Potential Effects of Mongolian Beaver Activity on Riparian Ecosystems in the Upper Ulungur River

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Abstract. The Mongolian beaver (Castor fiber birulai) is rare in China and occurs only in a small part of Xinjiang. Local studies describe where it lives and what habitat it selects, but few studies have asked what its activities do to the surrounding riverbank environment. This paper reviews 17 sources published from 1994 to 2024, including five local studies or official reports, seven studies or reviews from other regions, and five environmental or technical sources. The evidence supports a clear but scale-dependent conclusion. Although Mongolian beavers may not significantly alter the entire upper Ulungur River, their activities—such as dam building, burrowing, lodge construction, and feeding—can change nearby water flow, vegetation, and riverbank conditions. The strongest evidence suggests that beaver dams slow water flow, trap sediment, and change the shape of nearby riverbanks. Feeding on willows may also affect willow regeneration and distribution. The upper Ulungur River is arid, with limited wet riverbanks and willow stands. Therefore, even small wet patches created or maintained by beaver activity may be important to the local ecosystem. This paper argues that the Mongolian beaver is a localized ecosystem engineer. It may not significantly alter the entire watershed, but its effects around frequently used sites are real and deserve attention. Protecting the Mongolian beaver therefore requires more than monitoring population size. It also requires protecting the river sections where beavers are active, keeping riverbank habitats connected, and preserving enough willow resources.

Keywords: Mongolian beaver, ecosystem engineer, riparian ecosystem, arid river, evidence synthesis.

1. Introduction

Beavers are often called ecosystem engineers because dam building, lodge construction, burrowing, and feeding can change water flow, sediment, vegetation, and habitat [1-3]. This is why beavers are sometimes considered in river restoration projects. However, their effects vary from river to river. Local climate, channel shape, discharge, plant species, beaver density, and the number of dams all influence the final result [2, 3]. Changes that are obvious in small temperate streams may be much less noticeable in dry rivers.

The Mongolian beaver (Castor fiber birulai) is a useful case for studying this difference. It is a subspecies of the Eurasian beaver and lives in the Ulungur River system, including the Bulgan River in Qinghe County. An official survey in 2023 estimated that about 830 Mongolian beavers lived in the region. Local studies have recorded family activity sites, lodges, food caches, and beaver dams. They also found that beavers more often select deeper water, sheltered banks, and places with more willows [4-8].

The upper Ulungur River is dry, its flow changes greatly by season, and suitable riparian woodland is limited. These conditions may restrict the size of beaver effects, but they may also make the few modified wet patches more important. This paper asks a simple question: what parts of the familiar beaver effect still appear in this arid river system?

Most local studies focus on practical conservation questions: How many beavers remain? Where are their lodges? What kinds of river sections do they select? How should they be protected? These studies are valuable, but their ecological meaning has not been brought together in one site-scale explanation.

The main gap is not simply a lack of studies. Local observations and international mechanism studies have usually been discussed separately. By combining them carefully, this paper can identify

the changes that are most likely around Mongolian beaver activity sites, even though the exact basin-wide magnitude is not yet measured.

Core question: What local effects might Mongolian beaver activity have on the riparian environment of the upper Ulungur River?

The analysis focuses on the direction, location, and likely scale of the effect. It also distinguishes conclusions supported by local observations from broader claims that would require direct field comparisons.

More specifically, the review considers which ecological effects have been repeatedly identified in past beaver studies, which Mongolian beaver activities and habitat preferences have been directly recorded in local studies, what changes in water flow, riverbanks, and vegetation are most likely when existing research and local data are combined, and how the arid climate, seasonal flow, deep river channel, and limited willow stands of the upper Ulungur River may limit these effects.

To answer these questions, the study reviews past research on how beavers affect water flow, river channels, vegetation, and biodiversity; summarizes local evidence on Mongolian beaver distribution, dams, lodges, food sources, and habitat selection; identifies the ecological changes most likely to occur around beaver activity sites in the upper Ulungur River; explains which findings from Europe and North America can be used to understand local conditions, and why; and uses the combined evidence to suggest practical conservation measures and directions for future research.

The main contribution of this paper is its focus on scale. A species does not need to transform a whole river basin to have an important ecological role. In a dry river where wet banks and willow stands are limited, even small changes caused by beavers may create useful habitat for other organisms. Understanding this pattern can help protect Mongolian beavers more effectively and make riverbank management more targeted.

This paper mainly analyzes possible changes around beaver activity sites and what these changes mean for the upper Ulungur River. It does not assume that every environmental change in the basin is caused by beavers. Its main point is that beaver activity may not significantly change the whole basin, but can still cause real local changes around dams, lodges, burrows, and feeding sites.

2. Literature Review

2.1. Beavers as Ecosystem Engineers

Jones et al. define ecosystem engineers as organisms that alter the physical environment and, as a result, change the resources available to other species [1]. Beavers mainly do this in three ways. Dams alter water flow; dams, lodges, and burrows alter sediment, banks, and channel form; and feeding changes woody vegetation and nearby habitat [2, 3]. One activity can also produce several effects. For example, a dam can influence both water flow and sediment deposition. Table 1 summarizes these links between beaver activities and nearby ecological changes.

Table 1. How beaver activities can lead to ecological changes nearby

What beavers do		What changes first		What may happen nearby
Build dams	→	Flow and water residence time	→	More local water retention and wetter banks
Build dams, burrow, and construct lodges	→	Sediment and bank form	→	More varied channel-edge habitat
Feed on woody plants	→	Plant removal and regrowth	→	Changes in vegetation structure and habitat

2.2. Effects on Hydrology and River Form

Beaver dams slow water and keep it in one place for longer. Water may spread into side channels or low areas, while sediment collects behind the dam. Nearby bank moisture, groundwater connections, water temperature, and channel form may also change [2, 3, 9]. These physical changes can create several kinds of habitat within a small area.

The size of the effect depends on the setting. Valley form, slope, discharge, dam number and age, and continued dam maintenance all matter [3, 10]. Dense dam groups in small temperate streams may form large pond systems. In a deep, dry channel, one occasional dam will usually affect a much smaller area.

Even so, the immediate direction of change near an active dam is fairly consistent: flow slows, sediment retention increases, and the edge of the channel becomes more varied. The wider result can differ by river section and season [3, 10], but the local physical effect is the most reliable starting point for this study.

2.3. Effects on Vegetation

Beaver feeding may damage some plants while helping others grow again. When beavers cut older stems, the canopy becomes more open, although heavy feeding may kill some plants. At the same time, many plants can grow new shoots after being cut. Areas used often by beavers may therefore contain plants at different growth stages, making the vegetation younger and more patchy [2, 3, 11].

In the upper Ulungur River, willows are both an important food source for beavers and a major part of the riparian habitat [4–6]. Repeated feeding is therefore likely to change the age and distribution of willow stands. Whether total willow cover increases or decreases depends on how heavily beavers feed and how quickly the willows regrow.

Beaver feeding is not simply good or bad. It creates a cycle of cutting and regrowth. If willows recover, this cycle can leave a mix of young and mature vegetation in the same area. If feeding is too intense, willows and other woody plants may decline.

2.4. Effects on Biodiversity

Beaver ponds, wet ground, open riverbanks, and the edges between land and water provide several small habitat types. Studies in other regions have found that beaver activity can affect birds, insects, mammals, amphibians, fish, and aquatic invertebrates [10–12]. The response varies by species, but overall, beaver activity tends to create a wider variety of local habitats.

This is especially important in the upper Ulungur River, where moist and varied riverbank habitat is limited. Even a small area affected by beavers may provide other animals with food, shelter, or breeding space that is otherwise scarce. It is therefore reasonable to conclude that beaver activity may increase local habitat diversity. However, because species respond differently, it is too early to assume that every species will increase.

2.5. Research on Mongolian Beavers in China

Local studies have mainly recorded where Mongolian beavers (*C. f. birulai*) live, where they build lodges, which woody plants they eat, and what kinds of habitat they prefer [4–8]. These studies repeatedly report that Mongolian beavers prefer deeper water, sheltered banks, more willows, and less human disturbance. A 2023 survey estimated a population of about 830 animals [8]. This suggests that beaver activity occurs at multiple sites across the Ulungur River system, so the local changes caused by beavers may also appear in more than one place.

Dam building is an important local difference. Mongolian beavers often live in deep river sections and do not always need dams. They are more likely to build when low discharge or drought makes the water shallow [4, 5]. Their strongest hydrological effects should therefore be concentrated at active dams and may become more visible during low-water periods.

2.6. Research Gap and the Role of This Review

Local and international studies answer different parts of the same question. Local research shows where Mongolian beavers live and what they do. European and North American research explains how the same activities change rivers. This review links the two. It uses local observations to identify where a mechanism is present, then uses mechanism studies to judge the most likely ecological result.

3. Research Methods

3.1. Research Design

This study did not conduct a new field survey or experiment. It used an evidence synthesis with the upper Ulungur River as a focused case. The evidence was organized into four topics: water, banks and sediment, vegetation, and biodiversity. Local records were used to identify actual Mongolian beaver activities, while studies from other regions were used to explain the ecological processes linked to those activities.

3.2. Search Strategy

Sources were searched on journal websites, Google Scholar, Crossref, and accessible Chinese academic databases. The search ended in July 2026. Keywords included *Castor fiber birulai*, Mongolian beaver, Ulungur River, Bulgan River, ecosystem engineer, hydrology, channel form, sediment, riparian vegetation, biodiversity, and lodge-site selection.

3.3. Inclusion Criteria and Source Selection

The final review included 17 sources published from 1994 to 2024: five local studies or official reports [4–8], seven studies or reviews from other regions [1–3, 9–12], and five environmental or technical sources [13–17]. A source was kept only when it helped answer the main research question.

- Local sources had to describe Mongolian beaver distribution, activity, or habitat selection.
- Studies from other regions had to explain effects on water, sediment, channel form, vegetation, or biodiversity.
- Broad reviews had to compare several regions or identify a repeated ecological mechanism.
- Official sources were used for population, distribution, legal status, and conservation context.
- News, unsourced summaries, and studies unrelated to the main question were excluded.

3.4. Materials and Background Datasets

The review also considered JRC Global Surface Water, MODIS vegetation indices, Sentinel-2 surface reflectance, Landsat Collection 2 Level-2 products, and ERA5-Land [13–17]. These datasets describe the wider water, vegetation, and climate setting of the upper Ulungur River. In this paper they are used to understand the conditions in which beaver activity occurs.

3.5. Evidence Framework

Four evidence levels were used to keep different source types clear. Level A is a direct local comparison between beaver and non-beaver sites, or before and after an activity. Level B is a direct local record of beavers, structures, feeding, or habitat. Level C is a mechanism study from another region. Level D is an official report or environmental dataset that describes background conditions. The main synthesis uses Level B to show that an activity occurs locally and Level C to explain the likely site-scale effect of that activity. Table 2 summarizes the availability and role of each evidence level used in this review.

Table 2. What each type of evidence contributes to the review

Level	Type of evidence	Available in this review	Contribution
A	Direct local comparison of active and inactive sites, or before and after activity	No	Would measure the local effect size
B	Local records of beavers, structures, feeding, habitat, and distribution	Yes	Shows which activities occur locally and where
C	Mechanism studies from other regions or beaver populations	Yes	Explains the likely ecological result of a recorded activity
D	Official population reports and environmental datasets	Yes	Describes population and environmental context

As shown in Table 2, this review contains no Level A evidence, but Levels B and C can still be combined to support a site-scale conclusion. Level B confirms that an activity occurs locally, while

Level C explains its likely ecological effect. This framework supports a positive local conclusion without turning it into a basin-wide claim.

3.6. Data Extraction and Synthesis

- Local studies and conservation reports were used to record population context, habitat selection, and observed activities.
- Studies from other regions were used to identify repeated changes in water, channel form, vegetation, and biodiversity.
- For each study, the location, beaver species, activity, and main finding were recorded.
- The findings were then compared with the dry, strongly seasonal, willow-limited setting of the upper Ulungur River.
- The final step was to identify the most defensible site-scale conclusion for each ecological topic.

3.7. Data Analysis

The analysis first listed local activities such as dam building, burrowing, lodge construction, and feeding on woody plants. It then matched each activity with ecological changes reported in existing studies. Because the studies used different methods and were conducted in different settings, the results were compared by direction and mechanism rather than combined in a new statistical test.

3.8. Ethical Considerations

This study did not handle animals and had no human participants. It does not publish unverified or sensitive locations of beaver families, because detailed locations could increase disturbance or poaching risk.

4. Results: Evidence Synthesis

4.1. Local Baseline and Directly Recorded Activities

Local sources confirm beaver families, lodges, food caches, use of woody plants, and several dams in the Ulungur River system [4–8]. They also show repeated selection of sufficiently deep water, sheltered banks, more willows, and lower human disturbance. Together, these observations show that Mongolian beaver activity is not spread evenly along the river. It is concentrated in particular riverbank patches, which is also where ecological effects should be strongest.

4.2. Hydrological and Geomorphic Effects

Four sources report that beaver dams can slow flow, increase water residence time, retain sediment, and make nearby banks wetter [2, 3, 9, 10]. Burrows and lodges can also alter bank structure over a small area. Because dams are locally recorded [4, 5], the most defensible interpretation is that these physical effects do occur at some active sites in the upper Ulungur River, especially during low-water periods. Table 3 summarizes the main hydrological and channel changes supported by the available evidence.

Table 3. Hydrological and channel changes supported by the available evidence

Expected change	Evidence	Evidence link	Synthesis for the upper Ulungur River
Slower flow near an active dam	Local dam records and mechanism studies [2–5, 9, 10]	B + C	A likely and direct effect at active dams
More local water retention and wetter banks	Mechanism studies and reviews [2, 3, 9, 10]	Mainly C	Likely within a small area around maintained dams
Sediment retention and a more varied channel edge	Mechanism studies and reviews [2, 3, 10]	B + C	Likely at active structures, especially during low flow
Temporary reduction in downstream movement of water	Results differ among settings [3, 10]	C	Possible over short reaches and periods
Additional wet riverbank patches	Combined local setting and mechanism evidence	B + C + D	Spatially limited, but potentially important in an arid river

As shown in Table 3, the strongest supported changes are slower water, greater sediment retention, and a more varied river edge near active dams. These patches will not cover the whole basin, but in an arid river they can add wet bank habitat where it is otherwise limited.

4.3. Vegetation Effects

Local studies confirm that Mongolian beavers feed on willows and other woody plants [4–6]. Other studies show a common sequence: older stems are removed, light reaches the lower canopy, and new shoots may grow [2, 3, 11]. Repeated use should therefore shift some feeding patches toward younger growth and a more mixed age structure. This is a real vegetation effect even when total plant cover does not increase.

4.4. Biodiversity and Habitat Effects

Studies from other regions report changes in birds, fish, insects, and other species around beaver-modified sites [10–12]. The local evidence supports the first step in this process: active sites can add slower water, wetter edges, exposed banks, woody material, and different stages of willow growth. These features increase habitat variety. A local increase in species richness has not yet been measured, but the creation of additional habitat types is a reasonable ecological benefit of clustered beaver activity.

4.5. Main Findings and Strength of Support

Table 4 summarizes the main conclusions and shows how strongly each one is supported by the combined evidence.

Table 4. Main conclusions from the combined evidence

Main conclusion	Evidence	Strength	Interpretation
Beavers select deep, sheltered, willow-rich river sections	Local studies and official sources [4–8]	Strong	Directly supported locally
Lodges, burrows, feeding, and occasional dams occur locally	Local records [4–6]	Strong	Directly supported locally
Active dams modify nearby flow, sediment, and banks	Local dam records plus mechanism studies [2–5, 9, 10]	Moderate to strong	Most likely during low-water periods
Repeated feeding changes willow age and patch structure	Local willow use plus cutting and regrowth studies [2–6, 11]	Moderate	A supported site-scale inference
Activity clusters increase habitat variety	Combined physical, vegetation, and biodiversity evidence [2–6, 10–12]	Moderate	Likely ecological value in willow-limited reaches
Total local species richness increases	No matched local species survey	Not yet measured	A testable next question
The whole upper river is physically transformed	Local activity is uneven and dams are occasional	Not supported	The effect is localized rather than basin-wide

Table 4 shows that evidence is strongest for locally recorded activities and their immediate effects. Basin-wide transformation and an increase in total local species richness are not supported by the current evidence.

4.6. Overall Pattern

The four tables show a consistent scale pattern. Evidence is strongest for local beaver activity and its immediate physical effects, moderate for changes in willow structure and habitat variety, and least direct for whole-basin or total biodiversity outcomes. This does not make the local result unimportant. It shows that Mongolian beavers act through small, concentrated patches rather than through continuous transformation of the entire river.

4.7. Statistical Analysis

No new statistical test was conducted because the reviewed studies examined different rivers and used different indicators. Clearly defined values from individual studies were retained, but they were not combined into one average effect size. The result of this paper is a mechanism-based and scale-based synthesis rather than a numerical meta-analysis.

5. Discussion

5.1. The Mongolian Beaver as a Localized Ecosystem Engineer

The combined evidence supports a direct answer to the research question: Mongolian beavers can affect riparian ecosystems in the upper Ulungur River. Dams slow water and retain sediment; lodges and burrows change bank structure; and willow feeding changes plant age and distribution. These effects are linked to activities that have been recorded locally [4–6] and to mechanisms found repeatedly in other beaver studies [2, 3, 9–11].

The key point is scale. The Mongolian beaver is unlikely to rebuild the entire upper river into a continuous pond system. Instead, it produces a network of small modified patches around active dams, lodges, burrows, and feeding areas. The immediate physical and vegetation effects in these patches are the strongest conclusion of this review.

5.2. Why a Small Local Effect Can Still Matter

The upper Ulungur River is dry, strongly seasonal, and limited in willow-rich riparian habitat. Under these conditions, ecological importance should not be judged only by the percentage of the basin affected. A small patch of slower water, retained sediment, wetter bank, or young willow growth may provide resources that are uncommon in the surrounding river corridor.

This leads to the main new interpretation of the paper: arid conditions probably reduce the spatial extent of beaver engineering, but they may increase the value of each successful activity patch. The effect is therefore best described as spatially limited but potentially meaningful, especially where several activity sites are close enough to form a connected cluster.

5.3. Use of European and North American Research

Research on the Eurasian beaver (*Castor fiber*) is especially relevant because it is more closely related to the Mongolian beaver than the North American beaver (*Castor canadensis*). Studies of both species are still useful when they describe basic processes such as flow reduction, sediment retention, bank modification, and willow regrowth.

The local setting changes the size and frequency of these effects, not the basic mechanism. This is why international research can support a site-scale interpretation for the upper Ulungur River while local observations determine where that interpretation applies.

5.4. Conservation Implications

Conservation should treat beavers and their riverbank habitat as one system. Protecting animal numbers alone is not enough if willow stands, sheltered banks, and connections between activity sites are lost. Management should therefore identify clusters of lodges, burrows, dams, food caches, and feeding areas, then protect the riverbank corridor around those clusters.

This site-based approach is also practical. Monitoring can focus on water level, sediment, bank moisture, willow regrowth, and a small set of indicator species near active sites and matched comparison reaches. It would show where beaver activity adds useful habitat and where heavy feeding or conflict with human infrastructure needs separate management.

5.5. Study Limitations

The main limitation is that the review does not include a matched local comparison of active and inactive river sections over time. Therefore, it cannot give a precise basin-wide effect size or confirm a local increase in total species richness. These limits narrow the scale of the conclusion, but they do not remove the site-scale conclusion supported by local activity records and well-established ecological mechanisms.

5.6. Recommendations for Future Research

Future work should first map active dams, lodges, burrows, feeding areas, and family activity ranges. Each active site should be paired with a similar river section without current beaver activity. Water level, sediment, bank moisture, willow age structure, and selected species should then be measured in more than one season.

A before-after-control-impact (BACI) design would be especially useful. It would compare active and comparison reaches and also follow the same locations through time. Remote-sensing data could then be linked to known activity locations instead of being interpreted only at the basin scale.

6. Conclusion

This review concludes that Mongolian beavers do affect the riparian ecosystem of the upper Ulungur River, but they do so mainly through small and concentrated activity patches. At active dams, flow is likely to slow and sediment retention is likely to increase. Around lodges, burrows, and feeding sites, bank structure and willow age patterns are also likely to change. Together, these processes create a more varied river edge and may add valuable habitat in a dry system where wet riparian patches are scarce. The Mongolian beaver should therefore be understood as a localized ecosystem engineer: its basin-wide physical effect is probably modest, but its site-scale ecological role can be meaningful. The most useful management response is to protect connected clusters of beaver activity and willow habitat, then measure those sites directly. This is a stronger and more practical conclusion than either assuming that beavers restore the whole river or treating their local effects as negligible.

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