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Citizen and Community Science Approaches to Understanding Changes in Coastal Habitats Using Anecdata.org

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Cover Page Footnote

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by Alexis Garretson, Cait Bailey, Ashley Taylor, Alexis Dabulewicz, Beth Bisson, Nathan Dorn, Keri Kaczor, Mary Ann Nahf, Hannah Webber, Mark Whiting, and Jane E. Disney

ABSTRACT

Coastal ecosystems are facing increasing threats from human activities and environmental changes. However, there is often a lack of data at the appropriate scales to address these concerns. Online tools that support citizen science and community science data collection can provide stakeholders and policymakers with a wealth of information and data on ocean-related topics, such as water quality, marine biodiversity, and ocean health. Citizen science platforms, like Anecdata.org, can facilitate data collection, raise public awareness, and encourage the engagement of stakeholders in ocean policymaking. This community-driven platform promotes effective, open, and democratized science, hosting numerous active projects with users helping address critical coastal issues.

INTRODUCTION

Maine is defined by its coastline in both literal and figurative ways. Coastal Maine is subject to the spatial-temporal dynamics of various biological processes that can be altered by anthropogenic climate change, unsustainable harvesting or marine resource management strategies, and land use practices in watersheds that have downstream effects on coastal habitats.

Because of the lack of available coastal data in certain regions, some environmental impacts and their future implications are poorly understood at local, regional, and global scales. Addressing such challenges is imperative. In 2019, Maine's marine economy accounted for $2.1 billion dollars in wages, a 25 percent increase from 2009, and $3.5 billion in gross domestic product, a 41 percent increase in the same period (NOAA 2022). Ensuring a sustainable future for Maine's marine economy requires collective action and coordination across diverse stakeholders at multiple levels, formally (e.g., governmental) and informally (e.g., coastal residents, fishermen, and business owners). Citizen and community science approaches offer a path toward collecting coastal data to inform these actions. There is a role for both citizen science and community science in the future of Maine's marine economy, which in turn is dependent on conservation efforts to protect Maine's iconic coastal habitats. For this article, we define citizen science as scientist-initiated, and community science is defined as initiated at the grassroots level, both aimed at increasing the data collection capacity across the landscape (Lin Hunter et al. 2023).

In our experience, a lack of communication spaces for stakeholders, limited availability of data on resource status, and challenges in sharing early-warning data are key contributors to the failure or breakdown of community-based collaboration that is essential to maintaining coastal economies.

We have contributed to the landscape of resources for citizen and community science by launching a data collection platform at Anecdata.org that provides tools for both citizen science and community science projects by accommodating collaborative project design and streamlining data collection and management for coastal and other habitats and resources. Here, we provide case studies on the utility of Anecdata to support local data collection on the coast of Maine while playing a role in managing and protecting coastal resources. Project managers from multiple Maine projects have joined in authorship to share perspectives on our coastal projects, provide details on data collection processes, and discuss the impact of those efforts, where applicable, on project participants, coastal communities, and local and state-level decision-making.

THE ANECDATA PLATFORM

Anecdata was developed at the Community Environmental Health Lab at MDI Biological Laboratory in Bar Harbor, Maine, to facilitate data gathering and sharing activities. A variety of Maine coastal projects on Anecdata highlight the ways that communities in Maine have used the platform to (1) evaluate whether a resource may be at risk of depletion or harm from anthropogenic climate change, (2) coordinate community efforts to restore or monitor coastal environments, and (3) provide a staging ground for local efforts towards policymaking or behavioral change (Disney et al. 2017a). From our perspective, cyberinfrastructure in citizen and community science spaces provides a flexible tool on local and global scales for facilitating collective action and cooperation across sectors.

Projects on Anecdata connect science and civic action as outlined by Pandya (2014), including scientist-led, contributory, co-created, and community-directed science. An analysis of the Anecdata site reveals that members of the public initiate most projects on Anecdata (considered community science), but that a substantial proportion (10 percent to 15 percent) are initiated by scientists in nonprofit, government, or educational settings (considered citizen science). However, most of the coastal Maine projects described in this article are scientist-led, with only a couple having evolved from community-directed efforts. The majority of data contributors and users across the Anecdata platform are members of the public, but the rate varies depending on the project described. The type of data collected varies and includes data for monitoring biodiversity, invasive species, and water quality, among others. In addition, these projects vary in the extent to which data collection activities have contributed to policy, educational, or research-related goals. Over the past decade since Anecdata was initiated, the site has transformed into a generalized web platform, continuing to serve many projects along Maine's coast as well as those in other coastal areas in Europe, Australia, Canada, and Asia.

KEY FUNCTIONS OF CITIZEN AND COMMUNITY SCIENCE PROJECTS IN COASTAL MAINE

Coastal projects on Anecdata fall into several categories important to cooperatively managing environmental institutions. We present 12 projects, the issues being addressed, progress to date, and future considerations. Many projects fall along a continuum of community collective action and co-creation; here, we highlight four key functions:

Identifying Potentially Vulnerable Resources and Providing Sentinel Data

Identifying potentially vulnerable resources and providing sentinel data (data critical to decision-making) play a crucial role in coastal environmental management and science by providing valuable insights into the impacts of environmental changes on coastal ecosystems. In the case of citizen science, by engaging community members to monitor and document changes in key indicators such as water chemistry, species abundance, and ecosystem health, scientists and policymakers can gain a comprehensive understanding of coastal vulnerabilities and potential hazards. This information enables proactive decision-making, effective resource management, and the development of mitigation strategies to protect and sustain coastal environments in the face of ongoing environmental challenges such as rising sea levels, ocean acidification, and climate change. In the case of community science, the same goals can be accomplished from citizen-led initiatives.

By consolidating the data in one place, the Anecdata platform enables the identification of vulnerable resources and the detection of environmental changes or threats at a broader scale. It allows for data analysis, visualization, and interpretation, which is essential for understanding coastal vulnerabilities and informing management decisions.

Coordinating Restoration, Monitoring, or Management Activities

Coordinating restoration, monitoring, or management activities involve bringing together multiple stakeholders, such as scientists, researchers, government agencies, nongovernmental organizations (NGOs), and local communities, to work toward common goals. In contrast to projects aimed at determining whether a system might be at risk, projects of this type coordinate actions in response to the knowledge—from existing scientific literature or previous projects—that a resource is degraded or threatened.

Restoration activities involve rehabilitating and enhancing degraded or damaged coastal ecosystems, including initiatives like habitat restoration, erosion control, and reintroduction of native species. Monitoring activities involve systematic observation and data collection to assess coastal ecosystem status, trends, and changes. It encompasses

the measurement of various parameters such as water quality, biodiversity, species populations, and habitat conditions. Management activities involve implementing strategies and actions based on scientific knowledge and monitoring data to protect, sustainably use, and conserve coastal resources.

Coordinating these activities ensures that efforts are aligned, avoid duplication, and maximize efficiency and effectiveness. Coordination facilitates the exchange of information, expertise, and resources among stakeholders, allowing for better-informed decision-making. It also enables the identification of gaps and priorities, promotes adaptive management, and encourages collaboration among diverse actors with complementary skills and knowledge.

A platform like Anecdata can help avoid duplication of efforts by promoting awareness of ongoing projects and their results. It can also support coordination efforts by providing tools for project planning, resource allocation, and tracking progress. Through the platform, stakeholders can work together, align their activities, and enhance the overall effectiveness and efficiency of coastal environmental management.

Affecting Policy or Behavioral Change

The data and findings generated through citizen and community science initiatives can serve as powerful tools for advocacy and awareness-raising, enabling communities to communicate their concerns and priorities to policymakers and stakeholders effectively. By highlighting the impacts of human activities on coastal ecosystems and showing the potential benefits of adopting more sustainable practices, citizen and community science projects can drive policy changes that promote conservation, restoration, and sustainable resource management. Furthermore, these projects have the potential to trigger behavioral changes among participants and the wider community, fostering a deeper connection to the coastal environment and encouraging responsible actions that contribute to its preservation. Overall, the ability of coastal citizen science projects to affect policy or behavioral change is instrumental in fostering community engagement, promoting environmental stewardship, and achieving long-term sustainability goals in coastal areas.

Anecdata hosts several features that can help support policy-making and behavioral changes, including a community announcements project and a direct messaging feature that can be used between project members. These features can alert members to upcoming events, public hearings, proposed legislation, or other community actions.

Influencing Formal Academic Research

While not all projects aim to integrate formal academic research or publication, academic research outputs can extend the reach of project findings and can lend credibility in pursuing other goals, particularly as they relate to policy. By actively engaging with academic researchers, stakeholders can shape research agendas, methodologies, and priorities. This collaboration between academia and coastal management practitioners enhances the relevance and applicability of research outcomes, facilitating the translation of scientific findings into actionable recommendations and policies. By bridging the gap between theory and practice, influencing formal academic research promotes knowledge exchange, informs decision-making processes, and contributes to more effective and sustainable coastal management practices.

Maine coastal projects on Anecdata have driven academic research,[1] resulting in publications that feature Maine datasets (Clark et al. 2019) and have informed the development of privacy and other features on Anecdata that have applications and implications across both citizen and community science projects (Bailey et al. 2021).

CASE STUDIES

Maine coastal projects on the Anecdata platform represent each of the four key functions of community science projects in coastal Maine. These examples are outlined in Tables 1 and 2.

The first project on the Anecdata site was Eelgrass Monitoring, a Community Lab project to track the presence and absence of eelgrass (*Zostera marina*) in coastal bays and coves. After the Gulf of Maine warming event in 2012 and the complete disappearance of eelgrass in upper Frenchman Bay, this project confirmed that this disappearance was not a localized event; eelgrass had disappeared from multiple other upper bay locations along Maine's coast, as far south as Casco Bay. A second eelgrass project called Maine Eelgrass Density was set up on Anecdata for the collection of eelgrass density and flowering data in eelgrass restoration areas in Frenchman Bay and comparison areas in Acadia National Park. This project involved public engagement, including the direct involvement of volunteers, local student interns, and school groups in eelgrass studies to assess the recovery of these populations over time (Disney et al. 2017a, 2017b).

A related project, Green Crab Studies, was established with the goal of understanding the association between

TABLE 1: **Overview of Maine Coastal Case Study Projects on Anecdata**

Project	Project goal	Year started	# of observations	# of observers	Project type*
Eelgrass Monitoring[1]	Monitor eelgrass (*Zostera marina*) presence to track species population	2013	111	42	Contrib. sci.
Maine Eelgrass Density[2]	Monitor eelgrass (*Zostera marina*) density and coverage as indicators of eelgrass health	2016	36	11	Contrib. sci.
Green Crab Studies[3]	Monitor the European green crab population to help combat the invasive species migration	2014	160	23	Contrib. sci.
Bar Harbor Cruise Ship Monitoring[4]	Report water quality at Bar Harbor port within cruise ship routes to identify possible discharge from ships	2017	231	7	Collab. sci.
Acadia Region Water Quality Monitoring[5]	Report water quality for various projects in the Acadia Region, including Maine Healthy Beaches and other initiatives.	2014	2,096	7	Collab. sci.
Project ASCO (Assessing Seaweed via Community Observations)[6]	Monitor biomass of rockweed (*Ascophyllum nodosum*) to track species population abundance in an area	2020	135	72	Contrib. sci.
Coastal SOS Monitoring (Maine Signs of the Seasons)[7]	Provide data to advance coastal ecology and climate change research, improve participants' understanding of ecology and climate science, and increase climate stewardship activities in Maine and New Hampshire.	2018	843	48	Contrib. sci.
Maine Marine Sediment Monitoring[8]	Monitor mudflat pH changes and clam population in relation to pH changes to assess ocean acidification impacts	2014	811	92	Contrib. sci.
Maine Brook Trout and Water Quality[9]	Collect water quality information from brook trout streams and lakes.	2019	265	22	Contrib. sci.
Maine Phytoplankton Monitoring[10]	Monitor toxic phytoplankton species to track harmful blooms	2016	152	30	Collab. sci.
Gulf of Maine King Tides[11]	Report photographs of King Tides and weather to help predict the effects of sea level rise	2014	356	124	Contrib. sci.
Harpswell King Tide Impacts[12]	Report photographs of King Tides and abiotic factors to help predict the effects of sea level rise	2018	154	30	CDR

Notes: *Contrib. sci.=contributory science; Collab. sci.= collaborative science; CDR= community-directed research; (1) https://www.anecdata.org/projects/view/1; (2) https://www.anecdata.org/projects/view/206; (3) https://www.anecdata.org/projects/view/34; (4) https://www.anecdata.org/projects/view/205; (5) https://www.anecdata.org/projects/view/37; (6) https://www.anecdata.org/projects/view/693; (7) https://www.anecdata.org/projects/view/301; (8) https://www.anecdata.org/projects/view/44; (9) https://www.anecdata.org/projects/view/543; (10) https://www.anecdata.org/projects/view/139; (11) https://www.anecdata.org/projects/view/59; (12) https://www.anecdata.org/projects/view/307

invasive green crab abundance and declining eelgrass. Again, volunteers, local student interns, and students from local schools were engaged as citizen scientists and used various methods to assess green crab populations in and around restored and comparison eelgrass sites (Disney et al. 2017a). These three projects are examples of contributory community science because they were initiated by scientists, but relied on data contributions by community members.

Project ASCO (Assessing Seaweed via Community Observations) and Coastal Signs of the Seasons (Coastal SOS) both leverage Anecdata to facilitate collecting and sharing data on the growth, abundance, and timing of biological changes of *Ascophyllum nodosum,* a common intertidal seaweed often called rockweed. Project ASCO participants collect data on rockweed biomass in Maine's intertidal zone, where rockweed is a dominant species and provides a habitat for various organisms. By analyzing these data, scientists and resource managers gain knowledge on the statewide standing stock of this harvested marine organism. Coastal SOS focuses on monitoring the reproductive phenology of rockweed along the New England coast. By closely tracking this indicator species' annual reproduction,

TABLE 2: **Case Study Project Categories**

Project	Identifying potentially vulnerable resources and providing sentinel data	Coordinating restoration, monitoring, or management activities	Affecting policy or behavioral change	Influencing formal academic research
Eelgrass Monitoring and Maine Eelgrass Density	x	x	x	x
Green Crab Studies	x			x
Bar Harbor Cruise Ship Monitoring		x	x	
Acadia Region Water Quality Monitoring		x	x	
Project ASCO (Assessing Seaweed via Community Observations)	x		x	x
Coastal SOS Monitoring (Maine Signs of the Seasons)	x		x	x
Maine Marine Sediment Monitoring	x	x	x	
Maine Brook Trout and Water Quality	x	x	x	
Maine Phytoplankton Monitoring		x		x
Gulf of Maine King Tides and Harpswell King Tide Impacts	x		x	

which is influenced by water temperature at high tide (Bacon and Vadas 2004), researchers can better understand trends that may affect rockweed's reproductive success and can provide a model for developmental studies and possible reseeding in the future. By collecting data on biomass and monitoring for changes in foundation species like rockweed, these initiatives contribute to understanding and protecting the resilience of coastal resources and ecosystems.

Project ASCO and Coastal SOS are also examples of contributory citizen science projects, where the projects were initiated by researchers from a nonprofit and academic institution, respectively, but use community-contributed data to increase the scale and scope of the data collection across the region. Despite their shared focus on *Ascophyllum nodosum,* the projects collect distinct data and involve numerous partners, including the University of Maine Cooperative Extension, Maine and New Hampshire Sea Grant programs, Maine Maritime Academy, Schoodic Institute at Acadia National Park, the University of New Hampshire Cooperative Extension programs, and the USA National Phenology Network.

Finally, community-based king tide projects identify potentially vulnerable resources due to flood risk and anticipate hazards that may occur in the future (for example, see Peterman, Bevc, and Kermish-Allen 2019). There are two King Tides projects on Anecdata. One, based at the New England Aquarium called Gulf of Maine King Tides, has observations from Maine to Massachusetts. The other, Harpswell King Tide Impacts, is a local project led by the Conservation Commission in Harpswell, Maine. The goals of the projects include documenting changes over time and providing data that scientists and planners can use to create models and predict and mitigate future flooding events. Participants in these projects are encouraged to photograph the highest tides of the year, known as king tides, which give a glimpse into potential scenarios with rising sea levels. In the Gulf of Maine King Tides project, participants choose a location along the coast and include landmarks or infrastructure in their photos to provide context on water depth (Figure 1). Different project leaders have initiated local projects within this larger King Tides initiative, recruiting participants to take pictures of shoreline inundation during specific King Tide events. The Harpswell King Tide project is a picture post project (Graham et al. 2011) that focuses on repeatedly collecting photographic data at specific locations to show the impact of rising seas on roads, bridges, property, and ecosystems in Harpswell, Maine (Figure 2). This grassroots effort is a good example of a community-directed research project on Anecdata, as including data on tide height and weather has been instrumental in decision-making

FIGURE 1: **Shoreline Inundation during a King Tide in Acadia National Park**

Source: Anecdata.org.

FIGURE 2: **Flooding during a King Tide in Harpswell**

Source: Anecdata.org.

for the town. The project has created a record of changing coastal conditions by documenting the effects of higher tides and storm surges over time. As a result, the community has identified the most at-risk public roads and areas along the working waterfront and prioritized them for engineering analysis. The image data has provided credibility to the prioritization process.

These projects demonstrate the power of citizen and community science in identifying potentially vulnerable coastal resources and providing valuable sentinel data. From tracking eelgrass declines to monitoring rockweed abundance and documenting king tides, each initiative showcases the collaboration between scientists, communities, and volunteers. Participants contribute to a collective effort to understand and protect coastal ecosystems by engaging in data collection, observation, and documentation.

Other projects have also been explicitly initiated to monitor resources known to be at risk due to anthropogenic climate change and to provide insights into whether management or restoration actions have been successful. For example, the Maine Marine Sediment Monitoring Project was initiated by the Hancock County Soil and Water Conservation District to document the changes in mudflat pH in response to ocean acidification and acid rain while monitoring the ecosystem responses to these anthropogenic impacts. This monitoring revealed a low sediment pH of 1–2 pH units below typical seawater pH, which may be due to carbon dioxide. Spat collectors with predator screens show that clam recruitment is unpredictable and variable, but so far, not related to sediment pH (Whiting 2018). Experiments by the Downeast Institute showed that predators have a larger impact on spat recruitment than sediment chemistry (Beal and Otto 2019). The Maine Brook Trout and Water Quality project, initiated by the Trout Unlimited Downeast Chapter, monitors freshwater in Hancock and Washington Counties. This project tracks changes in water chemistry, fish densities, and macroinvertebrate communities to assess the current status of these relative to EPA and other water quality criteria. So far, results show widespread acid rain effects, including variable and often very low pH, low alkalinity, and low calcium below critical thresholds for Atlantic salmon survival, biodiversity, and freshwater community integrity (Whiting 2020). A pilot liming project showed increased fish densities, particularly of Atlantic salmon and brook trout, improvements in macroinvertebrate communities, increases in leaf pack processing rates, and other positive outcomes for the restoration of stream ecosystems in eastern Maine (Whiting and Rukosky 2016). These projects were conducted in conjunction with local community members and county or state government organizations (Maine Department of Environmental Protection and Hancock County Soil and Water Conservation District).

The Bar Harbor Cruise Ship Monitoring project on Anecdata provides an archive of data collected by the Community Lab at the request of the town of Bar Harbor. These data are collected every few years to address public concerns regarding potential wastewater discharges in the harbor by visiting cruise ships. Data on fecal bacteria, nutrients, and turbidity are collected, as elevated levels could indicate a potential discharge from a visiting ship. The data are included in a report prepared for the town and are shared with the town council, town committees, and others

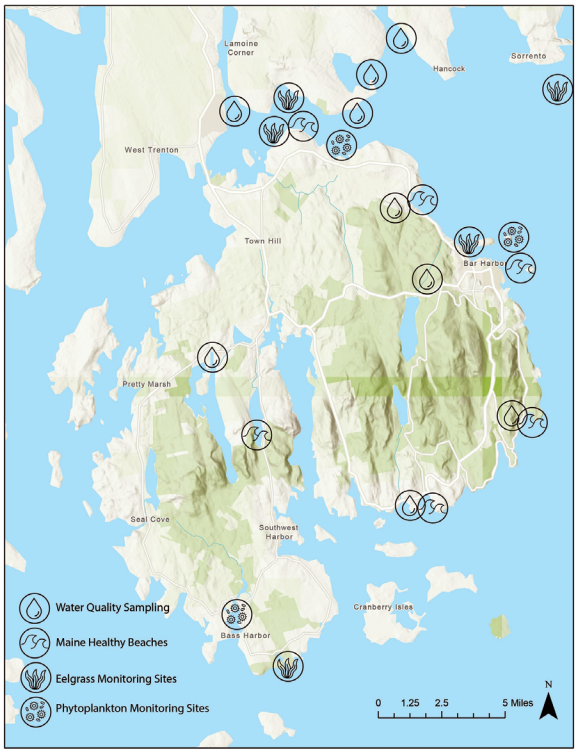
interested in learning about the outcomes. During monitoring, few discharges were detected, but on occasions where elevated bacteria levels were found, small passenger vessels had inadvertently discharged gray water (wastewater from sinks and showers). These findings lead to increased communication between local officials and ship captains and industry representatives regarding expectations for ships in the harbor.

Acadia Region Water Quality Monitoring is a project that archives data from multiple projects with similar goals to ensure the health of the bay and the safety of those in contact with the water. The project includes Mount Desert Island sample sites that are monitored for the Maine Healthy Coastal Beaches Program. These include Town Beach in Bar Harbor, Hulls Cove Beach, Hadley Point, Seal Harbor Beach, and Sand Beach. Additional monitored beaches are freshwater sites, including Lakewood and Echo Lake Beach. Information on beach status is available through the Maine Healthy Beaches website, but the entire Acadia Region beach dataset can be downloaded from Anecdata for analysis, inclusion in reports, or grant applications. Beyond beach data, this project has water quality data from pre- and post-eelgrass restoration efforts, which help document the state of the bay for municipal comprehensive planning, conservation action planning, and future grant solicitation. The locations of water monitoring efforts in the Acadia Region Water Quality Monitoring project are depicted in Figure 3.

The Maine Phytoplankton Monitoring project is an example of a researcher-initiated project that started as a volunteer effort for the Maine Department of Marine Resources and has expanded to include various other institutions, including Woods Hole Oceanographic Institute and the Florida Fish and Wildlife Conservation Commission. The data collected through this project have informed an article on the biogeography of the *Pseudo-nitzschia* species composition in the Gulf of Maine. As this article highlights, these data provided information on an unprecedented bloom of *Pseudo-nitzschia australis* in the region accompanied by extremely high domoic acid concentrations (Clark et al. 2019). The direct collaboration with expert researchers enabled a more specific characterization of domoic acid, a human health-relevant biotoxin that has implications for the safe consumption of shellfish in the Gulf of Maine.

Coastal SOS is another researcher-initiated project. A 2022 webinar provides an overview of how Coastal SOS

FIGURE 3: **Sites of Monitoring Initiatives in the Acadia Region Water Quality Monitoring Project**



data are used to advance research in a changing marine environment.[2] The information collected on the timing of reproduction in *Ascophyllum* provides a baseline for understanding the impacts of climate change on the initiation and cessation of reproduction in each season. Currently, interseason variability may be obscuring climate effects, but continued data collection may reveal these relationships and their impact on rockweed habitat over time.

While many projects are not initiated with the explicit goal of contributing to academic research objectives, the data collected by these local projects can be invaluable for large-scale synthesis research. Because the data are licensed for reuse, data can be shared with databases that aggregate observational data. For example, projects from Anecdata providing biodiversity information have been imported into the Global Biodiversity Information Facilities, including many of our project case studies (Eelgrass Monitoring, Maine Eelgrass Density, Green Crab Studies, Bar Harbor Cruise Ship Monitoring, Acadia Water Quality Monitoring, Project ASCO, Coastal SOS, Biodiversity Information Facilities,

these data have been accessed more than 30,000 times and have informed 12 research articles.

DISCUSSION

There are many efforts across Maine to address coastal issues, including assessing the effects of climate change on shorelines and waterfront infrastructure and documenting invasive species abundance, fisheries declines, and impacts of visitor use and cruise ship visitation on water quality. Although these issues can seem insurmountable, they are important to address as Maine adapts to changes over time (Johnson 2020). Citizen and community science initiatives are moving the needle in terms of data collection and moving data to action. As a result of project efforts, there is an increased understanding of shifting baseline metrics, changes in water quality, and potential for conservation and restoration of coastal habitats, and improved ability to prioritize infrastructure needs along Maine's coast. Despite these gains, there remain challenges that may require complex solutions that have not yet been considered, partly because they can result in contention between stakeholders. These include graduated sanctions or penalties, which are rarely implemented to discourage noncompliance with established rules. Conflict resolution mechanisms are essential to address disputes among resource users; however, these are often difficult to implement and are superseded by public hearing processes that sometimes pit resource users against each other. The availability of sound baseline data can go a long way toward addressing the root causes of noncompliance and resolving disputes among resource users, as we have seen happen with projects discussed in this paper.

Numerous efforts have involved students in school and informal science learning programs in collecting data as citizen scientists. These experiences for young people build environmental literacy skills as well as a sense of well-being, self-confidence, and purpose, as outlined in the Maine Environmental Literacy Plan (Maine DOE 2022). Citizen science and community science experiences for both young and older people can drive improvements in coastal and other environments with implications for the conservation of habitats, species, and preservation of ways of life. This functionality is important for Maine, which depends on its natural resources to support livelihoods on the coast and across the state.

CONCLUSIONS

The key functions of citizen and community science projects in coastal Maine include identifying vulnerable resources, coordinating restoration and monitoring activities, affecting policy or behavioral change, and influencing formal academic research. These functions are vital for coordinating collective action as well as for understanding and managing coastal ecosystems, promoting sustainability, and ensuring the long-term well-being of coastal economies and communities. People of all ages can make contributions to citizen and community science efforts and, in the process, build environmental literacy skills and derive a sense of accomplishment and making a difference in the world. The Anecdata platform is a valuable tool for facilitating these functions by providing a centralized data repository, promoting collaboration, and supporting decision-making processes in coastal environmental management.

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NOTES

1 https://www.anecdata.org/pages/publications

2 https://extension.umaine.edu/signs-of-the-seasons/webinars/#rockweed-phenology-research

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