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Environmental protection, the economy, and jobs: National and regional analyses ☆

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Abstract

The relationship between environmental protection (EP), the economy, and jobs has been an issue of harsh contention for decades. Does EP harm the economy and destroy jobs or facilitate economic growth and create jobs? We address this issue by summarizing the results of the Jobs and the Environment Initiative, research funded by nonprofit foundations to quantify the relationship between EP, the economy, and jobs. We estimate the size of the US environmental industry and the numbers of environment-related jobs at the national level and in the states of Florida, Michigan, Minnesota, North Carolina, Ohio, and Wisconsin. This is the first time that such comprehensive, detailed estimates have been developed.

Our major finding is that, contrary to conventional wisdom, EP, economic growth, and jobs creation are complementary and compatible: Investments in EP create jobs and displace jobs, but the net effect on employment is positive.

Second, environment protection has grown rapidly to become a major sales-generating, job-creating industry—$300 billion/year and 5 million jobs in 2003.

Third, most of the 5 million jobs created are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, etc., and the classic environmental job (environmental engineer, ecologist, etc.) constitutes only a small portion of the jobs created. Most of the persons employed in the jobs created may not even realize that they owe their livelihood to protecting the environment.

Fourth, at the state level, the relationship between environmental policies and economic/job growth is positive, not negative. States can have strong economies and simultaneously protect the environment.

Finally, environmental jobs are concentrated in manufacturing and professional, information, scientific, and technical services, and are thus disproportionately the types of jobs all states seek to attract.

Keywords: Jobs; Environmental protection; Economy; Industry; Manufacturing; Skills; State; Occupations

1. Introduction: the issue

The relationship between environmental protection (EP), the economy, and jobs has been an issue of harsh contention for decades. Analysts and policymakers of all points of view seem to agree that a strong relationship exists between EP and jobs; the debate is over the sign of the correlation coefficient. Does EP tend to harm the economy and destroy jobs or to facilitate economic growth and create jobs? If the latter is the case, can the positive affects be quantified and estimated at a meaningful level of detail?

Here, we address this issue by summarizing the initial results of the Jobs and the Environment Initiative, a research effort funded by nonprofit foundations designed to quantify the relationship between EP, the economy, and jobs.[1] We estimate the size of the US environmental

☆This paper finds that, contrary to the conventional wisdom, environmental protection has evolved into a major US industry, that most of the 5 million jobs created are for occupations not related to the environment, and that detailed economic and employment impacts can be estimated for individual states.

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industry in 2003 and the numbers of environment-related jobs created at the national level and in the states of Florida, Michigan, Minnesota, North Carolina, Ohio, and Wisconsin.

2. Previous studies

Numerous studies have been undertaken over the past two decades to estimate the economic and employment effects of EP. These can be grouped into three types: (i) theoretical analyses and cases studies, (ii) econometric simulations of policy alternatives, and (iii) empirical estimates derived using historical data. Below we review some of the major studies in each category.

2.1. Theoretical analyses and cases studies

In 1992, Meyer analyzed the impact of environmental legislation on differential interstate rates of economic performance and tested the hypothesis that pursuit of environmental quality hinders economic growth and job creation (Meyer, 1992). He ranked the 50 states on the basis of the stringency of their environmental laws and then compared the environmental rankings with measures of economic growth and job creation between 1973 and 1989. He found no evidence to support a negative relationship between environmental regulation and economic performance, and his results showed the opposite. Meyer found that the states with the most ambitious environmental programs had the highest levels of economic growth and job creation over the period.

In 1993 and 1995, Bezdek examined the available empirical evidence and found that, contrary to conventional wisdom, strict environmental regulations do not damage US industry, reduce international competitiveness, or cost thousands of jobs, and he found that strict environmental standards may even foster economic development (Bezdek, 1993). He concluded that recent major empirical studies reject the hypothesis that there is a negative relationship between EP and economic and job growth.

During the 1990s, Goodstein conducted several studies examining the relationship between EP and employment (Goodstein, 1994). He examined the impact of existing regulations on overall employment rates, shutdowns and layoffs, regulation-induced capital flight, estimates of the costs of environmental regulation, and specific industries and case studies. He found that little empirical evidence exists that environmental regulation destroys jobs and that ex ante estimates of the costs of compliance have been much higher than actual costs. He also showed the conditions under which EP might lead to increased employment.

In 1995, Templet hypothesized that the economy is dependent on the environment to provide resources and accept wastes, and that a healthy environment should make for a better economy (Templet, 1995). He cited empirical evidence from a number of studies substantiating that finding and showing that states with lower pollution levels and better environmental policies generally have more jobs, better socioeconomic conditions, and are more attractive to new business. He conducted a case study of Louisiana case that found that jobs increased while pollution declines. He concluded that there is little evidence that progressive environmental policies are detrimental to a state's economy and that there is substantial evidence that the converse is true.

In 1995, Repetto reported that EP requirements have not contributed to job loss or reduced international competitiveness for US companies. He also found that firms with superior environmental performance are no less profitable than others in the same industry (Repetto, 1995). He concluded that appropriate US environmental policies could protect the environment with far greater economic efficiency.

In 1997, Berman analyzed the regulation of air pollution in manufacturing plants in Los Angeles. He examined employment growth in the Los Angeles region in plants subject to these regulations, and compared growth at these plants to employment growth at similar plants in Texas and Louisiana. He found that, while the Los Angeles regulations imposed costs on regulated plants, they had little effect on employment and that there were no large job losses due to these regulations. His major finding was that the most severe episode of increased air quality regulation of manufacturing industries did not have a large effect on manufacturing employment.

In 1998, Morgenstern, Pizer, and Shih examined the possibility that workers could be adversely affected in heavily regulated industries, which has led to claims of a "jobs vs. environment" tradeoff (Morgenstern et al., 1998). They explored how increased environmental stringency can influence the industry-level demand for labor and developed estimates for four heavily polluting industries (pulp and paper, plastics, petroleum refining, and iron and steel). Their results indicated that increases in environmental spending do not cause job loss. Their model showed that the overall demand effect is mitigated by employment increases associated with new environmental spending.

In 1999, Arnold, Forrest, and Dujack examined claims about the costs of environment regulations by reviewing the available research (Arnold et al., 1999). They found that, while the claims about damage to the economy can mostly be attributed to misinformed advocates or exaggeration, the majority of the fault lies in a lack of accurate communication of economists' findings about the effect of environmental regulation to the general public. Worst-case economic impact scenarios for a regulation—such as potential increases in unemployment and plant closures—are reported not as low probabilities, but as serious threats. They concluded that the view that environmental regulation seriously harms the US economy is not supported by the data.

In 1999, Bliese reviewed dozens of well-designed studies that tested the assertion that EP harms the economy (Bliese, 1999). The results of these studies indicate that EP normally has no negative impact on the economy overall, and often has a positive effect. He noted that the studies only searched for economic impacts of environmental policies—and found none; they did not estimate environmental or public health benefits. He concluded that the "environment vs. the economy trade-off" is a myth, even in narrowly economic terms.

In 1999, Yapijakis found that widespread fears of job losses from EP are unfounded and that, when job creation aspects of pollution control policies are factored in, EP has increased net employment in the US (Yapijakis, 1999) Further, actual layoffs due to regulation have been extremely small. EP raises employment levels and provides some recession-proof stimulus to aggregate demand. Government data reveal that few manufacturing plants are shut down as a result of environmental or safety regulations.

In 2000, Renner found that creating an environmentally sustainable economy has already generated an estimated 14 million jobs worldwide (Renner, 2000). He reported that many new opportunities for job creation are emerging, ranging from recycling and remanufacturing of goods, to greater energy and materials efficiency and the development of renewable energy. Jobs are more likely to be at risk where environmental standards are low. He concluded that investing in the environment, in renewable energy, and energy efficiency will generate more jobs than investing in extractive industries and fossil fuels.

2.2. Econometric simulations of policy alternatives

In 1989, Arvind Teotia and his associates estimated the macroeconomic impacts of the use of clean diesel engine technology in light trucks to comply with corporate average fuel economy (CAFÉ) standards. They assumed that the new engines would capture 15 percent of the light truck market and estimated that by 2022, between 70,000 and 110,000 jobs would be created (Teotia et al., 1999).

In 1989, Bezdek and Wendling simulated the impact of the two major acid rain control bills that were then being considered in the US Congress (Bezdek and Wendling, 1989). They found that between 100,000 and 195,000 net jobs would be created, depending on which bill was enacted. Economic and job impacts were estimated for each state and employment requirements by occupation at the national level were also estimated.

In 1990, Jorgensen and Wilcoxen estimated the impact of environmental regulations on the US economy by simulating the growth of the economy between 1974 and 1985 with and without these regulations (Jorgenson and Wilcoxen, 1990). They concluded that the effect of these regulations was that the economy grew 0.2%/year more slowly than it would have otherwise, and that by the early 1990s GNP was about 2.5% less. In 1993, they extended the analysis to assess the impacts of the Clean Air Act Amendments of 1990 and concluded that the net impact of the Amendments would further reduce the rate of growth of GNP (Jorgenson et al., 1993). They did assess the benefits of EP or estimate employment impacts.

In 1990, a Motor Vehicles Manufacturers Association study of the potential impact of increased CAFE standards predicted that tighter CAFE standards would result in the loss of between 159,000 and 315,000 jobs in the motor vehicle industry (Motor Vehicle Manufactures Association, 1990). Secondary effects from consumer fuel savings were not estimated and the report did not consider that fuel savings by consumers would result in additional spending on other products and higher employment in the affected industries.

In 1992, GelIer, DeCicco, and Laitner estimated the impact of a "high efficiency" scenario for the energy-using sectors of the economy and found that a national strategy of investment in environmentally benign energy sources and energy efficiency would create one million net new jobs in the United States within 10 years (Geller et al., 1992). They also found that by increasing the fuel efficiency of passenger cars from 28 mpg in 1990 to 40 mpg in 2000 and 50 mpg in 2010, 244,000 additional jobs would be created by 2010.

1993, MISI simulated the impact that the environmental provisions of the North American Free Trade Agreement would have on US exports and jobs (Management Information Services, Inc., 1993). The study estimated that by 2000, NAFTA would generate $3.8 billion in US environmental export sales to Mexico and create nearly 70,000 jobs in the US Jobs estimates were disaggregated by state.

During the 1990s. Laitner, DeCicco, Elliott, Geller, Goldberg, Morris, and Nadel examined energy consumption patterns in the four-state Midwest region of Illinois, Indiana, Michigan, and Ohio and the states of New York, New Jersey, and Pennsylvania, and projected energy consumption through 2010 assuming business-as-usual policies and trends (Laitner et al., 1994). They then developed an energy efficiency scenario assuming more aggressive implementation of energy efficiency measures and analyzed the potential economic benefits of the scenario. They found that by 2010, the energy efficiency scenario would create 132,000 net new jobs in Midwest region and 164,000 net new jobs in New York, New Jersey, and Pennsylvania.

In 1999, Bernow, Cory, Dougherty, Duckworth, Kartha, and Ruth examined the impact of implementing a set of integrated policies designed to bring the US in compliance with the Kyoto Protocol (Bernow et al., 1999). They found that the US could reduce its carbon emissions to its Kyoto target and that the prescribed policies would produce net economic savings. Specifically, they estimated that by 2010 almost 900,000 net new jobs would be created, relative to the baseline.

A 2001, a Friedman study for the Union of Concerned Scientists analyzed the effects of increasing CAFE standards to 40 mpg by 2012 and to 55 mpg by 2020 (Friedman et al., 2001). UCS estimated that employment, wages, and income would increase over the 10–20-year horizon of the study. By 2010, the analysis projected a net increase of over 40,000 jobs; by 2020, the study projected an increase of 104,000 jobs. In a 2002 update of this study, UCS highlighted the potential job gains by industry and state resulting from increased CAFE standards, and estimated that 183,000 new jobs would be generated (Union of Concerned Scientists, 2002).

In 2002, research staff at the University of Illinois analyzed the Midwest's Clean Energy Development Plan, which advocated energy efficient technologies and development of renewable energy resources, especially wind power and biomass energy (Regional Economics Applications Laboratory, 2002). They estimated that implementing the plan would create more than 200,000 new jobs across the 10-state Midwest region by 2020.

In 2002 and 2004, Barret and Heorner assessed the impact of a set of policies designed to provide steady increases in energy efficiency and reductions in carbon emissions, while improving overall economic efficiency (Barrett and Hoerner, 2002). They analyzed the macroeconomic impact of these policies and estimated that an additional 660,000 net jobs would be created in 2010 and 1.4 million in 2020. This would increase employment in the service sector and reduce the rate of decline in employment in manufacturing.

In 2004, the New Apollo Initiative proposed an economic development plan for the US based on diversifying energy sources, making the US less dependent on foreign oil, investing in industries of the future, promoting construction of energy efficient buildings, and investing in cities and communities (New Energy for America, 2004). It estimated that a $30 billion investment per year for 10 years would add more than 3.3 million jobs to the economy and stimulate $1.4 trillion in new GDP.

In 2004, UCS analyzed the effects of implementing a national renewable electricity standard (RES) that would require electric utilities to supply a set percentage of their electricity from renewable sources (Union of Concerned Scientists, 2004). It found that a under a national RES of 20% by 2020, the US would increase its total renewable power capacity by nearly 11 times over present levels and would create more than 355,000 new jobs.

In 2004, Levinson and Taylor examined the effect of environmental regulations on trade flows by developing an economic model to demonstrate how unobserved heterogeneity, endogeneity, and aggregation issues bias measurements of the relationship between regulatory costs and trade (Leninson and Taylor, 2004). They applied an estimating equation derived from the model to data on US regulations and net trade flows among the US, Canada, and Mexico for 130 manufacturing industries from 1977 to 1986. Their results indicated that industries whose abatement costs increased most experienced the largest increases in net imports. For the 20 industries hardest hit by regulation, the change in net imports they ascribed to the increase in regulatory costs amounted to more than half of the total increase in trade volume over the period.

In 2005, Bezdek and Wendling estimated the economic impacts on the US of enhanced CAFE standards and found that such changes would have positive economic effects and create 300,000 jobs, although the costs in terms of vehicle characteristics and prices and limited consumer choice could be significant (Bezdek and Wendling, 2005). There would be widespread job displacement and job impacts were disaggregated by industry, state, and occupation.

2.3. Empirical estimates of actual environmental employment

For two decades, Environmental Business International has been publishing estimates of the size of the US environmental industry with times series data beginning in 1970. The data are disaggregated by Services (analytical services, wastewater treatment, solid waste, hazardous waste, remediation, and consulting and engineering), Equipment (water and chemicals, instruments and information, air pollution control, waste management, and process and prevention), and Resources (water utilities, resource recovery, and clean energy systems and power). EBI estimates that the size of the US environmental industry has increased from $18 billion in 1970 to $227 billion in 2003. Corresponding employment or jobs numbers are not published.[2]

MISI has been estimating the economic and jobs impact of the environmental industry for two decades.[3] Using an econometric input–output (I–O) model to estimate the direct and indirect impact of the industry, MISI estimates that EP has increased from $39 billion in sales (2003 dollars) and 700,000 jobs in 1970 to $300 billion (2003

[2]Environmental Business International, Inc., San Diego, California, www.ebiusa.com

[3]Roger H. Bezdek. "The Environmental Protection Industry and Environmental Jobs in the U.S.A." In Leal Filho and Kate Crowley, eds., *Environmental Careers, Environmental Employment, and Environmental Training: International Approaches and Contexts*. Frankfurt am Main: Peter Lang Publishers, 2001, pp. 161–179; "State of the Industry: Jobs and Sales Created by Environmental Protection." *New England's Environment*. Vol. 1, No. 8 (August 1999), pp. 12–16; "The Net Impact of Environmental Protection on Jobs and the Economy." Chapter 7 in Bunyan Bryant, editor., *Environmental Justice: Issues, Polices, and Solutions*, Washington, DC: Island Press, 1995, pp. 86–105; "The Economy, Jobs, and the Environment." *Proceedings of GEMI '95: Environment and Sustainable Development*. Arlington, Virginia, March 1995, pp. 65–79; "Environment and Economy: What's the Bottom Line?" *Environment*, vol. 35(7) (September 1993), pp. 7–32. Roger H. Bezdek and Robert M. Wendling, "Environmental Market Opportunities." Chapter 9 in T.F.P. Sullivan, editor, *The Greening of American Business*. Rockville, Maryland: GII Press, 1992, pp. 196–224; Management Information Services, Inc., *Jobs and Economic Opportunities in the U.S. Created by Environmental Protection*. Periodic reports, 1986–2004.

dollars) and 5 million jobs in 2003—see the discussion in Section 5.

In 2001, MISI analyzed the environmental industry and jobs in six Midwestern states: Illinois, Iowa, Michigan, Minnesota, Ohio, and Wisconsin.[4] It found that in 1998, environment-related employment in these states totaled 893,000 widely distributed among sectors, industries, jobs, and skills. Jobs estimates were disaggregated among each of the six states.

In 1999, the US International Trade Administration (ITA) estimated the world market for environmental products and services and the size of the US market, including estimates at the state and metropolitan statistical area (MSA) levels.[5] ITA estimated that the 1999 US environmental market totaled $189 billion, almost 38% of the global $499 billion market. In meeting the demands of those markets, the US environmental industry was estimated to have generated $196 billion of revenues and over 1.4 million jobs. The ITA US employment estimates were disaggregated by state and by selected MSAs.

The Census MA200 survey has been one of the more respected sources for information on the US environmental industry.[6] This report was not available for a number of years after 1994, but was revived for 1999. The MA200 results are not consistent with previous reports, but they presented a snapshot of major portions of the environmental industry by detailed North American Industry Classification System (NAICS) industry and by state. However, the survey's biggest weakness is that it only covers the mining (NAICS 21), manufacturing (NAICS 31-33), and electric power generation industries (NAICS 22111). Thus, while the survey estimates are of sufficient quality, they lack comprehensiveness and describe only a fraction of the environment-related business activities in the US Pollution abatement costs were disaggregated by capital expenditures and operating costs, but employment estimates were not included.

3. Methodology

The economic and employment effects of EP expenditures were estimated using the Management Information Services, Inc. model, database, and information system. A simplified version of the MISI model as applied in this study is shown in Fig. 1.

The first step involves translation of environmental expenditures into per unit output requirements from every industry in the economy. Second, the direct output requirements of every industry affected by the expenditures are estimated, and they reflect the production and technology requirements implied by the environmental spending. These direct requirements show, proportionately, how much an industry must purchase from every other industry to produce one unit of output. Direct requirements, however, give rise to subsequent rounds of indirect requirements. The sum of the direct plus the indirect requirements represents the total output requirements from an industry necessary to produce one unit of output.

Economic I–O techniques allow the computation of the direct and the indirect production requirements. Direct industry output requirements are converted into total output requirements from every industry by means of the I–O inverse equations. These equations show not only the direct requirements, but also the second, third, fourth, *n*th round indirect industry and service sector requirements resulting from environmental expenditures. Next, the total output requirements from each industry are used to compute sales volumes, profits, and value added for each industry. Then, using data on manhours, labor requirements, and productivity, and employment requirements, the number of jobs created within each industry are estimated.

The next step requires the conversion of total employment requirements by industry into job requirements for specific occupations and skills. To accomplish this, MISI utilizes data on the occupational composition of the labor force within each industry and estimates job requirements for 700 occupations encompassing the entire US labor force. This permits estimation of the impact of environmental expenditures on jobs for specific occupations.

Utilizing the modeling approach outlined above, the MISI model allows estimation of the effects on employment, personal income, corporate sales and profits, and government tax revenues in the US Estimates can then be developed for detailed industries and occupations.

The final step in the analysis required assessing the economic impacts on individual states, which were estimated using the MISI regional model, which allows the flexibility of specifying multi-state, state, or county levels of detail. Because of the comprehensive nature of the modeling system, these regional impacts are consistent with impacts at the national level.

4. What constitutes an environmental job?

4.1. Ambiguities and questions

As discussed below, we estimate that EP created nearly 5 million jobs in the US in 2003, and these were distributed widely throughout all states and regions within the US But how many of these are "environmental jobs" or "green jobs?" More specifically, what constitutes an "environmental job?" While a definitive analysis of this important

[4]Management Information Services, Inc. *Survey of Jobs and the Environment Issues in Six Midwestern States: Identifying Policy Challenges and Opportunities*. Report prepared for the Joyce Foundation, Chicago, IL, July 2001.

[5]US Department of Commerce, ITA, Office of Environmental Technologies Industries. *Environmental Industry of the United States*, a USDOC/ITA web-accessible briefing generated by Environmental Business International, Inc. for 1999.

[6]US Department of Commerce, Bureau of the Census. *Pollution Abatement Cost and Expenditures: 1999*. MA200(99), November 2002.

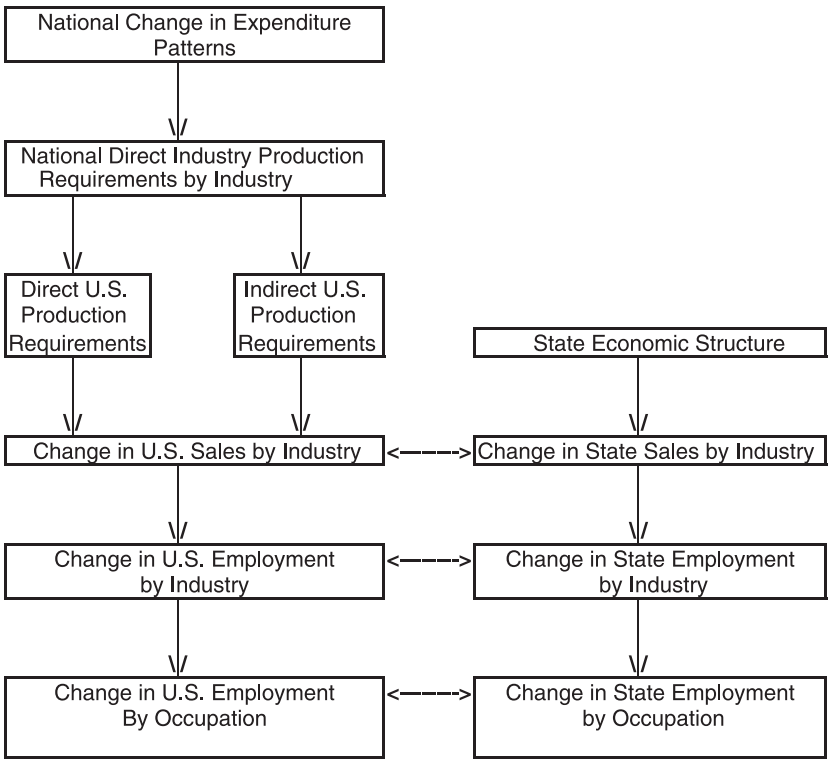

Fig. 1. Use of the MISI model to estimate the economic, employment, and occupational impacts of environmental protection. *Source*: Management Information Services, Inc., 2006.

topic is outside the scope of this report, our review of the literature indicates that there is no rigorous, well-accepted definition of an environmental job. Rather, the definitions used are often loose and contradictory.

Clearly, an ecologist or an environmental engineer would constitute an environmental job, as would an employee of the federal or a state EP agency. However, there are ambiguities. For example, most people would agree that the positions in a firm that assembles and installs solar thermal collectors would be considered environmental jobs. But what about the jobs involved in producing those solar panels, especially if the factory involved used coal-based energy, one of the most controversial fossil fuels in terms of emissions? Here, these manufacturing jobs are included as jobs created indirectly by environmental expenditures.

Most analysts would consider jobs in a recycling plant to be environmental jobs. But what if the recycling plant itself produces air pollution? What about a firm in North Carolina that produces emissions control equipment for power plants in Alabama? It seems clear that the jobs in the North Carolina company should be considered green or environmental jobs, even though the user of the equipment in Alabama may cause pollution in North Carolina. What about environmental engineers and environmental controls specialists working in a coal-fired power plant? What about the workers who produce environmental control equipment for the plant?

There are many firms in the US that produce products for the automotive industry. Should those that produce components for fuel-efficient vehicles be considered part of the environmental industry, but not those that produce components for gas guzzlers? If so, is there any way to accurately distinguish between these? Should all factories producing catalytic converters be considered environmental jobs, even when some of these converters are used on low miles-per-gallon vehicles?

These relevant questions have, in fact, been generated by shifts in environmental policy itself. The early stages of the environmental movement in the 1970s and 1980s focused primarily on "end-of-the pipe" solutions: The remedies focused on cleaning or minimizing air, water, or solid waste pollutants after they had been produced. However, EP has evolved to include entire processes, so, rather than cleaning up at the end of the pipe, the entire manufacturing and servicing processes are being designed to minimize the production of pollutants. Therefore, it is possible that efficient processes designed to produce relatively little waste output could actually result in a decrease in the number of "environmental" jobs if these are defined strictly as "end of the pipe" jobs. Energy efficiency could ultimately result in less need for electric power and could result in the shutting down of a coal-fired electric power plant. While some may view such a shutdown as an environmental plus, many environmental jobs in that power plant involving pollution abatement would be in this case lost.

While solid waste abatement is a major area of environmental concern, does this imply that all persons engaged in trash collection are performing environmental

jobs? What part of the tourism industry constitutes "ecotourism," and are all jobs associated with ecotourism green jobs? Are forms of alternative energy green industries, with all jobs counting as environmental jobs?

There is also the issue of how to account for indirect job creation and how broadly or narrowly to define an indirect environmental job. For example, what of ancillary jobs created across the street from a factory producing solar collectors, such as those in a fast food restaurant, dry cleaner, etc. whose customers are primarily the workers at the renewable energy factory. Are these latter jobs also considered to be "indirect" green jobs or environmental jobs? We include such indirect jobs here.

4.2. Definitions and concepts used here

Here, we consider that jobs can be considered to be "green" relative to the way the job was performed previously, i.e., in a production process, a change in technology that reduces waste emissions or energy consumption makes the jobs in that process "greener" than before. Based on extensive research and literature review, we determine that environmental jobs are best understood when viewed in a continuum, with jobs that generate environmental degradation or extraction at one end; a range of greener jobs involving clean production measures and technologies to reduce environmental impacts in the center, and the other end of the spectrum where jobs have a positive environmental impact (see Fig. 1). Using this concept, we define environmental industries and green jobs as those which, as a result of environmental pressures and concerns, have produced the development of products, processes, and services, which specifically target the reduction of environmental impact. Environment-related jobs include those created both directly and indirectly by EP expenditures (Fig. 2).

There exists relatively little rigorous research addressing the practical relationship between EP and job creation. Even some research in this area sponsored by environmental organizations is off the mark, in that it has tended to emphasize jobs creation in classically green activities, such as environmental lawyers or workers in recycling plants. However, while these jobs count as jobs related to the environment, we found that classic environmental jobs constitute only a small portion of the jobs created by EP. The vast majority of the jobs created by EP are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. In fact, most of the persons employed in these jobs may not even realize that they owe their livelihood to protecting the environment. For example, as illustrated in Fig. 3, in the US in 2003, we estimate that EP created: More jobs for secretaries (97,900) than for environmental scientists (50,700); more jobs for management analysts (82,600) than for environmental engineers (45,200); more jobs for bookkeepers (71,600) than for hazardous materials workers (33,300); more jobs for janitors (56,400) than for environmental science technicians (25,000); more jobs for computer systems analysts (30,000) than for chemical engineers (8200); and more jobs for truck drivers (25,200) than for biological technicians (12,100).

More generally, arguments stressing the economic benefits and job creation resulting from EP and clean energy initiatives are not currently being made in a rigorous manner, which disaggregates these benefits to a level of detail that is meaningful to policymakers. The level

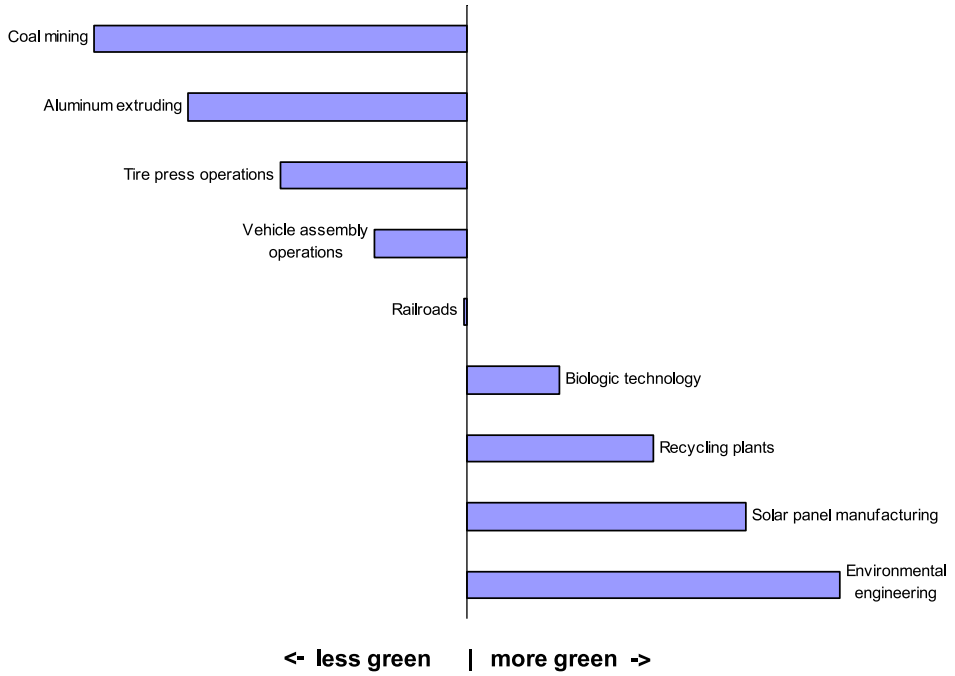

Fig. 2. The environmental job spectrum. *Source*: Management Information Services, Inc., 2006.

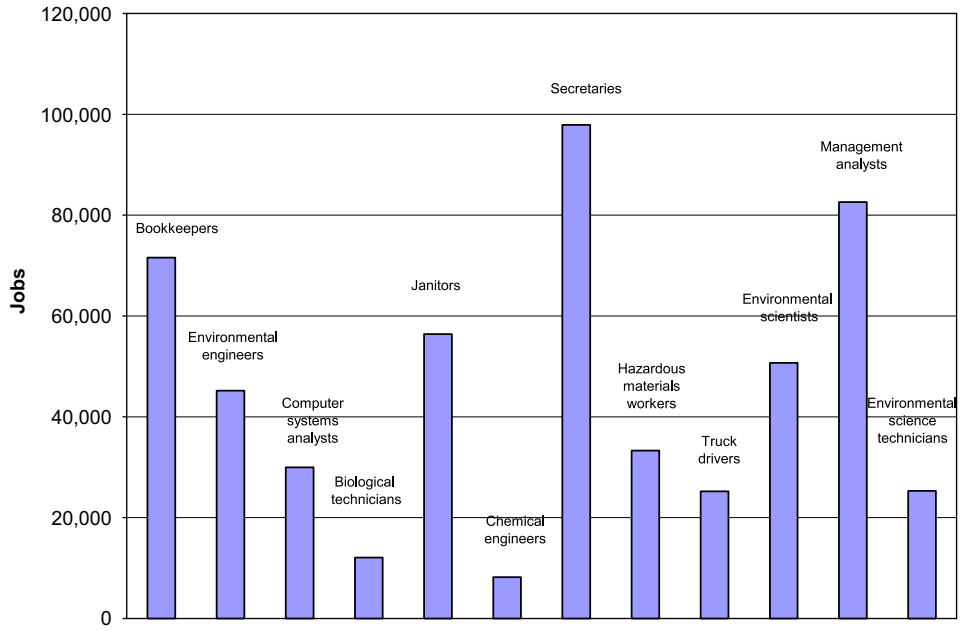

Fig. 3. Selected US jobs created in 2003 by environmental expenditures. *Source*: Management Information Services, Inc., 2006.

of detail required is at the sector, industry, state, city, and county level, and the jobs created have to be identified by industry, category, skill, and specific occupation at the state and local level. The findings summarized here provide data at such levels of detail.

4.3. Jobs distribution in typical environmental companies

There are thousands of environmental companies located throughout the US and they generate jobs for nearly 5 million workers in virtually every community. These firms range from the very small one or two person "mom and pop" shops to very large firms employment thousands of workers; they employ workers at all levels of skills, from the most basic and rudimentary to the very high skilled technical and professional; include environmental service firms and manufacturing firms; include those whose market is local, those whose market is state and regional, those who market is national, and those whose market is international, and they face the same problems, challenges, and opportunities as other companies

Given the wide diversity in the size, function, and technologies of environmental companies, it is impossible to estimate the job profile of the "average" environmental firm. However, it is possible to identify the jobs and earnings profiles of typical types of firms involved in environment-related areas of work. Table 1 shows the 2003 occupational job distribution and employee earnings of a typical environmental remediation services company; Table 2 shows the same data for a typical wind turbine manufacturing company. These tables illustrate the points made above.

First, firms working in the environmental and related areas employ a wide range of workers at all educational and skills levels and at widely differing earnings levels.

Second, even in environmental companies, most of the employees are not classified as "environmental specialists." For example, in the environmental remediation services firm profiled in Table 1, most of the workers are in occupations such as laborers, clerks, bookkeepers, accountants, maintenance workers, cost estimators, etc. All of these employees owe their jobs and livelihoods to EP, but, in general, they perform the same types of activities at work as employees in firms that have little or nothing to do with the environment.

This is illustrated even more forcefully in Table 2. The occupational job distribution of a typical wind turbine manufacturing company differs relatively little from that of a company that manufactures other products. Thus, the production of wind turbines and components requires engine assemblers, machinists, machine tool operators, mechanical and industrial engineers, welders, tool and die makers, mechanics, managers, purchasing agents, etc. These are "environmental" workers only because the company they work for is manufacturing a renewable energy product. Importantly, with the current national angst concerning the erosion of the US manufacturing sector and the loss of US manufacturing jobs, it is relevant to note that many environmental and renewable energy technologies are growing rapidly.[7]

[7]For example, windpower is the most rapidly growing source of electrical power in the world.

Table 1
Typical employee profile of a 100-person Environmental Remediation Services Company, 2003

Occupation	Employees	Earnings
Hazardous materials removal workers	22	$36,204
Septic tank servicers and sewer pipe cleaners	8	30,419
Construction laborers	7	32,382
First-line supervisors/managers of construction/extraction	5	50,673
Truck drivers, heavy and tractor-trailer	5	33,044
General and operations managers	3	86,258
Laborers and freight, stock, and material movers	2	21,620
Truck drivers, light or delivery services	2	27,437
Office clerks	2	23,384
Refuse and recyclable material collectors	2	26,796
Insulation workers	2	32,256
Secretaries (except legal, medical, and executive)	2	25,998
Bookkeeping, accounting, and auditing clerks	2	31,217
Plumbers, pipefitters, and steamfitters	1	41,202
Executive secretaries and administrative assistants	1	36,729
Maintenance and repair workers	1	30,849
Environmental engineering technicians	1	36,939
Operating engineers and other const. equip. operators	1	40,520
First-line supervisors/managers of office/ administrative	1	47,576
Chief executives	1	116,435
Construction managers	1	73,994
Cleaners of vehicles and equipment	1	21,704
Cost estimators	1	56,753
Janitors and cleaners	1	25,746
Environmental engineers	1	69,930
Industrial truck and tractor operators	1	27,741
Carpenters	1	38,588
Construction and maintenance painters	1	33,296
Accountants and auditors	1	53,865
Dispatchers (except police, fire, and ambulance)	1	29,537
Water and liquid waste treatment plant and system operators	1	31,049
First-line supervisors/managers of transportation operators	1	46,914
Sales representatives, wholesale and manufacturing	1	42,683
Customer service representatives	1	30,366
First-line supervisors/managers of mechanics and repairers	1	49,088
Environmental scientists and specialists	1	62,003
Receptionists and Information clerks	1	22,775
Environmental science and protection technicians	1	44,867
Other employees	12	47,422
Employee total	100	$39,621

Source: Management Information Services, Inc., 2006.

Table 2
Typical Employee Profile of a 250-person Wind Turbine Manufacturing Company, 2003

Occupation	Employees	Earnings
Engine and other machine assemblers	31	$33,359
Machinists	27	37,191
Team assemblers	16	27,668
Computer-controlled machine tool operators	12	37,254
Mechanical engineers	10	65,772
First-line supervisors/managers of production/operating	10	54,705
Inspectors, testers, sorters, samplers, and weighers	8	37,202
Lathe and turning machine tool setters/ operators/tenders	6	36,729
Drilling and boring machine tool setters/ operators/tenders	4	36,509
Welders, cutters, solderers, and brazers	4	36,530
Laborers and freight, stock, and material movers	4	28,466
Maintenance and repair workers	4	41,318
Tool and die makers	4	40,047
Grinding/lapping/polishing/buffing machine tool operators	4	31,899
Multiple machine tool setters/operators/ tenders	4	37,517
Industrial engineers	3	64,659
Industrial machinery mechanics	3	42,315
Engineering managers	3	99,404
Shipping, receiving, and traffic clerks	3	29,516
General and operations managers	3	110,702
Industrial production managers	3	85,512
Industrial truck and tractor operators	3	31,416
Purchasing agents	3	51,702
Cutting/punching/press machine setters/ operators/tenders	3	28,907
Production, planning, and expediting clerks	3	41,601
Milling and planing machine setters/ operators/tenders	3	37,380
Mechanical drafters	2	44,090
Customer service representatives	2	36,036
Bookkeeping, accounting, and auditing clerks	2	32,760
Office clerks, general	2	27,227
Sales representatives, wholesale and manufacturing	2	50,757
Janitors and cleaners	2	28,476
Sales engineers	2	66,591
Accountants and auditors	2	54,873
Tool grinders, filers, and sharpeners	2	40,520
Executive secretaries and administrative assistants	2	39,638
Mechanical engineering technicians	2	46,767
Electricians	2	45,570
Other employees	48	45,969
Employee total	250	$42,726

Source: Management Information Services, Inc., 2006.

5. Findings at the national level

We found that, contrary to general public perception and public policy understanding, since the late 1960s, protection of the environment has grown rapidly to become a major sales-generating, profit-making, job-creating industry. Expenditures in the US for EP have grown (in constant 2003 dollars) from $39 billion per year

Table 3
Environmental protection expenditures and jobs in the us economy, 1970–2003

	Expenditures (billions of 2003 dollars)	Jobs (thousands)
1970	$39	704
1975	77	1352
1980	121	2117
1985	158	2838
1990	204	3517
1995	235	4255
2003	$301	4974

Source: Management Information Services, Inc., 2006.

in 1970 to $301 billion per year by 2003—increasing more rapidly than GDP over the same period—see Table 3. If "EP" were a corporation, it would rank higher than the top of the Fortune 500, for our estimate of 2003 EP expenditures ($301 billion) ranks it higher than the sales of $259 billion for Wal-Mart, the largest corporation in the US In 2003, EP generated five million jobs distributed widely throughout the nation.

Many companies, whether they realize it or not, owe their profits—and in some cases their existence—to EP expenditures.[8] Many workers, whether they realize it or not, would be unemployed were it not for these expenditures: In 2003, EP created nearly five million jobs distributed widely throughout the nation. To put this into perspective, the size of environment-related employment is over ten times larger than employment in the US pharmaceuticals industry, nearly six times larger than the apparel industry, almost three times larger than the chemical industry, nearly half the employment in hospitals, and almost one-third the size of the entire construction industry.

We estimate that in 2003 protecting the environment generated $301 billion in total industry sales, $20 billion in corporate profits, 4.97 million jobs, and $45 billion in Federal, state, and local government tax revenues.[9] Clearly, providing the goods and services required for EP has become a major US industry with significant effects on the national economy and labor market and on those of individual states.[10]

6. Findings at the state level

As part of the research initiative we have thus far estimated and assessed the environmental industry and jobs in six states: Florida, Michigan, Minnesota, North Carolina, Ohio, and Wisconsin.[11] Our findings are summarized in Tables 4 and 5.

6.1. Aggregate and sectoral findings

Table 4 summarizes the parameters of the environmental industries in each state. The size of the industry in each state differs considerably, from $5.4 billion in Wisconsin to $15.4 billion in Florida, generally corresponding to the differences in state GDP. However, the industry share of state GDP differs from a high of 3.9% in Michigan to a low of 2.6% in Minnesota. Similarly, environment-related employment ranges from 220,000 in Florida to 92,000 in Minnesota—again reflecting mainly the differences in the sizes of the state labor forces. Environmental employment ranges from a high of 4.9% of total employment in Ohio to 2.9% in North Carolina.

The shares of each state of the total US environmental industry and environment-related jobs also differ substantially, depending largely on the size of state GDP and labor force. Nevertheless, there are some important differences among the states. For example, while the number of environment-related jobs is about the same in both Michigan and Florida and each state has about 4.4% of the national total, the population of Florida is nearly twice that of Michigan—Florida represents about six percent of the US population while Michigan comprises 3.4%. That is, per capita, the size of the environmental industry in Michigan is nearly twice that of the industry in Florida.

Table 5 shows the industry sector distribution of total employment and of environmental employment in each of the six states. It and Table 4 illustrate that environment-related jobs are distributed among all sectors, but are heavily concentrated in several. Significant portions of the environmental jobs in each state are in the public administration sector which, given the public nature of EP, is to be expected. However, most of the environmental jobs in the states are in the private sector, and focusing on these reveals that they are heavily concentrated in several sectors.

[8]In this paper,"expenditures" refers to all public and private spending in the environmental sector (EP spending) and is used interchangeably with "sales."

[9]The national estimates have been developed by MISI beginning in 1986 using the model and database summarized in Section 2, and have been updated periodically over the past two decades. The six states discussed here were selected for detailed analysis at the request of the funders of the work. The overall project goal is to eventually conduct similar analyses for as many states as possible and, at present, estimates are being developed for three more states—Arizona, California, and Connecticut—to provide better geographic coverage. In addition, analyses for states such as New York, Oregon, and Washington that have traditionally been viewed as environmentally aggressive can help determine if environmental job growth has been more rapid in these states. Findings will be posted on the MISI web site when available: www.misi-net.com

[10]As discussed, all estimates of the size of the environmental industry rely critically on the exact definition of the industry. Since there is no official definition, estimates of the size of the environmental industry differ according to the source. In MISI's case, the definition of the industry includes human and environmental sustainability principles, and MISI's estimates thus include a broader range of environmental activities in the economy than some other definitions that have been developed.

[11]The detailed findings for each state are available on the MISI web site: www.misi-net.com

Table 4
Summary of the environmental industries in six states in 2003

	Environmental industry (billions) ($)	Environmental jobs	Environmental industry as a percent of		State environmental industry as a percent of		Private sector environmental jobs	
			State GDP (%)	State jobs (%)	Total US environmental industry (%)	Total US environmental jobs (%)	Manufacturing (%)	Professional, scientific, technical (%)
Florida	15.4	220,000	3.1	3.0	5.0	4.4	7	22
Michigan	12.9	217,000	3.9	4.9	4.3	4.4	29	29
Minnesota	5.1	92,000	2.6	3.5	1.7	1.8	21	23
North Carolina	9.1	112,000	3.1	2.9	3.0	2.9	24	20
Ohio	12.2	176,000	3.2	3.3	4.1	3.5	29	25
Wisconsin	5.4	97,000	2.9	3.5	1.8	2.0	31	16

Source: Management Information Services, Inc., 2006.

Of particular note is that the private sector environmental industry is more manufacturing intensive than other average private sector activity in the states. As shown in Fig. 4, in Florida, 7.4% of private sector jobs in the environmental industry is in manufacturing, compared to 6.2% in manufacturing among all private sector jobs in the state; in Michigan, 29% of private sector jobs in the environmental industry is in manufacturing, compared to 17% in manufacturing among all private sector jobs; in Minnesota, the comparable shares are 21% and 15%; in North Carolina, the comparable shares are 24% and 19%; in Ohio, the comparable shares are 29% and 18%; in Wisconsin, the comparable shares are 31% and 21%.

The jobs concentration is even more pronounced with respect to employment in the professional, scientific, and technical services sector. As shown in Fig. 5, in Florida, 22% of private sector environmental jobs is in professional, scientific, and technical services, compared to 6% of all private sector jobs in the state; in Michigan, 29% of private sector environmental jobs is in professional, scientific, and technical services, compared to 8% of all private sector jobs in the state; in Minnesota, the comparable shares are 23% and 5%; in North Carolina, the comparable shares are 20% and 5%; in Ohio, the comparable shares are 25% and 7%; in Wisconsin, the comparable shares are 16% and 4%.

Conversely, there are relatively few private sector environmental jobs in other parts of the states' economies, including retail trade, finance and insurance, health care and social services, and transportation and warehousing.

The concentration of environmental jobs within certain industrial sectors is instructive and interesting. While accounting for only abut 3–5% of total employment in each state, the industry sector composition of environmental employment is highly skewed in favor of certain sectors—including manufacturing. This indicates that investments in the environment will provide a greater than proportionate assist to the states' manufacturing sectors. All of these states are seeking to modernize and expand their high-tech industrial and manufacturing bases. Table 5 and Fig. 4 indicate that the environmental industry can aid in this objective.

Similarly, environmental investments generate, proportionately, 3–4 times as many jobs in professional, scientific, and technical services as the state averages. Jobs in this sector include the high-skilled, high-wage, technical, and professional jobs that all states seek to attract and retain. Table 5 and Fig. 5 indicate that investments in EP can be of considerable assistance here.

6.2. Environmental jobs by occupation

We disaggregated environmental employment in each state by specific occupations and skills. The results for Florida and Michigan are representative of those for the six states, and this information for selected occupations is given in Tables 6 and 7. These tables illustrate that environmental jobs are widely distributed among all occupations and skill levels and, while the number of jobs created in different occupations differs substantially, employment in virtually all occupations is generated by environmental spending.

As noted in Section 4, the vast majority of the jobs created by EP are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc., and most of the persons employed in these jobs may not even realize that they owe their livelihood to protecting the environment. This is further illustrated in Tables 6 and 7, which list the jobs created by EP in Florida and Michigan in 2003 within selected occupations. For example, Table 6 shows that EP generated in Florida: More jobs for sheet metal workers (821) than for geoscientists (241); more jobs for office clerks (4968) than for environmental engineers (2545); more jobs for executive secretaries (2432) than for landscape architects (313); more jobs for janitors (1827) than for natural science managers (207); more jobs for electricians (708) than for chemists (242); more jobs for truck drivers (2870) than for septic tank servicers (2181); more jobs for financial managers (684) than for conservation scientists (371); more jobs for

Table 5
Environmental-related jobs in each state, by industry

Industry	Florida employment		Michigan employment		Minnesota employment		N. Carolina employment		Ohio employment		Wisconsin employment	
	Total	Environmental	Total	Environmental	Total	Environmental	Total	Environmental	Total	Environmental	Total	Environmental
Agriculture, forestry, fishing and hunting	2300	192	3515	216	800	86	3700	120	1564	129	2500	208
Mining	4900	459	5226	627	5200	515	4000	293	10,505	678	1300	145
Utilities	26,800	4973	24,136	6914	12,000	2902	14,000	2114	26,109	5949	11,600	2782
Construction	445,900	9966	173,244	8633	125,200	4497	211,800	4732	212,409	7061	123,500	4295
Manufacturing	388,800	9849	659,736	38,895	344,300	11,974	604,300	14,013	805,716	28,149	506,500	17,400
Wholesale trade	313,200	3692	178,545	4021	127,800	2151	163,600	1827	243,493	3634	113,000	1752
Retail trade	920,400	5833	503,576	351	301,700	1778	432,500	2582	591,557	322	319,000	1962
Transportation and warehousing	202,100	1300	90,412	544	80,100	507	110,700	632	130,002	516	94,600	555
Information	171,800	4278	86,397	170	62,600	1751	75,600	1797	103,334	148	49,700	1382
Finance and insurance	330,900	1962	168,065	202	138,100	1062	143,700	855	248,897	209	129,800	861
Real estate and rental and leasing	153,400	1680	61,676	278	37,900	527	47,800	577	66,212	248	27,900	416
Professional, scientific, and technical services	384,400	28,606	195,553	39,432	118,200	12,922	146,300	11,616	221,765	24,657	89,000	9341
Management of companies and enterprises	65,600	1032	152,641	2188	59,000	1385	61,200	971	134,502	1848	37,600	861
Administrative/support/waste management/ remediation services	807,500	41,971	294,857	25,287	117,300	7622	213,700	10,001	319,058	17,242	118,200	7586
Educational services	108,400	3198	70,286	2537	48,400	1676	61,600	1753	97,489	3186	46,100	1807
Health care and social assistance	777,200	4364	516,974	1269	318,300	2099	366,600	1848	678,618	1205	320,500	2330
Arts, entertainment, and recreation	157,200	1030	53,009	449	36,900	247	44,000	240	58,265	399	35,500	229
Accommodation and food services	651,300	5286	327,545	188	196,200	1525	291,000	1837	410,303	187	209,500	1641
Other services	317,800	3107	175,892	2676	118,900	1330	162,400	1335	229,701	2465	131,300	1310
Public administration	1,055,500	86,723	670,515	81,624	402,400	35,545	644,600	52,865	801,500	77,877	411,800	40,337
State total	7,285,400	219,500	4,411,800	216,500	2,651,300	92,100	3,803,100	112,007	5,390,999	176,109	2,778,900	97,200

Source: Management Information Services, Inc., 2006.

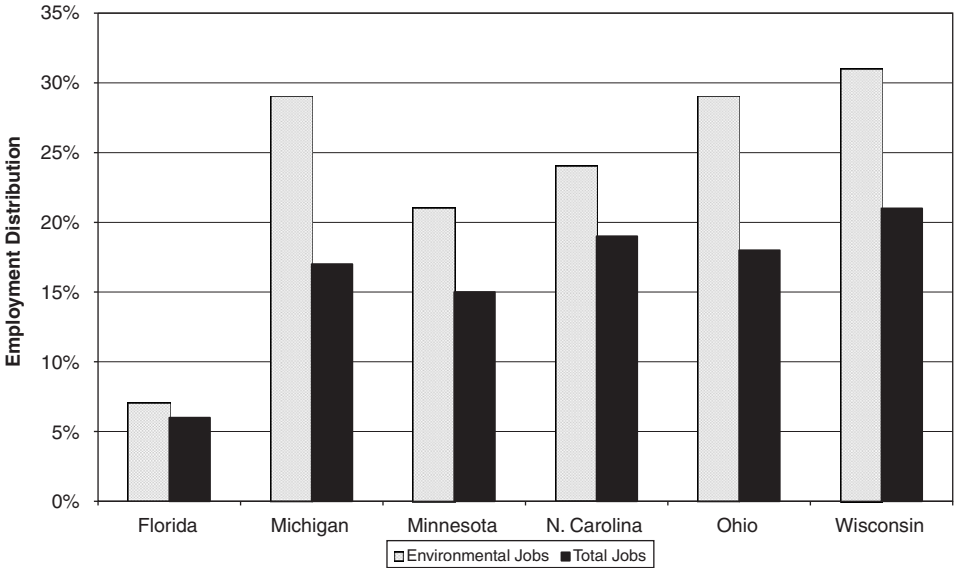

Fig. 4. Private sector manufacturing jobs. *Source*: Management Information Services, Inc., 2006.

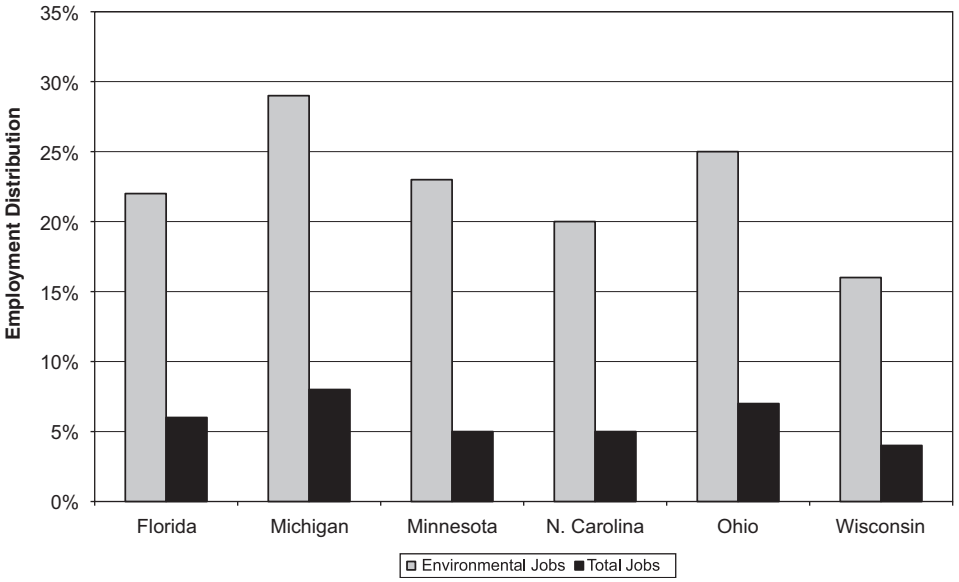

Fig. 5. Private sector professional, scientific and technical jobs. *Source*: Management Information Services, Inc., 2006.

management analysts (2049) than for environmental engineering technicians (1289); and more jobs for computer software engineers (1839) than for hazardous material removal workers (1267).

Table 7 shows similar findings for Michigan. Thus, many workers in Florida and Michigan are dependent on EP for their employment, although they often would have no way of recognizing that connection unless it is brought to their attention.

The importance of environmental spending for jobs in some occupations is much greater than in others. For some occupations, such as environmental scientists and specialists, environmental engineers, hazardous materials workers, water and liquid waste treatment plant operators, environmental science protection technicians, refuse and recyclable material collectors, and environmental engineering technicians, virtually all of the demand in both states is created by EP activities. This is hardly surprising, for most of these jobs are clearly identifiable as "environmental" jobs.

However, in many occupations not traditionally identified as environment-related, a greater than proportionate share of the jobs is also generated by EP. On average, environment-related employment in Florida comprises only 3% of total employment and in Michigan comprises 4.9%, in 2003 EP expenditures generated jobs for a greater than proportionate share—as much as 10% or more—of many professional occupations in the two states, including chemists, civil engineers, computer software engineers, electronics engineers, geoscientists, landscape architects, medical scientists, natural sciences managers, surveyors,

Table 6
Environmental jobs generated in florida in 2003, by selected occupations

Occupation	Jobs
Accountants and auditors	1272
Bookkeeping and accounting clerks	2092
Cashiers	3591
Chemists	242
Computer software engineers	1873
Conservation scientists	371
Customer service representatives	2334
Electricians	708
Electronics engineers	781
Environmental engineers	2545
Environmental engineering technicians	1289
Environmental scientists and specialists	5659
Executive secretaries and administrative assistants	2432
Financial managers	684
Forest and conservation workers	199
Geoscientists	241
Graphic designers	296
Hazardous material removal workers	1267
Inspectors, testers, and sorters	323
Janitors and cleaners	1827
Landscape architects	313
Mechanical engineers	250
Management analysts	2049
Marketing managers	454
Medical scientists, except epidemiologists	255
Natural science managers	207
Office clerks	4949
Pest control workers	1161
Security guards	1614
Septic tank servicers and sewer pipe cleaners	2141
Sheet metal workers	821
Stock clerks	2587
Training and development specialists	431
Truck drivers	2870
Water and liquid waste treatment plant operators	5484
Welders and Solderers	328

Source: Management Information Services, Inc., 2006.

Table 7
Environmental jobs generated in Michigan in 2003, by selected occupations

Occupation	Jobs
Accountants and auditors	1780
Chemical engineers	197
Computer and information systems managers	535
Construction laborers	880
Customer service representative	2425
Electricians	1079
Engine and other machine assemblers	186
Environmental engineers	1382
Environmental scientists and specialists	1523
Employment, recruitment, and placement specialists	525
Financial analysts	353
Forest and conservation technicians	190
Forging machine setters, operators, and tenders	204
Geoscientists, except hydrologists and geographers	272
Hazardous material removal workers	1210
Human resource managers	297
Industrial engineers	739
Industrial machinery mechanics	464
Inspectors, testers, and sorters	1161
Janitors and cleaners	3040
Landscaping and grounds workers	1101
Machinists	966
Management analysts	1134
Marketing managers	311
Mechanical engineering technicians	307
Medical scientists, except epidemiologists	225
Office clerks	4118
Packers and packagers	952
Receptionists and information clerks	1512
Refuse and recyclable material collectors	5454
Sales representatives, technical and scientific products	563
Secretaries	2522
Security guards	1115
Septic tank services and sewer pipe cleaners	702
Tool and die makers	524
Truck drivers, heavy and tractor trailer	2176
Water and liquid waste treatment plant operators	5130
Word processors and typists	523

Source: Management Information Services, Inc., 2006.

urban and regional planners, chemical engineers, and engineering managers.

For many other occupations, also not traditionally identified as environment-related, a greater than proportionate share of the jobs is also generated by EP. On average, environment-related employment in Florida comprises only 3% of total employment and in Michigan 4.9%, in 2003 EP generated jobs for as much as 10% or more of many highly skilled, technical occupations in the two states, including architectural and civil drafters, chemical technicians, civil engineering technicians, electrical and electronics engineering technicians, electrical and electronics equipment assemblers, electrical and electronics drafters, fiberglass laminators and fabricators, forest and conservation technicians, heating, air conditioning, and refrigeration mechanics and installers, industrial engineering technicians, surveying and mapping technicians, chemical plant and system operators, electrical and electronics repairers, engine and other machine assemblers, surveying and mapping technicians, and network systems and data communications analysts.

The above findings are significant for they indicate that EP creates jobs in greater than proportionate share in two categories that Florida and Michigan—and other states—are eager to attract: (i) college-educated professional workers, many with advanced degrees, and (ii) highly skilled, technical workers, with advanced training and technical expertise, many of them in the manufacturing sector. EP thus generates jobs that are disproportionately for highly skilled, well-paid, technical and professional workers, who in turn underpin and provide foundation for entrepreneurship and economic growth.

Our work thus demonstrates that EP can form an important part of a strategy for states based on attracting and retaining professional, scientific, technical, high-skilled, well paying jobs, including manufacturing jobs. While a successful strategy must have other components as

well, rarely has any state recognized the economic and jobs benefits that could flow from specifically encouraging the development of environmental and environment-related industries as an economic development initiative. Indeed, usually the opposite is the case: Most states usually tend to view EP as economically negative.[12]

Another important finding derived here is the significance of the environmental industry compared to other sectors of the state economies. For example, the tourism industry generates about 540,000 jobs in the Florida, and this state well recognizes the key role that tourism plays in the state economy. Here, we estimate that environment-related jobs in Florida total 220,000—jobs that tend to be more highly skilled and better paying than those in the tourism sector. This fact is not widely known or appreciated by state policy-makers.

7. Comparison to other estimates of environmental spending

Aside from the estimates presented here, the only other comprehensive, consistent time series of estimates of US environmental expenditures over the past four decades are those developed by Environmental Business, International (EBI).[13] The MISI and EBI data series are not strictly comparable. For example, MISI estimates environment-related spending using the expenditure concept and disaggregates spending by media (air, water, land, etc.) and other categories such as R&D, energy-related environmental programs, and so forth. EBI focuses on revenues to business and classifies spending into services (analytical, hazardous waste, consulting & engineering, etc.) equipment (air pollution control, waste management, instruments & information, etc.), and resources (water utilities, resource recovery, and clean energy & power).

A comparison of the MISI and EBI estimates[14] is given in Table 8, which shows that:

- During the 1970s, the EBI estimates of environmental expenditures were significantly higher than the MISI estimates.
- From 1980 through 1995, the MISI and EBI estimates were roughly comparable
- By 2000, the MISI estimates were larger than the EBI estimates.
- The percentage growth rates in expenditures over the past four decades were roughly comparable, and both data sets show the rate of increase in environmental spending decreasing after 1970.
- The forecast rate of growth of environmental spending through 2010 by both EBI and MISI are nearly identical, although from different bases.
- EBI shows the rate of growth of expenditures to be between three and 5% from 1995 to 2003, whereas MISI shows the rates of growth to be considerably higher, although declining.
- MISI forecasts that from 2010 to 2020, environmental expenditures will increase by 23%, whereas EBI presents no forecasts beyond 2010.

Table 8
Comparison of estimates of the growth of environmental expenditures in the US (expenditures in billions of 2003 dollars)

	MISI		EBI[a]	
	Expenditures (millions/$)	Growth (%)	Expenditures (millions)	Growth (%)
1970	39		73	
1975	77	97	100	37
1980	121	57	125	25
1985	158	31	148	18
1990	204	29	201	36
1995	235	15	210	5
2000	273	16	221	5
2003	301	10	227	3
2010	357	19	268	18
2015	398	11	NA[b]	
2020	439	10	NA	

Source: Management Information Services, Inc. and Environmental Business International, Inc., 2006.

[a]EBI expenditures in current dollars were converted by MISI to 2003 dollars.

[b]NA, not available. EBI did not forecast expenditures beyond 2010.

8. Conclusions and suggestions for further research

8.1. Findings at the national level

Our first major finding is that EP, economic growth, and jobs creation can be complementary and compatible: Investments in EP can create jobs, not destroy them.[15]

[12]These policies differ considerably among the states, and some states have belatedly begun to recognize the economic benefits of environmental protection. For example, Florida has initiated a major Everglades restoration program and has prohibited offshore drilling, Michigan has implemented a hydrogen program, Arizona has aggressively promoted solar and wind, and Washington is initiating an ambitious biomass program.

[13]The EBI data are available for purchase at www.ebiusa.com. In 1990, EPA published estimates of environmental costs (US Environmental Protection Agency, Office of Policy, Planning, and Evaluation. *Environmental Investments: The Cost of a Clean Environment*. EPA-230-11-90-083, November 1990) and Pace University published estimates of the environmental costs of electricity (Richard Ottinger et al., *Environmental Costs of Electricity*, New York: Oceana publications, 1990). However, no time series data are available for these data and the estimates are not comparable to the MISI estimates.

[14]EBI present its estimates in current dollars. For comparison here, MISI converted the EBI current dollar estimates to constant 2003 dollar estimates using the GDP deflator series.

[15]While environmental protection both creates and displaces jobs, we have found the net jobs effect to be strongly positive, although jobs impacts will vary from case to case. Further, even when the net jobs effect is strongly positive, it must be recognized that significant job displacement may be occurring. For example, in analyzing the likely economic and jobs effects of enhanced CAFE standards, we estimated that by 2020 347,000 net jobs would be created. However, this estimate was the combination of

This finding is important because it differs from what many legislators and policy-makers currently believe.

Second, contrary to general public perception and public policy understanding, since the late 1960s protection of the environment has grown rapidly to become a major sales-generating, profit-making, job-creating industry—$300 billion/year. and 5 million jobs in 2003. The size and the job creating potential of the environmental industry is something that few are aware of.

Third, the vast majority of the five million jobs created by EP are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, etc., and the classic environmental job (environmental engineer, ecologist, conservation technician, etc.) constitutes only a small portion of the jobs created. In fact, most of the persons employed in the jobs created may not even realize that they owe their livelihood to protecting the environment.

This finding is important for, even recognizing that EP is good for the economy and is creating 5 million jobs, the first impression is likely that these are jobs for environment specialists, ecologists, environmental regulators, etc. We found that jobs for all occupations and skills are generated, and this should be of interest to organized labor, trade and professional associations, and policy-makers.

8.2. Findings at the state level

Our first major finding at the state level, derived from detailed analyses of the environmental industry and jobs in Florida, Michigan, Minnesota, North Carolina, Ohio, and Wisconsin, is that the overall relationship between state environmental policies and economic/job growth is positive, not negative. States can and do have strong economies and simultaneously protect the environment, and states with the strongest environmental records also have the best job opportunities and climate for long-term economic development.

This is a key finding. In our analysis of the six states we found that all of them assume that there is a negative relationship between protecting the environment and economic and job growth. Thus, the states' policies relating to EP and economic/job development focus on "reforming," "streamlining," and "rationalizing" environmental rules and regulations (a euphemism for weakening them), "simplifying" and "accelerating" environmental permitting, and otherwise sacrificing the environment to economic growth and job creation. Hopefully, the research reported here will begin to change these state attitudes and polices.

Second, environmental jobs in each of the states are concentrated within a number of sectors, including manufacturing and professional, information, and scientific, and technical services, and this is significant because the states are seeking to modernize and expand their high-tech industrial and manufacturing bases. Thus, not only is the relationship between EP and jobs positive, but the types of jobs created are disproportionately scientific, professional, technical, high-skilled, manufacturing, and high-wage jobs—the very types of jobs that all states are attempting to retrain and attract. These types of jobs are a prerequisite for a prosperous, middle class society able to support state and local governments with tax revenues—which states already recognize. Of particular note, in the six states studied thus far data show that investments in the environment will provide a greater than proportionate assist to the manufacturing sector.

Finally, EP can form an important part of states' economic development strategies, and there is no inherent institutional impediment in any state to using existing economic assistance policies and incentives to facilitate development of environmental industries and jobs. This is a key policy finding because, at present, none of the states we examined appreciates this potential: (i) no state has integrated environmental industry and job development into its general strategic or economic development plan; (ii) state environmental departments and agencies have little or no focus on environmental employment or job development; (iii) state labor and workforce departments and agencies have little or no focus on environmental industries or jobs.

Each state is home to diverse environmental companies, many global leaders in their field,[16] but their strong role in employment generation is largely overlooked in economic development initiatives and policy. Altering states' perceptions and policies here is essential.

8.3. Suggestions for further research

Our work has identified several areas requiring further research. First, a more rigorous and generally accepted definition of what constitutes an "environment-related job" is required. Environmental advocates have tended to identify the more glamorous types of jobs, such as ecologist, wildlife biologist, conservation specialist, solar energy researcher, etc., but we found that the overwhelming majority of environment-related jobs are for the standard occupations, skills, and professions. Nevertheless, the numbers and types of jobs—both in general and in specific industries and firms—are in need of much additional research.

(*footnote continued*)
total gross job creation of 433,000 jobs and the displacement of 86,000 jobs. That is, while nearly 350,000 *net* jobs would be created, nearly 90,000 jobs would still be lost. This has obvious policy implications. See Roger H. Bezdek and Robert M. Wendling, "Fuel Efficiency and the Economy," *American Scientist*, op. cit., and Roger H. Bezdek and Robert M. Wendling, "Potential Long-term Impacts of Changes in US Vehicle Fuel Efficiency Standards," *Energy Policy*, op. cit.

[16]As part of this research project, we identified and assessed a representative sample of environmental firms in each state selected for heterogeneity with respect to size, geographic location, and services and products provided. These findings are available on the MISI web site: www.misi-net.com

Second, the empirical work reported here needs to be expanded. While we have analyzed the environmental industries in six states, it remains to be determined how representative our findings are for the rest of the US At least as important, our analyses of each state were not comprehensive, and much more detailed assessment of several individual states is required. Such an assessment would look in detail below the state level to specific geographic regions and industries and conduct in-depth analyses of specific environmental firms.

Finally, it would be useful to have international perspective. We found that in the US environment-related activities account for 3–5% of national and state GDP and jobs. Using generally consistent concepts and definitions, it would be interesting to determine how these estimates compare to estimates of environmental industries and jobs in other developed nations. International comparative analyses of detailed results at the sector, industrial, and occupational level would be especially useful.

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