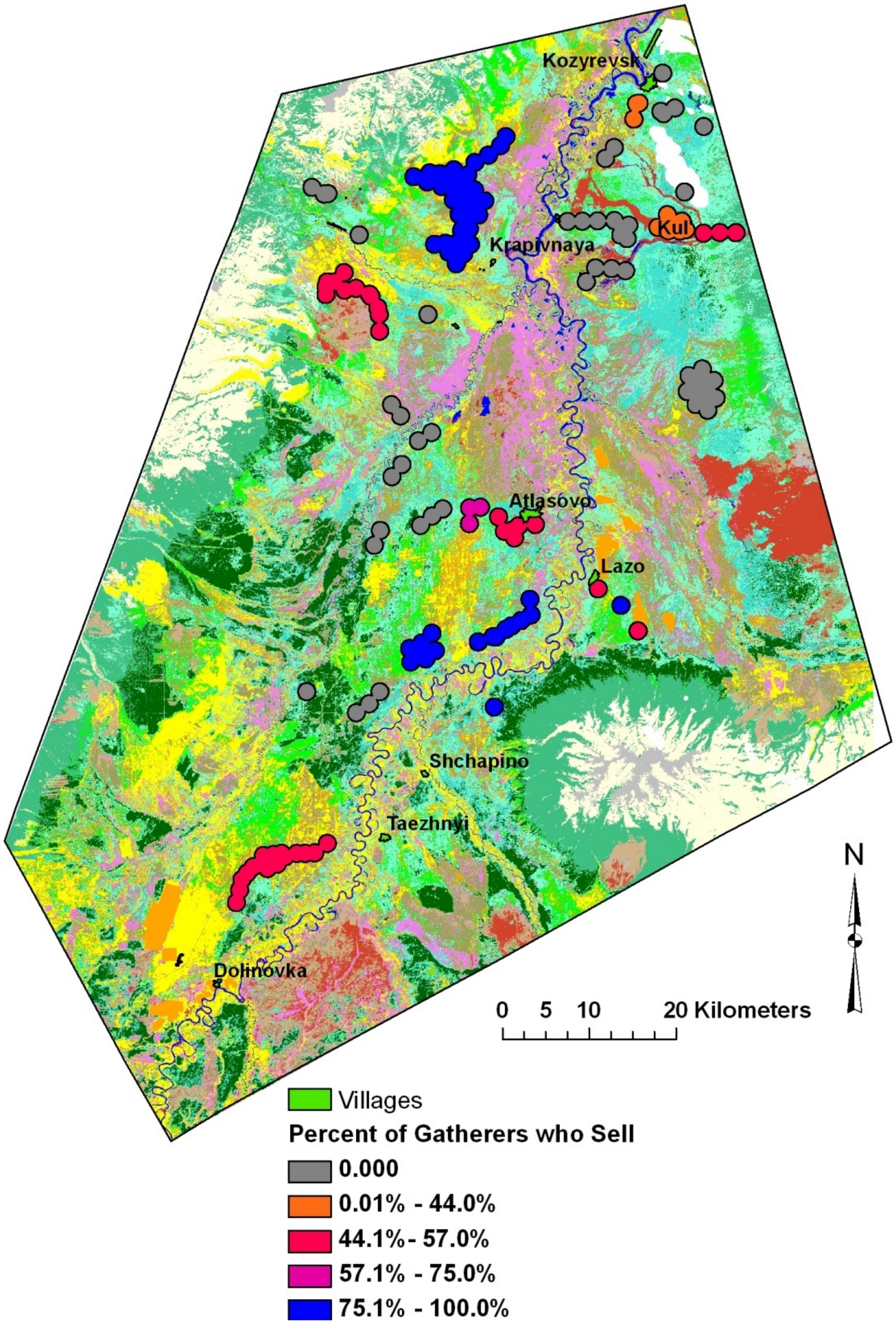


Figure D-6: Variation across the landscape in lingonberry harvests that are marketed. (Polygons represent gathering sites.) Gathers who sold their harvests tended to gather further away from the villages. There were two notable exceptions to this pattern: 1) gatherers near Atlasovo also tended to market their harvests; and 2) gatherers in the site of Kul', which is located further from Kozyrevsk (in comparison to other sites), tended not to sell their harvests. (Map based on 2003 data.)

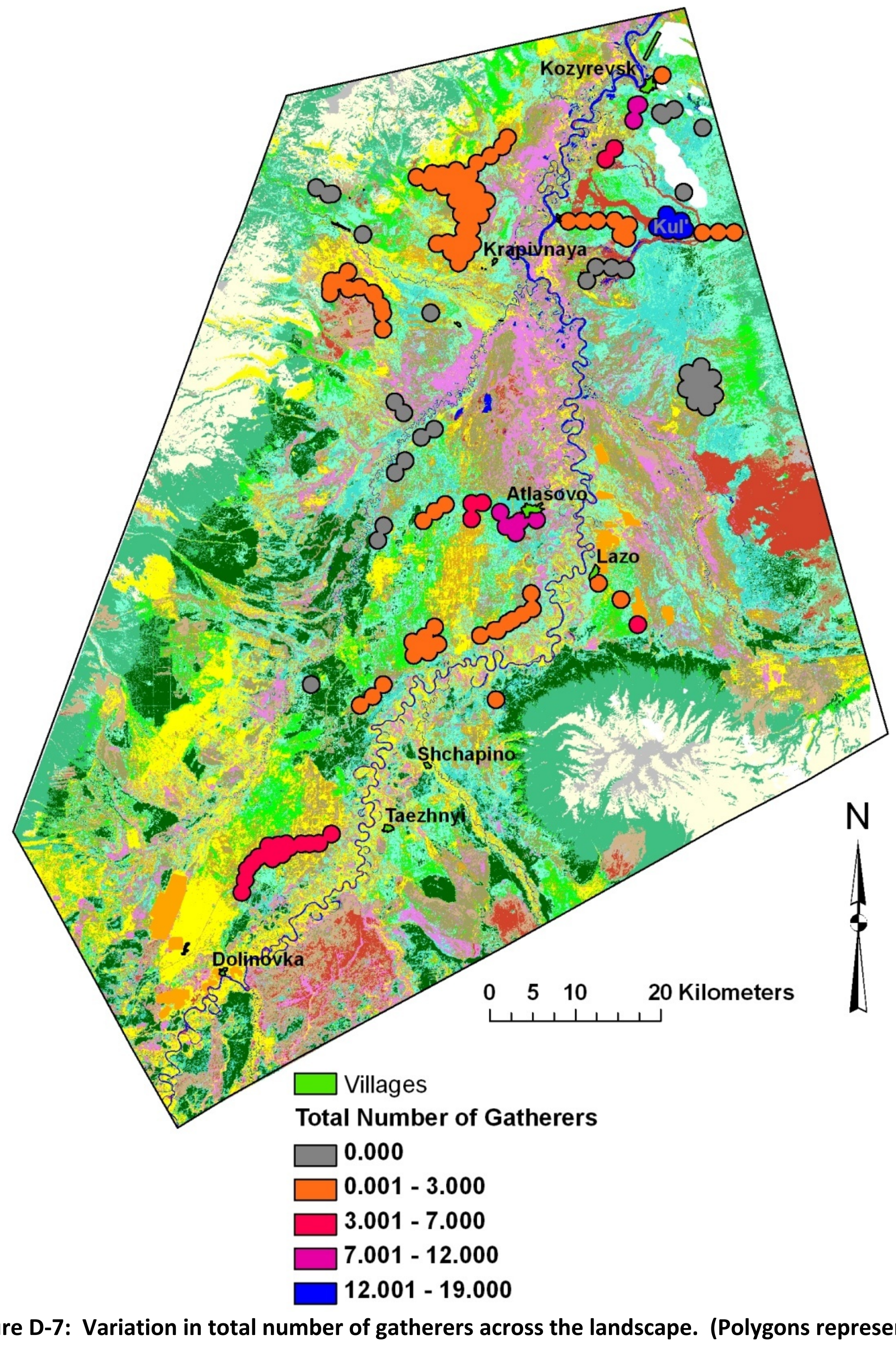


Figure D-7: Variation in total number of gatherers across the landscape. (Polygons represent gathering sites.) Higher numbers of gatherers tended to frequent sites in proximity to villages. The highly popular site of Kul' is an exception to this pattern. (Map based on 2003 data.)

Distribution of land-cover types across the landscape

Graphical analysis revealed clear patterns of variation in land-cover type both within and among regions in the central Kamchatka River valley. Four concentric rings were created around the villages of Atlasovo, Dolinovka, and Kozyrevsk to match the following intervals: **Zone I** = 0-5 km; **Zone II** = 5-15 km; **Zone III** = 15-25 km; **Zone IV** = 25-35 km. The following figures depict this variation for selected land-cover types.

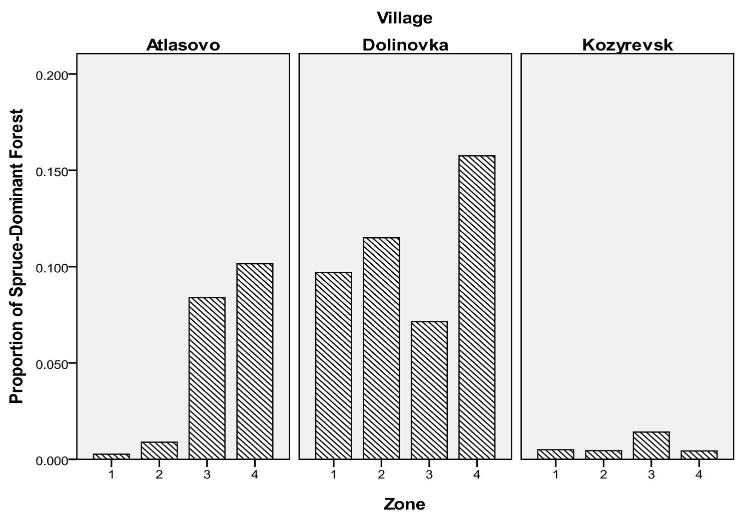


Figure D-8: Proportion of spruce-dominant forest by zone for three villages.

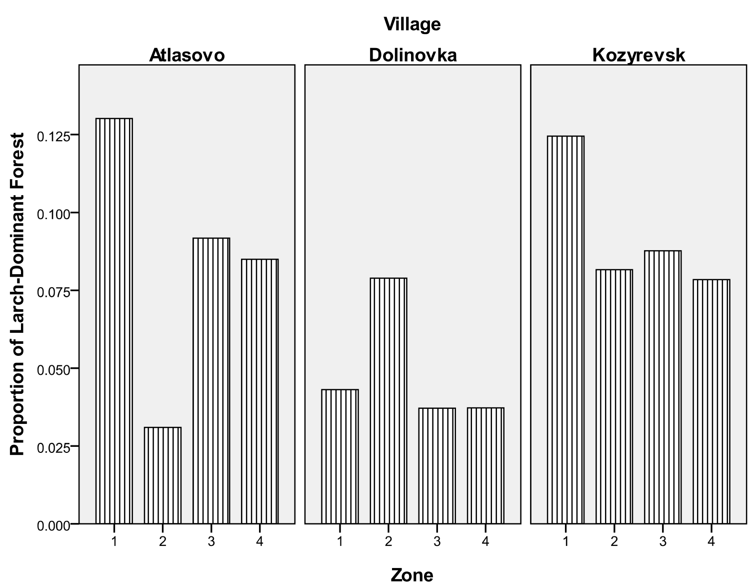


Figure D-9: Proportion of larch-dominant forest by zone for three villages.

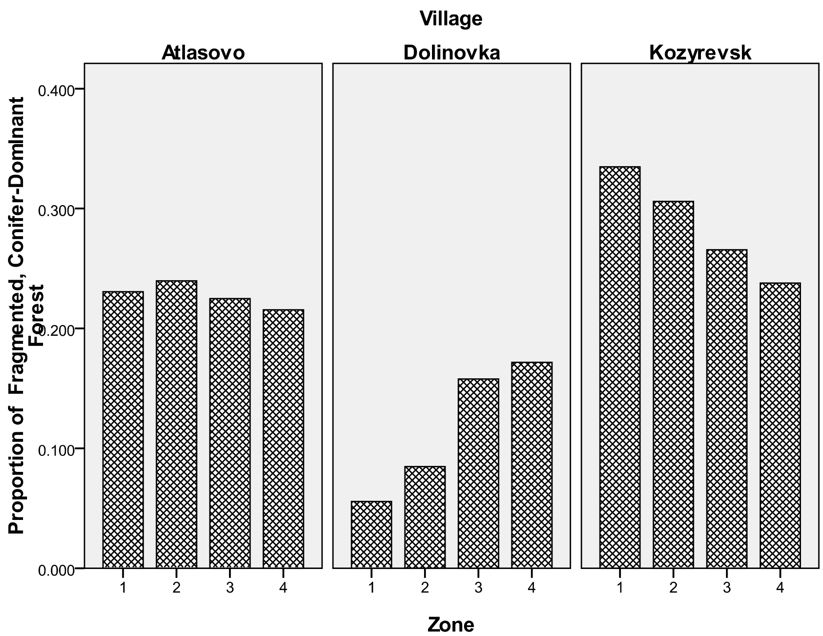


Figure D-10: Proportion of fragmented, conifer-dominant forest by zone for three villages.

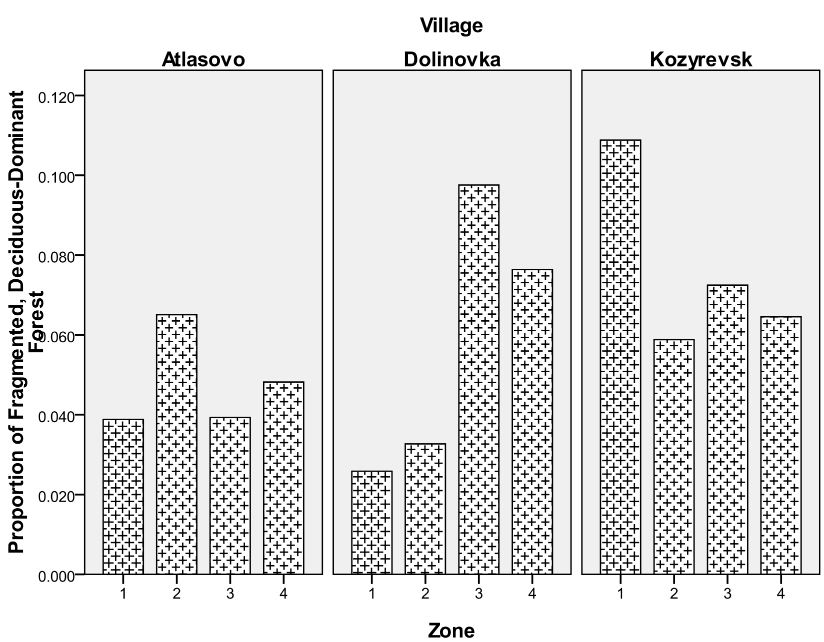


Figure D-11: Proportion of fragmented, deciduous-dominant forest by zone for three villages.

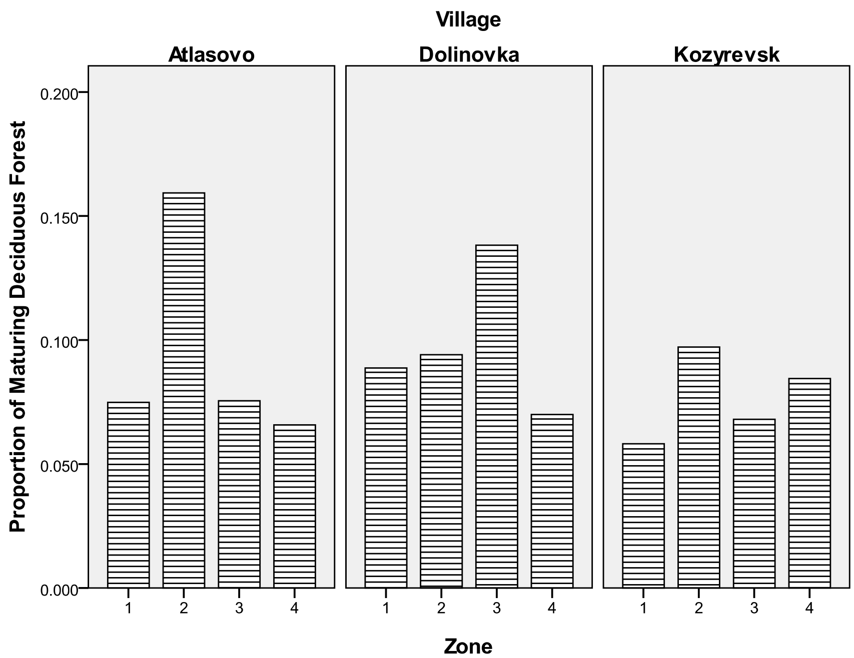


Figure D-12: Proportion of maturing deciduous forest by zone for three villages.

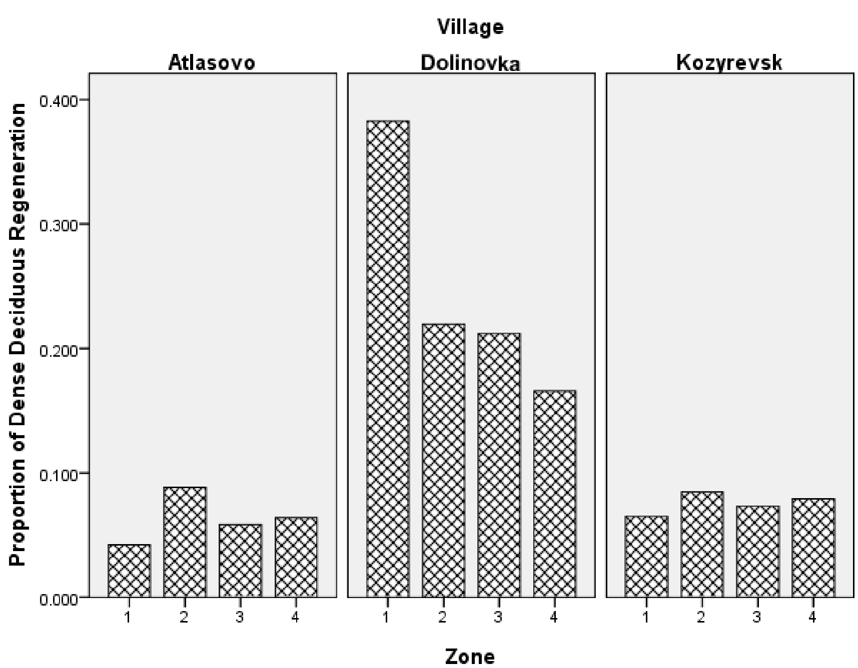


Figure D-13: Proportion of dense deciduous regeneration by zone for three villages.

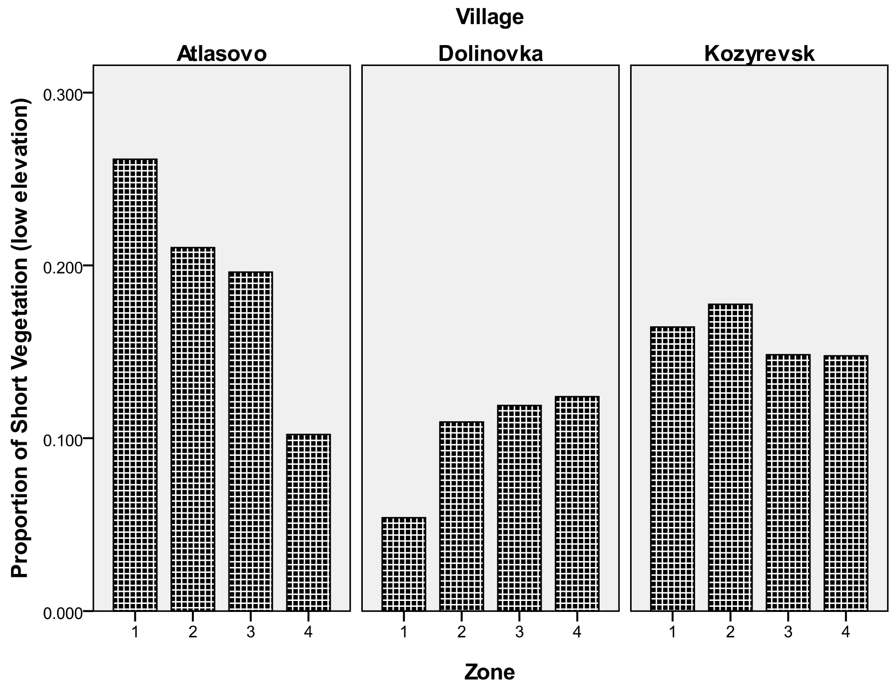


Figure D-14: Proportion of short vegetation by zone for three villages.

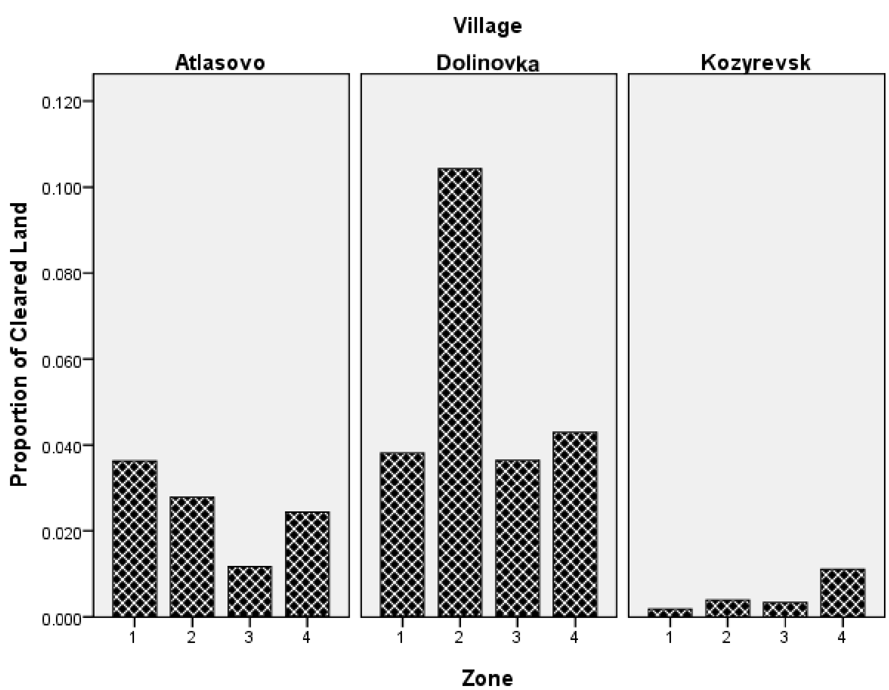


Figure D-15: Proportion of cleared land by zone for three villages.

Comparison of land-cover types in designated gathering sites and non-gathering sites

The following graphs (*refer to Figures D-16 – D-23*) enabled a visual comparison of the proportion of land-cover types in gathering sites (represented by polygons—*refer to Figures D-5 – D-7*). They helped validate the designation of these sites by showing clear distinctions in land-cover proportions between gathering sites and non-gathering sites. These trends, however, varied according to zone and village, as explained below in more detail.

Spruce- and larch-dominant forests (primary or minimally disturbed)

First, proportions of spruce-dominant forests are noticeably higher in non-gathering sites than in gathering sites (*Figure D-16*). This result is expected as lingonberry harvests do not occur in these forests. The overlap of these forests in gathering sites is most likely due to chance: they were close enough to other land-cover classes to be included in the gathering sites. The overall dearth of these forests in Kozyrevsk and Atlasovo compared to Dolinovka confirmed that the most favorable spruce habitat in the central Kamchatka depression is concentrated in its southern portion. Second, the patterns of larch-dominant forest were more complicated to decipher (*Figure D-17*). In theory, these forests should not be prevalent in gathering sites due to their higher crown closure, which blocks light penetration that is essential to lingonberry growth and development. In Dolinovka, this prediction held; however, in both Atlasovo and Kozyrevsk there is a high proportion of larch-dominant forest in gathering sites near the villages. The designation of "green" zones directly around the villages could explain the high proportion of larch-dominant forests in gathering sites in Zone I, particularly in the case of Atlasovo, which was established more recently than Kozyrevsk. In the latter village, the majority of larch-dominant forests in Zone I were selectively cut in the 1930s and 40s, which preserved the overstory coverage to some degree. The proportion of these forests in gathering sites greatly diminished with increasing distance from both villages, confirming the outward radiation of logging operations. (Refer to Zones II, III, and IV surrounding Atlasovo, and to Zones III and IV surrounding Kozyrevsk.)

Fragmented coniferous- and deciduous-dominant forests

Fragmented forests were expected to be proportionately higher in gathering sites than in non-gathering sites, particularly the deciduous-dominant forests that seem to have been more recently disturbed. (*Refer to section on discriminant analysis in Chapter 6.*) This pattern generally held across all zones for all villages (*Figures D-18 and D-19*). The differences were especially pronounced in the fragmented, larch-dominant forests in Atlasovo (Zones II and III), where their proportions within gathering sites were nearly twice those in non-gathering sites. Also, in Atlasovo the proportions of both birch and larch-dominant fragmented forests in gathering sites increased with greater distance from the village, reflecting the logging trajectory of this area. This same overall trend occurred in Dolinovka (with the exception of Zone III), again confirming the path of logging that has taken place primarily to the north of this village. In Kozyrevsk, the high proportion of fragmented, birch-dominant forests in gathering sites in Zone I indicated logging that was resumed in proximity to the village in the early 1990s.

Maturing deciduous forest and dense deciduous regeneration

These land-cover types appear primarily after severe fires. The less dense maturing deciduous forests typically support high lingonberry yields (during favorable harvest years. This trend was apparent in the distinct differences in the proportions of maturing deciduous forests in gathering and non-gathering sites, especially as distance from the villages increased, as exemplified in Zone IV surrounding Atlasovo, and in Zones III and IV surrounding Kozyrevsk (*Figure D-20*). This trend made sense given that fires often occur in current logging areas that are further from the villages. There were also differences in the proportion of dense deciduous regeneration between gathering and non-gathering areas, showing that this land-cover type was generally less likely to occur in non-gathering sites compared to gathering sites (*Figure D-21*). There were, however, exceptions: in Zone IV surrounding Atlasovo and Kozyrevsk, and in Zone III surrounding Dolinovka the proportion of dense deciduous regeneration was higher in gathering sites than in non-gathering areas. One explanation may lie in the complex mosaic typical of a post-fire landscape where this land-cover type coincides with others (e.g. maturing deciduous forests) that support high lingonberry yields.

Short vegetation and cleared land

Although the ecological data suggested that short vegetation was the most auspicious land-cover type for gathering (*refer to the ANOVA analysis in Chapter 6*), the outcome in *Figure D-22* was not as convincing, which may be due, in part, to classification error. In this case, both forests in early successional stages, and other short vegetation (e.g. wetlands) had very similar spectral signatures. In Dolinovka the proportion of short vegetation within gathering sites far exceeded that outside of these sites. These patterns were less apparent in Kozyrevsk and

Atlasovo, although differences in the proportion of short vegetation in gathering and non-gathering sites grew with increasing distance from the villages (see Zone III surrounding Kozyrevsk and Zone IV surrounding Atlasovo). The high proportion of this land-cover type in non-gathering sites in Zone I surrounding Atlasovo likely indicated the expansive wetland area that begins just north of the village. Lastly, there should be a much lower proportion of cleared land in gathering sites than in non-gathering sites, given the nascent development stage of the herbaceous-subshrub layer in this land-cover type. This pattern held across zones in all three villages (*Figure D-23*). The relatively high proportion of cleared land in non-gathering sites in Zone I surrounding Atlasovo was most likely due to the misclassification of wetlands as forests in initial successional stages. In Zone II surrounding Dolinovka the high proportion of cleared land may be traced to a major burn east of the Kamchatka River. In this case there was much less classification error.

The figures below show land-cover type as a proportion of the aggregate area of all gathering sites within a specific zone, and as a proportion of the remaining area outside of these sites within this zone. Zones around each village occur at the following intervals: **Zone I** = 0-5 km; **Zone II** = 5-15 km; **Zone III** = 15-25 km; **Zone IV** = 25-35 km.

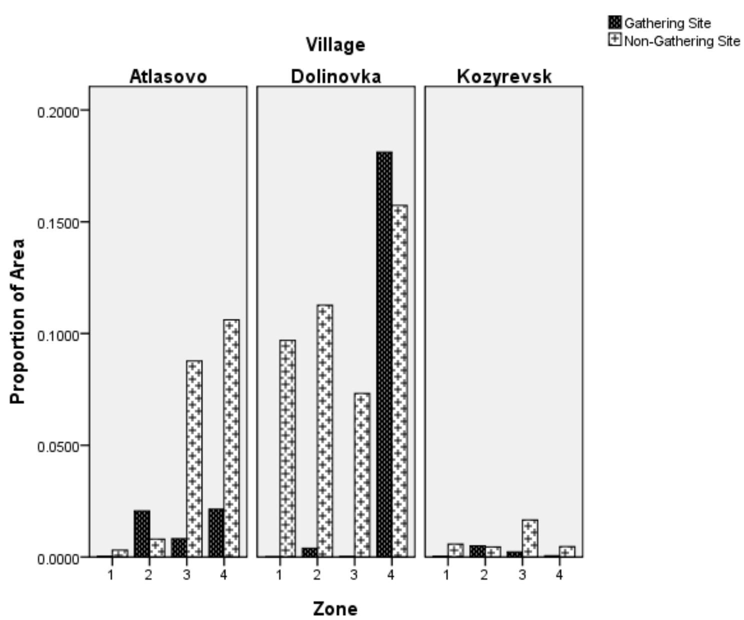


Figure D-16: Comparison of spruce-dominant forests in gathering versus non-gathering sites across four zones for three villages.

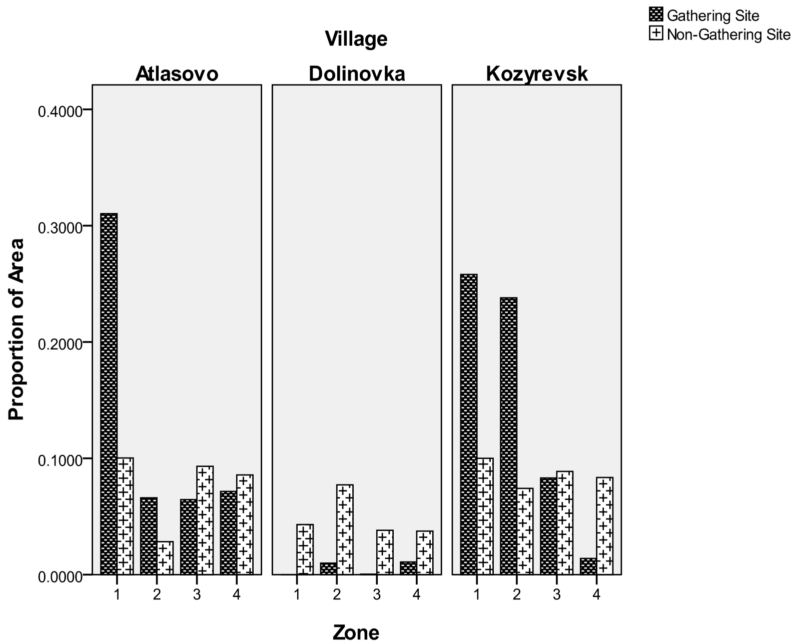


Figure D-17: Comparison of larch-dominant forests in gathering versus non-gathering sites across four zones for three villages.

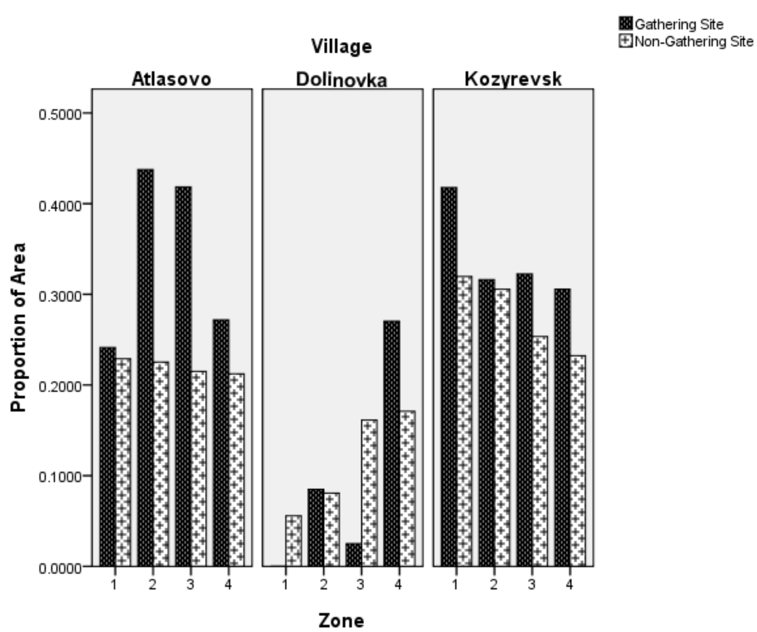


Figure D-18: Comparison of fragmented, coniferous-dominant forests in gathering versus non-gathering sites across four zones for three villages.

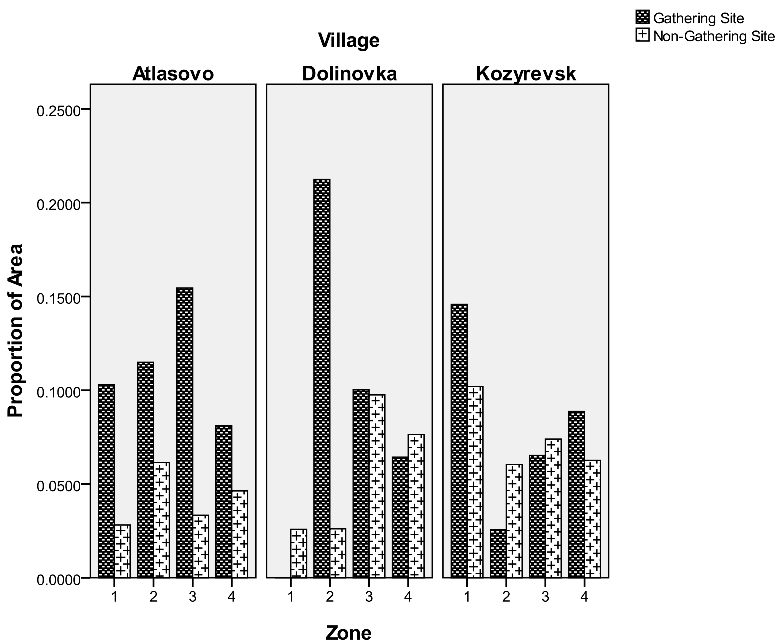


Figure D-19: Comparison of fragmented, deciduous-dominant forests in gathering versus non-gathering sites across four zones for three villages.

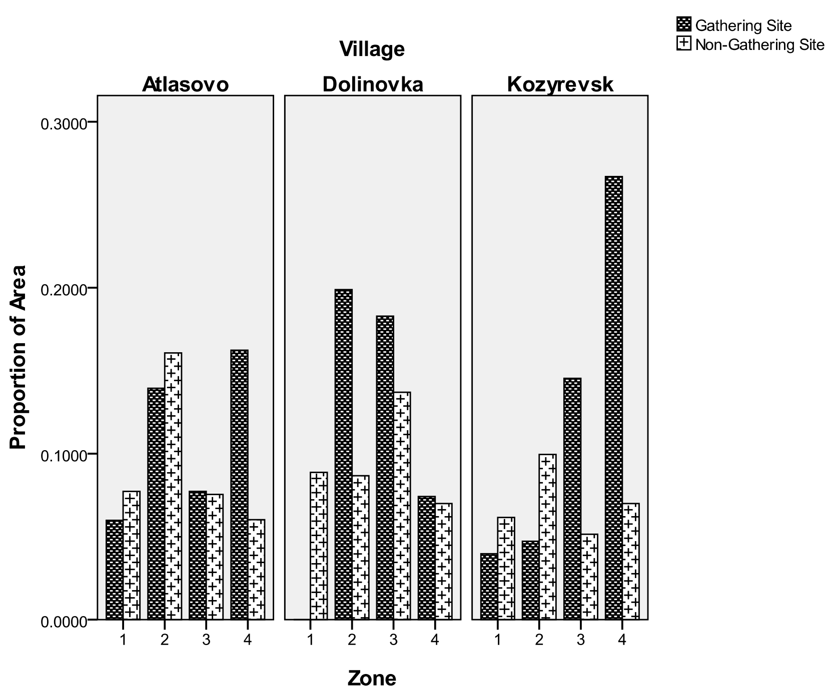


Figure D-20: Comparison of maturing deciduous forests in gathering versus non-gathering sites across four zones for three villages.

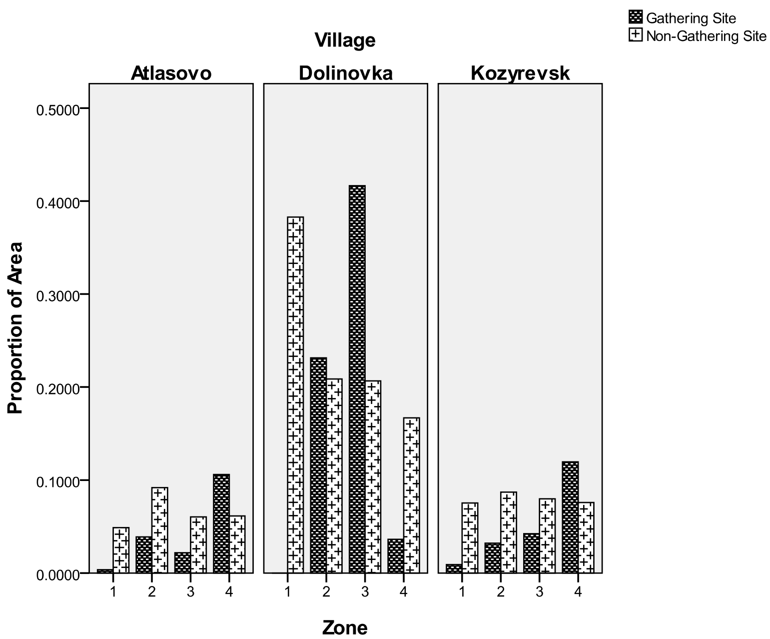


Figure D-21: Comparison of dense deciduous regeneration (non-floodplain forests) in gathering versus non-gathering sites across four zones for three villages.

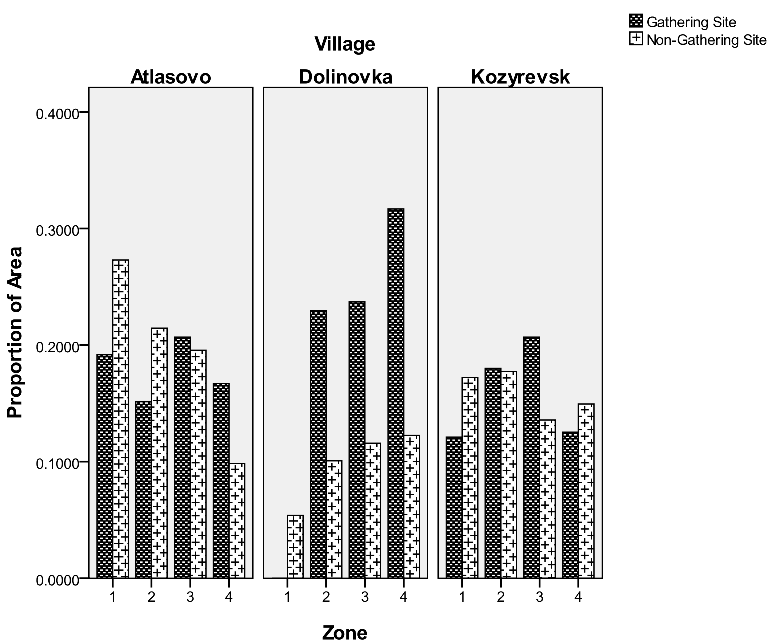


Figure D-22: Comparison of short vegetation (low elevation) in gathering versus non-gathering sites across four zones for three villages.

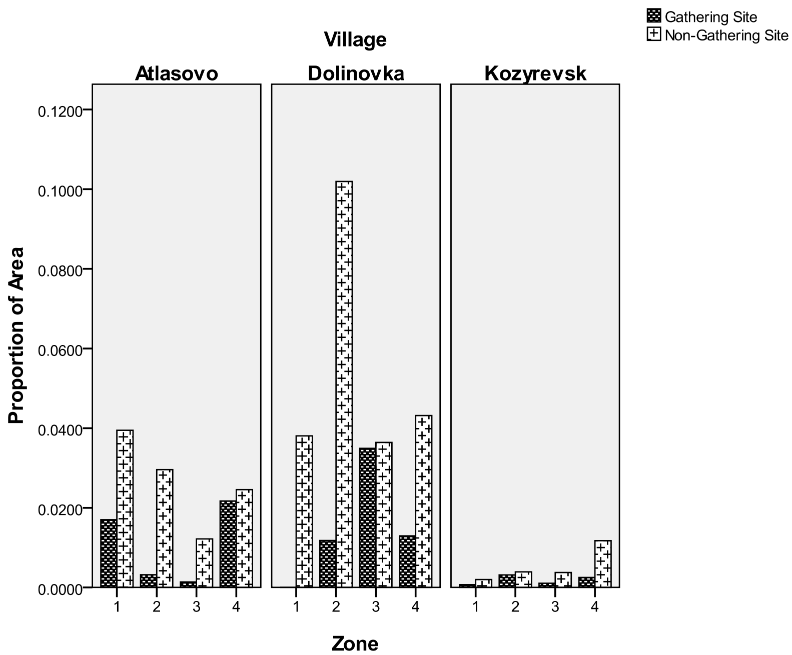


Figure D-23: Comparison of cleared land in gathering versus non-gathering sites across four zones for three villages.

Comparison of main, intermediate, and forest (Types I, II, and III) road densities in designated gathering sites and non-gathering sites

The figures below show density of each road type for all of the gathering sites within a specific zone, and for remaining area outside of these sites within this zone. Zones around each village occur at the following intervals: **Zone I** = 0-5 km; **Zone II** = 5-15 km; **Zone III** = 15-25 km; **Zone IV** = 25-35 km. These analyses revealed distinct differences in road densities between gathering and non-gathering sites, especially in forest (Type III) road densities. Thus, they helped to substantiate further the designation of the polygons representing gathering sites in this study.

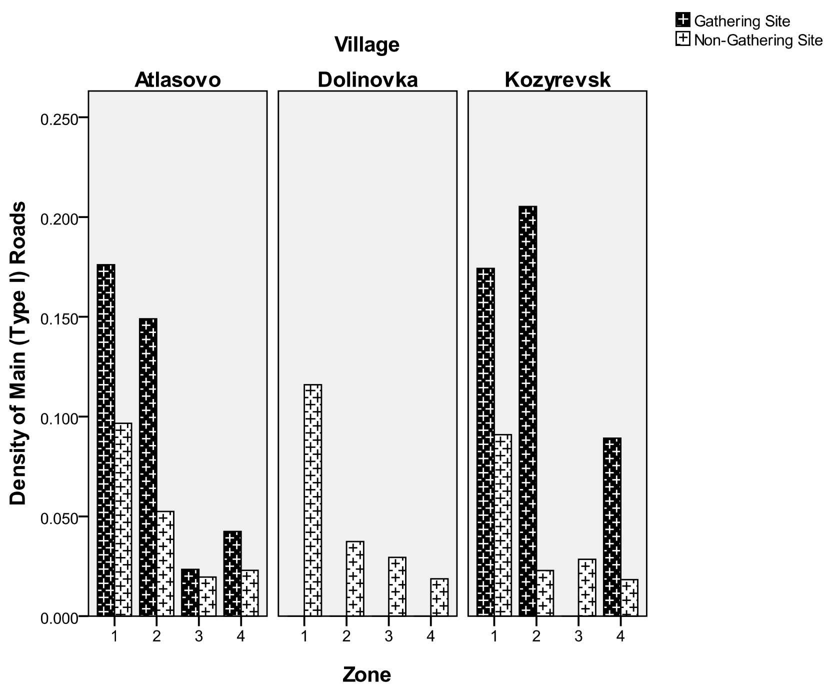


Figure D-24: Comparison of main (Type I) road density in gathering versus non-gathering sites across four zones for three villages.

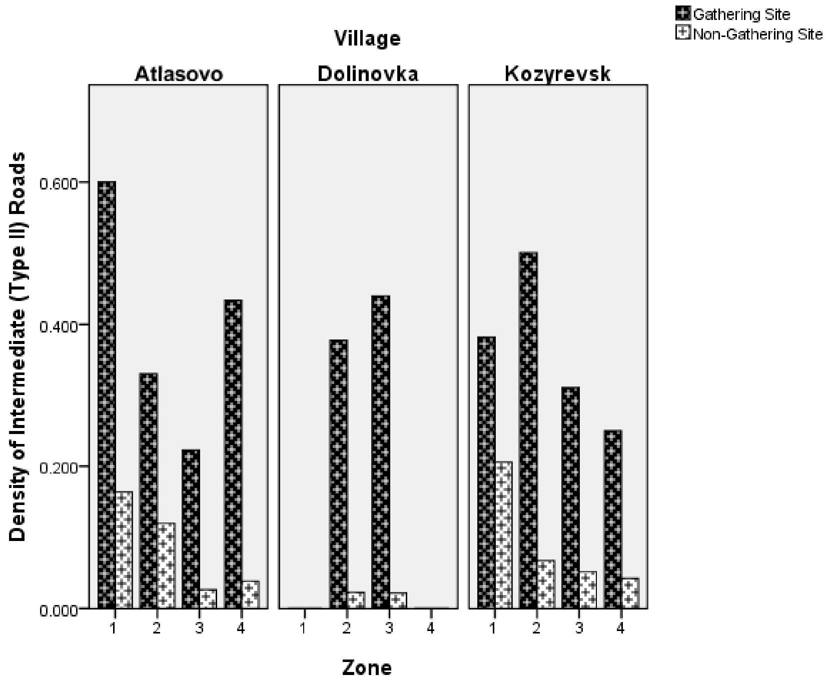


Figure D-25: Comparison of intermediate (Type II) road density in gathering versus non-gathering sites across four zones for three villages.

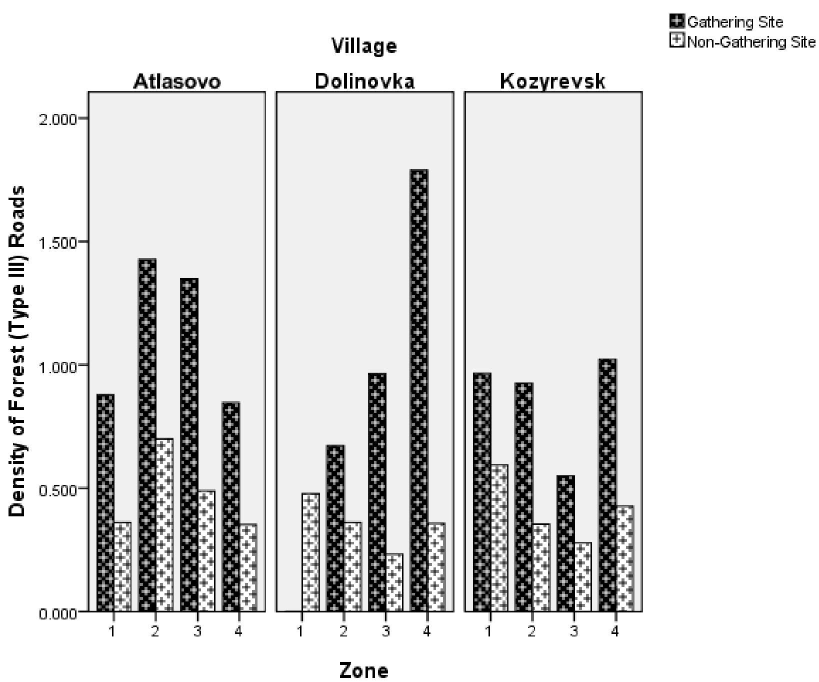
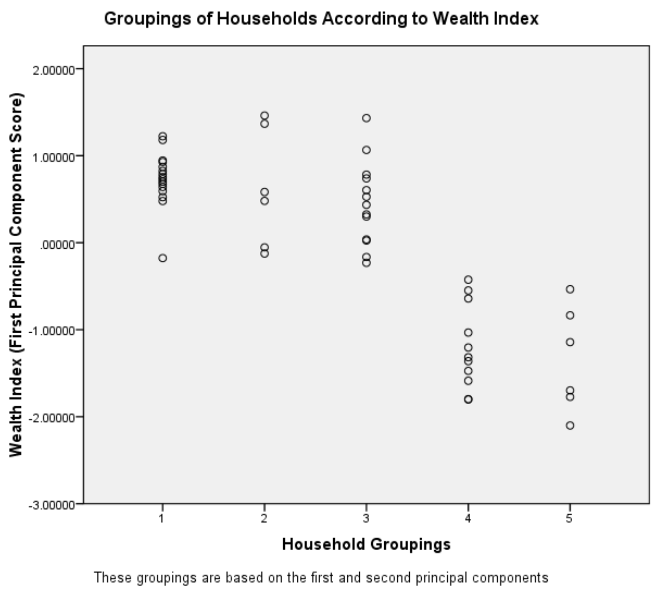


Figure D-26: Comparison of forest (Type III) road density in gathering versus non-gathering sites across four zones for three villages.

Appendix E

First and second principal components of Principal Component Analysis (PCA)



a.

b.

Figures E-1: Household distribution by socio-economic group (Group 1 is the highest) along the wealth index based on the first and second principle components for a) 2004; and b) 2006,8.

Third principal component
Dependents and wealth

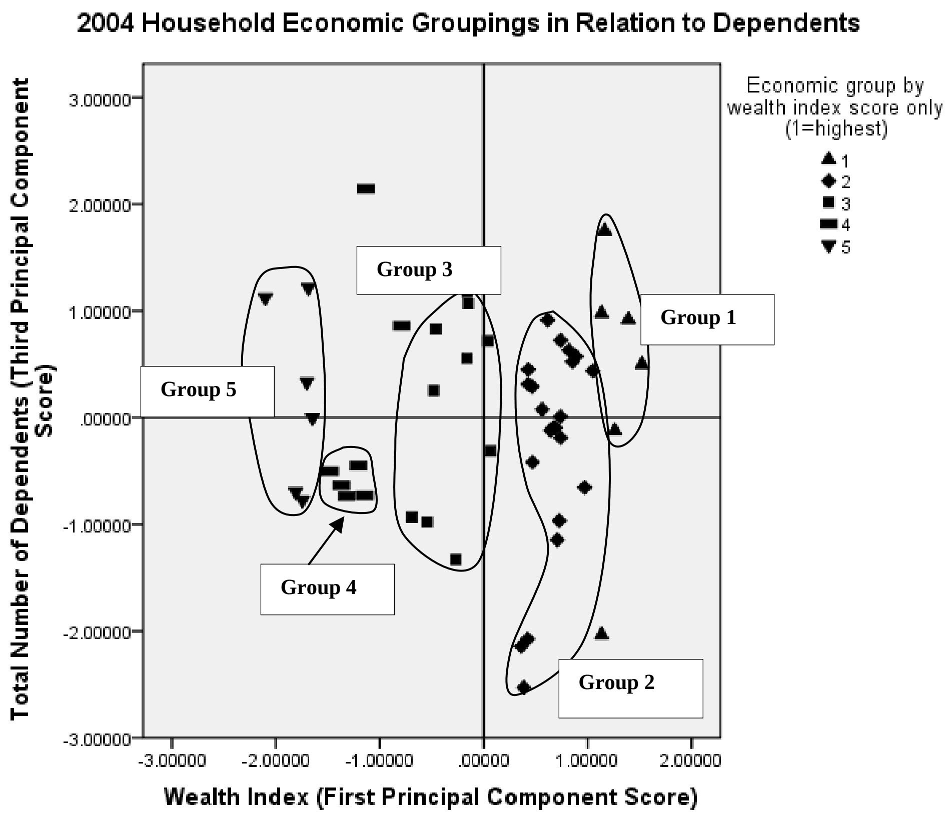


Figure E-2: 2004. Relationship between household economic status and total number of dependents. Economic groupings are based on wealth index score only.

Household analysis by economic group:

- *Wealthiest group (1):* all households except for one had between one and four dependents; there were two dependents outside of the home in this group.
- *Second to highest economic group (2)*: nearly half of the households had no dependents, while those that did had a smaller family size; there were seven dependents outside of the home in this group.
- *Middle economic group (3):* half of the households had no dependents, while those that did tended to have larger families; there were seven dependents outside of the home in this group.
- *Second to lowest economic group (4)*: half of the households had no dependents (these were primarily pensioner households); one of the outliers in this group had four dependents, two of whom were outside of the home.
- *Lowest economic group (5)*: a third of the households had no dependents, while the remaining households were small; there were two dependents outside of the home.

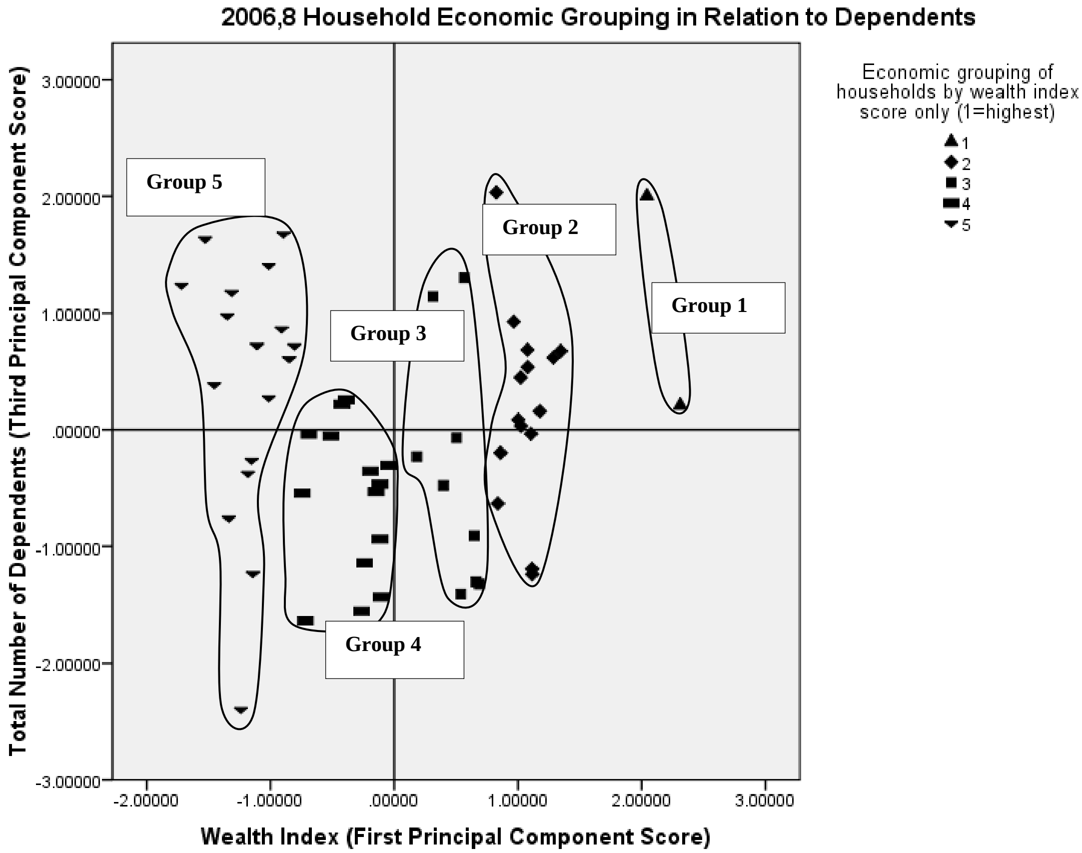


Figure E-3: 2006,8. Relationship between household economic status and total number of dependents. Economic groupings are based on wealth index score only. In 2006,8 the variable of total number of dependents had the lowest negative factor score in the third principal component signifying that households with a positive index score in this component tended to have fewer (or no) children. The variable of kin networks had the highest positive factor score. Consequently, some households with two dependents still had positive index scores due to their high level of connectedness kin networks. No clear relationships between integration in kin networks and wealth, and between integration in kin networks and total number of dependents were discerned.

Household analysis by economic group:

- *Wealthiest group (1):* one household had no dependents; the other household had two dependents (both at home) and also the highest wealth score in the data set; each household was connected to one other household in a kin network.

- *Second to highest economic group (2)*: households that had dependents were larger; a third had no dependents; there were five dependents outside of the home; households were well-integrated into kin networks.

- *Middle economic group (3):* nearly half of the households had two or three dependents; a third had no dependents; there were ten dependents living outside of the home; there was a lower degree of integration into kin networks in this group.

- *Second to lowest economic group (4)*: households were large (only two had no dependents); there was only one dependent outside of the home; households were well-integrated into kin networks.

- *Lowest economic group (5)*: households in this group dominated by pensioners not employed outside were small (only a third had dependents); there were three dependents outside of the home; households were well-integrated into kin networks.

Dependents and other income

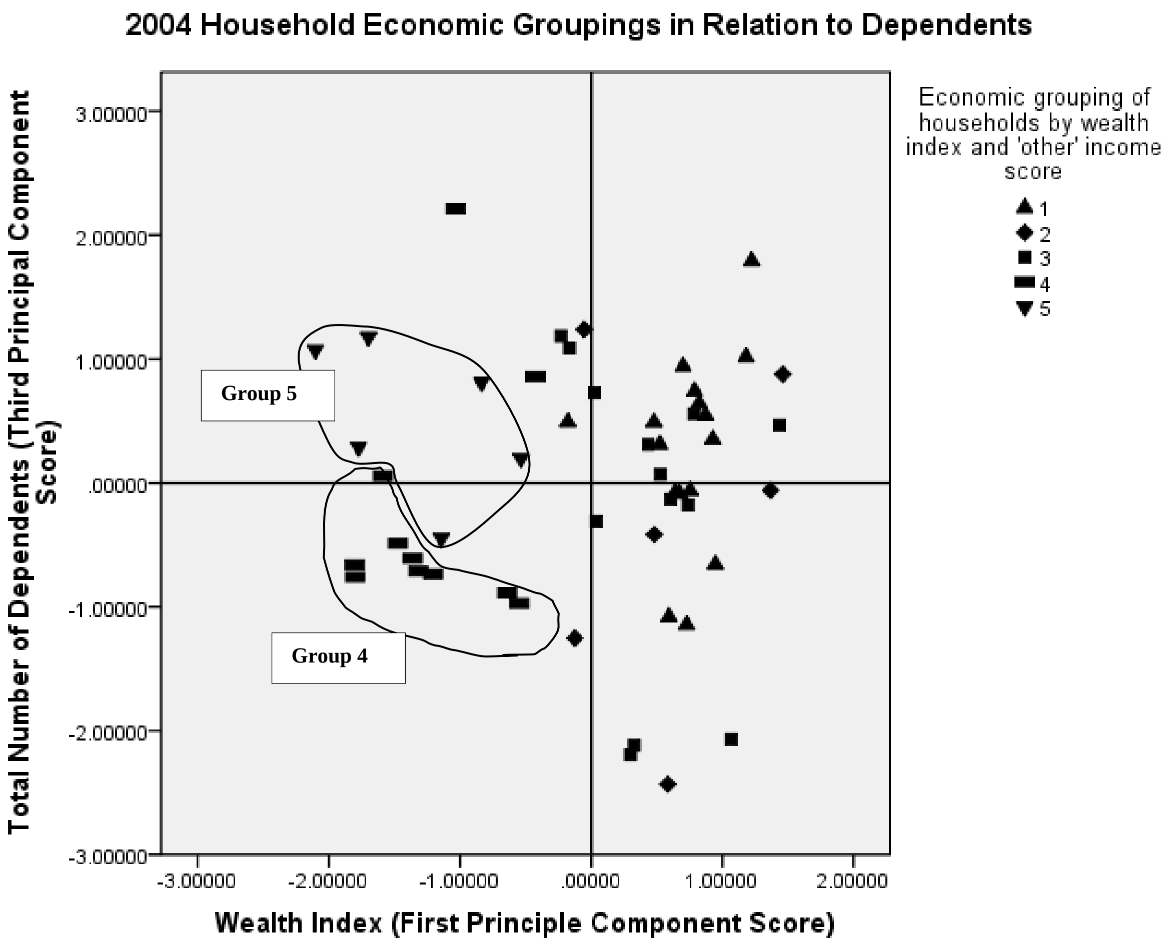


Figure E-4: 2004. Relationship between household economic status and total number of dependents. Economic groupings are based on both the wealth index score and other income. The wealthiest, second wealthiest, and middle groups (Groups 1, 2, and 3, respectively) were highly scattered in terms of total number of dependents.

Household analysis by economic group:

- *Wealthiest group (1):* more than half of the households had between two to three dependents; there were five outside of the home. (Mean number of dependents=1.62; mean non-timber forest product income score=1.35; mean of all other environmental income score=0.88; mean total livelihood score=15.5.) (*Refer to Materials and methods section in Chapter 7 for an explanation of scores.*)

- *Second to highest economic group (2)*: two-thirds of the households in this group had between two to three dependents; there was only one dependent outside of the home. (Mean number of dependents=1.67; mean non-timber forest product income score=

12.06; mean of all other environmental income score=0.67; mean total livelihood score=16.83.)

- *Middle economic group (3):* comparatively smaller households; there were nine dependents outside of the home. (Mean number of dependents=1.31; mean non-timber forest product income score= 1.06; mean of all other environmental income score=0.31; mean total livelihood score=12.77.)
- *Second to lowest economic group (4)*: households were small in this group dominated by pensioners; there were three dependents outside of the home. (Mean number of dependents=0.64, mean non-timber forest product income score= 0.25; mean of all other environmental income score=0.73; mean total livelihood score=14.09.)
- *Lowest economic group (5)*: every household in this group had at least one dependent; there were three dependents outside of the home. (Mean number of dependents=1.33; mean non-timber forest product income score= 2.21; mean of all other environmental income score=3.67; mean total livelihood score=17.33.)

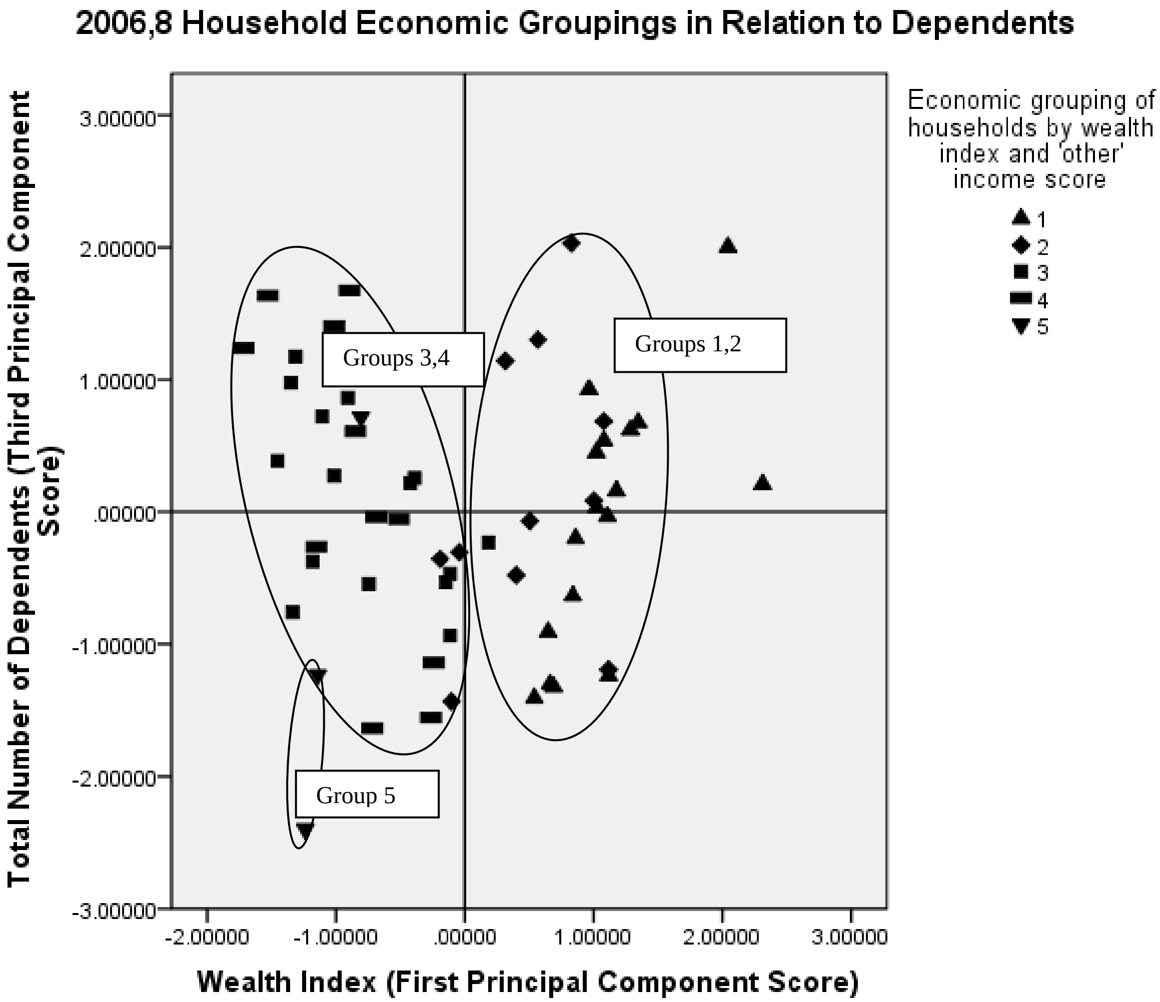


Figure E-5: 2006,8. Relationship between household economic status and total number of dependents. Economic groupings are based on both the wealth index score and other income. The wealthiest groups (Groups 1 and 2) and the less wealthy groups (Groups 3 and 4) tended to cluster together. The households with a positive dependent score tended to have fewer to no children; they were also related to at least one other household in the area. The middle groups (Groups 2 and 4) were more integrated into kin networks than either the wealthiest or lowest groups.

Household analysis by economic group:

- *Wealthiest group (1):* more than two-thirds of the households in this group had dependents; nearly half of these dependents lived outside of the home; these households were highly integrated into kin networks. Inputs from other income into this group were the lowest of all groups.

- *Second to highest economic group (2)*: the majority of households had dependents; there were three dependents outside of the home; households in this group were well integrated into kin networks. Acquisition of other income was high in this group.

- *Middle economic group (3):* there were comparatively few dependents in this group where over half of the adults were pensioners; there were two dependents outside of the home; these households were fairly well-integrated into kin networks. The contribution of other income in this group was modest.

- *Second to lowest economic group (4)*: well over half of the households had dependents with relatively large family size; there was only one dependent outside of the home; these households were also well-connected within kin networks. There was a high incidence of environmental income among this group, with some households earning substantial amounts.

- *Lowest economic group (5)*: all three households in this small group had dependents; one had four dependents, and one had two at home; the third household had one dependent outside of the home; only one of these households had relatives in the region.

Table E-1: Summary of household participation in livelihood activities in 2004 and 2006

Livelihood Activity	***2004*** ***N= 52*** ***Number of households***	***Percentage*** *(of total responses)*	***2006,8*** ***N= 57*** ***Number of households***	***Percentage*** *(of total responses)*
Garden production	50	96.2	57	100.0
Income earned (*mean in Rubles [p] 2006,8 only*)	13	25.0	25 (*10,940.11p.*)	43.9
Livestock	15	28.8	17	29.8
Raised in the past	18	34.6	39	84.8
Income earned (*mean in Rubles [p] 2006,8 only*)	3	5.8	3 (*133,280.56 p.*)	5.3
Fishing	43	82.7	57	100.0
Income from fish (*mean in Rubles [p] 2006,8 only*)	--[23]	--	9 (*6,204.33 p.*)	15.8
Income from caviar (*mean in Rubles [p] 2006,8 only*)	--	--	9 (*64,667.56 p.*)	15.8
Income from fish and caviar combined (2004 only)	5	9.6	--	--
Gathering of non-timber forest	52	100.0	55	96.5
Income earned (*mean in Rubles [p] 2006,8 only*)	25 (*8,846.32 p.*)	48.1	24 (*21,854.48 p.*)	42.1
Exchanged or given away	22	42.3	12	52.2
Frequency of use/week:				
• Every day	30	57.7	20	47.6
• 2-3 times	9	17.3	15	35.7
• 1 time	7	13.5	3	7.1
• <1 time	4	7.7	3	7.1

[23] Indicates missing or unavailable data.

• n/a	2	3.8	1	2.4
Small-scale timbering	4	7.7	16	28.1
Income earned	2	3.8	0	0
Hunting	7	13.5	17	29.8
Income earned (*mean in Rubles [p] 2006,8 only*)	--	--	3 (*41,125.00 p.*)	5.3
Farming (for profit—2004only)	6	11.5	--	--
Total livelihood activities score *(sum of livelihood activities pursued based on assigned ordinal scores—see Table 7-4)***:**				
• **5**	1	1.9	--	--
• **9**	1	1.9	--	--
• **10**	5	9.6	--	--
• **11**	--	--	1	1.8
• **13**	3	5.8	1	1.8
• **14**	--	--	23	40.4
• **15**	25	48.1	6	10.5
• **16**	1	1.9	3	5.3
• **17**	3	5.8	6	10.5
• **18**	9	17.3	8	14.0
• **19**	4	7.7	3	5.3
• **20**	--	--	4	7.0
• **21**	--	--	2	3.5

Table E-2: 2006,8 only. Contribution of livelihood activities to total household food budget, and importance ranking of activity to household livelihood.

Livelihood Activity / *House-hold response / Percentage of all households N=57*	***Garden production***	***Livestock***	***Fishing/ caviar***	***Non-timber forest products***	***Small-scale timbering***	***Hunting***
Percent of Food Budget:						
• >60%	27 / 47.4	1 / 1.8	5 / 8.8	--	--	--
• 40-60%	13 /22.8	3 / 5.3	11 / 19.3	3 / 5.3	--	1 / 1.8
• <40%	6 / 10.5	5 / 8.8	12 / 21.1	22 / 38.6	--	3 / 5.3
• n/a[24]	11 / 19.3	48 / 84.2	29 / 50.9	32 / 56.1	--	53 / 93.0
Importance Ranking:						
• 1st	**48 / 84.2**	3 / 5.3	**10 / 17.5**	--	2 / 3.5	1 / 1.8
• 2nd	5 / 8.8	4 / 7.0	**16 / 28.1**	**21 / 36.8**	--	2 / 3.5
• 3rd	1 / 1.8	4 / 7.0	8 / 14.0	**15 / 26.3**	2 / 3.5	1 / 1.8
• 4th	--	1 / 1.8	--	4 / 7.0	3 / 5.3	3 / 5.3
• 5th	--	--	2 / 3.5	--	1 / 1.8	3 / 5.3
• 6th	--	--	--	--	--	1 / 1.8

[24] Although consistency was strived for throughout the interview process, not every respondent was able to estimate the percentage that each livelihood activity contributed to their overall food budget; thus, there are areas of missing data. Also, ties occurred in the rankings.