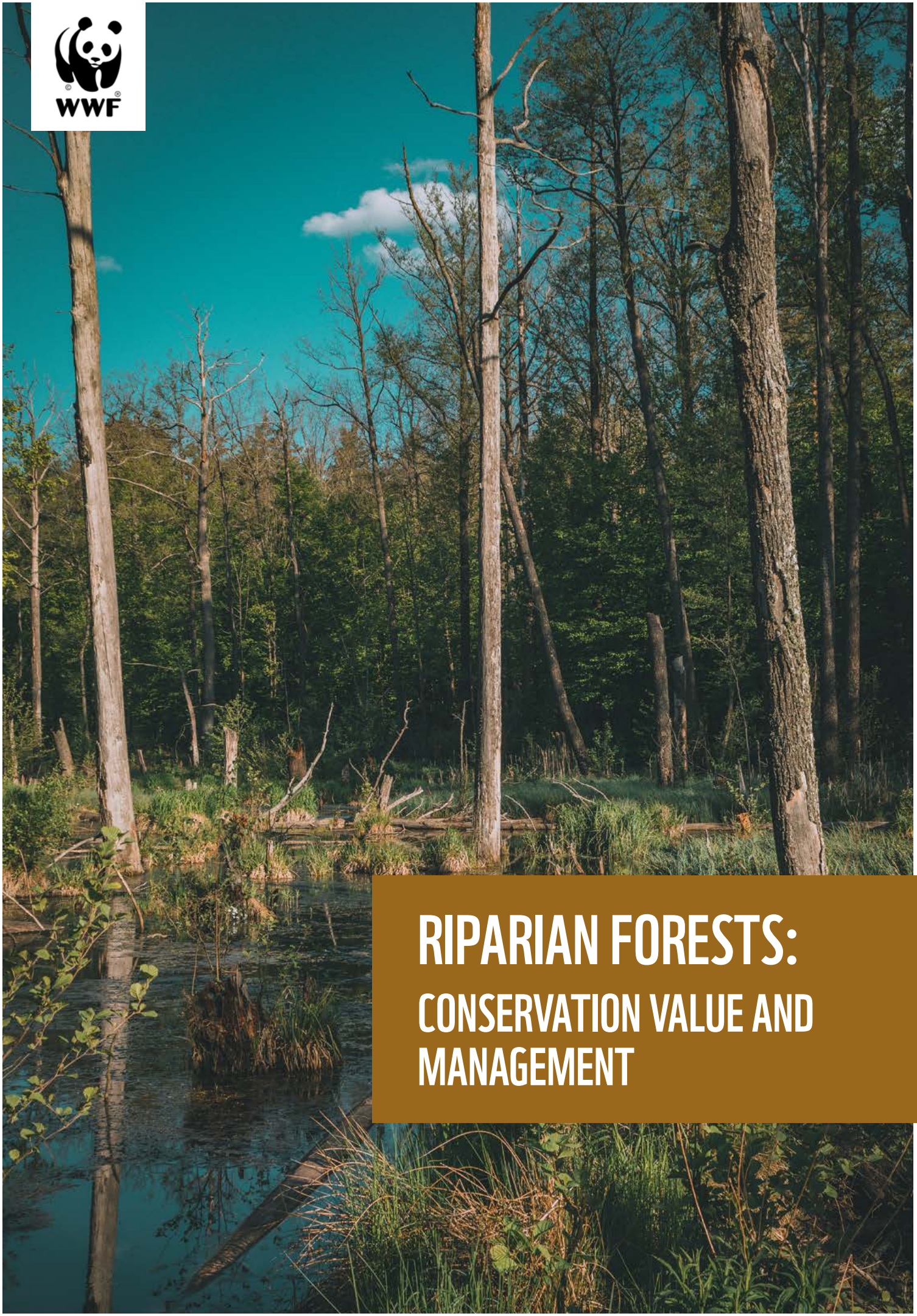

RIPARIAN FORESTS:

CONSERVATION VALUE AND MANAGEMENT

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FOREWORD


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One of the key tasks of WWF-Ukraine is to ensure the conservation of the most valuable ecosystems of Ukraine. Forest ecosystems are among the most important in maintaining biodiversity, stabilizing the climate, and meeting the basic needs of Ukrainians for recreation, food, and other. These forest properties are often called ecosystem services. To ensure their continuity, it is necessary to implement a sustainable forest management practices, which will allow preserving forest landscapes resistant to climate change and biodiversity-rich.

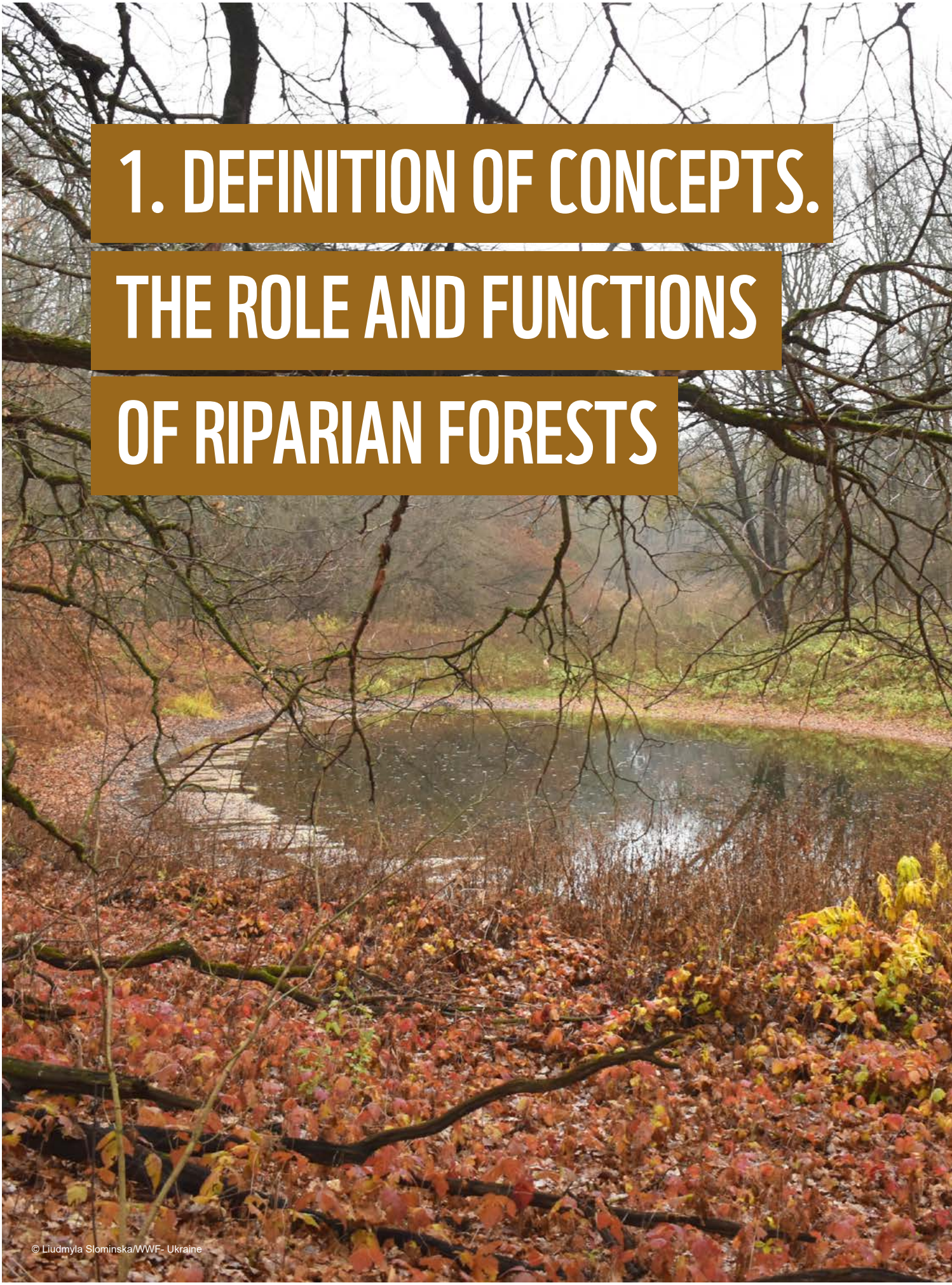
A vital role in this is played by introducing best practices and approaches to managing forest ecosystems, particularly riparian forests, to which this publication is devoted.

THE PUBLICATION CONSIDERS THE FOLLOWING ISSUES RELATED TO RIPARIAN FORESTS:

- definition of concepts related to the legal status and natural features of these forests;
- statistical data on the location of riparian forests in Ukraine;
- characteristics of the habitats associated with these forests and recommendations for their management;
- review of legislation and forest management practices in riparian forests in Ukraine and other countries of Central and Eastern Europe;
- recommendations for changing economic patterns for more sustainable management of riparian forests.

Research and analysis will be helpful to environmental activists, specialists in forestry and utilities sector, auditors, specialists in the protected areas, environmental educators and engineers, and local communities.

1. DEFINITION OF CONCEPTS. THE ROLE AND FUNCTIONS OF RIPARIAN FORESTS



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Riparian forests are one of the most vulnerable forest ecosystems. A large number of rare habitats and species are related to them; hence, compared to other forests, they require special attention and special management. Such forests grow under the conditions of annual flooding for different periods of time during spring floods while their formation is affected by the geological work of rivers and results from various channel and alluvial processes. This causes a great typological diversity and peculiar site conditions and forest biotic community.

Riparian forests play a vital role in the provision of habitats and food for many living organisms. They also serve as wildlife corridors for animal migrations. Shading of water bodies with tree crowns helps regulate water temperatures.

In addition, riparian forests perform a number of important ecosystem functions: bank protection and erosion prevention; protection of water bodies from clogging and silting; even distribution of surface runoff and flood protection; regulation of evaporation and maintenance of groundwater levels; improvement of water quality, etc.

The major reason for their degradation and disappearance is human activities, namely failure to consider the peculiarities of these forests in forestry. In addition, such forests are negatively affected by excessive regulation of rivers, drainage reclamation, and reduction of the areas of natural floodplain vegetation due to the development of agricultural land and construction.

According to the legal status and peculiarities of natural conditions, riparian forests can be divided into **protection riparian forests, floodplain forests, and wet and swampy forests.**

PROTECTION RIPARIAN FORESTS — forest areas (forest strips) along the banks of rivers, lakes, water bodies, etc. Their width is determined by the Resolution of the Cabinet of Ministers of Ukraine "On approval of the Procedure for dividing forests into categories and identification of specially protected forest areas" [37]. They also include specially protected forest areas: forest areas along river sources and bank protection forest areas. Protection riparian forests protect natural environment, in particular waters, from the negative impact of natural and anthropogenic factors.

This category is identified only on the forestry lands planned by forest management and can include both floodplain and swampy forests, as well as other types of forest ecosystems.

FLOODPLAIN FORESTS are all forests growing in river floodplains. Floodplain forests can belong to different categories within the forestry lands planned by forest management. Herewith, floodplain forests can grow on lands having various ownership (state, communal, or private) and purpose (water fund lands, agricultural lands, etc.). Legally, forest areas that lack permanent forest users and are not planned by forest management are not considered forests. Forestry measures are not carried out on them, but clearcut logging can; these lands can also be used for other economic needs.

WET AND SWAMPY FORESTS include hygrotopes 4 and 5 (wet and very wet site conditions) according to Pogrebnyak's [36] forest typological classification. The edaphic grid of soil nutrient status and moisture class served as the basis of site conditions classification. Indices of individual groups of forest soils by nutrient status are as follows: A — poor soils (infertile pine site type); B — fairly poor (fairly infertile pine site type); C — fairly rich (fairly fertile (usually hardwood) site type); and D — fertile (usually hardwood) site type on black soils. Individual hygrotopes are assigned respective numbers: 1 — dry; 2 — fresh; 3 — moist; 4 — wet; 5 — very wet. Forests with wet and very wet site conditions can be located both in river floodplains and beyond them, for example on floodplain terraces, and belong to different forest types according to forest inventory.


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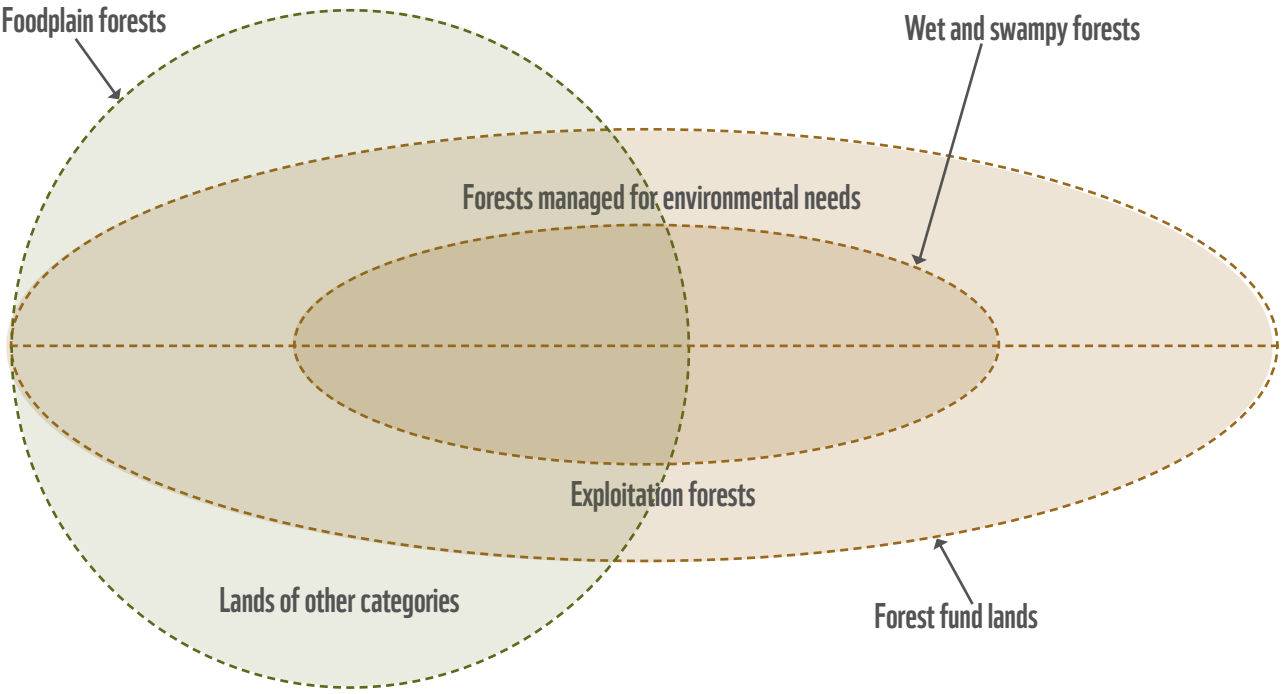
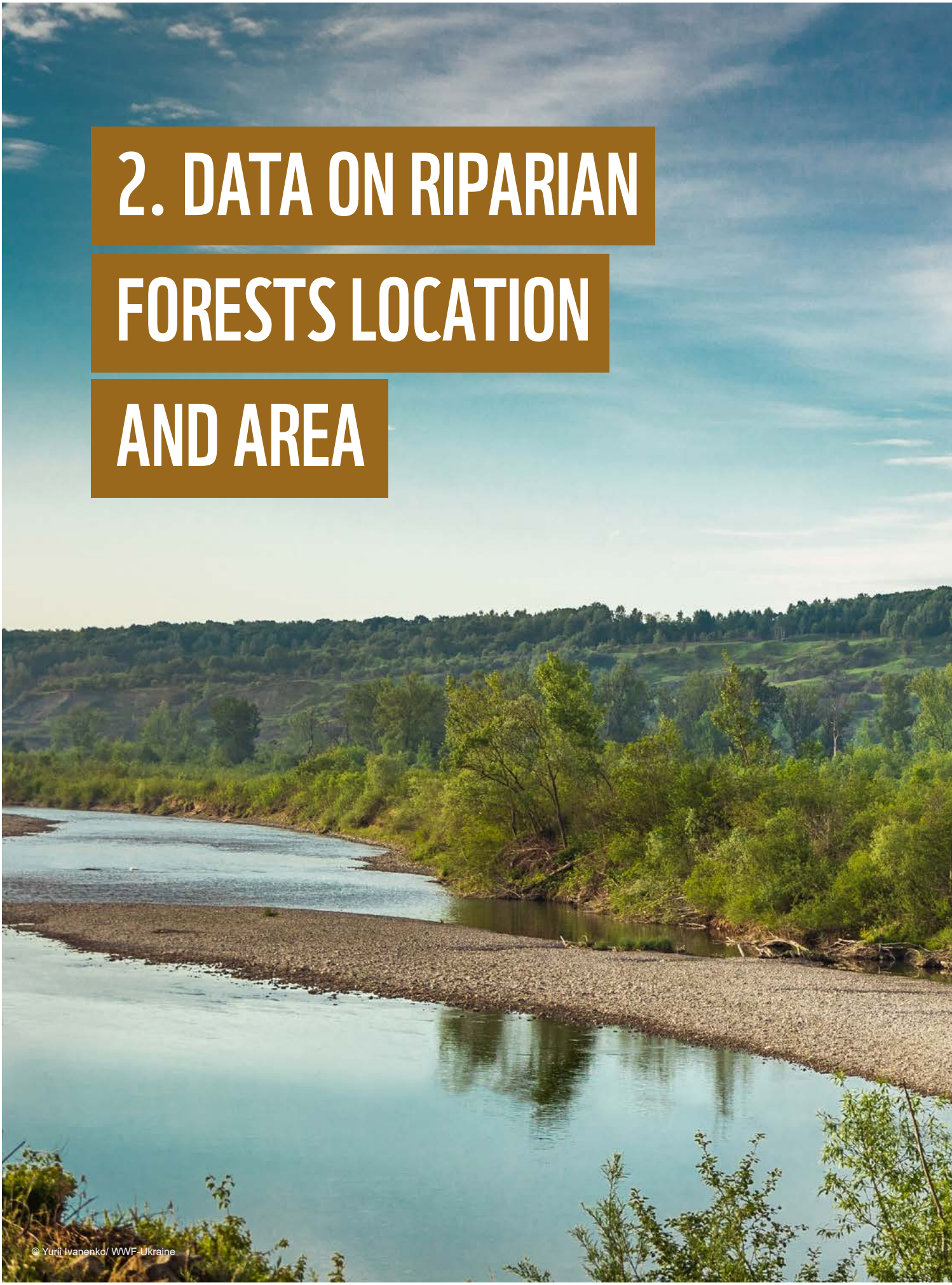
CATEGORIES AND LEGAL STATUS OF RIPARIAN FORESTS



Therefore, management of riparian forests involves a number of ecological, economic, and social aspects. Apart from conservation value, these forests, being a source of raw materials, also have economic value. Their water protection value is crucial. Riparian forests, undoubtly, have an important social function since they perform recreational tasks. Efforts to create an eco-network and development of the Emerald Network have demonstrated the importance of these forests in forming the ecological framework. Besides, riparian forests are managed by a wide variety of landowners and land users and are the basis of the nature reserve fund sites.

The purpose of this study is to analyze the data on riparian forests and the rules and practices of managing such forests, determine their value from biodiversity perspective, and provide recommendations for sustainable management that will contribute to such forests preservation. This research and analysis will be useful to environmental activists, forestry and communal experts, and auditors. It will also be useful to the nature reserve fund experts — eco-educators and engineers for natural complexes protection.

2. DATA ON RIPARIAN FORESTS LOCATION AND AREA



2.1. LOCATION AND AREAS OF FLOODPLAIN FORESTS AND PROTECTION RIPARIAN FORESTS MANAGED BY THE STATE AGENCY OF FOREST RESOURCES OF UKRAINE

According to the Guidelines on the State Forest Cadastre and Primary Forest Inventory [29], floodplain forests are not classified into a separate category in the course of forest management and inventory of the forest fund. Therefore, it is extremely difficult to analyze the structure and dynamics of the state forest fund in the floodplain part. To do this, it is necessary to first determine floodplain boundaries and then inventory the floodplain forests of the forest fund.

Currently, floodplain forests are mainly classified as protection strips along rivers, anti-erosion forests, as well as forests of green zones, which in turn are divided into forestry and forest park parts [37; 52].

The area of floodplain forests managed by the State Forestry Agency of Ukraine is relatively small — about 440,000 hectares (Table 1). The total area of floodplain forests in Ukraine is about 600,000 hectares. However, these forests perform important functions and are of great economic value. The largest share of floodplain forests is concentrated within the forest steppe (about 41%), Polissia and steppe (29% each), but there are practically no floodplain forests in Crimea.

Table 1.
DISTRIBUTION OF FLOODPLAIN FORESTS MANAGED BY THE STATE FORESTRY AGENCY, BY NATURAL ZONES AND CATEGORIES.

Forest Category	Area		Stock	
	thousand hectares	%	thousand hectares	%
Polissia				
Exploitation forests	79,17	60,8	15817,23	57,4
Protection forests	25,66	19,7	5601,91	20,3
Forests of conservation, scientific, historical, and cultural value	18,80	14,5	4671,33	16,9
Recreational forests	6,53	5,0	1490,23	5,4
Total	130,16	100	27580,70	100
Forest Steppe				
Exploitation forests	61,57	34,8	13355,50	33,8
Protection forests	74,14	41,9	16061,55	40,6
Forests of conservation, scientific, historical, and cultural value	23,38	13,2	5478,87	13,9
Recreational forests	17,88	10,1	4618,09	11,7
Total	176,97	100	39514,01	100
Steppe				
Exploitation forests	3,47	2,7	852,08	3,3
Protection forests	50,29	39,4	9412,46	36,1
Forests of conservation, scientific, historical, and cultural value	21,08	16,5	4440,37	17,0
Recreational forests	52,87	41,4	11358,00	43,6
Total	127,71	100	26062,91	100
Carpathians				
Exploitation forests	0,61	46,2	113,85	45,8
Protection forests	0,47	35,6	86,63	34,9
Forests of conservation, scientific, historical, and cultural value	0,06	4,6	13,81	5,6
Recreational forests	0,18	13,6	34,16	13,7
Total	1,32	100	248,45	100
Ukraine, Total				
Exploitation forests	144,82	33,2	30138,66	32,3
Protection forests	150,56	34,5	31162,55	33,4
Forests of conservation, scientific, historical, and cultural value	63,32	14,5	14604,38	15,6
Recreational forests	77,46	17,8	17500,48	18,7
Total	436,16	100	93406,07	100

According to the Resolution of the Cabinet of Ministers of Ukraine "On approval of the Procedure for dividing forests into categories and identification of specially protected forest areas" [37], floodplain forests belong to all four categories. For instance, exploitation forests aimed to meet economic needs in wood predominate in Polissia and the Carpathians, protection forests predominate in the forest steppe, and recreational and protection forests predominate in the steppe (see Table 1). In general, floodplain forests in Ukraine are mainly categorized as protection and exploitation forests.

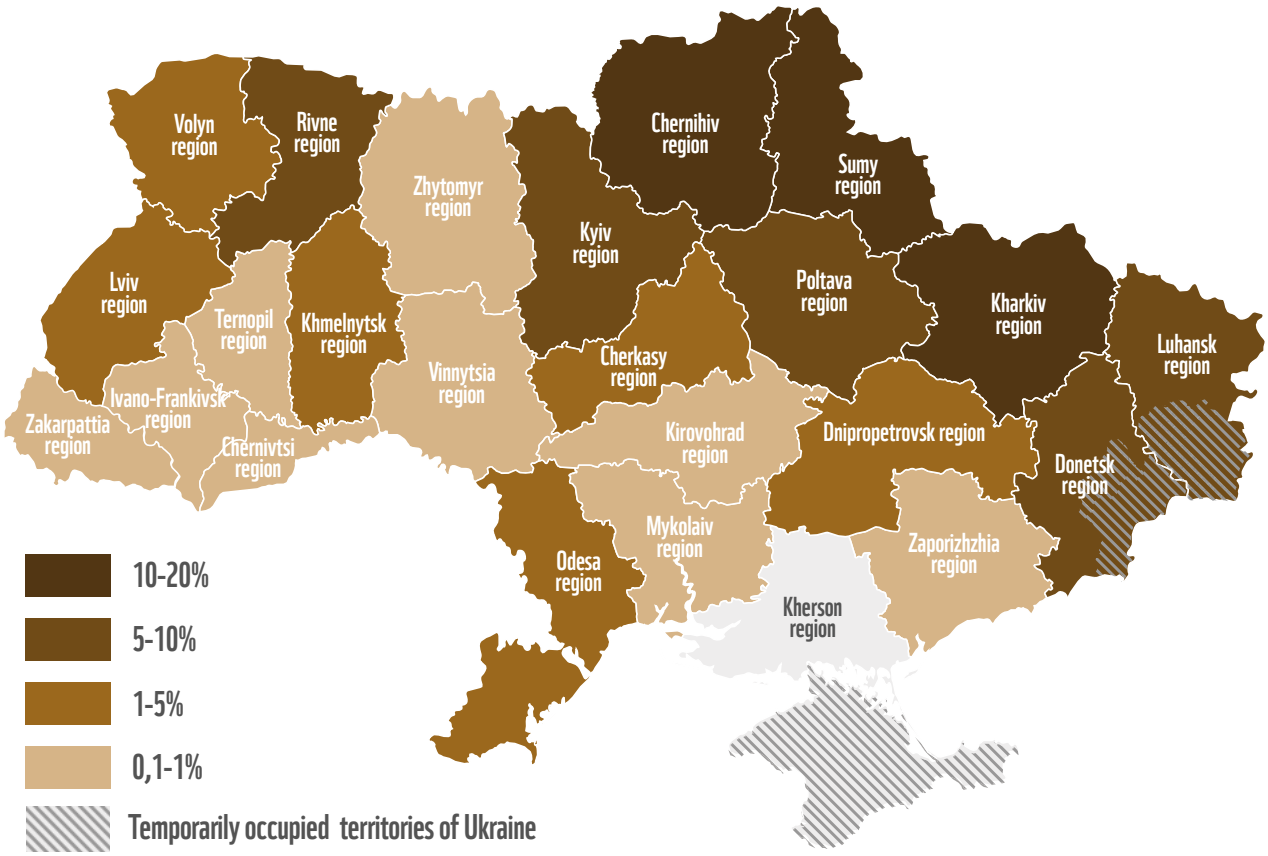
The largest areas of floodplain forests are concentrated in the Left Bank Ukraine (Table 2), in particular in Chernihiv, Kharkiv, Sumy, Poltava, Donetsk, and Luhansk regions. Floodplain forests can be divided into two groups: (1) forests suitable for exploitation (exploitation forests, strips along rivers, lakes, water bodies, etc., and forestry parts of green zone forests), and (2) those excluded from exploitation (anti-erosion forests, forest park parts of green zone forests).

Table 2.

DISTRIBUTION OF FLOODPLAIN FORESTS MANAGED BY THE STATE FORESTRY AGENCY AND FORESTS REGARDED AS STRIPS ALONG WATER BODIES, BY TERRITORIAL-ADMINISTRATIVE UNITS (REGIONS).

Region	Floodplain forests		Strips along water bodies	
	Area, thousand hectares	%	Area, thousand hectares	%
Vinnytsia	2,09	0,5	3,09	1,3
Volyn	6,91	1,6	15,34	6,4
Dnipropetrovsk	15,99	3,7	-	-
Donetsk	32,28	7,4	-	-
Zhytomyr	1,17	0,3	20,11	8,4
Zakarpattia	0,30	0,1	44,41	18,5
Zaporizhzhia	2,86	0,7	-	-
Ivano-Frankivsk	0,86	0,2	15,67	6,5
Kyiv	41,01	9,4	19,43	8,1
Kirovohrad	0,97	0,2	1,80	0,7
Luhansk	26,64	6,1	-	-
Lviv	19,78	4,5	4,41	1,8
Mykolaiv	0,42	0,1	-	-
Odesa	8,29	1,9	-	-
Poltava	34,16	7,8	19,70	8,2
Rivne	37,60	8,6	8,53	3,6
Sumy	61,31	14,0	29,24	12,2
Ternopil	0,63	0,1	2,39	1,0
Kharkiv	55,06	12,6	17,84	7,4
Kherson	-	-	-	-
Khmelnytsk	5,07	1,2	4,27	1,8
Cherkasy	6,42	1,5	17,54	7,3
Chernivtsi	0,75	0,2	6,71	2,8
Chernihiv	75,59	17,3	9,49	4,0
Total	436,16	100	239,97	100

LOCATION OF FLOODPLAIN FORESTS MANAGED BY THE STATE AGENCY OF FOREST RESOURCES OF UKRAINE



LOCATION OF RIPARIAN FOREST STRIPS MANAGED BY THE STATE AGENCY OF FOREST RESOURCES OF UKRAINE

The species composition of floodplain forests is diverse and includes more than 80 tree and shrub species. However, alder (37%), oak (33%), birch (15%), and poplar (6%) forests predominate (Table 3).

Table 3.
DISTRIBUTION OF FLOODPLAIN FORESTS MANAGED BY THE STATE FORESTRY AGENCY, BY SPECIES.

Species	Area		Stock	
	thousand hectares	%	тthousand cubic meters	%
Black alder	160,40	36,8	31 693,84	33,9
Common oak	143,00	32,8	32 693,64	35,0
Silver birch	65,17	14,9	12 287,11	13,1
Common ash	14,41	3,3	3224,35	3,5
White willow	9,05	2,0	1867,66	2,0
Black poplar	8,65	2,0	2162,61	2,3
Aspen	8,63	2,0	1850,46	2,0
White poplar	5,60	1,3	1394,46	1,5
Other species	21,25	4,9	6231,94	6,7
Total	436,16	100	93 406,07	100

2.2. LOCATION AND AREAS OF WET FORESTS IN THE PLAINS OF UKRAINE

In Ukraine, the area of wet forests with wet and very wet hygrotopes (hygrotopes 4–5) is not precisely identified since respective published data are lacking. According to our expert assessment, the area of wet forests in the plains of Ukraine is about 550,000 hectares.

The largest areas, both in total and in terms of the size of individual plots, are concentrated in the right bank (Western and Zhytomyr) Polissia (Table 4).

Table 4.
DISTRIBUTION OF WET FOREST AREAS MANAGED BY THE STATE FORESTRY AGENCY, BY TERRITORIAL-ADMINISTRATIVE UNITS (REGIONS).

Region	Wet and very wet site conditions											
	Wet infertile pine site type (A_4)		Very wet infertile pine site type (A_5)		Wet fairly infertile pine site type (B_4)		Very wet fairly infertile pine site type (B_5)		Wet fairly fertile site type (C_4)		Very wet fairly fertile site type (C_5)	
	thousand hectares	%	thousand hectares	%	thousand hectares	%	thousand hectares	%	thousand hectares	%	thousand hectares	%
Vinnytsia	-	-	-	-	-	-	-	-	1,02	0,4	0,07	0,3
Volyn	3,32	19,2	1,68	7,4	23,71	16,9	4,48	12,5	65,64	27,1	7,45	27,3
Dnipropetrovsk	-	-	-	-	0,02	-	-	-	0,39	0,2	0,07	0,3
Donetsk	-	-	-	-	-	-	-	-	1,44	0,6	-	-
Zhytomyr	5,45	31,6	5,71	25,2	40,51	28,8	10,38	28,9	30,11	12,4	2,64	9,7
Zakarpattia	-	-	-	-	-	-	-	-	0,88	0,4	-	-
Zaporizhzhia	-	-	-	-	-	-	-	-	0,29	0,1	0,06	0,2
Ivano-Frankivsk	-	-	0,12	0,5	0,69	0,5	-	-	6,43	2,6	-	-
Kyiv	0,14	0,8	-	-	3,06	2,2	0,16	0,4	16,38	6,8	1,16	4,3
Kirovohrad	-	-	-	-	-	-	-	-	0,18	0,1	-	-
Luhansk	-	-	-	-	0,06	-	-	-	1,36	0,6	0,18	0,7
Lviv	0,13	0,8	0,04	0,2	2,50	1,8	0,46	1,3	20,01	8,2	0,29	1,1
Mykolaiv	-	-	-	-	-	-	-	-	-	-	-	-
Odesa	-	-	-	-	-	-	-	-	1,01	0,4	0,98	3,6
Poltava	-	-	-	-	0,06	-	0,06	0,2	4,31	1,8	1,31	4,8
Rivne	8,03	46,6	15,04	66,4	63,83	45,4	19,64	54,7	56,15	23,2	9,42	34,6
Sumy	-	-	-	-	0,46	0,3	0,09	0,2	6,32	2,6	1,02	3,7
Ternopil	-	-	-	-	0,01	-	-	-	0,43	0,2	0,01	-
Kharkiv	-	-	-	-	0,15	0,1	-	-	2,30	0,9	0,16	0,6
Kherson	-	-	-	-	-	-	-	-	0,15	0,1	0,08	0,3
Khmelnytsk	0,16	0,9	0,06	0,3	1,52	1,1	0,18	0,5	5,84	2,4	0,15	0,5
Cherkasy	-	-	-	-	0,34	0,2	0,24	0,7	4,44	1,8	0,69	2,5
Chernivtsi	-	-	-	-	-	-	-	-	0,50	0,2	-	-
Chernihiv	0,02	0,1	0,01	-	3,78	2,7	0,21	0,6	16,83	6,9	1,50	5,5
Total	**17,25**	**100**	**22,66**	**100**	**140,70**	**100**	**35,90**	**100**	**242,41**	**100**	**27,24**	**100**

Note: forest typology provided is based on Pogrebnyak, 1955 [36].

Wet and very wet site conditions				Total	
Wet fertile site type (D_4)		Very wet fertile site type (D_5)			
thousand hectares	%	thousand hectares	%	thousand hectares	%
0,94	2,7	0,10	0,4	2,13	0,4
2,11	6,0	-	-	108,39	19,7
0,12	0,3	0,03	0,1	0,63	0,1
0,11	0,3	-	-	1,55	0,3
1,58	4,5	0,06	0,2	96,44	17,5
1,00	2,8	-	-	1,88	0,3
0,01	-	-	-	0,36	0,1
0,81	2,3	-	-	8,05	1,5
2,28	6,5	0,96	3,5	24,14	4,4
0,12	0,3	0,01	-	0,31	0,1
0,45	1,3	0,20	0,7	2,25	0,4
7,24	20,5	0,02	0,1	30,69	5,6
-	-	-	-	-	-
0,06	0,2	0,03	0,1	2,08	0,4
5,26	14,9	2,67	9,6	13,67	2,5
0,44	1,2	0,01	-	172,56	31,4
3,41	9,6	0,68	2,5	11,98	2,2
0,30	0,8	0,01	-	0,76	0,1
1,28	3,6	0,56	2,0	4,45	0,8
1,81	5,1	21,49	76,9	23,53	4,3
0,78	2,2	0,18	0,6	8,87	1,6
2,29	6,5	0,82	2,9	8,82	1,6
0,65	1,8	-	-	1,15	0,2
2,32	6,6	0,11	0,4	24,78	4,5
35,37	**100**	**27,94**	**100**	**549,47**	**100**

Thus, in the right bank Polissia the area of wet forests, which are characterized by wet and very wet conditions, is 317.3 thousand hectares. Their largest share in the area covered by forests is in Rivne region — 23.9%. Volyn region has the second largest share — 23.3%. The lowest share is in Zhytomyr region — 14.21%. In some state forest enterprises (SFEs), the share of wet forests is much higher. For example, it reaches 39.9% in Olevsk SFE (Zhytomyr Region) and 37.7% in Yemilchyn SFE (Zhytomyr Region).

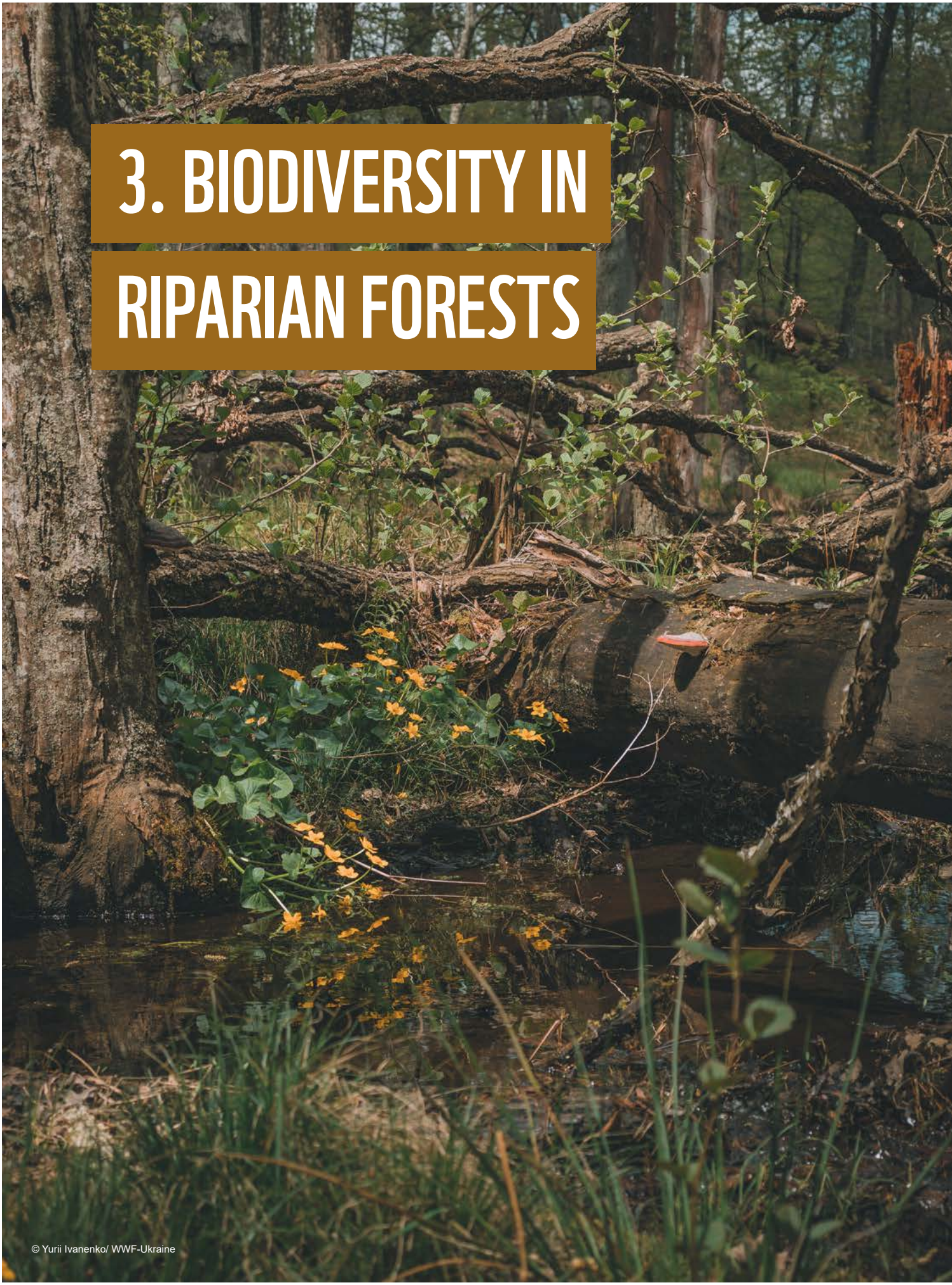
We will list the main forest types and the dominant tree species in those types of site conditions (TSC). For the names of tree species, abbreviations are used: PS — pinus sylvestris (Scots pine), B — *betula* (birch), Q — *quercus* (oak), AG — *alnus glutinosa* (black alder), etc. In particular, the A_5 forest type is represented solely by low-density bog pine groves (A_5PS); A_4 — pine, pine-birch, and birch ecosystems of oligotrophic and oligo-mesotrophic forest-swamp complexes (A_4–bPS); B_4 — pine, pine-birch, and birch ecosystems with an admixture of oak on mesotrophic bogs (B_4–q–bPS); B_5 — pine, pine-birch, and birch ecosystems with an admixture of oak on mesotrophic, heavily watered swamps (B_5–q–bPS); C_4 — ecosystems of black alder on mesoeutrophic forest swamps (C_4–AG); C_5 — ecosystems of black alder on mesoeutrophic heavily watered forest swamps (C_5–AG); D_4 — ecosystems of black alder on drained eutrophic forest swamps (D_4–AG); D_5 — ecosystems of black alder on eutrophic heavily watered forest swamps (D_5–AG).

Analysis of table 4 shows that in all three regions, the area of oligotrophic forest-swamp complexes (trophotope — fertile site type) is the smallest while the area of conglomerate trophotope is the largest.

In a number of other regions of Ukraine, the share of wet forests is insignificant. For example, in Podilla (Vinnytsia, Khmelnytsk, and Ternopil regions), it varies between 0.1% and 0.3% of the forested area (predominantly TSC C_4 and D_4).

Herewith, the share of such forests is significantly higher in the lower parts of large rivers — the Dnipro, the Danube, and the Dniester. Their distribution areas are insufficiently studied and are mostly represented by typical wetlands.

3. BIODIVERSITY IN RIPARIAN FORESTS



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Specific natural conditions of floodplain and wet forests of Ukraine led to the formation of a number of rare habitats within them. The habitat-based approach to biodiversity protection assumes protection of not only individual species of living organisms listed in the Red Book of Ukraine and international protection lists, but also their genera and habitats. This approach is the basis of the Bern Convention on the Conservation of European Wildlife and Natural Habitats, to which Ukraine has been party since 1996. Within the environmental legislation of the European Union, the habitat-based approach is one of the fundamental ones and is regulated, in particular, by the Habitat Directive.

In Ukraine, a complex approach to the protection of ecosystems and habitats, in particular in forestry, is insufficiently regulated both at the legislative level and in practice. Herewith, there are state documents regulating the protection of rare plant communities (the Green Book of Ukraine [18]) and scientific developments that enable adaptation of Ukrainian legislation to EU standards. According to the National Habitat Catalogue of Ukraine [31], most habitats of wet forests of Ukraine are rare and require protection at the European level.

This study lists habitats related to riparian forests and provides recommendations on their balanced management. Habitats are numbered according to the National Habitat Catalogue of Ukraine. Numbering according to Resolution No. 4 of the Bern Convention, Annex 1 of the EU Habitat Directive, the EUNIS system, the syntaxonomy of ecological and floristic classification according to the Brown-Blanquet method, as well as the types of site conditions according to Pogrebnyak [36] classification are also provided.

A comparison of forest inventory data, in particular TSCs, with rare habitats formed within them is provided in table 5 for the identification of rare habitats within floodplain wet forests of the forest fund.

Table 5.
OCCURRENCE OF RARE HABITATS OF WET FORESTS IN CERTAIN TYPES OF SITE CONDITIONS.

No.	Rare habitat	Typical TSCs
1	Д1.6.3. Carpathian grey and black alders galleries Д1.6.4. Ash-alder alluvial forests	wet fairly fertile site type — C_4, wet fertile site type — D_4
2	Д1.6.1. Willow-poplar forests of floodplains	wet fairly fertile site type — C_4, very wet fairly fertile site type — C_5, wet fertile site type — D_4, very wet fertile site type — D_5
3	Д1.6.2. Moist and occasionally flooded oak-elm forests	fresh fairly fertile site type — C_2, fresh fertile site type — D_2, moist fairly fertile site type — C_3, moist fertile site type — D_3, wet fairly fertile site type — C_4, wet fertile site type — D_4
4	Д1.7.1. Eutrophic swamps with layer of black alder or birch	wet fairly fertile site type — C_4, very wet fairly fertile site type — C_5, wet fertile site type — D_4, very wet fertile site type — D_5
5	Д1.7.2. Bogs with layer of birch	wet fairly infertile pine site type — B_4, very wet fairly infertile pine site type — B_5
6	Д2.2.3. Wet Scots pine forests	wet infertile pine site type — A_4, wet fairly infertile pine site type — B_4
7	Д2.5.2. Bogs with a layer of pine	wet infertile pine site type — A_4, very wet infertile pine site type — A_5
8	Т5.1. Thermo-xerophilous fringes, Д1.4.1. Subacidophilous species-rich oak and pine-oak forests, Д1.4.2. Continental termophilous oak forests	fresh fairly fertile site type — C_2

3.1. POPLAR OR WILLOW FLOODPLAIN AND GALLERY FORESTS

The National Habitat Catalogue of Ukraine:

Д1.6.1. Willow-poplar forests of floodplains.

Syntaxonomy: *Salicetea purpureae* Moor 1958, *Salicetalia purpureae* Moor 1958, *Salicion albae* Soó 1951.

EUNIS: G1.111. Middle European white willow forests, G1.36. Ponto-Sarmatic mixed poplar riverine forests.

Annex I of the Habitat Directive: 91E0* / Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*).

Resolution 4 of the Bern Convention: G1.11 — Riverine Salix woodland, G1.3 — Mediterranean riparian woodland.

Forest typological classification by Pogrebnyak:

fresh fairly infertile sedge site type (B_2), fresh fairly fertile poplar site type (C_2), moist fairly infertile sedge site type (B_3), moist fairly fertile poplar site type (C_3), moist fairly fertile willow-poplar site type (C_3), wet fertile poplar-willow site type (D_4), wet fairly fertile willow site type (C_4), wet fertile willow site type (D_4), very wet fertile willow site type (D_5).

Rare plant species of the Red Book of Ukraine:

broad-leaved helleborine (*Epipactis helleborine*), Elbe helleborine (*Epipactis albensis*), common twayblade (*Listera ovata*), lesser butterfly-orchid (*Platanthera bifolia*).

Rare animal species of the Red Book of Ukraine:

osprey (*Pandion haliaeetus*), black kite (*Milvus migrans*), white-tailed eagle (*Haliaeetus albicilla*), black stork (*Ciconia nigra*).

This forest type includes willow forests in river floodplains or more successionally advanced forests dominated by black poplar (*Populus nigra*) and white poplar (*Populus alba*). Willow thickets are mainly formed by white willow (*Salix alba*). Habitats are formed on heavy, rich in alluvial sediment, silty-swamp, or sandy soils. Plant communities include trees and shrubs species able to withstand frequent and long-term flooding by surface waters and groundwaters that are close to the surface. Key factors in the development of these forests include significant annual fluctuations in groundwater levels and annual deposition of sediment due to spring floods.

Poplar forests are located near the raised banks of large watercourses, floodplain islands, and ridges of riparian and central floodplains with layered loamy soils with groundwater depth of 2–4 m and minor deposits of alluvial substrate.

The total area of willow plantations in Ukraine is about 12,000 hectares and of poplar plantations — slightly smaller. They are mainly widespread in the floodplains of large rivers, such as the Desna, the Dnipro, and the Danube. Currently, these forests are mostly mature and permanent. In the floodplains of small, anthropogenically transformed rivers, a hybrid of white willow and crack willow — gold-crack willow (*Salix rubens*) — is common. It grows on narrow strips on the banks of rivers, often with an admixture of American ash. Usually, hybrid poplar plantations are planted in floodplains due to better wood productivity and growth rate compared to natural species.

The major method of regeneration of poplar and willow stands is coppice regeneration, of which they are rather capable. Seed regeneration is intensive on shoals free of vegetation. However, due to the high dynamic characteristics of these ecotopes, young seedlings often die there.

MANAGEMENT

Poplar or willow floodplain and gallery forests represent the first stages of succession (formation) of forest vegetation. Their management should consider the factors that enhance their formation (channel processes and deposition of alluvium, spring floods). Most of these forests were formed in the last 30–40 years, when the scale of cattle grazing and hay harvesting within riparian complexes decreased; hence, as river influence decreases, they will gradually transform into oak-ash and ash-elm forests.

The major threat to these forests is invasive species — ash-leaved maple, false indigo-bush, wild cucumber, and Virginia creeper. Poplar and willow trees are affected by common mistletoe.

Due to their high mosaic nature, all activities in these forests should be planned carefully. Logging should be carried out under the condition of preserving the ground cover; canopy closure should be reduced by no more than one third. Due to satisfactory regeneration of all the species dominant in these forests through growth from the stump, this is an effective measure of forest restoration after logging and protection against catastrophic events (i.e. consequences of floods, storms). In the course of poplar and willow forests tending, the emergence and development of the undergrowth of trees characteristic of forests at later dynamics stages — elm, common ash, and common oak — should be enhanced. Regulated livestock grazing and haying should be introduced and maintained, but only when this does not contradict the water protection function of these forests. Arrangement of recreational areas without artificial cover can also be an effective measure to preserve the diversity of poplar and willow forests. Most of these forests grow in the water protection zone and are subject to the restrictions stipulated by the Water Code of Ukraine.

3.2. NON-WET FLOODPLAIN OAK-ELM-ASH FORESTS ALONG GREAT RIVERS

The National Habitat Catalogue of Ukraine:

Д1.6.2. Moist and occasionally flooded oak-elm forests.

Syntaxonomy: *Alno glutinosae-Populetea albae* P. Fukarek et Fabijanić 1968, *Alno-Fraxinetalia excelsioris* Passarge 1968 *Fraxino-Quercion roboris* Passarge 1968.

EUNIS: G1.22. Mixed oak-elm-ash woodland of great rivers.

Annex I of the Habitat Directive: 91F0. Riparian mixed forests of *Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris).*

Resolution 4 of the Bern Convention: G1.22 — Mixed oak-elm-ash woodland of great rivers.

Forest typological classification by Pogrebnyak:

fresh fairly fertile field elm site type and its halogen variants (C_2), fresh fertile field elm-field maple site type and its halogen variants (D_2), fresh fertile field elm-ash site type (D_2), fresh fairly fertile maple-linden site type (C_2), fresh fairly fertile elm site type (C_2), fresh fertile elm-ash site type (D_2), moist fertile field elm-field maple site type and its halogen variants (D_3), moist fertile field elm-ash site type (D_3), moist fairly fertile maple-linden site type (C_3), moist fertile elm-ash site type (D_3), moist fertile elm site type (D_3).

Rare plant species of the Red Book of Ukraine:

wild garlic (*Allium ursinum*), thin-spiked wood sedge (*Carex strigosa*), broad-leaved helleborine (*Epipactis helleborine*), Elbe-helleborine (*E. albensis*), violet helleborine (*E. purpurata*), snake's head fritillary (*Fritillaria meleagris*), fritillaria minor (*F. ruthenica*), common snowdrop (*Galanthus nivalis*), summer snowflake (*Leucojum aestivum*), spring snowflake (*L. vernum*), Turk's cap lily (*Lilium martagon*), common twayblade (*Listera ovata*), bird's nest orchid (*Neottia nidus-avis*), Bouché's star of Bethlehem (*Ornithogalum boucheanum*).

Rare animal species of the Red Book of Ukraine: short-toed snake eagle (*Syrcaetus gallicus*), osprey (*Pandion haliaeetus*), black kite (*Milvus migrans*), white-tailed eagle (*Haliaeetus albicilla*), black stork (*Ciconia nigra*).

This type includes forests of floodplains of large rivers, which sometimes can be found on poorly drained plains. They often have a well-developed synusion of spring geophytes, which is replaced by nitrophilous and mesophilic species in summer. Groundwaters are located at the depth of one meter or more. Habitats are characterized by moderate moisture in summer. Oak-elm-ash forests grow on well-drained loamy and silty alluvial deposits in high-level floodplains.

Such forests are most common in the Left Bank Ukraine — in the forest steppe and northern steppe zones, and are rarer in Polissia. On the Right Bank, they used to occupy very small areas, but now they are practically absent. The total area of oak forests in Ukraine accounts for 1.5 million hectares [51], of which floodplain forests amount to no more than 100,000 hectares.

Species of the oak genus, due to their light-demanding nature, are included in polydominant groups facing a constant danger of displacement by more shade-tolerant accompanying species since oak has unsatisfactory regeneration in both pure and mixed forests. In artificially created monodominant forests, coppice oak groves, and secondary oak stands, the ability to self-regulate and self-regenerate is weak. In such cases, forests structure should be optimized.

MANAGEMENT

These are subclimax forests, which are rather mosaic due to the peculiarities of micro- and meso-relief, which affects groundwater levels and gleyed horizon depth. When preparing the soil for planting forest species, it is important not to make furrows to the depth of gleyed horizon since this limits the soil layer in which tree roots develop. It is hard to follow this rule due to undulating micro-relief. Tending of forest species is complicated by aspen, and sometimes hazel, undergrowth, as well as tall grass. Forests satisfactorily regenerate after logging due to growth from the stump.

These forests depend on the nature of spring floods. In areas where floods are irregular, there is a particularly high risk of adventitious species rooting: ash maple and Virginia creeper. The cessation of spring floods for various reasons (construction of engineering and hydrotechnical structures, hydromelioration, etc.) leads to an increase in the share of Norway and field maples and small-leaved linden in the tree stand structure, which makes it difficult to restore trees of the first size — common oak and common ash — in such forests.

In these forests, large birds of prey nest on old-growth trees. In addition, such trees are a habitat of bat colonies. These peculiarities should be considered when planning and carrying out forestry measures, in particular logging.

3.3. THERMOPHILIC (LIGHT) FLOODPLAIN OAK FORESTS

The National Habitat Catalogue of Ukraine:

Д1.4.1. Subacidophilous species-rich oak and pine-oak forests, Д1.4.2. Continental termophilous oak forests.

Syntaxonomy: Trifolio-Geranietea sanguinei T. Müller 1962, Quercetea pubescentis DoingKraft ex Scamoni et Passarge 1959.

EUNIS: E5.21. Xerothermophilic fringes, G1.7. Thermophilous deciduous woodland, G4.C. Mixed *Pinus sylvestris* — thermophilous *Quercus woodland*.

Annex I of the Habitat Directive: 91I0* — Euro-Siberian steppic woods with *Quercus spp*.

Resolution 4 of the Bern Convention: G1.7 — Thermophilous deciduous woodland.

Forest typological classification by Pogrebnyak:

fresh fairly fertile floodplain site type (C_2–Q), fresh fairly fertile linden site type (C_2T[1]–Q), fresh fairly fertile hornbeam-pine site type (C_2–C[2]–PS–Q), fresh fairly fertile hornbeam site type (C_2C–Q), etc.

Rare plant species of the Red Book of Ukraine:

sword-leaved helleborine (*Cephalanthera longifolia*), broad-leaved helleborine (*Epipactis helleborine*), Turk's cap lily (*Lilium martagon*), common twayblade (*Listera ovata*), bird's-nest orchid (*Neottia nidus-avis*), greater butterfly-orchid (*Platanthera chlorantha*), eastern pasqueflower (*Pulsatilla patens*), as well as four ***protected by the Bern Convention***: leathery grapefern (*Botrychium multifidum*), Northern dragonhead (*Dracocephalum ruyschiana*), *Jurinea cyanoides, Thesium ebracteatum Hayne*.

Rare animal species of the Red Book of Ukraine:

osprey (*Pandion haliaeetus*), black kite (*Milvus migrans*), white-tailed eagle (*Haliaeetus albicilla*), European badger (*Meles meles*), stag beetle (*Lucanus cervus*).

This category of forests includes oak forests, sparse forests, and forest edges on high hills within floodplains. These are rare forests that are relicts of once widespread oak forests. The hills on which these forests grow are rarely flooded or are even located above the flood level; they result from alluvial processes and are therefore composed of light soils with a specific layered profile.

Light oak forests and sparse forests have a low canopy closure, a weak understory, and a high degree of herbaceous cover (more than 40–50%), with meadow grasses predominating.

Factors that contributed to the formation of the thermophilic fertile site type include moderate cattle grazing and haying. In the 20th century, for economic reasons, within the fresh fairly fertile site type pine species were usually planted after clearcut logging on the place of oak forests. In addition, the impact of traditional forms of forest use (haying and cattle grazing), which contributed to the preservation of such communities, was minimized.

The major issue of the thermophilic fertile site type management is that these plantations produce wood of low quality and have a low stock. Self-regeneration is believed to be unsatisfactory in such forests due to the high level of sodding. Such a conclusion is made based on the undergrowth volume registered at inventory sites. Herewith, the age of individual oak trees is significant and so even a minimal number of undergrowth can compensate for this. Moreover, considering regeneration waves caused by biotic and abiotic factors, the self-maintenance of light forests is rather realistic.

[1]T – Tilia (linden)

[2]C – Cárpinus (hornbeam)

MANAGEMENT

Preservation of such park-type forests is possible under the condition of return to traditional forms of nature management (hay cutting, cattle grazing). In some areas, recreational areas with lawns and a minimum amount of artificial cover, bio-grasslands for feeding hunting animals, etc. could be arranged instead. In such forests, scientifically justified selective logging may be allowed. Common oak should be used for natural regeneration (it can be regenerated vegetatively). Individual specimens of small-leaved linden, common ash, and field elm are allowed. For better self-regeneration, measures that promote natural regeneration without destroying the soil cover should be taken. It is not recommended to plant pine species at clearcut logging sites within the thermophilic fertile site type, as well as in the areas directly adjacent to them.

In derived secondary stands, to which the majority of floodplain oak forests now belong, purposeful tending felling or conversion felling should be carried out. They should be started as early as possible to help regulate interactions between oak and other tree species.

Acceptable measures: removal of invasive species; maintaining natural groundwater level; and preserving the natural flow of rivers and forming meanders and floodplains.

3.4. NON-WET FLOODPLAIN ALDER AND ASH-ALDER FORESTS

The National Habitat Catalogue of Ukraine:

Д1.6.3. Carpathian grey and black alders galleries, Д1.6.4. Ash-alder alluvial forests.

Syntaxonomy: *Alno glutinosae-Populetea albae* P. Fukarek et Fabijanić 1968, *Alno-Fraxinetalia excelsioris* Passarge 1968, *Alnion incanae* Pawłowski et al. 1928.

EUNIS: G1.121. Montane *Alnus incana galleries*, G1.21. Riverine *Fraxinus-Alnus* woodland, wet at high but not at low water.

Annex I of the Habitat Directive: 91E0* — Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*).

Resolution 4 of the Bern Convention: G1.21 — Riverine *Fraxinus-Alnus* woodland, wet at high but not at low water.

Forest typological classification by Pogrebnyak:
wet fairly fertile alder site type (C_4), wet fairly fertile gray alder site type (C_4), wet fertile gray alder site type (D_4), very wet fairly fertile alder site type (C_5).

Rare plant species of the Red Book of Ukraine:

marsh pennywort (*Hydrocotyle vulgaris*), Turk's cap lily (*Lilium martagon*), common twayblade (*Listera ovata*), bird's-nest orchid (*Neottia nidus-avis*), wild garlic (*Allium ursinum*), thin-spiked wood sedge (*Carex strigosa*), broad-leaved helleborine (*Epipactis helleborine*), snake's head fritillary (*Fritillaria meleagris*), common snowdrop (*Galanthus nivalis*), Siberian iris (*Iris sibirica*), summer snowflake (*Leucojum aestivum*), spring snowflake (*Leucojum vernum*), Hungarian Lilac (*Syringa josikaea*); ***of Resolution 6 of the Bern Convention***: *Syringa josikaea*; ***of Annexes II and IV of the Habitat Directive***: *Syringa josikaea*; ***regionally rare species***: ostrich fern (*Matteuccia struthiopteris*).

Communities of the Green Book of Ukraine:

51. Community of common oak and common alder forests with yellow azalea (*Querceto (roboris)–Alneta (glutinosae) rhododendrosa (lutei))*;

52. Community of common alder forests with Hungarian lilac *(Alneta (glutinosae) syringosa (josikaeae))*;

53. Community of common alder forests (*Alneta glutinosae*), with the grass stand dominated by ostrich fern (*Matteuccia struthiopteris*);

54. Community of gray alder forests (*Alneta incanae*), with the grass stand dominated by European scopolia (*Scopolia carniolica*), association: gray alder forest with European scopolia *(Alnetum (incanae) scopoliosum (carniolicae))*;

55. Community of grey alder forests (*Alneta incanae*), with the grass stand dominated by ostrich fern (*Matteuccia struthiopteris*), association: gray alder forest with ostrich fern *(Alnetum (incanae) matteucciosum (struthiopteris))*;

56. Community of gray alder forests (*Alneta incanae*), with the grass stand dominated by wild garlic (*Allium ursinum*), association: gray alder forest with wild garlic *(Alnetum (incanae) alliosum (ursini))*;

57. Community of gray alder forests with Hungarian lilac (*Alneta (incanae) syringosa (josikaeae))*, associations: gray alder forest with Hungarian lilac *(Alnetum (incanae) syringosum (josikaeae))*, gray alder forests with Hungarian lilac and marsh-marigold *(Alnetum (incanae) syringosa (josikaeae)–calthosum (palustris))*, gray alder forest with Hungarian lilac and meadowsweet *(Alnetum (incanae) syringoso (josikaeae)–filipendulosum (denudatae))*, gray alder forest with Hungarian lilac and quaking sedge *Alnetum (incanae) syringoso (josikaeae)–caricosum (brizoiditis))*;

72. Community of common ash forests with Hungarian lilac *(Fraxineta (excelsioris) syringosa (josikaeae))*, common alder and common ash forests with Hungarian lilac *(Alneto (glutinosae)–Fraxineta (excelsioris) syringosa (josikaeae))*, and gray alder-common ash forests with Hungarian lilac *(Alneto (incanae)–Fraxineta) (exelsioris) syringosa (josikaeae))*.

These are floristically rich, highly productive tall mixed ash-black alder non-wetland forests with a complex of nemoral and alnetal elements on gleyed non-wetland loamy soils without stagnant moisture. The soil has a pronounced gley horizon. The development of tree stand depends on groundwater levels and their fluctuations. Under the normal conditions, certain areas are regularly affected by floods.

This type of forests is mainly concentrated in the Right Bank Ukraine — in the Carpathians and Zakarpattia, where it occupies an area of about 8,000 hectares. In the plains of Ukraine, these forests are spread sporadically in the forest steppe zone and occupy very small areas. They are of great water and coastal protection value, especially in the Carpathians; this is enhanced by the high growth capacity of alder, which it has until the maturity age. These forests often have a rare type of association of populations of dominant community species.

MANAGEMENT

Any forestry activities in this habitat type are undesirable. It is important not to disturb the fertile soil layer when planting forest crops since gley horizon is close. A decrease in the duration and frequency of floods leads to an increase in the share of Norway maple and littleleaf linden in plantations. Therefore, tending felling and sanitary logging are allowed, aimed, in particular, at maintaining populations of rare species, such as Syringa josikaea.

3.5. ALDER SWAMP FORESTS

The National Habitat Catalogue of Ukraine:

Д1.7.1. Eutrophic swamps with layer of black alder or birch.

Syntaxonomy: *Alnetea glutinosae* Br.-Bl. et Tx. ex Westhoff et al. 1946, *Alnetalia glutinosae* Tx. 1937, *Alnion glutinosae* Malcuit 1929.

EUNIS: G1.4. Broadleaved swamp woodland not on acid peat, G1.5. Broadleaved swamp woodland on acid peat.

Annex I of the Habitat Directive: 91D0. Bog woodland.

Resolution 4 of the Bern Convention: G1.41 — Alnus swamp woods not on acid peat.

Forest typological classification by Pogrebnyak:
wet fairly fertile black alder site type (C_4), wet fertile black alder site type (D_4), very wet fertile black alder site type (D_5).

Rare plant species of the Red Book of Ukraine:

swamp sawgrass (*Cladium mariscus*), *Ligularia bukoviensis*, varnished hook-moss (*Drepanocladus vernicosus*), pseudobryum moss (*Pseudobryum cinclidioides*), marsh pennywort (*Hydrocotyle vulgaris*), southern succisella (*Succisella inflexa*); ***of Resolution 6 of the Bern Convention***: *Ligularia bukoviensis, Siberian cineraria (Ligularia sibirica)*; ***of Annexes II and IV of the Habitat Directive***: *Ligularia bukoviensis, Ligularia sibirica.*

Rare animal species of the Red Book of Ukraine:

short-toed snake eagle (*Sircaetus gallicus*), osprey (*Pandion haliaeetus*), white-tailed eagle (*Haliaeetus albicilla*), black stork (*Ciconia nigra*).

Alder swamp forests belong to this type of riparian forests. The communities are formed by the tree species able to withstand a constantly high water level with stagnant excessive moisture in sub-terraced lowerings of floodplains and in passable valleys on the edges of peat bogs (peatlands) or in natural depressions and lowerings on gleyed, silty, rich peaty soils. Often, they have a well-defined microrelief — near-stem pedestals and watered spring fens.

The total area of alder plantations in Ukraine is 275.8 thousand hectares or 4.4% of forest areas, which is 20.9 thousand hectares more than according to 2002 records [15]. The increase in alder plantations area can be explained both by the re-wetting of previously drained lands due to the loss of functionality of reclamation systems and by the transfer of alder plantations lands to the forest fund. Stocks of alder stands amount to about 49 million cubic meters. Annually, 1.0–1.2 million cubic meters of wood are harvested in the alder forests of Ukraine [11].

Alder forests in Ukraine are mostly concentrated in Western and Eastern Polissia (more than 11% of forest areas). In general, alder stands in Polissia amount to 162.1 thousand hectares (58.8% of the total area of alder forests in Ukraine). Alder forests account for 35.4% of the soft-leaved forests area in Polissia. Three regions (Volyn, Rivne, and Zhytomyr) account for more than 86% of all alder plantations by stock and almost 88% by area. The average stock of the studied plantations per one hectare is 173 cubic meters. The distribution of alder forests within Polissia is uneven: almost 70% of them grow in two western regions — Volyn and Rivne [1].

The southernmost place of growth of alder forests in Ukraine, located hundreds of kilometers from the nearest settlements, is in the vicinity of Kardashynka village, Kherson region.

Since black alder successfully regenerates vegetatively and from seed, most plantations of this species are natural. Alder crops sometimes dominate the composition of riparian strips on non-forest lands. Within massive forests, a significant share of artificial alder forests can be found only in Polissia and the northern part of the forest steppe [11].

MANAGEMENT

The major stability factor of alder swamp forests is a stable hydrological regime. Alder is well regenerated by sprouts from the stump, which enables both selective and clearcut logging. After the clearcut logging, it is important to promote the emergence of undergrowth: leave seed trees, carry out selective soil mineralization in autumn, etc. For natural regeneration of alder forests, it is important to preserve the microrelief with large and small clumps of sedges and pedestals with alder trees. Young alder trees successfully take root on dead wood.

Management of these forests depends on landscape conditions. In sub-terraced alder forests near medium and large rivers, water springs and sources should be preserved. In alder swamp forests under steep slopes, it is necessary to conduct monitoring and take measures to combat water erosion.

Although they occupy narrow strips, alder gallery forests along the banks of lakes and small rivers play an important water protection role. Therefore, it is irrational to cut them. Alder forests are important for the nesting of large birds of prey, in particular greater and lesser spotted eagle and eagle-owl. In the course of logging, attention should be paid to the presence of large nests.

3.6. BIRCH SWAMP FORESTS

The National Habitat Catalogue of Ukraine:

Д1.7.2. Bogs with layer of birch.

Syntaxonomy: *Alnetea glutinosae* Br.-Bl. et Tx. ex Westhoff et al. 1946, *Sphagno-Betuletalia pubescentis* Scamoni et Passarge 1959, *Betulion pubescentis* Lohmeyer et Tx. ex Oberd. 1957.

EUNIS: G1.5. Broadleaved swamp woodland on acid peat (G1.51. Sphagnum *Betula* woods, G4.1. Mixed swamp woodland).

Annex I of the Habitat Directive: 91D0* — Bog woodland.

Resolution 4 of the Bern Convention: G1.51 — Sphagnum Betula woods.

Forest typological classification by Pogrebnyak:
cwet fairly infertile pine-birch site type (B_4), wet fairly infertile birch site type (B_4), very wet fairly infertile pine-birch site type (B_5), very wet fairly infertile birch site type (B_5).

Rare plant species of the Red Book of Ukraine:
rannoch-rush (*Scheuchzeria palustris*), creeping sedge (*Carex chordorrhiza*), bog adder's mouth (*Hammarbya paludosa*), Loesel's twayblade (*Liparis loeselii*).

Rare animal species of the Red Book of Ukraine:
short-toed snake eagle (*Circaetus gallicus*), osprey (*Pandion haliaeetus*), common crane (*Grus grus*), black stork (*Ciconia nigra*).

These are forest swamps, which differ little in species composition from grass-sphagnum fens. The habitat is widespread in the north and west of Ukraine, mainly in Polissia, often together with sedge-sphagnum fens and pine-suppressed sphagnum bogs.

Birch swamp forests form in small "swamps-saucers" (drainless lowerings), along lake banks, in places of groundwater exits on poor substrates, or within wide runoff valleys. In the latter case, birch-sphagnum forests are one of the vegetation complex elements and are affected by beavers, which triggers cyclic successions. Berry fields in such birch forests increase their recreational appeal. However, for their sustainable use, volumes of berries picked should be regulated.

Domination of birch within the tree stand provides indirect evidence that the bog's hydrological regime has undergone changes or even that fires have occurred. Birch grows in areas free from mosses and grasses. Even a slight ground cover damage enhances its undergrowth.

MANAGEMENT

Management of birch swamp forests relies on maintaining a stable hydrological regime. An increase in watering can cause the stand to dry out while its decrease can cause an increase in the stand and grass-shrub layer productivity as well as death of Sphagnum mosses. Logging with subsequent natural regeneration through leaving birch seed trees is allowed.

An important management task within these forests is the prevention of fires, especially in the second half of summer and autumn when swamps dry up. Birch-sphagnum forests, especially those having suppressed trees, serve as feeding grounds for animals (common cranes, black grouse, and western capercaillie) due to their berry fields and sedge fruits. In such cases, it is necessary to ensure an optimal canopy closure for the development of the above-ground cover.

3.7. PINE SWAMP FORESTS

The National Habitat Catalogue of Ukraine:

Д2.2.3. Wet Scots pine forests, Д2.5.2. Bogs with a layer of pine.

Syntaxonomy: *Vaccinio-Piceetea* Br.-Bl. in Br.-Bl. et al. 1939, *Vaccinio uliginosi-Pinetalia sylvestris* Passarge 1968, *Vaccinio uliginosi-Pinion sylvestris* Passarge 1968; *Oxycocco-Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946, *Sphagnetalia medii* Kästner et Flössner 1933, *Sphagnion medii* Kästner et Flössner 1933.

EUNIS: G3.E. Nemoral bog conifer woodland, G4.1. Mixed swamp woodland, G5.6. Early-stage natural and semi-natural woodlands and regrowth, X04. Raised bog complexes.

Annex I of the Habitat Directive: 91D0 — Bog woodland.

Resolution 4 of the Bern Convention: G3.E — Nemoral bog conifer woodland, X04 — Raised bog complexes.

Forest typological classification by Pogrebnyak:
wet infertile pine site type (A_4), wet infertile pine-birch site type (A_4), wet fairly infertile pine site type (B_4), wet fairly infertile pine-birch site type (B_4), very wet infertile pine site type (A_5).

Rare plant species of the Red Book of Ukraine: Carex globularis, stiff clubmoss (*Lycopodium annotinum*), leatherleaf (*Chamedaphne calyculata*); pod grass (*Scheuchzeria palustris*), rope-root sedge (*Carex chordorrhiza*), bog orchid (*Hammarbia paludosa*), dioecious sedge (*Carex dioica*), small cranberry (*Oxycoccus microcarpus*), Soft bog moss (*Sphagnum tenellum*); ***of Resolution 6 of the Bern Convention***: yellow azalea (*Rhododendron luteum*); ***of Annexes II and IV of the Habitat Directive***: *Rhododendron luteum*.

Rare animal species of the Red Book of Ukraine: short-toed snake eagle (*Syrcaetus gallicus*), osprey (*Pandion haliaeetus*).

Communities of the Green Book of Ukraine:
42. Community of Scots pine forests (*Pineta sylvestris*) with the grass stand dominated by black crowberry (*Empetrum nigrum*); 128. Community of the Scots pine-cassandra-sphagnum moss association group (*Pineta (sylvestris) chamaedaphnoso (calyculatae)–sphagnosa)*; 130. Community of the sphagnum- suppressed Scots pine formation *(Sphagneta (fusci) depressipinetosa (sylvestris))*; partially 129. Community of formations of sphagnum-suppressed Scots pine *(Sphagneta (fusci, magellanici) depressipinetosa (sylvestris))*, sedge-sphagnum *(Cariceto (rostratae et limosae)–Sphagneta (cuspidati))*, Rannoch-rush-sphagnum *(Scheuchzerieto – Sphagneta (cuspidati))* hilly-swampy complex.

The species composition of these forests combines the species of mesophilic pine forests with the species of raised bogs. They can be found in the lowerings of mesophilic pine and oak-pine forests and on the edges of swamps. They have peat wetland and muddy wetland soils. In contrast to sparsely forested wetlands with suppressed trees, trees in the generative age are mostly over eight meters (and up to 25 meters) tall.

Sphagnum bogs have a layer of Scots pine, often with downy birch or silver birch. The tree stand is generally sparse — its closure is 0.1–0.6. The trees are low (2–10 meters). These forests differ from wet oligotrophic pine forests by the absence of forest herbaceous species and presence of suppressed trees. Their species composition is similar to that of bogs without a tree layer. They can be a stage of formation of wet pine forests. In Ukraine, they are mainly widespread in Polissia, partly in Small Polissia, and the Carpathians. They have almost disappeared in Roztochcha.

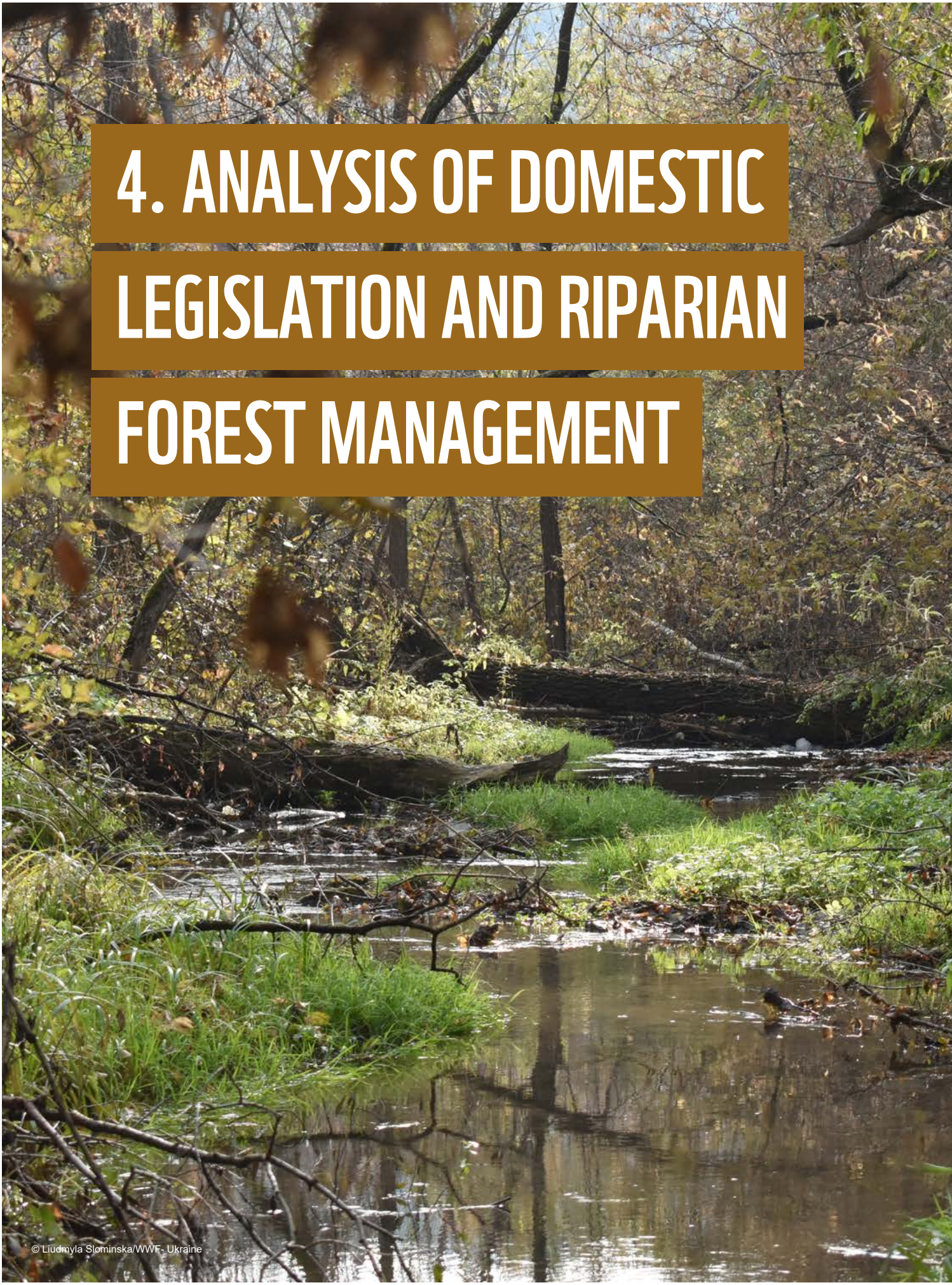
Unlike birch sphagnum forests, pine sphagnum forests have maintained a stable hydrological regime for a long period. Pine has a less plastic root system, is more vulnerable to changes in hydrological regime and fires, and is unable to regenerate quickly.

MANAGEMENT

Management of such forests relies on maintaining a stable hydrological regime; otherwise, there is a risk of the pine dying out and a birch stand forming. In case of a slight decrease in groundwater levels, plantation productivity and canopy closure may increase, the moss layer may completely or partially die out, and the species composition of plants of the grass-shrub layer and productivity of berry fields, which are an important source of food for animals, may decrease.

Logging within these forests is forbidden since it creates a risk of birches regeneration, especially in places where the ground cover is damaged. An important management task within these forests is the prevention of fires, especially in the second half of summer and autumn when swamps dry up. In berry fields, it is necessary to adhere to the recommended recreational loads and, in case of overexploitation, introduce restrictions on berry picking.

4. ANALYSIS OF DOMESTIC LEGISLATION AND RIPARIAN FOREST MANAGEMENT



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Current legal acts of Ukraine provide for the introduction of certain restrictions on forestry activities to preserve biodiversity, protect waters, and ensure performance of anti-erosion functions of riparian forests. However, national legislation pays insufficient attention to such forests, which creates a risk of their degradation. Certain management solutions considering the features of such forests are implemented at the level of individual regions.

Herewith, the FSC National Forest Stewardship Standard for Ukraine (criterion 6.7) states that an organization must protect or restore natural watercourses, water bodies, riparian zones and their connectivity, as well as avoid negative impacts on water quality and volume and mitigate and remedy occurring impacts.

4.1. PROTECTION RIPARIAN FORESTS

Current regulatory framework of Ukraine on forest management provides only for clearcuts with narrow felling areas in the forests of river floodplains and in stands classified as protection forest strips along the banks of rivers, lakes, water bodies, etc. (the Forest Code of Ukraine, 1994 [21]; Regulations for Improving the Quality of the Forest Composition, 2007 [38]; Principal Logging Rules, 2009 [42]).

In particular, the Principal Logging Rules indicate: "In forests located in river floodplains, the terms of narrow felling areas planning include: the sequence of fellings — cross-strip coupes; logging direction — against the river flow; coupe direction — at a right angle to the channel; logging season — winter." In another clause of the Rules, it is stated: "In stands classified as protection forest strips along the banks of rivers, lakes, water bodies, etc., logging with narrow felling areas is planned" [42].

In addition, within especially protective forest sites (EPFS), in particular along the banks of rivers, navigable and main canals, and lakes and water bodies (bank protection forest sites), principal logging is prohibited (Order of Special Use of Forest Resources, 2007 [39]).

In the Carpathian region, clearcut logging aimed at formation and improvement of forests in bank protection forest sites is prohibited, except for the management of solid windbreaks and plantations totally affected by pests and diseases (Principal Logging Rules in Mountain Forests of the Carpathians, 2008 [40]).

4.2. FLOODPLAIN FORESTS

Only some management aspects have been developed for the floodplain forests of Ukraine.

In particular, according to Article 80 of the Water Code of Ukraine (1995) [12], in order to protect the water level of small rivers, it is prohibited to reduce the natural vegetation and forest cover of the river basin, to plow floodplains, to use chemical agents within them, and to provide land sites in river floodplains for construction (except for hydrotechnical, hydrometric, and linear structures), as well as for gardening and horticulture. Thus, forestry in floodplains is not prohibited.

According to Article 2 of the Water Code of Ukraine, land, mining, forest relations, as well as relations regarding the use and protection of flora and fauna, territories and objects of the nature reserve fund, atmospheric air, exclusive (marine) economic zone, and the continental shelf of Ukraine, arising in the course of water bodies use, are regulated by relevant Ukrainian legislation.

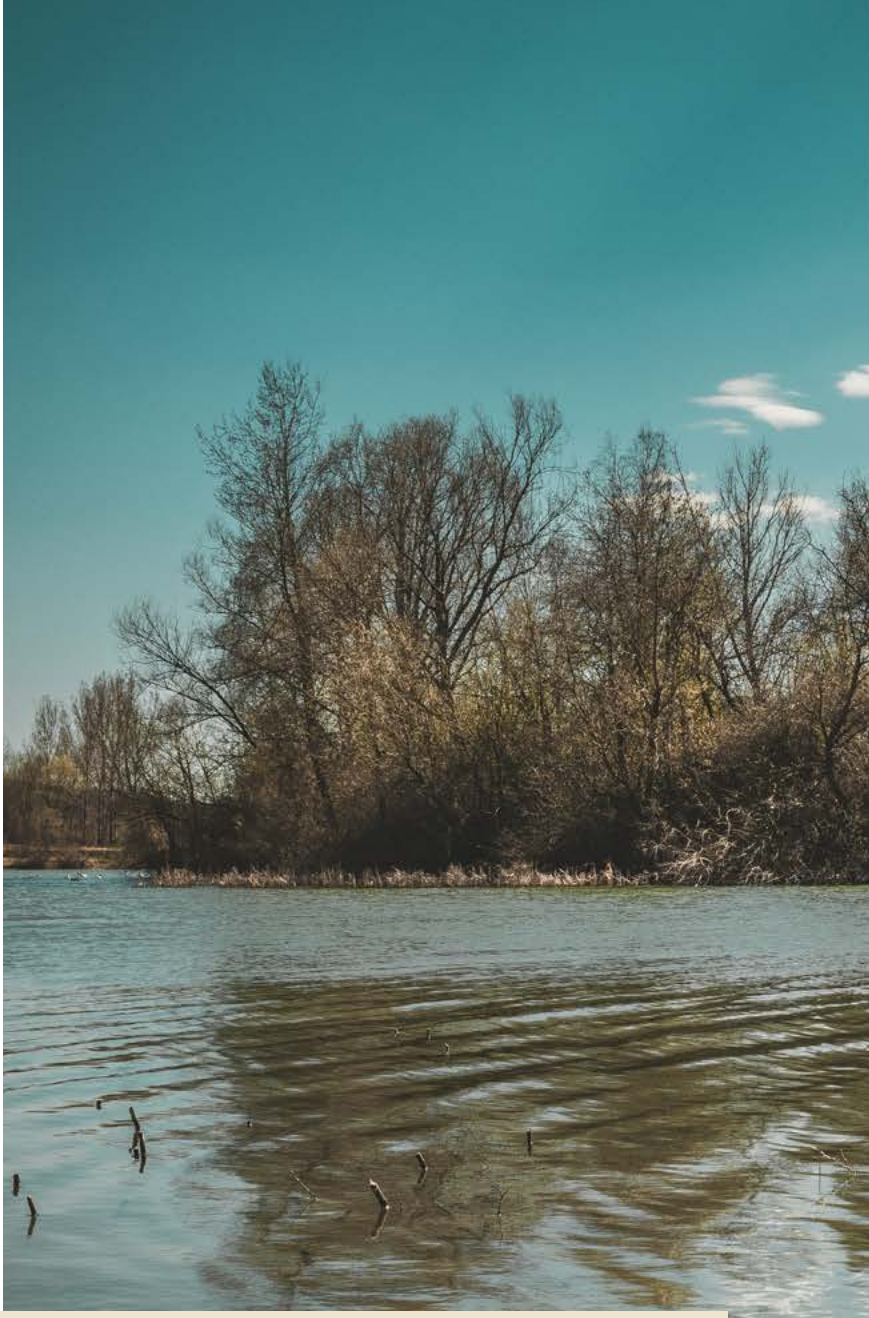
The Land Code of Ukraine (2002) [19] does not in any way mention floodplains or forest plantations and does not refer to the regulation of forest relations by the relevant legislation of Ukraine as the Water Code does.

4.3. WET AND SWAMPY FORESTS

There are no special legal acts that limit forest use in wet forests in Ukraine. For example, the Instruction on Forest Management (2006) [20] says nothing about wet forests.

Certain regulatory aspects of forest use in wet forests of Ukraine are considered in various documents. These include the restrictions established by the Principal Logging Rules [42] and the Principal Logging Rules in Mountain Forests of the Carpathians [40].

Restrictions on forest use in wet forests have been introduced in certain regions of Ukraine and by certain SFEs. Most of these restrictions, such as the exclusion of wet sites from the annual allowable cut, are caused by economic impracticability of exploitation of wet forest sites rather than the desire to preserve the landscape and biological diversity. Herewith, the crucial factor is that it is impossible to transport the felled wood along the marshy roads since the construction of roads to the logging sites in wet conditions, combined with the low productivity of stands in wet and very wet infertile and fairly infertile pine site types, make the exploitation of such felling areas unprofitable.



The forest and hunting management in regions with the largest areas of wet forests is conducted in two ways.

THE FIRST APPROACH is used by the Rivne Regional Forestry and Hunting Administration. At the II forest management meeting in 2019, at the request of the Administration's management, a joint decision was made with forest managers, according to which sites of wet pine and birch forests (hygrotopes 4–5) were excluded from the annual allowable cut for all jurisdictional SFEs. These are oligotrophic and mesotrophic forest swamps. For example, within the Project for Forestry Organization and Management in Dubensk SFE (Irpin, 2019) [44], the part on the company's annual allowable cut states: "Based on the II forest management meeting, pine and birch sites located in wet and very wet conditions are excluded from the annual allowable cut (hygrotopes 4–5), as well as alder sites located in very wet conditions (hygrotope 5)."

The Zhytomyr Regional Forestry and Hunting Administration (RFHA) uses **THE SECOND APPROACH.** At the regional level, the issue of limiting forest use in wet forests, in particular at the II forest management meeting in 2018, was not considered. However, such restrictions were introduced in some SFEs — some of wet forest sites were excluded from the annual allowable cut. For example, in Zhytomyr SFE, restrictions on forest use in wet forests (exclusion from annual allowable cut) have been partially introduced in recreational forests and fully in protection forests. However, there are no such restrictions in exploitation forests where exclusively clearcut logging is planned.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In most SFEs of Zhytomyr RFHA, the situation is similar. For instance, in Malyn SFE only pine forests (3.5 hectares) were excluded from exploitation forests in wet conditions; instead, clearcut logging was planned in birch forests in wet conditions (8.0 ha) and aspen forests in wet conditions (9.0 hectares).

In all cases, in the wet forests of the Zhytomyr RFHA, only clearcut logging was planned, the technology of which did not fundamentally differ from dryland forests logging. In wet forests, they cause significant damage to lower vegetation layers, forest litter, and soil to the depth of 25–30 centimeters, even if logging takes place in winter. Thus, the plant community is completely destroyed and the upper soil horizons are strongly damaged.

The analysis of environmental impact assessment (EIA) conclusions made by the Ministry of Natural Resources of Ukraine during 2020 and their comparison with annual allowable cut data developed by forest management companies for specific SFEs revealed a number of inconsistencies. In particular, EIA conclusions state that "in swampy areas of forest types B_5, C_5, D_5 logging is prohibited" [6,7,8,9,10]; however, forest managers included part of the management sections within the listed site conditions in the annual allowable cut. Moreover, some SFEs, especially in northern Polissia, have an A_5PS forest type, where clearcut logging is allowed according to respective EIA conclusions. Herewith, this type of site conditions requires significant conservation measures.

A large share of wet forest sites in Ukraine, especially alder and complex ash-oak-alder forests, are considered exploitation forests. As the research demonstrates, forest management in these forests does not differ from forest management in dryland forests, and within principal logging, clearcut logging is mostly planned and used.

Herewith, planning of other types of principal logging in wet forests is limited by several factors:

- high water levels in soils;
- low density of peat-swamp soils;
- low logging mechanization in Ukraine, namely lack of aggregate multi-operation forest logging/ harvesting machinery with a boom (such as LP-19 logging machine), which could minimize the number of equipment passes through the logging site, preserve the undergrowth of tree species, and generally have a much smaller negative impact on biological diversity.

5. ANALYSIS OF FOREIGN RIPARIAN FOREST MANAGEMENT

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5.1. MANAGEMENT PRACTICES: POLAND

According to the legislation of this country, riparian forests belong to the same-named category of protection forests. However, in practice, specific norms governing these forests management include such provisions:

- In a 10 meters wide strip along watercourses, lying trunks of trees, understory, and large stones are left (to facilitate the migration of animals and their access to the water body).
- Wood hauling using watercourses is prohibited.
- Clearcut logging is not used near watercourses, springs, and swamps [57].

The requirements for such forests management are also set out in the national FSC standard; in particular, measures to minimize negative environmental impacts of forest management activities should be applied in forests with moist site conditions (criterion 6.1.3); moist site conditions should be treated with particular precaution to prevent their damage and disturbance of water balance (criterion 6.1.4); the start and end times as well as the methods of forest management activities should consider local natural conditions and humidity of forest sites (criterion 6.1.6).

In wet, bog, and riverine forests, rules established by the national legislation for these types of forests should be followed while age and species differentiation should be considered in the course of their regeneration (criterion 6.3.2). Exploitation of bog and fen forests should be avoided whenever possible (criterion 6.3.3). Buffer zones with at least double tree height wide should be left along watercourses and water bodies; clearcut logging should be prohibited in such zones (criterion 6.5.6) [58].

According to the data provided by Polish NGOs representatives, in practice riparian forests often lack active intervention while in some regions have internal regulations for state forest management. However, the process is not centralized. The analysis of satellite images demonstrates that, in fact, intervention is mainly lacking on strips of several tens of meters wide along the water bodies.

5.2. MANAGEMENT PRACTICES: SLOVAKIA

According to Slovak law, forests belong to one of three categories: (1) protection forests (usually forests in extreme conditions), (2) special purpose forests (recreational, water protection, etc.), and (3) commercial forests [59].

These forests are identified individually; however, there no clear criteria for the identification of special purpose forests, including riparian ones [60]. There are clear criteria only for the identification of protection forests in extreme conditions.

However, the forest law prohibits clearcut logging and gradual felling within special purpose forests protecting water bodies. In some cases, other types of logging may be also prohibited — the decision is made for each forest individually. The Slovak Flood Protection Act also declares prohibition of “poor” forest management in the flood zone [61].

Also, the legislation of this country stipulates that logging restrictions within all protected areas having forestry restrictions may cause an increase in the number of pests and outbreaks of diseases. Therefore, forest users can claim compensation from the state for the implementation of forest protection measures that have no commercial value within a radius of 500 meters from protected areas.

5.3. MANAGEMENT PRACTICES: CZECH REPUBLIC

Czech legislation on riparian forests is very similar to Slovak one. It also declares the need to identify water protection forests but such forests are managed individually.

Within the Natura 2000 territories, management of riparian habitats mainly focuses on preserving or regenerating the natural species composition of stands. The management plans analyzed do not establish prohibitions or restrictions on clearcut or other logging.

The national FSC standard provides for the following. Wetlands, streams, ponds, watercourses, and lakes are considered to maintain and enhance their biodiversity, as well as regenerate their functions in the future (criterion 6.2.4). Intervention into riparian stands can be carried out only if necessary and within the limits of river basin management (criterion 6.3.16). In alluvial plains of permanent watercourses and ponds, no clearcut logging should be carried out on strips with a width equal to vegetation height (criterion 6.3.17) [62].

5.4. MANAGEMENT PRACTICES: ROMANIA

Romanian legislation provides for a separate category of water protection forests. The management of such forests is regulated by the management plans of respective forest users [63].

Moreover, by-laws provide for a very large number of various subcategories of protection forests [64].

However, according to the data provided by Romanian NGOs representatives, this does not actually result in any restrictions on logging in commercial forests. This conclusion is confirmed by the analysis of satellite images of forests along the large rivers in Romania. For example, areas adjacent to large rivers, including those that are close to the water, have traces of clearcut logging of different years.

In protected forests, the situation is different. Within the Natura 2000 territories (in Romania, as in other countries, they largely coincide with the protected territories at the national and local levels), most riparian forests belong to the habitats of Resolution 4 of the Bern Convention. Therefore, forestry measures within them require separate assessment of their impact on the Natura 2000 territories and they are often prohibited or limited to clearcut logging in small areas.


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5.5. MANAGEMENT PRACTICES: LITHUANIA

The Lithuanian Law on Protected Areas introduces the concept of coastal protection zones [65]. Such zones, depending on watercourse area or length, can vary from 100 to 500 meters. On the coast of the Baltic Sea and Curonian Bay, such a zone is 1,000 meters [66].

Clearcut principal logging is prohibited within coastal protection zones. Sanitary logging of "bad" plantations, including clearcut ones, is of course allowed, which is provided for by the law.

Within protected territories, management is allowed on an individual basis, but established restrictions should be also considered (for a strict protection zone, there is an almost complete ban on forestry activities). For the Natura 2000 territories, there are management plans in only 5% of cases.

The national FSC standard stipulates that river banks are one of the priority criteria for inclusion in representative areas where economic activity is significantly limited (criterion 6.5.4) [67].

5.6. MANAGEMENT PRACTICES: BULGARIA

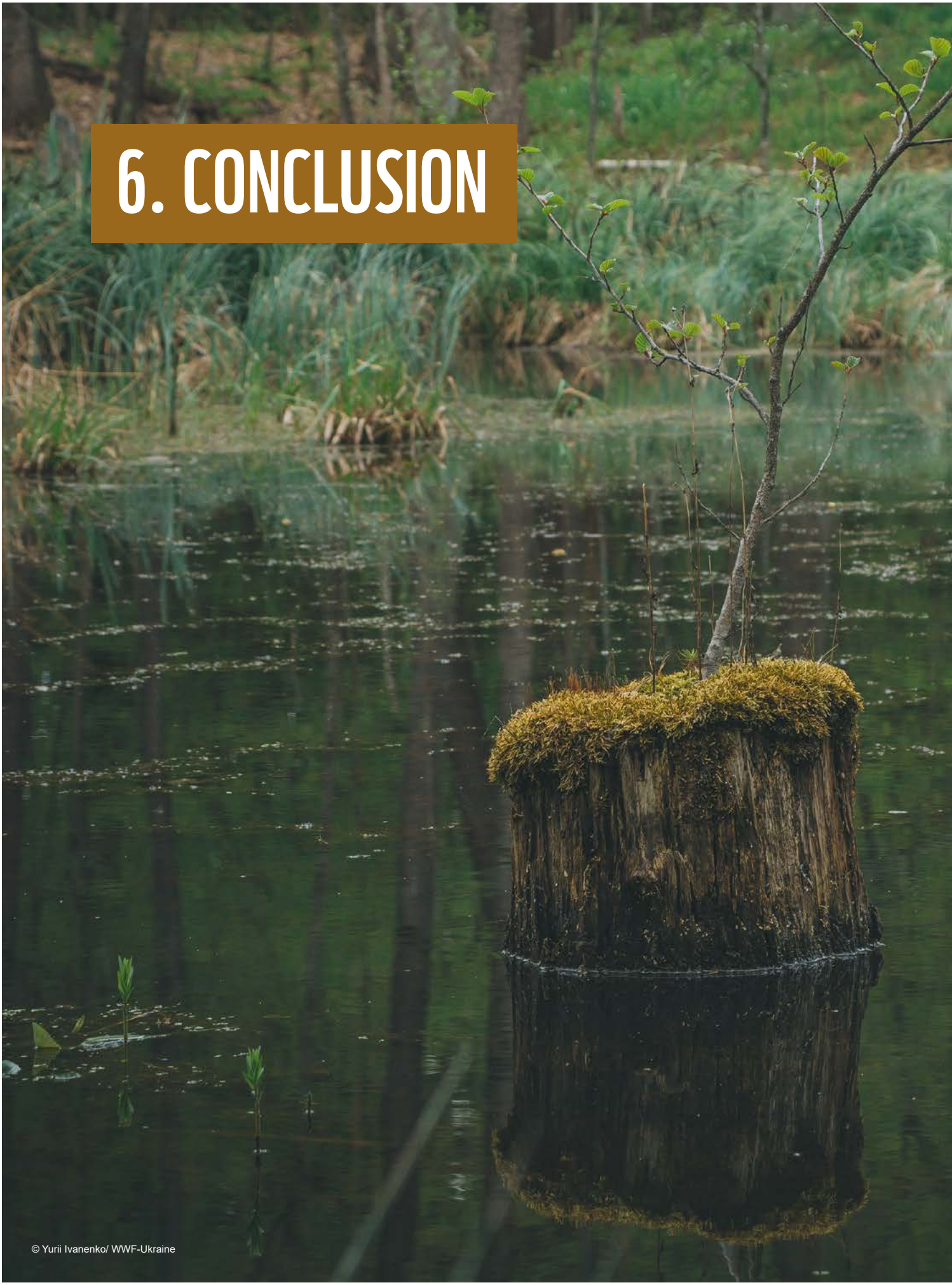
Within protected areas, floodplain forests are protected most strictly — only the removal of dead and dangerous trees is allowed there. Bulgarian forestry legislation defines all stands near water bodies as forests. However, without proper forest and land management documentation, they can be considered separate trees. Logging regulations establish a protection zone of at least 15 meters wide along permanent water bodies (with the exception of artificially created plantations). For them, the rules are the same as for protected areas.

In addition, there are 100 meters wide buffer zones along large rivers and 50 meters wide buffer zones along medium ones. For these zones, the maturity age of oak plantations for shaping logging has been increased.

Within the Natura 2000 territories, logging restrictions (varying from a total ban to intensity regulation) are applied in floodplain forests depending on habitat types. It is also required to leave at least 8% of dead wood during sanitary logging [68].

The national FSC standard provides for the following: along permanent watercourses and water bodies, 15 meters wide buffer zones should be formed, where logging is prohibited or where logging intensity may not exceed 50% of the wood stock; after logging, there should be no open spaces with a diameter greater than 10 meters; dead and dying trees are removed only if they endanger human life and health or impede the river flow (criterion 6.7.4) [69].

6. CONCLUSION



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1.

Riparian forests have specific types of site conditions. They play an important role in maintaining biodiversity: a large number of rare plant and animal species, as well as rare habitats, are concentrated in such forests. Therefore, when planning management activities in riparian forests, their natural features should be considered.

2.

Most swampy forests are concentrated in Polissia, and floodplain forests — in the Left Bank Ukraine. However, official statistical data are available only for the forests managed by the State Forestry Agency. There is currently no data on the areas of riparian forests beyond the forest fund and their use.

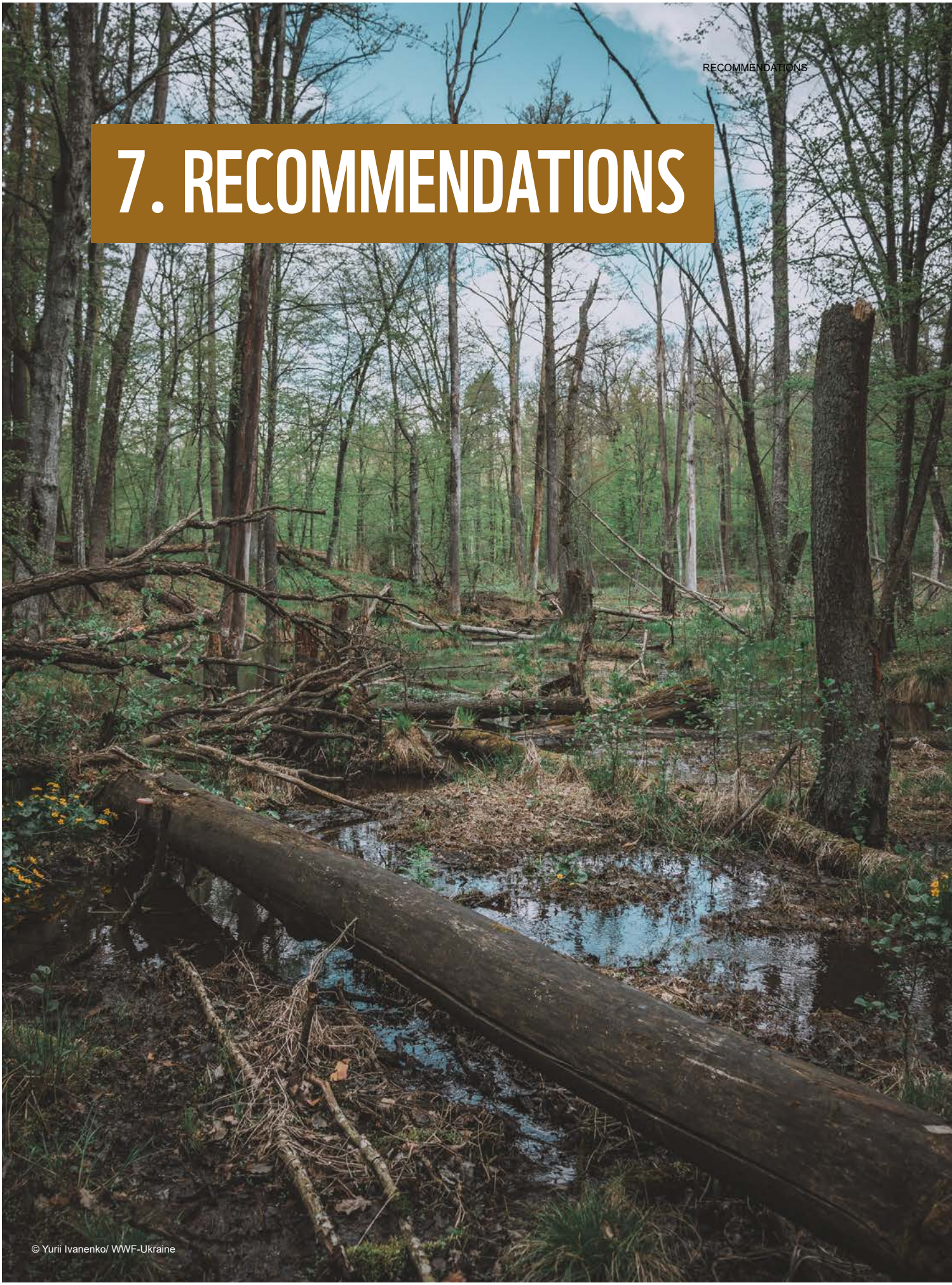
3.

Riparian forests are hardly considered in the legislation of Ukraine, and therefore the peculiarities of such forests are disregarded in management. In order to improve the management of riparian forests, they should be included in the legal framework, in particular in the Forest Code of Ukraine, relevant by-laws, as well as other state documents that regulate the use of natural resources.

4.

The European integration of Ukraine requires adaptation to EU legislation and environmental practices, in particular the introduction of a habitat-based approach. Therefore, it is important to consider Central and Eastern Europe countries having experience in managing riparian forests and their maintenance, in both national legislation and national FSC standards.

7. RECOMMENDATIONS



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Management of riparian forests should enhance the most effective performance of their ecological, economic, and social functions. Therefore, recommendations for the balanced management of such forests can be divided into two groups: (1) maximum limitation of economic activities (non-interventional management) and (2) optimization of economic activities where it is impossible to introduce restrictions (active management).

7.1. NON-INTERVENTIONAL MANAGEMENT

The major tool for limiting economic activities is the creation of nature conservation areas. The strictest protection rules and maximum restrictions apply to the nature reserve fund sites. SFEs having an FSC certificate also identify high conservation values (HCV) of category 3. This category provides for the protection of the most valuable and rare habitats, activities for which are determined according to the features of each of the habitats and can aim only at the latter's maintenance and/or enhancement. In addition, the habitat-based approach is used in the course of identification and zoning of the Emerald Network territories.

Non-interventional management should be primarily used for the most rare and vulnerable habitats, the share of which in the forest fund is insignificant and where partial restrictions of economic activities provide no desired effect. For example, the use of gradual felling and selective logging in very wet site conditions A_5–D_5 is impossible and impractical since logging equipment gets deeply stump in peat-swamp soils, which turns the territory of the habitat, where a certain method of logging is applied, into an impassable and partially forested zone with a hilly-swampy microrelief; moreover, biological diversity is significantly lost. For some of the other habitat types listed in Chapter 4, especially forests older than a hundred years, non-interventional management should be used as well.

Another tool for limiting economic activity is the exclusion of wet sites from the annual allowable cut. Given the uniqueness of riparian forests, as well as the threat to their existence in severely disturbed habitats, they should be identified as a separate category of forests in need of protection or, in the course of forest fund inventory, separated into "floodplain forests" and/or "swampy forests." This will improve forest management measures in floodplain forests and help obtain more accurate information about their current state in the course of forest management and monitoring [52]. This is especially relevant for site conditions A_4–D_4.

The introduction of restrictions on economic activities in most HCV forests should be preceded by the submission of scientifically justified proposals and comments regarding EIA reports and participation in forest management meetings, FSC-certification audits, etc.

7.2. ACTIVE MANAGEMENT

7.2.1. Principal Logging

Logging is a measure of forest tending and a method of wood harvesting. In the next few years, it is proposed to leave clearcuts with narrow felling areas as the major logging method. The width of the felling area in willow and alder plantations in all natural zones should not exceed 50 meters. In the plantations of other species in steppe floodplain landscapes, it also should not be wider than 50 meters, and in the forest steppe and Polissia — no more than 100 meters. Logging direction should be against the river flow, coupe direction — at a right angle to the channel, and logging season — winter.

An important criterion for principal logging is plantations maturity age. Logging age should be differentiated by the site class or groups of homogeneous forest types and should be aligned with the creation of management sections. The creation of management sections in oak plantations should consider oak origin (seed or vegetative). For the floodplain plantations in which principal logging is not prohibited, optimal maturity age is provided in table 6.

Table 6.
MATURITY AGE OF FLOODPLAIN PLANTATIONS.

Dominant species	Site class	Polissia, forest steppe	Steppe
Common oak, seed	I and >	151–160	121–130
	II	131–140	111–120
	III and <	111–120	91–100
Common oak, vegetative	II and >	111–120	91–100
	III and <	81–90	71–80
Common ash	All classes	81–90	71–80
Birch, black alder	All classes	61–70	61–70
Aspen, gray alder	All classes	41–50	41–50
White poplar	All classes	36–40	36–40
Other poplar species, tree-like willows	All classes	31–35	31–35

Principal logging should be aimed at forming natural plantations on the largest possible areas. In alder, white willow, and white poplar plantations, such logging should provide for only natural formation of future stands.

In mixed oak plantations, in the absence of sufficient natural oak regeneration, measures to enhance the latter should be implemented (preliminary logging of understory and weakened trees, loosening of litter, sowing acorns, leaving seed trees on stumps, etc.).

In case of insufficient natural regeneration of the major species, forest crops should be planted from stumps. During regeneration of the most valuable oak plantations on much larger areas, oak crops should be regenerated by sowing acorns.

A constant decrease in the share of major species plantations of natural origin (especially oak ones) simplifies their population structure, impoverishes the gene pool, and reduces biological diversity. In order to stop these negative processes, it is necessary to provide for selective and gradual principal logging, as well as combined logging on at least part (no less than 10%) of the areas. Such logging should be primarily carried out in mixed oak plantations of seed and vegetative origin of various ages.

In wet forests, especially alder and mixed ash-oak-alder forests, two- or three-stages gradual principal logging can be carried out. They can be used even under the current low technical support, but only in wet fairly fertile site types (C_4AG) and wet fertile site types (D_4AG), provided there are dense, organo-mineral soils that freeze deeply in winter and create favorable conditions for the passage of logging equipment without damaging the upper soil layers, especially on the snow cover. These soils could be found in such rare habitats as Д1.6.4. Ash-alder alluvial forests, Д1.6.2. Moist and occasionally flooded oak-elm forests, and Д1.7.1. Eutrophic swamps with layer of black alder or birch. However, two- or three-stage gradual logging in wet alder or wet birch forests are insufficiently developed, they are not planned by forest management, and therefore are not used.

7.2.2. Tending Felling

Tending felling in floodplain and swampy forests should help form stable and complex tree stands. In particular, favorable conditions for the development of understory and the second layer should be created in forest strips along the water bodies in the course of tending felling. In the areas of intensive erosion and destruction of banks, large trees and trees with superficially developed root systems washed away by the river flow should be primarily logged.


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TENDING FELLING IN OAK PLANTATIONS.

In pure oak plantations, weeding and cleaning should be carried out from below, and in mixed ones — from above. The first weeding should be carried out without severe damage to the tree stands closure. Shrubs and secondary tree species that suppress seed oak and ash should be cut down. Coppice shoots of oak, ash, and other species that suppress viable seed specimens of oak and ash should be cut down completely or significantly thinned during the first tending. The second weeding is recommended after 2–4 years, depending on density.

The first crop cleaning should be carried out at the age of 11–15 years by cutting down the accompanying species that suppress oak growth and by thinning its rows. Dense communities of seed oak and ash should be also thinned. Herewith, it is necessary to adjust and keep the ash admixture of up to 2–3 units. In the steppe zone, the upper story should be mainly formed of oak. In crops where pure oak rows are mixed with rows of accompanying species and shrubs or with pure rows of shrubs, shrubs and accompanying species that suppress oak growth should be removed while its rows should be uniformly thinned.

In mixed oak crops, in the course of thinning, simultaneously with taking care of the quality of trunks and the shape of the crown, it is necessary to remove unwanted species and oak coppice that suppress the trees of seed origin. The formation of the second story started in the course of cleaning should be continued while keeping the admixture of wild fruit species.

In natural oakeries, during thinning, it is necessary to continue tending of the oaks of seed origin by freeing them from suppression by secondary species and coppice specimens of oak and ash. In the course of such felling, dense communities of seed oak should be thinned, and the second story should be formed from accompanying and secondary species — Norway and field maples, linden, hornbeam, pear, and in the steppe — from Tatar maple and tall shrubs.

In coppiced oak stands, during thinning, coppice shoots of oak, ash, and other economically valuable species should be tended. Depending on their diameter and the overall closure of the tree stand, 1–3 trunks should be left on stumps until the thinning age. The second story should be formed from undergrowth and stunted oak trees.

In the course of thinning, it is recommended to thin dense communities of oak and secondary species so that there were gaps between the tree crowns to create conditions for natural regeneration of oak and other forest-forming species. Trees of the second story should be maintained regardless of the species and quality of trunks. Their logging is appropriate only for sanitary purposes.

TENDING FELLING IN ASPEN PLANTATIONS.

Significant thinning is not allowed during weeding in dense plantations. In the young stands with a significant admixture of oak, ash, maple, linden, and spruce, it is advisable to tend these species.

Cleaning in pure plantations should be carried out by uniform thinning of the tree stand while in mixed plantations the admixture of economically valuable species should be freed from suppression by aspen.

In the course of thinning in pure plantations, the best aspen trees of the upper story in communities should be tended. Trees affected by aspen bracket should be removed. In mixed plantations, in addition to the best aspen trees, economically valuable species should be tended.

During thinning in pure plantations, tending of the best aspen specimens should be continued, and in mixed plantations, the share of economically valuable species should be increased.

TENDING FELLING IN BLACK ALDER PLANTATIONS.

In pure plantations of coppice origin, weeding assumes thinning coppice shoots while leaving 5–6 shoots on stumps. If there are seed specimens, they should be tended. In the course of cleaning, the number of shoots should be reduced to 3–4 per stump. Dense areas of alder of seed origin should be also thinned.

In mixed black alder young stands, during weeding, it is recommended to free communities and single seed trees of alder and other economically valuable species from suppression.

In the course of cleaning, the greatest attention should be paid to tending of alder specimens of seed origin and economically valuable species.

During thinning, it is necessary to continue thinning of alder coppice shoots and focus on tending of trees of seed origin as well as of the admixture of economically valuable species. Coppice shoots should be thinned to 1–3 shoots depending on stump diameter. The best trees of economically valuable species should be used to form the upper story. Dense communities of seed alder should be thinned while leaving small gaps between the tree crowns. If an alder plantation has shade-tolerant species or tall shrubs (viburnum, bird cherry, or alder buckthorn), it is necessary to form the second story and an understory.

In the course of thinning, the number of coppice shoots from one stump should be reduced to 1–2 shoots. It is also necessary to thin dense communities of alder of seed origin and to thin alder in rows. The ratio of other species in plantation composition should be regulated: the share of admixtures of fast-growing light-loving species should be reduced while the share of economically valuable ones should be increased.

TENDING FELLING IN POPLAR PLANTATIONS.

In forest crops, thinning of young stands should be carried out oftener, but with less intensity. In mixed crops, it is necessary to thin poplar in rows and cut part of the trees that suppress it. Overgrown shrubs should be also removed.

In the course of weeding, one best trunk should be left on the stump in coppice plantations. In order to reduce the probability of fresh wounds being inhabited by clearwing moths, tending should be carried out in autumn. When canopy closure in rows increases, it is recommended to carry out the second tending involving uniform thinning of the tree stand and elimination of intertwined tree crowns.

During cleaning in forest crops with narrow row spacings (1.5–2.0 m), logging should be carried out in a linear-selective manner with logging of every second row.

In the course of thinning, tending of the best trees of the upper story is optimal. In plantations of several poplar species, preference should be given to the more valuable ones, but trees of other species should not be removed completely. An admixture of the best trees (up to 30%) of other fast-growing species (alder, willow, etc.) should be left. The trees of less fast-growing species (elm, maple, linden, etc.) should be used to form the second story.

It is recommended to continue tending of the best poplar trees and other species during thinning. Through thinning, stand density can be reduced to 0.6.

In natural stands, there are individual specimens or areas of gray poplar (a natural hybrid of white poplar and aspen). In the course of tending felling, gray poplar should be given preference.

TENDING FELLING IN WILLOW PLANTATIONS.

In coppice plantations, weeding and cleaning should be planned in case of excessive density or presence of seed specimens that are suppressed by coppice ones. Depending on the tree stand structure, logging should be carried out either evenly on the entire area or only in dense areas. In the young stands of heterogeneous origin, willow seed specimens should be freed from suppression by partly cutting down the coppice. In the course of tending of seed specimens, individual coppice shoots can be completely cut. To ensure high-quality formation of trunks, they should be cleaned of boughs. In order to prevent over-moistening or weeding, low intensity cleaning should be carried out.

Thinning should be planned in dense stands. In mixed plantings, the best trees of other fast-growing species should be left. Shade-tolerant species should be used to form the second story. Plantings of coppice origin require partial cutting of saplings in coppice shoots.

In coppice willow stands, thinning should be planned if there is a large number of coppice with poorly developed crowns on stumps, as well as if they have seed specimens suppressed by coppice shoots.

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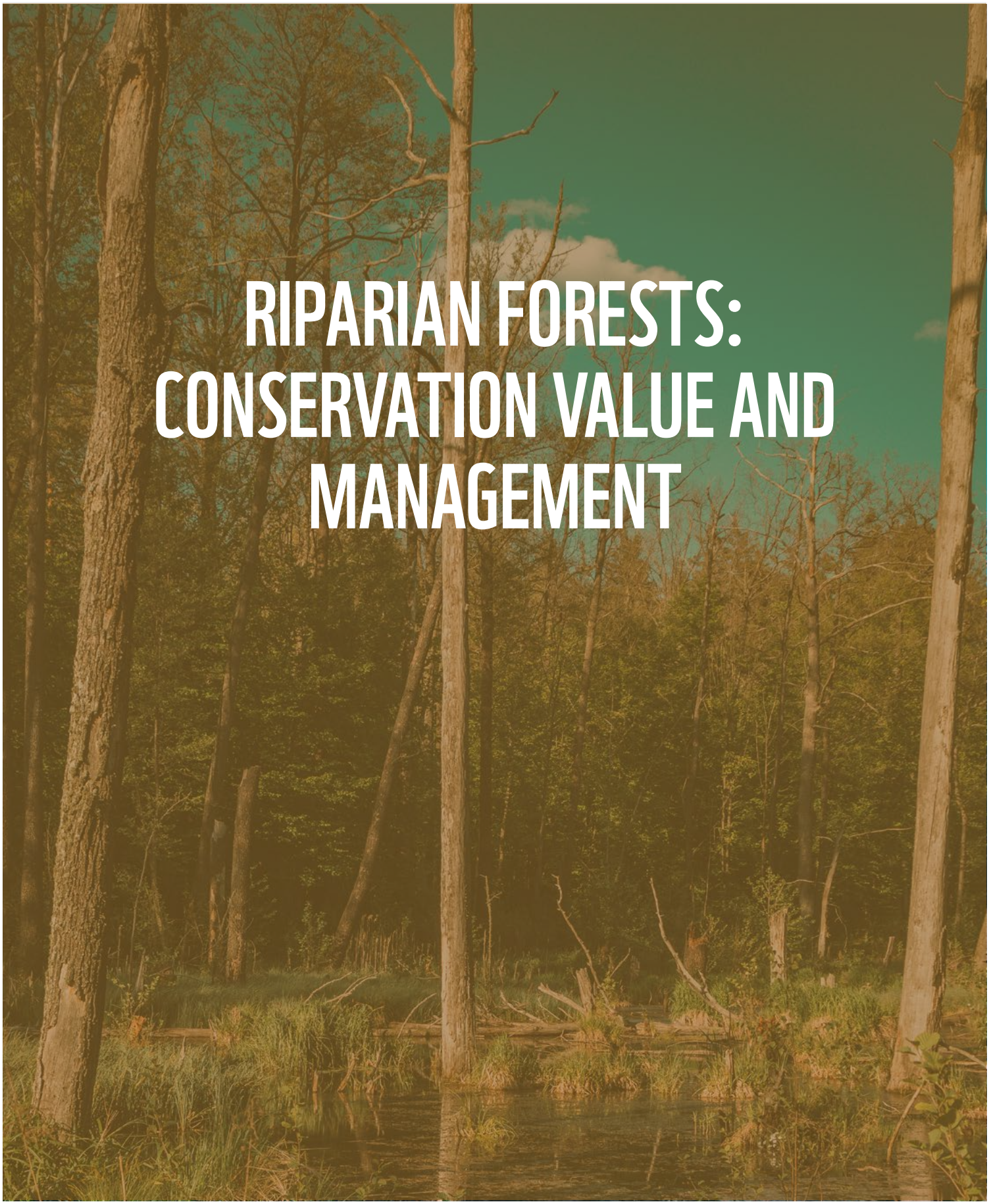

RIPARIAN FORESTS: CONSERVATION VALUE AND MANAGEMENT

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