LOWER MISSION CREEK HABITAT CONSERVATION & RESTORATION PLAN

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MISSION CREEK
RESTORATION INITIATIVE

PLAN ACKNOWLEDGEMENTS

ACKNOWLEDGEMENTS

This Plan would not have been possible without the longstanding support of Mission Creek Restoration Initiative (MCRI) Steering Committee organizations, and the dedication, knowledge, and foresight of their representatives.

MCRI Committee Organizations

- Ministry of Forests, Lands, Natural Resources and Rural Development (MFLNRORD) – Fisheries Section; Water Stewardship Division
- City of Kelowna – Planning Department; Parks Department
- Regional District Central Okanagan (RDCO) – Planning Department; Parks Department
- Okanagan Nation Alliance (ONA) – Fisheries Department
- Westbank First Nations
- Central Okanagan Land Trust
- Friends of Mission Creek
- BC Conservation Foundation

Consultants

- Okanagan Nation Alliance – Conceptual restoration designs; Plan Section 10 content
- Dobson Engineering/Watershed Engineering – Conceptual designs engineering support
- Alliance Communications – Plan editing, formatting, and layout; MCRI outreach
- Matthews Environmental Consulting – Plan author; MCRI committee coordination; project management

Funding

MCRI also extends its gratitude to the following for their strong funding support throughout Plan development.

Habitat Conservation Trust Foundation

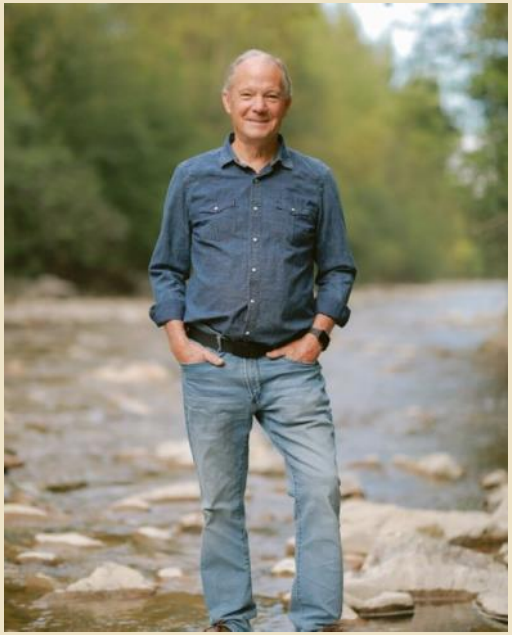
Okanagan Basin Water Board

Freshwater Fisheries Society of BC

Okanagan Nation

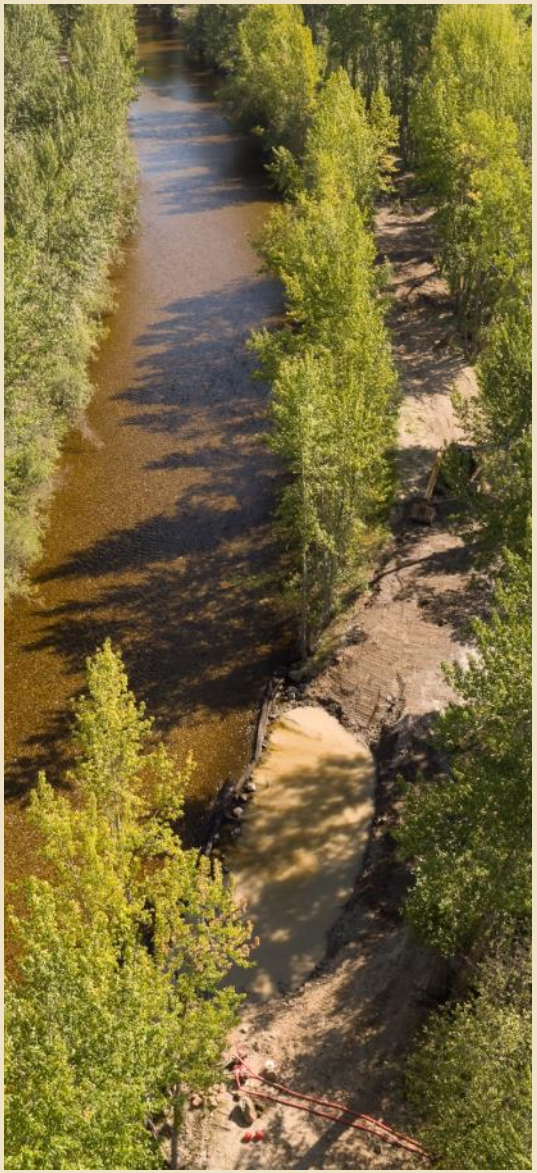
We acknowledge that our work occurs in the traditional, ancestral, unceded territory of the Syilx/Okanagan people.

syilx Okanagan Nation Alliance



The Plan is dedicated to the memory of Don Dobson (1947-2021). He was a long-time member of the MCRI, and was instrumental in the delivery of several Mission Creek habitat-restoration projects and the restoration designs presented in the Plan. He will always be remembered for his wide-ranging expertise, work ethic, professional and respectful approach, and his kind and generous personality. His legacy will be long and strong.

TABLE OF CONTENTS



TABLES

EXECUTIVE SUMMARY

MISSION CREEK is critically important to the Okanagan Basin. It is a major source of environmental, social, cultural, recreational, economic, and water-supply benefits. Our ability to access these benefits has declined dramatically over time due to post-colonial land-development impacts on creek function, fish and wildlife habitat, water quantity, and water quality, particularly within lower Mission Creek.

If we do not act to conserve and restore these values, species reliant on aquatic and riparian habitat will continue to decline, along with the associated benefits they provide. Equally important, flood risks will increase, especially in light of climate-change modeling that projects changes in peak flow, timing, and increased intensity.

Habitat restoration can significantly enhance flood protection, as well as water quantity and water quality outcomes, benefiting the ecosystem and local communities. This document (the Plan), prepared by the Mission Creek Restoration Initiative (MCRI) Steering Committee, combines the wealth of knowledge available to support restoration, and provides recommendations to help conserve and restore Mission Creek's critical ecosystem and flood-protection services.

Through the MCRI, considerable restoration progress has been achieved, including delivery of a large-scale restoration project in lower Mission Creek downstream of Casorso Road Bridge. The goal of the Plan is to build on that past work and offer guidance for continued collaboration to protect and restore this high-value ecosystem and ensure flood-protection needs are addressed into the future.

The scope of the Plan extends upstream 12 km from the confluence with Okanagan Lake to the East Kelowna Road Bridge. This area was chosen due to the high level of human impacts, the historical importance of this section for fish and wildlife, and the high potential for environmental and flood-protection improvements.

In addition to providing restoration recommendations, the Plan documents the history and ecology of Mission Creek to provide a starting point for understanding its importance to Syilx Okanagan Nation, the local community, and the wider Okanagan Basin.

Mission Creek supports many fish species, including Okanagan Lake kokanee and rainbow

ISSUES ADDRESSED BY THE PLAN

Land-development activities, including channelization for flood control, resulted in severe loss of fish and wildlife habitat and supported populations. This is evident in the 1938 and 2009 aerial photos below. Historically (top photo), Mission Creek meandered 120 metres across the valley bottom and was about 30 kilometres long. Channelization in the 1950s reduced creek width to 30 metres and its length to about 11 kilometres (lower photo). This led to higher gradients and water velocities, leading to reduced channel stability and flood-plain functionality.

wildlife species, many designated as endangered or at risk. These natural assets generate numerous recreational and economic benefits, including the intensively used Mission Creek Greenway recreation corridor and the Okanagan Lake recreational fishery, which has generated up to $12 million in annual angler expenditures locally and provincially. In addition, the long-standing cultural and spiritual importance of the creek to Syilx Okanagan Nation is well documented, and is represented in the Plan through ongoing input and technical support from the Okanagan Nation Alliance.

Habitat conservation and restoration recommendations presented in the Plan were developed at a conceptual level based on technical feasibility for achieving flood-protection and ecosystem objectives. Before determining if a recommendation can proceed to an on-the-ground project, the necessary funding and land requirements, permitting, and engineering must be addressed. Restoration also depends on collaboration with many partners to secure the resources needed to support future project implementation.

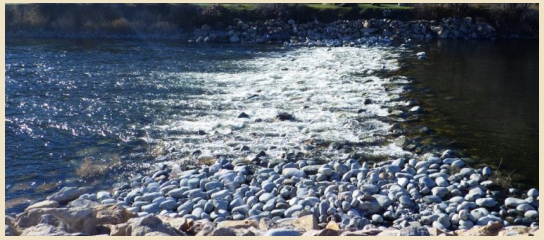
Mission Creek has been extensively studied, revealing its hydraulic power, past failures from attempting to control this power, and the best course of action to improve flood-protection and habitat conditions. Based on these findings, the Plan's highest-priority recommendation is to conserve remaining fish and wildlife habitat in areas where current values are high and retention is a viable option. By preserving quality habitat, and allowing it to continue to supply ecological services without human intervention, we avoid the cost of replacing the services it provides.

Where restoration is needed, setting back dikes to expand the floodplain is another high-priority recommendation in areas where this approach is feasible, providing the most effective way to prevent flood damage and support critical ecosystem functions. Creating space for the creek to maintain habitat and ecosystem processes avoids long-term maintenance interventions and costs. Research has indicated that costs associated with setting dikes back can be lower than rebuilding existing dikes to accommodate projected flow increases expected with climate change.

The Plan recognizes that floodplain expansion is a long-term undertaking with challenges that may be difficult to overcome in some locations. As a result, recommendations are included for smaller-scale creek-bed restoration projects with lower funding and land-securement requirements, facilitating delivery of on-the-ground projects over the short term. These recommendations include re-establishing riffle-pool sequences to restore creek bed stability and habitat diversity. These interventions are meant to replicate processes that would occur naturally if the creek was given space.

PLAN SOLUTIONS

If no action is taken, creek values will continue to decline and flood risk will increase. The Plan provides recommendations for lower Mission Creek aimed at restoring ecosystem values and improving flood protection. This includes floodplain expansion to restore natural creek and floodplain function as was undertaken by MCRI in 2016-2019 (top photo) and riffle installation (lower photo) to improve creek channel stability and fish habitat.



Sediment-capture basins are also recommended in the uppermost section to facilitate ongoing removal of large sediment volumes transported from the upper watershed. This project is critical in the near term to protect downstream riffle-pool projects and existing aquatic habitat values. Concurrently, preparations for responding to potential land-securement opportunities as they arise to support future floodplain expansion should also be a priority focus.

Partnerships have been vitally important in the delivery of all MCRI projects, including development of this Plan. A wide range of organizations are represented on the steering committee, including federal, provincial, local, and Syilx Okanagan Nation governments, the Okanagan Nation Alliance, and local community organizations. These partners have provided direction, oversight, and expertise through all phases of Plan development. MCRI is also linking its work to related resource-management plans and studies to foster greater support, facilitate collaborative project planning, and increase access to implementation resources.

The Plan is designed to be adapted and implemented in phases over time based on need, opportunity, and available resources to maximize benefits for fish, wildlife, and people for many future generations. As a living document, it will be updated as needed to reflect changing priorities as well as new perspectives from science and Syilx Okanagan Nation Traditional Ecological Knowledge.

The Plan builds on significant past MCRI successes and outlines next steps for restoring the wealth of benefits this creek once generated, while enhancing climate-change resilience for local communities. Through direction outlined in the Plan, and continued focus on partnerships and collaboration, the outlook for Mission Creek will be much brighter moving forward.

SUMMARY OF KEY PLAN RECOMMENDATIONS

A brief overview of habitat conservation and restoration recommendations is provided below. Detailed site-specific recommendations with supporting information are presented in Section 10 and Appendix 1.

Okanagan Lake to Lakeshore Drive Bridge

- Due to channel and adjacent land constraints, current recommendations are limited to ensuring fish passage is maintained over time, particularly during low-flow conditions.

Lakeshore Drive Bridge to Burbank Street

- Where feasible, conserve existing pockets of kokanee spawning habitat and intact riparian habitat.
- The highest priority for restoration is to expand the channel and floodplain with a setback dike throughout this section where opportunities for property purchase or a Conservation Covenant come available, funding can be secured, and any existing infrastructure limitations can be addressed.
- Recognizing dike setback will require a long-term focus in many locations within this section to address funding and land requirements, riffle additions within identified locations are recommended as interim measures to improve aquatic habitat diversity and channel stability according to the following:
  - In the short term, focus on riffle construction within the upper half of this section where channel expansion requirements are low
  - The lower half of this section will also benefit from riffle construction, but will generally require a longer-term approach due to the need for channel expansion to accommodate riffle structures.
  - If floodplain expansion is not feasible in the short term, aim to proceed with sediment basin/s construction upstream of Cottonwood Pedestrian Bridge within 5-10 years to address ongoing sediment deposition issues in lower Mission Creek. Specific location will be determined following engineering investigations.

Burbank Street to 300 meters upstream of East Kelowna Road Bridge

- Habitat conservation and protection should be the primary focus based on quality and quantity of existing habitat and lower flood risk, recognizing some site-specific actions may be required in the future if significant habitat issues emerge.

SECTION 1: INTRODUCTION

MISSION CREEK is the largest tributary flowing into Okanagan Lake, contributing important ecological and human benefits. In pre-colonial times it meandered freely within an expansive floodplain corridor, with natural geography being the only control on creek form and function. Available historical records indicate this creek once supported exceptionally high levels of habitat diversity, quality, quantity, and ecosystem productivity.

Flood-protection works undertaken in lower Mission Creek in the 1950s, in addition to other land-development activities over time, caused major loss of aquatic and riparian habitat and dramatic declines in fish and wildlife populations. Recent assessments indicate stream-channel degradation is continuing and expected to increase with climate change.

Experts predict that without a substantial focus on conservation and restoration, habitat loss will increase over time and jeopardize future sustainability of some fish and wildlife populations. Other potential impacts include reduced water quality and quantity as well as diminished social, cultural, recreational, and economic benefits.

Considering the intense level of agricultural and residential development within the historical floodplain of Mission Creek and associated habitat loss since colonization, it is clear the creek cannot be returned to its former state.

However, based on levels of fish production the creek once supported and opportunities for habitat restoration over time, the creek presents excellent potential for increasing fish and wildlife production.

Due to the importance of Mission Creek as a kokanee and rainbow trout producer for Okanagan Lake, mitigation of habitat losses has been identified as the key priority by government fisheries managers in the Okanagan for more than 30 years.

The *Okanagan Basin Study (*1970s) and the *Okanagan Lake Action Plan* (1996-2008) highlighted the importance of Mission Creek for Okanagan Lake fish production and associated contributions to the largest recreational fishery in the Okanagan Basin. In addition, wildlife studies identified the importance of Mission Creek riparian habitats for a wide range of species, including many listed as at-risk

MISSION CREEK
RESTORATION INITIATIVE

MCRI is a multi-phase, multi-stakeholder effort directed and overseen by a steering committee with representatives from federal, provincial, First Nation, and local governments, along with local environmental organizations.

provincially and federally. While those studies led to a strong focus on regulatory-based habitat protection, it was obvious habitat loss had been extreme and restoration would be needed to ensure sustainable populations over the long term.

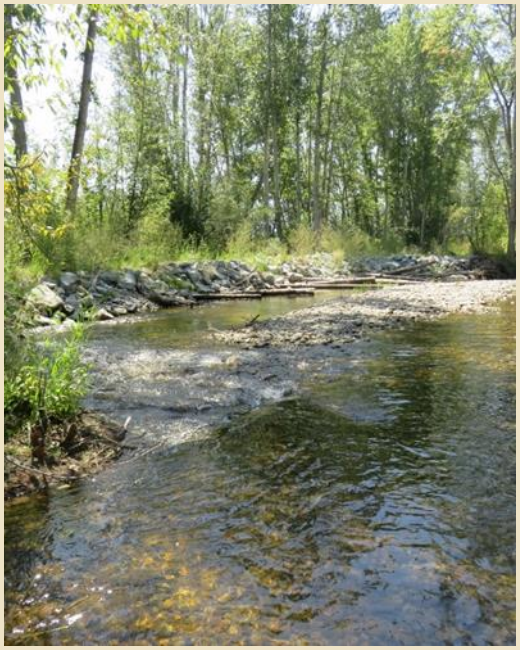
MCRI's first large-scale habitat restoration project re-naturalized floodplain function and re-established important fish habitat features within Mission Creek between Casorso Road and Gordon Drive.

To inform and guide Mission Creek restoration planning and implementation efforts, the MCRI was launched in 2003. Guided by a steering committee of representatives from federal, provincial, local and Syilx Okanagan Nation governments, along with local environmental organizations, MCRI's mandate is to protect and restore Mission Creek and Its ecological, social, cultural, recreational, and economic values. To date, MCRI has undertaken several important projects, including baseline monitoring, large-scale habitat restoration, associated effectiveness monitoring, and preliminary restoration planning.

To guide MCRI's future habitation restoration efforts, the Lower Mission Creek Habitat Conservation and Restoration Plan (the Plan) was completed in 2022. The Plan provides comprehensive strategy recommendations for protecting and restoring fish and wildlife habitat within the lower 12 kilometres of creek where habitat loss has been the most severe. Plan objectives are primarily focused on increasing productivity, diversity, and resilience of aquatic and riparian populations over the long term, and ensuring the current level of flood protection is maintained or improved.

Plan development was directed and overseen by the steering committee and involved large in-kind contributions of time, along with funding from the Habitat Conservation Trust

To date, MCRI has undertaken several important projects, including effectiveness monitoring (photo below), a large-scale habitat restoration project (photos left and bottom), and development of this Plan.



Foundation, Okanagan Basin Water Board, and Freshwater Fisheries Society of BC.

This document outlines why and how the Plan was developed; its targeted goals, objectives, and guiding principles; plan scope, and pertinent background information. This is followed by the core component of the Plan, which presents detailed descriptions of future conservation and restoration strategy recommendations, and concludes with implementation and communications strategies to facilitate successful Plan roll-out.

SECTION 2: PLAN GOAL, OBJECTIVES & GUIDING PRINCIPLES

The Plan was developed to provide long-term direction for MCRI conservation and restoration efforts. The steering committee built a strong foundation for plan development based on MCRI vision and mission statements (see sidebar). This strategic direction, and MCRI's desire to move forward with large-scale restoration, informed the Plan goal, objectives, and guiding principles.

GOAL

MCRI's goal for the Plan is to create a long-term, multi-phase strategy for lower Mission Creek that conserves, restores, and enhances ecological, social, cultural, recreational, and economic values and assets, while improving flood protection and climate-change resilience.

OBJECTIVES

- Conserve and restore fish and wildlife habitat to re-establish natural form and function, and increase productivity of indigenous species.
- Improve flood and sediment-transport capacity.
- Ensure conservation and restoration activities respect First Nations' historical, social, cultural, and spiritual values, traditions, and connections.
- Contribute to community health and enjoyment by safeguarding public access and enriching educational and recreational pursuits along the Mission Creek Greenway.
- Generate funding to provide long-term support for Plan implementation.

GUIDING PRINCIPLES

- Sustain and rebuild fish and wildlife populations through habitat conservation and restoration of natural ecosystem processes.
- Recognize Mission Creek as a key contributor to Okanagan water quality and quantity, and the associated benefits derived from conserving and restoring aquatic and riparian habitat.
- Ensure all restoration, adaptive-management planning, and project implementation efforts advance climate resilience at community, provincial, and federal scales.
- Ensure Plan content aligns with existing and future ecological, flood-protection, and recreational-planning efforts within Mission Creek watershed and the entire Okanagan.

MISSION CREEK
RESTORATION INITIATIVE

VISION STATEMENT:

- ***Restoring and protecting Mission Creek to enrich ecological, social, cultural, recreational, and economic values for the Okanagan***

MISSION STATEMENT:

- ***Restore fish and wildlife stocks and habitat***
- ***Conserve and expand biodiversity and protect species at risk***
- ***Improve flood protection***
- ***Nurture partnerships and secure funds that support Mission Creek conservation and restoration***

- Collect and use pertinent data and emerging science to guide best practices for implementing conservation and restoration strategies.
- Integrate multiple stakeholder input and efforts to optimize innovation and prevent the duplication of precious and limited human and financial resources.
- Build community capacity and long-term buy-in by engaging with residents and collaborating with local governments, businesses, non-profit organizations, and educational institutions.
- Share project objectives, activities, and outcomes regularly to inspire fundraising and inform similar works in other communities.

A key Plan objective is to restore natural form and function to fish and wildlife habitat. This will improve productivity of indigenous species such as the spawning kokanee above and the Great Basin spadefoot toad (right).

SECTION 3: PLAN PURPOSE

MCRI has progressed significantly toward improving ecosystem and community values in lower Mission Creek. Successes include a long-term monitoring program, a large-scale habitat-restoration project, and preliminary planning for future large-scale restoration. However, without a plan to identify future needs, priorities, and associated habitat-management strategies, MCRI has not gained the support needed to proceed with a broad-based restoration initiative.

The Plan fills that void, providing a crucial tool for proactively guiding aquatic and riparian habitat conservation and restoration actions over the long term within one of the most important watersheds in the Okanagan. It will also generate the necessary regulatory, financial, and community support needed to inform, inspire, and mobilize successful delivery.

The Plan is a living document and will be updated to reflect new data, implementation outcomes, and related recommendations for area-specific impacts/conditions, habitat values, or land-securement opportunities. The Plan will be also be adjusted in the future to reflect outcomes of ongoing efforts to improve collaboration with First Nations in future strategy development and implementation.

PROVEN APPROACH

The Plan is designed to build on the successes of similar restoration plans from other jurisdictions by incorporating strategies that have demonstrated benefits within similar applications. One example is the *Penticton Creek Master Plan (Mould Engineering, 2017),* which has directed successful restoration of several sections of lower Penticton Creek, and will drive restoration of the full length of flood-controlled channel.

CONSERVATION/RESTORATION

The Plan identifies strategies to conserve existing high-value aquatic and riparian habitat and restore degraded habitat. This approach recognizes how critical Mission Creek fish and riparian wildlife habitat values are to the long-term viability of local and global populations.

These strategy recommendations have been developed at a conceptual level based on technical feasibility and potential for achieving established flood protection and target fish population response objectives. Considerable investigative work will be required before determining if recommendations can proceed

Phase-1 floodplain expansion allows spring runoff to flow into the new flood-plain (top photo), which stores flood waters and captures sediment. When flooding subsides, water flows back into the creek (bottom photo).

to on-the-ground projects, including the ability to secure the necessary land and funding.

Assessments of existing habitat form, function, and utilization have contributed to a better understanding of what can be achieved with restoration. Resulting data informs the best approach for achieving specified ecosystem-based objectives. It has long been recognized that protecting existing high-value habitat can be a cost-effective and low-risk approach to achieving habitat and species goals when compared to restoration actions.

For Mission Creek, extensive habitat loss requires strong focus on restoration to achieve long-term fish/wildlife population health and sustainability.

FLOOD PROTECTION

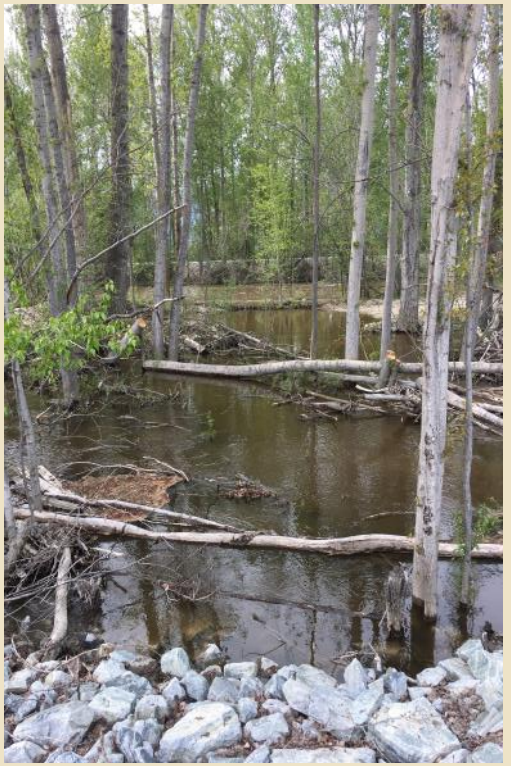
In addition to conserving and restoring fish and wildlife habitat, a priority objective of the Plan is to implement strategies that meet or exceed provincial flood-protection requirements. This will be accomplished by collaborating with provincial regulators and local governments to achieve ecosystem and flood-protection objectives, while addressing future impacts from climate change.

Many conceptual restoration designs presented in this Plan involve some level of channel and floodplain expansion. This approach inherently improves flood protection by reducing flood-stage water levels, while also addressing conservation and restoration objectives. Other benefits include improved restoration structure resiliency and function over time, as well as enhanced water quality and quantity.

KEY CHALLENGES & SOLUTIONS

The Plan will address many challenges associated with large-scale habitat restoration. These include the high cost of restoring a highly modified creek, the need for ongoing funding support, and the ability to respond when opportunities for floodplain expansion through land securement arise. These challenges will be met by building a strong case for restoration that clearly identifies restoration needs and priorities, and ensures effective implementation and outreach strategies are in place.

Expanding the floodplain (photos left and below) improves flood protection by reducing flood-stage water levels, while also addressing conservation and restoration objectives. Other benefits include improved restoration structure resiliency and function over time, as well as enhanced water quality and quantity. The insert photo shows vegetation regrowth in the flood-plain since it was restored in 2016.



SECTION 4: OVERVIEW OF PLANNING PROCESS

The Plan represents years of dedicated effort by the steering committee to develop and implement a strategy for large-scale restoration of Mission Creek.

The steering committee's early focus was to better understand the status of aquatic and riparian habitat and supported species, key limiting factors, and future potential. To that end, a number of studies were commissioned to investigate Mission Creek sedimentation issues and other factors impacting habitat quality and quantity, the current status of fish and wildlife habitat and populations, and habitat restoration feasibility.

In response to study findings, MCRI's focus shifted to exploring restoration opportunities, which resulted in the purchase of agricultural properties within an important section of lower Mission Creek in 2014. This led to construction of a large-scale restoration project within the secured properties (2015-2016), implementation of a long-term effectiveness monitoring program (2014-ongoing), and completion of small-scale restoration projects within the original project footprint (2017-2019). These activities generated support for future projects and provided essential information on restoration effectiveness (i.e., structural stability and species' response), and how it can be improved in the future.

Preliminary planning for a broad-based restoration plan focused on lower Mission Creek began in 2017 by:

- Establishing area-specific restoration priorities based on points assigned according to a wide range of parameters including fish values, riparian wildlife/species-at-risk values, and land-securement potential.
- Assessing land-securement opportunities based on identified priorities, availability, and landowner support.
- Exploring opportunities to collaborate with local and provincial governments on funding and implementation where joint flood-protection and restoration benefits exist.

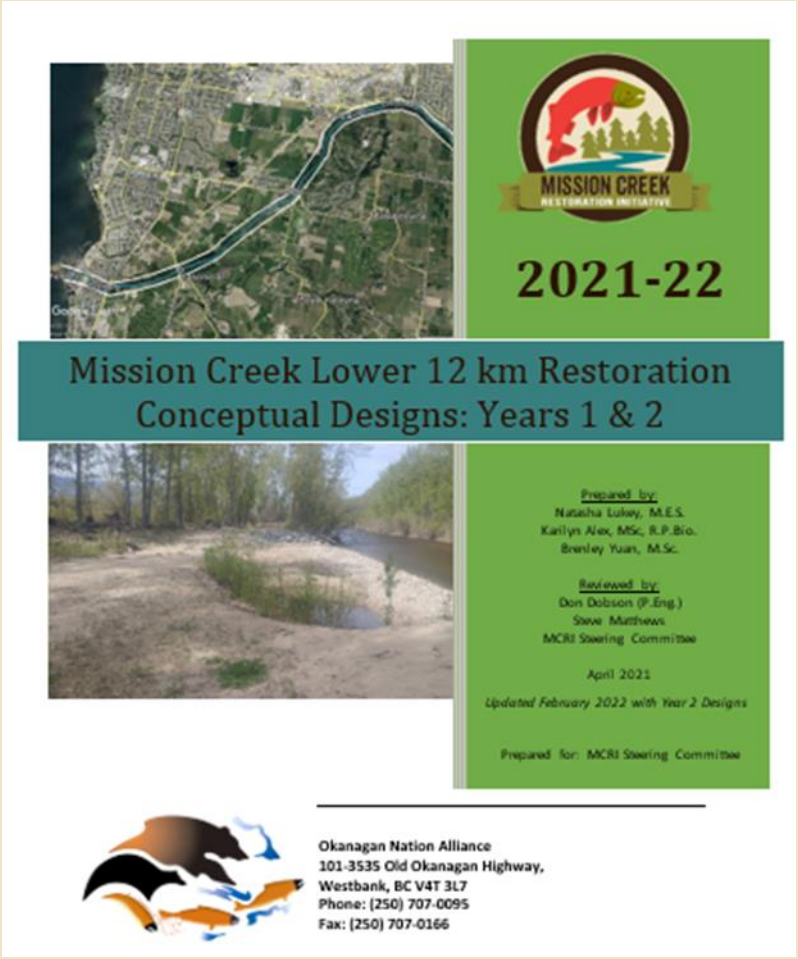
These efforts led to implementation of a two-year initiative starting in April 2020 aimed at developing the Plan. As a first step, the steering committee commissioned the *Mission Creek Lower 12 km Restoration Conceptual Designs Report,* which includes detailed reach-specific habitat conservation strategies and conceptual restoration design recommendations for the

While spring runoff in 2018 reached record levels, Mission Creek restoration works held up exceedingly well.

The following year, adaptive management continued with the in-stream placement of large boulder clusters (below) to improve spawning and rearing habitat for rainbow trout, kokanee, and other indigenous fish species.

lower section of the creek. *(Primary Reference: K. Alex and N. Lukey, 2022, at right).* With future conservation and restoration direction confirmed, the Plan document was developed and finalized following intensive committee and peer review.

During Plan development, MCRI secured partial funding for an engineered design to restore a priority reach identified in the Plan. The funding must be used within the 2022/23 budget year (April 1, 2022-March 31, 2023), or it will be lost.



The primary reference for the Plan shown above identifies main impacts and restoration solutions to fish and wildlife habitat degradation and loss in the lower 12 kilometres of Mission Creek. Year-1 designs identified the creek's energetic interactions, stability, and fish and wildlife habitat under historic, current, and anticipated climate-change conditions, and proposed actions to restore fish and wildlife habitat. Year-2 designs refine the proposed restoration actions, resulting in a phased, ecosystem-based, time-step approach to restoring the creek's stability and ecosystem services for the benefit of fish, wildlife, and people.

SECTION 5: PLAN SCOPE

The Plan will guide future conservation and restoration activities on lower Mission Creek. Recommendations are focused on conserving existing high-value habitat, where applicable, and undertaking restoration-based changes to the channel and floodplain. The aim is to re-establish aquatic and riparian habitat quality, quantity, and diversity, while ensuring flood-protection requirements are maintained or improved.

Outside the scope of this Plan are limiting factors to fish and wildlife habitat, which are the responsibility of regulatory authorities (e.g., provision of environmental flow). Plan recommendations aim to address these limitations, where feasible. For example, conservation and restoration actions are expected to improve groundwater, stream-flow, and water-temperature conditions through enhanced floodplain water retention, improved riparian vegetation function, and increased channel-pool development.

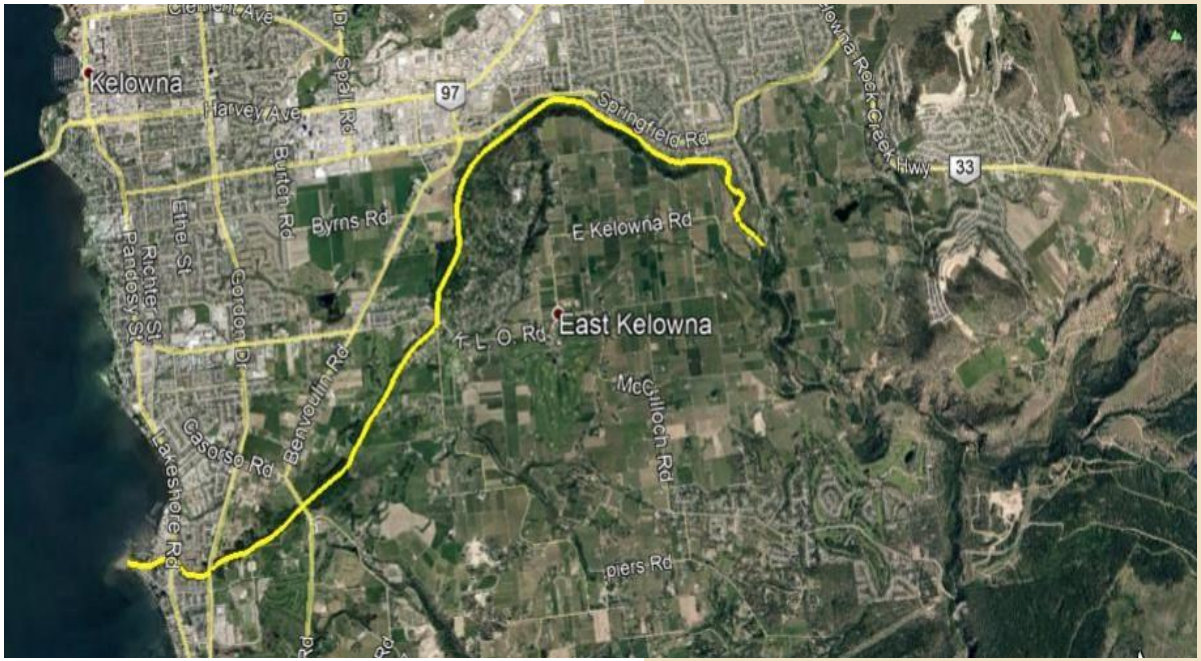
GEOGRAPHIC FOCUS

The geographical area of focus for the Plan is approximately 12 kilometres of Mission Creek extending from the confluence with Okanagan Lake to 300 metres upstream of East Kelowna Road Bridge (photo below). The steering committee chose this section based on its importance for kokanee production, and because it is the most impacted by development and related habitat loss.

Most of this section was channelized and diked in the 1950s, resulting in extensive loss of floodplain area and function, and reduced aquatic and riparian habitat quantity and

The Plan's focus area is 12 kilometres of Mission Creek from East Kelowna Road Bridge to where it meets Okanagan Lake (photo below). This section was chosen for its importance to kokanee production, and because it's the most impacted by development and related habitat loss.

Figure 1: MCRI project area in yellow on Mission Creek



quality. This area also offers the highest potential for generating ecological and flood-control benefits through conservation and restoration.

The upper portion of this section within Reach 7 has retained more natural function and habitat features due to the lower level of development impact, providing a good basis for what could be achieved in the downstream reaches. (See page 67 for more detailed information on this creek section.)

The section of Mission Creek extending above the point 300 metres upstream of East Kelowna Road Bridge to the fish migration barrier located 19 kilometres upstream (Gallagher's Canyon), falls outside the geographical scope of the Plan. Due to low anthropogenic impacts, this section has retained greater channel width, floodplain area, and aquatic and riparian habitat.

While the steering committee recognizes the need to protect or restore habitat in this upper section, specific strategies are not identified in the Plan due to limited restoration resources. Emerging high-priority needs and opportunities in that section will only be considered if they don't significantly impact current Plan recommendations. The Plan will likely be expanded in the future to reflect a shift or greater focus once current Plan implementation is well advanced, and upstream priorities are identified.

TIMELINE

The Plan is designed to provide long-term direction for restoring lower Mission Creek. The timelines for individual projects will depend on a number of factors, including funding availability, land tenure and securement opportunities, collection of supporting information, and permitting. (See Section 11 for more details.)

In the upper portion of Mission Creek in Reach 7 (top photo) and further upstream in the Gallagher's Canyon Area (bottom photo), the creek and floodplain have retained more natural function than the lower reaches due to fewer development impacts. This exemplifies what could be achieved downstream in future project phases.

SECTION 6: LINKS WITH OTHER PLANS & PLANNING PROCESSES

Mission Creek has been a major focus for better understanding environmental status, flood-protection and water-supply conditions, associated limiting factors, and potential remediation options. This prompted development of several planning and project-development initiatives that overlap with the goal and objectives of the Plan.

It is important to recognize those commonalities, where possible, explore opportunities for coordinated approaches, and establish delivery partnerships. This approach can help reduce conflicts, facilitate higher levels of support, and increase access to project-implementation resources.

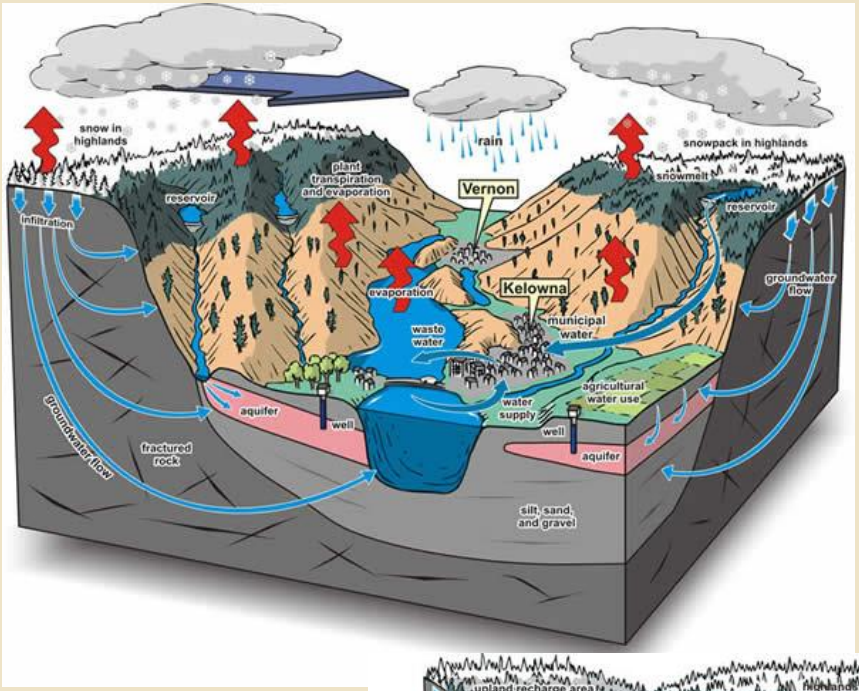
The following are related initiatives for which applicable learnings or direction have been considered. Opportunities for establishing mutually beneficial partnerships will be explored as part of future project planning.

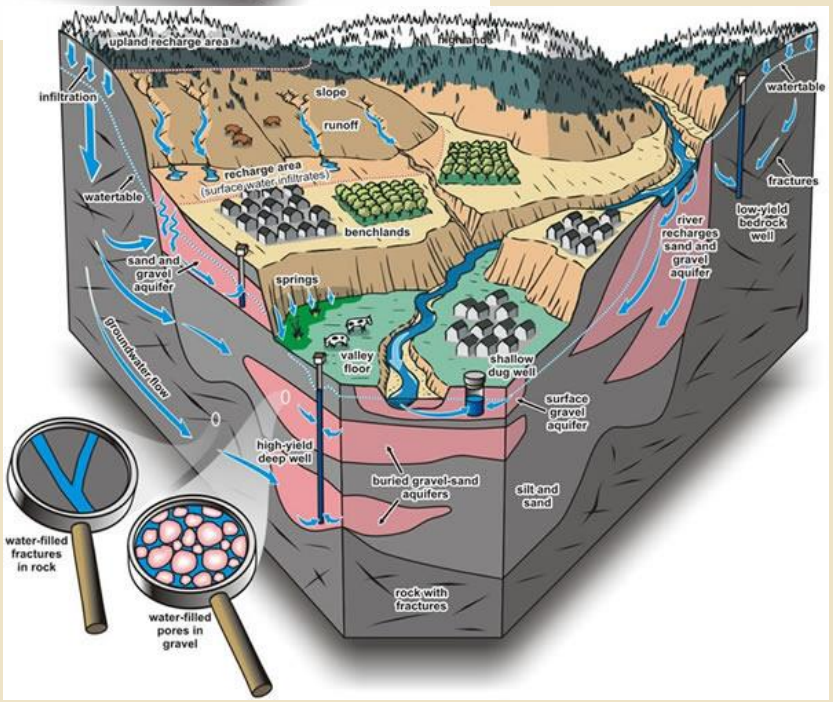
- **Okanagan Collaborative Flood Planning Group** is improving communications and collaboration amongst organizations with a vested interest in Okanagan flood protection, including Mission Creek. MCRI has shared Plan recommendations with this group and is pursuing collaborations on future projects with potential for mutual benefits.
- **Central Okanagan Regional Flood-Management Plan** (RFMP) helps the Regional District of Central Okanagan (RDCO) and its member municipalities identify, assess, and manage flood risk in the Central Okanagan. MCRI aims to incorporate Plan recommendations into Phase 3 of the RFMP involving development of flood-risk mitigation strategies.
- **Mission Creek Regional Park Management Plan** provides guidance on future development, operation, and stewardship of Mission Creek Regional Park, which incorporates 92 hectares adjacent to Mission Creek. MCRI is exploring opportunities with RDCO to integrate Plan recommendations within areas of park-designated lands.
- **Mission Creek Water Use Plan** defines monthly availability of water under a full range of water-supply scenarios, and provides allocation strategies to best address environmental, agricultural, and residential requirements. It is vital that Plan strategies recognize established water-allocation

Strategic collaboration among key project stakeholders throughout the planning, design, and construction stages reduces conflicts, facilitates higher levels of support, and increases access to project-implementation resources.

scenarios outlined in the *Mission Creek Water Use Plan*, including low-flow scenarios.

- **Mission Creek Flood Protection Works Study (2020)** was commissioned by the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD) to create flood-mitigation recommendations based on future flood-flow projections. MCRI is exploring partnerships with the Ministry and City of Kelowna to deliver dike-setback projects benefiting flood protection as specified in this study, and fish and wildlife habitat as recommended in the Plan.
- **Okanagan Basin Water Board Surface/ Groundwater Studies** were underway when this Plan was developed. They will clarify the roles ground and surface water are expected play in addressing future environmental-flow requirements. This information will be considered in future design planning.





OBWB is studying Okanagan Basin water resources (surface water, top; groundwater, right) to clarify the roles they are expected to play in addressing future environmental flow requirements. Findings will be considered in future MCRI design planning.

SECTION 7: MISSION CREEK FISH & WILDLIFE SPECIES & HABITAT INFORMATION

This section outlines changes in fish and wildlife populations and their habitats over time, as well as past conservation/restoration efforts. (See details in Appendix 2 and *Primary Reference: K. Alex and N. Lukey, 2022, Section 13.)*

Mission Creek, located in British Columbia's southern interior, is the largest watershed in the Okanagan Basin. Before entering Okanagan Lake, the creek flows about 75 kilometres from high-elevation headwater lakes and forests through heavily developed agricultural and residential properties in the central Okanagan and City of Kelowna boundaries.

Historically, the creek and surrounding habitat were home to abundant and diverse fish and wildlife populations, which provided important ecosystem values and sustenance for early First Nations' peoples. The creek has undergone considerable change over time, largely due to anthropogenic effects, but continues to be an important watershed based on existing and potential ecological, social, cultural, recreational, and economic values.

FISH SPECIES

Mission Creek is considered the most important fish-producing system in the Okanagan Lake basin *(Andrusak et al., 2008),* supporting a wide range of indigenous fish species including kokanee, Okanagan Lake adfluvial rainbow trout, resident rainbow trout, mountain whitefish, peamouth chub, longnose dace and, more recently, sockeye salmon.

Due to the regional importance of Okanagan Lake rainbow trout and stream-spawning kokanee populations that originate in Mission Creek, they have been thoroughly studied over the years. These studies provide strong data on life history, population metrics, and habitat use.

Due to limited information on other fish species, the following overview focuses on rainbow trout and kokanee populations and their strong reliance on Mission Creek.

Okanagan Lake Adfluvial Rainbow Trout

Mission Creek is considered the primary source of production for Okanagan Lake adfluvial rainbow trout *(Galbraith and Taylor, 1970, Koshinsky, 1972, Wightman and Sebastian, 1979).* These fish use Mission Creek and other tributaries for spawning and early rearing (one or two years), after which juvenile trout enter the lake for up to five years before returning to

Mission Creek is considered Okanagan Lake's most important fish-producing tributary. Adfluvial rainbow trout (top) and kokanee (middle) are the prominent species and support ecological, recreational, and economic values.

Sockeye, chinook, and steelhead salmon stocks will continue to grow with restoration, and could contribute to the Okanagan Lake recreational fishery in the future.

spawn. This unique, late-maturing fish stock largely relies on kokanee for food during their lake-rearing period. This facilitates rapid growth resulting in fish exceeding 12 kilograms at maturity.

There is limited information on the current status of the adfluvial rainbow trout population. Adult spawner escapement monitoring in the late 1970s (as well as periodic Okanagan Lake recreational fishery creel census and juvenile population assessments in Mission Creek undertaken in the 1970s and 1980s) provided rudimentary indicators of population status. More recent recreational fishery assessments indicate this population has suffered significant declines over time due to documented habitat loss and associated drops in kokanee populations, their primary food source.

Kokanee

Okanagan Lake supports stream- and lake-spawning kokanee populations. These fish are vital for the ecosystem, providing an important food source for many fish and wildlife species. They are also a significant source of nutrients for stream and lake environments and are key to the Okanagan Lake recreational fishery.

Mission Creek supports up to 70% of total stream-spawning kokanee production annually *(MFLNRORD, 2020).* These fish rely on spawning and rearing (incubation) habitat in the creek before migrating to the lake as fry to feed and grow for several years before returning to the creek to spawn.

Mission Creek kokanee spawner escapement is well documented for the past 50 years. Information from spawner surveys and Okanagan Lake recreational-fishery assessments provide clear evidence of a major decline in the stream-spawning population over time, with loss of stream habitat from development impacts believed to be a primary cause.

A significant increase in kokanee spawner numbers over the past two years is a positive sign, and highlights the importance of moving forward with Plan implementation to facilitate continued growth in this population.

Sockeye Salmon

Sockeye salmon have recently gained access to Okanagan Lake due to downstream barrier remediation, and were observed spawning in Mission Creek in 2020. These migration improvements, along with population enhancement efforts, will likely facilitate a continued increase in sockeye numbers and help establish Columbia River chinook and

Okanagan Lake supports stream- and lake-spawning kokanee. An increase in kokanee spawner numbers over the past two years is a positive sign, and highlights the importance of moving forward with Plan implementation to facilitate continued species growth.

Restoration will also improve habitat for other indigenous species such as peamouth chub (top) and longnose dace.
(Bottom photo by Robert J. Eakins)

steelhead populations in the future. These species will likely use habitat similar to that described below for kokanee and rainbow trout, making habitat conservation and restoration even more important.

WILDLIFE SPECIES

Mission Creek riparian areas provide important habitat for many wildlife species. They serve as interfaces between terrestrial and aquatic ecosystems, and provide many essential functions such as removing excess sediments and nutrients, reducing flood flows, and improving stream flows by increasing water-storage capacity. About 80% of Okanagan wildlife species rely on riparian/wetland areas for portions of their life cycles. *(Ministry of Environment, 1998).*

Mission Creek riparian areas support many bird species, amphibians, and a wide range of mammals such as bats, beavers, muskrats, black bear, and whitetail and mule deer. (See Appendix 2 for known species occurrences.)

At-risk species identified in 2014 are the spotted bat (top), cutleaf water parsnip (middle), lance-tipped darner (bottom), western screech owl (top left), western painted turtle (bottom left), and great blue heron (centre).

Habitat loss has played a major role in the decline of many wildlife populations that depend on Mission Creek riparian areas, and has contributed to the subsequent listing of several species as at-risk provincially and federally.

Eleven listed wildlife species and two plant species were observed during a 2014 inventory in lower Mission Creek conducted by Ecoscape Environmental Consultants in 2015. (See details below.)

Barn swallows (top left), common nightingales and California gulls (below) are species at risk.

Small at-risk species are the Mexican mosquito fern (left) and the western small-footed myotis (below).

Table 1: Mission Creek at-risk species

SPECIES GROUPS	COMMON NAME	SCIENTIFIC NAME	PROV STATUS 1	COSEWIC LISTING 2	HABITAT ASSOCIATION
Amphibian	Great Basin spadefoot*	*Spea intermontana*	Blue	Threatened	Wetland
Birds	California gull	*Larus californicus*	Blue	-	Rural
	common nighthawk	*Chordeiles minor*	Yellow	Threatened	Open/Grassland
	barn swallow	*Hirundo rustica*	Blue	Threatened	Rural/Riparian
	great blue heron	*Ardea herodias*	Blue	-	Wetland/Riparian
	western screech-owl	*Otus kennicottii*	Red	Threatened	Riparian
Invertebrate	lance-tipped darner	*Aeshna constricta*	Red	-	Wetland
Mammals	spotted bat*	*Euderma maculatum*	Blue	Special Concern	Wetland/Riparian
	western red bat*	*Lasiurus blossevillii*	Red	-	Wetland/Riparian
	western small-footed myotis*	*Myotis ciliolabrum*	Blue	-	Wetland/Riparian
Reptile	western painted turtle	*Chrysemys picta bellii*	Blue	Special Concern	Wetland
Plants	cutleaf waterparsnip	*Berula erecta*	Blue	-	Wetland
	Mexican mosquito fern	*Azolla mexicana*	Red	-	Wetland

***Not confirmed during 2014 surveys**

AQUATIC & RIPARIAN HABITAT CONDITIONS & UTILIZATION

Mission Creek has suffered extensive anthropogenic impacts over time. These include channelization and diking for flood protection, agricultural and residential land development, and water diversion. This led to severe changes in channel morphology, watershed processes, and aquatic and terrestrial habitat, resulting in the loss of 80% of fish habitat, 75% of riparian wildlife habitat, and corresponding declines in supported populations (*Gaboury, 2003).* If no action is taken, these impacts are expected to intensify due to projected flow increases resulting from climate change.

Below is a brief overview of habitat conditions and species utilization within the geographical area covered by the Plan, as well as information on the area immediately upstream for comparison purposes.

Area in Plan Scope (Okanagan Lake to km 12 upstream)

Channelization resulted in a narrower channel with higher gradients and water velocities, along with a loss of functional floodplain. Flood-control works also prompted large-scale residential and agricultural development adjacent to the creek, which led to increased water use, impacts to water quality resulting from erosion, input of various sources of effluent, and removal of riparian vegetation.

Habitat shortfalls include severely limited spawning-habitat quality, fewer riffle and pool areas for rearing, and less functional riparian areas throughout this section. In addition, this section can suffer from seasonal low stream flows and high water temperatures.

Even with these habitat limitations, kokanee use this section of creek extensively, with about 70% of total spawners counted within this section on average *(Andrusak et al., 2008).* This area preference may be partially due to kokanee's tendency to use lower stream reaches for spawning (H. Lorz, 1958, MFLNRORD). It also highlights the importance of this stream section.

Based on habitat conditions and sampling of mature fish, it is assumed rainbow trout use this section primarily for migration *(C.Wightman, 1975).*

Wildlife habitat is severely limited within this creek section due to development impacts. Riparian habitat is restricted in total area, width, connectivity, and plant-species diversity. A few localized healthy riparian areas remain, but are typically small and comprise small patches of habitat within an extensive area of Mission Creek. As a result, wildlife species diversity and population status, including at-risk species, indicate a depleted riparian area.

Taken circa 1905, this photo shows the extent of flood events and their impacts on nearby residential and agricultural properties.

In the '40s, the creek washed away part of Kelowna's rural road network (below). In June 1948, Mission Creek washed away the bridge on KLO Road (bottom).

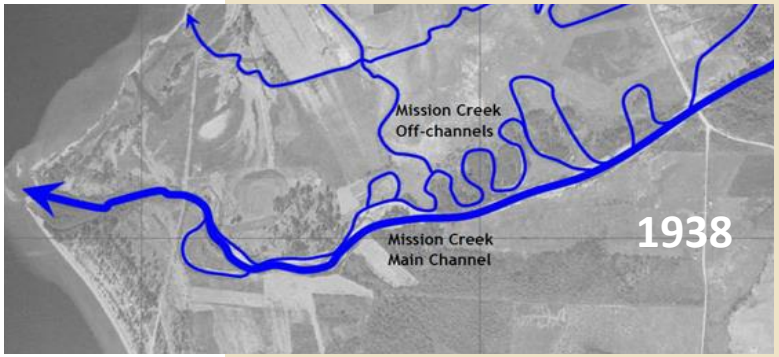
The upper portion of this section (Reach 7) displays a higher level of natural creek function and habitat due to reduced development impacts. Channel and riparian width are generally only restricted by natural geographic land forms, and habitat quality and quantity are superior to downstream areas. This reach provides a good basis for what could be achieved in the lower reaches.

Area Outside Plan Scope (km 12 to km 19)

The upper seven kilometres of stream extending from East Kelowna Road Bridge (km 12) to the impassable falls at Gallaghers Canyon (km 19), have undergone low levels of anthropogenic modification. Therefore, this section has retained a substantially wider channel and floodplain that exhibit a broad range of gradient, substrate, and hydraulic conditions typical of a natural system. This section has also retained high levels of habitat complexity, quantity, and quality, along with more stable flows due to the majority of water intakes being located in the downstream section.

This upper section provides the majority of spawning and rearing habitat for the adfluvial rainbow trout population (*Wightman and Sebastian, 1979*), and supports 30% of Mission Creek kokanee spawning (*Andrusak, et al., 2008*). This section also appears to be well suited for sockeye, chinook, and steelhead spawning and rearing, if and when they successfully establish in Okanagan Lake. Considering available spawning substrate and quality rearing habitat, favorable hydraulic conditions, and habitat availability within nearby Mission Creek tributary streams (KLO Creek and Hydraulic Creek), this section should support production needs for all of these species well into the future.

Riparian areas within this section are much larger in total area, width, and continuity compared to conditions in the lower 12 kilometres. This provides superior wildlife habitat and increased benefits for aquatic species. No wildlife utilization data is available for this section of Mission Creek.



Historically, as shown in the top photo, Mission Creek meandered 60-80 metres across the valley bottom and was about 30 kilometres long. Channelization in the 1950s reduced the creek's width to 30 metres and its length to about 11 kilometres. This led to higher gradients and water velocities, along with a loss of functional floodplain.

HISTORY OF MISSION CREEK HABITAT PROTECTION, ENHANCEMENT & RESTORATION

Mission Creek has long been recognized for its valuable fish and riparian wildlife production, therefore it has received more habitat protection and restoration focus than any other Okanagan Lake tributary (*MFLNRORD, 2020*).

Below is a brief summary of prominent Mission Creek habitat protection and improvement initiatives. (See Appendix 2 for more details.)

Habitat Protection

There is a range of legislative policy and regulatory tools available to protect and conserve fish habitat. These include proactively applied standards and best practises that provide results-oriented guidance for developers, as well as regulations that are applied through compliance and enforcement actions. These tools act as important violation deterrents, and can lead to positive outcomes that improve habitat conditions.

All land-development projects undergo intensive regulatory review processes to ensure aquatic and riparian habitat are appropriately protected. If determined that habitat damage or loss will be incurred, site compensation is prescribed to restore lost habitat. In cases where it is determined on-site compensation will provide limited value, the *Fisheries Act* authorizes the use of compensation banks to assign habitat-loss compensation dollar value to approved off-site locations. To that end, the Mission Creek Aquatic Habitat Compensation Bank (MCAHCB) was established and has been a primary target for directing required compensation dollars from off-site development projects within the central Okanagan.

These funds have been key to the successful delivery of recent MCRI restoration planning and implementation projects.

Another example of Mission Creek habitat protection is the ongoing effort to ensure adequate flow to support healthy fish populations. Compliance and enforcement monitoring has prompted flow agreements with large water-user groups (e.g., *2010 Mission Creek Water Use Plan*) to ensure greater accountability for addressing aquatic flow requirements.

Steam-flow protection has been further strengthened with implementation of the *BC Water Sustainability Act (2016),* which requires that stream-specific environmental-flow needs defined in the act are addressed. This focus on ecosystem flow needs has led to acquisition of several water-storage and diversion licenses on Mission Creek by provincial fisheries aimed at increasing available flow for fish (*MFLNRORD*).

Habitat Enhancement & Restoration

Several projects have focused on improving creek aquatic and riparian habitat. These have involved both landscape and population manipulation to increase fish production, and habitat restoration projects to re-establish natural form and function. Three projects with

MCRI Phase 1 Habitat Restoration Project included dike setback construction (top photo) and channel restoration work (middle photo).

To determine project success, ongoing creek and species monitoring has been conducted annually since large-scale restoration was completed.

significant positive impacts on aquatic habitat productivity are summarized below.

- **Smithson Alphonse Dam Removal (1980)**. This structure, about 11 kilometres upstream of Okanagan Lake, was installed in Mission Creek as a low-profile, water-diversion weir in 1954. Over time, erosional downcutting created a fish-migration barrier, making the weir a flood-management risk. Structures were removed and the affected channel was infilled within a one-kilometre section of creek to mitigate flood risk and provide fish-accessible channel conditions. This provided unrestricted access to eight kilometres of quality spawning and rearing habitat for rainbow trout and kokanee, and has likely led to significant production increases.
- **Mission Creek Kokanee Spawning Channel** has also contributed to increased kokanee production. Built in 1988 within the water-bypass channel created during the Smithson Alphonse Dam removal/channel infill project, the 800-metre spawning channel is fed by water diverted from the creek. While this habitat-enhancement project supports annual contributions of up to one million fry, it has frequent operational issues and substantial annual maintenance requirements (*Andrusak, et al., 2008*).

MCRI Phase-1 Habitat Restoration Project (2015-2019) involved the purchase of two creekside properties between Gordon Drive and Casorso Road, and subsequent construction of a 540-metre-long set-back dike along with floodplain and channel restoration works. MCRI project effectiveness monitoring has demonstrated that this innovative project substantially improved floodplain function, increased riparian and aquatic-rearing habitat quantity and quality, and improved flood protection by reducing flood-stage water levels within the project footprint.

Another Phase-1 project objective was to use the high-profile location, along with strong community outreach, to showcase and build long-term support for future restoration efforts. This objective is being met, with awareness, buy-in, and support increasing continually from all levels of government, including Syilx Okanagan Nation, interest groups, funding organizations, and the community.

Smithson Alphonse Dam was built in 1954 as a water-diversion weir. Due to erosion, as shown in the photo below, it was removed in 1980 and the creek channel was infilled within a one-kilometre section of creek to reduce flood risks and improve accessibility for fish.

Built in 1988 within the bypass channel created by Smithson Alphonse dam removal, the 800-metre-long spawning channel shown below has also contributed to increased kokanee production.

SECTION 8: MISSION CREEK VALUES & ASSETS

The following outlines the wide range of contributions from Mission Creek. Development impacts described above have reduced these contributions significantly, but they still remain critical to a broad geographical landscape and highlight the need and potential for restoring values.

ECOLOGICAL VALUES

Mission Creek is the largest Okanagan Lake tributary in the Okanagan Basin, supporting a wide range of fish and wildlife species, several listed as at-risk by federal and provincial governments. It supports the highest level of kokanee and adfluvial rainbow trout production of all Okanagan Lake tributaries, and provides important riparian habitat for 11 documented species at risk.

Other ecosystem values include important contributions to Okanagan Basin water quality through the storage of sediment and nutrients within the Mission Creek floodplain, and improved water quantity as a result of floodplain-retained freshet water, which enhances groundwater storage and facilitates surface-flow contributions to Mission Creek during dry periods.

SYILX OKANAGAN FIRST NATION VALUES

Mission Creek has a long history of important contributions to Syilx Okanagan spiritual, cultural, and economic values. The Syilx People have an inherent responsibility to act as caretakers of the land, which includes protecting and respecting *siwɬkʷ* (water) and *tmixʷ* (all life forms on Earth). The work Okanagan Nation Alliance (ONA) conducts to restore and protect the health of Okanagan water systems asserts this responsibility.

ONA's leadership and utilization of Traditional Ecological Knowledge with western science has resulted in multiple successful river-restoration outcomes, such as the recovery of Okanagan sockeye population, critical habitat recovery, and movement toward western policy changes in land and water management.

SOCIAL, CULTURAL, AESTHETIC & EDUCATIONAL ASSETS

Mission Creek generates important social benefits for Okanagan communities, including contributions to physical and mental well-being. Other values are associated with environmental aesthetics, cultural connection, and educational opportunities. These values are currently under-

Mission Creek's invaluable natural assets strongly support the area's ecological, social, cultural, aesthetic, recreational, and educational values.

represented and would increase with habitat protection and restoration *(A. Taylor and S. Wilson, 2013)*.

RECREATIONAL IMPORTANCE

Mission Creek provides abundant recreational opportunities for many residents and visitors. A 2013 report, *The Natural Capital of Mission Creek in Kelowna: The Value of Ecosystem Services*, estimates the annual contribution of outdoor recreation to the area's economy at more than $2 million.

The Mission Creek Greenway, envisioned and instigated by the Friends of Mission Creek in the mid-1990s, boasts a 16.5-kilometre trail used by about 1,500 people daily for walking, running, cycling, horseback riding, and bird watching. Annual kokanee stream spawning is also a popular viewing activity.

Adjacent to the creek is Mission Creek Regional Park, which is home to the Environmental Education Centre for the Central Okanagan (EECO). With about 30,000 visitors annually *(2018 RDCO Annual Review),* EECO showcases ecological displays and offers recreational and educational programs for school children and the public.

Fishing, which was once a popular activity in Mission Creek, is no longer allowed because of depleted kokanee and trout stocks. The creek is the primary producer of these species for the Okanagan Lake recreational fishery, which was once the most important fishery in the Okanagan.

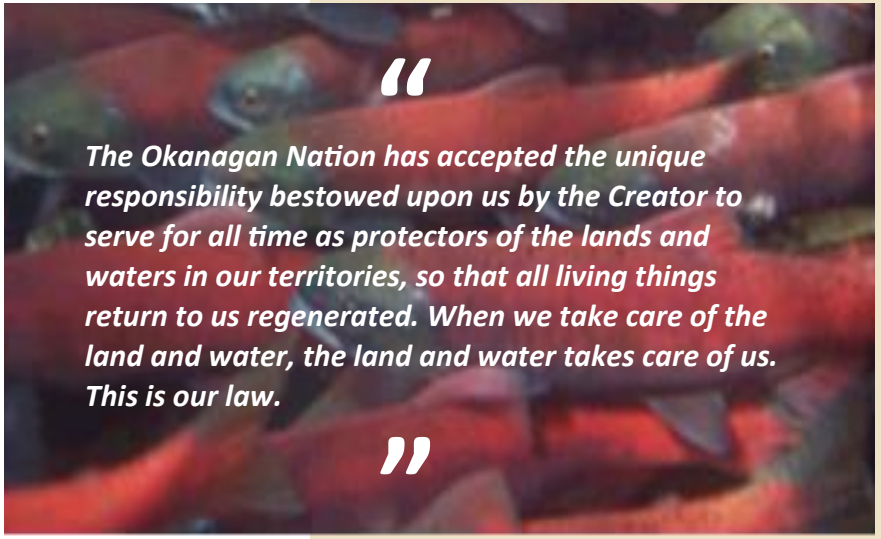
ECONOMIC CONTRIBUTIONS

Rainbow trout and kokanee production from Mission Creek is critical to the success of the Okanagan Lake recreational fishery. As reported in a 2019 study by the Freshwater Fisheries Society of BC, this fishery once supported up to 70,000 angler days yearly, with more than $12 million spent annually. Steadily declining kokanee and rainbow trout catch rates became evident in the late 1980s, and hit a low point in the 1990s due to decreases in these populations. This led to a major drop in recreational fishing and associated economic contributions, with the current fishery value estimated at less than $2 million annually *(MFLNRORD, 2020).*

Past economic contributions highlight what could be achieved with successful Plan implementation. In addition, sockeye, chinook, and steelhead may also provide future recreational value if/ when their populations reach levels to support angler harvest.

For thousands of years, the Syilx/ Okanagan people were self-reliant and well provided for through their own ingenuity and use of the land and resources, including many from Mission Creek and surrounding areas.

In July 2014, the Okanagan Nation Alliance endorsed the Syilx Water Declaration, a portion of which is shown below.



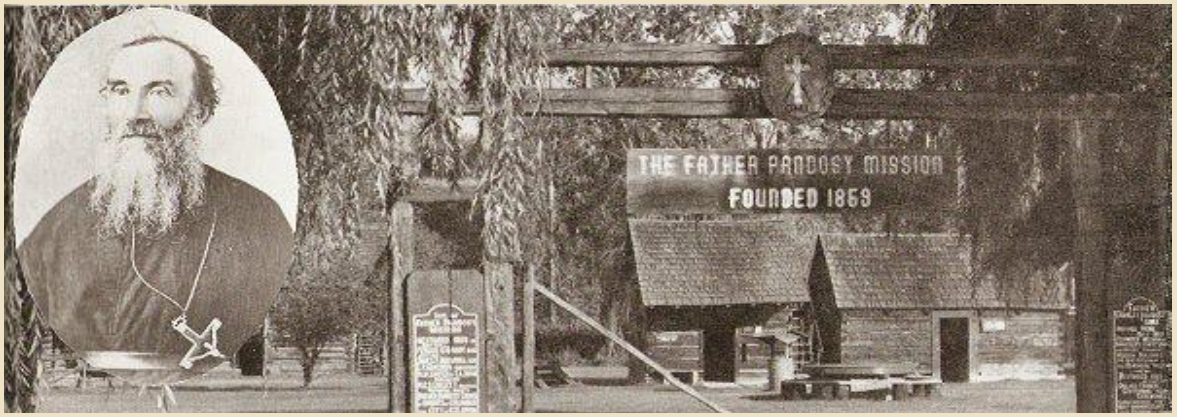
WATER SUPPLY CONTRIBUTIONS

As the largest Okanagan Lake tributary, Mission Creek is a major domestic, agricultural, and industrial water source for the Central Okanagan. There are now 265 water licenses on the creek authorizing diversion, use, and storage of water. (*Burge, 2003; ONA 2020).* Many water licenses authorizing use from Okanagan Lake are also indirectly supported by Mission Creek, as it provides the largest inflow to the lake. Plan implementation has the potential to increase water availability for ecosystem and human uses through enhanced water storage and groundwater supplementation.

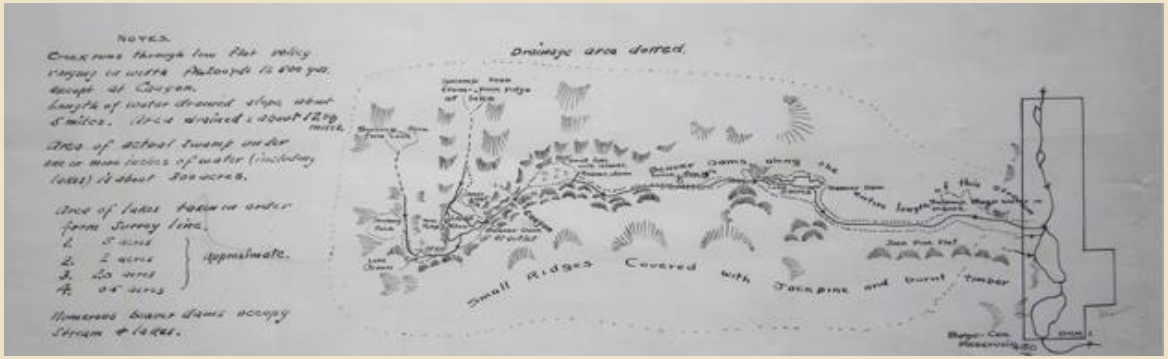
HISTORICAL SIGNIFICANCE

The creek and surrounding habitat were home to abundant fish and wildlife stocks that sustained early First Nations' people in all aspects of their lives.

European history in the area was also closely tied to Mission Creek. From the building of Father Pandosy Mission in 1859, to early 20th-century irrigation works, the creek greatly influenced how the central Okanagan evolved. Recognizing Mission Creek's historical importance, the Province designated it a BC Heritage River in 1996.



European history was also closely tied to the creek, from the building of Father Pandosy Mission in 1859 (top photo) to irrigation works built in the early 1900s (right photo). The linen map below is typical of those drawn by surveyors looking for dam sites for irrigation systems.



SECTION 9: HABITAT CONSERVATION & RESTORATION CHALLENGES & BENEFITS

KEY CHALLENGES

Challenges related to large-scale restoration are well documented and can be difficult to overcome. The biggest hurdle is the high cost of re-establishing aquatic and riparian habitat form and function when the creek has been severely modified. This is true for Mission Creek, where extensive habitat restoration is required involving channel/floodplain width expansion and, in some cases, purchase of adjacent land to accommodate these changes. This challenge is magnified by limited access to long-term funding for all aspects of restoration project planning and implementation, including monitoring, maintenance, and public outreach.

Another challenge is the difficulty in aligning land-securement needs with opportunities, since properties may not be available for purchase within a project's delivery timeline.

Finally, projects involving large expenditures and substantial landscape changes within a highly valued natural resource can be challenging, and therefore require strong support across all levels of government, including Syilx Okanagan Nation, and the community.

KEY BENEFITS

Even with these challenges, there is a strong case for Mission Creek habitat conservation and restoration based on the wide range of potential ecosystem and human benefits across a broad geographical expanse.

In forecasting these benefits, a review of assessment data on historical fish and wildlife production in Mission Creek, and how habitat loss from land development has reduced production levels, provides strong evidence for potential improvement, and how it can be achieved. In addition, measures of the value of associated human benefits over time highlight the importance of Mission Creek at current production levels, and the potential for enhancing those benefits through habitat conservation and restoration. (See Table 2 on next page.)

Land securement to enable habitat conservation and restoration is a key challenge for long-term project success. As shown in the lower Mission Creek aerial photo above, there are many land owners and uses abutting the creek, making the Plan a vital technical, awareness-building, and fundraising tool during the overall process.

Table 2: Summary of potential project outcomes and related benefits

POTENTIAL OUTCOMES	BENEFITS
Improved Fish & Wildlife Production	♦ **Increases population resilience, diversity, and contributions to species-at-risk recovery** ♦ **Increases recreation and economic contributions** ◊ The Okanagan Lake recreational fishery was once a major driver of the valley's economy, contributing more than $12 million annually. This has decreased as kokanee and rainbow trout populations have declined. The previous value of this fishery indicates what could be achieved in the future with improved fish production. ◊ A 2013 report estimates the value of natural capital associated with wildlife viewing, hiking, and general appreciation nature in the MCRI project area is more than $10 million annually. It also estimates that restoring the creeks' lower reaches boost value by at least ten percent *(A. Taylor and S. Wilson, 2013).* ♦ **Increases First Nations' harvest opportunities** ◊ Syilx Okanagan Nation have longstanding cultural and spiritual connections with Mission Creek fish, wildlife, and plants, which have largely disappeared due to declines in these populations.
Improved Floodplain Area & Function	♦ **Improves water quantity** through increased water storage within existing groundwater supplies, which provides a larger source of water for mitigating low stream flows and enhance community water supplies. ♦ I**mproves water quality** by filtering water and facilitating increased sediment and nutrient storage.
Improved Climate Change Resilience	♦ **All restoration outcomes contribute to advancing climate change resilience, including expected changes in temperature and precipitation and mitigating effects from extreme events and disturbances such as floods and drought.**

2018 brought a 1-in-200-year flood. Phase-1 MCRI restoration works held up well, and resulted in the formation of several new riffles in the main channel and improved flow from the expanded floodplain back into the creek at the south end of the project. Photos show the setback dike (top) and Mission Creek Greenway (bottom) during high spring flows.

SECTION 10: FUTURE HABITAT CONSERVATION & RESTORATION RECOMMENDATIONS

As previously noted, Mission Creek presents high restoration potential and opportunity for significant increases in fish and wildlife production. The following section details area- and reach-specific information on current creek channel and habitat conditions, and recommendations aimed at increasing Mission Creek fish and wildlife population productivity, diversity, and resilience, in addition to ensuring the current level of flood protection is maintained or improved.

This information was taken directly from, or based on, the MCRI-directed conceptual designs project report, which was completed in early 2022. (*Mission Creek Lower 12 km Restoration Conceptual Designs: Years 1 & 2. Lukey, Alex, and Yuan 2022).* Please refer to this document for more detailed information.

The conservation strategy and restoration design recommendations discussed below have been developed at a conceptual level based on technical feasibility and potential for achieving established flood protection and target fish species and population response objectives. They provide an important next step in area-specific restoration planning for lower Mission Creek, and will form a technical foundation for proceeding with engineered designs that support on-the-ground restoration projects in the future.

It is important to recognize there are several questions that need to be answered before proceeding with future project delivery, with the most important being: Will the necessary land and funding support be available? That question along with other logistical requirements will need to be assessed as a first step when a Plan recommendation is identified for future delivery.

GENERAL GUIDELINES FOR STRATEGY DEVELOPMENT

The following guidelines provided a basic framework for identifying information needs and proceeding with restoration design development in the lower reaches of Mission Creek.

Fish and Wildlife Species

Conservation values are critical to the long-term viability of local, regional, and global populations, highlighting the importance of conserving existing high-value aquatic and riparian habitat. To that end, we must:

- Prioritize conservation of existing high-quality habitat, where viable, recognizing this may be the most cost-effective and lowest-risk approach to achieving habitat and species goals.
- Prioritize options for restoring naturally self-sustaining processes and habitats, and minimize the need for ongoing human-facilitated maintenance.
- Incorporate infrastructure, flood protection, and fish, wildlife, and habitat criteria according to current and projected climate change-influenced flow and hydraulic parameters.
- Incorporate Traditional Ecological Knowledge (TEK) into conservation and restoration strategy development.
- Consider impacts to adjacent land use, and the potential to integrate Plan recommendations into future infrastructure modifications and development planning.

Aquatic Habitat

Recommendations are largely based on the requirements of kokanee and rainbow trout according to the following rationale:

- Fish from the family Salmonidae, including rainbow trout and kokanee, are the species

most sensitive to Okanagan freshwater quality, quantity, and physical habitat requirements (*R. Treek, et al., 2020*). By addressing these species' needs, requirements for other indigenous species using the creek will be met.

- Rainbow trout and kokanee are listed as regionally significant species due to population impacts, and ecosystem, economic, and recreational contributions (*MFLNRORD, 2021*).
- The data base on Mission Creek rainbow trout and kokanee populations (including aquatic and riparian habitat conditions over time, habitat needs, future potential, and response to management such as restoration) far exceed what is available for other Mission Creek fish and wildlife species.
- Sockeye, chinook, and steelhead trout habitat needs are also considered in development of future conservation and restoration strategies. This is based on recent migration barrier mitigation in Okanagan River, which has facilitated recent sockeye access to Okanagan Lake, and the potential for these species to establish returning populations.
- Okanagan salmonids require diverse habitat types, encompassing the historical range of aquatic habitat utilized by many other species (e.g., riffle-pool sequences, off-channel habitat, and suitable flow volumes, water quality, and timing).

Riparian and Floodplain Habitat

Recommendations are based on:

- Available information on proper-functioning floodplains as they pertain to Mission Creek and other regional watersheds.
- Listings of indigenous riparian plant species within the lower Mission Creek watershed.
- Habitat needs of regionally significant riparian wildlife species, including species-at-risk and at-risk vegetation communities.
- Potential contributions to aquatic habitat values.
- Outcomes from Phase-1 restoration, including floodplain function (water retention/drainage, fish stranding), riparian vegetation response (artificial plantings and natural colonization), and wildlife species utilization.

CONCEPTUAL DESIGN DEVELOPMENT STEPS

As noted earlier, conceptual designs were developed based on technical feasibility and potential for achieving flood-protection and fish-population objectives, recognizing there are many factors to consider in moving from design to on-the-ground work.

Many important tasks were completed over two years to deliver the recommended conceptual conservation and restoration designs. To start, the vast information files were reviewed, including historical records on creek-channel and ecosystem conditions, scientific reports, and photos.

Additional information was collected from steering committee members and others with intimate knowledge of Mission Creek. This led to development of design objectives, target outcomes, and a project-delivery work plan.

The complex technical steps that followed were extensive, and included compiling existing technical information, filling data gaps, and identifying restoration constraints and opportunities, design criteria, hydraulic modeling, information analysis, and finally, reach-specific design options and recommendations.

Throughout the process, the steering committee provided ongoing oversight, review, and input, and was key to successful project delivery.

KEY INFORMATION FOR CONCEPTUAL DESIGN DEVELOPMENT

There is a long list of required information that must be collected and analyzed to support conceptual design development. Some baseline information was sourced from applicable references, but assessments of channel and habitat status were required to provide a current view of creek conditions and future restoration potential, along with modeled projections of restoration design applicability and performance.

The following provides a summary of some of the key information components.

Design Criteria

Identifying criteria to guide conceptual design development, and incorporating Traditional Ecological Knowledge (TEK), where available, were key steps toward ensuring ecosystem and flood-protection requirements were fully addressed.

Flood Protection & Infrastructure

Restoration plans for Mission Creek inherently address flood-protection issues by aiming to restore the creek's water and sediment transport capacities. The steering committee requires all final designs to be prepared and stamped by a certified professional engineer, and to incorporate the following infrastructure and flood-protection measures:

- Maintain flood capacity and stream bed stability at Q200 flows (flows estimated to occur once every 200 years), incorporating future climate-change flow projections.
- Ensure dikes meet *Dike Design and Construction Guide Best Management Practices for British Columbia.*
- Maintain creek access where and how specified by MFLNRORD, RDCO, City of Kelowna, and other relevant dike/recreation area maintenance organizations.
- Ensure no negative impact on existing water intake/outlets and other infrastructure at all flows.

Creek Flows – Fish & Ecosystem Requirements

Creek flow is a critical factor in supporting a healthy aquatic ecosystem, and has been the source of biological production limitations in Mission Creek over time due to water extraction associated with land-based development. The regional *Mission Creek Water Use Plan* and the *BC Water Sustainability Act* have provided important tools for better addressing ecosystem flow requirements **(**see Section 7 for more details). It is vital that habitat conservation and resto- ration efforts recognize current and potential future flow scenarios to maximize benefits.

Flow criteria for the conceptual designs were established according to recommendations from Northwest Hydraulic Consultants (2020) regarding key flow requirements and mitigation measures in Mission Creek. Additional information on flows of interest originates from MCRI Phase-I adaptive management designs, which identify flow requirements for current or projected future indicator species utilizing Mission Creek (*Alex and Lukey 2019, Dobson 2019*).

Biological Criteria - Fish Habitat

Fish production levels in Mission Creek have declined dramatically over the years in conjunction with habitat loss, but continue to remain the highest of any Okanagan Lake tributary. With recent efforts to restore anadromous fish passage into Okanagan Lake, Mission Creek is increasingly important in supporting the potential establishment of sockeye, chinook salmon, and steelhead trout populations in the future.

The following criteria were established to ensure maximum indigenous fish species' benefits are achieved from the conceptual designs:

- Prevent negative impacts to natural upstream, downstream, and adjacent areas (e.g., floodplain, riparian), or on previously restored habitat areas.
- Integrate effective pool habitat and lateral diversity (e.g., gravel bars), wherever possible.
- Integrate effective side channel and off-channel habitat (e.g., backwaters, floodplains), wherever possible.
- Ensure sediment-extraction methods are as unintrusive as possible for fish, wildlife, and vegetation, if sediment basin/s is included in designs (see more details below). Refer to Shuttleworth Creek and Ellis Creek sediment basin restructuring as examples.

Biological Criteria - Wildlife Habitat

Riparian wildlife habitat has seen a similar decline with loss of floodplain area and associated vegetation. Although records on impacts to

wildlife species are more limited than for fish, it is clear wildlife species and populations have seen major declines over time.

Restoration of floodplain area and habitat will provide major benefits according to the following design criteria:

- Maximize opportunity for enhancing/increasing corridors and patch sizes and connectivity to existing protected areas.
- Integrate aquatic/riparian connectivity with upland terrestrial habitat wherever possible.
- Minimize impacts to existing high-quality wildlife habitat (terrestrial, riparian, aquatic).
- Maximize hydraulics and hydroperiod (water retention) for black cottonwood establishment.
- Create relatively small, isolated, and fish-free wetlands in addition to reconnected floodplain, where possible.
- Integrate wildlife protection measures, where possible (e.g., road mitigations, directed human access, maximum buffer size between human pathways and restored habitats).

Traditional Ecological Knowledge (TEK)

TEK exists for Mission Creek; however, colonization has detrimentally impacted the continuity and traditional ways of knowing, holding, and sharing it. Therefore, TEK at the time of this document's drafting, was inaccessible.

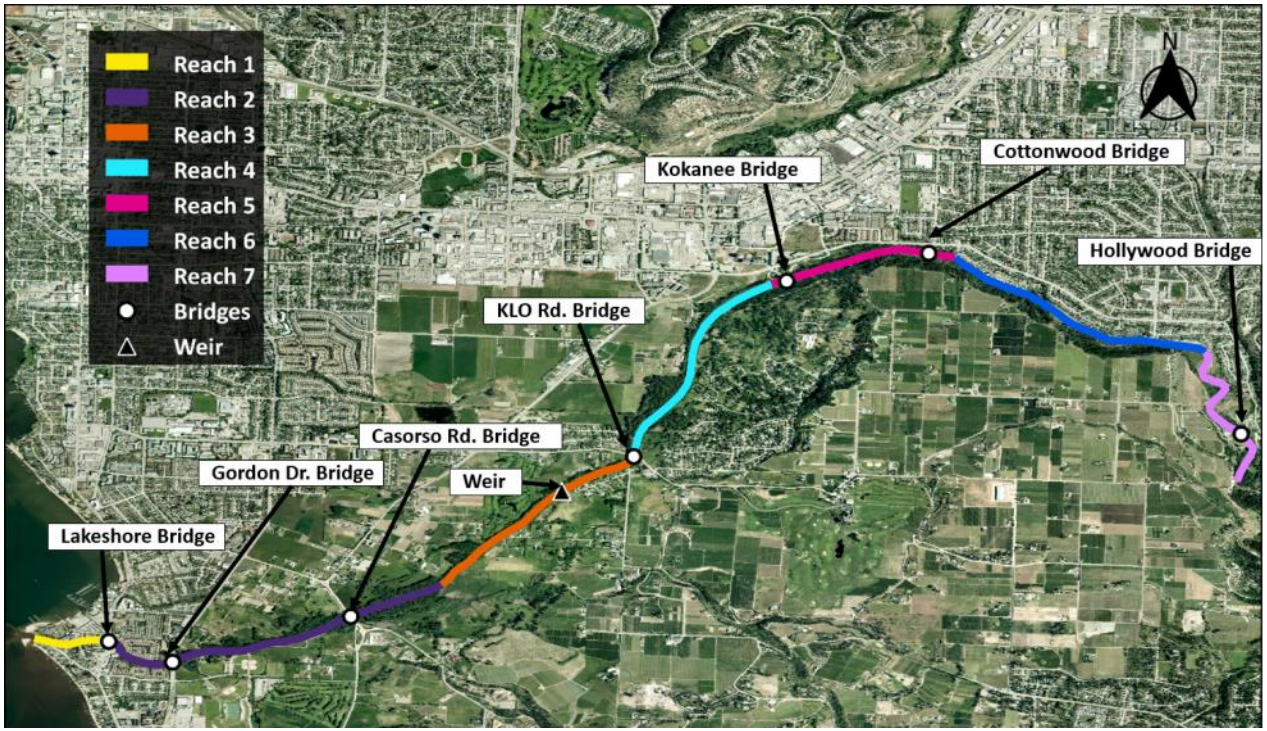
Therefore, opportunities for ongoing engagement by TEK keepers (elders and community members) on design recommendations and future design implementation phases will be offered according to the following considerations:

- TEK processes occur at the discretion of Westbank First Nations and Okanagan Indian Band.
- Design phases incorporate opportunities for gathering TEK keepers and include TEK, wherever possible.
- Designs are reviewed and input provided by TEK keepers.

Reach Designations

As discussed previously, Plan scope and the conceptual designs presented below are for the lower 12 kilometres of creek, extending upstream from Okanagan Lake to approximately 300 metres upstream of East Kelowna Road Bridge. This section of creek involves a wide range of morphological, hydraulic, and associated habitat conditions.

Figure 2: Mission Creek restoration design scope with reach breaks



Conceptual designs have been developed according to a number of parameters including channel width, gradient, sediment conditions (i.e., size, aggrading or degrading), current habitat conditions, and restoration objectives. The designs are generally applicable to a narrow range of values for these parameters to ensure a high level of effectiveness. As a result, this section of creek was divided into smaller lengths known as reaches, which are defined as sections of streams or rivers along which similar hydrologic conditions exist, such as discharge, depth, area, and slope.

Habitat Inventory

Another important step to developing restoration designs is to identify current habitat types and conditions to establish a baseline for potential future changes. The following provides a summary of aquatic and riparian habitat assessment results. Figures 4 and 5 on pages 39 and 40 display the various aquatic habitat types within lower Mission Creek according to the designated reaches.

Aquatic Habitat Conditions

As described earlier, post-colonial development within the creek's floodplain negatively impacted the creek's physical and hydrological conditions, including a severe reduction in floodplain and channel width. (See Figure 3 at right). This disrupted the creek's energy balance and ability to convey flood water and sediment effectively and safely. This energy imbalance has also caused a loss of vital floodplain connections and contributed to unstable, coarsening, and degrading salmonid habitat conditions, which are likely to worsen over time. The main challenges for Mission Creek's lower 12 kilometres for fish habitat are concentrated in Reaches 1-6 and include:

- Reduced bankfull widths (width of water surface where water just begins to overflow into the active floodplain) causing increased water velocity, altered channel morphology, and loss of fish habitat diversity, quantity, and suitability.
- Creek-bed instability resulting from stream modifications, including diking and channelization (unbalanced aggradation/ degradation).
- Loss of riffle-pool sequences that provide critical habitat for fish rearing and spawning.
- Loss of meander bends, resulting in reduced availability and diversity of fish habitat.
- Loss of floodplain area and overbank flows, reducing water storage and flow-supplementation capacity.
- Loss of riparian habitat and benefits for wildlife, channel/bank stability, and nutrient input.
- Loss of riparian vegetation within degraded floodplain areas.

Riparian Habitat Conditions

The majority of riparian habitat has been removed in Reach 1 due to channelization and residential development. In reaches 2-6, riparian habitat is generally limited to narrow fringes of native plant species dominated by black cottonwood and willow species, in addition to several non-indigenous species (*See N. Lukey, K. Alex, B. Yuan, 2022 for more details*). Larger riparian areas are dispersed throughout this section within regional government-owned lands/parks (primarily Regional District of Central Okanagan) and agricultural properties with undevelopable land adjacent to the creek. This is evident in Figures 4 and 5 on pages 39 and 40 as dark green areas along the creek corridor.

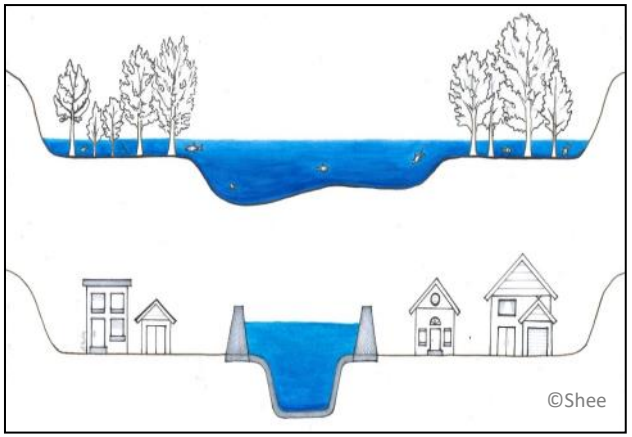


Figure 3: Typical creek confinement resulting in changes to overbank (floodplain flows) and bed stability (from Yuan and Alex 2021).

Figure 4: Mission Creek current habitat types (Reaches 1-4)

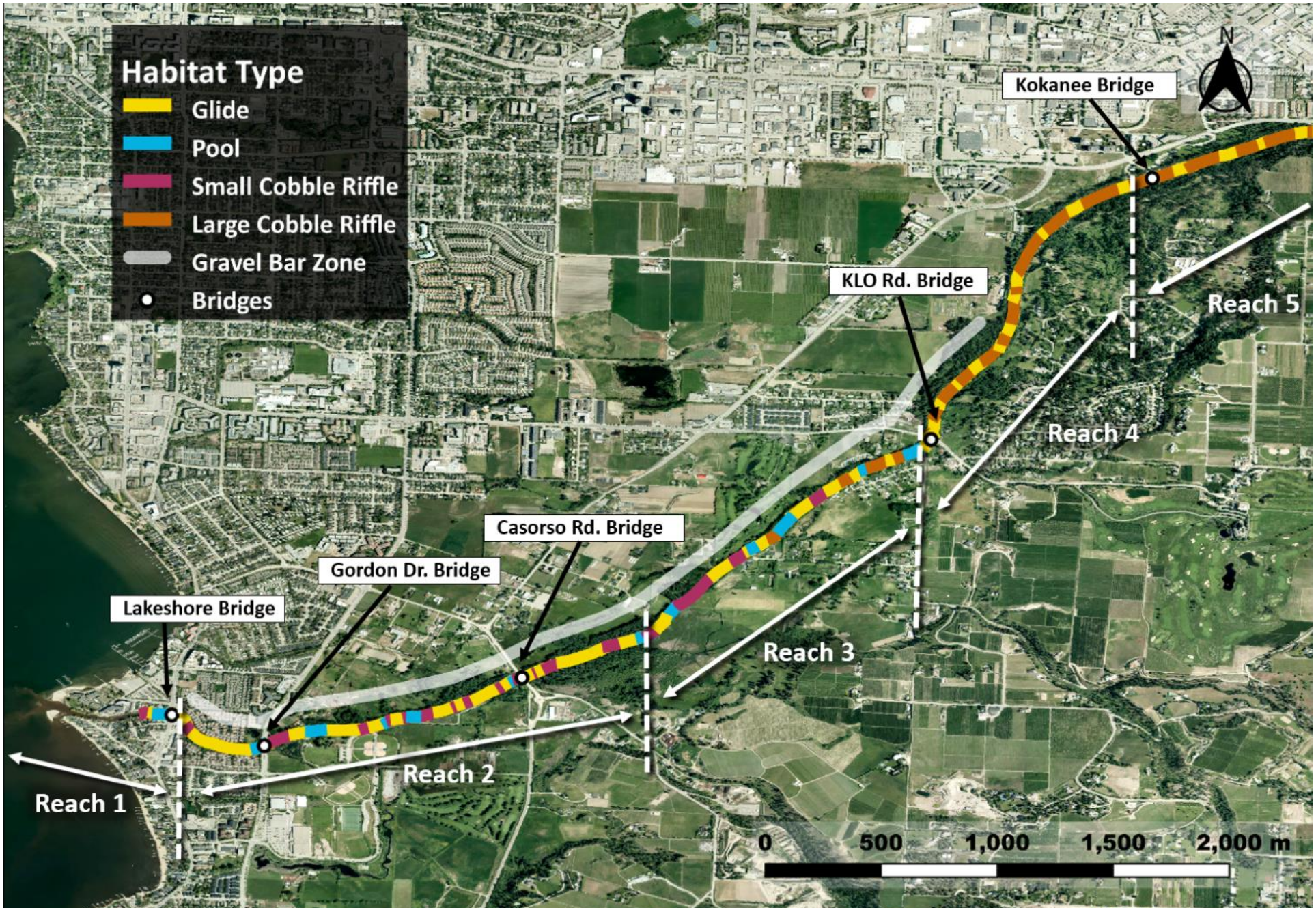
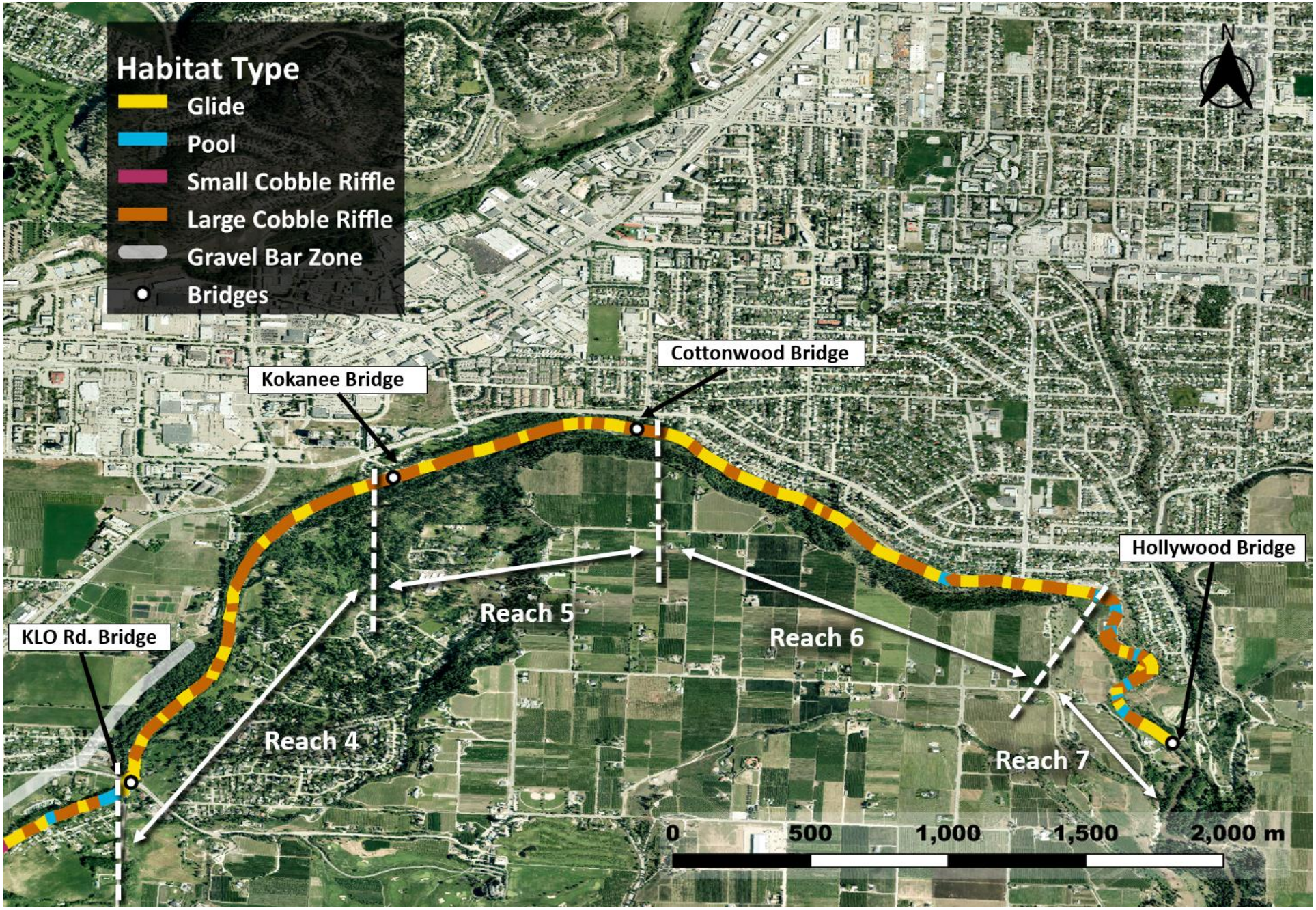


Figure 5: Mission Creek current habitat types (Reaches 4-7)



DETERMINING THE 'BEST-FIT' DESIGN

Design Options

A wide range of habitat restoration techniques and designs are commonly applied to creeks and rivers across the globe. Each addresses an area or site-specific habitat shortfall, associated hydraulic and channel conditions, and/or target fish-species requirements. What follows are high-priority restoration design strategies identified by the MCRI steering committee to address current conditions within lower Mission Creek.

Habitat Conservation

Conservation of existing quality aquatic and riparian habitat through regulatory measures, covenants, and other conservation-based agreements or regulations should be considered as part of any future restoration project design. 'No disturbance' should be the goal where habitat values may be difficult to replace, or the design should protect and incorporate existing habitat features into the restoration plan.

Reaches 2-6 have limited quality aquatic habitat to conserve, with the exception of some dispersed high-use kokanee spawning areas in Reaches 2 and 3. Riparian habitat is generally limited to narrow fringes, but within those areas of more extensive riparian vegetation described above, those values should be protected, where possible.

Reach-7 priorities should be habitat conservation and protection due to the higher level of natural aquatic and riparian habitat values.

Dike Setback & Floodplain Expansion

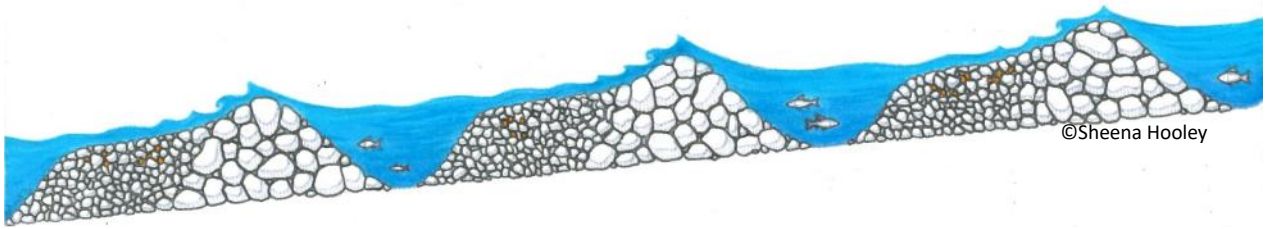
Based on available literature and historical Mission Creek ecosystem productivity, setting back the dikes along the lower creek to facilitate channel and floodplain expansion will provide the highest gains for fish habitat and flood protection. This will allow the creek to naturally develop the desired aquatic and riparian habitat diversity, quality, and quantity with minimal human intervention and associated costs.

In addition, a wider floodplain would contribute to reduced flood-stage water levels, and increased sediment capture and groundwater storage. In conjunction with dike setback, there are opportunities to increase availability and quality of riparian habitat through area expansion and vegetation improvements.

Riffles

These are important features in all natural creeks, located in areas of transition to increasing gradient. Riffles often occur in association with pools, and are largely comprised of cobbles and boulders that provide important functions, including hydraulic energy dissipation,

Figure 6: Profile diagram of a typical riffle, and photo of a completed riffle project on Okanagan River



oxygenation, invertebrate production, and fish rearing (feeding and resting) areas. Gravel disposition is also common in association with riffle hydraulics, providing important spawning habitat.

Riffles are widely used in restoration to control gradient and sediment degradation and aggradation issues. They are built by placing rock fill in an existing channel; typically so the upstream slope of the fill is much steeper than the downstream slope. This creates a longitudinal profile similar to natural riffles. Pools form at the upstream slope of the riffle (referred to as a riffle/ pool sequence) due to the backwatering effect, providing quality rearing habitat. Gravel can be added to the downstream slope, or deposit naturally depending on upstream sources.

Sediment Basins

Sediment sources in upper Mission Creek contribute to ongoing deposition of large volumes of granular materials throughout the lower section. This can cause many issues, including aquatic habitat degradation and reduced flood capacity. Floodplain expansion is the best strategy for sediment capture, but may not be feasible in the short term. The creation of sediment basin/s in the upper area of the Plan scope would provide a interim tool for capturing and removing sediment, limiting impacts in downstream locations.

Additional Aquatic Habitat Restoration Options

The following restoration techniques could be applied within select locations within Reaches 2-6 to improve habitat diversity and function. These designs typically do not provide the level of flood-protection benefits associated with dike setback and riffle construction.

Engineering and biological assessments will be required to determine appropriate locations for these restoration approaches to ensure the specified channel capacity requirements are maintained. These design approaches have been successfully implemented within the MCRI Phase 1 project with positive results and are recommended as additional restoration options in conjunction with the higher priority designs discussed earlier in this section. See Appendix 3 for more information on each of these restoration options.

- **Boulder Clusters –** Boulders provide important aquatic habitat benefits within natural streams, but are often lacking in heavily developed watersheds due to channel modifications. Replication of boulder features in the form of clusters is a common approach to restoring habitat diversity within streams. This restoration technique has been well tested over time, resulting in development of highly durable and effective designs. Boulder cluster installations on Mission Creek have utilized a four-boulder arrangement in a diamond shape with the apex facing upstream. This has resulted in development of scour pools within, and immediately downstream of the structure, providing important rearing habitat, as well as areas of gravel deposition providing spawning habitat.

- **Gravel Bars and Boulder Lines –** These techniques are utilized to restore meander patterns that have been lost due to channelization, contributing to increased habitat diversity. Gravel bars are natural features which form due to gravel or cobble deposition over time in areas of reduced velocity, contributing to development of flow sinuosity or meanders. Gravel-bar construction or modification within select locations can be an effective tool for replicating these benefits. Boulder lines can also be installed in the stream channel to replicate the function of a gravel bar by deflecting flow laterally. Boulders are placed in a series of lines extending from the stream bank across a portion of stream width in a downstream angle causing flow to direct across the channel during lower flow periods.

- **Large Woody Debris –** The benefits of large woody debris (LWD) within a stream channel for providing rearing habitat has been well documented. The addition of LWD generally consisting of logs or root wads to replicate natural in-stream wood features has been a long-standing restoration strategy for

providing cover and generating creation of scour pools. Opportunities should be explored where LWD can be installed without compromising channel capacity.

Riparian Area Enhancement

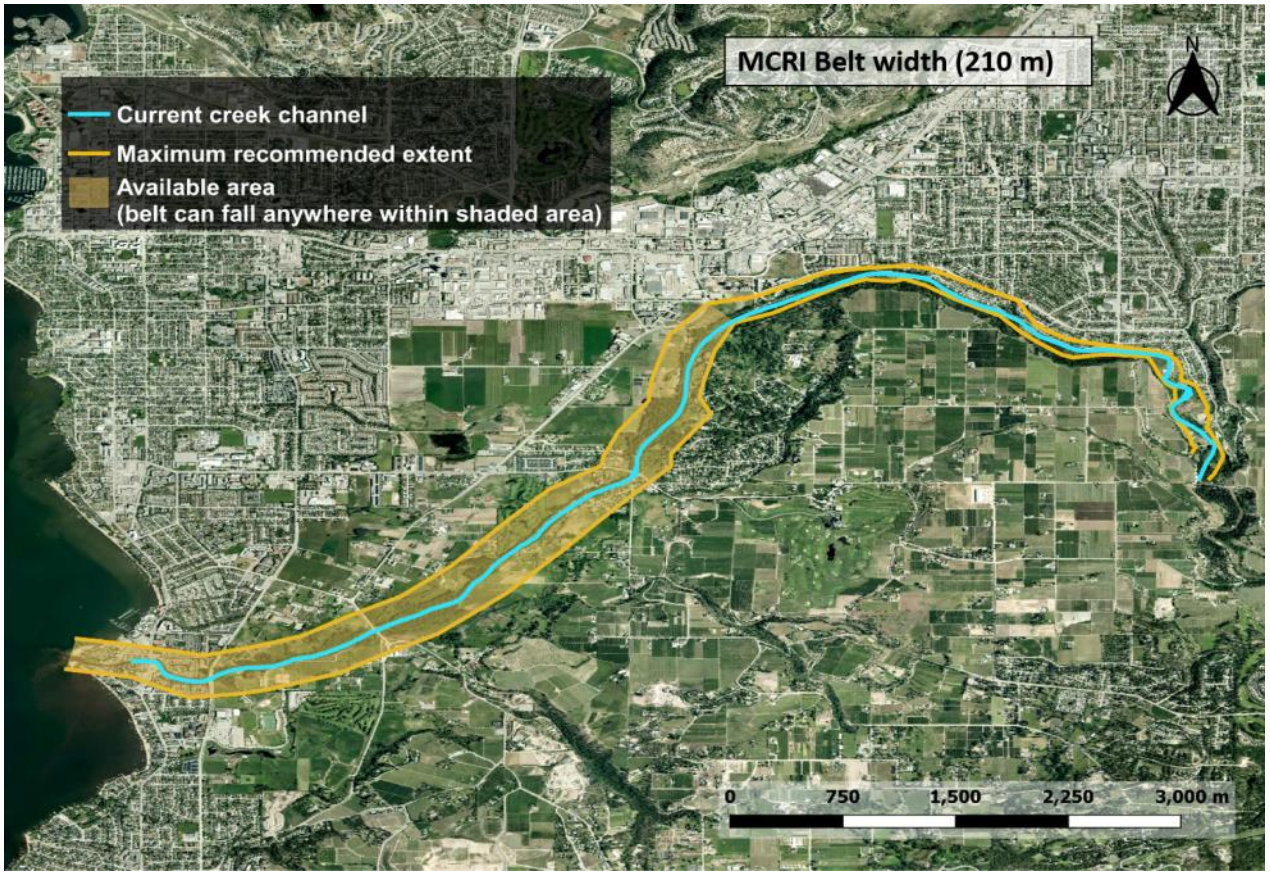
Designs involving some level of channel and floodplain expansion must address restoration of riparian vegetation within areas of disturbance, dikes and confinement berms, and newly established floodplain area. Based on results from Phase-1 restoration, this can be largely achieved through natural colonization where there are large numbers of donor trees and shrubs in close proximity to facilitate seed and root-based colonization. Some artificial plantings may be required within locations where natural recolonization is more challenging, such as riprap banks.

Achieving Ideal Restoration Outcomes for Lower Mission Creek

As noted above, dike setback provides the greatest overall benefits of all available design options, with values increasing as bankfull and floodplain width expand. However, there are many site-specific factors that can limit applicability and extent of this design approach, including cost, infrastructure (e.g., bridges, pipelines), and property status and availability.

Meander Belt Width

Figure 7: Recommended target meander belt width for Mission Creek based on current height of land (the 210 m belt width can be located anywhere within the shaded area)



To determine the full range of potential benefits from this approach, the target floodplain width (also referred to as meander belt width) for achieving optimum restoration outcomes was estimated at a theoretical level. Meander belt width (or belt width) is the space a meandering stream occupies on its floodplain, in which all natural channel processes occur (*Parish 2004*).

If implemented correctly, meander-belt delineation is a valuable tool for reducing risks to life and property, while balancing aquatic habitat values in the long-term (*Parish 2004*).

The target belt width for Mission Creek has been identified as 210 metres between the landward toe of each setback dike. This belt width would

result in primarily self-regulating stability, allowing sediment and hydraulic processes to occur. It would also ensure long-term fish and wildlife habitat regeneration, with significantly less human-derived maintenance effort.

As well as having immense benefits for fish and wildlife, setting back the dikes will confer many other benefits to the creek and its required management processes, including (*NHC 2020*):

- Reducing risk to dikes from erosion, sedimentation, debris, aggradation.
- Increasing safety factor as width between dikes increases.
- Removing future constraints on raising dikes, reducing need for riprap armoring, and riparian tree removal from dikes.
- Promoting overbank flow, sorting fine sediments, and fertilizing the floodplain (*BC Ministry of Environment, Lands and Parks, 1998).*

It is important to note that biological and flood-protection benefits are still generated at belt widths less than 210 metres, but there is a general reduction in benefits, in addition to increasing maintenance costs with declining width. Please refer to the primary reference (*N. Lukey, K. Alex, B. Yuan, 2022*) for a detailed maintenance cost comparison at varying belt widths.

Figure 7 (right) displays the recommended belt width along the lower Mission Creek corridor, which is feasible based on current land height on each bank. For the reaches in the aggradation and transition zones, extending from the mouth to approximately the Environmental Education Centre for the Okanagan (Reaches 1-4), neither bank was chosen as the "required" side for setback placement. Based on current land height, the setback can fit anywhere within the orange shaded area on either bank.

Design Applicability Assessments for Lower Mission Creek Reaches

Feasibility studies were undertaken at various stages of conceptual design development to determine the appropriate application for each reach. This involved modeling to see how various design approaches would influence sediment movement, degradation and aggradation, and design functionality.

Results indicated that Mission Creek's energy imbalance, bed instability, and subsequent fish habitat degradation may be resolved in part by restoring the riffle-pool balance within Reaches 2-6. Modeled designs determined that re-profiling channel slope using riffle sequences in each reach would stabilize the bed and establish some lost habitat features (e.g., spawning and pool habitat). Various scenarios for each reach were tested to identify required riffle specifications, including the most stable bankfull width. This also included riffle size and longitudinal spacing within the creek channel to maximize benefits (primarily pool size), while minimizing impacts to existing dike flood capacity and spawning habitat.

The following additional considerations for future riffle projects were generated from this study:

- Once dike setback and bankfull-width expansion are completed, the river will naturally re-organize into riffles and pools, reducing the need to build all recommended conceptualized riffles.
- Further investigation is needed to determine how riffles could improve function of existing water infrastructure (e.g., intake weirs, kokanee spawning channel intake).
- Further refined, site-specific construction designs should include more intense survey and modelling near existing structures and at other flows of interest for each structure's intended function (e.g., Mill Creek diversion outlet, irrigation/water intakes, flood control outlets, and bridges).

These studies also identified the need for sediment capture within the upper portion of Reach 6 or within Reach 7 (where habitat impact would be minimal) by constructing deep mid-channel basins with ongoing sediment removal as

an important tool early in the restoration process. This would reduce potential negative impacts on future downstream restoration works and existing habitat. Riffles in all reaches can be installed before sediment basin/s and extraction begin; however, pools may fill in if upstream sediment load is not mitigated. Once the basin/s is constructed, pools may eventually self-scour and riffles may re-sort naturally. Ideally, the sediment basin is operational within five to ten years. Also note that sediment captured at an upstream basin may be extracted and used for subsequent habitat-restoration projects.

Finally, it was determined that restoration of Reaches 1 and 7 would not be appropriate at this time for the following reasons:

- In Reach 1, the channel is heavily confined by residential properties, gradient is very low, and hydrology is influenced by Okanagan Lake water levels. This causes a backwatering effect that slows the water, causing substantial deposition of fine sediment. This section contains no rearing or spawning habitat for target fish species, only providing a migration route to available habitat in the upstream reaches. As a result, no conceptual design recommendations are provided for this reach; however, there is a strong need for ongoing vigilance to ensure fish access is maintained during lower-flow periods.
- Reach 7 has experienced much fewer anthropogenic impacts, resulting in retention of considerable natural channel and floodplain conditions. This includes a high level of aquatic and riparian habitat diversity, quantity, and quality. As a result, the focus in this reach should be to ensure habitat values are protected over the long term.

Restoration Timeline Considerations

There is a wide range of conceptual design strategies identified in this Plan requiring extensive planning and supporting resources to deliver on-the-ground projects. This can include land securement, funding, regulatory permits and logistical considerations. The length of time required to address these factors will be the determining factor in establishing a realistic timeline for project delivery, and will help establish a schedule for Plan implementation.

Short Term

Plan recommendations will focus on those actions where immediate funding and land securement requirements are lower. For example, habitat conservation measures, riffle projects and/or sediment basin project delivery in locations not requiring significant changes to channel width (no dike setback required), in addition to planning for future dike setback and floodplain expansion. This will include preparations for responding to potential land-securement opportunities that may arise, laying the foundation for a future dike-setback project.

Long Term

Focus will shift to continued planning and implementation of design recommendations involving dike setback as opportunities come available. In addition, opportunities for delivery of riffle projects will continue as specified in the Plan. (See Section 11 for more detailed information on recommended project planning and implementation actions.)

HABITAT CONSERVATION AND RESTORATION RECOMMENDATIONS

The following general and reach-specific habitat conservation and restoration recommendations are based on information presented in the Plan's primary reference: *Mission Creek Lower 12 km. Restoration Conceptual Designs: Years 1 & 2* (*N. Lukey, K. Alex, B. Yuan, 2022*).

Design recommendations employ well-researched river processes observed in rivers across North America (*Newbury 2010, Schumm 1977, Leopold et al. 1964, Hynes 1970*), literature reviews specific to Mission Creek and other Okanagan watersheds, assessment and analysis of current hydrological and morphological conditions, fish and fish habitat, and creek/habitat response to a wide range of restoration applications.

All information underwent intensive review and input from the steering committee in addition to organization-specific reviews by City of Kelowna, Regional District of Central Okanagan, and

Ministry of Forests, Lands and Natural Resources Operations and Regional Development.

A summary review of design recommendations is provided below. More detailed information is available In Appendix 1, which presents a comprehensive review of reach-specific habitat constraints and associated conservation and restoration recommendations. This provides readers the option of choosing which level of information best fits their needs and interests.

General Recommendations

Conservation and restoration recommendations presented below have been developed at a conceptual level focused primarily on technical feasibility and potential benefits. Extensive logistical planning is required before determining if a conceptual design can transition to a feasible on-the-ground project (including funding availability and existing land status and use).

- Conservation of existing high-quality aquatic and riparian habitat in all reaches is a high priority, and should be a key consideration in development of future restoration projects
- Setting back dikes to expand channel and floodplain width offers the best tool for improving fish and wildlife habitat and flood protection. The wider the floodplain, the greater the benefits and the lower the long-term maintenance costs.
- Conceptually, the optimum floodplain width (also referred to as meander belt width) for achieving these benefits in Mission Creek has been identified at 210 metres. It is recognized this will not be possible in many locations, and significant benefits can be achieved at reduced floodplain widths.
- Costs associated with setting dikes back can be lower than rebuilding existing dikes to accommodate projected future flow increases.
- Restoration of riffle-pool sequences provides the best option for restoring bed stability and habitat diversity in Mission Creek where channel expansion opportunity is limited, and aggradation and degradation processes are negatively impacting habitat quality.
- Gravel-bar modifications or additions provide another option for increasing habitat diversity within the creek, provided there is sufficient capacity to accommodate flood flows.
- Studies identified the need for sediment capture within the uppermost reaches by constructing deep mid-channel basins with ongoing sediment removal as an important tool early in the restoration process, thereby reducing potential negative impacts on future downstream restoration works.

Reach-Specific Recommendations

- Prioritize the monitoring of fish access through Reach 1 during low-flow periods to ensure fish passage is maintained.
- Limit Impacts to existing kokanee spawning habitat in Reach 2, and functional riparian habitat associated with crown and private lands in Reaches 2-6. Future restoration project benefits must be weighed against loss of existing habitat.
- Floodplain expansion will provide ecosystem and flood-protection benefits in Reaches 2-6; however, prioritize land acquisition and setback efforts in Reaches 2, 3, and 4B to start.
- Prioritize riffle installation in Reaches 4A, 5, and 6, where less immediate bankfull width expansion and dike setback are required prior to riffle construction. Riffle construction in reaches 2, 3 and 4B, should occur after dike setback and bankfull channel widening.
- Prioritize protection and conservation of existing habitat in Reach 7 over the long term based on existing high natural ecosystem values.
- Aim for sediment basin development within the next five to ten years, within an appropriate site located as close to the sediment source as possible. This should include investigating options upstream of Reach 5, where impacts to existing habitat values can be minimized.

See Table 3 on next page for a reach-by-reach summary of habitat issues, considerations, and recommendations. More detailed reach-specific information is available in Appendix 1.

Table 3: Summary of current habitat conditions and recommendations by reach

REACHES	SEDIMENT ZONES	MAIN FISH HABITAT ISSUES & CONSIDERATIONS	RECOMMENDATIONS
1 (Lake to Lakeshore Bridge)	Aggradation (fines)	♦ Confined by residential properties ♦ High level of sand deposition ♦ Lacking rearing and spawning habitat - migration route only	♦ Maintain fish access ♦ No design recommendations at this time due to confinement/sediment limitations ♦ Revisit when sediment management decisions are made upstream
2 (Lakeshore Bridge to upstream of Casorso Bridge)	Aggradation (gravel bars)	♦ Important spawning reach ♦ High variation in local slope ♦ High variation in bankfull width; generally too narrow ♦ Lacking pool habitat ♦ Floodplain disconnection	♦ Install riffles (in association with dike setback) to encourage spawning areas and pools. ♦ Retain existing kokanee spawning habitat where feasible ♦ Dike setback aimed at maximizing floodplain width
3 (Upstream of Casorso Bridge to KLO Bridge)	Aggradation (gravel bars)	♦ Important spawning reach, some spawning gravel coarsening in sections ♦ High variation in bankfull width; generally too narrow ♦ Lacking pool habitat ♦ Floodplain disconnection	♦ Install riffles (in association with dike setback) to encourage spawning areas and pools. ♦ Dike setback aimed at maximizing floodplain width
4 (Upstream of KLO Bridge to Kokanee bridge)	Aggradation-degradation transition (gravel bars)	♦ Gravel sizes coarsening to outside kokanee spawner range, ♦ Highly unstable bed ♦ Bankfull widths too narrow ♦ Lacking pool habitat ♦ Floodplain disconnection	♦ Install riffles to stabilize bed (will also increase pool habitat and potentially spawning habitat). ♦ Dike setback aimed at maximizing floodplain width
5 (Kokanee Bridge to Cottonwood bridges)	Degradation (no gravel bars)	♦ Kokanee spawning channel at upstream end ♦ Mainstem hydraulic conditions and gravel size far outside spawning ranges ♦ Bankfull widths too narrow ♦ Lacking pool habitat ♦ Floodplain disconnection ♦ Unstable bed	♦ Install riffles to stabilize bed (will also increase pool habitat and potentially spawning habitat). ♦ Dike setback aimed at maximizing floodplain width
6 (Cottonwood bridges to Burbank Street)	Degradation (no gravel bars)	♦ Bed stable but mostly outside kokanee spawning range (small patches); slope higher than historical ♦ Bankfull widths too narrow ♦ Lacking pool habitat ♦ Floodplain disconnection	♦ Install riffles to stabilize bed (will also increase pool habitat and potentially spawning habitat). ♦ Dike setback aimed at maximizing floodplain width
7 (Burbank St. to Gallaghers Canyon)	Generally naturally functioning	♦ Low level of anthropogenic impacts resulting in high level of habitat diversity, quantity and quality ♦ Functioning floodplain with quality riparian areas	♦ Monitor to ensure ecosystem values are protected over the long term

SECTION 11: PLAN IMPLEMENTATION STRATEGY

As previously discussed, there are many challenges associated with implementing habitat conservation and restoration measures, including high costs, funding limitations, and difficulties associated with land securement. This implementation strategy aims to facilitate a smooth roll-out of the identified recommendations through a proactive and collaborative approach aimed at effectively responding to ecosystem needs, opportunities, and project delivery challenges.

IMPLEMENTATION ACTIONS & TIMELINES

There are several implementation actions that will be key to successful delivery of Plan recommendations. A summary of priority actions is detailed below with a projected implementation timeline. The duration required for delivery of each action can be variable depending on the level of required funding and land securement, in addition to other factors such as regulatory and logistical considerations. For those actions with a defined delivery plan in place, specific completion dates are provided. For actions involving conservation-based protection measures, an open-ended timeline is specified, recognizing the need for continued oversight. In the case of restoration-based actions, no definitive timeline is provided, recognizing the uncertainty associated with time requirements for addressing project delivery requirements.

Develop a project-specific engineered design based on Plan recommendations (2022/23)

- As part of the Plan development process, MCRI secured partial funding support to proceed with development of an engineered design for a priority reach according to the specified conceptual design. This design will form the basis to proceed with the on-the-ground restoration project. The engineered design must be completed within the 2022/23 fiscal year (April 1, 2022 – March 31, 2023) or the funding commitment will be lost. This action involves two tasks:
  - Confirm the priority reach and recommended conceptual design for development of the engineered design.
  - Aim to undertake the engineered design at a location with a high probability of proceeding to on-the-ground works within 1-2 years following design completion. As such, the steering will need to consider current opportunities when assessing site potential.

Apply the engineered design to on-the-ground restoration project delivery (2023/24 or 2024/25)

- Best fit will be a riffle or sediment basin construction project with minimal channel expansion requirements as specified in the Plan (see Section 10) to meet this timeline.
- The final timeline will depend on when funding, property (if needed), permitting, and any logistical limitations (e.g., site access) can be addressed.

Address conservation-based priority actions (ongoing)

- Ensure unobstructed fish migration through Reach 1, particularly during low-flow periods. This will require annual inspections of migration conditions.
- Retain (conserve) existing high-value aquatic and riparian habitat where feasible, as part of any future restoration project as directed by the Plan. This will be addressed as a component of all project plans, including municipal, provincial and federal permitting processes.
- In addition, this will require ongoing regulatory oversight by the mandated agencies of all land-

development initiatives with potential to impact these values.

Confirm restoration project priorities (ongoing)

- It is recognized that future conservation/ restoration project selection will require ongoing review of Plan-specified priorities in conjunction with current factors that may change over time, such as funding and land-securement opportunities. This review process may lead to consideration of alternative project/design options to facilitate moving forward within a reasonable time frame, and to reduce the risk of losing valuable opportunities.
- For potential large-scale floodplain expansion projects, a long-term planning focus is required based on the land and funding challenges that must be addressed to support implementation. In addition, annual assessments of land and funding securement needs and opportunities for all identified priority locations are required to ensure we can successfully respond when these valuable resources come available. This approach will also apply to riffle-construction projects involving some level of channel expansion as specified in the Plan.

Proceed with identified on-the-ground project priorities (variable timeline)

- Large-scale projects involving channel and floodplain expansion typically require a 5-10 years+ timeline to reach the implementation stage, depending on land and funding requirements and availability.
- For small-scale in-channel restoration projects, funding and channel expansion requirements are much lower, allowing for short-term project planning and implementation, generally within a 5-year timespan. This would include the site-specific riffle and sediment basin construction project recommendations specified in the Plan.
- Ensure all projects are supported by long term effectiveness monitoring.

Please refer to Section 10 and Appendix 1 for detailed information on Plan conservation and restoration project recommendations.

Develop partnerships (ongoing)

- Successful delivery of Plan recommendations will depend on establishing strong support across a broad base of stakeholders. The Plan is approaching this challenge through development of partnerships with all levels of government, including Syilx Okanagan Nation, and community organizations. These partnerships have been, and will continue to be, based on the wide range of mutual benefits that can be generated from restoring Mission Creek aquatic and riparian habitat, including improved ecosystem function, reduced flood risk, water quantity and quality improvements, and increased recreational and economic contributions. In addition, these partnerships will provide enhanced project funding opportunities. The steering committee is an excellent example of this collaborative approach and will play a big role in furthering future partnership development.

Secure funding (ongoing)

- Costs for restoration project planning, design, property securement, on-the-ground works, and monitoring can be a major limiting factor to successful project implementation. As a result, it is important that all viable funding options are explored early in the project planning process. The following is a summary of potential funding sources.
  - **Outside Grants and Foundation Funds**: There are several funding sources that can only be accessed by local non-profit organizations. The MCRI has worked closely and successfully with its community partners to apply for this funding in support of both site-specific work and more general initiatives that raise public awareness and support for Mission Creek. Going forward, MCRI will continue to work with these collegial groups to secure these important funds. Successful funding acquisition from these sources depends on quality project

proposals demonstrating watershed importance, need for restorative actions, strong methodology, high cost/benefit, and large partner funding contributions. Due to the inherent limitations on habitat restoration-based funding, development of project collaborations aimed at achieving ecosystem benefits in addition to flood protection, recreation, and economic benefits, will open the door to a much wider array of funding opportunities.

◊ **Mission Creek Aquatic Habitat Compensation Bank:** MCAHCB was established by the City of Kelowna, under the authority of the Federal *Fisheries Act*, and through agreement with the three levels of government. It provides the ability to direct assigned compensation dollar values (resulting from habitat loss at the location of City infrastructure projects and private development projects) to habitat restoration at off-site locations within Mission Creek deemed to provide higher value. MCAHCB has been a primary target for directing off-site compen- sation funds for several years, which has helped to support past MCRI restoration planning and implementation projects). The MCAHCB will continue to accumulate funds resulting from off-site habitat loss compensation that will benefit Plan directed projects in the future.

◊ **Public donations**: Conservation and restoration of Mission Creek is important to local communities. Establishing an endowment fund for Mission Creek restoration would allow for private donations and private - sector sponsorships. In addition, municipalities can accept donations from the public, which can provide individuals and private companies charitable tax receipts for donations.

In Kelowna and many other communities, the swell of public support for important environmental work has successfully raised significant funds that move projects forward more quickly and often more effectively. The Mission Creek Greenway project several years ago is a successful and demonstrable example of that approach. As the MCRI moves forward with its work, these opportunities will arise and the MCRI partners will maintain close communication with collegial groups to mobilize this sector as opportunities present themselves.

Secure land (ongoing)

♦ Mission Creek habitat restoration involving floodplain expansion largely depends on availability of adjacent agricultural land, and will rely on achieving full property-owner support and agreement. Ongoing monitoring of property availability and access to securement funding will be key to ensuring opportunities are not lost. In addition, the Regional District Central Okanagan and City of Kelowna hold substantial creekside properties. Development of partnerships with these organizations, and involvement in existing planning processes, will be key to integrating Plan recommendations within this land base.

♦ Conservation Covenants and other land-protection tools will be explored on properties where conservation measures are recommended, and purchase is not an option.

SECTION 12: PLAN COMMUNICATION STRATEGY

A comprehensive communications strategy that informs and engages government, including Syilx Okanagan Nation, other stakeholders, and the community is key to successful Plan implementation. MCRI has a long history of outreach and communications through a variety of tools including the MCRI website (https://www.missioncreek.ca), media updates, videos, and participation at community events such as children's festivals and salmon festivals. These efforts have contributed to a strong base of support that will assist in the transition to larger-scale conservation and restoration project focus in the future through implementation of this Plan.

PURPOSE

The purpose of this communications strategy is to increase stakeholder and public awareness of Mission Creek values, ecosystem impacts and needs, and conservation and restoration benefits. In addition, a proactive approach will be used to inform and engage stakeholders, funders, affected community groups, and the public, on all aspects of Plan implementation. This will include ongoing information dissemination via:

- MCRI website
- Media releases
- Project signage
- Videos and related ecological film festivals
- Site tours
- Official completion celebrations
- Community events such as children's, water, and fish festivals
- Discussions with individual property owners
- Online opportunities for input.

The steering committee will continue to provide oversight and direction in the delivery of these communications initiatives.

GUIDING PRINCIPLES

The following principles will guide delivery of this communications strategy:

- Maintain open and transparent outreach/education approach.
- Include all interested/affected by the project.
- Recognize different communications needs for different groups.
- Provide simple, relevant, and timely information specific to each target audience.
- Optimize outreach by collaborating with partner organizations.
- Acknowledge funders, partners, contributors.
- Celebrate successes to foster support and stewardship.

Outreach partnerships are essential for building community support. MCRI worked with Lake Country Art Gallery and Fat Cat Children's Festival to create a mural of Mission Creek stocked with fish created by local children, which has been displayed at community events and Kelowna City Hall.

- Monitor/modify outreach tactics/ tools to continually improve outreach/engagement.

COMMUNICATIONS SENSITIVITIES

There are several potential sensitivities related to restoration projects involving changes to the creek landscape. Proactive communication strategies are required that provide clear information on proposed works and the benefits to the environment and community to alleviate potential concerns that may arise. These include:

- **Flood Protection:** Historically, Mission Creek has been the source of major flooding that severely impacted private and public properties. In response, governments of the day implemented flood-control measures including channelization and diking. These have generally addressed flood risk, so any substantial changes to flood-control infrastructure can concern citizens.
- **Recreational Opportunities:** The creek is regarded as a natural gem, which is highlighted by the Mission Creek Greenway Regional Park. The expansive trail system along the creek provides quality recreational opportunities, including hiking, biking and wildlife viewing. As with flood protection, any perceived change and potential loss of trails and park land could cause concern.
- **Other Concerns**: Disruptions during construction, aesthetic changes, potential maintenance requirements, loss of agricultural property, and property-specific issues.

COMMUNICATIONS SCHEDULE

The timeline for Plan communications will be largely dictated by the Implementation Strategy schedule (see above), and associated project specific outreach requirements.

SECTION 13: REFERENCES

PRIMARY REFERENCE

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Photo courtesy of Jan Vozenilek, Copper Sky Productions

SECTION 14: APPENDICES

APPENDIX 1: Detailed Reach-Specific Habitat Information, Conservation & Restoration Recommendations

APPENDIX 2: Detailed Background Information – Fish and Wildlife Species and Habitat

APPENDIX 3: Glossary of Terms

APPENDIX 1: Detailed Reach-Specific Habitat Information, Conservation & Restoration Recommendations

REACH 1: OKANAGAN LAKE TO LAKESHORE DRIVE BRIDGE

KEY MESSAGES:

- ***Poor quality aquatic and riparian habitat – conditions include severely confined channel, no functional riparian area, backwatering effect from the lake, and high level fine sediment deposition.***
- ***Values currently limited to providing a fish migration route to upper reaches.***
- ***Recommendation: Ensure fish access is maintained during low flows.***

REACH 2: LAKESHORE DRIVE TO UPSTREAM OF CASORSO ROAD BRIDGE

KEY MESSAGE: Riffle-pool habitat restoration is possible for Reach 2 with dike setback and bankfull channel widening.

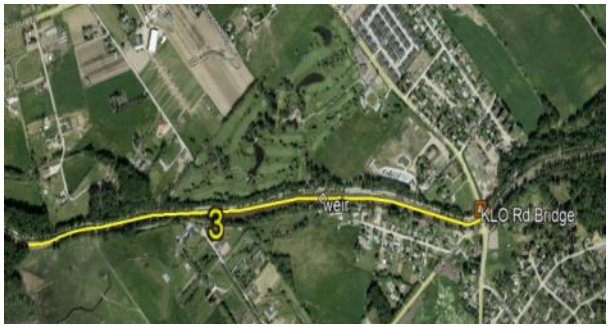
Table 4: Reach-2 habitat conditions and restoration design recommendations

Sediment Zone	Aggradation (deposition)
Riffles and Pools	*Current: 6 pools
	Conceptualized: 9 riffle/pool sequences
Recommended Riffle Morphology	Spacing: 160-210 m Height: 1.25 m Total length: 21 m
Bankfull Width	Current: 23 m
	**Required for stable riffle with adequate dike freeboard: 37 m
Bankfull Width Expansion Required Before Riffle?	Yes
Dike Setback Required Before Riffle?	Yes
Dike Freeboard (M)	Current: < 0 m
	**With riffle construction: 0.6
Comments & Considerations	♦ Water level can overtop dike at current and projected 1-in-200-year flood. ♦ Large variation in channel width and slope; therefore, stable riffle distance varies. ♦ Small cobble riffles within these reaches; do not disturb as the associated small gravels are potentially spawning gravels (i.e., avoid backwatering with pools). ♦ Reach contains MCRI Phase I; conduct additional monitoring and modeling to determine whether riffles are required here. ♦ Future construction engineered designs must account for water infrastructure downstream of Gordon Road.

**Current number of riffles was not inventoried **Assuming dike setback*

Figure 8: Reach-2 habitat conditions and restoration design recommendations

REACH 3: UPSTREAM OF CASORSO ROAD BRIDGE TO KLO BRIDGE



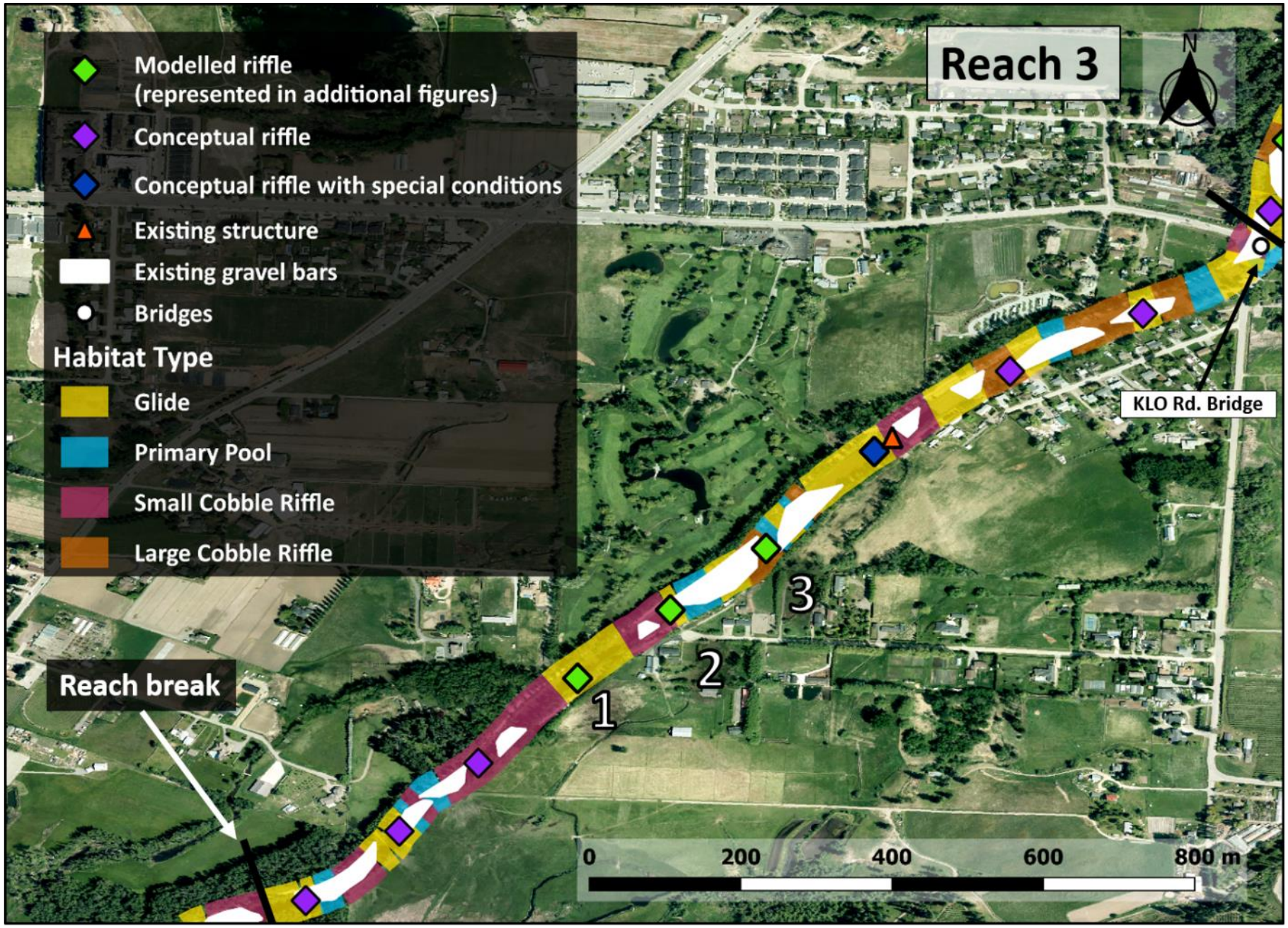
KEY MESSAGE: Riffle-pool habitat restoration is possible in Reach 3 with dike setback and bankfull channel widening.

Table 5: Reach-3 habitat conditions and restoration design recommendations

Sediment Zone	Aggradation (deposition)
Riffles and Pools	*Current: 7 pools
	Conceptualized: 8 riffle/pool sequences
Recommended Riffle Morphology	Spacing: 165-210 m Height: 0.9 m Total length: 15 m
Bankfull Width	Current: 27 m
	**Required for stable riffle with adequate dike freeboard: 37 m
Bankfull Width Expansion Required Before Riffle?	Yes
Dike Setback Required Before Riffle?	Yes
Dike Freeboard (M)	Current: < 0 m
	**With riffle construction: 0.6
Comments & Considerations	♦ Water level can overtop dike at current and projected 1-in-200-year flood. ♦ Large variation in channel width and slope; therefore, stable riffle distance varies. ♦ Small cobble riffles within these reaches; do not disturb as the associated small gravels are potentially spawning gravels (i.e., avoid backwatering with pools). ♦ Existing intake weir has filled in; consider incorporating riffle construction as functional intake structures. ♦ Weir and bridges must be accounted for in construction engineer designs.

**Current number of riffles was not inventoried **Assuming dike setback*

Figure 9: Reach-3 habitat conditions and restoration design recommendations



REACH 4A / 4B: KLO BRIDGE TO KOKANEE BRIDGE

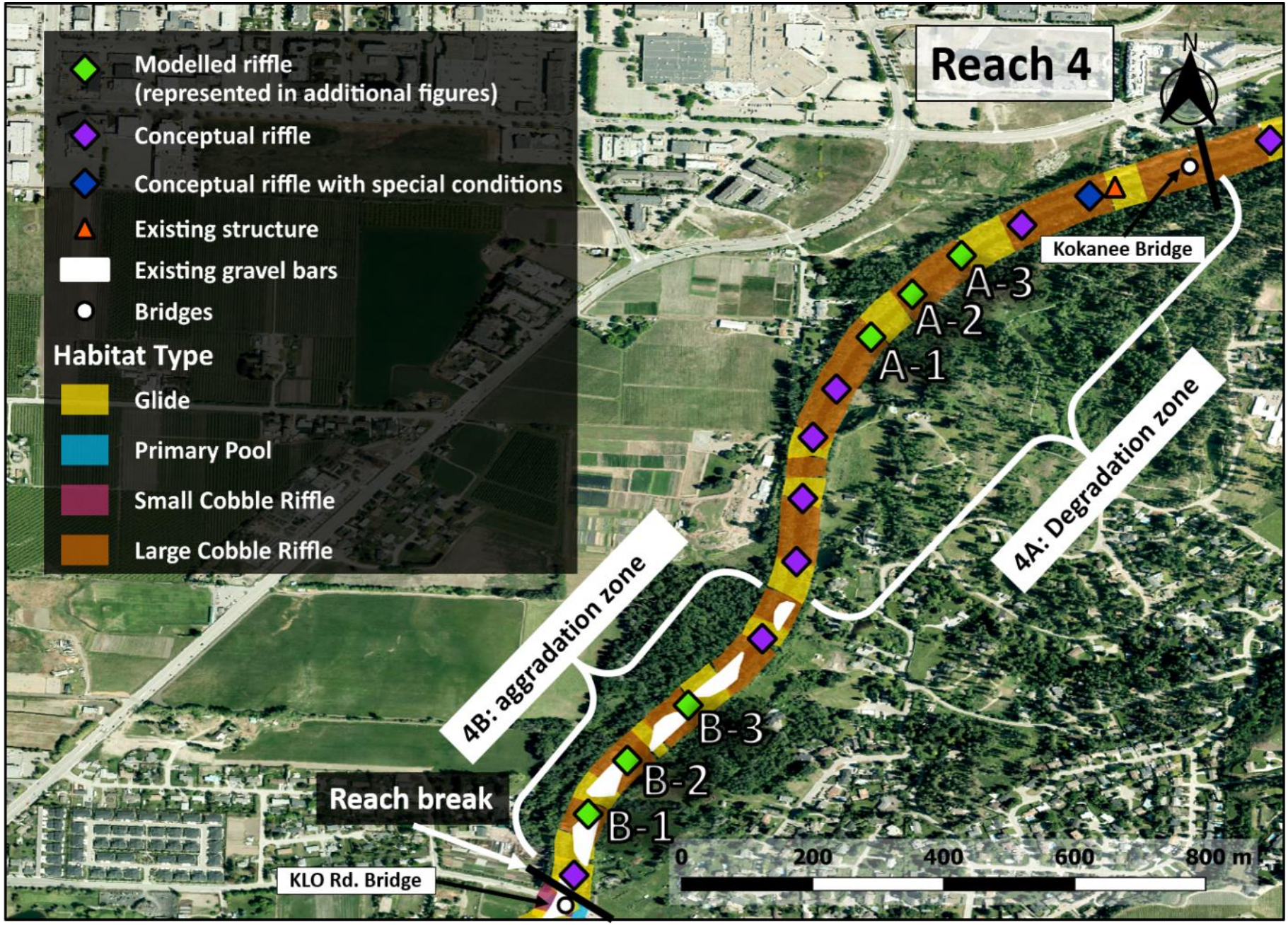
KEY MESSAGE: Riffle-pool habitat restoration is possible in Reach 4 with partial dike setback and bankfull channel widening.

Table 6: Reach-4 habitat conditions and restoration design recommendations

Sediment Zone	Degradation - aggradation transition	
Riffles and Pools	*Current: 0 pools Conceptualized: 14 riffle/pool sequences	
Recommended Riffle Morphology	*4A – degradation zone* Spacing: 120 m Height: 0.71 m Total length: 12 m	*4B – aggradation zone* Spacing: 180 m Height: 0.71 m Total length: 12 m
Bankfull Width	Current: 30 m Required for stable riffle with adequate freeboard: 37 m	
Bankfull Width Expansion Required Before Riffle?	Not in degradation zone, but required in aggradation zone	
Dike Setback Required Before Riffle?	Not in degradation zone, but required in aggradation zone	
Dike Freeboard (M)	Current: < 0 m **With riffle construction: 0.4-0.6	
Comments & Considerations	♦ Water level can overtop dike at current and projected 1-in-200 year flows. ♦ There is no left dike in these areas in downstream portion of reach (i.e., requires mitigation in immediate future regardless of restoration actions). ♦ Downstream section of reach includes CoK- KLO property acquisition, in same area where freeboard is deficient; possible next site for setback construction. ♦ Mill Creek diversion and bridges must be accounted for in construction engineer designs.	

**Current number of riffles was not inventoried **Assuming dike setback in 4B aggradation zone (downstream portion of reach)*

Figure 10: Reach-4 habitat conditions and restoration design recommendations



REACH 5: KOKANEE BRIDGE TO COTTONWOOD PEDESTRIAN BRIDGE

KEY MESSAGE: Riffle-pool habitat restoration is possible in Reach 5 without immediate dike setback and bankfull channel widening.

Table 7: Reach-5 habitat conditions and restoration design recommendations

Sediment Zone	Degradation
Riffles and Pools	Current: 0 pools
	*Conceptualized: 5 riffle/pool sequences
Recommended Riffle Morphology	Spacing: 120 m Height: 0.5 m Total length: 9.6 m
Bankfull Width	Current: 30 m
	Required for stable riffle with adequate freeboard: current width
Bankfull Width Expansion Required Before Riffle?	No
Dike Setback Required Before Riffle?	No
Dike Freeboard (M)	Current: 1.2 m
	With riffle construction: 0.6
Comments & Considerations	♦ Riffles can be placed in this reach without immediate dike setback or bankfull widening. ♦ Reach is almost entirely within bounds of regional park; setback limited to right bank due to escarpment. ♦ Consider KO channel & how to improve function (entrance occurs near Reach 5-6 break).

**Current number of riffles was not inventoried **Assuming dike setback*

Figure 11: Reach-5 habitat conditions and restoration design recommendations

REACH 6: COTTONWOOD PEDESTRIAN BRIDGE TO BURBANK STREET

KEY MESSAGE: Riffle-pool habitat restoration is possible in Reach 6 without immediate dike setback, but requires immediate bankfull channel widening.

Table 8: Reach-6 habitat conditions and restoration design recommendations

Sediment Zone	Degradation
Riffles and Pools	Current: 2 pools *Conceptualized: 11 riffle/pool sequences
Recommended Riffle Morphology	Spacing: 160 m Height: 0.5 m Total length: 8.5 m
Bankfull Width	Current: 26 m Required for stable riffle with adequate freeboard: current width
Bankfull Width Expansion Required Before Riffle?	Yes
Dike Setback Required Before Riffle?	No
Dike Freeboard (M)	Current: 0.73 m **With riffle construction: 0.6
Comments & Considerations	♦ Riffles can be placed in this reach with bankfull widening (note: channel is confined on left bank by natural escarpment, and on right bank by houses). ♦ Widening the left bank is logistically challenging for access, balancing cut and fill, and impacts to existing riparian habitat. Widening left bank means loss of natural habitat without offset anywhere else. ♦ Consider kokanee channel & how to improve function (entrance occurs near Reach 5-6 break).

**Current number of riffles was not inventoried **Assuming dike setback*

Figure 12: Reach-6 habitat conditions and restoration design recommendations

REACH 7: BURBANK STREET TO 300 METRES UPSTREAM OF EAST KELOWNA BRIDGE

KEY MESSAGES:

- ***No restoration recommended at this time.***
- ***Ensure strong regulatory focus on conserving habitat.***
- ***Low-level anthropogenic impacts resulting in semi-natural channel and habitat conditions.***
- ***Excellent example of historic habitat values and dike-setback and floodplain-expansion benefits in downstream reaches.***

APPENDIX 2: Detailed Mission Creek Fish & Wildlife Species & Habitat Information

Mission Creek is the largest watershed in the Okanagan Basin, flowing approximately 75 kilometres from high-elevation headwater lakes and forests, through heavily developed agricultural and residential properties within the City of Kelowna, before entering Okanagan Lake.

Mission Creek plays a critical role in supporting a wide range of important indigenous fish, wildlife and plant species. In addition, the creek is an important contributor to water quality and quantity, and has the potential to play an important role in building resiliency to impending climate-change impacts.

Anthropogenic changes to the creek over time have been extensive, including channelization and diking for flood protection, rural and urban encroachment, water diversion, and infrastructure development. In addition, both human-induced and natural changes in sedimentation patterns within the watershed over time have altered channel morphology and hydrology. These changes have resulted in extensive habitat loss and associated declines in fish and wildlife populations.

FISH SPECIES – HISTORY & CURRENT STATUS

Mission Creek is considered the most important fish-producing system in the Okanagan Lake basin (*Andrusak et al., 2008*), supporting a wide range of indigenous fish species including kokanee and the Okanagan Lake adfluvial rainbow trout population. Mission Creek also supports a resident rainbow trout population throughout its length, which is thought to have originated from Okanagan Lake adlfluvial trout residualization, as well as historical hatchery trout introductions to lakes in the upper watershed, which formed naturally producing populations. (See Table 9 below for a full listing of Mission Creek fish species.)

Table 9: Mission Creek fish species; yellow-listed species are not considered to be of conservation concern

FISH NAME (ENGLISH & SCIENTIFIC)	PROVINCIAL LISTING	COMMENTS
Burbot (*Lota lota*)	Yellow	
Kokanee (*Oncorhynchus nerka*)	Not listed	♦ Mission Creek is largest contributor of Kokanee to Okanagan Lake *(MWLAP 2001)* ♦ Kokanee Spawning Numbers (historic): 700,000-1,200,000/yr ♦ Kokanee Spawning Numbers (2010): ~ 16,000 ♦ See Figure 13 for Kokanee escapement estimates
Longnose dace (*Rhinichthys cataractae*)	Yellow	
Mountain whitefish (*Prosopium williamsoni*)	Yellow	
Peamouth chub (*Mylocheilus caurinus*)	Yellow	
Rainbow trout (*Oncorhynchus mykiss*)	Yellow	
Redside shiner (*Richardsonius balteatus*)	Yellow	
Sculpin (*Cottus sp*)	n/a	
Sucker (*Catostomus sp*)	n/a	
Mussel (*Anadonta* spp.)	Yellow	

Further evidence of the importance and high restoration potential of Mission Creek is found in a 2003 study that prioritized Okanagan Region watersheds based on outcomes from past provincial assessment processes, in addition to current status ratings provided by provincial fisheries and habitat-protection staff. This study identified the level of importance of each watershed according to presence of regionally significant fish species, level of habitat impacts, fish-production potential, and habitat-restoration potential. Mission Creek was identified along with Okanagan River as the highest ranked watersheds in the Okanagan Basin, and amongst the highest ranked watersheds in the Okanagan Region *(Matthews and Bull, 2003).*

Known occurrences of indigenous fish species in lower Mission Creek are listed on the next page. All of these species listings are yellow listed in BC, so not considered to be of conservation concern at this time (*Species Ranking in BC., 2002).*

It is important to note that some species are considered locally extirpated, so not included in the table. For example, Traditional Ecological Knowledge identifies coho, chinook, sockeye, steelhead, and lamprey as extirpated following Okanagan Lake, Okanagan River, and Columbia River modifications.

Rainbow Trout

Mission Creek is considered the primary source of production of the Okanagan Lake adfluvial rainbow trout stock, based on accessible stream length, the quantity and quality of suitable spawning and rearing habitat *(Galbraith and Taylor, 1970, Koshinsky, 1972),* and spawning adult and juvenile assessments *(Wightman and Sebastian, 1979).* These fish utilize Mission Creek and other tributaries for spawning which extends from late April to mid-June. Fry emerge from the gravel in July/early August, and rear in the stream for 1-3 years, with the majority migrating to the lake during freshet at ages 1+ and 2+.

Once reaching the lake, juveniles spend the majority of the next one to two years feeding on invertebrates within the littoral zone. They then move into the pelagic zone to feed primarily on kokanee for the remainder of their lake rearing period, before returning to their natal stream to spawn. Habitat conditions during the stream-rearing period, including flow and water temperature and in-lake food availability, are key factors controlling growth and survival of this population. This unique late-maturing genetic strain can reach sizes exceeding 12 kilograms, providing a highly sought after catch in the Okanagan Lake recreational fishery.

There is limited information available on the size of this population. Spawner assessments were conducted from 1975-1978 using counts and biological data collected at a fish ladder located at a former migration barrier (Smithson Alphonse Dam) approximately eight kilometers upstream from the mouth. Average adult returns to Mission Creek during that three-year period were 445 spawners. Information was also collected on length, sex, fecundity and egg retention. This information, in addition to detailed habitat and juvenile population assessments, provided the basis for stream-production carrying- capacity estimates and resulting juvenile contributions to Okanagan Lake (*Wightman and Sebastian, 1979).* Population assessment information from other Okanagan Lake tributaries highlights the dominant role Mission Creek plays in production of this fish stock.

The migration barrier and associated fish ladder was removed in 2000, after which spawner counts were not possible due to problems associated with freshet flows during the spawning period. Other counting methods were attempted in Mission Creek and other tributaries in the 1980s with limited success (i.e., counting fences, seining, and electroshocking), so were discontinued. Streamside observations have provided some information on spawning locations when turbidity levels were sufficiently low *(Matthews per comms., 2000).*

With the challenges associated with assessing spawner numbers since ladder removal, and the high cost of undertaking ongoing juvenile population assessments, the ability of fisheries

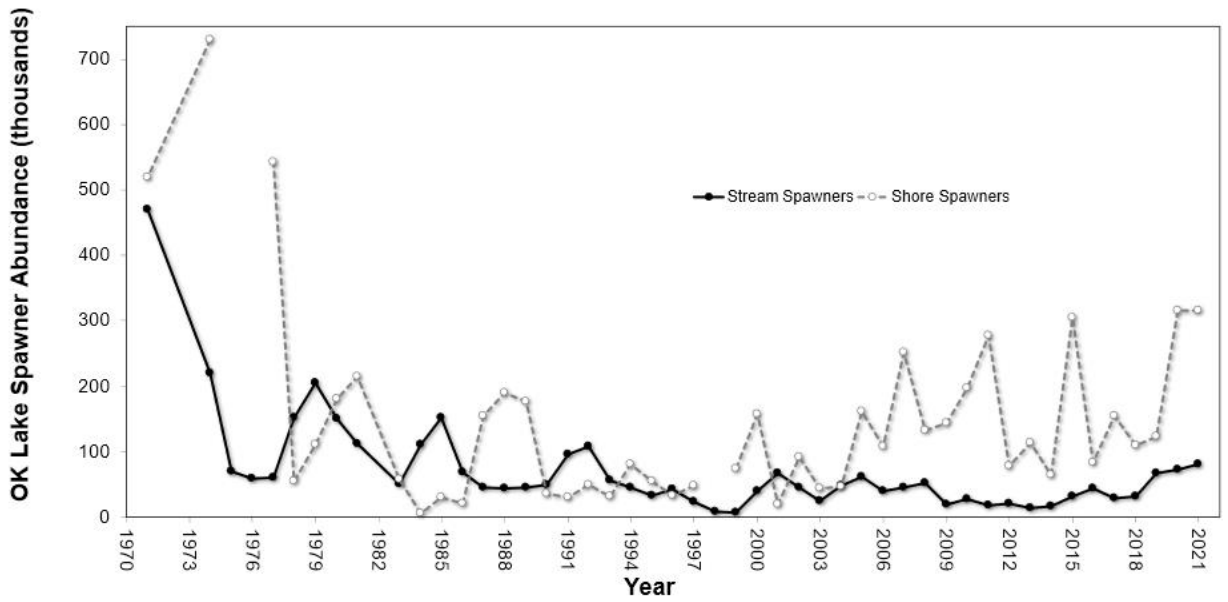
managers to estimate the lake and stream population is limited. Okanagan Lake recreational fishery assessments are undertaken when the necessary resources are available, but this method is largely limited to providing population trend information *(MFLNRORD, 2020).*

Kokanee

Okanagan Lake supports stream-spawning and lake-spawning kokanee populations. These fish are a critical component of the ecosystem, providing an important food source for many fish and wildlife species, in addition to being a significant source of nutrients for the stream and lake environment. They also contribute to an important recreational fishery.

Stream-spawning kokanee enter the tributaries to spawn between late August and early October. Fry emerge from the gravel in spring and migrate into Okanagan Lake during freshet flows. They typically spend approximately four years rearing in the lake before returning to their natal stream to spawn (small numbers of age five and age six kokanee have been sampled in Okanagan Lake spawning populations). Kokanee are vulnerable to low incubation survival in the creek resulting from poor quality habitat conditions (spawning, rearing, flow, and water temperature), in addition to impacts from anchor ice. Lake-rearing conditions (water temperatures, food availability) can also play a big role in growth and survival.

Figure 13: Okanagan Lake kokanee spawner escapement estimates (figures taken from Webster 2021)



Mission Creek supports the majority of the Okanagan Lake stream spawning kokanee population *(Andrusak et al., 2008),* typically making up greater than 50% of the stream spawning total (Figure 13). Regular Okanagan Lake kokanee spawner enumerations were initiated in 1970, and with few exceptions, have continued annually. Mission Creek has the most extensive enumeration data, providing excellent trend information for this stream-spawning component of the lake's population. A continuous decline in Okanagan Lake kokanee was recorded over a three decades extending from the 1970s through the 1990s, before hitting an all time low in 1998, including an estimate of only approximately 1000 spawners in Mission Creek (Figure 14). Much of this decline is attributed to a combination of habitat loss from flood protection related channelization and diking, along with other stream-development impacts, including water extraction and changes in lake rearing conditions *(Andrusak et al., 2008).*

Kokanee stream and shore-spawner numbers showed a moderate rebound in the early 2000s, but major fluctuations continued through 2019. Recent spawner estimates are very encouraging with numbers in 2020 and 2021 reaching levels which have not been seen since the 1970s. This strong upward trend is clearly evident in Mission

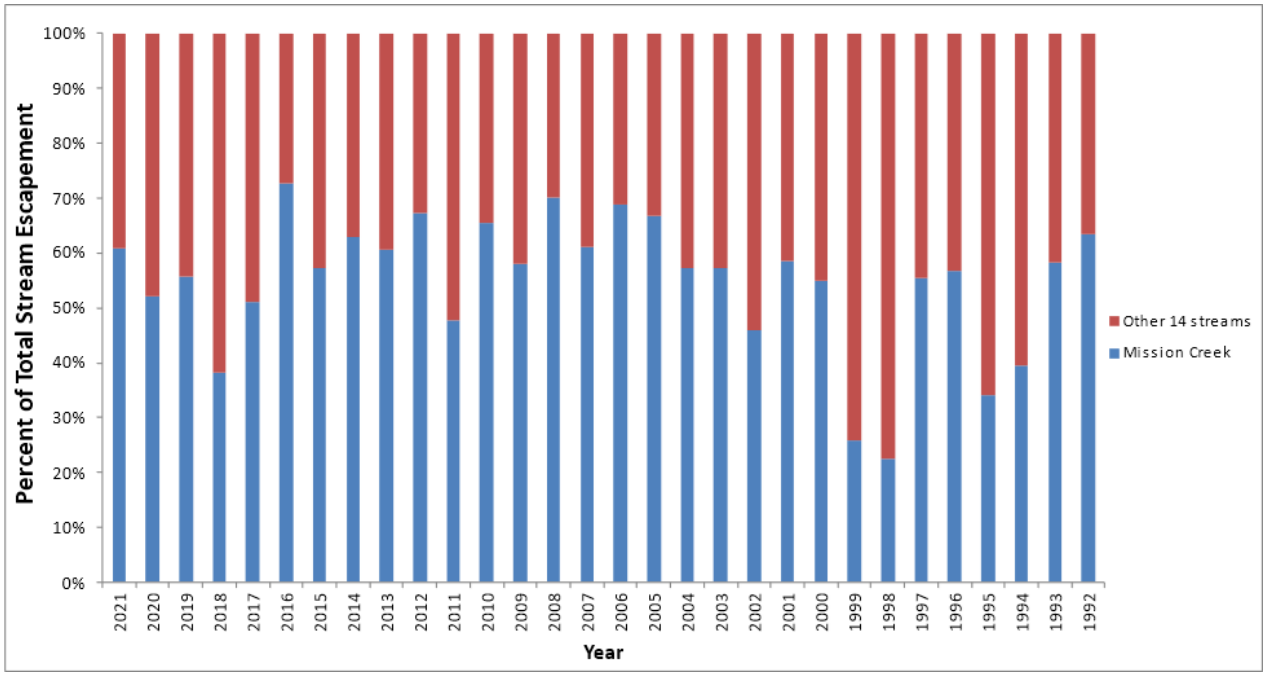
Creek where numbers have increased significantly over the past three years. Mission Creek continues to play the major role in Okanagan Lake stream spawning kokanee production (see Figure 14 , right), highlighting the importance of conserving and restoring the creek's fish and riparian habitat over the long term.

Mission Creek kokanee and rainbow trout production is a critical contributor to the ecosystem, providing a food source for many fish and wildlife species, and nutrient contributions at a watershed level. These species are also the primary target in the Okanagan Lake recreational fishery, which generates major economic benefits (more detail below).

Other Fish Species

Sockeye is another species that uses Mission Creek for spawning and rearing. Until recently, there have been numerous migration barriers and other modifications within the Okanagan and Columbia River basins that have reduced sockeye survival and restricted access, including at Okanagan Lake. Through the efforts of Okanagan First Nations and government partners, these barriers have been remediated, allowing for the first sightings of sockeye in Mission Creek since the flood-control dams were constructed. It is anticipated these changes will facilitate a continued increase in sockeye numbers and access for chinook and steelhead in the future, putting

Figure 14: Mission Creek spawner abundance relative to the broader Okanagan Lake tributaries system (figures taken from Webster 2021).



that much more importance on efforts to improve habitat conditions in Mission Creek. It is anticipated these species will utilize similar habitat to that described above for kokanee and rainbow trout, and will benefit from future conservation and restoration actions resulting from Plan implementation.

There are many other indigenous fish species that rely on Mission Creek for some, or all, of their life cycle. Examples include mountain whitefish, longnose dace, peamouth chub and redside shiner. There is limited information available for these species as they pertain to Mission Creek, largely due to limited data from non-targeted sample collections. As a result, habitat-utilization information is largely limited to available literature.

As discussed earlier, efforts to restore aquatic habitat for rainbow trout and kokanee will provide benefits for all of these species based on the high level of water-quality and habitat-condition sensitivity exhibited by trout and kokanee.

Rainbow Trout & Kokanee Habitat Conditions & Utilization

Lower Mission Creek fish populations, including Okanagan Lake adfluvial rainbow trout and kokanee, have access to approximately 19 kilometers of creek upstream of Okanagan Lake before migration is blocked by a series of high gradient waterfalls, referred to as Gallaghers Canyon.

The majority of lower Mission Creek (Reaches 1-6) extending from Okanagan Lake to Burbank Street have been severely impacted by a wide range of development activities, resulting in a low gradient, narrow channel, and loss of functional floodplain areas with limited habitat complexity, quantity, and quality. These modifications, in conjunction with major water losses from water diversions, resulted in reduced water quantity and seasonal low-flow and temperature issues.

Habitat suitability for juvenile and adult trout is generally low throughout most of this section due to limited availability of rearing features such as pools, riffles, boulders, and large woody debris, in addition to the flow and temperature limitations *(Wightman and Sebastian, 1979).*

Kokanee spawning habitat suitability is variable with some limited areas of high use (primarily Reach 2), but incubation survival may be low due to high inter-gravel sediment concentrations, and periodic flow and temperature issues *(B. Yuan, et Al. 2020).* A kokanee spawning channel located eight kilometres upstream from Okanagan Lake is likely compensating for some of these habitat limitations by providing a large area of controlled flows and high-quality gravel that is contributing between 10-30% of total kokanee production for Mission Creek. Overall, this lower section is supporting approximately 70% of total kokanee spawners annually at current low escapements *(MFLNRORD, 2020).* This apparent preference for the lower section of creek may be partially explained by low spawner densities and the tendency of kokanee to occupy lower reaches during creek spawning, particularly in creeks that are accessible for long distances (*H. Lorz, 1958, S. Matthews, per comms.).*

Mission Creek upstream of Reach 6 – extending from Burbank Street to East Kelowna Road Bridge (Reach 7), and reaching to Gallaghers Canyon (km 19) – has experienced a much lower level of anthropogenic modification, including channelization and diking. As a result, this section has retained a substantially wider channel and floodplain, exhibiting a broad range of gradient, substrate and hydraulic conditions, and an associated high level of habitat complexity. In addition, flows are typically more stable since the majority of water intakes are located downstream. This section has been described as a high-quality rearing area for rainbow trout based on habitat features, hydraulic conditions, and level of rainbow trout parr utilization. In addition, results from the Smithson Alphonse Dam fish-ladder counts, juvenile assessments, and streamside observations, indicate the vast majority of spawning trout utilize the upstream section (*Wightman and Sebastian, 1979, Matthews per comms., 2020).*

This stream section is also valuable for kokanee production. Kokanee enumerations in this section of stream have been limited to periodic helicopter counts over the years (the most recent in 2006) due to ground access limitations and the large area. These aerial counts, which covered the full length of accessible stream in combination with ground counts in the lower section, provided an estimate of 30% of total spawners utilizing the upper section *(Andrusak, et al., 2008).* This percentage has been applied to the annual ground count total to provide a spawner estimate for the full accessible length of Mission Creek. This section also appears to be well suited to sockeye, chinook and steelhead spawning and rearing if and when they successfully establish in Okanagan Lake.

Wildlife Species – History & Current Status

Mission Creek riparian areas provide important habitat for many wildlife species. Approximately 80% of the Okanagan's species rely on riparian/ wetland areas for at least some portion of their life history *(Ministry of Environment, 1998).* This

includes many bird species, amphibians, and a wide range of mammals such as bats, beavers, muskrats, whitetail and mule deer, black bear, and several species of rodents.

The full list of wildlife species reliant on Mission Creek in the past and present is too numerous to present. Table 10 (right) provides an extensive listing of known occurrences within the current Mission Creek floodplain.

Many wildlife and plant species utilizing Mission Creek riparian habitat are listed as at-risk federally and provincially due to habitat loss and other factors. Table 1 on page 24 details listed wildlife species that were observed during a 2014 inventory in lower Mission Creek.

Table 10: Known wildlife occurrences within the current Mission Creek floodplain

Name (English & scientific)	Provincial listing	Comment
Black bear (*Ursus americanus*)	Yellow	
Deer (*Odocoileus* spp.)	Yellow	
Great Basin Pocket Mouse (*Perognathus parvus*)	Blue	
Grizzly bear (*Ursus arctos*)	Blue	*considered locally extirpated; historical seasonal use in lower reaches; designated Endangered by Syilx (Okanagan) Nation
Common Muskrat (*Ondatra zibethicus*)	Yellow	
Raccoon (*Procyon lotor*)	Yellow	
River otter (*Lontra canadensis*)	Yellow	
Spotted Bat (*Euderma maculatum*)	Blue	
Columbia Spotted Frog (*Rana luteiventris*)	Yellow	
Great Basin Spadefoot (*Spea intermontana*)	Blue	
Gopher Snake (*Pituophis catenifer deserticola*)	Blue	
North American Racer (*Coluber constrictor*)	Blue	
Western Painted Turtle (*Chrysemys picta bellii*)	Blue	
American Dipper (*Cinclus mexicanus*)	Yellow	
American Robin (*Turdus migratorius*)	Yellow	
Barn Swallow (*Hirundo rustico*)	Blue	
Bald eagle (*Haliaeetus leucocephalus*)	Yellow	
Black-capped Chickadee (*Poecile atricapillus*)	Yellow	
California Gull (*Larus californicus*)	Blue	
Canada Goose (*Branta canadensis*)	Yellow	
Cedar waxwing (*Bombycilla cedrorum*)	Yellow	
Common Nighthawk (*Chordeiles minor*)	Yellow	
Great Blue Heron (*Ardea Herodias*)	Blue	
Killdeer (*Charadrius vociferus*)	Yellow	
Lewis's Woodpecker (*Melanerpes lewis*)	Blue	
Mourning Dove (*Zenaida macroura*)	Yellow	
Northern Flicker (*Colaptes auratus*)	Yellow	
Northern Goshawk (*Accipiter gentilis*)	Blue	
Orange-crowned warbler (*Oreothlypis celata*)	Yellow	
Spotted sandpiper (*Actitis macularius*)	Yellow	
Tree Swallow (*Tachycineta bicolor*)	Yellow	
Western Screech-owl (*Megascops kennicotti*)	Blue	
Western Wood-pewee (*Contopus sordidulus*)	Yellow	
Yellow Warbler (*Setophaga petechial*)	Yellow	

Mission Creek Wildlife Habitat Conditions & Utilization

Riparian areas serve as interfaces between terrestrial and aquatic ecosystems, providing many important ecosystem contributions. Riparian vegetation can be effective in removing excess nutrients and sediment from surface runoff and shallow ground water, and in shading streams to optimize light and temperature conditions for aquatic plants and animals. Riparian vegetation, especially trees, is also effective in stabilizing streambanks and slowing flood flows, resulting in reduced downstream flood peaks. Riparian ecosystems generally compose a minor proportion of the landscape, but are typically more structurally diverse and more productive in plant and animal biomass than adjacent upland areas.

Several important plant communities found within lower Mission Creek riparian areas have been identified as sensitive ecosystems in BC to provide a higher level of regulatory protection (BC Conservation Data Center). This includes:

- common cattail marsh
- black cottonwood / common snowberry – roses
- black cottonwood - Douglas-fir / common snowberry - red-osier dogwood
- hard-stemmed – bulrush deep marsh
- black cottonwood - Douglas-fir / Douglas
- maple - common snowberry
- trembling aspen/common snowberry/ Kentucky bluegrass.

As is described for aquatic habitat, riparian wildlife habitat is severely limited downstream of Burbank Street (Reaches 1-6) due to development impacts. Riparian habitat is restricted in total area, width, plant species diversity, and connectivity. A few localized healthy riparian areas remain in association with regional government parks and dispersed sections of private land adjacent to Mission Creek. These are unsuitable for development, but they are typically small in area and offer small patches of habitat within an extensive portion of Mission Creek. As a result, wildlife species diversity and population status, including species at risk, is representative of a depleted riparian area.

Mission Creek riparian habitat upstream of Reach 7 (Burbank Street to East Kelowna Road Bridge) displays a much greater degree of natural form and function. This results in larger riparian areas containing a higher level of vegetation diversity, density, and plant health. In addition, floodplain connections with the creek channel have been largely retained (limited to no diking), providing all benefits associated with a proper functioning floodplain. This trend toward improving habitat moving upstream is further accentuated above Reach 7 (East Kelowna Road Bridge to Gallaghers Canyon), where an even higher degree of natural creek form and function has been retained. No wildlife utilization data is available for this section of Mission Creek.

History of Mission Creek Habitat Protection Conservation & Restoration

Mission Creek has long been recognized for its important role for Okanagan Lake rainbow trout and kokanee production. As a result, it has received more habitat protection and restoration focus than any other Okanagan Lake tributary *(MFLNRORD, 2020).* Considerable attention has been directed at legislation-based protection measures and delivery of a variety of enhancement and restoration projects. These past actions can provide important insight and learnings on the issues of the day, and how they may relate to current production limitations, the success of various remediation approaches, and how those outcomes can inform future strategies.

The following provides an overview of some prominent examples from the past as well as the studies which were the driving force behind these actions.

Habitat Protection

Protecting and restoring stream habitat in the Okanagan has been a major focus of fisheries managers for many years, based on the high priority placed on recovery of Okanagan Lake kokanee and rainbow trout populations, and

conserving indigenous fish and wildlife populations. Many fish species rely on tributary streams, including Mission Creek, for spawning and rearing. The Ministry of Forests, Lands, Natural Resource Operations, and Regional Development (MFLNRORD), and Fisheries and Oceans Canada have policies to proactively protect stream habitat by applying development standards and guidelines, as well as reactive tools utilizing compliance and enforcement according to applicable legislation.

An example of regulatory-based actions aimed at protecting stream habitat is provision of conservation flows for fish. Considerable effort has been undertaken to ensure there is sufficient flow to support healthy fish populations within Mission Creek and other fish producing streams in the Okanagan. Many studies have been undertaken over the years providing stream-specific, science-based flow recommendations covering all trout and kokanee life stages. This has led to the development of flow agreements with licensees, highlighted by the *Mission Creek Water Use Plan* in 2010, to provide a higher level of accountability for provision of aquatic flow requirements in supplying agricultural and residential needs, and implementation of associated water-release protocols.

Subsequent studies have further refined stream-flow requirements due to implementation of the *BC Water Sustainability Act* in 2016, which requires that water is managed such that the volume and timing of water flow required for proper functioning of the aquatic ecosystem (referred to as "environmental flow needs") is provided at all times. This legislation has provided a higher standard of stream flow protection at a provincial level, and the established environmental-flow needs will be incorporated into all water use plans for irrigation districts and municipalities. They will also form the basis for ongoing compliance assessments by the licence holders and regulatory authorities.

This focus on better understanding stream-flow conditions and associated ecosystem requirements has also led to acquisition of water licenses on Mission Creek to support improved stream flow. This includes storage licenses on headwater lakes to provide increased capacity for conservation-based water releases during low flow periods, and downstream diversion licenses to eliminate associated water use.

Habitat-protection measures aimed at limiting development impacts have also resulted in some improvements to Mission Creek habitat. Land-development plans go through an intensive regulatory review process to ensure important riparian and aquatic habitat within the target stream is appropriately protected. In some cases, developers are directed to allocate compensation funds to improve habitat conditions within identified off-site priority habitat locations where it is determined the compensation would provide higher restoration value. Mission Creek has been a primary target for directing compensation funds from off-site development projects within the central Okanagan in recent years, and these funds have been key to the successful delivery of recent MCRI restoration planning and implementation projects.

The Plan recognizes that these regulatory responsibilities are a critical component of ensuring long-term habitat viability, which can only be delivered by the mandated authorities, and therefore, are outside the scope of this document. As such, the Plan identifies strategies focused on conservation and restoration of priority areas of creek through non-regulatory approaches, to complement and build upon the benefits derived from the policies, guidelines, and associated compliance and enforcement activities discussed above.

Habitat Enhancement & Restoration Projects

There have been several habitat-improvement projects over the years aimed at increasing Mission Creek fish and wildlife production. Before discussing these projects, it is important to look back at the studies that set the stage for these early efforts, and continue to provide valuable insight into longstanding habitat shortfalls and potential remediation strategies.

The *Okanagan Basin Study* (1968-1972) provided one of the first detailed investigations into Okanagan Lake tributary habitat conditions. The primary habitat-based recommendations focused on stream-specific flow requirements (including Mission Creek) and the need for "improving both natural and artificial reproductive facilities". This study was followed by a series of habitat and fish population-based assessments by provincial fisheries staff, which provided an extensive information base on Mission Creek kokanee and rainbow trout populations, habitat suitability and utilization, and restoration recommendations.

Study outcomes played an important role in delivery of a major habitat-restoration project in 1980 aimed at securing permanent fish passage and reducing flood risks at the site of the former Smithson Alphonse Dam. This structure was constructed in 1954 as a water diversion weir located approximately 11 kilometers upstream of Okanagan Lake. A vertical slot fishway was added on or around 1955 to provide fish passage, but ongoing erosional down-cutting immediately downstream of the weir limited fish access, necessitating a series of modifications to the weir structure and fishway over the following years. Continued erosion at the site eventually resulted in a vertical drop at the structure of close to five metres, creating major challenges in maintaining fish passage. This structure was soon identified as a high flood management risk, and in 1980 was removed in conjunction with infilling of the channel for a distance of approximately one kilometre downstream, to improve flood protection and provide fish-accessible channel conditions. This project played an important role in the future of Mission Creek rainbow trout and kokanee production, providing a long-term fish passage solution and unrestricted access to seven kilometres of high-quality spawning and rearing habitat.

Another project driven by the outcomes of these early studies ,and facilitated by remaining infrastructure from the Smithson Alphonse Dam removal project, is the Mission Creek Spawning Channel. Constructed in 1988 within the water bypass channel created during dam removal/ infill, the spawning channel is 800 metres long and is fed by a water diversion from Mission Creek. This provides high-quality spawning gravel in association with optimum flow and hydraulic conditions. This habitat-enhancement project has been successful for kokanee utilization (10– 30% of total creek escapement), incubation survival (up to 40%), and resulting contributions to Okanagan Lake (up to 1 million fry), highlighting its important contribution toward increasing Okanagan Lake kokanee production. It has, however, suffered from frequent operational issues and substantial annual maintenance requirements *(Andrusak, et al., 2008).*

More recent restoration efforts have been influenced by the *Okanagan Lake Action Plan* (OLAP; 1995-2007), a multidisciplinary initiative focused on identifying causes and implementing solutions to remediate the declining kokanee population *(Ashley and Shepherd, 1996).* The OLAP listed Mission Creek as the highest priority for stream restoration, and facilitated the release of two reports outlining habitat restoration design considerations for lower Mission Creek *(M.Gaboury, P.Slaney. Mar 2003; and, M. Gaboury, J. Good, S. Mould., Mar 2004).* In addition, OLAP was the driving force behind the launch of MCRI, which conducted several directed studies to better understand the status of fish and wildlife habitat and supported populations, as well as property securement opportunities, then used that information to identify restoration options and priorities.

This work led to securement of two properties in lower Mission Creek and delivery of the Phase-1 habitat restoration project that was completed in 2016. This project involved setting back 540 metres of flood-control dike in conjunction with floodplain and channel restoration works that resulted in the following outcomes *(T. White, 2017):*

- Creation of an additional 18,000 m^2 of floodplain habitat.

- Re-connection of 600m^2 of off-channel rearing habitat for juvenile rainbow trout and whitefish.
- Creation of four deep pools/meander notches providing 750 m^2 of high-quality holding habitat/thermal refugia in combination with 300 m^2 of LWD/c for migrating kokanee during late summer months.
- A 15 cm reduction in flood levels along this section of Mission Creek.
- A four-fold increase in riparian habitat (600 m^2 to 24,000 m^2); > 600 native trees and shrubs planted.

Another objective of this project was to use the high-profile project location, combined with a strong outreach and communications program, to showcase and build strong support for long-term restoration. There are clear indicators this objective has led to significant increase in levels of awareness and support from all levels of government, community and First Nations, and funding organizations.

A listing of documented Mission Creek habitat enhancement and restoration projects is provided on the next page.

Photo courtesy of Jan Vozenilek, Copper Sky Productions

Table 11: Documented habitat enhancement and restoration projects within the current Mission Creek floodplain

RESTORATION PROJECT	DATE	LOCATION	DETAILS (REFERENCE)
Gravel Platforms	1979	km 17-19 upstream of Okanagan Lake	♦ Spawning gravel was placed within boulder cribbing lined platforms at four locations. ♦ Gravel was displaced after first freshet. Some of the boulder cribbing still remains and is providing rearing habitat. No further gravel supplementation undertaken since that time with exception of Mission Creek Spawning Channel. (MFLNRORD files)
Removal of Smithson Alphonse Dam	1980	~11 km upstream of Okanagan Lake	♦ Smithson Alphonse Dam started as a small, fish-passable water diversion weir with a vertical slot fishway which after many years of erosion, created a five-metre elevation drop that created severe fish-migration issues. ♦ Removal of this barrier was accomplished by infilling the channel for a distance of approximately one kilometre to overcome the dam elevation drop and provide fish-accessible channel gradients. ♦ Dam removal re-established fish access to an additional nine kilometres of habitat, providing quality spawning and rearing habitat for many fish species *(C. Wightman, 1975).*
Coarse Fish Barrier	1980	~10 km upstream of Okanagan Lake	♦ This concrete structure was installed at the downstream end of the Smithson Alphonse Dam removal and infill project. It was designed to limit passage of introduced species. The structure was buried sediments deposited the following freshet (1981) resulting in permanent loss of functionality.
Spawning Channel	1988	~10 km upstream of Okanagan Lake	♦ Constructed in 1988 using the water bypass channel from the Smithson Alphonse Dam removal project. Channel is 800 m long and is fed by a diversion from Mission Creek which provides optimum flow over high quality spawning gravel. ♦ Reasonably successful in regard to kokanee utilization (15 – 25% of total creek escapement), incubation survival (up to 40%), and resulting contributions to Ok Lake (up to one million fry). ♦ High maintenance requirements including periodic water diversion repairs/modifications and annual gravel cleaning *(Andrusak, et al., 2008).*
Newbury Riffle	2000	~11 km. Upstream of Okanagan Lake	♦ Experimental riffle constructed immediately downstream of the spawning channel intake to provide rearing habitat and facilitate gravel deposition. Study of substrate changes for two years showed some improvement in gravel, but freshet flows caused significant damage resulting in poor functionality. ♦ Restoration approach was abandoned as a mechanism for efficiently improving substrate quality/quantity for kokanee. *(ONA, 2020)*

Continues over...

Table 11: Documented habitat enhancement and restoration projects within the current Mission Creek floodplain (cont.)

RESTORATION PROJECT	DATE	LOCATION	DETAILS (REFERENCE)
MCRI Phase 1	2015 - 2016	1.8 km upstream of Okanagan Lake	♦ Setback a 540-metre section of dike on the south side of Mission Creek, Results include: ◊ An additional 18,000 m^2 of floodplain habitat ◊ Re-connection of 600 m^2 of off-channel rearing habitat for juvenile rainbow trout and whitefish ◊ Creation of four deep pools/meander notches providing 750 m^2 of high quality holding habitat/ thermal refugia in combination with 300 m^2 of LWD/c for migrating kokanee during late summer months ◊ A 15 cm reduction in flood levels along this section of Mission Creek ◊ A four-fold increase in riparian habitat (600 m^2 to 24,000 m^2); > 600 native trees & shrubs planted ◊ *(T. White, 2017)*
MCRI Phase 1 Adaptive Management	2019	1.8 km upstream of Okanagan Lake	♦ **Project 1** - Two boulder clusters were installed in Mission Creek channel within the footprint of the Phase-1 project, with the goal of providing kokanee and rainbow trout rearing and spawning gravel deposition. Each cluster consisted of four boulders arranged in a diamond shape, with the apex pointing upstream. Results from 2020 monitoring indicate the structures remained stable, significant scour pools were created providing rearing habitat, and there was substantial spawning gravel deposition in association with the clusters that was heavily utilized by kokanee. ♦ **Project 2** – A series of six boulder lines were installed along the right bank periphery of Mission Creek channel within the Phase-1 footprint, with the goal of directing increased flow into a Phase-1 meander pool (Meander Notch 2). Results from 2020 indicate the boulders remained stable, and they were responsible for increased flow in Meander Notch 2.

APPENDIX 3: Glossary of Terms

APPENDIX 1 – DEFINITIONS

Adfluvial Fish: Spawn in tributary streams where the young rear from 1-4 years before migrating to a lake system.

Anadromous Fish: Migrate from freshwater where they hatch to the ocean where they spend most of their lives before returning to freshwater to spawn.

Anthropogenic: Caused or produced by humans.

Bankfull width: The width of the surface of the water from bank to bank at the point where water just begins to overflow the banks into the active flood plain. In streams where there is no flood plain it is often the width of a stream or river at the dominant channel forming flow that re-occurs every 1-2 years.

Boulder Clusters: Provide important aquatic habitat benefits within natural streams but are often lacking in heavily developed watersheds due to high channel instability. Replication of boulder features is a common approach to restoring habitat diversity within streams. Boulder clusters are groups of large rocks placed in a stream to improve habitat, by creating scour pools and areas of reduced velocity. The pools provide important rearing areas for many fish species and can offer thermal refugia during low flow periods. These clusters can also contribute to improved spawning habitat by generating gravel deposition.

Boulder Lines: This is a common restoration technique for re-establishing natural meander patterns in streams. Boulders are placed in a series of lines extending from the stream bank across a small portion of stream width in a downstream angle causing flow to direct across the channel during lower flow periods.

Channelization: Alteration of the course of a river or other waterway to form straight channels, typically to protect against flooding.

Channel morphology: The interplay between the force of water and the stability of bed and bank materials.

Conceptual Design: For the purposes of this Plan, this involves a design based on technical feasibility and potential to achieve established biological and flood protection objectives.

Conservation Covenant: a legal document registered against a property's title through agreement with the property owner to restrict the use of the property, typically to protect a natural or heritage feature or value.

Channel confinement: The degree to which channels are limited (or confined) in their ability to move laterally resulting from natural geographical features or man-made structures, such as dikes.

Setback Dike: A dike that is built inland, or set back further from the riverbank or shoreline than a traditional dike, providing more land between the water body and the dike to reduce potential damage from flooding and retain/enhance natural values.

Dike freeboard: The vertical distance from the top of the dike to water surface during projected maximum flood flow.

Floodplain: An area of land adjacent to a river or stream that stretches from the banks of its channel to the base of the enclosing valley walls or other confinement structure (i.e., dike), and that experiences flooding during periods of high discharge. Floodplains provide many important functions including flood-risk reduction benefits by slowing runoff and river flows, and storing flood water and critical habitat for many fish and wildlife species. Floodplains in this region typically engage at the average annual spring freshet (1-2 year discharge).

Glide: A calm stretch of shallow, smoothly flowing water, as in a river.

Gravel bars: A transitional gravel deposit that lacks any rooted vegetation, located either between the stream banks and the wetted perimeter of the stream, or entirely within the

wetted perimeter of the stream.

Hydroperiod: The number of days per year an area of land is wet or the length of time there is surface water at a location.

Indigenous species: A species that is present in a given region or ecosystem as a result of only local natural evolution.

Land securement: For the purposes of this Plan, this refers to acquisition of land for habitat conservation and/or restoration through a voluntary landowner agreement that may involve a Conservation Covenant or purchase.

Large Woody Debris (LWD): Large wood debris, particularly logs and root wads, provide important rearing habitat features in streams with substantial sources of trees within the floodplain. LWD is contributed to streams on an ongoing basis due to bank erosion, causing trees to fall into the channel. The benefits of large woody debris (LWD) for providing cover habitat and causing development of scour pools has been well documented. The addition of LWD to replicate natural in-stream wood features has been a long-standing restoration strategy.

Meander Belt Width: The area that a stream currently occupies, or can be expected to occupy; the space which a meandering stream occupies on its floodplain, and in which all of the natural channel processes occur (*Parish 2004*). Meander belt delineation is practiced in other Canadian municipalities (*Parish 2004*).

Q200 flows: river discharge (flows) estimated to occur once every 200 years.

Reach: Section of a creek, stream, or river along which similar hydrologic conditions exist, such as discharge, depth, area, and slope.

Regulatory measure: Any law, regulation, rule, procedure, decision, policy, or administrative action.

Riparian area: The transitional area between an upland dry area and a water body such as a stream or lake consisting of various water-tolerant plants and trees such as cottonwoods, willows, and sedges. Healthy riparian areas serve many functions, including protecting water quality, stabilizing erosion, and deposition processes, buffering high flows, providing habitat for wildlife, and providing aesthetic and recreational value.

Riffle: Areas of transition to increasing gradient in streams and rivers, characterized by shallow, fast- moving water broken by the presence of cobbles and boulders. Riffles generally occur in association with pools and gravel depositions, providing many important functions including hydraulic energy dissipation, oxygenation, invertebrate production, fish rearing (feeding and resting), and spawning areas.

Riffle/Pool sequence: Repeating pattern of riffle and pool habitat sections. One full sequence is measured from middle of riffle one, through pool, to middle of riffle two. For a waterbody with Mission Creek's characteristics, total distance in our area is typically ~6 x bankfull width (based on mathematics and principles in Leopold et al. 1964.

In a flowing stream, a riffle-pool sequence develops as a stream's hydrological flow structure alternates from areas of relatively shallow to deeper water. This sequence is present only in streams carrying gravel or coarser sediments. Riffles are formed in shallow areas by coarser materials, such as gravel deposits, over which water flows. Pools are deeper, calmer areas. The sequence within a stream bed commonly occurs at intervals of from five to seven stream widths *(lisle 1979).* A sorting mechanism for a riffle-pool sequence. Geological Society of America Bulletin, Part 11. v. 90, p. 1142-1.157, July 1979, Doc. no. M90703.

Sediment basin: Area of reduced water velocity to settle out and remove target sediments (fines, gravels, cobble).

Species at risk: Species that are classified as endangered, threatened, extirpated, or of special concern according to provincial and federal listings.

Substrate: The composition of a streambed, including either mineral or organic materials made

of a range of material sizes including (from small to large): fines (sand, clay, silt), gravels, cobble, boulders, bedrock.

Traditional Ecological knowledge: "Traditional knowledge is a cumulative body of knowledge, know-how, practices, and representations maintained and developed by peoples with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations, and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, ritual, spirituality and worldviews." (*UNESCO/ICSU, 2002)*

"Our cultural ways of knowing are passed from one generation to the next through our captikwł, our stories. Within these stories we find our values, protocols, and laws. They share a worldview that understands the reciprocal nature between Syilx/Okanagan peoples and our territory. Our captikwł tell us how to live on the land. They serve as a reminder of natural laws and protocols that need to be followed in order for future generations to survive in harmony with the tmix^{w}." *(Terbasket, P., & Shields, S., 2019)*

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