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Improvement of draining waterbodies to create de novo habitats in black stork feeding areas

The overview was prepared as part of the BALTCF project 15.11.2018/051S17 „Freshwater health control through Black Stork perspective"

2022

Contents

Introduction

The number and quality of feeding sites are of decisive importance for the survival and reproduction of the species. Experts have assessed the deterioration of the quality of the feeding grounds as one of the main reasons for the decline in the productivity of the Estonian black stork population, and thus also in the number of the entire population (Rosenvald and Lõhmus 2003). The black stork feeds in various biotopes in Estonia - from fishponds to plowed fields (Lõhmus & Sellis 2001), but mostly in watercourses. Studies on river fisheries have identified a significant negative impact of dams and river dredging on fish stocks, including not only migratory fish, but also resident fish species. These activities have reduced the diversity (and biomass) of the fish population, not only among local river fish, but also several sea fish that spawn in rivers lose their breeding opportunities (Tambets et al. 2007).

Based on the terms used in land reclamation, in this text waterbodies are divided into the following subcategories according to the formation and development of the waterbody:

1) natural watercourse,

2) heavily modified watercourse, i.e. deepened brooks and rivers,

3) artificial waterbody or ditch.

Natural waterbodies are not part of drainage systems and therefore these waterbodies are not considered in this paper.

These so to say former rivers and brooks, which have been regularly straightened and reshaped for the purpose of land draining, were distinguished as strongly changed waterbodies.

Artificial waterbodies were primarily those waterbodies that were built because of human activity: mainly ditches or canals built during making land drier.

In 2019-2022, Eagle Club/BALTCF project 051S17 "Freshwater health control in the perspective of the black stork" took place and a total of 1187 sections of the waterbodies where black storks could feed were evaluated. The final part of the document analyses the questionnaire data.

Recommendations for land improvement systems were prepared by Tarmo Evestus (Eagle Club).

Black stork food and feeding areas

The black stork's diet consists primarily of small fish. Bird is hunting while actively moving - along brooks, riverbanks, meadows, etc. When catching prey from the water, it is characteristic to the species to create a shadow with open wings. In Estonia, the following are designated as prey: brown and green frogs, tadpoles, lamprey, Prussian carp, ninespine stickleback, three-spined stickleback, minnow, pike, burbot, grayling, trout and crayfish. Frogs are probably the most important prey in spring and fish in summer. At the same time, the composition of the prey depends on both the year and the hunting skills of the individual (Eagle club's data).

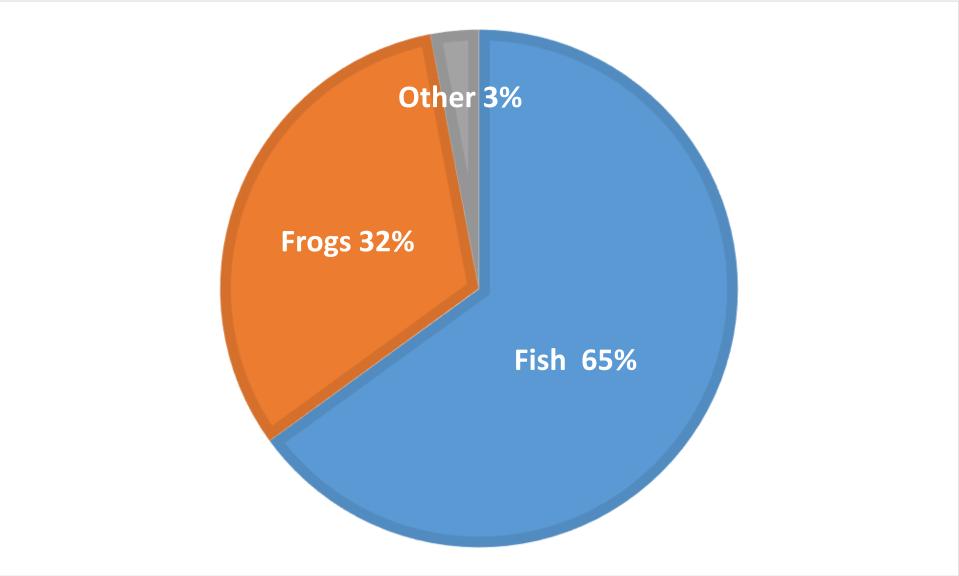


Figure 1. Proportion of prey items in the diet of nestlings of Karula black stork nest in Valga County.

Web camera analysis showed that between 2016 and 2019, the young birds in the Karula's nest had mainly fish in their meals - two out of three meals contained fish. In about one out of three cases, old birds brought frogs. Of the fish, it was possible to determine mainly pike, brook trout, weatherfish, perch, ninespine stickleback, trout and eel (Figure 1). Unfortunately, this does not show the real situation, since mostly only fish with a characteristic appearance can be determined.

According to radio and satellite telemetry surveys, old birds can feed up to 25-40 km away from nests with young. Accordingly, the feeding area of the black stork is up to approx. 1000 km^2. Only 55 percent of fixed feeding sites were located within a 10 km radius around the nest and 89 percent within a 20 km radius (Rosenvald 2011). The farthest feeding sites of the Karula webcam male bird from the nest were up to 30 km away.

The feeding area of the male black stork nesting in Karula was 560 km^2 in 2017 and 580 km^2 in 2018 (Figure 2). The feeding areas of both years overlapped to the extent of 92 percent. At the same time, it should be noted that the particularity of the feeding area of this black stork is that the feeding area is in only one direction from the nest and its size is about 2-3 times smaller than the average calculated feeding area size.

The foraging area of the second male bird in Karula equipped with the transmitter was 680 km^2 in 2017 and 460 km^2 in 2018, but they overlapped to the extent of 95 percent. These are two black storks nesting in neighbouring territories, whose feeding areas overlapped only to a small extent, although the distance between their inhabited nests was 7 km. This placement of two neighbouring feeding areas suggests that black storks are also territorial with respect to feeding areas and avoid feeding on neighbouring feeding areas.

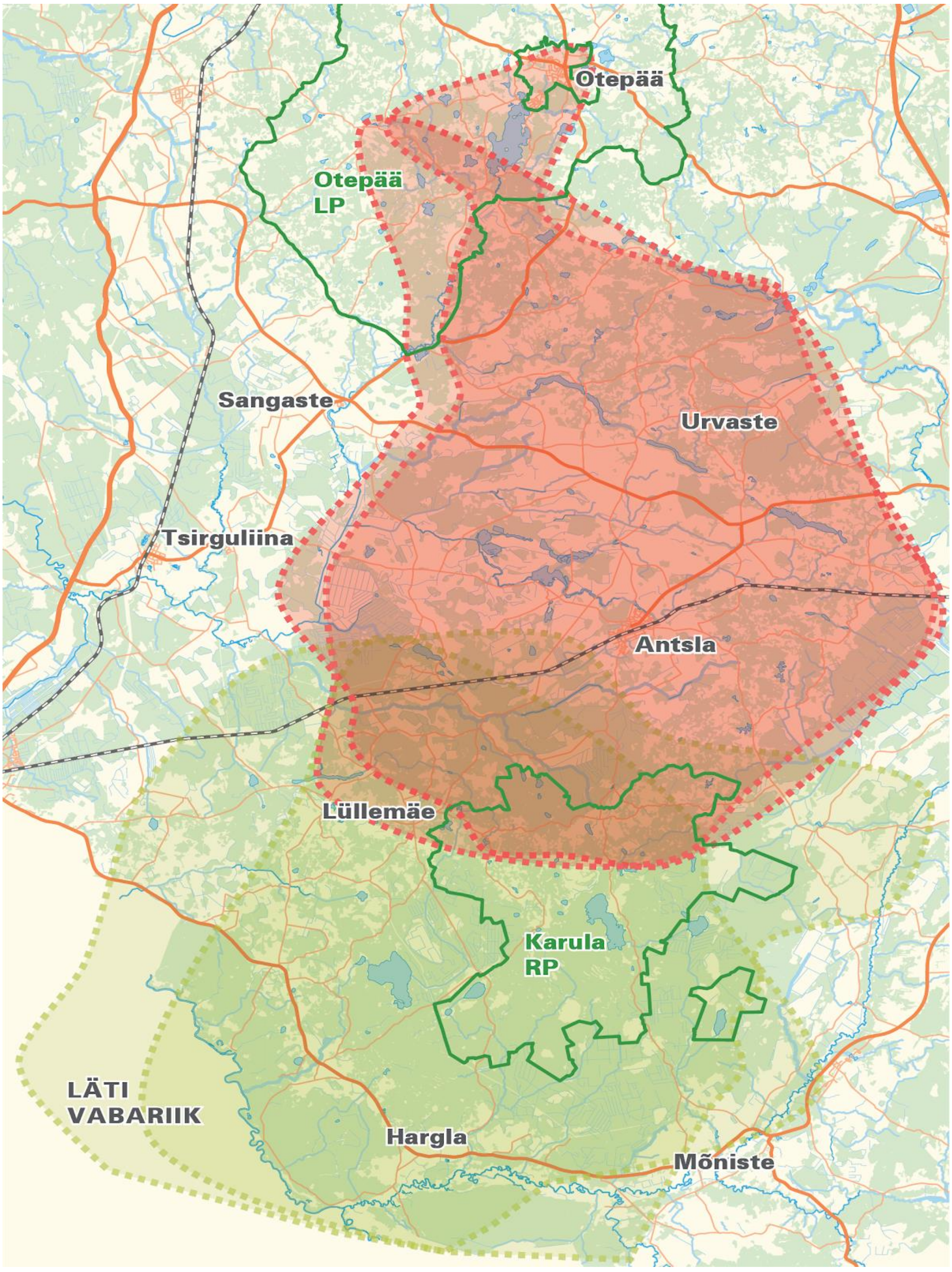


Figure 2. Feeding areas of two black storks nesting about Karula (red is a camera nest and green is a territory of neighbouring nesting area) in 2016 and 2017.

The analysis of the feeding areas of Karula black stork revealed that there are about 1330 km of watercourses and 1270 ponds and 110 lakes in the feeding area of one pair. Thus, there are many feeding places. The main proportion is small ditches (57 percent of the total length) (Figure 3). In their natural state, brooks and rivers make up only one-fifth (10 percent, approx. 140 km) of the waterbodies remaining in the feeding area. This percentage is considerably lower, as the analysis was made based on drainage objects. In addition, the naturalness of the rivers has also been changed by dam building. The largest feeding waterbodies are Väike-Emajõgi, Antsla, Visela and Ärnu rivers and Lambahanna, Restu, Voki and Koigu brooks.

GPS points where storks feed was most abundant in ditches and small and medium-sized recipients (dredged brooks). As a conclusion of the analysis, it can be said that although the strok spent the most feeding times in the ditches, this was due to their large number in the surrounding landscape If look at the options for feeding waterbodies in the landscape surrounding the nest, then storks preferred natural and heavily modified waterbodies (dredged brooks) of different sizes. The results of several years show (in different years the sample includes partially different storks) that ditches are visited most randomly, and natural and heavily modified waterbodies are the sites where birds repeatedly returned.

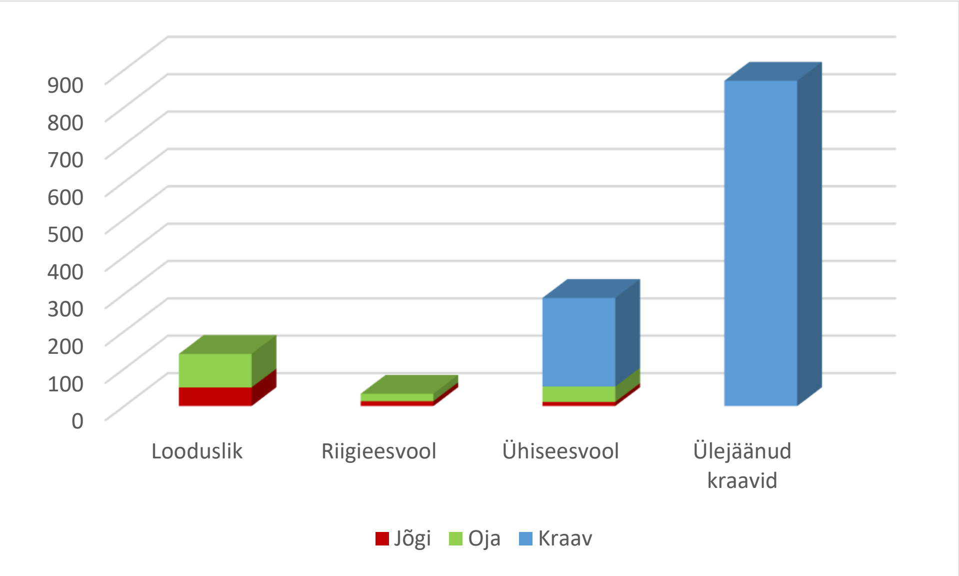


Figure 3. Distribution of watercourses in the foraging area of the Karula black stork. From left to right: watercourse in its natural state, state recipient, other recipients, other ditches. Red – river, green – brook, blue – ditch.

A comparison of all random waterbodies with the waterbodies used by storks for feeding showed that the waterbodies chosen by storks have significantly better access, more stony and clayey bottoms, more transparent water, and significantly less muddy bottoms than random waterbodies. When only ditches were compared separately, the influencing features in the final model were watercourse's width, flow velocity, bottom type, and stork access. Ditches used for feeding were wider than random ditches, had faster currents, better access for storks, and had less grassy or muddy bottoms. Therefore, if during the reconstruction, the variability of the flow speed of the ditches is increased, and if their accessibility is improved (by brush removal) and the muddy sections of the waterbody are cleaned, the quality of the ditches as a feeding place for storks could be increased.

Studies have also shown that natural brooks have a higher fish species richness than dredged brooks and ditches. It turned out, however, that ditches, as completely artificial waterbodies, can be useful for fish to a significant extent. The higher species richness of natural brooks does not depend on "random visitors" but shows their greater diversity and the possibility of providing habitats for several species at the same time (Rosenvald, 2011). Trout and brook trout preferred natural brooks over other types (brook trout also avoided dredged brooks), since for both species the superiority of a natural brook comes from its better transparency and higher flow velocity. Minnows were more likely to occur in waters with higher flow velocity and depth. Stone loach preferred natural brooks and avoided ditches, but when other features were added, waterbody type was no longer significant, and greater depth and faster flow indicated a higher probability of occurrence. Pike preferred waterbodies with greater aquatic plant coverage, and none of the traits were significant for ninespine stickleback and burbot.

Land improvement (drainage) and its impact

Estonia is in a climate zone where precipitation clearly exceeded evaporation (approx. 700 mm per year versus approx. 400 mm per year) in the past. As a result, the rather sparse natural hydrological network of Estonia caused extensive siltation. About half of Estonia's land area is forest land, a one third is agricultural land and a one fifth is covered by swamps and bogs. **To avoid excess moisture, more than half of Estonian agricultural land has been drained. According to the data of the last years, the differences between precipitation and evaporation have decreased significantly, and as a result, it would be essential to critically review the entire drainage network and eliminate as much as possible.** There are melioration systems on 1.3 million hectares of land, of which 0.6 million hectares are agricultural lands and 0.7 million hectares are forestry lands. Most drainage systems were built during Soviet times between 1960 and 1980.

According to Land Improvement Act, land improvement means the drainage or irrigation of land and the two-way regulation of the water regime of soils, as well as soil improvement, agricultural engineering and other work to manage land improvement systems that is done to increase the cultivation value of land zoned for agricultural or forestry use or to protect the environment. The purpose of land improvement is to increase the agricultural or forestry value of the land for the purpose of land use in such a way that environmental protection is also ensured. In the sense of the Land Improvement Act, „*´civil engineering work required to protect the environment' means a civil engineering work required for complying with environmental protection requirements, primarily in order to minimize the risk of the spread of nonpoint source pollution resulting from the use of agricultural or forestry land and to ensure the greatest possible self-purification capacity of the artificial recipient* ". Thus, the Estonian Land Improvement Act deals with environmental protection very narrowly and does not consider all direct environmental risks related to land improvement.

The usability of drained land is determined by the functioning capacity of the regulating drainage network and the size and planned shape of the fields designed with land improvement. The criterion for the good functioning of the regulatory network is a drainage norm of 0.5 m, i.e. a situation where the groundwater level in the area between the drains or ditches is at least 0.5 m below the ground level. In connection with the intensification of agricultural production and the increase in the capacity of agricultural machinery, the drainage intensity has been gradually increased up to 1.55 times compared to the original. Thus, the efficiency of the drainage network, but at the same time the effects on the environment, have continuously increased. The task of forestry land drainage ditches is to quickly drain away surface water to prevent forestry land flooding. Therefore, the normative performance of the system is not so sensitive to the height of the water level in the drainage ditches.

There are many environmental problems related to drainage systems and their maintenance in Estonia. The most important ones are briefly described below:

- Deterioration of waterbodies due to increased sediment load

In Estonia, a large source of pollution of waterbodies is diffuse pollution caused by agriculture (e.g. fertilizing fields and grazing animals, which causes approximately 47 percent of all human-caused pollution) and point pollution. The land improvement system significantly contributes to the rapid spread of nutrients created during agricultural production and forest management, as well as plant protection products in waterbodies. Since the diffuse load spreads only through flowing water, the diffuse load is carried by running water into the recipients of the country and from there mostly into the lake or the sea. Land improvement is also accompanied by an increase in the sediment load, which occurs during the digging of drainage ditches, their maintenance, and because of subsequent geomorphological processes. It is not possible to completely avoid the spread of diffuse load, but it can be minimized by using the environment protecting civil engineering work of the land improvement system.

- There is poor habitat and less biodiversity in and around dredged watercourses and ditches.

Natural brooks are characterized by variable flow velocity, waterbody width and depth, and diverse bottom types. In this way, one waterbody provides habitats for many organisms with different needs. When natural brooks are deepened and straightened, the richness and abundance of fish species decreases. However, it has become clear that ditches can be of significant use to fish. Studies conducted on drainage systems have shown that among the studied amphibians, the common and moor frog preferred to breed in natural puddles, and not in ditches, which were significantly more abundant in drained areas compared to puddles. Reconstruction of drainage systems causes aquatic invertebrates to become more unvaried throughout the drainage system. After the reconstruction, the total diversity of invertebrates decreased by 20 taxa or 10 percent in the ditches and by as many as 48 taxa or 30 percent in the puddles (due to their extensive drying). As a result of ditch reconstruction works, natural small waterbodies are largely destroyed or dry up before the tadpoles undergo metamorphosis. This causes a significant deterioration in the living conditions of aquatic and semi-aquatic species. In British lowland grasslands, macroinvertebrate communities have been shown to differ significantly in regularly cleaned ditches compared to ditches that have not been cleaned after digging, and the latter also had higher numbers of species (Painter, 1999). The more variable the characteristics of the ditches, the greater the species diversity of aquatic macroinvertebrates in the ditched areas (Painter, 1999).

- Degradation of bogs and peatlands

When (re-)constructing drainage ditches in mires to lower the water level, both the water regime of the mires and the natural carbon flow are disturbed. In Estonia, drained forest land currently accounts for 25 percent of the total area of forests. Immediately after the construction of the ditch network, the groundwater level decreases, the duration of floods decreases and water runoff increases, as excess water is drained out of the area by ditches. Soil aeration and organic matter decomposition conditions improve. The nature of soil degradation consists in the deterioration of soil condition and function. The reason is damage and destruction of natural soil and also a human activity. Drainage of peat soils leads to intensive land use and oxidation of peat, both are an important sources of greenhouse gas emissions, because soil organic material breaks down faster.

Practical recommendations for the maintenance and construction of land improvement systems arising from the protection of the black stork

As it was explained above, a large part (40 percent) of the riverbed of the watercourses suitable for the black stork has been significantly changed, and due to land improvement, the water regime of all our natural watercourses has (at least somewhat) changed. Therefore, to survive black stork must adapt to the existing situation and use drainage systems as feeding places. The representativeness of feeding places is determined by three criteria:

a) Abundance of biota, mainly fish and amphibians. At the same time, fish and amphibians depend on the naturalness of the waterbody through the food chain and habitats in the waterbody. The more natural the waterbody, the richer and more numerous the food base of the black stork. However, when developing the recommendation measure, we primarily paid attention to preserving and improving the state of the fish population, since fish are the main food base and source of energy for young birds.
b) The variability of the bottom of the waterbody. Water flow speed and depth are important prerequisites for fish diversity. However, the black stork hunts on the bottom of the waterbody and is therefore more successful in watercourse sections where the water depth is lower or suitable substrate is available. Natural watercourses are characterized by the variability of the bottom microhabitats, and therefore most of them have places that are suitable for hunting for the black stork.
c) Access to water. Large trees or bushes often grow on the banks of waterbodies, which make it difficult for a large bird like the black stork to land on or take off from the waterbody. Therefore, black storks often visit watercourses in old forest which are naturally sparse or newly maintained ditch sections in search of food. It is important to ensure black stork access on large brooks and main ditches.

The following are recommendations for the maintenance/establishment of land improvement systems based on the types of waterbodies.

Recommendations for maintaining a heavily modified watercourse

“Former” rivers or brooks and their sections, which have been deepened and straightened during land improvement work, belong here. These waterbodies are natural recipients. Recipients are divided into a jointly used natural recipients maintained by the State and artificial recipients.

“Jointly used recipient” means an artificial recipient on whose water level or on whose water pipe's water flow capacity the proper functioning of a land improvement system situated on the registered immovables of several owners depends.

- The artificial recipient must ensure the draining of excess water from the drainage network or the flow of water to the irrigation network.
- An artificial open recipient must have the greatest possible self-purification capacity.
- A land improvement system must minimize the risk of nonpoint source pollution.
- The land improvement system must be safe.

Jointly used natural recipient maintained by the State (or *state recipient* here) has a catchment area of more than 10 km2, the maintenance obligation of which can be assumed by the State through the Agriculture and Food Board. The length of natural recipients in Estonia is approx. 5400 km. **All these waterbodies are potential feeding grounds for the black stork. The Eagle Club is ready to provide the PTA with a GIS layer of all the natural recipients that fall into important feeding areas for the black stork.**

The feeding area of the black stork in the Karula region includes the following recipients - Väike-Emajõgi (in several sections), Antsla river, Tsirgu brook, Lambahanna brook, Laanemetsa brook, Ärnu river, Visela river, Restu brook, Leese brook, Haabsaare brook, Luuste brook. Thus, all major waterbodies in the Karula black stork's feeding grounds are jointly used natural recipients maintained by the State. In many of these waterbodies, the Environmental Agency has assessed the state of the waterbody as good. Only Visela and Lambahanna brook are in poor condition, and the pressure factors for these waterbodies are scattered agricultural pollution and drainage. At least 1/3 of the morphological state of all these waterbodies has been changed during land improvement. However, during black stork feeding watercourse evaluation fieldwork, most of them (74%) have been assessed as suitable for the black stork, although a large part should restore/increase naturalness.

One of the most important measures to improve the ecological status of heavily modified watercourses (mainly state recipients) is to increase their naturalness.

The most important thing is to ensure that during the maintenance the curves that are still preserved or that have already appeared are not straightened or deepened. In the most comprehensive version of watercourse restoration, the entire bottom of the waterbody is restored. When dredging rivers, the goal has generally been to achieve as uniform fall as possible. However, from the point of view of aquatic life, efforts should be made to maintain and increase the variability of flow rates. The meanders in restored watercourses cause a slight decrease in the flow rate and thus the drainage effect, while contributing to the improvement of the ecological condition of the waterbody. The restoration of the (old river-) bed is initially like straightening in terms of its consequences, but over time the waterbody and its fauna will return to a close to natural state. The shape (curvature), depth and bottom profile of the riverbed can be changed. For this purpose, bottom overflows, and mini rapids (stones, gravel, etc.) can be placed at the bottom of the waterbody, based on the nature of the bottom of the waterbody. In addition to creating faster-flowing sections using wooden deflectors, reconstruction could dig deeper sites (which try to mimic natural deep points or sections), especially in faster-flowing ditches or dredged brooks, such as bends, where flowing water keeps it clean. Restoration also includes opening the ends of old rivers, allowing fish to spawn in these suitable sections. When opening the ends of old rivers, the idea must be based on the principle that only a third of their number can be opened. Unopened old rivers are a favourable habitat for amphibians and invertebrates.

The partial restoration of historic brooks or the addition of only stones and gravel to fast-flowing sections also has a significant positive effect. The water flow upstream of these sections slows down and downstream accelerates, increasing the diversity of habitats and thus the diversity of species. In natural conditions, fallen tree trunks have an important place as a source of food and shelter for life. Underwater wood also increases bottom diversity.

Formation a two-level flow bed also has a positive effect. The goal of morphologically diverse bed is a variety which comes from a narrow, winding, stony low-waterbed and a wide, straighter high-waterbed. The shallow waterbed is formed during the removal of the sediment, ensuring some meandering of the shallow waterbed, and leaving or installing boulders, suitable stones, gravel in the bed. If possible, the inner bend of the recipient's large waterbed is treated as flat as possible, or a two-level flow bed is designed in the recipient. The method allows sediment to be removed from the second stage during low water so that it is not carried downstream during removal.

It is necessary to include all remedial works and their capacity in the maintenance plans of jointly used natural recipient maintained by the State and land improvement systems.

A long-term and ambitious biodiversity strategy has not been integrated into the currently valid land improvement system legislation (Land Improvement Act). In the Land Improvement Act, it is necessary to supplement the requirements for the land improvement system. In addition to the fact that the regulating network must consider the water regime of the soil suitable for agriculture or forestry, the environmental effects of the drainage network must also be considered.

In the maintenance of natural watercourses and artificial waterbodies (ditches), the principle must be applied that only those drainage systems are maintained, in which the productivity of land for commercial use is higher than the negative environmental impact associated with the drainage system.

Recommendations for the maintenance/building of an artificial waterbody

· **Ditch extensions** (sediment ponds) are necessary to increase the variety of ditches, providing more diverse and stable habitats, as well as to catch (sediment) sediments during construction and subsequent years in the drainage network. Since the flow speed is lower in them, suspended solids settle in them, and thus a minimum amount of sediment gets into the head currents. Due to the greater depth, water is preserved in the extensions even when the ditches dry up. Ditch extensions must be built in mineral soil to avoid collapsing down the ditch slopes. Therefore, during the reconstruction or renewal of ditches, they should be established in fresh boreal, fresh boreo-nemoral forests, and paludified forests, and their establishment should be avoided in minerotrophic swamp forests, ombrotrophic bog forests and drained peatland forests. The dimensions (especially the depth) and the number of ditch extensions are specific to the species group – lower and warmer water extensions (depth up to 30 cm deeper than the bottom of the ditch) are suitable for amphibians and insects, deeper ponds are suitable for fish. From the point of view of black stork feeding areas, ditch extensions of various sizes are suitable.

· **Stands on banks and buffer strips.** The purpose of trees on the banks is to prevent transfer nutrients to the ditches, inhibit the overgrowth of waterbodies with aquatic plants and reduce erosion, provide food source to aquatic organisms, and create favourable living conditions for organisms. A dense stand inhibits the growth of vegetation in the bed, and its absence, on the contrary, promotes the growth of plants. The stand is preferably designed on the sunny side of the ditches. Designing a stand is also the elimination of some trees and bushes. This is activity that regulates the growth of vegetation in the recipient's bed and lowers the water temperature to some extent. At the same time, it must be considered that open or semi-open waterbodies are more suitable for habitats for amphibians as well as some fish species. Therefore, ditches should also have some sections without trees. Designing the stand in this way also ensures favourable access for the black stork, but at the same time it also provides shade conditions for the fearful bird.

· **Beaver dams and other flow obstacles.** The impact of the beaver dam on the operation of the land improvement system and the ecological condition of the waterbody is multifaceted. On the negative side, in addition to the large-scale prevention of drainage and the blocking the passage for fish, the slope stability of a flooded brook bed decreases by 2-3 times. On the positive side, flooding of beaver dams creates new econiches in the waterbody and increases the abundance of amphibians. In recipients sensitive to damming, the formation of beaver dams should be avoided, and the dams should be eliminated before a large amount of sediment accumulates behind them. It is also important to avoid beaver ponds in areas where water quality is important for certain species. In the case of flowing waterbodies, it is mostly important to ensure the availability of passages for fish to larger waterbodies. Even if smaller watercourses dry up completely during a drought, without dams and beaver dams, fish can repopulate the watercourses after a dry period. A beaver pond does not necessarily damage the land improvement system if the system can withstand from time to time rise in the water level. When eliminating a beaver dam, one must consider how much sediment has accumulated behind it. The dam cannot be opened suddenly, because in this case a large amount of sediments will quickly move downstream, which can damage the habitats there. It would be important to open the obstacle in such a way that the wood material is first removed up to the sediment layer accumulated behind it. The sediments accumulated behind the dam should then be removed, and only as a last step should the wooden material be finally disposed of. With this approach, sediment removal during removing of dam is minimal.

· **Mitigation ponds** are important breeding grounds for both brown frogs and newts. Therefore, recommendations for their establishment are taken from amphibian experts. In addition, mitigation ponds add habitat to several aquatic macroinvertebrates, especially dragonflies, in the drained forest landscape. Unfortunately, however, mitigation ponds do not bring back species lost during ditch reconstruction. Ponds must be built separately from ditches in wetter habitat type groups. Ponds may not be dug in nature conservation valuable sites, instead of springs, habitats of protected species or keystone habitats. Therefore, the locations of waterbodies should be selected together with a nature conservation biologist to exclude the destruction of habitats important for nature conservation. To build ponds, the one should choose lower places that are exposed to the sun as much as possible (e.g. close to forest roads), where water naturally collects and which would probably be destroyed during the reconstruction. For 100 ha of ditched forest land, at least 5 mitigation ponds must be constructed. The ponds should be in clusters, with 3-4 ponds in each cluster, and the distance between the waterbodies should not exceed 200 m. Groups of ponds are necessary for successful breeding of amphibians (Rannap et al., 2009), and 200 m is the distance that most amphibians, incl. newts can pass (Jehle, 2000; Kupfer and Kneitz, 2000). To prevent the shadow of the waterbody and to prevent overgrowth, a 5-7 m wide area around the waterbody must be cut down and uprooted when the ponds are built. Mitigation ponds must have as flat shores as possible (at least the slope of the north bank is preferably no more than 25°) so that during high water in the spring, a floodplain area where the water is low is created on the waterbodies. There the water warms up quickly and is therefore an important breeding ground for amphibians and a rich habitat for invertebrates also develops there. Mitigation ponds must not be smaller than 100 m^2 in size to allow to build a flat shore area. The total depth of ponds should be between 1.5 and 2 m (Rannap et al., 2009). However, the depth of the ponds should be equal to the depth of the ditches to prevent them from being drained by nearby ditches.

Analysis of questionnaires

During the Eagle Club/BALTCF project 051S17 „Freshwater health control through Black Stork perspective" conducted from 2020 to 2021 and total 1,187 sections of the waterbodies where black storks could have been feeding were evaluated. The assessed sections were generally divided into three equal groups - natural brooks and rivers that are not part of land improvement systems (hereinafter natural brooks and rivers) (37%), state recipients (32%) and other recipients and ditches (31%). All assessed state recipients were built from former natural rivers and brooks.

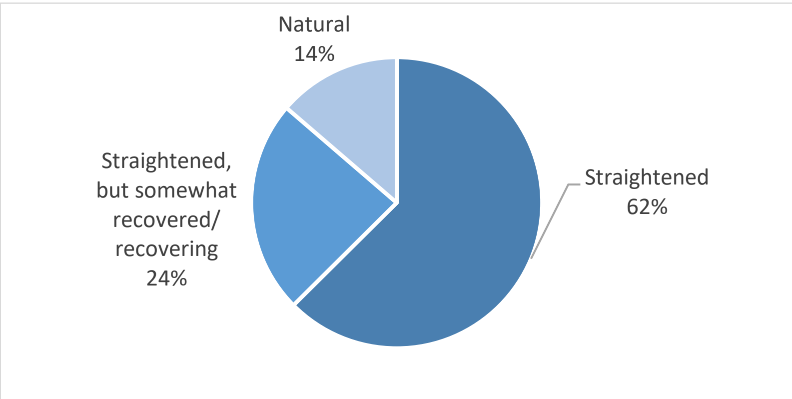
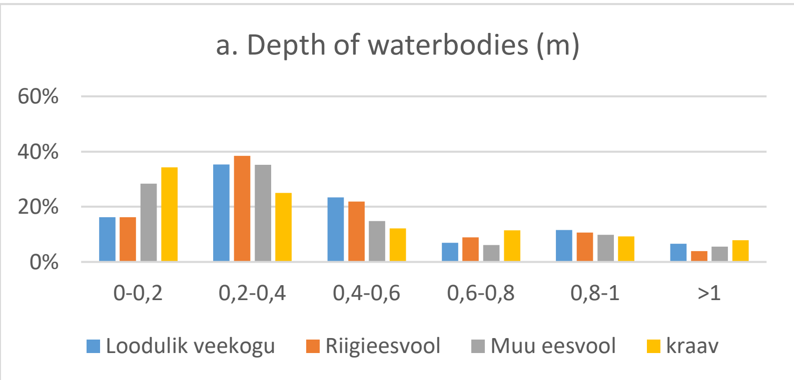


***Figure 1**. Distribution of sections of assessed waterbodies according to their natural or non-natural status. Natural status - 14%, straightened - 62%, straightened, but meandering somewhat recovered/recovering - 24%.*

During the inventory, each section of the waterbody was described according to several parameters, but the most important parameters were the natural riverbed (whether the waterbody is straightened or not), flow speed, water transparency and average depth. A comparison of all these important parameters shows that the three types of waterbodies - natural brooks and rivers, state recipients and other recipients are quite similar.



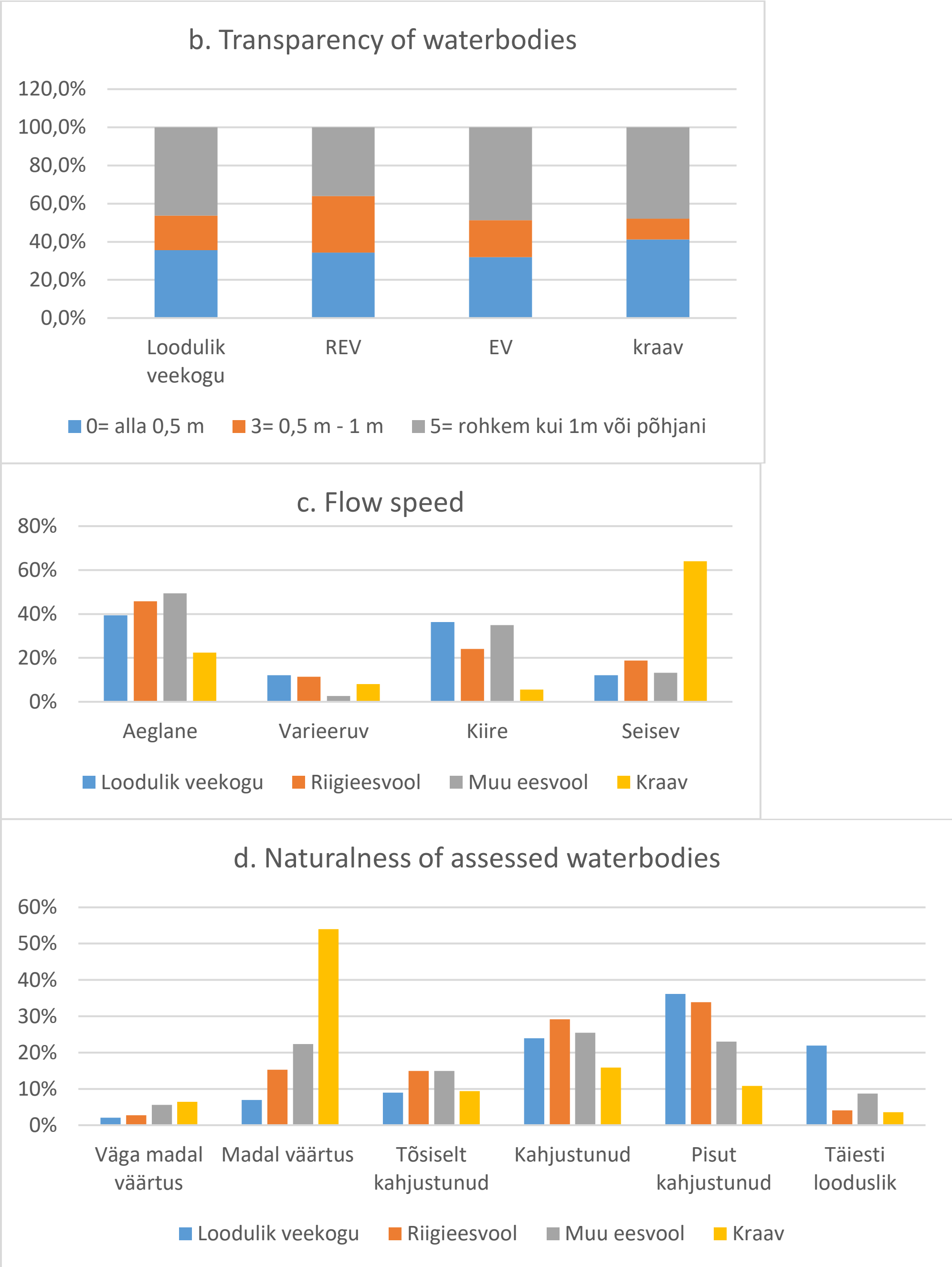


Figure 2. *Distribution of inventoried waterbodies according to a – depth (blue – waterbody in natural status; orange – state recipient, grey - other recipients, yellow – ditch), b – transparency (from left to right: same as previous; blue- less than 0.5m, orange – 0.5-1m, grey – more than 1m or to the bottom), c -flow speed (for colours see a; from left to right: slow, variable, fast, standing water) and d – naturalness (for colours see a; from left to right: very low value, low value, seriously damaged, damaged, a bit damaged, natural).*

From this it can be concluded that many natural brooks and rivers have also been heavily modified, and state recipients and other recipients are, like natural brooks and rivers, important feeding places for the black stork.

During the evaluation, the observers also made suggestions to change the section that was passed into a more suitable watercourse. The proposals for land improvement systems are presented in the figure below. In general, the proposals can be divided into two - conditions that improve access to the black stork and proposals that improve the ecological condition of the waterbody (including fish stocks). The surveyors assessed the most important measure to be the removal of brush, especially in the recipients. In the case of ditches, this measure was not the most important. At the same time, the inventory results show that the access conditions for the black stork were not rated significantly better on ditches than on other waterbodies.

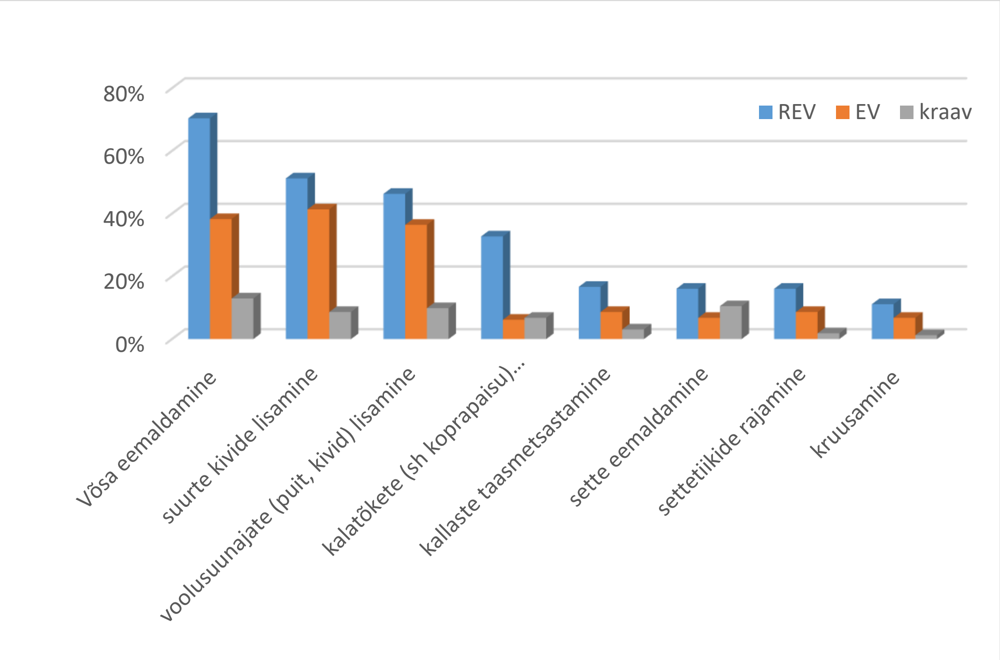


Figure 3. *The inventors' suggestions for improving the condition of the assessed sections. Colours: blue – state recipient, orange – other recipients, grey – ditch. From left to right: removing of brushes, adding big boulders, deflectors, removing obstacles, reforestation, reducing sediment, sediment ponds, graveling.*

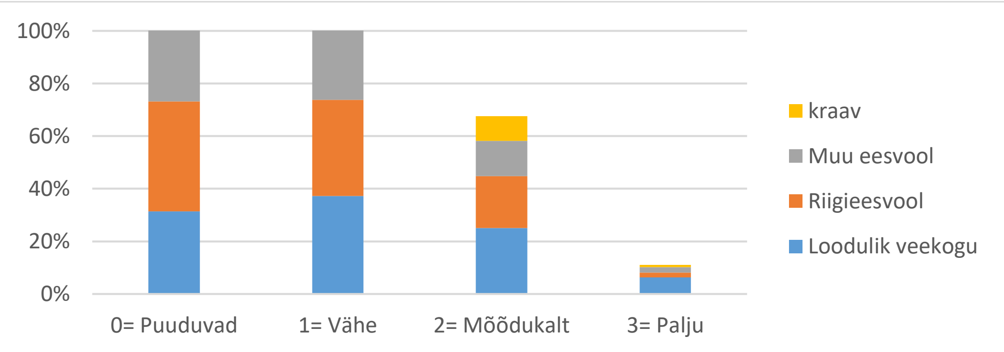


Figure 4. *Inventor's assessment of black stork access to waterbodies. For colours see Figure 3a, c, d. From left to right: 0=missing, 1= few, 2= moderately, 3= a lot.*

It is noteworthy that during the inventory, it was found that the fish were spotted the most in the recipients. There is a high probability that they are present in most natural brooks and rivers, but because there are more shelters and the water level is often deeper, the fish simply could not be spotted. As expected, the least number of fish were found in ditches.

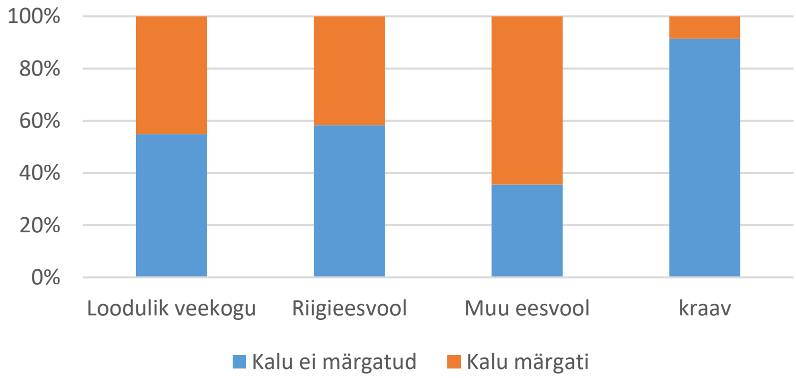


Figure 5. *Registration of fish in different types of waterbodies. Colours: blue – fish was not registered, orange – fish was registered. From left to right: natural waterbody, state recipient, recipient, ditch.*

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