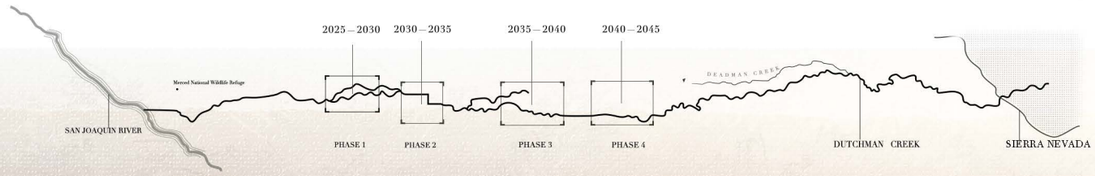
Beijing Forestry University
School of Landscape Architecture

Following the theme “Natural Intelligence…?” of the 13th Barcelona International Landscape Biennial, the School of Landscape Architecture at Beijing Forestry University selected five exemplary student projects from outstanding undergraduate and postgraduate coursework completed in the past two years. Selection criteria emphasized intellectual depth, innovation, completeness, and the projects’ capacity to respond effectively to contemporary landscape challenges at diverse scales.

These projects highlight the continuous exploration and integration of “natural intelligence,” addressing ecological processes related to wildlife, plants, water systems, and urban environments. They illustrate the school’s commitment to sustainability and ecological resilience through landscape research, education, and practice at various scales—from regional to site-specific interventions. The school’s landscape education is also deeply grounded in nature-based solutions and applying natural intelligence (NAI) to address climate change, biodiversity conservation, and social inclusion. Collectively, this work demonstrates how faculty and students advance landscape innovation by applying “natural intelligence,” responding to global challenges such as climate change and human health, and providing inspiration and insight for future practices.

WORKING WITH BEAVER ENGINEERS: FIRST STEP IN RESTORING ECO-CORRIDORS

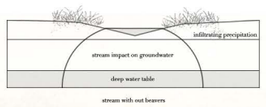
20-YEAR CORRIDOR VISION



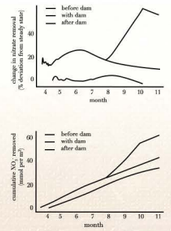
The beaver ecological restoration project is divided into four phases, and this design drawing shows the construction and expectations of the first node from 2025 to 2030 . The whole project is expected to run for 20 years, based on the Dutchman creek, connecting the surrounding reserves and national parks, and opening up the ecological corridor from the Sierra Nevada to the San Joaquin Valley.
The site was originally a large amount of farmland, resulting in drought and water shortage. The government agrees to renovate farmland to improve the ecological conditions of the site. Planting water-saving plants on some farmland to reduce the use of agricultural water; Part of the farmland has been converted into wetlands, and after the introduction of beavers, the river has been transformed to retain a large amount of water sources, gradually cultivating an oasis on the barren land.

ECOLOGICAL ENGINEER

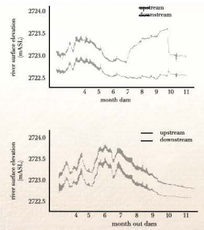
RESIST DROUGHT



PURIFICATION



FLOW REGULATION



Reduce the Impact of Fire by Three Times

During wildfires, the NDVI values of riparian vegetation near beaver dams remain similar to those before the fire, while vegetation in river sections without beavers is affected by the fire more than three times as much as in beaver-inhabited areas. When a fire does occur, the riparian zones around beaver dams retain enough water, making them less flammable.

Increase nitrate removal 44.2%

The nitrate removal rate rose to a stable level of 53.1%. Overall, compared to conditions without a dam, the instantaneous effect of the dam increased the cumulative nitrate removal by 44.2%.

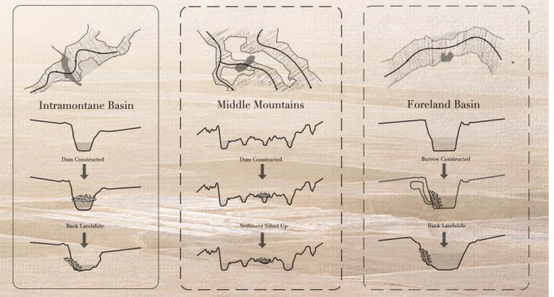
Reduce peak flow 30%-50%

Before the dam was destroyed, the maximum slope applied by the dam to the adjacent low-density sediments increased by 161.5%. This gradient far exceeded the maximum gradient caused by snow-melt-driven hydrological extreme events.

HYDRAULIC ENGINEER

PATTERN DIAGRAM OF BEAVER POND

BEAVER IMPACTS ON RIVER MORPHOLOGY



Water fow: Velocity 1-2.6 ft/s. River characteristics: Width ≤50 ft, silty substrate. Vegetation: Riparian zone ≥80 trees/acre. Terrain : Slope ≤15°, Watershed≥0.4 mi. Human interference: Distance ≥330 ft from roads/farms

Country/City	Merced/USA
University / School	Beijing Forestry University School of Landscape Architecture
Academic year	2024-2025
Title of the project	Working with Beaver Engineers：First Step in Restoring Eco-corridors
Authors	Yehong Yuan, Luyi Lin, Yilin Li, Wanlin Qu, Meixin Song, Ziyao Tang, Xi Zhang, Di Li

TECHNICAL DOSSIER

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Title of the project Working with Beaver Engineers: First Step in Restoring Eco-corridors

Authors Yehong Yuan Ziyao Tang Wanlin Qu Meixin Song Luyi Lin Yilin Li Xi Zhang Di Li

Title of the course Landscape design

Academic year 2024-2025

Teaching Staff Xiaoyu Ge Xi Zheng Wei Duan

Department / Section / Program of belonging Bachelor of Landscape Architecture

University / School Beijing Forestry University School of Landscape Architecture

Written statement, short description of the project in English, no more than 250 words

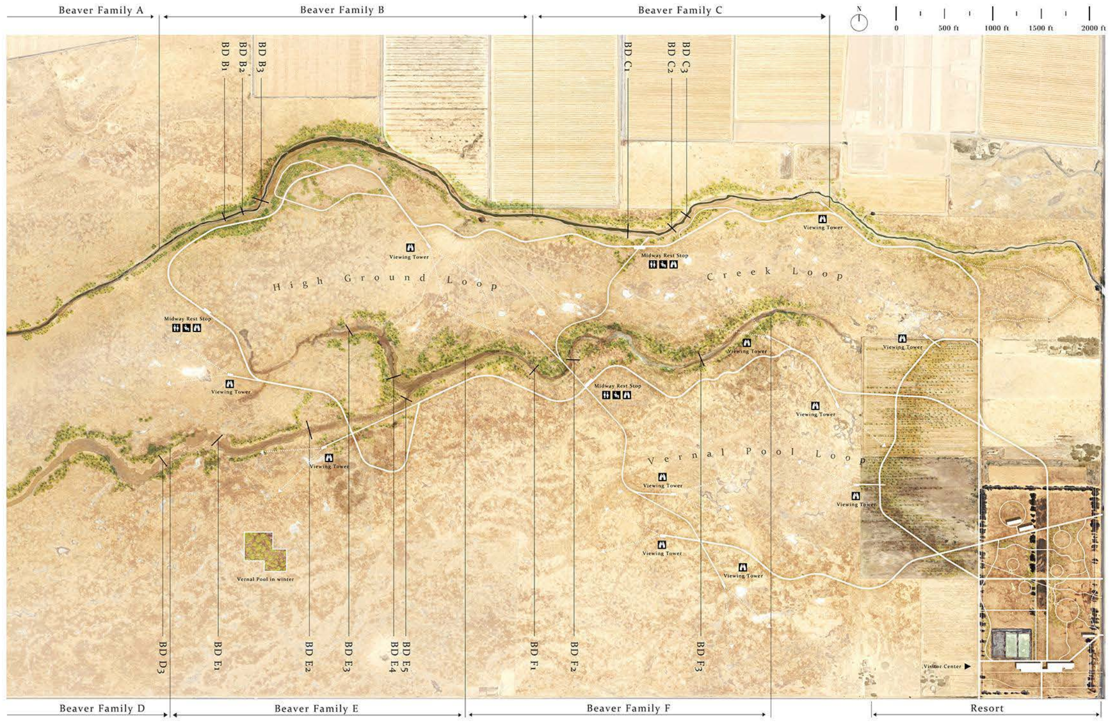
California's Central Valley exemplifies the ecological consequences of intensive agriculture and groundwater overextraction, with water tables dropping over 10 meters in less than a century. To address growing groundwater deficits, nearly 900,000 acres in the San Joaquin Valley may need to be fallowed by 2040. In response, California has launched a "multibenefit land repurposing" strategy to transition farmland toward more water-resilient uses.

Our team proposes a novel restoration approach: leveraging "natural intelligence" embodied by the North American beaver (Castor canadensis), rather than substituting nature with technological complexity. Beavers, as ecosystem engineers, instinctively build dams, retain water, and reshape habitats—functions refined over millennia that act as a form of natural algorithm. Their behaviors enhance water quality, restore wetlands, and support biodiversity.

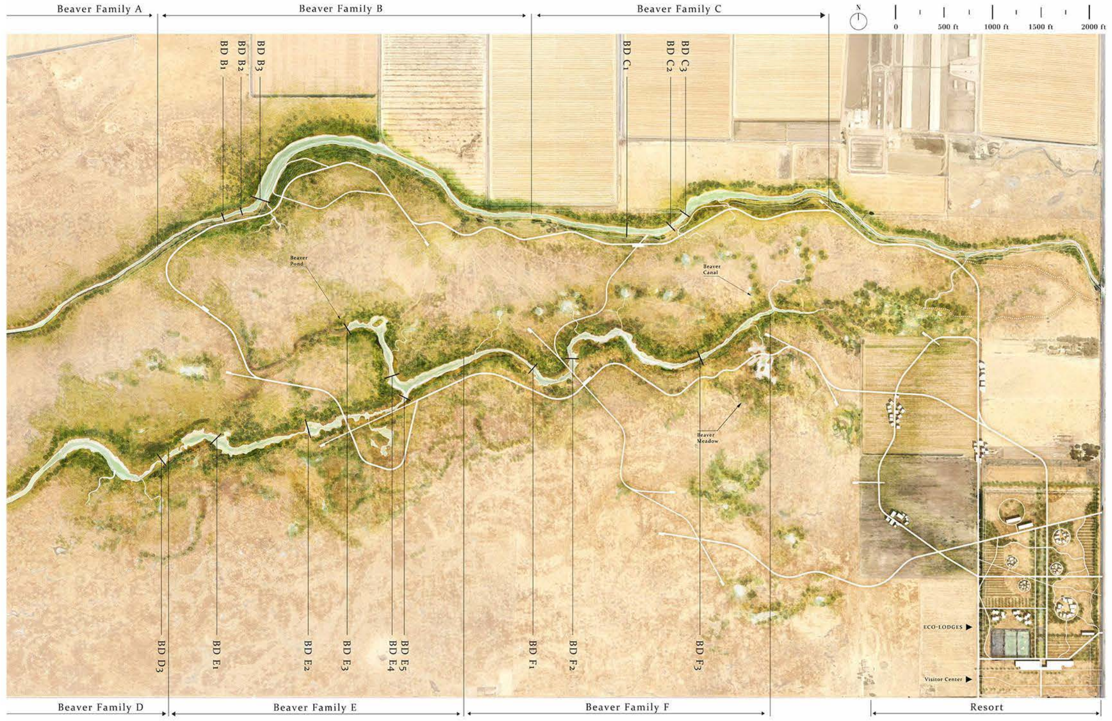
Using the Beaver Restoration Assessment Tool (BRAT), we identified optimal sites in the Dutch Slough watershed—an ecological corridor between the Sierra Nevada and Merced National Wildlife Refuge. Initial interventions include planting willow cuttings and constructing Beaver Dam Analogues (BDAs) to simulate early-stage beaver dams and create favorable hydrological and vegetative conditions.

The goal is to attract and reestablish beaver populations, whose ongoing activity will maintain dynamic, adaptive dam systems. These living infrastructures can outperform artificial ones in retaining floods, recharging aquifers, and restoring habitat networks—initiating a self-sustaining, resilient ecological cycle driven by nature itself.

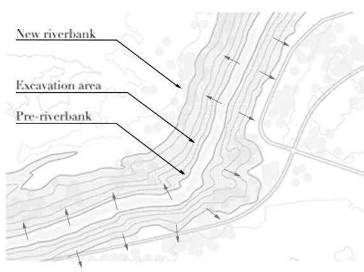
AFTER HUMAN CONSTRUCTION Master plan 2027



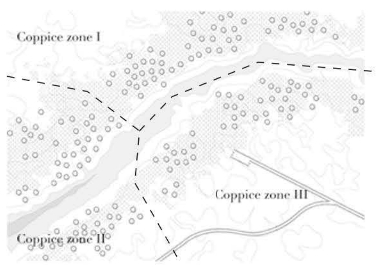
AFTER BEAVER COLONIZATION Master plan 2030



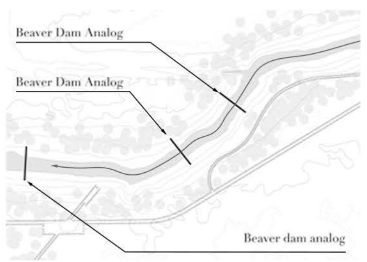
EARTHWORK ADJUSTMENT



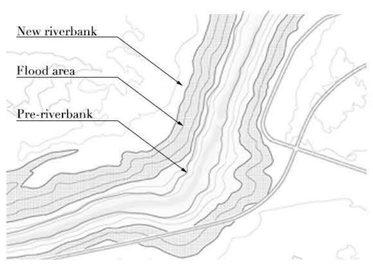
PLANT WILLOW TWIGS



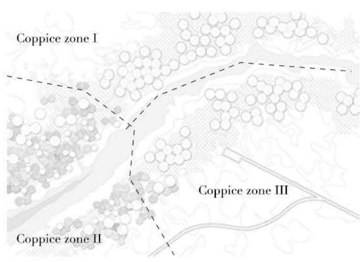
CONSTRUCT BDA



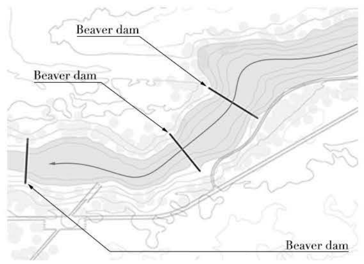
FROM NARROW DITCHES TO PONDS



FROM WASTELAND TO WILLOW GROVE



FROM BDA TO REAL BEAVER DAM



RIVERBANK EXCAVATION
The steep gradient of the original riverbank limits the availability of pond area, making it insufficient to support beaver habitat establishment. Excavating the bank to achieve a 1:5 (H:V) slope aligns with beavers' natural dam-building behavior, facilitating the creation of a sustainable riparian habitat suitable for colonization.

FOUNDATION FILLING
Additional geotechnical excavation and structural reinforcement work has now been systematically implemented across the primary foundations of the observation tower, elevated viewing platform, and all secondary supporting infrastructure to safely elevate the tower's operational height while dramatically enhancing the panoramic visitor experience through optimized sightlines.

TREE SCARCITY
The site currently lacks sufficient woody vegetation, and most existing tree species are not preferred forage for beavers. That means, targeted tree enhancement and supplemental planting are needed to establish suitable beaver habitat.

VEGETATION INCREASE
Plant Salix lasiolepis, Frangula rubra, Leymus condensatus, and other native trees, shrubs, and grasses, along with aquatic species like Typha domingensis, throughout the site to provide forage and construction materials for beavers, while enhancing the landscape.

COPPICE ZONE
To support the ecological habits of beavers, Salix spp. will be planted within a 10–60 meter riparian buffer zone. Each beaver territory will include three coppice management units, each at least 0.4 hectares in size, to sustainably meet the family's annual foraging requirements.

RIVER CONDITION
The placement of BDAs requires careful consideration of hydrological factors such as flow velocity, water level flu., and sediment ; topographical and geological factors including channel slope, riverbed substrate, and valley width ecological factors such as vegetation cover.

SELECT LOCATON
When selecting BDA locations, it is also important to consider the length of river segments typically occupied by beaver families, as well as the effects of cascading dam spacing under varying hydrological and geomorphic conditions.

BDA INSTALLATION
The structure reduces flow velocity, increases upstream water retention, and raises water levels. It helps sustain local water availability during dry seasons and mitigates flood peaks during wet periods, thereby moderating seasonal hydrological fluctuations.

REMODELING THE RIVER
Upstream sediment interception causes riverbed aggradation, while reducing downstream erosion and enabling bank accretion. Differential flow velocities erode concave banks and deposit on convex banks, increasing channel meandering.

FLOODPLAIN RECONNECT
Beaver activities modulate riverine flow velocities, enhance sediment retention, gradually induce riverbed aggradation, thereby promoting the development of hydrologically active floodplain ecosystems through the restoration of lateral connectivity.

HABITAT ESTABLISHMENT
Beaver ponds act as hydrological reservoirs in droughts, maintaining stable water levels. In the Merced region, these wetlands provide refuge for over 61 bird species, 15 native fish populations, and threatened amphibians including the California frog.

WILLOW GROVE
After approximately three years of cultivation, the newly planted trees in the area will have grown sufficiently to provide both food and building materials for beavers, at which point they will be reintroduced to the site.

COPPICE ZONE
As beavers fully utilize available vegetation in one zone, they instinctively transition to the next adjacent area, thereby enabling natural secondary succession in the previously harvested zone while maintaining continuous habitat value.

ECO-REGENERATION
The stumps regenerate through coppice sprouting, while canopy removal increases light availability, allowing shrubs and saplings to flourish. This growth drives plant succession and enhances riparian vegetation diversity.

WATER RETENTION
Beaver dams effectively intercept and slow the river flow, creating deep ponds that enable seasonal rivers to reliably retain substantial water volumes throughout prolonged dry seasons, supporting critical aquatic habitats.

SEDIMENT RETENTION
The dam significantly slows the river's downstream flow, allowing suspended sediments to accumulate behind its structure, with field measurements showing an estimated average deposition rate of 266 cubic yards per year per main dam.

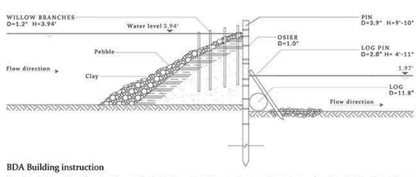
BIODIVERSITY
Beaver ponds formed by these engineered dams effectively replace the dry riverbed sections and provide wetland habitats for diverse wildlife during breeding seasons, thereby enhancing local biodiversity around active beaver pond ecosystems.

WORKING TIMELINE

HUMAN CONSTRUCTION

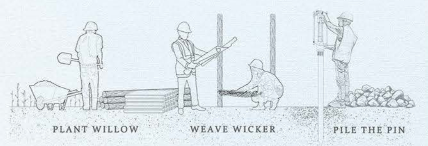
BEAVER COLONIZATION

BDA CONSTRUCTION DRAWINGS



BDA Building instruction

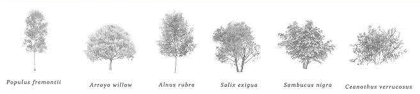
-Drive vertical posts into the creek bed to reinforce and support the constructed log spillway bridge. Scrap ash logs milled to approximately 3 in. × 3 in. and up to 9 ft. in length were sharpened at one end and driven into the creek bed using a gas-powered Titan post driver.
-Remove invasive honeysuckle and other dense vegetation to allow sufficient sunlight for wetland species to re-establish. Dormant native wetland plants have been observed locally and are expected to recover with improved conditions.
-Place gravel and rocks onto and around the clay plug structure to prevent erosion. Fill the transitional space between the clay plug and the Beaver Dam Analog (BDA) thoroughly.
-Plant scrub willow and native wetland seeds directly into the dam structure and surrounding banks, creating suitable wildlife habitat and providing future foraging resources for beavers.



Results

Water depth increased significantly from approximately 1 inch to between 2–3 feet. Within the first week, fish, tadpoles, and frogs were observed developing at normal growth rates. Dragonflies were observed by the second week. Increased diversity of butterfly and moth species was noted. Beavers are anticipated to colonize the area and begin maintaining dams within approximately three years. Tree protection methods and water-leveling devices may be installed as necessary. Mosquito populations are expected to decline due to an increase in natural predators. Native fish can migrate upstream past the dam structure during periods of higher water flow. Crayfish created burrows around the clay plug through the topsoil, causing minor downstream seepage. However, this activity did not appear to compromise the integrity of the Wetland and Beaver Dam Analog (WTBDA) structure. After heavy rainfall, it may be necessary to reposition displaced rocks and add larger, heavier rocks around edges. Maintaining extra stockpiles of rocks nearby is recommended. Noticeable creek widening into braided channels occurred, along with increased saturation of lower bank soils. Established vegetation, including grasses and mosses, effectively prevented erosion during high flows.Minimal to no erosion was observed, accompanied by expected sediment deposition.

BUILDING MATERIALS



Food and building materials:
Approximately 5-10 acres (2-4 hectares) of willow stands (such as Arroyo Willow, Salix lasiolepis) are required at an optimal density of 200–300 trees per hectare, to sustainably produce at least 1.5 tons (fresh weight) of branches per hectare annually.

Regeneration management:
When willow crowns and branches have been browsed or gnawed by beavers to an extent exceeding 70%, supplemental planting is recommended. Establishing rotational harvesting plots (or rotational cutting zones) can significantly enhance regeneration efficiency and sustainability.

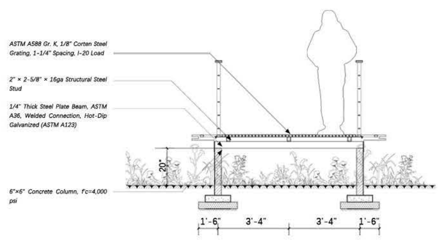
Vegetation configuration:
Preferred Species: Arroyo Willow (Salix lasiolepis), a native drought-tolerant willow species, is recommended due to its strong regenerative capacity and its desirability as food by beavers, which frequently consume its bark and tender branches.

Alternative food sources:
Complement willow plantings with poplar species (Populus spp.) as supplemental forage, particularly during periods when willow supply may be insufficient.

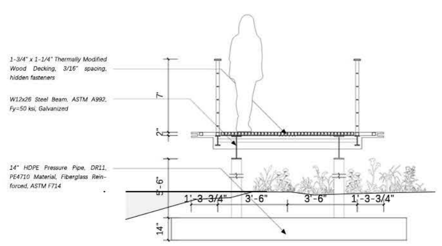
Eco-regenration
When willow (Salix spp.) canopy cover reached approximitely 30%, North American beavers (Castor canadensis) were introduced to accelerate willow regeneration through their natural browsing behavior. Once browsing exceeds approximately 70% of the willow canopy or branch biomass, supplementary planting becomes necessary. Establishing rotational harvesting zones can significantly enhance willow regeneration efficiency. The total area designated for willow groves should be carefully planned and managed to ensure sustainable habitat conditions, adequate regeneration, and sufficient forage supply for future beaver populations.

DETAIL DRAWINGS

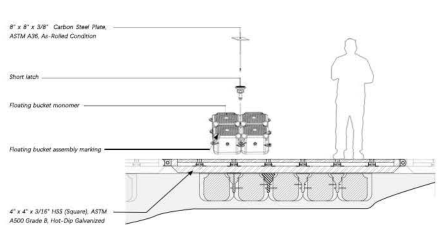
GROUND TRAIL



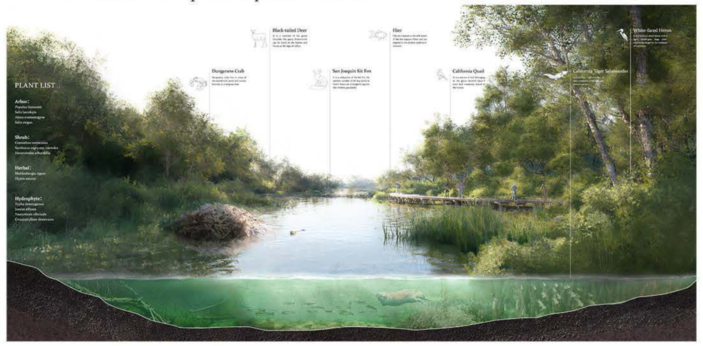
ELEVATED BOARDWALK



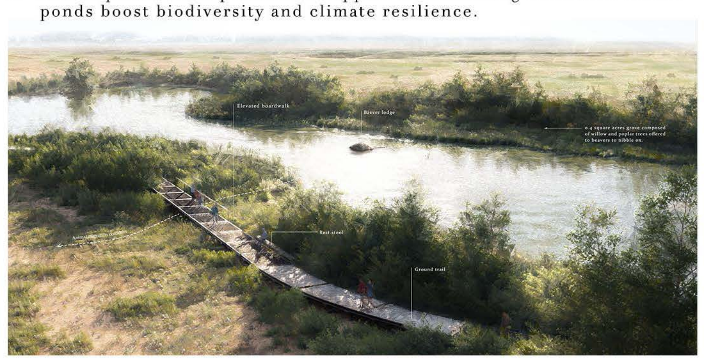
FLOATING BOARDWALK



▲ Dams slow river flow, raise ponds, increase soil moisture, and create lush zones for riparian plant revival.



▲ Native plants were planted to support dam building and food. Beaver ponds boost biodiversity and climate resilience.



▲ Three types respond to seasonal water change, reduce disturbance, and enrich visitor experiences.

▲ Beaver-themed homestays support field trips, offering immersive ecological learning for students and families.

▲ Low-profile deck with vision-friendly panels and telescopes for quiet, close-up animal observing.