

# Sustainable Coastal Systems

*“Nearly all our present ecological problems arise from deep-seated social problems” Murray Bookchin*

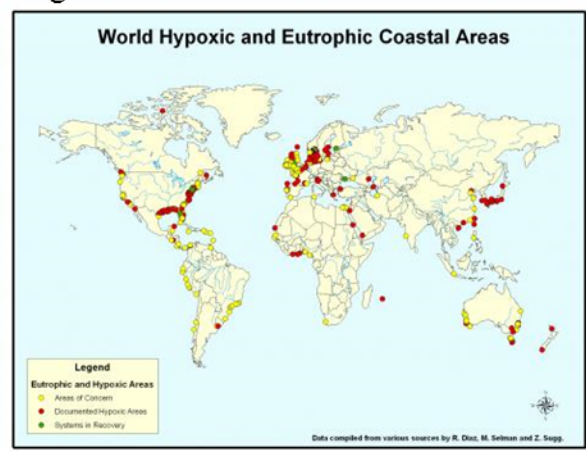
The vision for this proposal is to **create the preeminent interdisciplinary sustainable coastal systems program in the nation** by bringing together biologists, chemists, and engineers with anthropologists, sociologists, political scientists, planners, emergency managers, and economists to better integrate science and social needs into more effective environmental stewardship, environmental and hazard mitigation planning, and public policy development by linking the *ecological security of coastal ecosystems with the economic security of coastal communities*. In other words, we view the coastal zone as a single integrated ecological-social-economic system. The threats and challenges faced by Florida are the same as those faced by coastal communities around the world. The solutions, methodologies, and technologies we develop at UCF will have immediate application to other geographic locations and will give international visibility to UCF’s programs.

## Scientific and Social Problems Driving the Formation of this Cluster

Coastal regions are home to a large and growing proportion of the world's population and as a result are undergoing serious environmental decline (Figure 1). Today, approximately 3 billion people live within 100 miles of a coastline. Population growth, and associated activities, degrade coastal and marine ecosystems. As a result, 50% of the world's wetlands disappeared in the 20<sup>th</sup> century and nearly 60% of the world's coral reefs are seriously degraded or threatened by development and other human activities. Pollution from industry, agriculture, and urban areas is degrading the quality of much of the world's fresh water.

While coastal counties account for only 10% of the land mass of the continental United States, 39% of the nation's total population live in those counties where they generated 45% (\$7.1 trillion) of the country’s gross domestic product (GDP) in 2012. Given the intense concentration of infrastructure, economic production, and population along the coast, there is a growing need for focused research and policy development to maintain the integrity and quality of the natural resources that make these areas an essential part of our society.

Figure 1



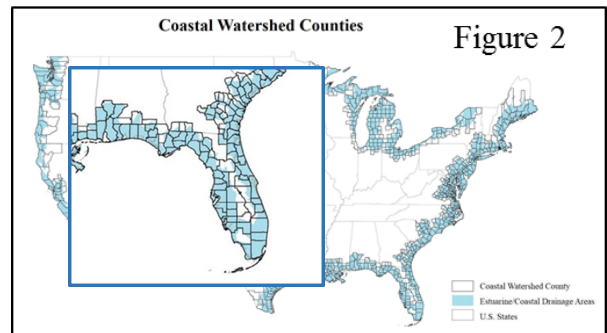
Since 2000, 16 hurricanes, 2 tropical storms, and 3 major flood events impacted U.S. coasts costing the nation \$420 billion and nearly 2,725 deaths. In the long term, the effects of climate change on these zones are potentially even more damaging to both the human and natural environment. Likely effects include fundamental threats to agriculture and fisheries; an increase in coastal population vulnerability to sea level rise, flooding and storm surge, migration of human populations affected by coastal issues, mass migration or extinction of species, invasive flora and fauna species, and emerging disease concerns. These issues will also affect other coastal areas worldwide, ultimately leading to concerns over human security.

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Numerous components of Florida's economy are based on the exceptional diversity and quality of the natural resources and recreational assets of the region. On a regular basis we hear about threats to these assets – climate change, sea level rise, invasive species, coastal development, emerging diseases, and others. In addition, the growth of major coastal cities (Tampa, Miami, and Jacksonville), rapidly developing port facilities and the associated cruise industry, and the burgeoning I-4 corridor, with Orlando as a defining urban hub, create challenges that are unique to Florida and that will require regional thinking and planning. The environmental, social, and economic future of Florida in the 21<sup>st</sup> century depends on the ability of science and technology to guide effective community planning, policy making, and natural resources stewardship.

In Florida, nearly 80% of residents live in coastal counties on land just a few feet above sea level. The coastal economy in Florida accounts for approximately 80% (\$563B) of the state's GDP. As population density and economic activity in the coastal zone increases, pressures on coastal ecosystems will also increase. These pressures, coupled with predicted sea level rise and other climate related changes, have pushed local governments, planners and emergency managers to take coastal ecosystem issues seriously. The Tampa area, Punta Gorda, Satellite Beach in Brevard County, and northeast Florida have all commissioned sea level rise studies. Four south Florida counties (Broward, Miami-Dade, Palm Beach, and Monroe) have adopted the Army Corps of Engineers' estimate of sea level rise as part of a "climate change compact" that describes the impact of sea level rise and how they may have to respond.

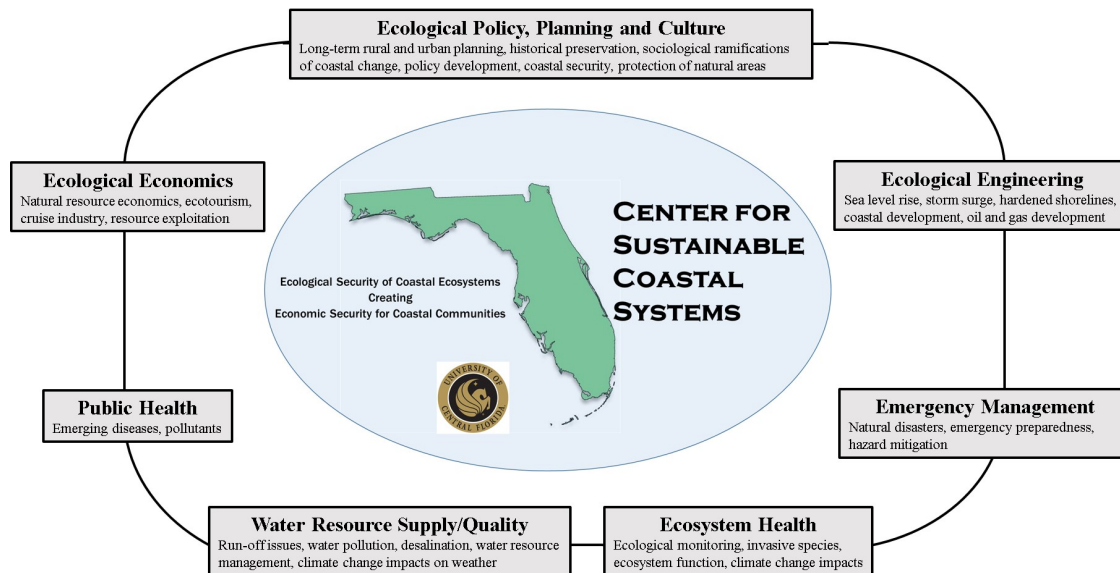
Statistics relating to coastal communities are based on political boundaries; however, "coastal systems" are more than simply the counties that contact the ocean. While no standard definition of what constitutes a coastal system exists, coastal systems are functionally defined as "areas encompassing the landward limit of marine influence and the seaward limit of terrestrial influence". This translates to regions up to 100 miles inland as well as similar distances offshore (Figure 2). Using this definition virtually all of Florida, including Orlando, is "coastal" (Figure 2 inset) and the State becomes a model for the rest of the country and coastal communities world-wide.



With increased anthropocentric and natural pressures in these economically productive and ecologically sensitive zones, we require an interdisciplinary, evidence-based, whole-community approach to increase the resiliency and sustainability of coastal communities. Building the capacity of these communities is a complex process as it requires balancing environmental, social, and man-made systems while mediating incentives and powers employed by multilevel governance and economic systems. Responsible management of Florida's exceptional coastal resource assets and ocean-based economy will depend on innovative scientific research that can be applied to ecosystem-based approaches to address complex environmental, economic and social problems. The ultimate goal of this cluster is to facilitate that development while ensuring the sustainability of Florida's coastal and ocean resources and economy for future generations. This program will be a permanent answer to an important responsibility that will affect generations of Floridians. **Florida's citizens should be able to count on UCF to be a leading scientific voice regarding the changes and vulnerabilities developing on its own coast.**

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**1) Cluster Leadership Plan:** The ultimate objective for this proposed cluster is the creation of a *Center for Sustainable Coastal Systems*. This initiative, being led by Professor Graham Worthy, Chair of Biology, unites multiple departments in the Colleges of Sciences, Engineering and Computer Science, Health and Public Affairs, and Business Administration. Clustering of core faculty, who are leaders in ecosystem health, ecological engineering, ecological economics, emergency management, and ecological security, will be transformative. New cluster faculty members will regularly meet with existing core faculty, representing all of the disciplines involved in the cluster, to share problems, interact and collaborate. Communication amongst members is critical and the cluster leader will be engaged in all activities to assure good understanding and to avoid losing information in the process. Ultimately it will be the role of the cluster leader and core faculty to integrate the disciplinarians currently within each department.



The formation of this cluster will transform thinking beyond disciplinary limits to focus research and teaching on new challenges for the coming century. These include understanding complex local, national, and international problems related to anthropogenic and natural changes in coastal systems. This cluster will also develop entirely novel programs in research and both undergraduate and graduate education. First generation interdisciplinary work comes from disciplinarians who recognize the need to converse across disciplines when they realize they cannot address the issue within their own discipline. Second generation work is problem-oriented and works around a complex set of research questions, acquiring the necessary methodologies to solve the problem. Our cluster will use both first and second generation interdisciplinary thinking by organizing interdisciplinarians around the problems of ecological and human security in complex coastal ecosystems. **The goal of this proposed effort is to create a broad-based research and development cluster at UCF that will integrate science and social needs to focus research and to train students in conservation and resource management.** These efforts will be forward looking and timely in the protection of Florida's environment and coastal economy, as well as having significant national and international consequence.

**2) How will this Cluster be unique and competitive?** We currently have successful, productive disciplinarians in multiple departments – many of whom have a history of collaboration with each other (Appendix 1.1). The strength of the current proposed research cluster will be the

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addition of a select group of interdisciplinarians who will act to focus the research activities of current core and associated faculty housed in traditional departmental settings and to act as a conduit for cross-fertilization of ideas, development of innovative and collaborative research, and the “translation” of science into policy and planning. Adding these core interdisciplinarians will result in a dramatic increase in our research capacity and productivity, as well as our ability to develop a robust diverse funding base.

This proposed cluster will position UCF as the premier institution in Florida integrating basic research and novel teaching to address coastal issues. The overall strategy is to create a visionary, entrepreneurial, and transdisciplinary research cluster at UCF that becomes a statewide and national model for how coastal states should address future environmental, social, and economic challenges and growth opportunities. The *Center* will strategically position the strengths of UCF to address and understand the future of coastal communities that must balance growth and conservation. The *Center* will also promote partnerships and collaborations with other major Florida research institutions as well as fostering research partnerships with private- and public-sector organizations, other UCF Centers, and the Florida Consortium of Metropolitan Universities.

Florida has a strong network of university and private research interests focused on ocean and coastal issues at local and regional scales (Table 1). These entities represent potential partners for research projects and collaborations. Despite their expertise, no other group has developed a national brand for academic excellence in truly interdisciplinary, long-term coastal systems research – specifically no other institution integrates the social sciences, economics, emergency management and planning, and policy development with life sciences, chemistry and engineering or has a plan for re-organizing these disciplines into problem-oriented expertise. The majority of our Florida institutions (Table 1) have strengths in biology, oceanography and/or coastal engineering but, with the possible exception of FAU, do not fully integrate other disciplines. There are a handful of institutions, outside of Florida, that to varying degrees approach our vision (e.g., School of the Coast and Environment, Louisiana State University; the Sustainability Institute,

Table 1		Departments With Coastal Emphasis										
Institution	Primary Center/College/Program	biology	coastal engineering	aquatic edumetry/toxicology	policy & law	anthropology	sociology	emerg. mgt.	rural/urban planning	resource economics	medicine	
<b>In-State</b>												
Florida Atlantic University	Harbor Branch Oceanographic Institute & Florida Center for Environmental Studies	X	X	X			X		X		X	
Florida A&M University	School of the Environment	X		X	X				X			
Florida Gulf Coast University	Coastal Watershed Institute	X			X		X					
Florida Institute of Technology	Indian River Lagoon Research Institute	X	X	X								
Florida International University	Marine Sciences Program	X	X	X								
Florida State University	FSU Coastal and Marine Lab	X		X								
University of Florida	Whitney Laboratory for Marine Bioscience & Engineering											
University of Florida	School of Sustainable Infrastructure and Environment	X	X	X							X	
University of Miami	Rosenstiel School of Marine and Atmospheric Science	X		X								
University of North Florida	Coastal Biology Flagship Program	X										
University of South Florida	College of Marine Sciences	X	X	X								
University of West Florida		X		X								
<b>National</b>												
Duke	Nicholas School of the Environment & Center for Sustainability and Commerce	X		X	X		X			X		
Louisiana State University	Louisiana Universities Marine Consortium/ School of the Coast and Environment	X	X	X				X	X		X	
Northeastern University	Urban Coastal Sustainability and Adaptation	X	X									
Texas A&M University	Institute for Sustainable Coastal Communities	X	X	X				X	X			
Texas A&M University - Corpus Christi	Harte Research Institute	X			X		X			X		
UNC Chapel Hill	Institute of Marine Sciences & Coastal Hazards Center	X	X		X			X	X		X	
UNC Wilmington	Center for Marine Sciences	X	X	X							X	
University of New Hampshire	Sustainability Research Collaboratory	X	X	X	X		X				X	
University of Rhode Island	Sustainable Coastal Communities and Ecosystems	X		X					X	X		
University of Southern Alabama	Dauphin Island Sea Lab	X		X								
University of Southern Mississippi	Gulf Coast Research Lab	X		X								
University of Texas	Marine Sciences Institute	X		X								

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University of New Hampshire; and the Institute of Marine Sciences and Coastal Hazards, UNC Chapel Hill) (Table 1), but no others fully achieve it.

What makes our proposed cluster unique – what differentiates it from these other existing institutions – is its interdisciplinary approach. The traditional silo structure of other institutions limits their creativity, flexibility, and nimbleness in their response to developing issues. The present proposal, if successful, will position UCF as a nationally recognized, centralized, integrative, and entrepreneurial institution focused on sustainability of coastal systems. This cluster will bring together scientists, educators, industry leaders, and communication experts representing academic institutions, government agencies, non-government organizations, private/public consortia, and corporations to form a solid intellectual foundation and ultimately sustain and grow the *Center*. The *Center* will conduct interdisciplinary research to develop scientific theories of coupled natural-social system interaction effects, test hypotheses, develop new approaches, and cultivate knowledge-transfer regarding coupled natural-human ecosystem processes and services in a complex, high biodiversity, human-dominated coastal landscape.

The *Center* will attract and retain high-quality graduate students by communicating a compelling interdisciplinary vision, providing high-quality experiential educational experiences, offering competitive fellowships/stipends, and integrating research with education. A national campaign will be initiated to attract and retain high quality undergraduate and graduate students with a strategic focus on students from underrepresented groups and people with disabilities, through organizations like the Association of Environmental Studies and Sciences, that harbor experts and students of all relevant stripes. Excellence, innovation, diversity leadership, teamwork and effective knowledge transfer will be core values infused into and across all levels of the program.

**3) Core and Associated Faculty:** Current core faculty include, in addition to the cluster leader, Betsy Von Holle (COS-Biology), Cherie Yestrebsky (COS-Chemistry), Dingbao Wang (CECS-Civil, Environmental & Construction Engineering), Peter Jacques (COS-Political Science), Sarah Barber (COS-Anthropology), Walter Milon (COBA-Economics), and Claire Knox (COHPA-Public Administration). These individuals have international prominence, a long history of collaboration, and the ability to integrate research, teaching, and critical thinking across multiple disciplines.

Associated faculty include individuals with expertise in **marine and coastal ecology** (COS-Biology: Kate Mansfield, Linda Walters, Lisa Chambers, Geoffrey Cook), **water resources under conditions of climate change and sea level rise** (COS-Biology: Reed Noss, John Weishampel; CECS-CECE: Kelly Kibler, Talea Mayo, Stephen Medeiros, Arvind Singh), **water quality** (CECS-CECE: Steven Duranceau; COS-Chemistry: Melanie Beazley, Andres Campiglia, Christian Clausen, Florencio Hernandez), **environmental sociology** (COS-Sociology: Hyung Park), **natural resource economics** (COBA-Economics: Mark Dickie, David Scrogin), and **emergency management and planning** (COHPA-Public Administration: Naim Kapucu, Christopher Hawkins). While not specifically coastally-oriented, it is anticipated that recent faculty hires in geospatial analysis will add to the strength of this cluster. Inclusion of these associated faculty gives the cluster the disciplinary depth of technical and intellectual expertise required to address the complex issues relating to sustainable coastal systems.

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**4) Short-term and Long-term Cluster Objectives:** **Short term objectives** are to 1) lead a world-class effort to understand ecosystem health and function with the concomitant ramifications for human health; 2) assess natural and human-related impacts to coastal ecosystem health, restoration, sustainability, and mitigation; and 3) characterize and integrate physical, chemical, biological, and socio-economic processes impacting coastal communities and ecosystems. **Long term objectives** are to 1) provide data and develop decision support models for planners, policy makers, and stake-holders to determine success of implementing coastal management and mitigation actions; and 2) train today's young scientists entering the workforce as science emissaries with interdisciplinary skills that can be applied beyond academia, ultimately resulting in outstanding career opportunities.

To achieve national and international prominence in this key program of graduate study and research, and to focus our research and teaching programs, we need to bring together a core group of five faculty (see Proposed Hiring Plan below) who work across traditional research boundaries or are working in transdisciplinary fields (e.g., ecological modeling, ecological engineering, ecological economics, historical and cultural ecology, political geography, environmental sociology, emergency management, and policy, planning, and security). Some of these disciplines (e.g., ecological modeling or ecological policy and planning) have been around for a while whereas others are less well known. Ecological engineering, which differs from environmental and water resources engineering, is an emerging discipline integrating ecology and engineering that explores “designing” sustainable ecosystems to integrate human society with its natural environment. Ecological economics is a transdisciplinary and interdisciplinary field that addresses the interdependence and coevolution of human economies and natural ecosystems over time and space. Historical ecology, modern human ecology, and archaeology are of great importance for modeling the long-term impacts of human action in coastal settings, as well as providing insight into small-scale and past sustainable practices that can be applied more broadly. A cultural anthropologist specializing in fisheries management, coastal tourism/ecotourism, coastal development, and/or sustainable subsistence in coastal contexts will bring a new dimension to understanding coastal systems.

## **5) Alignment between Cluster Objectives and Strategic Priorities**

**5.1 University Priorities:** This will expand the ability of UCF, "**America's partnership university**", to collaborate with a large number of historical and new partners, including federal, state, and local government agencies, for-profit corporations, indigenous groups, foreign governmental agencies, and non-profit and non-governmental organizations, as well as being a resource for coastal issues on a global scale. The creation of this cluster will also enhance the **international prominence of our undergraduate and graduate programs** – attracting high quality students to UCF. There is also enormous potential to build upon existing relationships to broaden international development and scholarly relationships with multiple countries throughout Latin America and Southeast Asia fitting the vision of the new Global Academy. Collectively, new hires within this cluster will position UCF as a **regional and national leader in sustainable coastal research** and as a major contributor to **support and enhance regional economic development**.

**5.2 College Priorities:** This cluster will enhance the ability of each of the Colleges to develop new undergraduate and graduate offerings as well as expand research capacity in an area of critical regional and national concern. College of Sciences (COS) and College of Engineering and

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Computer Science (CECS) have just completed searches for hires with joint appointments across College boundaries. Current cooperation between units will expand and lead to increased extramural funding for all units involved – because state and local governments and business leaders are increasingly aware of the interdependence between natural and social systems and the need for interdisciplinary research and outreach programs.

**5.3 Departmental Priorities:** The proposed hires fit with development priorities and collaborative interests of all of the member departments. Biology, Chemistry, and CECE are currently expanding their respective coastal research capacities, both in personnel and infrastructure, to build upon existing programmatic strengths and to enhance ties between departments. CECE has an outstanding program assessing potential impacts of sea level rise and storm surge. Biology has world-class conservation research programs in sea turtle biology, oyster ecology, and marine mammal ecology as well as being a leader in climate change research, sea level rise, and studies of invasive species. Political Science has a PhD program in national and international Security Studies, which includes human and environmental security. Economics has a history of national and state oriented research in coastal systems and offers both undergraduate and graduate courses in environmental and natural resource economics. Anthropology and Sociology are investing in current research strength and by bringing in new faculty with expertise in geospatial analysis and past environments whose competencies would support research on human-natural coastal systems.

**6) Evidence-based Impact and Assessment of Funding Potential:** Current faculty are respected and productive members of the coastal research community and UCF is an institutional member of the Florida Institute of Oceanography, Florida Sea Grant, Florida Climate Institute, and the Southeast Coastal Ocean Observing Regional Association, as well as being a charter member of two Cooperative Ecosystem Study Units operating within the State of Florida. UCF faculty have numerous long-term research collaborations and partnerships with regional universities and potential state and federal funding agencies (e.g., National Oceanic and Atmospheric Administration (NOAA), US Fish and Wildlife Service (USFWS), US Geological Survey (USGS), Department of Homeland Security (DHS), National Science Foundation (NSF), and Federal Emergency Management Agency) which support the strength of our existing traditional programs and we anticipate enhanced funding success from these and other agencies. Collectively, core and associated faculty have received over \$19M of external funding, over the past 5 years in coastal related research, with other grants pending (Appendix 1.1).

To address issues relating to coastal sustainability, competitive research teams need to apply broad interconnected areas of scholarship about both natural and human processes. Ultimately they need to examine biological and engineering issues but they also need to include key aspects of human processes. As an example, NSF has a group of programs that focus on *Science, Engineering and Education for Sustainability* (SEES). These include *Coastal SEES*, focused on the sustainability of coastal systems, and the *Dynamics of Coupled Natural and Human Systems* (CNH) program. The CNH program and similar interdisciplinary environmental science programs are likely to continue into the future, given their broad applicability to science and society. The proposed cluster will immediately place UCF into a national leadership position to compete for those and other federal funding initiatives, as well as significant monies derived from the RESTORE Act (BP Oil spill: **R**esource and **E**cosystems Sustainability, **T**ourist **O**pportunities, and **R**evived Economies of the Gulf Coast States Act), the Department of Homeland Security Centers of Excellence program, and potential new and/or expanded partnerships with industry (e.g., Port

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Canaveral, and the associated cruise industry, or coastal power plants). Existing external partnerships and relationships with federal and state agencies (e.g., NOAA, NASA, National Marine Fisheries Service, USFWS, National Park Service, USGS, Department of Defense, Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection, St John's River Water Management District) will be enhanced. With increased federal funding and a renewed focus on local implementation of hazard mitigation plans and projects in coastal ecosystems, this proposed cluster will also be able to work directly with agency leaders to provide recommendations for comprehensive land use plans, environmental monitoring, hazard mitigation plans, and coastal management plans.

There are several examples of research funding where this cluster will be very competitive. NSF-Coastal SEES and the NSF-CNH programs both fund projects of 3-5 years duration with total budgets in the range of \$800K to \$2M. RESTORE Act funds (derived from a \$15B endowment from BP oil spill penalties and fines) will be an obvious source of funding. These monies are to be used "for projects, programs, and activities that will improve the ecosystems or economy of the Gulf Coast region" and "carry out research, observation, and monitoring to support the long-term sustainability of the ecosystem, fish stocks, fish habitat, and the recreational, commercial, and charter fishing industry in the Gulf of Mexico". Additional monies related to the BP oil spill are available through the Gulf of Mexico Research Institute (\$500M), National Fish & Wildlife Foundation (\$2.5B), National Academy of Sciences (\$500M), Florida Institute of Oceanography (\$100M), and awards made through the Natural Resource Damage Assessment process (\$500M).

**7) Graduate and Undergraduate Curriculum:** The formation of this cluster will result in greater career opportunities and enhanced domestic and international prominence of both our undergraduate and graduate programs. It could result in the development of a new Professional Science Masters (PSM) in Sustainable Coastal Systems as well as strengthening existing graduate programs (e.g., MS in Biology, PSM in Conservation Biology, MA in Anthropology and Ph.D. programs in Conservation Biology, Security Studies, Environmental Engineering, and Environmental and Natural Resource Economics) (Appendix 1.2). Faculty associated with this proposed cluster will also diversify undergraduate course offerings in each of the participating departments, but specifically will add courses relevant to the BS in Interdisciplinary Studies (Environmental Studies) and BS in Biology (Marine Sciences concentration) (Appendix 1.2). Tremendous opportunities also exist in the development of regional needs training, specifically expanding current programs in emergency management planning and disaster response (COHPA – Undergraduate Minor in Emergency Management and Homeland Security; Graduate Certificate in Emergency Management and Homeland Security). Additionally, there is a growing demand for development of an undergraduate Certificate in Coastal Management. Coastal managers work in interdisciplinary teams in complex governance systems to effectively solve coastal area issues and many agencies require such training.

Interdisciplinary faculty are well suited to developing team-taught courses that cover multiple viewpoints on issues. The ability to integrate a range of perspectives into our courses will better prepare our future graduates to function in an increasingly interdisciplinary world. Overall, this cluster will help anticipate trends in coastal development patterns and issues thereby aligning future regional needs training efforts with the appropriate coastal impacts and societal needs.



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**8) Proposed Hiring Plan:** Candidates for these new positions will apply through a single job search ad that will be placed on appropriate interdisciplinary listservs, as well as through discipline-oriented advertising services. A single ad will invite applications from individuals who are active research leaders in the interdisciplinary fields of ecological modeling, ecosystem health, ecological engineering, ecological economics, ecological policy, coastal political geography, and coastal urban-regional planning. Applicants will select preferred tenure home and joint appointments will be made to link together matching interests. The search committee will be led by the cluster leader and be composed of the identified existing core faculty and relevant Department Chairs. Input and recommendations will be sought from prospective home departments throughout the process. Interviews will be undertaken in the potential home departments of each candidate utilizing the standard hiring process for that department. The core search committee will make recommendations to the cluster leader and, after consultation with appropriate Department Chairs, a list of qualified candidates will be presented to the Provost.

Once new faculty are in place, it is critically important to have a mentorship plan in place for junior faculty. Tenure-track faculty will be assigned a faculty mentor both from within their home department and from the senior membership of the cluster adopting the philosophy of the COS early-career mentoring program. Additionally, mid-career faculty will be offered mentorship by senior faculty to aid in their career development. Recognizing that core faculty, by definition, are interdisciplinary and may be working in areas that are outside the scope of traditional departments, each participating department commits to involving other core cluster faculty in order to properly assess the quality of scholarship for faculty during both annual and Promotion & Tenure evaluations. To help support the future success of this proposed cluster, all participating departments commit to distributing a portion of their share of IDC, generated by core cluster faculty, to be used to help fund initiatives for the overall cluster.

Recent joint faculty searches partnering Biology, Chemistry, and CECE, as well as historical collaborations between those departments and others such as Business and Biomedical Sciences, are representative of the readiness of these departments to embrace researchers outside of their discipline. Faculty in many of these participating departments have already collaborated on research and/or teaching and there is a solid foundation for future collaborations.

**9) Space Assignment Plan:** The research and teaching environment of this cluster will be enhanced if the offices of all of the new interdisciplinary hires and core faculty were co-located. Minimally, initial space that allows for the co-location of at least the new core faculty should be identified – potentially in the Biomolecular Sciences annex of Building 20 or in the Research Park. Ultimately co-location of all core faculty in the new Interdisciplinary Research Building, or similar space, would be preferred. The respective research labs of new hires will most appropriately be housed in their home departments. This facilitates better integration into their home faculty environment, communication and collaboration with other faculty/students, and allows for sharing of existing instrumentation and research facilities. Appropriate lab space is available in Biology (approx. 800 sq. ft. that will require renovations costing approximately \$300K) and CECE (confirmed with respective Chairs). This cluster will require a total of five faculty offices (with the seven existing core faculty and cluster leader remaining in their home departments until appropriate colocation space is available). In addition, office space for up to ten graduate students and proposed support staff would be desirable. If space limitations prevent cluster hires from being housed together, all participating departments commit to supplying adequate office and

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specialized lab space for the new hires and their students. Conference rooms in each of the participating departments could be used, on a rotating basis, for large group meetings unless adequate space is available in the vicinity of the cluster offices.

**10) Metrics of Success:** An annual report will be generated to enumerate quality/quantity of publications, number of invited presentations, graduate student productivity, grant proposal submission and success rates, and internal/external collaborations of core and associated faculty. These metrics will be compared against historical values for current faculty to track growth and success of the program. We predict an immediate increase in UCF's prominence in assessing coastal systems and, over the long term, will strive to get recognition of the cluster as both a state and federally recognized Center of Excellence. Once students begin matriculating from the associated undergraduate programs, we will track employment success rates and salaries, and use these hiring data to feed back to our curricula so we can be responsive to actual societal needs. We will also track graduate students who complete our programs to determine whether they are successful in post-degree employment and if they maintain an interdisciplinary approach in their work, as reflected by the nature of their collaborations, joint appointments in multiple departments, publishing of high-impact interdisciplinary papers, or obtaining grants with interdisciplinary themes.

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### Appendix 1:

#### 1.1 Prior & Current Funding Support and Scholarly Activities:

Associated and core faculty have received over \$19M in external funding in areas related to coastal systems over the past 5 years. These projects were funded by a wide variety of federal (e.g., NSF, NOAA, NASA, USFWS, USGS, NPS, EPA, USDA, USHHS, USDOE, RESTORE), State of Florida (e.g., Department of Health, Department of Environmental Protection, Fish and Wildlife Conservation Commission, Department of Transportation, Florida Space Institute, Florida Institute of Oceanography, Florida Sea Grant), and other agencies/organizations (e.g., IRL National Estuary Program, The Nature Conservancy, South Florida Water Management District, St. Johns River Water Management District, Kresge Foundation, National Geographic Society). As might be expected, the differential costs of doing research in different disciplines has been reflected in the total funding received by those departments. Over the past 5 years, participating and core Biology faculty received almost \$8M (Chambers, Cook, Mansfield, Noss, Von Holle, Walters, Worthy, and Weishampel), current CECE faculty received over \$3M (Duranceau, Kibler, Mayo, Medeiros, Singh, Wang), Chemistry faculty received \$1.5M (Beazley, Yestrebky), Public Administration faculty received \$5.3M (Kapucu, Knox), and Anthropology faculty received \$200K (Barber), while Business, Political Science, and Sociology faculty received minimal external support. The cluster will not only build on previous successfully funded projects, but will also build the capacity of other participating departments to generate and participate in funded research.

#### Selected major proposals currently funded or out for review:

- PIs: P. Jacques, J. Milon, L. Walters, D. Wang, M.O. Tatari, K. Kang, and A. Singh. Long-term coupled social and ecological drivers of estuarine health in coastal ecosystems. NSF – CNH program. \$1.5M pending
- PI: G.A.J. Worthy. Gulf Consortium for Cetacean Health and Abundance in Nearshore and Coastal Ecosystems (Gulf CHANCE). Gulf of Mexico Research Initiative. \$1.9M pending
- PI: G.A.J. Worthy. Habitat use, distribution and health of endangered West Indian manatees potentially affected by the Deepwater Horizon oil spill. Gulf of Mexico Research Initiative. \$372K pending
- PI: G.A.J. Worthy. Filling gaps and monitoring dolphin populations in the Florida Panhandle. FIO Centers of Excellence Research Grants Program. \$300K pending
- PIs: S. Hagen, J. Weishampel, L. Walters, D. DeLorme, D. Wang, and S. Medeiros. Integrated modeling for the assessment of ecological impacts of sea level rise. NOAA. \$2.4M active

#### Selected recent scholarly activities (current UCF faculty in bold):

- Carmichael, R.H., M. Graham, A. Aven, **G.A.J. Worthy** and S. Howden (2012) Were multiple stressors a ‘perfect storm’ for northern Gulf of Mexico bottlenose dolphins (*Tursiops truncatus*) in 2011? *PLoS ONE* 7(7):e41155.
- Chen, X., K. Alizad, **D. Wang** and S. C. Hagen (2014) Climate change impact on runoff and sediment loads to the Apalachicola River at seasonal and event scales. *Journal of Coastal Research* 68:35-42, DOI: 10.2112/SI68-005.1.
- Elie, M.R., **C. Clausen**, and **C.L. Yestrebky** (2014) Application of a magnesium/co-solvent system for the degradation of polycyclic aromatic hydrocarbons and their oxygenated derivatives in spiked soil. *Chemosphere* 117:793-800.

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- Huang, W., S.C. Hagen, P. Bacopoulos, and **D. Wang** (2015) Hydrodynamic modeling and analysis of sea-level rise impacts on salinity for oyster growth in Apalachicola Bay, Florida. *Estuarine, Coastal, and Shelf Science* 30:389-398.
- Hu, Q., **C.C. Knox** and **N. Kapucu** (2014). What have we learned since 9/11? A network study of the Boston Marathon Bombings Response and Recovery. *Public Administration Review* 74:698-712.
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Faculty from the Department of Biology have a long history of engagement in coastal conservation issues – regionally, nationally and globally – through involvement on federal and state panels, committees, and review boards as well as with their individual research into oysters (Walters), sea turtles (Ehrhart, Mansfield, Weishampel), marine mammals (Worthy), coastal wetlands (Chambers), and coastal fisheries (Cook). Our faculty combine state-of-the-art technologies and methodologies, along with solid field-work, to assess the ramifications of climate change (Von Holle), sea level rise (Noss, Weishampel), invasive species, anthropogenic disturbances, and coastal development on our native systems.

Participating water resources engineering faculty (CECE) have examined the ecological effects of sea level rise and climate change impacts in the northern Gulf of Mexico and the northeast coast of Florida. Through these funded projects and collaborations with faculty from FSU and UNF, various hydrologic and hydrodynamic models were developed and integrated for evaluating the responses of surface water and groundwater systems to climate change and sea level rise, and further assess the impact to the environment and ecological systems. The developed tools have been used for water management districts and local communities for water resources planning and decision making.

Participating faculty from the Department of Chemistry have focused on groundwater (Yestrebky, Clausen) and surface water contamination (Beazley, Campiglia, Hernandez) and remediation options using nanoscale and microscale reactive particles with liquid membranes for environmentally friendly alternatives to traditional approaches of water clean-up. Some of these

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projects have been demonstrated in coastal areas of Florida and all present cost-effective options for industry and government entities to be better stewards of Florida's environment. These projects have been funded through the NSF, NASA, EPA, and industry. Technologies developed from these projects have been used successfully for industry and government projects throughout the US.

Participating emergency management (Knox and Kapucu) and urban planning (Hawkins) faculty from the School of Public Administration have focused on analyzing and building public and nonprofit sector capacity for sustainability and disaster resiliency. Related research includes coastal restoration and mitigation plans and policies (Knox), sustainability planning and policies in local governments (Hawkins), and network governance in emergency management (Kapucu). Federally funded projects have not only produced highly cited publications, but also the design and implementation of capacity building tools in public and nonprofit sector organizations throughout central Florida.

### **1.2. Development of Undergraduate and Graduate Curricula:**

There is a critical need, throughout the United States, and in Florida in particular, for professionals who have a specialization in the field of coastal systems. These proposed curricular additions will provide trained and experienced professionals who will meet the modern practical and administrative challenges that face 'real world' practitioners and will set UCF at the forefront of training this next generation of professionals. UCF is uniquely positioned with a faculty that has the research expertise and practical experience to train these new students.

On annual basis, over \$200B is spent on environmental protection and conservation in the United States, and this figure will likely increase as the country responds to growing needs for clean water, clean air, renewable energy, and effective mitigation and adaptive responses to emerging human health issues, climate change, and sea level rise. In comparison, the U.S. biotechnology industry has annual revenues of approximately \$70B. Demand for individuals trained in the fields of human and environmental health, environmental science, coastal engineering, and conservation biology will be driven by national and global needs for clean water and environmental sustainability.

New faculty hires, associated with traditional departments, will develop new course offerings in their respective disciplines and team taught courses crossing over traditional discipline boundaries thereby adding to the breadth of offerings available to undergraduate students in the BS in Biology (Coastal Ecology/Marine Biology concentration), BS in Environmental Engineering, and the BS in Interdisciplinary Studies (Environmental Studies Track). These students will receive instruction and experience across a broad spectrum of STEM sciences, social sciences, business, planning, and humanities. Tremendous opportunities also exist in expanding current programs in emergency management planning and disaster response (COHPA – Undergraduate Minor in Emergency Management and Homeland Security or Graduate Certificate in Emergency Management and Homeland Security).

New interdisciplinary courses will add to the breadth of offerings available to students in the Ph.D. in Conservation Biology. Political Science is developing its new Ph.D. in Security Studies in which coastal security is an urgent and growing concern. Anthropology's planned Ph.D. program in Integrative Anthropological Sciences will examine dynamics of transformation in both modern and past societies, including the study of long-term social and ecological change in coastal environments. The popularity of the Environmental Planning track in the MS in Urban and

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Regional Planning has resulted in expanding the program to include three proposed new courses designed to focus on Florida's unique planning environment, including Water Management and Coastal Planning; these new hires could further diversify course offerings in this program. The PSM in Conservation Biology currently enrolls students in course offerings from the Departments of Biology, Economics, Public Administration, and Political Science and this degree program will benefit greatly from the expertise added through the proposed cluster.

There is potential for development of an undergraduate Certificate in Coastal Management. Similarly, potential exists for the development of a new PSM in Sustainable Coastal Systems under the auspices of Interdisciplinary Studies. Core coursework, and the internship component that would be the culminating experience for the degree program, would provide students with the focused and guided experience that help develop the analytical skills necessary to present research hypotheses, proposals, and data to meet their own research goals and those of current/future employers. This proposed PSM program would consist of 40 hours at the graduate level, including 16 hours of core courses drawn from one of the participating cluster departments; 10 credit hours of work experience internship, research analysis and reporting; and 14 hours of professional development, including courses in communications, mathematics, philosophy, public administration, and business management (drawn from other member departments). This program would be responsive to growing market needs for well-trained, experienced, and intellectually balanced graduates who can integrate knowledge from biology, economics, engineering, planning, political science, business management, sociology, and anthropology to develop effective common-sense solutions to the complex and dynamic challenges of our coastal systems.