Determining Priority Riparian Management Areas in The Okanagan Valley, BC

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Abstract

Riparian area management is critical for conservation of aquatic and terrestrial species as well as for the provision of ecosystem services. This is especially so in the Okanagan region, a major agricultural area with high levels of biodiversity. This project aimed to use GIS to identify the areas where riparian restoration and management should be prioritized.
To determine this, data on fish ranges and high-ranking conservation zones was used to highlight the areas which should be prioritized for wildlife conservation purposes. Data from agricultural land use, building points and major roads was used to illustrate riparian areas most vulnerable to degradation. Determining the areas where all of these factors coincided allowed us to determine four major areas which should be prioritized for riparian restoration and management.
We found that 43% of the river area in the Okanagan should be managed for conservation purposes and 54% for vulnerability to degradation. The four areas of highest priority comprised 15% of total river area. Existing restoration projects in the Okanagan coincided with most of the priority areas found in this analysis. Expanding them to include more of the highlighted areas is highly suggested.

Description of Project and Study Area

The health of riparian ecosystems is essential for a number of species and environmental services. Their place as a transition zone between rivers and uplands allows them to have a diversity of natural features (Gyug 2000), high availability of water, a humid microclimate and nutrient-rich forage from effluent flows (Bunnel 1993), making riparian ecosystems ideal for a wide variety of terrestrial species. Their role in filtering effluent water also provides clean and clear water for aquatic organisms and their productive vegetation act as a great source of organic matter for the ecosystem. (Dosskey, 1997). When vegetation is appropriate, shade from canopy trees allows for cooler and more oxygenated water, essential for the survival of a number of riparian species (Dosskey, 1997).

However, the health of these ecosystems is constantly compromised due to forage removal, river bank erosion and chemical contamination. Among the most important contributors to its degradation is agriculture, which plays a significant role in modifying vegetation and loading surrounding effluents with fertilizer or animal waste (Willms, 1998). Development of buildings and roads has also resulted in significant loss of riparian areas in most ecosystems (Sawicz et al). Projects for restoring vegetation and controlling contamination are continuously happening across Canada and are usually funded by agencies such as Fisheries and Oceans Canada (Pearson 2009).

In the Okanagan, a highly-productive agricultural area in northern British Columbia, 73% of riparian area has been lost since the 1800s (BC Ministry of Environment). Being a region where most major cities are built around a river and which hosts a big portion of the province's wildlife, riparian restoration and management appears to be a priority. Several projects such as the Mission Creek Restoration Project (Missioncreek.ca) and the Okanagan River Restoration Initiative (Syilx.org) have already started doing so. But it is a time and resource-intensive process—from the 3,000 kilometers covered by rivers in the Okanagan, where should they start? This project aims to use Geographical Information Systems to determine which areas should be prioritized for riparian restoration and management based on their importance for terrestrial and aquatic organisms, as well as their vulnerability for degradation from agriculture and development.

Methodology of Analysis

The following data was gathered for this project's analysis:

- Agricultural Land Reserve polygons from *BC Data*
- Fish Ranges from *BC Data*
- Okanagan river areas, roads and buildings from the GIS lab's G/: drive.
- Okanagan wildlife conservation areas and their priority rankings from *BC Data*

A project boundary was then created by drawing a new polygon that represented the Okanagan region (as there is no established geographical boundary). All of the data was clipped to this boundary.

The first step in the analysis was to determine which riparian areas were the most important for wildlife conservation. For this, we used the Fish Ranges and the Wildlife Conservation layers. In both of these, it was important to first do a "selection by attributes" in order to determine which areas represented the highest priorities. In the Fish Ranges layer, we decided that there were two aspects which should be taken into account: the area where salmon species reside (as this is one of the most important species in the Okanagan and, being of high commercial value, will allow for funding of restoration projects) and the area where species at risk reside. Two new layers were created from these attribute table selections.

For the Wildlife conservation areas, we decided that we would focus on those that were listed to have the highest conservation ranking. A new layer was created from this selection. The layers were, then, buffered according to the proximity we considered appropriate for each factor. Through research, we found that areas 500 meters from hatching grounds were of significant importance to aquatic organisms (BC Ministry of Environment) and that terrestrial wildlife was disturbed within 200 meters of its natural environment (Manitoba Conservation, 2008). The layers were then buffered accordingly and the new, buffered layers clipped to the river layer in order to highlight the river areas which were found within the designated proximity. We then created a layer from the intersection of these three, therefore highlighting the river areas which had the greatest concentration of species at risk and should be prioritized for restoration and management due to conservation concerns.

The next step was determining, from these prioritized areas, which ones were the most vulnerable to degradation due to development and agriculture. For this, a similar approach than for the conservation analysis was used. Since the major effect of agricultural land comes from the contamination of its effluents, their presence affects a wider range of land. We considered that riparian areas within 2 kilometers of agricultural land would be highly vulnerable to degradation. On the other hand, road and building development happens on a closer-range basis and mainly affects the area immediately surrounding it. We, therefore, considered that any river within 200 meters of a road or a building would be at risk of degradation.

Buffers for these layers were, then, created accordingly and their buffers clipped to the river layer. A new layer created from the union of these three new layers represented all of the areas which were most vulnerable to degradation. A union, instead of an intersection, was chosen for this layer for two reasons. First, because there is minimal geographical overlay between the two areas, buildings and roads being concentrated around the major cities and agricultural land otherwise. The second reason was that vulnerability, as opposed to species at risk, is not cumulative: a higher number of factors of degradation do not necessarily make the area more vulnerable. This was not the case with conservation areas, where a higher concentration of species at risk did increase the urgency of management.

However, to identify the most specific and distinct areas for management priority we wanted to select those that were in proximity to all six examined factors. For this, an intersection layer was also created from the vulnerability factors.

Intersecting the two resulting intersection layers (priority due to conservation purposes and priority due to vulnerability to degradation) gave us a new, final layer: the areas with highest restoration and management priority. This layer represented all areas that were in close proximity to high-rank conservation zones, salmon and fish species at risk, agricultural land and development constructions.

Discussion and Results

We found the Conservation Priority layer to cover a distance of 1355.7 kilometers. Out of a total river distance of 3161.6 kilometers, this shows that 43% of the river area in the Okanagan should be managed for conservation purposes. As for degradation, we found that vulnerable areas covered 1704.4km of river length, or 54% of the rivers in the region.

The total area in the region that was within the range of all six studied factors (salmon species, fish species at risk, wildlife conservation areas, agricultural land use, buildings, and roads) was equivalent to 468.5km, or 15%, of total river length, and was concentrated in four main areas. Two of them lay in the vicinity of the city of Kelowna, one area in the vicinity of the city of Penticton, and one area just south of Skaha Lake between Penticton and Osoyoos.

Two major restoration projects are currently in place in the Okanagan region, the Mission Creek Restoration Project (Missioncreek.ca) and the Okanagan River Restoration Initiative (Syilx.org). The Mission Creek Restoration Project focuses on the lower 12 kilometers of Mission Creek from the East Kelowna Bridge to Okanagan Lake. This project therefore encompasses the second most northern region, in the vicinity of the city of Kelowna, that was identified as a Highest Priority for Management and Restoration from our analysis. This project involves restoration practices such as creating habitat for species at risk, improving drainage for agricultural land, planting riparian vegetation and maintaining the nearby Greenway. The second project, the Okanagan River Restoration Initiative, focuses on the banks of the Okanagan River, near Okanagan Falls. This area is located at the southern end of Skaha Lake, and encompasses the highest priority area located between Penticton and Osoyoos. The projects involves the replanting of indigenous plants to provide shade for salmon to hide from prey, the increase in habitat area for riparian wildlife, and the improvement in vegetation filtering of runoff. Over time, the mentioned projects will ideally lower the degraded status of these highlighted areas. Two of the four areas were found to have highest priority for management and restoration in this project have been included in the main restoration projects in the Okanagan region. The remaining two areas are therefore the most suitable, and in need, for future restoration project proposals. Although two of the four areas of highest priority for management and restoration have already been addressed by different organizations that aim for recovery of the riparian area, and this represents a significant progress, our analysis shows the vast majority of river length in the Okanagan region is still potentially impacted negatively or identified as being at risk by at least one form of environmental factor. The results of this analysis indicate that there is still much needed to be done in order to protect the full extent of riparian areas in the Okanagan.

It is important to discuss certain decisions taken in the analysis and how they influenced the obtained results. One of them was the decision to clip, instead of intersect, the river layer to identify the regions of water that met the species' conservation criteria. The 'Clip' command was used as this would create output features with only the input feature attributes (from either the salmon, species at risk or conservation area layers), and not the clip features (from the river layer). As we are primarily interested in the attributes (specifically the length) of the buffered/input layers rather than that of the river/clip layer, the Clip tool is more ideal compared to the Intersect tool. The Intersect tool would create output features that contain all the input features. To minimize the amount of output attributes and better isolate the attributes of interest, Clip was chosen over Intersect to identify which parts of the river layer overlapped with the buffered conservation layers.

The decision to use an 'intersect' command instead of a 'union' one when creating the conservation priority layer was also significant. In a Union, the output feature class combines all the features and attributes from each of the input feature classes. On the other hand, an Intersect creates an output feature class that only combines the features and attributes that are common to all the input feature classes. As the regions covered by the selected fish species and the high-ranking conservation areas are quite extensive, a union of these buffered/clipped layers would result in almost all of the river areas being chosen as conservation priority areas. Although any factor that makes a river riparian area vulnerable to negative impacts is important, too large an extent of highlighted river areas would make it more overwhelming to choose which areas of the river to prioritize over the other. An Intersect was chosen as the most appropriate to help in identifying which areas had the greatest overlap in both fish and terrestrial species of conservation importance, and therefore should be prioritized in management.

The opposite was done when analyzing vulnerable areas. In this case, a Union was done instead of Intersect as buildings and roads occupied a distinctly different geographical location compared to agricultural lands, and there would have been little to no overlap between the three layers should an Intersect been done. Therefore, a Union was done to highlight all areas susceptible to at least one form of degradation or another.

Uncertainties and Sources of Errors

1. *Buffers not specific to Okanagan region:*

The Okanagan region is noted for its high biodiversity and species uniqueness. However, it is also a region where most endangered species reside in the province (Ministry of Environment, 1998). The clipped Conservation Rank layer displays habitats for wildlife species at risk in Okanagan region. Since a specific value for the Endangered Species habitats in Okanagan, the layer was given a buffer of 200 meters to represent the suggested 200m "Reserve Zone" from the Manitoba Conservation Forest Practices Guidebook, an area in which "no harvest, mechanical, or ground disturbance can take place"(Manitoba Conservation and Manitoba Water Stewardship, 2008). However, due to the difference in geographical conditions and level of species' sensitivity to disturbances between Manitoba and BC, the buffer applied as the "Reserve Zone" might need to be adjusted to a suitable value that is specific to species at risk in Okanagan region. In addition, while analyzing the vulnerable areas to degradation, the agricultural land layer was given a buffer of 2 kilometers to account for the ability of potential fertilizer and pesticide run-off from fields to impact a large area of rivers (wwf.panda.org). While this is only a general range, it does not apply for specific regions. The map would provide a more precise result if the map data included information exclusively for Okanagan region with respect to its land use, soil productivity and topography.

2. *Incomplete Fish Range data:*

Habitat distribution of fish species at risk played a significant role in determining the riparian area management priority, because either change in water quality or adjacent forest structure can have huge impact on the fish species in the rivers. The Fish Range map data downloaded from Data BC includes habitats of a variety of fish species in BC. However, information of a few endangered fish species in Okanagan region such as speckled dace, Umatilla dace and northern mountain sucker could not be found. The areas of the mentioned species might still be included in the mapped management priority area, however they were not highlighted as higher priority. Indicating which areas are higher priority is important in terms conservation of endangered species, as endangered species are more sensitive to changes in their living environment.

3. *Possibilities outside of the project boundary:*

In order to obtain a more precise result of the study, a project area was defined by drawing a rectangle that include the entire Okanagan River and most of its river branches. There are some riparian areas in Okanagan region that are excluded from the project area which might also be of conservation priority or vulnerable to degradation.

Future Research Suggestions

The GIS analysis we completed is of a large scale and not specific. There are many variations among the Okanagan's major riparian area, which could only be portrayed by more detailed analysis. Specific segments of the priority management areas should be more closely examined, analyzing areas where riparian management has previously happened. A greater understanding of the complexity of stream health can expand management efforts towards other environmental values (Richardson, 2003). Future analyses can also compare the riparian zone health in a Remote Sensing comparison of the same site in different years. This type of analysis would be helpful for observing the progression riparian zones can make when logging methods, buffers, and other human activity components are altered.

We suggest GI Scientists delve deeper into this analysis by specifying the ALR (Agricultural Land Reserve) for arable crop productive land vs. ALR grazing land/unproductive land. This research could provide additional information on potential hazards for riparian areas. Specifying the type of agricultural use (ie. chicken, pig, or cow farming or organic vs. conventional food production) could also allow us to consider potential risk for contamination from poor manure management.

Moreover, although migration patterns for salmon may differ each year, it would be helpful to understand the migration tendencies from previous recent years so further riparian protection could be implemented for those areas. Reserve zones can vary upon a series of factors, such whether the predominant salmon species in a stream is anadromous or catadromous and their anticipated spawning years. This type of data may be difficult to acquire or not exist. However, studies that have been allotted a more generous amount of funding can consider this expansion and contribute to riparian management knowledge.

Our analysis also lacks a consideration of the altitudes of the region. Riparian management buffers can depend on the slope of the surrounding area of a stream (for strip-cutting trees on a slope). The likelihood of landslides can also change if climatic influences are supportive of that vulnerability -suggesting a greater precaution should be taken when dealing with exceptionally vulnerable steep riparian areas that contain BC freshwater wildlife. We suggest future research to also consider data on previous climatic events and the average amount of rainfall the Okanagan receives along the Priority Management Zone. This new distinction could provide a basis for a greater understanding of the specific measures needed to be taken at different locations along the freshwater ecosystem.

Appendices

i. References

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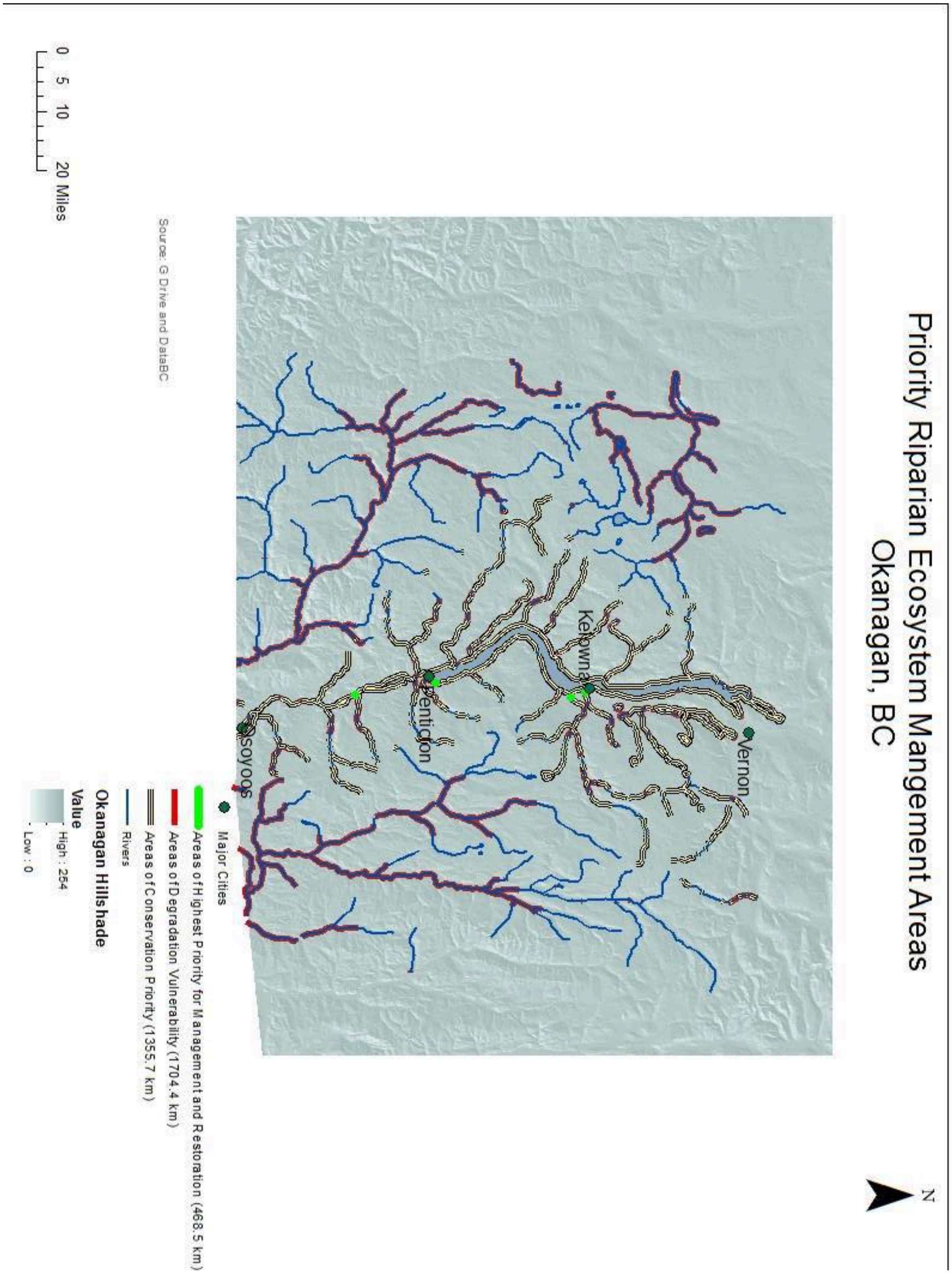
ii. Maps and Figures



iii. Flowchart