Ottawa's ponds as an open-air laboratory for research into urban ecology

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Summary

This project investigated the biodiversity of urban water bodies used for storm water management in Ottawa, Canada. Preliminary findings suggest that some of these managed water bodies contain similar levels of biodiversity to unmanaged, "natural" water bodies, although there are a number of highly degraded managed sites with very low biodiversity. The presence of fish in 10 out of 20 managed ponds suggests relatively healthy ecosystems. Analysis of mosquito monitoring data suggests that the presence of managed water bodies does not affect the number of mosquitoes in an area. In conclusion, urban ponds can contribute ecosystem services including storm water management and biodiversity without increases in insect disease vectors.

Why study urban ponds?

Perceptions of urban environments are often coloured by the preconceptions of the observer. The general public might see an urban park as luscious green space – an oasis of nature in an otherwise barren, built-up environment – but ecologists tend to see a "world of wounds" where once was a natural landscape. Over the past few decades, there has been an increasing realisation that urban ecosystems house a considerable wealth of biodiversity, bringing flora and fauna to the doorsteps of local residents. Sometimes these ecosystems are the by-product of certain types of construction for practical ends, and urban drainage facilities are a prime example of this. These relatively small ponds, lakes, and creeks are used to retain flood water and control its movement across largely impermeable urban areas. However, the creation of these lakes or the cooption of natural lakes creates a potential habitat for all kinds of species that would not otherwise be able to inhabit the area. The problem is that along with the positive aspects of biodiversity and their function in water management, there are also a range of negative aspects: drowning hazards, mosquito

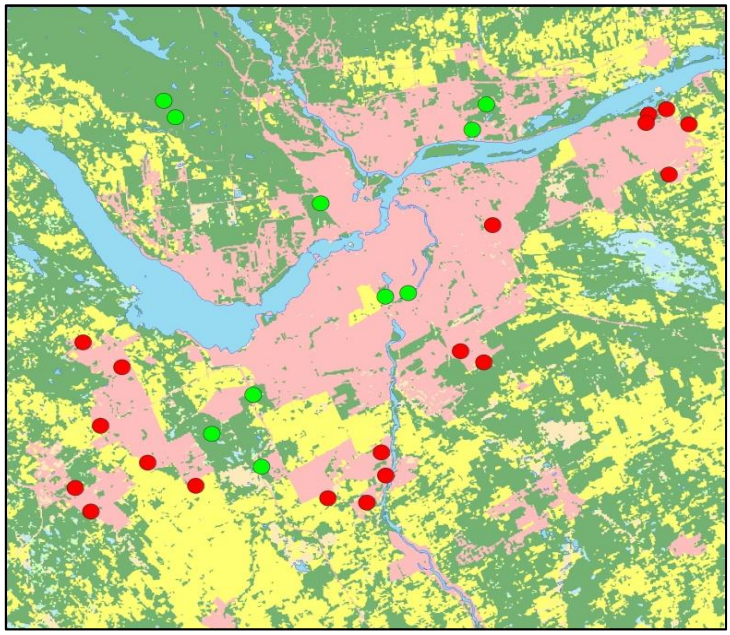

Figure 1 – Land use map showing the locations of 20 storm water facilities (red points) and 10 comparison sites (green points) in Ottawa suburbs – urban areas are pink, agricultural areas are yellow, and natural areas are green.

populations, and low aesthetic quality.

The Hugh Cary Gilson Award permitted me to critically evaluate some of the pros and cons of these urban wetlands from a biological perspective while generating (i) working relationships with the City of Ottawa, and (ii) baseline data for the use of this system of water bodies in teaching and research at Ottawa's universities. This involved the biological and chemical characterisation of 20 of the city's storm water management facilities (SWMFs) alongside 10 water bodies that were not managed for urban drainage (Figure 1). Although I originally planned to investigate damselfly populations (specifically variations in the levels of parasitism between different water bodies), I was made aware of extensive mosquito sampling performed by the City of Ottawa between 2006 and 2010. Due to the importance of these mosquito populations to human epidemiology, I shifted the focus of the research project onto this group. In particular, I was interested in populations of vectors of West Nile Virus (WNV, mostly *Culex pipiens* in Ottawa) to investigate a potential role for urban wetlands in driving mosquito population dynamics.

How "natural" are storm water ponds?

Sampling of the benthic macroinvertebrate communities at the 30 focal ponds was carried out in the spring of 2011, around two weeks after ice melt. The 10 comparison lakes comprised three water bodies within Gatineau Park (a protected area), two water bodies within the Green Belt surrounding Ottawa (an area that is also protected from development but that contains agricultural land), two water bodies in low density residential areas, one pond in a high density residential area, one water body in a public park, and one water body in an urban nature reserve. These comparison water bodies provide a range of aquatic habitats along the urban-rural continuum against which the SWMFs were evaluated.

Figure 2 - Comparison of Saratoga (left) and Clark Bellinger (right) SWMFs. Inset left: vehicle oil in the car park that drains into the Saratoga SWMF. Inset right: fish caught during sampling at Clarke Bellinger SWMF.

Preliminary results suggest that there are surprisingly similar levels of diversity at most of the SWMFs and the comparison sites, although some of the SMWFs are heavily degraded. The variation in levels of degradation was evident in the water chemistry data, which showed high levels of metals, salts and nutrients in the SMWFs compared to the comparison sites. By way of example, the photographs above show two SMWFs that differed dramatically in their biological communities. Saratoga SMWF (Figure 2 left and left inset) is a completely artificial basin that drains from a nearby apartment complex. Much of that drainage passes through a car park (left, inset) that clearly vehicle-related pollution to the water body. There were no signs of life within this pond. However, this contrasts with the Clarke Bellinger SMWF where large numbers of small fish were caught incidentally during macroinvertebrate surveys (Figure 2 right and right inset). Indeed, fish were found in 10 of the 20 SWMFs that were surveyed. This finding has implications for the management of the sites, as the Canadian Fisheries Act grants strong legislative protection to any habitats containing fish.

Do storm water ponds contribute to mosquito populations?

The City of Ottawa employs consultants to monitor for West Nile Virus in local mosquito populations. This involves standardised trapping of adults at around 61 locations (variable between years) around the city between the Centre for Disease Control (CDC) weeks 23 and 40. Additional larval mosquito surveys occur at hundreds of water bodies around the city throughout the summer. Any potential WNV vectors are then assayed for the virus using PCR. Residents in North America frequently associate water bodies with mosquitoes and there is no doubt that the presence of water bodies in urban environments generally increases mosquito populations. I constructed statistical models to analyse these time series data in more detail, looking at both the variation within seasons and the variation between years.

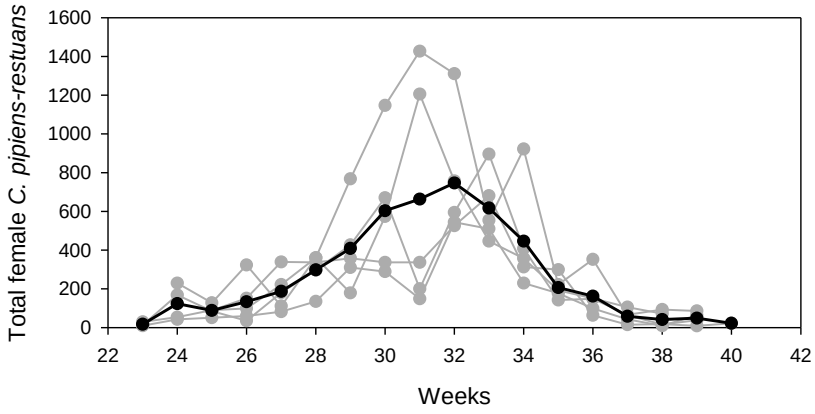

Figure 3 - Seasonal variation in the West Nile Virus vector *Culex pipiens-restuans* between 2006 and 2010. Individual years are shown in grey and the five-year average is shown in black.

Statistical models taking into account variation between years suggested that those traps which were located close to storm water facilities or in built-up areas did not catch more mosquitoes than other traps. Indeed, the principal drivers of mosquito populations seem to be based around meteorological variables rather than land use.

Next steps

In addition to the final completion of the projects listed above, there are two more steps that I have planned to round-off the wider project. The first of these is a study of the perceptions that are held by local residents concerning the SWMFs that are located close to their homes. The work carried out so far has demonstrated that there is not an enhanced problem of mosquitoes from the SWMFs, and it is clear that they provide a service in terms of local hydrology. However, the wellbeing of residents is partly dependent upon the aesthetics of the environment as well as its functionality. I plan to conduct a survey of local residents and compare their perceptions of the SWMFs with the biological and chemical survey results taken in 2011. If residents rate diverse habitats more favourably then that will provide a strong argument for the management of SMWFs for biodiversity to enhance this ecosystem service. The second step is to provide course instructors in the Carleton University and University of Ottawa Biology Departments with a write up of the baseline data collected during this project. It is my hope that monitoring at these water bodies will continue as part of undergraduate and graduate courses and that the resulting dataset will be of interest and of use to both my academic and municipal collaborators.