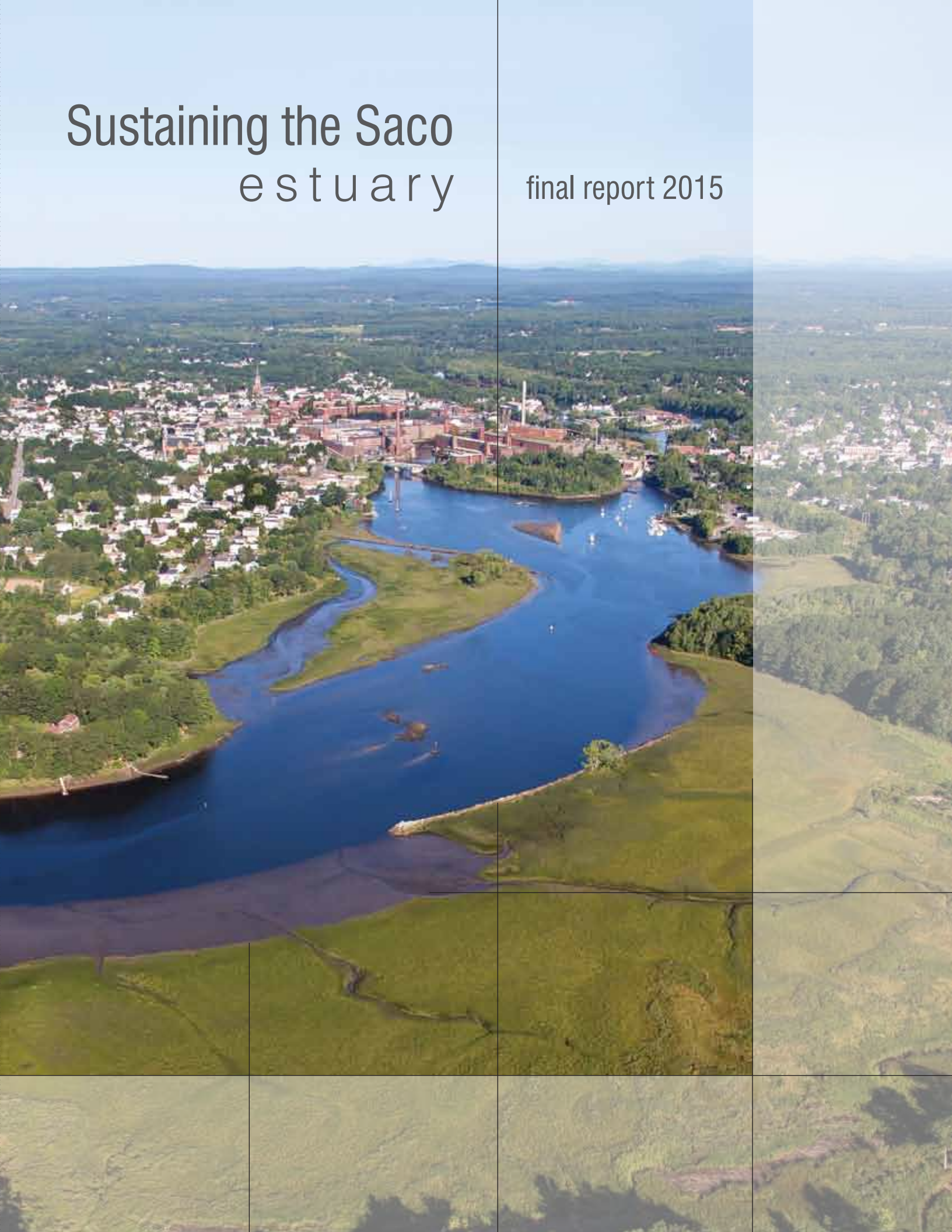


# Sustaining the Saco e s t u a r y

final report 2015



# Sustaining the Saco estuary

final report 2015



## Project Leaders

Christine B. Feurt, Ph.D.  
University of New England and  
Wells National Estuarine Research Reserve  
Tel: (207) 602-2834  
Email: cfeurt@une.edu

Pamela A. Morgan, Ph.D.  
University of New England  
Tel: (207) 602-2227  
Email: pmorgan@une.edu

## Project Team

*University of New England*

Mark Adams, Ph.D.  
Anna Bass, Ph.D.  
Carrie Byron, Ph.D.  
Michael Daley, Ph.D.  
Michael Esty

Noah Perlut, Ph.D.  
Michele Steen-Adams, Ph.D.  
James Sulikowski, Ph.D.  
Stephan I. Zeeman, Ph.D.

*Wells National Estuarine Research Reserve*

Jacob Aman  
Michele Dionne, Ph.D.

Jeremy Miller  
Kristin Wilson, Ph.D.

This research is part of Maine's Sustainability Solutions Initiative, a program of the Senator George J. Mitchell Center, which is supported by National Science Foundation award EPS-0904155 to Maine EPSCoR at the University of Maine.

Report Editing and Design: Waterview Consulting

# CONTENTS

---

CHAPTER 1	INTRODUCTION: Why Is the Saco Estuary an Ideal Living Laboratory for Sustainability Science? . . . . .	1
	<i>by Christine B. Feurt and Pamela A. Morgan</i>	
CHAPTER 2	RECOGNIZING AND ENGAGING THE STEWARDSHIP NETWORK: Actively Working to Sustain the Saco Estuary . . . . .	7
	<i>by Christine B. Feurt</i>	
CHAPTER 3	PLANTS OF THE SACO ESTUARY: Tidal Marshes . . . . .	17
	<i>by Pam Morgan</i>	
CHAPTER 4	BENTHIC MACROINVERTEBRATES OF THE SACO ESTUARY: Tidal Flats and Low Marsh Habitats . . . . .	29
	<i>by Anna L. Bass</i>	
CHAPTER 5	FISH OF THE SACO ESTUARY: River Channel and Tidal Marshes . . . . .	39
	<i>by Kayla Smith, Kristin Wilson, James Sulikowski, and Jacob Aman</i>	
CHAPTER 6	BIRD COMMUNITY OF THE SACO ESTUARY: Tidal Marshes . . . . .	57
	<i>by Noah Perlut</i>	
CHAPTER 7	FOOD WEB OF THE SACO ESTUARY'S TIDAL MARSHES . . . . .	69
	<i>by Carrie Byron</i>	
CHAPTER 8	LAND USE AND LAND COVER ALONG THE SACO ESTUARY'S SHORELINE . . . . .	81
	<i>by Mark Adams</i>	
CHAPTER 9	SEA LEVEL RISE AND THE SACO ESTUARY: Tidal Marshes . . . . .	105
	<i>by Michael Esty</i>	
CHAPTER 10	WATER QUALITY IN THE SACO RIVER . . . . .	113
	<i>by Stephan I. Zeeman and Tyler Spillane</i>	

## INTRODUCTION

---

**WHY IS THE SACO ESTUARY  
AN IDEAL LIVING LABORATORY  
FOR SUSTAINABILITY SCIENCE?**

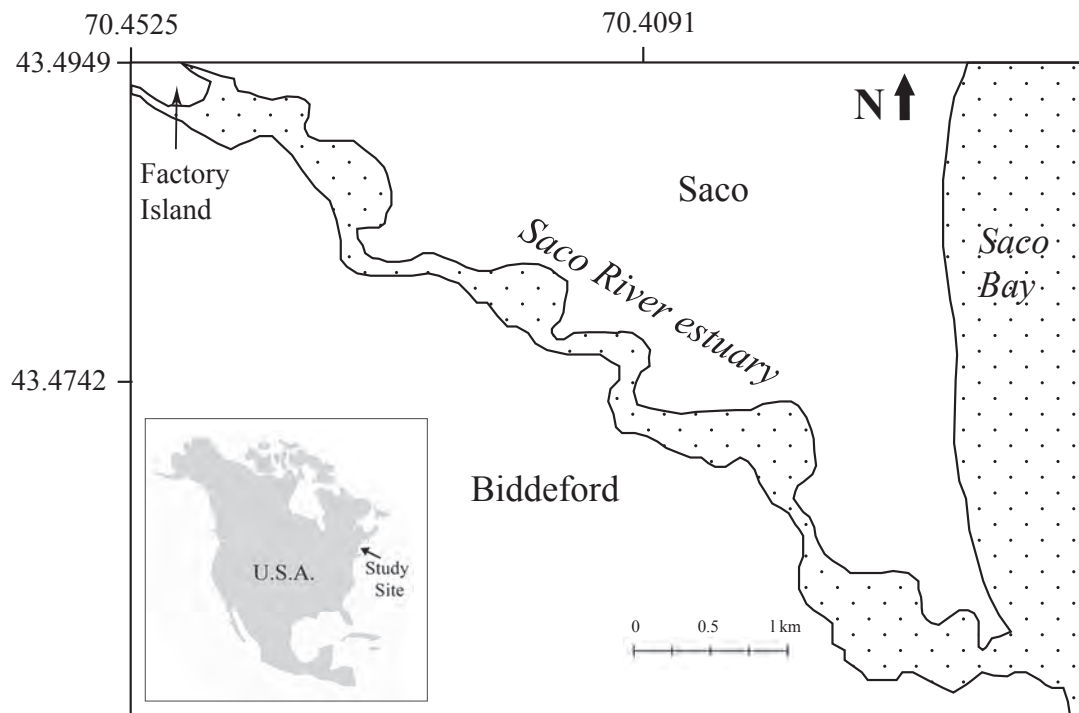
BY CHRISTINE B. FEURT and PAMELA A. MORGAN

**The Saco Estuary had not been researched  
in a focused interdisciplinary way**

The Saco River watershed is the largest watershed in southern Maine. With headwaters in the White Mountains of New Hampshire, it encompasses more than 4,400 km<sup>2</sup>. The Saco River watershed provides clean healthy drinking water to over 100,000 people living and working in communities in southern Maine. The ten-kilometer long estuarine portion of the river lies below the first dam on the river and features a variety of coastal habitats, including tidal wetlands, rocky outcrops, sand beaches and mudflats. Salinities in the estuary range from 0 ppt near the dam to 10–32 ppt at the river's mouth (Fitzgerald et al. 1993). This stretch of the river is bordered by the cities of Saco and Biddeford (Figure 1). The University of New England (UNE) is located in the city of Biddeford, at the mouth of the Saco River. Proximity to the estuary and Gulf of Maine is a factor in many students' decisions to attend UNE.

When the Saco Estuary Project began in 2009, the ecology of the Saco River estuary was not well understood. Very few scientists had studied its fish or bird populations, and only a limited amount of information (from the Maine Natural Areas Program) existed about the estuary's plant communities. Researchers at UNE were interested in understanding how the physical attributes of the watershed such as water quality and flow of pollutants and nutrients from headwaters to the ocean interact with the land use in the region to affect the plants and animals using the estuary for habitat, breeding, migration and feeding.

Scientists were also interested in understanding the social and economic characteristics of the region surrounding the estuary and how the quality of life and sense of place that people experience can be understood as part of a linked social-ecological system. This is a new name for an old idea. Linkages between the ecological system and social system can be viewed through the lens of history and the cultural heritage of the Saco River estuary that people have called home for



**FIGURE 1** Map of the Saco Estuary, which extends from near Cataract Dam at Factory Island to the river mouth.

hundreds of years. The concept of creating a resilient social-ecological system focuses on how the people living in a place work together to build relationships, support a robust economy, and protect the natural systems that contribute to human wellbeing. The Saco Estuary Project research revealed surprising improvements in the ecosystem health of the Saco Estuary and connected the actions of organizations, governments and local groups to the improvements.

### Environmental change in the Saco Estuary is linked to social change

The Saco River has always been a focal point for life in the region. The area has a rich history, being home first to the Abenaki people, and then settled by Europeans in 1631. Samuel de Champlain visited the estuary in 1605 and described seeing Native Americans growing corn, beans and squash at the mouth of the river (Figure 2). During the 18th century the area's rich natural resources provided for an economy based on lumbering, ship building and farming. Where the Saco River ran between downtown Biddeford and Saco, it narrowed around Factory Island and flowed over two falls, which provided the energy for the growth of manufacturing in the early 19th century. Textile mills came to dominate the local economy as Biddeford and Saco grew to be booming industrial cities. The industrial boom had consequences for the ecosystem health of the estuary. Construction of dams and chemical runoff from the cities were the legacy of industrial success, but they polluted the Saco River downstream of the mills and blocked the ancestral migration routes of fish species. These changes produced enduring ecological





**FIGURE 2** Samuel de Champlain mapped the Saco Estuary in 1605.

*Citation: Champlain, Samuel de (1567?-1635). "Chouacoit" [facsimile]. Paris: J. Berjon, 1613. As reproduced by, Biddeford, Me.: McArthur Public Library, mcmap.0036, circa 1950.*

consequences for water quality and wildlife and represent a loss for the wellbeing of people living in the region who depended upon fish resources and clean water.

Economic conditions led to the closing of the mills in the 1960's. National water quality legislation in the 1970's contributed to improvements in water quality as the Saco Estuary began to recover from some of the ravages of economic boom of the mill era. Today, Biddeford is the sixth most populated city in the state of Maine with more than 22,000 residents, and Saco's population of more than 15,500 has been steadily growing. The cities of Biddeford and Saco are working to create a shared identity as a vibrant place for people and businesses. One of the focusing elements of their shared vision is the Saco River and its importance to the region's heritage, economy, and the wellbeing of people who live, work and play along its shores. While the impacts of the mills on the river have declined, coastal development, increasing population density, changing land use and climate change will all play a role in determining the long-term sustainability of qualities of the Saco Estuary that are important to the people in the region. Social and land use changes associated with increasing development will be exacerbated by anticipated changes in weather patterns, including increased incidents of intense rainfall, drier summers and sea level rise affecting both natural systems and built infrastructure. There is a pressing need for scientific research to help us understand the status of the estuary and to be able to monitor change over time. Information that indicates the health of the estuary can be used to inform decisions, evaluate the effects of local policies and showcase success stories where local actions have conserved and restored locally valued conditions.

## The Saco Estuary Project was part of a statewide initiative funded by the National Science Foundation and coordinated by the University of Maine

In 2009 as part of a collaborative National Science Foundation (NSF) EPSCoR grant, researchers from the University of New England and the Wells National Estuarine Research Reserve began a directed program of scientific research on the Saco Estuary. The National Science Foundation awards this type of grant, the Experimental Program to Stimulate Competitive Research (EPSCoR), with a specific goal of building the capacity of a state to conduct innovative cutting-edge research through partnerships that include colleges and universities, private industry, government and others. Maine EPSCoR at the University of Maine oversees and implements the state's NSF EPSCoR programs. The five-year statewide research program that began in 2009 and ended in 2014 was called Maine's Sustainability Solutions Initiative (SSI). Maine's Sustainability Solutions Initiative was inspired by a 2006 Brookings Institution report, *Charting Maine's Future: An Action Plan for Promoting Sustainable Prosperity and Quality Places*.

The Saco Estuary Project was one of a suite of research projects across the state aimed at applying sustainability science to address complex issues important to the people of Maine.

## What is sustainability science and how did it shape the Saco Estuary Project?

The Sustainability Solutions Initiative introduced the Maine research community to sustainability science. What is sustainability science, and how did it influence the design and execution of the Saco Estuary Project? Kates et al. (2001) described sustainability science as a distinct field of study that “seeks to understand the fundamental character of interactions between nature and society... and on society's capacity to guide those interactions along more sustainable trajectories.” Many researchers have discussed the salient characteristics of sustainability science in the scientific literature as the field has emerged and evolved over the past two decades.

The Maine Sustainability Solutions Initiative developed criteria guiding all of the research projects in the state with the goal that the projects would advance sustainability science and education priorities while focusing on solutions to unique social-ecological problems in the state. All of the elements below were incorporated into the Saco Estuary Project. The sustainability science approach was new to researchers and students at UNE and Wells NERR and to the many stakeholder groups who worked with researchers during the five years of the project.

The Saco Estuary Project incorporated the following sustainability science criteria:

1. Develop integrated, interdisciplinary teams in which researchers and other partners are committed to working together for research and education on the estuary.
2. Create new and integrated research, education, or service learning (internship) opportunities for students in the research focus area.



3. Identify local groups (stakeholders) who care about sustaining the ecosystem health of the estuary.
4. Fully engage stakeholders whose work and interests connect to the estuary and who are concerned about ecosystem health and how it is integrated with important community values.
5. Work with stakeholders in place-based dialogues to create information collaboratively that is relevant to improving situations identified as important.
6. Support the development of student job skills and competencies in Science Technology, Engineering and Math (STEM) fields related to the research focus.

How did these criteria play out in the Saco Estuary Project? Local, state and federal government officials, conservation and watershed groups, businesses, land trusts and interested citizens partnered with UNE faculty and students and scientists from the Wells National Estuarine Research Reserve to engage in collaborative research. Together they shaped the goals of the project to understand how coastal wetlands, birds and fish populations could be indicators of the ecological health of the estuary. The wetlands, birds and fish that depend upon the estuary are affected by pollution that runs off the land, increased amounts of pavement in the areas that drain to the estuary and altered rainfall and temperature patterns affected by climate change. Groups like the Saco River Salmon Club, Saco River Corridor Commission, Biddeford Conservation Commission and Open Space Committee and the Coastal Water Commission share concern for these issues. These issues have the potential to affect local business owners, prompting business owners and the Biddeford Saco Chamber of Commerce and Industry to join other project stakeholders to contribute to and learn from the project.

Researchers and stakeholders partnering through the Saco Estuary Project were interested in understanding how the current social and economic characteristics of the region connected to the ecosystem health of the estuary. Using videos and photographs, student researchers identified and documented the ways people use the estuary for livelihoods and recreation and how businesses depend upon the health of the estuary. Student research was augmented by a Maine PBS documentary focusing on the changes in the Saco Estuary resulting from changes in policies and management. During the project, students learned from local officials and community leaders about the mechanisms used by governments, businesses and organizations to understand and protect the ecological, social and economic values of the estuary. Five years of researcher, student and stakeholder engagement activities helped to build a shared understanding about ways to manage and protect the natural assets of the estuary, build a resilient economy connected to those natural assets and conserve the rich cultural heritage linked to the estuary.

The remaining chapters in this technical report present the results of each aspect of the research, stakeholder engagement, education and outcomes of this research.

## LITERATURE CITED

- Brookings Institution. 2006. *Charting Maine's Future: An Action Plan for Promoting Sustainable Prosperity and Quality Places*. Washington, D.C: The Brookings Institution Metropolitan Policy Program.  
Available from <http://www.brookings.edu/~media/research/files/reports/2006/10/cities/maine>
- Kates, R., W. Clark, R. Corell, J. Hall, C. Jaeger, I. Lowe, J. McCarthy, H-J Schellnhuber, B. Bolin, N. Dickson, S. Faucheux, G. Gallopin, A. Grubler, B. Huntley, J. Jager, N. Jodha, R. Kasperson, A. Mabogunje, P. Matson, and H. Mooney. 2001. Sustainability science. *Science* 292(5517): 641–642.  
Available from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=257359](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=257359)