A Transformations Transect as Social Innovation: COBALT Network Forms in the Gulf of Maine to Develop the Concept

Glenn G. Page[1], Holly Parker[2], Sam Matey[2], Michael Tlusty[3], and Cedric Woods[3]

[1] SustainaMetrix LLC
[2] University of New England, USA
[3] University of Massachusetts Boston, USA

Corresponding author: Glenn G. Page, gpage@sustainametrix.com

Abstract

The global pandemic has demonstrated that our most pressing issues are interrelated in multiple, hard to define ways. Governments alone are ill-equipped to deal with the complex array of issues presented by the Earth of the Anthropocene, such as social inequity; rural-urban divide; disruption of food systems and supply chains; disintegration of natural ecosystems; and the sheer magnitude of climate change. A new research network known as COBALT (Collaborative for Bioregional Action Learning & Transformation) will use a novel Transformation Transect that follows a road network from the tip of Cape Cod to Nova Scotia's Cape Sable Island. This transect offers a lens into the nested nature of ecosystem governance across an urban to rural region that can illuminate how government, civil society and market forces can create positive momentum to respond to ecosystem change in coastal regions of the Gulf of Maine.

The research network will take the novel approach of visualizing governance transformations along the Gulf of Maine transect through a bioregional macroscope lens. We will address the following research questions:

- *When have crises along the Gulf of Maine transect become windows of opportunity for innovation and novelty?*
- *When have societal and ecological transitions along the transect been mishandled and led to today's wicked problems?*
- *What insights can be applied from these past crises and transitions to inform how the examined bioregions can successfully move from preparation for to navigation of governance transformation in response to the Gulf of Maine's rapidly changing ecosystem?*

Keywords: transformation transect, social inequity, rural-urban divide, anthropocene era, wicked problems

Introduction

The global pandemic offers yet another strong signal that our most pressing issues facing humanity are interrelated in multiple, hard to define ways. Our collective response to the meta-crisis was aptly described by Jonathan Rowson (2020) when he noted "in almost every part of the world, our scope for action on the emergency is constrained by our forms of governance, our political economy, our imperious technology, our institutional logics and our social norms." Governments alone are ill equipped to deal with the complex array of Anthropocene Era issues such as social inequity, rural-urban divide, disruption of food systems and supply chains, fragmentation and collapse of natural ecosystems, and the sheer magnitude of climate change (Rockström et al. 2009, Biermann et al. 2012, Mintzberg et al. 2018). Classical management theory emphasizes the ability to control these dimensions through forecast, planning, organization, and traditional hierarchical forms of leadership. However, 'quick-fix' solutions in these forms flounder and often backfire in the face of interconnectedness, volatility and uncertainty. Too often, we fail to consider interactions with other systems, operating as if there is one best solution that is context independent. We reduce complex problems to singular issues and often ignore multiple viewpoints (Jackson, 2019).

The pandemic disruption has offered an opportunity to examine how sources of governance can work together towards transformative change. While many bottom-up responses to crises and inequities are visible in our current systems, such as Occupy Wall Street and the Extinction Rebellion Movement, these expressions of civil society are one type of governance response to ecosystem change. Conversely, top-down responses, such as the Paris Climate Agreement have highlighted the need for society to question governance systems and the expression of power in its efforts to address social and ecological issues. Truly understanding how governance responses can be integrated requires a more collective and participatory form of "seeing" issues with attention to formal and informal power relationships, i.e. the governance systems, and how more participatory forms of governance structures can evolve to address the interconnected, complex, cross-scale, wicked challenges and opportunities of our time.

This article establishes the context, framework and implementation of COBALT (Collaborative for Bioregional Action Learning & Transformation). This network has committed to an approach for collective "seeing" the green shoots of transformational change and understanding how governance mechanisms can support and enable more just, equitable and regenerative response to ecosystem change in the Gulf of Maine. COBALT will use a novel Transformation Transect that offers a geo-referencing framework that follows an existing road network from the tip of Cape Cod to Cape Sable Island, Nova Scotia (Figure 1). This transect offers a lens into the nested nature of ecosystem governance across an urban to rural region that can illuminate how

government, civil society and market forces can create positive momentum to respond to ecosystem change in coastal regions of the Gulf of Maine.

COBALT Forms
Why COBALT?

SustainaMetrix, the University of New England and the University of Massachusetts Boston have initiated a planning process to accelerate a nascent convergent research network: COBALT (Collaborative for Bioregional Action Learning & Transformation). The network is focused on governance response to ecosystems change in the Gulf of Maine to learn how to better see, map, connect and accelerate synergistic momentum that aligns government, market forces and civil society, as discussed in Mintzberg, Etzion, & Mantere (2018). This "seeing" will allow for the intentional integration of governance mechanisms that support a more equitable and regenerative future for the Gulf of Maine and its biological and human systems.
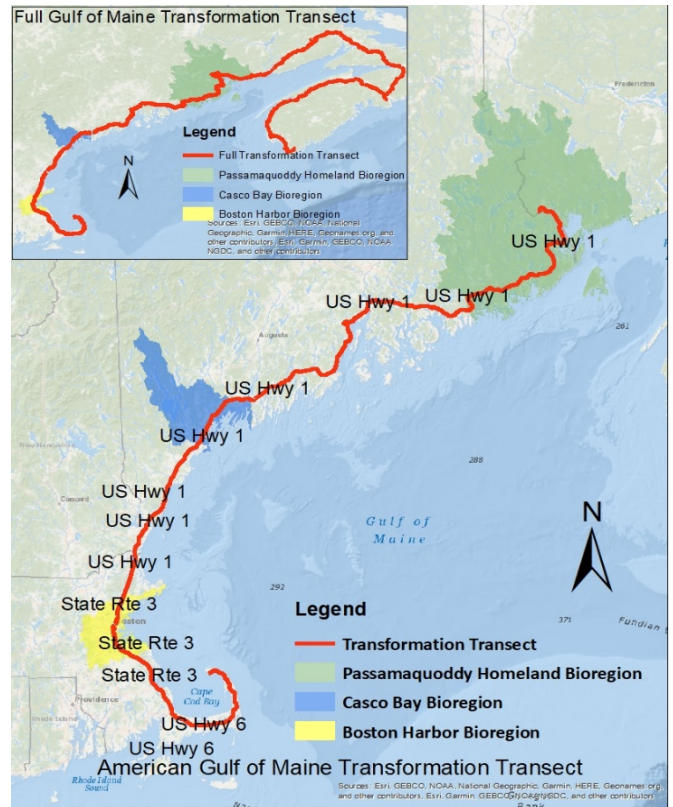

Figure 1: Gulf of Maine Transformations Transect

The Gulf of Maine is one of the best studied systems in the world. The nations of US and Canada have committed to an ecosystem approach to Gulf of Maine management which by definition is holistic and integrated. Tribal governments have been practicing their own version of an ecosystem approach for thousands of years, and aspects of their traditional ecological knowledge remain embedded in their modern culture (Daigle, Michelle, Ranco, & Emery, 2019). Even with this collective and formal commitment to an integrated approach there is no common vision for or collective understanding of ecosystem-based management. Ironically, the ecosystem approach is often expressed in isolated, sectoral approaches as opposed to a collective commitment that is systemic. These factors make the Gulf of Maine ideal for this network.

COBALT is built upon principles of inclusive engagement (Suarez, 2018) and is rooted in STEM research, integration of arts and humanities and critically with indigenous knowledge systems (Fazey et. al 2018). Since April 2020, the PI and Co-PIs, have engaged a wide range of local, regional, national and international collaborators to create a playbook for high quality collaboration (Woodland and Hutton, 2012) to meet this research challenge requiring diverse perspectives (Fazey et. al 2020). For example we have commitment from the following: Chief of the Passamaquoddy Peoples in New Brunswick Canada; Director of the Maine Indian Tribal

State Commission; Chair, Schoodic Riverkeepers as well as a wide range of academic partners listed in the concluding section.

The appropriate scale for this collective seeing of interconnected systems is at the level of the bioregion. Bergman and Dasmann (1977) were among the first to define the term bioregion: "the term refers both to geographical terrain and a terrain of consciousness—to a place and the ideas that have developed about how to live in that place." A bioregion's boundaries are not fixed by human or political factors, but rather take into account flora, fauna, climate, rivers, lakes, mountains and valleys. It is a place-based organizing structure, most suited to understanding the potential mechanisms to supporting resilient communities (Thayer, 2003). Examining interconnected systems through a bioregional lens reveals nested and often fragmented forms of governance that occurs at the municipal, regional, state and federal scales and the critical need to better see how the power dynamics of market forces and civil society interact with government. As an action research network, we hypothesize that facilitating this collective seeing through a "bioregional macroscope" will allow us to better understand how to nurture the "green shoots" of transformative change, i.e. change leading towards more just, equitable and regenerative forms of development within the Gulf of Maine bioregion. By "green shoots" of transformative change we refer to the collective capacity to create fundamentally new systems of social/ecological interactions when the existing system is untenable (Walker et al., 2004).

COBALT Framework

COBALT applies the participatory action research framework illustrated in Figure 2, based on "The Analysis of Governance Responses to Ecosystem Change: A Handbook for Assembling a Baseline" (Olsen, Page, & Ochoa 2009). This framework is an action-research process that poses questions including but not limited to:

Figure 2: Framework for Ecosystem Governance Baseline

- How have the types and intensity of human activities changed in the area of focus over the past one hundred years?
- Have these changes in human activity been related to changes in environmental conditions and the goods and services that it generates?
- What was the response of the governance system to key events and ecosystem change?
- If there was no response, why?
- Are there major differences in opinion as to the significance of ecosystem changes that have occurred, their causes and impacts?
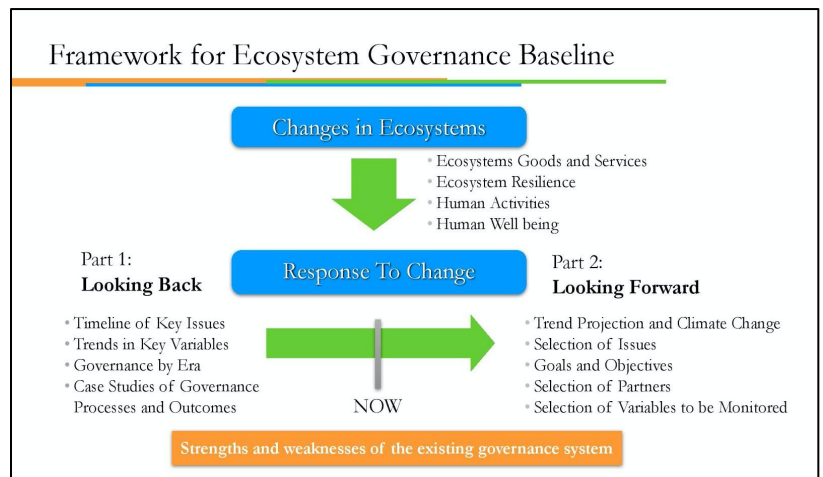- How does this recent history constrain responses to future changes?

COBALT will apply this framework across sectors including energy, food, water, transportation, education, health, finance. We will focus this research on the Gulf of Maine (Fig 1). This geography is ideal for this network, as it is transboundary with a wide range of governance, market forces and civil society structures. Furthermore, policies and strategies across these sectors call for an integrated ecosystem approach that significantly integrates indigenous knowledge systems. This well studied system is biophysically transforming due to climate change, rising sea levels and hotter and more acidic waters (Pershing et al., 2018). Yet a functional response remains fragmented, sectoral, and largely top-down. There is virtually no access to capital to better see, let alone support, the "green shoots" of transformation that are emerging across the system.

COBALT focuses on three defined bioregions delineated based on watersheds and cultural history: the urbanized Boston Harbor and Associated Islands, the urban/suburban/rural Casco Bay watershed with a focus on Portland/South Portland, and the watersheds comprising the ancestral Passamaquoddy homeland, primarily in rural Washington County. We have selected three very different coastal bioregions as foci along the transformation-transect, ranging from majority-urban to majority-rural, each with unique historical path dependencies as well as governance, civil society and market forces. Our research network is built upon core principles of engaging underrepresented voices, leaders from indigenous, rural and immigrant communities who are rarely engaged in orchestrated planning processes. Together with globally recognized research and finance experts, we believe this integrated approach will generate new ways of seeing and investing in leverage points and adjacent possible outcomes when government, civil society and market forces work together in response to change (Westley & McGowan, 2017). For example, when concerned citizens formed the Friends of Casco Bay/Casco Baykeeper® in 1989 in the greater Portland Maine area, this was in response to a report identified the waters of Casco Bay as one of the most polluted regions in the nation. The Water Quality Monitoring Program that was launched was an example of these sectors of integrating to assess the health of the Bay.

These three bioregions are linked by the Transformations Transect (Figure 1), offering a geo-referencing framework and a road trip experience to welcome a wide range of systems observations that are guided and curated by the research network. The transect follows a road network on US Highways 1 and 6 and MA State Route 3 from the tip of Cape Cod to the Canadian border on the St. Croix River, paralleling the entire US portion of the Gulf of Maine. This transect continues in Canada through New Brunswick and into Nova Scotia ending near Cape Sable Nova Scotia (Figure 1, inset). Points along the transect serve as virtual reference locations to pin data collected on a given system, creating what we envision as opportunities to stimulate public involvement and generate significant broader impacts of public engagement across the Gulf of Maine and across our wider network.

This transect offers a lens into the nested nature of ecosystem governance across an urban to rural region that can illuminate how government, civil society and market forces can create positive momentum to respond to ecosystem change. Most environmental and societal issues both impact upon, and are impacted by, conditions and actions at both higher and lower levels in

an ecosystem and governance hierarchy and are increasingly relevant to market forces, civil society and government. While there are some issues that can be addressed more effectively at one level or within one sector, and less effectively at another, this is increasingly rare. The choice of the issue or set of issues to be addressed must therefore be made in full knowledge of how responsibility and decision making authority is distributed within a layered governance system across the three sources of governance. Planning and decision making at one scale, for example within a municipality or province, should not contradict or conflict with planning and management at another – for example, at the scale of the nation. The reality is that such contradictions and conflicts are common, as market forces, civil society and government are often working at cross purposes. A major opportunity for COBALT will be to better see and recognize these differences and understand strategies that have helped to transform the dynamics. In practical terms, a central feature of COBALT is to better see integrated forms of planning and decision-making that recognize and analyze issues and goals at least at the next higher and lower levels in the governance system and the implications for more synergistic and constructive activity between market forces, civil society and government. This work also relies on learning how to see reinforcing feedbacks that produce undesired outcomes and that lock them into certain trajectories, as well as creating new ways of seeing that can help move the system in new directions (Olsson, Moore, Westley, & McCarthy, 2017).

Implementing COBALT

In 2020, we have made significant progress since the launch of this research network, focused on navigating social-ecological transformation, through two linked initiatives. In early 2020 Glenn Page of SustainaMetrix and Per Olsson of the Stockholm Resilience Centre founded the Transformation Systems Mapping and Analysis Working Group. There are over 140 members from 26 countries and 12 workstreams, one of which is focused on the Gulf of Maine

Figure 3: Transformations as a multi-level and multi-step process.

and is comprised of 35 people representing interdisciplinary social/ecological systems perspectives. In August 2020, this workstream hosted a 6-month planning workshop - "Story of Place: Co-creating a Bioregional Macroscope" - to create adaptive co-management systems in the vein of Folke et al. (2005, 2010) and Olsson, Folke, and Berkes (2004). Five different bioregional teams (three from each main Gulf of Maine region, two from Scotland) focused on
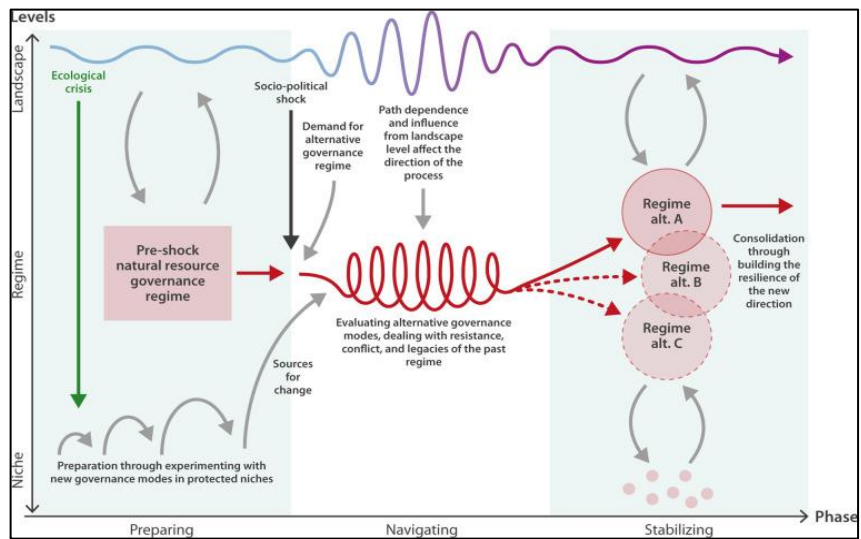
their bioregion's human and environmental story, including deep analysis of beliefs, behaviors, and institutions at multiple levels, using the process visualized in Figure 2.

As presented in Figure 3, (Herrfahrdt-Pahle et. al 2020), governance transformations can be visualized as multi-level and multi-phase processes. In the preparation phase, a crisis or anticipated risk, such as increasing awareness of a rapidly warming Gulf of Maine, can trigger initiatives to experiment with new innovations at a niche scale and alternative integrative governance models. These experiments and the innovations they generate can be developed and combined with other ideas that share the same concerns. One example is the growing shift from capture fisheries, particularly the imperiled lobster fishery (Le Bris et al., 2018) to regenerative and profitable forms of socially acceptable aquaculture and reestablishment of historical fish runs, through ecosystem restoration supported by new governance structures such as the Downeast Fisheries Partnership. Opportunities for transitioning towards new governance modes can open up due to abrupt change at the landscape level, following a socio-political shock, such as new federal support for alternative sources of energy, or dam removal for the restoration of sea run fish that are essential to the survival of the Passamaquoddy culture and people. Alternative governance modes, developed in the preparation phase, can be transferred into the navigation phase and become institutionalized. Examples include policies that integrate offshore wind development with integrative, multi-trophic aquaculture, and dam removal with public involvement in habitat restoration. This process includes evaluating and combining a range of adjacent possible futures and competing ideas and approaches across government, market forces and civil society. This phase could lead to the institutionalization of a sustainability transformation that further accelerates adoption of renewable energy, dam removal, fish passage, ecological aquaculture, and new forms of tourism celebrating the local food, indigenous wisdom & renewable energy systems.

The research network will take the novel approach of visualizing governance transformations along the Gulf of Maine transect through the bioregional macroscope lens. We will address the following research questions in addition to the inquiry framework presented above in Figure 2:
- *When have crises along the Gulf of Maine transect become windows of opportunity for innovation and novelty?*
- *When have societal and ecological transitions along the transect been mishandled and led to today's wicked problems?*
- *What insights can be applied from these past crises and transitions to inform how the examined bioregions can successfully move from preparation for to navigation of governance transformation in response to the Gulf of Maine's rapidly changing ecosystem?*

There is growing international recognition that the lack of human capacity to practice a more integrative, ecosystem approach is a key factor limiting forward progress in the governance of coastal systems in response to ecosystem change. Yet no standards of performance have been developed for assessing the effectiveness and impacts of projects and programs that have adopted the ecosystem approach (Cicin-Sain et al. 2006). This research network will document most relevant conceptual frameworks and methods for assessing both the trajectory and the

maturity of management initiatives through a governance lens and gauging their impacts upon the condition of coastal ecosystems. These are the core ingredients for an approach that builds the capacity of local populations and local leaders to identify the forces that are shaping the coastal ecosystems of which they are a part and select the actions that can maintain and enhance the qualities that are critical to a desirable future.

Gulf of Maine as Ideal Location

The U.S. and Canadian governments have made commitments to an ecosystem approach to management of fisheries in the Gulf of Maine. Nevertheless, this is proving far more difficult to implement and is widely interpreted in many different contexts from federal, state to local governments. While many align to the Malawi Principles for the Ecosystem Approach defined in a workshop in Lilongwe, Malawi, 26-28 January 1998, the actual implementation has proved elusive. Tribal governments have been practicing their own understanding of an ecosystem approach for thousands of years, and aspects of their traditional ecological knowledge remain embedded in their modern culture yet rarely identified or celebrated (Daigle, Michelle, Ranco, & Emery, 2019). Even with this commitment to an integrated approach there is no common vision for or collective understanding of ecosystem-based management (Stephenson 2012). Ironically, the ecosystem approach is often expressed in isolated, sectoral approaches as opposed to a collective commitment that is systemic.

Governance issues that have been identified in Gulf of Maine include: insufficient consideration of cumulative impacts of single activities; many different actors at many different scales using different tools, standards, and approaches; insufficient public appreciation of trade-offs among competing objectives; and a perception of a lack of transparency of governance and lack of public participation in management process (Stephenson, 2012). This context makes the Gulf of Maine an ideal location for an interdisciplinary action-research network dedicated to enable new knowledge, data-intensive tools and innovative components that further develop governance response to ecosystem change. This network embraces the challenge of harnessing the data revolution to better understand the implications of a wide range of integrating factors such as aging demographics, in and out migration, energy transitions, broadband connectivity, invasive species, loss of keystone species, habitat fragmentation, income inequality, systemic racism, and food insecurity all at a time of a public health crisis and economic uncertainty.

Our planning framework is convergent research that appreciates the daunting challenges of implementing an ecosystem approach and integrates conceptualizations, data visualizations, integrated coastal zone management (Forst, 2009), stewardship of ecosystem services (Folke et al., 2010; Holling and Gunderson, 2002; Walker et al., 2009), data intensive and context sensitive decision making, sustainability transformations (Herrfahrdt-Pähle et. al 2020) and innovations in the field of evaluation, specifically Blue Marble evaluation (Patton 2019, Patton 2020). For example, we will be using the Orders of Outcome framework (Olsen, Page, & Ochoa 2009) to track progress towards key outcomes in Gulf of Maine ecosystem governance. Furthermore, the Historical Atlas of Maine, an ambitious effort to present historical geography in

cartographic form will be integrated into this work as examples of data visualization of social-ecological systems (Hornsby, Judd, & Hermann, 2014). Our attention is focused on expanding the use of the visualizations within the Transformation Transect as a contribution to public knowledge and understanding by demonstrating the power of maps and multiple forms of digital media in conveying complex social/ecological and governance relationships. As a network we will also explore building off this convergent research to further develop a social-ecological atlas for the wider Gulf. For example, at the southern extent of the Gulf of Maine, the Boston Harbor region has experienced the full transformation described in Fig. 3, with the ecological crisis of being the most polluted harbor in the US, the socio-political shock being the lawsuit filed against the Environmental Protection Agency, and its eventual recovery (Dolin 2004, Bowen et al. 2019). Yet Traditional Ecological Knowledge was not accounted for through this process. This region, while on the mend ecologically in many ways, is currently struggling with how sea-level rise will impact coastal development (Kirshen et al. 2020). TEK methods need to be instilled in this process to ensure minimal inequity in resultant solutions.

Partnerships and Stakeholder Engagement

For this research, we frame the coastal communities along the Gulf of Maine as an interconnected, cross-scalar, real-world 'living laboratory' in which to map these transitions and identify innovative responses through reflexive and deliberative research and policy practices and encourage radically different forms of community and civil society network engagement in the process of "seeing" these "innovations" to be sure they are indeed just, equitable and regenerative. This is social, moral, ecological and political work, and must be rooted in margin-centered design, engaging voices who represent people most at risk from a rapidly changing Gulf of Maine.

Our network in the Gulf of Maine includes planners, academics, community activists, appointed officials, tribal leaders, and more. We are developing this research network in collaboration with a wide range of local partners including: Tufts Friedman School of Food and Nutrition; MIT Energy Initiative; Schoodic Riverkeepers; UMaine EPSCoR; Gulf of Maine Research Institute; Massachusetts Bays National Estuary Partnership; Penn State Geodesign Lab; The Integration Investment Project; the New England Ocean Cluster, and WorldLink. We also feature international colleagues from Future Earth Coasts, Stockholm Resilience Centre, Waterloo Institute of Social Innovation and Resilience, and partners in Iceland, Scotland, Finland, Ireland and Northern Ireland focusing on similar issues in these coastal areas.

COBALT will develop the bioregional transformation transect with this wider research network. This will include formalizing the research network with agreed upon principles of high quality collaboration, applying team science (Cooke & Hiton, 2015), monthly planned synchronous meetings, a wide range of asynchronous communications and three, two-day meetings in Portland, Maine, in 2021/2022 to further develop the research network. In this process, network stakeholders learn to see "green shoots" of transformation and map the phases.

Conclusion

While focusing on the Gulf of Maine, we appreciate the interconnectedness across the northern periphery of the North Atlantic and have partners in the research network that spans this region. This extended network applies a similar analytical framework to better visualize governance systems that respond more effectively to ecosystem change. COBALT will contribute to a process of informed community engagement to better understand major socio-political changes, the shocks that severely affected natural resource governance in the Gulf of Maine and the potential for systems level investment in the green/blue shoots of transformative change, thus building human capacity to continue this process in its next phase. Therefore, COBALT is envisioned to develop the transect concept, testing broader impacts for communication and public engagement to understand how transformation can occur along this transect and encouraging the public to "travel the transect" and participate in community action research endeavors. Finally, coasts are the frontline of change in the Anthropocene. Set against the ambitions of the SDGs, Paris Agreement, Aichi biodiversity goals, Sendai disaster risk reduction framework, and UN Decade of Science for Ocean Sustainability, our coastal bioregion-focused work is very timely. Our framework insists that a wide variety of stakeholder perspectives are essential to better see the root causes and drivers of social, economic and ecological change. This is a critical opportunity to apply the emerging art, craft and science of coastal governance and transformations systems mapping and analysis.

Citations

Bergman, P. & Dasmann R. Reinhabiting California. Ecologist. (1977) Dec; 7(10):399–401

Biermann, Frank, Kenneth Abbott, Steinar Andresen, Karin Bäckstrand, Steven Bernstein, Michele M. Betsill, Harriet Bulkeley et al. "Navigating the Anthropocene: improving earth system governance." Science 335, no. 6074 (2012): 1306-1307.

Bowen, J. L., C. J. Baillie, J. H. Grabowski, A. R. Hughes, S. B. Scyphers, K. R. Gilbert, S. G. Gorney, J. Slevin, and K. A. Geigley. "Boston Harbor, Boston, Massachusetts, USA: Transformation from 'the harbor of shame'to a vibrant coastal resource." Regional Studies in Marine Science 25 (2019): 100482.

Cooke, Nancy J., and Margaret L. Hilton. "Enhancing the effectiveness of team science." Washington, DC: National Academies Press (2015).

Cicin-Sain, Biliana, Veerle Vandeweerd, Miriam C. Balgos, Lindsey C. Williams, and Patricio Bernal. "Meeting the Commitments on Oceans, Coasts, and Small Island Developing States Made at the 2002 World Summit on Sustainable Development: How Well Are We Doing?." Global Forum on Oceans, Coasts, and Islands, 2006.

Daigle, John J., Natalie Michelle, Darren J. Ranco, and Marla R. Emery. "Traditional Lifeways and Storytelling: Tools for Adaptation and Resilience to Ecosystem Change." Human Ecology 47, no. 5 (2019): 777-784.

Dolin, Eric Jay. Political waters: the long, dirty, contentious, incredibly expensive but eventually triumphant history of Boston Harbor, a unique environmental success story. University of Massachusetts Press, 2004.

Fazey, Ioan, Niko Schäpke, Guido Caniglia, James Patterson, Johan Hultman, Barbara Van Mierlo, Filippa Säwe et al. "Ten essentials for action-oriented and second order energy transitions, transformations and climate change research." Energy Research & Social Science 40 (2018): 54-70.

Fazey, Ioan, Niko Schäpke, Guido Caniglia, Anthony Hodgson, Ian Kendrick, Christopher Lyon, Glenn Page et al. "Transforming knowledge systems for life on Earth: Visions of future systems and how to get there." Energy research & social science 70 (2020): 101724.

Folke, Carl, Stephen R. Carpenter, Brian Walker, Marten Scheffer, Terry Chapin, and Johan Rockström. "Resilience thinking: integrating resilience, adaptability and transformability." Ecology and society 15, no. 4 (2010).

Folke, Carl, Thomas Hahn, Per Olsson, and Jon Norberg. "Adaptive governance of social-ecological systems." Annu. Rev. Environ. Resour. 30 (2005): 441-473.

Forst, Mark F. "The convergence of integrated coastal zone management and the ecosystems approach." Ocean & Coastal Management 52, no. 6 (2009): 294-306.

Han, Cindy, Immigrants in Elected Office: Growing Influence Among Immigrants Elected to Office in Maine. Maine Public, 2020. www.mainepublic.org/post/immigrants-elected-office-growing-influence-among-immigrants-elected-office-maine.

Herrfahrdt-Pähle, Elke, Maja Schlüter, Per Olsson, Carl Folke, Stefan Gelcich, and Claudia Pahl-Wostl. "Sustainability transformations: socio-political shocks as opportunities for governance transitions." Global Environmental Change 63 (2020).

Holling, Crawford Stanley, and Lance H. Gunderson. Panarchy: understanding transformations in human and natural systems. Washington, DC: Island Press, 2002.

Hornsby, Stephen J., and Richard W. Judd. "Historical Atlas of Maine." University of Maine Press (2014).

Jackson, Michael C. Critical Systems Thinking and the Management of Complexity. John Wiley & Sons, 2019.

Kirshen, Paul, Mark Borrelli, Jarrett Byrnes, Robert Chen, Lucy Lockwood, Chris Watson, Kimberly Starbuck et al. "Integrated assessment of storm surge barrier systems under present and future climates and comparison to alternatives: a case study of Boston, USA." Climatic Change 162, no. 2 (2020): 445-464.

Le Bris, Arnault, Katherine E. Mills, Richard A. Wahle, Yong Chen, Michael A. Alexander, Andrew J. Allyn, Justin G. Schuetz, James D. Scott, and Andrew J. Pershing. "Climate vulnerability and resilience in the most valuable North American fishery." Proceedings of the National Academy of Sciences 115, no. 8 (2018): 1831-1836.

Mintzberg, Henry, Dror Etzion, and Saku Mantere. "Worldly strategy for the global climate." Stanford Social Innovation Review 16, no. 4 (2018): 42-47.

Olsen, Stephen B., Glenn G. Page, Emilio Ochoa. The analysis of governance responses to ecosystem change: a handbook for assembling a baseline. GKSS Research Centre, LOICZ International Project Office, Institute for Coastal Research. 2009.

Olsson, Per, Carl Folke, and Fikret Berkes. "Adaptive comanagement for building resilience in social–ecological systems." Environmental management 34, no. 1 (2004): 75-90.

Olsson, Per, Michele-Lee Moore, Frances R. Westley, and Daniel DP McCarthy. "The concept of the Anthropocene as a game-changer: a new context for social innovation and transformations to sustainability." Ecology and Society 22, no. 2 (2017).

Patton, Michael Quinn. Blue marble evaluation: Premises and principles. Guilford Publications, 2019.

Patton, Michael Quinn. "Evaluation Criteria for Evaluating Transformation: Implications for the Coronavirus Pandemic and the Global Climate Emergency." American Journal of Evaluation (2020): 1098214020933689.

Pershing, Andrew J., Katherine E. Mills, Alexa M. Dayton, Bradley S. Franklin, and Brian T. Kennedy. "Evidence for adaptation from the 2016 marine heatwave in the Northwest Atlantic Ocean." Oceanography 31, no. 2 (2018): 152-161.

Portland Public Schools, Learning to Succeed. 2016.
https://www.portlandschools.org/UserFiles/Servers/Server_1094153/File/News%20Items/Fast%20Facts%20October%202016.compressed.pdf

Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin, Eric F. Lambin, Timothy M. Lenton et al. "A safe operating space for humanity." Nature 461, no. 7263 (2009): 472-475.

Rowson, Jonathan. How to think about the meta-crisis without getting too excited. Emerge Blog February 17, 2020. https://www.whatisemerging.com/opinions/how-to-think-about-the-meta-crisis-without-getting-too-excited

Stephenson, Robert L. "A perspective on advancing ecosystem research for the Gulf of Maine." In American Fisheries Society Symposium, vol. 79, pp. 409-415. 2012.

Suarez, Cyndi. The Power Manual: How to Master Complex Power Dynamics. New Society Publishers, 2018.

Thayer, RL. Life Place: Bioregionalism Thought and Practice. Berkeley and Los Angeles: University of California Press; 2003. p. 6

Walker, Brian, Crawford S. Holling, Stephen R. Carpenter, and Ann Kinzig. "Resilience, adaptability and transformability in social–ecological systems." Ecology and society 9, no. 2 (2004).

Westley, Frances, and Katharine McGowan, eds. The evolution of social innovation: building resilience through transitions. Edward Elgar Publishing, 2017.

Woodland, Rebecca H., and Michael S. Hutton. "Evaluating organizational collaborations: Suggested entry points and strategies." American Journal of Evaluation 33, no. 3 (2012): 366-383.