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THE EFFECT OF REGULATING STREAMFLOWS ON THE BEAVER HABITAT IN CROATIA

UTJECAJ UREĐIVANJA VODOTOKOVA NA STANIŠTA DABRA U HRVATSKOJ

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Abstract

Beaver adjusts well to all the changes in its habitat on condition that food and water is provided throughout the year. In some cases beaver inhabits areas with very few food resources.

The fact that beavers unexpectedly choose some quite unusual habitats to settle on was in fact the reason for doing the research on these seemingly marginal habitats in the first place.

Although in Croatia there is a fair amount of well preserved habitats, some smaller stream flows are permanently being regulated, and that's which has to a higher or a lesser degree diminished their natural quality. In order to establish the real effect of stream flow regulation on the beaver habitat, research was made on 9 rivers in Central Croatia and it consisted of fieldwork and mapping the stream flows. As a control method we used topographic maps 1:25.000 and satellite photos provided by Google Earth.

938 km of stream flows were inspected on 9 km of rivers. It was recorded that natural vegetation covers 70% of those stream flows. 18% of stream flows were previously regulated (leveling beds, building dams etc.), but, due to ecological succession, herbaceous and ligneous vegetation - which we named "successive vegetation" - recovered and made it possible for the beaver to inhabit those terrains once again. On those parts of stream flows, beavers are commonly present, but there is also a danger of them getting hurt or forced out beacause of the stream flow regulation that periodically takes place.

Some time after the stream flow regulation, beavers cannot settle on those terrains because they have no vegetation. The stream flows that are regulated every year, cannot be inhabited by beaver at all.

Instructions that can be given to the company that conducts the stream flow regulations are not to remove the vegetation directly on the banks or inside the 5m perimeter. That would provide the conditions for the beavers, birds and other semi aquatic animal species. It would also prevent water temperature from rising and enrich the water with oxygen. Those instructions are being partly accepted, but in the future they should be applied on the majority of regulated stream flows.

Key words: Beaver, streamflow regulation, vegetation, protection of habitat, population density

Sažetak

Dabar se dobro prilagođava svim promjenama u staništu, pod uvjetom je da čitave godine osigurana voda i hrana. U nekim slučajevima obitava na ekstremno siromašnom području kada je u pitanju izbor hrane. Upravo odabir staništa i nastanjivanje dabrova na nekim neočekivanim područjima ponukale su na istraživanje dabra u naizgled marginalnim staništima. Iako Hrvatska ima očuvana staništa, neki manji vodotoci su pod stalnim meliorativnim zahvatima čime je bitno smanjena ili u potpunosti devastirana prirodnost tih vodotokova.

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Da bi utvrdili stvarni utjecaj na staništa dabra, pa i na same familije koje su već nastanjene na pojedinim lokacijama, izvršeno je istraživanje prirodnosti staništa na 9 rijeka središnje Hrvatske. Istraživanja su vršena obilaskom i terenskim kartiranjem vodotokova a za kontrolu i kao pomoćna metoda kod planiranja i provođenja terenskih istraživanja služile su topografske karte 1:25.000 te satelitski snimci Google Erth programa.

Na 9 rijeka ukupno je istraženo 938 km vodotokova. Na istraženim vodotocima utvrđeno je 70 % prirodne vegetacije, odnosno u cijelosti očuvanih prirodnih staništa. Na 18 % tokova izvršena je ranije melioracija (uređenje vodotoka, izravnavanje korita, izgradnja nasipa i sl.) ali se prirodnim putem (sukcesijom) vratila zeljasta i drvenasta vegetacija, koju smo nazvali sukcesivna, jer se prirodnim procesom sukcesije vratila vegetacija i na taj način stvoreni su uvjeti za obitavanje dabrova. Na takovim dijelovima vodotokova česta je prisutnost dabrova, ali je i stalna opasnost od protjerivanja ili stradavanja, jer se ti dijelovi vodotoka periodički ponovno čiste od vegetacije i uređuju.

Nakon uređivanja vodotokova određeno vrijeme nema uvjeta za dabrove jer nema ni vegetacije (dok se ponovno ne razvije) a na dijelovima gdje se svake godine čisti vegetacija, trajno je „sterilno" područje za dabrove.

Sugestija poduzeću koje gospodari vodama, da se ostavlja vegetacija neposredno na obali i do 5 metara uz obalu, kako bi ostali uvjeti za dabra, druge semiakvatične vrste, ptice močvarice, kako bi se spriječilo zagrijavanje vode i vršilo obogaćivanje vode kisikom, djelomično je prihvaćeno i na nekim dijelovima se primjenjuje, ali bi to trebalo primijeniti na vučinu vodotokova koji su već uređeni i koji se održavaju čišćenjem vegetacije u inundacijskom pojasu.

Ključne riječi: *Dabar, uređenje vodotoka, vegetacija, zaštita staništa, gustoća populacije*

INTRODUCTION
UVOD

Beaver habitats are well known and defined by the fact that beaver belongs to the semi-aquatic animal species. Hence, water surfaces rich with green succulent vegetation are the most suitable habitats for beaver, because they before all provide food but also peace and shelter.

Regarding the wide array of plant species beaver uses for food in the vegetation period or in winter, when the major part of its menu consists of soft broadleaves' bark, beaver inhabits a wide area of suitable biotopes. Beaver is well adjusted to environmental changes, provided that food and water are available throughout the year. In some cases, it also inhabits extremely poor habitats regarding food. Due to its relatively modest habitat demands, which the animal itself arranges in order to enhance living conditions, as well as high reproduction capacity (Heidecke 1983, Heidecke et al, 2003) provide this species with an advantage when inhabiting new areas. Beaver's ability to adjust to different habitat conditions enabled successful reintroduction in the greater part of Europe (Weinzierl 1973, Reicholf 1976, Zahner et al., 2005, Grubešić 2008). Watershed of the river Sava is one of the areas where three spatially divided projects of beaver introduction were successfully carried out (Grubešić et al. 2001, Grubešić et al. 2006).

Immediately after the beaver's return to Croatia, a dynamic spreading of beavers through the rich network of confluents commenced, even at a remarkably large distances in very short periods (Grubešić 2008).

The search for new habitats is the reason why beavers inhabited some unexpected areas (Grubešić 2008). Certain locations of beavers' families triggered the research of causes for migrations to larger distances and inhabitation of apparently marginal biotopes. These "marginal" biotopes in the middle part of Croatia are primarily the results of human activities regarding streamflow regulation and maintenance.

Similar problems for beaver, but also with beaver, in the inadequate habitat conditions are known in the areas where beaver is present long since and in greater numbers (Schwabet et al. 1994, Maier 1994, Zahneret et al. 2005). The influence of men on beaver habitat and the environment which

they inhabit is the conflict that lead towards the disappearance of beaver from the major part of Europe (Zahner et al. 2005), and with its reappearance it is actual again.

Together with the monitoring of beaver population in Croatia, there is also a need for the monitoring of natural state of certain habitats, especially confluents inhabited by beavers.

MATERIALS AND METHODS
MATERIJALI I METODE

For the purpose of this research and analysis, streamflows from the central part of Croatia which comprise the watershed of the river Sava were used.

The following confluents were taken into analysis: Kupa, Glina, Odra, Mrežnica, Korana, Lonja, Česma, Pakra, Ilova, Dobra and Krapina. During the field research, and in regard to beaver habitats recording and mapping of their distribution, these streamflows were analyzed and recorded on their specific parts according to the state they were in regarding the natural environment. Streamflows were divided into three categories regarding they natural look, i.e. the extent of the anthropogenic influence. Certain segments of streamflows were defined based on the following criteria:

- Segments of steramflows which remained intact and withstood natural appearance, where there were no regulations of river bed, shores and the littoral, i.e. which maintained their original course, natural shores and original - pristine vegetation inside the streamflow as well as on the shores and the surrounding area (min. 15 metres far from the shore).
- Streamflow segments under anthropogenic influence where some regulation has been carried out, shores and dikes were constructed, but in time succession took over the shores and the littoral area covering them with vegetation, shrubbery and trees which are very similar to the original ones (succulent plants of swamp and humid habitats, soft broadleaves' trees and shrubs), so that there is an impression of an almost original habitat.
- Segments of streamflows under anthropogenic influence where regulations were carried out, shores and the littoral part are arranged and (at least annually) grass mowing, succulent vegetation and trees and shrubbery removal is being conducted alongside the streamflow.

For certain parts of streamflows, their length and state of the flow, shores and the littoral area were observed and recorded.

For the purpose of habitat mapping, standard maps in proportion 1:25.000 and GPS equipment were used to state the positions of transition points and distances of certain parts of springflows. All the streamflows and specific situations were photographed and documented.

As a control method for determining the conditions of specific segments of springflows, satellite images from Google Earth application were used.

Collected data base on locations of specific beaver families was used to perform the estimation of the optimal habitat capacities of specific streamflows, i.e. the dangers beaver families may encounter regarding springflow regulations.

RESULTS
REZULTATI

The research was conducted on eleven rivers in total length of 1 186 km, which comprises 95% of the total length of all catchments. Collected data on the vegetation structure are presented in table 1. Cleaning and removing of vegetation is the most intense on river Lonja where more than 40% of streamflow is without vegetation. Almost 100% natural vegetation was recorded on 6 of the researched streamflows (62% of the researched area). These streamflows are the greatest potential for spreading of the beaver population. Apart from the vegetation mapping, a model of beaver population development was also made (presented in Figure3).

Table 1 Confluents researched regarding the type of vegetation
Tablica 1 Istraživani vodotoci obzirom na tip vegetacije

River *Rijeka*	Length *Duljina*	Investigated length *Istražena duljina*	Natural vegetation *Prirodna vegetacija*	Without vegetation *Bez vegetacije*	Succession vegetation *Sukcesivna vegetacija*
		%	km	km	km
Kupa	296	100	291	5	0
Glina	113	95	106	1	0
Odra	50	91	42	0	4
Mrežnica	64	100	64	0	0
Korana	134	100	134	0	0
Lonja	133	92	36	54	32
Česma	123	70	0	17	69
Pakra	72	88	35	9	19
Ilova	85	91	48	11	33
Dobra	104	100	104	0	0
Krapina	75	100	15	11	49
Total *Ukupno*	1249	95	874	108	206

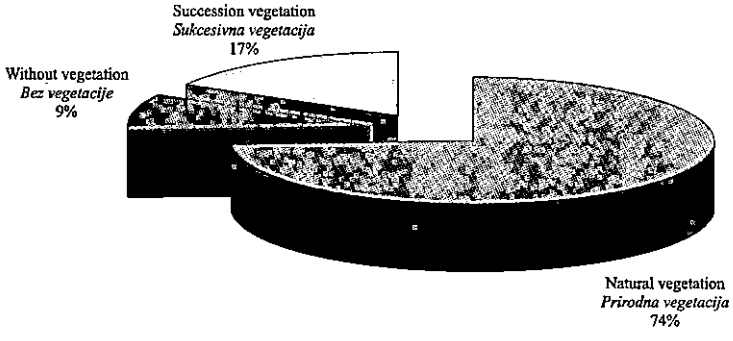

Figure 1 Structure of vegetation on the research area
Slika 1 Struktura vegetacije istraživanog područja

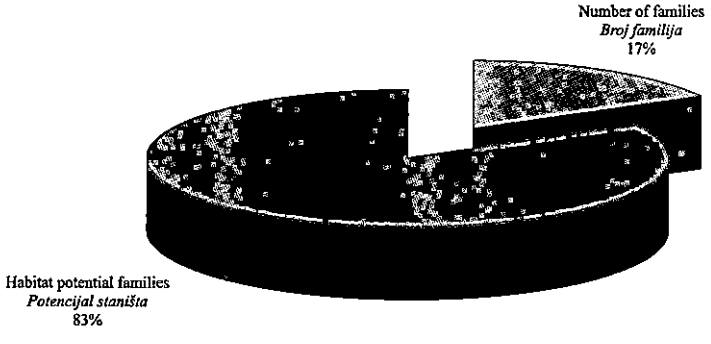

Figure 2 Relation between the temporary state and the habitat's potential
Slika 2 Odnos sadašnjeg stanja i potencijala staništa

DISCUSION AND CONCLUSIONS
RASPRAVA I ZAKLJUČCI

The analysis of 11 streamflows in a length of 1 186 kilometres shows that preserved natural spots with original vegetation are still dominant on shores and littoral areas. This is what enables the further spreading of beavers' families, i.e. filling of the available living space suitable for dwelling of beavers' families.

After the more detailed analysis of the wider area around the researched streamflows, the conclusion arises that the intensity of actions on streamflows coincides with the intensity of utilization of the surrounding surfaces, namely agricultural. Actions for streamflow regulations, construction of dikes and canals and their regular maintenance (grass mowing, shrubbery and trees removal), are the efforts made in order to protect the area from floods and water logging. Unfortunately, these actions also negatively affect habitats of mammals, birds and fish. It is beyond any doubt that preservation or return of the natural vegetation on meliorated parts of streamflows would result in favourable habitat conditions for numerous species, among which is also a beaver. Having in mind the experiences of researchers in other parts of Europe (literature citing) regarding beavers' presence within the agricultural ecosystems, the question emerges whether such localities are at all desirable as habitats for beavers, concerning all the potential damage they can cause on crops and shores, which will also affect the level of tolerance towards this species, shifting the attitude from desirable to undesirable.

Hence, it is beyond any doubt that streamflow regulation affects negatively the natural composition of the same, as well as other water and swamp habitats, but the amount of natural streamflows and their segments where succession brought back the initial vegetation after the regulation took place still provides stability and sufficient space for beaver population, with the possibility of spreading and the increase of population density.

According to the above stated, it is estimated that there is still room for the increased number of beavers, enhancement of the population density within the suitable parts of streamflows as well as colonization of confluents, oxbow lakes and other water surfaces with permanent water and a quality food basis.

According to foreign findings (Meyer et al, 2006), the estimation is that the optimal number of beavers for the researched streamflows is approximately 310 families, which is almost five times bigger number than at present.

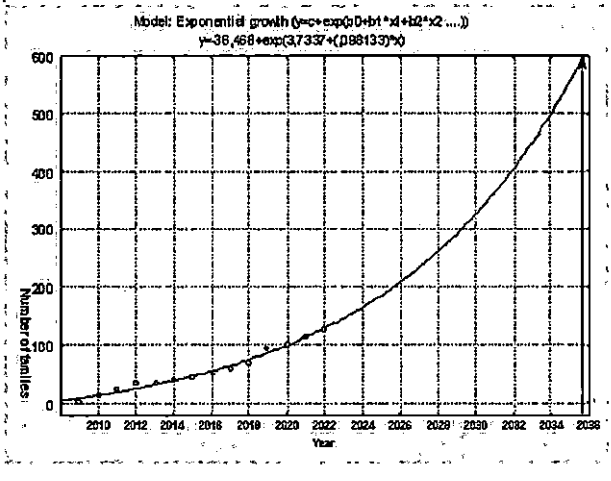

Figure 3 Model of beaver population development on the research area
Slika 3 Model razvoja populacije na istraživanom području

Based on the present research, the conclusion is that a population doubles in the period between 3 to 4 years, which means that 14 years remain until the habitat reaches its full capacity (Figure 3).

Measures required for protection of beavers and their habitats

Potrebne mjere za zaštitu dabrova i staništa

Having in mind that it is impossible to stop the regulation of streamflows, which is highly justified in some cases (flood prevention); it is essential to conduct regular activities regarding the informing and education of staff in water management companies. In the first place, contacts must be maintained with the competent staff and managers who decide when, where and what will be regulated and agree on protection measures for beaver families which inhabit the areas planned for regulation. It is also important to spread the information to the executive chiefs and machine operating staff who implements the streamflow regulation operations, especially mechanics who operate the machines, because the greatest danger a beaver may encounter is to be squashed by a machine while seeking logical refuge inside its den. It is recommended to exclude areas with dens, dams and increased beaver activities from such regulation operations, unless they are necessary for other water management objects.

Despite of wide regulation operations on streamflows, which were conducted on several places without the increased danger from floods or other negative consequences of the increased water-level, there is a great chance that such sites could in perspective be "returned" into the state of suitable habitats not only for beaver but also for the rest of the semi-aquatic species as well as swamp birds and the fish fauna.

Hence, in some regions (e.g. Žutica), where beaver colonisation was conducted in Croatia and the surrounding area, the agreement with the water management sector was reached, and even partially realized, to leave vegetation alongside shores of water management objects (canals, streams, oxbow lakes) and in the zone of 5 metres from shores. This resulted in several positive effects, for instance:

- preservation of the original shore vegetation as well as the natural features of the streamflow
- on parts of streamflows which are already regulated, alongside shores and in the littoral, succulent and wooden vegetation grows which is in its composition very similar to the vegetation which grows on natural habitats (succession of vegetation)
- food, shelter and reproduction space for semi-aquatic species and swamp birds is ensured
- The vegetation prevents overheating of water in summer, thus providing more favourable conditions for organisms which live in the water.
- Alongside the streamflow, there are various obstacles (fallen trees, branch piles and soil) that generate waterfalls which enrich the water with oxygen and also purify it (halt solid substances that the water carries).

In cooperation with the respective ministry for nature protection, the strategy for the regulation of streamflows, priorities and the extent of operations must be agreed, since it is not always necessary to completely remove the vegetation from a streamflow and the surrounding area under the excuse of proper functioning of a streamflow or a canal.

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*** Google Earth 2008