



**North Carolina's
Marine Science and Education Partnership**

***Economic Impacts and Opportunities for
Marine Science Research and Education in
Carteret County, North Carolina
2004***

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***Economic Impacts and Opportunities for
Marine Science Research and Education in
Carteret County, North Carolina***

***Executive Summary
August 2004***

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Carteret County is renowned for its beaches, its boating and the abundance of other recreational opportunities along its coastline. The coastline and its creeks, rivers and rich biological diversity also have attracted one of the largest concentrations of marine science research and education organizations in the nation. Yet, because these organizations have rarely been considered as a group, the magnitude of their activities has been largely overlooked.

In 2003, several of these institutions and agencies, along with the Carteret County Economic Development Council (EDC), formed the Marine Science and Education Partnership (MSEP) to explore common interests and opportunities.

The EDC, on behalf of the Partnership, contracted with the University of North Carolina's Office of Economic Development (OED) to document the economic impact of Partnership members in Carteret County and vicinity. The contract also called for an inventory of the marine sciences infrastructure within these organizations that could support and enhance a cluster of businesses related to marine sciences, therefore stimulating private investment and creating jobs.

The work revealed that the collective capabilities of MSEP are remarkable both in scale and in breadth. As a result, MSEP members have a significant direct and indirect beneficial impact on the Carteret County economy, a fact that until now has gone unnoticed because of the disaggregated relationship among organizations. Moreover, the study indicates that MSEP members possess physical and human resources with potential for even greater economic benefits to Carteret County, if these resources were better known.

MSEP Resources and Scale

The marine science resource base in Carteret County can be most appreciated when the organizations are viewed as a group. The OED compiled individual financial and organizational asset information gathered from MSEP partners to present a comprehensive economic overview and assessment.

During 2003, MSEP membership collectively accounted for:

- total revenues of \$58 million, including \$32 million in public grants and contracts, \$21 million in government appropriations and \$5 million in other support

- total expenditures of \$28 million of which \$20 million was expended within Carteret County
- total full-time employment of 487 jobs – 401 based in Carteret County – and a total Carteret County payroll of \$17 million

If MSEP were a single entity, it would likely rank among the largest, most diverse, and most comprehensive of marine research complexes in the US.

The physical infrastructure of MSEP members includes both general and specialized research and development facilities accommodating a wide range of scientific investigations:

- 162,645 s.f. of marine research facilities, including more than 40 individual laboratories, several large flexible-use laboratories and numerous specialty facilities, including a seafood pilot plant, molecular biology laboratories, biotelemetry labs, analytical laboratories and marine biotechnology wet labs
- 117,000 s.f. of museum and aquarium facilities that hosted over 405,000 visitors annually in previous years. Both attractions are expanding, which will increase both their size and visitation.
- a research fleet for the conduct of coastal and off-shore investigations that includes four major research vessels and more than 40 smaller craft

MSEP research and technical personnel comprise a broad and diverse pool of expertise in a variety of disciplines, ranging from coastal environmental management and integrated marine conservation to aquatic food products, oceanography, marine biology, marine biomedicine and marine biotechnology. The MSEP research team includes:

- 62 faculty and non-faculty researchers
- 248 technical and professional staff
- 58 post-doctoral, graduate and undergraduate research assistants
- 119 administrative and support personnel

The depth and breadth of scientific and technical expertise within MSEP is reflected in the success of the Partnership's faculty and staff in securing competitive funding, and publishing their research results. During 2003, MSEP members:

- managed 133 supported research projects worth \$25 million
- submitted an additional 78 research proposals for \$14 million
- produced 136 publications and papers
- enrolled 218 full-time graduate and undergraduate students

MSEP Economic Impact

The activities of the MSEP partners account for a substantial contribution to the economy of Carteret County. OED reported the estimated **direct, indirect, and induced impacts** of the MSEP organizations using two software/data services, IMPLAN and REMI. The services use input-output models to capture economic activity effects resulting from the creation and operation of MSEP organizations. The implicit assumption is that the direct, indirect, and induced spending attributable to MSEP programs would not otherwise have occurred in their absence.

The Marine Science and Education Partnership contributes \$127 million and 3,162 jobs to the Carteret County economy

- “existing” effects refer to actual employment and expenditures by MSEP partners
- “direct” effects refer to the direct changes in local demand resulting from the location of MSEP organizations in Carteret County
- “indirect” effects are from rounds of spending by companies supplying goods and services to MSEP organizations
- “induced” effects are generated by MSEP workers who otherwise would not be in the labor force in the target region

OED quantified the activities and infrastructures for member organizations to assess the economic impact of MSEP. Financial and employment information solicited from MSEP members was compiled to provide the basis for establishing MSEP’s contribution to the economy of Carteret County.

This OED analysis found that MSEP’s combined estimated economic impact in Carteret County (Exhibit 1) accounted for:

- a total of 3,162 jobs -- nearly 1 out of 10 jobs in the county
- \$127 million in economic output within Carteret County -- more than 8 percent of the county economy

Exhibit 1: MSEP Total Impacts in Carteret County (8 orgs)*					
	Existing	Direct	Indirect	Induced	Total
Labor Income	\$16,686,950	\$33,067,952	\$4,477,087	\$6,470,073	\$60,702,062
Employment	401	2263	183	315	3,162
Output		\$93,954,917	\$13,766,594	\$19,181,636	126,903,147

“Cloisters to Cluster” – Capitalizing On MSEP Collaboration Opportunities

Individually, each of the MSEP organizations is engaged in significant activities serving its primary mission. As active citizens of Carteret County’s compact geographic area,

the leadership and staff of the respective institutions have long been aware of the function and capabilities of the other organizations.

Each of the individual MSEP organizations possesses significant resources relevant to economic development. Efficient collaboration, aided by the fact that these institutions are concentrated in a relatively small area, can effectively integrate those resources.

Collaborative relationships within the local marine science community have grown in number in recent years. This increasing interactivity, along with recent facility expansions and institutional additions, stimulated interest in capitalizing upon mutually beneficial inter-institutional synergies. OED discussions with MSEP leaders suggest several areas of potential collaboration for further elaboration:

- Inter-institutional research proposals: The multi-institutional nature of MSEP's infrastructure and research resources suggests that collaborations would enhance the competitiveness of research funding proposals. A number of such joint proposals have been undertaken over the years, and discussions with MSEP researchers suggest receptiveness to increasing the number of cooperative approaches.
- Personnel recruitment and retention: Continued attraction of high-quality researchers and staff is critical to the vitality of MSEP. Several administrators cited their use of the diverse marine science community in Carteret County as a significant asset in the recruitment of key personnel.
- Marine science meeting co-sponsorships: Numerous marine science meetings and conferences occur regionally, nationally and internationally. Proactive collaborative hosting of such meetings at MSEP institutions would enhance the region's profile in scientific and industrial markets, while providing additional economic development benefits to the County.
- Marine and coastal policy research, analysis and development: A noteworthy aspect of MSEP membership is the proximity and communication between marine research institutions and state/national marine and coastal regulatory organizations. Increasing development pressures on coastal environments and communities creates an impetus for MSEP initiatives in collaborative coastal management research and policy development efforts.
- Marine Animal Veterinary Medicine: The N. C. State University (NCSU) College of Veterinary Medicine, which has faculty stationed at NCSU's Center for Marine Sciences and Technology (CMAST), is nationally known for its expertise in marine animal medicine. The initial collaboration between the N.C. Aquarium at Pine Knoll Shores and the NCSU veterinary school could be further developed to take full advantage of the pending specimen expansion of the new aquarium facilities.
- Valued-added marine products: Successful past and current collaborations between MSEP organizations in areas such as oyster hybridization, shellfish/finfish aquaculture, seafood processing and marine organism extracts, suggest potential for expansion, particularly in direct interaction among MSEP partners and private industry and entrepreneurs.

- High-impact tourism: Well-established tourism assets could be enhanced through interaction with MSEP partners to augment existing attractions with educational programs in the environment, marine biology, wetland conservation and advanced diving expertise.
- Beach renourishment/preservation practices and technologies: This thriving area of commercial interest could provide numerous opportunities for MSEP expertise on coastal management, near shore geology and sonar imaging instrumentation.

Carteret's Marine Cluster Challenge

Having assessed its current status, the challenge before MSEP and the Economic Development Council is to capitalize on the economic development potential this study revealed.

To do so will require a sustained cluster-building strategy targeted to marine education and research enterprises. Such an effort will require a management stewardship group, whether a new or existing organization, to spearhead and oversee the initiative. This cluster management organization must deliver services to cluster members, and provide the glue that keeps the cluster together.

A key element for success is communication. Strong formal and informal communications linkages show participants how their bottom-line interests are served by the cluster. Connections within the organizations of the Marine Science and Education Partnership, and between MSEP, Carteret County and the rest of the world must be established and maintained.

The power of networks brings like-minded organizations together on projects that can inspire them and spawn new ideas. MSEP members already are discovering the synergies of having similar and complementary missions but different contacts, resources and information networks. When the various networks are networked, the principals save time, benefit from a greater range of knowledge and techniques, and stay focused on the enterprise at hand.

Following the example of other areas in organizing clusters, some specific ways MSEP could begin to turn its information-sharing roundtables into a focused cluster-building effort are:

- cataloguing the key components of the cluster, including existing private enterprises
- articulating an achievable vision of what the cluster can become over the next 10 to 20 years, and
- identifying specific opportunities for growing the cluster and realizing greater synergies

Some of the returns that marine sciences firms in the Carteret County area might see from participating in a cluster-focused effort include:

- finding new markets or suppliers through the many contacts of MSEP members
- working with the universities and Carteret Community College to shape training curricula to the workforce required
- learning from the university and federal labs about new technology applications or research findings that could increase productivity or profitability
- using the specialized facilities of MSEP partners for product or process testing and/or joint projects; and
- increasing their political power to affect policy and competitiveness

One appeal of a cluster approach is that the particular strategies and required benefits can be determined and tailored by the participating organizations, depending on their markets, capacities and interests. In a cluster where technology advances are rapid, the firms may easily see the benefit of combining their knowledge to compete in a changing market.

If Carteret County can support cluster strategies that provide tangible benefits to the bottom lines of local companies, the value of MSEP will be more readily appreciated.

The Future

It is apparent from this study that Carteret County has a wealth of marine science operations, holding promise for both the scientific community and the county economy.

Each MSEP institution has significant assets and conducts a variety of activities that can contribute to economic development in a multitude of

ways. By combining the advantage of geographic proximity with efficient collaboration, the Partnership can achieve an effective integration of its collective resources. The result could be additional meaningful benefits to the scientific community, and to the people of Carteret County.

Having assessed its current status, the challenge before MSEP and the Economic Development Council is to capitalize on the economic development potential this study revealed.

***Economic Impacts and Opportunities
for Marine Science Research and Education
in Carteret County, NC***

Introduction

Carteret County, located along North Carolina's Crystal Coast, is typically associated with tourism, commercial and recreational fishing. Less well known, outside the national community of marine science and education, is that the county is home to a concentration of marine science and education organizations that is remarkable in both its scale and diversity.

These organizations include, in the order of their establishment:

1. National Oceanic and Atmospheric Administration (NOAA) Center for Coastal Fisheries and Habitat Research
2. North Carolina Maritime Museum
3. North Carolina Division of Marine Fisheries
4. Duke University Marine Lab
5. University of North Carolina Institute of Marine Science
6. North Carolina Sea Grant
7. N.C. Department of Environment and Natural Resources (DENR) office of the NC Division of Coast Management
8. North Carolina Aquarium at Pine Knoll Shores
9. North Carolina State University's Center for Marine Sciences and Technology (CMAST)
10. Carteret Community College's Aquaculture Technology Program

Recognizing the potential of the county in Marine Science and Education, the ten organizations and the Carteret County Economic Development Council (EDC) formed the Marine Science and Education Partnership (MSEP) in 2003 with the following objectives:

- To coordinate the efforts of individuals and institutions involved in marine science and education in Carteret county
- To cooperate in the development and use of facilities to promote marine science and education in Carteret county
- To use science, technology, and education to enhance the climate for marine-related business and industry in Carteret county
- To promote public education regarding, and involvement in, issues of environment and development in coastal and marine areas

- To assist citizens and public and private sector institutions in efficient, effective planning and management of the natural resources of coastal and marine environments
- To educate the business community on economic and social impacts of the marine science and education community in Carteret county
- To promote the education of local, state, and national governmental officials regarding the joint accomplishments of the marine science and education efforts in Carteret county
- To promote the value of marine science and education to the citizens of North Carolina
- To provide environmental advisory services to business and industry

The EDC, on behalf of the consortium, contracted with the University of North Carolina's Office of Economic Development (OED) to: (1) document the baseline economic impact of the consortium of Marine Science research and education organizations in Carteret county and vicinity, and (2) inventory the infrastructure that those organizations have to support and enhance the cluster of marine sciences-related firms that create jobs and private investment.

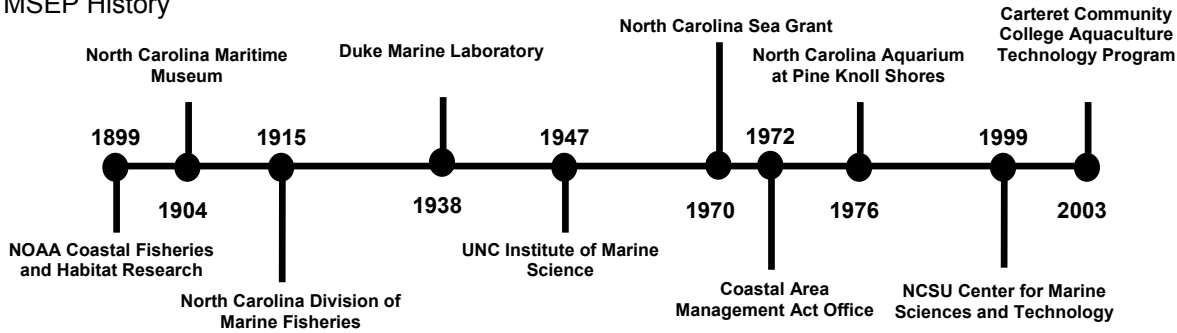
Over the course of several months, OED staff and researchers gathered and examined financial, operational and resource information on the organizations of the Marine Science and Education Partnership. This information was used to compile inventories of key resource offerings of the Partnership and to perform econometric modeling of the organizations individually and collectively to assess their economic impact.

This report presents the findings of this investigation in four sections. First, it presents an overview of the organizations that constitute the Partnership, reviewing briefly the history of their establishment and their missions. Second, it describes the scale of the Partnership's collective operations and characterizes the nature of its physical, scientific and intellectual resources. Third, it provides an analysis of the Partnership's economic impact within the economy of Carteret County. Fourth, it suggests areas of potential collaboration to achieve the stated objectives of the Partnership.

Section 1: *The Marine Science and Education Partnership - Three Centuries of Marine Science in Carteret County*

The diverse waters of Carteret County have attracted the attention of marine scientists for centuries. The first marine research field station was established in the county in 1860. Army surgeons stationed at Fort Macon catalogued the animal and marine life of the area and published their work in a series of articles in the 1870's. By the 1880's, professors and students from Johns Hopkins University were maintaining a field station in Beaufort and used the area as a summer teaching and research facility.

Exhibit 1
MSEP History



1. National Oceanic and Atmospheric Administration Center for Coastal Fisheries and Habitat Research (NOAA CCFHR)

The first of the Marine Science and Education Partnership members, the Center was founded in Carteret County in 1899 in a rented building in Beaufort, as the second oldest federal marine laboratory in the United States. The facility on Pivers Island was constructed in 1901 and research at this permanent site has continued since the summer of 1902.

The Center provides managers with information needed to understand and sustain coastal and marine resources. Sponsored by the National Oceanic and Atmospheric Administration (NOAA), the CCFHR conducts field and laboratory research on estuarine and ocean processes, habitat restoration, the dynamics of coastal and reef fishery resources, and the effects of human influences on resource productivity.

2. North Carolina Maritime Museum

The North Carolina Maritime Museum itself established its first public exhibit in 1904 at the U.S. Fisheries Laboratory – later the NOAA Center for Coastal Fisheries and Habitat Research - on Piver’s Island in Beaufort.

The North Carolina Maritime Museum documents, collects, preserves, and researches the maritime and natural history of coastal North Carolina. All of the museum’s programs and exhibits, both general and specialized, interpret the state’s cultural maritime history and offer a larger national perspective on coastal environment and barrier island ecology. The museum’s small craft research program preserves the history of boats and boat building in North Carolina. With an annual visitation of more than 180,000 people, the museum conducts more than 300 public programs each year, including field trips to coastal habitats, lectures, and workshops.

3. The North Carolina Division of Marine Fisheries (DMF)

While DMF can trace its roots back as early as 1822, when the North Carolina General Assembly enacted legislation to impose gear restrictions on oyster

harvest, it was in 1915 that it was first established as a commercial regulatory body. Today, DMF's mission is to maintain, preserve, protect and develop all of North Carolina's marine and estuarine resources. Today DMF is responsible for the stewardship of the state's marine and estuarine resources within all North Carolina coastal waters and to 3 miles offshore.

4. Duke University Marine Laboratory

Established in 1938, the Duke University Marine Laboratory was the first permanent academic research facility to locate in Carteret County. Today, the Marine Laboratory's mission is both education and research in basic ocean processes, coastal environmental management, marine biotechnology and marine biomedicine. The Lab provides educational, training, and research opportunities year-round to about 3,500 persons annually, including undergraduate, graduate and professional students enrolled in the university's academic programs; visiting student groups who use the laboratory's facilities; and scientists who come from North America and abroad to conduct their own research. The resident faculty represent the disciplines of oceanography, marine biology, marine biomedicine, marine biotechnology, and coastal marine policy and management.

5. UNC Institute of Marine Science

Carteret County's second marine academic research center, the University of North Carolina at Chapel Hill's Institute of Marine Science (IMS), was established in 1947. Located on 6.5 acres of waterfront property on Bogue Sound in Morehead City, the Institute's mission includes the conduct of both basic and applied Marine Science research. The Institute's resident faculty are committed to: (1) addressing important scientific questions related to the nature, use, development, protection, and enhancement of marine resources; (2) developing and applying technologically-advanced approaches to field, laboratory, and analytical problems; (3) communicating research results (and, where appropriate, new technologies) to both professional and public audiences; and, as time permits, (4) providing consultative assistance to government, business, and other groups to facilitate the application of new knowledge to practical problems. The Institute also provides students with opportunities for "hands on" field and laboratory experience by working with faculty on a wide range of research projects.

6. North Carolina Sea Grant

The North Carolina Sea Grant Program, established in 1970, is an inter-university effort of the University of North Carolina General Administration. Through several research, education and outreach programs, North Carolina Sea Grant works with individuals, groups, government agencies and businesses to develop an understanding of the state's coastal environment and promote the sustainable use of marine resources. Sea Grant's administrative headquarters are at North Carolina State University in Raleigh and its Carteret County offices are in Morehead City.

7. NC Division of Coastal Management office, N.C. Department of Environment and Natural Resources

The North Carolina Division of Coastal Management, part of the Department of Environment and Natural Resources, works to protect, conserve and manage North Carolina's coastal resources through an integrated program of planning, permitting, education and research. Established in 1972, the Division's NC Division of Coast Management offices in Morehead City is comprised of field representatives who are responsible for permitting and enforcement, as well as a planner who provides assistance to local governments developing land-use plans. The Division also collects and analyzes data for erosion rates, wetlands conservation and restoration, and to assess the impacts of coastal development.

8. North Carolina Aquarium at Pine Knoll Shores

The North Carolina Aquarium at Pine Knoll Shores is one of three aquaria established in 1976 to promote an awareness, understanding, appreciation, and conservation of the diverse natural and cultural resources associated with North Carolina's ocean, estuaries, rivers, streams, and other aquatic environments. The North Carolina Aquariums are a division of the North Carolina Department of Environment and Natural Resources. After years of planning, work began in 2003 on an expansion of the North Carolina Aquarium at Pine Knoll Shores from its original 29,000 square feet to 93,000 square feet. During the two years of construction, the Aquarium is operating out of temporary quarters at Atlantic Station Shopping Center in Atlantic Beach.

9. North Carolina State University Center for Marine Sciences and Technology (CMAST)

NC State University Center for Marine Sciences and Technology (CMAST). NCSU faculty and students have conducted research, education and extension activities in Carteret County since the 1960s. In 1968, the University of North Carolina authorized NC State University to offer a Ph.D. degree program in marine sciences. The NCSU Seafood Laboratory was established in 1970 and was housed in the NC Division of Marine Fisheries building from 1973-2000 when it moved to the CMAST facility. In 1997, the University of North Carolina approved establishment of the Center for Marine Sciences and Technology (CMAST). The Center includes faculty, staff and students from three Colleges and 17 departments at NC State University including scientists, educators and extension specialists. The CMAST facility, opened in August 2000, is a 51,000 sq.ft. research and education facility located on Bogue Sound on the west end of the Carteret Community College campus. It provides offices, meeting rooms and laboratory space for NC State University, NC Cooperative Extension Service, NC Sea Grant Program and Carteret Community College. Thus CMAST represents the first cooperative venture of this type in the state between a university, community college and federal and state agencies

10. Carteret Community College Aquaculture Technology Program

Beginning in 2003 Carteret Community College (CCC) launched its Aquaculture Technology Program that, in collaboration with Brunswick Community College, offers aquaculture lecture courses taught in person and via video conferencing in the "classroom of the future" in the CMAST facility on CCC's campus. The CCC Aquaculture Technology Program emphasizes both the science and enterprise management of mariculture (salt-water) species such as oysters, clams, soft-shell crabs, and marine finfish like catfish, yellow perch, and hybrid striped bass. CCC is completing development of a state of the art saltwater aquaculture training, demonstration, and research facility in 2004. Local area shellfish operations provide on the job training for our students through apprenticeships and cooperative education classes.

MSEP's Complementary Diversity

The first step in assessing the economic impact of the Marine Science and Education Partnership was to characterize the major activities in which the members are involved, collectively and individually. As represented in Exhibit 2, the members of the MSEP represent a diversity of functions ranging from basic scientific research to government regulation. Each organization has its own separate and distinctive mission and serves its own targeted constituency. Nonetheless, each occupies a position on the continuum of marine and coastal activities that intercepts one or more of the roles of its fellow MSEP members.

Common to some degree to all ten organizations are numerous differentiated but interconnected activities:

- basic and applied research
- planning and resource management
- policy and regulation
- tourism development
- formal post-secondary education
- professional development training
- public education
- management and entrepreneurship training for scientists
- advisory services

Exhibit 2

Capabilities of the Marine Science and Education Partnership

Focus areas:	UNC Institute of Marine Science	Duke University Marine Lab	NCSU Center for Marine Science and Technology	NOAA Center for Coastal Fisheries and Habitat Research	NC Division of Marine Fisheries	NC Sea Grant	DENR CAMA offices	NC Aquarium at PKS	NC Maritime Museum	Carteret Community College Aquaculture Program
Research										
Planning and resource management										
Policy and regulation										
Tourism development										
Formal post-secondary education										
Professional development training										
Public education										
Management training for scientists										
Advisory services										

Of these, research (as a source of innovations with commercial value), formal education and professional development training (including aquaculture entrepreneurs), and tourism development have the greatest direct impact on economic growth in the marine science cluster. The public education, planning and resource management activities are important to the sustainability of the ocean and the other marine resources that the university, citizens, federal labs and private enterprises use. The regulatory agencies can be an important resource for companies in permitting and compliance.

Section 2: The Marine Science and Education Partnership – MSEP Resources and Scale

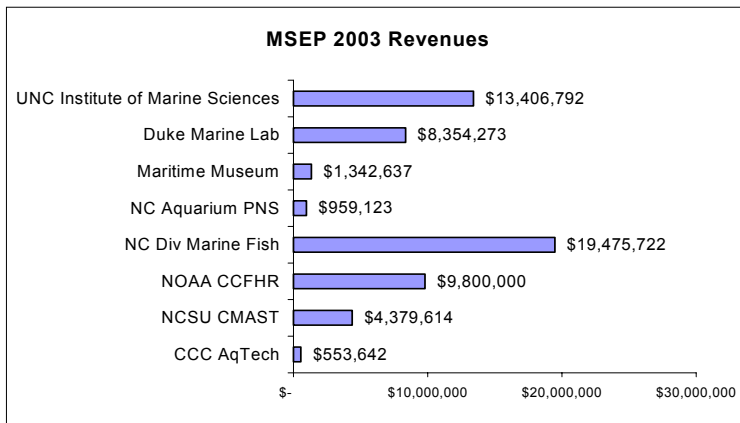
To appreciate the scale of the marine science resources in Carteret County it is helpful to view them collectively. Toward that end, OED gathered individual financial and organizational asset information on the Marine Science and Education Partnership organizational partners, and then compiled those data to present a comprehensive picture.

Operational Scale

During 2003 the MSEP membership collectively accounted for:

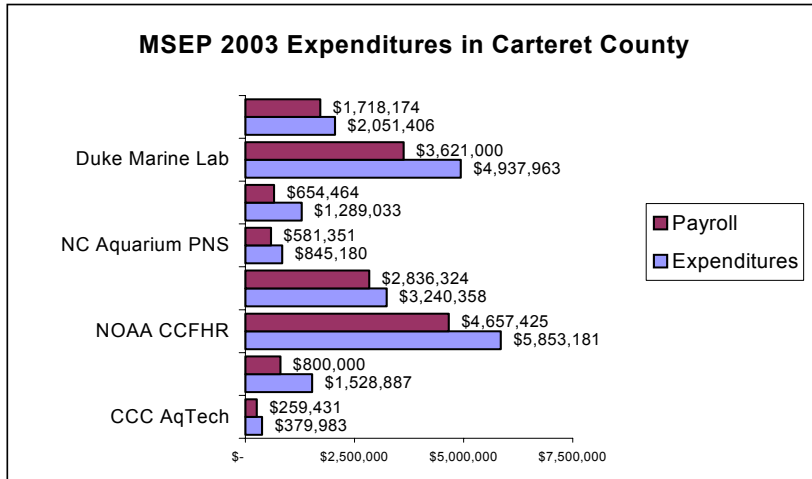
Revenues

- total MSEP revenues of \$58 million, including \$32 million in public grants and contracts and \$21 million in government appropriations
- revenues varied from \$20 million for the NC Division of Marine Fisheries to \$553,642 for Carteret Community College’s Aquaculture Technology program



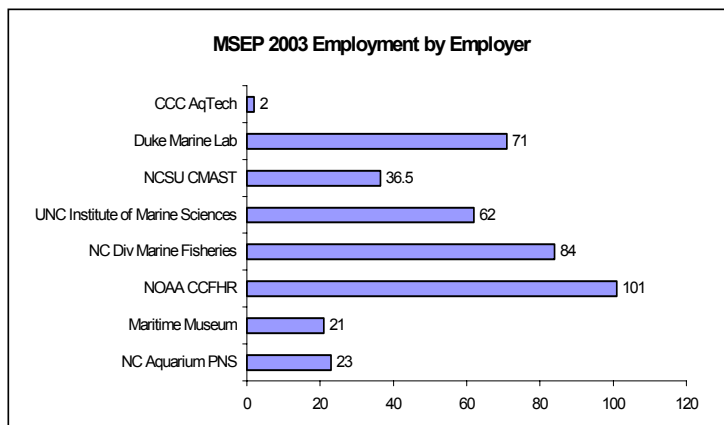
Expenditures

- total MSEP expenditures of \$28 million, of which \$20 million was expended in Carteret County
- of the \$20 million in MSEP expenditures in Carteret County, \$17 million (75%) was direct payroll costs



Employment

- total full-time employment of 487 jobs, of which 401 (82%) were based in Carteret County
- NOAA Center for Coastal Fisheries and Habitat Research was the largest employer (101)



Physical Assets

The physical infrastructure of the MSEP members spans a range of assets enabling a diverse range of marine and coastal science research:

Environmental Setting

While not conventionally considered an element of physical infrastructure, for the activities of the MSEP members, the geographic setting of their location is the perhaps the most important, and most distinctive, physical asset. This proximity to a marine environment that expresses much of the ecological diversity of the east coast of the U.S. is also the reason these institutions were located in Carteret County

The MSEP is located in North Carolina's central coastal region, a region rich in estuarine and wetland habitats. The nearby Albemarle-Pamlico Sound is the second largest estuary in the United States, comprising a watershed of approximately 30,000 square miles and encompassing over 9,000 miles of freshwater rivers and streams and over 1.5 million acres of brackish, estuarine waters. The area's system of barrier islands, sounds, and estuaries is rich in flora and fauna, and diverse habitats, including rivers, creeks, mud flats, unspoiled sand beaches, dunes, marshes, peat bogs, cypress swamps, bird islands, and coastal forests.

The MSEP's location is within the range of many species of both temperate and tropical biota. The edge of the Gulf Stream is located approximately 30 miles offshore, with reefs providing habitat for tropical species on the wide continental shelf. Moreover, the protected natural areas of Cape Lookout National Seashore Park and the Rachel Carson Estuarine Research Reserve are within easy boating distance. As one long-time researcher stated, "Coastal North Carolina is the world's biggest wet lab" - an excellent location for the pursuit of a diverse range of marine science research.

Research and development facilities

Among the numerous buildings, shops, offices and storage spaces that constitute the total physical infrastructure of the MSEP members are general and specialized research and development facilities accommodating a diverse range of scientific investigations. MSEP members reported that during 2003 they collectively managed 162,645 square feet of research and development facilities, including:

Laboratories

- More than 40 individual faculty laboratories and several large flexible-use laboratories supplied with running seawater systems
- numerous specialty facilities including molecular biology laboratories, bio-telemetry labs, analytical laboratories, food science laboratories, and marine biotechnology wet labs
- fisheries and marine organism facilities for specimen collection, preservation and identification

- aquaculture, and larval fish rearing laboratories

Special Use Facilities

- environmental chambers
- advanced diving facilities
- pilot seafood processing laboratories and test kitchen
- outdoor ponds with seawater habitats for controlled experiments

Research Vessels

A distinctive and indispensable category of physical assets for marine research is ships and boats for the conduct of near and off-shore investigations. The breadth of marine research conducted by MSEP is well supported by a diverse array of vessels. Collectively, the Partnership's research "fleet" is comprised of 4 major coastal and research vessels and 40+ mid-size power craft, including:

- the *R.V. Cape Hatteras*, a 135-ft. oceanographic ship operated for the National Science Foundation by the Duke/UNC Oceanographic Consortium
- the *R.V. Susan Hudson*, a 57-foot coastal oceans research vessel
- the *R.V. Capricorn*, a 47-ft. coastal vessel
- the *S.F. Hildebrand*, a 41 ft. coastal research Vessel, and
- more than 40 small craft ranging in length from 13 to 27 feet

Information and Communications Infrastructure

The ability of MSEP members to conduct research and offer educational field and course work – especially on a collaborative basis – is facilitated by the abundant information and communication resources available within the Partnership.

Information Technology:

- NC State University provides broadband high-speed internet access as part of the NC Research and Education Network (NCREN) to CMAST, Carteret Community College and UNC Institute of Marine Sciences. The DS-3 circuit supports a distance-learning classroom and video-teleconferencing capability with connections through MCNC and the North Carolina Information Highway to university, community colleges and county offices across the state
- the UNC Institute of Marine Science houses a computer room with network connections to university and regional computing facilities, as well a televideo classroom with an IH Down Link (located at Carteret Community College), and a fiber optics connection with CMAST

- the Duke University Marine Laboratory is equipped with a high-speed network connection for sharing of computer facilities between the Beaufort and Durham campuses, as well as fast Internet access public access cluster, with MACs and IBM-PCs.
- NOAA's Center for Coastal Fisheries and Habitat Research houses a network of 8 servers and 122 workstations offering high speed internet access and video conferencing facilities.

Libraries:

- the NOAA Center for Coastal Fisheries and Habitat Research's Rice Library has a collection of 17,000 volumes and 150 journal subscriptions in the area of fisheries, oceanography, coastal habitats, restoration, remote sensing, marine ecology, marine chemistry, toxicology, pollution and contaminants, land and resource use, invasive species, and protected species. The library contains extensive collection of rare volumes.
- the NCSU CMAST offers "virtual library" access and printed copy delivery over the web.
- the UNC Institute's Marine Science Library has a collection of over 1,000 books, 300 journals, and 25,000 reprints is strong in ichthyology, carcinology, malacology, ecology, mycology, biological oceanography, sedimentology, and microbiology
- the Duke Marine Lab's Pearse Memorial Library is comprised of over 23,000 volumes and 60 scientific journal subscriptions with a concentration in the marine sciences
- cooperative agreements for interlibrary loan and document deliver service have also been established among North Carolina State University, the NOAA Center for Coastal Fisheries and Habitat Research, the Duke University Nicholas School of the Environment Marine Laboratory, UNC Chapel Hill Institute of Marine Science, UNC at Wilmington, and East Carolina University

Public Education

A common element of each MSEP members' mission is the communication of information to the public on marine science and coastal resource issues. The accomplishment of this purpose can be aided by the use of the extensive public education facilities capabilities in place in Carteret County. Collectively, the MSEP members manage 117,000 s.f. of museum and aquarium facilities that host over 400,000 visitors annually. Numerous examples of collaboration among the Partnership in public education demonstrate the viability of these mechanisms. These facilities and activities include:

Public Education Facilities

- The North Carolina Aquarium at Pine Knoll Shores is located within the 295-acre Roosevelt Natural Area. This land was deeded to the State by the Roosevelt family and contains one of the largest remaining tracts of maritime forest on the east coast. This resource, which includes two wonderful nature trails, pristine salt marshes, swamp forests, and immediate access to Bogue Sound, is a significant physical asset for the aquarium's educational programs and visiting public.
- The Aquarium closed to the public on December 31, 2003 to begin construction on a \$25 million renovation and expansion. The construction will triple the size of the building, from 30,000 square feet to 93,000 square feet. Of the total space in the renovated aquarium, approximately 60% will be public area, containing a 306,000-gallon ocean tank and a 50,000-gallon tank, educational exhibits, two classrooms, a "discovery" classroom, a 150-seat auditorium, a 2400 sq. ft. gift shop, three sets of public restrooms, and associated gallery and public spaces.
- The North Carolina Maritime Museum's Carteret County operations include the museum headquarters, an 18,000-square-foot building offering educational exhibits interpreting North Carolina's coastal natural history, as well as commercial and sport fishing history.
- The Maritime Museum's 6,000-square-foot Harvey W. Smith Watercraft Center, on the Beaufort waterfront across from the museum, is a site where conservation, preservation, construction, and the restoration of wooden boats takes place.

Public Education Activities

- The North Carolina Aquarium at Pine Knoll Shores routinely offers public canoe trips, marsh explorations, dredge and trawl trips, river excursions, and trips to the Cape Lookout National Seashore. Activities introduce students to information about marine life, developed for grades 6 through 12 with an emphasis on making studies interdisciplinary. Some activities focus on math and science skills while others focus on the arts and the students' imaginations. All activities have been correlated to the North Carolina Standard Course of Study so that teachers and other educators can easily find activities to enhance their lessons.
- The Maritime Museum conducts more than 300 public programs each year, including field trips to coastal habitats, lectures, and workshops. Programs include staff-led field trips to a variety of coastal habitats, marine-life collecting cruises, fossil hunting, canoe trips, and coastal bird and plant trips. Its Watercraft Center offers evening and weekend classes in boatbuilding, model building, and half-model construction and its Summer Science for School for Children program, designed for students entering grades one through 10, introduces students to the natural environments and maritime history of coastal North Carolina.

- NC Sea Grant offers numerous programs targeted at an “Informed Citizenry”, developing life-long learning experiences through public lectures, museum and aquarium programs, clubs and organizations. It also supports pre-college education in coastal topics for K-12 students and teachers with marine and coastal education formats that meet state and federal education standards.

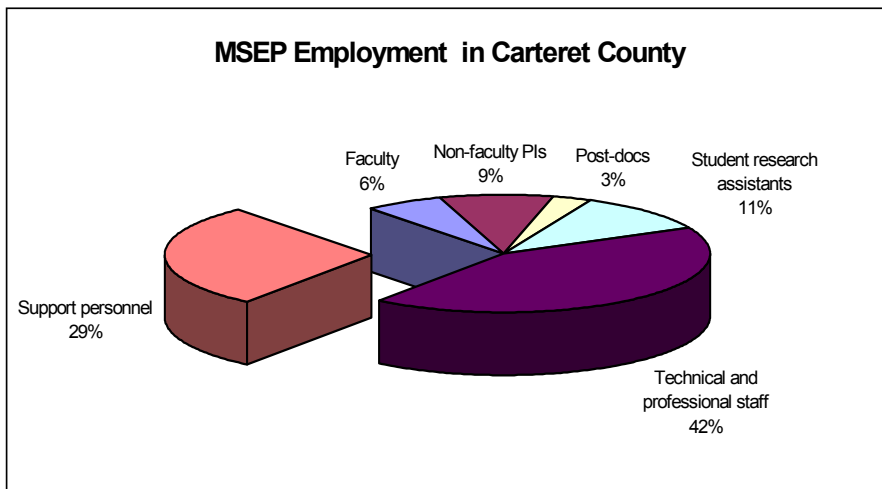
Human Resource Assets

Research and technical personnel make up 71% of all MSEP employees; encompassing a broad and diverse pool of research and education personnel in disciplines ranging from coastal environmental management and integrated marine conservation to oceanography, marine biology, marine biomedicine and marine biotechnology.

Research and Technical Personnel

Collectively, the MSEP research and technical “team” includes:

- 62 faculty and non-faculty researchers
- 248 technical and professional staff
- 58 post doctoral, graduate and undergraduate research assistants
- 119 administrative and support personnel



Expertise Areas

Like the sounds and waterways of the North Carolina coast itself, the expertise of MSEP personnel is broad, diverse and fertile. They represent a broad range of expertise in the coastal and marine sciences, as well as in development policy, regulations, and resource management, including:

- environmental toxicology and marine biochemistry
- water quality and contaminants testing
- ocean floor imaging and mapping
- marine and estuarine biology and ecology
- fisheries ecology and management
- marine biotechnology
- coastal marine policy and management.
- marine earth and atmospheric sciences
- advanced technologies and models in marine meteorology
- satellite oceanography
- coastal geophysical dynamics and computer visualization
- marine biotelemetry
- estuarine plume, inlet and barrier island dynamics
- mariculture and aquaculture, and enhancement of shellfish and finfish stocks
- seafood science, processing and packaging
- marine veterinary and veterinary medicine, pathology, and epidemiology and toxicology
- coastal and marine engineering and mineralogy
- marine and fisheries habitat protection and remediation
- growth, and reproduction of living marine resources
- wetlands conservation and restoration
- coastal development impact assessment
- marine archaeology

Activities and Outcomes

The depth and breadth of scientific and technical expertise within the MSEP is reflected in the success of the Partnership's faculty and staff in securing competitive funding and publications. During 2003, MSEP members:

- managed 133 supported research projects representing \$25 million in awarded funds
- submitted an additional 78 research proposals for \$14 million
- produced 136 publications and papers
- enrolled 218 full-time graduate and undergraduate students in 6 degree programs

Section 3: The Marine Science and Education Partnership – Economic Impact

To assess the economic impact of the MSEP, OED quantified the scale of the member organizations' activities and infrastructures. Finance and employment information solicited from eight of the ten MSEP members was compiled to produce data for establishing MSEP's contribution to the economy of Carteret County. Data were not obtained from the North Carolina Division of Coastal Management or North Carolina Sea Grant, therefore their economic impacts in Carteret County were not captured. However, their data may be incorporated into the OED report in the future.

OED calculated the estimated direct, indirect, and induced impacts of the MSEP organizations using two software/data services - IMPLAN and REMI – that use input-output models that captured economic activity effects resulting from the creation and operation of the MSEP organizations in Carteret County. The implicit assumption is that the direct, indirect, and induced spending attributable to the MSEP programs would not otherwise have occurred in the absence of those programs.

The activities of the MSEP partners were found to account for a substantial contribution to the economies of Carteret County. The effects described by these models include:

- “existing” effects refer to actual employment and expenditures by the MSEP partners
- “direct” effects refer to the direct changes in local demand resulting from the location of the MSEP organizations in Carteret County
- “indirect” effects are from rounds of spending by the companies that supply goods and services to the MSEP organizations
- “induced” effects are generated by MSEP workers who otherwise would not be in the labor force in the target region

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Economic Inputs

The IMPLAN and REMI models were based on the following information about the MSEP organizations:

- Their total revenue from sources outside the county was nearly \$59 million in 2003, including about \$32 million in public grants and contracts and \$21 million in government appropriations.

- The organizations' total expenditures are \$28 million, of about \$19.5 million was expended directly in Carteret County
- The MSEP organizations together employ 487 full-time equivalent staff, of whom 401 are based specifically in Carteret County, and a total Carteret County payroll of \$17 million.
- The 401 Carteret County employees consisted of 60 faculty and other principal investigators, 170 technical and professional staff, 115 support personnel, 12 post-doctoral researchers, and 44 graduate or undergraduate student research assistants, representing a broad range of job levels
- Over 405,000 visitors annually come to the attractions offered by the marine science partners, primarily the Aquarium and the Maritime Museum.

Economic Impact Findings

This OED analysis found that collectively the MSEP's estimated economic impact in Carteret County (Exhibit 3) accounted for:

- \$127 million in economic output within Carteret County
- a total of 3,163 jobs within Carteret County

Exhibit 3: MSEP Total Impacts in Carteret County (8 orgs)*					
	Existing	Direct	Indirect	Induced	Total
Labor Income	\$16,686,950	\$33,067,952	\$4,477,087	\$6,470,073	\$60,702,062
Employment	401	2263	183	315	3,163
Output		\$ 93,954,917	\$13,766,594	\$19,181,636	\$126,903,147

Impact Significance

The calculation of \$127 million in annual economic output and 3,163 in employment impact generated by MSEP organizations is an aggregation of *existing, direct, indirect and induced* impacts incurred only within Carteret County. These impacts are very significant contributors to the Carteret County economy, representing (Exhibit 4) nearly 4.2% of the county's personal income and more than 9.7% of county employment.

	Total in Carteret County, 2001	Amount Induced by Marine Science Industry	Percent
Personal Income (1)	1,448,429,000	\$60,702,062	4.19%
Jobs (2)	32,461	3,163	9.74%

(2): Carteret County 2001 Employment Source: www.rich.frb.org/research/regional/profiles/north_carolina/employment/total_employment.cfm

(1): Data provided from Implan Pro 2.0 Regional Analysis Data, Model Constructed by Office of Economic Development

Exhibit 5 delineates the MSEP's economic impacts by organization. The NC Aquarium alone accounts for over 5 percent of all jobs in the county. The Maritime Museum accounts for 2.75 percent of the total. Those organizations have the largest impacts because they attract tourists from outside the region whose spending generates jobs, income, and output in the services sectors.

Establishment	Labor Income	Percent of Total	Output	Percent of Total	Employees	Percent of Total	Percent of County
CCC AqTech	\$ 1,108,474	1.8%	\$ 2,640,605	2.1%	50	1.6%	0.16%
NCSU CMAST	\$ 1,517,942	2.5%	\$ 2,613,783	2.1%	67	2.1%	0.21%
NOAA CCFHR	\$ 6,242,549	10.3%	\$ 7,533,658	6.0%	168	5.3%	0.52%
NC Div Marine Fish	\$ 3,254,965	5.4%	\$ 241,151	0.2%	86	2.7%	0.26%
NC Aquarium PNS	\$ 27,256,039	44.9%	\$ 67,954,841	53.8%	1,724	54.5%	5.31%
Maritime Museum	\$ 14,215,498	23.4%	\$ 34,125,792	27.0%	893	28.2%	2.75%
Duke Marine Lab	\$ 4,584,767	7.6%	\$ 7,979,864	6.3%	79	2.5%	0.24%
UNC Marine Science	\$ 2,521,828	4.2%	\$ 3,253,475	2.6%	95	3.0%	0.29%
Total:	\$60,702,062		\$ 126,903,147		3,163		9.7%

Concentration of Impact

It is important to note that while the organizations that constitute the membership of MSEP have missions – statewide, nationally and internationally - that extend well beyond the bounds of Carteret County, the vast majority of economic impacts generated by their operations accrue to the economy of Carteret County. 90% of the total labor income impact, 96% of the total employment impact, and 97% of the total output impact accrue specifically within the county.

Exhibit 6: % of Total Impacts by MSEP Organization in Carteret County		
	Within Carteret County	% of Total
Labor Income	\$60,702,062	90%
Employment	3,163	96%
Output	\$126,903,147	97%

Section 4: “Cloisters to Cluster” – Capitalizing On MSEP Collaboration Opportunities

Individually each of the MSEP organizations is engaged in significant activities within their primary missions. As active citizens of the compact geographic area of Carteret County in which they are co-located, the leadership and staff of the respective institutions have long been aware of each others’ function and capabilities.

Each of the individual MSEP institutions possesses significant resources relevant to economic development. By combining the advantage of geographic proximity with efficient collaboration, the Partnership can achieve a more effective integration of their collective resources.

Recent years have seen an increase in the number of collaborative relationships with the Carteret County marine science community. This increasing interactivity, along with recent marine facility expansions and institutional additions, stimulated interest in capitalizing upon mutually beneficial inter-institutional synergies. OED discussions with MSEP leaders suggest several areas of potential mutually beneficial collaboration for further elaboration:

- Inter-institutional research proposals: The disaggregated nature of the MSEP’s infrastructure and research resources suggests that collaborations would enhance the competitiveness of research funding proposals. A few such joint proposals have been undertaken in recent years and discussions with MSEP researchers suggest increasing receptiveness.
- Personnel recruitment and retention: Continued attraction of high quality researchers and staff is critical to the vitality of the MSEP. Several administrators cited their use of the diverse marine science community in Carteret County as a significance asset in the recruitment of key personnel.
- Marine science meeting co-sponsorships: Numerous marine science meetings and conferences occur regionally, nationally and internationally. Proactive collaborative hosting of such meetings at MSEP institutions would enhance the region’s profile in scientific and industrial markets, while providing additional economic development benefits to the County.
- Marine and coastal policy research, analysis and development: A noteworthy aspect of the MSEP membership is the proximity and communication between marine research institutions and state/national marine and coastal regulatory organizations. Increasing development pressures on coastal environments and communities creates an impetus for MSEP initiatives in collaborative coastal management research and policy development efforts.
- Marine Animal Veterinary Science: A preliminary collaboration between the North Carolina Aquarium at Pine Knoll Shores and North Carolina State University’s School of Veterinary Medicine’s nationally renowned

expertise in marine animal veterinary sciences could be built upon to take full advantage of the pending specimen expansion of the new aquarium facilities.

- Valued-added marine products: Several past and current collaborations between MSEP organizations - such as those undertaken in oyster hybridization, shellfish/finfish aquaculture, seafood processing and marine organism extracts - suggest potential for expansion, especially in direct interaction among MSEP partners and private industry and entrepreneurial participants.
- High impact tourism: Well established tourism assets could be enhanced through interaction with MSEP partners to augment existing attractions with educational programs in environment, marine biology, wetland conservation and sport diving expertise and facilities.
- Beach renourishment/preservation practices and technologies: This thriving area of commercial interest could provide numerous opportunities for fusion of MSEP expertise on coastal management, near shore geology, and sonar imaging instrumentation.

Carteret's Marine Cluster Challenge

Capitalizing on the economic development potential of Carteret County's marine science and education resources will require a sustained and targeted marine industry cluster-building strategy. Such an effort requires a management stewardship group, whether a new or existing organization, to spearhead and oversee the initiative. This "cluster management organization" must deliver services to cluster members and provide the glue that keeps the cluster together.

Strong formal and informal communication linkages show participants how their bottom-line interests are served by the cluster. Connections within the organizations of the Marine Science and Education Partnership, and between the MSEP, Carteret County and the rest of the world must be established and maintained.

The power of networks helps connect like-minded organizations to work together on specific projects that can inspire them and spawn new ideas. The Marine Science and Education Partnership is already discovering the synergies of having similar and complementary missions but different contacts, resources and information networks. When the various networks are networked, the principals save time looking for the right person at the right time and stay focused on the interesting enterprise at hand.

What are some ways for the MSEP to get started in turning its information-sharing roundtables into a focused cluster-building effort? Following the example of other areas in organizing clusters, the Marine Science and Education Partnership could:

- articulate an achievable vision of what the cluster can become over the next 10-20 years, and
- identify specific opportunities for growing the cluster and realizing greater synergies.

A few of the types of return that marine science and related business firms in the Carteret County area might see from participating in a cluster-focused effort include:

- finding new markets or suppliers, through the many good contacts of the MSEP members
- working with the universities and Carteret Community College to shape training curricula to build a more diverse and productive workforce
- learning from the university and federal labs about new technology applications or research findings that could increase business productivity or profitability
- using the specialized facilities of the MSEP partners for product or process testing and/or joint projects
- increasing the MSEP political clout to affect policy and competitiveness

One appeal of a cluster approach is that the particular strategies and required benefits can be determined and tailored by the participating organizations depending on their markets, capacities and interests. In a cluster where technology advances are rapid, the firms may easily see the benefit of combining their knowledge to compete in a changing market.

By combining the advantage of geographic proximity with efficient collaboration, the Partnership can achieve an effective integration of their collective resources. If Carteret County can support cluster strategies that provide tangible benefits to local companies' bottom lines, the value of the MSEP will be more readily appreciated.

END