THE CARPATHIAN FORESTS

Europe's natural heritage

UNDER ATTACK

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Wolf (Canis lupus) from the Carpathian forests

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This report is based on bibliographic research, spatial analysis of satellite datasets, expert information from each country, field trips, and consultations with scientists.

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We need to change course — now — and end our senseless and suicidal war against nature.

UN Secretary-General António Guterres

As nature knows no borders, we need to establish a transnational network of non-intervention and roadless areas to protect the Carpathians.

Nuria Selva, Polish Academy of Sciences

EXECUTIVE SUMMARY

The Carpathian Mountains, Europe's second longest mountain range with majestic forests, are one of the most biologically unique ecosystems in the world and of vital importance for Europe. On a continent where contiguous communities of trees – mainly managed forests with simplified structures – covers only a third of Europe's surface, the Carpathians stand for Europe's largest area covered by virgin and old-growth forests outside Scandinavia and the Russian Taiga. The Carpathian range crosses eight countries in continental Europe and covers a surface almost seven times larger than the territory of Belgium.

Local rural communities depend on these forests for clean air, fresh water, protection against erosion, and livelihood.

The Carpathian Mountains are a powerful mosaic of habitats and are home to Europe's largest population of brown bears outside Russia. Lynx and wolves roam these forests along with wildcats and European bison. Around 140 bird species populate their trees and sky, while numerous fish species, newts, and frogs swim in their waters. Their forests play a crucial role in tackling the climate emergency. Older, more mature forests store more carbon, retain water, provide shelter and protection from floods, droughts, and other extreme weather. Local rural communities depend on these forests for clean air, fresh water, protection against erosion, and livelihood.

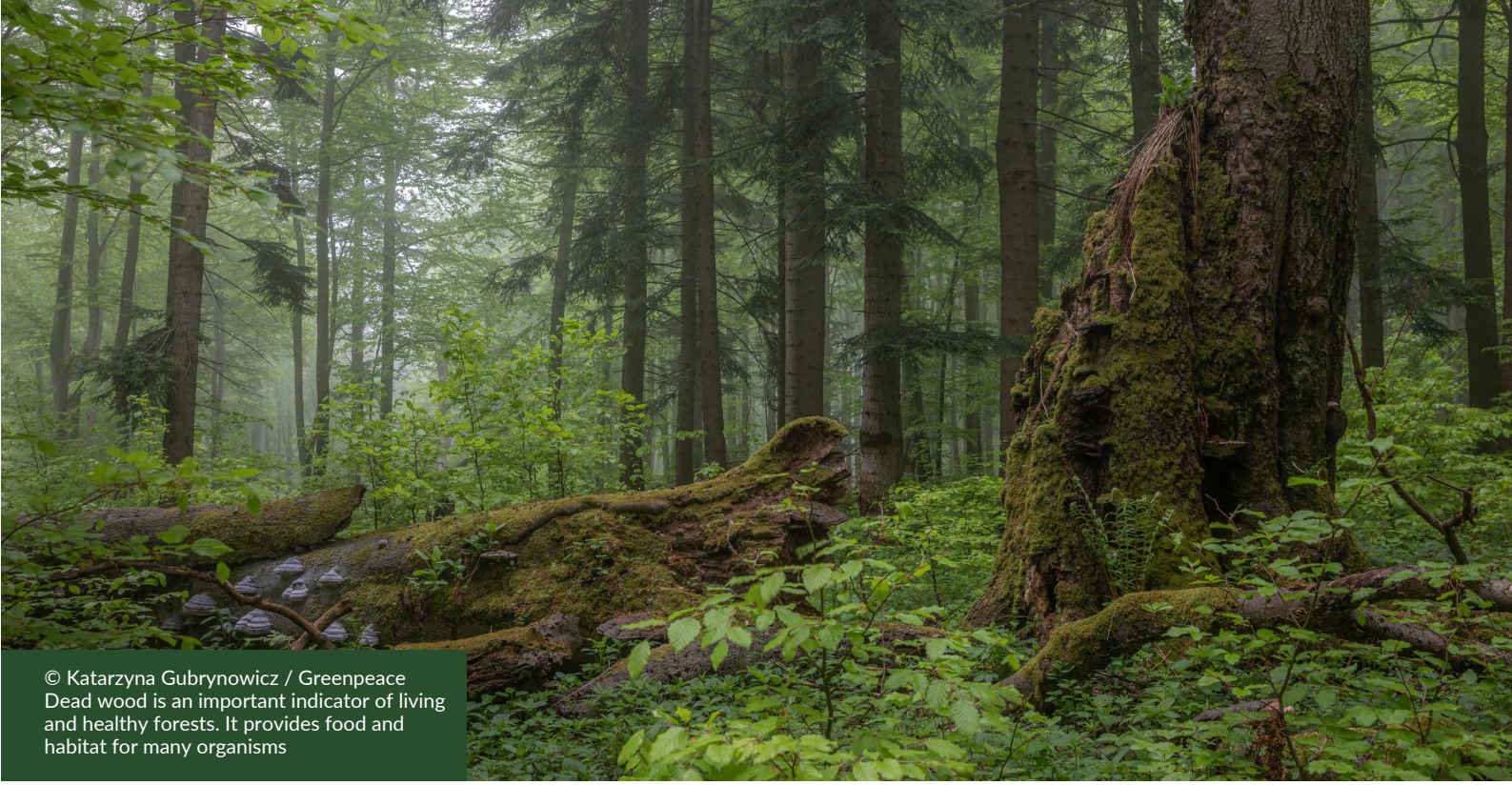
This report looks into how much the Carpathian forests have been impacted by production-driven forestry and what nature conservation measures have been applied so far to preserve this icon of Europe's natural heritage. As an irreplaceable ally in the face of climate and biodiversity crises, the Carpathians should be among the best-protected regions in Europe. And they are, at least on paper. Half of the forest area is included in the EU's Natura 2000 network, and most of the Carpathian region has been under some form of protection since the 1990s. But reality is a shocking opposite.

New technologies have altered the Carpathian forests over the last hundred years. Even today, new forestry roads are built at an unbelievable rate and scale to extract forest wood from areas that would otherwise not be accessible. A lot of unmapped virgin and old-growth forests are disappearing before our eyes. Over 7350 km² of Carpathian tree canopy have been lost to timber extraction in the last two decades across seven countries, of which five are EU member states. This area is more than twice larger than Paris, Berlin, Rome, Budapest, Brussels, and Warsaw combined.

Our analysis of satellite images, field inspections, and expert testimonies reveal that common forestry practices in the region prioritise wood production over nature protection. This significantly degrades the key components of viable forest ecosystems like deadwood, mother trees, and uneven-aged and mixed tree composition. This also changes landscapes, fragments ecosystems, increases erosion, shifts streams, and destroys homes for rare fungi, plant and animal species.

We lose more than 4 hectares of the Carpathian forests to wood extraction every hour

Irresponsible forestry practices are taking place in forests under different degrees of protection across the Carpathian region, including some areas of national parks. Only 3% of the Carpathian forests are fully protected from logging and new roads. This number should be significantly higher,



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Dead wood is an important indicator of living and healthy forests. It provides food and habitat for many organisms

especially if the European Union truly wants to achieve its Biodiversity Strategy targets for the strict protection of 10% of lands and waters by 2030. There is no time to wait, as we lose more than 4 hectares of the Carpathian forests to wood extraction every hour.

At the current pace, almost 20% of the Carpathian canopy cover from 2000 will be lost by 2050. Unprotected old-growth forests, the stepping stones for the restoration and vital ecosystems for endangered species will be the first to get eradicated. A human lifetime will not be long enough to restore the complexity of forest ecosystems in impacted areas.

So far, all protective measures, apart from strict reserves and non-intervention zones, have failed to stop the accelerated destruction of these forests. Even the long-awaited implementation of the Natura 2000 network of protected areas in the Carpathian EU member states did not halt logging or relieve other anthropogenic pressures on natural habitats and species. This report showcases irresponsible logging over the last two decades and maps the solutions needed to halt the destruction and accelerate regeneration of fragile ecosystems on which we depend.

To do so, Greenpeace calls on the European Commission and national authorities to urgently develop a transnational action plan and ensure adequate EU funding for its implementation to prioritise nature conservation and the well-being of local rural communities over exploitation.

At the current pace, almost 20% of the Carpathian canopy cover from 2000 will be lost by 2050.

Nature is in crisis – not only in Europe but across the globe. If we do not preserve places like the Carpathians, their biodiversity will collapse, and the consequences of the climate crisis we already face will be even more dire. We need to give nature a chance to recover and regenerate. It is up to the European leaders to take the first steps by banning irresponsible logging in the Carpathian forests, the one that prioritizes wood outputs over the ecology and social imperatives, as well as agreeing on a ten-year moratorium on new forestry roads before a transnational network of non-intervention areas is established across the whole region.

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THE CARPATHIANS AT GLANCE

The Carpathians are an arc-like mountain range, stretching across the borders of eight countries and covering a distance of approximately 1,500 km, second only to the Scandinavian Mountain range in Europe. They stretch from the so-called Iron Gates (a river gorge separating the Carpathians from the Balkans) on the Serbian-Romanian border to the Austro-Slovak border where the Danube river separates the Western Carpathians from the Alps. The highest sub-range of the Carpathians, the Tatra Mountains reach as high as 2,655 m above sea level at Gerlachovský štít in Slovakia.

The Carpathian region is one of the biologically most unique ecosystems in the world and of vital importance for Europe.

The Carpathian region is one of the biologically most unique ecosystems in the world and of vital importance for Europe. It covers an area of 209,000 km² – almost seven times the size of Belgium. It is a home to diverse nationalities, rich cultural heritage, and outstanding wildlife. The largest part of the area is located in Romania, followed by Slovakia, Ukraine, Poland, Hungary, Serbia, Czechia, and Austria. Austria, however, has less than 1% of the Carpathians, which often tends to get overlooked by literature and official documents. Furthermore, Austria is not part of the Carpathian Convention, "a subregional treaty to foster the sustainable development and the protection of the Carpathian region."[1], which was adopted and signed by seven countries, five of which are members of the European Union.

Fig.1. The Carpathian region consists of vast areas of mountain forests and grasslands in Central and Eastern Europe.

About 50% of the Carpathian forests across all Carpathian Convention countries are covered by the EU's Natura 2000 network of protected areas.

A number of international studies and reports refer to the Carpathians as an important and protected ecological backbone of Europe. Different forms of protection are in place at the national level – from landscape and water protective forests to national parks and strict reserves. About 50% of the Carpathian forests across all Carpathian Convention countries are covered by the EU's Natura 2000 network of nature protection areas.

Judging by official documents and statistics, an overall impression of protection is very positive. We aim was to check if this impression corresponds to the actual status of protection and to see what is happening in the Carpathian forests from the perspective of the EU biodiversity and climate strategies for 2030. Satellite images, local inspections, and expert testimonies, however, shed a completely different light on the existing "protection" formats. This report reveals appalling industrial forestry practices that should alert every decision maker responsible for protecting this unique European nature refuge.

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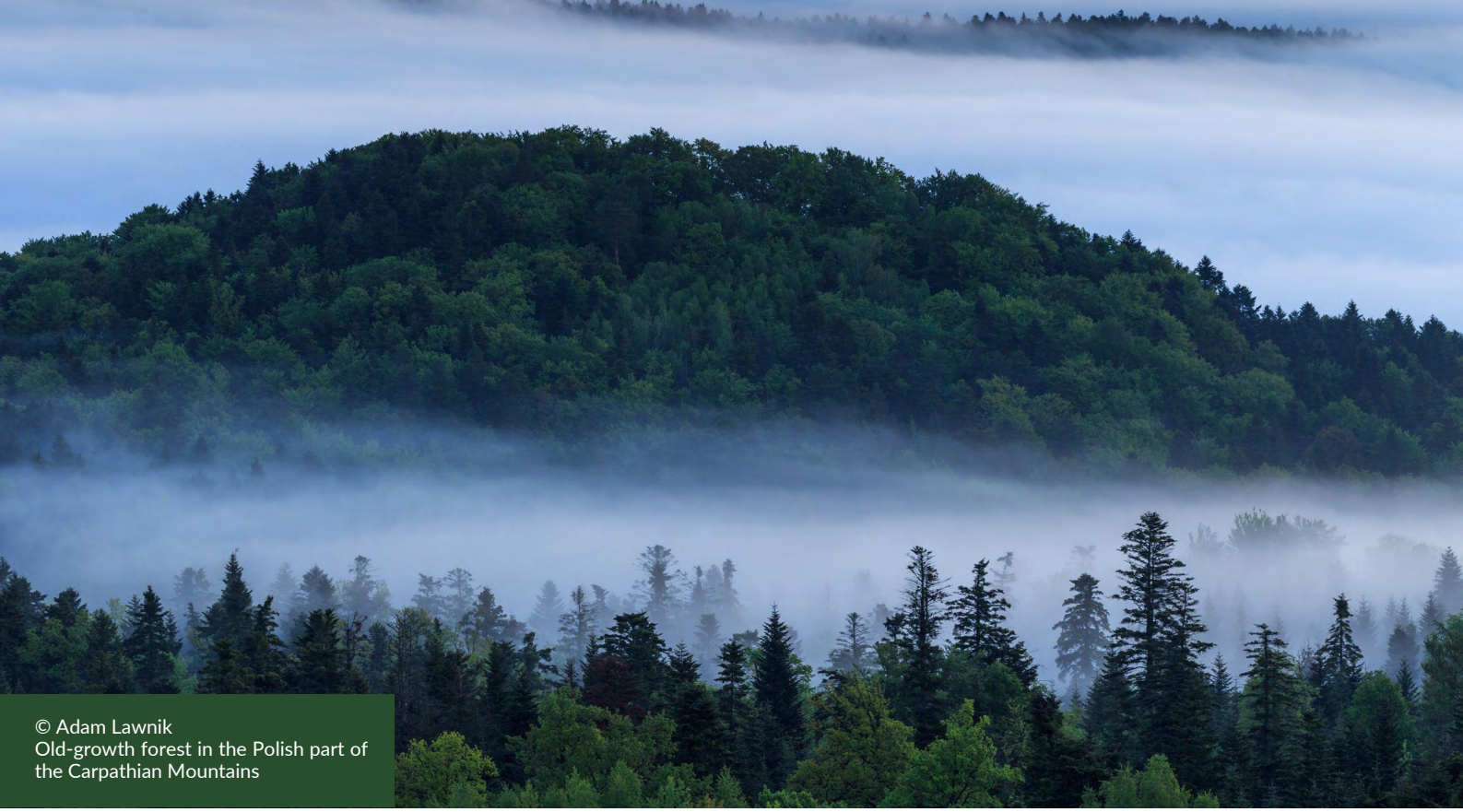
The Eurasian Lynx (Lynx lynx) is threatened by poaching and fragmentation of habitats



© Adam Lawnik
Old-growth forest in the Polish part of the Carpathian Mountains

THE MAJESTIC CARPATHIAN FORESTS

The Carpathian Mountains are home to various outstanding ecosystems, including mountain rivers, alpine grasslands, and montane forests. This report focuses on the priceless Carpathian forests, the dominant ecosystem and home to extraordinary wildlife.

After the last Ice Age (which ended approx. 11,000 years ago), forests expanded to cover around 80–90% of the European continent by the last days of the Neolithic period. Over time, many climatic and biological factors shaped these original European forests – featured by a great difference in the age-span of its trees – from seedlings and saplings to large old trees and a great quantity of dead wood. But as one species gathered momentum and started to assert dominion over others and the landscape, the fate of the forests began to change. As humans transitioned from nomadic hunter gatherer lifestyles to settled agriculture, forests gave way to land for crops and living space. Over centuries, humans turned large forest areas into farmlands, drained wetlands, and built cities. Deforestation has shrunk forest area, while forest management practices have influenced the composition, structure, and dynamic of the remaining forests (e.g. by replacing old trees and species-divers stands with spruce monocultures). Today, only a third (ca. 35%) of Europe is covered by a contiguous community of trees[2] – mostly managed stands (even-aged trees, monocultures, and allochthonous plants).

The least altered large forest areas in Europe remain in the mountain regions thanks to harsh terrain conditions discouraging their exploitation. These forests retain water, stabilize the climate, and provide protection from floods and fires. Their wilderness ensures survival for a wide variety of species. Unfortunately, the situation is changing.

This report reveals irresponsible forestry practices that raise the alarm for the Carpathians as one of last Europe's strongholds for virgin and old-growth forests.

HOME TO RED LISTED SPECIES

The Carpathian forests are among the most important flora and fauna refuges on the European continent. Combined with wildlife rich grasslands and free-flowing rivers, they make a powerful mosaic of habitats - a haven to a remarkable number of endemic species and home to Europe's largest population of brown bears outside Russia. Lynx and wolves roam these forests along with wildcats and European bison. Around 140 bird species populate the trees, including the Ural owl, capercaillie, three-toed woodpecker, or the eastern imperial eagle, many of which are on the red list of threatened species issued by the International Union for Conservation of Nature (IUCN). Carpathian waters are home to numerous fish species, newts, and frogs, while its meadows buzz with vital pollinating insects.

The Carpathian forests are among the most important flora and fauna refuges on the European continent.

Biodiversity hotspot pointers

- The Carpathians are home to the largest population of brown bears in Europe outside Russia (more than 7,000 individuals) and one of the largest populations of wolves (more than 3,500 individuals) and lynx (more than 2,300 individuals)[3].

- 40% of the European eastern imperial and lesser spotted eagle populations[4], large populations of western capercaillie, and many other forest birds[5].

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- Of the 31 reptile and amphibian species recorded in the Carpathians, 17 have been recognized as endangered and/or characteristic of the region[6].

- The waters of the Carpathian Fagaras Mountains shelter the critically endangered Asprete, a living fossil over 65 million years old and one of the rarest fish in Europe.

- The native flora of the Carpathians is among the richest of the European continent. It includes 3,988 native and archaeophyte vascular plants, 344 of which are extinct [6] endangered, on the verge of extinction, or

© Alex Găvan
Asprete (Romanichthys valsanicola) is considered one of the rarest fish in Europe. It is a living fossil of over 65 million years old

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Western capercaillie (Tetrao urogallus) is a large species of grouse characteristic for the Carpathians

FORESTRY ENDANGERING WILDLIFE

The application of new technologies in forestry practices over the last 100 years has heavily altered the Carpathian forests, despite their rugged topography and less accessible terrain for logging. In many places across the region local ecosystems have deteriorated and become less biologically diverse and more vulnerable to climate change. However, there are still many unprotected and unmapped virgin and old-growth forests that have retained their power to heal and regenerate degraded areas. Unfortunately, they are disappearing under our eyes.

On average a forest area of more than five football pitches is lost to wood extraction every single hour.

Our loss assessment includes the Carpathian Environment Outlook (KEO) area[7]. It is based on the spatial analysis of tree cover and tree cover loss, along with a research on loss to fires and different protection formats across the region.

Forest loss to wood extraction

Forests are much more than trees. They are complex systems of living organisms and nonliving elements. However, for the purpose of this research we extracted tree cover data for the entire KEO area. We analyzed in more detail national protection zones, followed by field inspections documenting forestry practices and a collection of expert testimonies. For example, one of the widespread forestry practices is the massive removal of dead or bark beetle-hosting trees from old-growth forests, even though this fosters soil erosion, changes water flow, and slows natural regeneration. Most of these areas require non-intervention protection in the form of a transnational network to keep the fragile ecosystems of the Carpathian mountains in the best condition possible.

Paper protection of forests

The total protection area of all forms of protection in the Carpathians – from strict reserves and national parks to landscape or water-protective forests – covers about half of the KEO forests. The number is very similar to the overall protection of the Carpathian forests under the Natura 2000 network safeguarded by EU laws (48%). In theory, this should guarantee sufficient protection for at least 50% of the forest area. But a closer look at satellite images and information collected from inspection visits and expert testimonies give a different picture. Only strictly protected forests and some areas of the national parks are free from logging (IUCN protected area categories Ia, Ib, and II, see below) and form a small and isolated group of non-intervention areas. All other protection forms are subject to extraction, including some parts of the national parks affected by the development of ski resorts, new roads, and irresponsible forestry practices.

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A new forestry road in Tatras National Park (Poland) built to extract wood after natural disturbances. When forests with trees uprooted by winds and full of dead wood are not disturbed by humans, a new cycle of ecological succession starts without any damage to the soil and water flows.

Table 1. *Distribution of Carpathian Environmental Outlook (KEO) per country and percentage of protected strict reserves and/or non-intervention KEO forests at national level.*

Country	Percentage of KEO area per country total size	Distribution of total KEO forests in percentage per country	Percentage of national KEO forests in strict and/or non-intervention protection*
Romania	29%	43.7%	2,4%
Slovakia	74%	20.5%	3.9%
Ukraine	4%	15.7%	4.7%
Poland	6%	8.7%	3.5%
Hungary	12%	4.6%	1.4%
Serbia	10%	3.9%	2.1%
Czechia	9%	2.9%	0.3 - 2%**

*Calculations based on WDPA and local research
**Difference between WDPA and literature

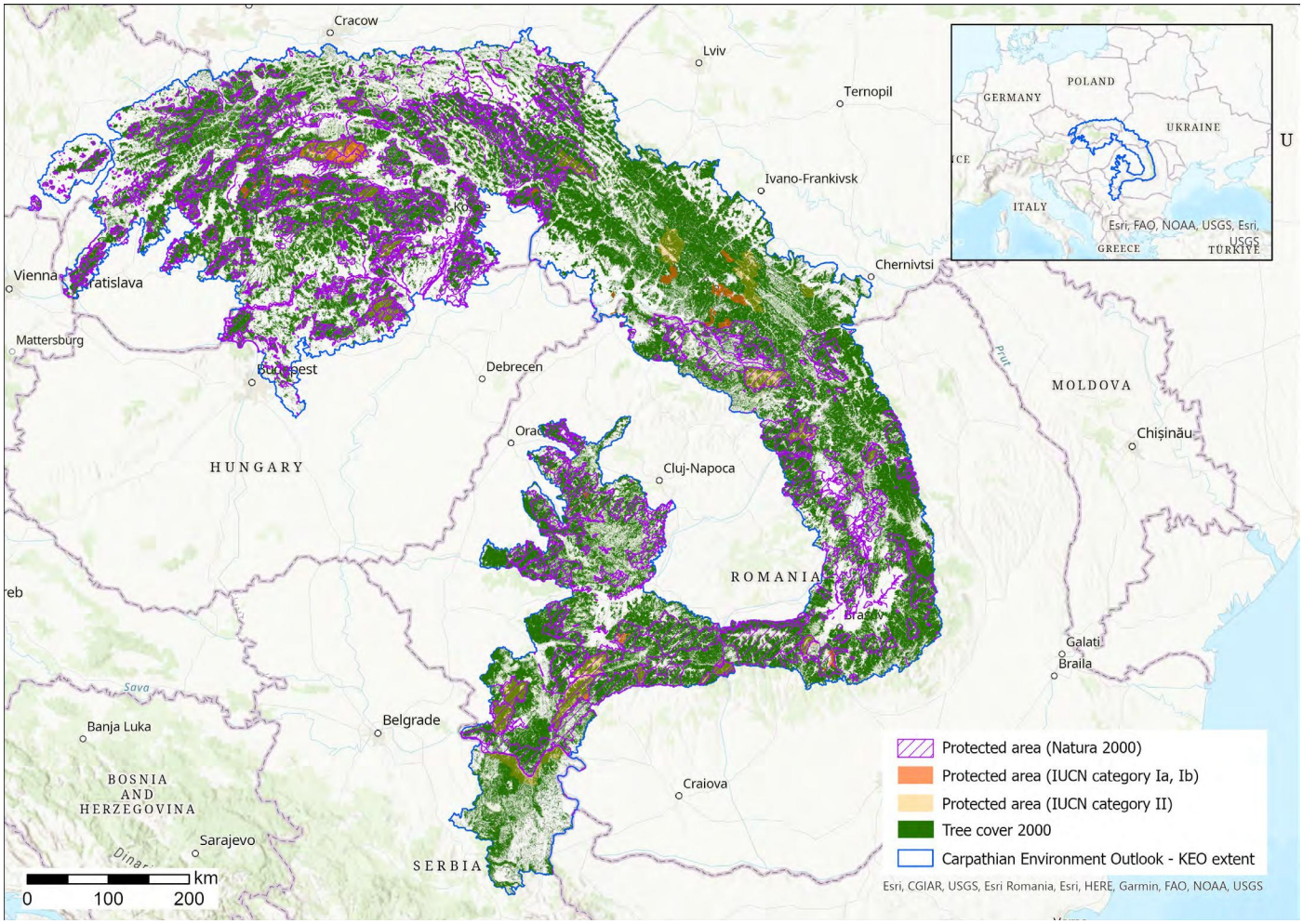

Fig. 2. KEO areas with tree cover protected under IUCN (categories Ia, Ib, and II) and Natura 2000.

© Cristian Grecu / Greenpeace
Illegal logging in the Făgăraș Mountains, Romania

Tree cover loss to wood extraction

After excluding total canopy loss to fires in all areas and natural death in non-intervention areas, where dead trees are left on site for different ecosystem services, this figure drops to about 7,350 km². This area is twice larger than Paris, Berlin, Rome, Budapest, Brussels, and Warsaw combined. At this point, we cannot say how much has been extracted from the virgin and/or old-growth forests in the meantime (our analysis will continue in this respect), but documented site visits and expert testimonies show that the most common forestry practices in the region prioritize wood production over nature protection and lead to significant degradation of key components of viable forest ecosystems (deadwood, mother trees, uneven-aged, and mixed tree composition). By our calculations, we are losing more than four hectares of the Carpathian forests to wood extraction every hour.

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Clearcutting of forests in Ukraine
- an example of irresponsible forestry

The KEO tree canopy cover area based on satellite Landsat imagery[8] in the year 2000 was 104,903 km². About 3.5% of it was lost between 2000 and 2010 and a further 3.9% between 2010 and 2020 and includes all types of forest areas – from spruce plantations to old-growth and virgin forests. What does this mean for the future of the Carpathian forests? If current trends remain the same, the Carpathians will have lost almost 20% of its tree cover from 2000 to 2050. This is 20,036 km² or about half the size of Switzerland or the Netherlands. Unprotected old-growth forests, which are the stepping stones for the restoration and are vital ecosystems for endangered species, will be the first to be eradicated.

If the impact continues until 2050, these forest ecosystems will not regenerate enough to restore their previous complexity within a human lifetime.

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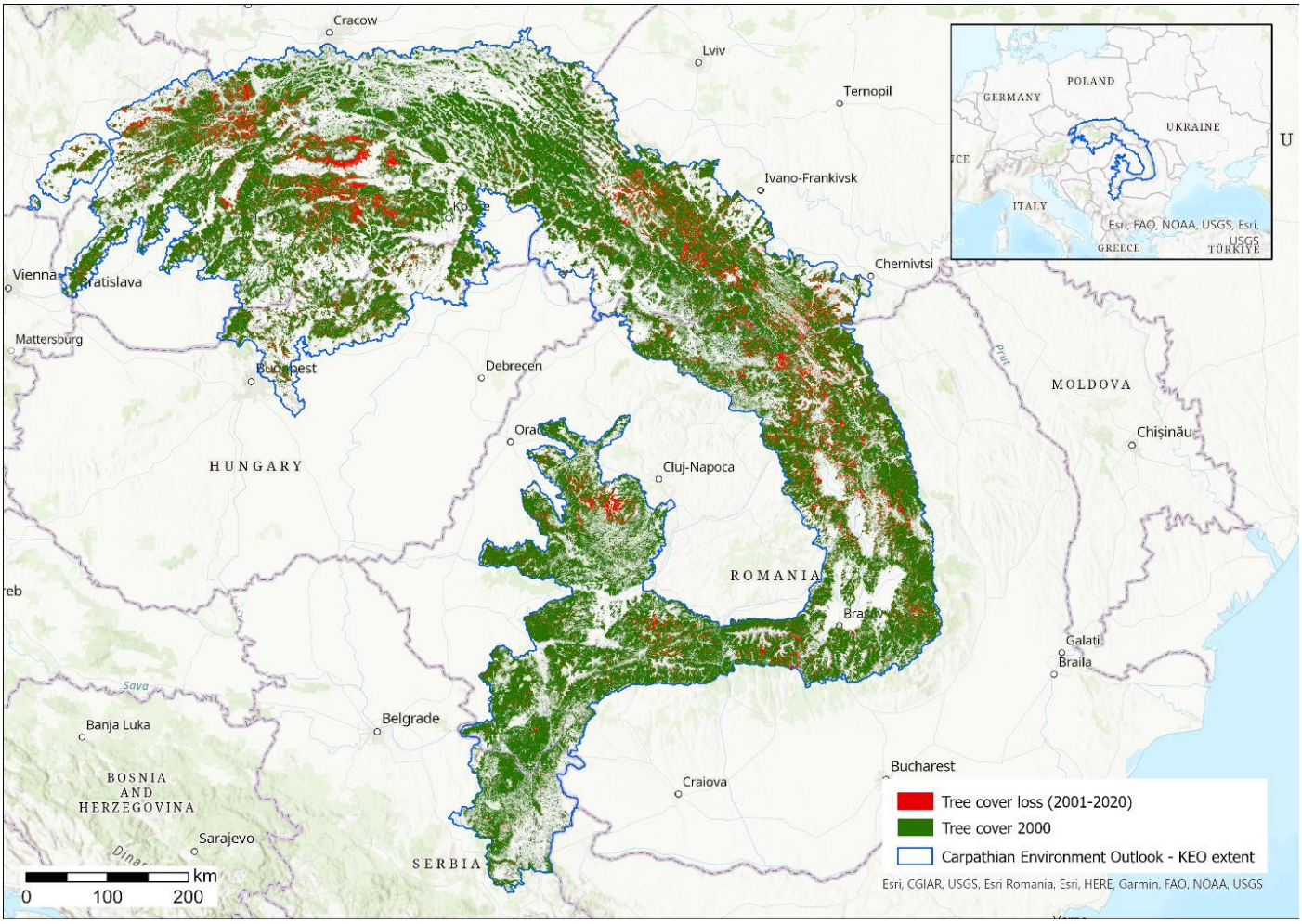
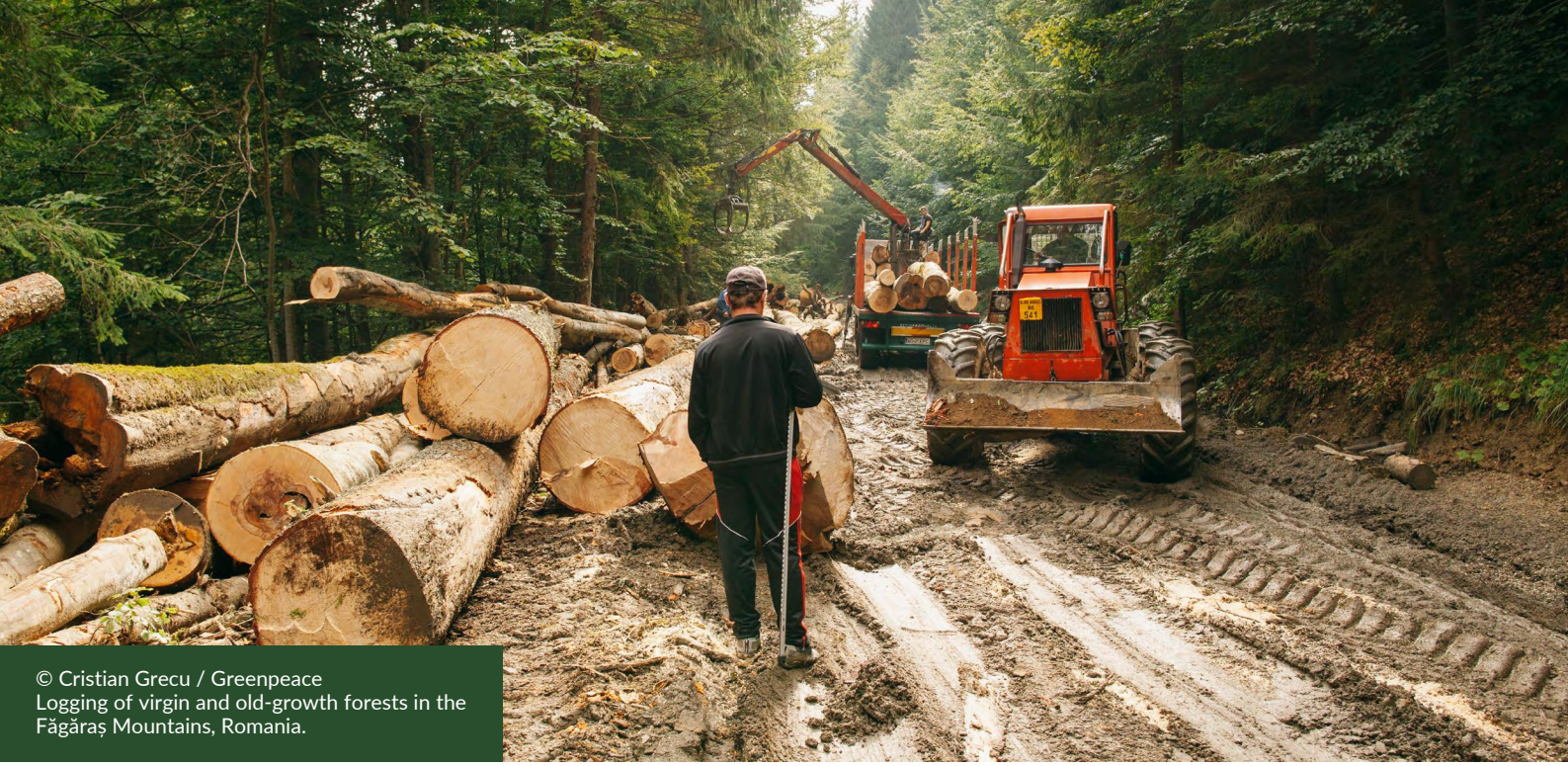
The three-toed woodpecker (Picoides tridactylus) is a characteristic species of mountain coniferous forests in the Carpathians. It is dependent on habitats in old-growth forests for food and shelter

Fig. 3. Recorded tree cover loss of 7779 km² in two decades.





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Logging of virgin and old-growth forests in the Făgăraș Mountains, Romania.

EU strategy for 2030?

Considering these figures, we are losing the Carpathian forests at an alarming rate. The further alarm is raised if we compare data for the EU and non-EU countries. In the last decade, we see an increase in tree cover loss in five EU member states (from 1360 km² in 2011–2015 to 1874 km² in 2016–2022), whereas in non-EU countries, this pace has not changed (428 km² in 2011–2015 to 427 km² in 2016–2022). Considering that the EU Biodiversity Strategy has set a target to put 10% of lands and waters under strict protection by 2030, the European Commission should be highly alerted by the fact that **45% of overall canopy loss in the EU part of the Carpathians concerns the forests protected under Natura 2000. Romania loses tree cover in protected and unprotected areas at the same rate, while Poland's losses are significantly higher in protected areas.**

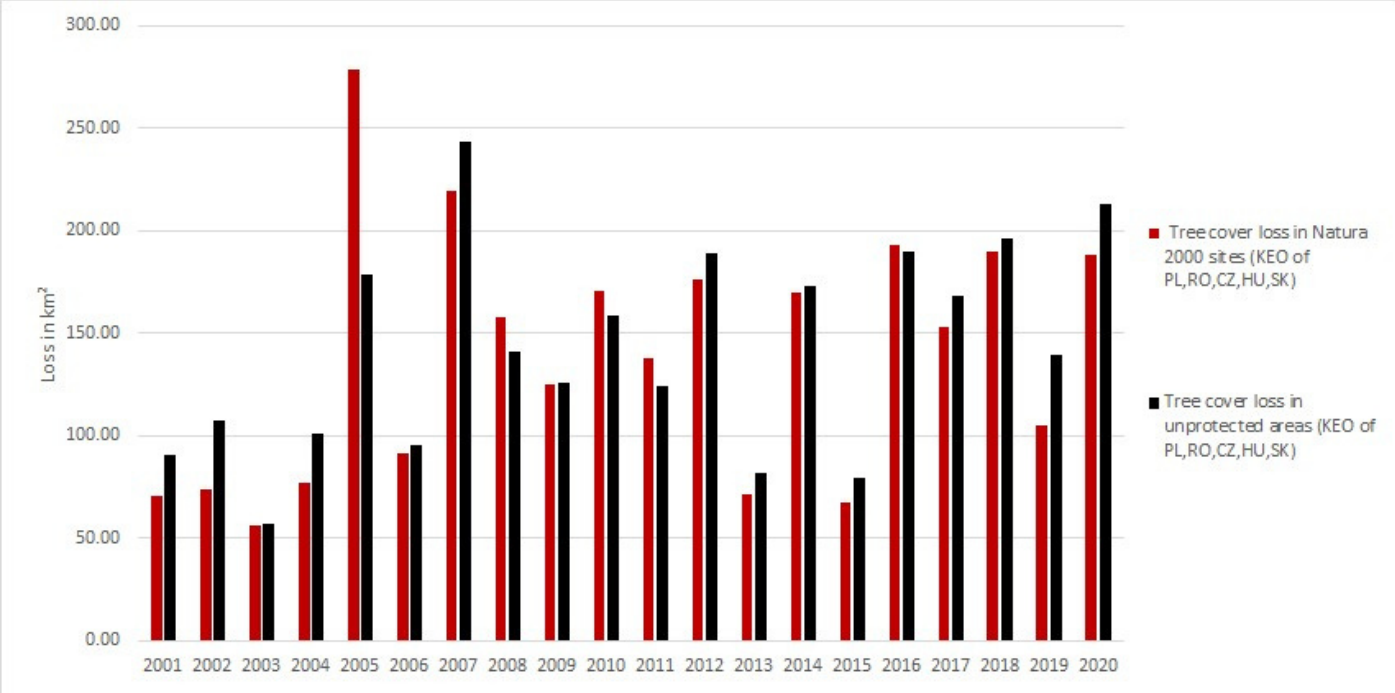

Fig. 4. Tree cover loss in the EU Carpathian forests

Logging impact on wildlife

Logging starts to affect wildlife from the bottom of the food web. The mosses, liverworts, and lichens characteristic to old-growth forests play an essential role as decomposers. By turning decaying plants into food, they support an invisible flow of energy that underpins the life of insects, birds, and other animals. By removing old trees and dead wood inhabited by mosses, liverworts, and lichens irresponsible logging breaks the lifecycle and gives it no time to recover before the next logging round. Like dominos, wildlife habitats, including those of rare beetles, birds, and mammals, start to fall. 798 plant and animal species dwelling in the Carpathians are threatened, and 18 more are already extinct. These figures are likely underestimated, as research data are limited. The list of endangered species includes several iconic birds. Two of them – the eastern imperial eagle and the European turtle dove – are threatened globally. The Carpathian white-backed woodpecker is estimated to account for 30% (11,400 pairs) of its entire population in Europe.

The Ural owl accounts for nearly 20% (2,285 pairs) (excluding Russia).[4] Their occurrence have been significantly reduced by irresponsible forestry, which destroys the key elements of their habitats (e.g. by removing dead trees) and largely simplifies ecosystems. This is because changes in forest composition, structure, and dynamics eventually lead to increased dominance of widespread, generalist species.[9][10][11]

Only a wooden stump was left after logging the mother tree in the Polish Carpathians. Removal of this viable component of forest ecosystems is an example of irresponsible forestry practice.

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Ural owl (Strix uralensis)

Forestry roads to destruction

Roads alter landscapes, fragment ecosystems, shift streams, increase erosion and fire risks, change local climate, facilitate human access, spread invasive species, promote urbanization, degrade habitats, and change the behavior of large territorial carnivores (e.g. bears, lynx and wolves) and other species.[12] [13] [14] The list of environmental impacts of roads is long and applies to a large extent to all forestry roads – from access roads to skid trails used to remove the cut timber and landing areas used by loaders and log trucks.

New forestry roads are built at an unbelievable rate to extract wood from areas that would otherwise not be accessible. The first research estimating the forestry road network in the Polish part of the Carpathians revealed the highest density ever reported in literature (108.5–140.7 m ha-1). Not only do they disturb nature, but can hardly be justified from the economic point of view. The maximum recorded density is in fact more than 15 times the upper limit for the recommended density of paved roads.[15] In most cases forestry roads are excluded from environmental impact assessments, which is why they are seldom subjected to public and expert scrutiny.

The existing network of forestry roads has already severely affected the Carpathian wildlife.

Roads pollute, spread unwanted species, and kill animals, directly or indirectly by allowing easier access to hunters[16]. By cutting habitats into fragments and opening new transport corridors they affect the behavioral patterns of many animal species. Some avoid roads, while others are attracted by them. For example bears avoid denning habitats when they become roaded.[17] [18] [19] To make things worse, the quality of denning habitats significantly drops with timber harvesting operations, including the construction and use of skid trails and logging roads.

© Cristian Grecu
Trees damaged by forestry road that cut through old-gorwth forest in Romania.

At a time when millions of euros are invested in water retention projects, almost nothing is done to prevent the loss of water owed to forest roads.

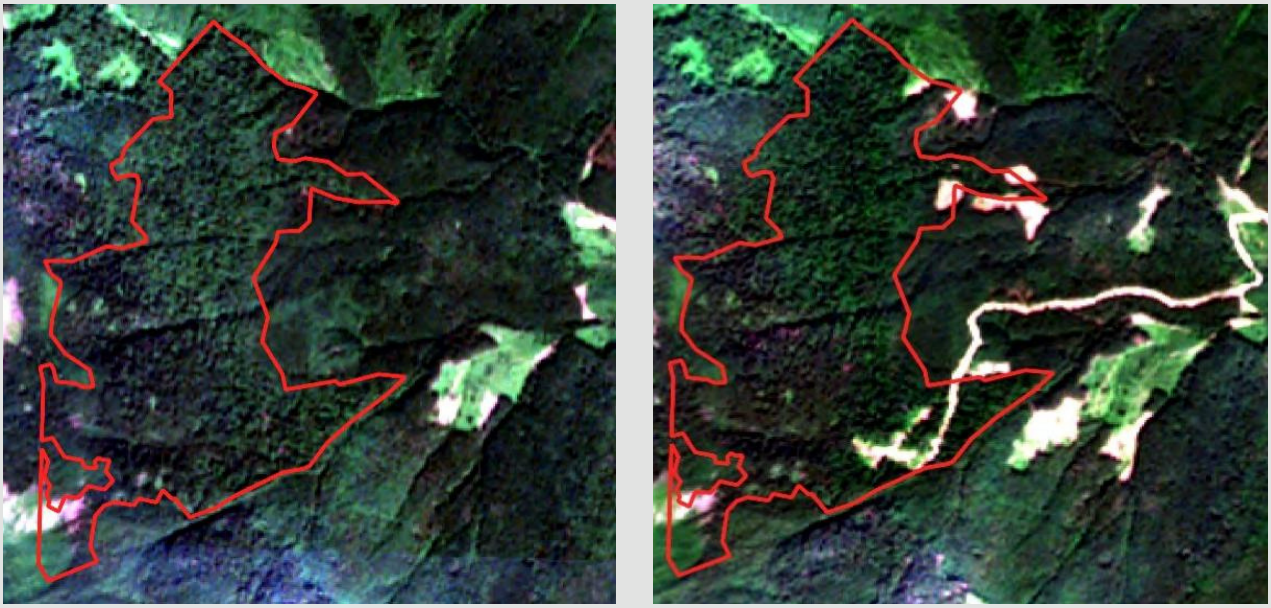
In addition, the impact of forestry roads on hydrological processes in the mountains is one of the least considered issues by decision-makers. At a time when millions of euros are invested in water retention projects, almost nothing is done to prevent the loss of water owed to forest roads. The highly compacted road surfaces generate an increase in annual frequency of floods.[20] Water flowing along forest roads moves material, deepens trails, undermines slope stability, and enhances the delivery of sediments to streams. The result is that its quality is degraded along the way.[21] [22]

As you're reading this report, new forestry roads are likely being built in the Carpathians, while others are being planned or considered. Considering that these new roads are being made for profit, wood exploitation of the Carpathians will not stop unless something is done about it. To overcome this challenge scientists are proposing new legislation to establish roadless areas as the last strongholds for vulnerable wildlife.[23] [24] [25]

© Robert Cyglicki
Brown bear (Ursus arctos) in a Ukrainian bear shelter. Bears' behaviours are changing due to irresponsible forestry. Sometimes this leads to bears' captivity

Forestry roads opening virgin forests to extraction

Forestry roads lead to wildlife destruction in remote parts of the Carpathian Mountains in Ukraine. For instance, in the 20th century, the road near the Svicha River was used to help transform the surrounding old-growth forests into spruce monocultures. Only the virgin and old-growth forests located higher in the hills have managed to survive so far. Sadly, the situation is changing under our noses.



Virgin forest (red) around the Svicha River. In 2020 the road is still far from the virgin forest. In 2022 forestry road gets into the mountain massif, and logging starts. Satellite data – Sentinel Hub

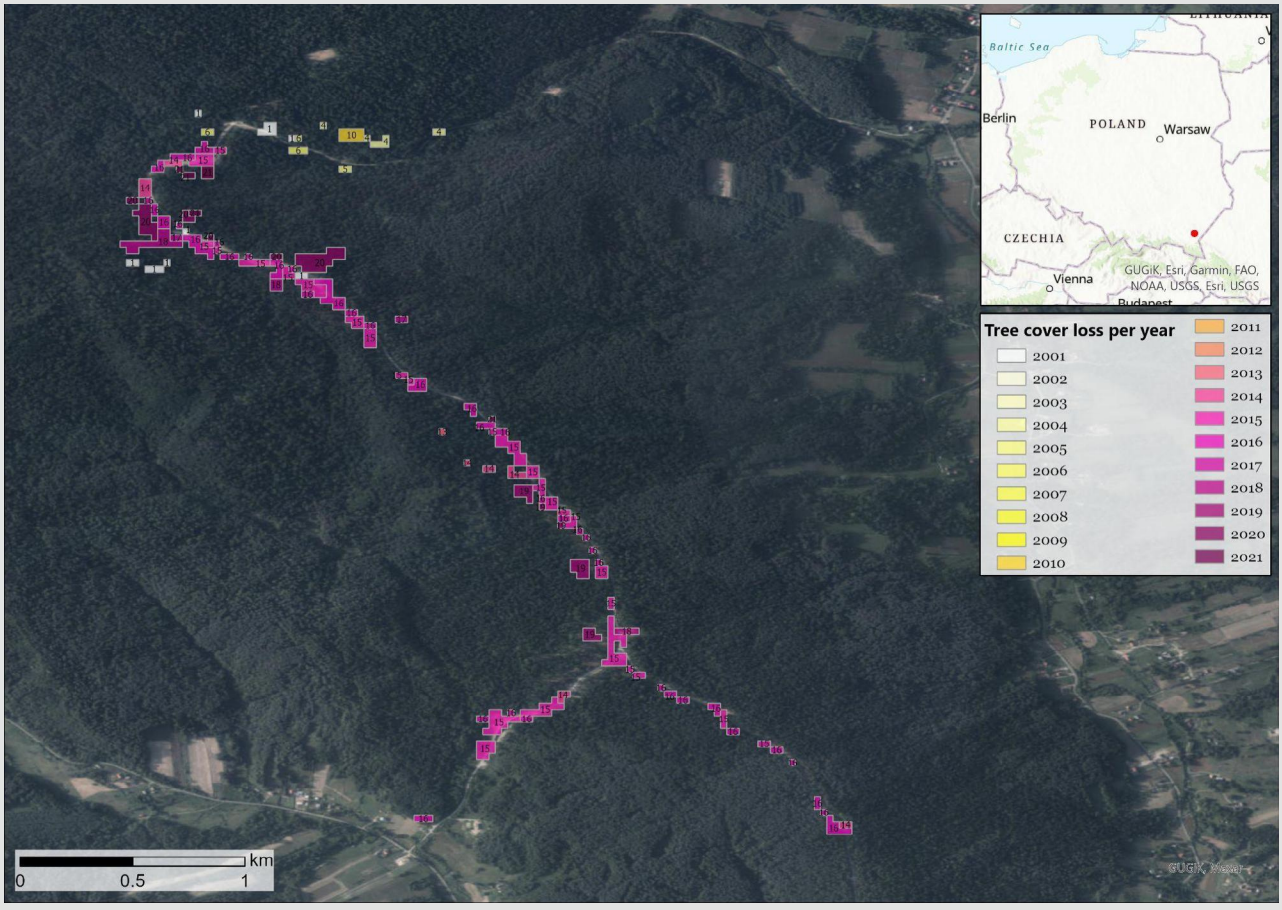
Between 2017 and 2021, the Vyhoda state forest enterprise constructed a 3,5 km long forest road leading straight to the virgin forests that allegedly needed sanitary clearcutting. By 2022, 3.5 hectares (near to five football pitches) have been cut, and more cutting is to follow soon.

Some of the new roads in Vyhoda state forest enterprise in Ukraine are built with EU support, such as "Roads to healthy forests".

Salamander caught in a deadly trap of forestry roads in one of the field inspections carried out in Ukraine in September 2022, over 1 killed individual was found per km of the road.

© Robert Cyglicki
Fire salamander (Salamandra salamandra)

The Foundation of Natural Heritage reports that none of the 182 completed construction and/ or reconstruction forestry roads projects in the Polish Eastern Carpathians has undergone environmental impact assessment.[26] Some of them are fully paved and used only by logging trucks. Recently, another logging road was started by the Lutowiska forest inspectorate in South-Eastern Poland, very close to brown bear wintering areas. Fortunately, it was stopped by a court after the legal intervention of the Nature Heritage Foundation.



Recorded impact of a single forestry road on tree cover loss in the Carpathians. One pixel covers 25 meters.

© Adam Lawnik
Old-growth forest in the Polish part of the Carpathian Mountains

LOGGING WORSENS THE CLIMATE CRISIS

The Carpathian Mountains and their ecosystems should be perceived not only as an outstanding refuge for a wide variety of species but also as critical to mitigating climate change and its consequences. Yet, industrial logging and forestry road construction, drastically deplete their natural potential to tackle the climate crisis. Actually, the situation is even worse, as conversion of broadleaved to coniferous forests changes the ability of a surface to reflect sunlight and evapotranspiration, which leads to climate warming.

Forests whose size is about 5% of the EU's total are responsible for about 17% of the EU's forest carbon storage.

According to UNESCO, the "ancient and primeval beech forests of the Carpathians and other regions of Europe are among the five world heritage sites with the biggest net carbon sink per unit area, capturing 11 tonnes of CO2 per ha per year. Currently, more than 70% of annual wood increment is harvested in the Carpathian forests.[27] Decreasing this harvesting rate will lead not only to a better protection of the Carpathian nature but also to a substantial increase in its annual carbon uptake.[28]

Carbon storage across the Carpathians has not been studied yet, but if the results from the Romanian forests[29] are extrapolated for the entire mountain range, the above- and below-ground biomass in all Carpathian forests should be storing 2 billion tonnes of carbon. This means that forests whose size is about 5% of the EU's total are responsible for about 17% of the EU's forest carbon storage.[30] Industrial logging, however, releases a large part of captured carbon into the atmosphere relatively quickly – within decades, if the timber is used for furniture or construction – and within hours, if it ends up as fuel. Forests that grow in their place will need hundreds of years to restore their storage capacity.

Regulating forest services

Forests play a crucial role in tackling the climate emergency not only as carbon sinks, but also as water cycle, rainfall, and temperature regulators.[31]

Forest covers improve water retention and minimize the risk of droughts and floods.[32] The regulating services of the Carpathian mountain forests are particularly important as they mitigate the consequences of heavy local precipitation and thunderstorms, typical for the mountains.[33] Forests intercepting water in the canopy and root system act as buffers between precipitation and runoff and slow down water draining into valleys.[34] Furthermore, by accumulating water in soil and biomass and by releasing it slowly, the Carpathian forests are also an important source of water for the region. As studies show, these regulating services are being disrupted by forestry: industrial logging drastically reduces the tree cover, and forestry roads facilitate runoff and heavy erosion, whereas runoff affects river water quality. One of the most efficient measures against the risk of droughts and floods in the Carpathian Mountains is local water storage, which entails eliminating road networks. Subsurface water storage can also be enhanced by protecting and restoring natural ecosystems like forests and grasslands.[35]

The more natural the forest ecosystem is, the bigger is its climate-regulating potential.

Temperature regulation is a good example of climate regulatory services by the forests. A study conducted in the Ukrainian Carpathians shows that average land surface temperature is the lowest in natural forests and the highest in disturbed ones. The more natural the forest ecosystem is, the bigger is its climate-regulating potential. This potential can severely be diminished by human and natural disturbances.

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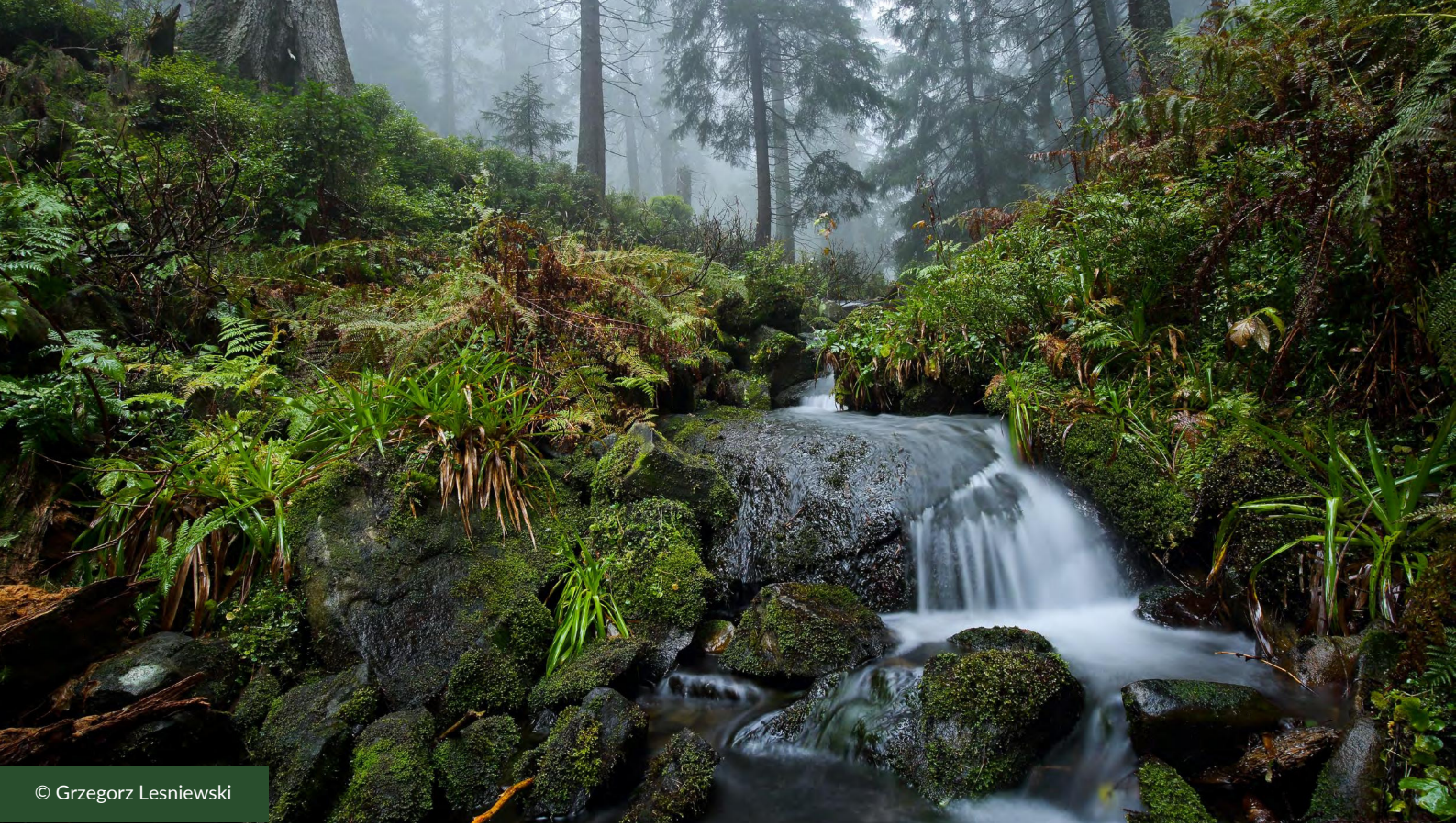

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Safe use of our safety net

Mountain forests are our very powerful natural allies in tackling the climate crisis. At the same time, they are more vulnerable to the impact of climate change.[36] Changes in the precipitation and temperature patterns will lead to the loss of biodiversity, particularly in forests made less resilient by irresponsible forestry. Moreover, they could substantially lower the quality of ecosystem services provided by forests.[37][38] The most important effects of the climate change (higher temperatures or droughts) expected in the Carpathians are:

- precipitation increase in the northern and decrease in the southern Carpathian Mountains,
- shorter snow cover period, which may reduce water supply in areas dependent on the Carpathian rivers,
- higher risk of flood,
- higher risk of erosion and landslides,
- higher risk of fires, regardless of origin,
- higher tree mortality, especially in spruce forests,
- shrinking of some mountain habitats as ecoclimatic zones shift.

To avoid the most severe consequences, we must slow down the pace of climate change and better protect the natural ecosystems of the Carpathians to increase resilience to change. For example, we must avoid further forest fragmentation and enhance ecological connectivity to allow for the species to adapt their range of shifts to the climate change.[39]

By establishing a network of non-intervention areas and banning irresponsible logging in the Carpathians, we can set a safety net for all species against the expected adverse effects of climate change.

EXTRACTING THE CARPATHIANS FOR GLOBAL MARKETS

There are clear indications that both small and large wood industry companies are using the Carpathian woof for manufacturing products sold all over Europe and the world.

The Carpathian forests are vital for all their inhabitants. Local rural communities obviously depend on clean air, fresh water, anti-erosion, and other ecosystem services. To a large extent they need wood for heating, construction, and other purposes. All of them can be met by prioritizing nature conservation and the wellbeing of local people over timber extraction. To make it happen, we need to remove the global market pressure from one of the most important nature refuges on the European continent.

There are clear indications that both small and large wood industry companies are using the Carpathian wood for manufacturing products sold all over Europe and the world. Multibillion European giants such as IKEA, Mondi, or Egger also use Carpathian wood for their production. The numbers still need to be verified, but it is highly plausible that Carpathian wood adds little value to the local economies and serves to feed the growing demand of global markets and company profits instead. We are talking about tens of millions of cubic meters of lumber. Halting irresponsible extraction of amounts this huge would save the remaining old-growth forests and minimize the threat to the Carpathian ecosystems.

© Thomas Einberger / Greenpeace
Timber Industry in Romania manufactures a wide range of wood based panel products.

© Daniel Mîrlea/ Conservation Carpathia Secular tree Făgăraș Mountains, Romania

WHERE THERE'S A WILL THERE'S A WAY

Wilderness Reserve in the Romanian Carpathians

The Fagaras Mountains are the highest in Romania. They are home to one of Europe's largest contiguous areas of high nature value forests with healthy populations of wildlife species. This area should enjoy the highest protection possible. But this is far from the case. Forests here are being destroyed at a shocking rate.

Biologist Barbara Promberger arrived in the Romanian Carpathians in 1995, initially to study wolves, and very soon fell in love with the majesty and vastness of the Carpathians. However, it soon became clear this precious habitat was in danger. In 2009, Barbara, her husband and fellow biologist Christoph Promberger, and a group of philanthropists and conservationists established the Foundation Conservation Carpathia (FCC) with the goal to stop irresponsible logging and ensure that vast areas of Carpathian forests are completely protected for the sake of future generations. To do that, FCC is purchasing land and hunting leases with private and public money. By now, the organization has bought over 27 thousand ha of forest and alpine grassland and placed it under full protection, taken hunting concessions for over 78 thousand ha of forests, stopped all trophy and sport hunting, and focused on mitigating human-wildlife conflicts. Its vision

is a future National park spanning over 200 thousand ha, with a long-term plan of handing it back to the Romanian State as a fully protected area. This is their story.

© Conservation Carpathia
Barbara Promberger

With its virgin forests and alpine grasslands, with thousands of plant and animal species, including those threatened with extinction in Europe, the sheer range of wildlife is staggering. Contiguous natural Carpathian forests play a vital role in terms of climate thanks to the type and sheer concentration of wood. “The carbon sink is amazing,” says Barbara. “In Strâmbisoara they did measurements, and the virgin forest there has 1200 cubic meters of wood alive and another 400 cubic meters of dead wood per hectare. If you compare that to a normal commercial forest, you’d have a total of a maximum 600 cubic meters per hectare – so it’s more than double.” Barbara believes the potential the Carpathian forests have for climate change mitigation is huge. “So huge that it should actually be funded through European money.”

Protecting the Carpathians doesn’t benefit people just in terms of climate stability and biodiversity. There are job opportunities too. Of the 115 people working for the foundation, Barbara says roughly half are from nearby villages and more are employed seasonally. Local people also work on forest restoration – growing, planting, and caring for the trees. Every year, the FCC restores about 100 hectares and has nine different tree nurseries.

The FCC has also helped establish "local gastronomic points", where entrepreneurs can set up businesses serving food for tourists. This is just a hint of what could be possible with a protected national park and ecotourism rather than continued logging. Losses from lack of jobs in forestry would completely be compensated by the jobs created with tourism and supporting services, according to the FCC study about economic benefits of biodiversity conservation.[40] Opening hearts and minds to the possibilities is key. Barbara and Christoph know how vital this is as they take local mayors to visit a national park in Germany and connect with local communities. But there is still much left to do. “The lack of political interest in change is still a very big challenge," she says. "I think politicians lag quite behind in their thinking”.

© DanDinu/ Conservation
Carpathia Valea Vladului, Romania

Protection of virgin forests in Ukraine

The Ukrainian Carpathians still boast relatively large areas of old forests. For a long time now, however, Ukrainian legislation has not favored their protection and has allowed their systematic destruction.

In response to the collective efforts of environmental NGOs, the Ukrainian parliament adopted changes to the Forest Code in 2017. These changes include the definition of virgin forests – the best preserved old forests with minimal human intervention – and requirements for their conservation. Later, in 2018, the Ministry of Environmental Protection approved standard methods to identify and preserve virgin forests.

What does this mean? Firstly, "virgin forests" have been recognised by the law. Secondly, the law has defined clear criteria for a forest to be recognized as virgin. This, in particular, means its area should be 20 ha or larger and show no or almost no signs of human intervention (such as cutting or roads). Thirdly, the law has set precise mechanisms to protect virgin forests. At the same time, environmental NGOs conducted field research to identify virgin forests in the Carpathians. The largest areas were surveyed by the World Wildlife Fund (WWF)-Ukraine. As a result, the organization's experts identified some 93 thousand hectares of forests that meet the virgin forest criteria. Since 2018, 12,288 hectares of virgin forests in the four Carpathian regions of Ukraine have received the strict protection status. Another 57 thousand hectares of forests are in the process to receive this status. It brings hope that the numerous valuable forests of Ukraine will be strictly protected.

However, many valuable forests are still at risk. After the full-scale Russian invasion, the government of Ukraine plans a significant increase in wood harvest. There is still much to be done.

© Robert Cyglicki
Virgin forest in Ukraine

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LARGE SCALE PROBLEMS NEED LARGE SCALE SOLUTIONS

The scale of the problem is significant and needs an adequate response. The existing platform of cooperation between the seven Carpathian countries, known as the Carpathian Convention, did not change much for the benefit of forests and local rural communities on a large scale. So far, all the protective measures have failed to acknowledge the scale of the problem and importance of these forests, which deserve to be recognised as Europe's natural heritage. Unfortunately, even the long awaited implementation of the Natura 2000 network of protected areas in the EU countries of the Carpathians has failed to halt logging or to relieve other anthropogenic pressures on natural habitats and species. Some can argue that this is not about the lack of regulations but about their enforcement, as Poland, Czechia, Slovakia, Hungary, and Romania are being investigated by the EU Commission for infringing several EU environmental laws. A closer look at tree canopy loss and ecosystem degradation to wood extraction, however, shows something different. In Poland, tree cover loss in Natura 2000 areas is higher than in unprotected areas. In Romania, the ratio is more or less the same, while in Slovakia and Hungary, unprotected areas suffer higher losses than those protected by Natura 2000. In all countries, mass-scale removal of trees uprooted by wind occurs in national parks, although they do not pose security threats.

Each country implements its specific institutional models and forestry control mechanisms. In Romania, all public forests are managed by Romsilva, a state-owned enterprise responsible for forest protection and timber production across all protected and unprotected areas (national parks, reserves, and industrially used forests). In Ukraine and Poland national parks and forest enterprises are separate legal entities operating under different laws and regulations. However, the one thing they have in common is forestry practices. They call them "sustainable", but they are anything but that.

Outdated forestry practices

Forestry across the Carpathian region follows industrial practices rooted in 18th-century science – wood harvests should be limited to what the land could produce, and trees should be assiduously replanted to ensure future supply.[41] Eventually, modern industrial forestry developed multiple functional uses of forestlands to balance social, ecological, and industrial interests. This concept is now applied to use of the 21st-century technologies to cut trees on very steep mountain slopes that had not been exploited yet. With the ongoing loss of old-growth forests and the fact that only 3% of the Carpathians are protected from logging, we cannot seriously speak of an ecological and social balance of interests on a large scale. Equally worrying is the fact that irresponsible forestry often turns natural heritage into wooden boards and toilet paper for global markets. At the same time people from rural local communities struggle to make ends meet.

The protection measures currently in place are by far insufficient to salvage what is left of the Carpathian forests and allow these forests to protect its wildlife and regenerate naturally. The ongoing mapping of the Carpathian old-growth forests and other large-scale functioning ecosystems already calls for an urgent and solid transnational action plan.

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Logging lift in Ukraine. This is one of the common irresponsible forestry practices that help to extract wood from very steep mountain slopes.

Connecting the dots for EU targets

We are not alone in calling for increased protection. The European Union committed itself to enlarge strict protection areas of very high biodiversity and climate value to 10% of its land (the EU Biodiversity strategy for 2030). We are racing against time - more precisely, against irresponsible logging that removes over 100-years old tree stands and destroys mountain ecosystems. We therefore see no objective reasons why the European Commission and respective governments would not act swiftly in proposing a network of non-intervention areas in the second longest mountain range in Europe. This could be a flagship project to safeguard Europe's natural heritage, and prove the EU's commitment to reach the targets it has set for itself under the 2030 biodiversity strategy and climate targets.

GREENPEACE SUPPORTS AND EXPECTS ACTION

Only 3% of the Carpathian Environment Outlook area is protected from extraction by law. Ongoing mapping of Carpathian old-growth forests and other large-scale functioning ecosystems clearly shows that this percentage should be significantly higher.

Action speaks louder than words

Carpathian ecosystems are under pressure from irresponsible forestry practices. Before one of the last resorts of Europe's old-growth forests is gone – and this could happen in our lifetime – we need to move the Carpathian Mountains to the top of the political agenda.

TOGETHER

- **WE CALL UPON THE EUROPEAN COMMISSION AND RESPECTIVE GOVERNMENTS** to put forward an EU funded **action plan for the Carpathians as a key European natural heritage.** A plan that prioritizes nature conservation and the wellbeing of local rural communities and their funding over exploitation. A plan that delivers a network of interconnected non-intervention areas to protect large-scale functioning ecosystems of the Carpathian Region. A plan that protects and restores old-growth forests and establishes roadless areas critical for the survival of endangered and threatened species. A plan that ensures transition to local use of the Carpathian forest wood.
- **WE ASK FOR AN IMMEDIATE BAN OF IRRESPONSIBLE LOGGING** in the Carpathian forests along with a **10-year moratorium on new forestry roads.** This time should suffice to implement the action plan for the Carpathians.
- **WE URGE COMPANIES** to **stop destroying Carpathian forests.** Responsible logging excludes exploitation of old-growth forests and industrial practices leading to complete removal or significant degradation of key components of viable ecosystems.

METHODS

Our key findings for this report are based on spatial analysis of tree canopy cover in the KEO area in the year 2000, taken as baseline from datasets published by Hansen et al. (2013), which are based on Landsat data with 30-m resolution, where one pixel represents an area with at least 50% tree canopy coverage. We used this method to avoid overestimating the tree coverage. Complete method documentation and explanatory notes are published separately as an appendix.

Protected areas were assessed based on the Natura 2000 network report from 2020[42], the World Database on Protected Areas (WDPA)[43] managed by the UN Environment Programme World Conservation Monitoring Center (UNEP-WCMC), expert research and assessment of the latest national protection measures for areas meeting the IUCN requirements for management categorization[44]. Special attention has been given to non-intervention areas that are set aside to protect biodiversity and exclude extraction of wood for commercial purposes. These mainly include protected virgin forests, strict reserves, and national parks with "non-intervention zones" (corresponding to the IUCN categories Ia, Ib, and partly II).

GLOSSARY

CARPATHIAN ENVIRONMENT OUTLOOK (KEO) AREA: area defined in 2004 by the UNEP's Division of Early Warning and Assessment 2004 for the Carpathian Convention member countries.

EU ACTION PLAN FOR THE CARPATHIANS: an EU coordinated, enforced, and financed action plan prioritizing nature protection and wellbeing of local rural communities over industrial timber production. The plan should include the establishment of a transnational network of protected non-intervention areas.

FORESTRY ROADS: forest access roads to extract wood, skid trails to remove the cut timber, and areas to collect logs prior to loading and removal by trucks.

IRRESPONSIBLE LOGGING: covers different types of logging, tree cutting, and planting practices that prioritize maximum wood output in short rotation cycles, regardless of biome health, ecological, climatic, and social imperatives. It is highly speculative, being driven by high and quick profits, usually against the needs of the ecosystem and local rural communities and businesses that add maximum value to the wood and offer long-lived finished wood products while preserving forests and their long-term carbon storage capacity.

IRRESPONSIBLE FORESTRY: extraction of remaining old growth forests and all types of clearcuts and shelterwood logging, as well as selective cuts which lead to complete removal or significant degradation of key components of viable forest ecosystems (deadwood, forest litter, mother trees/large old trees, uneven-aged and multi-species tree composition etc.)

LOCAL USE OF FORESTWOOD: criteria for local use of forest timber and non-timber forest products benefiting local rural communities should include local demand for firewood and local manufacturing of finished wood products as well as local non timber wood products that creates added value to local economies.

NATURAL FORESTS: are composed of tree species native to the area with most of the principal characteristics and key elements of ecosystems, such as complexity, structure and diversity according to the Carpathian Convention.

OLD-GROWTH FORESTS: composed of native tree species that have developed predominantly through natural processes with at least 10% canopy cover of more than 100 years old trees. Signs of human interference might be visible, but ecological processes are not significantly disturbed.

STEPPING STONES: forest patches providing food and shelter for dispersing animals and plants within larger disturbed habitats.

VIRGIN FORESTS: original in their structure and dynamics, developed by natural conditions and not influenced by human activities. They form specific types of natural forest communities with complex vertical and horizontal structures.[45]

REFERENCE, BIBLIGRAPHY

[1] Carpathian Convention (Convention on the Protection and Sustainable Development of the Carpathians), For more information, see the organization's web page on: www.carpathianconvention.org.

[2] Ministerial Conference on the Protection of Forests in Europe - FOREST EUROPE (2020), *State of Europe's Forests 2020*, Liaison Unit, Bratislava, available at: www.foresteurope.org/wp-content/uploads/2016/08/SoEF_2020.pdf.

[3] Boitani, L., Alvarez, F., Anders, O., Andren, H., Avanzinelli, E., Balys, V., Blanco, J. C., Breitenmoser, U., Chapron, G., Ciucci, P., Dutsov, A., Groff, C., Huber, D., Ionescu, O., Knauer, F., Kojola, I., Kubala, J., Kutal, M., Linnell, J., Majic, A., Mannil, P., Manz, R., Marucco, F., Melovski, D., Molinari, A., Norberg, H., Nowak, S., Ozolins, J., S. Palazon, S., Potocnik, H., Quenette, P.-Y., Reinhardt, I., Rigg, R., Selva, N., Sergiel, A., Shkvyria, M., Swenson, J., Trajce, A., Von Arx, M., Wolfl, M., Wotschikowsky, U. & Zlatanova, D. (2015), *Key actions for Large Carnivore populations in Europe*, Institute of Applied Ecology, Rome.

[4] Witkowski, Z.J., Król, W., Solarz, W., Kukuła, K., Okarma, H., Pawłowski, J., Perzanowski, K., Ruzicka, T., Sandor, J., Stanova, V. & Tasenkevich, L. (2003), *Carpathian List of Endangered Species*, WWF International Danube-Carpathian Programme, Vienna, and Institute of Nature Conservation, Polish Academy of Sciences, Krakow.

[5] Wilk T., Bobrek R., Pępkowska-Król A., Neubauer G., Kosicki J.Z. (red.), (2016), *Ptaki polskich Karpat – stan, zagrożenia, ochrona*, OTOP, Marki.

[6] Tasenkevich, L. (2003), *Vascular plants*, Carpathian list of endangered species, pp. 6-19.

[7] Price, M. F. (2008), *Carpathians Environmental Outlook 2007*, United Nations Environment Programme, Mountain Research and Development Vol. 28, Issue 2, Geneva, pp. 182-183.

[8] Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R. & Kommareddy, A. (2013), *High-resolution global maps of 21st-century forest cover change*, Science, Vol. 342, Issue 6160, pp. 850-853.

[9] Bengtsson, J., Nilsson, S.G., Franc, A. & Menozzi, P. (2000), *Biodiversity, disturbances, ecosystem function and management of European forests*, Forest ecology and management, 132(1), pp. 39-50.

[10] Czeszczewik, D., Zub, K., Stanski, T., Sahel, M., Kapusta, A. & Walankiewicz, W. (2015), *Effects of forest management on bird assemblages in the Bialowieza Forest*, Poland. iForest-Biogeosciences and Forestry, Vol. 8, pp. 377-385.

[11] Bouvet, A., Paillet, Y., Archaux, F., Tillon, L., Denis, P., Gilg, O. & Gosselin, F. (2016), *Effects of forest structure, management and landscape on bird and bat communities*, Environmental Conservation, Vol. 43, pp. 148-160.

[12] Ibisch, P.L., Hoffmann, M.T., Kreft, S., Pe'er, G., Kati, V., Biber-Freudenberger, L., DellaSala, D.A., Vale, M.M., Hobson, P.R. & Selva, N. (2016), *A global map of roadless areas and their conservation status*, Science, Vol. 354, Issue 6318, pp. 1423-1427.

[13] Iliopoulos, Y., Youlatos, D. & Sgardelis, S. (2014), *Wolf pack rendezvous site selection in Greece is mainly affected by anthropogenic landscape features*, European journal of wildlife research, 60(1), pp. 23-34.

[14] Wilk, T., Bobrek, R., Pępkowska-Król, A., Neubauer, G. & Kosicki, J.Z. (2016), *Ptaki polskich Karpat: stan, zagrożenia, ochrona*, Ogólnopolskie Towarzystwo Ochrony Ptaków, Marki.

[15] Affek, A.N. & Kowalska, A. (2017), *Ecosystem potentials to provide services in the view of direct users*, Ecosystem services, Vol. 26, pp. 183-196.

[16] Boston, K., (2016), *The Potential Effects of Forest Roads on the Environment and Mitigating their Impacts*, Current Forestry Rep 2, pp. 215–222.

[17] Petram, W., Knauer, F. &Kaczensky, P. (2004), *Human influence on the choice of winter dens by European brown bears in Slovenia*, Biological Conservation, Vol. 119, pp.129-136.

[18] Elfström, M., Swenson, J.E. & Ball, J.P., (2008), *Selection of denning habitats by Scandinavian brown bears Ursus arctos*, Wildlife Biology, Vol. 14, Issue 2, pp. 176-187.

[19] Elfström, M. & Swenson, J.E. (2009), E*ffects of sex and age on den site use by Scandinavian brown bears*, Ursus, 20 Vol. 2, pp. 85-93.

[20] Bowling, L. & Lettenmaier, Dennis. (2001), *The effects of forest roads and harvest on catchment hydrology in a mountainous maritime environment*, Water Science and Application, 2, Washington.

[21] Akbarimehr, M. & Naghdi, R. (2012), *Determination of most appropriate distance between water diversions on skid trails in the mountainous forest, north of Iran*, Catena, Vol. 88, Issue 1, pp. 68-72.

[22] Grace III, J.M. & Clinton, B.D. (2007), *Protecting soil and water in forest road management*, Transactions of the ASABE, Vol. 50, Issue 5, pp. 1579-1584.

[23] Selva, N., Kreft, S., Kati, V., Schluck, M., Jonsson, B.G., Mihok, B., Okarma, H. & Ibisch, P.L. (2011), *Roadless and low-traffic areas as conservation targets in Europe,* Environmental management, Vol. 48, Issue 5, pp. 865-877.

[24] Ibisch, P.L., Hoffmann, M.T., Kreft, S., Pe'er, G., Kati, V., Biber-Freudenberger, L., DellaSala, D.A., Vale, M.M., Hobson, P.R. & Selva, N. (2016), *A global map of roadless areas and their conservation status*, Science, Vol. 354, Issue 6318, pp. 1423-1427.

[25] Psaralexi, M.K., Votsi, N.E.P., Selva, N., Mazaris, A.D. & Pantis, J.D. (2017), *Importance of roadless areas for the European Conservation Network*, Frontiers in Ecology and Evolution, Vol. 5, pp. 2.

[26] Janeczko, E., Pniewska, J. & Bielinis, E. 2020. Forest tourism and recreation management in the Polish Bieszczady mountains in the opinion of tourist guides. Sustainability, Vol. 12, Issue 19: 7967.

[27] Anfodillo, T., Carrer, M., Valle, E. D., Giacoma, E., Lamedica, S. & Pettenella, D. (2008). *Report on Current State of Forest Resources in the Carpathians*, Carpathian Project – University of Padova, Legnaro.

[28]Greenpeace (2020), *The Future of Forests in the European Union Untapped potential for nature conservation and climate change mitigation*, press release, 03 December 2020.

[29] Dumitrașcu, M., Kucsicsa, G., Dumitrică, C., Popovici, E.A., Vrînceanu, A., Mitrică, B., Mocanu, I. & Șerban, P.R. (2020), *Estimation of Future Changes in Aboveground Forest Carbon Stock in Romania. A Prediction Based on Forest-Cover Pattern Scenario*, Forests, Vol. 11, Issue 9, p. 914.

[30] Barredo, J.I., San-Miguel-Ayanz, J., Caudullo, G.& Busetto, L. (2012), *A European map of living forest biomass and carbon stock*. Ispra, Italy, p. 16.

[31] Seidl, R., Albrich, K., Erb, K., Formayer, H., Leidinger, D., Leitinger, G., Tappeiner, U., Tasser, E. & Rammer, W. (2019), What drives the future supply of regulating ecosystem services in a mountain forest landscape?, Forest Ecology and Management, Vol. 445, pp. 37-47.

[32] Alberton, M., Andresen, M., Cittadino, F., Egerer, H., Fritsch, U., Götsch, H., Hoffmann, C., Klemm, J., Mitrofanenko, A., Musco, E. & Noellenburg, N. (2017), Outlook on climate change adaptation in the Carpatian mountains.

[33] Alberton, M., Andresen, M., Cittadino, F., Egerer, H., Fritsch, U., Götsch, H., Hoffmann, C., Klemm, J., Mitrofanenko, A., Musco, E. & Noellenburg, N. (2017), Outlook on climate change adaptation in the Carpatian mountains.

[34] Ministerial Conference on the Protection of Forests in Europe (2015), Forest Europe. State of Europe's Forests 2015, Madrid.

[35] Alberton, M., Andresen, M., Cittadino, F., Egerer, H., Fritsch, U., Götsch, H., Hoffmann, C., Klemm, J., Mitrofanenko, A., Musco, E. & Noellenburg, N. (2017), Outlook on climate change adaptation in the Carpatian mountains.

[36] Climate ADAPT, Adaptation in Carpathian Mountains, For more information, see the organisation's webpage on: www.climate-adapt.eea.europa.eu/en/countries-regions/transnational-regions/carpathian-mountains/impacts.

[37] Smaliychuk, A., Kruhlov, I., Chaskovskyi, O., Smaliychuk, G. & Bilanyuk, V. (2021), Climate Regulating Ecosystem Serivces of the Forest Landscape in the Ukrainian Carpathians, The Scientific Issues of Ternopil Volodymyr Hnatiuk National Pedagogical University Series, Geography, Vol. 51, pp. 48- 56.

[38] Elkin C, Gutierrez AG, Leuzinger S, Manusch C, Temperli C, Rasche L, Bugmann H. (2013), A 2°C warmer world is not safe for ecosystem services in the European Alps, Glob Chang Biol. Vol. 19, pp. 1827– 1840.

[39] Seidl R, Rammer W, Lexer MJ. (2011), Climate change vulnerability of sustainable forest management in the Eastern Alps, Clim Change, Vol. 106, pp. 225–254

[40] CARPATHIA. European Wilderness Reserve (2022), Socio-economic impact study on the creation of Fagaras National Park, Brasov.

[41] Popkin, G. (2021), Forest fight, Science, Vol. 374, Issue 6572, pp. 1184-1189.

[42] Natura 2000 network (2020), Report from 2020.

[43] World Database on Protected Areas (WDPA), For more information, see the organisation's webpage on: www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA.

[44] IUCN requirements for management categorization, For more information, see the organisation's webpage on: www.eea.europa.eu/themes/biodiversity/ protected-areas/facts-and-figures/IUCN-management-categories.

[45] Carpathian Convention, Criteria & Indicators for selection of virgin forests in the Carpathians.

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