Mapping beaver contributions to ecosystem service priorities across sectors and scales

Collin S. VanBuren and Emily Fairfax

Virginia Museum of NATURAL HISTORY

UNIVERSITY OF MINNESOTA


Photo: Emily Fairfax

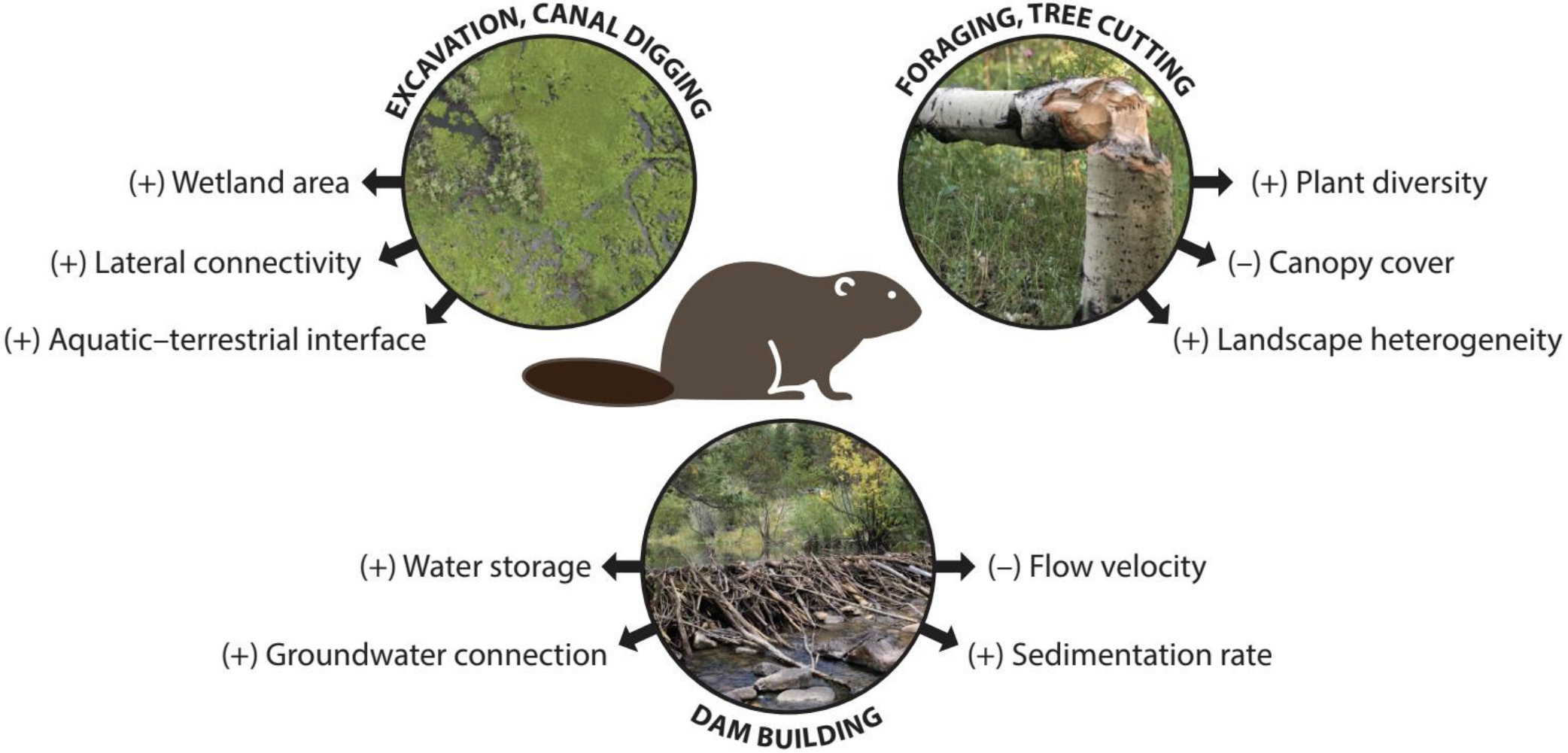
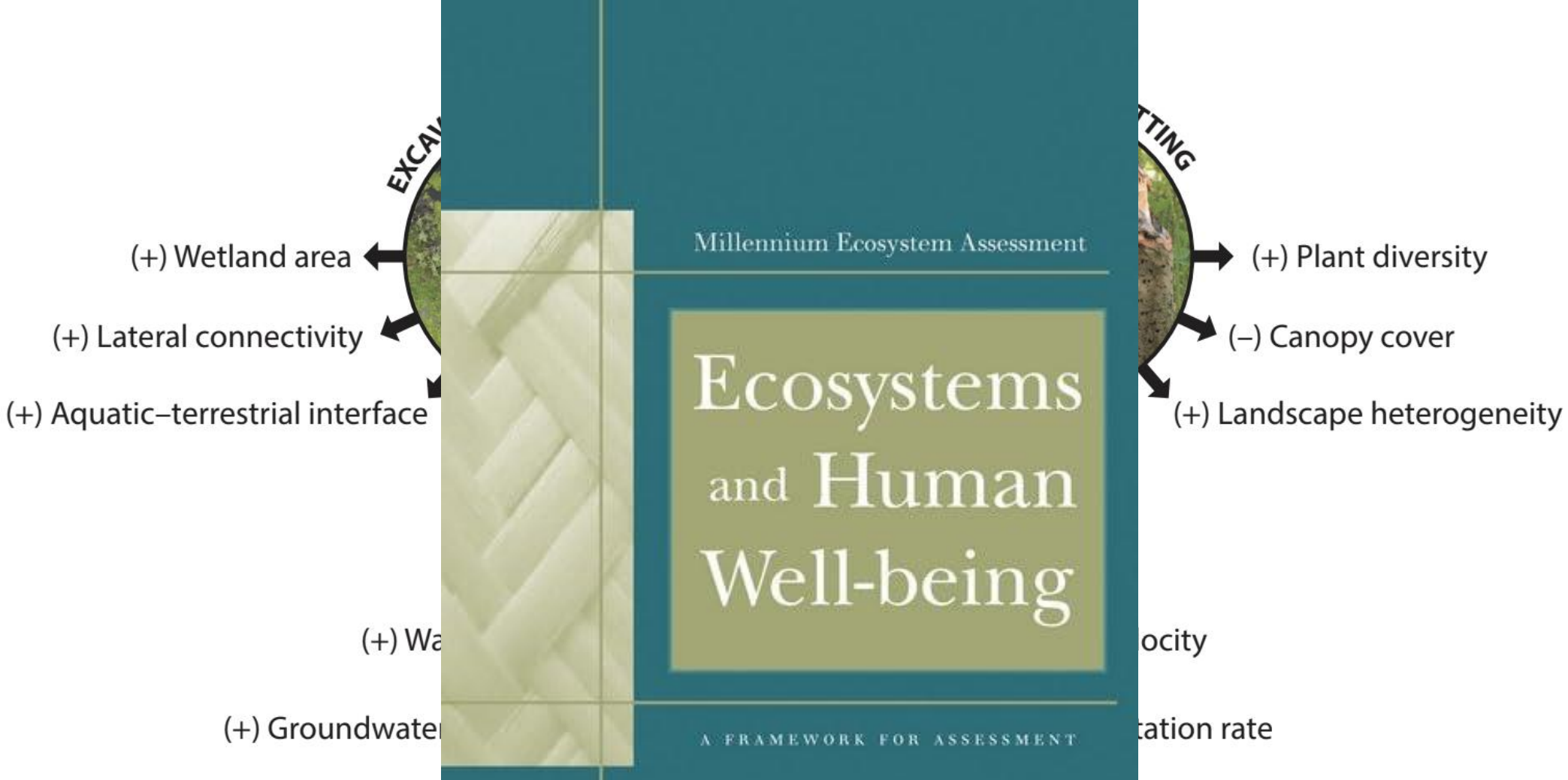


Figure 2

Conceptual diagram of beavers' three main ecosystem engineering behaviors: excavation, tree cutting, and dam building, as well as the resulting increase (+) or decrease (–) in key abiotic and biotic processes for wetland development and climate resilience.

Fairfax and Westbrook 2024



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MEA 2003
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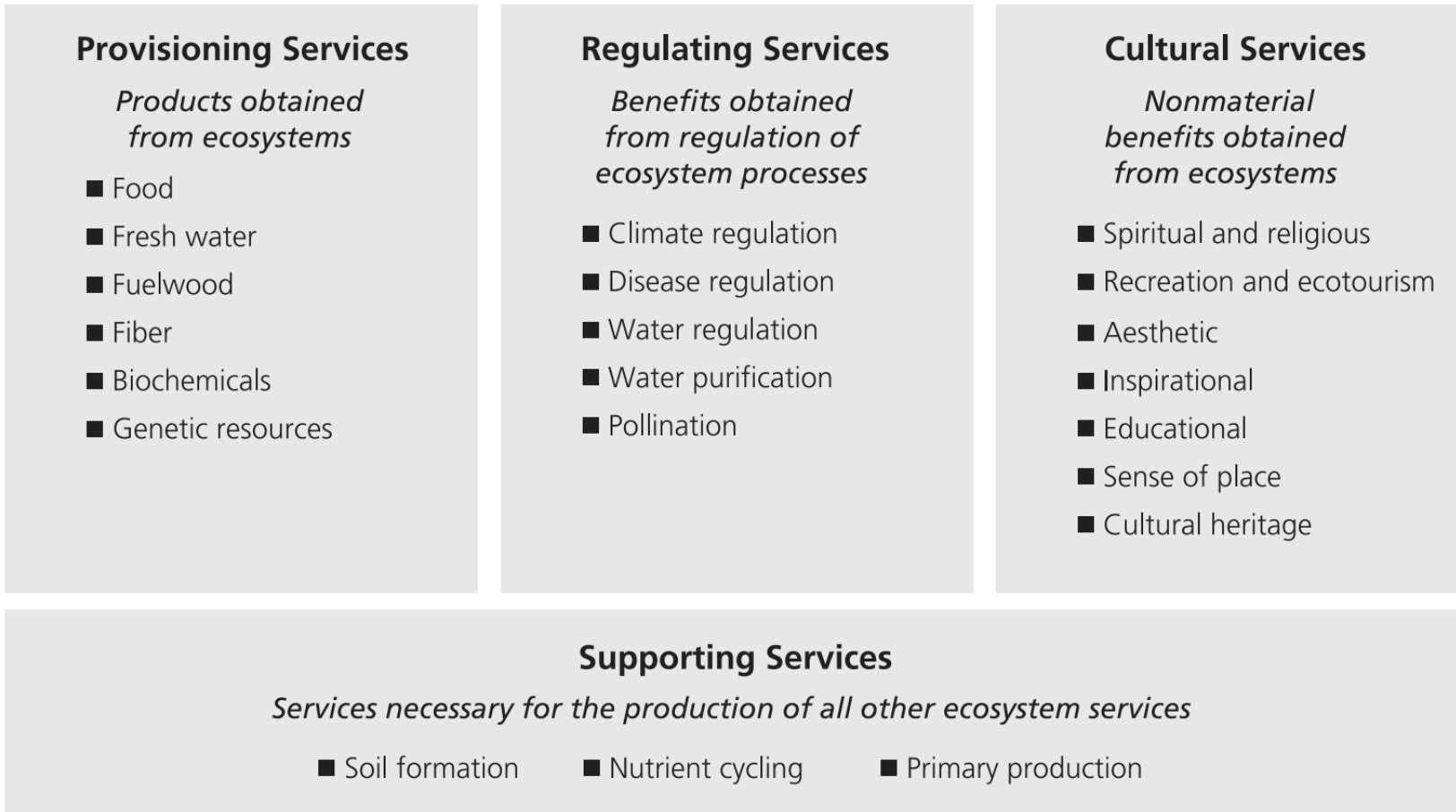
Provisioning Services
Products obtained from ecosystems
Food
Fresh water
Fuelwood
Fiber
Biochemicals
Genetic resources
Regulating Services
Benefits obtained from regulation of ecosystem processes
Climate regulation
Disease regulation
Water regulation
Water purification
Pollination
Cultural Services
Nonmaterial benefits obtained from ecosystems
Spiritual and religious
Recreation and ecotourism
Aesthetic
Inspirational
Educational
Sense of place
Cultural heritage
Supporting Services
Services necessary for the production of all other ecosystem services
Soil formation
Nutrient cycling
Primary production

MEA 2003

Kunming - Montreal

GLOBAL BIODIVERSITY FRAMEWORK

Products obtained from ecosystems

- Food
- Fresh water
- Fuelwood
- Fiber
- Biochemicals
- Genetic resources

Benefits obtained from regulation of ecosystem processes

- Climate regulation
- Disease regulation
- Water regulation
- Water purification
- Pollination

Nonmaterial benefits obtained from ecosystems

- Spiritual and religious
- Recreation and ecotourism
- Aesthetic
- Inspirational
- Educational
- Sense of place
- Cultural heritage

Supporting Services

Services necessary for the production of all other ecosystem services

- Soil formation
- Nutrient cycling
- Primary production

GBF 2022

MEA 2003

Kunming - Montreal

GLOBAL BIODIVERSITY FRAMEWORK

Target 11

Restore, Maintain and Enhance Nature's Contributions to People

Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services, such as regulation of air, water, and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature.

GOAL B

Prosper with Nature

Biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development for the benefit of present and future generations by 2050.

GBF 2022

MEA 2003

Table ES1. Ecosystem Services Potentially Provided by Beaver in the Escalante Basin, and Per-Unit Values

Ecosystem Service Provided	Per-unit value for service
Sediment Retention	$2 per cubic yard
Delayed Water Flow upstream of Reservoirs	$520 per acre–foot
Riparian Habitat	$1,000 per acre per year
Wetland Habitat	$8,000 per acre per year
Aquatic Habitat	$4,000 per acre per year
Pollutant Removal through Sediment Capture	$100,000 per year per percent improvement
Water Temperature	$74,000–$411,000 per river mile
Recreation	$75–$375 per recreation day
Aesthetic Benefits	Qualitative Description
Existence Value	Qualitative Description
Sensitive Species Habitat	$9–$256 per household per year
Flood Resilience	Qualitative Description

Source: ECONorthwest with data from a number of sources (see report)

Buckley et al. 2011

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Ecosystem service	Ecosystem service category	Number of value estimates
Moderation of extreme events (FloodDrought)	Regulating	11
Greenhouse gas sequestration (GHG)	Regulating	8
Water purification (Quality)	Regulating	26
Water supply (Supply)	Provisioning	6
Recreational hunting and fishing (HuntFish)	Provisioning	3
Habitat and biodiversity provision (HabBio)	Supporting	8
Nutrient cycling*	Supporting	0
Non-consumptive recreation (Recreation)	Cultural	17
Historical value*	Cultural	0

Buckley et al. 2011
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Department of the Interior Nature-Based Solutions Roadmap

Riverine Habitats
21. Beaver Management and Beaver Dam Analogs

- Drought mitigation
- Reduced flooding
- Carbon storage and sequestration
- Reduced wildfire risk
- Heat mitigation
- Aquifer recharge
- Resilient fisheries
- Jobs
- Mental health and well-being
- Tourism
- Cultural values
- Reduced erosion
- Supports wildlife
- Enhanced biodiversity
- Improved water quality
- Increased primary productivity

Buckley et al. 2011
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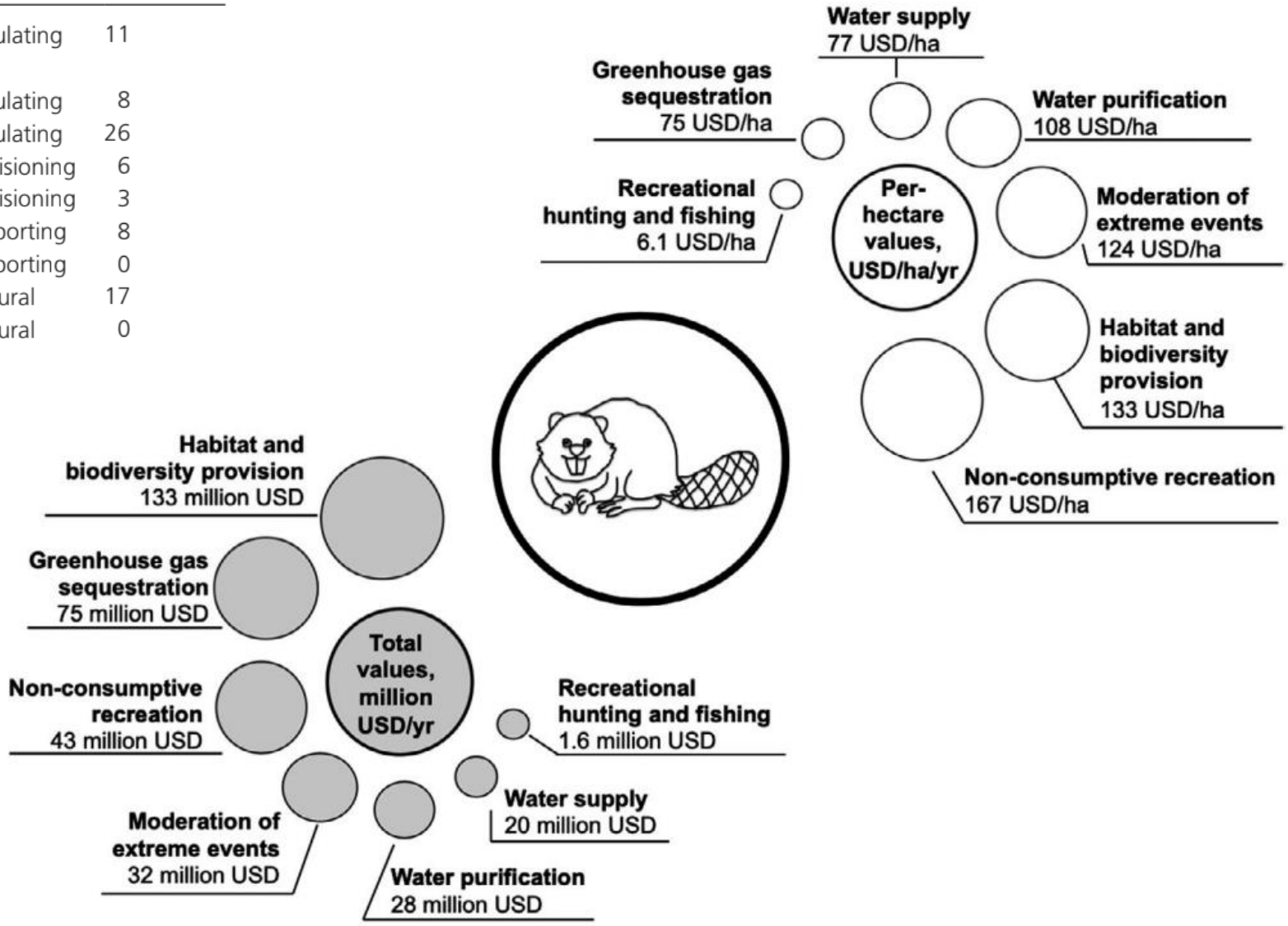

Fig. 1. Values of ecosystem services produced by beaver ponds, given in annual per-hectare values (white circles) and aggregated over the one million ha Northern Hemisphere beaver range per year (grey circles). Circles are not to scale.

Thompson et al. 2020

York et al. (2019) from surveys of ranchers

Ecosystem service
Forage for livestock
Family legacy for future generations
Sustainable flows of water
Water quality
Demonstrating good stewardship
Open space free from development
Reducing fuels for wildfire prevention
Solitude and privacy
Healthy riparian areas
Maintaining a community legacy of ranching
Natural environment free of weeds
Upland habitat for wildlife
Stream habitat for fish
Animals for hunting by self, family, or friends
Oil and gas production
Tourism, recreation, or hunting lease income
Plants for pollinating insects
Renewable energy production
Recreation opportunities for family or friends

CA Rangeland Trust

CA Climate Investments

Agricultural Land Conservation People value the continued existence of agricultural land. Sustained agricultural production generates revenue for farmers and food security for residents.

On-Farm Conservation Management Increased soil health reduces erosion, increases water retention, and improves habitat quality. New pollinator habitat increases productivity of nearby parcels.

Increased Efficiency of Agricultural Irrigation Improved water use efficiency reduces water needs and avoids property damage through reduced subsidence. More efficient pumps increase local air quality and improve human health.

Alternative Manure Management Sustainable manure management and compost production is associated with benefits related to soil health, odor reduction, and improved human health.

Wetland Restoration and Maintenance Well-functioning wetlands improve water quality, provide water storage, protect wildlife, and generate recreational and educational opportunities, among other benefits.

Fuels Management Reducing the likelihood of catastrophic fire avoids future property damage and the loss of ecosystem services provided by forests.

Restoration and Reforestation Restored forests increase air quality, control erosion, reduce flood and storm hazards, provide recreational opportunities, and bolster water supply.

Waste Prevention and Food Rescue Reducing food waste avoids meal costs and landfilling tipping fees while increasing food security. New production of compost, recycled products, and biogas increases commercial revenues.

Forest Conservation People value the continued existence of forested land and benefit from the ecosystem services forests provide.

Urban Forests and Green Space Expanded tree canopy may reduce energy needs, naturally manage stormwater, and reduce crime. Improved green space provides recreation opportunities that benefit human health and well-being.

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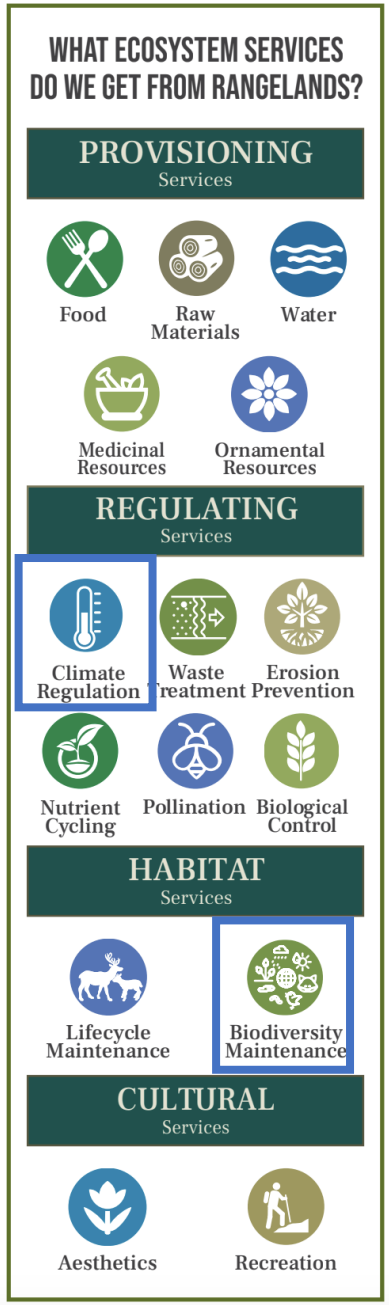

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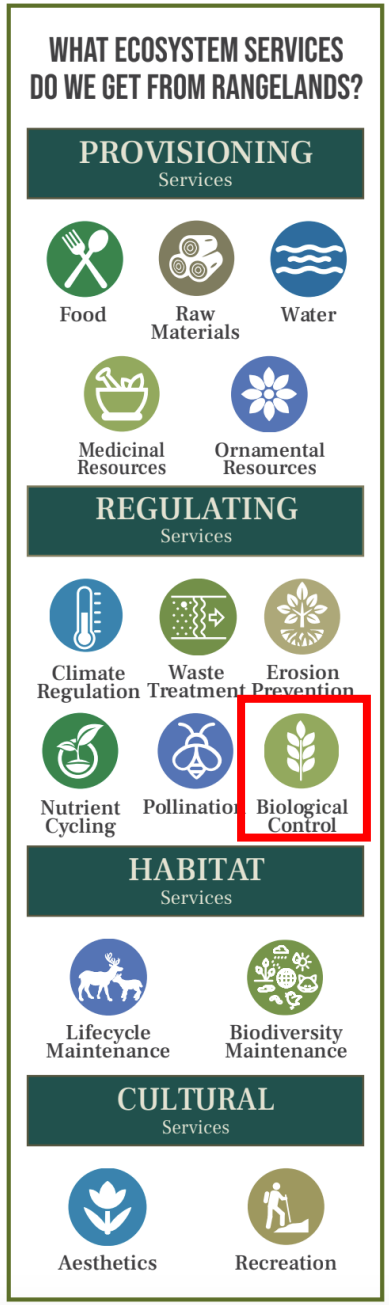

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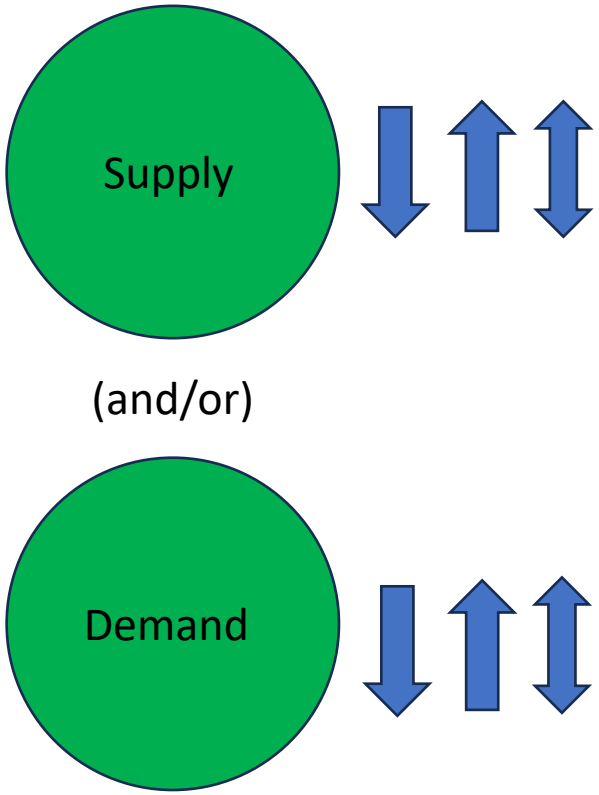
Methods

- Lists contained at least five ecosystem services
- Definitions were provided or could be inferred
- Ecosystem services are named individually in a list format
- Lists were derived from or applicable to areas where beavers are native

Impact on service:



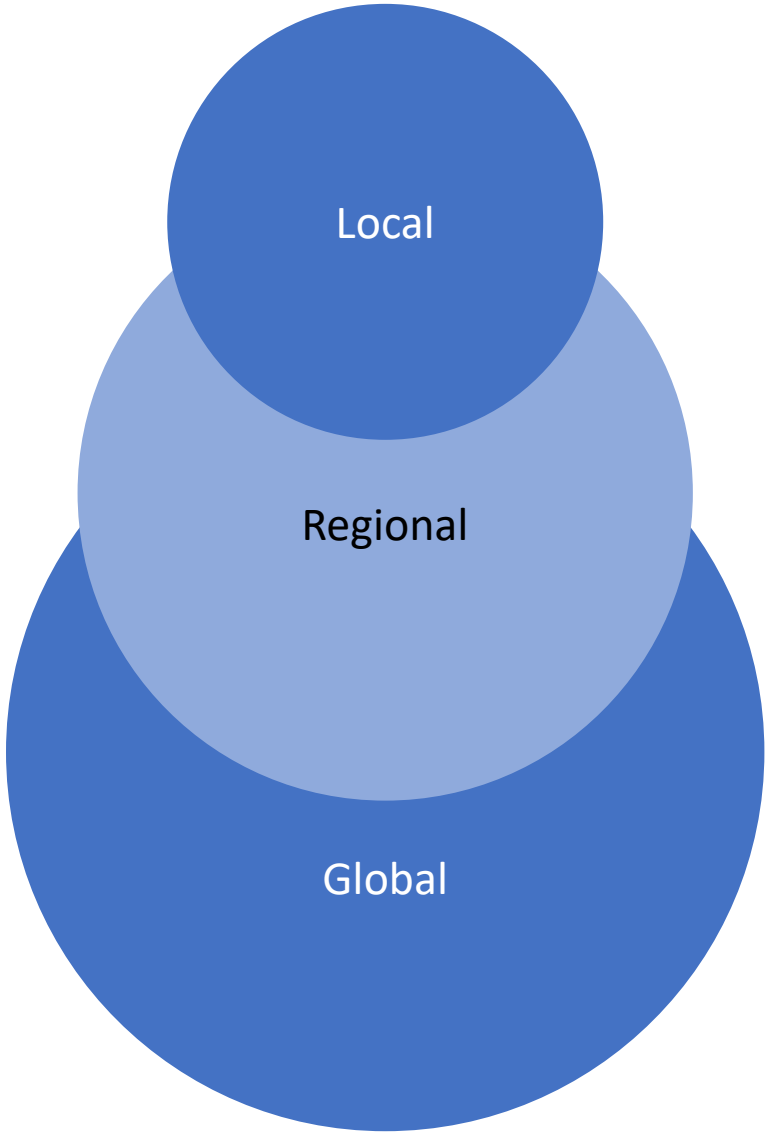
Impact on service:

Supply

(and/or)

Demand

Scale of impact:



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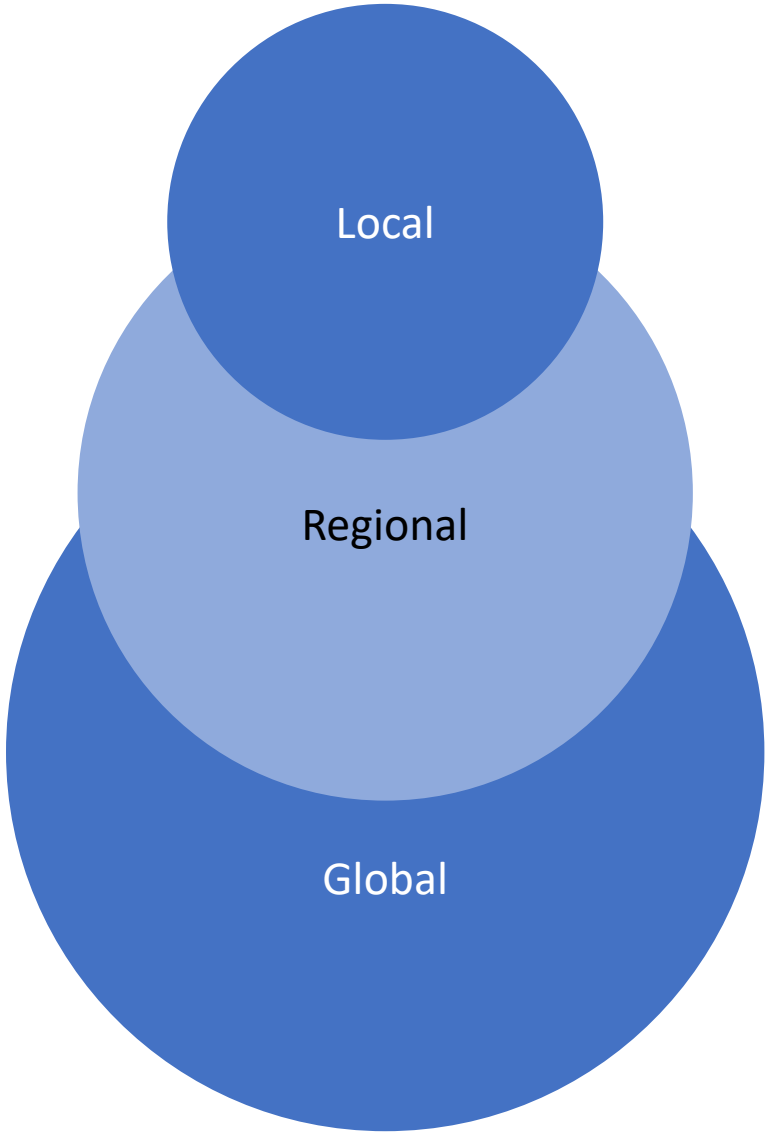

Level of confidence:

Low

Medium

High

	Local	Regional	Global
Increase supply	Climate regulation (9) Waste Treatment (6)	Biodiversity (11) Erosion control (10) Habitat (22) Nutrient Cycling (9) Pollination (9) Soil Health and Fertility (11) Water Quality (24)	
Decrease supply	Timber Provision (6)		
Affect supply		Carbon sequestration (9) Food and Feed (28)	
Increase demand			
Decrease demand		Conservation (16)	
Affect demand	Medicine and Health (7)		
Affect supply or demand	Aesthetics (8) Agriculture (17) Biological Control (8) Recreation (29)	Hazard Risk Reduction (11) Water Quantity (30)	Cultural and Spiritual (22)
No or unknown contribution	Air quality (8) Education (6) Energy (11) Materials (9) Waste Management (3)		

Key:

Low confidence

Medium confidence

High confidence

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Increase supply	Climate regulation (9) Waste Treatment (6)	Biodiversity (11) Erosion control (10) Habitat (22) Nutrient Cycling (9) Pollination (9) Soil Health and Fertility (11) Water Quality (24)	
Decrease supply	Timber Provision (6)		
Affect supply		Carbon sequestration (9) Food and Feed (28)	
Increase demand			
Decrease demand		Conservation (16)	
Affect demand	Medicine and Health (7)		
Affect supply or demand	Aesthetics (8) Agriculture (17) Biological Control (8) Recreation (29)	Hazard Risk Reduction (11) Water Quantity (30)	Cultural and Spiritual (22)
No or unknown contribution	Air quality (8) Education (6) Energy (11) Materials (9) Waste Management (3)		

Key:

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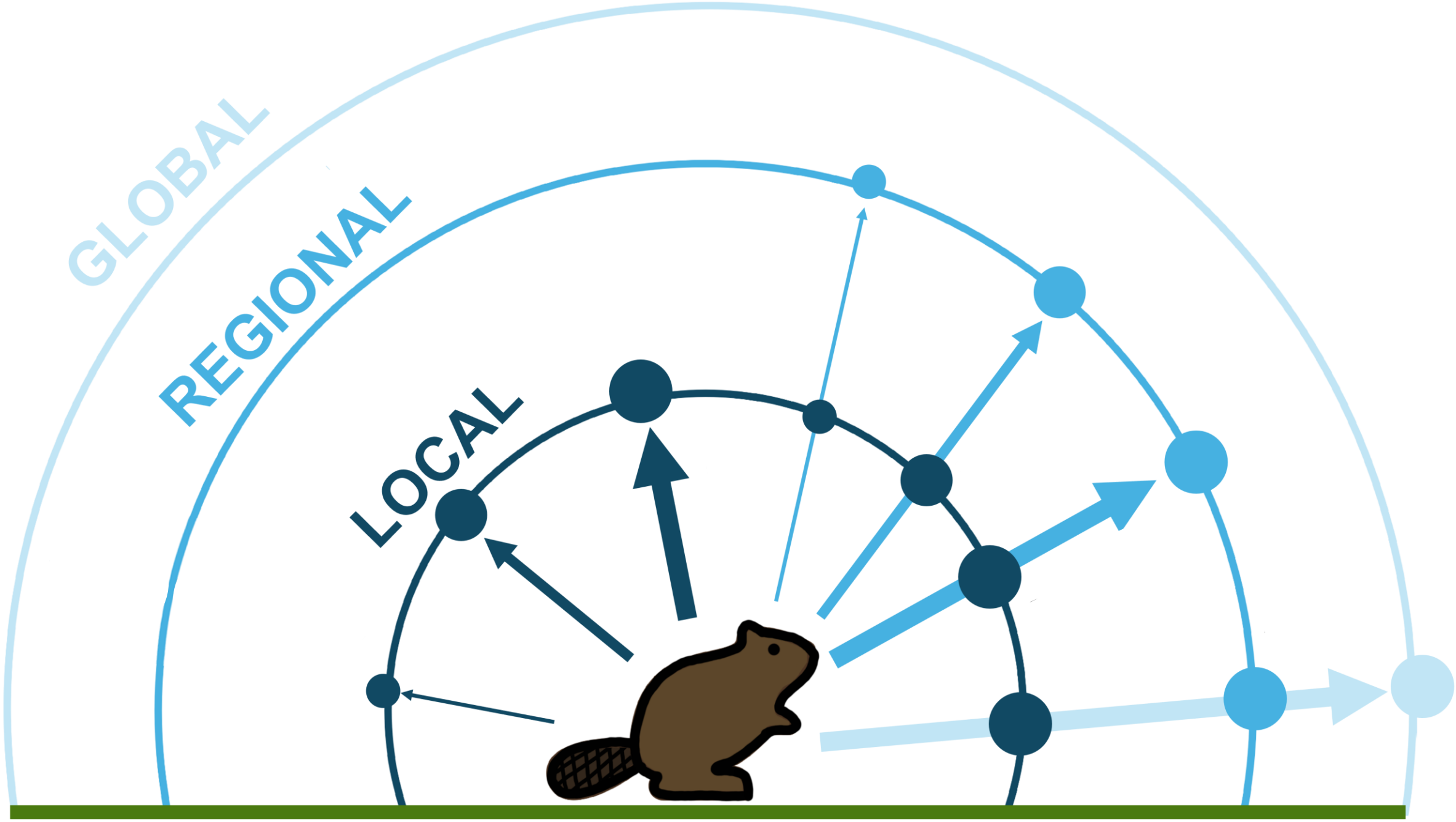
Photo: Emily Fairfax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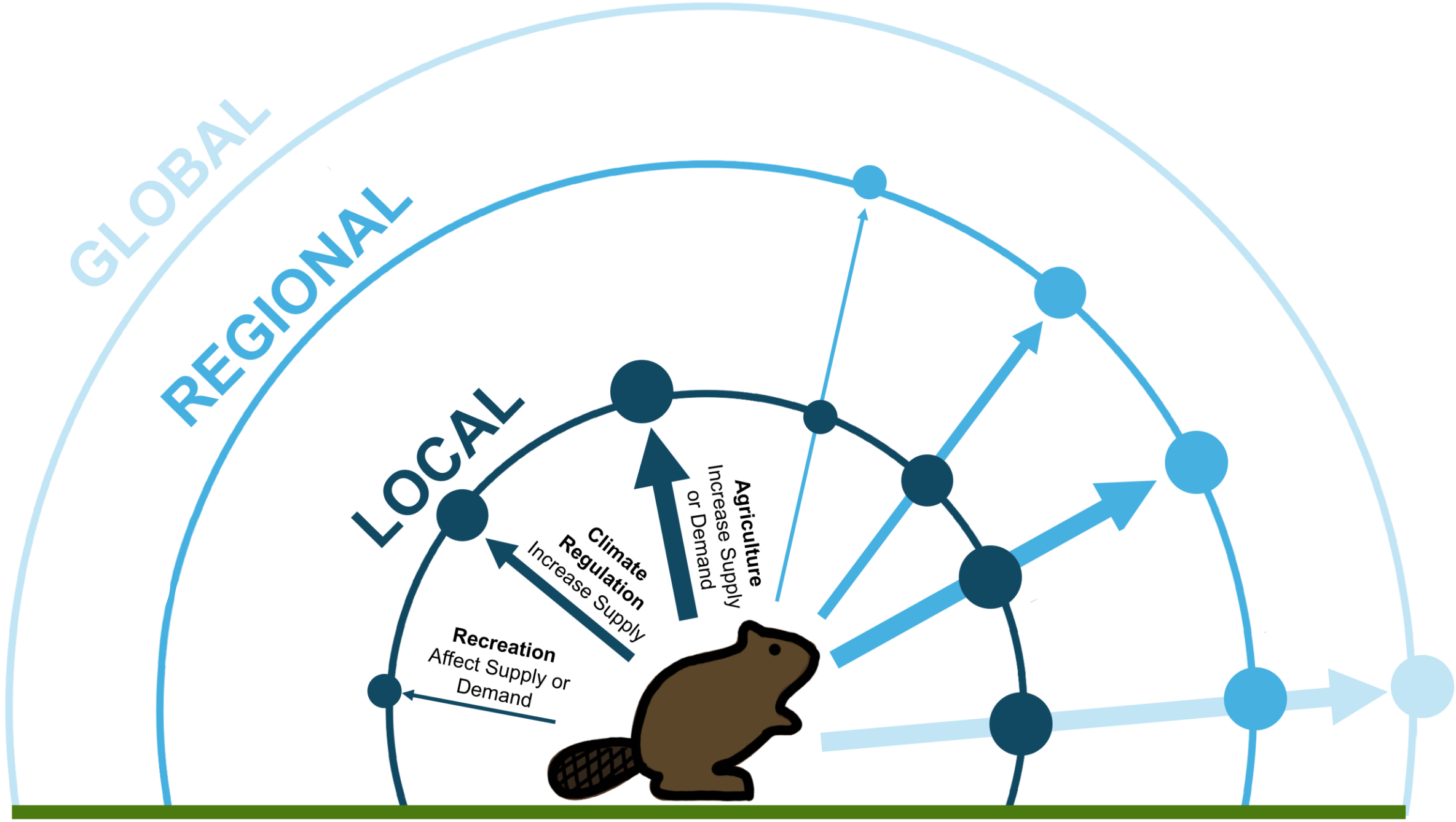
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Agriculture
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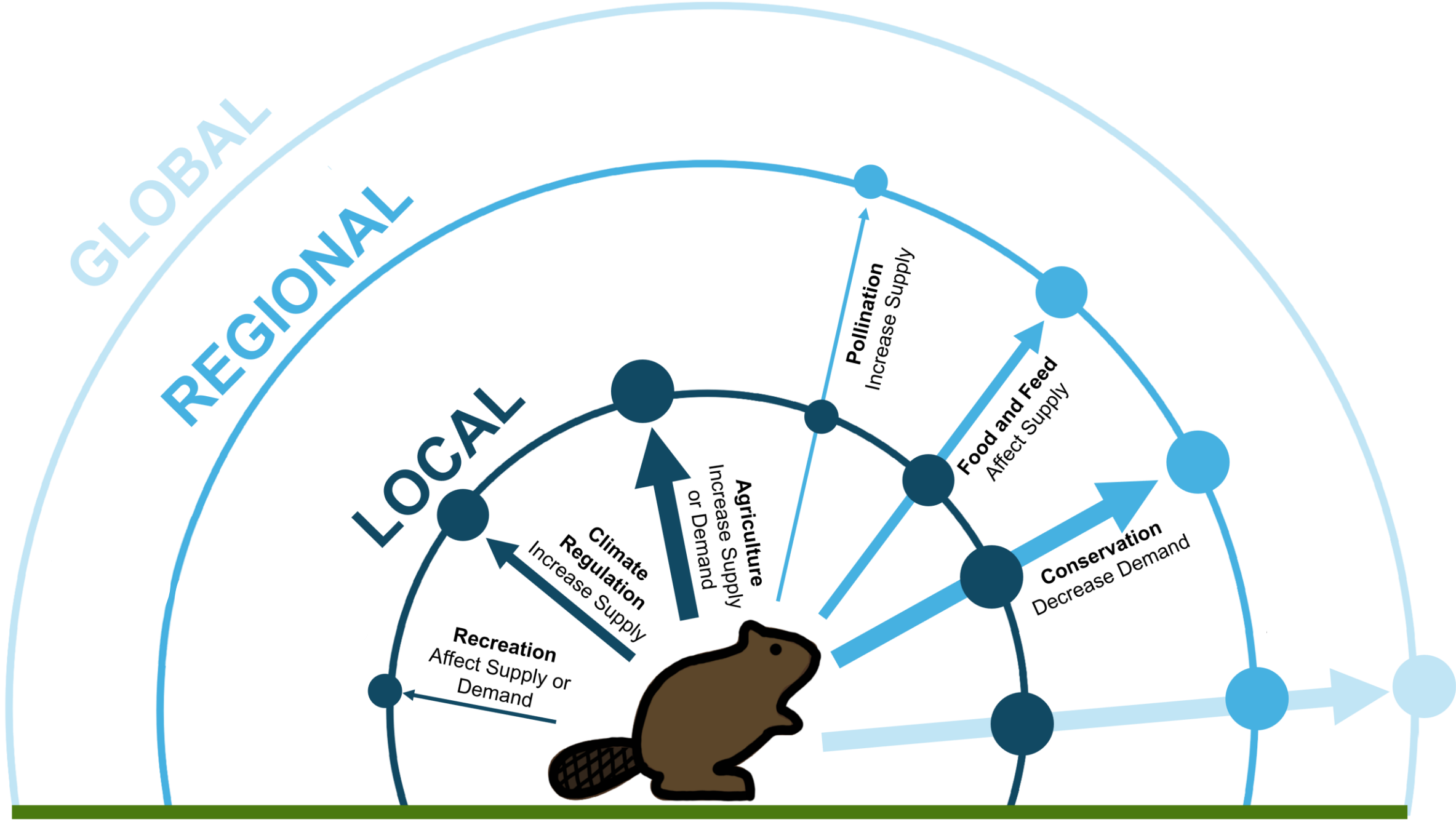
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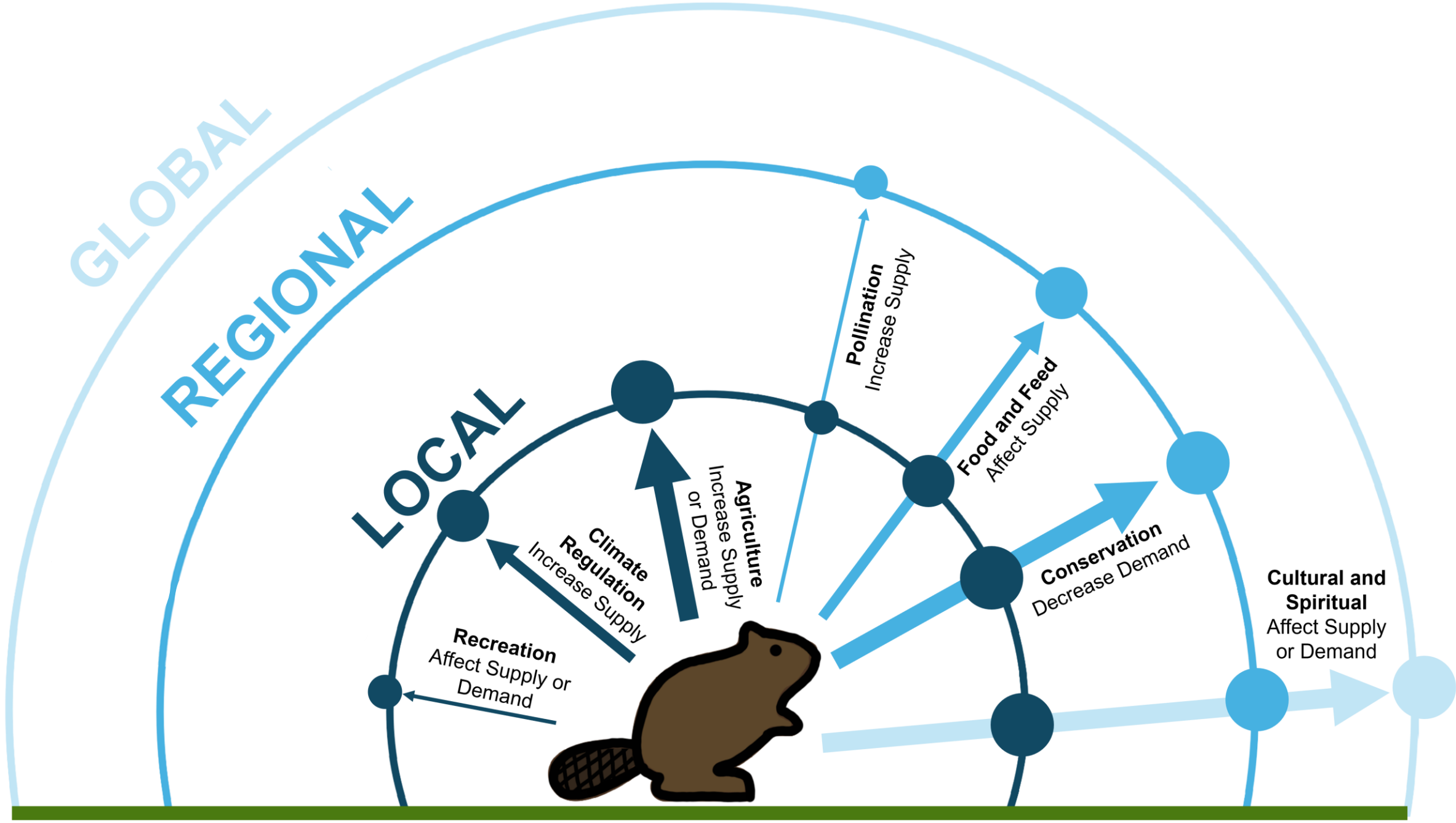
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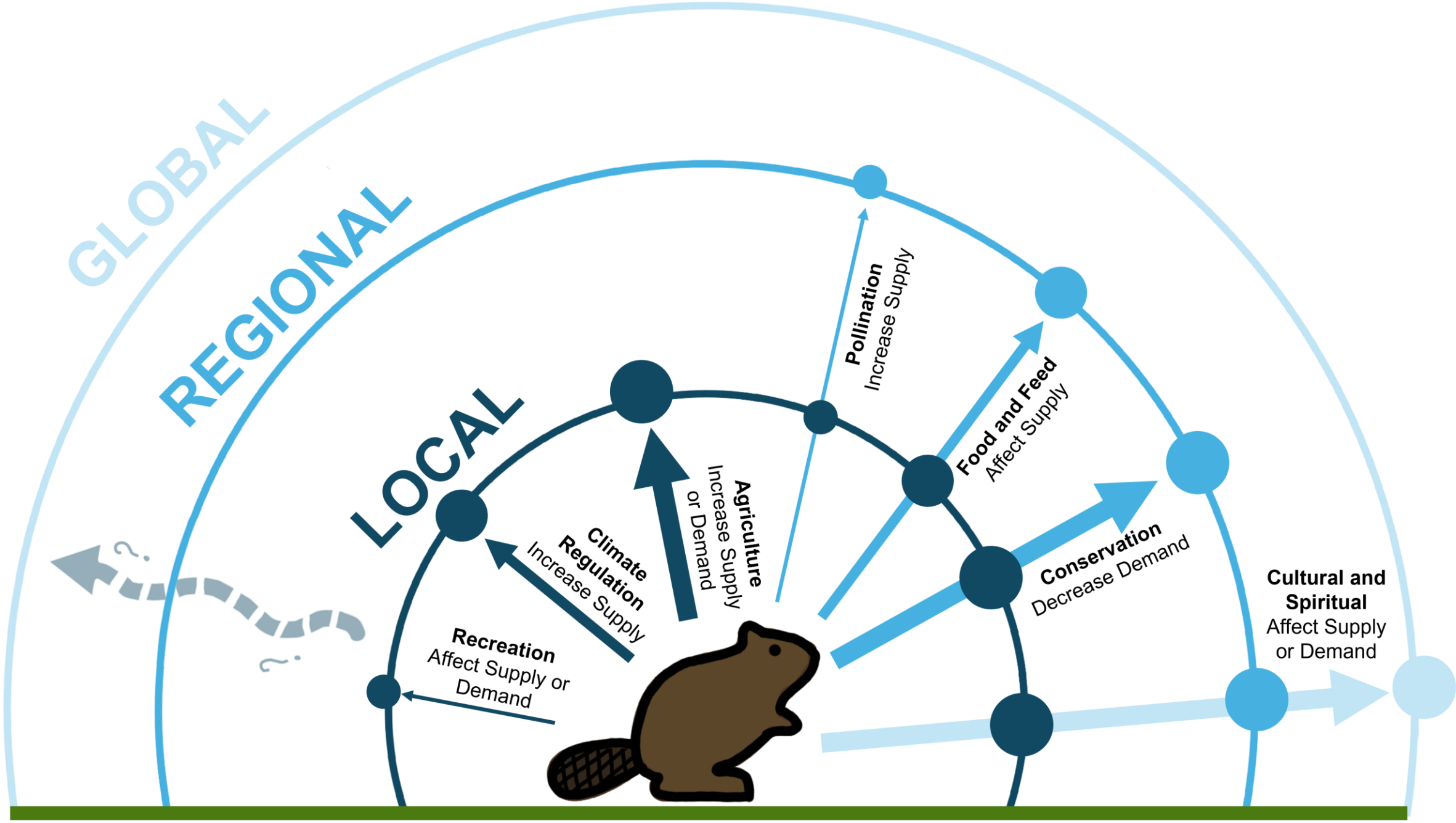
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Virginia Museum of NATURAL HISTORY

Photos: Anna Wheeler, Marshall Boyd

Thank you!

- Fairfax Lab
- Virginia Museum of Natural History Foundation
- Marhsall Boyd (VMNH)
- Anna Wheeler and colleagues, Dan River Basin Association
- Southeast Beaver Alliance
- Center for Adaptable Western Landscapes, Northern Arizona University
- And you!

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