Summary

In recent years ecological systems are affected by various natural and anthropogenic disturbances. These disturbances not only affect resource availability, physical and chemical environments, but they also disrupt ecosystem and community structure (Connell 1978, Resh *et al*. 1988). The impacts of human disturbances on stream ecosystems (e.g., organic enrichment, eutrophication, heavy metals, pesticides and petroleum pollution) have become more and more ubiquitous. These disturbances play an importance role in the shaping of fresh water ecosystems (Petersen *et al*. 1987). Municipal and industrial wastes, which are important pollutants of urbanized rivers and lakes, results in organic enrichment and metal pollution (Mason 1996). In addition, an increase in nutrient concentrations are a serious and well known consequence of a greater human presence within a watershed because municipal wastes and fertilizers are also significant nutrient sources from urban storm-runoff (Mason 1996). Urban runoff and industrial effluents may contain organic and inorganic substances potentially toxic to aquatic biota, whose identification is a difficult task that involves expensive and complex analytical techniques. At the present time there are approximately 70 000 chemicals in use or being distributed throughout the environment, and an additional 500-1000 are added each year. Although not all these chemicals are toxic, merely keeping up-to-date information on the possible toxicity of so many compounds is a prodigious task (Postel 1987). A further problem is the interaction that may occur once potentially toxic substances are mixed, which may result in highly toxic effluents. The complexity of ecosystems makes it difficult to estimate the explicit effects of given physicochemical factors on the structural and functional attributes. It is becoming more important for the development of methods which can analyze patterns of biotic communities and assessing the relative importance of multiple environmental variables on species assemblages.

The introduction of urban runoff pollutants such as nutrients and organic matter into the aquatic system of Sheldon Lake a year after restoration has set off a complicated series of biological and chemical reactions. These changes were brought about acceleration of the phytoplankton community during the summer of 2004 causing cultural eutrophication. Cyanobacterial species which are frequently associated with eutrophic systems dominated from June to September although the lake where artificially mixed. The artificial mixing alone were insufficient to cause a transition to a well-mixed system but at the end of summer, high-wind and storm events change the lake from a incomplete to a complete mixed water-body. A year after the bottom sediment removal for restoration purposes and to increase water detention, there are notably low abundance of macrophytes at all the sampling sites and submerged vegetation had failed to colonize the main basin. This phenomenon had led to consumer resistance among smaller organisms for e.g., *Bosmina* sp. that used the cyanobacterial surface bloom as refuge from grazing by planktivorous fish because of the lack of submerged vegetation. Furthermore the juvenile blue gill sunfish (*Lepomis macrochirus*) had changed their habitat choice to the littoral zone in response to presence of big mouth bass (*Micropterus salmoides*) and the lack of submerged vegetation in the pelagic zone. The highest density of invertebrates where observed in the soft sediment at an inlet of one of the urban runoff pipes. These species where the chironomid larvae of the genus *Chironomus* and Oligochaete worms which is also associated with organic pollution lotic systems and reflect the dominant functional feeding group collector-gatherers. During the summer cyanobacterial surface blooms were sampled and, microcystin molecular markers were used for the detection of toxic cyanobacterial strains in environmental samples. The *Microcystis* spp. strains from Sheldon Lake were analyzed by polymerase chain reaction with oligonucleotide primers that derived form the *mcy* gene cluster that is involve in microcystin synthesis. The presence of the *mcy* gene cluster in the analyzed strains indicates that the strains have the genetic potential to produce microcystin. The toxicity of the strains was also confirm with a protein phosphatase inhibition and ELISA assays. This data is of economic and public health value since it is be able to detect early stage blooms of toxic cyanobacteria, and *Microcystis* in particular, especially if it is on a sufficiently timely basis for municipalities and recreation facilities to implement a response plan for example in the case of Sheldon Lake. We also used Amplified fragment length polymorphism markers, which is based on the selective amplification of genomic restriction fragments by PCR, to bring into genetic "context" the collected strains from Colorado to other strains used in the study. We further differentiate between a *Microcystis aeruginosa* strain of Sheldon Lake, United States and geographical unrelated strains from South Africa, Europe and Asia. The study clearly demonstrates the superior discriminative power of AFLP towards the differentiation of geographical unrelated *Microcystis aeruginosa* strains that belong to the same species.

In the case of the Cache la Poudre River the presence of certain species and their relative abundance were used as well as biomarkers to measure the degree of coal tar contamination. Because of the numerous routes of exposure we found that, almost any species may be affected by coal tar. The dominance by a single phytoplankton taxon that was significantly higher at the contaminated sampling sites, than in the case of the reference areas were most probably due to environmental stress of coal tar residue on the other species. The Australia River Assessment system method which is based on the presence and absence of aquatic macroinvertebrates, compares to the number of animals found at a minimally degraded reference site, was used in the survey study. We observed that sampling sites 2, 4, 5 and 7 were severely degraded with none of the expected macro-invertebrate families found, which show a good parallelism with the results of the battery bioassay and also indicated the areas of highly contaminated sediment. Although we did not attempt in this study to measure toxic residue concentrations of the coal tar, we found that the biotest battery is useful, sensitive and inexpensive tool to detect toxicants in the environment.

To conclude, it is clear from the study that anthropogenic activities impacted negatively on both studied aquatic ecosystems, resulting in severe deterioration of the water quality in the Cache la Poudre River, and in the case of Sheldon Lake eutrophication and the associated bloom formation of toxic cyanobaterial spp., and thus, management strategies have to be developed to alleviate the severity of impact. To address the raised issue, several recommendations to improve management strategies for both water systems are made. In the case of the urban Sheldon Lake, it is suggested that a wetland system should be constructed to "filter" the inflow water from urban runoff and the Cache la Poudre River before it enters the lake. This will improve the quality of the inflow water to the lake, since the ability of wetlands to remove nutrients from urban runoff and sewage effluents is well documented (Wood 1994). Typically shallow wetlands allow for ready trapping of particles by the sediments and nutrient uptake by the aquatic vegetation and sediment microbes. However, two major drawbacks of routing flow through a constructed wetland is *firstly, the increased water loss due to evapotranspiration. It is estimated that as much a third of the effluent flow would be lost. Secondly, a constructed wetland may raise summer water temperature above those of the inflowing Cache la Poudre River, known as thermal mediation, affecting the intrusion dynamics in the receiving lake (Andradóttir & Nepf 2000). In the case of the Cache la Poudre River, the environmental laws should be greatly enforced, since the deterioration in the river ecosystem is mainly due to pollution and waste disposal. In the US about 95% of industrial and other hazardous waste is usually deposited of on site where it is generated (Postel 1987), making the Cache la Poudre a potential target for these practices, as was shown in my case study. It is further recommended that the battery of bioassays that was developed in the study be utilized to monitor the "health" in both the river and proposed constructed wetland ecosystems on a regular basis.*

References

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