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Evaluation of Ecology of the Fork Area at the Confluence of Assiniboine and Red Rivers in Winnipeg, Manitoba, Canada

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Abstract

The Assiniboine River, a prominent waterway in Winnipeg, Manitoba, Canada is an integral part of the city's geography, history, and culture. The Assiniboine River supports a diverse and dynamic ecosystem. As a tributary of the Red River, the Assiniboine River has played a crucial role in shaping Winnipeg's identity and continues to be a dynamic force that influences the city. The Forks Area in Winnipeg is a vital ecological region located at the confluence of the Red and Assiniboine Rivers. The Assiniboine River area is a thriving ecosystem teeming with a rich variety of flora and fauna. By the evaluation of ecology of this area, we can appreciate the importance of conservation efforts to preserve the natural heritage of this vital watercourse. This paper provides an examination of the ecology along the Assiniboine River and Red River, including the region's biodiversity, the impact of urbanization, conservation efforts, and the importance of preserving this valuable natural resource. The significance of this study lies in its potential to enhance our understanding of the intricate web of life in this area. This research can serve as a model for similar studies in other regions worldwide, particularly those near river confluences.

Key Words: *Biodiversity, Ecosystem, Assiniboine River, Red River, Fork Area, Winnipeg*

1. Introduction

Winnipeg, situated at the confluence of the Red and Assiniboine Rivers in the Canadian Prairies, boasts a unique geographical location. The Assiniboine River, a major tributary of the Red River, flows through the city, historically contributing to Winnipeg's growth and development [1]. The Assiniboine River, forms an integral part of Winnipeg's landscape and environment, profoundly shaping the region's ecology. The Assiniboine River area features diverse landscapes, including riparian zones, wetlands, forests, and grasslands, making it ecologically significant by providing a habitat for a wide array of plant and animal species. It serves as a habitat for diverse plant and animal species and supports various ecosystems [2][3]. Winnipeg, as the capital and largest city of Manitoba in Canada, experiences an extreme humid continental climate with notable variations between summer and winter temperatures (Fig. 1). The city's ecology is influenced by its location, climate, and the various species that inhabit it. The Forks Area, situated at the confluence of the Red and Assiniboine Rivers in Winnipeg, Manitoba, serves as a significant natural and urban ecosystem [4]. This dynamic and diverse environment sustains numerous species of plants and animals and has a rich historical significance as a traditional gathering place and a hub of the fur trade in the 18th and 19th centuries. The Forks, a historic meeting place, and green space in downtown Winnipeg, has been an essential part of the region's history for thousands of years and remains a significant point of interest due to its cultural and historical significance [1][4]. This paper discusses the Assiniboine River's geographical characteristics, historical significance, ecological importance, and contemporary challenges it confronts based on the literature survey and data obtained during site visits between the periods July-November 2022.

1.1 Historical Significance of Assiniboine River

The Assiniboine River has been of immense historical importance to the region [1]. Indigenous communities, including the Assiniboine people from whom the river derives its name, used the waterway for transportation, trade and sustenance. Early European settlers recognized the river's potential for trade and agriculture, leading to the establishment of forts and trading posts along its banks.

The fur trade era, marked by the presence of the Hudson's Bay Company and the North West Company, saw the Assiniboine River as a significant trade route. This historical heritage is still visible in the city's architecture, with remnants of historic forts and trading posts, as well as in cultural events that celebrate the river's role in the region's development.

The Forks has historically been a meeting place for over 6,000 years, with archaeological evidence dating back to around 4,000 BCE, indicating the presence of bison hunters at the site [4].

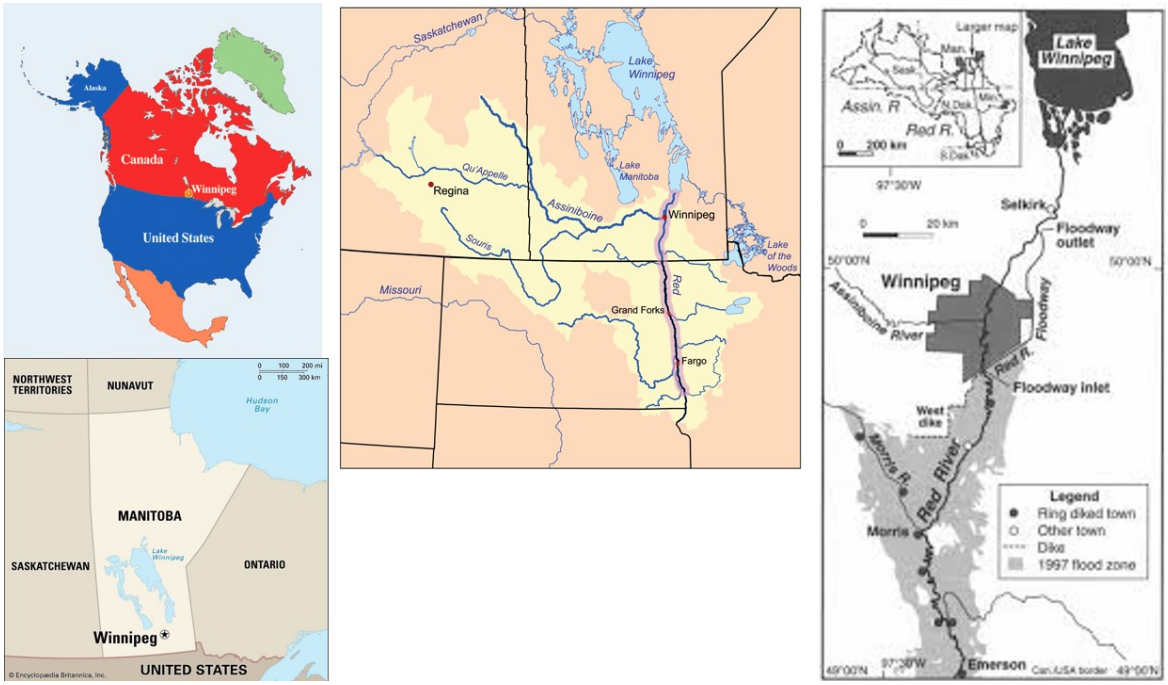

Fig.1 Location map of Winnipeg.

1.2 Geographical Overview

The Assiniboine River, originating in western Manitoba and stretching over 700 kilometers, eventually merges with the Red River in the heart of Winnipeg (Fig. 2) [1]. Along its course, the river meanders through diverse landscapes, including prairies (a very large area of flat land covered in grass with few trees) and forests, significantly influencing the topography and ecology of Winnipeg [5] [6].

This confluence of the Assiniboine River and the Red River at Forks Area has given rise to a unique Y-shaped river system within the city (Fig. 2). The confluence's impact extends beyond natural geography; it has played a pivotal role in shaping urban development, trade, and transportation routes, establishing Winnipeg as a strategic hub for commerce and cultural exchange.

The Forks Area of Winnipeg, spanning approximately 1,130 acres, offers a mix of urban and natural landscapes. It serves as a crucial ecological buffer between Winnipeg and its two major rivers, the Assiniboine River and the Red River. This area boasts an intricate network of wetlands, riparian zones, grasslands, and forested areas, each of which supports unique flora and fauna [6].

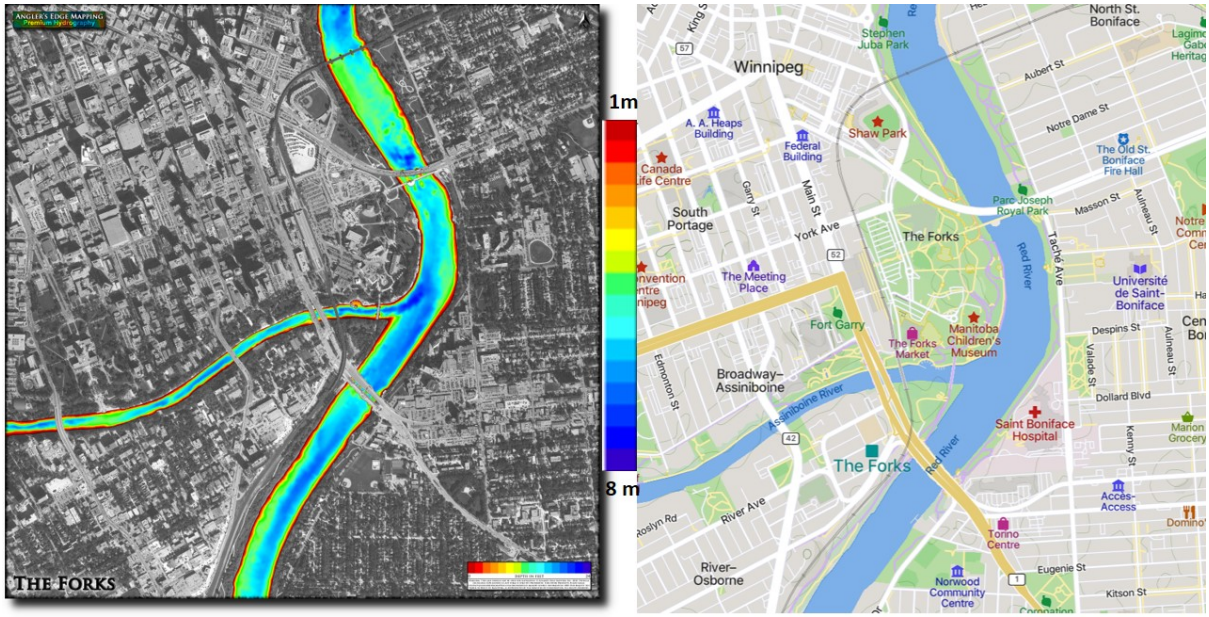

Fig.2 Map of the Fork Area at the Confluence of Assiniboine and Red Rivers in Winnipeg.

The city experiences a humid continental climate, characterized by significant temperature variations between winter and summer, with the latter seeing more rainfall. The average temperature in January dips to a chilly -16.4°C (2.5°F), while in July, it rises to a pleasant 19.7°C (67.5°F). The city receives an annual precipitation of 521.1 mm (20.52 in), with snowfall occurring on approximately 53 days and remaining on the ground for around 132 days each year (Fig. 3) [7].

Climate data for Winnipeg (Winnipeg James Armstrong Richardson International Airport) [hide]
WMO ID: 71852; coordinates 49°55′N 97°14′W; elevation: 238.7 m (783 ft); 1981–2010 normals, extremes 1872–present[a]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high humidex	6.3	11.1	28.0	34.1	40.2	46.1	47.3	45.5	45.9	34.3	23.9	9.3	47.3
Record high °C (°F)	7.8 (46.0)	11.7 (53.1)	23.7 (74.7)	34.3 (93.7)	37.8 (100.0)	38.3 (100.9)	42.2 (108.0)	40.6 (105.1)	38.8 (101.8)	31.1 (88.0)	23.9 (75.0)	11.7 (53.1)	42.2 (108.0)
Average high °C (°F)	−11.3 (11.7)	−8.1 (17.4)	−0.8 (30.6)	10.9 (51.6)	18.6 (65.5)	23.2 (73.8)	25.9 (78.6)	25.4 (77.7)	19.0 (66.2)	10.5 (50.9)	−0.5 (31.1)	−8.5 (16.7)	8.7 (47.7)
Daily mean °C (°F)	−16.4 (2.5)	−13.2 (8.2)	−5.8 (21.6)	4.4 (39.9)	11.6 (52.9)	17.0 (62.6)	19.7 (67.5)	18.8 (65.8)	12.7 (54.9)	5.0 (41.0)	−4.9 (23.2)	−13.2 (8.2)	3.0 (37.4)
Average low °C (°F)	−21.4 (−6.5)	−18.3 (−0.9)	−10.7 (12.7)	−2.0 (28.4)	4.5 (40.1)	10.7 (51.3)	13.5 (56.3)	12.1 (53.8)	6.4 (43.5)	−0.5 (31.1)	−9.2 (15.4)	−17.8 (0.0)	−2.7 (27.1)
Record low °C (°F)	−44.4 (−47.9)	−45.0 (−49.0)	−38.9 (−38.0)	−27.8 (−18.0)	−11.7 (10.9)	−6.1 (21.0)	1.1 (34.0)	−1.1 (30.0)	−8.3 (17.1)	−20.6 (−5.1)	−36.7 (−34.1)	−47.8 (−54.0)	−47.8 (−54.0)
Record low wind chill	−56.4	−57.1	−49.6	−35.8	−20.8	−7.9	0.0	0.0	−11.5	−24.2	−48.1	−50.6	−57.1
Average precipitation mm (inches)	19.9 (0.78)	13.8 (0.54)	24.5 (0.96)	30.0 (1.18)	56.7 (2.23)	90.0 (3.54)	79.5 (3.13)	77.0 (3.03)	45.8 (1.80)	37.5 (1.48)	25.0 (0.98)	21.5 (0.85)	521.1 (20.52)
Average rainfall mm (inches)	0.2 (0.01)	2.7 (0.11)	9.7 (0.38)	19.2 (0.76)	54.1 (2.13)	90.0 (3.54)	79.5 (3.13)	77.0 (3.03)	45.5 (1.79)	32.7 (1.29)	6.9 (0.27)	1.5 (0.06)	418.9 (16.49)
Average snowfall cm (inches)	23.7 (9.3)	12.5 (4.9)	16.5 (6.5)	10.6 (4.2)	2.6 (1.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.3 (0.1)	4.8 (1.9)	19.9 (7.8)	23.0 (9.1)	113.7 (44.8)
Average precipitation days (≥ 0.2 mm)	12.2	8.0	9.2	7.2	11.5	13.3	11.4	10.7	10.4	9.4	10.3	11.8	125.3
Average rainy days (≥ 0.2 mm)	0.67	0.93	2.9	5.1	11.3	13.3	11.4	10.7	10.3	7.9	3.0	0.84	78.3
Average snowy days (≥ 0.2 cm)	12.4	7.7	7.4	2.9	0.56	0.0	0.0	0.0	0.11	2.3	8.6	11.5	53.5
Average relative humidity (%)	72.7	71.7	68.5	49.1	46.7	54.5	55.6	52.4	54.8	60.1	72.0	75.1	61.1
Mean monthly sunshine hours	114.7	133.9	181.9	241.4	285.2	276.3	308.3	281.4	189.0	147.4	93.9	99.5	2,352.9
Percent possible sunshine	42.9	47.2	49.5	58.6	59.8	56.6	62.6	62.8	49.8	44.1	34.4	39.2	50.6

Source: Environment and Climate Change Canada[70][71][72]

Fig.3 Climate data of Winnipeg (https://en.wikipedia.org/wiki/Geography_and_climate_of_Winnipeg).

1.3 Geology of Winnipeg

The Winnipeg is situated at the bottom of the Red River Valley, a low-lying floodplain characterized by an exceptionally flat topography with gentle undulating surface near River banks (Fig. 4). This valley was carved out by the ancient glacial Lake Agassiz, leaving behind rich deposits of black soil. The region's geological composition spans a variety of bedrock types, from the ancient Precambrian rock of the Canadian Shield to more recent sedimentary rock formations [8]. The Precambrian rocks are predominantly composed of granites and granite gneisses, accompanied by volcanic rocks and ancient metamorphosed sedimentary rocks. Overlaying the Precambrian rock is sedimentary rock, deposited during the last ice age by the expansive glacial lake, Lake Agassiz, which once occupied south-central Manitoba. This lowland terrain features sedimentary layers resting atop rocks formed during the Ordovician, Silurian, and Devonian periods, which span from 485 to 359 million years old. The Winnipeg Formation serves as the basal sedimentary unit in much of southern and central Manitoba, Canada, functioning as a regional aquifer across a significant portion of its extent. This aquifer plays a vital role as a water source, particularly in southeastern Manitoba and Manitoba's Interlake area.

Fig. 4 Gentle undulating surface covered with grass during summer and with snow in winter.

1.4 Hydrology

The Assiniboine River, spanning 1,070 kilometres as it courses through the prairies of Western Canada in Saskatchewan and Manitoba, is a key tributary of the Red River. It encompassing a drainage area of 153,000 square kilometres at Headingley. Its meandering character features a single primary channel, which meanders within a flat, shallow valley in some sections and a steeper valley in others. Notably, the Assiniboine River's main tributaries include the Qu'Appelle, Souris, and White sand Rivers. The confluence of the Assiniboine River and the Red River, known as The Forks, stands as a significant hydrological feature in Winnipeg, Manitoba, Canada.

The hydrology of this area has been significantly impacted by the flow of water from melting glaciers at the end of the last glaciation period. The spillway valley floor serves as a natural floodplain for the river, and the valley itself has ample storage capacity. This makes it possible to construct the Shellmouth Dam north of Russell, both technically and economically [9]. The dam is designed to reduce flood damage for Winnipeg and other communities along the Assiniboine River.

2. Environmental factors

2.1 Environmental Importance of Assiniboine River

The Assiniboine River, along with its tributaries, serves as an essential natural resource for the region. It provides critical habitat for a variety of wildlife and fish species. The river also supports agriculture through irrigation, enhancing the fertile lands surrounding it.
However, the river faces environmental challenges. Pollution, sedimentation, and habitat degradation have impacted its ecological health. Conservation efforts are ongoing to protect and restore the river's ecosystem, highlighting the significance of the Assiniboine River in sustaining both natural and human communities.

2.2 Environmental impact of suspended sediments in the Rivers

Within the flat Red River plain, the gradient is considerably less, resulting in lower velocity for the river water flowing through the delta reach. Consequently, the sediments carried by the river waters get deposited onto the plain. The Red River is notable for its abundance of suspended sediment, particularly during flood events that lead to the erosion of riverbanks. This sediment serves as a reservoir for certain chemicals released into the environment, posing potential harm to aquatic species. Additionally, an increased sediment load can make water treatment for human consumption more challenging. This problem in the Winnipeg is experienced in the downstream part of the Confluence of Assiniboine River and Red River.

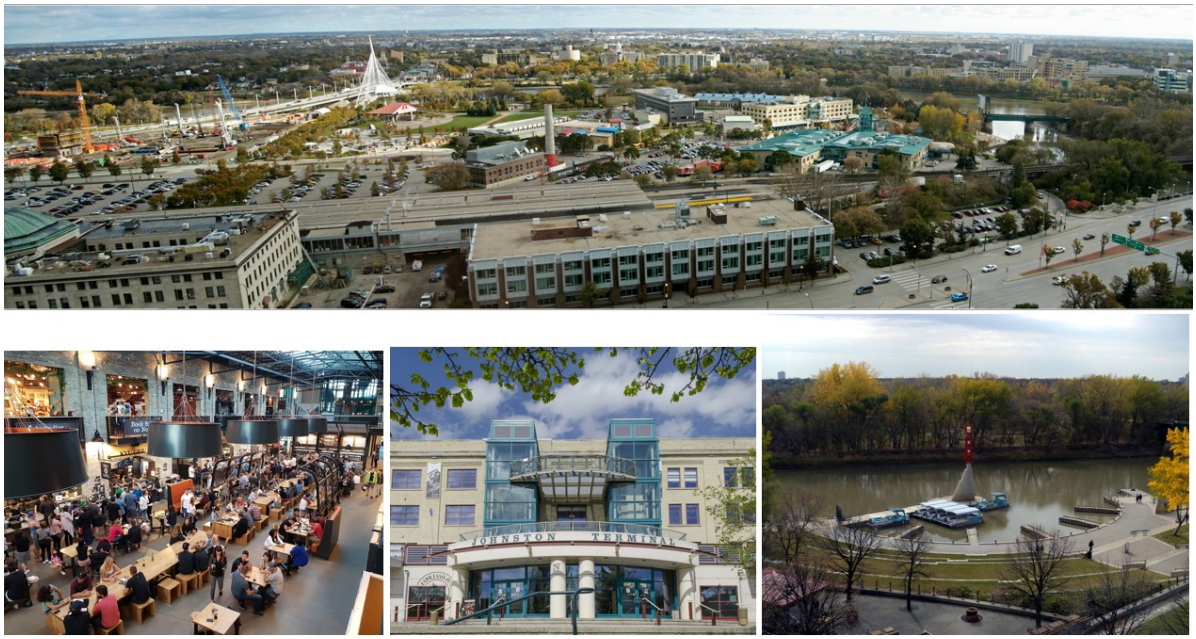

Fig. 5 Urbanization of Winnipeg (Fork Area).

2.3 Environmental Challenges

The Assiniboine River is a significant factor in the urban development of Winnipeg. However, the river poses a risk of flooding, particularly during the spring thaw when it is prone to overflowing. The Fork Area is ecologically significant but faces several environmental challenges [10]. These challenges include urban development, pollution, invasive species, and climate change, all of which threaten the area’s delicate balance. Urbanization and habitat fragmentation can disrupt wildlife corridors and reduce available habitat for native species (Fig. 5). Pollution stemming from storm water runoff and industrial sources poses a significant threat to water quality. Invasive species' proliferation can outcompete native flora and fauna. Additionally, climate change is altering the area's hydrology and impacting the timing of migrations and breeding for many species [11].

To address these challenges, sustainable land management practices such as agroforestry, perennial crops, organic amendments, etc., can increase carbon content of soil and vegetation cover and provide both local and immediate adaptation

benefits combined with global mitigation benefits in the long term. Additionally, green infrastructure planning can help cities become more resilient to climate change effects.

3. Biodiversity

The Assiniboine River and its adjacent riparian zones, as well as the Fork Area, exhibit rich and diverse biodiversity. The river and its riverbanks are thriving with various plant species, including cottonwood trees, willows, and grasses. These riparian habitats are essential breeding and nesting grounds for a multitude of bird species, encompassing waterfowl, songbirds, and raptors.

Within the river, a diverse range of fish species, including northern pike, walleye, and catfish, inhabit its waters, drawing anglers to the area. Amphibians and reptiles contribute further to the overall biodiversity of the region. Similarly, the Fork Area is a biodiversity hotspot, hosting a wide variety of plant and animal species. This region supports numerous migratory birds, making it a crucial stopover point along the Central Flyway, and the riverbanks and wetlands are inhabited by a diverse range of aquatic species, including fish, amphibians, and invertebrates. Additionally, terrestrial mammals, such as white-tailed deer, red foxes, and raccoons, find a home within this area, further enriching the overall biodiversity of the region.

3.1 Flora

Riparian Vegetation: The riverbanks of the Assiniboine River are adorned with a variety of plants, including cottonwood trees, Maple Trees, willows, and wildflowers (Fig. 6). These riparian habitats provide shelter and nesting sites for numerous bird species and serve as a buffer against erosion.

Fig. 6 Transition of Maple Tree Leaves from summer to fall.

Wetland Plants: Wetlands along the riverbanks host plants like cattails, water lilies, and bulrushes. These plants play a crucial role in maintaining water quality, providing habitats for amphibians and insects, and supporting the overall biodiversity of the region.

Grasslands and Forests: The areas adjacent to the river are dotted with grasslands where prairie grasses, such as big bluestem and switch grass, thrive. Mixed forests comprising species like oak, poplar, and spruce contribute to the ecological richness of the Assiniboine River area, providing habitats for various mammals, birds, and insects.

3.2 Fauna

Avian Species: The Assiniboine River area is a haven for birdwatchers, with species such as waterfowl, herons, bald eagles, and songbirds gracing the skies. Migratory birds such as Geese also frequent the region, making it a vital stopover point during their journeys (Fig. 7 and 8).

Fig. 7 Group of Geese (Gaggle) on the Ground of Fork Area.

Aquatic Life: The River itself is home to diverse aquatic life, including several species of fish like northern pike, walleye, and catfish. Insects, crustaceans, and mollusks also thrive in the river's waters, serving as a vital food source for various bird and mammal species.

Terrestrial Mammals: The Assiniboine River area is inhabited by a variety of mammals, including white-tailed deer, beavers, muskrats, and coyotes. These animals play essential roles in the ecosystem, contributing to seed dispersal, habitat modification, and pest control.

3.3 Impact of Urbanization

Winnipeg's growth and urban development have presented both opportunities and challenges for the ecological health of the Assiniboine River corridor. Urbanization has led to habitat loss, increased pollution, and alterations to the river's hydrology. Impervious surfaces and storm water runoff from urban areas can lead to water quality issues, sedimentation, and reduced habitat quality.

The presence of invasive species, such as common carp, has disrupted the natural balance of the river's ecosystem. The encroachment of urban development along the riverbanks has further exacerbated these challenges.

Fig. 8 Geese and Gosling adapted Fork Area Environment.

3.4 Conservation of Ecological Diversity

Efforts to protect and preserve the ecological diversity of the Assiniboine River and its surrounding areas are well underway. These initiatives encompass various strategies, including the restoration of riparian habitats, invasive species control, and the improvement of water quality. The central goal of these conservation programs is to strike a balance between urban development and ecological sustainability.

Collaborative projects involving the city and various organizations are focused on the development of green spaces and the creation of buffer zones along the riverbanks to mitigate the impact of urbanization. In parallel, public awareness campaigns have played a crucial role in engaging the community in these conservation efforts.

The ecological well-being of the Assiniboine River holds profound significance, benefiting not only local biodiversity but also the community's overall quality of life. Healthy ecosystems provide clean water, clean air, and recreational opportunities for both residents and visitors. Moreover, the river corridor serves as a living laboratory for environmental education and remains a valuable asset for the city.

It's important to note that preserving the Assiniboine River's ecology aligns with broader global conservation goals, including the protection of freshwater resources, the fight against climate change, and the preservation of diverse species.
The conservation efforts in the Fork Area have a rich history, with the municipal government of Winnipeg collaborating closely with environmental organizations and local communities to implement protective measures and restoration projects. These initiatives encompass the establishment of designated conservation areas, the adoption of sustainable land management practices, and the removal of invasive species, all with the overarching aim of preserving and restoring the unique ecosystems of the Fork Area.

Sustainable management and ongoing conservation efforts are of paramount importance in safeguarding the ecological health of the Fork Area. This includes the continued protection of natural habitats, vigilant water quality monitoring, and the promotion of sustainable urban planning practices. Public awareness and education campaigns serve as effective tools for garnering support for these initiatives and actively engaging the community in the protection of this vital urban ecosystem.

4. Discussions

The Assiniboine River of Winnipeg is a symbol of the city's rich history and its enduring connection to its natural surroundings including Forks area at the confluence of Assiniboine River and Red River [1]. It has played a crucial role in shaping Winnipeg's identity, serving as a reminder of the intricate relationship between urban centers and their natural environment.

As Winnipeg faces contemporary challenges, the preservation and sustainable management of the Assiniboine River are of paramount importance [10] [11]. This river offers valuable insights into the interplay between natural resources and urban development, serving as a model for other cities with similar ties to their waterways. Understanding the significance of the Assiniboine River underscores the profound impact that such rivers can have on the development and character of urban areas.

The Assiniboine River is a dynamic and diverse ecosystem that demands careful conservation efforts to ensure its long-term vitality, particularly in the face of ongoing urbanization. Striking a harmonious balance between development and the protection of the river's ecological treasures is essential for the region's future well-being.

The river's ecological health not only benefits local biodiversity but also enhances the quality of life for Winnipeg's residents [2] [3]. Preserving this natural wonder requires the active participation and collaboration of the government, organizations, and the community, making it a shared responsibility to safeguard this valuable resource for both current and future generations [9].

5. Conclusions

The Assiniboine River area in Manitoba, Canada, stands as a testament to the wonders of biodiversity, with its lush flora and diverse fauna creating a vibrant ecosystem that underscores the beauty and complexity of nature. By appreciating and conserving the unique plant and animal life in this region, we can secure a sustainable future for both the wildlife and the communities that depend on this precious natural resource.

The Fork Area in Winnipeg, Manitoba, is a remarkable urban-nature interface crucial to the region's ecology. Its diverse ecosystems and rich biodiversity make it a critical area for conservation. Addressing environmental challenges and implementing sustainable management practices are crucial for preserving this unique ecological treasure. This ensures the continued provision of valuable ecosystem services and contributes to the community's well-being for future generations. Similar studies could be beneficial in other parts of the world, particularly in regions near the confluence of two rivers. This would enhance our understanding and management of ecosystems in these areas.

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Author's Biography

Dr. Indra Prakash is a highly accomplished professional with more than 45 years of experience in geotechnical engineering, groundwater, environmental engineering, and geological engineering. He holds a Ph.D. in Geology (Geological Engineering), and his career has been marked by significant contributions, particularly during his tenure in the Geological Survey of India, where he served until 2012, ultimately attaining the position of Deputy Director General. Dr. Prakash's current work is focused on collaborative international research in Environmental Engineering and Civil Engineering, using Geographic Information Systems (GIS) and Machine Learning techniques. He has supervised Ph.D. research and played a key role at the Bhaskaracharya Institute for Space Applications and Geoinformatics (BISAG). His research interests span geotechnical engineering, environmental engineering, groundwater studies, and flood and landslide modeling, with numerous publications to his name. His active involvement in professional associations and editorial roles in international journals underpin his distinguished career. Dr. Indra Prakash's extensive experience and contributions have significantly advanced the use of geospatial and machine learning technologies in these fields. He is an active member of professional associations like the Indian Society of Engineering Geology and the Indian Society of Remote Sensing, and he has served as a reviewer and guest editor for various international journals. Dr. Indra Prakash is also a prolific author, having published two books and over 200 research contributions. Some of his selected publications have appeared in renowned journals, such as "Geocarto International" and "Knowledge-Based Systems."