Chapter 15.

LANDSCAPE LEVEL HABITAT SELECTION BY BEAVERS AND THE LONG-LASTING EFFECTS OF BEAVER SETTLEMENTS

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Introduction

Here, we consider habitat selection by beaver (Castor fiber) as well as document some effects that long-lasting beaver settlements have on their habitats. The main area under investigation is the Unzha river, an important tributary of the Volga River, which is the largest catchment area in European Russia. Beaver settlements were found in various rivers, streams, former river-bed lakes, and irrigation canals but they were not found in the main channel of Unzha River. These aquatic habitats differ in length, width and depth. We have conducted observations in this area since 1977 and this rather long observation period reveals that some places are more attractive to beavers than others. There are places where beavers appear repeatedly, and even when the settlements are exterminated by humans, the beavers return after some time. This suggests to us that some places provide high quality habitats and have characteristics that are attractive to beavers. Our goal here is to quantitatively determine the characteristics of the places along rivers and streams that are particularly attractive to beavers.

The area under investigation is in the district of the Volga-Unzha moraine-outwash-alluvial lowland plain (Spiridonov 1978). The area is slightly hilly, and the slope of rivers at sources and estuaries is 0.5 – 0.9 m per 1 km, while for small streams it reaches 7.5 m per 1 km.

Usually, the height of banks ranges from some cm to 1 m. Furthermore, the lowest parts of the flood plain can be occasionally flooded by the river during summer rains, whereas the more elevated part of the flood plain is flooded only in the spring. The bases
of the terraces are usually 1–5 m above the water level of the stream during flood events. The height of the terraces varies from 3 to 8 m. Beavers were found under different river bank conditions: in deep valleys with steep slopes and in lowlands where it is hardly possible to determine in what direction the river flows. During the spring flood, in the lowest parts, the area is under water, and beavers are then forced to leave their permanent settlements for 2–3 weeks and live near the fringes of the flood. It is during this period they are especially vulnerable to predation from wolf (*Canis lupus*). Here, we tried to determine what type of conditions in the river valleys and streams were more suitable for the beavers during different times of the year. This includes factors associated with the topography of the river and its riparian properties.

In the studied area there are very tortuous streams, as well some which are much straighter. The tortuosity is one factor of importance for the occurrence of beavers in the system. In the meanders of rivers, one shore is usually steep and the other is often much flatter. Below the steep bank, streams are usually deep enough; a condition which is important for beavers looking for a shelter. We evaluated the influence of that parameter on the choice of habitats by the beavers.

The spring discharge accounts for about 65% of the total annual volume of water, so high spring floods are common in the studied area. Where the rivers cross lowlands, this factor is important for beaver mortality, since it forces beavers to be more exposed to predators during flooding events. In such parts, small elevated areas become even more important, and sometimes beavers are able to establish settlements in such locations. On the other hand, the summer–autumn and winter discharges amount to about 25 and 10% of the annual volume of water, respectively (Bolysov and Fuzeina 2001). During these periods, streams are considerably shallower. In very dry years, beavers are not able to elevate the water level by constructing dams, and they have to leave their settlements to find spots with deeper water. As we demonstrated in Chapter 21 a sufficient depth of water (more than 40 cm) is of critical importance for the persistence of beavers. How beavers use shallow streams, and what places they select for dam construction, were important aims of this investigation.

**Methods**

We studied 40 rivers and streams by selecting stretches of river beds of about 6 km in length totalling 247 km. With such a large sample size in such a rugged area, for practical reasons we had to utilize sites that were somewhat accessible. However, we have no reason to suspect that the 247 km of rivers and streams that we studied were not representative of the entire river and stream system. Beaver settlements were also situated at streams, former river-bed lakes, and irrigation canals. We investigated both fairly large rivers, as well as small streams which almost become dry in mid-summer. We used a GPS unit to determine the exact position, and then used topographic maps (with a scale of 1:10000)
in a GIS to characterize relief conditions (width of valleys, steepness of the valleys’ sides, width of flood plains, and tortuosity of streams).

We divided the studied streams into longitudinal sections of equal length (200 m measured straight along the valley in the GIS). For each of the sections we described the characteristics of the valleys, the tortuosity of the stream, and the distance to the nearest tributary. Also, for each of the sections the number of browsed, cut or gnawed trees was calculated (Fig. 1).

To describe the shape of the valleys we made cross-sections of them. The valleys’ profiles represented a continuum from canyons with steep slopes, to lowlands where the rise from water to terrace was very gradual (Fig. 2). The beavers used both the low and high flood plain. For example, the Kastovo River valley represents steep slopes with a low flood plain (a height of 2–3 m), then gradually rises to the high flood plain (5–6 m above the river water level) where there are numerous former river-bed lakes that are filled with water in each spring. The beavers use all parts of the valley. Their trails stretch from the river to the high flood plain lakes. However, in most of the small streams the spring level of water does not exceed the summer level by more than 2 m.

During field research, all signs of beaver activity (lodges, burrows, dams, beaver ponds, cut trees, beaver canals, and marks on trees) were noted and their positions recorded with the GPS. At each occasion we described the forest and vegetation (species

Figure 1. Presentation of tree-cuts and dams in 200-m parts of the rivers. 1 – stream channel, 2 – a histogram indicating the number of cut trees, 3 – shows the location of a dam, 4 – text label for the section and 5 – boundary of each section for which data are presented.
composition, height and density of each forest level). We measured length and height of
dams above stream bottom just before and after the dam, and also 10 and 20 m upstream
of the dam. In order to assess the size of the pond created by the dam, we also measured
the distance upstream of the dam to where current could again be detected.

Statistical analysis was performed by Spearman’s rho and chi squared tests.

Results and discussion

Our measurements suggest four types of valley profiles. 1. Canyons where the flood plain
was less than 50 m. 2. Valleys with a width of the flood plain of 50–100 m. 3. Valleys
with a width of the flood plain of 100–200 m. 4. Lowlands where the valley bed was only
barely recognizable and the width of the flood plain exceeded 200 m. (Fig 2).

Beaver settlements were absent in the Unzha River main canal, probably because
of high spring floods. Here, during spring, floods cover the shores, and the river’s width
reaches 3 km. The beavers can survive only along the fringes of the flooded river. Also,

![Figure 2. Profiles of the valleys: 1. Canyon with flood plain < 50 m, 2. Valley with flood plain, width 50–100 m, 3. Valley with flood plain, width 100–200 m, and 4. Lowland with flood plain, width more than 200 m. In all cases, zero denotes the position of the channel. The x-axis shows distances from the channel (m)](image-url)
along the Unzha River banks, both aspen (*Populus tremula*) and birch (*Betula pendula* and *B. pubescens*) trees are absent. There are plenty of willow (*Salix* spp) shrubs, but in the area under investigation, beavers use willow to only a limited extent. Beaver settlements are found only in the former river-bed lakes of the Unzha River. Parts of shores of these lakes are elevated and are not flooded in spring. Along the shores there are aspen, birch, lime tree (*Tilia cordata*), and oak trees (*Quercus robur*) that the beavers use.

After the 1970’s, a large number of irrigation canals was built in the area (Fig. 3). The irrigation canals are inhabited by beavers where the animals are able to elevate the water up to a safe level and where there is some minimum level of food supply. The beavers usually occupy the parts of the canals that extend across the river flood-plains where there are always some edible trees. However, most parts of the canals extended across terraces and watersheds where pine (*Pinus silvestris*) forests predominate.

In the area there are numerous former river-bed lakes. In all of them we found beaver settlements. However, food resources along the lakes’ shores are soon exhausted and the beavers have to emigrate to the nearest rivers and streams.

Beaver settlements were found in all types of the valleys. Even in narrow canyons we found trees cut by beavers. However, a comparison of frequencies of beaver settlements in different types of valleys (Table 1) demonstrated a significant difference ($\chi^2=115$, $p < 0.001$) between habitats available and selected by the beavers. The animals willingly inhabited the lowlands, and they were plentiful in the rivers with broad valley. In one third of occasions they were found in streams with narrow valleys.

Signs of beaver occurrence were found in all rivers and streams regardless of their width, and in fact we observed beavers in waters with width 0.4–22 m. However, beavers exhibited a selection for sites with wider flood plains (Table 1). Note however, that beavers did not select localities based on stream width (see Chapter 21) and that beavers preferred waters with depths more than 40 cm (see Chapter 21).

![Figure 3. A sample area with rivers (blue) and irrigation canals (green) in the area under investigation.](image)
Closer investigations revealed that shallow waters (less than 40 cm) are unsuitable for the beavers, evidently because the animals can not find shelter from predators (see Chapter 21). The dams were usually found in the localities where the depths were less than 200 cm, and 90% of the dams were found in the river sections with depths less than 150 cm (mean 79±1.6 cm).

The tortuosity of the river sections varied dramatically (the ratio of the straight length to the length along the canal ranged between 0.3 – 1.0, n=298). A small, but significant, negative correlation was found between the presence of beaver and the index of tortuosity (Spearman rho = –0.14, p < 0.04, n=298). This suggests that beaver signs were found more often when the stream was more meandering (and thus in a flatter area). It is interesting that Gorshkov (see Chapter 11) also found a significant correlation between tortuousness of streams in the Tatarstan Republic and the beavers’ choice of habitats. It is obvious that occupying a locality situated a bit downstream from a tributary of the river presents more access to food resources for the beavers, that is along the shores of the main stream channel as well as in the tributary. These regularities are most visible in irrigation canals (Fig. 4). A dam built on the main stream downstream from a tributary elevates the water level in the main canal as well as in the lateral canal.

Table 1. Utilization of valleys with different profiles. Note that beavers exhibited a selection for sites where the width of the flood plain was greater (bottom line).

<table>
<thead>
<tr>
<th>Width of flood plain</th>
<th>&lt;50 m</th>
<th>&gt;50&lt;100 m</th>
<th>&gt;100&lt;200 m</th>
<th>&gt;200 m</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed number of sections</td>
<td>130</td>
<td>71</td>
<td>45</td>
<td>10</td>
<td>256</td>
</tr>
<tr>
<td>% of total no</td>
<td>51%</td>
<td>28%</td>
<td>17%</td>
<td>4%</td>
<td>100%</td>
</tr>
<tr>
<td>No of sectors inhabited by beavers</td>
<td>34</td>
<td>27</td>
<td>27</td>
<td>8</td>
<td>96</td>
</tr>
<tr>
<td>% of all sections in width class</td>
<td>26%</td>
<td>38%</td>
<td>60%</td>
<td>80%</td>
<td>37%</td>
</tr>
<tr>
<td>% of total no sections with beavers</td>
<td>35%</td>
<td>28%</td>
<td>28%</td>
<td>8%</td>
<td>100%</td>
</tr>
<tr>
<td>Habitat preference</td>
<td>0.68</td>
<td>1</td>
<td>1.64</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. Situations of dams in irrigational canals. (Arrows indicate the directions of the water flow).
In most cases, beavers lived in burrows made in banks and we found only 14 lodges. In three occasions we observed attempts of beavers to cover the caves in burrow’s corridors by branches, creating a lodge-like appearance. Only twice we found “kobl”, as beaver huts are named in Russia, above the thick roots of stumps in which beavers made a shelter. Of the 14 observed lodges, five were built in valleys with narrow (< 50 m) flood plains, three in the valleys with broader (50–100 m) flood plains, and six in lowland valleys.

Numerous cutting of aspen trees were found only concentrated in small plots. There were two types of mass cuttings of trees observed. One type was found in lowlands where the beavers were successful in flooding areas with a dam, so that the water came close to an aspen stand (Fig. 5). The second type of mass tree-cuttings was found on the slopes of terraces where the beaver found a stand of young (diameter < 10 cm) aspens (Fig. 6.). The number of cut aspens in one such place reached 220. Taking 10 aspen as a minimum criterion for mass tree-cutting, in total 128 such places were observed, with the average number of trees cut in one place being 48.7 (±3.2).

In total, we found and described 212 dams in natural water streams, including 120 working and 92 old, which already had been destroyed by water flow. They were built in waters of 1 to 30 m width and up to 113 cm of depth. The average depth of water

Figure 5. Beaver dam in the Kostroma area
near the dams was $84.5 \pm 5$ cm. 45 more dams were built in the irrigation canals. To stop the water flow, the beavers constructed dams from 1 to 60 m in length (mean $11.8 \pm 1.5$, mode=6, n=212). Sometimes the dams were constructed between islands and consisted of separate parts.

The dams usually were constructed of tree branches not more than 5 cm in diameter. They were reinforced by silt and sand carried by the water. The dams created a head of water, and along $276 \pm 51$ (range 30–830) m, the water was deeper than 35–40 cm. This was enough to provide shelter for the beavers.

Sometimes we found “cascades” of dams (i.e. many dams close together). A cascade of dams would be advantageous if the average distance between the dams were ca. 200 m or more because this is the average distance along the stream where the beavers are able to elevate the water level up to a depth of 40 cm (with the average slope of the area). However, in reality, the distance between neighbouring dams was only some tens of meters. The advantage of numerous dams in such a short stretch along a stream is unclear.

As can be seen in Fig. 7, in one area the beavers constructed 10 dams in a canal where the difference in altitude was only 3.5 m.

The beavers constructed the dams during early summer. In the next year the flood destroyed them. However, a part of the dams have been restored again by the beavers, and a few of them even existed for three years.
In the lowlands, where the level of the floodplain is \(< 1\) m above the water level in the main canal, the construction of beaver dams leads to the appearance of beaver ponds. These ponds were observed to exist up to 10 years. Because of the pond, beavers have access to food resources along a long fringe line around the pond. The beavers can use the rich resources of aspen on the slopes of terraces. As a result, the beaver settlements can survive for up to ten years. The animals build new dams downstream and upstream of the pond. As a result, a large forestless area has been created. The largest observed area was \(1100 \times 230\) m. Beaver meadows were found along many of the main rivers in the area under investigation, and of course their shapes follows the contours of the beaver ponds that existed here in the past (see Fig 5 and 6 in Chapter 9).
Conclusion

Our investigation demonstrates the capacity of beavers to utilize very different habitats, as well as revealing some preferences (lowlands, streams with more tortuousness, and streams with a width of ca. 6 m and a depth of ca. 80 cm). We found mass tree-cuttings in old aspen forests situated in lowlands and in young aspen forests situated on slopes of terraces. Beaver dams were often found at a short distance downstream from tributaries. Beaver ponds created by the construction of dams were found to last for up to 10 years. At the places where beaver ponds existed during many years there are now treeless areas (“beaver meadows”).

Reference