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MANAGING THE ONONDAGA LAKE WATERSHED IN NEW YORK, USA, THROUGH SCIENCE-BASED POLICY: A CASE STUDY

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Abstract

It is becoming increasingly important to manage natural resources to sustain a healthy ecosystem and healthy ecosystem services that supports socio-economic sustainability. Onondaga Lake was transformed from a pristine water body to a resort lake with commercial fishing, to a dumping ground for industrial wastes within a short period of less than 100 years during the Industrial Revolution in the 19th Century. The dominant paradigm at that time was that it was 'smart' to develop industrial processes, exploiting the natural resources to generate wealth. Today it is clear that industry, government, and the citizenry need to communicate amongst each other and learn to compromise on how natural resources are managed and used. It is also clear that best management practices should be carefully considered based on sound scientific data and analysis, and a political mandate with popular support is also necessary. Proper and politically mandated funding will provide the foundation for scientific understanding of ecosystem structure and function as well as develop proper facilities for processing urban wastewater and remediating the industrial legacy from the past. Using science to drive natural resource management policy has not been perfect in the Onondaga Lake case, due to the difficulty in having various stakeholders agree on policy. However, scientifically gathered data are used to guide monitoring, restoring and managing the Lake's natural system. This success is in large part due to the partnership of local, state and federal governments and the key initiative of Atlantic States Legal Foundation in alerting authorities to the pollution problem and using the U.S. federal legal mechanism to provide the legal foundation that allowed the political mandate for an Onondaga Lake management program.

Keywords: Rehabilitation, Legal Process, Policy Drivers, Politics, Science

1 INTRODUCTION

Bottom-up and top-down cooperation and coordination are necessary along the two-way flow of information between stakeholders and the federal government for successful management planning of ecosystems. In many cases, the single most important issue that can make or break a management plan is communication along this continuum of stakeholders/citizens - who are in direct contact with the ecosystem- with the government that is tasked with the responsibility, mandate and budget to bring a management plan to the point of implementation. The needs are many, which lie along a continuum from aesthetics to earned livelihoods.

Responsible government in a democratic system understands that it serves its citizens. From the government perspective, service includes ecosystem management that is associated with public health, economic development/security and social stability. It is from this perspective that the United States government crafted and implemented the Clean Water Act (CWA) that was signed into law in 1972[b] with further strengthening amendments passed in 1977.[c] It is under the CWA that government regulates

[a] Atlantic States Legal Foundation (ASLF) is an environmental NGO, founded in 1982, providing citizens and others access to affordable technical and legal assistance as well as help in organizing campaigns to protect environmental resources. Its initial work was mostly working on water resource issues and enforcing U.S. law against polluters. Over time the organization branched into other litigation and involvement with other issues in the U.S., Central and South America, China, and Eastern Europe –especially around the Black Sea. More detail about ASLF can be found at www.aslf.org.

[b] Although well beyond the scope of this paper, the history of the development and evolution of the Clean Water Act is in itself an interesting story. This legislation was very much designed and written from an ecosystem perspective and was developed in great measure by a PhD aquatic ecologist funded by public subscription to assist the committee of Congress taking the lead on this matter.

[c] After passage in 1972 everyone realized that things were much more complex than envisioned due to both the science and the management realities. We are still learning that even with the best of intentions such a complex law as this still does not meet all the nuances of the developing scientific knowledge base. Reality is much more complicated than any law can fully express.

discharges of pollution into the environment by setting standards based on science that should protect citizens and ecosystems from detrimental discharge of toxic materials (EPA, 2014). It also contains a mechanism to enforce compliance upon violators of the regulations. Further, and most significantly, there is also a provision that allows citizens themselves to enforce major provisions of this law through actions taken in Federal Courts[d] (Roberts & Dobbins). It has been through legal mechanisms that compliance has been maintained when and where violations have been identified. However, there is an increasing recognition that it is in the interest of the general public to maintain safe and healthy ecosystems as a foundation to robust long-term economic development. As research and awareness of environmental issues and human-ecosystem interactions become more clearly defined, the need for environmental compliance becomes critical for the well being of communities, and this is true for Onondaga Lake. Successful management of the lake system requires communication and compromise among stakeholders that include all users of ecosystems goods and services. It is the role of government to ensure equitable utilization of ecosystems goods and services among the stakeholders. All need to share the responsibility equally for successful management of the system to occur.

The Onondaga Lake region has seen industrialization since the Nineteenth Century. In the past, industries used waterways as a means for reducing processing and operational costs in order to increase profit. Onondaga Lake was transformed from a pristine water body to a resort lake with commercial fishing to a dumping ground for industrial wastes[e] within a short period of less than 100 years (DEC, 2014). Industrial activity around Onondaga Lake led to rapid degradation of the lake: ice harvesting was banned in 1901, swimming was banned in 1940 and fishing was banned in 1972. Since the lake cleanup started in the late 1980s to address all industrial and municipal pollution, Onondaga Lake has been a relative success story in taking a lake that was one of the most polluted[f] in North America and turning it around into a relatively healthy ecosystem [c].

2 DESCRIPTION OF ONONDAGA LAKE

Onondaga Lake is located within Central New York State, to the north and west of the City of Syracuse, which borders it to the south. The lake is to the south of Lake Ontario and east of the New York Finger Lakes region (Figure 1) (DEC, 2014). These lakes are remnants of the Great Lake Iroquois, created as the glaciers receded following the last Ice Age approximately 11,000 years ago (Kane et al., 2011). The morphometric characteristics of Onondaga Lake give the lake a large surface area to volume ratio (a factor of 90: Table 1)(NYSDEC, 2012) whereas Cayuga Lake with the largest surface area to volume ratio of the major Finger Lakes has a factor of only 18; much smaller than Onondaga Lake (NYSDEC, 2001). Nevertheless, Onondaga Lake is dimictic, i.e., mixes twice a year during spring and autumn, similar to the Finger Lakes[g](CECEOC, 2013). Nearby Oneida Lake[h], on the other hand, is polymictic, i.e., mixing occurs multiple times a year since it is very shallow with a surface area to volume ratio of 148 (Hetherington, 2013).

The major tributaries that flow into Onondaga Lake include Nine Mile and Onondaga Creeks that constitute up to 70% of the annual discharge volume into the lake. Other than these two major tributaries, approximately 20% of the total annual discharge into the lake comes from the Syracuse Metropolitan Wastewater Treatment Plant (METRO) that is operated and managed by Onondaga County[i]. The source of pollution to Onondaga Lake includes this massive quantity of wastewater being discharged into the lake as well as from chemical and other heavy industry that used the lake for their operational purposes [j].

[d] Section 505 of the Clean Water Act allows citizens a major role in taking action when government cannot for political reasons or will not go after polluters.

[e] The lake contains wastes from many industrial sources including General Electric (now Lockheed-Martin), General Motors, Crucible Steel, and Allied Chemical (now Honeywell), although most of the attention and remediation is being undertaken by Honeywell.

[f] This paper primarily concerns itself with issues of domestic sewage and stormwater run-off and does not detail the industrial contamination issues to any great extent. Readers interested in those issues can read various web sites such as www.Onondagalake.org and references found by searching "Onondaga Lake Superfund Site."

[g] Onondaga Lake is actually part of the Finger Lakes and the lake together with its major natural inlet, Onondaga Creek are in a valley that never filled with water except for this small lake.

[h] Oneida Lake is outside the Finger Lakes proper but due to its orientation is often called the "thumb" of the Finger Lakes.

[i] At certain times of the year when there is otherwise low flow from the tributaries, the METRO discharge can be more than 40% of the inflow.

[j] Most of these discharges are now from the legacy of the past and as stated previously will not be further discussed here.

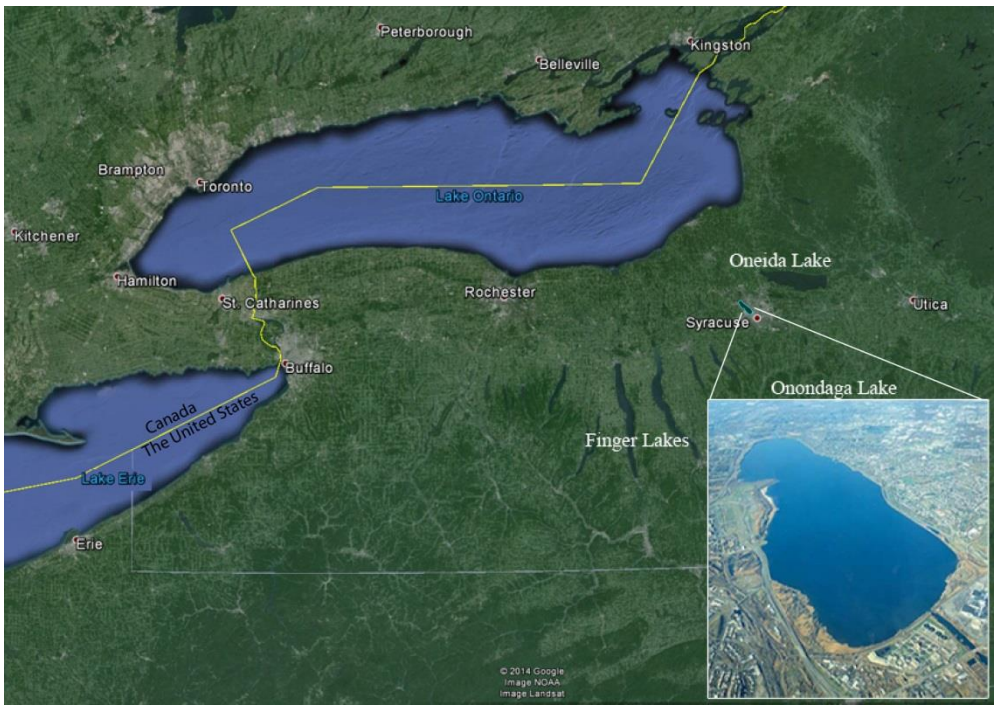

Figure 1 Map of the Lower Great Lakes and Inset Showing Onondaga Lake.
Courtesy: This map was created based on an aerial image from Google Earth

Table 2 Onondaga Lake Characteristics

Onondaga Lake Characteristics	
Latitude	43° 05' N
Longitude	76° 12' W
Lake Length	7.4 km
Lake Width	1.6 km
Lake Area	12 km^2
Lake Average Depth	10.7 m
Lake Maximum Depth	20 m
Lake Volume	132.5 Million m^3
Watershed Area	738 km^2

3 THE ACJ AND ONONDAGA LAKE

Atlantic States Legal Foundation (ASLF) filed the notice of Intent To Sue in 1988 against Onondaga County due to pollution discharge violations to limits set by the Clean Water Act and New York State regulations. The lawsuit was filed in Federal District Court and was joined by New York State. The lawsuit led to a consent judgment that was agreed upon by all parties involved in 1989. The original court order from 1989 had to be modified numerous times with an entirely new order now called an Amended Consent Judgment (ACJ), which was created in 1997 to enforce municipal wastewater treatment improvements and bring Onondaga County METRO operations into compliance by the end of 2012 (Onondaga County, 1997). The ACJ was renegotiated several times, and in its current form under the Fourth Stipulation of the ACJ, was authorized in 2009. This Fourth Stipulation finally allowed NYSDEC to issue a revised State Pollutant Discharge Elimination System (SPDES) permit to Onondaga County (Onondaga County, 2009)[k].

[k] SPDES is the name New York gives to the permits it is authorized to issue under delegation from the US EPA for the essential allowance for a facility to discharge surface water into "waters of the United States." These permits form the centerpiece of pollution control under the Clean Water Act.

Under the Fourth Stipulation to the ACJ, Onondaga County has agreed to bring its wastewater treatment and discharge into full compliance by 2018 with three main categories of actions[l]. These categories include: tertiary wastewater treatment systems, grey and green infrastructure collection systems, and lake and tributary ecosystem monitoring programs. The evolution of the ACJ and its implementation is a progression responding to results from related scientific studies on the lake ecosystem and natural processes, in which the instrumental regulatory requirements, administrative level decrees and effective communication contribute to the responsiveness of the process.

3.1 Tertiary Wastewater Treatment Systems

Ammonia and phosphorus levels in Onondaga Lake are two major water quality measures concerning the lake improvement programs. The Metro used to account for over 80% of the Lake's annual ammonia loadings (Pirro & Randy, 2006). Monitoring of the Metro effluent and lake tributary nitrogen load, as well as study on the dynamic Nitrogen cycling in Onondaga Lake led to Phase 1 and Phase 2 Total Maximum Daily Load (TMDL) for nitrogen, which became part of the ACJ and required Metro tertiary upgrades to add an advanced tertiary, biologically aerated filter (BAF) system for ammonia removal. The construction of this advanced treatment system was completed and came on-line in 2004, which has resulted in reduced ammonia discharges to the lake by approximately 90% and has had a significant impact on the nitrogen cycling in the lake. Since 2007, the lake's waters have met NYS water quality standards for ammonia developed for protection of aquatic life.

The Metro phosphorus TMDL reduction is being accomplished through construction and operation of the tertiary high rate flocculated settling (HRFS), which was designed to meet the effluent limit of 0.12mg/L of phosphorus in the Metro SPDES permit. However, based on data gathered since 1998 -- when the original TMDL was approved – scientific analyses and prediction by sophisticated water quality models, the new SPDES lowered the limit to 0.1mg/L, in order to achieve a 0.02mg/L phosphorus concentration in Onondaga Lake [f]. This limit is considered to be protective of contact recreation use and the fish community of the water body, both of which have become tangible goals as the Onondaga Lake cleanup progresses. Onondaga County is undertaking a Metro Phosphorus Optimization Project to further lower phosphorus in Metro discharges (CRA Infrastructure & Engineering, Inc., 2011). DEC has updated the phosphorus TMDL for Onondaga Lake and specified new best management strategies to better account for the variety of point and nonpoint sources of phosphorus in the Lake's 738 km^2 watershed (DEC, 2014).

3.2 Grey and Green Infrastructure[m] Collection System

While the METRO system was upgraded and capacity increased, it still cannot handle the volume of waste water during certain wet weather conditions because the City of Syracuse still has a century-old combined sewer system, where the stormwater and sewage come into the same pipes. During heavy rain or snow melting, the large volume of stormwater runoff combined with raw sewage may overload the METRO system, resulting in Combined Sewer Overflows (CSOs) discharged directly into Onondaga Lake tributaries causing deterioration of the water quality. There once were 72 CSO points along three tributaries of Onondaga Lake; 44 have been closed since the lake improvement project started, and 28 are still active. One of the major tasks for Onondaga County is to reduce the volume of CSOs into the Lake by applying both grey and green infrastructure technologies.

The grey infrastructure refers to traditional engineering solutions to improve the pipe network and increase its capacity, which in this case includes three major strategies: (1)construct Regional Treatment Facilities (RTF) to increase the system processing capacity; (2)separate the storm sewers from the sewage pipes; and (3)construct CSO storage facilities that can collect and hold large volumes of CSO output during heavy precipitation loads and gradually release the volume to METRO during dry weather when the system capacity allows. One RTF, a few sewer separation projects, and 2 large storage facilities with a total storage volume of 11.4 million gallons have been constructed (EPA, 2011).

The green infrastructure, unlike grey infrastructure dealing with concrete and gigantic pipes, incorporates both natural and engineered systems, using vegetation, soil and natural processes to design stormwater management practices that mimic nature to soak up, store and/or slowly release the collected

[l] Copies of the various consent orders and their modifications can be found on ASLF's and Onondaga County's websites.
[m] Onondaga County has a designated website, http://savetherain.us/, as a portal to all its grey and green projects and related documents.

runoff into soil or into the air through evapotranspiration[n]. Examples include rain gardens, bio-swales, green roofs, urban forestry, porous pavement and a combination of these technologies. Studies have indicated that green infrastructure practices can not only manage stormwater runoff in an effective, more cost efficient manner compared to grey infrastructure over time, but also provide many other social, economic and environmental benefits (NRDC, 2011).

Green infrastructure is a more decentralized approach that often produces numerous small-scaled projects that are more versatile and can easily be integrated with other urban improvement practices accomplishing multiple planning goals. Onondaga County, working with the City of Syracuse and the public directly, has built over 100 green infrastructure projects in many different forms in the last 3 years, and they capture over 100 million gallons of stormwater runoff every year (OCDEP). Its important functions in mitigating various urban stresses including water and air pollution, habitat scarcity, urban heat island effect and high energy consumption, etc. have brought green infrastructure under the focus of scientific research, application study and policy making when the entire global society seeks to build resilience to climate change.

The adoption of green infrastructure in the lake improvement programs in Onondaga County was initiated by community advocates including ASLF and its application became possible when the new County administration opened the door to this new alternative and coordinated the negotiation among ACJ parties and other stakeholders (NRDC, 2012). The implementation received assistance and support from the City of Syracuse and numerous community partners. While green infrastructure in Syracuse is more of a "faith-based program", which needs community support, buy-in and voluntary participation, proper updates to the related city regulations and building codes are essential to their application.

3.3 Lake and Tributary Ecosystem Monitoring Programs:

Proper coordination and cooperation among stakeholders and government, along with sufficient funding[o] and political motivation can provide the foundation to enhance environmental health. Onondaga Lake, as one of the most polluted water bodies in the world, has long become the research subject of various scientific disciplines. Many institutions in this area have dedicated decades of work to Onondaga Lake, concerning its limnological, chemical, ecological, and biological nature (Onondaga County, Save The Rain). Such scientific studies have produced a great amount of data and invaluable information, which provide a scientific base for today's restoration efforts. As part of the settlement of the lawsuit with Atlantic States Legal Foundation and New York State, Onondaga County is required to do monitoring of the chemistry and biology of the lake and publish its findings annually[p].

The initial monitoring plan was developed with major input from staff scientists at Atlantic States Legal Foundation and with input from the County's own Onondaga Lake Technical Advisory Committee as well as by the state and federal government agencies under whose jurisdiction this would fall. The resulting work, called the Ambient Monitoring Program (AMP) has been revised to meet the data gathering needs and the evolving recovery of the lake (*Onondaga County Department of Water Environment Protection* (OCDWEP)). Most importantly, the scientific data and analysis from AMP have been the feedbacks of the natural system to the lake improvement operations, resulting revisions and refinements to the clean-up and restoration process. Many local institutions continue their involvement in the lake study as partners of Onondaga County, implementing the AMP.

The AMP is widely looked upon as a model for what is needed to assess progress in such a process. Onondaga Lake is now in the process of recovery; monitoring of environmental conditions has revealed signs of recovery from pollution discharge into the lake. Data collected for the lake is among the most extensive collection for any freshwater body in the world. This large valuable research and data collection should not end here, given that global climate change is causing changes in ecosystem structure and function that can be identified and managed. However, this requires cooperation and communication at a larger level, i.e., among governments and communities that traditionally do not communicate among themselves. These challenges must be met in order to ensure continuation and sustainability of the global biosphere for future generations.

[n] Many resources including the United States Environmental Protection Agency's website (http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm) provide information about green infrastructure.

[o] The County's financial ability is not a relevant issue in their compliance with the court order. The County is responsible and must find the money from general revenues, grants and loans from state and federal programs, or through increased user fees.

[p] All of these reports, including the unanalyzed data can be found on the Save the Rain website previously referenced.

4 DISCUSSION

The effort to overcome more than a century of abuse of Onondaga Lake from domestic wastewater has been a long time effort with many ups and downs in the process. None of this would have happened without a major push from members of the public and various stakeholder groups during that period of time. There was public awareness of the issues early on and in fact the first group formally concerned with lake issues was formed in 1907 (Onondaga Lake Management Conference, 1993). Before there was focused attention on pollution issues, there was, albeit limited, public interest in the lake. Major movement, however, was not really possible until the post 1972 passage of the Clean Water Act by Congress and the resulting policies and processes that thus came into play.

Atlantic States Legal Foundation took the lead with its 1988 lawsuit only after the relevant government agencies refused to take action.[q] Since 1988 many other actors have come on stage and pushed for clean-up. These have included a federally mandated Council set up to coordinate efforts of various government agencies, scientifically orientated programs of local academics, local interest groups including sportsmen and outdoor recreationists, and the Onondaga Nation.[r] Gradually, over many years, the public has embraced Onondaga Lake as an asset for everyone and not just a lost cause industrial waste receptacle. As the public's attitudes have changed, the political leadership has evolved their ideas as well and now most everyone embraces the idea that clean-up funds are well spent.

However, as pollution from human wastes and industrial legacies are gradually eliminated and as the water quality of the lake improves, there still remain questions about what the future holds for the lake. By now the lake is largely a man-made body of water as wetlands have been filled, lake levels changed, and thus the lake bears little resemblance to the water body first seen by Europeans several centuries ago. For example one of these changes is that although there are now more than sixty species of fish that are found in the lake, most of them are not native– some not native to North America (Honeywell, 2009). Fishing, especially angler tournaments, is becoming more and more popular and impacts the financial well-being of the community; this is a far cry from when a century ago New York City restaurants could boast about Onondaga Lake fish on their dinner menus.

Part of the issue stems from the means used to get us to this stage of the clean-up. All work done on the lake has been the result of implementation of powerful federal laws. An alternative approach where scientists and the public would have come together with an implementable vision for the Onondaga Lake of the future has never taken place. Legal actions with the resulting carrots and sticks have put together clean-up plans and have furthermore guaranteed that funding would appear to carry them out. Without this mechanism a great clean-up plan could have been promulgated, but the prospects for its implementation would have been very weak. As a result, we will have a lake with good water quality, with much public use, with lots of biota, but we will not have *restoration* in any sense. Natural systems will not be restored except by chance and the fishery will remain forever degraded.[s]

[q] Atlantic States Legal Foundation spent many fruitless years trying to get New York State to enforce the law, but only with their refusal to act, did the Foundation proceed with its action.

[r] The Onondaga Nation is one of the nations that make up the Haudenosaunee Confederacy. They are located in the Onondaga Lake Basin and the lake itself is strongly embedded in their spiritual make-up.

[s] Perhaps a bit of restoration might be possible if Honeywell under its Superfund obligations is forced to spend money on it. A provision of this law requires compensation for "natural resource damages" and that exercise is now being undertaken. Although the intent of that law seems clear, there are numerous ways that a payment for other lake related matters could be made and no restoration carried out.

CONCLUSION

After many decades of studies, political altercations, legal actions, and huge expenditures of funds, Onondaga Lake is once again mostly remediated and once again an asset to the greater Syracuse, New York community. After many more years of extensive monitoring and analysis combined with other cultural and economic considerations, history will perhaps tell us if the efforts on this lake were appropriate and worthwhile. At this point, the lessons are unclear. Certainly, the price paid for destroying this resource has been high in terms of what was needed to reverse the degradation. This price is most likely beyond the means of most communities around the world. Questions must be asked if there is a better and cheaper way to accomplish these goals as the planet cannot allow more and more of its area to be written off as contaminated waste zones.

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