

NC STATE UNIVERSITY

Coastal Resilience and Sustainability Initiative White Paper

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HISTORY AND CHARGE

In the Fall of 2019, Executive Vice Chancellor and Provost Arden brought together leaders from across the campus and asked them to develop an interdisciplinary coastal resilience and sustainability research and engagement initiative at NC State that would lead to practical solutions to the challenges of climate change, resilience, and sustainability in the coastal zone. Looking beyond disaster response, he asked us to focus on creating a new vision for the future, one where rural and agricultural economies, coastal plain communities, and natural systems are more resilient in the face of ongoing change.

More specifically, the Provost charged us to:

- Determine what NC State's strengths are in the area of coastal resilience and sustainability, which might include creating an inventory of existing programs and expertise on campus.
- Identify 3-5 thematic sub-areas where NC State is or can become a national leader.
- Identify the most impactful ways that NC State can invest in coastal and sustainability efforts, with a focus on engaged research that can involve and assist vulnerable communities in North Carolina and beyond.

This white paper responds to that charge.

THE CHALLENGE AND NC STATE'S LEADERSHIP OPPORTUNITY

The world is unprepared for the challenges of climate change, and in many ways, North Carolina is at the epicenter of this challenge. In the coastal plain, changes in temperature and precipitation, intensifying hurricanes, flooding, sea-level rise, and saltwater intrusion are fundamentally altering ecosystems and communities. NC State University has internationally recognized expertise in the natural sciences, social sciences, engineering and technology, and a long and vibrant history of sustained engagement with communities, businesses, and policy-makers at all levels. Working together, our University has an unprecedented opportunity to develop a clearer understanding of the forces that are reshaping our state, and to create solutions to address them.

In North Carolina, as around the world, social, economic, and environmental sustainability are increasingly a part of the public discourse, with demands that society think differently about the future. Resilience, the capacity to anticipate, adapt and recover quickly from changing conditions, has become a focus in multiple sectors, including communities, environmental management, and public health. NC State's Sustainability Council defines successful sustainability as an effort that "pursues balanced, ethical solutions that are economically viable, environmentally sound, and socially just so that current and future generations may thrive." *A comprehensive, interdisciplinary, convergent approach offers the greatest hope for real progress and impact.* In fact, the only way to build resilience and sustainability – the most complex and pressing grand challenges of our time – is by building diverse teams that bring together different voices, perspectives, strengths, and values, all with a singular focus on developing solutions that work.

Eastern NC, generally east of I-95, is predominantly rural, with agricultural and natural resource-based economies, a rich history, and significant economic and environmental challenges. *Our university is a land grant leader, with clear excellence in engineering, agriculture, forestry, and rural community engagement.* **A focus on rural resilience could be a differentiator for NC State.** That is not to say that urban areas should be ignored, only that the particular needs of rural communities, where risks are high but resources may be more limited, have received limited attention and are especially compelling. Our innovation in science and engineering; sustainable business acumen; leadership in systems modeling and prediction; new approaches to public infrastructure and renewable energy. These strengths, combined with leadership in K12 and public health education in

rural areas and informal education to build scientific literacy as a catalyst for environmental change; and a growing focus on equity and inclusion that give communities voice and “capacity” for resilience collectively give us enormous potential. NC State’s Cooperative Extension Program, Institute for Emerging Issues, Sea Grant Program, and many other efforts across the colleges have built strong partnerships with communities. Collaboration with communities is key – solutions must be developed in partnership with communities.

As NC State develops its next Strategic Plan, the Coastal Resilience and Sustainability Initiative offers unique opportunities to bolster strategic priorities, especially in the following areas:

- Envisaging the Next Generation Land-Grant University – Addressing the rapid pace of change is a core land-grant responsibility, and is particularly apparent in thinking about climate change, coastal resilience and the need for adaptability and new approaches. NC State is an emerging leader on this critical issue of our time, and with appropriate investment, will become the go-to place for practical solutions and hands-on education in North Carolina and the world.
- Leveraging Partnerships to Advance Engagement – Partnerships are critical to success of the coastal resilience initiative – we cannot succeed in creating a more resilient future without deep and long-term engagement of partners across eastern NC, and well beyond. Faculty working in coastal resilience and sustainability already have a network of partners who are engaging – or want to engage – in this area, and can contribute much to the development of a “partnership ecosystem” at NC State.
- Strengthening University-Wide Interdisciplinarity – With a large number of faculty members representing all 10 colleges at NC State and a large number of students expressing interest in coastal resilience and sustainability research, engagement, and education, the Coastal Resilience and Sustainability Initiative could be a game-changing, exemplar “Interdisciplinary Academy” with appropriate investment.
- Continuing to Advance the Brand and Reputation of NC State – The Coastal Resilience and Sustainability Initiative is rapidly becoming a strength/center of excellence on campus. There are numerous stories that could be developed about how we “think and do” in the area of coastal resilience and sustainability, and how important our work is to the state, the nation and the world.

NC State’s resources and facilities are distributed across eastern North Carolina and provide exceptional opportunities for targeted coastal resilience and sustainability programming. In particular, partnerships with the Cooperative Extension program, which has expertise and offices in all coastal counties, the Center for Marine Sciences and Technology (CMAST) in Morehead NC, and NC Sea Grant’s research, extension and education expertise in Wilmington, Morehead City and Manteo NC can be key partners in developing this program. CMAST is part of the *NC Marine Science & Education Partnership (MSEP)* in Carteret County and is also part of the National Association of Marine Labs and Southern Association of Marine Labs, which greatly facilitates communication and collaboration among related programs across the region.

This Initiative can also leverage other existing efforts at NC State that are focused on climate adaptation and resilience. For example, the Southeast Climate Adaptation Science Center (SE CASC) supports related scientific research and collaboration across the southeast, and the Global Change Graduate Fellows program provides financial, scientific, and professional development support for graduate students who are interested in multi-disciplinary climate change related research. The SE CASC is funded by the US Geological Survey, with matching funds from NC State. The new Kenan Institute for Engineering, Technology & Science (KIETS) Climate Leaders Program will soon advertise for a Senior Faculty Fellow who will focus scholarly activities on climate change mitigation, and in 2021, select up to five NC State undergraduate or graduate students for the KIETS Climate

Leadership Scholars program, which will focus on leadership training and support internships with organizations working on climate change solutions.

In addition, the NC Climate Office, located on NC State's Centennial Campus, is a Public Service Center that works to define, predict and disseminate information about the climatic and environmental factors that impact the people of North Carolina. The Cooperative Institute for Climate and Satellites-North Carolina (CICS-NC), located in Asheville, is supported by NC State and the National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information and works to advance understanding of the current and future state of the climate, along with regular analysis reports about trends in collaboration with several additional partners. Finally, NC Sea Grant, also supported by NOAA and part of the National Sea Grant College Program, supports research and engagement on coastal adaptation and resilience with many partners, and funds competitive research projects conducted by faculty at NC State and other North Carolina universities. Over time, there are also rich opportunities for collaboration with UNC-Chapel Hill, Duke University, East Carolina University, and UNC-Wilmington, all of whom also have faculty conducting research that addresses climate change and coastal resilience.

SURVEY OF EXPERTISE, INTERESTS, AND BIG IDEAS

In late April and early May 2020, a survey designed to identify the expertise, current work and big ideas of our faculty related to coastal resilience and sustainability was distributed to all full-time faculty from every unit on campus. There were 168 responses to that survey, including faculty from all 10 Colleges and a few from other units on campus (Figure 1).

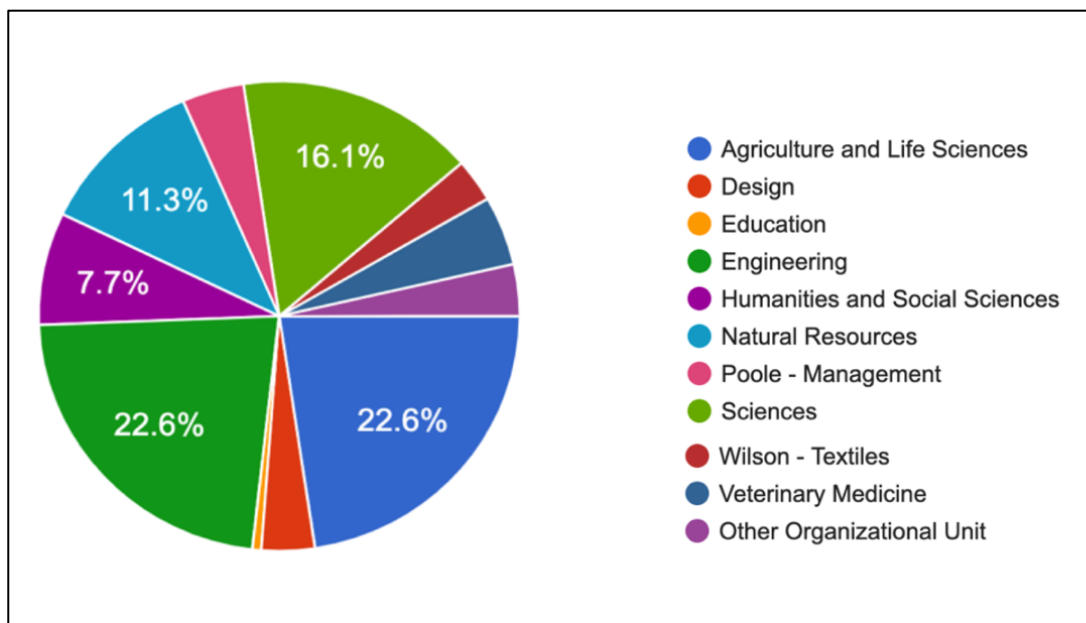


Figure 1. Distribution of survey respondents across the colleges.

Over 200 current projects related to coastal resilience and sustainability were reported in response to the survey, and over 100 big ideas were suggested. Current projects are funded by NSF, USDA, USACE, USGS, NOAA, NASA, DOE, EPA, various North Carolina state agencies, Novo Nordisk Foundation, and other private and business sponsors.

Areas of Expertise

In the survey, respondents were asked to self-identify their primary and secondary areas of expertise from a list of fourteen topics (Figure 2). Overall, respondents reported greatest combined primary and secondary expertise in education, engagement, modeling, and climate/environmental change. Across respondents, the areas of greatest *primary* expertise included education, engineering and infrastructure, and modeling. The areas of greatest *secondary* expertise included communication, engagement, education, and policy and planning. While education and engagement were the two most frequently reported areas of expertise among the respondents, these results may be more indicative of active practice rather than disciplinary research expertise as only about 10% of survey respondents were from Colleges that focus on those disciplines (Education, CHASS, Design).

Topic areas where primary and secondary expertise was more limited suggest areas where additional expertise may be needed to support this Initiative, and include economic development, design, and marine/aquatic ecosystems. Because equity and culture, policy and planning, and communication had low numbers as self-identified areas of primary expertise, there may be gaps in these areas as well.

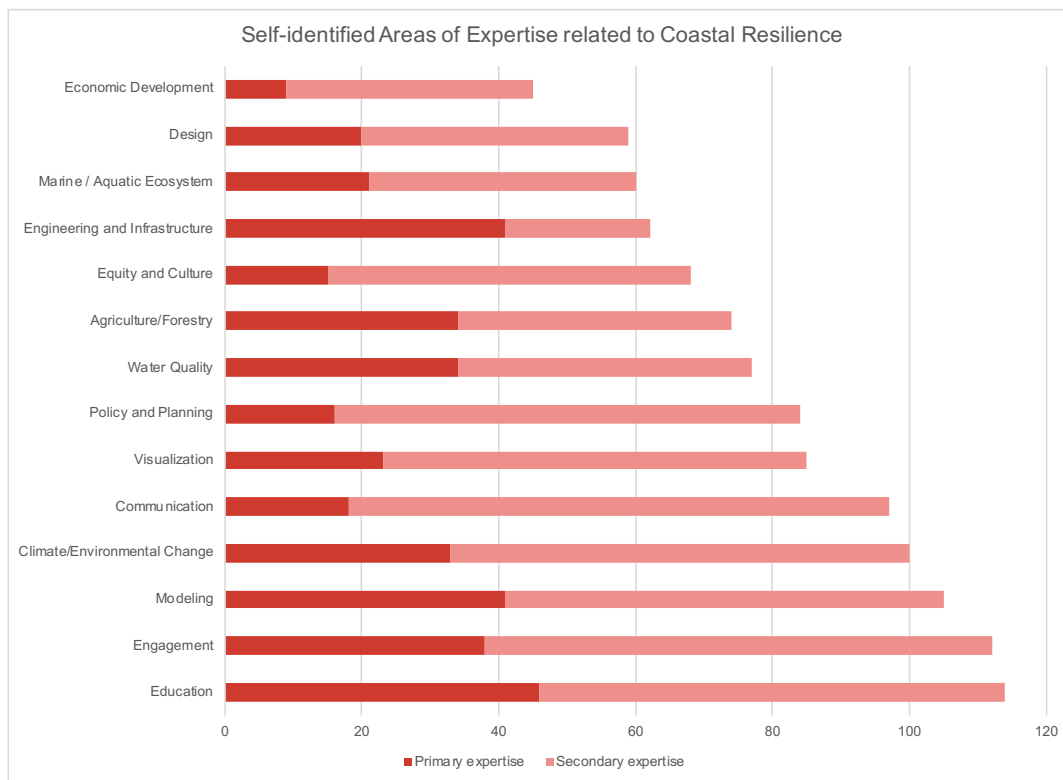


Figure 2. Self-identified areas of expertise related to coastal resilience

Clusters of Expertise

Individuals were highly connected across topic areas of self-identified expertise (Figure 3). In this image, black lines connect the individual respondents (red dots) with their areas of expertise (blue squares). Inferred from this network map and verified through cluster analysis, areas of expertise clustered into three groups. **Group 1** includes communication, economic development, education, engagement, equity and culture, and policy and planning. **Group 2** includes modeling, visualization, engineering and infrastructure, and design. **Group 3** includes climate/environmental change, agriculture/forestry, water quality, and marine/aquatic ecosystems.

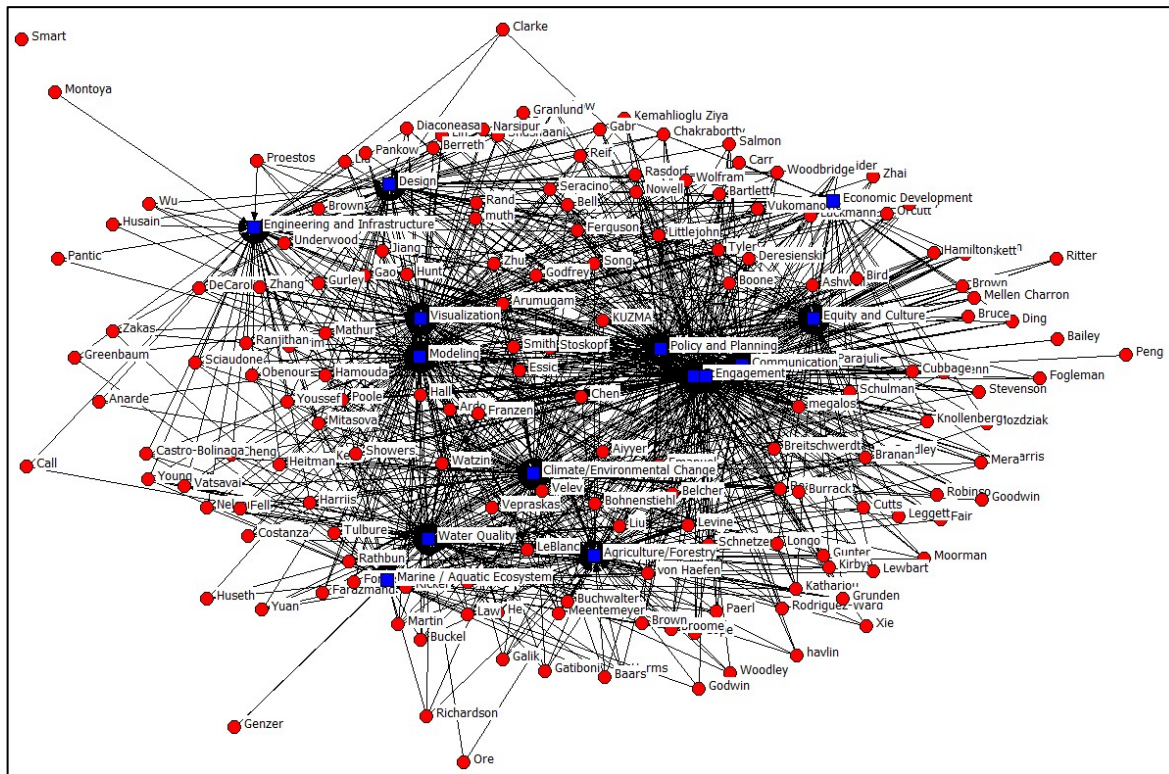


Figure 3. Network map of individual respondents and self-identified areas of expertise

Areas of Potential Collaboration

Respondents were also asked to choose topic areas in which they would like to collaborate (Figure 4). *Across all expertise areas and respondents, the most frequently selected collaboration interest was other individuals with the same expertise.* While deep expertise among closest disciplinary relatives is certainly needed to understand the components of a changing world, this more segmented approach to finding solutions cannot take on the large, complex grand challenges that are impeding greater resilience and sustainability. These challenges demand a systems approach that explicitly considers the links between people and the environment, and truly multidisciplinary or transdisciplinary teams. It will be important to consider the best approaches to building these kinds of teams and implement them moving forward.

Most respondents, however, also reported interest in collaborating with individuals with expertise in other areas, especially climate/environmental change, education, engagement, and modeling. Across all respondents, there was a *high* level of interest in collaborating with others with expertise in climate/environmental change, modeling, water quality, and marine/aquatic ecosystems. Respondents indicated *some* interest in collaborating with others with expertise in education, communication, economic development, and engagement.

The recognition of the importance of engagement is significant. Two-way, additive engagement with diverse communities and stakeholders, working together to co-produce an actionable research agenda that evolves with new understanding and community needs, and where results can inform new innovations and decision-making is the goal of this initiative.

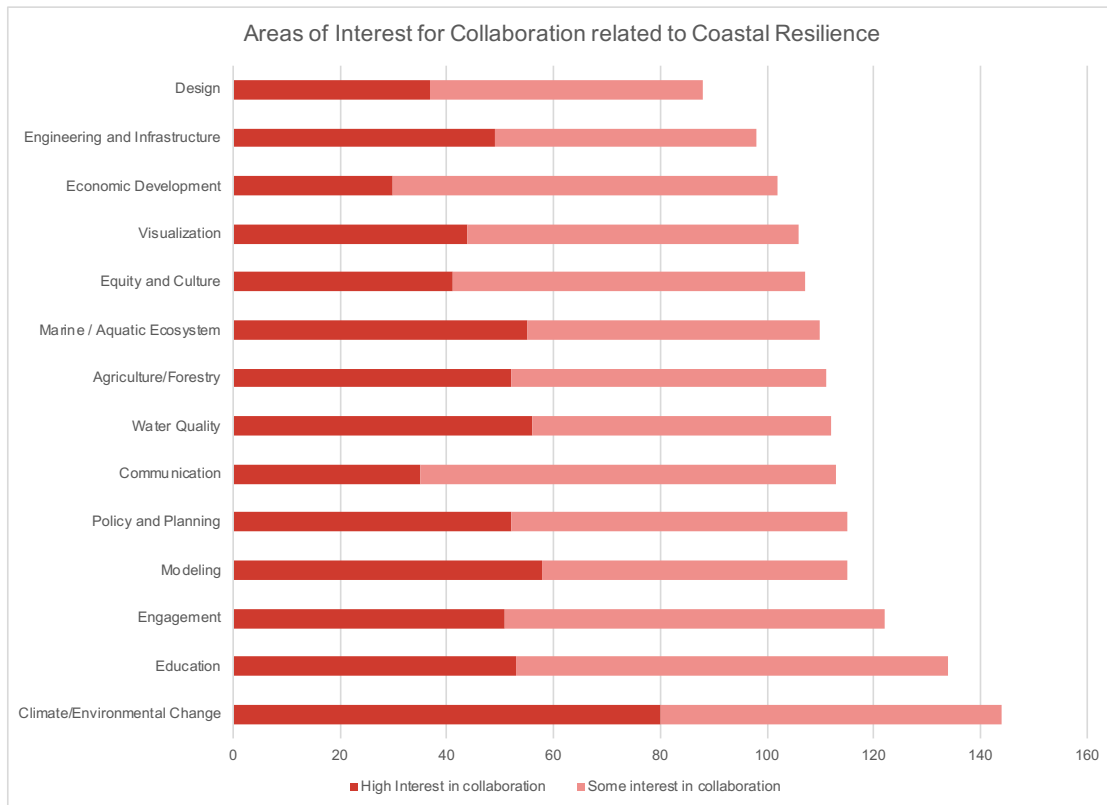


Figure 4. Areas of interest for collaboration among respondents

Collaboration Clusters

Correlation analysis was used to identify the relationship between respondents within a category of expertise and their areas of collaboration interest (Table 1). These groups offer clusters for future collaboration efforts. They also suggest that the faculty are still relatively more comfortable working within groups of closely aligned disciplines as the STEM disciplines and other areas tend to be somewhat differentiated in these groupings.

Individuals within this area of expertise...	...Would like to collaborate with individuals within these areas of expertise.
Agriculture/Forestry	Water Quality, Climate/Environmental Change, Economic Development
Climate/Environmental Change	Water Quality, Agriculture/Forestry, Visualization
Communication	Engagement, Equity and Culture, Education
Design	Engineering and Infrastructure, Visualization, Modeling
Economic Development	Policy and Planning, Engagement, Equity and Culture
Education	Communication, Engagement, Equity and Culture
Engineering and Infrastructure	Modeling, Design, Visualization
Engagement	Communication, Equity and Culture, Economic Development
Equity and Culture	Communication, Engagement, Education

Marine/Aquatic Ecosystem	Water Quality, Climate/Environmental Change, Modeling
Modeling	Visualization, Engineering and Infrastructure, Climate/Environmental Change
Policy and Planning	Economic Development, Engagement, Equity and Culture
Visualization	Modeling, Design, Engineering and Infrastructure
Water Quality	Marine/Aquatic Ecosystem, Climate/Environmental Change, Agriculture/Forestry

Table 1. Potential collaboration clusters for future work

Big Ideas and Areas of Interest

To help identify themes and areas where NC State could focus its efforts to move this initiative forward, faculty were asked to share their “big ideas in the realm of coastal resilience and sustainability,” things they would “like to see NC State pursue.” Over 100 ideas were submitted, spanning a diversity of interests. After organizing these responses into general categories, and discussing areas where interest was great and some overlap with the potential clusters identified above was evident, the leadership group identified the following initial thematic areas.

THEMATIC AREAS WHERE NC STATE COULD LEAD

Theme 1 – Challenges and opportunities in sustainable agriculture, forestry, and rural, natural resource-based economies. Understanding and adapting to climate change (e.g., changing temperature and precipitation patterns, increase in severe storms, subsidence and saltwater intrusion). Innovations in water management, for example, using sensors to manage irrigation, soil health, and downstream impacts of animal operations. Using agricultural lands to temporarily store floodwaters after storms. Strengthening/innovating in aquaculture, and supporting commercial fishing industries within NC’s agricultural portfolio.

Theme 2 – Water quality and quantity in the coastal zone. Strengthening water management for coastal resilience and sustainability, including but not limited to: innovations to address competing water use demands, wastewater management, microplastic pollution, and other contaminants of emerging concern. New watershed-wide approaches to nutrient management, stormwater management, and water recycling in the coastal zone.

Theme 3 – Energy resilience, and innovations in technology. Smart and connected energy systems, including, but not limited to innovations to ensure uninterrupted service, microgrids and local distributed systems, animal waste bioenergy, offshore wind, wave, and solar energy systems. Developing advanced robotics and observing applications, such as self-powered sensors and Autonomous Underwater Vehicles (AUVs).

Theme 4 – Coupled human and natural systems. Deep integration of human and natural systems incorporating climate change. Monitoring, modeling, prediction, visualization, and scenario planning innovations that result in enhanced resilience and sustainability at multiple scales, and over the long term. These might include, but are not limited to innovative interventions for flood mitigation and adaptation, and novel engineering and design standards that support communities and the environment, including new approaches to infrastructure.

Theme 5 – Mutually beneficial engagement that emphasizes social equity. Holistic approaches that respect communities and consider cultures, the roots of poverty, coastal development and entrepreneurship, and intersectional environmental science and justice.

Theme 6 – Education at NC State and beyond. New undergraduate and graduate programs at NC State, universal adult literacy and workforce development as a means for increasing economic opportunity, health, and resilience in coastal communities.

RECOMMENDATIONS TO MOVE THIS INITIATIVE FORWARD

Overall, our work to date indicates there is broad, campus-wide interest and enthusiasm for building disciplinary and interdisciplinary teams to do engaged research aimed at finding solutions to the challenges of coastal resilience and sustainability. There are also many solicitations seeking proposals for resilience research and innovation, across a spectrum of interests, and including both fundamental science and engineering, as well as new innovations and applications. This Initiative can serve the campus as both a clearinghouse of expertise and a catalyst for transdisciplinary activities across the colleges and beyond.

The Leadership Group is committed to moving forward to advance this Initiative. Specific steps that we will take, beginning in January 2021, include:

- Forming discussion groups around the thematic areas that have been identified, with activities that might help faculty get to know each other and find common interests.
- Sending the survey out one more time, targeting individuals and groups that we know have interest in the work we are doing, and inviting others that might join in the development of competitive teams for grant writing and other activities.
- Bringing Extension into the Initiative. We know that their connections to the community and knowledge about Eastern NC's culture, challenges, and opportunities will be a valuable addition to this initiative.
- Exploring the role that CMAST might play in supporting this Initiative as it grows. CMAST's facilities, access to local habitats and environments, and connections to the community provide much that might be leveraged.

The Leadership Group appreciates the Provost's investment in a half-time support person for this Initiative. Some modest additional investments could also be transformational in moving this Initiative forward. The following lists lay out our recommendations over the short and longer term.

Immediate/Short term –

- On-going workshops and other events to create working groups around the five thematic areas. *(support needed during and especially after COVID, when we can meet in person)*
- Database development – to make the survey data accessible and useful to others – create a directory of expertise, build out the inventory of current projects, etc., to facilitate collaboration. Web accessible, self-populated over time. *(IT support, working with the staff person)*
- Listening sessions with thought leaders and potential partners in eastern NC. *(support needed before and especially after COVID for participation costs, travel and in-person meetings)*
- A regular NC State Coastal Resilience and Sustainability Section in our campus e-news, highlighting current projects and new initiatives. *(in-kind support needed from NC State Communications)*

- Create, and keep up to date, a list of funding opportunities that could be matched with campus expertise. (*in-kind support from the Office of Research and Innovation and the Advancement Office*)
- Over the next year, determine an institutional structure that will advance this Initiative. That could include designating this as a cluster, with new hires in critical areas, or establishing a center with appropriate resources.

Next 1-3 years –

- Seed/Planning grants for interdisciplinary faculty teams, to target large funding opportunities and prepare competitive proposals. (*launch in Fall 2021, \$25K max. per award*)
- Competitive program to buy-out the teaching effort of faculty who are fully engaged in Initiative priorities. (*launch in Fall 2021*)
- Graduate assistantships for Coastal Resilience and Sustainability research, competitively awarded to faculty projects with high potential.
- Survey resilience and sustainability in curricula across the campus. Develop new curricula as appropriate, especially to support graduate education.
- Professional development opportunities to learn and share effective strategies for mutually beneficial public engagement and community engaged scholarship. (*meeting costs*)
- Conference development and support – 1) a large focused conference here in Raleigh that would showcase NC State, and bring in leading researchers for some sessions, or 2) several individual sessions incorporated into other existing conferences. (*travel and meeting costs*)
- Federal agency days/panels: bringing in Program Officers, highlighting funding opportunities, and providing the opportunity for engagement (*travel and meeting costs*)
- A “GRIP4Coastal Resilience & Sustainability” project, with resources contributed by partners and matched by Colleges.
- Innovation Challenge/[Entrepreneurship](#) Challenge focused on resilience and sustainability critical needs.
- [B-Corp](#) industry engagement and partnership development to drive investments and support businesses addressing resilience and sustainability.
- Non-profit entity engagement, reaching out to Program Officers, sharing NC State’s strengths, and exploring funding and engagement opportunities.
- Year-of-the Coast theme for NC State (with associated activities all year).
- Dedicated full time support person (as need is demonstrated).
- Evaluate the successes and failures of this Initiative, and adjust accordingly to make this a signature program at NC State.

With support, in five years, this Initiative will be visible and pervasive across the campus, with fully engaged transdisciplinary teams working together with communities on funded, actionable research that will lead to long term solutions to the challenges of coastal resilience and sustainability in the best Land Grant tradition.