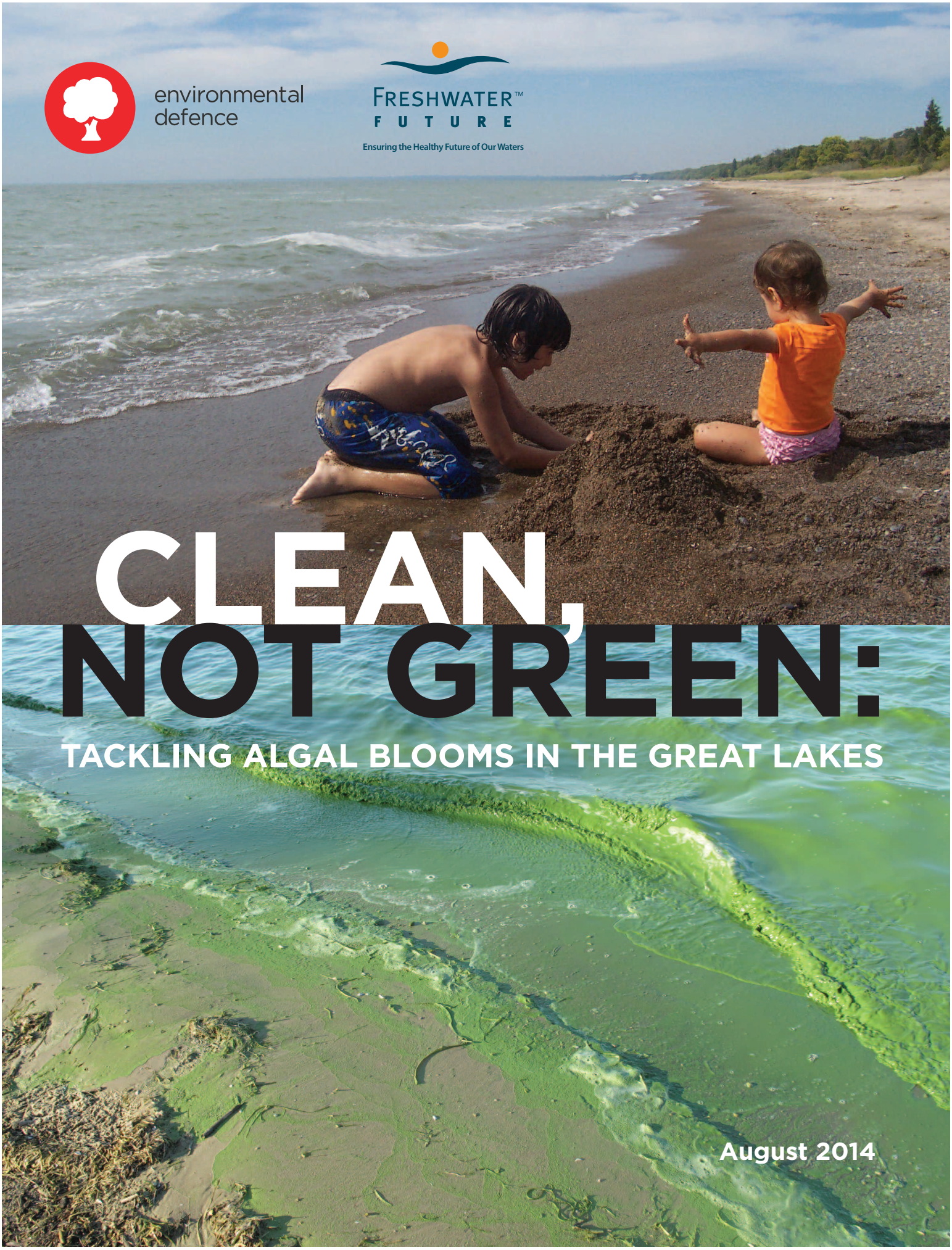

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Ensuring the Healthy Future of Our Waters

CLEAN, NOT GREEN:

TACKLING ALGAL BLOOMS IN THE GREAT LAKES

August 2014

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Tackling Algal Blooms in the Great Lakes

By Nancy Goucher, ENVIRONMENTAL DEFENCE and Tony Maas, FRESHWATER FUTURE CANADA

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Executive Summary

Background

In the 1970s, Lake Erie was suffocating from an onslaught of algal blooms and an overall decline in water quality and ecosystem health. In response, governments on both sides of the border, along with the Great Lakes community – including agriculture, businesses, communities, non-governmental organizations, and individuals – pulled together to bring life back to the lake. Lake Erie's restoration was one of the environmental movement's first and greatest victories.[1] But that victory appears to have been in the battle, not the war.

The Problem

Lake Erie is once again in a state of decline.[2] In fact, the worst algal bloom ever recorded occurred in 2011, covering an area almost the size of Prince Edward Island.[3] We thought this problem was solved years ago with the introduction of low-phosphate detergents and improved sewage treatment, but Lake Erie is not the same lake it was in the 1970s. Today, climate change and invasive species have changed the ecosystem, and recurring blooms suggest that current land-use practices are not sustainable in the Lake Erie watershed and more broadly across the Great Lakes basin.

Algal blooms happen when algae – microscopic, plant-like organisms that naturally live in the water – grow out of control. The resulting blooms can look like mats floating on the water, or like scum, foam or spilled paint on the water's surface. They can be brown, neon green, or blue-green, and can be smelly, slimy and even poisonous.[4]

Rapid algal growth happens when nutrient levels, light, pH, and temperature are just right. But phosphorus is by far the most important ingredient in their development.[5] In many of Ontario's lakes, including Lake Erie, the amount of phosphorus in the water controls how big and how bad a bloom becomes. So the key to controlling blooms is reducing the amount of excess phosphorus that reaches the lakes.

The phosphorus in Lake Erie comes from many different places, with the largest amount coming from agricultural lands.[6] Phosphorus helps plants grow. This is a good thing for farmer's fields, but too much of it is quite the opposite for the health of surrounding water bodies.

PHOTO: (Brenda Culler, ODNR Coastal Management)

Lake Erie is once again in a state of decline.[1] In fact, the worst algal bloom ever recorded occurred in 2011, covering an area almost the size of Prince Edward Island.[2]

The Harm

Large algal blooms can make water unsafe for people and their pets, fish and wildlife. Harmful algal blooms, made of a particular type of algae that release a variety of liver, skin, and neurological toxins, can make swimming unsafe. Large blooms also disrupt the way a whole lake ecosystem works. When algae die and sink to the lake bottom to decay, they rapidly deplete the supply of oxygen dissolved in the water, creating "dead zones," where fish and other aquatic life cannot survive. In extreme cases, this results in large numbers of dead fish washing onto shore.[7]

Blooms also have direct economic implications. Who wants to own property, spend vacation time, or play on beaches covered in slimy mats of algae? Blooms discourage people from enjoying the water which means fewer boaters, anglers, and beach goers – and less of the money they bring to shoreline communities. Maumee Bay State Park in Ohio lost an estimated $1.3 million US in 2011 because people didn't want to spend time on its algae-fouled beaches.[8]

Blooms cost municipalities and industry money when algae clog their water intake pipes, or when drinking water supplies need additional treatment to remove algae-related toxins.

Continuing on the current path is an expensive and risky proposition for both the environment and economy of the Great Lakes. But a different future is possible: a future of green farm fields producing globally and locally important foods; a future of green communities designed to work in harmony with the water cycle; and a future of beautiful, blue waters that support vibrant communities, economies and ecosystems.

The Opportunity

Saving Lake Erie will require changing our approach to land-use practices to reduce the amount of phosphorus reaching the lake, with a clear focus on helping farmers and the agricultural lands they care for. This report outlines a four-point plan to start Ontario and Canada down the path towards a healthy future for the Great Lakes.

1. Harness market forces to help farmers reduce nutrient runoff

- Support existing agricultural programs that have had success in reducing nutrient pollution, such as those that educate farmers about how to properly apply nutrients.
- Explore a broad suite of approaches that address the challenge of how to pay, and who pays, for practices to reduce nutrient pollution. Begin by evaluating the potential to use market mechanisms to reduce nutrient run-off. This would involve charging fees to the public or businesses for the pollution they create and using this money to support programs that prevent excess phosphorus from reaching the lakes. Such mechanisms could include tax-shifting, pollution taxes or nutrient trading (which creates a market to identify and fund the cheapest options for reducing nutrient pollution).

2. Build water smart cities, cultivate water smart citizens

- Design cities to better regulate stormwater and the nutrients it carries.
- Invest in green infrastructure, such as green roofs, wetlands, trees and vegetation, which can capture rainfall and improve the quality of stormwater runoff.
- Expand septic system maintenance and outreach programs that enable urban and rural residents to take action to prevent polluted water from running off their property.
- Develop an infrastructure funding plan, with support from all levels of government, to upgrade antiquated sewer systems that are subject to bypasses or overflows during heavy rainfall or snowmelt.

3. Improve scientific understanding of why blooms happen and their implications

- Conduct year-round monitoring in all watersheds to get a handle on the relative contribution of nutrients to the Great Lakes from Canadian rivers, and improve understanding of when most of the nutrient loading is occurring.
- Support scientific studies to better understand how lake dynamics affect algal blooms, which solutions work best in which locations, and how blooms are impacting human health and local economies.
- Support programs that bridge science, policy, and practice. This requires investing in data management, ensuring public accessibility to data, and the tracking of progress.

PHOTO: *A NASA satellite image captures algal blooms in the Great Lakes. Acquired August 3, 2014*

4. Create a policy framework that drives action

- Under the binational Great Lakes Water Quality Agreement, Canada has committed to setting phosphorus loading targets for Lake Erie and developing action plans to meet those targets. The first step towards meeting this commitment is for the governments of Canada and Ontario to finalize the Canada-Ontario Agreement and for Ontario to pass the proposed Great Lakes Protection Act.
- The government of Ontario should develop a comprehensive policy to protect wetlands which help to filter nutrients out of water.

The slimy truth: the problem of algal blooms in the Great Lakes

The Lorax was originally published in 1971. It tells the story of the plight of the environment – of what happens when forests are cut too fast and too much pollution builds up in the air and water. Back then, Lake Erie was at the centre of a burgeoning environmental movement across Canada and the United States, in part because of the algal blooms that plagued its waters. Governments, scientists, municipalities, and a host of community and environmental organizations on both sides of the border came together to find the source of the problem, and to do something about it by changing policies and practices. The benefits of these changes rippled across the Great Lakes in what was a heyday of coordinated action to protect the world's largest freshwater ecosystem.[9]

And these actions paid off – the health of Lake Erie rebounded, for several decades. Sadly, the problem is back and the algal blooms are worse than ever. Almost annually, blooms are blanketing large swaths of Lake Erie and showing up in areas across the Great Lakes, including the Bay of Quinte and Hamilton Harbour.[10] What is happening in Lake Erie should be seen as a warning that our current land-use practices are not sustainable, and that continuing with a "business as usual" approach will likely increase the intensity and frequency of blooms across the Great Lakes and Ontario.

The Great Lakes – together with the St. Lawrence River – hold nearly 20 per cent of the world's surface fresh water.[11] They are vital to the health of the nearly 40 million people – and the countless birds, animals, and fish – that live around, on and in them. They sustain lives and support livelihoods in two countries, eight states, two provinces and countless communities, supplying water for agriculture, industry, big cities and small towns. The Lakes support valuable commercial fisheries and a thriving tourism industry built on beautiful beaches, boating and angling, local food culture, and vibrant shoreline communities.

Protecting the Great Lakes is an ecological and economic imperative; allowing them to transform into seas of algae is simply not an option. As a shared resource, both Canada and the U.S. have a responsibility to protect the Great Lakes from algal blooms and other threats. This report, however, focuses specifically on the steps that can be taken in Canadian jurisdictions.

PHOTO, OPPOSITE: *Algae at shoreline* (Brenda Culler, ODNR Coastal Management)

What is an algal bloom?

Algae are the oldest form of life on Earth. They are part of a large and diverse group of microscopic plant-like organisms that are naturally occurring in salt water and freshwater bodies like lakes and ponds. Algae are essential to life in aquatic systems; they are the primary producers that form the base of the food chain.[12] Without algae, there would be no other life in lakes. But algae become a concern when their growth and reproduction get out of control and form large masses known as blooms.[13]

Algal blooms can have many different appearances. They can be blue, bright green, or brown. They can look like foam or a thick slurry. Blooms can resemble paint floating on the water or appear silky and hairy.[14] Some forms of algae create dense mats on the lake bottom that produce unpleasant odours. Others attach to rocks and surfaces along the shoreline.

The algal blooms that are of greatest concern are those that produce toxins that can cause illness in humans, pets and wildlife. These blooms are known as Harmful Algal Blooms (or HABs). Microcystis and Anabaena are examples of potentially toxic algae known to bloom in Lake Erie. Blue-green algae, which are not actually algae but rather a form of bacteria called cyanobacteria, are particularly concerning in terms of production of toxins, so these blooms are also categorized as HABs. Non-toxic blooms, known as nuisance algal blooms, can also be a problem. Lyngbya is a non-toxic, but odorous type of algae present in Lake Erie, and Cladophora is another type of nuisance algae that wash up on beaches, clog water intakes, and impact water quality.[15]

Algal blooms happen when the level of nutrients, light levels, pH, and temperature are just right.[16] Of these key factors that control algal growth, the most important is the availability of nutrients, mainly phosphorus. While a certain amount of nutrients, including phosphorus, is needed to support a healthy ecosystem, too much is a problem. Therefore limiting the amount of phosphorus is, in the Great Lakes and many other lakes, key to controlling algal blooms.[17]

IJC STUDY: A BALANCED DIET FOR LAKE ERIE

As a result of the increasing occurrence of algal blooms in Lake Erie, the U.S. and Canadian governments directed the International Joint Commission (IJC) to recommend policies and practices that could restore the health of the lake. *A Balanced Diet for Lake Erie: Reducing Phosphorus Loadings and Harmful Algal Blooms,* published in February 2014, integrates the work of over 60 scientific and policy experts, input from more than 400 people who attended public meetings on this issue, and over 130 comments from members of the public. The report proposes targets for phosphorus loadings to the lake and a series of policy, science and management recommendations to meet these targets. The recommendations found in this report are informed by the scientific conclusions summarized in the IJC study.

Phosphorous: the key culprit in a growing algae problem

The International Joint Commission (IJC) concluded in its 2014 study that "the single most important solution for the restoration of Lake Erie water quality is the reduction of phosphorus inputs." The root of the problem is the same as it was when Lake Erie was proclaimed to be dead four decades ago. However this time, addressing the algal blooms resulting from too much phosphorus is even more challenging because of new factors, in particular climate change and invasive species that are changing how the lake functions.

To make things worse, some studies are suggesting that more of the phosphorus making its way to the lakes these days is dissolved in the water, a form known as Dissolved Reactive Phosphorus or DRP. DRP is more easily and quickly taken up by algae than particulate phosphorus (see text box for explanation of different kinds of phosphorus). When algae are exposed to DRP, they are able to reproduce quickly, which under the right conditions, can result in rapid formation of algal blooms. There is also some evidence that the increase in DRP reaching the lake may also be increasing the types of blooms we most want to avoid – harmful algal blooms (HABs).[18]

PHOSPHOROUS IN DIFFERENT FORMS

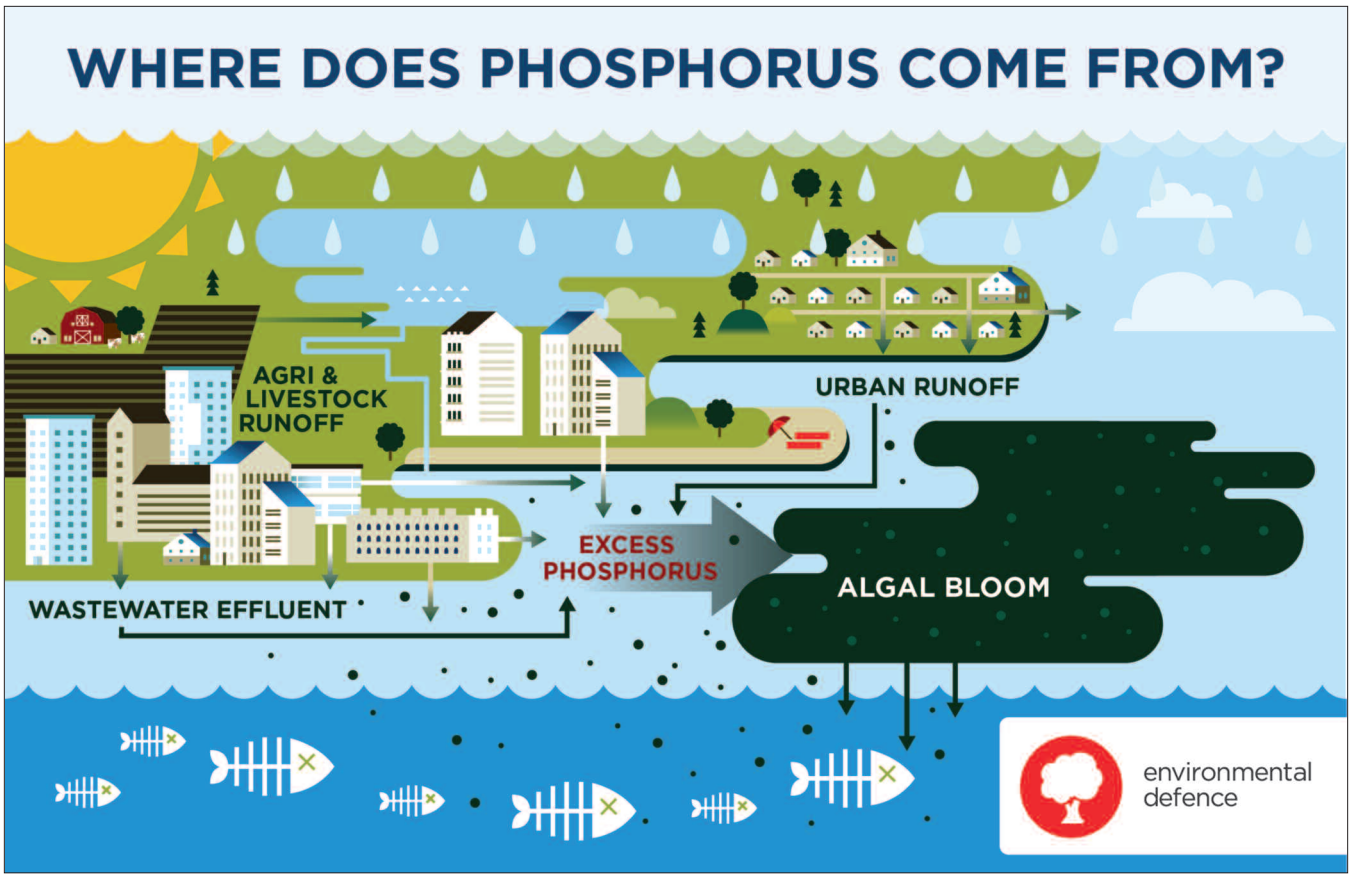
When scientists talk about the phosphorus in fresh water they use three terms: Total Phosphorus (TP), Particulate Phosphorus (PP) and Dissolved Reactive Phosphorus (DRP), which is also referred to as Soluble Reactive Phosphorus or SRP. To put it simply: TP = PP + DRP. PP is the phosphorus that is attached to sediments and organic matter floating or suspended in the water and takes longer to become available to support algal growth. DRP refers to phosphorus that is dissolved in the water that runs off the land to the lake where it is immediately available for uptake by algae. It is believed that increases in DRP may trigger and help sustain the recurring algal blooms in Lake Erie.[19]

Where is all this phosphorous coming from?

Sources of nutrients, like phosphorus, that find their way into water bodies fall into two general categories: point sources and non-point sources.

Point sources come from specific locations that can be accurately identified such as a discharge pipe from a sewage treatment plant. Point sources are responsible for approximately 16 per cent of the phosphorus inputs into Lake Erie.[20] In the 1970s, governments invested heavily in improving sewage treatment plants, which significantly decreased phosphorus inputs. In Lake Erie, the total amount of phosphorus coming from Canadian municipal sewage discharges was reduced by 82 per cent.[21]

However, during heavy rains – which are increasing in frequency with climate change – water from older urban storm drains and sewers often bypass municipal wastewater treatment plants and discharge directly into rivers and lakes. This can significantly increase phosphorus loadings from urban sources during rain events.[22]



Non-point sources of phosphorus are much harder to address because the origins of the nutrients are spread across the watershed landscape. The origins of the nutrients are spread across the watershed landscape. Rain and melting snow, often referred to as runoff, carry them from urban and agricultural lands into rivers and lakes.[23] Non-point sources are much harder to control than point sources, and while a lot has been done by rural and urban residents to reduce nutrient runoff over the past few decades, non-point sources still represent the largest portion of phosphorus reaching Lake Erie. Finding and implementing solutions that further reduce the

PHOTO: *Agriculture runoff. (Lynn Betts, U.S. Department of Agriculture)*

*Harmful algal bloom. Lake Erie. July 22, 2011. (*NOAA)

amount of phosphorus coming from non-point sources will be absolutely critical to restoring the health of Lake Erie, and preventing further degradation of the other Great Lakes.

Runoff from agricultural land in the watershed in both the U.S. and Canada is the largest non-point source of phosphorus entering Lake Erie today. This is because some of the fertilizers and manure that are applied to the land to enhance crop growth are washed into creeks and streams with rain and melting snow before they can be incorporated into the soil or taken up by crops.[24] The IJC study determined that a significant portion of the non-point source nutrients entering Lake Erie, in particular the western end of the lake, are coming from U.S. watersheds. However, practices in Canadian watersheds are still contributing to the problem and cannot be ignored. Meeting the nutrient reductions that scientists believe will be needed to save the lake will depend on the cumulative efforts of communities, agricultural producers and residents on both sides of the border.[25] In Canada, this means that we need to get a better handle on how much phosphorus is coming from each river draining into Lake Erie so that we can figure out where to prioritize efforts and to better understand how effective our actions are over time.

Another widespread practice on agricultural lands today – the use of subsurface tile drains – quickly removes water from fields and prevents them from being flooded. This allows farmers to use more land for crop production that would otherwise be too wet. But tile drains can also carry phosphorus-loaded water quickly off of fields, often directly into rivers and creeks.

Studies show that the warming climate and the related effects on weather patterns are likely to promote algal growth. A warmer climate means a warmer lake, creating the perfect conditions for large and sustained algal blooms.

Other sources of phosphorous

While runoff from agricultural lands is the major source of phosphorus feeding algal blooms, it is not the only source. Other sources of phosphorus that will need to be adequately addressed to reduce algal blooms in Lake Erie and the Great Lakes include:

- **Combined Sewer Overflows (CSO):** in older parts of many cities (e.g., Windsor, Hamilton, Toronto and Kingston) stormwater and sewage are collected in the same pipe system destined for the waste-water treatment plant. When too much rain overwhelms the system, water from the combined sewers flows largely untreated into lakes and rivers. This is a persistent challenge in Toronto where, during the major flood in July 2013, more than a billion litres of untreated sewage was released into Lake Ontario from the CSO system.[26]

- **Septic systems:** septic systems that store and treat sewage on individual rural and shoreline properties can leach phosphorus and other contaminants into nearby water bodies when not properly maintained or monitored.

- **Urban runoff:** rain and snowmelt in urban areas can carry a combination of phosphorus and other contaminants into storm sewers and watercourses. Sources of phosphorus in urban runoff include construction activities (which can loosen and release nutrient-laden sediments into water), lawn and garden activities, pet waste, and leaves from deciduous trees.

- **Atmospheric deposition:** phosphorus can also make its way into water bodies from the air by wind, rain and snowfall. Studies in 2011 determined that six per cent of the total phosphorus entering Lake Erie comes from atmospheric sources. Sources include decomposition of sewage sludge, exposed landfill and compost heaps, coal combustion, and dust from quarries, agricultural fields and unpaved roads.[27]

- **Internal loading:** when the soil and sediments are stirred up during dredging activities (the process of clearing or deepening navigational routes) or natural processes that cause the lake waters to mix (due to changes in temperature), phosphorus can make its way back into the water.

Factors exacerbating algal growth

A number of factors exacerbate and intensify the problem of algal blooms.

These exacerbating factors make efforts to reduce the amount of phosphorus running off of the land and washing into water bodies all the more urgent and important.

1. CLIMATE CHANGE

Studies show that the warming climate and the related effects on weather patterns are likely to promote algal growth. A warmer climate means a warmer lake, creating the perfect conditions for large and sustained algal blooms. Also climate change is increasing the frequency of intense weather events such as flash floods that deliver big, rapid bursts of phosphorus washing from agricultural and urban lands into rivers and lakes. Heavy spring rains followed by a long, warm summer were key factors in producing the record-sized algal bloom in Lake Erie in 2011.[28]

2. INVASIVE SPECIES

The invasive zebra and quagga mussels that have spread through the Great Lakes promote algal growth because they enhance the conditions algae need to grow: they increase water clarity so that the sunlight algae need to grow can penetrate deeper into the lake; they play a role in mobilizing nutrients; and they provide a surface for algae to attach and grow (on their shells). Mussels are thought to especially promote the growth of harmful algae in nearshore areas.[29]

23. LOSS OF NATURAL FILTRATION (WETLANDS)

Wetlands act like kidneys that filter water, cleaning out nutrients like phosphorus and other contaminants. Fewer wetlands mean more phosphorus can make its way into rivers and lakes. Lake Erie has lost more than 80 per cent of its coastal wetlands since settlement by Europeans began toward the end of the 18th century.[30] The loss of wetlands continues to this day. For instance, the 553-acre continentally significant St. Lukes' Marsh on the east shore of Lake St. Clair has recently been put up for sale. It's concerning because when the neighbouring wetlands were sold, they were converted into agricultural uses.

PHOTO: *Zebra mussels. (NOAA Great Lakes Environmental Research Laboratory)*

Algal blooms negatively impact our health and wealth

Algal blooms, especially when toxic, can have severe impacts on both the well-being of humans and aquatic ecosystems – impacts that can ripple through a regional economy that is deeply dependent on the health of the Great Lakes.[31]

Human and ecosystem health

Harmful algal blooms (HABs) can produce toxins that pose significant risks to the health of humans, fish and other animals.[32] When HABs decompose, they release a variety of liver, skin, and neurological toxins. Recreational activities such as swimming, waterskiing, and boating in contaminated water can result in rashes and skin irritation. If contaminated water is ingested people can experience gastrointestinal discomfort, and in very rare cases acute liver failure. Dogs have died from ingesting the toxins released by decomposing algae when they swim in contaminated waters and lick themselves afterwards. There have also been documented cases of human illness related to harmful algal blooms in Lake Erie.[33]

While drinking water treatment plants are generally well equipped to deal with toxins produced by harmful algal blooms, some systems can be overwhelmed. For example, in 2013 and again in 2014, residents in Carroll Township, Ohio were advised not to drink water from their local treatment plant, which takes in water from Lake Erie. The culprit was high levels of Microcystin – a toxin produced by harmful algal blooms.[34] During these drinking water advisories, citizens were warned not to use water for drinking, cooking, or even brushing teeth. Even using the water to bathe, wash hands or do laundry could result in skin irritation. Boiling the water does not solve the problem because it actually releases the Microcystin toxin, so residents were forced to find an alternative source of water for the two to three days during the advisory.[35]

The impacts of algal blooms extend beyond humans and pets. The toxins from harmful algal blooms have also been known to kill fish and the birds that feed on them.[36] And because some fish need clear water to be able to see and catch their food, cloudy algae-filled water can be a significant barrier to them finding enough to eat.[37]

PHOTO: *(Brenda Culler, ODNR Coastal Management)*

Algal blooms can also literally suffocate fish. Algae eventually die and sink to the lake bottom where they decay – a process that rapidly depletes the supply of oxygen dissolved in the water, creating "dead zones" where fish and other aquatic life cannot survive. This condition – when the dissolved oxygen level in the water is reduced to very low levels – is known as hypoxia. While hypoxia is a natural phenomenon, algal blooms lead to an increase in bigger and longer-lived dead zones. In extreme cases, they can result in massive fish kills with large numbers of dead fish washing onto beaches and shores.[38]

If the problem is not addressed and Lake Erie continues to see persistent and severe algal blooms, the Lake's ecosystem may be irreversibly altered. Changes in the food web structure, a loss in fish biodiversity, and a decline in fish populations are all possibilities if algal blooms continue to grow in size and increase in frequency.[39] The threat of population decline is greatest for visual feeding, cold-water fish that need clear water to be able to detect food and require higher levels of oxygen to survive, such as Lake Erie's commercially significant yellow perch and walleye.[40]

Costly consequences

While they may not know it, Canadians and Americans pay dearly each time there is an algal bloom. These costs have wide-ranging implications for industries, municipalities, property owners, and tourism, recreation and fishing sectors. Financial damage and the risk to local and regional economies are likely to keep increasing if the blooms get worse.

Municipal and industrial water takers
The 11 million people who rely on Lake Erie as a drinking water source – and the municipal water utilities that supply water to these people – could see costs increase because of the additional monitoring and treatment that is required when algal blooms occur near intake pipes.[41] This is, in fact, already occurring. In 2009, additional treatment needs cost Ohio $417,200 US for its 10 water utilities. In Toledo, Ohio, water treatment plant operators estimated they would need an additional $1 million US to properly treat algae-contaminated water.[42] Industrial and municipal water takers could also see an increase in infrastructure maintenance costs to deal with algae-clogged intake pipes.[43]

Property owners
If algal blooms continue to increase in size, duration and intensity, shoreline property owners could see their property values decline which could affect municipal revenues. A 2014 report by the binational International Joint Commission (IJC) that studied algal blooms in Lake Erie, estimated between 24,000 and 210,000 properties could be affected by harmful algal blooms on Lake Erie.[44] Excessive growth of Cladophora algae in the nearshore area can also be a significant nuisance to shoreline property owners because it can wash up on beaches, and impact water quality. More research is needed to better understand existing and potential future impacts on shoreline property owners around Lake Erie.

Local tourism
Lake Erie's vibrant tourism industry, which is based on the enjoyment people get from being on, in, or near the water, is also at risk when blooms occur. Ugly mats of algae and the associated unpleasant smells may deter tourists from spending time in coastal communities and lead to losses in revenues, incomes, jobs and tax revenues. The 2014 IJC report found that past algal blooms resulted in costly beach closures. In the case of Maumee Bay State Park in Ohio, the economic value of damages to beach recreation caused by algal blooms in 2011 was estimated at approximately $1.3 million US.[45]

If the problem is not addressed and Lake Erie continues to see persistent and severe algal blooms, the Lake's ecosystem may be irreversibly altered.

PHOTO: *(Brenda Culler, ODNR Coastal Management)*

Recreational and commercial fishing

The persistence of algal blooms could mean big trouble for recreational and commercial fishing and fishery-based economic activities. The potential for both reduced numbers of fish and losses in species diversity threaten the binational Great Lakes sport fishery, which is valued at $7 billion annually US.[46] The IJC estimated the financial damage to the recreational fishing industry in Ohio due to the 2011 record algal bloom at $2.4 million US. In Ontario, Lake Erie's commercial fishery – accounting for about 80 per cent of the total value of the province's $234 million Great Lakes commercial fishery – could be hit especially hard since it relies heavily on the health of yellow perch and walleye populations that are highly vulnerable to the effects of algal blooms.[47]

Potential risks and vulnerabilities caused by algal blooms

Public health risks	Tourism and recreational boating and fishing	Residential waterfront properties	Municipal, industrial, and rural water users	Environmental impacts
Recreational activities such as swimming, waterskiing, and boating in contaminated water can result in contact with toxins that leads to skin irritation. Ingested water can lead to gastrointestinal discomfort, and in very rare cases acute liver failure.	Damage to the quality and image of tourist attractions such as beaches, threaten local business. Increased maintenance costs for beaches to ensure usability. Reduced revenue from boaters and anglers deterred by unappealing algae.	Diminished appeal of waterfront property due to unappealing algae washing up on shores and potential bad smell. Value of waterfront property drops. Reduced municipal property tax revenues as a result of declining property value. Reduced economic activity due to reduced use of affected seasonal properties.	Increased maintenance costs due to clogged intake pipes. Increased drinking water costs due to additional treatment and monitoring.	Low oxygen levels could suffocate and kill fish. Severe, persistent blooms could lead to changes in food web, a reduction in fish stocks and risk to species variety.

PHOTOS, OPPOSITE: *top (Wisconsin Department of Natural Resources); middle (Center for Neighborhood Technology); bottom (Environmental Defence)*

Recommendations: a different future

The key to saving Lake Erie and the other Great Lakes from algal blooms is to reduce phosphorus inputs to the lake. This will require changes to decisions about how activities on the land are managed.

The good news is that the algal bloom problem in Lake Erie has been solved before, and the same key ingredients lie at the heart of the solutions this time: collaboration and innovation. In the 1970s, collaboration resulted in changes to government policies and programs. Industry formulated low phosphate and phosphate-free detergents, and enhanced sewage treatment systems.

Today, with so many sources of phosphorus distributed across the landscape – and with climate change, invasive species, and wetland loss exacerbating the problem – collaboration will need to be more intensive. All levels of government, including First Nations, need to work with agricultural industries, businesses, communities, non-government organizations, and individuals to develop and implement solutions.

Fortunately we have developed new tools that can be used in addition to those from the 1970s. For example, we now have information on the effectiveness of a variety of land management strategies. We also know more about the design, implementation and effectiveness of various market mechanisms to help pay for required practice changes.

Given what is at stake and the urgency of the issue, action must start now. The following four-point plan can start us down the path towards a long-term, sustainable future of green farm fields, green communities and blue waters. The plan can be adapted and improved as scientific understanding improves and more is learned about how to best prevent algal blooms.

1. Harness market forces to help farmers reduce nutrient runoff

The agricultural sector is taking many actions to reduce nutrient loading, and these efforts should be supported. For instance, many farmers are utilizing the "4Rs approach" to fertilizer application. This framework, developed by the fertilizer industry, encourages farmers to match nutrient supply with crop requirements to reduce nutrient loss from fields. It is based on applying the right source of nutrients, at the right rate, at the right time, and in the right place. This program should be expanded to accelerate uptake.

Over the longer term, there is a need to explore a broader suite of approaches that address the challenge of how to pay, and who pays, for practices to reduce nutrient pollution. With increasingly limited government resources stretched across a range of priorities, sustaining and scaling up funding to promote practices that reduce the amount of nutrient inputs to water is a significant challenge. Governments have tended to rely primarily on 'command and control' regulations that can require significant resources to ensure compliance. They have also used localized incentive and cost-sharing programs to work with farmers to voluntarily improve their practices (e.g., the Grand River Conservation Authority's Rural Water Quality Program, the Elgin Clean Water Program, and the Alternative Land Use Services (ALUS) program). While steps in the right direction, these approaches alone are not achieving the total nutrient reductions needed to reduce or eliminate algal blooms in Lake Erie and protect the Great Lakes. Achieving this goal requires finding innovative ways to pay for the costs of keeping water clean.

A key step toward this goal is evaluating various market-based policy instruments that result in the transfer of money from undesirable activities (e.g. pollution) to those that are desirable (e.g. reduced pollution). For example, the costs associated with nutrient reduction could be included in what consumers pay for certain products. Concepts such as tax-shifting, nutrient trading, correction of environmentally-damaging economic incentives, and pollution taxes should be evaluated for their applicability in the Ontario context. Looking at how such tools are being used elsewhere (e.g., South Nation Conservation in Ontario and the State of Wisconsin have developed nutrient trading programs) can provide insights into viability in the Lake Erie watershed and the broader Great Lakes context. The objective of these strategies would be to ensure that more money is available to help farmers pay for the additional costs associated with preventing nutrient runoff.

PHOTO: *Stream fencing protects against animal waste and streambank plantings create a "buffer strip" that filters pollutants from the water.* (US Department of Agriculture)

2. Build water smart communities, cultivate water smart citizens

In addition to agricultural runoff, two of the other most significant sources of phosphorus loading are poorly maintained septic systems and combined sewer overflows.[48, 49] All levels of government should work together to develop an infrastructure funding plan to upgrade antiquated sewer systems that are prone to bypasses or overflows during heavy rainfall or snowmelt.

Building smarter cities that are designed to better regulate stormwater and the nutrients it can carry into water bodies is an important complementary solution. Instead of washing directly into storm sewers and streams, rain and snow should be allowed to slowly infiltrate into the soil. To do so, city planning policies should be updated to ensure green infrastructure, such as filter strips, rain gardens, bio-swales, and engineered wetlands, is required in all new developments (particularly in suburban developments) and where possible in already built-up areas. The government of Ontario should look to the recommendations put forward by the Green Infrastructure Ontario Coalition to scale up green infrastructure programs and projects.[50]

Outreach and extension programs that inspire urban residents to become more involved should be supported. For example, the RAIN project, a joint initiative of Green Communities Canada and its member groups, is an excellent example of a program that educates people about actions they can take to prevent polluted runoff from their property from entering local waterways in urban areas.[51] For rural property owners and cottagers, additional programs are needed to make septic system maintenance easy and affordable, perhaps by offering low interest loans to property owners.

PHOTO: top (Waterfront Toronto); bottom (Peter McNeice)

3. Improve scientific understanding of why blooms happen and their implications

Enough is known about how and why algal blooms form to support vigorous and sustained action now. At the same time, critical knowledge gaps exist, particularly related to the total amount of phosphorus entering Lake Erie and the Great Lakes from Canadian watersheds. Getting a handle on how much phosphorous comes from where is not the only challenge. Understanding when major loadings find their way into the lakes is equally important. Capturing this information will require more sophisticated monitoring strategies to ensure data is collected year-round. This is especially important to be able to capture nutrient loadings during periods of significant runoff, including storm events and snow melt. Without this information, it is difficult to target priority watersheds, and evaluate the success of new and existing nutrient management programs.

Other information gaps that need to be filled include better understanding how lake dynamics affect algal blooms, which solutions work best in which locations (and the influence of activities such as tile drains on runoff), and the full scope of the human health, economic and ecological impacts and costs of algal blooms.

Provincial and federal funding is needed to support the research and monitoring programs necessary to fill these gaps and bridge science, policy and practice. Special care should be taken to ensure data collected across various governments and agencies is coordinated to maximize efficiency of funds spent on monitoring. This information should be made available to the public in accessible and understandable formats. Research and monitoring information is critical to understanding and accelerating the uptake of programs that have been proven successful at reducing nutrient loading to water bodies.

PHOTOS: left (FWC Fish and Wildlife Research Institute); right (Ocean Networks Canada)

The good news is that the algal bloom problem in Lake Erie has been solved before, and the same key ingredients lie at the heart of the solutions this time: collaboration and innovation.

4. Create a policy framework that drives action

Ontario currently lacks specific targets and action plans for reducing nutrient loading to the Great Lakes. The good news is that there are a number of mechanisms about to be finalized, or currently under review, that provide the basis for setting targets and creating action plans to meet them. The Canada-Ontario Agreement – currently awaiting final approval – outlines a five-year work plan for how the governments of Canada and Ontario will work together to meet their commitments under the binational Great Lakes Water Quality Agreement (which requires Canadian and U.S. governments to set new targets to reduce algal blooms in Lake Erie). Ontario's proposed Great Lakes Protection Act also includes provisions for the Minister of the Environment to set targets for a range of environmental issues, such as the reduction of nutrient loading. Passing this legislation should be a priority for the Ontario government. The first set of targets and action plans created under these mechanisms should focus on areas experiencing the highest levels of stress, particularly Lake Erie.

One of the most significant policy gaps in Ontario is our inability to protect critical wetlands from being converted to other land uses. While steps have been taken to update planning policy (e.g., the Provincial Policy Statements), they do not go far enough.[52] Ontario should develop a comprehensive policy, to protect existing wetlands, and restore currently degraded wetlands.


DEAD
SLOW
NO
WAKE

Conclusion

Lake Erie needs our help. The intensity and frequency of algal blooms on the Lake are closing beaches, increasing the cost of water treatment, and killing fish. Without immediate and decisive action, we may see shoreline property values plummet and the tourism economy of coastal communities devastated. We may find that we have a lake that can no longer support its valuable fishery or provide recreational opportunities to its residents. The state of Lake Erie and other algae hot spots such as Hamilton Harbour and the Bay of Quinte should be seen as an early warning of what could happen in the other parts of the Great Lakes.

But a different future is possible – for Lake Erie and for all of the Great Lakes. A future of green fields producing globally and locally important foods; a future of green cities designed to work in harmony with the water cycle; and a future of beautiful, blue waters that support vibrant communities, economies and ecosystems.

The four-point plan presented in this report offers initial steps to start reducing phosphorus loading across the Great Lakes basin. Immediate, aggressive and sustained action will be critical to healing Lake Erie. The innovative solutions designed and deployed to restore the health of this ailing lake can again ripple across the Great Lakes basin to realize a future of green fields, green communities, and blue waters.

PHOTO, OPPOSITE: (Peter McNeice)

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