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Urban Sustainability: Policy and Praxis

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The "Geotechnologies and the Environment" series is intended to provide specialists in the geotechnologies and academics who utilize these technologies, with an opportunity to share novel approaches, present interesting (sometimes counterintuitive) case studies, and most importantly to situate GIS, remote sensing, GPS, the internet, new technologies, and methodological advances in a real world context. In doing so, the books in the series will be inherently applied and reflect the rich variety of research performed by geographers and allied professionals.

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Chapter 1
Urban Sustainability: Perspectives on Change

Jay D. Gatrell and Mark W. Patterson

1.1 About This Book

Sustainability resides at the nexus of philosophy, practice, politics, and technology. As such, the policies, behaviors, and discussions associated with "sustainability" are often contested. Despite the potential for conflict, nearly all stakeholders at all scales recognize that sustainability and sustainable practices necessarily extend from and/or interact across three domains: Social Systems, Ecological Systems, and Economic Systems. The systems, most often referred to as the three pillars (Environment, Economic, and Social), are sometimes complementary; but often are juxtaposed in a functionally perpendicular fashion. As a result, theory and practice are often side-ways and often result in partial or imperfect results.

This book assembles a collection of papers that presents alternate approaches or views to understanding urban environments and sustainable initiatives across all three domains at the local and regional scale. In nearly all chapters, remote sensing technologies and techniques from GIScience are used to investigate, visualize, and understand social, economic, or environmental dynamics associated with sustainability on the ground and in place. While every effort has been made in this collection to broaden notions of sustainability, the book is not exhaustive—nor is it intended to be. Likewise, the book doesn't set out to chart a history of urban sustainability. Rather, the novel spatial applications, cases, and policy discussions are intended to provide the readers with new ways of thinking about sustainability on the ground and in place.

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1.2 Chapters

This collection is comprised of 15 substantive chapters organized (or at least conceptualized) in three parts. Part 1—Environmental Change and Urban Morphology focuses on more traditional geotechnical applications of the natural and built environments within the context of broader sustainability initiatives and/or the implications of urban land use change on the overall sustainability of cities. Part 2—Economic Change, Industry, and Sustainable Local Alternatives examines industrial adaptations, innovations, and practices associated with sustainability. In the process, the contributions include novel examples associated with non-traditional industries such as brewing, urban agriculture, and metal recycling. The papers will deploy descriptive statistics, mapping, and other visualization techniques. Part 3—Socio-Political Change and Adaptation draws on concepts from political ecology, new social movements, and even cultural geography to understand observed change on the ground—as well as the broader implication of urban environmental change on the every lives of urban and peri-urban residents.

In Part 1, five chapters provide a solid foundation for understanding and assessing urban environmental systems. The contributions examine urban water management issues (Chap. 2 Lawrence), the emergence of new inter-disciplinary approaches towards assessing and managing complex eco-systems (Chap. 2 Portman and Elhanan) and the several real world examples rapidly changing urban systems in multiple contexts using a variety of tools (Lulla and Jensen, Jensen and Hardin, and McLean et al.). In concert, these five chapters underscore the importance of assessing urban environmental change over time and across space (Table 1.1).

The six chapters in Part 2 focus more squarely on economic systems and the many ways in which cities, their residents, and industries have responded to the realities of globalization, increased competition, and historical market failures. The papers examine multiple facets of dynamic local food systems (Chaps. 7, 9, and 11), an investigation of a sustainable practices in urban craft breweries (Chap. 10), and even novel adaptations of residents to economic decline that promote sustainability (Chap. 8). While the topics of the chapters may appear to be disparate, each of the authors interrogates the empirical realities of economic responses to change and efforts to enhance the long term sustainability (or viability) of economic systems and/or strategies to redefine local economics that enhance urban ecologies. In the process, the contributions provide the reader with new ways to visualize (i.e., map) social networks, think about urban agriculture, and explore the real world implications of historically invisible industries like scrap metal recycling.

The final chapters in the book—Part 3—focus on the politics and decision making processes surrounding urban environmental change and sustainability. Lascell (Chap. 12) details the social and political movements and sustainability initiatives that have emerged in New Orleans since Hurricane Katrina devastated large portions of the city—notably the poorest and most vulnerable communities. In Chap. 13, Fuller examines the full range of environmental justice issues facing poor

Table 1.1 Summary of substantive chapters in this book

	Author(s)	Subject
2	Lawrence	Urban stream management
3	Portman and Elhanan	Ecosystem services assessment
4	Lulla and Jensen	Hyperspectral applications
5	Jensen and Hardin	Urban forests in arid environments
6	McLean et al.	Greenspace and sustainability in Las Vegas
7	Reid	Local food systems, sustainability, and networks
8	Chohaney et al.	Sustainable economic development and urban "Mining"
9	Hagelman et al.	Urban gardens and sustainable agriculture
10	Patterson et al.	Sustainability and breweries
11	Knigge et al.	Urban food hubs and sustainable local food
12	Lascell	Sustainability in Post-Katrina New Orleans
13	Fuller	Mapping environmental justice
14	Gallagher and Lawrence	Unmanned systems
15	Metcalf et al.	Greening as a social movement
16	Clay and Albers	Planning sustainable built environments

and working class neighborhoods as they struggle to enhance their personal environments, local economic conditions and the overall sustainability of neighborhoods. Chapter 14 presents the case for the use of unmanned systems to assess urban change and broader sustainability initiatives across space. In the final two chapters, the politics of greening (Metcalf) and decision making (Clay and Albers) are considered within the context of broader issues of sustainability across all three domains.

Chapter 2
Urban Stream Management Using Spatial Approaches for Stream Clean-Up Data

Patrick Lawrence

Abstract In recent decades many local communities, supported by state, federal and/or international programs, have engaged in efforts to remove human debris from urban stream systems. Typically these clean-up events have involved volunteers who collect garbage and other waste from stream banks or from the water. The aims of these programs are to improve overall stream conditions – especially aesthetics – and remove harmful materials from stream environments including tires, plastics, metals and other potential items of concern such as paint cans, and rubber products. Although many of these efforts report basic data on items collected, with the reports and information often submitted to agencies or the focus of media reports, beyond basic types and numbers of information collected, the data and report do not typically contain any geospatial aspects such as locations, areas cleaned, collection of specific items tied to locations, or addressing possible sources for the debris. Since 1997, local groups within the Maumee Area of Concern in northwest Ohio, USA have been organizing an annual stream cleanup event in their communities that has evolved to over 1000 participants working at more than 60 sites covering 4 streams. This chapter examines the results for the Ten mile Creek/Ottawa River clean-up sites using detailed site specific data from 1995 to 2006 that includes items collected and recorded on data forms and then compiled by location and types of items and examined in reference to spatial aspects of management actions including considering potential sources and addressing local land use and human activities contributing the specific items collected at locations along the stream. Results include identifying the top ten items collected and examples of locations where items can be tied to adjacent land uses for purposes of identifying actions to address continued and persistent sources of debris and needed responses. The recommendations and proposals based on this study are intended to inform decision-makers not only at the local scale but to influence how stream clean-up data can be utilized and to improve reporting of this information. And with the aim of encouraging the collection of geospatial and location aspects as a means of furthering utilization of urban stream clean-up data to support and assist management actions to address aesthetic aspects of urban stream environmental improvements and rehabilitation efforts.

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Keywords Urban • Water • Debris

2.1 Introduction

Among the many challenges facing urban streams is the growing issue of debris (or garbage) from various human activities and sources that end up in the waterway, along the banks, and within the riparian zone (which defines the edge of stream ecosystem). Common examples of this debris are paper and plastic products such as food containers and wrappers, construction materials, cigarette items, glass items, personal care products, household materials, clothing, and many other items discarded from residential, commercial or industrial sites typically found in urban settings (American Rivers n.d.). These items cause concern for their impact on visual or aesthetic appearances and as potential sources of water contaminants as they degrade in the natural environment (Allison et al. 1998; Burres 2009; Stickel et al. 2013). For example, the byproducts from the slow, but eventual, decay of rubber, plastic and other synthetic materials can be introduced into the stream aquatic environment. In recent decades concerted efforts have been undertaken in many urban communities to remove stream debris through directed local clean-up events organized by concerned groups and organizations (Riley 1998). These efforts mirror similar programs that focus on coastal and ocean debris.

In 2013, the Ocean Conservancy reported that the International Coastal Cleanup effort held worldwide resulted in 648,015 volunteers in 92 countries removing more than 12.3 million pounds of trash. The International Coastal Cleanup started in 1987 and has expanded to cover almost 13,000 miles of coastal and river/streams in more than over 80 countries worldwide (Ocean Conservancy 2014). In terms of cleanup of debris specifically from urban rivers and streams, several major programs have developed in many areas, including in the United States within California, Illinois, Wisconsin, Michigan, Ohio, Maryland, Pennsylvania, and New York State (Wang 2005; Missouri River Relief n.d.; Susquehanna River Basin Commission 1996). Internationally, examples include Australia, New Zealand, Israeli, Malaysia, and the United Kingdom.

Riley (1998) provides a comprehensive review and discussion of the challenges facing urban streams and rivers and provides science and community based solutions, that includes the need to remove unwanted debris.

> A *major portion of stream problems can be corrected by removing garbage*, *junk*, *and dumped waste from stream channels. Debris can deflect stream flows*, *causing significant bank erosion…may pollute the water… definitely destroys the aesthetic values of urban waterways*; *and it can back up flows*, *causing flooding*
>
> *Neighborhood stream cleanup projects are likely the most cost-effective flood damage reduction and water quality control projects a local organization can invest in* (*p. 328*).

Addressing debris from human activities has been the focus of numerous programs and policies within urban communities. The California Coastal Commission (n.d.) has produced a management plan to assist local municipalities in addressing trash and debris from storm water and urban runoff before it ends up in ditches and streams. Their recommendations include installing catch basin screens, netting, separators, litter or trash booms, and using anti-littering enforcement and education, along with organized community volunteer cleanups. The California Water Boards (2007) completed extensive assessment of trash found in streams within the San Francisco Bay region to identify potential sources and recommend management and regulatory solutions. The U.S EPA (2011) produced an informational flyer highlighting the issues and challenges with trash found in urban and coastal communities and how streams and rivers can be a significant source of garbage that can be harmful to aquatic ecosystems and the associated economic impacts from the subsequently polluted and degraded waterways. The Maryland Department of Environment (2010) completed an extensive study of daily loads of trash into the Anacostia River, pointing out the need for addressing sources.

For international examples, Golik and Gertner (1992) counted litter removed from six beaches located in Israel noting a density of 36 pieces per 5 m transect and that 70 % of the litter consisted of plastic with wood, metal, glass, and other materials making up the remainder. Their results suggested that proximity to a population center resulted in an increase to the amount of beach litter and that the presence of waves and storm events resulted in re-accumulation of litter on beaches frequently throughout the year. They also noted that unlike other coastal areas where ocean shipping and dumping were sources, within their study it was apparent that the recreational users of the beach were the main contributors as the litter consisted of items resulting from their activities (items included food and beverage materials, cosmetics, plastic bags, toys and garments).

It is important to note that in reference to this study, the focus on urban stream cleanup programs is on the sources and types of urban stream debris or garbage that is the result of human activities, and not the removal of woody debris or other natural materials that can also accumulate in urban streams. There is considerable debate and disagreement as to the need and the potential harmful impacts from the intentional removal of woody debris (such as tree falls) from stream and river systems. Although some programs and efforts are in place to remove such materials from streams due to their potential for backing up water flow resulting in upstream flooding or diverting stream flow energy into an adjacent stream bank creating potential for increased erosion, the practice of removing woody and other forms of natural debris from urban streams remains controversial. The New York State of Environmental Conservation (n.d.) has provided guidelines for the removal of woody debris and trash from rivers and streams where the debris could impact water flows by blocking bridge and culvert openings, diverting streams and causing bank erosion. They recommend that large woody debris (trees) found in the stream should be removed when it presents a risk to infrastructure, bridges or homes. Lassettre and Kondolf (2012) promote whether possible the conservation of woody debris in urban streams channels in order to maintain their important and well documented benefits as forms of natural habitat, sources of organic matter, and potential food sources. Readers interested in more details and discussion focusing on the specific issue of removal of woody debris from urban streams are referred to Larson et al.

(2001) or NSW Department of Primary Industries (2007), and research focused on the role of woody debris, for example Marcus et al. (2002).

Another view is taken by Nemeth and Keirsey (1999) who argue that organizing debris removal along stream channels, including woody debris, can serve little purpose if the streams remain stressed and devoid of life due to other human impacts; so why undertake the effort. The aim to make urban streams more "scenic" could be impacting the aquatic health of such natural systems. Nemeth and Keirsey (1999) extend their comments further to suggest that even the removal of human debris, such as wooden pallets, shopping carts, and tires could be seen as a means of creating aesthetic benefits that masks more serious environmental concerns associated with contaminated urban streams and related significant water quality concerns all too often present in these environments.

However, for the purposes of this study, the focus will be on how organized efforts to remove debris from human sources are undertaken by community organizations along urban streams. Of specific interest are whether data on items removed are collected and intended to be utilized to address source areas to implement voluntary or regulatory means to eliminate the sources so as to stop continued and persistent locations of stream debris? If such efforts are intended, what measures and methods are used to collect and organize the data and are any spatially based approaches used to identify stream sites where debris is found and collected, along with noting proximal source locations for this debris to determine appropriate follow-up management actions.

2.2 Stream Clean-Up Programs

The Ocean Conservancy prepares annual reports on International Coastal Cleanup (ICC) efforts worldwide, but does not provide an indication of the total number of clean-up programs or sites or distinguish between coastal and rivers/streams. However, the data do provide some insight as to the number of cleanup events and types of debris collected. During the 2013 ICC event, 648,015 volunteers covered 12,914 miles of shoreline and rivers/streams, removing 12.3 million tons of debris (Ocean Conservancy 2014). The most common items collected were: cigarettes, food wrappers, plastic bottles and caps, straws, plastic bags, glass bottles, and beverage cans. The 2014 report also includes case studies and highlights from several locations and examples of efforts undertaken to reduce the amount of debris found at some sites. Beyond summary data by country (and by state within the U.S), there is no spatial context to the reporting of collections or responses to address sources.

Information on specific individual stream cleanup activities also appears to be limited, with most materials consisting of promotional items intended to inform and recruit volunteers and instructions/guidelines for conducting a cleanup event. The Western Michigan Environmental Action Council (n.d.) provides detailed instructions on how to undertake a stream cleanup, focusing on organizing volunteers, insurance and safety issues, gaining permission to access properties, materials and supplies, and planning the event. Water Action Volunteers (2001) provides a simple ten step guide to conducting a stream and river cleanup, including list of materials and promotion of the event as well as the results and outcomes. In June 2011 the Friends of the Los Angeles River and Friends of the Chicago River (2011) produced a media release highlighting their friendly challenge to gather the most volunteers for their respective cleanup events. Since 1992 Friends of the Chicago River have collected thousands of pounds of garbage at 65 sites, while starting in 1989 the Friends of the Los Angeles River volunteers worked 15 sites, averaging 15 tons each year.

These types of summaries for urban stream cleanup activities appear to be the most the common form of reporting, with little information on specific sites or identification of sources areas that could be targeted for follow-up actions. In some cases urban stream cleanups are often undertaken in the context of larger regional watershed efforts as shown by such work undertaken within the Susquehanna River in Pennsylvania, where a local river basin compact was signed that dictated any dumping or littering upon the waters of the river or its tributaries was prohibited and was to be enforced by law enforcement officials (Susquehanna River Basin Commission 1996). There is very little evidence, reporting or documentation that urban stream cleanup efforts include methods or procedures – beyond counting number of volunteers, number of sites, miles cleaned, bags filled or weight of debris collected – to accurately document site specific results in terms of what is collected, where it is collected, and the identification of potential sources for the debris.

The focus of this study was to conduct a review of site level data from a multiple year period of cleanup activities within the Tenmile/Ottawa River watershed on the Maumee Area of Concern, located in northwestern Ohio, US. An annual stream cleanup event has been undertaken there since 1997, with detailed site information collected on types and total numbers of items collected by teams of volunteers. To date beyond summary reports by watershed, no detailed examination and analysis has been completed of the data from this cleanup activity. In addition, by working at the scale of the collection site it will be possible to examine the spatial context for items collected and consider proximal locations as sources for the debris collected. Such a study will provide opportunities to discuss and recommend how spatial aspects of urban stream cleanup activities should be examined and the benefits provided by such approaches in terms of future planning of subsequent cleanup events and addressing potential continued dumping or other site specific issues associated with the persistence of debris located at cleanup locations.

2.3 Maumee Area of Concern Clean Your Streams Event

Partners for Clean Streams (PCS) is the regional non-profit watershed organization in Northwest Ohio. PCS aims to strive for abundant open space and a high quality natural environment; adequate floodwater storage capacities and flourishing wildlife. Through various programs and activities, PCS encourages stakeholders to take local ownership of their aquatic resources, striving for local rivers, streams and lakes that are clean, clear and safe. This mission is achieved through many habitat restoration projects, public education, and volunteer opportunities and partnering with local businesses and organizations.

PCS is the umbrella organization for the Maumee Remedial Action Plan Committee in the Maumee Area of Concern (AOC), which is located in northwestern Ohio, US (Fig. 2.1). The Maumee AOC, which is the largest Great Lakes Area of Concern in the state of Ohio, has a complex list of water quality issues – referred to as Beneficial Use Impairments (BUIs) – which PCS works with the Ohio Environmental Protection Agency, other federal and state agencies, local municipalities, community partners, and volunteers EPA to address (Lawrence 2011). Efforts to address BUIs within the Maumee AOC have been undertaken since 1987 through various local organizations and partnerships with numerous local and regional partners and agencies, including associated programs within the State of Ohio intended to address Lake Erie (Ohio Lake Erie Commission 2013). For more information on the work of PCS in the Maumee AOC, readers are referred to: www.partnersforcleanstreams.org.

The Degradation of Aesthetics (BUI #11) has been addressed by various stream cleanup programs in the community, including a major event – *Clean Your Streams* (CYS) held each fall since 1997. CYS targets all types of trash in five major waterways including many tributaries and ditches, all within the Greater Toledo Metropolitan Area of the Maumee AOC. More than 70 volunteer groups pre-register and hundreds more volunteers "walk in" the morning of *Clean Your Streams* held each September. This includes youth groups, small businesses and large corpora-

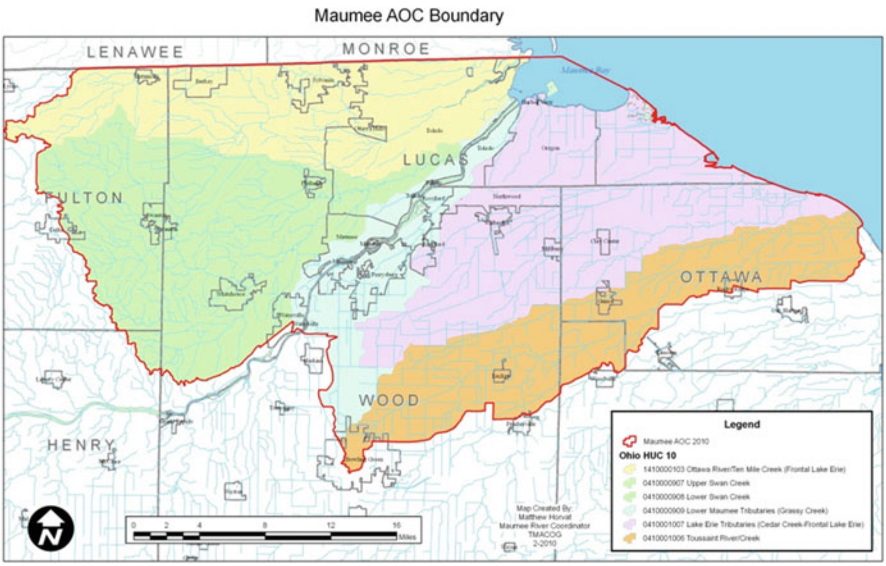

Fig. 2.1 Maumee Area of Concern, NW Ohio

tions, school groups, professional clubs, church groups, Scouts, YMCA programs, urban youth at risk groups, and various adult organizations.

For the *Clean Your Streams* program, trash is collected by different organizations, depending on location. The City of Toledo, OH and Lucas County maintenance crews donate the pick-up and deposition of collected refuse in the Hoffman Road Landfill. In and near the City of Oregon, OH, a private hauler, Waste Management, donates the hauling of the trash and disposes it at Evergreen Waste Management Landfill. Starting in 2013, all tires collected in our river cleanups were picked up by Bridgestone/Firestone contractors who worked directly with a local distributor to take the tires to a recycling facility in accordance to their "One Team, One Planet" program. More information on the annual CYS event planning and results can be found at: www.partnersforcleanstreams.org.

The *Clean Your Streams* event facilitates volunteers to remove all types of trash from local streams. In the past 17 years, thousands of volunteers have removed over 100 tons of trash from over 30 miles of ditches, streams and rivers around the Toledo, OH region. During the 2014 CYS event, 57 different streamside sites were cleaned and 16,366 lb of litter with 903 bags of trash were removed and disposed of properly. All of this litter had been disposed of improperly or illegally and through our volunteer efforts was collected and disposed of properly. Close to 1000 volunteers met for a brief introduction and safety training at 8 centralized kickoff locations and then spread out to designated sites and cleaned for about 2.5 h. After removing the often illegally dumped litter, these cleaner areas could have increased recreation use, improved water quality conditions, better aesthetics, biological productivity and reduction of waste related pollution (e.g. byproducts from breakdown of plastics). In addition to removing the trash, this program serves as an education tool to volunteers and passersby about litter. The amount of trash collected during CYS has increased from 15,315 to 18,882 lb in 2011 and 2012 respectively and 16,366 lb in 2013. In 2013, 903 bags of trash were collected, in addition to 96.5 tires and various types of "oversized" items too large for bags. These weights are estimated by our volunteers in the field and reviewed by the individual site coordinators and the event coordinator. The weights and number of bags and types of items collected are recorded on data sheets representing a team of volunteers.

Since 2013, the CYS program has significantly expanded in the number of volunteers and sites cleaned: from 726 volunteers and 40 sites to 1,175 volunteers and 60 sites being cleaned in 2011 and 2012 respectively. In 2013, there were 941 volunteers and almost 60 sites cleaned. There has been an increase of 22 % participation in the past 2 years, which is typical for the historically expanding numbers of the event. In terms of documentation, the individual data cards, which include information on the types and numbers of items collected by small working groups, are collected and annual summaries prepared for each of the five watershed to complete reporting on number of volunteers, sites worked, stream miles covered, total bags filled, and estimated weight of all bags and large items collected and removed. Each year these data are also compiled into an event report that covered the entire cleanup effort within the Maumee AOC and reported to the Lake Erie Commission office, which includes the information in the annual report for the Ohio Coastal

Weeks program (statewide stream, river and Lake Erie cleanup event in the State of Ohio 1 week each September) and the state information is submitted to the Ocean Conservancy as reporting for the International Coastal Cleanup.

2.4 Stream Clean-Up Data

Since 1987, the collection of stream cleanup data during CYS has consisted of the standard data collection form provided by the Ohio Lake Erie Commission. On this form volunteers can indicate the number of items collected by selecting from a comprehensive list of potential items covering the wide range of typical cleanup debris found during such events. They can also identify, list and count any additional items not listed as well as note any odd, peculiar or unique items. Once their cleanup is complete, the volunteers (in small teams of 3–5 people and working at assigned cleanup sites) tally their results by item and provide indication of the number of bags collected and total estimated weight of bags and any large items. These cards are then collected and the data summarized into watershed and overall reports for the entire Maumee AOC that was the focus of the cleanup effort. For example in 2014, hundreds of individually completed cards from the CYS event, were compiled to prepare a report highlighting the effort by 1,109 volunteers working at 61 sites within 4 watershed to collect over 16,000 lbs of items (same types of data also available for each of the watershed).

Historically, data on the types and numbers of items collected were not summarizes on the basis of individual sites within a watershed. During this study, each individual data card completed by volunteers within the Tenmile Creek/Ottawa River watershed during CYS over the 10 year period of the event from 1995 to 2006 was reviewed and information on the totals of individual items was assembled into a database inventory. The resulting data set included information collected for a total of 22 different collection sites (Fig. 2.2) used over the 10 year period at which over 88,000 individual items were collected and inventoried on the site data cards. A total of 20 different types of items were collected. Figure 2.3 illustrates a summary of top ten items collected, led by food wrappers and containers (18 % of total), plastic bags and wrappers (12 %), and metals cans at 12 %. Of note is that food or beverage related items, associated with fast food or grocery related products, accounted for four out of the top five items collected.

The next step in the analysis was to examine the 10 year trend in the data from the CYS event during the period 1995–2006 to see if there were any differences over time in reference to the relative amounts of different items collected. Figure 2.4 displays the trends for the top ten collected items from the Tenmile Creek/Ottawa River watershed 22 sites. Although there is considerable variability from year to year and over the 10 year record, a few general trends can be observed. The amount of food wrapper and containers (expressed as a % of the total) shows an increase from under 3 % prior to 2002, to becoming the most common item collected in 2006 at 31 % in 2006. Although not increasing as dramatically, there were also increases

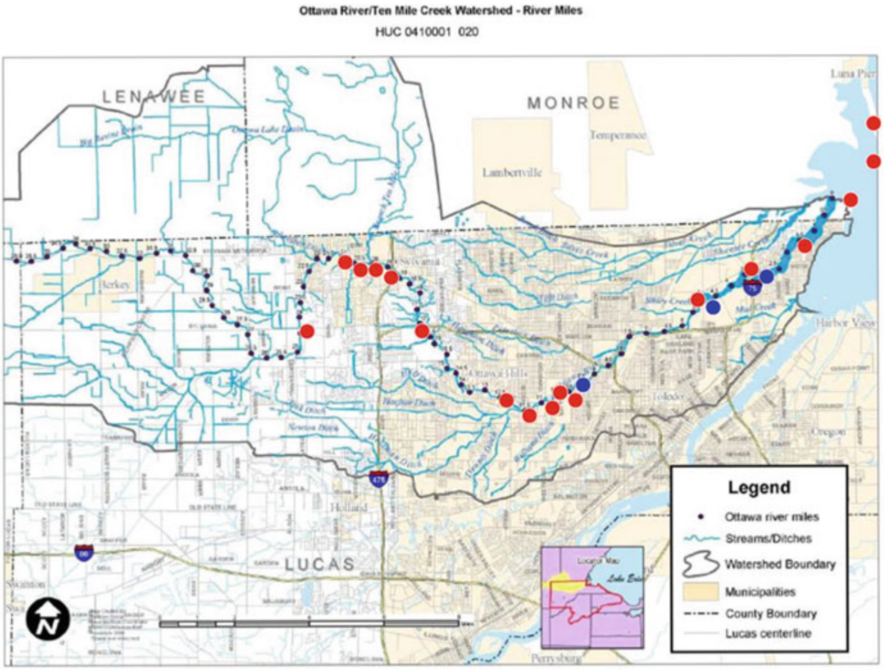

Fig. 2.2 Data collection sites from Tenmile Creek/Ottawa River

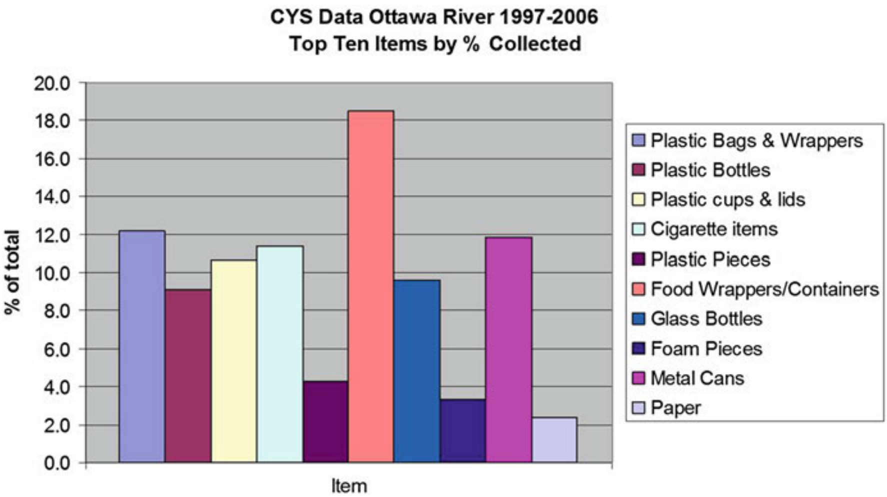

Fig. 2.3 Summary of items collected, 1997–2006

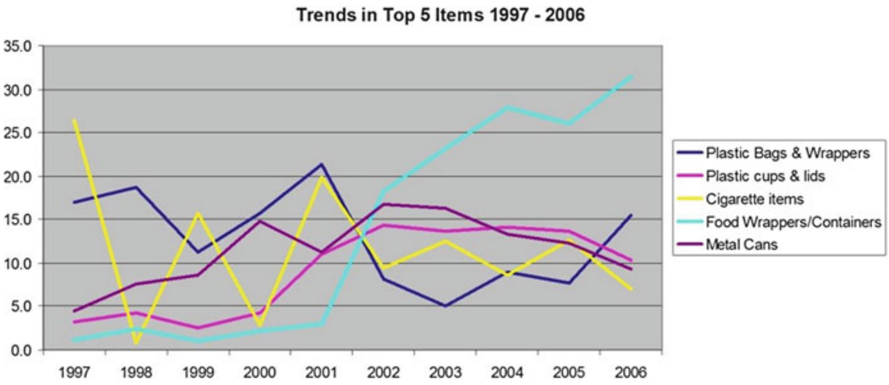

Fig. 2.4 Top 5 items collected, 1997–2006

in the number of plastic bags and cups over the decade period. However, caution should be expressed about attempting to draw to many specific inferences from this data set, since the collection of the information is based on the recording of items from a large number of differing volunteers, who although all are using the same type of data card, may not be consistent in terms of what is being collected and how it is recorded. But it is worth noting these general trends in considering future stream cleanup events within the CYS program and how the variations in items collected could inform event planning, targeted efforts at collection, and discussions regarding implementing debris sorting during CYS for separating recyclables. Such issues will be covered in more detail within the discussion section of this chapter.

Another level of basic analysis that was completed was at the site level, where for each of the 22 sites the collection data were compiled into annual calculations of total and % collected by item, and trends of the ten most common items collected. Since the sites extended from rural suburban to high density residential to mixed use with recreational (open space) lands to commercial/industrial land uses, there was interest in not only examining debris cleaned up at individual sites, but also whether differing local and proximal land uses may have an impact on items deposited (or dumped) and subsequently picked up by CYS volunteers. Decadal trends would also assist in the identification and assessment of problematic sites where items were collected year after year so as to consider various actions to stop reoccurrence of the presence of items at these sites.

In examining the collection of the most common items collected at each of the 22 sites a few interesting occurrences and general trends were observed and documented. For example, in the sites located near to roads or major street intersections more windblown and "floaters" were collected, such as paper products and plastic bags. As we move from the upstream sites and head down the river from mile 17 to mile 10 we can observe an increase in plastic bottles. In parkland and other public accessible areas, more cigarette butts are collected. Yet, food wrappers and containers (from fast food and grocery stores) remains consistently high in amounts at all

22 collection sites. Glass bottles and metal cans did not observe any spatial trends and remained in low accounts at all sites and over the entire decade collection period.

The final level of analysis involved an attempt to examine the dominant land use activities located along the stream collection sites and with the adjacent ½ mile proximity. The aim was to examine whether trends in the types and amounts of items collected at an individual stream site could be related to those human activities associated with land uses resulting in the deposit and subsequent wind or water movement of debris into the edge of stream or bank. In order to conduct this analysis a set of representative sites were examined, each of which had a distinctive set of adjacent land uses. The land uses were documented and characterized on the basis of examining recent aerial images for the sites. Sites selected included: mixed residential/commercial with parkland; floodplain area that included golf course and parkland with trails; the University of Toledo main campus; and an industrial/commercial land use site. Figure 2.5 represents the preliminary characterization of the mix of land uses located at the Ottawa Park floodplain site. The colored arrows represent conceptualization of potential major vectors for the transportation – via wind or water – from the source area (initial production or deposition) into the collection site at the stream edge. Orange represents movement off local park trails and other public access points around the park; yellow shows sources from an

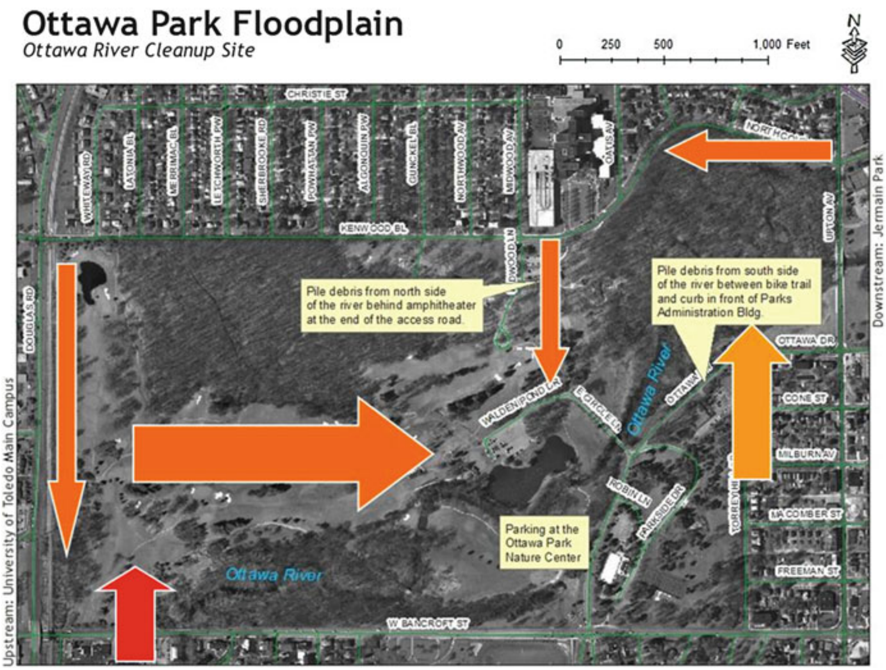

Fig. 2.5 Vectors of potential debris movement from adjacent lands into the Ottawa Park CYS site

adjacent residential neighborhood that would include homes, apartment buildings, parking lots, sidewalks, driveways and streets; while red portrays stream flow and floodplain deposition from the river into the golf course and parklands. By this means we can start to examine the collection of items from the stream cleanup activities in the context of sources and associated land use and human activities.

Also in preparing for the 2014 CYS event, the first attempt at assembling over 20 years of data on collection sites, including locations and organizing the individual site maps that had been prepared to assist volunteers in finding their assigned cleanup sites and providing them detailed information on parking, access, and where to pile their final bags with items collected for follow-up garbage hauling, was undertaken. Since the aim was to produce a consistent set of site maps (see example; Fig. 2.6) that could be readily accessible to a wide range of volunteers, rather than develop map and spatial materials by use of GIS, the decision was to prepare aerial images and resulting map products by use of Google Earth. Since 2008 over 60 individual site maps have been produced for use by event organizers and volunteers, including regular revisions and updates and adding new sites as requested by the CYS planning team members and individual kickoff coordinators responsible for site selection and allocation of volunteers across each of the five watersheds covered by the event each September.

In order to assist future CYS event planning, and to document the range and area covered by the cleanup efforts across numerous local municipalities within the five

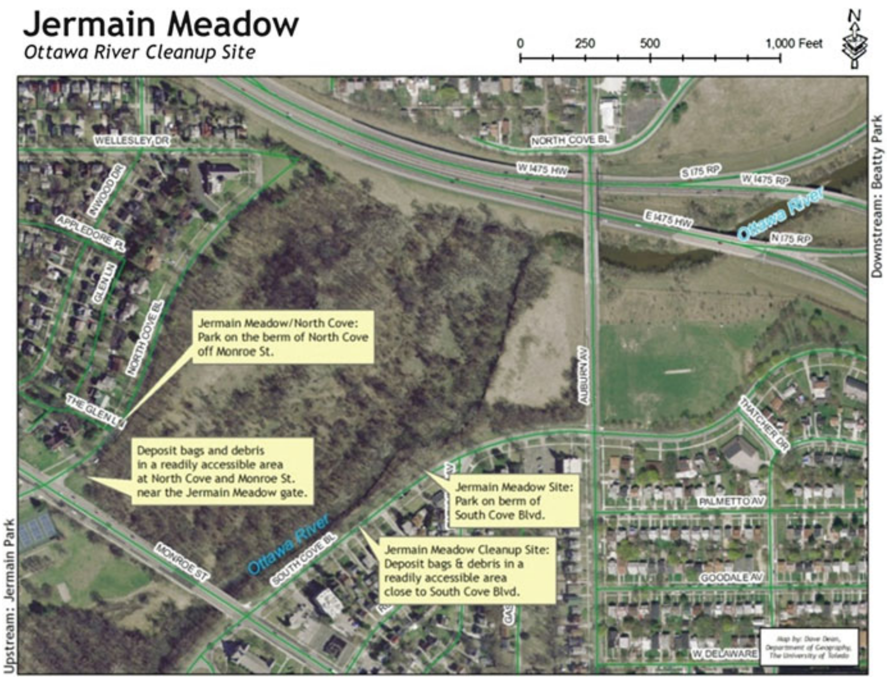

Fig. 2.6 Example of a CYS site map

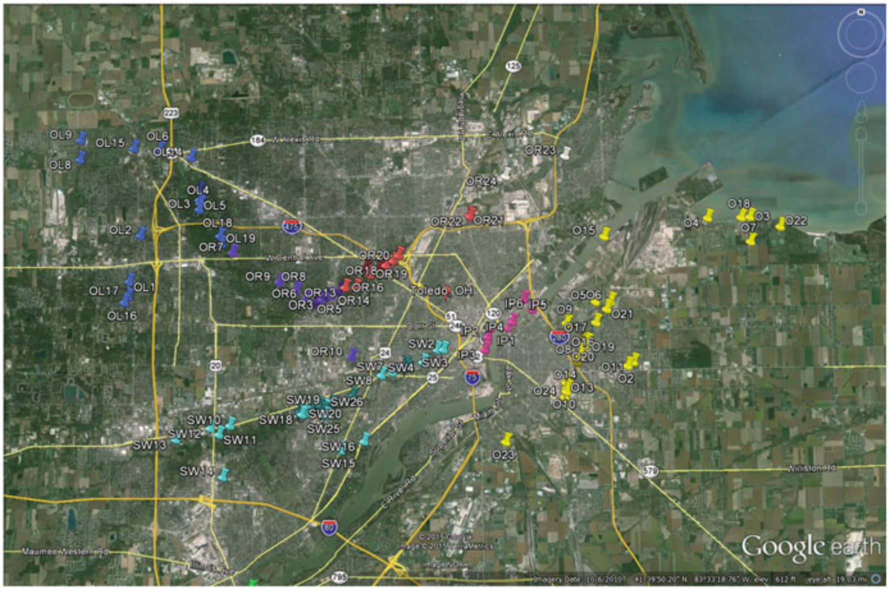

Fig. 2.7 CYS site listing map for Maumee Area of Concern

watersheds, for the first time a master CYS site map was also prepared listing by watershed every individual cleanup site used since 2000. Figure 2.7 shows the final product of this effort with over 100 sites map and color coded to each watershed, which provides a helpful understanding and illustration of the collective efforts undertaken by CYS volunteers to address stream cleanup needs within our local communities. An accompanying database was also developed that lists every site and its important characteristics and conditions, including GPS point, access, parking, stream miles to be cleaned, and where to leave debris collected for subsequent garbage pickup by municipal hauling services.

2.5 Discussion

As stream cleanup events continue to expand and increase in number both in the United States and worldwide – as an expression of the need to address restoration of urban streams and provide community based volunteer programs related to environmental concerns and issues – the ability and opportunity to move simply beyond the education value and "picking up garbage" should be expanded. Suggestions include using spatial data as means to address substantive improvements to reduce the amount of urban stream debris. As the example with the Clean Your Streams event in the Maumee Area of Concern in NW Ohio has illustrated, assembling data on locations and items collected can have additional value, especially in regards to identifying potential sources of debris from local and adjacent land uses and human activities, to noting targeted areas for continued cleanup efforts, to enacting policy and educational programs and efforts to reduce waste and collection along urban streams with communities of the Toledo OH region. Basic spatial approaches, including production of data based on location, annual and geographic trends, production of mapping of collection and site conditions, can all improve the actual stream clean up events, but also advance local and community discussions and efforts surrounding solutions and raising awareness of illicit dumping, problematic repeat offenders in terms of locations and nearby human activities that continue to generate debris, and improving public awareness around the importance of urban streams and efforts to address water quality, habitat, aesthetics and other aspects of their overall environmental conditions.

After over 20 years of the CYS program, and in the detailed examination and analysis of 10 years' worth of site level cleanup data from the Tenmile Creek/Ottawa watershed within the Maumee AOC covered under CYS, clearly great value has been – and can continue to be – recognized by considering the temporal and spatial aspects of the distribution of debris. For example, what is being cleaned up and where, and starting to consider beyond the actual cleanup, what progress be made on addressing some of the fundamental issues related to the production and location of debris located and removed from urban streams with the local communities. Specific efforts and action items that have been undertaken as a result of CYS and reviewing results include targeted efforts to collect and safely dispose of car tires, annually reassessing cleanup site locations to target new sites that need to be addressed, discussing long term problem sites and how to better address continued debris dumping with land owners and municipal officials, and especially focusing cleanup efforts in association with areas of urban streams that have also been the location for recent natural habitat restoration projects, so that in hand with the improvement to water quality and associated environmental benefits achieved at those sites from those projects, debris removal can also add to the environmental improvements. Examples within the Maumee AOC where CYS efforts have been linked to restoration efforts include the Ottawa River at the Boy Scouts of America Camp Miakonda and University of Toledo main campus, and on Swan Creek at Highland Park.

Similar efforts and program enhancements for stream cleanup events should also be pursued at other locations, especially where well established and organized activities are already in place and supported by volunteers and organizations to facilitate such events. Especially at those stream cleanup events where data on debris collected is already recorded, for example at events conducted as part of the International Coastal Cleanup program. These programs should consider more widely how the data can be used to examine spatial context as a means to better address stream debris issues and assist with broader education and decision-making that could begin to make progress in reducing urban stream debris. Spatial analysis methods and products, as simple as basic mapping, use of GPS, developing data and event support systems based on use of geographic information system (GIS) and event applying Google Earth and other publically available, user friendly, web based or open source mapping applications and spatial tools could be of great assistance to event planning, measureable outcomes of results, and drive solutions to address and ultimately reduce urban stream debris issues within communities.

2.6 Conclusions

With the increased interests and efforts in regards to the restoration or rehabilitation of the degraded natural systems and conditions of urban streams, the use of spatial concepts and tools has great appeal to advancing our understanding of these features and considering community based decision making and planning responses to address their improvements. Rarely are urban stream ecosystems uniform in terms of their environment conditions, human impacts or potential solutions in addressing water quality, sediment, habitat, landscape functions and features, flooding and drainage, and overall beautification. It would be great benefit for those involved at the community scale in working to understand and address these issues to consider or make wider use of spatial approach tools for informational, technological, planning means to determine science and social responses and solutions.

Although stream cleanup efforts are only one approach to resolve a specific urban stream issue- the persistent presence of debris in stream ecosystems due to human activities and land uses – the simple collection and removal of such items is often the only step taken. The richness and potential application and understanding of the data of locations and items collected could greatly enhance overall efforts to improve public awareness and education efforts concerning urban streams, and spatial understanding of the debris can lead to improving cleanup events and informing as to considering solutions to address the sources of such items in order to take a more broader view of addressing debris in the context of overall stream enhancements and restoration efforts.

Urban stream cleanup programs provide great community and environmental benefits and provide a venue to advance education and public awareness on the importance and value of these often stressed ecosystems. The increased number of such events, as evidenced by the information on cleanup activities by the Ocean Conservancy with annual reporting of the International Coastal Cleanup activities worldwide, is a very encouraging and positive sign as to the rise in appreciation of urban streams within our communities and the willingness of volunteers to assist in the organization and undertaking of this effort. In many cases, the collection of relevant and important data on the debris collected can result in better understanding of the types of items ending up in urban streams and target areas and sources to of these items. In this regard it would be encouraging to see that spatial aspects be more widely considered and the use of associated mapping and analysis tools – as presented in this chapter with the CYS program in NW Ohio, US – be more widely implemented for urban stream cleanup efforts and that by doing so enhance the overall aims to improve these ecosystems in our communities and advance better understanding and appreciation of urban sustainability movements and how critical addressing the contamination and degradation of streams is within the various approaches, efforts and opportunities to restore where possible natural environmental conditions in urban settings.

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