Maine EPSCoR

NSF EPSCoR

YR4 Reverse Site Visit

September 11, 2012

"Maine's Sustainability Science Initiative"

NSF EPSCoR award # EPS-0904155

to the University of Maine

July 1, 2009 to June 30, 2014

PI: Michael Eckardt, NSF EPSCoR Project Director

Co-PI: David Hart, SSI Research Project Director

Co-PI: Vicki Nemeth, Maine EPSCoR Director

Sr. Personnel: Laura Lindenfeld, SSI Faculty & Stewardship Council Member

Maine's RII Infrastructure Strategy

- Maine became an EPSCoR state in 1980 (first cohort)
- We have had 8 NSF EPSCoR RII Track 1 awards for a total of $49.6M
- Maine's strategy for these NSF EPSCoR RII awards has been to provide the infrastructure needed to create new research centers or major initiatives in areas that are consistent with the State's Science & Technology Action Plan.
- Historically been very successful in this single-focus strategy:

AEWC ADVANCED STRUCTURES & COMPOSITES CENTER

THE UNIVERSITY OF MAINE CLIMATE CHANGE INSTITUTE

FBRI FOREST BIOPRODUCTS Research Institute

Maine's RII Infrastructure Strategy

Our current award from NSF EPSCoR
for "Maine's Sustainability Science Initiative"
seeks to continue that success by creating a

Center for Sustainability Solutions

at the University of Maine

1865 THE UNIVERSITY OF MAINE
you're in a great place

NSF

Sustainability Science

- We are on the edge of a "mini-revolution" in sustainability science.
- Maine's higher education institutions have a long-standing history of research expertise in environmental, economic, and social issues of importance to the state, and of taking cutting-edge approaches to problem-solving.
- This RII Track 1 award has enabled Maine to become a leader in this field and to develop a novel approach geared toward achieving solutions by linking scientific knowledge with action.
- The problems being addressed are place-based with particular contexts, timeframes, and actors, and one of the more complex challenges is learning from this type of portfolio.

Maine's Sustainability Solutions Initiative (SSI)

Mission: To connect knowledge with action in ways that promote strong economies, vibrant communities, and healthy ecosystems in and beyond Maine.

Vision: Create a Center for Sustainability Solutions that searches for, implements, and evaluates policies and practices that promote economic development while protecting ecosystem health and fostering community well-being.

Introduction

Statewide Participation

SSP Partners (primarily undergraduate institutions)

THE UNIVERSITY OF MAINE

Maine's flagship research & PhD institution – home of Maine EPSCoR & core SSI research faculty

Eastern Maine Community College

UNIVERSITY OF SOUTHERN MAINE

Undergraduate & master's level students - core SSI research faculty

Southern Maine Community College

UNIVERSITY OF MAINE FORT KENT
UNIVERSITE DU MAINE

University of Maine at PRESQUE ISLE
North of Ordinary

UMF FARMINGTON
MAINE'S PUBLIC LIBERAL ARTS COLLEGE

UNITY COLLEGE IN MAINE

THE UNIVERSITY OF MAINE AT MACHIAS
Naturally!

College of the Atlantic
life changing. world changing.

Colby

UNIVERSITY OF MAINE AT AUGUSTA
1965

UNE UNIVERSITY OF NEW ENGLAND

Bowdoin

Bates College

Charting Our Progress

- The Maine EPSCoR Strategic Plan updated March 2012.
- Actively utilized in the management and implementation of the RII project.
- Every RII component – including each research team – has their actions grounded around the plan's goals, objectives, and strategies.
- Throughout our presentation, we will:
  1) Describe our progress since the YR2 RSV.
  2) Within each component, highlight how we have addressed the YR2 RSV recommendations.
  3) Highlight key parts of our trajectory for YR4 & YR5.

Introduction

Presentation Format

Goal #:	ME EPSCoR Strategic Plan Goal/NSF RSV Criteria:
1-4	Research & Integrated Education
5	Diversity
6-7	Workforce Development & STEM Education
8	Cyberinfrastructure
9	External Engagement (Outreach & Communication)
10	Evaluation & Assessment
11	Sustainability
12-13	Management

Other NSF RSV Criteria:	
Special Award Conditions	Strategic Plan Progress
Challenges, Actions, & Future Changes	Project Effectiveness

How can research help address key societal challenges?

- *China's Drought Threatens Farm Income, Drinking Water, Wildlife and Hydropower*, NY Times, 6/11/11
- *Making Food Safe Can Harm Wildlife & Water*, WBUR RADIO, 4/23/12
- *With Sewage in Hudson, a Big Blow to Business*, NY Times, 7/28/11
- *Can Biofuels Save Sub-Saharan Africa?*, NY Times, 6/28/11
- *A Clash Over Mining and Water*, NY Times, 3/21/12
- *Japan PM says two reactors must restart for "survival of society"*, Reuters, 6/8/12
- *Solve water problems or forget growth, India told*, Reuters, 4/30/12
- *Neighborhood Gags as Its Economic Engine Spews Pollution*, NY Times, 7/5/11

Assessing the challenges

- Most societal problems are inherently multi-faceted and interconnected.
- The human dimensions are often more complex than their biophysical dimensions.
- Divergent individual and institutional values frequently produce misunderstanding and conflict.
- Science doesn't have all the answers.
- Evidence-based solutions are in short supply.

The need for alternative approaches

- Post-Normal Science (*where "facts are uncertain, values in dispute, stakes high and decisions urgent"*)
  - Funtowicz, S.O. and J.R. Ravetz. 1993. Science for the post-normal age. Futures 25: 739-755.
- Wicked Problems
  - Rittel, H. and M. Webber. 1973. Dilemmas in a general theory of planning. Policy Sciences 4: 155–169.
- Mode 2 Knowledge Production
  - Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, and M. Trow. 1994. The new production of knowledge: the dynamics of science and research in contemporary societies. London: Sage.

A new science to help solve real-world problems

POLICY FORUM: ENVIRONMENT AND DEVELOPMENT

Sustainability Science

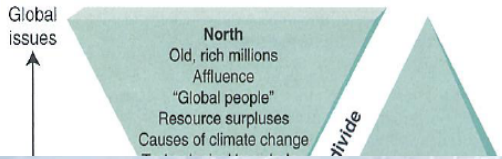
Robert W. Kates, William C. Clark,* Robert Corell, J. Michael Hall, Carlo C. Jaeger, Ian Lowe, James J. McCarthy, Hans Joachim Schellnhuber, Bert Bolin, Nancy M. Dickson, Sylvie Faucheux, Gilberto C. Gallopin, Arnulf Grübler, Brian Huntley, Jill Jäger, Narpat S. Jodha, Roger E. Kasperson, Akin Mabogunje, Pamela Matson, Harold Mooney, Berrien Moore III, Timothy O'Riordan, Uno Svedin

Meeting fundamental human needs while preserving the life-support systems of planet Earth is the essence of sustainable development, an idea that emerged in the early 1980s from scientific perspectives on the relation between nature and society (*1*). During the late '80s and early '90s, however, much of the science and technology community became increasingly estranged from the preponderantly societal and political processes that were shaping the sustainable development agenda. This is now changing as efforts to promote a sustainability transition emerge from international scientific programs, the world's scientific academies, and independent networks of scientists (*2*).

Core Questions

A new field of sustainability science is emerging that seeks to understand the fundamental character of interactions between nature and society. Such an understanding must encompass the interaction of global processes with the ecological and social characteristics of particular places and sectors (*3*). The regional character of much of what sustainability science is trying to explain means that relevant research will have to integrate the effects of key processes across the full range of scales from local to global (*4*). It will also require fundamental advances in our ability to address such issues as the behavior of complex self-organizing systems as well as the responses, some irreversible, of the nature-society system to multiple and interacting stresses. Combining different ways of knowing and learning will permit different social actors to work in concert, (iv) recognize the wide range of outlooks regarding what makes knowledge usable within both science and society. Pertinent actions are not ordered linearly in the familiar sequence of scientific inquiry, where action lies outside the research domain. In areas like climate change, scientific exploration, and practical application must occur simultaneously. They tend to influence and become entangled with each other (*5*).

In each phase of sustainability science research, novel schemes and techniques have to be used, extended, or invented. These include observational methods that blend remote sensing with fieldwork in conceptually rigorous ways, integrated place-based models that are based on semiqualitative representations of entire classes of dynamic behavior, and inverse approaches that start from outcomes to be avoided and work backwards to identify relatively safe corridors for a sustainability transition. New methodological approaches for decisions under a wide range of uncertainties in natural and socioeco-



Robert W. Kates, SSI Advisory Board Chair

(Kates et al. 2001. Science 292: 641-642)

Sustainability Science Definition

"…an emerging field of research dealing with the interactions between natural and social systems, and with how those interactions affect the challenge of sustainability: meeting the needs of present and future generations while substantially reducing poverty and conserving the planet's life support systems.:

- National Academy of Sciences

A growing emphasis on solutions

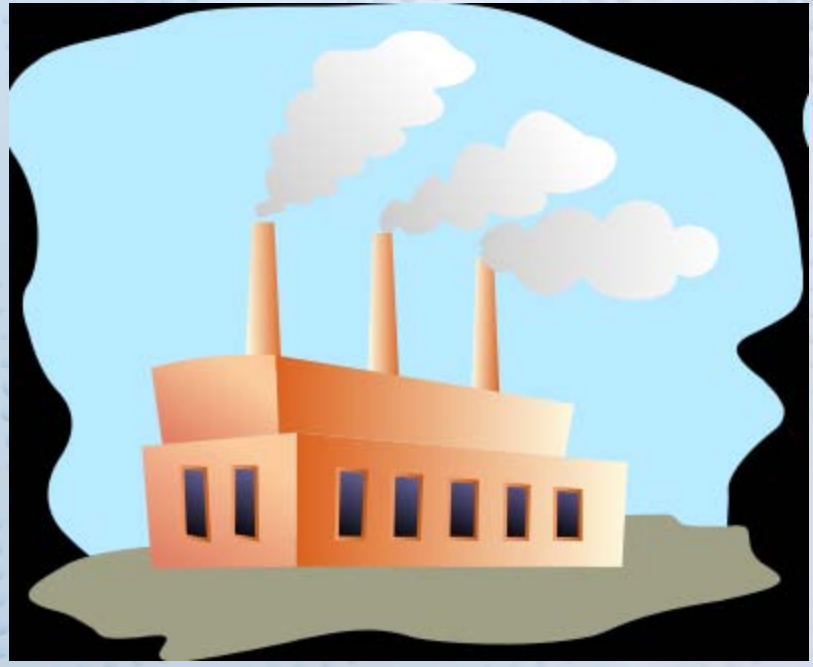
"We seek solutions. We don't seek — dare I say this? — just scientific papers anymore."

- Steven Chu, Nobel laureate and US Secretary of Energy

"In FY 11, NSF will continue to support and emphasize creative, interdisciplinary research that underpins ***the development of innovative solutions to pressing problems in sustainability science and engineering****."*

- Science, Engineering, and Education for Sustainability (SEES) 2011 Activities [http://www.nsf.gov/geo/sees/sees11.jsp]

Research universities as "knowledge factories"



http://sourcing.community.mfg.com/tag/virtual-factory

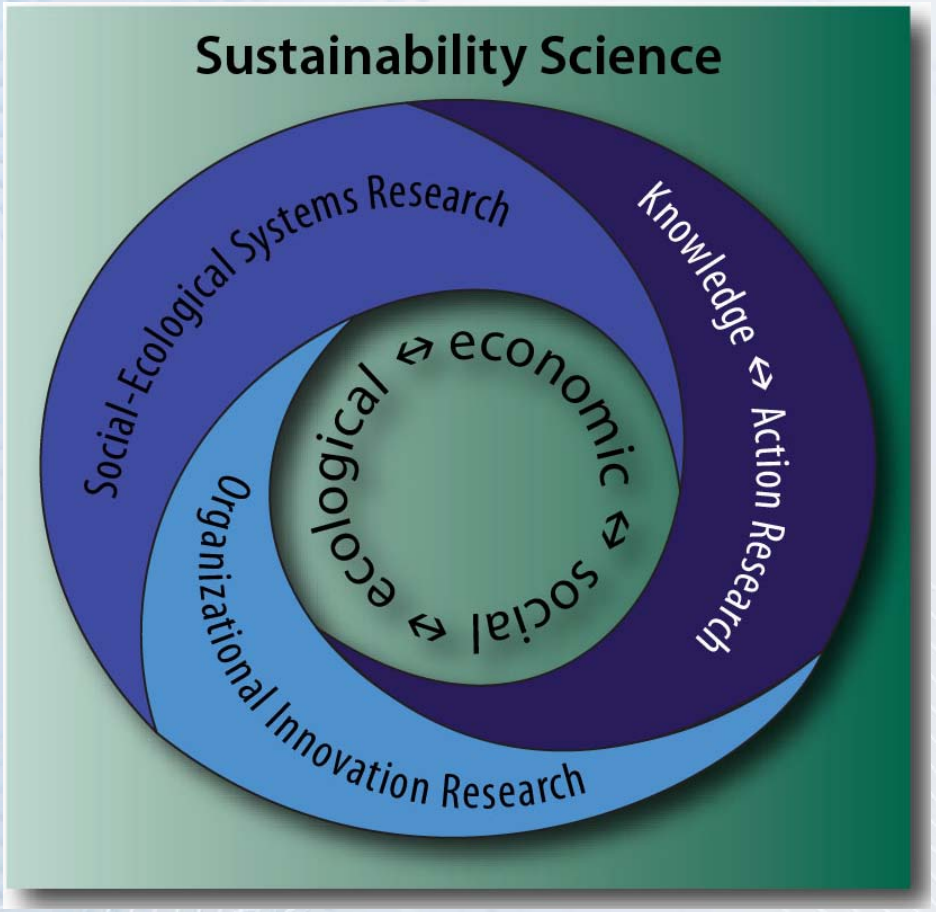
http://www.pikeresearch.com/research/sustainable-packaging

Universities and the Loading Dock Problem

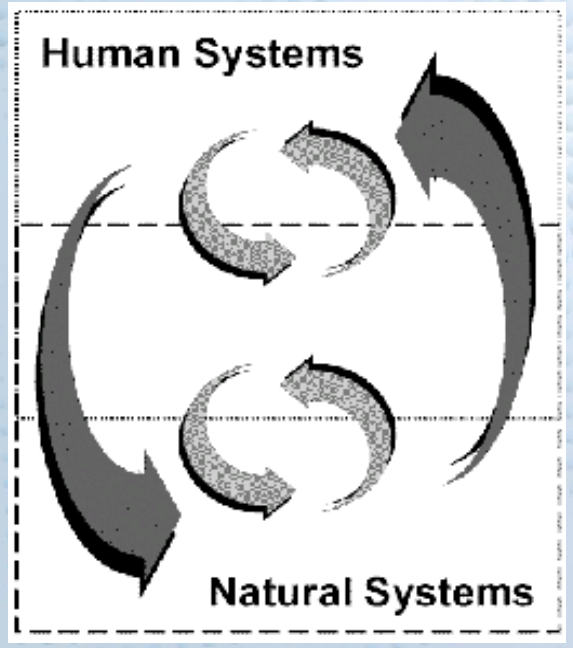
(Cash et al. 2003. PNAS 100:8086)

SSI: Three linked research strategies

- Understanding the dynamics of coupled social-ecological systems (SES)
- Analyzing and strengthening links between knowledge and action (K↔A)
- Investigating and fostering interdisciplinary integration and organizational innovation (OI)

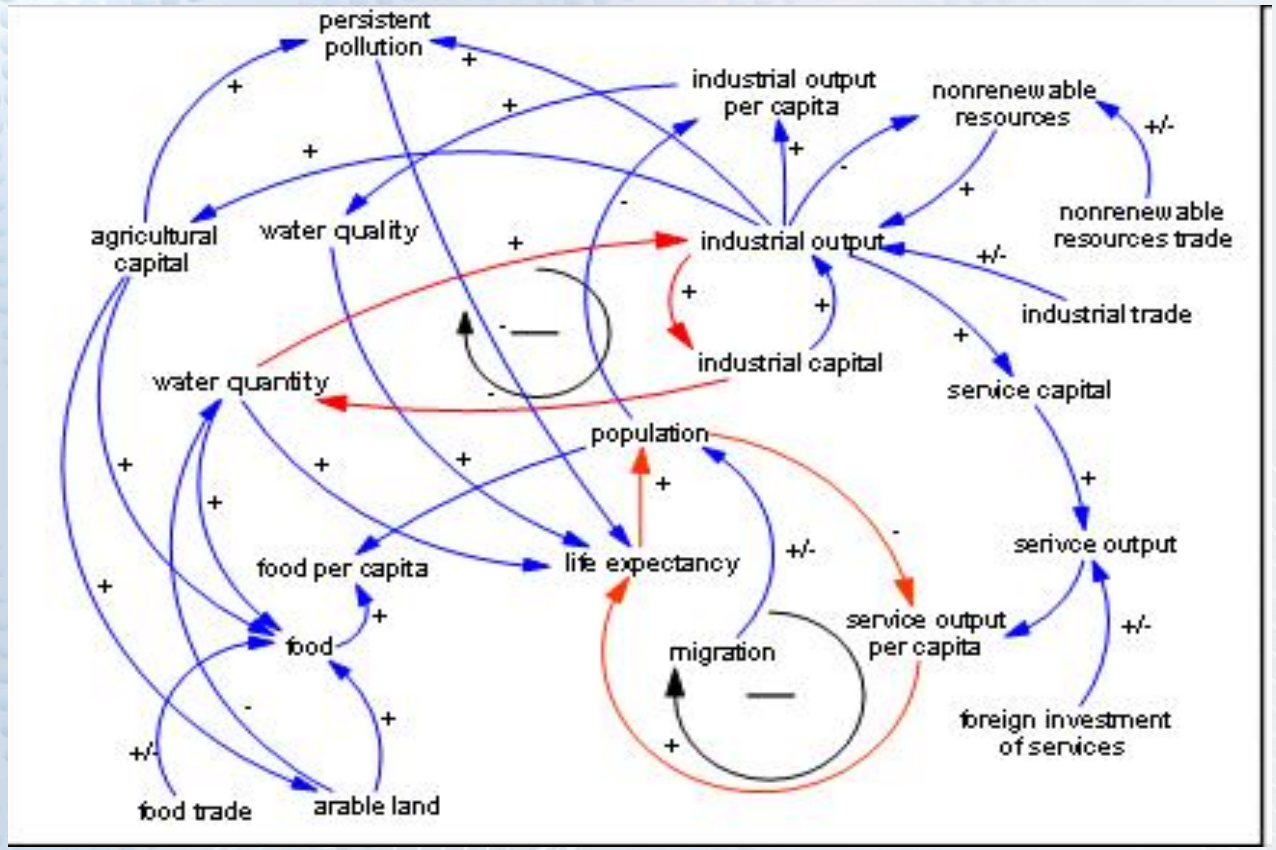


Social-ecological systems dynamics (SES)



nsf.gov

- SES thresholds, feedbacks, resilience
- SES as complex adaptive systems

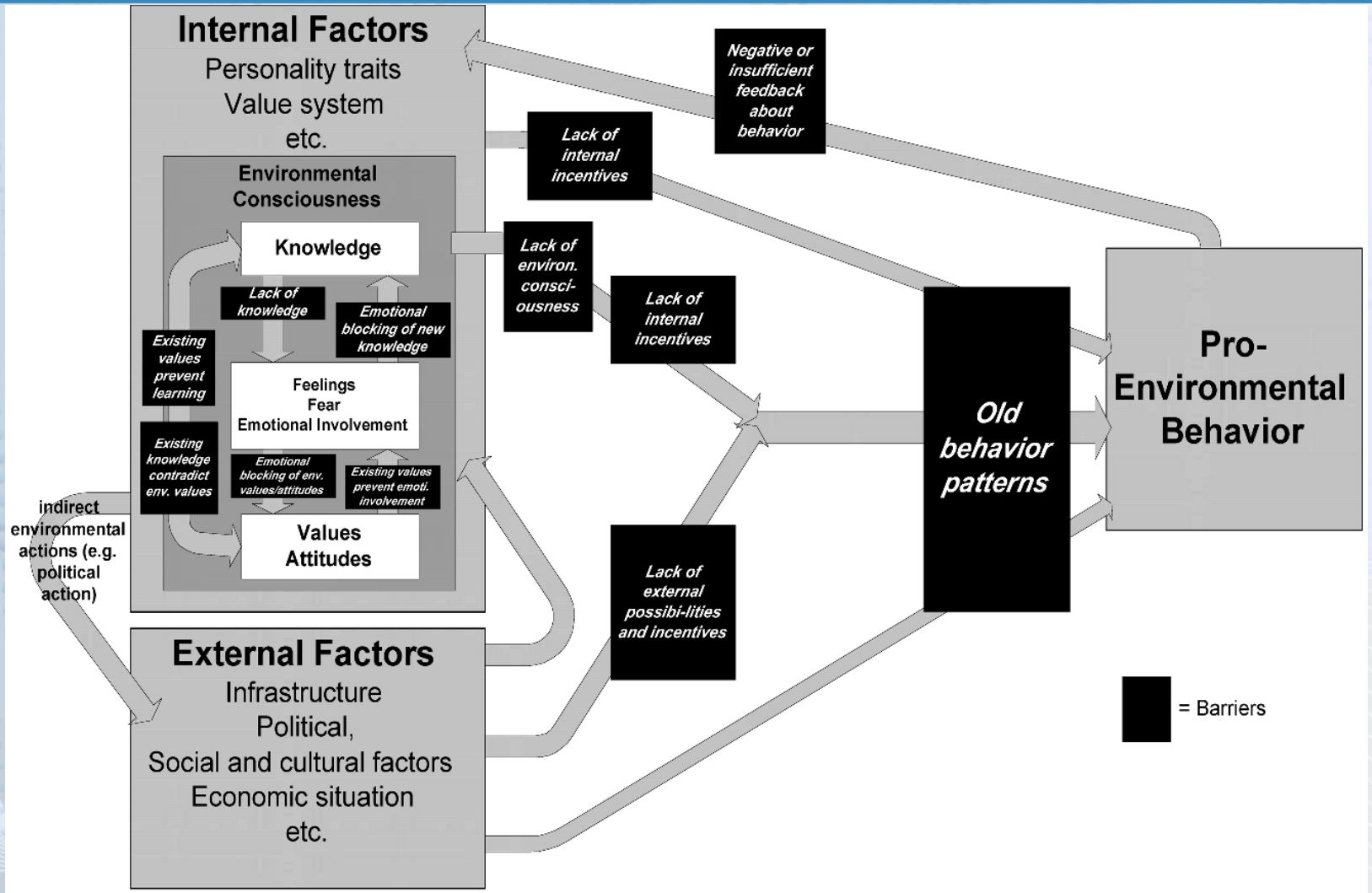


http://gwd.dpri.kyoto-u.ac.jp/english/research/index.html

Links between knowledge and action (K↔A)

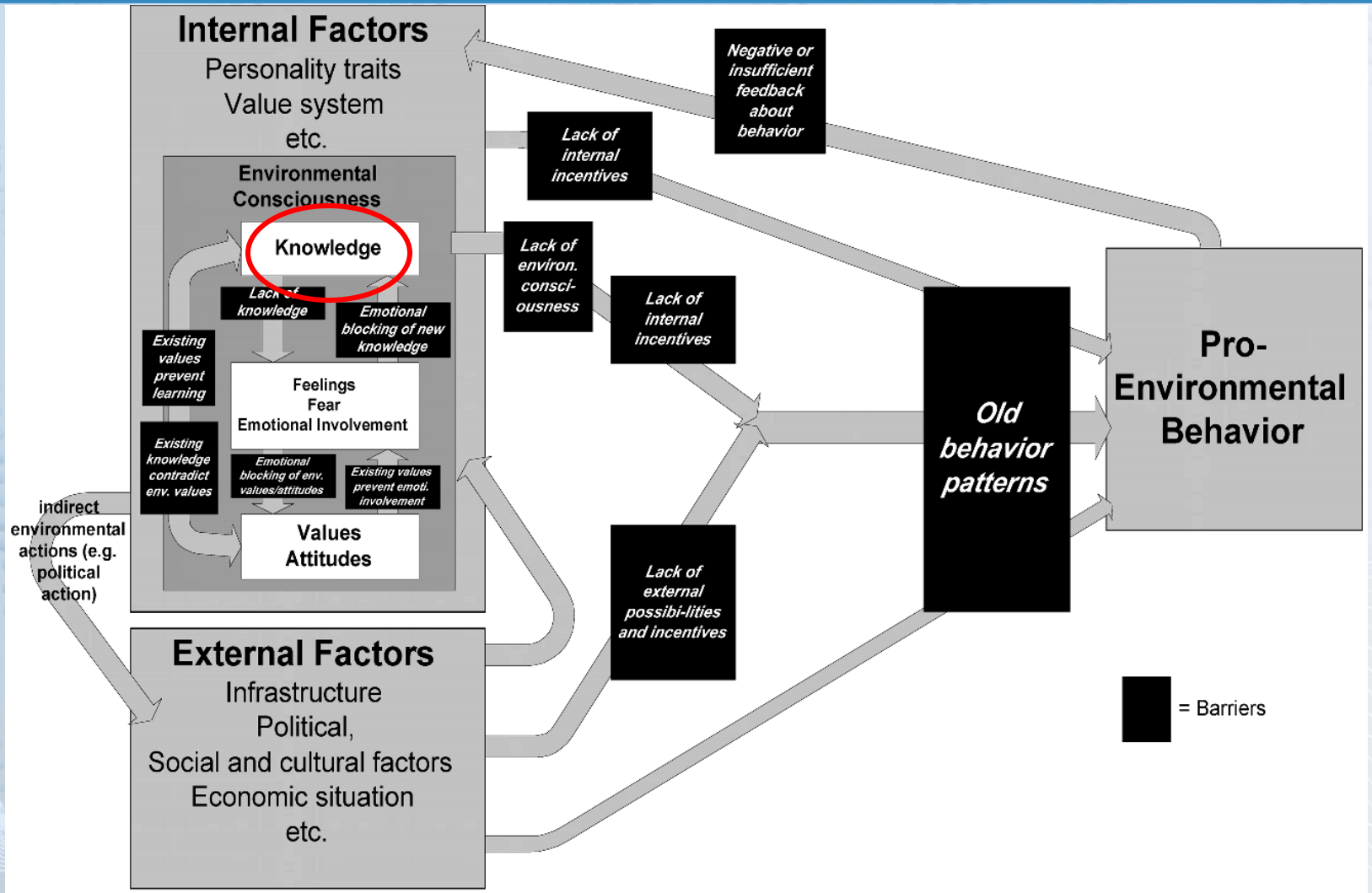
Kollmuss and Agyeman, 2002. *Environmental Education Research* 8:239-260.

K↔A models: Added complexity



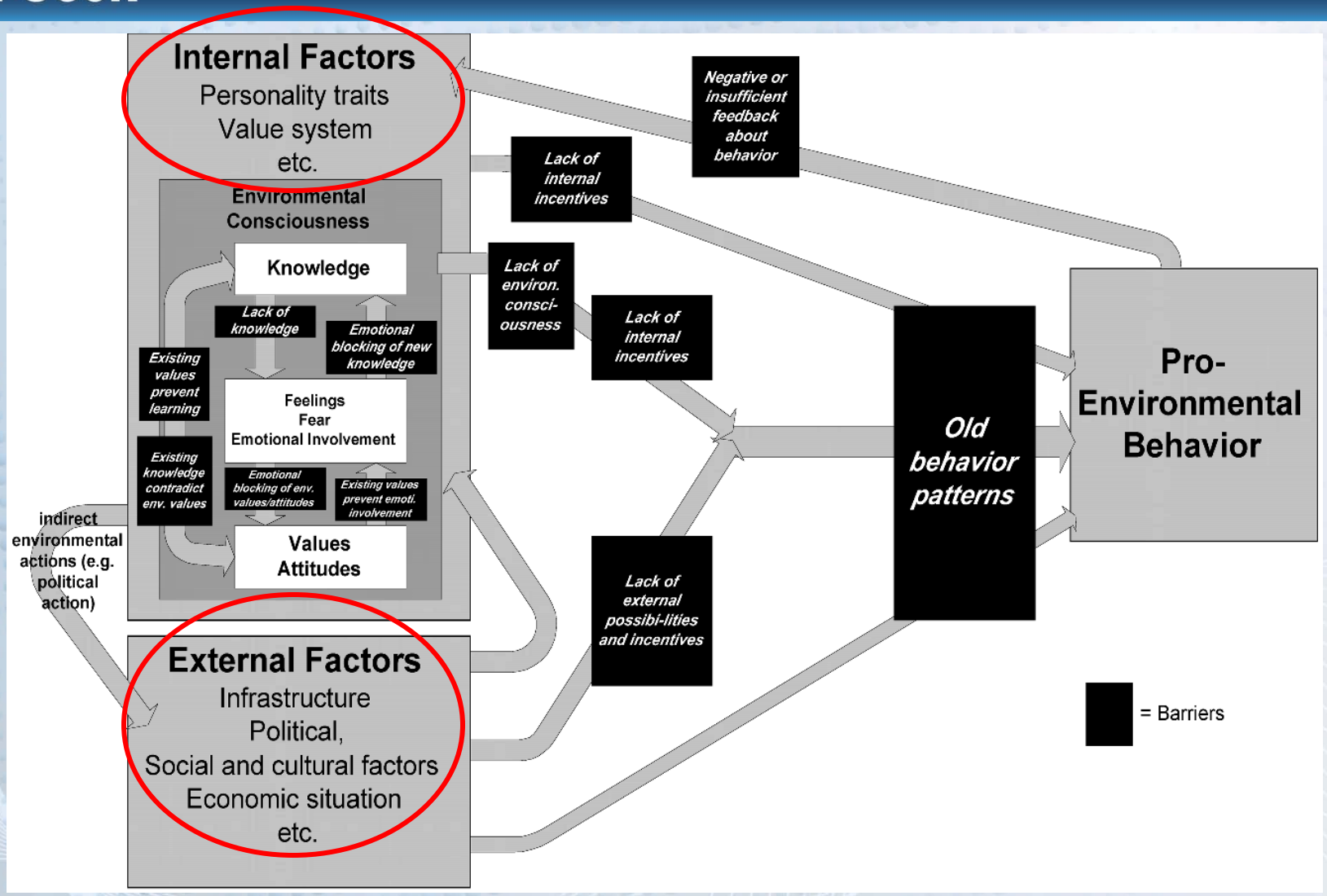
Kollmuss and Agyeman, 2002. *Environmental Education Research* 8:239-260.

K↔A models: Added complexity



Kollmuss and Agyeman, 2002. *Environmental Education Research* 8:239-260.

K↔A models: Added complexity

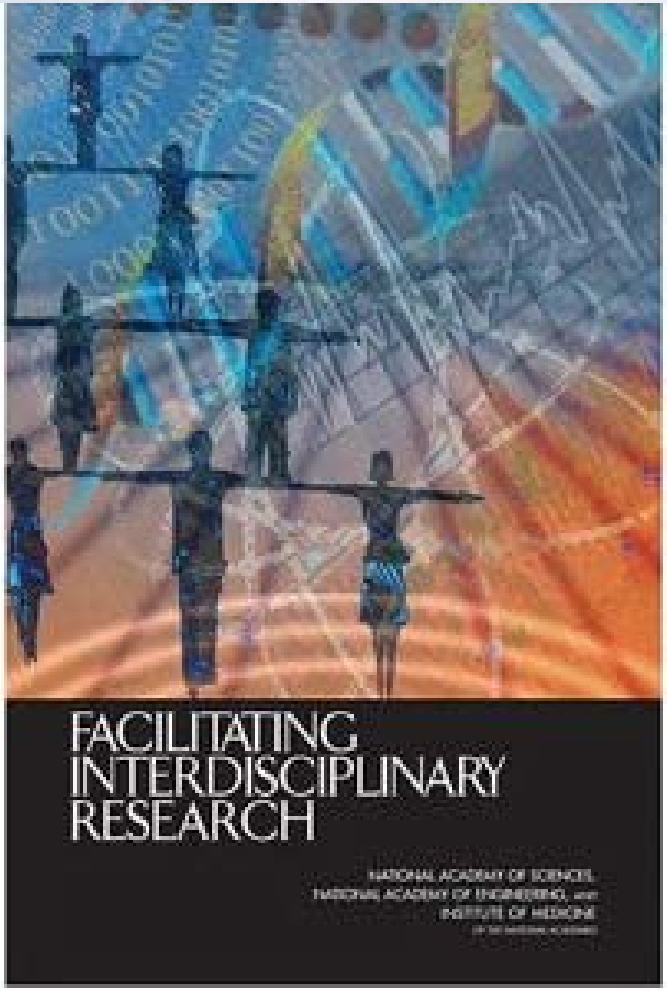


Kollmuss and Agyeman, 2002. *Environmental Education Research* 8:239-260.

Interdisciplinary integration & organizational innovation

- Individual and institutional factors influencing interdisciplinary collaboration and university-stakeholder partnerships

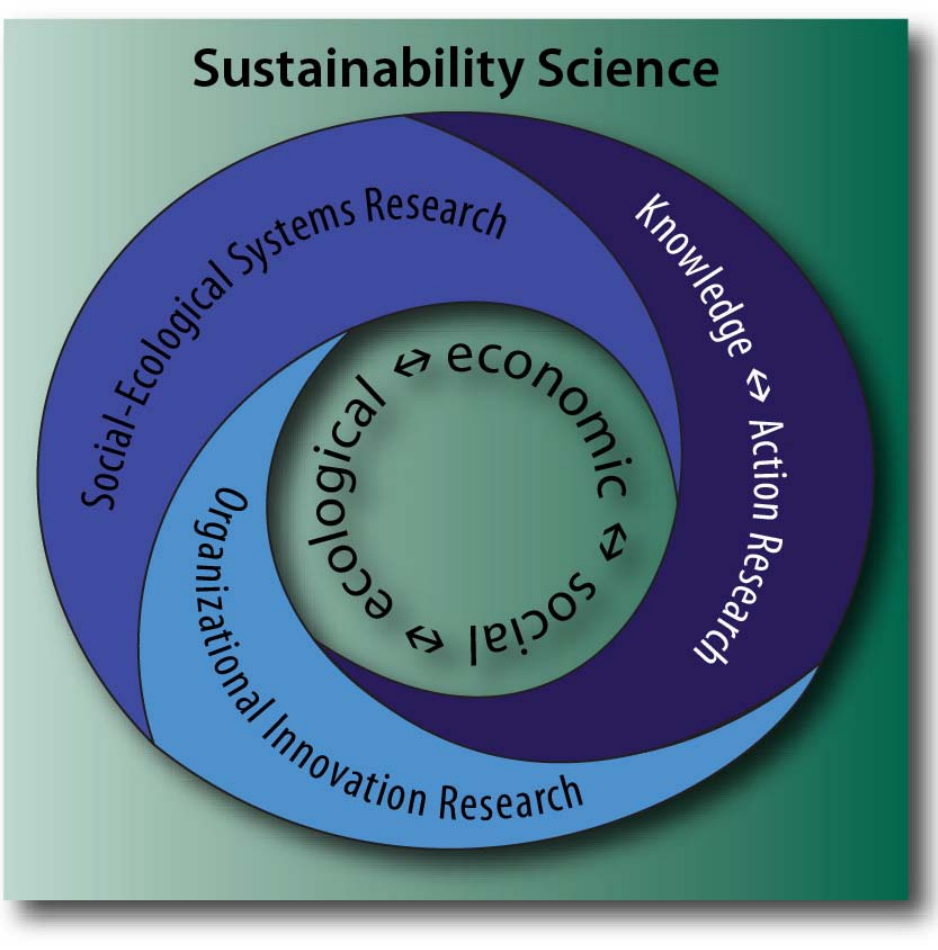
- Determinants of organizational learning



www.nap.edu

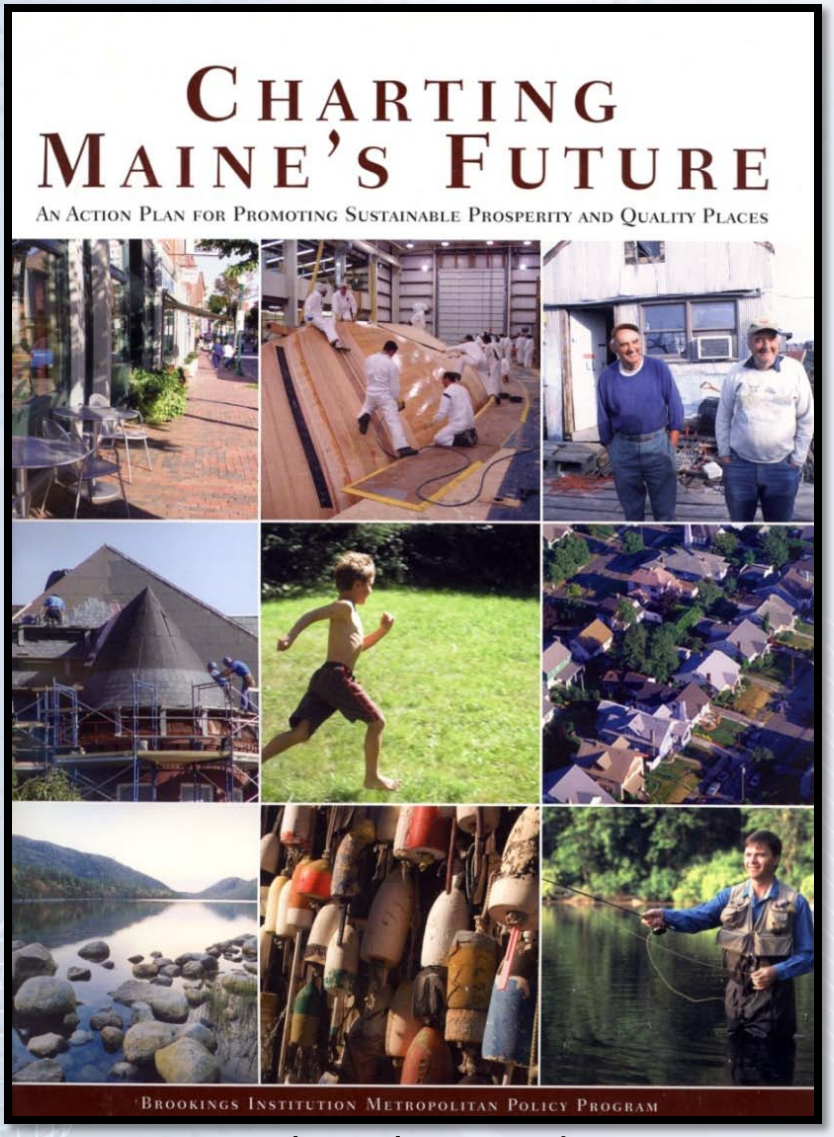
SSI's approach to sustainability science

Central Research Foci



SSI's model system: Landscape dynamics

Turner, Lambin & Reenberg. 2007. The emergence of land change science for global environmental change and sustainability. PNAS 104: 20666-20671.



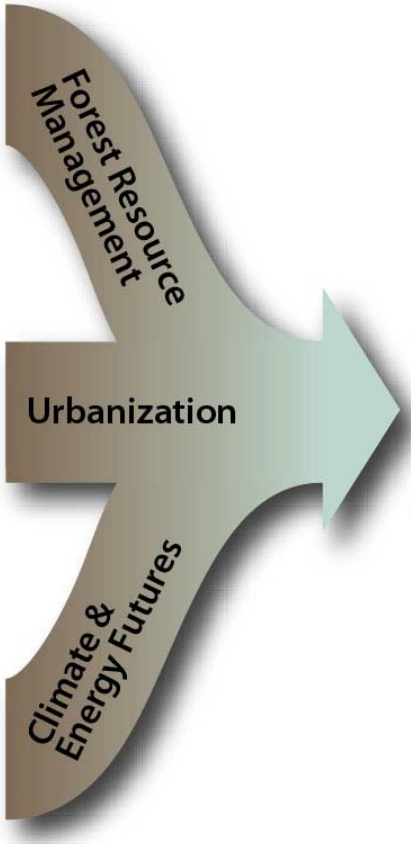
www.brookings.edu

Landscape-related processes influencing SES in Maine

- Urbanization
- Forest ecosystem management
- Climate and energy

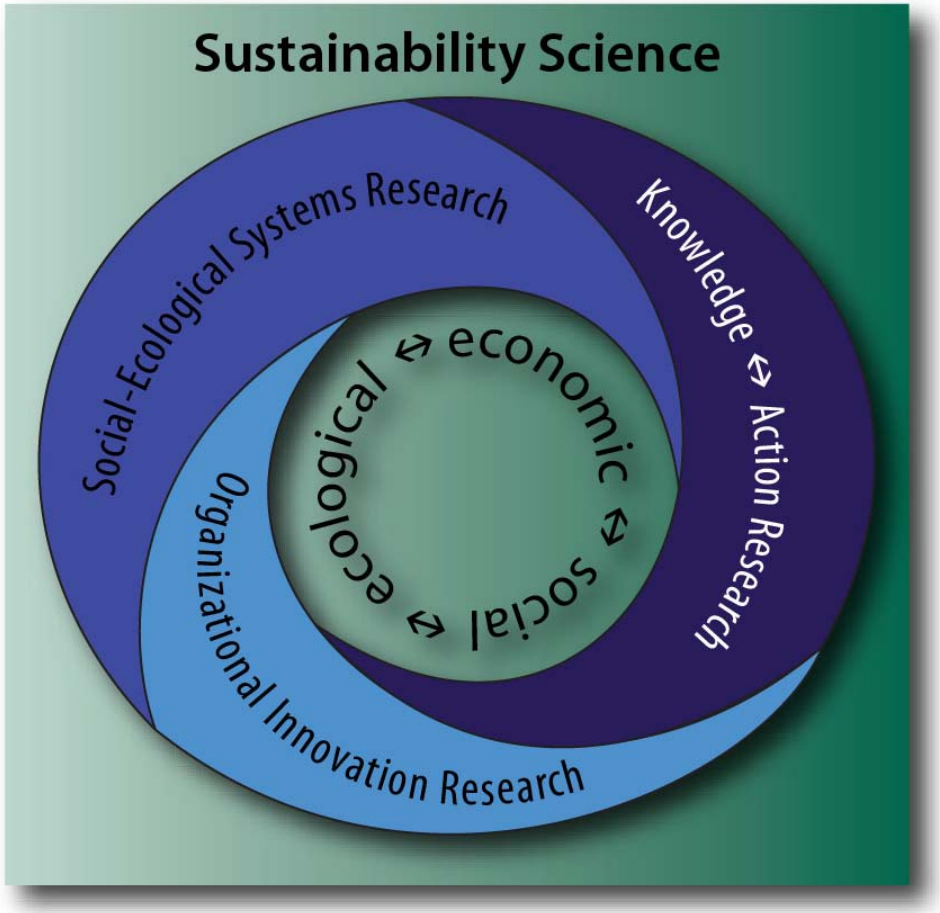
SSI's approach to sustainability science

Model System



Landscape Change

Central Research Foci

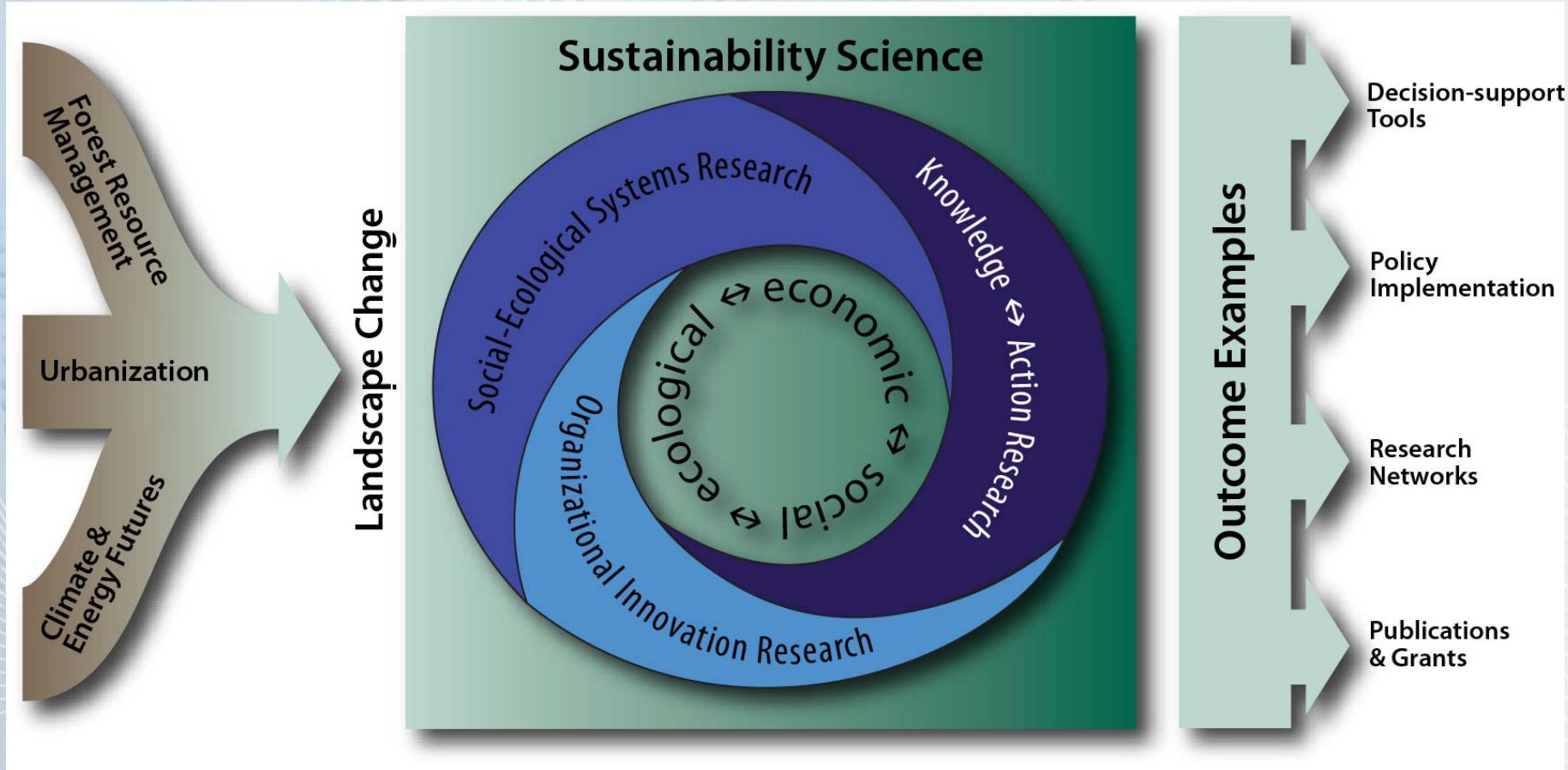


SSI's approach to sustainability science

Model System

Central Research Foci

Solutions

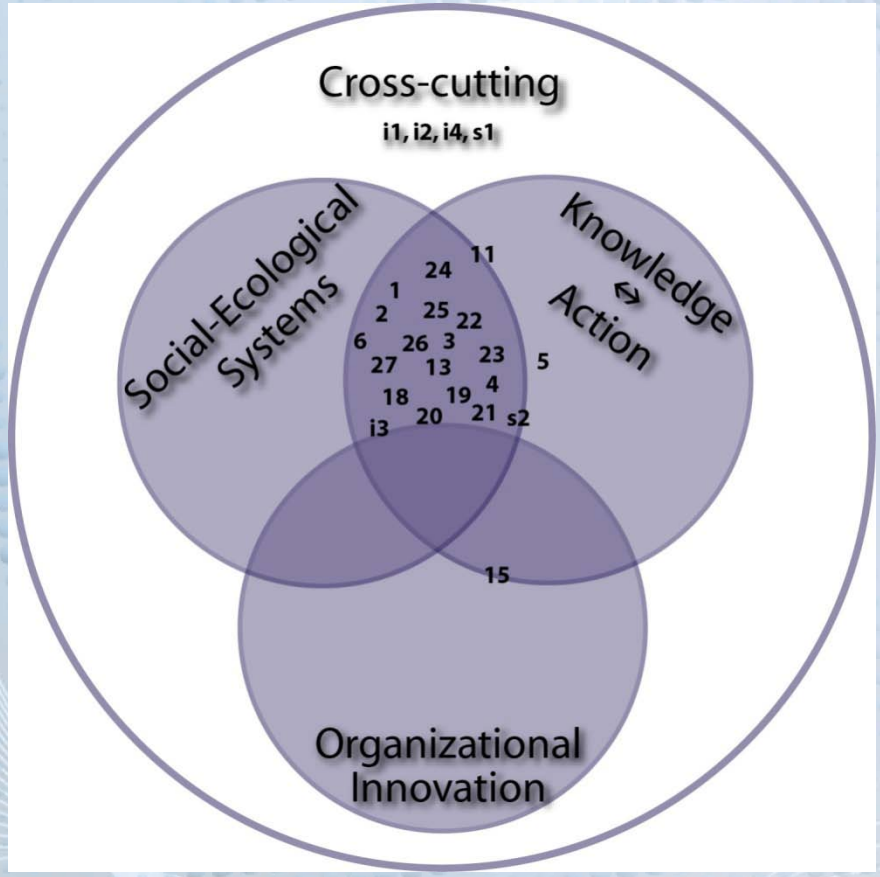


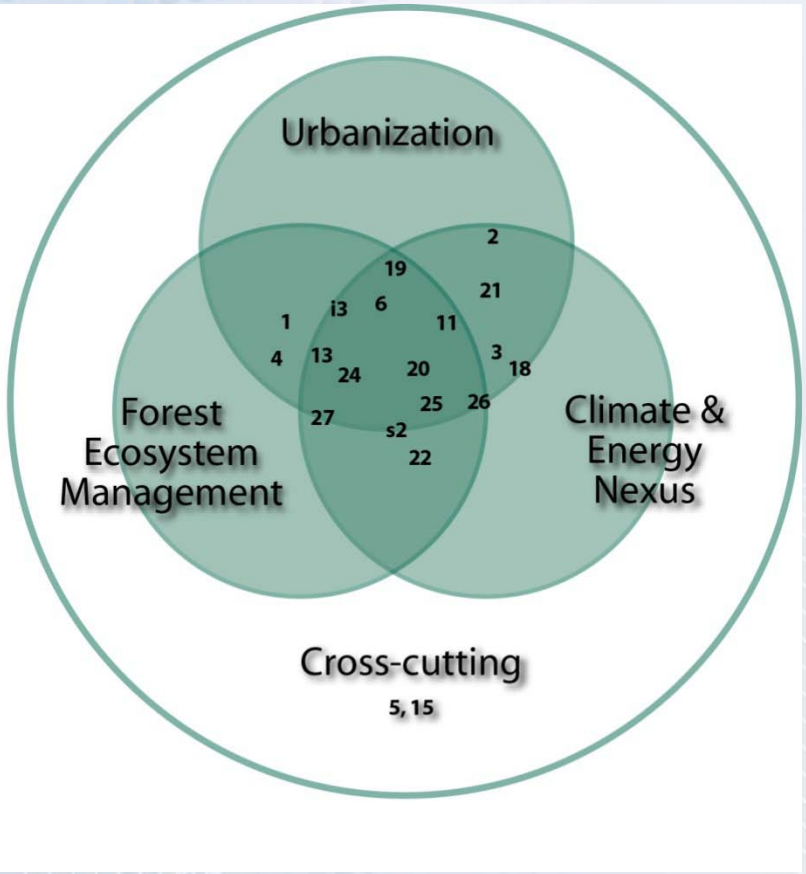
SSI emphasizes solutions

"SSI is unique in the country as an endeavor that is solutions-based and bridges disciplines between researchers, stakeholders and institutions."

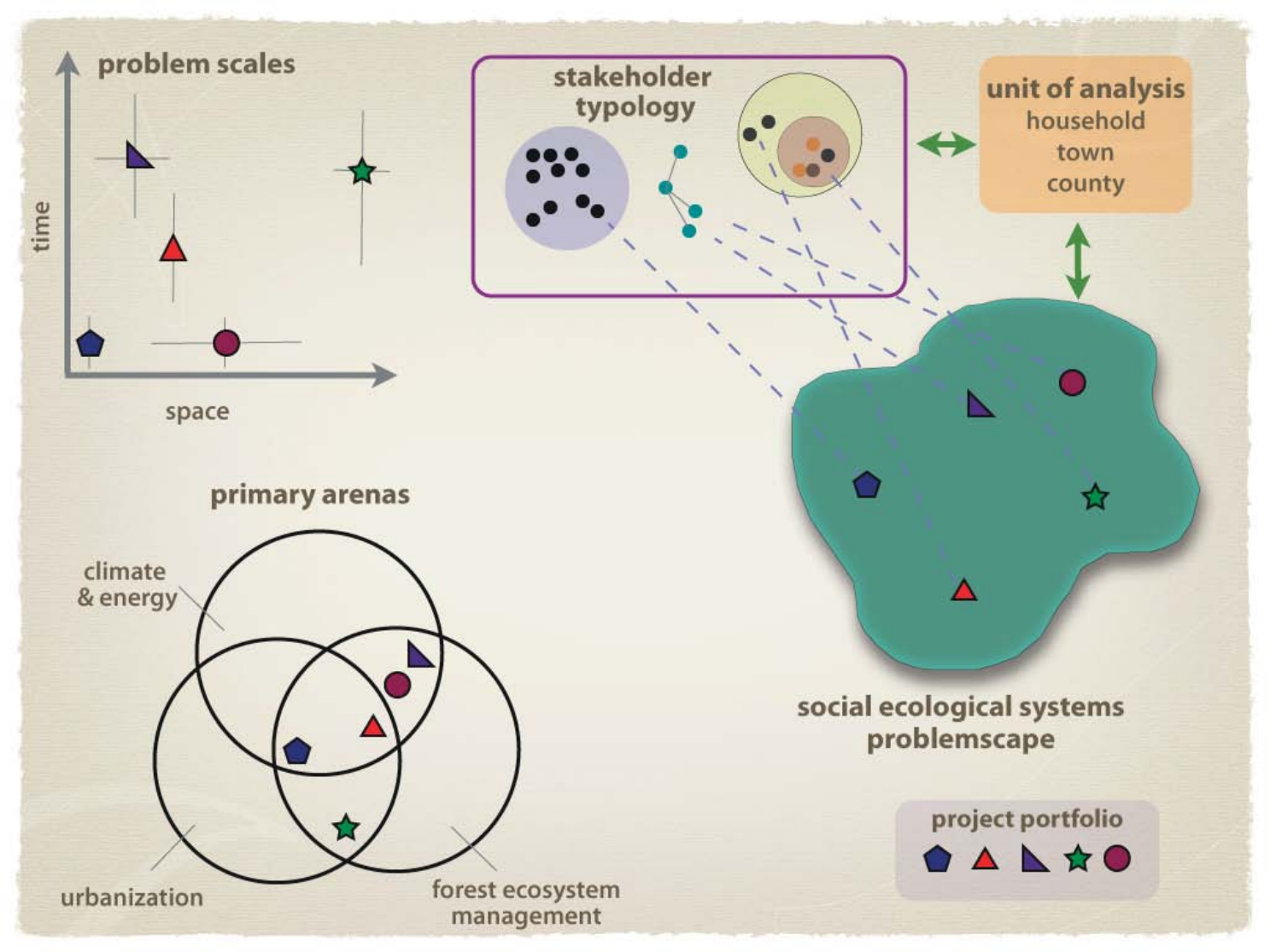
- Robert W. Kates

SSI's research portfolio strategy





The design of SSI's research portfolio



Jain et al., in prep

NSF's portfolio strategy

In FY 2011, NSF is ***highlighting the connections among elements of the SEES portfolio*** and the development of human capital for SEES-related research by funding projects on sustainability themes that integrate the social, natural, and engineering sciences. ***As an investment portfolio***, SEES supports research and education that spans ten NSF Directorates and Offices.

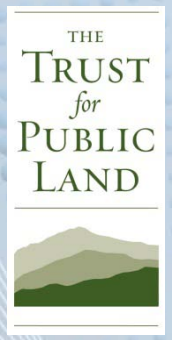
[http://www.nsf.gov/geo/sees/sees_portfolio.jsp]

Strategy for SSI's place-based research projects

- Engage with stakeholders to co-define problems
- Mobilize and support interdisciplinary research teams
- Strive to create durable researcher-stakeholder partnerships
- Develop knowledge co-production strategies
- Emphasize solutions
- Encourage innovation and risk-taking
- Evaluate outcomes and improve effectiveness

SSI's diverse partnerships

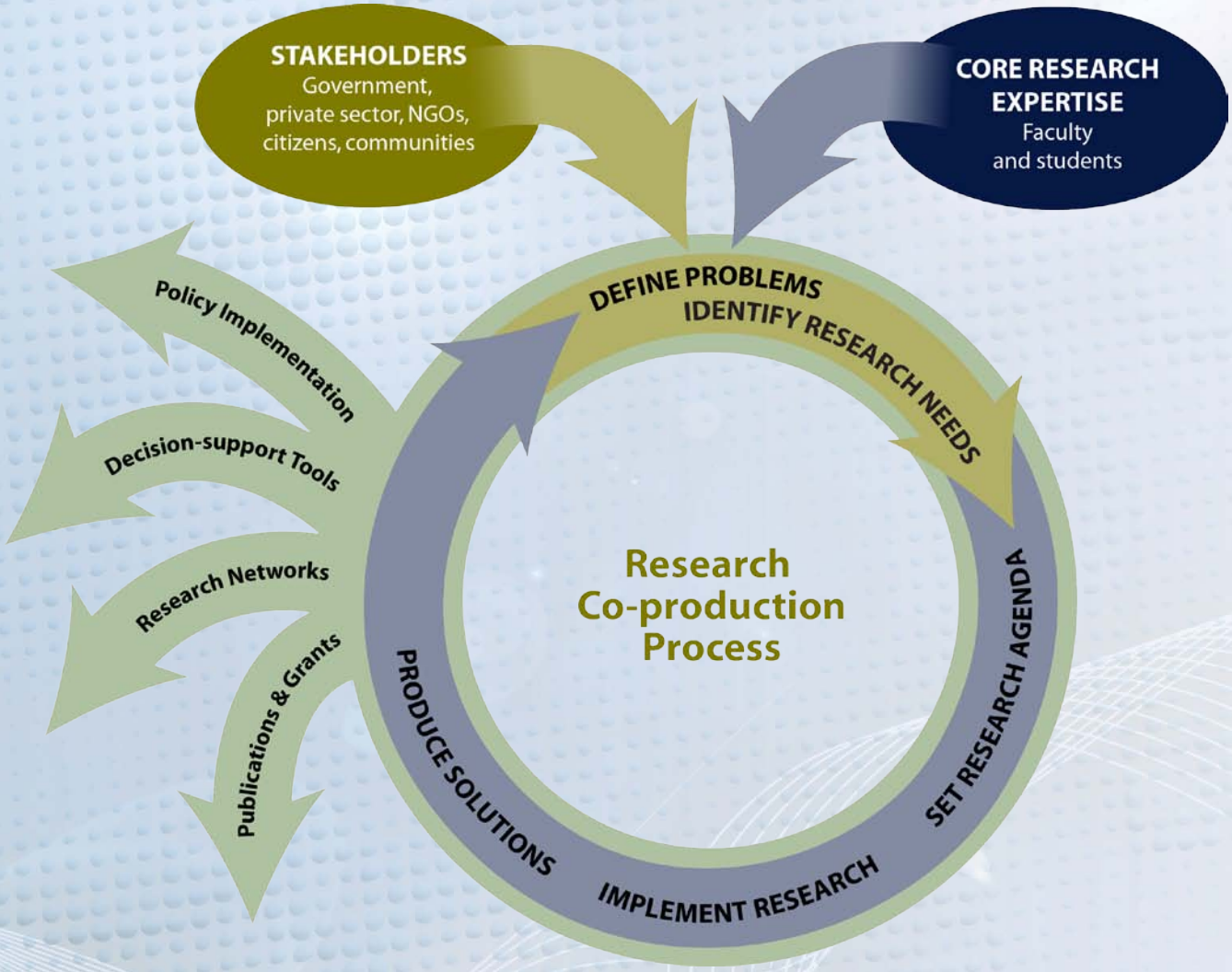

US Army Corps of Engineers®




Penobscot Indian Nation


Houlton Band of Maliseet Indians

SSI's iterative & adaptive research cycle



Goal #1: Create a world-class, solutions-driven sustainability science research center recognized for its innovative approaches to interdisciplinary research and deep commitment to collaboration with diverse stakeholders.

Goal 1: Major Accomplishments

- Maine has become a leader in sustainability science.
  - One of four institutions invited to present their research at the National Academies' *"Sustainability Solutions"* symposium, May 2012
  - Organizer of sustainability science symposium *("The role of knowledge institutions in sustainability")* at 2013 American Association for the Advancement of Science meeting
- Largest research partnership of universities and colleges in history of state, all focused on solutions-driven sustainability science.
- NSF EPSCoR award has helped leverage nearly $9 million in additional funding to date from federal and state agencies, the private sector, and private foundations.

SSI represented at National Academies

Science, Innovation, and Partnerships for Sustainability Solutions

A National Academies Symposium

May 16-18, 2012, Pew DC Conference Center

Wednesday, May 16, 2012

9:00 AM **Welcome from the National Academies**
Ralph J. Cicerone, National Academy of Sciences

9:10 AM **Welcome and Goals of the Symposium**
Pamela Matson, Stanford University, Committee Chair

9:20 AM **Keynote Addresses**
Subra Suresh, National Science Foundation
John Holdren, Office of Science and Technology Policy

10:15 AM **National & International Funding Scope for Sustainability Science Research**
Tim Killeen, National Science Foundation.

10:45 AM **Science for Sustainability: Case Studies of Research**
o Susannah Scott, University of California, Santa Barbara
o David Hart, University of Maine
o Holm Tiessen, Inter-American Institute for Global Change Research
o John Martin Anderies, Arizona State University

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Goal #2: Investigate the dynamics of social-ecological systems, with particular emphasis on SES resilience.

Goal 2: Major Accomplishments

- NSF Research Coordination Network – Science, Engineering and Education for Sustainability grant, *"Engineering Research Collaboratory for Sustainable Infrastructure in a Changing Climate"*, J. Kartez, co-PI
- NASA grant, Climate and Biological Response Program, *"Integrating global species distributions, remote sensing information and climate station data to assess recent biodiversity response to climate change"*, $1,636,276, McGill, co-PI
- NSF Coupled Natural and Human Systems proposal, SSI vernal pools team, for submission on Nov 20, 2012. PIs include Calhoun, Bell, and Hunter.

Goal #3: Examine the connections between scientific knowledge regarding SES dynamics and stakeholder actions that potentially affect SES resilience.

Goal 3: Major Accomplishments

- K↔A research has contributed to new legislation and public policies
  - Legislative testimony by SSI team members was pivotal to the passage of Legislative Bill 1613 to sustain Maine's unique tradition of public use of private land
  - 34 public presentations and formal presentations of testimony based on SSI's SES and K↔A research in Yr 3
- US Housing and Urban Development grant, (*"Southern Maine Partnership for Sustainable Development"*), $1.6 million, J. Kartez, project partner
- SSI leads a unique partnership of tribes, federal and state agencies for responding more effectively to invasive forest pests

Goal #4: Test models of organizational science to understand and improve interdisciplinary collaboration and university-stakeholder partnerships.

Goal 4: Major Accomplishments

- NSF Research and Evaluation on Education in Science and Engineering (REESE) proposal, *"Understanding and predicting interdisciplinary success: An empirical research project"*, McCoy and Gardner, PIs
- After OI research identified barriers to interdisciplinary teamwork, organizational changes were made that resulted in improved collaboration and researcher satisfaction
- OI research has identified a strong commitment by SSI team members to researcher – stakeholder partnerships that are likely to persist after the current NSF EPSCoR RII project

OI outcome: Improved interdisciplinarity

"One of the most impressive things about SSI is that interdisciplinarity is truly central to this initiative; nothing is forced. Furthermore, the administration, management, faculty, post-docs, and students are part of this program because of the interdisciplinarity - that element that is so hard for many programs to address. Indeed, the interdisciplinary nature of the initiative seems to be one of the central elements that draws people to SSI."

- *Review of SSI project by American Association for the Advancement of Science, May, 2011*

SSI research portfolio

Representative projects

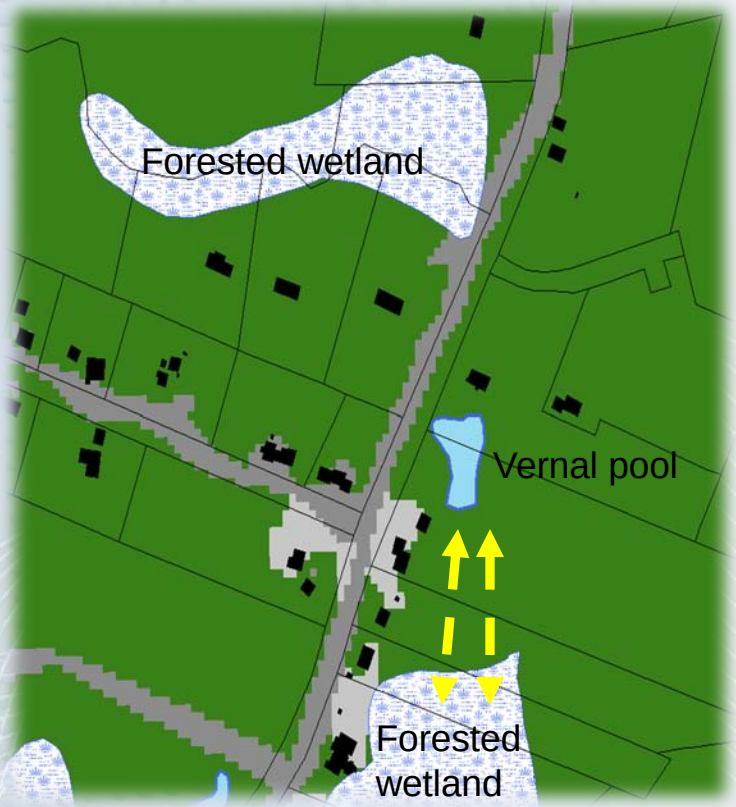
- Municipal planning research (Urbanization and Forest Management)
  - Balancing economic development with natural resource protection in municipal planning
- Tidal energy research (Energy)
  - Developing tidal energy in Cobscook Bay
- Climate adaptation research (Climate)
  - Adapting to climate change in coastal towns

Municipal planning – Problem context

- **Biophysical context**
  - Vernal pools – small seasonal wetlands with unique aquatic species in forested landscapes
- **Socioeconomic context**
  - Residential and commercial development, property values, consumer preferences
- **Decision-making context**
  - Potential development restrictions within 250 ft of pools
  - Municipal planners seek flexibility
  - Key stakeholders
    - Planners, land owners, developers, Army Corps, US EPA, ME DEP, ME State Planning Office, NGOs

Municipal planning – SES research

- Determining relationships among habitat requirements of wetland species, landscape heterogeneity, and parcel development processes



- Multiple habitat needs of wood frogs
  - Vernal pools – breeding
  - Forested wetlands – summer
  - Upland forest – winter
  - Breeding site fidelity
  - Forest specialists
- Requires permeable landscapes

Municipal planning – SES research

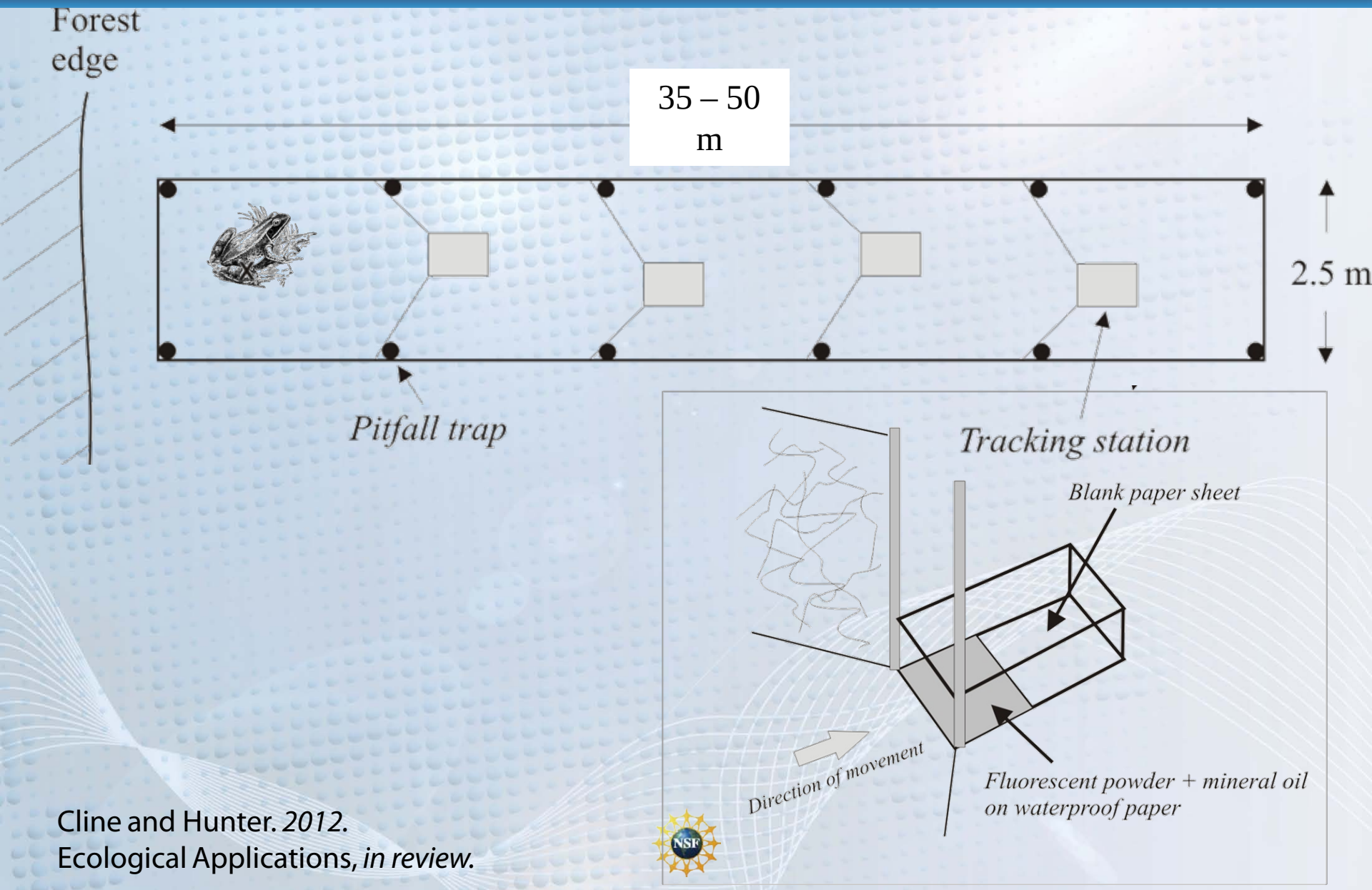
hayfield

lawn (0%, 45-85% canopy)

row crop (feed corn)

recent clear-cut (3-5 yrs post-harvest)

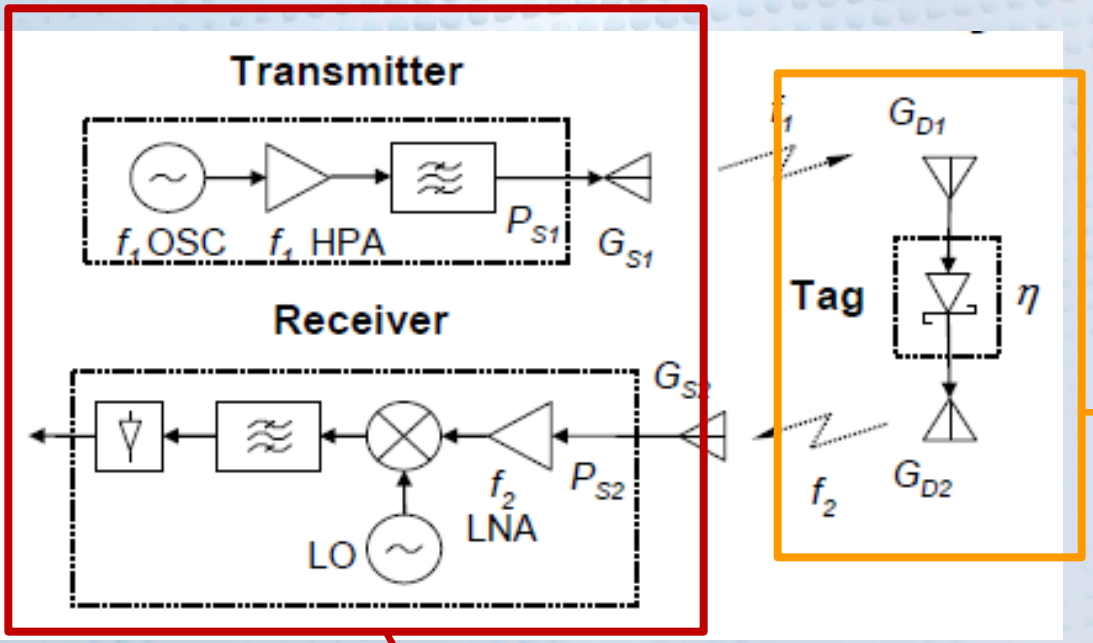
Municipal planning – SES research



Cline and Hunter. *2012.* Ecological Applications, *in review.*

Municipal planning – SES research

Development of a harmonic direction finding (HDF) system to track juvenile wood frogs (behavior, demographic rates)…



Municipal planning – K↔A research

Ostrom's General Framework for Analyzing Sustainability of Social-Ecological Systems

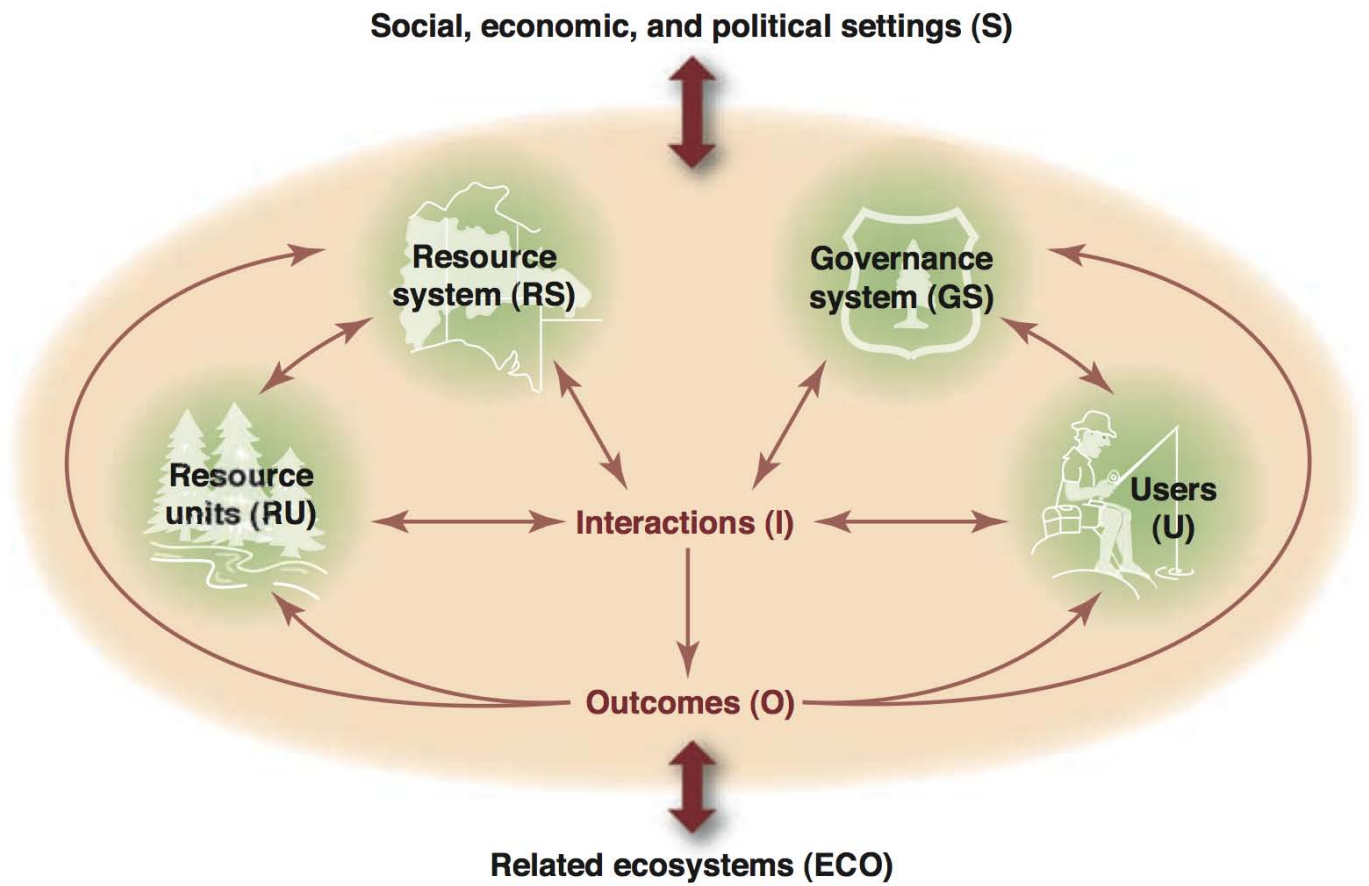
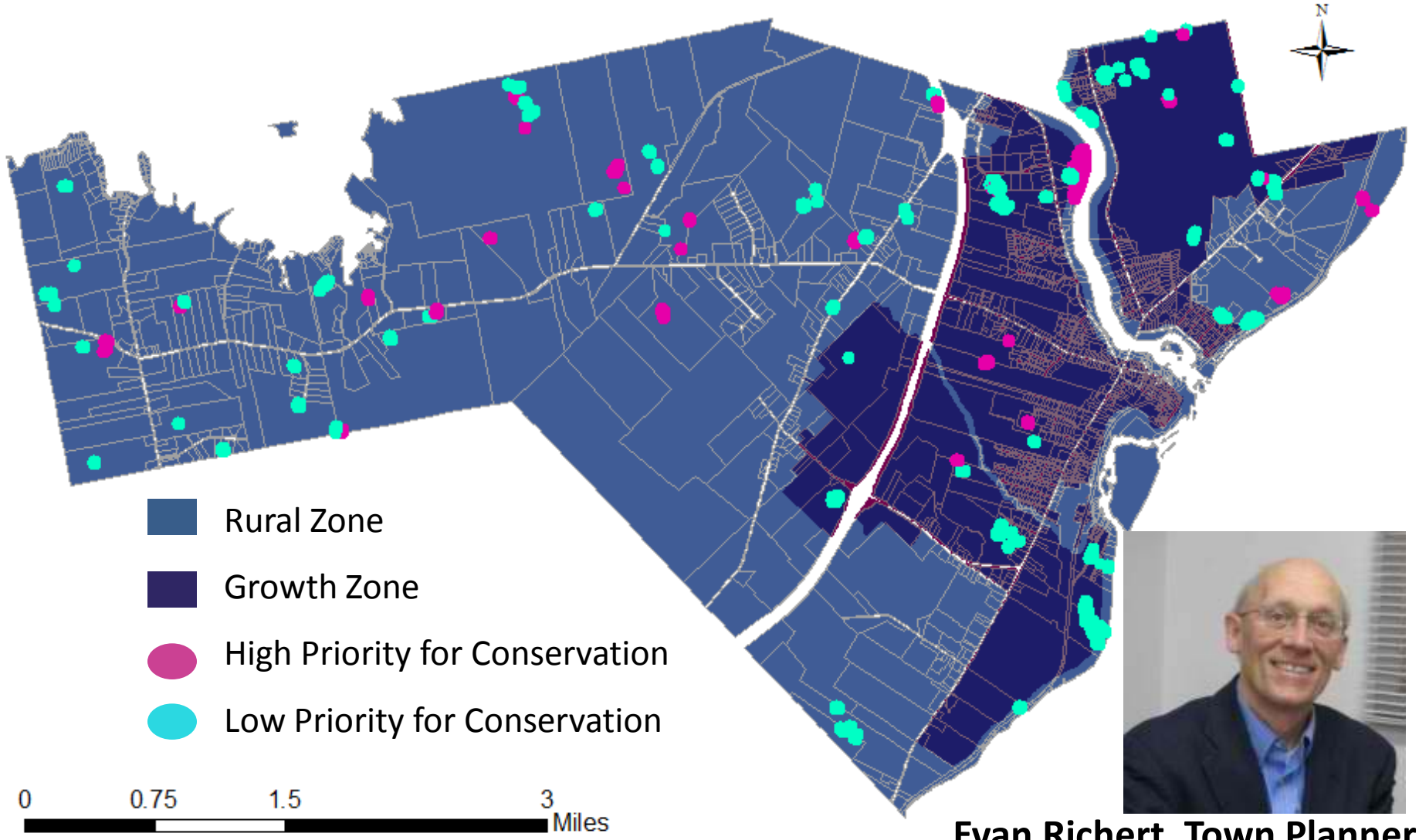


Fig. 1. The core subsystems in a framework for analyzing social-ecological systems.

from Ostrom (*Science*, 2009)

Municipal planning – K↔A research



Evan Richert, Town Planner

Municipal planning – Key accomplishments

Intellectual merit

Freeman, R.C., Bell, K.P., Calhoun, A.J.K., and C.S. Loftin. 2012. Incorporating economic models into seasonal pool conservation planning. Wetlands 32: 509-520.

Jansujwicz, J.S., Calhoun, A.J.K., Leahy, J. and Lilieholm, R. 2012. Using framing theory with mixed methods to develop a private landowner typology. Society and Natural Resources, *in review*.

Sewall Foundation grant, 2011. ("*Planning for Development and Natural Resources Conservation*")

Progress towards solutions

Morgan, D.E., and A.J.K. Calhoun. 2012. The Maine Municipal Guide to Mapping and Conserving Vernal Pools. Maine Audubon Society, Falmouth, ME.

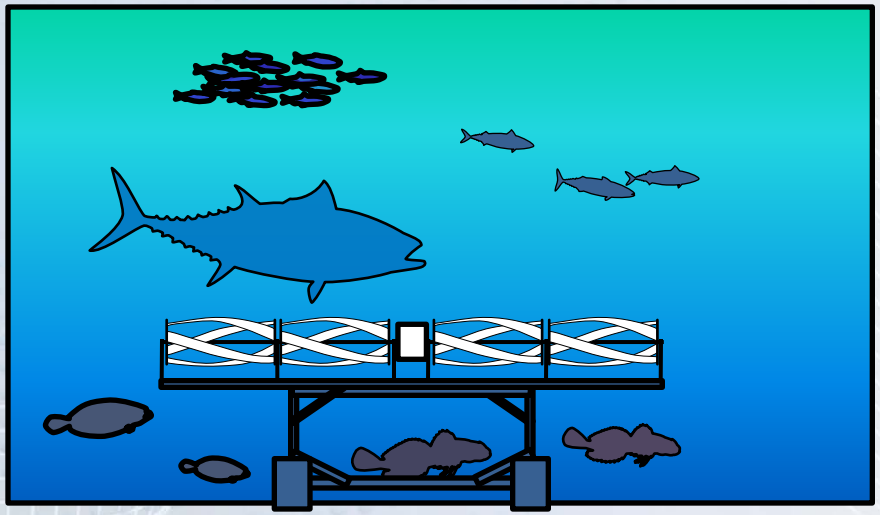
Research results incorporated into Special Area Management Plan of the US Army Corps of Engineers

Tidal energy – Problem context

- **Biophysical context**
  - Tidal power density, turbine design and spacing, environmental effects of infrastructure
- **Socioeconomic context**
  - Economic feasibility, stakeholder perceptions
- **Decision-making context**
  - Significant regulatory uncertainty associated with ocean energy development
  - Key stakeholders – Federal and state agencies, City officials, Tribal communities, Industry, Aquaculture, Fishermen, NGOs

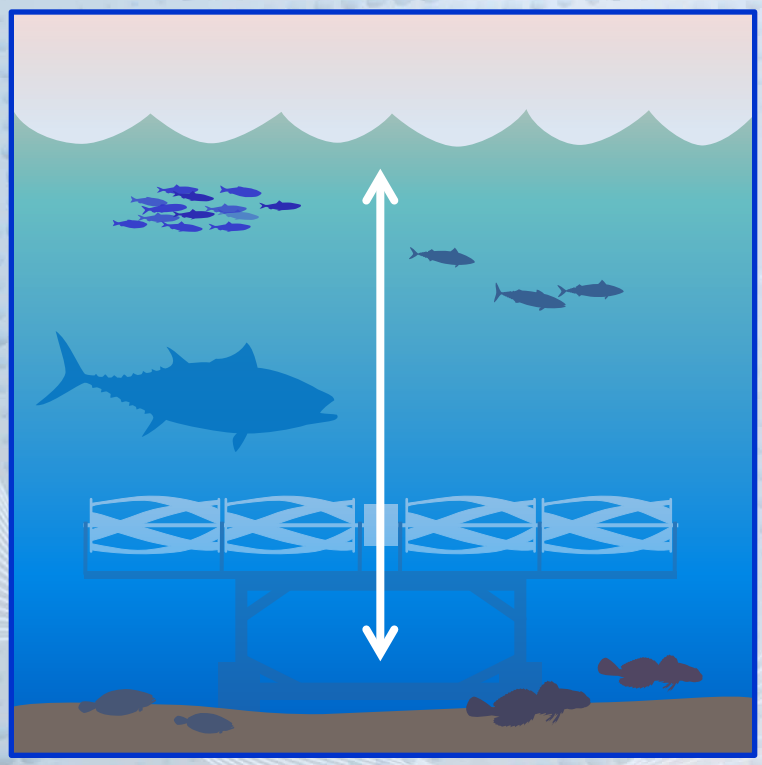
Tidal Energy – SES Research

- Physical oceanographic modeling of tidal power density
- Effects of energy extraction on hydrodynamics
- Effects of turbines on fish behavior, fish distributions and fishing activity

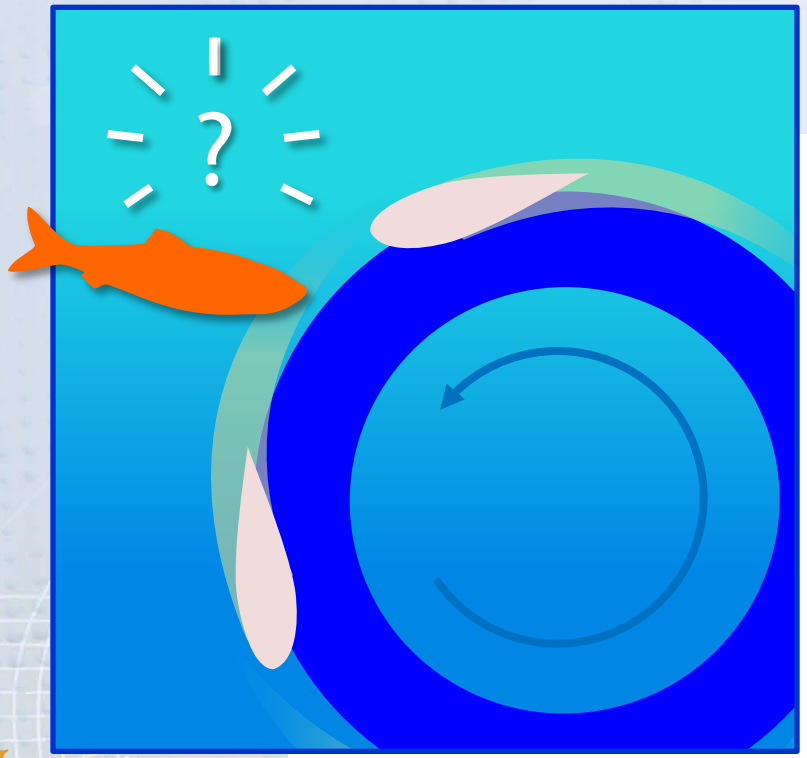


Tidal energy – SES research

1 **Indirect impacts:** fish presence and vertical distribution

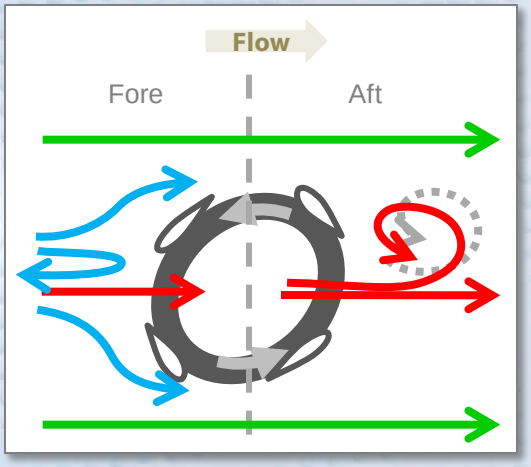


2 **Direct impacts:** fish interaction with turbine

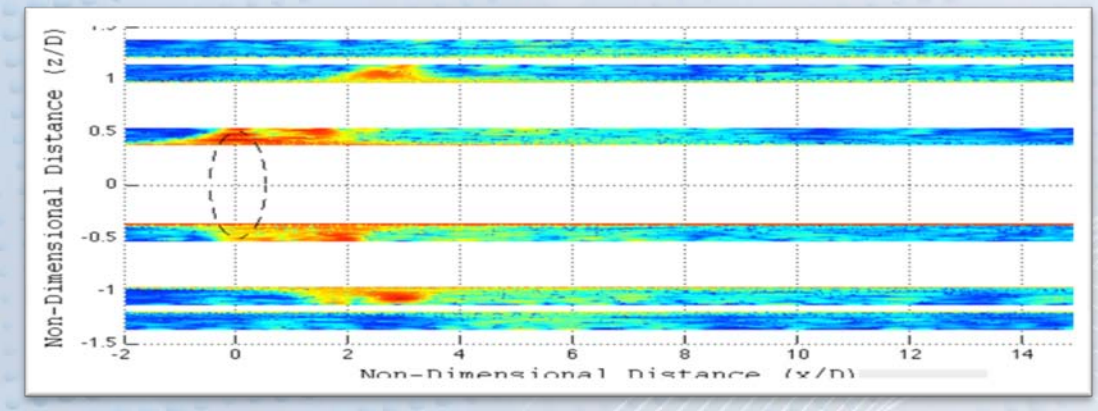


Tidal energy – SES research

Fish behavior around a turbine



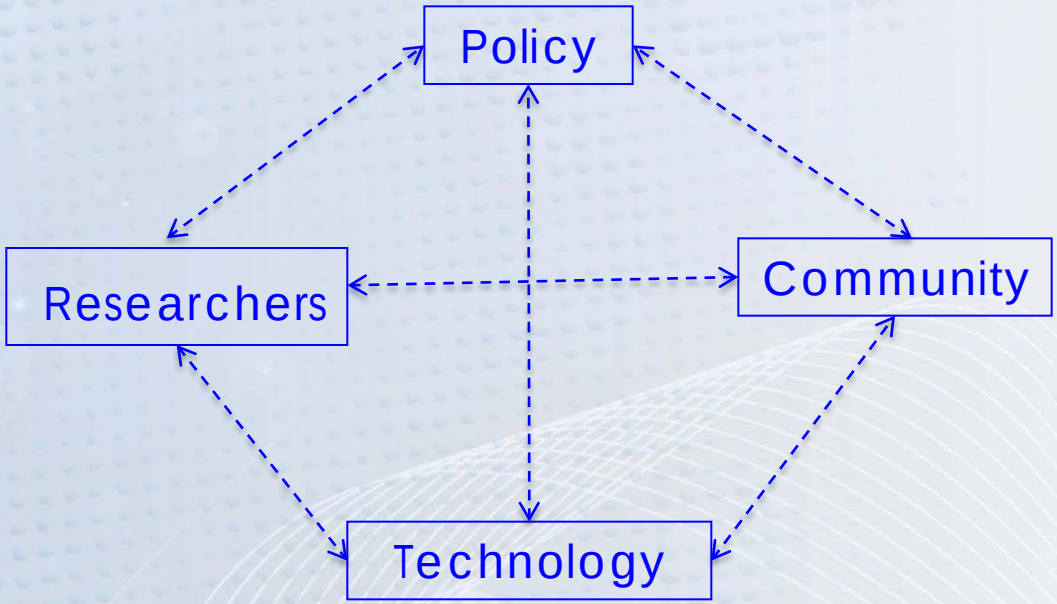
Current behavior around a turbine



Future research: Computational fluid dynamics integrating fish behavior for a more complete understanding of fish interaction with tidal devices

Tidal energy - K↔A research

- Stakeholder "Map"
  - who & information needs?
- Stakeholder interactions
  - who, frequency, context?
  - how information is used?
- Stakeholder perceptions
  - social acceptability?
  - information gaps?
  - outreach strategies?



Tidal energy - K↔A research

Industry

City Officials

Agencies (Federal/State)

FERC

DEP

DOE

Aquaculture

Passamaquoddy Tribe

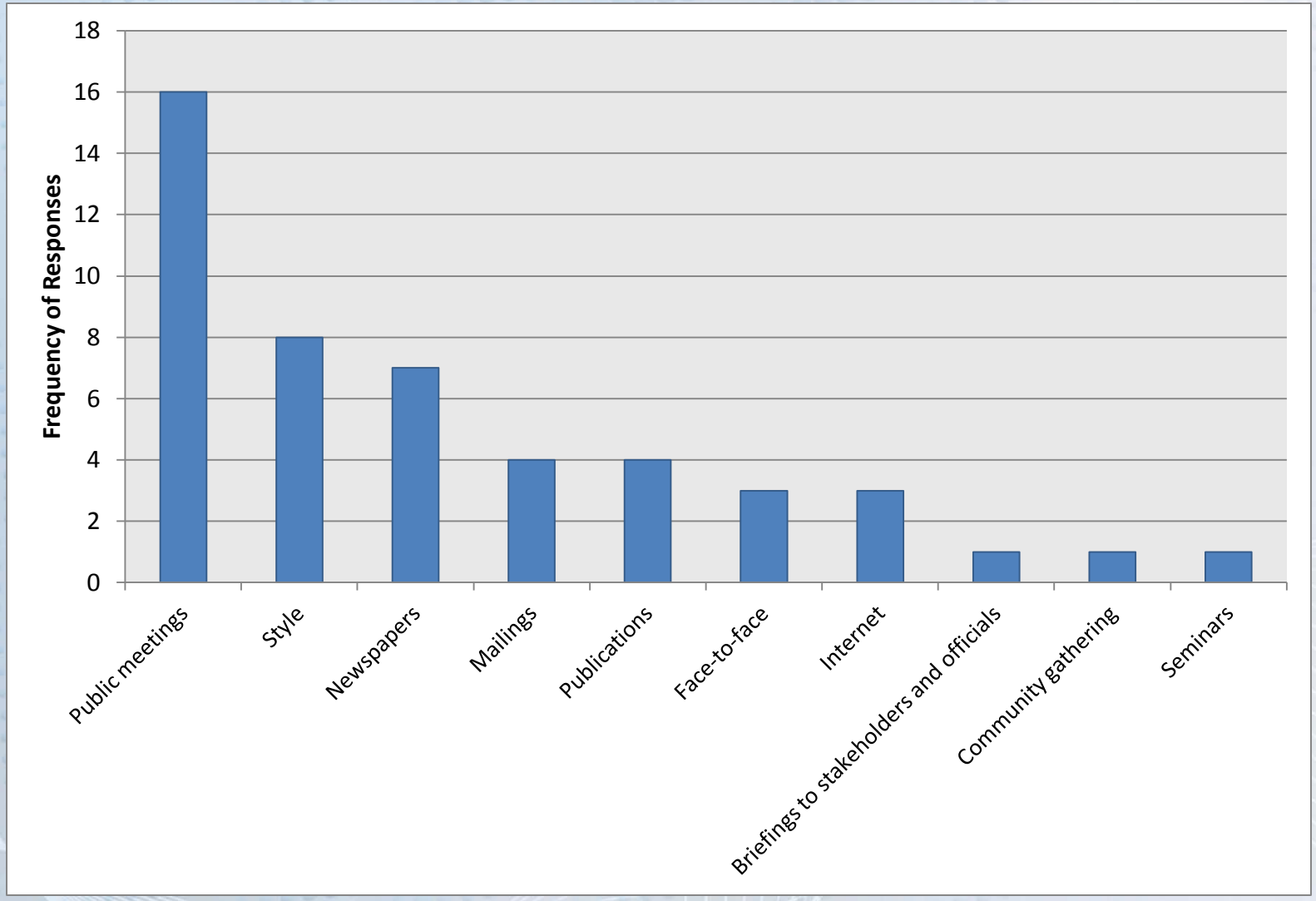
Fishermen

Tidal energy - K↔A research

- Observations & Interviews (2010-present)
  - Scientists, developers, policy-makers, community members
- Stakeholder survey (2010)
- Focus groups (Spring 2012)
  - Technology, policy, community

Ken Woisard/SSI

How should we deliver results?



Tidal energy - K↔A research

MAINE EPSCoR

orpc

Pre-filing (2009)

Pilot Project License Application Filed

FERC
FEDERAL ENERGY REGULATORY COMMISSION

U.S. Fish & Wildlife Service

US Army Corps of Engineers

United States Coast Guard
U.S. Department of Homeland Security

NOAA FISHERIES SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

DEPARTMENT OF Environmental Protection
STATE OF MAINE

FERC Decision (2012)

DEPARTMENT OF CONSERVATION
STATE OF MAINE

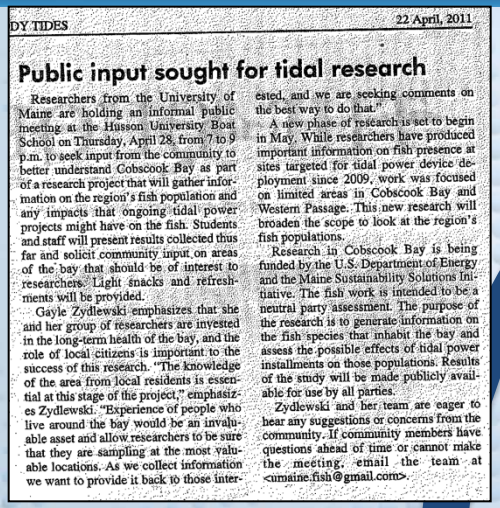
DEPARTMENT OF Marine Resources
STATE OF MAINE

FERC
FEDERAL ENERGY REGULATORY COMMISSION

Maine Historic Preservation Commission
STATE OF MAINE

STATE OF MAINE
Department of Inland Fisheries and Wildlife

Tidal energy - K↔A research



DY TIDES 22 April, 2011

Public input sought for tidal research

Researchers from the University of Maine are holding an informal public meeting at the Husson University Boat School on Thursday, April 28, from 7 to 9 p.m. to seek input from the community to better understand Cobscook Bay as part of a research project that will gather information on the region's fish population and any impacts that ongoing tidal power projects might have on the fish. Students and staff will present results collected thus far and solicit community input on areas of the bay that should be of interest to researchers. Light snacks and refreshments will be provided.

Gayle Zydlewski emphasizes that she and her group of researchers are invested in the long-term health of the bay, and the role of local citizens is important to the success of this research. "The knowledge of the area from local residents is essential at this stage of the project," emphasizes Zydlewski. "Experience of people who live around the bay would be an invaluable asset and allow researchers to be sure that they are sampling at the most valuable locations. As we collect information we want to provide it back to those interested, and we are seeking comments on the best way to do that."

A new phase of research is set to begin in May. While researchers have produced important information on fish presence at sites targeted for tidal power device deployment since 2009, work was focused on limited areas in Cobscook Bay and Western Passage. This new research will broaden the scope to look at the region's fish populations.

Research in Cobscook Bay is being funded by the U.S. Department of Energy and the Maine Sustainability Solutions Initiative. The fish work is intended to be a neutral party assessment. The purpose of the research is to generate information on the fish species that inhabit the bay and assess the possible effects of tidal power installments on those populations. Results of the study will be made publicly available for use by all parties.

Zydlewski and her team are eager to hear any suggestions or concerns from the community. If community members have questions ahead of time or cannot make the meeting, email the team at <umaine.fish@gmail.com>.

Redefine Problem
Identify Needs

Problem Identification

EVALUATION

Observations of & interviews with stakeholders

Stakeholder meetings

Focus Groups

Electronic survey

Research Plan

Present Results

Data Collection & Analysis

Tidal energy – Key accomplishments

Intellectual merit

Johnson, T.R., J. Jansjuwicz, G. Zydlewski. 2012. Stakeholder perspectives of tidal power development in Maine. Estuaries and Coasts, *in review.*

NOAA Grant. Fish distribution in relation to tidal hydropower in Downeast Maine.

Research partnership with Hirosaki University, Japan

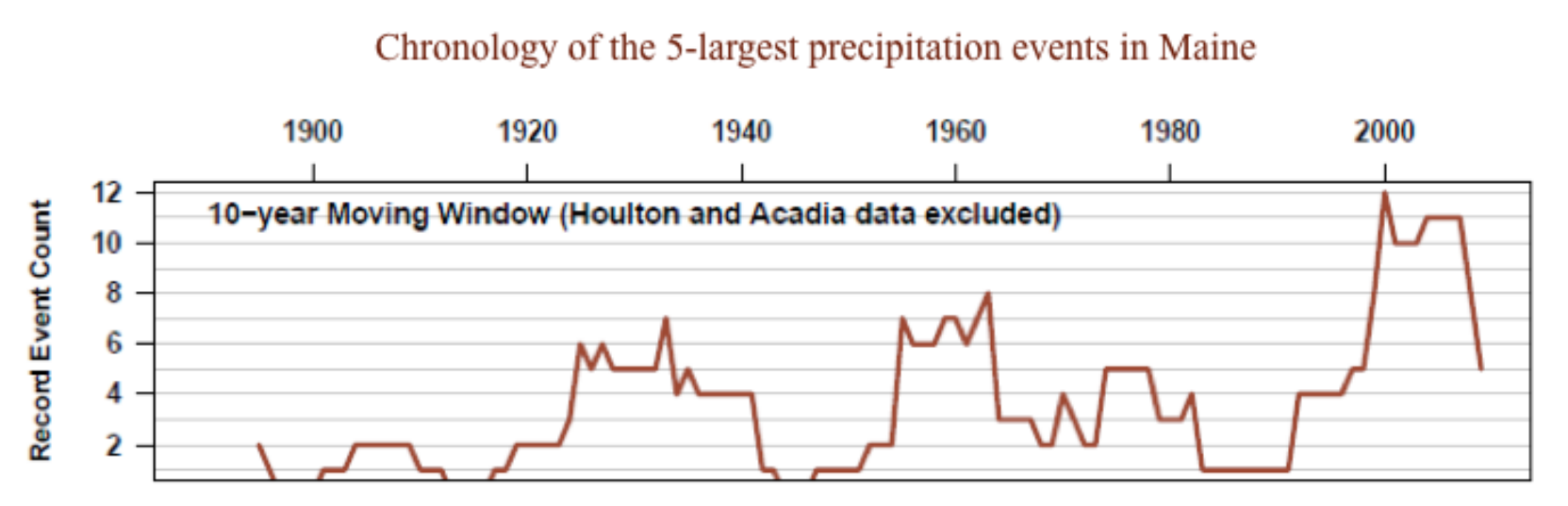
Progress towards solutions

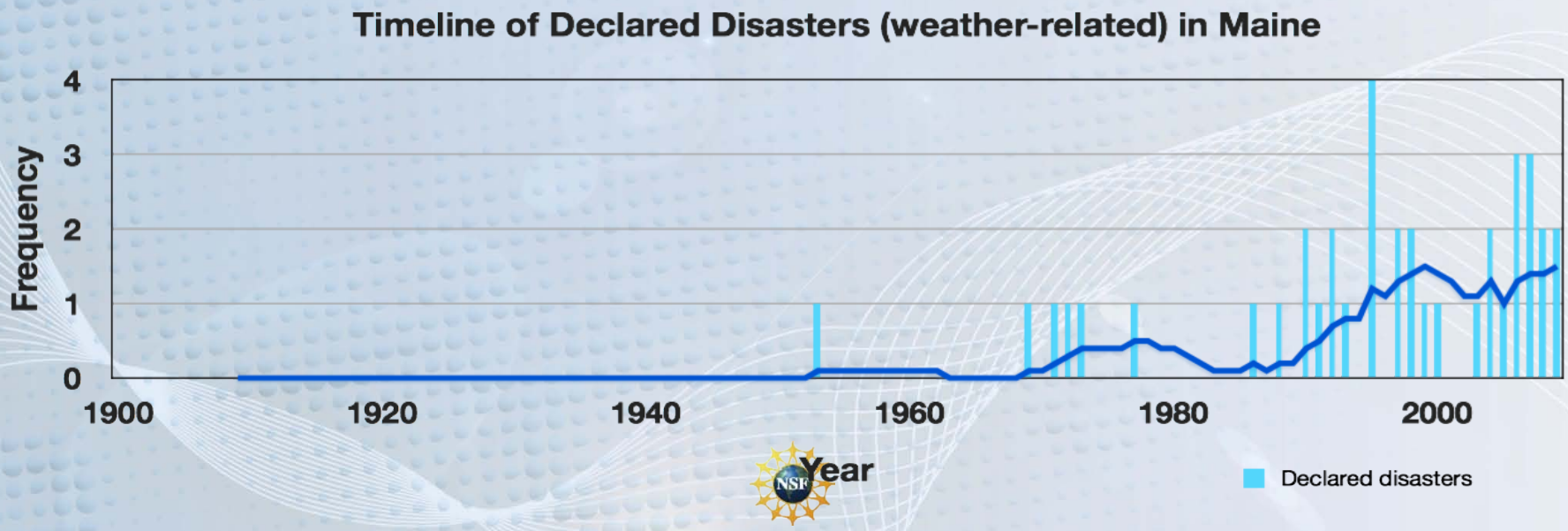
One of first commercial projects in US to generate power to grid

Climate adaptation – problem context

- **Biophysical context**
  - Climate - hydrology modeling
  - Role of Atlantic hurricanes
- **Socioeconomic context**
  - Infrastructure vulnerability
- **Decision-making context**
  - Institutional mapping & decision calendars
  - Key stakeholders – ME DOT, ME Emergency Planning Agency, US DOT, FEMA, State Planning Office, Municipalities

Climate adaptation – SES research





Modeling predictability of extreme rainstorms to support vulnerability assessment and vulnerability assessment

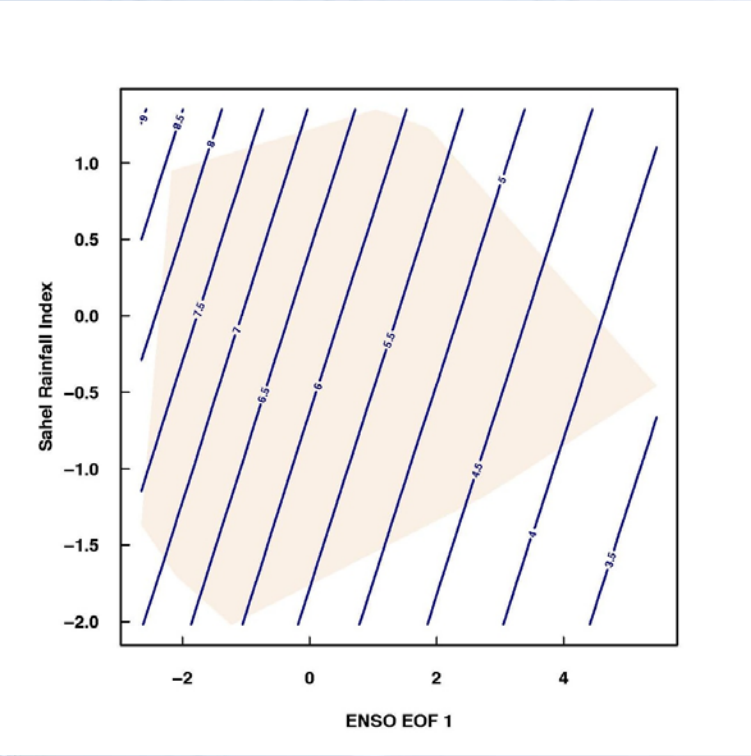
Data-driven approach to assess the role and significance of African dust on hurricane counts

- Bayesian MCMC approach
- Poisson
- Negative Binomial

El Nino-Southern Oscillation and Sahelian Dust are important predictors for the North Atlantic hurricane counts.

Current work develops conditional distributions of extreme precipitation for coastal Maine

Conditional Mean of the Hurricane Count Distribution



Climate adaptation – K↔A research

Town council

FEMA

Town planner

SMRPC
Southern Maine Regional Planning Commission
Serving the Municipalities of Southwestern Maine

Town harbor master

MaineDOT

Department of Environmental Protection
State of Maine

Town engineer

Town administrator

MID-COAST
REGIONAL PLANNING COMMISSION

Emergency Management Agency
State of Maine

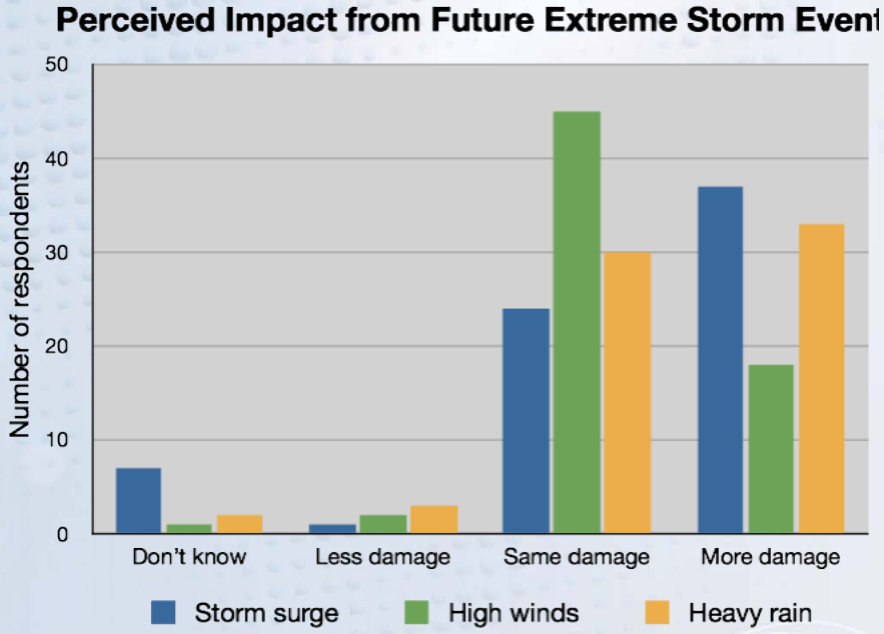
SPO Maine State Planning Office

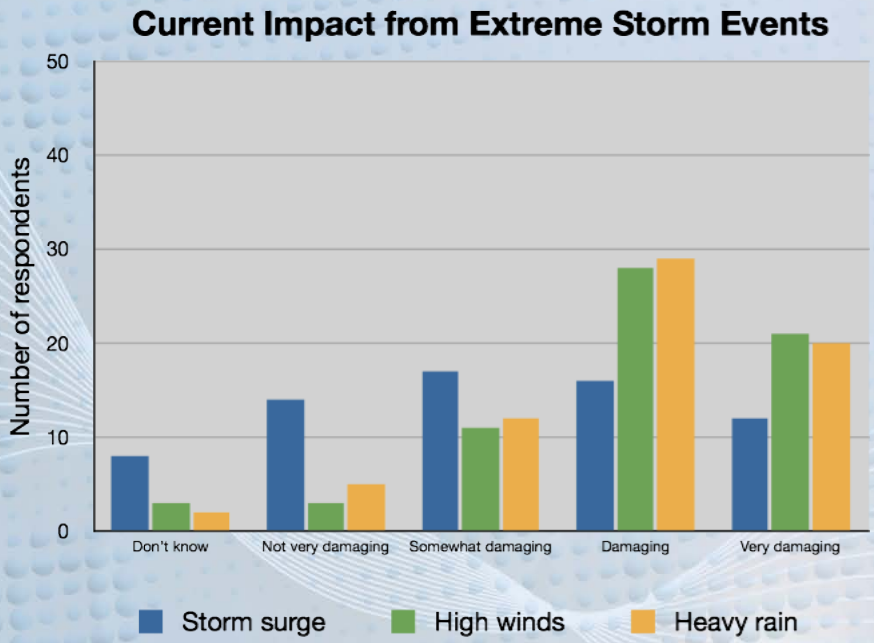
NSF

Climate adaptation – K↔A research

Survey Themes:

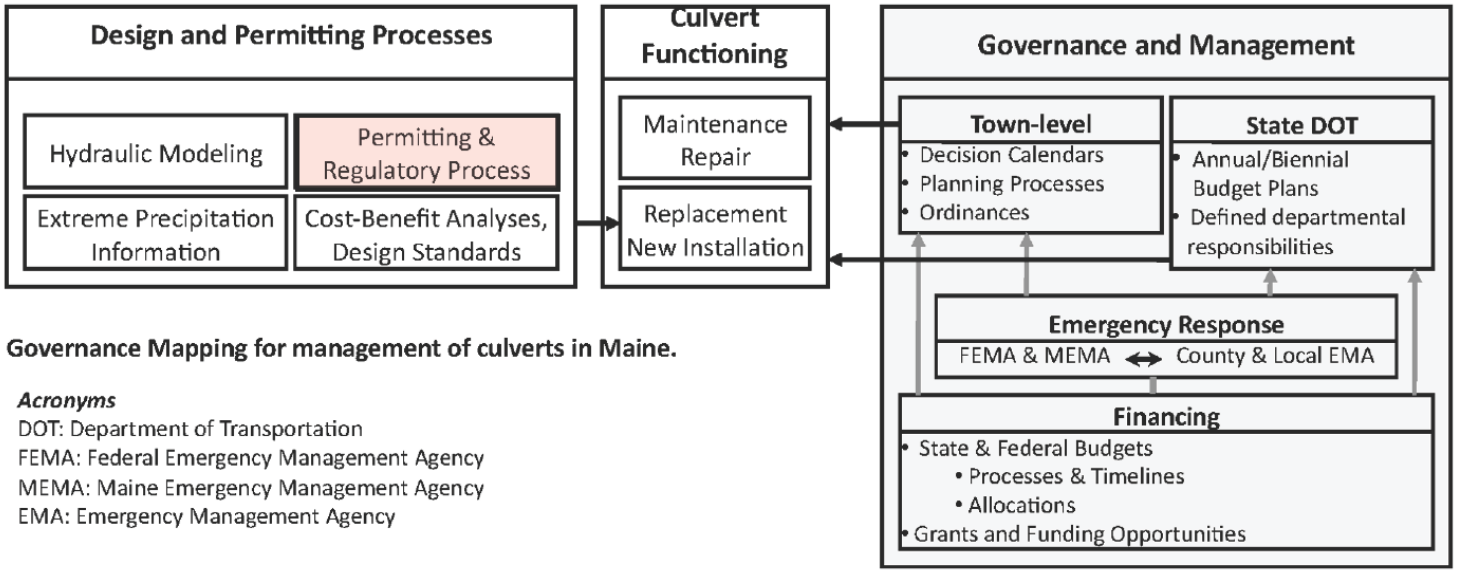
- Municipal official typology.
- Municipality typology.
- Extreme storm impacts on infrastructure.
- Perceived future impacts on infrastructure.
- Types of climate-related information currently being utilized.





Climate adaptation – K↔A research

- Further developing a comprehensive mapping related to governance



Governance Mapping for management of culverts in Maine.

Acronyms
DOT: Department of Transportation
FEMA: Federal Emergency Management Agency
MEMA: Maine Emergency Management Agency
EMA: Emergency Management Agency

- Unraveling the relationship between agency responsibilities and linked permitting standards
- Design and installation procedures: Nonstationary climate and Ecological Connectivity
- Detailed comparison of Maine DOT vs. town culverts: Procedures, financing, opportunities for innovation

Climate adaptation - Key accomplishments

Intellectual merit

Sea Grant Climate Adaptation grant, National Oceanic and Atmospheric Administration. Stancioff and Jain, co-PIs.

Gray, A. G. 2012. Climate-related adaptation in coastal Maine: A study of governance and decision processes. M.S. Thesis.

Progress towards solutions

Creating a statewide database to predict culvert vulnerability and prioritize management options.

Major results of SSI's portfolio approach

- New grant from National Socio-Environmental Synthesis Center (*"Forest communities at a tipping point?"*); Brian McGill and Kathleen Bell, PIs
- IGERT proposal ("A*dvancing renewable energy solutions by linking knowledge with action"*); Kathleen Bell and Laura Lindenfeld, lead PIs
- IGERT-Cyberinfrastructure Framework proposal ("*Synergistic Data Integration, Modeling, and Knowledge Discovery to Foster Sustainability*"); Shaleen Jain, lead PI

Research and Education

Broader Impacts

1. Advance discovery while promoting teaching, training, and learning

- Over 100 researchers from 30+ fields
- Engagement with over 200 stakeholder organizations (including Wabanaki communities in Maine)
- 4 new faculty, 6 post-doctoral researchers, 54 graduate students, over 100 undergraduate students
- Launched statewide collaborative of 11 colleges and universities

Advance Discovery, Promote Learning: Organizational Innovation Research

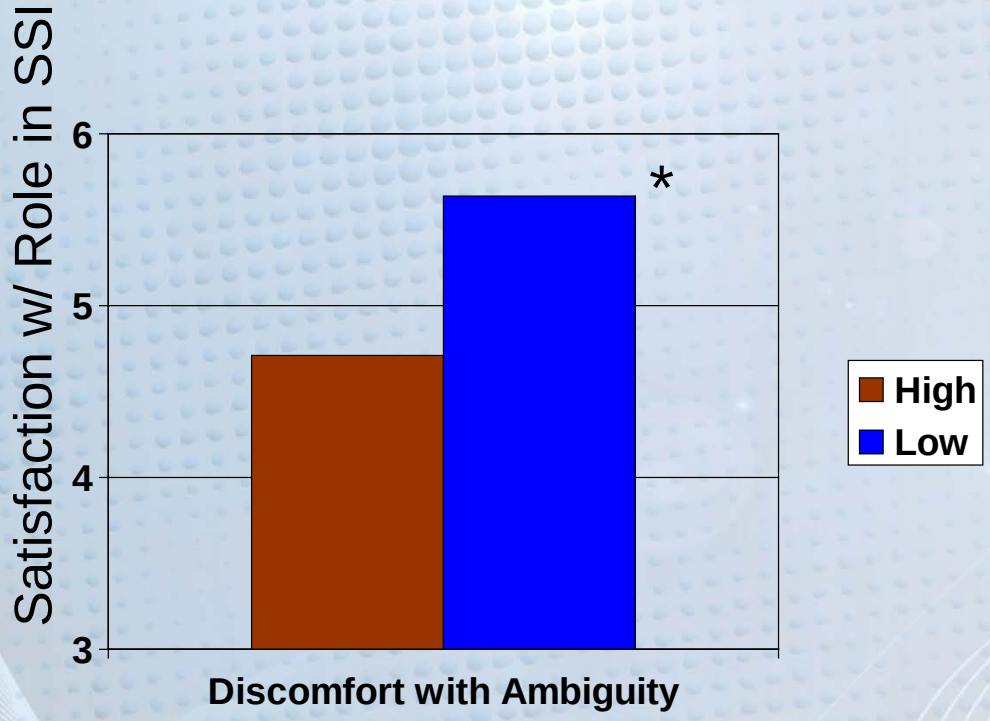
Examples of findings:

- Researchers with less tolerance for ambiguity fare less well than those with high tolerance. *(McCoy and Gardner)*

- Perceptions of concepts like "stakeholder" and "action" vary. Creating cohesion in language use creates a stronger framework for collaboration. (*McGreavy, Hutchins, Lindenfeld, & Silka)*

- For a multi-institutional project like SSI, establishing a liaison individual at each partner institution creates a stronger network and leads to improved outcomes. (*Budzinski, Lindenfeld, & Silka)*

Individual Factors: Discomfort with Ambiguity



Changes implemented:

- Research Council
- Internal peer review process

Satisfaction: $\beta = -.34$, $p < .05$

McCoy, Newell, & Gardner

Research and Education

Broader Impacts

2. Broaden participation of underrepresented groups

A research example:

The Emerald Ash Borer Project

Images provided courtesy of the Bangor Daily News and Tony Sutton

The Emerald Ash Borer Project: Co-defining Problems and Solutions

"This process was about recognizing that we were not necessarily the experts on this particular issue. Humility and seeing yourself as a learner and a researcher are key hurdles to overcome."

Darren Ranco, SSI Faculty member and member of the Wabanaki community

3. Enhance infrastructure for research and education

- **Partnerships:**
  - 320 individual collaborators at 169 institutions and organizations in the research and integrated education component
  - 24 partners in workforce development, educational outreach and communication, and human resource development
- **SSI Network**
- **Facilities and Instrumentation:**
  - Social Science laboratory in the *Innovative Media Research Center*
  - *Experimental Economics Laboratory*

4. Broaden dissemination to enhance scientific understanding

Integrated communication activities highlights:

- Annual SSI Conference in partnership with Maine Water Conference
- Mitchell Lecturers:
  - Elinor Ostrom (2010)
  - Baruch Fischhoff (2011)
  - Pamela Matson (2012)

Benefits to society

K↔A Model:

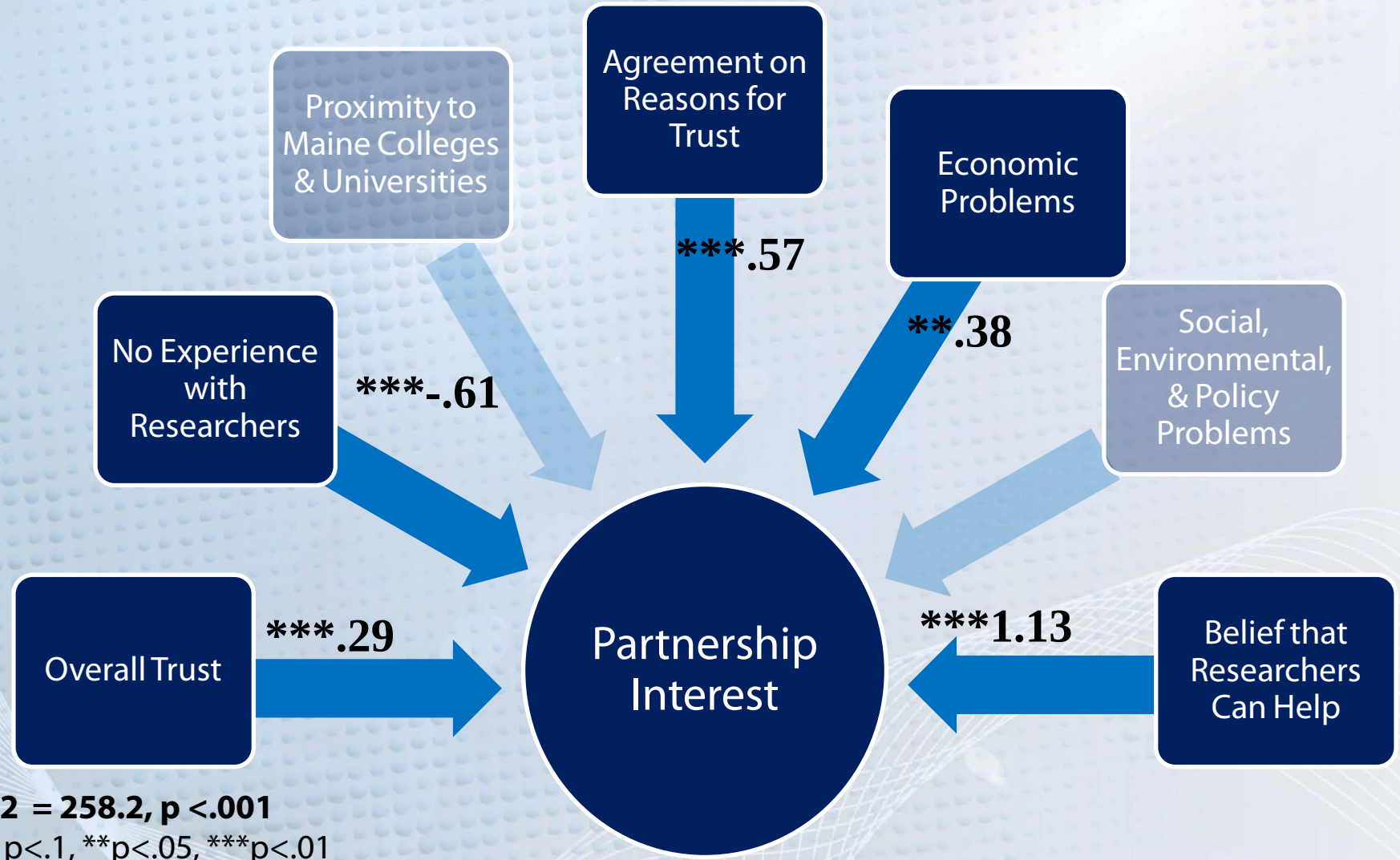
- Designed to align the demand for science with supply
- Producing science and scientific products with the needs of stakeholders in mind, while maintaining the role of science as independent broker

An example:

- Maine Municipal Agents and Partnership formation

Research & Education

Broader Impacts



χ^2 = 258.2, p <.001

* p<.1, **p<.05, ***p<.01

Variables with insignificant effects are faded in the model

Diversity

Broadening Participation

Goal #5: Engage all aspects of the state's human and institutional resources in the achievement of the RII project goals and objectives.

Maine EPSCoR has two main objectives for broadening participation in STEM:

1) Through increased individual diversity.

2) Through increased institutional and partner diversity.

Diversity

Individual Diversity

Objective 5.1: Broaden overall participation through increased individual diversity.

While Maine fluctuates between the first or second least diverse state in the nation, with NSF-defined minorities consisting of only ~3.4% of the population, Maine EPSCoR has a demonstrated commitment to programs and activities that broaden the participation of women and underrepresented groups in STEM.

Directly Supported Participants

Includes new hires, faculty summer salary/release time, professionals, and research internships for graduate, undergraduate, and high school students.

	YR1	YR2	YR3
Total supported	264	345	318
Female	47%	45%	48%
Underrepresented	5%	7%	8%

Indirectly Supported Participants

Participants engaged in various outreach, workforce development, external engagement, and collaborative activities that were sponsored and supported by Maine EPSCoR.

	YR1	YR2	YR3
Total participants	3,524	1,709	6,348
Female	58%	72%	47%
Underrepresented	8%	8%	8%

Diversity

Broadening Participation – Persons with Disabilities

Camp CaPella

Year-round recreational and educational program for children and adults with disabilities.

- **2011 Pilot Program:** 138 campers, ranging from elementary school age to adults, were introduced to topics in environmental sustainability and related careers in the natural outdoors setting of the camp, one day a week.
- **2012 Intensive Program**: SSI-related activities expanded to one of four daily rotational units. 125 campers participated.

"It seems to be inherent to our population of campers to love the outdoors and all it encompasses. However, they are often left out of the experience. When the campers were told they were going to be scientists , they got so excited." – Beth Smyth-Handley, Program Coordinator

Diversity

Broadening Participation – Persons with Disabilities

Center for Community Inclusion & Disability Studies University of Maine

- YR1 & YR2: Planning for collaboration.
- YR3 Pilot Program: development, implementation, and evaluation of a model for supporting the transition of Maine students with disabilities into STEM-related postsecondary educational opportunities.
- Included a 3-day workshop series for 10 high school students from throughout the state.

"I have much more understanding of college and STEM careers and heard about so many options."

"I learned about how to get into a 4-year school, instead of a 2-year school."

"Overall, I gained more knowledge about college."

Diversity

Broadening Participation – Low Income/First Generation

Upward Bound
University of Maine

- **Summer 2012:** The 6-week group research project focused on climate change and the sustainability of human behaviors.
  - SSI faculty researchers Mark Anderson and Caroline Noblet and SSI graduate student Jenny Shrum served as facilitators.
  - 28 at-risk high school students participated.

Diversity

Broadening Participation – Women & Girls

UMaine Women's Resource Center

Expanding Your Horizons:

YR2: 5th year with Maine EPSCoR support; 514 7th and 8th grade girls participated.

YR3: EYH Conference on hold for redevelopment.

YR4: Maine EPSCoR Program Assistant & Diversity Specialist serves as chair of planning committee. Spring 2013 conference will include SSI-related mentors and workshops.

National Girls Collaborative Project:

- YR2: Maine EPSCoR provided match to support 5 additional mini-grant applicants, who provided STEM programs and activities for over 100 girls across the state.
- YR3: Program transition into beginning second NSF award period (5 years).
- YR4: An expanded mini-grant process is set to begin fall 2012, to which Maine EPSCoR has committed additional funding. The Maine EPSCoR Program Assistant & Diversity Specialist serves on the MGCP Leadership Team to foster this collaboration.

Diversity

Broadening Participation – Women & Girls

UMaine Rising Tide Center (NSF ADVANCE)

- **YR3:** SSI collaborated with ADVANCE and UMaine's Center for Teaching and Assessment on an Interdisciplinary Research (IDR) Workshop Series.
- **YR3:** Center hosted its first annual networking conference in May 2012 with support from Maine EPSCoR.
- **YR4:** Collaborating on the implementation of a statewide expertise database to assist in the development of collaborations.

Diversity

Broadening Participation – Native Americans

Native STEM Scholarship Development Program

- SSI Native Collaborative Research Assistants Natalie Michelle and Anthony Sutton and SSI faculty and NSSDP Coordinator Darren Ranco have held or participated in over 20 events for over 400 Native participants ranging from elementary-aged to adults. These included discussion panels, hands-on workshops, and youth camp activities.
- 4 undergraduates, 2 graduate students, and 1 faculty attended the American Indian Alaskan Native Climate Change Working Group Spring Meeting in Arizona in April 2012.

Diversity

Broadening Participation – Native Americans

Native STEM Scholarship Development Program Graduate Research Assistants

SSI Native American Collaborative Research Assistantships seek to build research collaborations with Maine's Native American communities and help spark interest and train the next generation of STEM researchers in collaborative research and outreach.

Natalie Michelle, Master's student in Public Administration, graduated May 2012

Anthony Sutton, Master's student in Communication, graduated May 2012

Diversity

Institutional Diversity

Objective 5.2: Expand institutional and partner diversity in this project (type, geographic, disciplinary).

Progress:

- Core SSI research teams at UMaine and University of Southern Maine
- Sustainability Solutions Partners (SSP) program created for statewide undergraduate & community college involvement currently includes:
  - 5 private colleges: Bates, Bowdoin, Colby, University of New England, and Unity College
  - 4 UMaine system colleges: UM Presque Isle, UM Farmington, UM Augusta, and UM Fort Kent
  - Eastern Maine and Southern Maine Community Colleges workforce development projects

Diversity

Institutional Diversity

Collaborations

Type:	YR1 Institutions	YR1 People	YR2 Institutions	YR2 People	YR3 Institutions	YR3 People
Higher Education	20	99	28	66	31	101
Industry	11	15	19	24	24	26
Government	11	23	47	83	47	84
Nonprofit	58	84	58	79	56	96
K-12	3	3	5	5	10	12
Other	0	0	1	1	1	1
TOTAL:	103	224	158	258	169	320

Workforce Development

In the Sustainability Solutions Initiative

Goal #6: Foster the next generation of sustainability science professionals through efforts that are linked to the diverse challenges and opportunities in this emerging field.

Increase statewide capacity to produce and support sustainability science professionals by:

- Hiring new positions at all levels
- Supporting existing positions at all levels to participate in SSI
- Providing training & mentoring at all levels.
- Providing new curriculum and learning opportunities.

Workforce Development

In the Sustainability Solutions Initiative

Objective 6.1: Provide direct research support for SSI participation and engagement at all levels.

	YR1	YR2	YR3
Total supported	264	345	318
Faculty	87	109	100
Postdocs	2	2	6
Graduate students	40	49	54
Undergraduate	81	144	101
High school students	21	20	21
Prof/Tech/Admin	33	21	36

Workforce Development

In the Sustainability Solutions Initiative

Objective 6.2: Engage graduate students in SSI mentoring, programs, and opportunities.

SSI Graduate Students

- 22 graduate students to date admitted as SSI PhD cohort students, with 3 more starting in the spring.
- Two-course sequence in sustainability science approved by SSI Stewardship Council & implemented.
- SSI Graduate Certificate has been developed in coordination with Ecology and Environmental Sciences program (EES).
- Graduate travel supported (avg. of 1-2 national conference/student/year)
- Formal and Informal Mentorship.
- IGERT and future directions.

Impact of SSI on Graduate Education at the University of Maine

"SSI has developed a model program for mentoring graduate students based on shared responsibility, true teamwork, and vertical integration from high school students through undergrads, grad students, and postdocs to faculty leaders. SSI students have not only made excellent progress towards degrees but also have won competitive graduate awards. We could only wish for more such graduate students."

Graduate Dean, Professor Dan Sandweiss, University of Maine

Workforce Development

In the Sustainability Solutions Initiative

Objective 6.2: Engage undergraduate students in SSI mentoring, programs, and opportunities.

SSI Undergraduate Programs

- Sustainability Concentration
- Statewide Sustainability Curriculum through SESYNC award
- Formal and informal mentorship

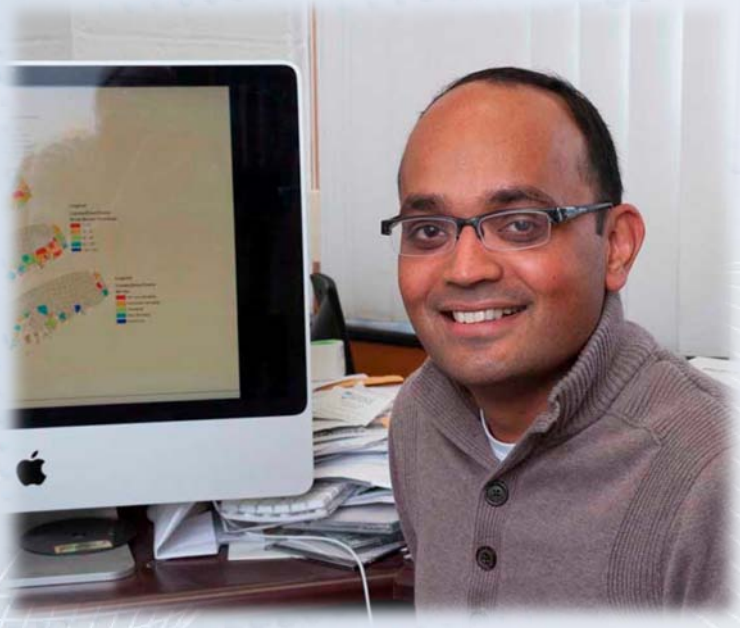
Workforce Development

In the Sustainability Solutions Initiative

Objective 6.4: Support SSI faculty development through mentoring, programs, and opportunities.

SSI Faculty & Postdocs

- Formal and informal mentorship
- Faculty CAREER award



Workforce Development

In the Sustainability Solutions Initiative

Objective 6.5: SSI interdisciplinary project & team structure fosters collaborative learning, development, and solutions approaches.

- Annual State Conference
- SSI Seminars
- SSI Workshops
- SSI Retreat
- National EPSCoR Conference

Workforce Development

In the Sustainability Solutions Initiative

Objective 6.6: Engage the state's community colleges in sustainability-related workforce development activities.

Community Colleges

- Supporting workforce development projects at:
  - Eastern Maine Community College
  - Southern Maine Community College

- EMCC also part of our team at the recent NSF EPSCoR-sponsored workshop to bring EPSCoR, Campus Compact, and SENCER programs together in states.

Workforce Development

General

Goal #7: Prepare Maine's current and future STEM workforce through coordinated programs, opportunities, training, and knowledge dissemination.

In addition to Workforce Development in SSI,
and the programs described in our Diversity section
(i.e. for women, Native Americans, disabled),
we also implement and support several other
programs and opportunities

Workforce Development

General

Objective 7.1: Implement and support related STEM programs and opportunities that directly engage students and teachers at all levels.

High School Research Internship Program

- Provides paid summer research internships to over 20 students each year.
- Students are active members of UMaine research teams, working in labs and in the field.

"[A highlight of this internship was] getting to know all the grad students…and learning about their research and what they were studying, and about all these different aspects of forestry I never knew existed."

Other STEM Partnerships

Maine Mathematics and Science Alliance:

- Participated in their workshop to design their newly formed Reach Center.
- Working with them to develop a sustainability science STEM intensive for middle school students (summer 2013).

UMaine Center for Research in STEM Education (RISE):

- NSF Math Science Partnership grant for middle school physical sciences

SSI Research Teams/Institutions:

- Colby College: watershed education program for grades 5-8 (180 students/yr)
- Several others are in the beginning stages of developing K-12 curriculum that builds on their research.
- Children's Water Festival fall 2012

Workforce Development

General

Objective 7.2: Promote professional and leadership development for educators in STEM, and foster STEM approaches and activities that value prior learning across subjects.

Biogeomon 2012: 7th International Symposium on Ecosystem Behavior

- piloted a first-ever K-12 teacher workshop in conjunction with this professional international conference.
- 17 teachers from throughout Maine took part in the conference and were partnered with 8 of the presenting scientists who acted as mentors.
- Teachers then participated in their own workshop to learn how to work with the scientists data sets and develop their analytical skills.

"It was an amazing experience to watch these teachers learn, working with world-class scientists."

- Stephen Norton, UMaine Professor Emeritus & Conference Organizer

Teacher Professional Development

UMaine Center for Research in STEM Education (RISE):

- Support their annual teachers workshop each summer (100-200 teachers/yr)

Maine Mathematics and Science Alliance:

- Supported their Governor's Leadership Academy for two years (50 teachers)

UMaine's Project Reach:

- U.S. Department of Education National Professional Development program.
- Statewide project to address Maine's English Learner populations
- Particular focus on STEM education and skills for sustainability science fields.
- Pre-service & in-service teacher professional development.

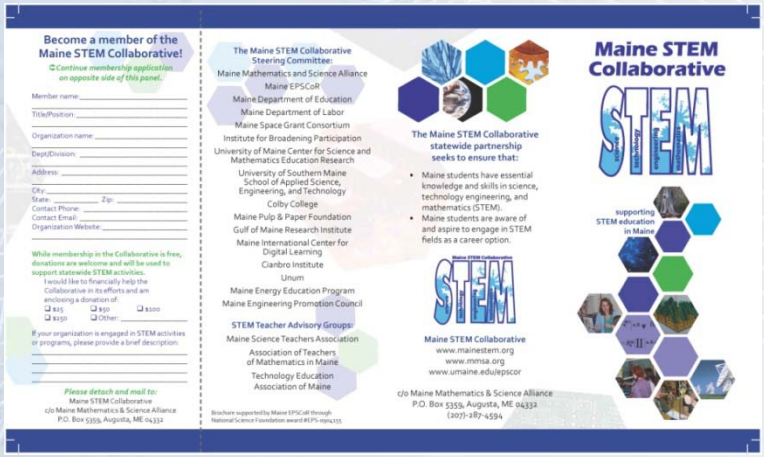
Workforce Development

General

Objective 7.3: Take a leadership role in working with partners throughout the state to build, integrate, and implement best practices in STEM.

Maine STEM Collaborative

- A statewide partnership of education, research, business, government, and non-profit sectors.
- Governed by Steering Committee of 16 organizations
- 100+ general members from throughout the state
- Large network in state of informal STEM programs
- Integration/collaboration traditionally minimal and not targeting identified needs with research-based curriculum



Maine STEM Collaborative

- **Bi-annual Maine STEM Summits** (350 participants each)
- **Database** of existing STEM programs, activities, organizations, etc.
- **Commissioned STEM baseline studies:**
  - 1) Statewide STEM capacity
  - 2) K-12 student achievement
  - 3) K-12 certification endorsements
  - 4) K-12 Teacher survey

Importance of Investing in STEM

- **LD-1101:** "Resolve, To Understand and Assist in Efforts To Promote Science, Technology, Engineering and Math Education," sponsored by Sen. Elizabeth Schneider (Orono) July 2009.
- **Maine Dept. Ed. STEM Strategic Plan:** subsequently required by legislature
- **Maine Dept. Ed. Environmental Literacy Plan**
- **Maine Dept. Labor longitudinal Study**

Maine EPSCoR & Statewide CI efforts

- Created CI Committee which developed Maine CI Plan (Growing Maine's Cyberinfrastructure 2010-2015).
- Resulting plan aligns with a broader Northeast Region plan to address connectivity, high-performance computing, virtual organizations, and scientific collaborations.

CI Collaborators include:

- CIOs from leading regional research institutions
- Northeast Cyberinfrastructure Consortium (NECC) with VT, NH, RI, DE
- NE Research and Education Networks (NEREN)
- National R&E Networks (CANARIE and Internet2)

Leveraging of Statewide CI efforts

- **BTOP: $25M BTOP broadband infrastructure award**
  - Provided the new, critically-needed fiber routes for middle mile fiber throughout rural areas of state.
- **NSF EPSCoR RII Track 2 (NECC)**:
  - fiber leases (utilizing above) to extend state's research and education fiber optic network
- **NSF EPSCoR C2:**
  - End-to-end high-speed connectivity for UMaine System campuses
- **NIH INBRE CI Supplement**:
  - Equipment to "light" the new statewide fiber routes

Cyberinfrastructure

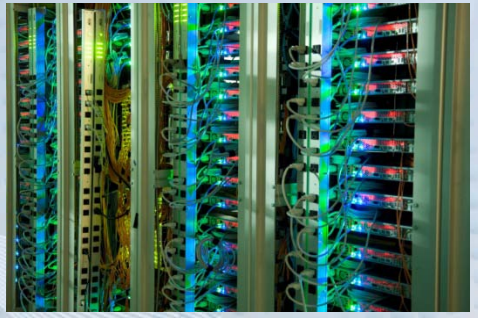
Overall

Goal #8: Utilize cyberinfrastructure to improve communication, collaboration, visualization, and data management capabilities that enable innovation and competitiveness in the sustainability science focus area.

➢**NSF EPSCoR RII Track 1:**

- Communication, visualization, and data tools for end-users to take advantage of the increased bandwidth capabilities in state.

- The end result is that our Track 1 cyberinfrastructure has a direct impact on the research environment for our SSI researchers and students.



Cyberinfrastructure

Bandwidth & Hardware

Objective 8.1: Expand statewide cyberinfrastructure capabilities through upgraded high bandwidth fiber interconnections and hardware.

Progress to Date:	On-going & Future Directions:
1) **Multipoint Control Unit**: Installed high definition 30-port MCU for videoconferencing	- Utilization with new SSI Communications Center
2) **Switchgears:** Installed 18 high bandwidth Gigabyte Ethernet switchgear modules	- On track to install final 6 in YR4
3) **Cloud cluster**: created environment (D-space & intranet) on UMaine's new supercomputer (dedicated server messi.target.maine.edu)	-Provide training to SSI participants on utilization of cloud -Populate D-space with data from all SSI research teams

Cyberinfrastructure

Communication & Visualization

Objective 8.2: Provide new communication and visualization tools.

Progress to Date:	On-going & Future Directions:
1) Visualization walls: -Finalized prototype testing -Installed large-scale portal in new SSI Communications Center -Created K-12 laptop visualization wall	-SSI Communications Center goes "live" Sept. 2012 - Provide training to SSI -Utilize K-12 walls with SSI researchers
2) Videoconferencing: - added videoconferencing capabilities for SSI, Maine EPSCoR, USM, Colby, Unity, Maine STEM Collaborative - Provided Movi licenses & webcams	-Provide training to all SSI partners -Test at All-Team meeting Sept. 2012 -Expand webcam & Movi licenses at SSP institutions for one-on-one & small group collaboration

SSI Communications Center

Cyberinfrastructure

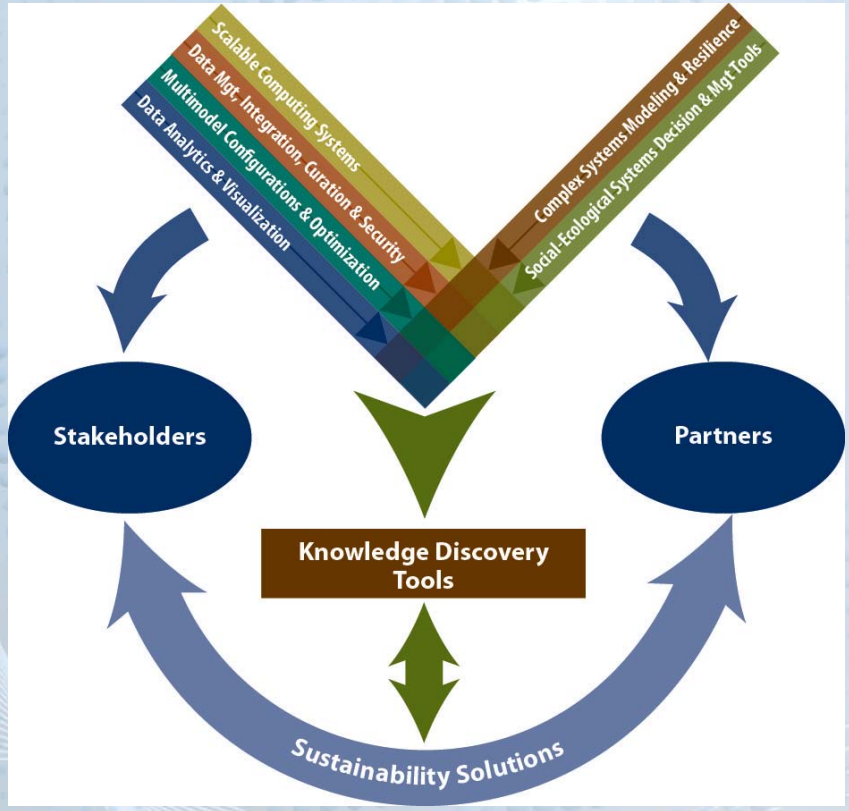
Data Handling

Objective 8.3: Develop systems for data handling across the SSI portfolio and institutions.

SSI researchers & students will utilize an integrated, common data storage system on the D-space cloud cluster on UMaine's supercomputer, with appropriate levels of open access for other researchers and public stakeholders.

Progress to Date:	On-going & Future Directions:
1) **SSI Cyberinformatics Group**: - Completed SSI data surveys - Developed and finalized Data Plan	-Implement recommended strategies -Work with UMaine Fogler Library on open access
2) **CI Personnel**: Worked to develop two new CI positions in UMaine System's Advanced Computing Group	-On track to hire by Oct. 2012 - Engage with SSI researchers on data integration needs -Work to get SSI research data catalogued on D-Space server

IGERT-CIF21: Synergistic Data Integration, Modeling, and Knowledge Discovery to Foster Sustainability (SYNERGY)



Develop a forward-looking graduate research, education, and training program that harnesses the advances in computational science and engineering to *enable innovative data-driven decision-making and solutions that foster sustainable development*.

Train a new generation of collaborating scientists and engineers with skills to engage and thrive in diverse problem solving environments that require *amalgamation of knowledge, methodologies, computation and know-how from various disciplines and engagement with decision and policy makers*.

External Engagement

Overall

Goal #9: Create and maintain an effective outreach and communication network through strategies that engage project participants, stakeholders, and the general public.

Two-fold approach

In addition to the extensive outreach and communication networks embedded in the SSI research project, additional strategies are also utilized via:

- Engagement through the SSI research component
- General outreach and communication

External Engagement

Stakeholders

Objective 9.1: Establish stakeholder communication networks that allow for two-way sharing, and for information dissemination about the SSI research.

Stakeholders

- *Solutions* Newsletter
- Other publications:
  Maine Policy Review
  Special Issue
- Communicating Science Workshops

External Engagement

Objective 9.2 : Disseminate and communicate research results to the scientific community.

Scientific Community

- SSI Seminar Series
- UMaine presentations
- NSF EPSCoR CNH Workshops, Living on Earth II and III
- National Sustainability Science Conference
- AAAS Symposium: Role of knowledge Institutions in Sustainability Science

External Engagement

General Public

Objective 9.3: Build scientific literacy for the general public and K-12 community in areas related to the sustainability science research focus.

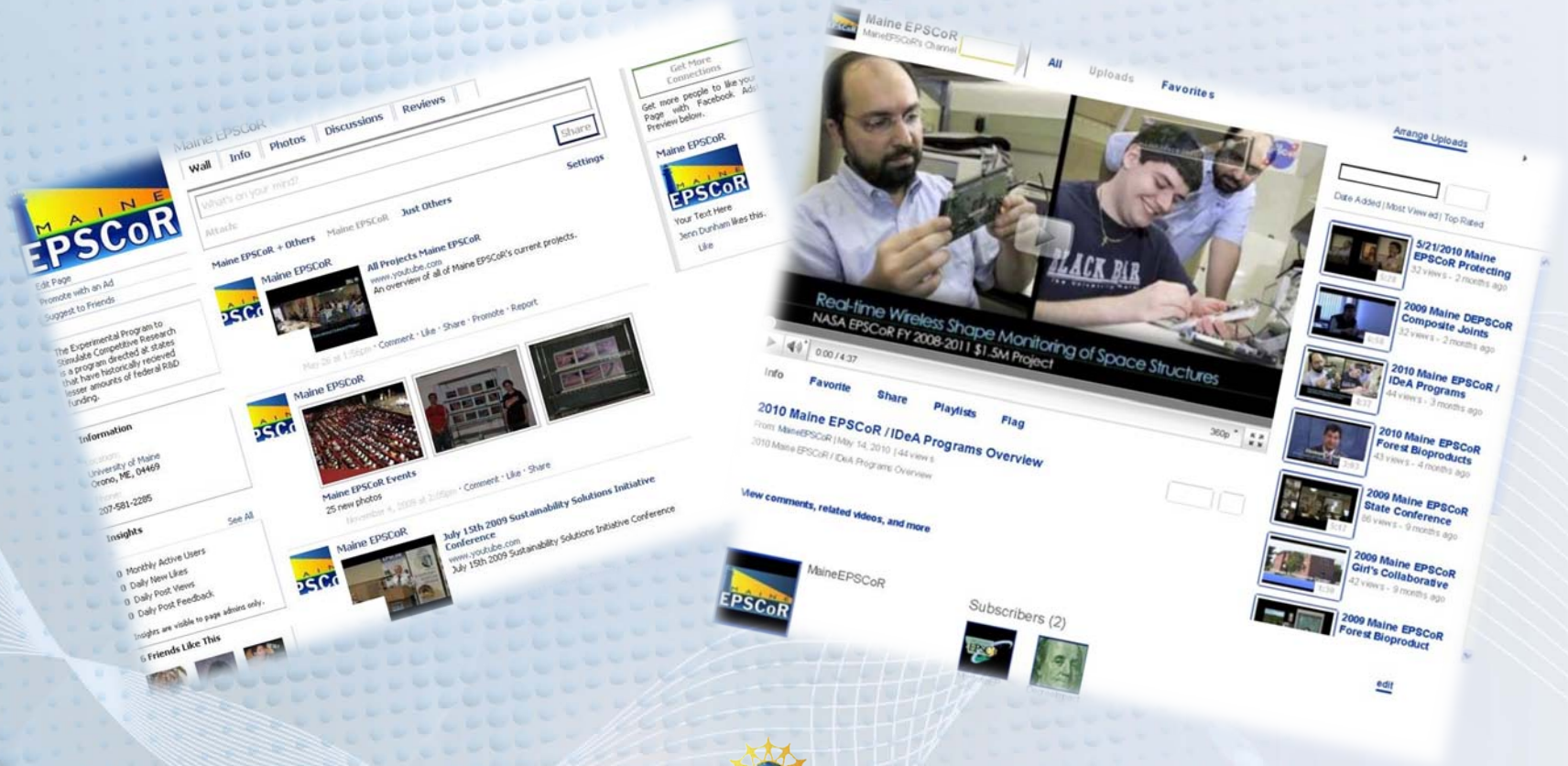
Maine EPSCoR newsletter, exhibits, displays, posters, etc.

External Engagement

General Public

Social Networking Media

Facebook page, YouTube videos, Twitter (pending)

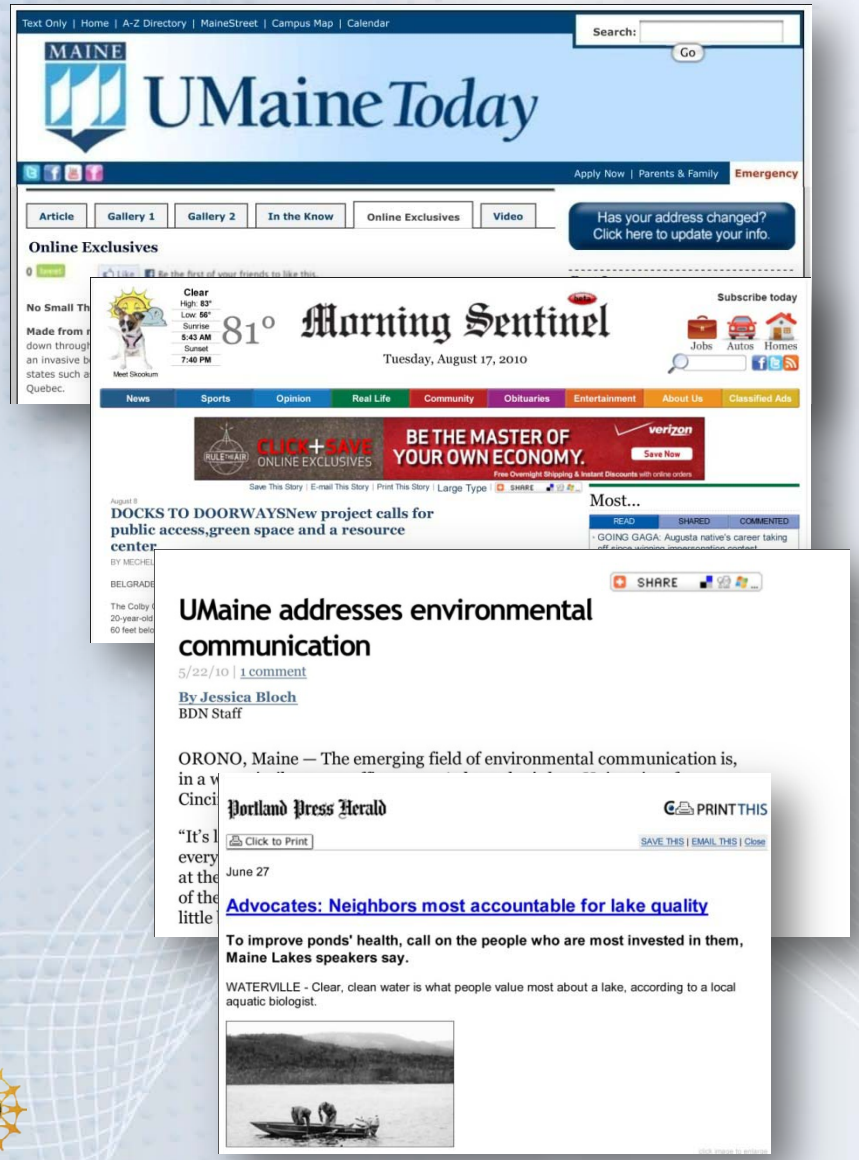


External Engagement

General Public

Media Coverage

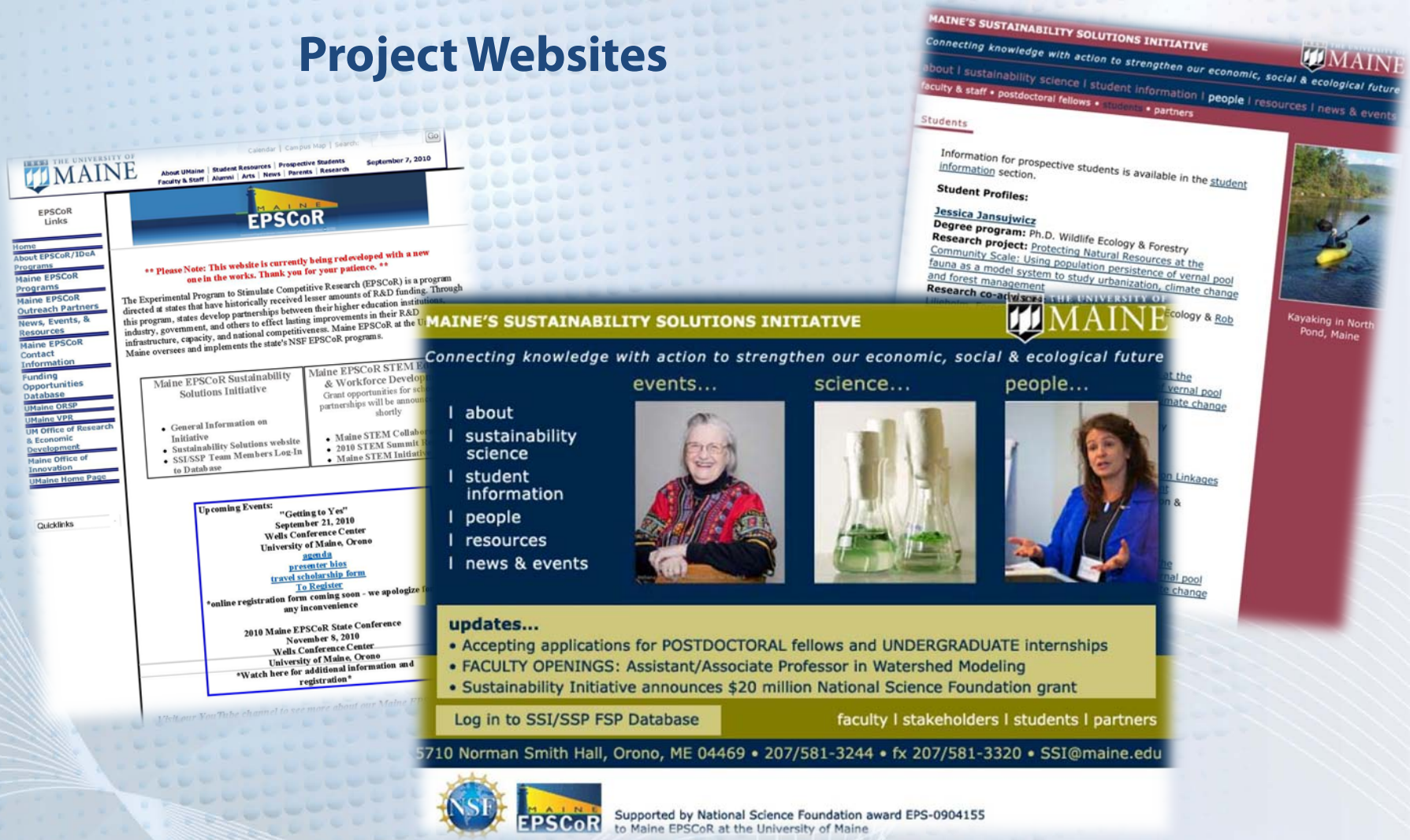
- *UMaine News, 7/30/10* - Researchers Hope to Stop Emerald Ash Borer Before it Reaches Maine
- *UMaine Today, Dec. 09* - No Small Threat
- *UMaine News, 7/15/09* - UMaine Announces $20M NSF Grant for Sustainability Initiative
- *8/8/2010 Morning Sentinel* - Docks to Doorways: new project calls for public access, green space and a resource center
- *6/27/2010 Portland Press Herald* - Advocates: Neighbors most accountable for lake quality
- *5/22/2010 Bangor Daily News* - UMaine addresses environmental communication



External Engagement

General Public

Project Websites



External Engagement

General Public

Maine Public Broadcasting Network

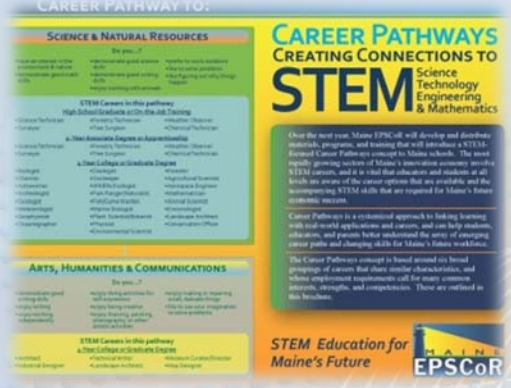
- On-going collaboration to produce documentaries that focus on SSI's research and its importance to Maine.
- First two documentaries were nominated for Emmy awards this spring.
- Accompanying podcasts, plus website presence linking to SSI resources & information.

External Engagement

K-12

K-12 and STEM

- Maine STEM Collaborative communications & presentations
- Exhibits and presentations at Maine STEM teacher conferences
- Maine STEM Summit reports
- Maine STEM Career Pathways brochure
- Landscape studies on STEM in Maine



Evaluation & Assessment

Overall

Goal #10: Employ multiple qualitative and quantitative evaluation processes to improve project effectiveness and assess achievement toward goals.

- Maine EPSCoR has a five-prong approach to evaluation & assessment:

1) External evaluators
2) AAAS
3) Advisory Board
4) NSF EPSCoR
5) Internal

- The challenge lies in balancing the different recommendations with being able to effectively implement and manage this complex initiative (many vested interests and often different expectations).
- All feedback from evaluation and assessment mechanisms is utilized by the Maine EPSCoR Management Team and SSI Stewardship Council to make on-going adjustments in the RII project's strategic actions.

Evaluation & Assessment

External Evaluators

Objective 10.1: Utilize external evaluators to assess the project's performance, with a particular focus on the evolution and outcomes of collaborative relationships, student integration in the research process, and external stakeholder interaction.

External Evaluators:

Dr. Eric Welch, University of Illinois, Chicago

Dr. Julia Melkers, Georgia Institute of Technology

- **Evaluation design includes:**
  - quantitative and qualitative longitudinal study over five year project
  - formative evaluation to provide feedback to Maine EPSCoR management
  - Summative evaluation to provide outcome measures
- **Evaluation schedule:**
  - Site visits 1-2x annually
  - On-line surveys and other data collection activities on-going during year

Evaluation & Assessment

AAAS

Objective 10.2: Utilize AAAS to provide scientific peer review to help ensure high quality program delivery.

American Association for Advancement of Science (AAAS)

Two on-site assessments during 5-year project with each consisting of:

- 2 days with panel of 4-5 national experts
- Interactions with project leadership, research teams, students, outreach participants, stakeholders, industry/business, and university/state/government leaders
- First site visit: May 2011 (YR2)
- Second site visit: May 2013 (YR4)

Evaluation & Assessment

SSI Advisory Board

Objective 10.3: An SSI Advisory Board provides on-going scientific assessment and guidance to the research project team.

- SSI Advisory Board provides ongoing assessment and guidance on sustainability science research and integrated education.
- Members and affiliations
  - Bob Kates (Chair), Presidential Professor of Sustainability Science, University of Maine
  - Nancy Dickson, Senior Researcher, Kennedy School of Government, Harvard University
  - Morgan Grove, USDA Forest Service
  - Susan Hanson, Research Professor, Clark University
  - George Jacobson, Professor Emeritus, UMaine and Maine State Climatologist
  - Ted Koffman, Executive Director, Maine Audubon
  - Thomas Parris, Vice-President for Sustainability, ISciences, LLC
  - Pam Person, Climate Change Task Force, League of Women Voters
  - Tarla Rai Peterson, Professor & Boone and Crockett Chair, Dept. of Wildlife and Fisheries Science, Texas A&M University
  - Kenneth Young, Executive Director, Kennebec Valley Council of Government

Evaluation & Assessment

Objective 10.4: Participate in NSF EPSCoR evaluation and other activities to continually refine the RII project.

- **NSF EPSCoR Reverse Site Visits:**
  - YR2: September 2010
  - YR4: September 2012

- **NSF EPSCoR Site Visits:**
  - Annually by NSF EPSCoR Program officer(s) and Office Head when possible

- **Other NSF EPSCoR activities:**
  - NSF EPSCoR Project Administrator and Educational Outreach Director best practices workshops (participated & presented)
  - NSF EPSCoR National Conferences (participated & presented)

Evaluation & Assessment

Internal

Objective 10.5: Management teams engage in on-going review to ensure that the project achieves goals, objectives, and benchmarks.

Maine EPSCoR Management Team:

- Meets monthly to review progress, challenges, and actions needed, using all inputs as feedback loops.
- Conducts annual site visits of all research teams and institutions.

SSI Stewardship Council:

- Meets weekly; reviews research & education progress, challenges, issues, and actions

SSI Research Council:

- Meets monthly; reviews research progress, challenges, issues, actions

Maine EPSCoR Office:

- On-going financial & programmatic review
- Benchmarks assessment through information gathered through on-line reporting databases

Evaluation & Assessment

Key Observations by Evaluators

- "SSI is diverse and challenging to conceptualize. It involves a new and emerging discipline that combines researchers and stakeholders from diverse backgrounds, working together to define both problems and solutions. To accomplish this, SSI has engaged an impressive diversity of participants."

- "One of the most impressive things about SSI is that interdisciplinarity is truly central to this initiative; nothing is forced. Furthermore, the administration, management, faculty, postdocs, and students are part of this program because of the interdisciplinarity."

Evaluation & Assessment

Key Observations continued

- "The subsequent layers of organization and management have also been very active and appear to be fulfilling the needs of the initiative. Importantly, the leadership is aware of the challenges in managing such a comprehensive initiative and has taken steps to assess, and where necessary, modify its structure."
- "Maine EPSCoR has engaged nearly all of higher education in the state of Maine. This level and type of involvement is an incredible and perhaps unique achievement. Importantly, the engagement is not only broad and active, but real and functional."
- "Impressive progress in hiring students across institutions; both graduate and undergraduate students are highly motivated and acquiring new research skills."
- "The project has developed clear programmatic structure for on-going communication and interaction with faculty and students across the state."

Evaluation & Assessment

Key Recommendations & Actions

- **Streamline the research focus on fewer high-impact projects:**
  - **Actions:** teams have combined; tightened & clarified annual review process which resulted in termination of one project (lack of progress).; deeper cross-team collaboration that manifests itself in dual mentoring of grad students, proposals submitted, and collaborative research.

- **Continued attention to challenges presented with SSI Partner Institutions (SSPs) at different levels and capacity:**
  - **Actions:** learning what kinds of situations are leading to success; recognizing different learning curves for different institutions; mentoring to a truer appreciation of what interdisciplinarity looks like.

Evaluation & Assessment

Key Recommendations & Actions continued

- **Increase high-visibility publications & major grants:**
  - **Actions:** Management Team Seed Grant funding for development of collaborative proposal & grants; recognition that synthesis across project portfolio takes longer but currently 5 publications in various stages of completion addressing these issues.

- **Continued focus on women & minorities in new hires & students:**
  - **Actions:** all four new postdocs are female; two new Native American graduate students, 1 Latina (one Ph.D., two Masters)

- **Implement formal postdoc mentoring program:**
  - **Actions:** all four new hires have formal postdoc mentoring plans and are co-mentored.

Sustainability

Beyond the RII

Goal #11: Sustain the SSI infrastructure, impacts, and achievements through the continued integration of scientific entrepreneurship, institutional and external support, partnerships, education, workforce development, and constituency outreach.

Sustainability science-related problems require a long-term commitment, as well as long-lasting collaborations between interdisciplinary researchers, institutions, and stakeholders.

Sustainability

Mechanisms & Infrastructure

Objective 11.1: Mechanisms for post-RII sustainability are put into place during the RII project.

- Interdisciplinary collaboration and stakeholder partnerships have become easier and more rewarding for many SSI faculty, thus increasing the prospects for a long-term commitment to solutions-driven sustainability science.
- On schedule to create Senator George J. Mitchell Center for Sustainability Solutions in YR5.
- Three new permanent SSI faculty at UMaine (50/50 split between Mitchell Center and home department).
- Post-EPSCoR commitments to continuing SSI graduate students.

Sustainability

External Support

Objective 11.2: Provide post-RII sustainability for SSI efforts through external grants, contracts, and other support.

- $9 million in external funding awarded to date.
- Major increase in submission of large, interdisciplinary, solutions-driven grant proposals to federal agencies.
- New relationships with large private foundations focused on solving sustainability-related problems.
- Expanded partnerships with the private sector (e.g. renewable energy and engineering services).
- Management Team Seed Funding for the development of large, collaborative grant proposals (6 efforts awarded to date).

Sustainability

Synergies

Objective 11.3: SSI is established as a leader in Maine and beyond in creating synergies to solve place-based sustainability science problems.

- Increasing requests from diverse stakeholders for assistance from SSI in solving pressing problems in and beyond Maine.
- UMaine's new strategic plan dramatically increases the emphasis on interdisciplinary research and university – community partnerships.
- Growing media coverage of SSI.
- SSI has become a role model for other universities seeking to develop interdisciplinary research programs focused on solving real-world problems.

Management

Overall RII Project

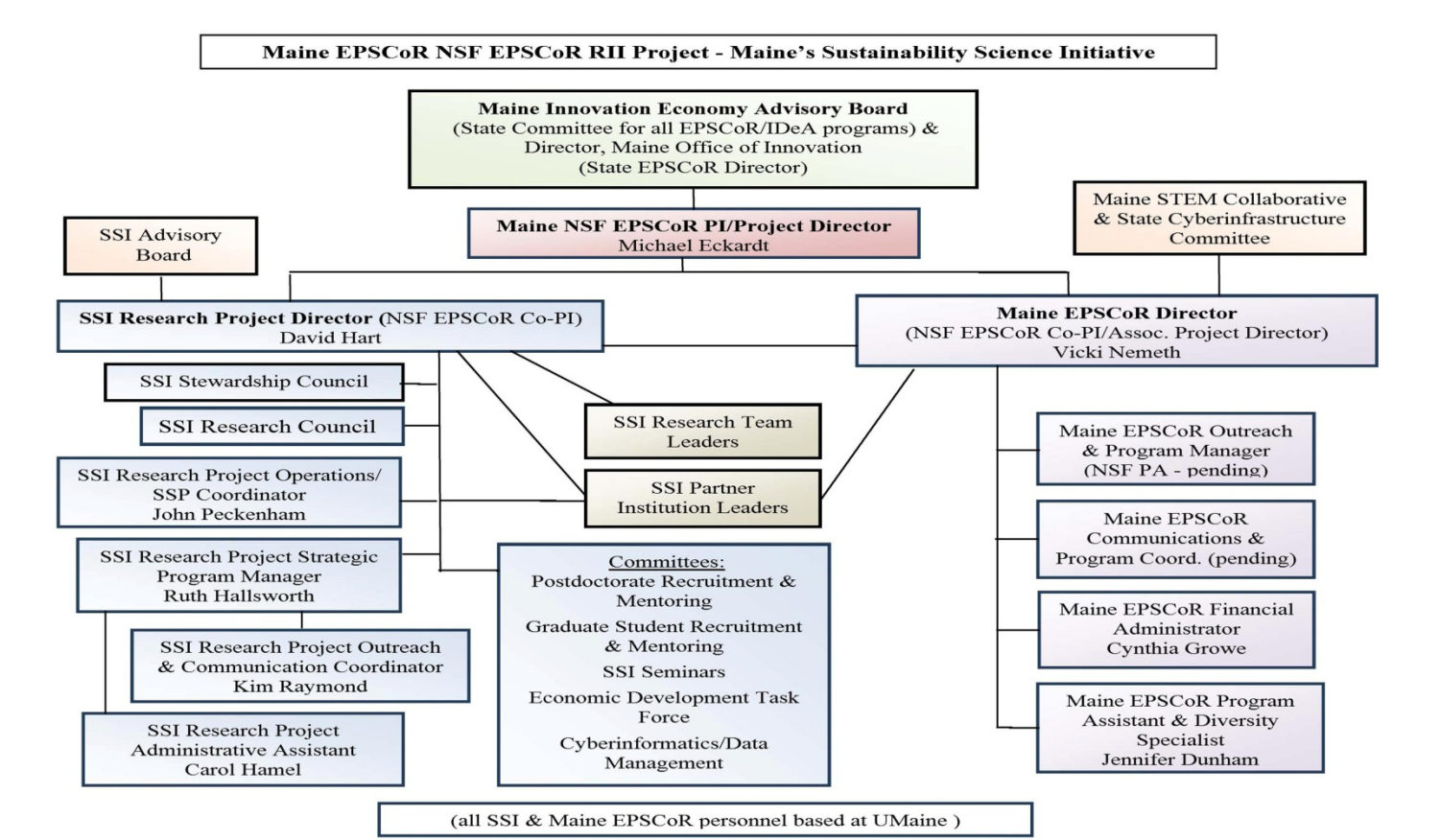
Goal #12: Implement an effective management plan that will support and ensure the overall success of the Maine EPSCoR RII project.

An effective management plan is key
to ensuring the current and continued success
of a project of this complexity and magnitude.

Management

Overall RII Project

Objective 12.1: Use an effective organizational and management hierarchy for administration and oversight of the overall RII project.



Management

Overall RII Project

Objective 12.2: Systems ensure administrative, programmatic, and fiscal integrity for all project components and institutions.

- All SSI financial, purchasing, and human resource transactions for all 6 of the UMaine System campuses are done through the Maine EPSCoR office.
- Maine EPSCoR office works closely with other UMaine administrative departments such as Sponsored Research to ensure adherence to policies and procedures.
- SSI office directly oversees and manages participants in research & integrated education, maintaining multiple communication mechanisms.
- All SSI participants directly report on progress and outcomes through multiple mechanisms.

Management

Within the SSI Research

Goal #13: Broad coordination of management and decision-making results in a shared vision for SSI research and integrated education, effective interdisciplinary outcomes, and participatory project management.

- One of the challenges of large interdisciplinary research projects involving active stakeholder collaborations is to manage the complex research and partnership component of SSI.
- In response to this challenge, SSI has developed and refined a multi-level organizational/management matrix structure.

Management

Within the SSI Research

Objective 13.1: Establish organizational structure and systems that ensure effective communication, coordination, and exchange among SSI research teams and SSI management committees.

- **SSI Stewardship Council**: oversight and responsibility for management of all aspects of the SSI research and integrated education project.
- **SSI Research Council**: established YR2 in response to OI research; provides guidance & recommendations about research-related issues for SSI.
- **SSI Committees**: provide guidance to Research Council and Stewardship Council in specific areas.

Management

Within the SSI Research

Objective 13.2: Create internal communication mechanisms, feedback loops, and strategies to ensure the effectiveness of the interdisciplinary SSI research project.

- Overlap of membership between Stewardship Council, Research Council, and Committees .
- Feedback goes to the Stewardship Council for action, which can refer issues and recommendations to the Management Team for further review.
- All SSI members part of monthly All-Team meetings, discussion groups, research retreats, workshops, and seminars.
- Internal communications include doSSIer newsletter, listservs, and the internal SSI website server where information and resources are posted.

Management

Within the SSI Research Project

Objective 13.3: Establish a system for effectively managing the SSI interdisciplinary research portfolio.

Utilize an integrated matrix management system for interdisciplinary, integrated, and collaborative research teams.

	Urbanization	Forest Resources	Climate/Energy
Social-ecological Systems	1, 2, 3, 4, 6, 11, 13 19, 20, 21, 24, 25 i3	1, 4, 6, 13 19, 20, 22, 24, 25, 26, 27 i3, ss2	2, 3, 6, 11, 18 19, 20, 21, 22, 24, 25, 26 ss2
Knowledge-Action	1, 2, 3, 4, 6, 11, 13 19, 20, 21, 24, 25 i3	1, 4, 6, 13 19, 20, 22, 24, 25, 26, 27 i3, ss2	2, 3, 6, 11, 18 19, 20, 21, 22, 24, 25, 26 ss2
Organizational Innovation			

i1, i2, i4, ss1

5

15

Management

Within the SSI Research Project

Other Mechanisms:

- Utilize a formal process to support and review projects in portfolio on an on-going basis.
- Monitor research progress at the overall level of the cross-cutting research themes and the model problem arenas, and also at the team level.
- Utilize peer critique and feedback when appropriate.
- Develop mechanisms for integration across the portfolio through multiple avenues.

Special Conditions

Progress on Special Award Conditions

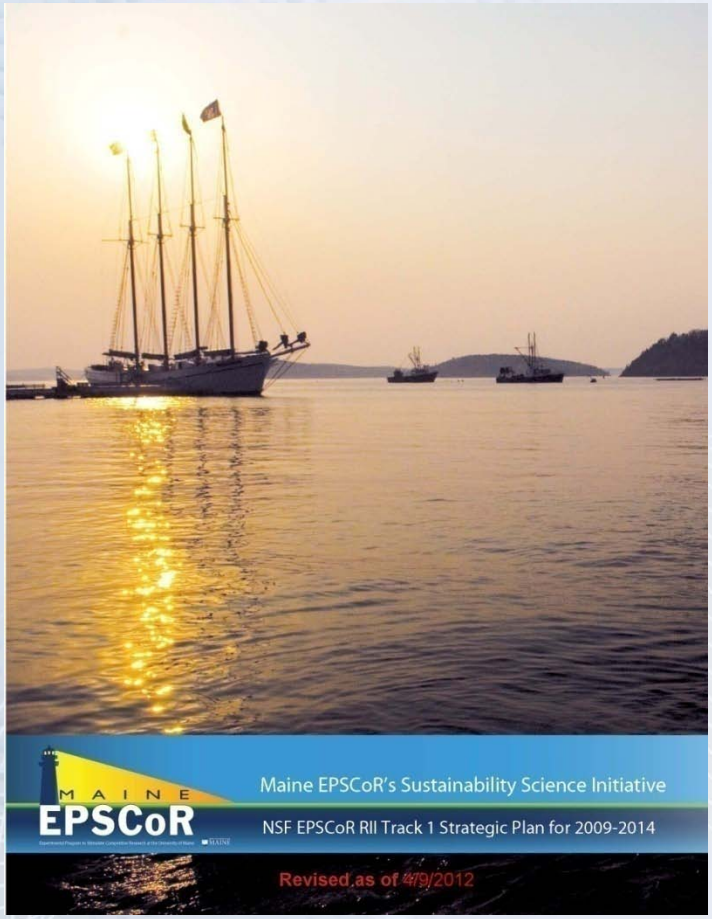
Maine EPSCoR jurisdiction-specific terms and conditions have all been met each year and include:

1) Cost sharing provided at the required amount of $800,000 per year (plus significant voluntary cost contributions).
2) Participant support is utilized only for activities falling under that category, and funds are tracked separately with written policies & procedures in place.
3) General Programmatic Terms & Conditions: all have been met with no key personnel changes or changes in project scope. All reporting requirements have been addressed.

Strategic Plan

Progress Relative to Strategic Plan

- Strategic Plan goals directly correspond with RII criteria.
- Every RII component (and research team) is reviewed at multiple levels on how effectively benchmarks are being met.
- Objectives and benchmark targets are reviewed at least annually.
- Almost all benchmarks have been met or exceeded during each of the three project years.
- Changes in strategies and actions are made as needed on an on-going basis to ensure success.



Challenges

Turning Challenges into Opportunities

Challenges:	Actions:
1) **Economic Development**: difficult due to nature of sustainability science research	-Created Econ. Dev. Committee -Supporting two Econ. Dev. seed projects in YR4 & YR5
2) **Interdisciplinarity**: engagement & ownership by participants; changing institutional cultures	-OI research leads project effectiveness actions -Joint promotion & tenure committees
3) **Data Integration & Sharing**	- Created Data Integration group - New CI hires to implement

Challenges

Challenges continued:	Actions:
4) **Partner Institutions (SSPs):** working with institutions at very different stages of capacity & capability in sustainability science research a) Limited expertise & faculty #s b) First large federal award for many c) Primary teaching institution restrictions	a) Provided assistance & flexibility in project design, & allowed greater integration of research and education b) Provided administrative & programmatic expertise & support & mentoring; SSP Coordinator c) Altered funding cycle to assure summer research support; virtual meetings & workshops; videotape all meetings & post on internal server
5) **Post-EPSCoR**	- Stewardship Council retreats to plan how to most effectively institutionalize SSI statewide
6) **The problem of success:** responding to an increasingly diverse set of problems being brought to us (complex sustainability science issues)	-Continue to build statewide capacity to be able to move into new model problem areas -Identify emergent themes across the SSI research

Effectiveness

Overall

Return on Investment

This Track 1 project has:

- Had a tremendous impact on the state of Maine with it's wide reach and solutions-driven approach that engages community stakeholders.
- Brought together a diverse group of faculty who are eager to work in interdisciplinary teams and dedicated to overcoming the inherent challenges.
- Engaged an extremely talented and enthusiastic pool of students at all levels who are excited to pursue research in this interdisciplinary field.
- Had a significant impact in developing partnerships and programs to broaden institutional and individual participation.
- Invested in cyberinfrastructure that is of benefit to the entire state.
- Already generated almost $9M in external funding.
- Demonstrated that it can consistently meet or exceed almost all targeted program benchmarks.

Conclusion

- SSI has made major progress during its first three years in mobilizing diverse academic expertise, promoting interdisciplinary teamwork, engaging with a wide range of stakeholders, and advancing the theory and practice of sustainability science.
- SSI's use of Maine as a sustainability science laboratory offers unprecedented opportunities to link theory with practice.
- By building partnerships with diverse stakeholders that are based on mutual respect and common purpose, SSI is helping to strengthen public support for the role of science in solving societal problems.
- SSI represents an unwavering, long-term commitment to linking knowledge with action to strengthen our economic, social and environmental future.

Impact

"The best part of collaborating across SSI research projects is the opportunity to work with such an eclectic mix of professionals. There is no substitute for being able to learn new and innovative ways to approach research. I am constantly impressed with my SSI colleagues and continue to learn from them day in and day out."

- Mike Quartuch, SSI Graduate Student

"I think it's a great opportunity for the students to take what they've learned in the classroom and apply it to real life situations, and take what they've learned and go the next level. And to go down avenues they never would have in the walls of the school."

- Chris Crocker, Orono High School Teacher & Parent of High School Research Internship Program Student

Impact

"SSI offers a great opportunity for us to do cutting-edge research that is academically exciting and at the end of the day is about solving real problems that will help real people."

- Teresa Johnson, SSI Faculty Member

"This is cutting edge research, and golly, we have stakeholders like me, just a plain old person interested in lakes, participating in something that that's important."

- Maggie Shannon, Executive Director of the Maine Congress of Lake Associations

"SSI is unique in the country as an endeavor that is solutions-based and bridges disciplines between researchers, stakeholders and institutions."

- Robert W. Kates, co-founder, field of sustainability science

ssi maine's sustainability solutions initiative

Connecting knowledge with action to strengthen our economic, social and environmental future

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MAINE EPSCoR

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Supported by National Science Foundation award EPS-0904155 to Maine EPSCoR at the University of Maine.