STEPPING BACK FROM THE WATER: MANAGING WETLANDS, RIPARIAN AREAS AND FLOODPLAINS IN THE KETTLE RIVER WATERSHED

DISCUSSION PAPER FIVE – SEPTEMBER 10, 2014

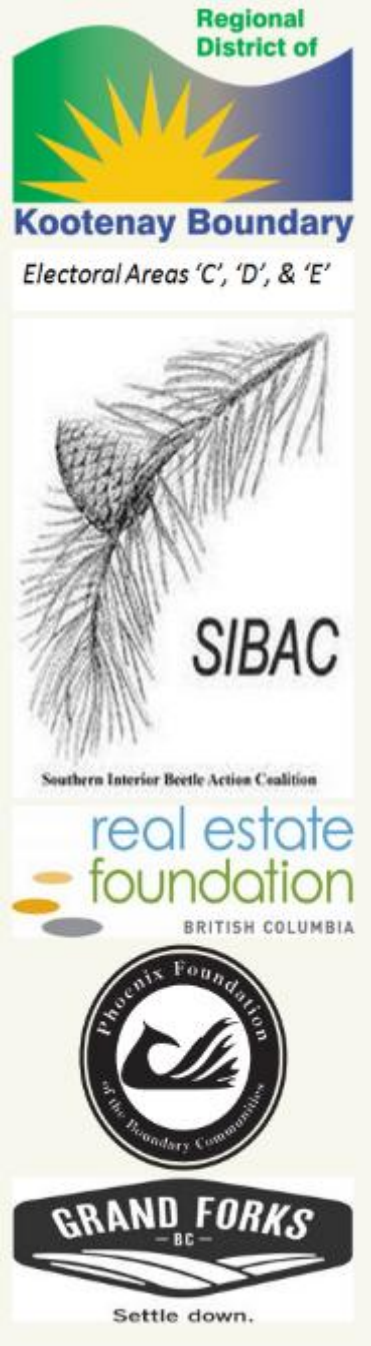
Regional District of Kootenay Boundary

Kettle River Watershed Management Plan

The Kettle River Starts Here

Suggested citation

Watt, G. and the KRWMP Stakeholder Advisory Group. 2014. *Stepping back from the water: Managing Wetlands, Riparian Areas and Floodplains in the Kettle River Watershed*. Discussion Paper Five for the Kettle River Watershed Management Plan. Grand Forks, B.C., Regional District of Kootenay Boundary. Available at http://kettleriver.ca/what-we-are-planning/discussion-paper-5.



Acknowledgements

Thank you to the Regional District of Kootenay Boundary (Electoral Areas of Christina Lake, Rural Grand Forks and West Boundary), Southern Interior Beetle Action Coalition, the Real Estate Foundation of BC, the Phoenix Foundation of the Boundary Communities and the City of Grand Forks for their financial support of this planning process.

Thank you to the Stakeholder Advisory Group, Technical Advisory Committee and other participants for your ideas, networking and support in developing this work.

Cover Photo: "Cottonwoods and pine protecting the shoreline during flood" – Graham Watt

Contacts:

Graham Watt
Coordinator, Kettle River Watershed Management Plan
250.442.4111
plan@kettleriver.ca
http://kettleriver.ca

Bill Baird
Kettle River Steering Committee Chair; Director for Electoral Area 'E' Director
250.445.6578

Roly Russell
Stakeholder Advisory Group Chair; Director for Electoral Area 'D' Director
250.584.4677

Mark Andison
RDKB Manager Operations
1.800.355.7352
mandison@rdkb.com

CONTENTS

1 INTRODUCTION

The Regional District of Kootenay Boundary is developing a watershed management plan for the Kettle River in Canada. This plan will consider issues and develop strategies and actions related to water quantity, water quality, and aquatic ecosystems, across the Kettle River watershed.

The Watershed Management Plan is supported by a Stakeholder Advisory Group (Advisory Group) representing a broad range of interests from across the Boundary and beyond. In the spring and summer of 2014, we are sharing the ideas that we are considering for the Kettle River Watershed Management Plan, with the intent that community members participate in the conversation and help us develop the plan.

The purpose of this discussion paper is to outline issues, strategies and actions related to wetlands, floodplains, and riparian ecosystems, which are critical for maintaining watershed health and all of the benefits humans derive from it. The paper complements and builds on the ideas presented in all of the previous discussion papers, focusing particularly on issues along the water's edge:

- Discussion Paper 1 – *Towards the Kettle River Watershed Management Plan: A Vision for the Kettle River Watershed* [30]
- Discussion Paper 2 – *Working together: Growing our capacity for watershed stewardship in the Kettle River Watershed* [32]
- Discussion Paper 3 – *Sustaining the flow: managing water supply and demand to support ecosystem health and community needs* [33]
- Discussion Paper 4 - *Water Quality and Source Water Protection: Issues and Strategies in the Kettle River Watershed* [34]

The strategies and actions discussed in this paper have been identified by the Advisory Group and are the basis for further discussion by the community before finalizing the Kettle River Watershed Management Plan.

2 OVERVIEW OF SHORELINE SYSTEMS

2.1 Riparian Areas

On the water's edge – it's where we live, where we work, and where we play. Residents and visitors in the Kettle River watershed value the shorelines and water bodies for the views, for learning about nature, and for accessing water for various purposes. However, activities near water bodies can

strongly affect aquatic ecosystem health and many other human uses of water because of the special characteristics of shoreline ecosystems, otherwise known as riparian areas.

What are *riparian areas*? Put simply, they are the strips of land along the edges of bodies of water (springs, wetlands, lakes, streams, rivers) where soil, vegetation and other organisms are shaped by and depend on the presence of water above or below the surface [1,13]. The riparian area has a small footprint on the land but a big impact on watershed health and function (Figure 1).

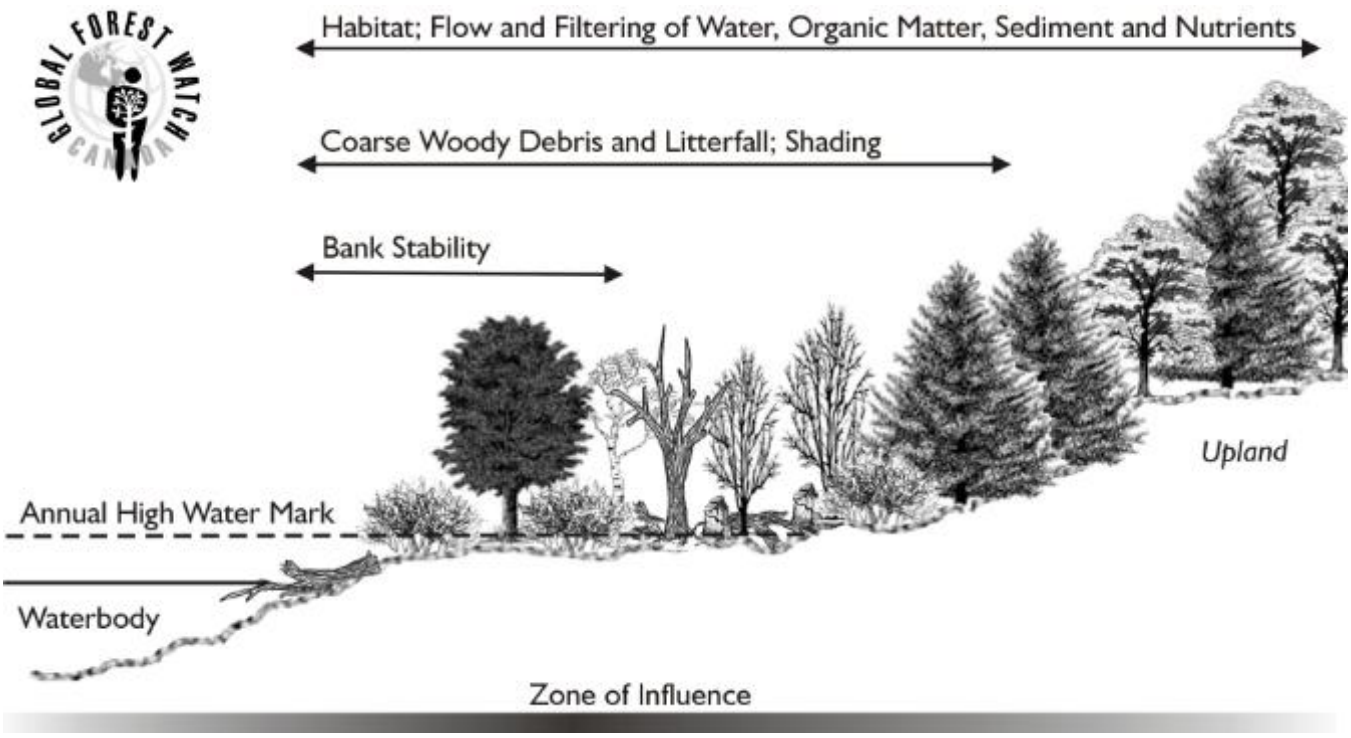


Figure 1. Riparian area zone of influence components and functions. Image from Global Forest Watch [15].

Riparian areas and wetlands are critical for supporting biodiversity by providing habitat for native plants and animals, and providing important functions for society by regulating water quantity and improving water quality. Other benefits to society include water movement and storage, groundwater recharge, shoreline protection, and shading and forage for livestock and wildlife, in addition to the many aesthetic, cultural and recreational values around water bodies [13,26,29].

All shorelines are also vulnerable to development and over-use. Many of our activities near water – building, paving, clearing, grazing animals and mowing – harm riparian habitat, plants and soils [1]. When riparian areas and wetlands are damaged, not only is local habitat lost – increased erosion and sedimentation can impact downstream fish and wildlife habitat as well as landowners.

As an example, trees, shrubs and native plants have large root systems that buffer moving water during floods. When they are removed and replaced with non-native grasses and other plants with shallow roots, high waters can easily undermine banks and cause them to slump, and surface run-off can carve into the banks. The added sand, gravel and stones in turn provide even more material and energy to streams and rivers, increasing erosion, channel migration and flooding risk downstream. Slopes with grades from 15%-25% may yield significant sediment if disturbed, and steeper slopes are even more prone to shed heavy sediment loads when disturbed [1].

Table 1. Some characteristics of healthy and unhealthy riparian areas [2].

Category	Description
Healthy	• Intact with natural vegetation that is characteristic of the site ecosystem • Multiple layers of native vegetation (trees, shrubs, forbs, mosses) provide habitat, shade and cover • A diversity of rooting depths from different banks forms a deep, binding root mass that protects the shoreline from erosion and promotes infiltration • Human or livestock use is minimized and/or designed and maintained to protect riparian function • Channel form and sediment bedload are stable and characteristic of the site and landscape • Performs all riparian functions expected for the site
Healthy but with problems	• Somewhat intact natural vegetation, with some trees or shrubs removed and some non-native vegetation • Increased development with hardened surfaces upslope of riparian area provide pollution and erosion • Higher levels of human or grazing use impact vegetation structure and cause some bare ground seasonally, although actions are being taken to minimize damage • Rooting mass and depth diversity diminished • Some evidence of changes to sediment load and channel characteristics • Some riparian functions impaired
Unhealthy	• Native vegetation removed (trees and shrubs) • Understory dominated by non-native grasses and invasive plants • Extensive exposed soil or active erosion; little or no root mass increases erosion risk • Sediment impacts in the water body; stream channel incised (downcut) or aggraded (widened) • Most riparian functions impaired (habitat, water quality, flood protection)

The width of the potential riparian area varies depending on many factors such as hydrology, topography, geology and geomorphology [13]. For instance, in a broad floodplain with a wide area where the river meanders, the natural riparian area could extend hundreds of meters from the bank. But for a smaller stream in a steep, narrow valley the riparian area may extend only a few meters.

On the other hand, the zone influencing a riparian area in terms of water runoff, sediment inputs, shade, and wildlife habitat extends much further from the water body. This is recognized in forest management with the riparian reserve zone and riparian management zone designations [21], discussed in Section 3.1.

What we know: The Phase 1 Technical Assessment found that information on riparian and wetland systems was overall very limited for the Kettle River watershed. A preliminary aerial photo assessment of riparian vegetation cover was conducted on major streams in agricultural areas of the watershed [25]. About half of the riparian areas examined have good coverage by trees and shrubs on both sides of the channel. Stream sections with potentially reduced riparian function are Boundary Creek, Beaverdell Creek, July Creek, and sections of the Kettle River in the Christian Valley, Westbridge to Rock Creek area. However, the Phase 1 Report recommended that further work be conducted on riparian conditions to support planning and prioritization for management and restoration.

As a result, the Advisory Group established a *Riparian Working Group* to identify information needs for riparian management, conduct necessary research and monitoring, and advise on priorities for restoration. The Granby Wilderness Society (GWS) has received funding from the Southern Interior Beetle Action Coalition to conduct a *Riparian Threat Assessment* on major impacts on riparian areas at the watershed and site scales. The threat assessment builds on a 2012-2013 project that assessed the threatened riparian cottonwood ecosystem and prioritized sites for conservation and restoration.

Figure 2. Example of resource road crossing a small stream. Note sediment over and adjacent culvert (J. Coleshill photo).

Analysis of landscape-level threats is underway, with emphasis on road-stream crossings and riparian land use (Figure 2). Preliminary analysis of resource roads and stream crossings reveals almost 11,000 road-stream intersections in the Canadian portion of the watershed (Figure 3). The approximate footprint of resource roads in the Boundary is 3% of the watershed area, with a total length greater than 15,000 km. Fieldwork from the summer season also sampled riparian conditions at over 90 random sites in representative sub-watersheds. The final report is expected late in 2014.

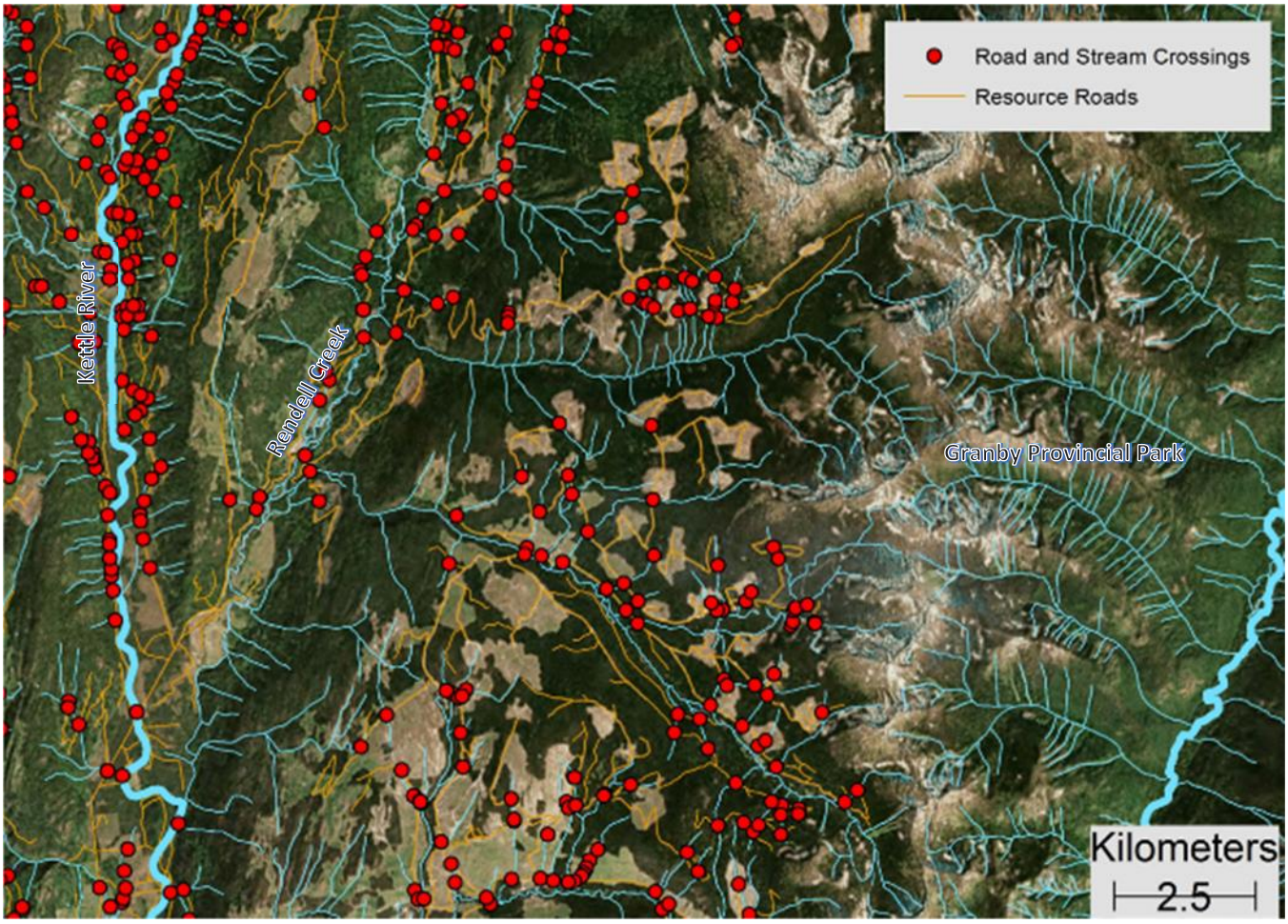


Figure 3. Road-stream crossings in the upper Kettle and Granby Provincial Park region. Stream crossings often increase sediment delivery to streams and interrupt the connectivity of aquatic habitat (J. Coleshill, Granby Wilderness Society).

2.2 Wetlands

Wetlands are areas of land that are saturated by water, permanently or intermittently, for long enough that soil becomes waterlogged, aquatic plants grow and other biological activity adapted to a wet environment occurs [6,27]. In the Southern Interior of B.C., wetlands include five primary types: bogs and fens (dominated by peat vegetation), swamps, marshes, and shallow open water. There are also floodplains, wet meadows and ephemeral wetlands. Large shallow open water wetlands may sometimes be classified as lakes, and many lakes have wetland fringes.

Similar to riparian areas, healthy wetlands provide critical wildlife habitat and important functions for society including water filtration and treatment, flood protection, groundwater infiltration, and

aesthetic and recreational opportunities. However, wetlands can lose these functions through alteration or destruction by people. Such impacts include [6]:

- Filling or draining wetlands to support croplands or developing roads and buildings;
- Changes to the water balance and alteration of surface hydrology through development (intercepting flow or altering drainage), water diversion and use and vegetation alteration;
- Groundwater extraction that lowers the water table or stream inflows;
- Increase in sediment loads from roads, agriculture, recreation activities and construction;
- Abuse of sensitive areas by off-highway vehicles and ATVs; and
- Displacement of native plants and animals by invasive species.

More information about managing wetlands in B.C. can be found in a comprehensive guidebook for protecting, restoring, managing and working around wetlands: *Wetland Ways: Interim Guidelines for Wetland Protection and Conservation in British Columbia* [6]. It provides specific guidance for agriculture, grazing, forestry, mining, oil & gas, recreation and transportation & utility activities.

What we know: Information on wetlands is available from the BC Wetlands Atlas (online [5]). It comes from various sources including air photo mapping, wetland inventories, and legacy data. It is certainly not complete; an examination of the Grand Forks area reveals that some large wetland complexes are not included in the inventory. Additionally, many wetlands in the Atlas have only limited data available. A wetland inventory using air photo analysis, remote sensing techniques, and field verification is understood to be a priority to identify and prioritise wetlands for protection, conservation and restoration.

There are a number of large wetland complexes associated with river oxbows (former river channels) along the valley bottoms, such as Johnson's Flats, Boothman's Oxbow, and Edwards Pond on Gilpin Road. Other wetlands are associated with springs and seeps on hillsides, low-gradient valleys near streams such Eholt Creek, small lakes and ponds across the Okanagan Highlands above the West Kettle River, and headwater wetlands in saddles between stream and river drainage divides.[1]

Historically, the valley bottoms of the southern interior of BC had an abundance of wetlands. Because these were attractive sites for agriculture, settlement, hydroelectric development and industry, many wetlands have disappeared. In the Okanagan Basin, for instance, 85% of natural wetlands have been

[1] A map of lakes in the Kettle River watershed is available at http://kettleriver.ca/wp-content/uploads/2013/02/krwlakes.jpeg

lost to agricultural drainage, stream channelization and housing, and in the Kootenay and Arrow Lakes areas there were extensive losses of wetlands because of hydroelectric development [6].

There are no estimates of wetland loss for the Boundary, but local examples brought to the attention of the Advisory Group include: the loss of wetlands around the south end of Christina Lake; the filling in of Pahoda Slough west of Community Futures in Grand Forks; the drainage of wetlands in Eholt Creek for hay fields; and infilling of local floodplain wetlands near Rock Creek.

2.3 Floodplains

Floodplains are features of river valley bottoms formed by the deposit of stream-borne sediment (alluvium) under current climatic conditions [9,22]. They change and evolve depending on the rate of sediment supply (volume and size), the availability of sites where sediments can accumulate, and the stream power of the channel. During floods, streams and rivers also move around and across the floodplain, placing our homes, roads, businesses and farms in harm's way.

Community planning increasingly addresses the risks of flooding by limiting development of flood-prone areas in consideration of the probability of flood damage, acceptable social, economic and environmental use of the land in relation to the hazards, and the protection of human life [8].

Figure 4. Flood erosion along Boundary Creek. Note the original bank location by the shrubs on the left (G. Watt photo)

A related hazard to flooding is the movement of rivers, either through severe channel erosion, lateral channel migration or the evolution of alluvial fans [12] (Figure 4). As Rapp and Abbe [22] point out, floodplain maps based on "fixed-bed" hydraulics (where the substrate is assumed to be unmoving) fail to characterize areas susceptible to channel erosion within and away from flood zones. The Channel Migration Zone (Figure 5) may be delineated through remote sensing, air photo analysis and field investigations, which can help reduce risks to human communities, infrastructure, and floodplain ecosystems by guiding land use, development, and land management near rivers [11,16,18,22].

What we know: Several Boundary communities have been designated as subject to recurrent and severe flooding as numerous historical floods (1894, 1942, 1948, 1956, 1983, 1986, 2006 and 2011) have affected low-lying areas along the Kettle and Granby Rivers. Floodplain mapping was developed

in the early 1990s for these communities that shows the elevations of 20-year and 200-year floods [25]. Official Community Plans, floodplain and zoning bylaws in the watershed also recognize flood and erosion hazard areas (Section 3.1), and these hazards are explicitly addressed in Ferry County's Shoreline Master Program, now undergoing a comprehensive update [7,19].

However, channel migration, development in the floodplain and the shifting hydrology due to climate change means that these floodplain maps may be out of date [8]. New locations of bridges, dikes, embankments and erosion control measures combined with changes in sediment loads may affect flooding depth and extents. In the future, climate change could affect flooding by increasing peak flows earlier in the spring [25]. The Advisory Group has identified the need to update floodplain maps to account for these changes as a priority for local government and the province. Given the recent observed changes in river morphology, there would also be merit in performing analysis of potential channel migration to guide development and land management decisions and the revision and application of bylaws concerning shoreline protection and erosion hazards [16,22].

The role of constructed and natural storage in mitigating flooding has been considered by the Advisory Group. A preliminary review was conducted on the feasibility of one or more dams to reduce flood risk on the Granby River (Burrell Creek and Granby River near Howe Creek). Even very large structures would not be effective for flood control because the volume of water they would retain would be insignificant compared to spring freshet flows [25], although they may have other benefits that bear further consideration [33]. Natural storage in the form of wetlands, forest cover, organic matter in forestry and agriculture, and other approaches should also be studied in more detail, as identified in Discussion Paper 3 [33].

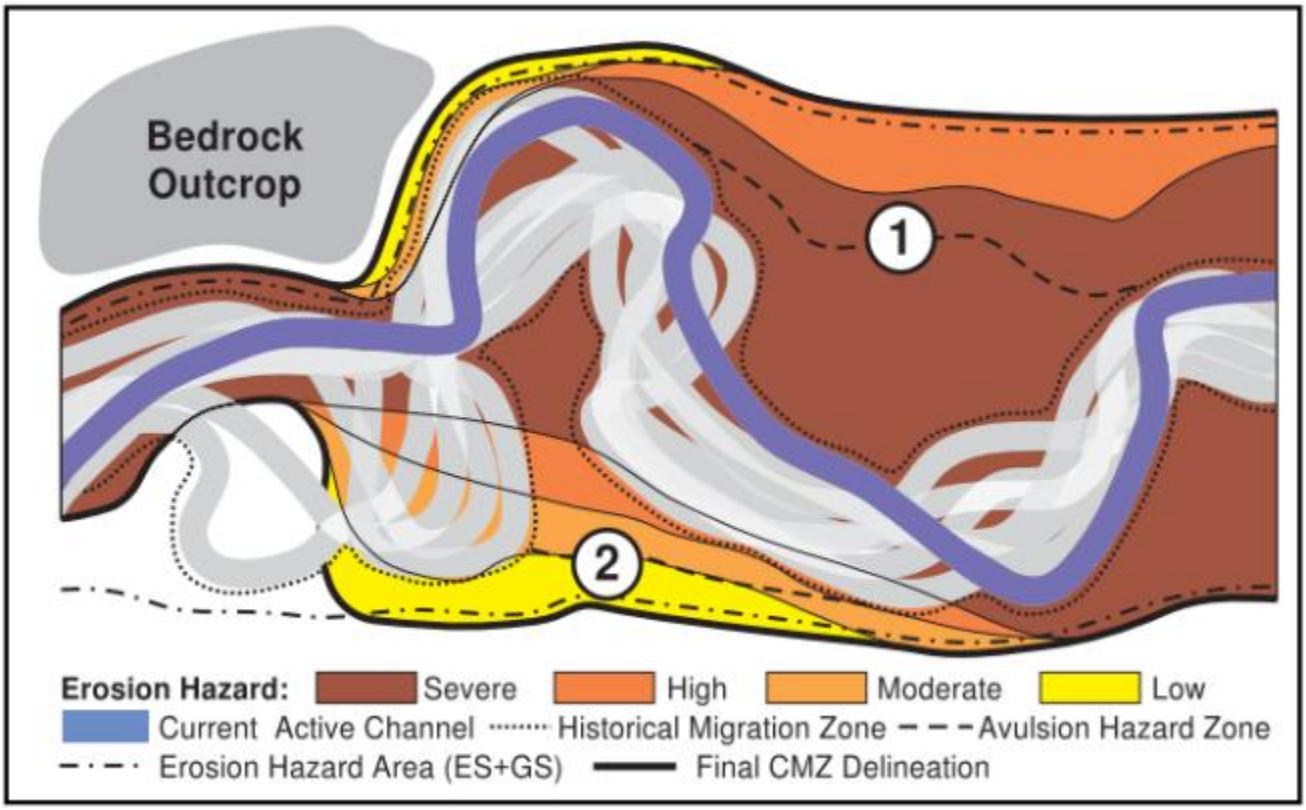


Figure 5. Conceptual erosion hazard map illustrating Channel Migration Zone delineation (Rapp and Abbe 2003 [22]). Description: In this conceptual erosion hazard map, the current active channel is highlighted (blue) to illustrate how trends in channel movement make this river susceptible to erosion beyond its Historical Migration Zone (HMZ). Consequently, the areas downstream of the migrating channel are highlighted as a severe erosion hazard. Additionally, the Avulsion Hazard Zone (AHZ) identified as (1) is severely at risk in the event of a channel avulsion given its likelihood of occupation by the river, which would be followed by lateral erosion. The other AHZ (2) is considered a moderate erosion hazard because it is less likely to be occupied by the main channel.

3 STRATEGIES TO PROTECT AND IMPROVE SHORELINE FUNCTIONS

3.1 Establish riparian buffers and set-backs from water features

Because of the well-known impacts of development, agriculture and resource management on water bodies and the risks to habitation from floods and erosion, numerous guidelines and regulations exist for different jurisdictions that guide the establishment of riparian buffers and setbacks [1,4,6,21,29]. A *buffer* is a relatively natural and undisturbed area of shrubs and trees between the shoreline and active upstream land use. A *setback* is the distance separating structures or management from the edge of the water or the edge of the buffer, and can be used to ensure development is located a safe distance from steep slopes and areas subject to flooding, or to protect views of waterways [29].

There are a great number of laws and regulations that Guidelines for buffers and setbacks vary depending on the type of activity (i.e. forestry, agriculture or land development), the type of water body, and the aquatic ecosystem functions or values being considered. Typically, buffer and setback recommendations address some of the following values of riparian areas:

- Water quality functions of riparian area
- Effect of slope on effectiveness of vegetation filtration
- Risks of groundwater contamination
- Flooding risk
- Shoreline migration
- Bank stability
- Habitat values [1]

The design of buffers and setbacks to protect these values depends on a number of factors that vary from site to site. For instance, wide, forested buffers are more effective at removing pollutants and sediment than grassy areas, and functions such as flood and erosion control have more to do with hydrology and landscape factors than the width of the buffer alone [1].

The RDKB, City of Grand Forks, and Village of Midway have adopted floodplain management bylaws, and the City of Greenwood addresses flood risk through their zoning bylaw. These bylaws are principally intended to reduce the risk of injury, loss of life and damage to buildings and structures due to flooding, and specify restrictions on habitable areas within the designated (200 year) floodplain or specified setback distance and elevation from the natural boundary (see inset 1). For instance, the RDKB Floodplain Bylaw specifies flood levels as 3 m higher than the natural boundary of the Kettle and Granby Rivers and 1.5 m above all other water bodies, with floodplain setbacks of 30 m from the Kettle and Granby Rivers, 15 m from other watercourses, and 7.5 m from other water bodies and dykes [23].

1 Definition of Natural Boundary

The RDKB Floodplain Bylaw [23] (in accordance of the Land Act [20]) defines the 'natural boundary' as the "visible high water mark of any lake, river, stream, or other body of water where the presence and action of the water are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river, stream, or other body of water a character distinct from that of the banks thereof, in respect to vegetation, as well as in respect to the nature of the soil itself, and also includes the edge of dormant side channels of any lake, river, stream, or other body of water."

Similar to the 'natural boundary' is the concept of the 'High Water Mark', which also includes the active floodplain at a given flood return interval (often 1.5-2 years) [17].

The RDKB has previously considered Development Permit Guidelines for protecting water quality and habitat functions of riparian areas around Christina Lake and tributaries [24]. The objective of the draft guidelines was to seek the retention of a 15 m vegetated riparian buffer area on shoreline properties, with flexible application for shallow parcel depths and small lots. Implementation of the draft guidelines was suspended until further study of riparian conditions and consideration of guidelines across the watershed, both of which are now underway.

Under the BC *Forest and Range Practices Act* (FRPA) Forest Planning and Practices Regulation [21], a number of restrictions are placed on logging and other activities near water bodies in the riparian management area depending on the size of water body, presence of fish and/or fish protection designations, biogeoclimatic zone, and location in a community watershed. Licencees may also establish an alternative 'results-based' approach in an approved forest stewardship plan [28].

For most streams and wetlands under FRPA, a riparian reserve zone is established where no harvest is permitted, and a broader riparian management zone sets targets for tree retention [21,28]. No mandatory riparian reserves are required for the smallest streams. Small streams, however, may constitute three quarters of total stream length and drain most of the total watershed area, and downstream aquatic conditions are highly sensitive to harvesting near the stream bank [14].

Given the increasing concerns about sediment and temperature impacts on fisheries and other water resource values identified through stakeholder engagement, water quality data and the Riparian Threat Assessment, as well as potentially increasing risks to safety and property from flooding and erosion [31,33,34], the Advisory Group recognizes the need to re-consider the planning and management of urban and rural development, resource roads, riparian reserves and management areas, and related resource and agricultural management practices to better protect the ecological function of shorelines and waterways.

The Advisory Group recommends that due consideration be given by local and provincial authorities to promoting and regulating the conservation and/or restoration of healthy, functional riparian buffers and development setbacks (Table 1) to standard widths such as 6 m for small streams, 10 m for small wetlands, and greater than 20 meters for permanent water bodies (30+ for fish bearing) (Table 2).

Table 2. *Example* riparian buffer widths for gentle slopes [1,10,15,29]. Steep slopes, areas susceptible to erosion, and areas with upslope development would require additional buffer width to protect riparian functions and slope stability, and setback and buffer guidelines would need to be adapted to local conditions.

Water body type	Ecosystem value / function	Buffer width / type
Permanent water body	Water quality	20 m (clay and till) – 50 m (coarse-textured soil), not including steep slopes
	Fish protection & habitat	30 m – 100 m
	Microclimate	100 m
Intermittent streams	Water quality	6-10 m native vegetation, perennial grasses
Small wetlands	Water quality	10 m with shrubs and perennial grasslands
All water bodies	Wildlife habitat corridors	100-400 m, depending on species

Setbacks and buffers would need to be tailored to specific conditions and may vary depending on: fish presence; vegetation cover type and composition; topography and slope; substrate; surficial aquifers, shallow groundwater and springs/seeps; floodplain and channel migration zones; and environmentally sensitive areas [1]. It is anticipated that policies for area-wide setbacks and buffers would be developed by the Implementation Team and Riparian Working Groups and implemented through appropriate local government and resource management planning processes (i.e. zoning, forest stewardship plans), and supported by provincial legislation, locally-tailored guidebooks, incentives, and demonstration sites.

3.2 Draft Outcomes

The Advisory Group recognizes the tremendous challenge in conserving and restoring shoreline systems, given the intersection of land management interests, regulatory bodies, and cultural preferences for landscape appearance and access to water. However, further loss of riparian, wetland or floodplain function will put aquatic ecosystems, drinking water, and economic development at risk of further degradation. Therefore the Advisory Group recommends achieving the 'good' outcome below as soon as is practical, and moving towards the excellent outcome over the longer term.

Good outcome: Achieve 'No net loss' or degradation of riparian area, wetland and floodplain ecological function through conservation of existing riparian buffers and mitigation of effects of future developments and/or agricultural, industrial and forestry activities.

Excellent outcome: Achieve a restoration of historical shoreline area size and function through a watershed restoration program active in all land uses. Targets size and function are to be determined through a riparian restoration program carried out in the implementation phase.

3.3 Strategies, management directions, and actions

This section summarizes the strategies, management directions and actions related to floodplains, wetlands and riparian areas being considered by the Advisory Group. Strategies and Management Directions were first outlined in Discussion Paper 1 [30]. Here they are expanded on with additional strategies and actions to be undertaken by specific agencies or organizations, and timelines over the first phase of implementation (2014-2017).[2]

[2] The *Implementation Team* was identified in Discussion Paper 2 [32] as the partnership of RDKB, other government agencies, local organizations and individuals who lead the first phase of implementation. It is expected to evolve into a more formal organization or partnership following a governance study by the implementation team. The Implementation

Strategy 1. Increase community understanding, support and capacity for stewardship of the Kettle River Watershed.[3]

Direction 1.1. Improve understanding of watershed function, integrity, resilience, and sustainability. Fill gaps in understanding through scientific studies and ongoing monitoring.

Action 1.1.1 Consider the findings regarding current condition and recommendations for protection and management of the forthcoming *Riparian Threat Assessment* (Granby Wilderness Society), as appropriate, in *Plan* implementation, local government planning, and resource management decisions (Implementation team, local & provincial government; by 2015).

Action 1.1.2 Implement a *Sensitive Ecosystem Inventory* for the Kettle River Watershed, with particular emphasis on identifying all wetlands and riparian areas (provincial government, implementation team; by 2016).[4]

Action 1.1.3 Consider updating floodplain maps in areas at risk of flooding to address potential or expected changes in hydrology related to climate change, incorporating higher resolution elevation data (local & provincial government, implementation team; by 2017).

Action 1.1.4 Consider undertaking a planning-level Channel Migration Zone (CMZ) [16] study for settled areas of the Kettle River, Granby River and Boundary Creek to identify land use hazards related to channel migration and avulsion (local & provincial government, implementation team; by 2017).

Direction 1.2. Build broad support for improved watershed management, including the development, implementation, and continued support of policies and regulations that safeguard watershed health.

Action 1.2.1 Assess and improve the consistency, alignment and application of policies and regulations for protecting habitat in aquatic and related upland ecosystems, for instance, resource management and local government jurisdictions (Federal, provincial and local governments, with lobbying and monitoring by local government and non-governmental organizations; ongoing).

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team is expected to lead in the monitoring, reporting, and/or coordination of work by the various agencies and groups involved.

[3] Strategies are repeated in all discussion papers but only the actions that are directly related to wetlands, riparian areas and floodplains are identified here; the final draft plan will compile and arrange all actions by strategy and theme.

[4] A Sensitive Ecosystems Inventory (SEI) systematically identifies and maps at risk and ecologically fragile ecosystems in a given area as part of a comprehensive ecosystem mapping framework [3].

Action 1.2.2 Consider and implement measures to provide increased protection for areas near water at risk of erosion due to vegetation removal and development. This could include shoreline set-backs for development, forestry, agriculture and landscaping; bylaws to control tree cutting on steep slopes; or other measures. Support with a combination of education, incentives, regulations, setbacks and development permitting (Provincial government, RDKB, municipalities, with support of Implementation Team; by 2015).

Action 1.2.3 Update and implement, as appropriate and through municipal and electoral area planning processes, the Riparian Area Development Permit Guidelines previously drafted for Electoral Area of Christina Lake (RDKB and municipalities, Implementation Team; by 2017)

Direction 1.3. Improve capacity for watershed stewardship

Action 1.3.1 Align and target stewardship and funding programs (i.e. Environmental Farm Plan; Farmland-Riparian Interface Stewardship Program) to address and support conservation and restoration of riparian areas and wetlands (Implementation team, stewardship organizations, provincial government; ongoing).

Action 1.3.2 Work with local conservation groups to establish a formal 'Streamkeepers' group or similar organization for ongoing water quality monitoring, wetland/riparian restoration and other stewardship activities (implementation team, stewardship groups, fish and wildlife groups, Boundary Habitat Stewards; 2015)

Action 1.3.3 Share results of Riparian Threat Assessment, Sensitive Ecosystem Inventory, floodplain mapping and related studies in the watershed information system and regularly through awareness and outreach programs (Implementation Team; ongoing).

Action 1.3.4 Develop and publish a 'Riparian Buffer Guide' booklet specific to shorelines within the RDKB that summarizes applicable regulations, articulates 'Riparian Buffer Area Requirements' and highlights options for conservation, restoration and beneficial management practices for landowners (implementation team, Boundary Habitat Stewards; 2015)

Strategy 2. Improve the quality, reliability and security of water supplies through sustainable management of water resources (see Discussion Paper 4).

Strategy 3. Improve watershed health and function in the Kettle River Watershed

Direction 3.1. Maintain or increase the extent and cover of permanent vegetation, including forests, in uplands, stream corridors and on floodplains

Action 3.1.1 Implement or extend incentives for retaining or increasing native tree, shrub and grassland cover and functional tree cover in urban and rural areas (provincial government, local municipalities, implementation team; ongoing)

Direction 3.2. Protect soil and improve soil health to improve water retention and decrease erosion

Action 3.2.1 Implement and align agricultural and forestry stewardship incentives for grazing, nutrient management, crop management & soil conservation (provincial government, implementation team; ongoing)

Direction 3.3. Maintain or increase the areal extent and function of wetlands and riparian areas across the watershed

Action 3.3.1 Develop a *Watershed Restoration Program* to strategically design, fund and implement conservation and restoration projects for wetlands, riparian areas, and in-stream systems (Implementation team, provincial government; by 2015).

Direction 3.4. Encourage shoreline and bank protection measures that protect aquatic and riparian habitat

Action 3.4.1 Work with landowners and resource managers to identify at-risk areas and support shoreline protection measures that protect aquatic and riparian habitat (implementation team, provincial government; ongoing)

Strategy 4. Maintain or enhance recreational, cultural and amenity values

Direction 4.1. Maintain a healthy sport fishery through habitat protection and restoration, continued stocking of recreational lakes and the protection of native fish populations in tributaries and rivers

Action 4.1.1 Identify the source, transport and fate of sediment currently affecting fish habitat and investigate the aggradation (widening) of the Kettle and Granby Rivers (Provincial government, university researchers, implementation team; by 2017).

Direction 4.2. Promote responsible recreation

Action 4.2.1 Collaborate with recreation and trail user groups to share information on stream and riparian protection, develop sign and brochure content and support trail, camping and staging area stewardship programs (Implementation Team, Trail Agreement groups; ongoing)

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