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PINE NUTS IN PRIMORSKY PROVINCE: CHALLENGES AND OPPORTUNITIES.

Pine nuts in Primorsky province: Challenges and Opportunities.

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CONTENTS

1. INTRODUCTION

The Amur-Heilongjiang temperate mixed forests are the most biologically diverse temperate forests in Asia, and among them the mixed conifer broadleaved forest of Primorsky province (also known as *Ussuri Taiga*) are defined by greatest diversity (Simonov and Dahmer, 2008). Over-logging and wildfires pose the main threat to these forests, whereas climate change is introducing new risks such as diseases or drought events. In order to address these new and existing risks, new management strategies are needed for the conservation of these mixed conifer broadleaved forests. In this sense, multifunctional forest management practices are a key land use strategy, capable of meeting divergent societal interests, supporting forestry practices acceptable to different social groups, and remaining consistent with the principles of sustainable development (Schmithüsen, 2007).

Derived from these multifunctional forests, non-wood forest products (NWFPs) are of importance for the development of rural areas. In the Russian Far East, especially in Primorsky province, the collection of non-wood forest products such as the gathering of nuts, wild berries and other edible, medicinal or aromatic plants, or forest beekeeping, is very prevalent. The benefits from these uses contribute to sustainable forest management and conservation strategies while creating new livelihood options for rural and forest-dependent communities. Often, non-wood product forests are collected individually and sold directly to sustain local family-owned enterprises and business.

One of the most relevant NWFPs foraged in Ussuri Taiga are pine nuts. The collection of Korean pine cones and the extraction of their edible seeds, known as pine nuts, is an example of sustainable forest-based local economy. It creates strong incentives to protect forest ecosystems and it supports local economy.

The main objective of this study is to assess the current status of the pine nuts sector of Primorsky province in terms of its obstacles and opportunities, to identify the gaps between the needs of the sector and its current conditions, in order to suggest the ways to improve the institutional and regulatory context and to create a stronger portfolio of market strategies, both domestic and international.

2. FOREST SYSTEMS OF PRIMORSKY PROVINCE

2.1 FOREST OF PRIMORSKY PROVINCE: DISTRIBUTION AND CONSERVATION STATUS

Primorsky province (165,900 km^2) is the southernmost part of the Far East Federal District of Russia, comprising most of the Russian part of the Ussuri river basin, especially the Sikhote-Alin mountain range that extends between the Pacific coast and the Western Primorye lowlands, where the Ussuri river flows north toward the Amur river demarcating the Russian-Chinese border. In its entirety, the Amur river basin covers a territory of 1.8 million km^2, of which 55 % is within Russia. With a total length of around 4,500 km, the Amur is one of the ten largest rivers in the world and the last free-flowing major river in Asia (Simonov and Egidarev, 2018). The Amur river ecoregion is among the most diverse places in the world in terms of species and habitats, including emblematic forest species such as the Amur tiger (*Panthera tigris altaica*) and the Far Eastern leopard (*Panthera pardus orientalis*). The south part of the Ussuri river basin, the southern corner of the Amur ecoregion, contains very rich mixed conifer broadleaved forests of high ecological value (Figure 1).

Mixed conifer broadleaved forests: distribution, ecology and uses

Known as "Ussuri taiga", this region of temperate mixed conifer broadleaved forests has long, cold winters, and mild and humid summers. The climate is characterized by high variation in temperatures, both daily and seasonally, with dry winters and cool summers. The average temperature in January is -27.2 C degrees, and +17.3 C degrees in August ("Global Species - Ecoregions" 2019).

The elevation gradient in the Russian Far East causes a change in vegetation. The general sequence of vertical zones repeats a sequence from south to north appearing from bottom to top as summer-green broadleaved forests, mixed conifer broadleaved forest (Ussuri taiga), dark conifer evergreen forests, *Betula ermanii* forests, *Pinus pumila* thickets and alpine tundra (Okitsu, 2003).

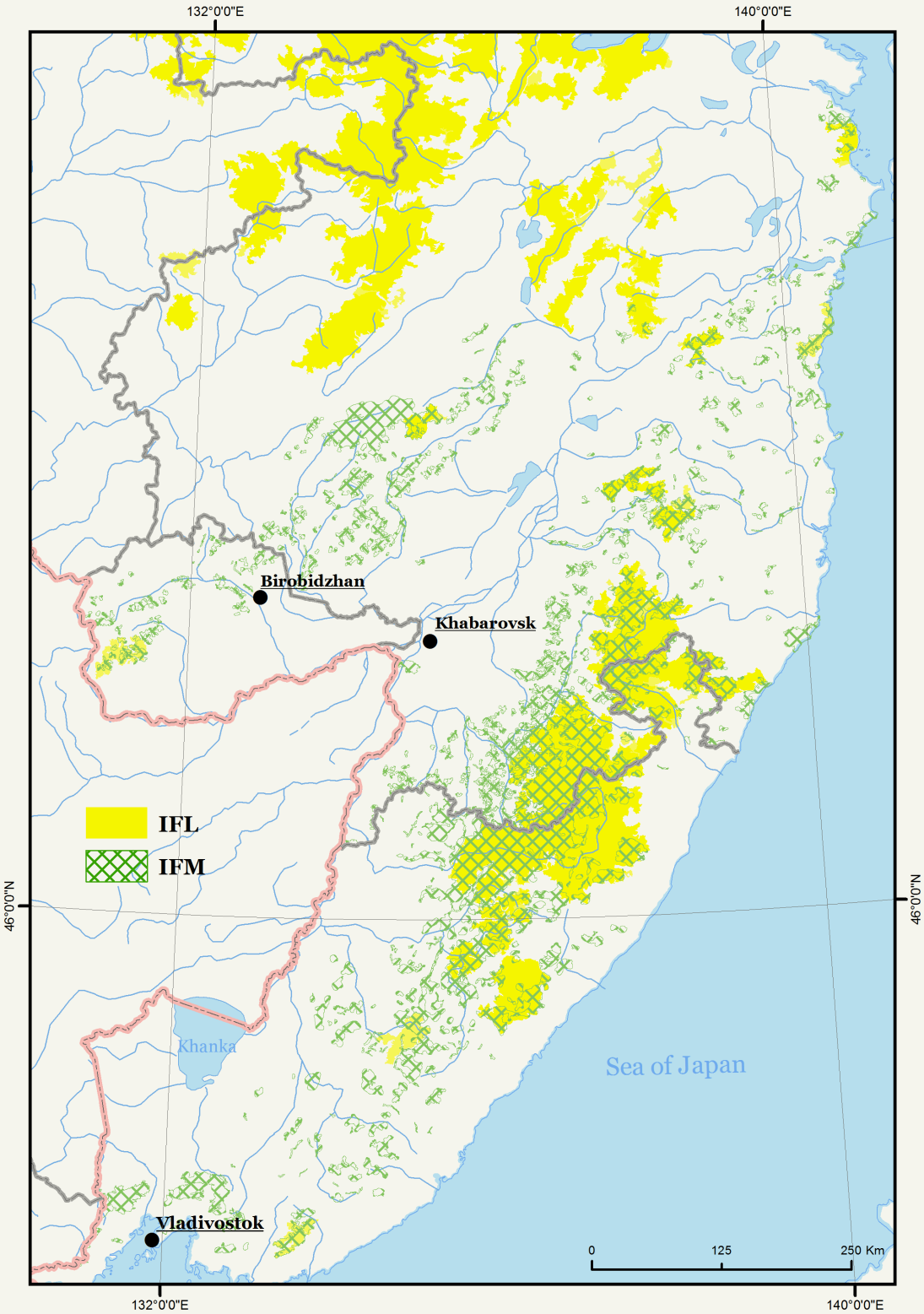

Figure 1. Intact Forest Landscapes (IFL) and Intact Forest Massifs (IFM) in Primorsky and Khabarovksy provinces. Intact forests landscapes are defined as large areas of unfragmented primary (wild) forests and treeless ecosystems least affected by human activity, with a minimum extent of 500 km². Intact Forests Massifs are undisturbed areas of at least 10 km² (Potapov *et al.*, 2017). In 2016, there were 17,5 million hectares of IFL in Primorsky and Khabarovsky province; and almost 6 million hectares of Intact Forest Massifs (they often overlap). *Source: the Amur Branch WWF Russia.*

Its location, climate influence, and palaeobotany make Ussuri taiga the most biologically diverse forest in northern Asia (Simonov and Dahmer, 2008). The maritime influence moderates the climate, precipitation is high enough to support rich forests, and the region is a boundary area between mountains, river plains and seacoast. These forests form the lower vegetation belt from the sea level up to altitudes of 800-900 m. The region is also sensitive to global climate changes as it is under the influence of cold airflow from north-eastern Asia during the winter and summer monsoons, whose pattern might be altered by global warming.

Ussuri mixed conifer broadleaved forests are co-dominated by *Pinus koraiensis* with various broadleaved tree species such as *Tilia amurensis, Tilia mandshurica, Fraxinus mandshurica, Quercus mongolica, Betula costata, Kalopanax septemlobus, Phellodendron amurense* or *Ulmus japonica* (Kolesnikov, 1956; Krestov, 1997) (Figures 3-6).

Mixed conifer broadleaved forests include different tree and shrub layers, formed by species of different growth forms and diverse life strategies (Figure 2). The usual top height of the tree layer is 25-35 m, but Korean pine can reach 45 m overtopping the canopy of other tree species. Uneven-aged structure is a characteristic feature of old-growth Korean pine broadleaved forests. This results in a highly heterogeneous stand structure where all diameter classes are present. Trees in such stands grow in cohorts reflecting the gap character of stand dynamics. Lower canopy sublayers (though without clear boundaries) occupy space from 12-20 m above ground (*Acer mandshuricum*, *Acer mono*, *Maackia amurensis* or *Ulmus laciniata*), , and at 6-10 m formed by most shade tolerant species (*Acer pseudosieboldianum*, *Acer ukurubduense*, *Carpinus cordata*, *Lingustrina amureniss* and *Padus avium*).

Shrubs in the mixed conifer broadleaved forests are diverse and abundant. Commonly the shrub layer is sparse under the canopy, sometimes very dense in gaps. This layer is important in regulating the development of the tree saplings. The herb layer is normally well developed, and mosses are present at extremely cold and/or extremely dry sites.

Figure 2. Profile of a typical stand of mixed Korean pine broadleaved forest on the Sikhote-Alin Range: 1 = *Pinus koraiensis*, 2 = *Abies nephrolepis*, 3 = *Betula costata*, 4 = *Tilia amurensis*, 5 = *Acer mono*, 6 = *Acer ukurunduense*, 7 = *Acer tegmentosum* (Source: Krestov, 2003).

Korean pine nuts and Mongolian oak acorns are the basis for the main food webs in the Ussuri taiga. They play an important role in Amur tiger conservation as key food source for rodents, black bear (*Ursus thibetanus*), and wild boar *(Sus scrofa*), the primary prey for Amur tiger (*Panthera tigris altaica*) and the Amur leopard (*Panthera pardus orientalis*), as well as for smaller predators of the mink family specialised in small rodents. Also dependent

on the ecosystem are a number of deer species. The population of wolves is controlled mainly by competition of tigers, with a similar ecological niche. The forest avifauna is also rich (Andersson, 2005).

The Sikhote-Alin range is one of the few places where significant areas of old-growth Korean pine-broadleaved forest remain intact. This forest type overlaps closely with the range of the Amur tiger and plays an important role on its conservation.

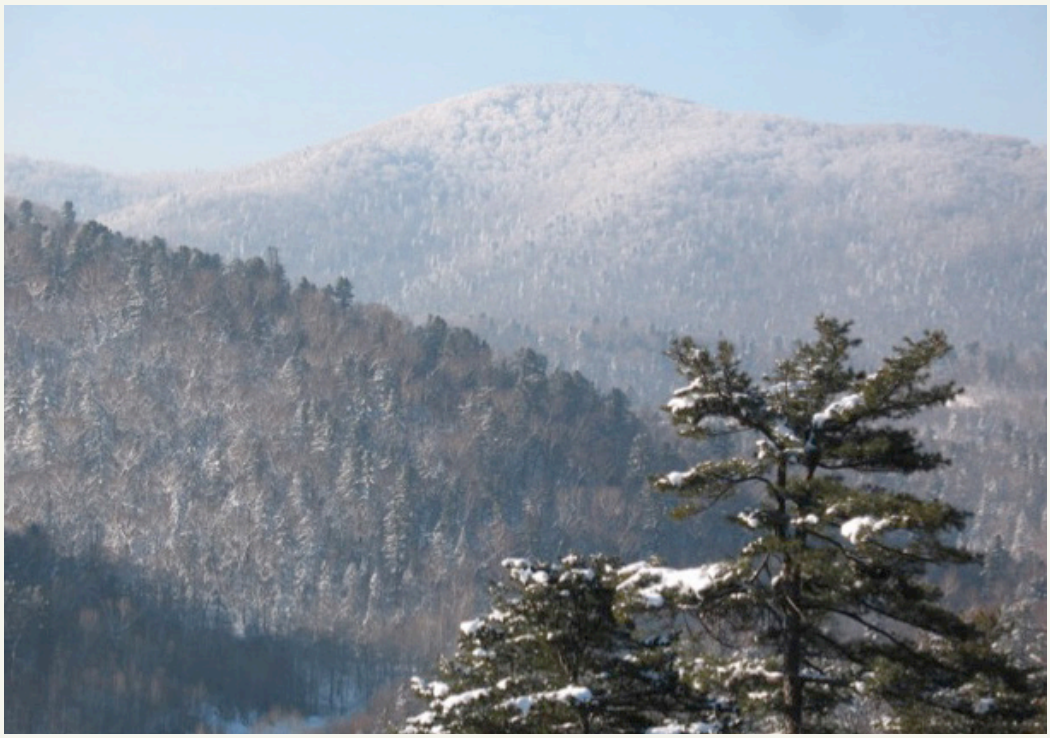

Figure 3. Landscape view of mixed conifer broadleaved forests in the Russian Far East.

Figure 4. Landscape view of mixed conifer broadleaved forests in the Russian Far East.

Figure 5. Landscape view of mixed conifer broadleaved forests in the Russian Far East.

Figure 6. Presence of dead wood in mixed conifer broadleaved forests in the Russian Far East.

2.2 SOURCING FUNCTION OF KOREAN PINE FOREST ECOSYSTEMS

The Korean pine (*Pinus koraiensis*), called in Russia "Korean cedar," or *Корéйский кедр,* is widely distributed in Northeast China, the Korean Peninsula, Japan, and in the Russian Far East where it is one of the most valuable and commercially important timber and nut production species (Jin *et al.*, 2017) (Figure 7). In the north of its range, it grows from 600 m to 900 m, whereas further south it reaches 2,600 m (Changbai Shan range).

The Korean pine is a large tree that in its native habitat and growing conditions can reach 30-50 m, with long green or purple cones. It is a pyramidal shaped tree with a gray-brown bark. Flowers in May and cones mature in October of the following year (Figure 8 and Figure 9).

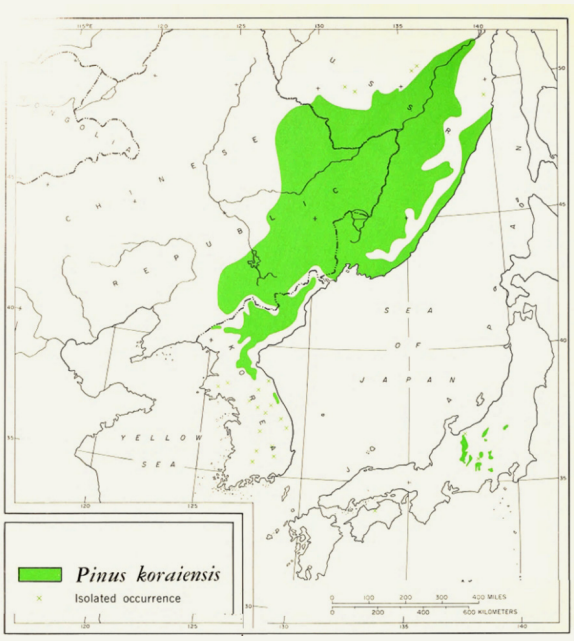

Figure 7. Historic distribution of Korean pine forest *(adapt*. Critchfield and Little, 1966).

Figure 8. Old Korean pine, Vostretsovo (Primorsky province)

Figure 9. Korean pine illustration *(by Matt Strie by source: https://www.conifers.org/pi/Pinus_koraiensis.php consulted November 2018*)

Korean pine timber is esteemed and had been used widely due to its straight grain, small shrinkage and small deformation. The wood is versatile and very useful for construction. It is light, and easy to work. It had also been used for a great variety of products, including telephone poles, railroad ties, bridges, boats, plywood and flooring, furniture, sports equipment, and musical instruments. It is easy to break down into chips, particle board, or pulp for paper. In Northeast China, it is most popular tree for forest plantations, exceeding 0.5 million hectares (Shen, 2015).

Its seeds, the Korean pine nut kernel, are a nutritious source of protein (amino acids) and oil (fatty acids), with vitamins and some fatty acids that are essential for human body (Shen, 2003; Zhang *et al.*, 2016). The nut oil contains 11.5% of the unusual fatty acid pinolenic acid.

Korean pine has been considered unique in traditional pharmacy. All parts (needles, wood, cones, seeds, etc.) have different medicinal properties attributed by local traditions, used to treat many diseases. Needles have antiscorbutic properties. They are also used for coniferous baths. Resin (cedar tar) is an antiseptic and is used for the preparation of patches and ointments. Turpentine and rosin are obtained from resin by distillation. The tree is also a source of tannin. These products are a medicinal raw material. Oil obtained from Korean pine cones or needles is a curative remedy used both in medicine and in cosmetic industry. It is rich in vitamins, microelements, and vegetable proteins. When pine nut processing was still done manually, even the thin film around the kernels was held back separately, to be used as pillow filler, due to folk medicine attributing it curative and a preventive phytotherapeutic properties (Gukov *et al.*, 2017). Today, it is mostly cones from Korean pine which are valuable to local villagers who depend on pine nut sales for their livelihoods.

In the understory grow more than 200 medicinal and aromatic plant species that can be used for medical purposes (Schroeter, 1975), outstanding the wild ginseng, collected by local communities. Other trees species are the endemic Far East linden trees, such as Take linden (*Tilia taquetii*), Amur linden (*Tilia amurensis*) and Manchurian linden (*Tilia mandshurica*) that provide nectar as base for beekeeping.

2.2 THREATS: ILLEGAL LOGGING AND WILDFIRES

In the last decades, the amount of old-growth Korean pine broadleaved forests in the area has decreased drastically as a result of over-logging and wildfires. From 1950 to 2000, the 14.5 million hectars were lost, i.e. more than 80 % of the original area (Figure 10).

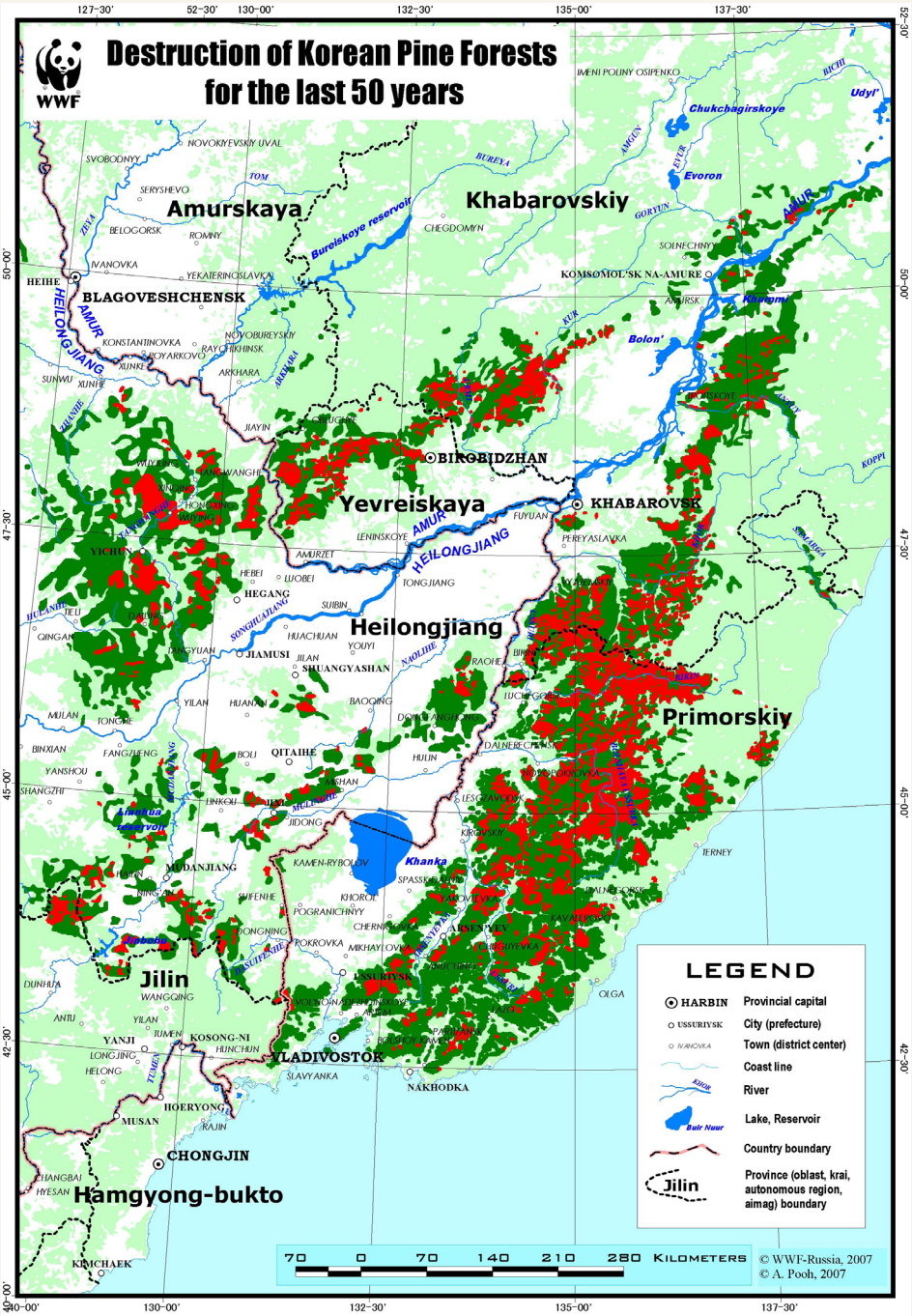

Figure 10. Loss of Korean pine forests in the Amur ecoregion from 1950 until 2000. The Korean pine broadleaved forests occupied in 1950 17,471,140 hectares. In red, the Korean pine forests in 2000 (3,013,933 hectares). In green, the loss of 14.5 million hectares in 50 years. *Source: The Amur Branch of WWF Russia.*

After experiencing single logging and/or fire events, Korean pine broadleaved forests are replaced by secondary forest formed by *Betula platyphylla* and *Larix dahurica* forests (350,000 ha). Yet after repeated logging or several fires, most secondary forests are dominated by either *Quercus mongolica* (1,500,000 ha), especially near human settlements, or they are converted to agricultural land (1,200,000 ha), which nowadays are often fallen fallow (Andersson, 2005).

Illegal logging and overlogging

In the last years, mixed conifer broadleaved forests have been seriously degraded by rampant illegal logging or over-logging. Specially affected have been Korean pine trees for its high-quality timber. Currently, Russian Far East forestry sector is strongly orientated towards roundwood and sawnwood exports to Northeast China where logging in natural forests is banned (Fedichkina and Lankin, 2016). China's logging ban creates additional pressure over nearby primary forests located in the Russian Far East. Illegal logging in the area represents a threat to forests, biodiversity and to responsible businesses (Smirnov, *et al.*, 2013).

In response to this situation, in 2010 Russia listed the Korean pine in Appendix III of CITES (*Convention on International Trade in Endangered Species*). The new rules created a new layer of protection for the species; exports of Korean pine need CITES permits, making it harder for the illegal timber trade to continue. In 2014, Mongolian oak (*Quercus mongolica*) and Manchurian ash (*Fraxinus mandshurica*) were also listed in Appendix III of CITES. At the same year, in advance of the Global Tiger Summit in St. Petersburg, President Putin added Korean pine to the list of species for which all logging was banned. Consequently, no logging of Korean pine is currently permitted in the Russian Far East [1].

Unfortunately, CITES compliance is currently difficult, as the government body with the control function (*Rosprirodnadzor*) is not authorized to control forestry activities and sales in forest areas, which instead is the responsibility of the provincial forest management departments and of the prosecution service. The lack of effective coordination, significant drawbacks in the primary accounting of timber, and insufficient funding allocated to state forest services – are among the causes of the over-logging of high value tree species in primary forests and in the areas where felling should not take place at all (Fedichkina and Lankin 2016).

Fellings declared as putatively sanitary or selective logging remain another problem for mixed Korean pine broadleaved forests. The presence of lumberjacks in an area is authorized through a veil of official documents, to only camouflage the creaming of the best commercial and highest value trees otherwise prohibited by forest legislation to harvest, instead of damaged or low-quality timber. The reporting documentation is deceptive whereas state control over law implementation and holding violators accountable remain inefficient (Feditchkina and Lankin, 2016).

These abuses, done on a large scale by commercial companies, largely contribute to the problem of illegal (or logging over permitted volume). People from local communities are left out of these highly profitable and illegal equations. They rely on timber mostly for personal use. These problems are exacerbated by corruption at the borders, allowing the passage of illegally harvested timber from Russian to China, despite a very long list of required documentation designed to ensure legality, even for those species not listed in CITES Appendix III (WWF, 2018).

After Korean pine, hardwoods are especially susceptible to illegal logging. Among valuable hardwoods, the most affected species are Mongolian oak (*Quercus mongolica*), Manchurian ash (*Fraxinus mandshurica*), Japanese elm (*Ulmus propinqua*), Amur linden (*Tilia amurensis*) and Manchurian linden (*Tilia manshurica*) (Figure 11). These species grow only on certain sites and their harvesting is strictly limited. However, their timber is highly demanded and paid for, which stimulates intensive searches for plundering high quality hardwood old growth. Large volumes of hardwoods, exceeding legal limits, are still being exported mainly to China to feed massive domestic and global demand for cheap furniture and flooring.

1 WWF Forests, Pine Nuts and Tigers. Inside the effort to save Russia's great cat. https://www.worldwildlife.org/magazine/issues/fall-2014/articles/forests-pine-nuts-and-tigers

In the area of the province closest to the Chinese border, illegal logging is estimated between 50–70 % of all harvesting, predominantly transported by trucks to Russian-Chinese border crossings and to southern sea ports, both for transport to China. In the rest of Primorsky province, the illegal timber is mostly transported by rail or to the eastern sea ports and it is estimated between 40-50 % of all harvesting (Smirnov *et al.*, 2013).

The consequences of illegal logging on affected stands are negative for forest ecosystem resilience:

- the obliteration of natural undergrowth, which eliminates a potential source of natural regeneration;
- the destruction of the forest floor due to skidder tracks, owing to a lack of silviculture technology; this exposes mineral soils and instigates soil erosion;
- the introduction of debris and slash to cutting sites, increasing the fire hazard.

Moreover, forest degradation from illegal logging threatens traditional livelihoods of taiga villagers and indigenous people, including hunting, forest beekeeping and pine nut collection (Smirnov, 2013).

Figure 11. Sites of illegal logging with a felled Mongolian oak (on the left) in the mixed conifer broadleaved forests (on the right).

Wildfires

Fires are frequent in Russia's boreal forests and often it is the main disturbance factor. Many fire scars are visible across the landscape and vegetation patterns often dominated by evidence of past fire history, favouring the occurrence of simplified, often nearly pure Mongolian oak stands, frequently with reduced canopy closure (Figure 12). Wildfires can hugely influence the local biome by changing the vegetation cover, shaping the vegetation structure and altering the local climate (Wu *et al.*, 2018). Moreover, wildfires represent the main factor that determines the dynamics of carbon pools in the ecosystems of boreal forests.

Stands of mixed conifer broadleaved forests usually have a complex structure as mentioned above (see chapter 2.1), there may be two tree strata and one or several shrub strata besides a species-rich herb layer. The level of different strata of Korean pine broadleaved forests suggests an adaptation to low intensity fires (Figure 13). In fact, the lack of fire due to firefighting can direct those stands to overcrowded forest, much more sensitive to drought, climate change and wind storms or fire storms (Agee, 1993).

Forest fires present a positive and a negative face. This two-faced role of forest fires is evident in the boreal zone. In the southern and central parts of the zone, forest fires are one of the most dangerous environmental phenomena, causing significant economic losses with a strong negative ecological impact on forest ecosystems and biodiversity. On the contrary, in unmanaged and unused forests of the northern and sparsely stocked taiga and forest tundra, particularly on permafrost sites, surface fires occurring at long-return intervals of 80 to 100 years represent a natural

mechanism that prevents the transformation of shrubland or grassland to forests. Under severe climatic conditions, fire is often responsible for forest decline and extension of the tundra to the south. Fire is the major reason for the "human-induced" treeless belt along the boundary between the taiga and tundra in northern Eurasia. It presently is 100-250 km wide and its area increases by 0.3 million ha per year (Shvidenko and Schepaschenko, 2013).

Global change models suggest that boreal systems are likely to be among the most susceptible to elevated temperature (Gauthier *et al.*, 2015; Olsson, 2009), perhaps leading to greater fire hazard, longer fire seasons, and increased fire severity. It is important to recognize the episodic nature of severe fire seasons throughout the boreal (and temperate) zones. It is highly likely that global climate change will be reflected not only in increases in average burned area in the boreal zone, but in both increased amplitude of interannual variations in burned area and severity, and an increase in the number of regions simultaneously experiencing high fire years when they occur. Combined impacts of these types of changes with changing capacities for fire management in boreal forest countries have the potential to cause severe alterations in fire regimes. Changes in fire severity or in fire return interval can have major impacts on carbon sequestration and forest health and sustainability (Kasischke *et al.*, 1995).

However, it is possible to observe in disturbed but species-rich secondary forests abundant regeneration of Korean pine and other species under the canopy (fig. 13), indicating the potential of the forest ecosystem for resilience and restoration if pressure by felling of burning diminished.

Figure 12. Signs of fire presence in a secondary forest derived from mixed conifer broadleaved forest in Primorsky province.

Figure 13. Abundant regeneration of *Pinus koraiensis* under disturbed secondary forest canopy in Primorsky province.

3. INSTITUTIONAL FRAMEWORK

3.1 LAND TENURE RIGHTS, FOREST LEASES AND NUT HARVESTING ZONES

The sustainability of forest uses depends on both natural (environmental) and human factors. Formal and informal rules have been designed to structure expectations, interactions and practices in the forestry sector. Currently, two federal laws govern over Russia's forestry sector – the 2006 Forestry Code (*Lesnoy Codex*) and the 2001 Land Code (*Zemelny Codex*), specifying the repertoires of users' property rights and responsibilities. Although 95% of land, including forests, is public (owned by the state), land tenure is not limited to the question of formal ownership. The configuration of property rights plays a crucial role in creating incentives (and disincentives) for sustainable forest use by differentiating between the classes of forest users: owners, proprietors, claimants, authorized users and authorized entrants (Ostrom, 1999).

A full ownership includes the decision-making over the full spectrum of rights, from the right of alienation of transferring the land, such as selling, to the right of management that include decisions about the maintenance, harvesting volumes and various limits including environmental limits. I

Under the last category ("authorized entrant"), in Russia the right of free access to public forests is granted to all citizens by article 11 of the Forestry Code, including certain withdrawal rights such as hunting, fishing and foraging activities including collecting pine nuts for private use. It is similar to public access rights or "right to roam" adopted in Nordic, Baltic and Central European countries.

Nevertheless, the majority of Primorsky forests suitable for logging, also containing non-timber forest products, are leased to logging companies as long-term leases , granting them the rights of management and commercial use in exchange for these companies to carry out long-term management plan of the leased areas. The logging companies control the right of withdrawal (but cannot limit the right of access) and lease out, as sub-leases, forest stands for the commercial harvesting of wood and non-wood products.

To regulate over the withdrawal of pine nuts from forests for commercial uses, and also to protect forests defined by high productivity of pine nuts from being logged, a special land designation category was adopted, the Nut Harvesting Zones. The history of this designation goes back to the 1950s when the NHZs were first designated. Only sanitary logging was allowed in the NHZs where all commercial logging was banned by law. Given the reality of misgovernance and illegal logging conducted under the name of "sanitary

logging," Russian government banned all logging activities in the PHZs (Federal Law 140177-7, adopted on July 1, 2019).

During the time of the late Soviet economy, collecting pine nuts was quite common, providing secondary income to many rural people in Primorsky and Khabarovsky provinces. A well-organized distribution structure took care of pine nut marketing and sales via the network of co-ops run by the state, where rural populations could sell non-timber forest products which included forest honey, pine nuts, berries, mushrooms and other "gifts of the forests." The distribution and re-sale was organized via specialized stores titled "Dari Taigi" - "the Gifts of Taiga" run in many rural towns and large cities. After the collapse of the Soviet economy, the system of state-run forest co-ops was discontinued, leaving pine nut collectors to their own devices in terms of marketing and sales.

Today, this state network of distributing of the non wood forest products no longer exists. The commercial uses of forests are regulated by the Russian Forest Code, whereas marketing distribution of these products is the responsibility of pine collectors themselves, not consolidated in any professional association or union.

4. PINE NUTS IN THE RUSSIAN FAR EAST

4.1 PINE NUTS PRODUCTION AND PROCESSING

In the Russian Far East, no Korean pine plantations currently exist and even nurseries to cultivate pine seedlings for plantation purposes are rare. However, from experiences in Northeast China, where more than half a million hectares of Korean pine have been planted since 1950, it is known that management schedules for silvicultural practices (i.e. thinning) are being successful for increasing both timber and cone production (Jin et al., 2017; Nguyen *et al.*, 2019).

The product of the Korean pine that offers the highest market value, and without compromising the persistence of the ecosystem, are the edible pine nut kernels obtained from its cones. This emblematic product is considered a delicacy, not only consumed habitually by locals, but also valued by kitchen professionals and pastry masters who call the pine nuts "taiga diamonds". The major part of annual production of the Russian Far East is exported inshell or half-processed to China and Metropolitan Russia, where the kernel is cleaned, packed and re-exported with high added value withhold only there. Sourced from these informal imports from the Russian Far East, as unprocessed cones or inshell pine nuts, China is thus considered to be the main pine nut kernel exporter worldwide, while Russia appears as a minor player in official figures (INC, 2015).

The cones of Korean pine become ripe one and a half year after spring pollination. They fall usually in autumn with the first frosts and on windy days, though some can remain on trees until winter. The sizes of ripe cones make from 8 to 17 cm in length, they are ovate-elongated with deflected scales (Gukov *et al.*, 2017). Each cone weighs about 280 g fresh (120 g dry) and contains around 120 seeds, or pine nuts (55 g, 47% of weight of the dry cone, 20% of the fresh cone); each seed (less than 0.5 g, 12-16 mm) is coated with a hard, woody shell (60% of its weight). The kernel (0.18 g) appears within is cream white, covered with a thin, dry tegument or film that is easily removed (Figure 14). These yield rates imply that only one sixth (18%) of the dry cone weight are edible kernels, i.e. 8% of the weight of fresh harvested cones: for 1 kg kernel, about 12 kg cones are processed (Nguyen *et al.,* 2019).

Pine nuts are currently highly priced in international markets. Their collection (along with other non-timber forest products) might be one of the most important livelihood strategies for residents in forest and adjacent areas and harvesting them might have profound positive influence on forest farmer's economy (FAO, 1998; FAO, 2013).

4 Personal interview with the head of the trade union of regional aviation workers of Khabarovsky province, who is now a beekeeper. November 16th, 2018, Vladivostok, International Beekeeping Forum.

Figure 14. Cones and pine nut kernels of Korean pine.

In good crop years, the volume of nuts harvested in Russian Far East (Khabarovsky province, Primorsky province and Amurskaya province) reaches 20 to 30 thousand tonnes inshell. Mean pine nut yield in Russian Far East was reported in 2,300 t, with best crops exceeding 4,600 t from leased Seed Harvesting Zones (SHZ) (2008-2014). Until the legal reform in 2007, when collecting from other forest areas was free and could be sold in the formal market, official annual yield was about 10,000 t (2000-2007), and even 19,400 t in bumper crop 2004, equivalent to 48,500 tonnes of cones (Lepeshkin, 2018).

Note that the ratio of this yield to the total area of Ussuri Taiga (2,88 million hectares) would be less than 7 kg/ha pine nuts (16 kg/ha cones). On the contrary, assuming a mean per-hectare yield of, for instance, 500 kg cones, an effectively harvested area of only 50,000-100,000 hectares would be estimated. In northeast China, for instance, a mean seed production around 15 kg per tree has been estimated and 100-300 kg per hectare/ha, equivalent to 250-750 kg/ha cones (7-20 harvested trees per hectare) (Shen, 2015). If 50-100 harvested matures pines per hectare were assumed, this figure would agree with mean productions of 2-4 t/ha cones reported by Nguyen *et al.* (2019).

However, cone production is very variable not only between zones in the same year, but also between years, being in mast years 4–12 times higher than in non-mast years (Nguyen *et al.*, 2019). The variable that mostly determine cone production of a tree is its size (stem and crown diameter), and the per hectare output, depends also on the number of cone-bearing trees per hectare and the site quality. Nevertheless, since the collapse of effective forest administration after the end of the Soviet Union, no sound annual data of cone and seed yields per municipalities are available.

Harvesting

Cone harvesting is done manually in autumn (until November 15th) by climbing the tree and throwing them using a hooked pole. This hard and dangerous job is often performed by working parties consisting of dozens of men camping in the harvesting area within the forest and shifting during the crop season. They can work as self-employed or be hired by enterprises who hold Nut Harvesting Zone leases.

Processing

There are three successive products according to the processing phase; pine cones, pine nuts and kernels. The process of obtaining the final product, the shelled and clean kernel (Figure 15) begins with the collection of the cones, which takes place between September and December, and on the excellent crop year can extend to next spring and summer.

Figure 15. Pine nuts processing.
First row: Cones are crashed in mills for separating inshell pine nuts from scales and debris; second row: pine nuts are sieved into different size classes; third row: shelling machines and kernels drying in stoves (still before separating from shell rests).

In autumn, the scales of the cones are already quite dry and therefore release the pine nuts easily when moved and passed through mills, before separating the pine nuts by sieving from rests of cone scales and rachis. The inshell pine nuts can be stored and, according to the demand, shelled and processed.

Before processing, pine nuts are classified by size. Once cracked in mills, their kernels are separated from the woody shell debris. To eliminate impurities from kernels obtained, a selection and separation of the defective ones is made using sorting machines with photoelectric and colorimetric cells (Sortex) that distinguish rancid pine nut kernels by colour. Finally, a final manual selection by hand is done, as a quality control.

The process continues with the brushing of the kernels to remove the film, a thinner protective brownish layer covering it. Depending on the quality and appearance of the kernel, and when it is going to be consumed, the appearance is improved by washing with water, and drying immediately to 4 % standard humidity.

As all woody cone debris and shells can be used as fuel in small boilers at the same processing companies, or in private homes, or as mulch in gardening, the cone processing is almost waste free.

Product fluxes and international trade

A large portion of the nuts harvested in Primorsky is exported as inshell (Figure 16), mainly to China.

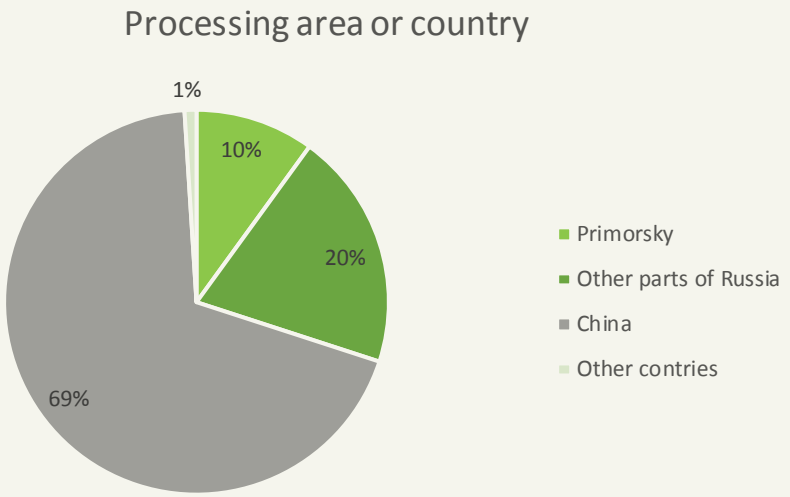

Figure 16. Regions where the pine nuts collected in the Primorsky province are processed (Lepeshkin, 2018).

Only 10% of pine nuts collected in Primorsky province remains in the province for further processing. 20% are processed in other Russian regions, and 69% are sold to China as inshell, for processing. Additionally, half of the kernels processed in Primorsky province are exported to China, too. The rest is distributed through domestic trading networks (25%) and regional retail (25%).

The price paid to the producer (cone processor) in factory is about 1,000 ₽/kg clean kernel (13.33 €/kg), though a large proportion is still exported cheaper before sieving kernel from shell rests, for final processing in Chinese factories that depend on this supply from Russia (O. Lee, comm. pers. 2018).

Main companies in the sector

Major countries that consume pine nuts are China, the Unites States, as well as other countries of Asia Pacific Region, and Europe. However, direct supply of pine nuts from Russia to other countries is quite difficult without an intermediary country, which is China.

The reasons that are preventing a direct supply from Russia to other countries without the intermediary are related to the complex and time-consuming process of registration permits for export (license) and the current political context.

There are six companies in Primorsky province that are leasing forest lots for harvesting pine nuts, from which only one is involved in processing, the rest are involved in harvesting and exporting (Table 1).

Table 1. Companies that are leasing forest lots.

Company	Harvesting	Processing	Exporting
“Mining Processing Plant “ Jsc (Dalnerechesk) ГОК	■		■
“Partner” Ltd (Kovalerovo)	■		■
“Tiger” community (Bikin)	■		■
“Proizvodstvenno-zagotovitelnaya baza” Ltd (Arseniev)	■	■	■
“Sidatun” Ltd	■		■
“Krechet” Interregional Public Organization Society of Hunters Fishermen	■		■

There are also several companies in the region that are purchasing pine nuts from freelance cone pickers who harvest for private use. Those companies also participate in processing and distribution of pine nuts. However, since the 2007 Russia’s legal reform, they are not able to legalize their operation completely due to the absence of legal documents on the origin of the raw material. The regions where those companies operate are the village of Mikhailovka (Mikhailovsky district) and the cities of Spassk, Dalnerechensk and Vladivostok.

4.2 PINE NUTS IN THE CONTEXT OF RURAL AREAS DEVELOPMENT: SOCIAL, ECONOMIC AND ENVIRONMENTAL FUNCTIONS

Pine nuts sector: social and economic functions

Activities around the harvesting and commercialization of pine nuts, along with other non-wood forest products, represent a useful mean of strengthening livelihoods due to generating employment and creating direct and indirect sources of revenues in rural areas.

Pine nuts harvesting can also be a complementary seasonal activity for agriculture or forestry sectors. In many cases it is an alternative for the diversification of these activities and a supplementary extra income for people living in rural areas.

However, collecting pine cones outside leased Nut Harvesting Zones generates often a very irregular employment with lack of transparency along the value chain. The sector does not have any association or network which could join efforts among small local producers to create a useful platform to sell their products and even to ensure the protection of their source of business, the mixed conifer broadleaved forests.

Participation in an association would help local producers to get in touch with each other, obtain more information on how to produce higher quality product, identify shortcomings and set joint work goals. In addition, producers can seek joint financing and participate in training events, markets, research discoveries and increase their awareness of the industry and opportunities available and rise the products marketing possibilities.

Korean pine, due to its pine nuts production, has a vital social importance, since the economic importance of the tree is not based solely on the value of its product, but also in the benefits it is generating for regional economic development. The reliance on ecosystem services creates strong incentives to protect forests while creating sources of livelihoods in rural communities.

Forests and environmental functions

Mixed conifer broadleaved forests in the Russian Far East are one of the few temperate forests ecosystems that still maintain the big predators such as Amur tiger and leopard and therefore harbours species of all steps of the animal food web. Moreover, pine nuts, as well as other edible nuts growing in these types of forests, serve as a first food source for several animals (rodents, bears or boards) preyed by big predators.

Pine nuts collection and processing can be developed, together with other forest practices, in a framework of multifunctionality and sustainability. Forests play an important role in the economic activity of rural zones, and thus it is essential to expand and increase their economic value while maintaining sustainable and multifunctional forests. Nevertheless, such partnership among the different forest economic sectors is currently missing.

Finally, biodiversity is extremely important for an ecological system because it allows for competition and natural selection among different plant species, thus reducing the risk of disease and vulnerability to pathogens. Mixed conifer broadleaved forests play a key role in human economic, social and healthy development.

Sustainable forest management (SFM) was defined in the *Ministerial Conference on the Protection of Forests in Europe* (November 2009) as:

"the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems".

1. Criteria and indicators have been also adopted to promote sustainable forest management and facilitate the evaluation of progress towards it. The criteria for SFM are: Maintenance and appropriate enhancement of forest resources and their contribution to **global carbon cycles**
2. Maintenance of forest ecosystems' **health and vitality**
3. Maintenance and encouragement of **productive functions** of forests (wood and non-wood)
4. Maintenance, conservation and appropriate enhancement of **biological diversity** in forest ecosystems
5. Maintenance, conservation and appropriate enhancement of **protective functions** in forest management (notably soil and water)
6. Maintenance of other **socio-economic functions** and conditions.

5. PRODUCTION AND MARKET

5.1 PRODUCT CHARACTERISTICS

The pine nuts are collected from natural forest and therefore they are free of any pesticide or chemical product. They have a high nutritional value, contain 14% of easily assimilated proteins, a high content of mono and polyunsaturated fatty acids, and minerals such as potassium, phosphorus, magnesium, iron, folic acid and calcium (Table 2).

Table 2. Chemical components of the Korean pine compared with other pines (Shen, 2015).

Chemical components	*Pinus koraiensis*	*Pinus pinea*	*Pinus edulis*
Water (g/100g)	2.80	5.1	5.9
Fat (g/100g)	67.89	44.9	60.98
Protein (g/100g)	12.76	31.6	11.57
Cruid fiber (g/100g)	3.07	--	10.70
Ash (g/100g)	6.55	4.5	2.26
Carbohydrate (g/100g)	6.93	13.9	19.30
Energy (kcal)	688	583	629

If they are well protected inside the cones, the pine nuts are preserved for more than 5 years. Also removed from the cone, their life inshell is very long if they are kept refrigerated and in dry conditions (between -5 ºC to 2 ºC), but both inshelled or shelled they will deteriorate quickly in warm conditions and in humid environments, becoming rancid or moulded in a few weeks.

The pine nut can be classified according to the size and the way of elaboration (brushed or cleaned). When the pine nut destination is directly the final consumer, the size is extra and it is brushed and washed, while if it goes to the elaboration of others food products, the size is small and only brushed.

Pine nuts can be eaten both raw and roasted. It is a natural product highly demanded by the food industry, used mainly in baking, but it is also used as a culinary seasoning and as an appetizer.

Pine nuts of the Korean pine have a number of advantages over the pine nuts of the Siberian pine, the main advantage is being its larger size.

The most demanded fraction is 580-630 pieces per 100 grams (Figure 17). It is a requirement of American and European retailers. This requirement is achieved by sieves, while the smaller-sized fraction can be sold on the domestic market.

Pine nuts are one of the most expensive nuts on the market, with price of Korean pine nut kernel on the international market reaching 20,000 -22,000 € per tonne. Retail prices of raw nuts range in Russia up to 73 € per kg (16.60 € for a 227 g package). Pine nuts are sold in different formats, with or without the shell. However, taking into account that processors get only 1,000 ₽/kg per clean kernel (13.33 €/kg), and transport costs are not limiting given the small volume of the product, the added value captured by intermediates and traders is big (Table 3).

Figure 17. Examples of packing of pine nuts.

Table 3. Price table for Korean pine nut kernel (2018).

City	Shop	Weight [g]	Price [₽]	₽/kg	€/kg
Moscow	Азбука Вкуса	100 g	512 ₽	5 120 ₽	68.27 €
		200 g	617 ₽	3 085 ₽	41.13 €
Vladivostok	street market	50 g	150 ₽	3 000 ₽	40.00 €
		500 g	950 ₽	1 900 ₽	25.33 €
		500 g	1 000 ₽	2 000 ₽	26.67 €
		1000 g	1 800 ₽	1 800 ₽	24.00 €
		1000 g	2 000 ₽	2 000 ₽	26.67 €
		1000 g	2 400 ₽	2 400 ₽	32.00 €

By analysing the situation on the pine nuts market over the last 15 years, the prices for unprocessed pine nuts inshell were fluctuating from $1,000 USD to $6,000 USD per one tonne, prices for kernel from $15,000 USD to $36,000 USD per tonne. The prices on the domestic market can exceed the export prices. With the existence of illegal export routes, the prices for pine nuts on the domestic market are rising. The prices, however, drop is when pine nut export is under strict government control (Lepeshkin, 2018).

The local retail market in Vladivostok is characterized by:

- Little supply of pine nuts. There are very few brands, but labels indicate the species and harvest year.

-The product is usually packaged in plastic or cellophane bags, vacuum-packed or not.

-The main presentation of pine nuts in retail is just as raw kernels; no elaborated products have not been found except jars of linden honey mixed with pine nuts.

- The packaging usually does not indicate the geographical origin of the pine nut and in any case presents a seal of quality.

In Moscow retail, Korean pine nut kernels are less present, though more expensive, than Siberian ones (*Pinus sibirica*), and both are found in well-sorted supermarkets (*Азбука Вкуса, Город игрушек, Город игрушек, Супермаркет ТЦ «Сокольники»*), but interestingly not in organic food or health sections where for instance walnuts or hazelnuts are available.

5.2 QUALITY REQUIREMENTS AND MARKETING

Only few companies in the region are able to satisfy the product quality requirements of the international market. Those are “Harvesting and Production Foundation” Ltd, “Natsi” Ltd in Siberia and “Vigado” Ltd (Pine Forest) in the Moscow Region.

In order to guarantee the quality of pine nuts, avoiding the adulteration of the product and to have a regulatory framework that minimizes the problems of robbery and tax evasion, it would be necessary to apply traceability rules.

Due to the political context and sanctions, the distribution of the product directly to its main consumer USA directly is difficult. Consequently, the path of the Russian product is Russia-China-USA as well as Western European countries.

In order to implement the direct sales, following strategies are necessary:
1. Development and promotion of brands
2. Participation in international exhibitions.

Currently, the subsidiary of “Harvesting and Production Foundation” Ltd has received a contract for placement on its pine nut product of WWF (Panda) brand. The placement of this logo will enhance promotion and confirm the legality of the product from harvesting to the store shelf.

6. CHALLENGES AND OPPORTUNITIES

6.1 SWOT ANALYSIS OF PRIMORSKY PINE NUTS SECTOR

	Strengths	Weaknesses
Internal	High productivity capacity from the Ussuri taiga, with potential to increase if forest ecosystem conservation state is improved.	Lack of market transparency, which turns against the often-informal pine nuts value chain actors.
	Non wood=non-destructive forest product; if sustainably yielded, plainly compatible with persistence of forest ecosystem conservation, wildlife, etc.	Lack of licenses for commercial harvesting out of leased Nut Harvesting Zones (NHZ) hampers formal commerce of those pine nuts.
	Traditional activity, linked to the territory & culture, esteemed by the rural environment and Russian consumers.	Manual harvest by tree climber, high labour risks associated and strong seasonality (2 month in autumn).
	High quality product, high economic value.	No regional sectorial association network, no distinctive quality mark or regional label for local pine nuts differentiating from other, e.g. the smaller Siberian, pine nuts.
	Excellent product with high demand on world market.	Production based in only one species, Korean pine.
	Seasonally complementary economic activity for rural areas.	Few regional companies that process and trade the pine nuts under own brands, while many cones or unprocessed pine nuts are transported to European Russia or exported more often to China, not withholding added value regionally.
	Opportunities	**Threats**
External	Growing demand in the world market due to problems of competing pine nut species (*P. pinea*), or less appreciation (smaller *P. sibirica*)	Deforestation and overlogging are decreasing the area of the Korean pine broadleaved forests and negatively influenced its productivity.
	Good marketing chance for Product Identity as sustainable, fair, wild-collected product with positive cultural and health connotations (FSC certification & WWF-label or “harvested from tigers land”)	Lack of an enforcement of clear national and regional policy, regulation and standards in this sector and product.
		Climate change. The climate change is altering the rain regime and increasing drought periods, which can lead to extreme weather periods. Also, there are new diseases and plagues that can affect crops production.
		Wildfires. Wildfires are also decreasing the area of Korean pine broadleaved forests

6.2 NEEDS AND GAPS

The Amur ecoregion, and especially the Ussurisky, Sikhote-Alin Nature Reserves and Bikin National park still contains part of old-growth forests, a natural heritage of mankind with unique characteristics and functions that make them an ideal study site for the complexity of primary forests. But out of strictly protected areas, non-wood forest products such as linden honey, pine nuts and medicinal and aromatic plants can offer sustained economic activity supporting the conservation of Ussuri taiga, if extracted in a sustainable rate and manner.

Modern comprehensive scientific studies of mixed conifer broadleaved forests of the Far East provide a good reason to consider their lifelong use as the only sustainable alternative for the further development of Primorsky province. Pine nuts are both in quantity and added value one of the paramount natural products to sustain this growth. The available technology for the extraction of nut kernels and their vacuum packaging makes possible their regional processing and commercialization, both on the domestic and exported to global market, as part of endogenous regional development (Gukov *et al.,* 2017).

The main needs of the regional sector identified in order to take advantage of its potential are:

- Legislative and regulatory reform for the system of leases, licenses or permits to commercially harvest pine cones also out of Nut Harvesting Zones for obtaining an export permit.
- Shutting off all possible channels for the illegal export of resources across the borders.
- Developing the production with possibility of direct exports to final consumer markets, bypassing intermediary countries.
- Participating in the activities contributing to the conservation of pine forests.

The necessary conceptual foundations of the industry must include simplified rental relations, eliminate barriers to trade legal product and simplify and make more transparent the system of rights to the turnover of non-timber resources (legalization of employment of population and sub-posts). The free use for the population for personal use should also be favoured.

Final Considerations

- Development of the regional pine nuts value chain is an effective project.
- It affects several areas in the economy such as food and processing industry.
- Volume of sales is not limited.

6.3 CHALLENGES AND PROPOSED NEXT STEPS

A. REGULATION AND LEGAL FRAMEWORK

- Create a representative working group to form new legislation on the proposed scheme of cone harvesting outside NHZ. This group should include the Ministry of Natural Resources / Rosleskhoz, Ministry of Agriculture, Union for the Harvesting and Processing of Wild Plants, forest science, non-governmental organizations and the public, environmental community.
- Create a phased plan for the enactment of new legislation.
- Test innovations in a pilot version in a number of regions (for example, Primorsky province).

- Introduce a number of amendments to the current legislation to eliminate obvious contradictions (general terminology “non-timber resources”, unlimited collection for own needs, etc.)

B. **INTEGRATION OF FOREST SYSTEM MANAGEMENT**

- Take all possible measures to stop illegal logging and poaching in the Primorsky province.
- Restoration, or favouring natural regeneration, of Korean pine as the naturally dominant species of Ussuri taiga where feasible throughout the historic distribution area.
- Silvicultural treatments that preserve and improve the habitat of mixed broadleaved species.
- Promote subsidies to those activities that suppose a conservation or improvement of the forests.
- Improve the integration of compatible pine nuts harvesting activity in the forest management outside the established nut harvesting zones, or delineation of new zones.
  - Enhance the integration of pine nut harvesting into forest planning tools and ensure its monitoring (Forest administration).
  - Development technical-informative material on management forestry and pine nuts harvesting.
  - Dissemination actions to the forest sector.
  - Promote research about the pine nuts production of the Korean pine.
  - Conduct studies on the potentiality of pine nuts production from mixed Korean pine broadleaved forests.
  - Create models of sustainable management.
  - Ensure knowledge transfer generated to the forest sector and production sector.

C. **CIVIL SOCIETY, MOBILIZATION AND ASSOCIATION**

- Develop a sense of partnership among all market actors along the value chain to improve the flow of information among them for sharing one channel experience
- Engage in discussions with stakeholders on how to improve the system of value chain.
- Share of information and available, real and free statistical data.
- Exchange with other countries.

D. **PINE NUTS SECTOR**

- Seek access to financial services.
- Increase the knowledge of socioeconomics aspects of the sector and their concerns.
  - Study of the socio-economic characteristics (age, situation, production...) of the sector.
  - Opinion polls to discover the worries and expectations for the future.
  - Promote associations to defend their needs and interests
  - Elaborate *a pine nuts harvesting* guideline providing good practices for a sustainable use of the source.

E. PRODUCT DEVELOPMENT

- Explore the potential for technological upgrade and possible mechanization of the harvesting and processing of pine nuts. Encourage the creation of specific support lines for machinery acquirement in order to improve technologically both the harvesting and processing of pine nuts.
- Quantification of the production. Plan and coordinate different agents involved to know truthfully the production of pine nuts.
- Financial support for the transformation and marketing of non-wood forest products.
- Create standards of origin and quality with specific rules that enables consumers to recognize the product.
- Establish systems of traceability to guarantee the quality and origin of the pine nuts to the final consumer:
  - Regulate the accreditation procedure of the traceability in all stages of production, transformation and distribution of pine nuts.
  - Promote the development of fair practices in the trade.
- Promote quality packaging that ensure a seal of quality.
- Development and dissemination of culinary uses of pine nuts.
- Set up integrated centres for pine nuts products harvesting, processing, and storage.

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