

# Riparian Conditions of the Lower Chena River

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## Abstract

Riparian areas serve a wide range of functions that are important for a sustainable watershed. These include streambank stability, floodwater storage, contaminant filtering and storage, habitat for fish and wildlife, and recreation. The lower Chena River is one of few river segments in Alaska with relatively heavy human development on its sides. A map of the lower Chena River was constructed using a geographical information system. With use of aerial images and photos the riparian areas were classified as in either “natural” or “unnatural” condition. Further classification included the width and type of the riparian area. The survey shows that approximately 60 % of the riverside



of the lower Chena River is in a “natural” condition, when considering the riparian strips in immediate proximity to the river. The proportion between “natural” and “unnatural” conditions becomes closer to 50/50 when the “natural” riparian area has to have a width of at least 50 feet. With proper management, including protection and restoration through the establishment of buffer zones, it should be possible to increase the part of well-functioning riparian areas along the Chena River. It is hoped that this study can be a helpful contribution in the sustainable management of the Chena River Watershed.

## Introduction

This report was written as an assignment in the course NRM F370, *Introduction to Watershed Management*, at the University of Alaska Fairbanks. The students were told to come up with and conduct a project related to watershed management throughout the fall semester of 2012. The idea of this project was developed in co-operation with the Fairbanks Field Office of U.S. Fish and Wildlife Service.

The word riparian is an adjective meaning “of, pertaining to, or situated or dwelling on the bank of a river or other body of water” (Dictionary.com). The scientific literature provides slightly different definitions of the term riparian areas/zones/corridors, here is one by Naiman and Decamps (1997): “The riparian zone encompasses the stream channel between the low and high water marks and that portion of the terrestrial landscape from the high water mark toward the uplands where vegetation may be influenced by elevated water tables or flooding and by the ability of the soils to hold water.”

A watershed is a system consisting of many components, serving different functions. The riparian areas constitute major components in the watershed, and serve functions that are closely tied to their role as connecting links between terrestrial and aquatic systems. Five important functions are briefly described below.

- Streambank stability:

Riparian vegetation greatly increases stabilization and decreases erosion of the streambank. Beeson and Doyle (1995) found that major erosion was 30 times more prevalent on nonvegetated banks as on vegetated banks.
- Floodwater storage:

Riparian areas can attenuate floods by absorbing and storing water during and after high flow (National Research Council 2002). Vegetation increases this capacity (Mitsch & Gosselink 2000).
- Contaminant filtering and storage:

Riparian areas can help maintain good water quality by filtering, binding and transforming sediments, nutrients and pollutants (Barling & Moore 1994; Naiman & Decamps 1997; National Research Council 2002).
- Habitat for fish and wildlife:

Riparian areas provide habitat and food for a diverse array of species. Their relative contributions to biodiversity greatly exceed the proportion of the landscape they occupy (Naiman et al. 1993; Naiman & Decamps 1997). They may also serve as

corridors through which species can migrate and disperse. Riparian vegetation is important for aquatic life in many ways, for example, by providing woody debris that provide habitat for invertebrates, which again may increase fish productivity (Gregory et al. 1991).

- Recreation:

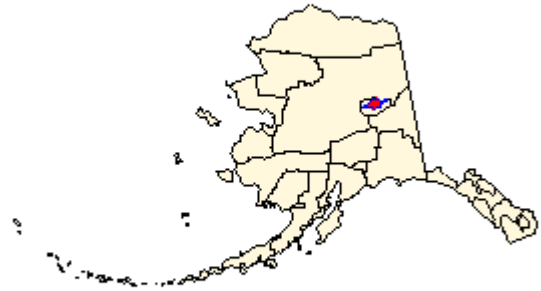
Riparian areas are often perceived as aesthetical areas and are an important recreational resource for humans. Fishing, bird watching, wildlife enjoyment, camping, swimming, and boating are examples of popular activities taking place in riparian areas.

To make sure that riparian functions are being sustained, a common management approach is to establish riparian buffers. Riparian buffers are zones along the riverside where certain human activities are restricted. There are two aspects to management of riparian areas with buffers: the width of the buffer and the allowable activities within the buffer. These aspects are taken into consideration in this study. There is a large amount of literature providing recommendations on riparian buffers (Coles-Ritchie 2009).

The lower Chena River is one of few river segments in Alaska with relatively heavy human development on its sides, due to its location within the city of Fairbanks. Such areas offer challenges in balancing ecological and social objectives. In order to perform good riparian management it is important to have a good account of the riparian conditions along the river, both qualitatively and quantitatively. The objective of this study was to contribute to that goal, by constructing a map integrated with information on the riparian areas of the lower Chena River.

## Study area

The Chena River originates in east-central Alaska and runs west/south-west approximately 241 km to its outlet in the Tanana River near the city of Fairbanks, at 64°48'N, 147°55'W (Oswood et al. 1992) (Figure 1). The watershed of Chena is 762 km<sup>2</sup> and lies in the physiographic province of the Yukon-Tanana Upland. The climate here is continental, with long cold winters and short summers, and relatively little precipitation. Average temperature ranges from -9.7 °F / -23.2 °C in January to 62.4 °F / 16.9 °C in July, and mean annual precipitation is 10.34 inches / 262.6 mm (ACRC).



**Figure 1:** Location of the Chena River watershed within the Fairbanks North Star Borough, Alaska, USA.

The Chena River is a clear-water river, fed by precipitation and subsurface flows (Oswood et al. 1992). The annual discharge cycle is typical of rivers in the subarctic. During winter the discharge is low and stable (20-30 m<sup>3</sup>/s near the outlet), but peaks during spring and snowmelt. Runoff in May often exceeds 100 m<sup>3</sup>/s. After this peak it declines during summer and fall, but with some variable peaks (Oswood et al. 1992).

Most of the watershed is covered by hundreds of feet of sediment (sand, gravel and finer sediments) deposited by river and glacial activity (Mulligan 2004). Organic layers are generally less than a foot deep (Mulligan 2004). The boreal forest covers most of the watershed, thus black spruce (*Picea mariana*) is a common species here (Oswood et al. 1992). In areas that are better drained and have no permafrost you can find white spruce (*Picea glauca*), cottonwood (*Populus tacamahacca*), birch (*Betula papyrifera*), and aspen (*Populus tremuloides*) (Oswood et al. 1992). In riparian areas there are in addition willow (*Salix* spp.) and alder (*Alnus* spp.) (Oswood et al. 1992). The river supports 13 species of fish, including seven salmonids (Oswood et al. 1992).

The riparian areas of the Chena River that are covered by this report are both riversides from the outlet and upstream until the bridge where University Ave crosses the river (see Figure 4, page 8).

## Methods and Approach

A map of the lower Chena River was constructed using the geographical information system *ArcGIS 10.1 for Desktop* from Esri (esri.com). The map consists of two lines, one for each riverside, which again consists of multiple line segments. Each segment is represented in an attribute table that contains information on the riparian conditions.

The main source used in construction of the map was an aerial image of Fairbanks with four inches resolution, obtained from Fairbanks North Star Borough. The pictures were taken between June and August 2012. In addition, the Bird's Eye feature in the web mapping service Bing Maps (Microsoft Corporation) was used. This feature displays detailed images at an oblique, 45-degree angle, and all locations may be viewed from all four cardinal directions. To supplement the aerial images, georeferenced photos were used to determine the riparian conditions. These photos were obtained partly from Bob Henszey at the Fairbanks Field Office of U.S. Fish and Wildlife Service, and partly from the web mapping service Google Maps (Google Inc.).

All the line segments, representing a stretch of the riverside, were given values and descriptions that can be read in the attribute table. The table presents riparian features of each segment under four headings: "Condition", "Width", "Type", and "Comments". These are explained below.

"Condition": A riverside is first classified in either of two broad categories, according to its condition in its immediate proximity to the river:

1 = "natural"

2 = "unnatural"

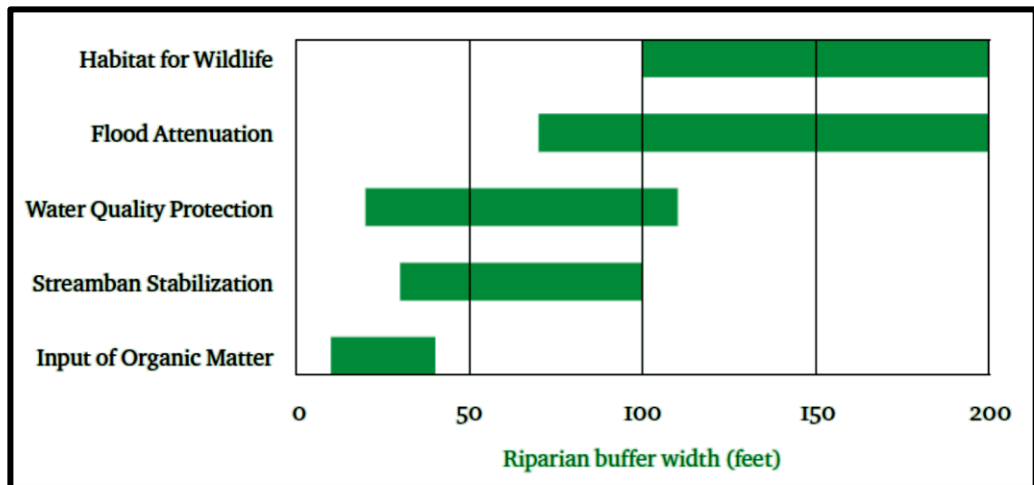
Other applicable terms are *unmodified* and *modified*, or *undisturbed* and *disturbed*. A riverside does not have to be natural in its purest sense to be placed in this category. For example, some human modification in the past which not substantially alter the natural character can be ignored.

"Width": Since the width of buffer zones are essential in determining which functions they provide, and in which magnitude, an estimation of the width of the riparian area is given. This is not given if the riverside is in an "unnatural" condition.

1 = more than 50 feet (15 meters)

2 = less than 50 feet (15 meters)

The choice to distinguish areas wider and narrower than 50 feet was based on information compiled by Coles-Ritchie (2009). It can be argued that a minimum buffer zone of 50 feet is too narrow (see Figure 2). However, Coles-Ritchie (2009) also recognizes that some conditions make it impractical to implement recommended buffer width, for example where there already is a high degree of development, like in the Fairbanks city area.



**Figure 2:** The range of recommended riparian buffer widths encountered by Fischer and Fischenich (2000) in their review of riparian buffer literature. The widths for “Habitat for Wildlife” and “Flood Attenuation” were truncated before the very large values of 1600 feet and 490 feet, respectively. Figure from Coles-Ritchie (2009).

“Type”:

If the riverside is in a “natural” condition, one of the following riparian types is assigned to the segment (Figure 3):

- “tributary”
- “low/no vegetation”
- “intermediate vegetation”
- “high vegetation”

If the riverside is in an “unnatural” condition, one of the following riparian types is assigned to the segment (Figure 3):

- “riprap”
- “lawn/dirt”
- “unnatural excavated bulge”
- “ramp”
- “other installation”
- “impervious surface”

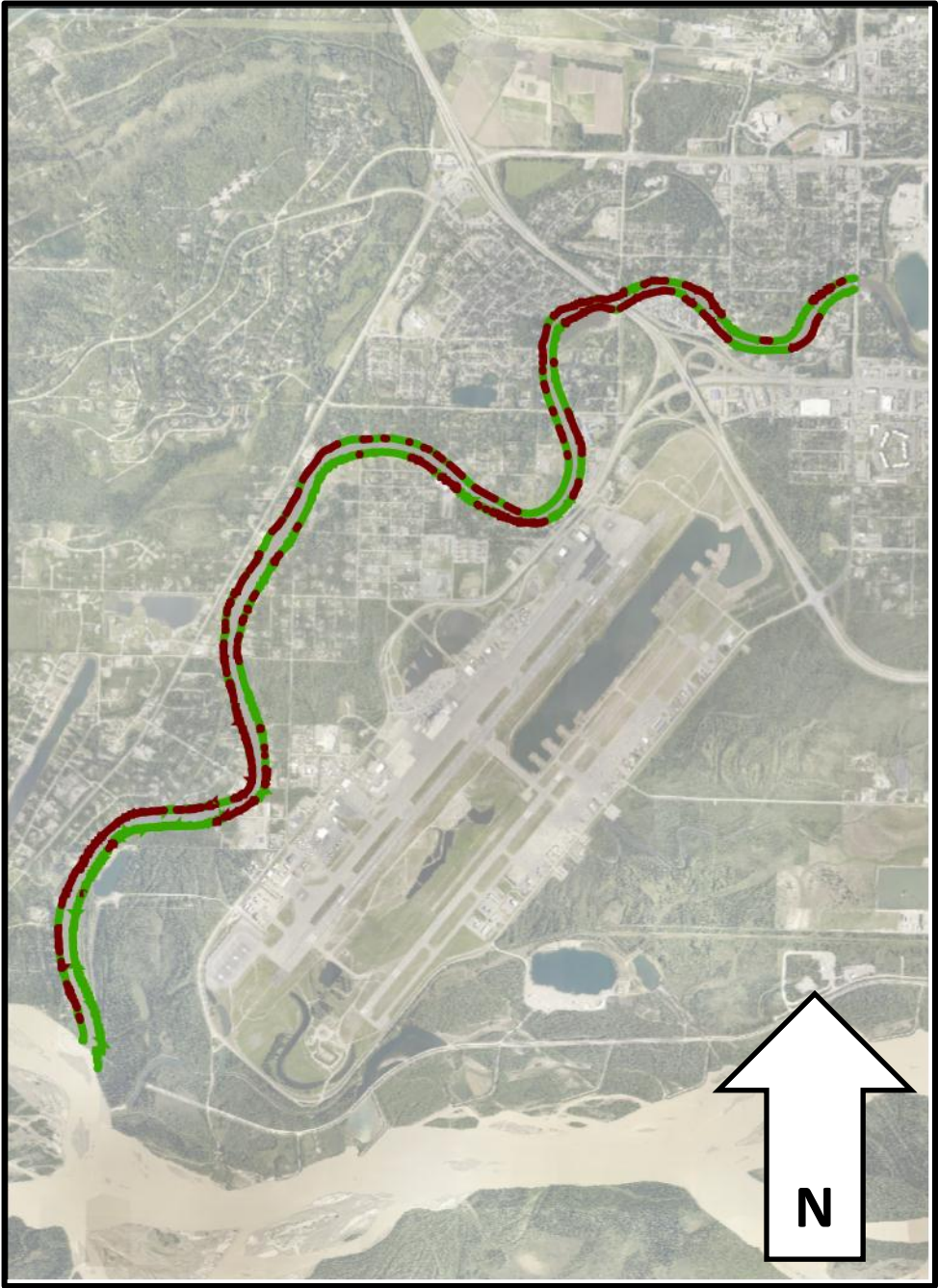
“Comments”: Other useful information.



**Figure 3:** Representations, from the Chena River, of some of the riparian “types” that the riversides were categorized within. “Natural” conditions to the left, “unnatural” conditions to the right. All photos: Bob Henszey.

**Results**

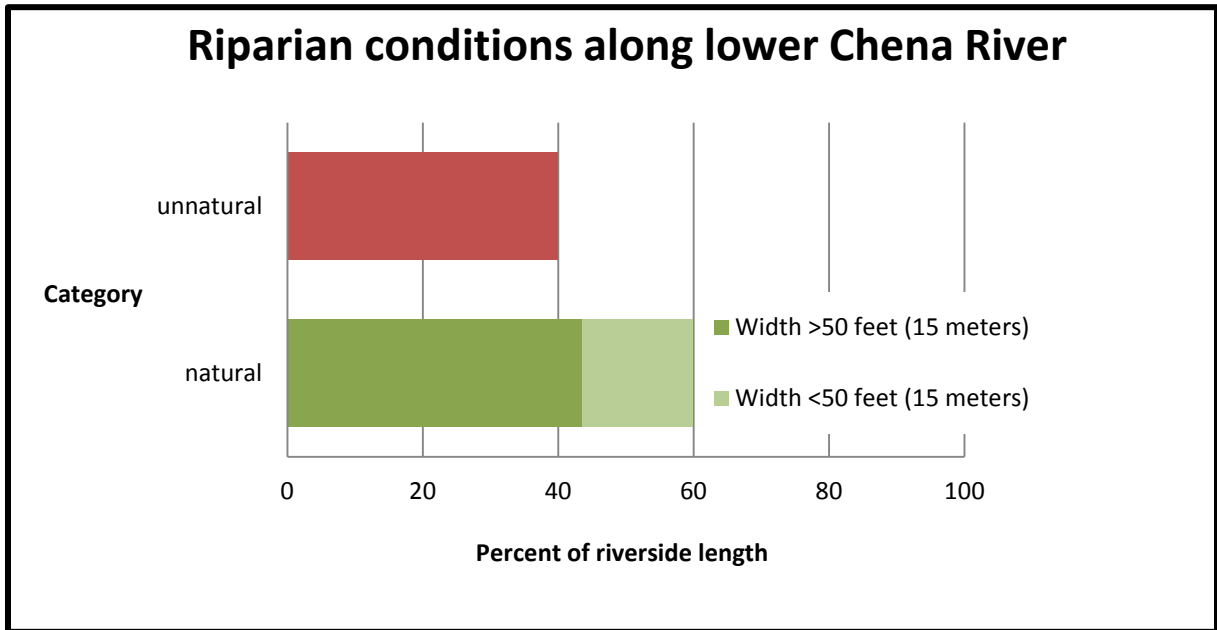
The resulted digital map is available at Fairbanks Field Office of U.S. Fish and Wildlife Service. A rough overview of the geographic distribution of “natural” and “unnatural” riparian conditions can be seen in Figure 4.



**Figure 4:** Geographic distribution of “natural” and “unnatural” riparian conditions along the lower Chena River. Green=“natural”, dark red=“unnatural”.

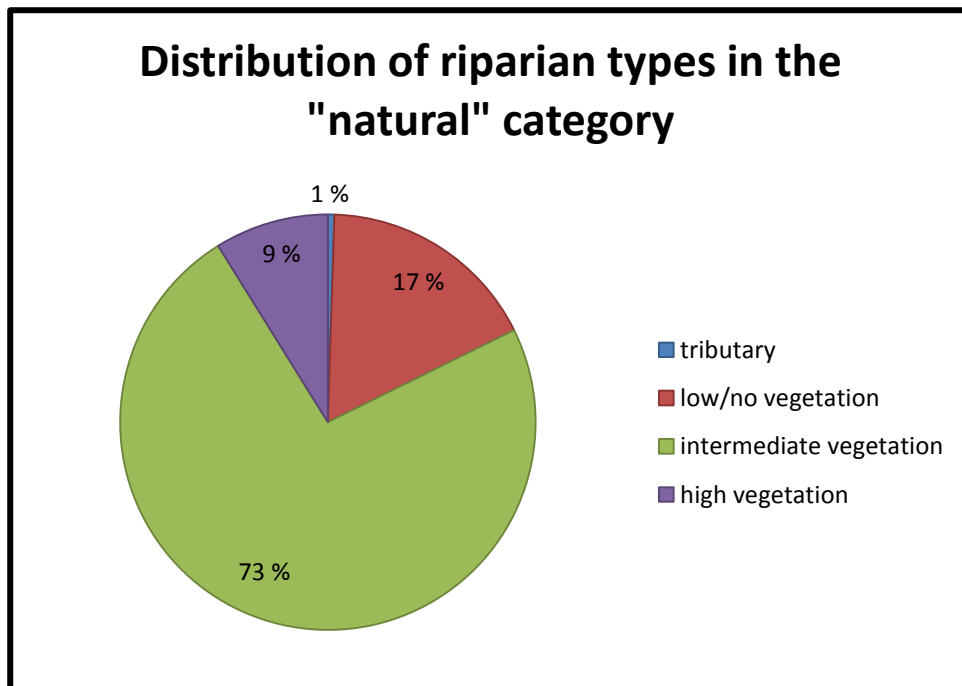


Figure 5 shows the distribution in percentage of “natural” and “unnatural” riparian areas along the lower Chena River.



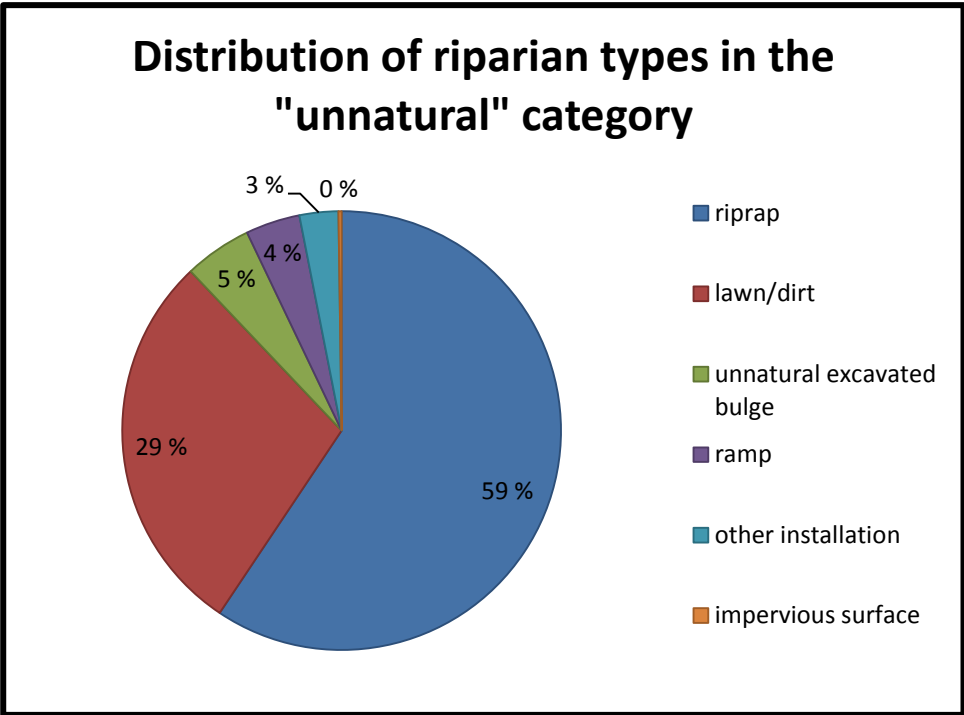
**Figure 5:** Distribution in percentage of «natural» and «unnatural» riparian conditions along the lower Chena River.

Figure 6 shows the distribution in percentage of the different types of “natural” riparian conditions.



**Figure 6:** Distribution of the different types of “natural” riparian conditions along the lower Chena River (both “width” categories combined).

Figure 7 shows the distribution in percentage of the different types of “unnatural” riparian conditions.



**Figure 7:** Distribution of the different types of “unnatural” riparian conditions along the lower Chena River. The part of “impervious surface” was less than 0.25 %.

## Discussion

Well-functioning riparian areas are essential to a sustainable watershed. Humans and other life, both present and future generations, will benefit from the protection and restoration of riparian areas, due to the wide range of functions they provide. At least five national policy objectives are dependent on good riparian management if they are to be achieved: protection of water quality, protection of wetlands, protection of threatened and endangered species, reduction of flood damage, and beneficial management of federal public lands (National Research Council 2002).

It is not to be expected that urban areas have the same quality and quantity of riparian conditions as undeveloped land. This is especially the case with the width of the riparian zone. Developed areas, like the Fairbanks city area, are unlikely to have rivers with riparian zones in natural conditions that spans very far away from the river bank. However, in a certain distance from the riverside it should be possible to maintain a high coverage of good riparian conditions even in well developed areas. This study shows that approximately 60 % of the riverside of the lower Chena River is in a “natural” condition, when considering the riparian strips in immediate proximity to the river. The proportion between “natural” and “unnatural” conditions becomes closer to 50/50 when the “natural” riparian area has to have a width of at least 50 feet. With proper management it should be possible to increase the “natural” part in both width categories. There are two main options for managers who intend to improve overall riparian condition: protection or restoration. Coles-Ritchie (2009) gives a good presentation of these riparian management options, with a focus on the Fairbanks North Star Borough. Establishment of riparian buffers is a way of approaching such management. Complete protection or restoration is not always necessary. For example, a multiple-zone buffer system can be implemented, in which less and less disturbance is allowed as you approach the river (National Research Council 2002).

At this time, the most common type of natural vegetation along the lower Chena River is “intermediate vegetation”, that is, shrubs and low trees. Different vegetation types have different impact on a range of patterns and processes, including hydrological and ecological (Lyons et al. 2000; Tabacchi et al. 2000). This can be considered in management and restoration of riparian areas.

The most common “unnatural” riparian types are “riprap” and “lawn/dirt”. Together, these categories make up almost 90 % of the “unnatural” parts of the lower Chena River. The main reason for constructing riprap along a riverside is usually to stabilize and prevent erosion of the bank. However, downstream of a riprap construction it will become greater stream velocity and possibly

greater erosion (Coles-Ritchie 2009). In addition will other, like ecological, benefits be lost (Coles-Ritchie 2009). Some disturbance along riversides is inevitable, and in many cases desirable or required. But when considering interventions in the riparian zone one should carefully weigh the pros and cons to determine what the most sustainable solution is.

There are some possible sources of error when conducting a survey like this. First, defining a border between water and land along a river is not straightforward when working on an aerial image. For example, overhanging vegetation can make it difficult to see the bank underneath, and different water levels complicate the decision of a border of the river. Even though the main source, the aerial image, is of a relatively recent date, some of the additional sources are of older dates and may have contributed to wrong classifications. Some wrong classifications of vegetation types may have occurred because of difficulty to decide when looking at images from above. Generally, there is a certain degree of discretion involved when doing classifications in this way. However, the overall main results are not likely to be heavily affected by this.

Of course, a survey of riparian conditions can be done more thorough, which can be considered before future studies of the Chena River. For example, more aspects of riparian condition can be added, and remote sensing can be supplemented with field surveys for more accurate classifications.

Hopefully, this study can be a helpful contribution in the sustainable management of the Chena River Watershed.

## **Acknowledgements**

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