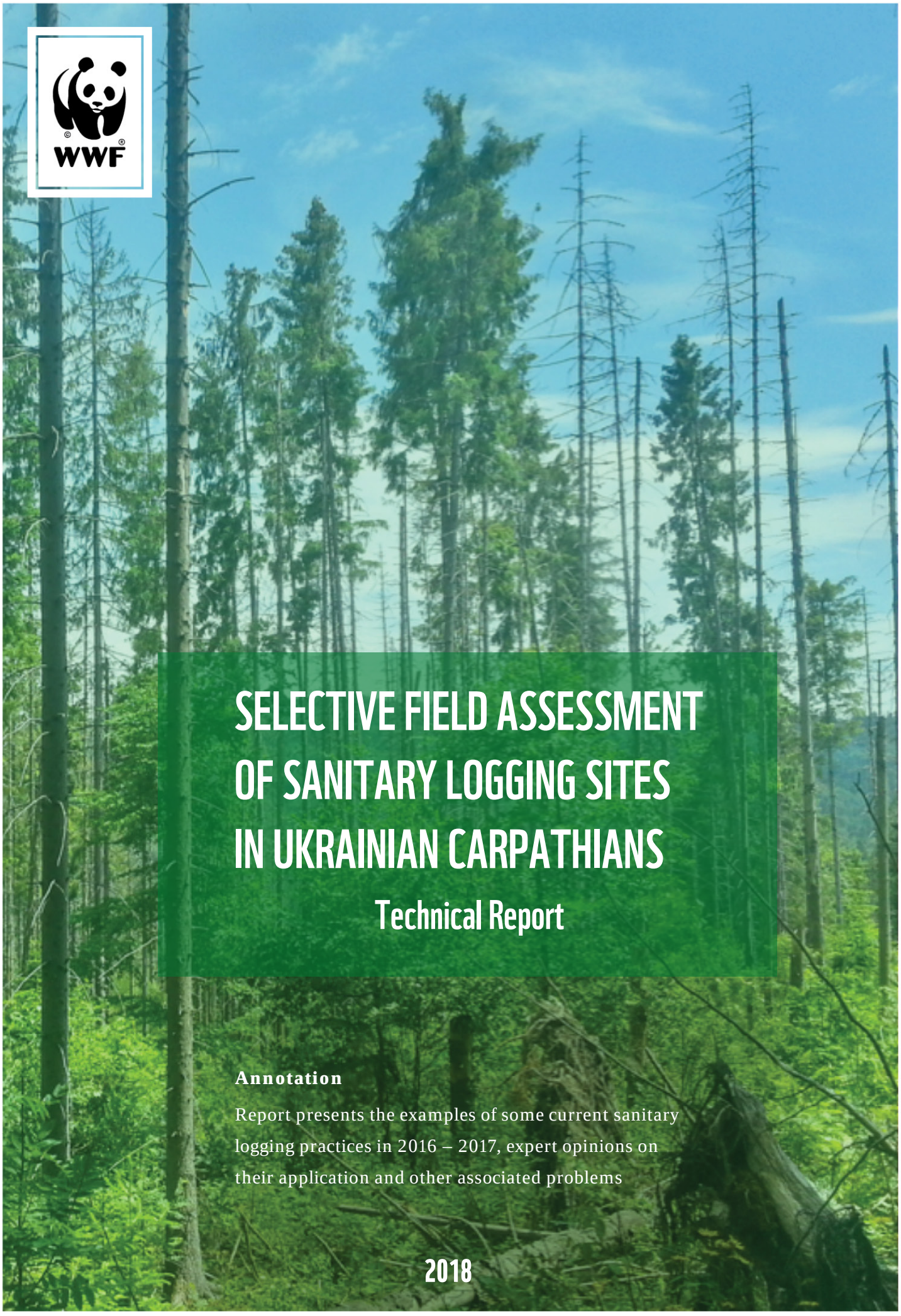

SELECTIVE FIELD ASSESSMENT OF SANITARY LOGGING SITES IN UKRAINIAN CARPATHIANS

Technical Report

Annotation

Report presents the examples of some current sanitary logging practices in 2016 – 2017, expert opinions on their application and other associated problems

2018

Disclaimer notice:

The study was commissioned by Earthsight and supervised by WWF Germany hiring international forest experts.

“Presented information is a result of randomly selected sanitary cut logging sites observations and could not reflect the full picture of forestry practice in the Carpathian region of Ukraine. The views expressed in this report do not necessarily reflect those of the authors, partners, and organizations engaged in carrying out and otherwise supporting project implementation.”

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Executive summary

The Ukrainian Carpathians administratively consist of Lviv, Ivano-Frankivsk, Chernivtsi and Zakarpattya oblasts (regions) [6]. According to national forest law, there are several economically significant types of harvesting in Ukrainian forests. They include main logging, thinning, sanitary clearing and other types of logging [11].

Sanitary logging is carried out in areas of intensive dying and damaged forest stands [4]. However, according to the reported statistical observations for 2016 in Ukraine, all forest users harvested nearly 47%[1] of the total timber from sanitary fellings, indicating either a catastrophic situation regarding the health of the forests or the use of this type of felling in addition to the allowed annual cut volume harvesting.

To investigate the situation on ground, WWF Germany formed a team of international researchers, including four experts with PhD in forestry and biology, and three experts with over 10 years' experience in nature conservation and other forest research topics. However, due to security threats the team does not wanted to be named. The international experts selected the areas that were chosen by state forestry enterprises for sanitary cutting with the aim to observe health conditions of certain trees subjected to removal from the stands. The team carefully documented available evidence and measured morphological characteristics as well as health indicators of trees on the harvesting sites, in order to identify the conditions of the forest stands that were reported for sanitary cutting [5, 7, 8]. The international experts visited sites with various forest stand conditions including, ones where logging has not started or where harvesting has been completed, sometimes including nearby sites that were logged in previous years. Therefore, this report provides information and expert opinions on an assessment of visited sites, regarding the necessity of sanitary logging and an adherence to the national sanitary cutting rules [8]. The international team of forest experts randomly selected sites for assessment including sites with clear cut and selective sanitary logging types.

As is stated above, the original plan for this study had been to visit only planned felling sites, as it is difficult to assess whether or not sanitary felling was justified, once it has already been completed. However, due to frequently changing logging plan information, the team found that in 8 of the visited sites logging had already been finished. During the expedition the team visited also other suspicious sanitary sites in addition. For some of

[1] http://agrex.gov.ua/лісогосподарська-діяльність-у-2016-році

these completed sites, the team was still able to draw tentative conclusions from stumps, leftover needles and branches.

When drawing overall statistical assumptions on the findings, it was reasonable to create different percentages: one for ongoing/planned felling sites only (where more concrete conclusions are possible) and another for all sites. The team also excluded one case from the analysis, since the logging there occurred a very long time ago, leaving particularly little reliable evidence upon which to come to a fair conclusion.

Findings of the international team of forest experts resulted in 18 cases, which include summary statistics for pre-harvest, sanitary and other types of forestry violations that also affect FSC certification principles (based on Table 4). In the case of the sanitary issue, different figures are given depending on whether the team included the claimed cancelled cuts and whether they included the completed ones.

- ***Sanitary felling justification***: The overall (including finished and cancelled cuts) situation according to expert opinions shows that 61% of all sites were inappropriately justified, and 80% were either not appropriately justified or of questionable/doubtful justification. Excluding the cancelled ones takes the figures to 60%/78%. Looking only at planned/ongoing/not cancelled cases the figures are 67%/78%. Excluding one site, where the logging happened a long time ago, and the sites with cancelled loggings results in 64% of the sanitary sites being inappropriately justified and 86% having a questionable/doubtful justification. Thus, the experts had no doubts about the correctness of the implementation of sanitary cuts on only about 20% of the surveyed areas from the silvicultural point of view;
- ***Pre-harvest violations***: 89% of cases showed pre-harvest planning violations;
- ***Logging violations***: 55% of ongoing or recently completed cases showed evidence of violations of harvesting practices (one case excluded, since the logging occurred such a long time ago this presumably cannot be assessed).

The conclusions of this report cannot be considered as being fully representative of the sanitary logging practices of all forest users (owners). However, in order to minimize selection bias, the investigation team randomly selected sanitary cut sites throughout the entire territory of the Ukrainian Carpathians. The information were obtained from local foresters and from openly published a list of planned sanitary logging sites in 2017.

These results should serve to start an open dialogue about the various problems on long term application of sustainable forestry principles in the Ukrainian Carpathians.

Methodology

Selection of sites

For the study, the international team of forest experts selected sites from all four regions in the Ukrainian Carpathians. During the selection the team paid attention also to information about the forestry enterprises, with the most planned sanitary cuttings recorded, as well as those that raised reasonable concerns amongst local public activists and forestry professionals. Thus, the team selected sites in the Lvivska, Ivano-Frankivska, Chernivetska and Zakarpatska regions (table 1).

Table 1. **Information on the sites investigated in the Chernivtsi, Zakarpattya, Lviv and Ivano-Frankivsk oblasts**

№	Site №	Map location (Appendix A)	Area, ha	Type of logging	Year of logging	Site conditions
1	21	Figure 1	n/a	sanitary clear cut	2014	logging has been finished
2	19	Figure 2	1,5	selective sanitary	2017	selected for logging
3	18	Figure 2	2,2	selective sanitary	2017	selected for logging
4	14	Figure 3	n/a	selective sanitary	2017	selected for logging
5	16	Figure 4	6,4	selective sanitary	2017	selected for logging
6	15	Figure 5	3,97[1]	selective sanitary	2017	logging has been finished
7	27	Figure 6	n/a	sanitary clear cut	2016	logging has been finished
8	4	Figure 7	2,03[1]	sanitary clear cut	2017	in the process of logging
9	54	Figure 7	1,58[1]	sanitary clear cut	2016	logging has been finished
10	5	Figure 8	2,83[1]	“urgent” clear cut[2]	2017	selected for logging
11	53	Figure 9	1,0	“urgent” clear cut	2017	logging has been finished
12	7	Figure 10	1,1	“urgent” clear cut	2017	selected for logging
13	8	Figure 11	2,1	“urgent” clear cut	2017	in the process of logging
14	49	Figure 13	n/a	sanitary clear cut	2017	in the process of logging
15	47	Figure 14	2,1	sanitary clear cut	2017	in the process of logging
16	51	Figure 15	2,6	shelterwood	2017	logging has been

[1] Measured by GPS

[2] The “urgent” clear cut type of logging is not described in the national forestry legislation (more explanations in conclusions)

№	Site №	Map location (Appendix A)	Area, ha	Type of logging	Year of logging	Site conditions
				cutting (formerly selected as a clear cut)		finished
17	52	Figure 16	1,4	sanitary clear cut	2016	logging has been finished
18	31	Figure 17	1,1	sanitary clear cut	2016	logging has been finished

Field measurements on sites selected for sanitary cutting

Strip and square sample plots were established in the still growing forest stands according to the configuration and size of the area. The international team of forest experts defined for each tree's diameter at breast height (DBH) the merchantable class of tree (1 – commercial, 2 – semi-commercial, 3 – fuel wood), specific category of tree conditions[1] (1 – without any signs of weakening, 2 – weakened, 3 – very weakened, 4 – dying, 5 – fresh dead standing trees, 6 – old dead standing trees) in accordance with the interpretations detailed in an attachment 3 in "Sanitary cut rules in forests of Ukraine" [8]

To determine the visual signs necessary to prescribe sanitary clear cuts, the team visually examined adjacent stands of dying or damaged trees affected by insect pests or fungus diseases [2, 3, 9]. The height of 20-25 trees were measured [1]. Relative density was calculated by comparing the ratio of a cross-sectional area of the investigated forest stand to a modeled optimal forest stand [10]. The presence or absence of needles or leaves, the degree of their damage or dying, the intensity of damage by needle or leaf-eating insects, the degree of damage to the remaining or existing tree branches, stem sections and other remains were also taken into account after clear cut sanitary logging [2, 7, 9].

Field measurements on the sites after clear sanitary cuttings

If the trees were already harvested and removed by the time of the inspection, the team set strip sample plots to observe any damages on the available stumps [1]. The team determined the degree of damage to the stumps caused by the stem pests, rotten roots and other infections and by the appearance and physiological state of the stumps [9]. The age of the cut forest stands was determined by the annual growth rings of the trees. The available woody remnants were also examined.

[1] http://zakon.rada.gov.ua/laws/show/555-95-%D0%BF?lang=en

Forest site assessment characteristics

Chernivetska oblast

Berehometskyy SFE

1. Type of logging: Sanitary clear cut *site number 21, Appendix A,* Figure 1 *(see also* Table 1*)*

Year of logging: Approx. 2014

Site condition: Logging completed

Forest site characteristics and main findings:

The site selected for a sanitary clear cut does not correspond to the location of the coordinates that indicate the center of the sub-compartment. Stumps of old trees were found on the site. The forest stand age was 65-70 years and included dead standing and fallen trees. Before cutting, the forest stand was heavily sparse (with uneven relative density 0.3-0.4). Tree harvesting happened approximately 2-3 years ago. Opened canopy places are overgrown with wild blackberries and raspberries. Natural regeneration of fir (70-80%) and partly spruce (20-30%) was detected with multiple ages that ranges between 5 to 25 years, and are allocated irregularly on the site with the height of 6-10 meters.

Conclusion: Sanitary clear cut was concluded by forest experts to be reasonable at the time of logging.

2. Type of logging: Selective sanitary cut *site number 19, Appendix A,* Figure 2 *(see also* Table 1*)*

Year of logging: 2017

Site condition: Selected for logging but cancelled (as of 07.2017)

Forest site characteristics and main findings:

The site is adjusted to the previously clear cut area, which happened 10-20 years ago. The forest stand is multi-aged with a predominance of fir trees (80%). There are two layers of fir which is mixed with spruce. The age of the older trees in the first layer is nearly 80 years, and the younger generation is close to 50-60 years old. The average height of the first layer of fir growth is about 32-35 m. The plantation has a high relative density

(0.8-0.9). The second layer of fir growth is about 25-30 m high. Natural seed regeneration is located in tree communities with a predominance of fir. As a result of competition, the third layer includes suppressed trees. Some fir trees (1-2%) are damaged by a fungus (*Melampsorella cerastii Wint.*) (Fig. 1). However, most suppressed fir trees are damaged by stem pests (*Ips typographus, Ips acuminatus*), which is a natural process in such conditions.

Small groups of fallen dead trees were found. Signs of severe damage such as defoliation and dechromation [21] were not visually detected (Fig. 1).

Fig. 1. Fir forest stand selected for sanitary logging (left side) and tree damaged by fir fungus (Melampsorella cerastii Wint.) (right side), sanitary logging was later cancelled

Insignificant diffusion of tree crowns does not exceed the significant level of 10% for defoliation or dechromation (foliage discolouration). In the stand, there is a prevalence of trees in the category 1-2 of tree conditions according to the sanitary rules of the forests of Ukraine [13]. Old dead trees category 6) account only for up to 2%. These trees are in an unsatisfactory condition or already dead due to natural conditions. Additionally, they mainly have smaller diameters or are old (category 6). The trees are damaged by the stem pests and located only on the side adjacent to the open area. Fallen dead trees that died 3-5 years ago were also detected.

This case study shows a rather intense and natural regeneration of firs replacing old and fallen trees. Some boundary marks on trees in the sub-compartment indicated that the site was being prepared for selective sanitary logging licensing (Fig. 2). However, when the

team requested documentation from the sub-compartment, the site preparations appeared to come to a halt.

No paint marks, or harvesting site posts marking the selected area for the sanitary logging were further discovered. Additionally, no stamps on stump roots indicating selected trees for sanitary logging within the site boundaries were found.

Fig. 2. Site boundary marks on trees

Conclusion: The tree selection or site selection for sanitary logging does not meet the standard selection criteria (12, 19, 40). The boundaries of the selective sanitary logging and therefore its configuration are not consistently clearly marked on the site. The random selection of trees indicating DBH, the class of merchantability and category of condition were assessed and Data indicates that the majority of trees were in categories 1-2 (Appendix B, Table 1&2). Additionally, these data suggest that any type of selective sanitary logging in this stand would be not advisable.

3. Type of logging: Sanitary *site number 18, Appendix A,* Figure 2 *(see also* Table 1*)*

***Year of logging*:** 2017

***Site condition*:** Selected for logging

***Forest site characteristics and main findings*:**

The predominant species are fir (90%) with spruce (up to 10%). The forest stand age is 70 years. Some trees aged 50-60 years belong to a second layer. The average height of the trees is 30-32 m. Relative density is even (0.7-0.8) (Fig. 3).

Most trees are in a good condition (categories 1-2). There are no signs of intense dying. Some old dead trees were found (category 6 conditions). There are no signs of the site being marked for sanitary logging.

Conclusion: The international team of forest experts would not recommend this forest stand for sanitary logging (selective or clear cut).

Fig. 3. Fir-spruce dominated stand

4. Type of logging: Selective sanitary cut *site number 14, Appendix A,* Figure 3 *(see also* Table 1*)*

Year of logging: 2017

Site condition: Selected for logging

***Forest site characteristics and main findings*:**

This site includes a forest stand adjacent to a clear cut area (1-2 years old). The main species are fir (80-90%) mixed with beech (10-20%) and spruce (up to 10%). The forest stand is 110-120 years old. The second layer is represented by fir and, partly, beech. The second layer is 60-70 years old. The average height of the first layer is 32-35 m.

The forest stand's relative density is uneven and varies within the area from 0.6-0.7 to 0.9. There are gaps of 20-30 m with natural regeneration of fir and beech with a height of 8-10 m.

Trees are mostly in a good condition (category 1-2). Some category 6 fir trees can be found (1-2%) within the site. These trees are located along the edges of the site with solid main and small crown branches. The trunks are damaged by stem pests. The bark of most of the trees is already stripped. The dead standing trees are already slightly affected by tender fungus (*Phellinus hartigi*).

On the site, a portion of trees are allocated for selective sanitary logging with marks that show the merchantability, numbers on the trunks and their roots, as well as the official stamps. Some of them (the fir infected with stem pests) are allocated for selective sanitary logging. However, there are some trees marked for sanitary cutting, which, according to the category of condition, do not meet the sanitary normative criteria (Table 2).

Table 2. **Characteristics of fir trees selected for sanitary logging that do not meet the standard criteria**

№ of trees (stamp on the trunk)	Species	DBH, sm	Height, m	Merchantable class of trees	Category of condition	Selection to sanitary logging (remarks)
123	Fir	58	35.1	commercial tree	2	does not comply with Sanitary rules
105	Fir	71	37.9	commercial tree	2	does not comply with Sanitary rules
109	Fir	63	37.8	commercial tree	2	does not comply with Sanitary rules

Some trees have lower category of merchantable class than should be (i.e. instead of being marked as having a commercial value, they are indicated to be half commercial) (Fig. 4).

Fig. 4. Fir tree №106 is marked as category 1 and without reason is selected to be sanitary logged

Fir trees selected for logging (stamped) are in categories 1-2 and they are located near open areas with easier access to them. There are no signs that the site is selected for clear cut. In addition, no boundaries of the harvesting site were identified at the time of inspection.

Some trees with a visible cancer convexity (up to 20% of the circumference of the trunks) are not marked for logging. At same time, a small cancerous presence does not significantly reduce vitality nor does it significantly impact wood characteristics. Within site boundaries, there were dead standing trees that were also not marked for logging. On the sides of the skidding trails, damaged trunks of live trees were also detected. This damage may cause their future deterioration and decline.

Conclusion: There is no need to select all marked trees for sanitary logging (violation of the sanitary cut rules: numbers 12, 19, 27, 40, and 42).

5. Type of logging: Selective sanitary cut *site number 16, Appendix A,* Figure 4 *(see also* Table 1*)*

Year of logging: 2017

Condition of the site: Presented as selected for logging

***Forest site characteristics and main findings*:**

The first layer is mixed with fir (80-90%), beech (10-20%), and spruce (5-10%) species. The second layer is represented by fir and beech. The unevenly aged tree stand has an approximate mean age of 100-110 years. The forest stand's relative density is 0,8 with groups of some dead fallen trees (with open gaps). Dead trees are at the 2-3 stage of trunk decomposition. Within the gaps, a natural regeneration of fir sp. is located at 3-6 m height.

A few fir trees have cancer (*Melampsorella cerastii,* Wint.) and tinder damage (*Phellinus hartigi* (All. et Schnab.) Bond.). Some of the trees are characterized by a 4th Kraft class that is naturally suppressed and on the verge of decline. There are some dead standing fir trees in the first layer (equivalent to category 6 of the state condition).

There are no signs that would indicate the site is selected for sanitary logging.

In the stand, there are two groups of declining spruce and fir trees (category 6) with a size of 0.2-0.3 ha. Groups of dead trees are located on elevated areas. The trunks are affected by stem pests and are already stripped of bark (category 6 of conditions). On the other trees, bark is stripped off and the crowns are at the stage of falling off. A significant number of trees are at this stage of decline and most trees are already rooted or broken. There are groups of intensive fir and beech natural regeneration with a height of between 4 and 6 meters.

Conclusion: The stand may require a sanitary logging intervention. However, such management activity should have been carried out 3-5 years ago. At present, there is no continual threat of stem pest distribution from this site since the pest infestation has moved onto another area.

6. Type of logging: Selective sanitary logging *site number 15, Appendix A,* Figure 5 *(see also* Table 1*)*

***Year of logging*:** 2017

Condition of the site: Logging has finished

***Forest site characteristics and main findings*:**

The tree stand has mixed fir, beech, and spruce trees, with an age of 100-120 years. The second layer consists of fir and beech. The average height of the tree stand is 30-35 m. The trees are in good condition without signs of intense dying or damage (Appendix B, Table 3&4). There are groups of fir and beech trees with natural regeneration on the site. However, the degree of regeneration is insignificant.

Spruce, fir and beech tree stumps were found on the site, which indicate the selective type of logging. Most of the stump roots were stamped. Almost all stumps have their bark partly stripped from their roots (Fig.5). This indicates recent selective logging activity.

However, during the inspection it was not possible to identify any boundary marks or posts indicating sanitary logging. At the same time about 80% of the stumps are not affected by root rotting and there are indications that the trees were alive when they were cut (Appendix B, Table 5). Parts of crowns and branches with live healthy needles were found on the site. The international team of forest experts observed a number of other legal violations on the site. They include standing trees damaged during felling, not cleared site from the timber residuals as well as badly damaged and eroded skidding trails and trees growing next to them.

Based on these observations, it is hard to find evidence that the logging operation performed on this site was carried out in accordance with national legislation.

Conclusion: The international team of forest experts mainly would not recommend this forest stand for sanitary logging (violation of the sanitary rules number 12, 19, and 40).

Fig. 5. Physically stripped off stump bark, resin on the stumps indicates that the trees were alive during cutting

***Recommendation*:**

1. Limitation of using the same logging practice.

2. During application of selective sanitary logging measures, there needs to be an implementation of practices that reduce tree damage, promote natural regeneration and use of machinery with less impact on ground cover and soil, as well as introducing systematic forestry measures for the prevention of stem pests.

7. Type of logging: Sanitary clear cut *site number 27, Appendix A,* Figure 6 *(see also* Table 1*)*

***Logging age*:** 2016

***Condition of the site*:** Logging has been finished

***Forest site characteristics and main findings*:**

A sanitary clear cut was carried out in the 60 year old mixed spruce-fir-beech site in 2016. Most of the stumps (Fig. 6) are not damaged by root rot or other pathogens (stumps with core rot did not exceed 10%).

Fig.6. Clear cut area after sanitary logging of a spruce forest in 2016

Some dead, fallen trees are left on the site with indication of infestations by stem pests and tinder fungus. Forest stands growing along the perimeter of the cleared area, predominantly spruce, did not have any signs of being damaged or dying. Their general appearance does not show indications of any intensive forest stands decline. As a result of the clear cut, dead fallen trees were found in the lower part of the site (Fig. 7).

Fig. 7. Site edge post of a sanitary clear cut (left) and damaged trees after a clear sanitary cut

Conclusion: Despite the absence of visual signs indicating stand dieback, it was selected for a clear sanitary cutting. The team would not recommend this forest stand for sanitary logging

***Recommendation*:** Apply complex silvicultural methods (selective logging, etc.) for various stand formation and natural seed regeneration.

As a general observation, most of the growing trees, exposed to the direct sunlight, adjusted to clear or selective sanitary logging sites visited within the area, are in decline or already dead (Fig. 8).

Fig. 8. Dead standing fir trees in the forest near the clear cut open areas

If during selected sanitary logging, a stand's relative density is heavily decreased by selective logging of healthy trees (1-2 categories of condition), further dying of the forest stand can be caused, which usually ends with clear cut logging.

Zakarpatska oblast

Volovetskyy SFE

8. Type of logging: Sanitary clear cut *site number 4, Appendix A,* Figure 7 *(see also* Table 1*)*

***Logging age*:** 2017

***Condition of the site*:** In the process of logging

***Forest site characteristics and main findings*:**

This forest stand contained mixed 50-60 year old spruce (80%), beech (15%), and fir (5%) with additional cherry, sycamore maple, and sessile oak trees. The height of the trees is 25-27 m. The trees are in good condition and have high vitality (category 1-2 of conditions). There were separate trees affected by cancer (up to 20% of the circumference), but no part is more than 5-10%. Small groups of trees were found. Fallen dead trunks of spruce at different stages of decomposition, affected with honey fungus (*Armarilla*) are also found on the site.

Intensive invasion of stem pests in this area and adjacent areas were not detected as their share does not exceed approx. 5%. Tree decline was found only in small groups of trees.

Sanitary clear cut was ongoing on the site. Some part of the forest stand was still untouched, which allowed us to collect data on its state (Appendix B, Table 6). The boundaries of the harvesting area are marked with red paint but without the stamped marks. Boundary edge posts were not available on the corners of the site. The marks on standing trees indicating merchantable quality are visible. Wood remains were seen in the partially cut site. Most of them have healthy green needles and leaves (Fig. 9).

Fig. 9. Parts of the crown of spruce and beech left on the site

About 30% of stumps are affected with root rot. Other stumps were without any significant diseased damage and with the remains of resin flow.

Conclusion: Prescribtion of the sanitary clear cut on the site is questionable. The international team of forest experts would recommend this forest stand for selective sanitary logging.

9. Type of logging: Sanitary clear cut *site number 54, Appendix A,* Figure 7 *(see also* Table 1*)*

Year of logging: 2016

Condition of the site: Logging has been finished

Forest site characteristics and main findings:

This forest stand has a predominance of spruce mixed with fir, beech, common hornbeam and cherry trees. The 60 year old site was selected for sanitary clear cut and was harvested in 2016 (Fig. 10). The height of the forest stand was approximately 25-27 m.

The boundaries of the site were marked with red paint. However, the official stamps within the boundaries of the selected site were not found. There was only one post, indicating information about sanitary clear cut.

Fig. 10. Site after sanitary clear cut in 2016

Most of the tree stumps were without visible signs of damage, indicating that the trees were cut in a vital state. The presence of healthy woody remains, fresh needles and leaves indicates that the trees were healthy before cutting. However, some old spruce trees were

dead indicated by stumps. The examination of the adjusted forest stands indicates they are in a healthy condition.

Conclusion: The international team of forest experts would not recommend this forest stand for sanitary logging.

10. Type of logging: "Urgent" clear cut *site number 5, Appendix A,* Figure 8 *(see also* Table 1*)*

Year of logging: 2017

Condition of the site: Selected for logging

Forest site characteristics and main findings:

This site includes a 60 year old spruce stand (70-80%) mixed with beech and ash (20-30%). The height of trees is 25-27 m. The relative density of the forest stand is 0.7-0.8.

The broadleaved species are in good condition and show no signs of dying. Groups of dying spruce trees were found on the site, with a radius of 10-20 m they are unevenly distributed around the site. The spruce tree stand shows signs of damage by annosus root rot. The old and dead trees dominate this area (category 6 of conditions). Dead trees are without bark or partly covered with bark. Dead fallen trees were also found on the site (Fig. 11).

Fig. 11. Forest stand selected for "urgent" clear cut (left side) and a boundary mark of "urgent" clear cut marked (right side)

There are no edge posts detected on the site selected for sanitary cutting. Boundaries of the selected area are marked with red paint.

Conclusion: Selective sanitary logging was appropriate on the site 4-5 years ago. The international team of forest experts would not recommend this forest stand for clear cut sanitary logging at the observation time (violation of the sanitary rules number 12, 19, 40).

11. Type of logging: "Urgent" clear cut *site number 53, Appendix A,* Figure 9 *(see also* Table 1*)*

Year of logging: 2017

Condition of the site: Logging has finished

Forest site characteristics and main findings:

There is a spruce stand with beech, maple and other broad leaved tree species. Age of stand is 60 years old (Fig. 12).

Fig. 12. Site after "urgent" clear cut in 2017

The stand was harvested as an "urgent" clear cut. According to an analysis of the stumps, the proportion of damaged by annosus root rot fungus trees was about 50%, including 15% of the dead tree stumps (Appendix B, Table 7). However, at the same time most of the woody remains included live needles. This indicates that the trees were in a viable state during cutting. Thus, the consequences of damage by stem pests or other pathogens were not detected. Forest stands adjacent to the site are in good condition and show no signs of dying.

Conclusion: The team would not recommend this forest stand for a clear cut on the grounds of its state of health, as the percentage of diseased trees does not exceed 90%.

12. Type of logging: **"**Urgent" clear cut *site number 7, Appendix A,* Figure 10 *(see also* Table 1*)*

Year of logging: 2017

Condition of the site: Selected for logging

Forest site characteristics and main findings:

This site includes a forest stand of spruce and beech mixed with fir and maple, of natural origin. Spruce grows in groups. The age of the stand is 55 years. The average height is 25-27 m.

Most trees are in good health condition (categories 1-2 prevail). However, some groups of spruce are damaged. Dead spruce trees belong to a category 6 condition. Some spruce trees are already fallen dead,thus, the stand is not dense. At same time, further progression of spruce dieback on the site was not detected.

The forest stand was selected for an "urgent" clear logging (on sanitary grounds). The boundaries of the selected site, marked with red paint were detected. There were stamp marks visible on the boundary trees as well as a corner site post (Fig. 13).

Fig. 13. Boundaries of "urgent" clear cut in the forest stand

A sample plot was set by forestry staff for determination of the categories of tree conditions. The plot was set in a non-typical part of the forest stand (Fig. 14) (Appendix A, Figure 12), which is a violation of the Sanitary rules.

Fig. 14. Established sample plot (left side) and other part of the forest, which was selected for "urgent" clear cut on the basis of sanitary cut rules

The sample plot includes mainly groups of dead spruce trees. The parameters of forest stands on the sample plot and area of logging, calculated based on the measured information (Appendix B, Table 8-24), are significantly different (Table 3).

Table 3. **Information about forest stands on the sample plot and on the rest of the area selected to "urgent" clear cut**

Part of the stand	Composition of tree species	Age, years	Average		Site Index	Relative density	Volume, m^3/ha
			H, м	DBH, см			
Site	70% Spruce, 30% Beech with Fir and Maple	55	20.8	25.9	I	0.61	266
Sample plot	90% Spruce, 10% Beech with Maple	55	21.3	27.7	I	0.13	46

Merchantable class of the selected trees is not high quality and complies with the marks applied by the forestry workers.

Conclusion: Selecting this stand for harvesting on sanitary grounds is inappropriate (violation of the sanitary rules number 12, 19, 27, 29, 40, 42).

13. Type of logging: **"**Urgent" clear cut *site number 8, Appendix A,* Figure 11 *(see also* Table 1*)*

Year of logging: 2017.

Condition of the site: in the process of logging.

***Forest site characteristics and main findings*:**

The stand is dominated by spruce with a small addition of hardwoods (up to 10%). The age of the stand is nearly 60 years. The team found live crowns without significant signs of damage or deterioration characteristics on most felled and growing trees. The proportion of dead standing and dying trees does not exceed 20%. The site is a part of a forest that generally looks to be in good condition and without any signs of intense drying. According to an analysis of the stumps, the proportion damaged by annosus root rot fungus trees was about 60%, including 25% of the dead tree stumps (Appendix B, Table 25).

The following violations were detected during the field investigation:

- the logging area is incorrectly indicated on the site corner posts and on the felling license ticket (2.1 hectares), the actual area measured by GPS device is 2.67 hectares, which confirms overcutting of the licensed area by 0.57 hectares;
- the boundaries of the logging site are not within the allocated sub-compartment boundaries indicated on the digital forest maps.

Conclusion: The appropriateness of this clear cut on the grounds of the state of health is questionable.

Possible violations of basic harvesting legislation procedures established for final clear cut logging systems and technological logging process requirements were found. The indicators include: shorter period between the previous and next fellings, as established in national legislation for adjusted clear cut sites; the configuration of the site in relation to the slope is different; and the permitted logging size area is above the limit. Thus, possible illegal logging on the area of more than 0.5 hectares needs further appropriate law enforcement investigation.

Lvivska oblast

Slavskyy SFE

14. Type of logging: Sanitary clear cut *site number 49, Appendix A,* Figure 13 *(see also* Table 1*)*

***Logging age*:** 2017

***Condition of the site*:** Planned for logging

***Forest site characteristics and main findings*:**

The spruce tree stand was 60 years old. The average height was about 25-27 m. The site has boundaries with a finished clear cut area. The forest stand is highly thinned. Undergrowth is intensively developed. No natural seed regeneration of main tree species is present (Fig. 15).

Fig. 15. Spruce forest stand selected for sanitary clear cut

The tree stand consisted mainly of old dead spruce trees (category 6 of conditions) (Appendix B, Table 26). The largest number of dead forest trees was concentrated on the boundaries of the site. The decline most likely took place 3-5 years ago. Some trees have broken trunks as a result of a storm. Partial breaking and destruction of the branches of old dead trees was observed with a significant number of fallen dead trees.

Other trees on the site were found to be in a deteriorated condition with signs of disease caused by stem pests and are estimated to be in satisfactory and unsatisfactory conditions (categories 3-4 condition)

Conclusion: The site selection for sanitary clear cut wasn't questionable.

15. Type of logging: Sanitary clear cut *site number 47, Appendix A,* Figure 14 *(see also* Table 1*)*

Year of logging: 2017

Condition of the site: in the process of logging

***Forest site characteristics and main findings*:**

A sanitary clear cut is prescribed on this site. The forest stand consisted of old dead trees that died about 5-8 years ago. Sources of infection were stem pests and annosus root rot fungus. There is evidence of natural seed regeneration of spruce, beech, birch and other species. This forest stand was not an active resource for pests or other pathogens. Intense pest damage occurred in the past. Remains of old dead trees and other remnants were found at different stages of decomposition (Fig. 16).

Fig. 16. Site after sanitary clear cut

In 2017, dead standing trees are to be cleared following the creation of a fir plantation with other mixed species.

Conclusion: Selecting this stand for sanitary cutting was appropriate. However, the harvesting should have been done 5-8 years ago. During actual logging, this site was not a resource for pests and pathogens. The existing natural regeneration would entirely restore the forest stand.

Ivano-Frankivska oblast

Vyhodske SFE

16. Type of logging: Shelterwood system *site number 51, Appendix A,* Figure 15 (reported to the team as having been selected for the sanitary logging in the past) *(see also* Table 1*)*

***Logging age*:** 2017

***Condition of the site*:** Logging has been finished

***Forest site characteristics and main findings*:**

The site is situated in a forest parcel represented by a mixed fir-beech stand with spruce as well as oak, birch and other broadleaved species. Fir forms the top canopy layer, and is present in other layers. The remaining stand age is approximately 100-110 years and mostly in a good, healthy condition (Appendix B, Table 27). The height of the first layer is 28-32 m. The second layer is represented by spruce and fir with heights of 20-25 m. The third layer is 5-10 m high, consisting mainly of spruce and fir (Appendix B, Table 28). Natural regeneration on the site is scattered over the area. The height of natural regeneration is about 50-200 cm (Appendix B, Table 29).

The site was selected for a sanitary clear cut in 2014 (old posts with information were found). However, it was not cut at that time. The stand, at the time of selection for sanitary cutting, was in a good condition. According to the forestry enterprise information, the last stage of shelter wood logging was carried out. During this stage, mainly fir trees from the top layer were logged (Appendix B, Tables 30-32).

After the last logging stage, natural regeneration was not sufficiently encouraged (Fig. 17). Appropriate technological actions were not taken, which would meet the shelter wood system criteria. There was also a lack of information about the previous harvesting stages.

The selected area is clearly marked with red paint. Marks indicating the selection for sanitary cutting in the past were found on the trees.

Conclusion: To carry on the sanitary clear cut on this site would be inappropriate as it would violate the sanitary rules number 12, 19, and 40). The simultaneous complication of the last stage of gradual logging is also questionable, as this silvicultural system was applied without sufficient natural regeneration on the site.

Fig.17. Poor seed regeneration on the site after final step of shelter wood system harvesting

17. Type of logging: Sanitary clear cut *site number 52, A,* Figure 16 *(see also* Table 1*)*

***Logging age*:** 2017

***Condition of the site*:** Logging has been finished

***Forest site characteristics and main findings*:**

The age of the stand is 100-110 years and consists of a mixed stand with fir, spruce, beech, oak and other species. The height of the upper layer of the forest stand is 30-35 m. The relative density of the forest is irregular.

Sanitary clear cut conducted on this site in 2016. Old fir trees were cut down together with other species from the top layer. Many various aged regeneration groups remained with a height of 6-15 m on the site (Fig. 18).

Fig.18. Natural fir-spruce regeneration left after a clear cut sanitary logging

Natural regeneration of fir, spruce, and beech was found. Larch and oak trees were planted on the other part of cutting area. Some big fir seed trees were left on the site for natural seed regeneration.

Adjusted forest stand did not have signs of intense damage or dying. However, some fir trees fit to the 2nd and 3rd condition categories. There is no significant reason for selecting this tree stand for a clear cut type of logging.

Conclusion: The international team of forest experts would not recommend this forest stand for sanitary logging (possible violation of the sanitary rules number 12, 19, 40).

Osmolodske

18. Type of logging: Sanitary clear cut *site number 31, Appendix A,* Figure 17 *(see also* Table 1*)*

Year of logging: 2016

Condition of the site: Logging has been finished

***Forest site characteristics and main findings*:**

The site includes a fir-spruce stand mixed with birch and beech trees and they are approximately, 65-75 years old. Their height is 23-25 m. In 2016, a sanitary clear cut was

conducted. A group of uncut trees (about 30% of the area) was left on the site. These were previously suppressed trees in an unsatisfactory condition, with a diameter of 8-12 cm and height of 10-12 m. The reason for leaving those trees uncut is unclear, since this group of trees is unsuitable for providing natural regeneration (Fig. 19). It appears that this forest stand was left behind because it has no economic value.

Fig. 19. Site after clear sanitary logging

Based on visual observations of the stumps, these trees in the past did not show signs of infestation or disease (Appendix B, Table 33). The forest stands that are adjacent to this area are in a good condition and show no signs of intense damage or decline. There is a lack of reliable natural regeneration. Additionally, erosive processes are developing on the slopes. Windbreak has affected the lower part of the mountain slope which has been cleared by previous and numerous logging activities.

Conclusion: The team would not recommend this forest stand for sanitary clear cut in 2016 (violation of the sanitary rules number 12, 19, 27, 40, and 42).

***Recommendation*:** Restrictions of further similar logging on the slope due to very thin soil layer, stony conditions, and no signs of spruce decline.

Table 4. **Results of sanitary felling assessment**

№	Point # (Site identify-cation #)	Type of sanitary felling	Felling status	Types of illegalities assessed				Names of main types of forest violations			Unsustainable sanitary measures	Summary
				Illegal license	Healthy trees selected	Violations in felling practices	etc.	Violations of national legislation procedures (Instruction on pre-harvesting evaluation methodology and proper management procedure), visual site identification in forest	Mapping problems	Violations in felling practices		
Site 1	21	Clear cut	Comple ted	No	N/A	N/A	Yes	Corner (edge) site posts are missing, there no other visual marks that characterize proper management practices				Sanitary clear cut was reasonable
Site 2	19	Selective	Not yet started (cancell ed on the momen t of report writing)	N/A	Yes	N/A	N/A	1. Corner (edge) site posts are missing, there no other visual marks that characterize proper management practices 2. Individual trees are not marked for the preharvesting assessment			Prevalence of trees in the 1-2 health categories indicate that the use of any kind of sanitary logging in this forest stand is inappropriate.	The site was proposed by SFE for selective sanitary logging, at the moment of field inspection there were the signs of a planned sanitary felling (marked site boundary on some trees), however an official respond to our request after the visit

												said it is not planned)
Site 3	18	Selective	Not yet started (cancelled on the moment of report writing)	N/A	N/A	N/A	N/A	1. Corner (edge) site posts are missing, there no other visual marks that characterize proper management practices 2. Individual trees are not marked for the preharvesting assessment			Most trees are in good condition (1-2 categories of condition prevail)	The site was proposed by SFE for a selective sanitary logging, an official response to our request after the visit said it is not planned
Site 4	14	Selective	Not yet started	N/A	Yes	N/A	Yes	1. Corner (edge) site posts are missing, there no other visual marks that characterize proper management practices 2. Three trees marked for sanitary cutting, which, according to the tree health (sanitary category of conditions), do not meet the criteria of tree selection for sanitary logging		On the sides of the skidding damaged trunks of trees were detected.		There is no need to select all marked trees for sanitary logging (violation of the point of rules number 12, 19, 27, 40, 42).

Site 5	16	Selective	Not yet started (cancelled on the moment of report writing)	N/A	N/A	N/A	N/A	1. Corner (edge) site posts are missing, there no other visual marks that characterize proper management practices				The planting requires clear sanitary logging. However, such cutting should have been carried out 3-5 years ago. At present, there is no threat of stem pest distribution from this plot.
Site 6	15	Selective	Completed	N/A	Yes	N/A	Yes	Corner (edge) site posts are missing, they are not in accordance with standard visual marks that characterize proper management practices		1. Growing trees are heavily damaged during felling 2. Logged site is not cleared of timber residuals 3. Badly damaged and eroded forest road		Selective sanitary logging on this site is inappropriate (violation of the sanitary rules, number 12, 19, 40). About 80% of the stumps are not damaged by root rotting and indicate that the trees were alive when they were cut
Site 7	27	Clearfell	Completed	N/A	?	N/A	No				As a result of a clear cut, there is a windthrow in the forest stand next to the logged site	Most of the stumps are not damaged by root rotting or pathogens. During selected sanitary logging density decreasing of the forest stands causes dying of the plants. The cutting of healthy trees (1-2

												categories of condition) causes further dying of the forest stand. Selective sanitary logging on this plantation is inappropriate
Site 8	4	Clear cut	Underway	N/A	?	N/A	Yes	Not correct information stated on the corner (edge) site posts		Logged site is not cleared of timber residuals	Information is not published on a website	Sanitary clear cut of this plot was questionable Most of the tree stumps were cut without visible signs of damage, indicating that the trees were cut down in a vital state. The appearance of the remains after cutting with needles and leaves indicates that the trees were healthy before being cut. The examination of forest stands sharing boundaries with the cutting plot shows they are in good condition and an absence of continuous dying. Some old spruce trees were dead indicated by stumps.

Site 9	54	Clear cut	Completed	N/A	Yes	Yes	Yes	Corner (edge) site posts are missing, there are no other visual marks on trees that characterize proper management practices		1. Logged site is not cleared of timber residuals 2. Live trees are being logged	Information is not published on a website	About 30% of stumps are affected by root rot. Tree cutting on this plot is questionable (violation of the point of rules number 12, 19, 40).
Site 10	5	Clear cut (urgent)	Not yet started	N/A	Yes	N/A	Yes	Corner (edge) site posts are missing			Information is not published on a website	Initially, the site was indicated as the one, which required sanitary logging. After a field inspection and further data gathering, it was discovered to be named as "urgent clear cut". According to explanations it was wrongly named a "final clear cut" which required urgent attention due to its condition(legislative measure if it meets the final felling criteria)

Site 11	53	Clear cut (urgent)	Completed	N/A	?	Yes	Yes	1. Corner (edge) site posts are present but official information on them is missing 2. Deviations in surveyor's compass mapping (felling area is placed in wrong place)	Site boundaries don't match with forest parcel boundaries on digital maps	Logged site is not cleared of timber residuals		The stands were cut down during the urgent clear cutting of the trees. Places selected for cutting were visible on the plot. Stumps and cutting remains were seen on the plot. According to an analysis of available stumps, it was found that the proportion of damaged trees was about 50%. 15% of the damaged stumps were dying trees. Most cutting remains had live needles. This indicates that the trees were in a viable state during cutting. The consequences of damage by stem pests or other pathogens were not detected. Forest stands adjoining the plot are in a good condition and without signs of dying. The appropriateness of this clear cutting is doubtful.

Site 12	7	Clear cut (urgent)	Not yet started	N/A	Yes	Yes	Yes	Data assessment plot was placed in inappropriate place (in accordance with digital forestry map in different (neighboring) site	Site boundaries don't match with forest parcel boundaries on digital maps			Firstly, the site was indicated as one which required sanitary logging. After a field inspection and further data gathering, it was discovered to be named as "urgent clear cut". According to explanations it was wrongly named a "final clear cut" which required urgent attention due to its condition (legislative measure if it meets the final felling criteria) The appropriateness of this clear cutting is doubtful as the age of the stand was detected to be near 55 yrs.
Site 13	8	Clear cut (urgent)	Underway	partly	Yes	N/A	Yes	1. According to a felling ticket, the licensed felling area is 2.1 ha, but 2.67 ha (measured by GPS) were actually harvested 2. Deviations in surveyor's compass mapping (felling area is placed in wrong place)	Site boundaries don't match with forest parcel boundaries on digital maps			

Site 14	49	Clear cut	Not yet started	N/A	N/A	N/A	N/A				Harvesting of dead trees, sanitary cutting should have been conducted 3-5 years ago	The plot selection for clear sanitary cutting was appropriate.
Site 15	47	Clear cut	Underway	partly	No	N/A	Yes	1. Licensed felling area is 1.2 ha, but 1.35 ha (measured by GPS) were actually harvested 2. Deviations in surveyor's compass mapping	Site boundaries don't match with forest parcel boundaries on digital maps		Harvesting of dead trees, sanitary cutting should have been conducted 3-5 years ago	Selecting of this stand for sanitary cutting was appropriate.
Site 16	51	Clear cut	Underway	partly (for area of 0.08 ha)	?	Yes	Yes	1. Licensed felling area is 2.6 ha, but 2.68 ha (measured by GPS) were actually harvested 2. Corner (edge) site posts are missing, there are no visual marks that characterize proper management practices	Site boundaries don't match with forest parcel boundaries on digital maps	1. Exploitation of tractors with continuous tracks system (crawlers) for logs skidding in Carpathians. 2. Damage of ground cover	Natural forest regeneration is not secured	1. The plot was selected for a sanitary clear cut in 2014 (old posts with information were found). However, it was not cut at that time. The stand at the time of selection for sanitary cutting was in a good condition. Sanitary cutting on this plot was inappropriate (violation of the point of rules number 12, 19, 40). 2. According to the information of the

										during log skidding		forestry enterprise in this area, the last part of shelter wood logging was carried out. During this stage, mainly fir trees from the top layer were cut down (Appendix B, table 3-5). After the last stage of shelter wood cutting its natural regeneration was not sufficiently provided (Fig. 17). Technological actions were not taken, which would meet the shelter wood logging criteria.
Site 17	52	Clear cut	Comple ted	partly (for area of 0.07 ha)	?	N/A	Yes	1. Licensed felling area is 1.4 ha, but actually harvested 1.47 ha (measured by GPS) 2. Deviations in surveyor's compass mapping	Site boundarie s don't match with forest parcel boundarie s on digital maps			Some old fir seed trees were left in the plot for natural seed regeneration. Forest stand located near this area was detected without signs of intense damage or dying. Only some fir trees belong to the 2nd-3rd categories of condition. There is no significant reason for selecting this tree stand for sanitary logging (violation of the point of rules number 12, 19,

												40).
Site 18	31	Clear cut	Completed	N/A	?	Yes	Yes	Published information about a logging type on the SFE website doesn't match the information stated on the site posts	Site boundaries don't match with forest parcel boundaries on digital maps	Timber residuals obstruction and damages to a watercourse	As a result of a clear cut, there is a windthrow in a forest stand next to a logged site	Most stumps of cut trees are in a good condition without signs of intense damage or dying of the forest stand in the past. The Forest stands that are adjacent to this area are in a good condition and without signs of intense damage or dying out. There is a lack of reliable natural regeneration. Erosive processes are developing on the slopes. Sanitary clear cut in 2016 was not appropriate (violation of the point of rules number 12, 19, 27, 40, 42).

Conclusions

1. The team of international forest experts investigated 18 forest sites in Ukrainian Carpathians, which in the first place were selected for sanitary logging, during the inspection, the logging type for some of them was changed to final harvesting. There were namely: sanitary clear cut (on 8 sites), selective sanitary cut (on 5 sites) and 5 sites of “urgent” clear cuts, which were indicated as sanitary clear cut at the beginning of the research. The “urgent” clear cut type of logging is not described in the national forestry legislation and this area shows signs of a sanitary cut in the final harvesting stage. It was detected in the Zakarpattya region after the national legislation change to existing “Sanitary rules in forests of Ukraine” in October 2016, heavily restricting the use of a sanitary clear cut. However, at the time of writing this report, this type of logging was requalified as a final type of pre-planned logging. Forest experts doubt the necessity of this requalification. Among the visited sites, logging has finished on 8 sites, 6 sites were selected but not logged yet, and 4 sites were in the process of being harvested.
2. More than 60% of all visited sites were not appropriately justified from a tree sanitary health problems point of view, and during the visits the international team of forest experts observed a typical list of possible violations of “Sanitary rules in forests of Ukraine” (SRFU) such as:
    - Selection of healthy trees (category 1-2 of SRFU conditions) for sanitary logging (violated SRFU articles: 12, 19, 40);
    - Manipulation of sample plot applicability, data from which is used for sanitary permit prescriptions, typically such sites are established in unrepresentative areas of the forest to show a higher number of damaged trees (violated SRFU article # 29);
    - Damage to trunks and their lower parts, natural regeneration destruction, and soil damages due to skidding (violated SRFU articles: 27, 42).
3. More detailed forest violation types are presented in the table above.
4. More than 80% of cases showed pre-harvest planning problems.
5. More than 50% of ongoing or recently completed cases showed evidence of violations of harvesting practices. Visited forests of the Ukrainian Carpathians mostly are in a good condition. The team of international forest experts have not observed intensive forest

dieback areas on a large scale at these field visits. Only small groups of trees and some declining coniferous spruce stands were seen, mostly due to the decline of old trees (category 6 of SRFU conditions). Such diebacks could have been caused by annosum root rot disease, stem pest infestation and water level decline. Given this and the level of observed violations on the visited sites, it seems that sanitary logging in Carpathians is rather used to obtain official permits for industrial timber logging, than for improving the health of the existing stands and for the formation of a sustainable forest environment in the future.

6. Generally, the international team of forest experts can distinguish between two main reasons for large scale correctly assigned sanitary forest logging in the Ukrainian Carpathians:

   ***First*:** Due to the health conditions of the forest and as a result of spruce dieback, monocultures or other reasons.

   ***Second*:** Due to the location of forest stands around open clear cut areas – some trees or groups of trees, mainly spruce, decline along the harvested site perimeter. Stand degradation and complete decline happens due to more intensive influence of environmental factors and biotic impact, particularly, because of increased light, temperature regime, and humidity change along with the next stem pests' invasion. On such sites, selective sanitary logging is typically prescribed. There are also cases during harvest where some live trees in good health are subjected to logging (categories 1-2 of SRFU conditions). Often, dead trees remain or are not completely removed even if they were prescribed for logging. Intense and not carefully completed selective harvesting in such fir-spruce forests causes further stand degradation leading to more weakened trees that require further logging.

7. Forest stands, which were reasonably selected for clear cuts, consisted mainly of old dead trees. Sanitary clear cuts on such areas are justified from the legislative point of view but not beneficial to the health of the stand or development purposes. This is due to the fact that old dead forest stands no longer pose a threat to pests and diseases for a healthy forest. In these types of forest, natural regeneration has already been well-established and dead standing trees will serve as a source of further biodiversity development and their removal will affect the regeneration process, and in some cases it also will cause soil erosion.

Recommendations

1. Submission of information by forestry management about planned sanitary activities to websites and appropriate authorities, which includes site area configurations on the forestry maps and their GPS coordinates. This could help decrease the general level of public pessimism and show that forestry enterprises could work in a transparent way. A recommendation is to invite as many third parties to the inspection process of any sanitary logging sites as communities and the general public request. This could make the process transparent as well as quick.
2. Responsible government officials and state institutions need to reform the whole forestry sector which will:
   - be based on developed and publicly agreed national forest policy (based on the national forestry inventory information about the existence of forest resources in regions and their possible timber increment percentage use for logging),
   - clearly state the logical organizational structure (separate state policy coordinating agency, forestry management organization, and state law enforcement department),
   - create effective forest law enforcement system;
   - be established as a financially independent system based on free market values to increase the market value of forest resources (this could lift the financial pressure to cut as much forest as is needed for the economic survival of forest enterprises).
3. Law enforcement agencies should pay more attention to the real state of logging procedures and national forest policy institutions should reinforce national law by turning the development path towards planning harvests rather than spontaneous sanitary logging, unrestricted by size.
4. Apply other sanitary measures, apart from large scale logging before significant forest loss, including monitoring the formation of forest stands with a wide range of local trees and leaving dead standing and decayed trees (up to 20% of its volume) as well as supporting the introduction of appropriate biological pest control methods, establishing pheromone and other traps, etc.
5. Stop prescribing sanitary clear cut in the forest stands that only consist of already dead standing trees (category 6 of conditions) where natural regeneration is sufficient.

6. Increase forest resilience by implementing silvicultural treatments oriented at formation of mixed stands with greater biodiversity from only indigenous local species.
7. Implement the development of long-term forest management plans (for a period of more than 10 years) for forest users/owners with an aim to support development (improvement) of forest stands' resilience by implementing special silvicultural treatments to create forests with greater biodiversity and desired characteristics, depending on ecological and economic circumstances.
8. Do not prescribe sanitary logging measures for stands when there are mainly dead standing trees with category 6 of the conditions and when the presence of intense and natural regeneration in such stands shows that there is no continual threat of stem pest distribution since the pest infestation has moved onto another area.

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Appendix A: Information about location, geographic coordinates and area of the observed sites

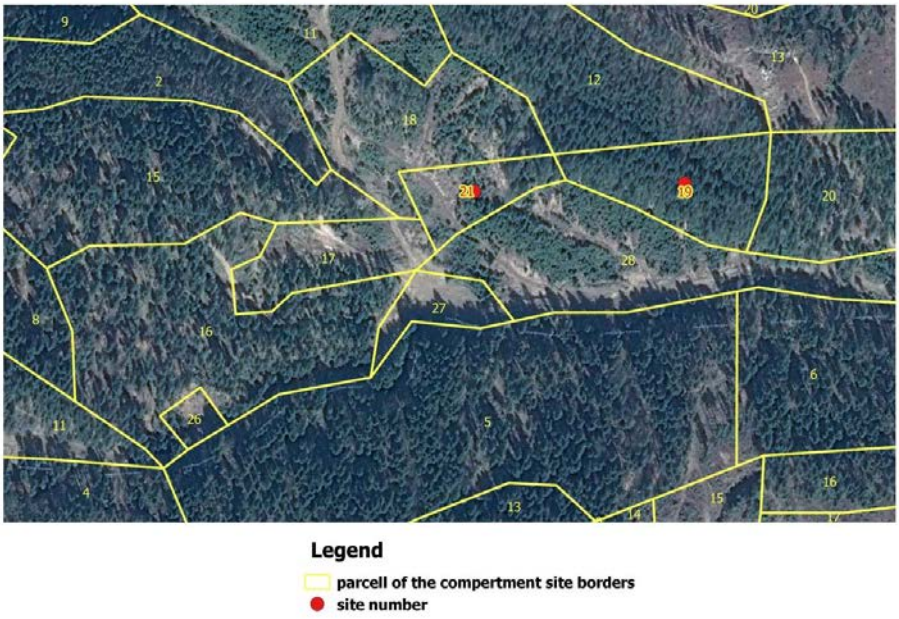

Figure 1. Location of the site №21 (coordinates X=25.281437; Y=48.122778)

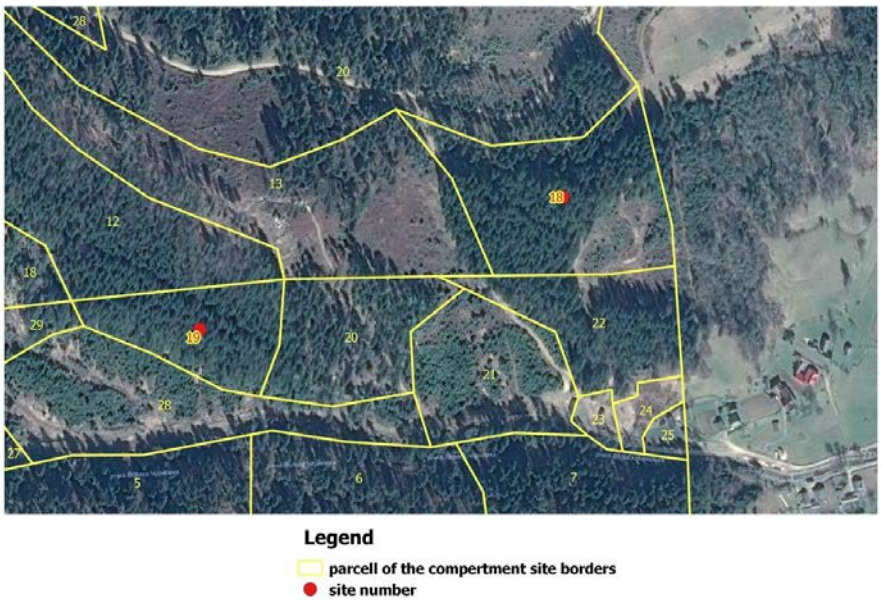

Figure 2. Location of the sites №19 (X=25.284359; Y=48.122739) and №18 (X=25.289593; Y=48.123768)

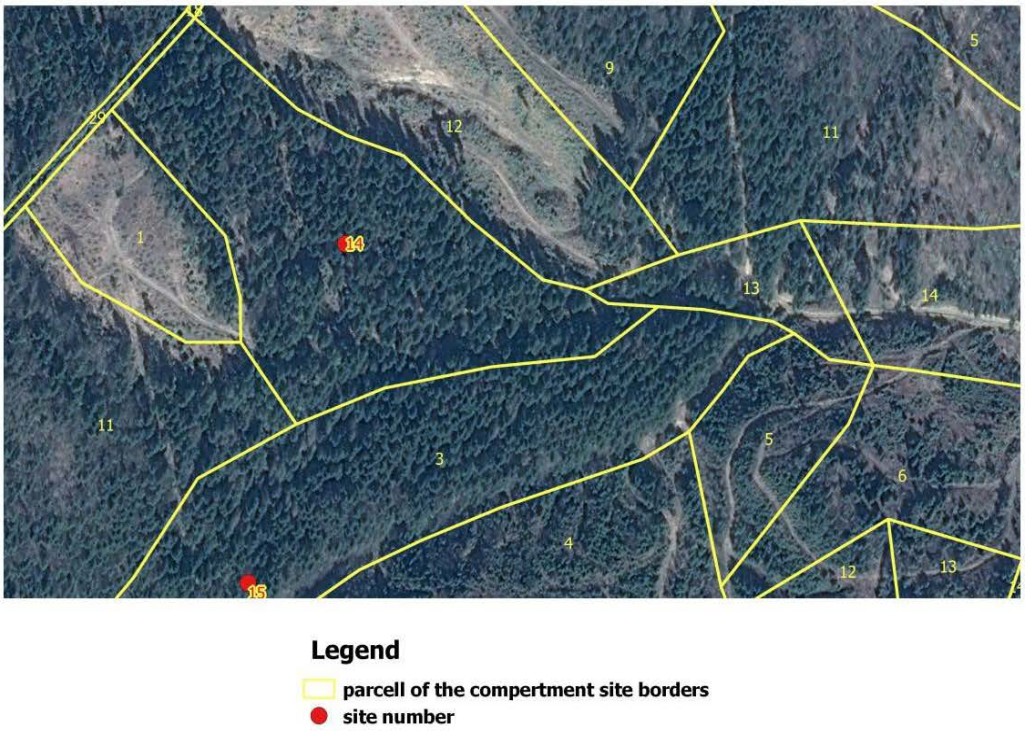

Figure 3. Location of the site №14 (X=25.276814; Y=48.134690)

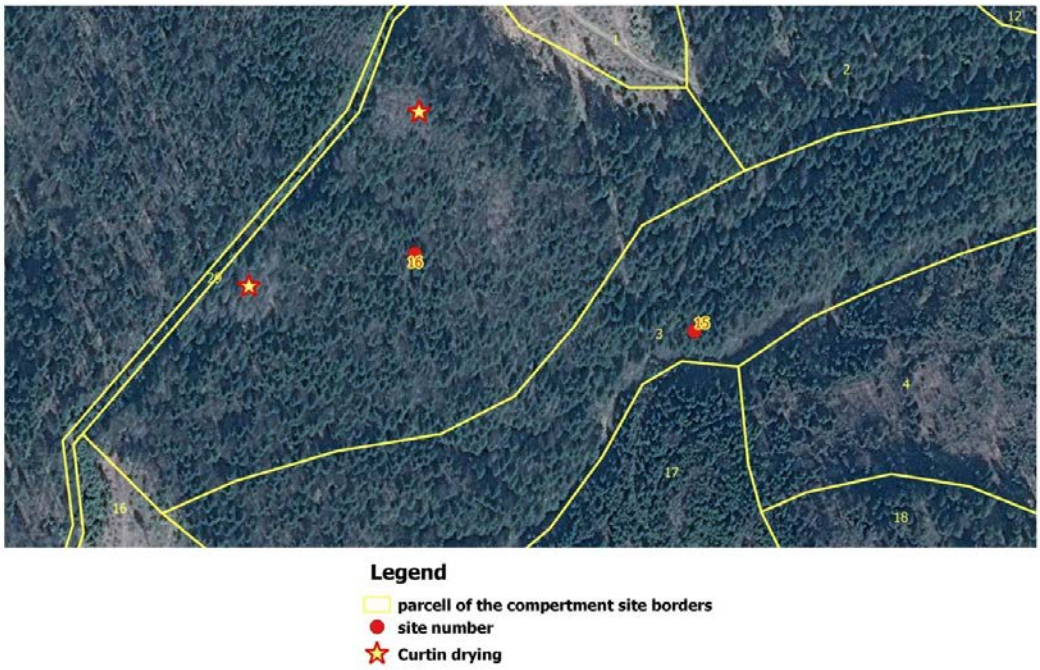

Figure 4. Location of the site №16 (X=25.272074; Y=48.132718)

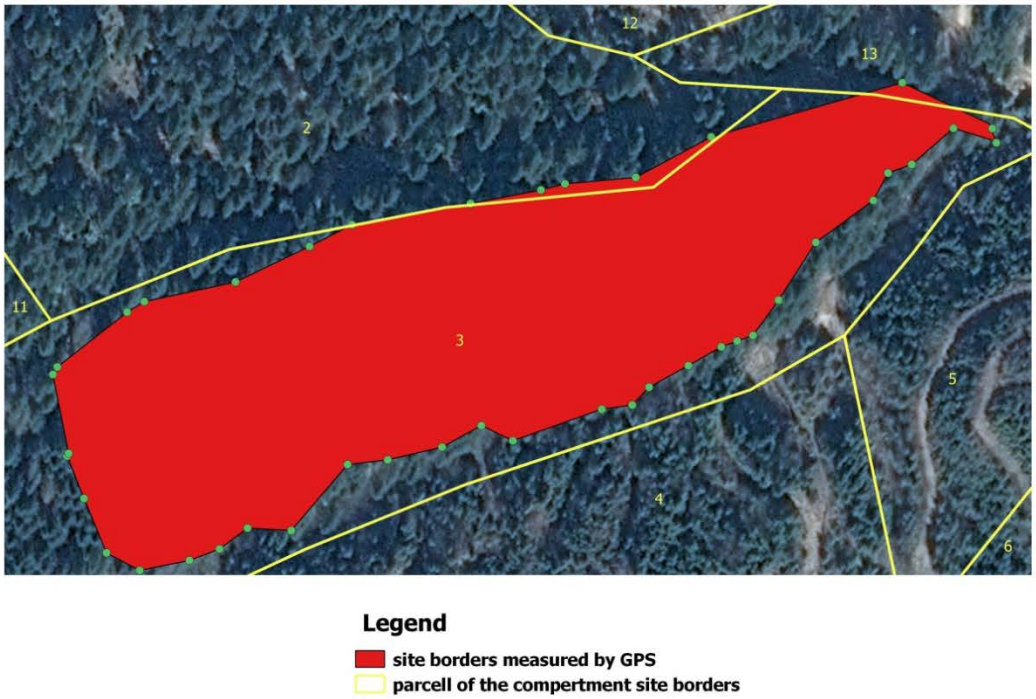

Figure 5. Location of the site №15 (X=25.275366; У=48.131968)

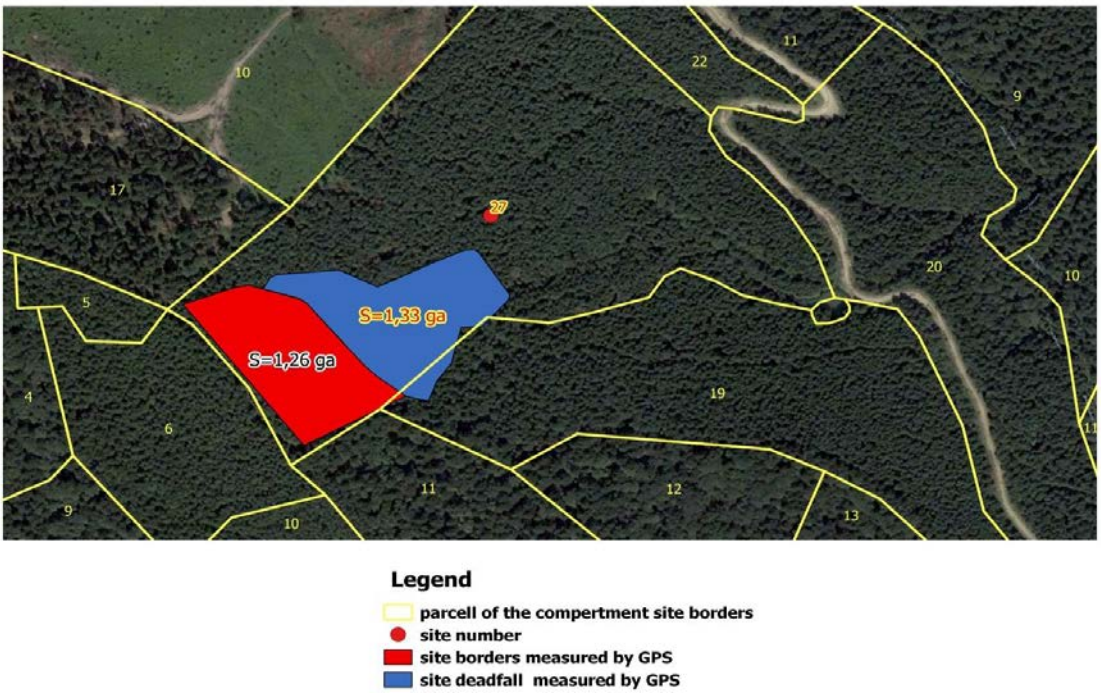

Figure 6. Location of the site №27 (X=25.218028; У=48.090005)

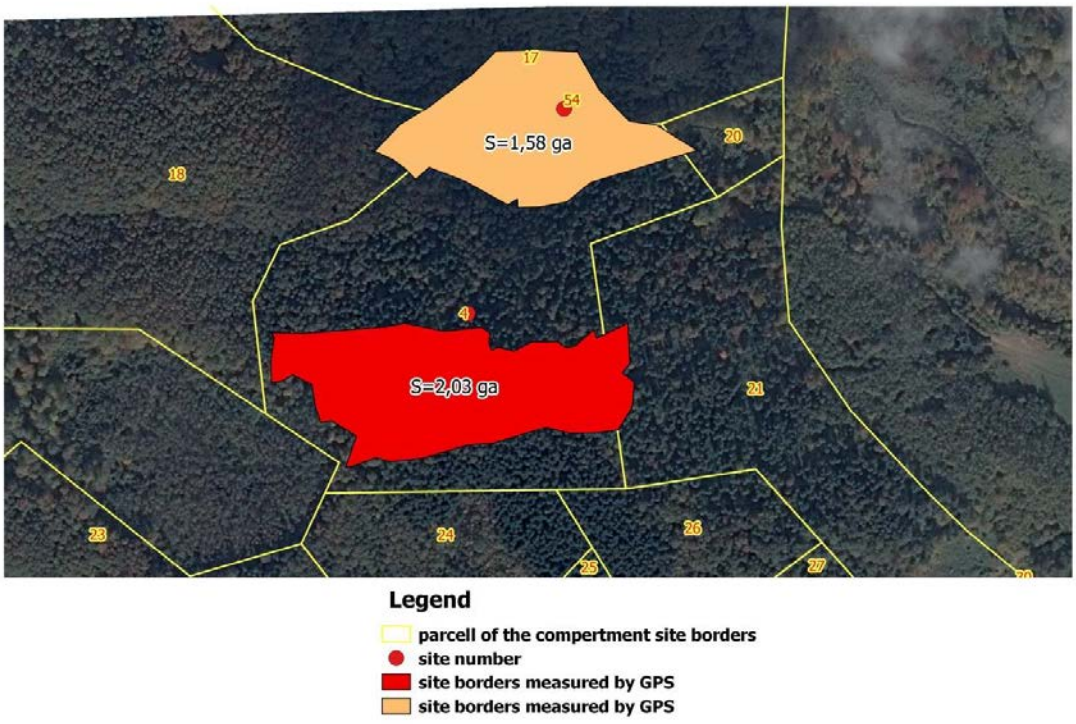

Figure 7. Location of the sites №4 (X=22.961083; У=48.732376) and 54 (X=22.962117; У=47.733756)

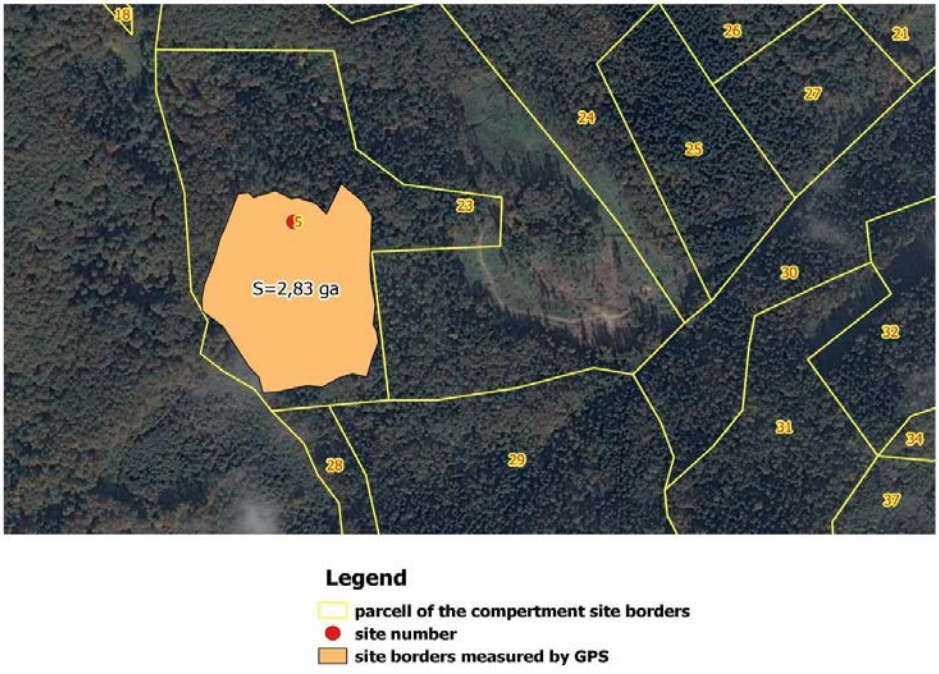

Figure 8. Location of the site №5 (X=22.957348; У=48.7289)

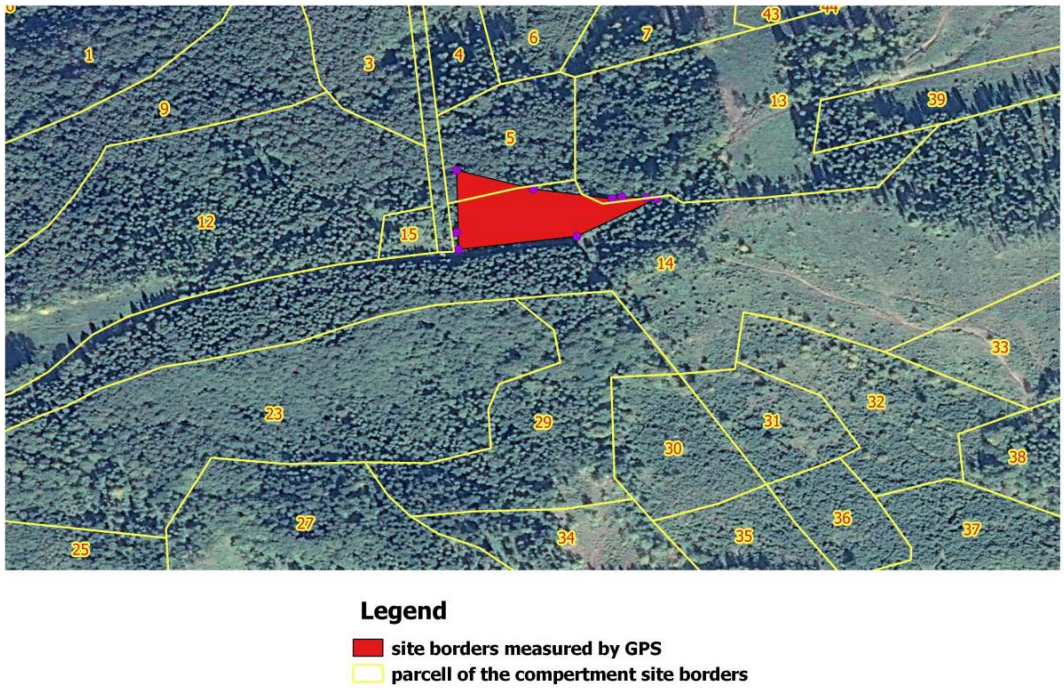

Figure 9. Location of the site №53 (X=22.86515; Y=48.88034)

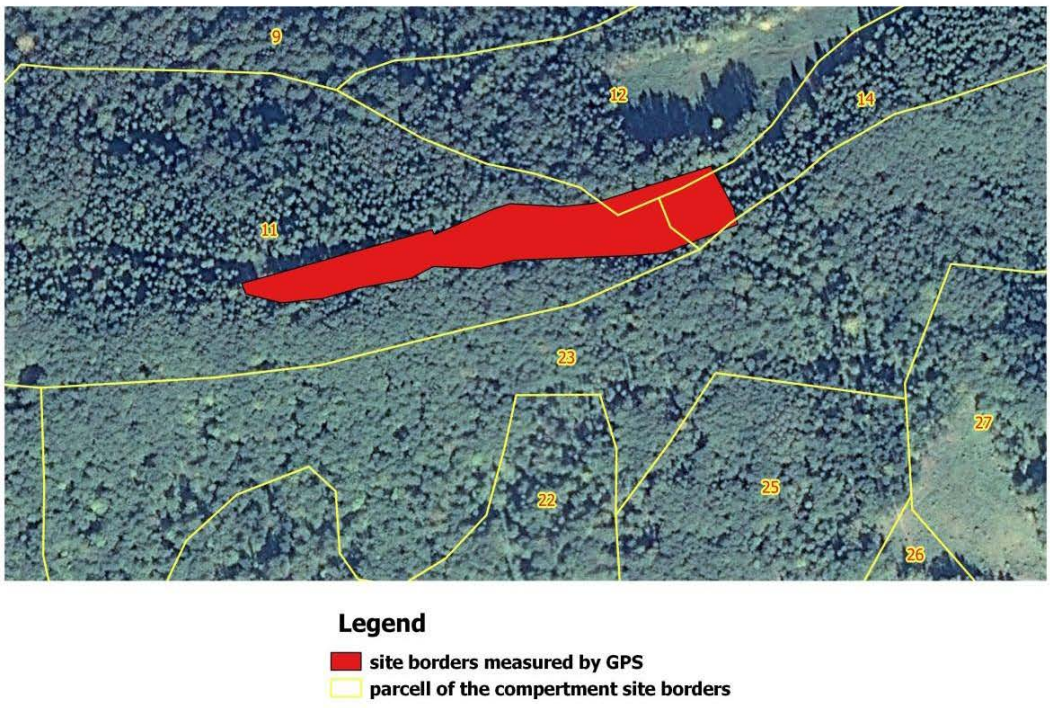

Figure 10. The boundaries of a pre-planned "urgent" clear cut that don't match the sub-compartment boundaries on the state forest digital map (site №7, X=22.853566; Y=48.878072)

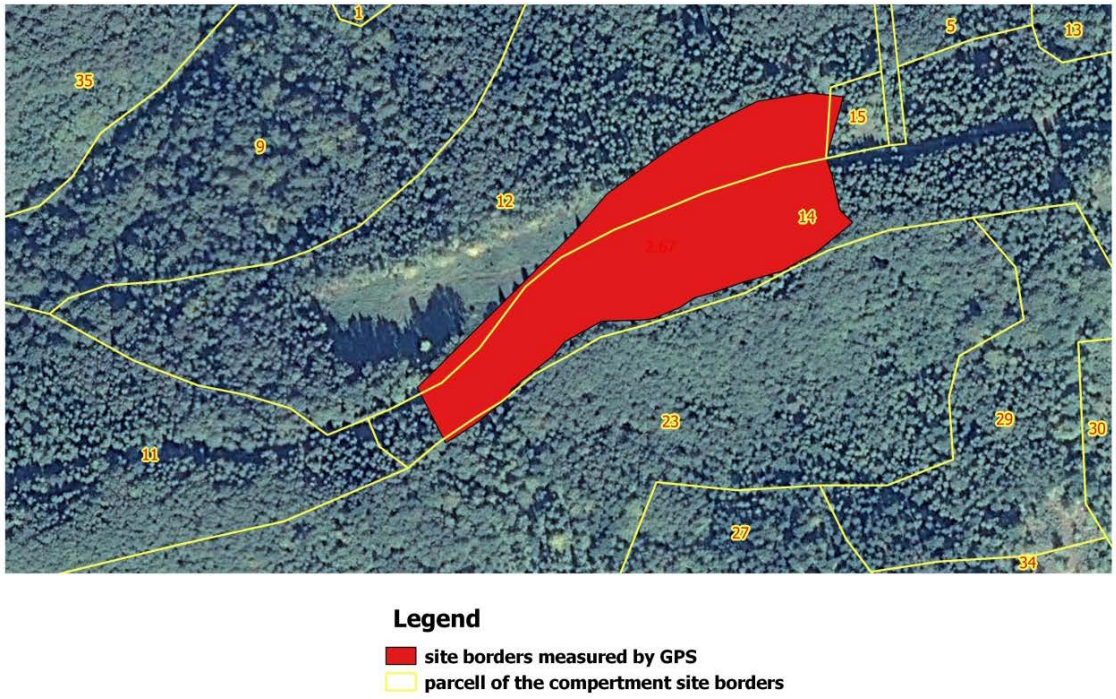

Figure 11. Location of the site №8 (X=22.86742; У=48.87994)

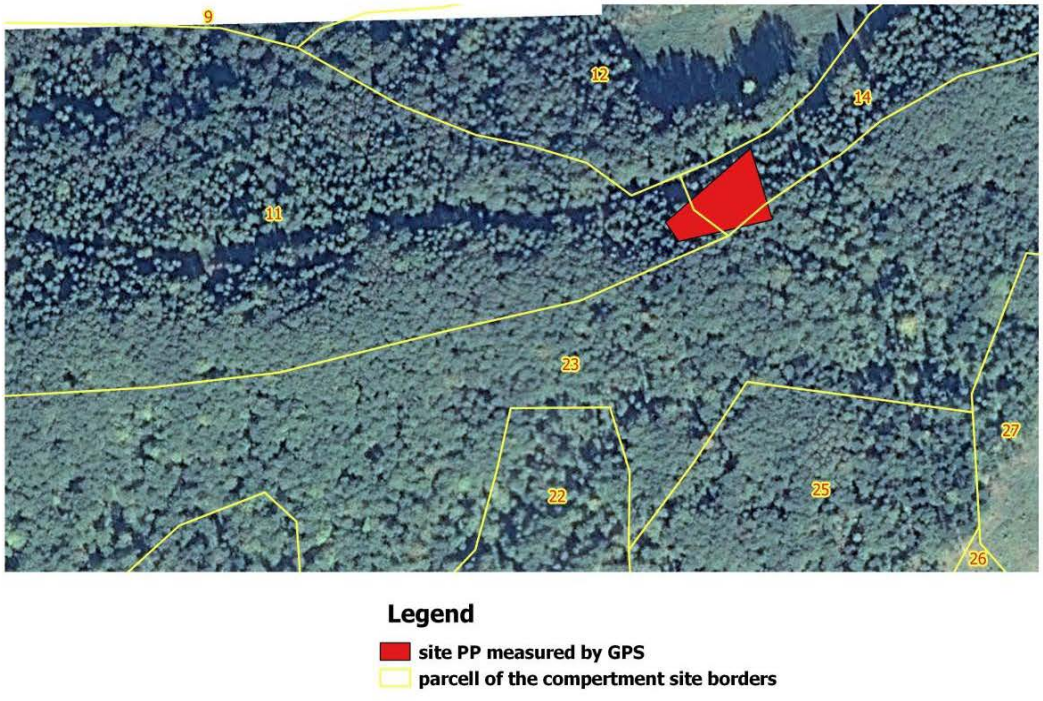

Figure 12. Positioning of a sample plot in sub-compartment 11 (site №7)

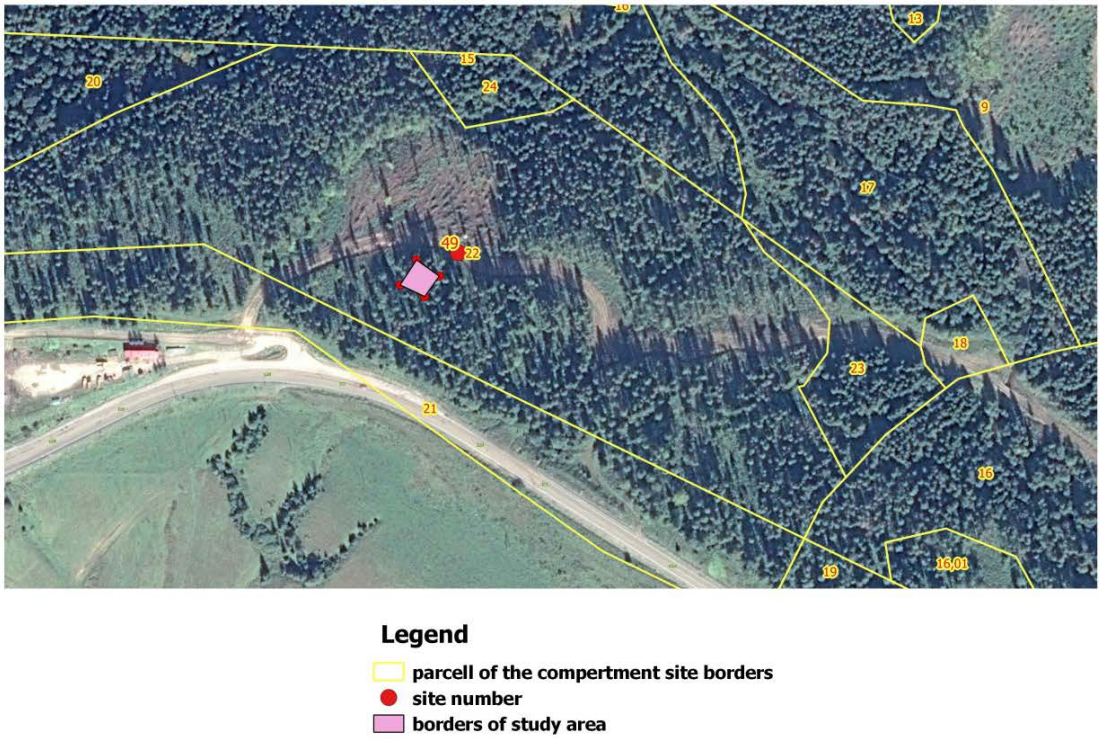

Figure 13. Location of the site №49 and its sample plot (X=23.22511; Y=48.90315)

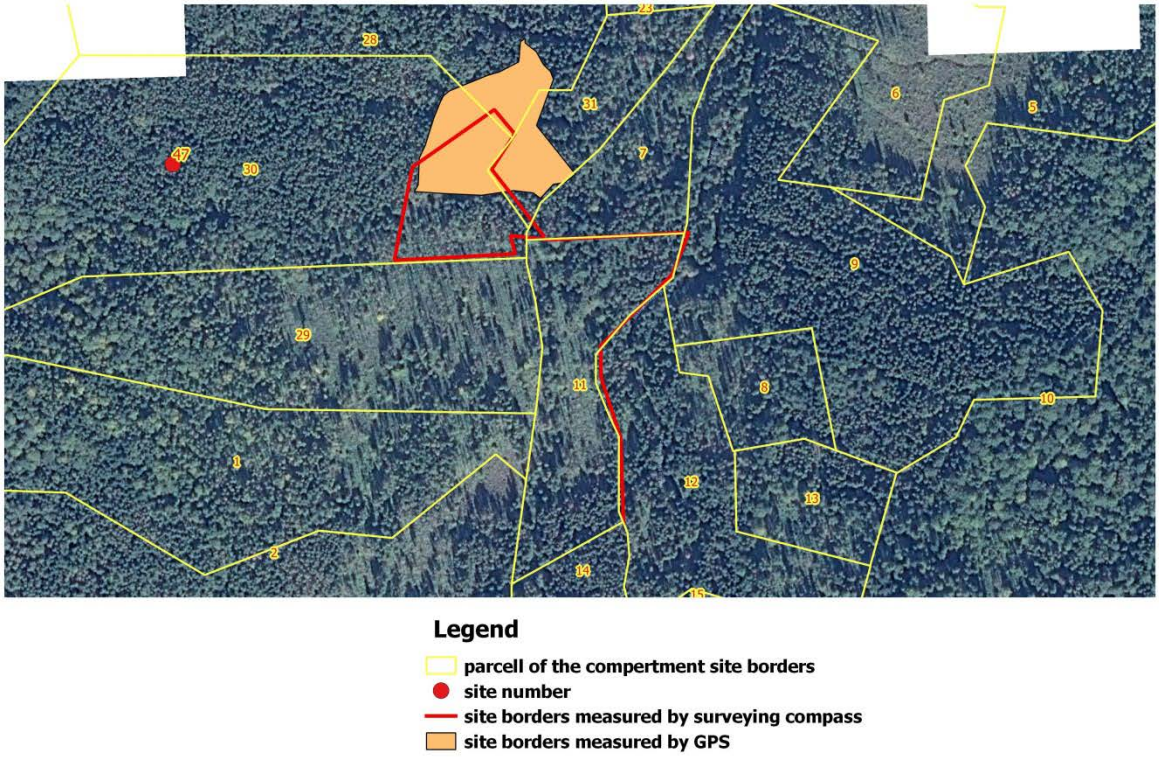

Figure 14. Location of the site №47 that don't match the sub-compartment boundaries on state forest digital map (X=23.15760; Y=48.89377)

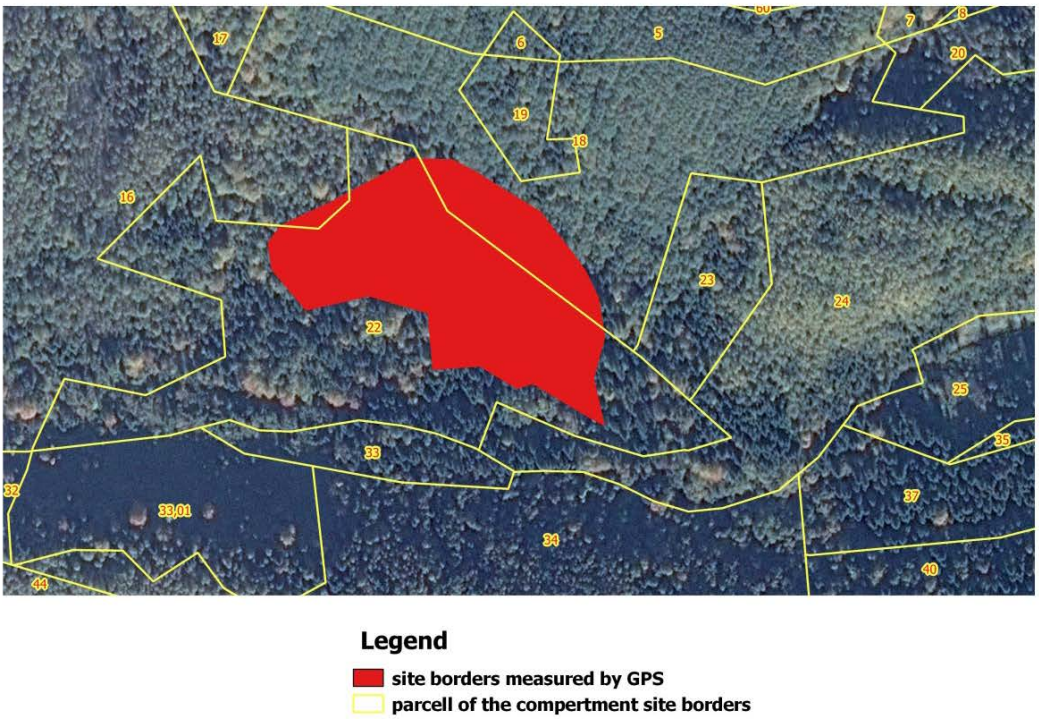

Figure 15. Location of the site №51 that don't match the sub-compartment boundaries on state forest digital map (X=23.93813; Y=48.91074)

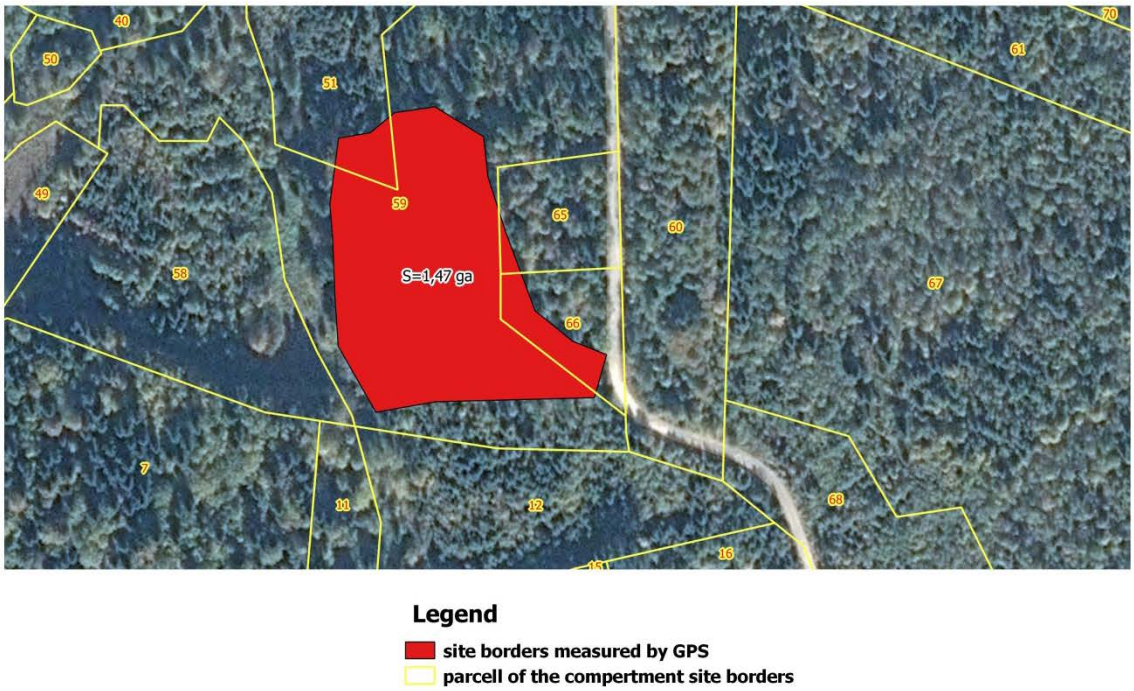

Figure 16. Location of the site №52 that don't match the sub-compartment boundaries on state forest digital map (X=23.98201; Y=48.93584)

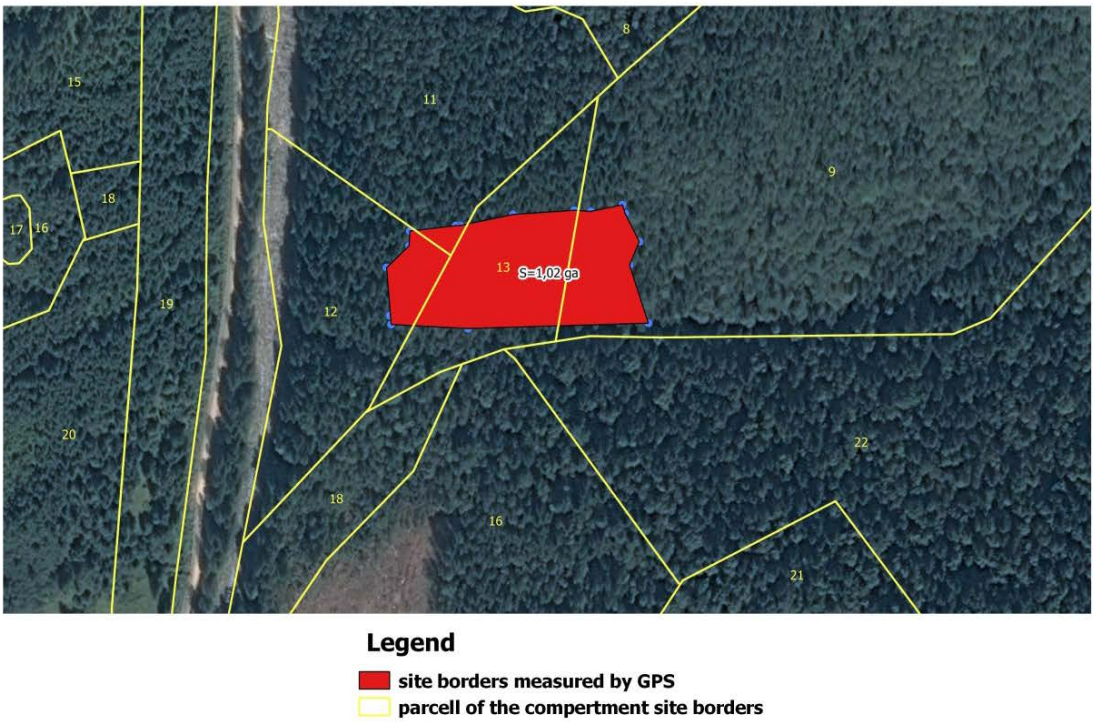

Figure 17. Location of the site №31 that doesn't match the sub-compartment boundaries on the state forest digital map (X=24.02066; У=48.63969)

Appendix B: Additional information about the observed forest stands

Table 1. **Information about wood quality of trees on site #19, selected for sanitary logging**

DBH, cm	Species: fir			
	commercial trees	semi-commercial trees	fuel wood tree	total
16	0	0	4	4
20	0	1	9	10
24	2	6	1	9
28	13	1	0	14
32	6	1	0	7
36	8	0	0	8
40	2	0	2	4
44	3	0	0	3
48	2	1	0	3
52	3	0	0	3
56	1	0	0	1
Total	40	10	16	66

Table 2. **Information about sanitary condition of trees on the site #19, selected for sanitary logging**

DBH, cm	Species: fir (1-6 category of conditions)						Total
	1	2	3	4	5	6	
16	0	0	0	3	0	1	4
20	0	0	3	3	0	4	10
24	1	5	2	0	0	1	9
28	6	8	0	0	0	0	14
32	4	2	1	0	0	0	7
36	2	6	0	0	0	0	8
40	2	0	2	0	0	0	4
44	3	0	0	0	0	0	3
48	2	0	1	0	0	0	3
52	3	0	0	0	0	0	3
56	1	0	0	0	0	0	1
Total	24	21	9	6	0	6	66

Table 3. **Information about sanitary state of trees which were left on site #15 after selective sanitary logging (area of a sample plot – 0.05 ha)**

№	Species	DBH, cm	Wood quality of trees	Condition
1	fir	16	fuel wood tree[5]	6
2	fir	12	fuel wood tree	2
3	fir	15	fuel wood tree	3
4	fir	42	commercial tree[6]	1
5	fir	10	fuel wood tree	4
6	fir	10	fuel wood tree	4
7	fir	12	fuel wood tree	3
8	fir	10	fuel wood tree	6
9	fir	42	commercial tree	1
10	fir	14	fuel wood tree	2
11	fir	29	commercial tree	2
12	fir	22	semi-commercial tree	2
13	fir	8	fuel wood tree	4
14	fir	34	commercial tree	1
15	fir	22	semi-commercial tree	2
16	fir	36	commercial tree	3
17	fir	10	fuel wood tree	3
18	fir	8	fuel wood tree	4
19	fir	12	fuel wood tree	3
20	fir	20	semi-commercial tree	2
21	fir	8	fuel wood tree	3
22	fir	8	fuel wood tree	2
23	fir	8	fuel wood tree	4
24	beech	8	fuel wood tree	2
25	fir	8	fuel wood tree	3
26	fir	6	fuel wood tree	5
27	fir	46	commercial tree	2
28	fir	8	fuel wood tree	2
29	fir	8	fuel wood tree	2
30	fir	16	fuel wood tree	3
31	fir	20	semi-commercial tree	1
32	fir	40	commercial tree	1
33	fir	14	semi-commercial tree	1

[5] e.g. suitable for fire wood
[6] good quality timber

Table 4. **Information about the height of the main tree species left on site #15 after selective sanitary logging (plot size – 0.05 ha)**

№	Species	DBH, cm	Height, m
1	beech	33	30.6
2	fir	56	36.5
3	fir	19	23.2
4	fir	71	40.8
5	fir	76	41.7
6	fir	18	22.2
7	fir	9	7.9
8	fir	50	37.1
9	fir	45	36.2
10	fir	11	10
11	fir	40	31.4
12	fir	45	37.5
13	spruce	35	28.4
14	spruce	13	7.1
15	fir	56	34.1
16	spruce	27	26
17	spruce	13	13.8
18	fir	12	8.1
19	fir	25	19.4
20	fir	12	12
21	fir	10	11.8
22	fir	16	17.5
23	fir	18	19.4
24	fir	8	8.1
25	fir	15	13.8
26	fir	18	17.3
27	fir	12	11.7
28	fir	36	31.0

Table 5. **Information about stump conditions after selective sanitary logging on site #15 (plot size – 0.05 ha)**

№	Species	DBH, cm	Damaged, %	Stamped
1	fir	11	0	no
2	fir	19	0	no
3	fir	45	0	yes
4	fir	48	20	yes
5	fir	55	0	yes
6	fir	40	0	no
7	fir	56	0	yes
8	fir	80	80	yes
9	fir	71	0	yes
10	fir	67	0	no
11	fir	16	0	no

Table 6. **Information about trees selected for sanitary clear cut on site #4**

№ of tree	Species	DBH, cm	Wood quality of trees	Category of conditions	Remarks
1.	spruce	36	semi-commercial tree	2	-
2.	spruce	34	commercial tree	2	-
3.	spruce	38	semi-commercial tree	3	damaged by pests
4.	spruce	22	semi-commercial tree	1	-
5.	spruce	40	semi-commercial tree	1	-
6.	spruce	22	semi-commercial tree	6	damaged by pests
7.	spruce	26	semi-commercial tree	1	-
8.	spruce	34	semi-commercial tree	2	-
9.	spruce	36	semi-commercial tree	2	cancer, 10%
10.	spruce	36	semi-commercial tree	2	cancer of trunk, 10%
11.	spruce	32	semi-commercial tree	2	-
12.	spruce	28	semi-commercial tree	1	-
13.	spruce	22	semi-commercial tree	1	-
14.	spruce	20	semi-commercial tree	5	-
15.	spruce	24	semi-commercial tree	1	-
16.	spruce	32	semi-commercial tree	3	defoliation, 40%
17.	spruce	28	semi-commercial tree	3	-
18.	spruce	32	semi-commercial tree	1	-
19.	spruce	28	semi-commercial tree	2	-
20.	spruce	24	semi-commercial tree	5	-
21.	spruce	24	semi-commercial tree	6	-
22.	spruce	28	semi-commercial tree	2	-
23.	spruce	24	semi-commercial tree	2	-

№ of tree	Species	DBH, cm	Wood quality of trees	Category of conditions	Remarks
24.	spruce	20	semi-commercial tree	1	-
25.	spruce	24	semi-commercial tree	2	-
26.	spruce	20	semi-commercial tree	4	-

Table 7. **Information about stump conditions on site #53 selected for "urgent" clear cut (area of sample plot – 0.84 ha)**

№	Species	DBH, cm	Damaged of stump, %	Remarks
1	spruce	25	30	-
2	spruce	21	0	-
3	spruce	16	0	-
4	spruce	40	0	-
5	spruce	22	0	-
6	spruce	29	0	-
7	spruce	34	0	-
8	spruce	18	0	-
9	spruce	43	9	-
10	spruce	41	0	-
11	spruce	53	0	-
12	spruce	26	80	-
13	spruce	27	80	-
14	spruce	45	60	-
15	spruce	23	100	dead
16	spruce	28	0	-
17	spruce	17	100	dead
18	spruce	40	45	-
19	spruce	43	30	-
20	spruce	40	30	-
21	spruce	23	0	-
22	spruce	16	100	dead
23	spruce	47	50	-
24	spruce	26	10	-
25	spruce	30	10	-
26	spruce	26	0	-
27	spruce	65	30	-
28	spruce	18	0	-
29	spruce	44	50	-
30	spruce	30	0	-
31	spruce	37	20	-
32	spruce	40	100	dead
33	spruce	38	65	-
34	spruce	43	100	dead
35	spruce	50	85	dead
36	spruce	34	0	-
37	spruce	31	80	-

№	Species	DBH, cm	Damaged of stump, %	Remarks
38	spruce	65	0	-
39	spruce	28	30	-
40	spruce	52	0	-
41	spruce	31	45	-
42	spruce	38	60	-
43	spruce	32	100	dead
44	spruce	60	30	-
45	spruce	45	75	-
46	spruce	40	10	-
47	spruce	50	0	-
48	spruce	24	35	-
49	spruce	35	80	-
50	spruce	35	55	-
51	spruce	32	70	-
52	spruce	30	15	-
53	spruce	23	20	-
54	spruce	35	60	-
55	spruce	40	50	-
56	spruce	23	0	-
57	spruce	36	0	-
58	spruce	17	100	dead
59	spruce	28	10	-
60	spruce	49	60	-
61	spruce	26	0	-
62	spruce	29	30	-
63	spruce	41	10	-
64	spruce	10	100	dead
65	spruce	10	100	dead
66	spruce	49	30	-

Table 8. **Information about the wood quality of spruce trees on site #7 selected for "urgent" clear cut (without taking into account the trees growing on a sample plot)**

DBH, cm	Species: spruce			
	commercial trees	semi-commercial trees	fuel wood trees	total
12	0	0	15	15
16	0	2	64	66
20	6	21	60	87
24	17	48	25	90
28	17	33	9	59
32	17	26	7	50
36	16	11	6	33

40	2	2	0	4
44	1	1	0	2
Total	76	144	186	406

Table 9. **Information about the health state condition[7] of spruce trees on site #7 selected for "urgent" clear cut (without taking into account the trees growing on a sample plot)**

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
12	1	3	2	2	1	6	15
16	3	13	11	12	4	23	66
20	1	28	19	7	0	32	87
24	15	46	14	5	0	10	90
28	15	31	6	2	0	5	59
32	17	22	8	1	1	1	50
36	10	15	5	2	1	0	33
40	2	1	1	0	0	0	4
44	2	0	0	0	0	0	2
Total	66	159	66	31	7	77	406

Table 10. **Information about the wood quality of beech trees on site #7 selected for "urgent" clear cut (without taking into account the trees growing on a sample plot)**

DBH, cm	Species: beech			
	commercial trees	semi-commercial trees	fuel wood trees	total
8	0	0	9	9
12	0	0	25	25
16	0	0	37	37
20	0	0	22	22
24	0	1	14	15
28	0	3	15	18
32	0	1	12	13
36	0	2	9	11
40	1	2	10	13
44	0	1	3	4
48	1	0	0	1
52	0	0	1	1
56	0	1	1	2
60	0	0	1	1
Total	2	11	159	172

[7] The category of tree conditions according to the sanitary rules of the forests of Ukraine [8]

Table 11. **Information about the health state condition of beech trees on site #7 selected for "urgent" clear cut (without taking into account the trees growing on a sample plot)**

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
8	8	0	0	0	0	1	9
12	23	0	0	2	0	1	26
16	36	1	0	0	0	0	37
20	21	0	0	1	0	0	22
24	14	0	0	0	0	0	14
28	16	1	0	1	0	0	18
32	13	0	0	0	0	0	13
36	11	0	0	0	0	0	11
40	13	0	0	0	0	0	13
44	4	0	0	0	0	0	4
48	1	0	0	0	0	0	1
52	1	0	0	0	0	0	1
56	2	0	0	0	0	0	2
60	1	0	0	0	0	0	1
Total	164	2	0	4	0	2	172

Table 12. **Information about the wood quality of spruce trees on site #7 selected for "urgent" clear cut (on the sample plot established by forestry staff)**

DBH, cm	Species: spruce			
	commercial trees	semi-commercial trees	fuel wood trees	total
16	0	2	7	9
20	4	5	2	11
24	5	4	0	9
28	13	4	4	21
32	9	2	0	11
36	4	1	0	5
40	0	0	0	0
44	4	0	0	4
Total	39	18	13	70

Table 13. **Information about the health state condition of spruce trees on site #7 selected for "urgent" clear cut (on the sample plot established by a forestry)**

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
16	0	3	0	2	0	4	9
20	3	5	2	1	0	0	11
24	2	6	1	0	0	0	9
28	9	8	2	0	2	0	21

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
32	6	5	0	0	0	0	11
36	5	0	0	0	0	0	5
40	0	0	0	0	0	0	0
44	3	1	0	0	0	0	4
Total	28	28	5	3	2	4	70

Table 14. **Numbered by forestry workers spruce trees belonging to category 6 of conditions on site #7 selected for "urgent" clear cut (on the sample plot established by forestry staff)**

№	№ on the tree	DBH, cm	Category of conditions
1	23	16	6
2	26	24	6
3	25	14	6
4	28	16	6
5	31	16	6
6	30	12	6
7	29	16	6
8	16	24	6
9	9	16	6
10	63	20	6
11	37	17	6
12	32	16	6
13	53	20	6
14	73	16	6
15	8	16	6
16	92	24	6
17	86	16	6
18	98	20	6
19	95	16	6
20	96	12	6

Table 15. **Distribution of spruce trees by wood quality that are not marked on the sample plot of site #7 selected for "urgent" clear cut**

DBH, cm	Species: spruce			
	commercial trees	semi-commercial trees	fuel wood trees	total
16	0	0	1	1
20	0	0	1	1
24	1	1	0	2
28	0	0	0	0
32	1	0	0	1

36	1	0	0	1
40	1	0	0	1
Total	4	1	2	7

Table 16. **Distribution of spruce trees by category of health conditions without marks on the sample plot of site #7 selected for "urgent" clear cut**

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
16	0	0	0	0	0	1	1
20	0	0	0	0	0	1	1
24	1	1	0	0	0	0	2
28	0	0	0	0	0	0	0
32	1	0	0	0	0	0	1
36	1	0	0	0	0	0	1
40	1	0	0	0	0	0	1
44	0	0	0	0	0	0	0
Total	4	1	0	0	0	2	7

Table 17. **Distribution of unrecorded beech trees by wood quality without marks on the sample plot of site #7 selected for "urgent" clear cut**

DBH, cm	Species: beech			
	commercial trees	semi-commercial trees	fuel wood trees	total
8	0	0	3	3
12	0	0	2	2
16	0	0	2	2
20	0	0	2	2
24	0	2	2	4
28	0	0	1	1
52	0	0	1	1
Total	0	2	13	15

Table 18. **Distribution of unrecorded beech trees by category of conditions without marks on the sample plot of site #7 selected for "urgent" clear cut**

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
8	3	0	0	0	0		3
12	2	0	0	0	0		2
16	2	0	0	0	0		2
20	2	0	0	0	0		2
24	4	0	0	0	0		4
28	1	0	0	0	0		1
52	1	0	0	0	0		1
Total	15	0	0	0	0		15

Table 19. **Information about the height of beech and maple trees on site #7 selected for "urgent" clear cut**

№	Species	DBH, cm	Category of conditions	Height, m
1	beech	52	1	27.9
2	beech	24	1	24.5
3	beech	21	1	22.7
4	maple	25	1	24.2
5	maple	11	1	13.8
6	maple	27	1	25.5
7	maple	39	1	25.9
8	beech	15	1	16.4
9	beech	31	1	25.5
10	beech	54	1	32.6
11	beech	18	1	21.9
12	beech	32	1	29.2
13	beech	27	1	23.9
14	beech	22	1	24.3
15	beech	41	1	26.9
16	beech	21	1	19.6
17	beech	42	1	28.7
18	beech	25	1	25.7
19	beech	29	1	23.6
20	beech	32	1	22.2
21	beech	16	1	19.4
22	beech	20	1	20.8
23	beech	16	1	19.0
24	beech	26	1	20.2
25	beech	33	1	26.0
26	beech	37	1	28.2
27	beech	22	1	25.6
28	beech	15	1	21.6

Table 20. **Information about height of spruce trees on site #7 selected for "urgent" clear cut**

№	Species	DBH, cm	Category of conditions	Height, m
1	spruce	31	2	22.7
2	spruce	34	2	24.5
3	spruce	45	2	25.1
4	spruce	44	2	27.0
5	spruce	27	2	22.3
6	spruce	29	2	21.5
7	spruce	30	2	23.4
8	spruce	44	1	24.4
9	spruce	17	3	14.8
10	spruce	24	1	21.8
11	spruce	36	1	25.1
12	spruce	29	1	20.8
13	spruce	27	2	20.0
14	spruce	46	2	23.9
15	spruce	14	4	12.9
16	spruce	46	1	27.3
17	spruce	37	1	27.1
18	spruce	29	2	23.6
19	spruce	30	1	20.6
20	spruce	24	2	19.8
21	spruce	38	1	23.0
22	spruce	21	2	18.7
23	spruce	32	2	19.6
24	spruce	36	2	24.2
25	spruce	30	1	23.7
26	spruce	23	2	22.0
27	spruce	32	1	21.6
28	spruce	31	1	24.1
29	spruce	37	1	25,0
30	spruce	28	2	21,2

Table 21. **Distribution of fir trees by wood quality on site #7 selected for "urgent" clear cut**

DBH, cm	Species: fir			
	commercial trees	semi-commercial trees	fuel wood trees	total
16	1	0	1	2
20	0	0	1	1
24	0	0	0	0
28	0	2	0	2
32	1	1	0	2
36	4	0	0	4
40	0	0	0	0
44	0	0	0	0
48	0	1	0	1
Total	6	4	2	12

Table 22. **Distribution of fir trees by wood quality on site #7 selected for "urgent" clear cut**

DBH, cm	Species: spruce (1-6 category of conditions)						Total
	1	2	3	4	5	6	
16	0	2	0	0	0	0	2
20	0	1	0	0	0	0	1
24	0	0	0	0	0	0	0
28	1	1	0	0	0	0	2
32	2	0	0	0	0	0	2
36	4	0	0	0	0	0	4
40	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0
48	1	0	0	0	0	0	1
Total	8	4	0	0	0	0	12

Table 23. **Distribution of maple trees by wood quality on site #7 selected for "urgent" clear cut**

DBH, cm	Species: maple			
	commercial trees	semi-commercial trees	fuel wood trees	total
12	0	0	1	1
16	0	0	1	1
20	0	0	2	2
24	0	0	2	2
28	0	1	3	4
32	0	1	1	2
36	0	1	1	2
40	0	1	0	0
44	0	0	0	0
48	0	0	0	0
Разом	0	4	11	15

Table 24. **Distribution of maple trees by condition on site #7 selected for "urgent" clear cut**

DBH, cm	Species: maple						Total
	1	2	3	4	5	6	
12	1	0	0	0	0	0	1
16	1	0	0	0	0	0	1
20	1	1	0	0	0	0	2
24	2	0	0	0	0	0	2
28	3	1	0	0	0	0	4
32	2	0	0	0	0	0	2
36	2	0	0	0	0	0	2
40	1	0	0	0	0	0	1
44	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0
Total	13	2	0	0	0	0	15

Table 25. **Information about stump condition on site #8 selected for "urgent" clear cut (area of sample plot – 0.06 ha)**

№	Species	DBH, cm	Damaged of stump, %	Remarks
1	spruce	38	0	-
2	spruce	37	20	-
3	spruce	30	15	-
4	spruce	33	0	-
5	spruce	32	0	-
6	spruce	30	0	-
7	spruce	32	0	-
8	spruce	32	0	-
9	spruce	30	0	-
10	spruce	40	0	-
11	spruce	32	0	-
12	spruce	36	0	-
13	spruce	29	100	dead
14	spruce	27	100	dead
15	spruce	20	100	dead
16	spruce	53	5	-
17	spruce	26	100	dead
18	spruce	13	100	dead
19	spruce	10	0	-
20	spruce	27	100	dead
21	spruce	30	100	dead
22	spruce	32	5	-
23	spruce	32	0	-
24	spruce	28	100	dead
25	spruce	30	5	-
26	spruce	18	10	-
27	spruce	30	0	-
28	spruce	39	50	-
29	spruce	26	70	dead
30	spruce	35	50	-
31	spruce	40	0	-
32	spruce	34	10	-
33	spruce	24	30	-
34	spruce	40	0	-
35	spruce	40	20	-
36	spruce	36	0	-
37	spruce	20	100	dead
38	spruce	33	10	-

№	Species	DBH, cm	Damaged of stump, %	Remarks
39	spruce	23	0	-
40	spruce	25	0	-
41	spruce	33	5	-
42	spruce	34	0	-
43	spruce	30	60	-
44	spruce	33	0	-
45	spruce	30	70	dead
46	spruce	16	100	dead
47	spruce	20	80	dead
48	spruce	30	50	-
49	spruce	40	50	-
50	spruce	39	50	-
51	spruce	19	20	-
52	spruce	29	70	-
53	spruce	42	30	-
54	spruce	16	100	dead
55	spruce	30	10	-

Table 26. **Information about trees on sample site #49 selected to sanitary clear cut**

№	Species	DBH, cm	Wood quality of trees	Category of conditions	Height, m
1	Spruce	28	semi-commercial tree	3	27.1
2	Spruce	36	commercial tree	2	28.6
3	Spruce	28	dead standing tree	6	-
4	Spruce	24	semi-commercial tree	3	24.3
5	Spruce	20	fuel wood tree	6	-
6	Spruce	28	commercial tree	4	29.6
7	Spruce	24	fuel wood tree	6	26.3
8	Spruce	36	fuel wood tree	6	30.1
9	Spruce	28	semi-commercial tree	4	26.9
10	Spruce	28	fuel wood tree	6	-
11	Spruce	24	commercial tree	3	29
12	Spruce	28	commercial tree	2	-
13	Spruce	20	commercial tree	3	-
14	Spruce	28	fuel wood tree	6	-
15	Spruce	28	semi-commercial tree	2	-
16	Spruce	28	fuel wood tree	6	-
17	Spruce	32	semi-commercial tree	3	-

№	Species	DBH, cm	Wood quality of trees	Category of conditions	Height, m
18	Spruce	32	semi-commercial tree	2	-
19	Spruce	24	commercial tree	3	-
20	Spruce	32	fuel wood tree	6	-
21	Spruce	36	fuel wood tree	6	-
22	Spruce	20	fuel wood tree	3	-
23	Spruce	16	fuel wood tree	6	-
24	Spruce	32	fuel wood tree	6	-
25	Spruce	40	fuel wood tree	3	-
26	Spruce	24	fuel wood tree	6	-
27	Spruce	36	commercial tree	3	35.6
28	Spruce	24	commercial tree	4	27.8
29	Spruce	20	fuel wood tree	4	-

Table 27. **Information about trees left on site #51 after shelter wood logging (area of a sample plot is 0.04 ha)**

Species	DBY, cm	Category of conditions	Wood quality of trees
Rowan	8	1	fuel wood tree
Rowan	4	1	fuel wood tree
Rowan	8	1	fuel wood tree
Oak	24	1	fuel wood tree
Spruce	24	1	fuel wood tree
Fir	16	2	fuel wood tree
Oak	8	1	fuel wood tree
Spruce	24	1	fuel wood tree
Beech	16	1	fuel wood tree
Fir	48	1	semi-commercial tree
Spruce	28	2	commercial tree
Fir	24	3	fuel wood tree
Spruce	24	3	fuel wood tree
Fir	12	1	fuel wood tree
Spruce	12	1	fuel wood tree
Fir	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	12	1	fuel wood tree
Spruce	12	1	fuel wood tree

Species	DBY, cm	Category of conditions	Wood quality of trees
Spruce	20	2	fuel wood tree
Spruce	56	2	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	44	3	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	12	4	fuel wood tree
Spruce	12	3	fuel wood tree
Birch	8	1	fuel wood tree
Birch	8	1	fuel wood tree
Rowan	8	1	fuel wood tree
Rowan	8	1	fuel wood tree
Spruce	32	2	semi-commercial tree
Birch	8	1	fuel wood tree
Birch	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Fir	8	1	fuel wood tree
Spruce	8	1	fuel wood tree
Rowan	8	1	fuel wood tree
Rowan	8	1	fuel wood tree
Spruce	20	2	semi-commercial tree
Fir	8	1	fuel wood tree
Fir	8	1	fuel wood tree
Spruce	16	3	semi-commercial tree
Fir	12	1	fuel wood tree
Fir	8	1	fuel wood tree
Oak	24	2	fuel wood tree
Spruce	16	3	fuel wood tree
Fir	8	1	fuel wood tree
Fir	8	1	fuel wood tree
Beech	24	1	fuel wood tree

Table 28. **Information about height of tree species on site #51 after shelter wood logging (area of a sample plot is 0.04 ha)**

№	Species	DB cm	Height, m
1	fir	20	15.1
2	fir	16	12.4
3	fir	16	10.8
4	fir	60	25.2
5	beech	12	8.8
6	fir	32	24.5
7	spruce	20	16.6
8	beech	20	11.8
9	spruce	20	9.8
10	spruce	84	31.4
11	fir	32	23.9
12	fir	32	25.2
13	spruce	52	25.2
14	beech	44	23.8
15	fir	10	5,1
16	beech	54	25.4
17	beech	64	27.1
18	spruce	16	12.9
19	fir	10	7.4
20	fir	11	6.9
21	fir	9	6.0

Table 29. **Information about natural seed regeneration on site #51 after shelter wood logging (area of a sample plot is 0.04 ha)**

Species	Number	Percent of species in regeneration, %	Height, cm	Category of conditions
Spruce	41	57.7	88	1
Fir	26	36.6	72	1
Beech	1	1.4	200	1
Oak	3	4.3	183	1

Table 30. **Information about stumps of cut-down trees on site #51 after shelter wood logging (area of a sample plot is 0.04 ha)**

Species	Number of stumps	Percent of stumps, %	Diameter, cm	Percent of damage, %
Spruce	11	44	55	10
Fir	10	40	37	0
Beech	1	16	47	0

Table 31. **Number of stumps of cut-down trees on site #51 after shelter wood logging (area of a sample plot is 0.04 ha)**

Diameters of stumps, cm		
beech	**spruce**	**fir**
56	44	75
48	40	56
44	54	40
40	28	48
-	36	80
-	32	60
-	28	72
-	32	24
-	28	28
-	44	56
-	-	68

Table 32. **Additional information about stumps of trees on site #51 after shelter wood logging (area of a sample plot is 0.04 ha)**

Parameters	Stump gradation by species		
	Spruce	Fir	Fagus
Average diameter of stumps, cm	37	55	47
Number of stumps	10	11	4
Percent of stumps, %	40	44	16
Percent of damaged stumps	10	-	-

Table 33. **Information about stumps on site #31 after clear sanitary cutting (area of a sample plot is 0.04 ha)**

Species	Diameter of stump, cm	Percent of damage, %	Species	Diameter of stump, cm	Percent of damage, %
Spruce	48	0	Birch	32	10
Spruce	36	0	Fir	52	5
Spruce	44	0	Fir	40	0
Spruce	36	0	Birch	32	10
Spruce	44	0	Fir	28	0
Spruce	36	0	Birch	28	20
Spruce	34	80	Fir	40	0
Birch	24	0	Fir	24	10
Fir	56	30	Birch	44	20
Spruce	58	0	Spruce	40	0
Spruce	32	30	Spruce	44	0
Spruce	44	20	Spruce	38	85
Fir	32	10	Spruce	42	90
Spruce	40	50	Spruce	64	0
Fir	20	0	Fir	46	0
Fir	18	0	Fir	72	0
Fir	30	0	Fir	28	0
Spruce	32	40	Fir	44	45
Spruce	22	0	Spruce	44	0
Fir	32	20	Spruce	40	0

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