Vice President's Conversation on the Future

Trend Research: Environmental and Natural Resource Management

Descriptor Definition

This paper includes a brief synopsis of the trends in quality and sustainability of Ohio's environment and natural resources with a focus on water, soils and forests. It provides information about the relationships among these resources, and Ohio's economy and citizens. It addresses some of the current and potential trends that may threaten theses resources.

Authors' Insights[i]: Descriptor Relevance

Ohio is blessed with abundant water, fertile soil and productive forests. The future of the health and wealth of the people and the productivity of Ohio's agricultural and other industries are strongly dependent on the environment and these natural resources. Historically, many of these resources were not sustainably managed, and our water quality, soil productivity and forest health have suffered greatly. As a result, the economy and the well - being of Ohioans were diminished. In recent decades, Ohio has taken many positive steps toward improving the environment and sustaining our natural resources which is crucial to the well-being of Ohio's citizens and the future of the economy that they depend on.

Trend Information and Interpretation

Water quantity and quality

Ohio has 61,532 miles of streams and rivers and more than nearly 200,000 acres of lakes, reservoirs, and ponds (USEPA 1991). Ohio has an average rainfall of approximately 39 inches annually (NOAA 2000). In general, Ohio is a very water rich state. Ohioans consume more than 11 billion gallons of water each day for personal and business use (ODNR 2013). Water consumption in Ohio is strongly linked to business and energy production. The economic impacts of water on business, tourism, and other water uses are difficult to quantify. The impact of water on tourism, one of many industries that depend on it, is estimated to be $38 billion annually (Healthy Water Ohio 2014).

In the past, Ohio industries such as coal mining have severely damaged both surface water and ground water aquifers in the southern and eastern part of the state. In northeastern Ohio, industrial waste polluted the Cuyahoga River to the point that it caught fire. In the late 1960's Lake Erie was considered "dead". In the 1970's through environmental regulation such as the 1977 Clean Water Act which regulated "point source pollution" such as antiquated sewage treatment facilities and industrial waste the Lake Erie watershed started to recover. Throughout the 1980's and 90's measures were enforced that improved the lake's water quality and hence the overall fishery. More recently, several water related issues have emerged. We have chosen to briefly focus on the following: Harmful Algal

Blooms (HAB's), and natural gas and petroleum from shale formations.

1. Harmful Algal Blooms (HAB's)

HAB's continue to threaten water quality in Lake Erie and the Ohio River. HAB's are caused by excess nutrients entering ditches, streams and rivers. Major sources of these nutrients include:

- Agriculture (both excess fertilization and improper timing of fertilizer and manure application). Potential solutions include the implementation of Best Management Practices.
- Combined Sewer Overflows (common in older cities and neighborhoods where the sanitary sewer is combined with the storm sewer)
- Failing home sewage treatment systems (Many soils in Ohio are not suitable and systems tend to fail with age).

Increased evidence of cyanobacteria that can result in HAB outbreaks in Ohio lakes has directed the conversation toward Best Management Practice (BMP) being examined by farmers, agribusiness, Extension, the college, legislators and media.

Recent trends in water sampling in the Lake Erie Watershed have shown an increase in the Dissolved Reactive Phosphorous (DRP) percentage in water samples while Total P has been fairly stable. Historically, improvement in Lake Erie water quality from the 1970's to 1990's resulted from management of point sources of phosphorous, including sewer and industrial sources, through changes in treatment and the reduction of phosphorous entering the system from detergents. Agriculture contributed to reduction of non-point sources by adoption of soil conservation tillage practices that reduced total P loading. From 1998-2005, total phosphorous loading from non-point sources into Lake Erie was estimated to account for 60.8 percent of the total load. Agricultural land use is high in the basin with 59% of Ohio's Lake Erie area under cultivated agricultural land. In the western basin area of the watershed the percentage approaches 72% (OEPA 2010).

The level of adoption of agronomic BMP's such as soil testing, nutrient incorporation and timing of application have come under scrutiny. On farm research is currently being studied to determine the validity of the Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat and Alfalfa (Vitosh et. al. 1995) regarding phosphorous as we look to see if we can reduce the amount of phosphorous being applied without a yield drag.

2. Water and Natural Gas from Shale Formations

A newly emerging demand on Ohio's water resources is the production of natural gas from shale formations in eastern Ohio. This is producing unprecedented economic opportunities in eastern Ohio, but there are concerns about the effect of this industry on the water resources of this portion of Ohio. It can take up to 8 million gallons of water to hydraulically fracture a single well. To date more than 1,100 wells have been drilled in Ohio (ODNR and OEPA 2014). While most of the water remains thousands of feet underground, a portion of the water is forced back to the surface through the well bore. This water, which can contain a variety of toxic substances which can impair water quality if it enters streams or lakes, is temporarily stored and trucked to deep well injection sites. Some

companies are reusing this water on other well sites. There is also the potential for contamination from shale gas well production to contaminate drinking water wells. The Ohio Department of Natural Resources and the Ohio Environmental Protection Agency are the regulatory authority over oil and gas drilling and production in Ohio.

Soils

There are numerous physical, chemical and biological properties that contribute to soil quality (Doran et. al. 1994). Consequently it is difficult to quantify soil quality much less determine trends. However, research on soil quality points to the importance of soil carbon which can have a major influence on many other indicators of soil quality (Aziz et. al. 2013). Conservation tillage practices including continuous no-till, cover crops and proper application of manure can help to raise soil carbon levels and reduce soil erosion. This improves soil quality and function including ability to enhance agronomic productivity and environmental quality including a reduction in offsite damage (Rodale Inst,. 1991). An added benefit to conservation tillage is the sequestration of carbon from the atmosphere. The adoption of no-till and other soil conservation practices in the United States has the potential to sequester approximately 300 million tons of soil carbon each year (Lal et. al. 2004). In 2009, approximately 35.5 percent of U.S. cropland in major crops employed some form of no-till operations; a growing trend with an annual increase of 1.5% per year from 2000 to 2007 (Horowitz et. al. 2010).

Forests and Natural Ecosystems

Ohio's forests and natural ecosystems provide a wide variety of ecosystem services ranging from economic (e.g. wood products, tourism, and fuel) and health benefits (e.g. improved air and water quality, and recreational opportunities) to cultural (e.g. natural heritage, research and education) and biological benefits (e.g. wildlife and plant diversity), (Bonnell 2009). Forests are heavily concentrated in the unglaciated portions of Ohio, but play important roles in ecosystem services even in areas where they make up less than 10 percent of the landscape.

At the time of European settlement, Ohio was nearly 95 percent forested (Widmann et. al. 2014). Upon settlement the forest was cleared for agriculture and development and by the 1940's only about 12 percent of Ohio was forested (Ervin et al. 1994). The percentage of forest cover has steadily increased until it reached nearly 30 percent in the early 1990's (Figure 1). Since that time the total forest acreage in Ohio has remained essentially unchanged (31 percent in 2011; Widmann et. al. 2014).

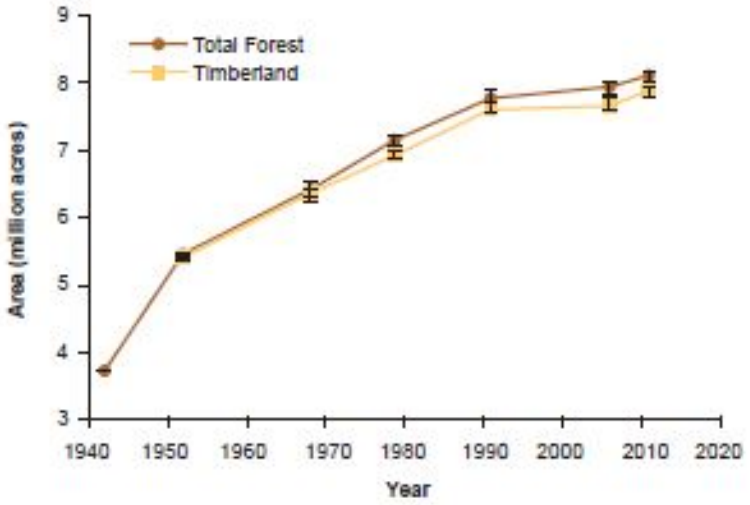

Figure 1. Area of forest land and timberland in Ohio. From ***Ohio's Forests-2011***; Widmann et. al. 2014)

Although the acreage of forest has not changed significantly in the past two decades, the forests of Ohio have been changing in other ways. The average parcel size has decreased significantly in recent years leading to an increase in forest fragmentation which can negatively impact the ecosystem services that they provide. The most recent survey of forests by the USFS found that 93.2 percent of the plots inventoried had invasive plant species present. These plants can greatly diminish the productivity of our forests and negatively impact our ability to regenerate and sustain them in the future. Chestnut blight, Dutch elm disease and gypsy moth are all non-native pest that were first found in Ohio in the 20th century. They have all had significant long lasting negative impacts on the forest. Since emerald ash borer was found in Ohio in 2002, there has been a rapid influx of non-native invasive pests including emerald ash borer, Asian long-horned beetle, hemlock woolly adelgid and thousand canker disease of walnut. If left unchecked, these and other pests that are likely to infest our forest ecosystems in the future could considerably diminish the diversity and productivity of Ohio's forests. Proactive management is the key to sustaining our forest ecosystems. Prevention, early detection and rapid response to newly discovered infestations are necessary to minimize the impacts to Ohio's forests, the environment and economy, and Ohio's citizens.

Overall Summary of Trend Information

Since this descriptor paper covers a wide variety of topics related to environmental and natural resources management it is difficult to compile an overall trend summary. In many cases Ohio has made great strides in our management of the environment and our natural resources in the past 40 to 50 years. Numerous federal and state regulations that protect Ohio's water, air and other natural resources have been passed and are having a positive effect. However, as the population of Ohio, the nation and the world increases and resources become more scarce, additional challenges continue to emerge.

Most federal and state agencies that regulate and manage natural resources in Ohio are underfunded and understaffed. For example, the total number of employees of the Ohio Department of Natural Resources decreased by 19.3 % from 2007 to 2014 (Figure 2). In addition the universities charged with conducting research and extending knowledge to Ohio's citizens lack resources. Consequently, Ohio has become somewhat reactive rather than proactive to environmental and natural resources issues.

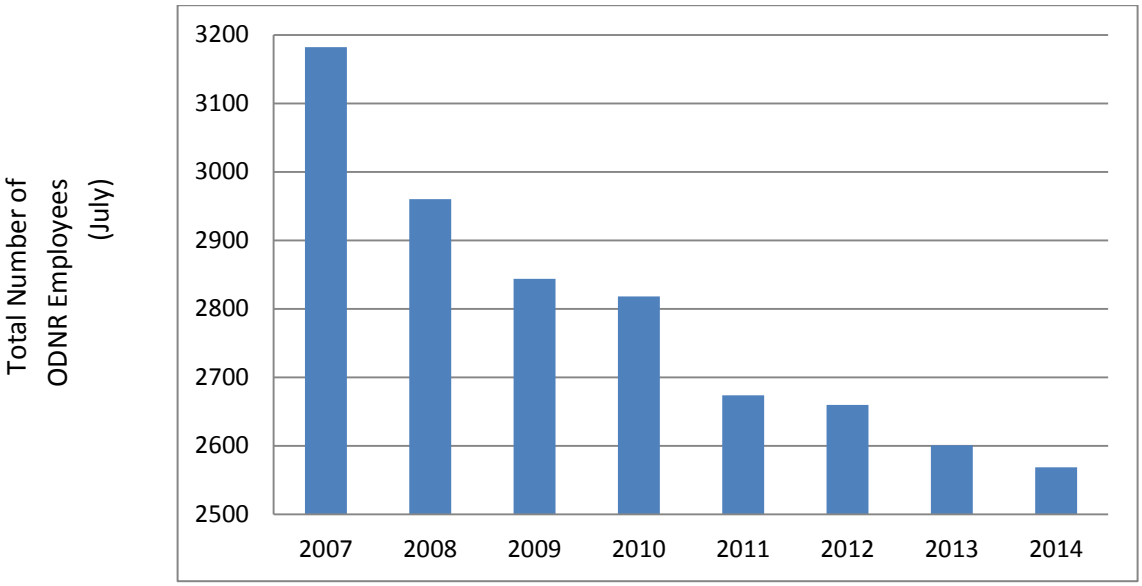

Figure 2. Total number of Ohio Department of Natural Resources (ODNR) employees from 2007-2014. From Ohio Department of Administrative Services, *State Employee Trend Reports*. Numbers extracted from July reports. http://das.ohio.gov/Divisions/HumanResources/HRDOCBPolicy/StateEmployeeData/StateEmployeeTrendReports.aspx

Author Insights - Alternative States for the Future

A. Internal and external pressures from population growth and the utilization of natural resources to sustain the economy will decrease significantly. Funding and staffing for organizations and agencies that protect, manage and research environmental issues will increase. Consequently, environmental quality as defined by the trends in this descriptor paper will improve significantly (0.20).

B. Internal and external pressures from population growth and the utilization of natural resources to sustain the economy will increase slightly. Funding and staffing for organizations and agencies that protect, manage and research environmental issues will remain the same or

increase slightly. Consequently, environmental quality as defined by the trends in this descriptor paper will stay about the same or decrease slightly (0.40).

C. Internal and external pressures from population growth and the utilization of natural resources to sustain the economy will increase considerable. Funding and staffing for organizations and agencies that protect, manage and research environmental issues will remain the same or decrease. Consequently, environmental quality as defined by the trends in this descriptor paper will decrease significantly (0.40).

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[i] Along with the research-based data and statistics included in this document, is information provided by the research paper authors. Although these author insights are not directly cited with research references, they reflect research, observation, logic, intuition, and well-considered expectations compiled by the authors. The Author Insights sections of this paper are offered for discussion and to help provide a wider perspective for incorporating the descriptor data into the possible future trends. These conclusions are drawn by the authors using their knowledge of the scholarly references and their years of professional experience related to the descriptor, and are provided to help the reader more effectively envision the future impact and effects of the descriptor.