NORTH CAROLINA'S OCEAN ECONOMY

A First Assessment and Transitioning to a Blue Economy

Sea Grant North Carolina

Duke NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS

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EXECUTIVE SUMMARY

North Carolina's ocean and coastal areas and their resources shape a unique and important segment of the state's economy, particularly for its Eastern region. From seafood and commercial fishing opportunities, to access to global markets through shipping and transport, and finally tourism and recreation, thousands of jobs and billions in revenue for the state depend on the ocean and coast. Yet to date, this segment of North Carolina's economy has not been identified as a discrete contributor in the state. This report provides a first assessment of the existing information available to measure the size and extent of North Carolina's ocean economy, and proposes next steps to transition to a *blue* economy.

Overall in 2013, North Carolina's 20 coastal counties represented 6.8 percent of the state's total gross domestic product, or GDP, at $32 billion, and 8.2 percent of total employment with 336,522 employees. The ocean economy in North Carolina is closely linked to these counties.

North Carolina's ocean economy is defined as the economic activities that take place in the ocean, receive inputs from the ocean, and provide outputs to the ocean (e.g., pollution), including, but not limited to the coastal counties, coastal waters under the state's jurisdiction, and adjacent federal waters where relevant for the state's economy. Ten ocean services have been described as the basis for the sectors and industries in this segment of the economy: seafood, minerals, energy, marine biotechnology, transport and trade, tourism and recreation, carbon sequestration, coastal protection, waste disposal, and the existence of biodiversity.

Although many of these services are not currently measurable in the marketplace (e.g., waste disposal, existence of biodiversity), an initial estimate using available data suggests North Carolina's ocean economy contributed $2.1 billion to GDP in 2013, and an estimated 43,385 jobs. These results are based on data from the National Ocean Economics Program, a widely used database derived from the U.S. Department of Labor, Bureau of Labor Statistics' Quarterly Census of Employment and Wages.

The results should be treated with caution and as indicative only, particularly given the absence of information available on recreational fishing and coastal development. Recreational fishing provided an estimated $1.6 billion in sales, and 16,150 additional jobs, not captured in the above estimates. Similarly, coastal properties in North Carolina are valued on the order of hundreds of billions, and include a number of second homes or recreational properties not currently included in the data that meet the definition of the ocean economy.

Even at these very conservative estimates, North Carolina's ocean economy shows the vital contributions of the ocean to the livelihoods and revenues of North Carolina's coast. For the coastal counties, the ocean economy contributes 6.6 percent of GDP and 12.9 percent of employment. Employment in the ocean economy measures comparably statewide to other natural resource-based segments of the state's economy, such as food manufacturing (51,560 jobs), textile and textile-product mills (33,582 jobs), wood-product and paper manufacturing (32,206 jobs), and farm employment (21,247 jobs).

Natural resources and ecological systems underpin the state's ocean economy, functioning in economic terms as the ocean economy's natural capital asset base. This asset base could be categorized to include, among others, the state's fish stocks, beach and coastal water quality, and natural habitats and the biodiversity that they support.

For years, economists have recognized that natural capital assets provide inputs or factors of production for economic activity, and in turn, receive outputs (i.e., impacts) from this activity. Activities in the ocean economy, which depend on the health of the underlying natural capital asset base, also have the potential to deplete it — putting jobs and economic growth at risk.

More recently, the term "green economy" has been coined to link measurements and investments in such capital together with produced capital (e.g., machinery and human-made structures) and human capital (e.g., skills and expertise with which labor is applied) as the basis for total wealth. As such, the state's GDP can be considered an imperfect measure of the economic returns on its total capital or wealth, and economic growth would be achieved by increasing the state's total wealth, including its natural capital, produced capital and human capital.

The green economy concept has been applied to the ocean economy in recent years to describe a "blue economy." A blue economy is achieved when economic activity is in balance with the long-term capacity of the underlying ecosystems and natural resources to support this activity and remain resilient and healthy, as defined by the Economist Intelligence Unit in 2015.

The blue economy concept creates a lens by which to better view the state's ocean economy and connect those activities to the underlying ecological systems and natural resources that provide a number of benefits for North Carolinians. At a minimum, this concept helps state residents and policymakers:

(i) Better understand a unique and discrete segment of the state's economy, particularly of the coastal region, as a basis for more targeted policy, potential opportunities for clustering of industries and increased investment; and

(ii) Visualize the connection between this significant segment of the economy and the state's ocean resources and ecological systems, and eventually, the economic relationship between the two.

Additionally, the application and development of the concept in North Carolina could provide a decision tool to better understand and visualize the impacts of potential policies on discrete coastal and ocean natural capital assets, and the subsequent returns from the ocean economy.

This initial assessment of the state's ocean economy relies on existing economic data from the National Oceanic and Atmospheric Administration and the National Ocean Economics Program. The assessment could be improved with additional market and non-market data. A blue economy model also could be applied and monitored to illustrate the economic impacts from policy reforms that change resource flows or alter outputs/impacts from economic activity. The report summarizes available data, while beginning to articulate the rationale for an ongoing blue economy research program.

GLOSSARY OF TERMS

Ocean economy in North Carolina refers to the economic activities that take place in the ocean, receive inputs from the ocean, or provide outputs to the ocean, including from (but not limited to) coastal counties defined by the North Carolina Coastal Area Management Act of 1974 (CAMA), coastal waters under the state's jurisdiction and adjacent federal waters (where relevant for the state's economy). More broadly, Colgan (2013) defines the term as a measure of economic activity associated with the oceans, and selects data from the Quarterly Census of Employment and Wages based on two criteria: (i) production of goods or services where ocean and marine resources are an input or where the good or service will be used primarily or exclusively in the marine setting, or (ii) the geographic location of an economic activity implies a relationship with the oceans.

Coastal economy in North Carolina refers to the economic activities that take place in the 20 coastal counties defined by CAMA.

Blue economy refers to a sustainable ocean and coastal economy, which emerges when economic activity is in balance with the long-term capacity of ocean and coastal ecosystems to support this activity and remain resilient and healthy.

Economic impact refers to the employment (full-time and part-time jobs), personal incomes and output (business sales) generated by coastal and ocean economic sectors. Total economic impact is comprised of direct, indirect and induced impact.

Direct economic impact results from expenditures associated with a given coastal and ocean economic sector. For example, recreational anglers purchase supplies at a bait shop and those revenues provide wages to bait-shop employees.

Indirect economic impact results from suppliers of coastal and ocean economic sectors purchasing goods and services and hiring workers to meet demand. For example, a bait shop serving recreational anglers purchases fishing gear like hooks and tackle. The company selling the fishing gear provides wages to their employees, and those wages are considered indirect economic impacts of the recreational-fishing sector.

Induced economic impact results from employees in coastal and ocean economic sectors purchasing goods and services at a household level. For example, the bait-shop employees purchase groceries for their families.

Economic multiplier refers to the increase in the final income arising from any new injection of spending. Indirect and induced economic impacts are considered multiplier effects.

Economic value refers to a monetary value of economic welfare, i.e., well-being or satisfaction. It is often measured with consumer surplus, which is the difference between willingness to pay for a good or service relative to its market price. Alternatively, producer surplus is an economic measure of the difference between the amount a producer of a good receives and the minimum amount the producer is willing to accept for the good.

Ecosystem services refer to the benefits people obtain from ecosystems.

Gross domestic product (GDP) refers to the value of the goods and services produced by the nation's economy, or in this case, the state of North Carolina's economy, less the value of the goods and services used up in production.

Non-market value refers to the value of goods and services that do not have an obvious market price. Environmental goods and services like clean air and water require non-market valuation techniques to determine their total economic value.

I. INTRODUCTION

Why Measure North Carolina's Ocean Economy?

The ocean and coasts provide food, livelihoods and economic opportunity for a large portion of the world. Recent projections suggest that as the population climbs to 9.6 billion and people worldwide gain greater purchasing power, there will be an increasing need for additional supplies of food and energy (Economist Intelligence Unit, 2015). In the face of increasing demand, many countries are turning to the ocean and coasts as a frontier for jobs and economic growth, with offshore renewable energy, aquaculture and marine biotechnology emerging alongside established industries in many places (Economist Intelligence Unit, 2015).

This global trend in ocean and coastal economic growth is particularly relevant for North Carolina. The state's ocean and coastal areas and resources are important contributors to its economy, and support a range of livelihoods, services and benefits. The ocean and coasts provide seafood, commercial fishing and aquaculture opportunities, access to global markets through shipping and transport, and thousands of jobs in tourism and recreation, including recreational fishing. In particular, recreation and tourism along the state's coast have boomed since World War II, leading to an economy almost entirely based on tourism in some areas.

Economic services and sectors supported by ocean and coastal resources and ecological systems have been shown to be significant segments of larger market — and non-market — economies (Edwards et al., 2014; NOAA, 2015a; NOAA, 2015b; Economist Intelligence Unit, 2015). Relative to other sectors such as manufacturing and financial services, the economic activity linked to North Carolina's ocean and coastal areas and resources remains relatively undefined as a discrete segment of the state's economy. Exclusion risks missing opportunities to enhance collaboration, and even clustering, between this economic segment's sectors, as well as a coordinated policy vision, strategy and supporting infrastructure for its growth (Edwards et al., 2014). For example, a Mississippi assessment suggested treating the state's ocean economy as a distinct investment opportunity, where productivity, innovation and growth could be increased through specific attention from public and private leaders (Edwards et al., 2014). As such, this report provides a first assessment of the existing information available to measure the size and extent of North Carolina's ocean economy in order to inform targeted policy.

Defining the Ocean Economy

Countries around the world have defined the term "ocean economy" differently, with the U.S., specifically the National Ocean Economics Program or NOEP, using: "an industry (a) whose definition explicitly ties the activity to the ocean, or (b) which is partially related to the ocean and is located in a shore-adjacent ZIP code" (Park and Kildow, 2015). In the case of NOEP in the U.S., relevant industries and sectors in the entire coastal or Great Lakes states have been used to measure the ocean economy.

In recent years, efforts have increased throughout the U.S. to measure the country's ocean economy as a discrete segment of economic activity, with unique characteristics and customized policy responses. Many efforts build off work led by the Center for the Blue Economy at the Middlebury Institute of International Studies at Monterey (e.g., Colgan, 2013). Recently, the Office for Coastal Management in the National Oceanic and Atmospheric Administration, also known as NOAA, the Economics: National Ocean Watch, or ENOW, data set to produce a first summary of the U.S. ocean and Great Lakes economy (NOAA, 2015a), as well as for California's ocean economy (NOAA, 2015b).

Nationwide, NOAA (2015a) reports that in 2013 the national ocean economy accounted for:

- 149,000 business establishments,
- 3 million employees, or 2.2 percent of total U.S. employment,
- $117 billion in wages, and
- $359 billion in gross domestic product, or GDP, which was 2.2 percent of total U.S. GDP.

II. NORTH CAROLINA'S OCEAN ECONOMY

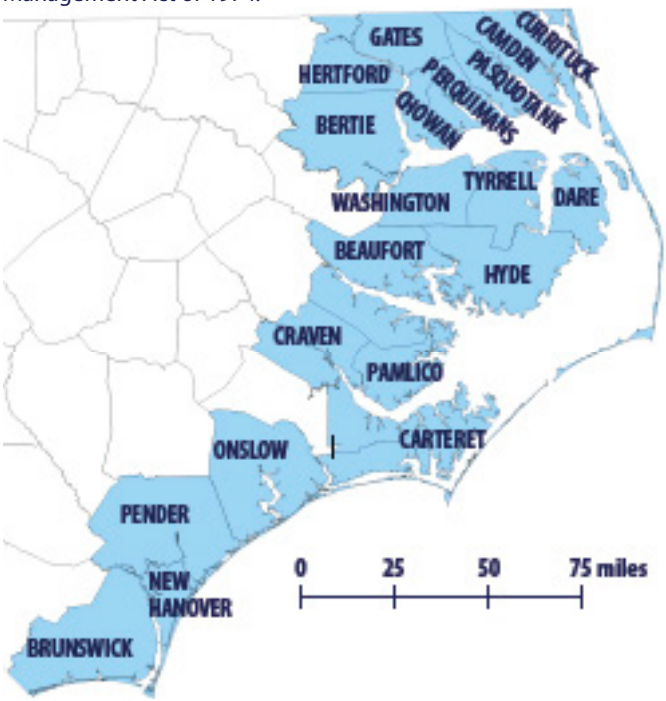
Given the range of definitions and the importance of the broader coastal areas in shaping ocean industries, this report adopts a version of the definition proposed by Park and Kildow (2015) for the ocean economy. North Carolina's ocean economy is thus defined as: "the economic activities that take place in the ocean, receive inputs from the ocean, or provide outputs to the ocean, including from (but not limited to) coastal counties defined by CAMA, coastal waters under the state's jurisdiction and adjacent federal waters (where relevant for the state's economy)."

North Carolina's ocean economy is defined as:

"the economic activities that take place in the ocean, receive inputs from the ocean, or provide outputs to the ocean, including from (but not limited to) coastal counties defined by CAMA, coastal waters under the state's jurisdiction and adjacent federal waters (where relevant for the state's economy)."

In the case of North Carolina, shore-adjacent areas linked to the ocean could be considered as defined in 1974 by the Coastal Area Management Act, or CAMA, as *counties that (in whole or in part) are adjacent to, adjoining, intersected by or bounded by the Atlantic Ocean (extending offshore to the limits of State jurisdiction […]) or any coastal sound* [N.C. Gen. Stat. §113A-103 (2) (2014)]. Inland limits of coastal sounds are defined based on the limits of seawater encroachment under normal conditions. As shown in **Figure 1**, the 20 coastal counties covered by CAMA in North Carolina are Beaufort, Bertie, Brunswick, Camden, Carteret, Chowan, Craven, Currituck, Dare, Gates, Hertford, Hyde, New Hanover, Onslow, Pamlico, Pasquotank, Pender, Perquimans, Tyrrell and Washington.

Figure 1. North Carolina counties covered by the Coastal Area Management Act of 1974.



Significant portions of North Carolina's ocean economy depend upon the underlying ecological systems and associated ecosystem services — the benefits people obtain from ocean ecosystems. Other sectors depend upon the location provided by the ocean and coast. However, all of the state's ocean economy has the potential to impact the underlying ecological systems and services.

Provisioning services, like seafood, have a market price. *Regulating services* that affect climate, floods, wastes and water quality; *cultural services* that provide recreational, aesthetic and spiritual benefits; and *supporting services,* such as nutrient cycling, are "ecological commodities" that have economic value but are not exchanged in a market. Hence, these services are harder to quantify in economic terms (Millennium Ecosystem Assessment, 2005; Boyd and Krupnick, 2009).

As such, this report expands on the standard ocean economy sectors where outputs are exchanged in the marketplace. A range of current and potential economic sectors for which markets do and do not yet exist, as well as the ocean services that drive them and where applicable, the ecosystem services on which they depend, are included as components of North Carolina's ocean economy, as shown in **Table 2**.

This characterization of the ocean economy does not include a number of recognized marine ecosystem services (Liquete et al., 2013), such as regulating services for climate and weather or cultural services for cognitive effects. The criterion for including economic sectors was whether or not scarcity has been clearly measured or determined, producing an "ecological commodity" from an ecosystem service.

Table 2. Components of North Carolina's ocean economy.

Ocean service (Ecosystem service)	Economic sector
Seafood (Provisioning)	Fisheries • Finfish fishing • Shellfish fishing • Other marine fishing Aquaculture • Finfish farming • Shellfish farming • Other aquaculture Processing, retailing • Seafood-product preparation and packaging • Seafood canning • Fresh and frozen seafood processing • Fish and seafood markets
Minerals	Limestone, sand and gravel • Construction sand and gravel mining • Industrial sand mining
Energy (Provisioning)	Oil and gas • Crude petroleum and natural gas extraction • Drilling oil and gas wells • Support activities • Oil and gas pipeline and related structures
	Renewables • Off-shore wind
Marine biotechnology (Provisioning)	Pharmaceuticals, chemicals, etc.
Transport and trade	Transport • Deep-sea and coastal freight transportation • Deep-sea and coastal passenger transportation • Port and harbor operations • Marine-cargo handling • Other support activities to water transportation Ship and boat building • Ship building and repair • Boat building and repair • Boat dealers • Navigational services to shipping • Marine-related construction
Tourism and recreation (Cultural)	Tourism • Scenic and sightseeing transportation, water and other • Recreational-goods rental • Sports and recreation instruction • Zoos and botanical gardens • Nature parks and other similar institutions • Marinas • Amusement and recreational services, not elsewhere classified • Hotels (except casino hotels) and marinas • Bed and breakfast inns • RV parks and recreational camps • Full-service restaurants • Limited-service eating places • Snack and nonalcoholic beverage bars Recreational fishing • Bait and tackle stores • Fishing-tackle wholesalers • Charter and head-boat operations

Ocean service (Ecosystem service)	Economic sector
Tourism and recreation continued	Coastal development • New investment • Depreciation
Carbon sequestration (Regulating)	Blue carbon (i.e., coastal vegetated habitats)
Coastal protection (Regulating)	Habitat protection, restoration
Waste disposal (Regulating)	Assimilation of nutrients, solid waste
Existence of biodiversity (Provisioning, cultural, supporting)	Protection of species, habitats

Some economic sectors produce final outputs in the sense that they enter directly into a household's production or utility function, while others produce intermediate outputs used to produce other final outputs. A total measure of economic value across sectors should only consider the values or social surplus of the final outputs from each, in order to avoid double counting (Boyd and Krupnick, 2009). For example, care must be taken in distinguishing final outputs for development of coastal communities and infrastructure ("coastal development" sector), protection of them ("coastal protection" sector), and tourism and recreation.

Though not included above, North Carolina's coast also provides significant services for the U.S. military by virtue of its location, serving as home to large bases.

In attempting to provide a first measurement of North Carolina's ocean economy, two data sets provided the majority of available information. The NOAA ENOW data set (NOAA, 2016) provides data on annual GDP, wages and employment for six sectors of the ocean economy in coastal states, drawn from the U.S. Department of Labor, Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) (BLS, 2016). NOEP, which is maintained by the Center for the Blue Economy, provides data for years prior to the start of the ENOW data set in 2004 (NOEP, 2016).

The most recent information from these data sets provides the contribution to GDP and total payroll in 2013 from the following economic sectors:

- Living resources: Fisheries, aquaculture, seafood processing and retailing;
- Marine construction;
- Marine transportation;
- Offshore-mineral extraction;
- Ship and boat building; and
- Tourism and recreation.

These economic sectors show up well in market data; however, they are not the only important sectors, and perhaps not even the largest. Rather, these sectors have data available, and provide indicators of how ocean resources and ecological systems impact the state's market economy.

Measurement Challenges

Comparable GDP and payroll data are unavailable for other ocean economic sectors due to a variety of factors. Some economic sectors like oil and gas do not have a presence in North Carolina. Others like marine biotechnology do not have a unique business classification code specified by the North American Industry Classification System or NAICS, the standard used by government agencies to analyze statistical data related to the U.S. business economy.

A number of ecosystem services — carbon sequestration, coastal protection, waste disposal and biodiversity — have non-market economic values but no comparable GDP or payroll metric. Social benefits, however, can be measured in terms of substitute values (e.g., coastal protection by natural habitats substituted by costs of a seawall). Additional estimates of economic impacts and values are available for recreational fishing, coastal development and habitat protection/restoration, though not their contribution to GDP or total payroll.

The oceans and coasts provide a wide range of benefits that do not lend themselves to traditional economic measures, particularly as many are not necessarily captured in marketplaces, as shown in **Figure 2** (Park and Kildow, 2015). Both market and non-market goods and services must be assessed to account for the full extent of the ocean economy. For this reason, this report aims to reference and assess available information on non-market goods and services in economic sectors such as carbon sequestration, coastal protection, waste disposal and the existence of biodiversity as supplementary information to the measures of contribution to GDP.

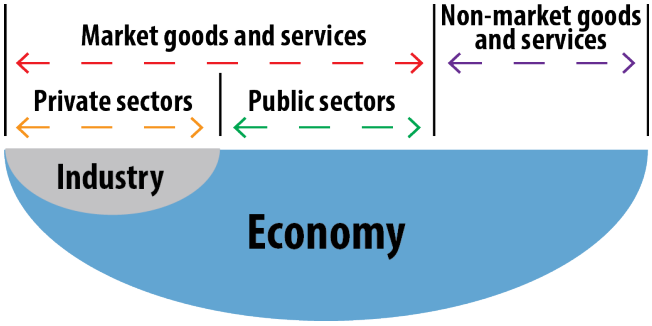


Figure 2. The ocean economy includes market and non-market goods and services. Source: Park and Kildow, 2015.

Emerging sectors present an additional challenge to measuring the ocean economy. Sectors like marine biotechnology, renewable energy, carbon markets and the restoration industry are nascent in North Carolina; thus, data to measure them are limited or nonexistent. Also, in the case of carbon storage, it would not be included in the national income accounts used for measurement.

New industries often are poorly characterized by the NAICS codes, making measurement challenging. For example, the ecological-restoration industry can be classified by 15 distinct industries from architectural, engineering and related services (NAICS code 5413) to professional, scientific and technical services (NAICS code 5416) to construction (NAICS code 531) (BenDor et al., 2015).

Initial Measure of North Carolina's Ocean Economy

In total, the sectors of the state's ocean economy where NOEP (2016) data were available showed a total contribution to GDP of $2.1 billion, an estimated 43,385 jobs and a total payroll of $820.1 million in 2013, as shown in **Table 3** (NOAA, 2016). However, these results should be treated with caution and viewed as indicative only, given the limited information available on key economic sectors.

NOEP data do not include multiplier effects for any sectors, including the recreational fishing sector, nor do they report on coastal property value. NOEP also does not report self-employment data, obscuring the size of sectors like commercial fishing and fish processing.

Some sectors appear less economically important than they are in reality; hence, values from other studies are reported to complement the NOEP data. Some values reported include economic multipliers like indirect and induced economic impacts, while others refer only to direct economic impacts. Table 3 clarifies which measure of value is reported for a given category.

Although not included in this assessment, North Carolina's coast provides a service for the U.S. military, as the home for large bases that utilize uninhabited areas for training and operations. Further marine ecosystem services also could be included, though they are further removed from the marketplace (Liquete et al., 2013).

Figure 3 and **Figure 4** on page 15 show the relative importance of each ocean sector based on GDP and employment, and together, they suggest the labor intensity of different sectors.

Table 3. Initial measure of North Carolina's ocean economy.

		Sourced from NOEP (2016)[1]			Sourced from other studies
Ocean service	**Economic sector**	**Contribution to GDP ($ millions)**	**Employment**	**Total wages ($ millions)**	**Economic impacts and values**
Seafood	Fisheries • Finfish fishing • Shellfish fishing • Other marine fishing	188	1,300	31	Without imports (NMFS, 2015): • $132.9 million sales • $54.2 million income • $73.6 million value added
	Aquaculture • Finfish farming • Shellfish farming • Other				Direct without imports (NCREDC, 2013) • $0.91 million
	Processing, retailing • Seafood-product preparation and packaging • Seafood canning • Fresh and frozen seafood processing • Fish and seafood markets				Without imports (NMFC, 2015): • $141.2 million sales • $59.5 million income • $77 million value added
Minerals	Limestone, sand and gravel • Construction sand and gravel mining • Industrial sand mining	16	105	5	Aurora Phosphate mine (Beaufort County Board of Commissioners, 2008; EPA, 2009): • $74 million payroll • $173.3 million/year direct • $462.2 million/year total
Energy	Oil and gas • Crude petroleum and natural gas extraction • Drilling oil and gas wells • Support activities • Oil and gas pipeline and related structures Renewables	Not available			
Marine biotechnology	Pharmaceuticals, chemicals, etc.	Not available			
Transport and trade	Transport[2] • Deep-sea and coastal freight transportation • Deep-sea and coastal passenger transportation • Port and harbor operations • Marine-cargo handling • Other support activities to water transportation	310	1,746	117	Ferry system (ITRE, 2009): • $8.6 million/year net travel-time benefits • $351.7 million/year tourism expenditures supported N.C. ports (ITRE, 2014): • $13.8 billion • $4.3 billion wages
	Ship and boat building • Ship building and repair • Boat building and repair • Boat dealers • Navigational services to shipping	386	1,425	60	GDP (MARAD, 2013): • $5.9 million direct • $413.1 million direct, indirect and induced

		Sourced from NOEP (2016)[1]			Sourced from other studies
Ocean service	**Economic sector**	**Contribution to GDP ($ millions)**	**Employment**	**Total wages ($ millions)**	**Economic impacts and values**
Transport and trade continued	Marine-related construction	65	668	30	
Tourism and recreation[3]	Tourism • Scenic and sightseeing transportation, water and other • Recreational-goods rental • Sports and recreation instruction • Zoos and botantical gardens • Nature parks and other similar institutions • Marinas • Amuseument and recreational services, not elsewhere classified • Hotels (except casino hotels) and marinas • Bed-and-breakfast inns • RV parks and recreational camps • Full-service restaurants • Limited-service eating places • Snack and nonalcoholic beverage bars	1,120	38,138	578	Beach tourism (Bin et al., 2005; NCDC, 2014): • $74.3-$276.7 million[4]
	Recreational fishing	Not available			(NMFS, 2015) • $1.6 billion sales • $633.8 million income • $989.1 million value added
	Coastal development	Not available			Coastal county property value (Doggett, 2015) • $163.5 billion
Carbon sequestration	Blue Carbon (i.e., coastal vegetated habitats)	Not available			
Coastal protection	Habitat protection and restoration[5]	Not available			Biodiversity, habitat and flood relief in coastal wetlands (Brander et al., 2006; USGS, 1997) • $9.3 billion
Waste disposal	Assimilation of nutrients, soild waste	Not quantified			Estimate of Bogue Sound submerged aquatic vegetation pollution removal services (NCDEQ, 2016) • $3,045/acre/year
Existence of biodiversity	Protection of species and habitats	Not quantified			
Total		**$2.084 billion**	**43,385**	**$820 million**	

Notes for Table 3:

[1] All figures in 2013 U.S. dollars.

[2] Includes deep-sea freight, marine passenger, marine transport, search and navigation equipment, and warehousing.

[3] Includes amusement and recreation services, boat dealers, eating and drinking places, hotels and lodging places, marinas, recreational parks and campsites, scenic-water tours, sporting-goods retailers, zoos, and aquaria.

[4] The reported values are calculated by multiplying the number of beach visitors — 70 percent of the 9.5 million overnight visitor trips were to the beach in 2013 (NCDC, 2014) — by the consumer surplus estimates for overnight beach users ($11 to $41 per visitor) (Bin et al., 2005).

[5] Examples in North Carolina generally include oyster-reef restoration and creation, saltwater-wetland restoration, and estuarine-shoreline restoration (Lawrence et al., 2015). Increasingly, living shorelines have been used as a type of designed shoreline-stabilization technique that incorporates live components such as marsh plants, frequently in combination with rock or oyster-sill structure (NCDEQ, 2016).

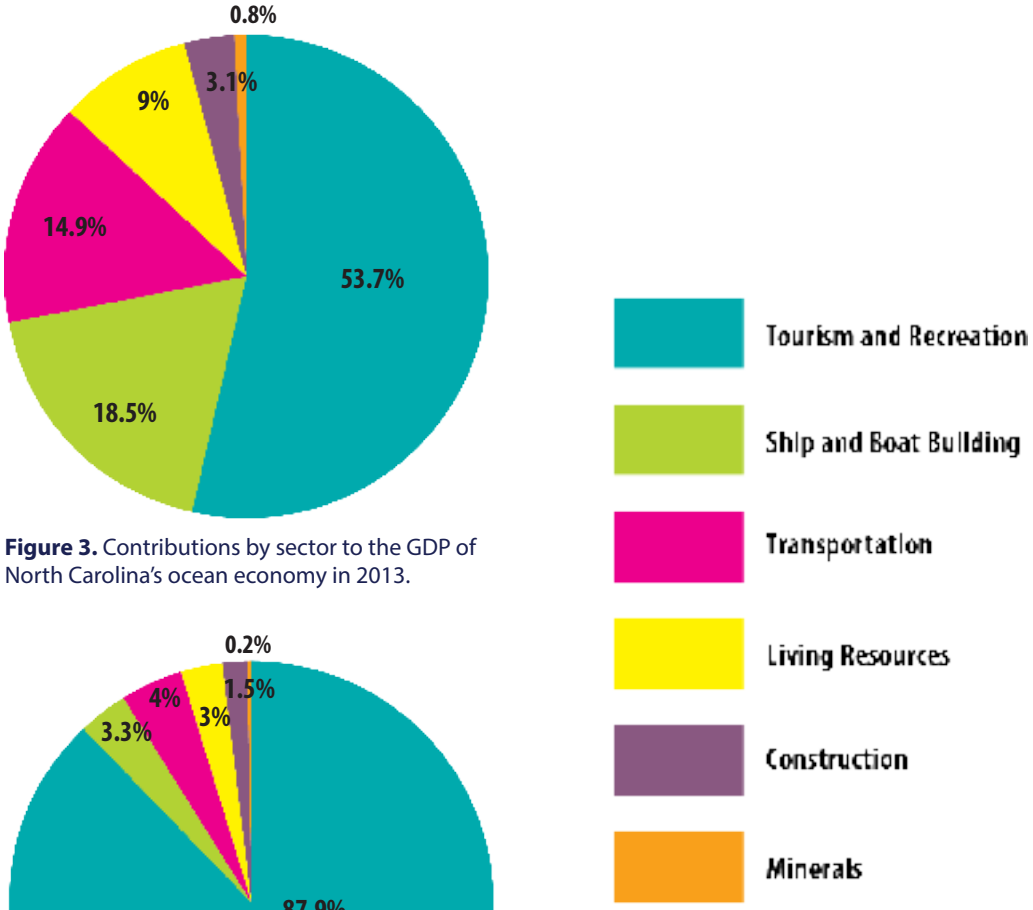


Figure 3. Contributions by sector to the GDP of North Carolina's ocean economy in 2013.

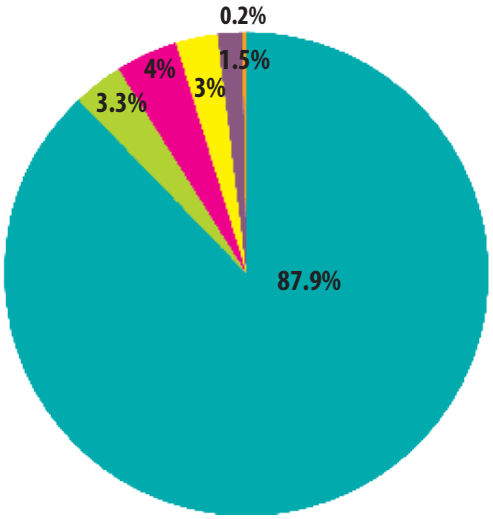


Figure 4. Contribution by sector to employment in North Carolina's ocean economy in 2013.

Selected Sectors of North Carolina's Ocean Economy

Seafood. The state's seafood industry, comprised largely of fishing operations and processors/retailers, contributed $188 million to GDP and supported 1,300 livelihoods in 2013. This represents approximately 9 percent of GDP and 3 percent of employment in the state's ocean economy (NOEP, 2016).

Of note, the QCEW, the basis for NOEP, significantly undercounts employment in the fisheries-harvesting sector because fishing enterprises are mostly exempt from unemployment insurance. The self-employed, common in commercial fishing, also are not counted. In 2013, Dare and Carteret Counties, the top seafood-landing counties by ex-vessel value, had the highest number of nonemployer establishments, 450 and 371, respectively, in NAICS code 11 (agricultural, forestry, fishing and hunting) for all North Carolina counties (U.S. Census, 2016). These businesses have no paid employees and are not counted in the NOEP (2016) data. Most nonemployers are self-employed individuals operating unincorporated businesses.

Supplementing the NOEP (2016) data with National Marine Fisheries Services data reveals the greater economic impact of the commercialfishing sector. According to NMFS (2015), the state had approximately 5,744 commercial fishing jobs, without accounting for imported seafood. Adding imported seafood raises this number to 9,579 jobs. These jobs include commercial harvesters, seafood processor and dealers, and seafood wholesalers and distributors.

Blue Economy Growth Sector: Oyster Aquaculture

Oyster aquaculture has the potential to produce a substantial source of income and economic stability for North Carolina's commercial fishing industry, as well as for the ocean economy as a whole. Additionally, oysters provide numerous environmental co-benefits, including water-quality improvement through nutrient filtering (Nelson et al., 2004) and habitat provision for other species (Breitburg et al., 2000). Excluding harvest, the annual value of ecosystem services produced by oyster reefs is estimated between $2,226 and $40,064 per acre (Grabowski et al., 2012).

While commercial harvest of wild oysters in North Carolina has been on an upward trajectory — growing 193 percent in value from 2004 to 2014 — the value of cultivated, or aquacultured, oysters has remained stagnant. In 2014, the value of harvested wild oysters was $4.54 million (NCDMF, 2015a), while the farm-gate value for aquacultured oysters was only $450,000 (NCDMF, 2015a).

Significant investments in oyster reef restoration and aquaculture in Virginia have led to remarkable growth that North Carolina might emulate. The 2014 farm-gate value of cultivated oysters in Virginia was nearly $17.1 million compared to just under $250,000 in 2004 (Hudson and Murray, 2015).

State and federal policies could advance North Carolina oyster aquaculture by promoting:

- Development of new oyster sanctuaries, i.e. shellfish reef restoration, closed to harvest.
- Establishment of additional cultch planting sites open to harvest.
- Capacity for existing and establishment of new hatcheries to further develop specific broodstock lines, provide nurseries, and eliminate seed and spat supply bottlenecks.
- Frequent water-quality monitoring to prevent unnecessary shellfish harvest closures.
- Strengthening of shellfish poaching prevention programs.
- Oyster-shell recycling programs.
- Dedicated program funding to administer and provide outreach and technical assistance to the industry and those interested in pursuing shellfish leases.

Table 4. Top five locations by ex-vessel value of commercial fish landed in 2013. Source: NCDMF, 2015a.

Location		$ millions
Counties	Dare	21.07
	Carteret	11.23
	Hyde	7.98
	Pamlico	4.62
	Onslow	4.60
Ports	Wanchese (Dare Co.)	13.39
	Morehead City/Beaufort (Carteret Co.)	7.40
	Shiloh (Camden Co.)	5.87
	Engelhard (Hyde Co.)	4.50
	Hatteras (Dare Co.)	3.31

Table 5. Top five commercial species by ex-vessel value of landings in 2013. Source: NCDMF, 2015a.

Nonfinfish ($ millions)		Finfish ($ millions)	
Blue crab	30.0	Southern flounder	5.7
White shrimp	6.3	Tunas	3.2
Brown shrimp	6.0	Swordfish	2.9
Oysters	3.4	Atlantic croaker	1.7
Hard clams	2.3	Summer flounder	1.4

Some coastal counties have significant seafood landings that make the seafood industry a key employment sector. **Table 4** displays the top five counties and ports by value.

Commercial landings trends vary by region and by species. For instance, the weight and value of commercial seafood landings has stayed relatively consistent in the Albemarle Sound during the past two decades as shown in **Figure 5**, whereas the Pamlico Sound experienced a significant decline as shown in **Figure 6**.

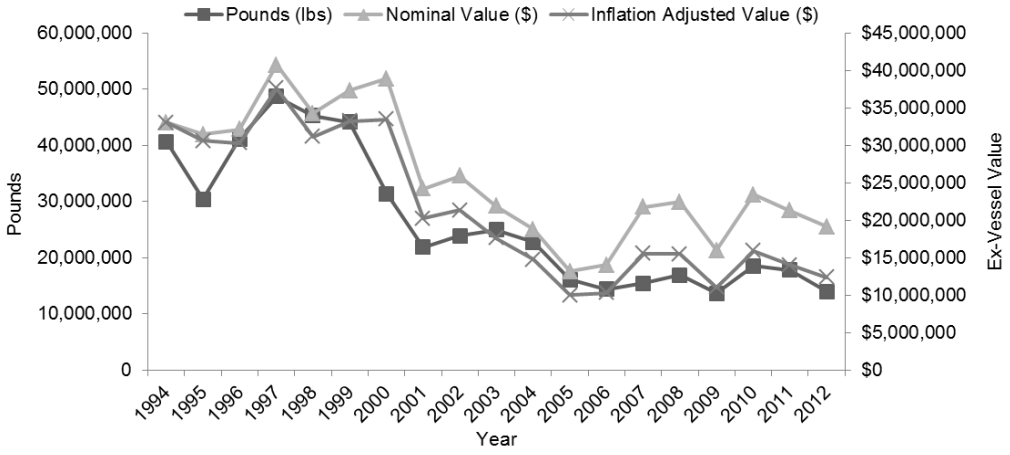


Figure 5. Commercial landings from the Albemarle Sound in North Carolina. Source: Hadley and Wiegand, 2014.

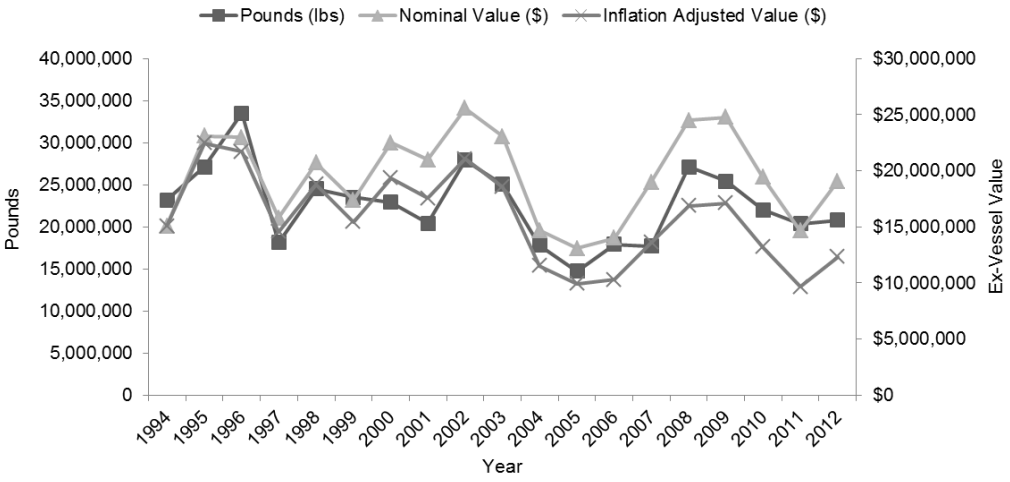


Figure 6. Commercial landings from the Pamlico Sound. Source: Hadley and Wiegand, 2014.

Landings by weight and value have varied greatly over time for the state's top commercial species. Over two decades — from 1994 to 2012 — landings declined by 50.3 percent for blue crab, while value fluctuated (NCDMF, 2016). During the same time period, landings for southern flounder declined by 66.3 percent with a corresponding consistent decline of 44.7 percent in value. **Table 5** shows the top five commercial nonfinfish and finfish species as of 2013.

Commercial fishing continues to be an important economic activity, as well as a cultural tradition along the coast; however, it does not maintain the regional economic role it once had. Seafood imports from foreign countries, regulatory changes and the loss of working waterfronts are issues of concern for commercial fishermen (Hadley and Wiegand, 2014).

Renewable Energy. Based on the state's long coastline, a large area of shallow water from which to erect turbines, and the convergence of the Gulf Stream and the Labrador Current, efforts to assess the state's offshore wind energy potential have been underway for some time. Adjacent to state waters, the U.S. Bureau of Ocean Energy Management (BOEM) has designated three Wind Energy Areas (WEAs) for leasing consideration: Kitty Hawk, Wilmington West and Wilmington East (NCDEQ, 2015).

A 2009 University of North Carolina at Chapel Hill study entitled "Coastal Wind: Energy for North Carolina's Future," produced spatial maps of optimal development locations (UNC-CH, 2009). This study highlighted that North Carolina has the largest offshore wind potential on the East Coast, with some total 20 gigawatts (GW) of potential in all water depths within 50 miles of the coast, without accounting for any constraints from conflicting uses (UNC-CH, 2009). A subsequent report by the Governor's Scientific Advisory Panel on Offshore Energy (NCDC, 2011) noted that after factoring in potential use constraints, the state's shallow waters could accommodate as much as 50 GW of capacity — more than 100 percent of North Carolina's total electricity use at that time.

Table 6. Estimated U.S. Atlantic Coast offshore wind potential. Source: Menaquale, 2015.

State	Offshore Wind Potential (GW)
North Carolina	31.7
South Carolina	21.0
Florida	16.4
New Jersey	15.8
Massachusetts	14.5
New York	11.6
Virginia	11.3
Georgia	10.5
Maryland	4.7
Rhode Island	2.7
Delaware	1.7
Maine	1.2
New Hampshire	0.1
Connecticut	0.0

The nonprofit Oceana estimates that the state has 31.7 GW of potential, or over 2.5 billion barrels of oil equivalent over 20 years — the most of any state on the U.S. Atlantic Coast, as shown in **Table 6** (Menaquale, 2015). According to the report, offshore wind also could support 48,000 jobs in North Carolina, although leases would be for federal waters.

In addition to offshore wind, a number of universities and research centers currently are studying the feasibility and potential of ocean wave and current energy in North Carolina.

Marine Biotechnology. The marine environment is a rich source of biological and chemical diversity. This diversity has been the source of unique chemical compounds with the potential for industrial development as pharmaceuticals, cosmetics, nutritional supplements, molecular probes, enzymes, fine chemicals and agrichemicals.

Globally, the marine biotechnology industry generates revenues on the order of some $2 to $3 billion, with potential for 12 percent annual growth (European Science Foundation, 2010). Currently, little information is available to suggest significant economic activity in marine biotechnology in North Carolina. However, research in this field is increasing, given the state's leading position in the U.S. in biotechnology with the recent establishment of the Marine Bio-Technologies Center of Innovation in Wilmington, together with the University of North Carolina Wilmington's MARBIONC program (BioMarine, 2015).

Tourism and Recreation. Tourism and recreation alone provided 54 percent of the state's ocean economy GDP ($1.1 billion), as well as 88 percent of its ocean economy employment in 2013. The contribution of tourism and recreation from the ocean economy to the GDP of a number of coastal counties is sizable, for example constituting 13 percent of GDP in Dare County and 7 percent in Carteret County, (NOEP, 2016).

These high tourism values still are incomplete; they do not account for large industries like recreational fishing and coastal development. In North Carolina, 4.97 million recreational fishing trips were taken in 2012, resulting in $1.6 billion of spending and the creation of an estimated

Blue Economy Growth Sector: Ecotourism

Tourism and recreation is the largest ocean economy sector in North Carolina, and tourism expenditures in coastal counties continue to grow. Tourism expenditures in the 20 coastal counties reached almost $2 billion in 2013, a 4.3 percent increase over 2012 (Tuttle, 2015). Dare County, home to the Outer Banks, accounted for almost half of those expenditures with $953 million.

Tourism's continued success is predicated on the natural amenities that attract visitors, namely a healthy coastal ecosystem and the unique natural resource assets of coastal North Carolina. While beachfront communities have capitalized on tourist dollars, inland coastal areas also have unique, natural assets that could spur job growth via ecotourism. Ecotourism is a form of travel that relies on the conservation and restoration of ecosystems and natural resources.

For example, Tyrrell County's Red Wolf Coalition, a nonprofit organization, uses proceeds from guided hiking, biking, bird watching and paddling activities to generate funds to preserve the red wolf population. Camping platforms on the Roanoke River encourage paddlers to spend multiple days in inland coastal counties, spurring demand for local outfitters, food, transportation services, and other supplies.

State and federal policies could advance ecotourism by promoting:

- Sustainable sources of funding for beach nourishment.
- Training and extension to coastal communities on sustainable-tourism business models.
- Marketing and development of ecotourism attractions like paddling and birding trails.

16,150 jobs (NMFS, 2015). In the 28 counties that make up North Carolina's broader coastal region, overnight visitors spent $3.6 billion and 91 percent reported leisure as the primary purpose of their trip (NCDC, 2014).

Coastal development also should be considered part of tourism and recreation, given that demand for tourist lodging drives up property values. The insured value of properties in coastal North Carolina was estimated to be $163.5 billion in 2012 (Doggett, 2015).

Such a high reliance of the state's ocean economy upon the tourism sector presents several challenges: The sector is seasonal and weather-dependent, subject to fluctuation due to the state of the nation's macroeconomy, and comprised largely of low-paying, part-time jobs.

Non-Market Sectors: Carbon Sequestration, Coastal Protection, Waste Disposal and Existence of Biodiversity. As mentioned previously, North Carolina's ocean and coastal ecosystems and natural resources provide a number of significant benefits not captured in the marketplace: sequestering carbon that would otherwise have been released into the atmosphere, attenuating flooding in coastal communities, disposing of wastes generated onshore, and supporting the existence of biodiversity.

Seagrasses and salt marshes along the coast have been shown to sequester and store significant amounts of "blue carbon." Sea grasses and salt marshes store carbon on the order of 500 to 950 megagram CO_2e, or equivalent carbon dioxide, per hectare, respectively (Pendleton et al., 2014). Approximately a quarter of that carbon is susceptible to global release (Pendleton et al., 2012).

Studies have looked at the areal extent and other biophysical aspects of seagrass (Ferguson and Korfmacher, 1997; Fonseca and Bell, 1998; Mallin et al., 2000; Kelly et al., 2001; Biber et al., 2008) and salt marsh ecosystems (Hackney and Cleary, 1987; Wiegert and Freeman,1990; Deegan et al., 2000; Mallin et al., 2000) in North Carolina. However, no studies to date have calculated the carbon stock susceptible for release in these coastal marine

ecosystems. An ongoing study is using remote sensing to investigate the impacts of climate change on seagrasses in North Carolina (NCCOS, 2015).

North Carolina's waters are home to a wide diversity of plants and animals at various stages in the life cycle, including a variety of endangered and threatened sea turtles, pelagic seabirds and marine mammals. People value the existence of such biodiversity and have demonstrated a willingness to pay for it, even though markets do not exist. In the case of North Carolina, a number of studies have attempted to estimate these values, including Whitehead (1992); Whitehead et al. (1995), and Smith and Crowder (2011).

North Carolina's Ocean Economy in Perspective

As indicated by **Figure 7**, the state's ocean economy weathered the 2008 global financial crisis relatively well, though growth had been flat in real terms until 2013. The 2013 data show the ocean economy increasing slightly and approaching the pre-recession levels of 2007 and 2008.

Tourism and recreation within the state's ocean economy has increased more steadily in real terms, following more closely the statewide trend of tourism and recreation as shown in **Figure 8**.

Although representing a relatively small proportion of the state's GDP and employment ($454.5 billion and 4 million jobs, respectively, in 2013), the ocean economy is a significant portion of the GDP of North Carolina's 20 coastal counties (NOEP, 2016). For these counties, the ocean economy contributes 6.5 percent of GDP and 12.9 percent of employment.

Economic activity is not uniformly distributed throughout these counties as shown in **Table 7**. Tourism areas have seen significant growth in recent decades, notably in waterfront — and particularly oceanfront — communities, while many rural inland areas have seen stagnant economic growth and limited employment opportunities.

Employment in North Carolina's ocean economy — 43,385 jobs — measures favorably to other natural resource-based segments of the state's economy. It rivals the 51,560 jobs in food manufacturing and surpasses other segments like wood-product and paper manufacturing and textile mills as shown in **Figure 9**.

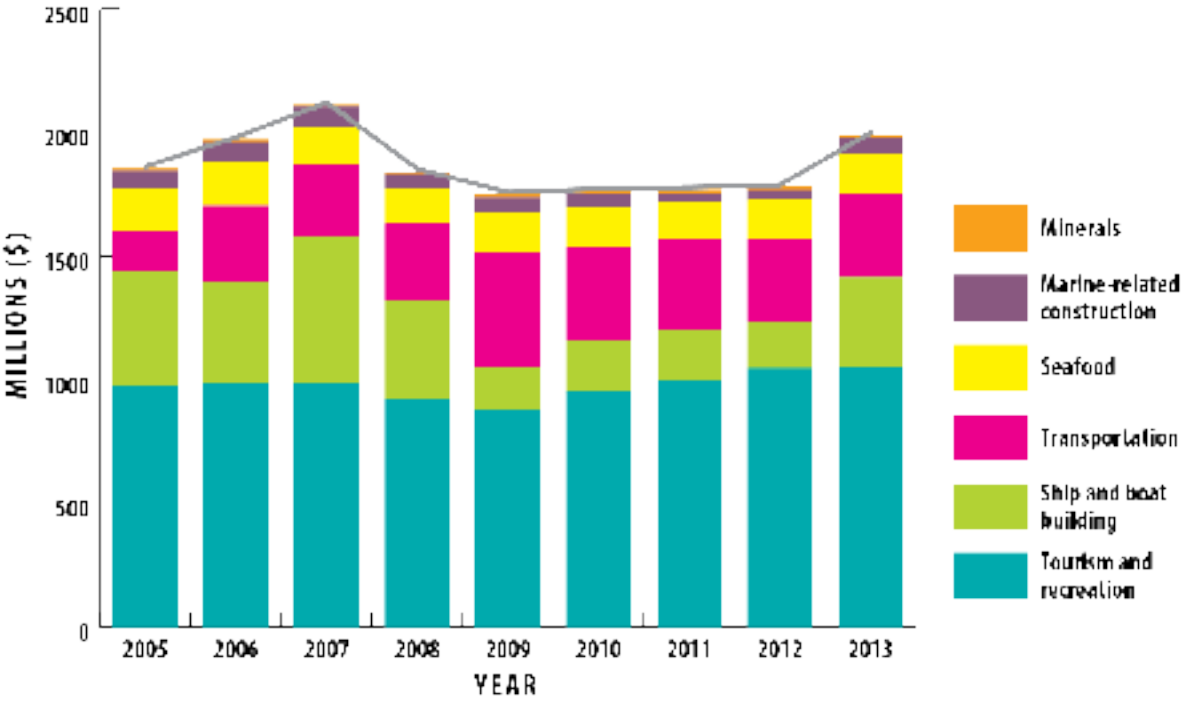


Figure 7. North Carolina ocean economy trends from 2005 to 2013 for available sectors (real GDP in 2009$) Source: NOEP, 2016.

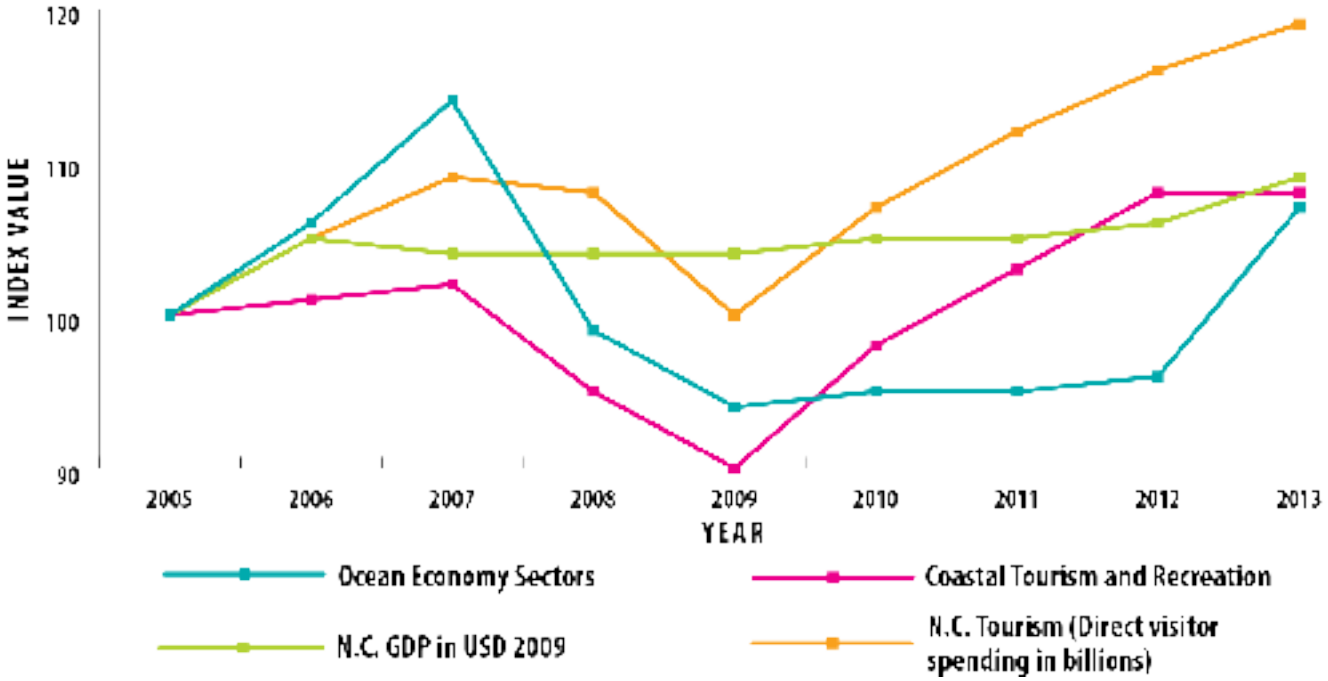


Figure 8. North Carolina economic trends from 2005 to 2013. Source: NOEP, 2016; U.S. Census Bureau, 2016.

Table 7. Percent employment in North Carolina's ocean economy for selected counties. Source: NOAA, 2016; NOEP, 2016; BLS, 2016.

County	Ocean Economy Employment
Dare	26.3
Carteret	18.6
Onslow	12.4
New Hanover	12.2
Brunswick	11.8
Craven	10.0
Pasquotank	9.5
Beaufort	8.4

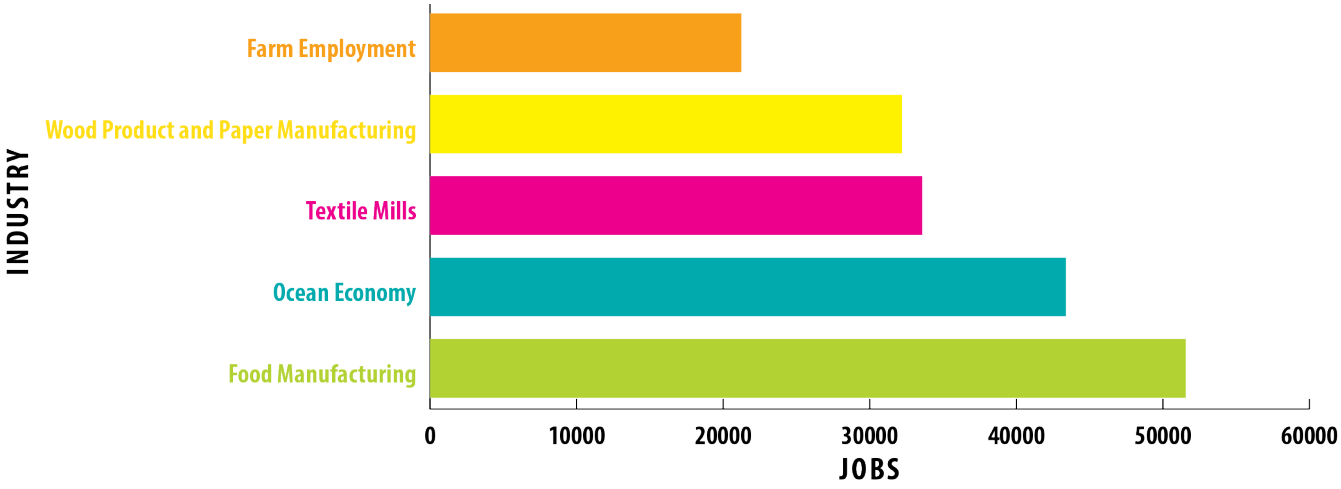


Figure 9. Employment in selected North Carolina economic sectors in 2013. Source: NOEP, 2016; U.S. Census Bureau, 2016.

North Carolina's Coastal Economy

In addition to the "ocean economy," NOEP, and a number of states in recent years, have taken a broad view of the "coastal economy," defined here for North Carolina as "all economic activities and industries for the 20 CAMA coastal counties of North Carolina." While this report focuses only on the ocean economy, one could assume a relationship exists between the ocean and all sectors of the economy in coastal counties, where the location may reflect a desire of the population to be near the ocean. Indeed, this segment of the economy in some cases may grow faster than the population, with employers to sustain it moving inland.

populated oceanfront counties with significant urban populations (e.g., New Hanover County). Accordingly, employment and GDP vary greatly among the coastal counties. In 2013, New Hanover and Onslow Counties dominated with 96,657 and 47,763 jobs respectively, while counties like Beaufort, Brunswick, Carteret, Craven, Dare and Pasquotank ranged from 15,000 to 40,000 jobs each. The remaining coastal counties had less than 10,000 jobs each (NOEP, 2016). See **Annex 1** for figures depicting the level of employment and GDP for each coastal county.

Table 1. Economic contribution of North Carolina's coastal counties in 2013. Source: NOEP, 2016.

County	Employment	Wages ($ billions)	GDP ($ billions)
All N.C. counties	4,057,439	182.5	483.1
All N.C. coastal counties	331,991	11.9	32.8
N.C. coastal counties as a percent of all N.C. counties	8.2	6.5	6.8

In 2013, the coastal counties represented 6.8 percent of GDP for all North Carolina counties, contributing $32.8 billion, as shown in **Table 1** (NOEP, 2016). The number of business establishments, level of employment and wages in the coastal counties represent 10.1 percent, 8.2 percent and 6.5 percent, respectively, for all North Carolina counties.

North Carolina's coastal economy varies greatly from inland agriculture-based coastal counties (e.g., Hertford and Hyde Counties) to oceanfront tourist destinations (e.g., Dare County) to more

Other analyses define coastal economic activity as limited to nearshore areas and rely on ZIP codes as the geographic unit of analysis (Colgan, 2004; Latham and Lewis, 2012). Calculating economic impacts for North Carolina's nearshore areas would be a more precise measure of the coastal economy, and could be carried out as a next step after this initial assessment. In addition to nearshore areas, ZIP code areas that border the state's sounds, estuaries, rivers and tidal creeks in the coastal counties could be included as a more precise coastal-economy measurement.

III. TRANSITIONING TO A BLUE ECONOMY

Given the significance of North Carolina's ocean economy in terms of contribution to GDP and statewide employment, and its linkages to underlying natural resources and ecological systems, the concept emerging worldwide over the past decade for a "green economy" and "green growth" may be a particularly useful lens for the state.

The green economy was featured prominently in the outcome statement by countries at the Rio+20 Earth Summit in 2012, as a tool for policymaking that provides a lens for looking at economic and environmental policy together (United Nations, 2012). Just before the Summit, the Organization for Economic Cooperation and Development (OECD) developed a global green-growth strategy to support policies that:

- Enhance efficiency in the use of resources and natural assets, and reduce waste;
- Spur innovation to simultaneously create value and help solve environmental problems;
- Create new markets by stimulating demand for green technologies, goods and services; and
- Boost investor confidence through greater predictability and continuity in addressing environmental issues (OECD, 2011).

The OECD has since developed a wide body of work suggesting policy recommendations for the green economy. Many of these recommendations focused on enhancing sustainability of extractions from natural resources as inputs into economic sectors, and reducing outputs or impacts from these sectors affecting these resources and the ecological systems. In 2016, the OECD released the most comprehensive measure to date of the global ocean economy (OECD, 2016).

In North Carolina, the Department of Environment and Natural Resources, now known as the Department of Environmental Quality, articulated "growing the green economy" as one of its 2009-2013 Strategic Plan goals (NCDENR, 2009).

Prior to the Rio+20 Earth Summit in 2012, the United Nations Environment Program (UNEP) together with a group of partners applied the concept of the green economy to the ocean economy — i.e., a "blue economy." Their focus was on policies to "green" the ocean economy, looking sector by sector. Subsequently, a number of national and international summits were held on the blue economy, as featured in the United Nations Food and Agriculture Organization's (FAO) 2014 State of World Fisheries and Aquaculture report (FAO, 2014).

Drawing from these efforts, the Economist Intelligence Unit (2015) defined the concept of the blue economy as: "when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy." Essentially, the blue economy concept is a lens by which to view and develop policy agendas that simultaneously enhance ocean health and economic growth.

Blue Economy refers to a sustainble ocean and coastal economy, which emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy. Essentially, the blue economy concept is a lens by which to view and develop policy agendas that simultaneously enhance ocean health and economic growth.

The blue economy concept recognizes that some activities in the ocean and coastal economy depend on the status of the underlying natural "capital," while all have the potential to deplete it, degrading the ecological systems and putting jobs and economic growth in this segment of the economy at risk. Increasingly in other states and in other countries, policy frameworks and industries are emerging that simultaneously enhance or expand the natural and manufactured capital of the blue economy. Essentially, the blue economy concept provides a lens by which to measure and identify these types of opportunities in the aggregate, and support enabling policies, for a net benefit to the ocean economy and environment.

North Carolina's ocean economy is supported by, and in turn affects, a wide range of natural resources and ecological systems. In aggregate, these natural resources and ecological systems can be considered as the state's portfolio of "natural capital" assets along the coast, capable of producing a flow of benefits such as income.

This does not exclude the intrinsic values of these systems, that is, irrespective of benefits to people, but rather emphasizes their connection to the economic activity defined in the ocean economy.

The state's waters lie at the juncture where the largest ocean currents in the Atlantic meet. The Labrador Current from the north and the Gulf Stream from the south merge temperate and subtropical waters, respectively, at Cape Hatteras. This mixing of coastal waters provides key spawning and nursery grounds for a diversity of plants and animals, while the waters offshore contain deep-water canyons characteristic of the northern system and deep-water coral wilderness stretching to the south (NCDC, 2011). North Carolina also possesses the East Coast's largest estuarine system at 2.3 million acres. These landscape features shape the state's living estuarine and marine resources.

These ecological systems provide a natural capital asset base underpinning North Carolina's ocean economy, which could be categorized by:

- Fish stocks, including nonfinfish species,
- Beach and coastal water quality, and
- Natural habitats, which support a wide range of biodiversity.

Essentially the state's — and the country's — total wealth comprises three asset types: (i) natural capital such as that described above, (ii) produced capital (e.g., machinery and structures), and (iii) intangible capital (skills, expertise, etc. with which labor is applied) (World Bank, 2006). Essentially, the state's GDP can be measured as the economic returns on its total capital or wealth. Economic growth would be achieved by increasing the state's total wealth — the total value of its different assets.

As implied by its definition, North Carolina's ocean economy receives inputs as a factor of production from the state's natural capital, and at the same time provides outputs that affect the natural capital. Dredging, sand mining and beach nourishment are examples of outputs or impacts from coastal development on natural habitats (MAFMC, 2015a), as is construction or expansion of ports, marinas, harbors or channels for shipping (MAFMC, 2015b). If properly managed, many of these natural capital assets are renewable and capable of yielding a sustained flow of benefits. For example, fish stocks are a renewable natural capital asset providing a flow of inputs into the production of seafood. The status of this natural capital asset is tracked by the North Carolina Division of Marine Fisheries, which categorized 37 different species in 2015 as viable, concern, depleted, unknown, or recovering as shown in **Figure 10** (NCDMF, 2015b).

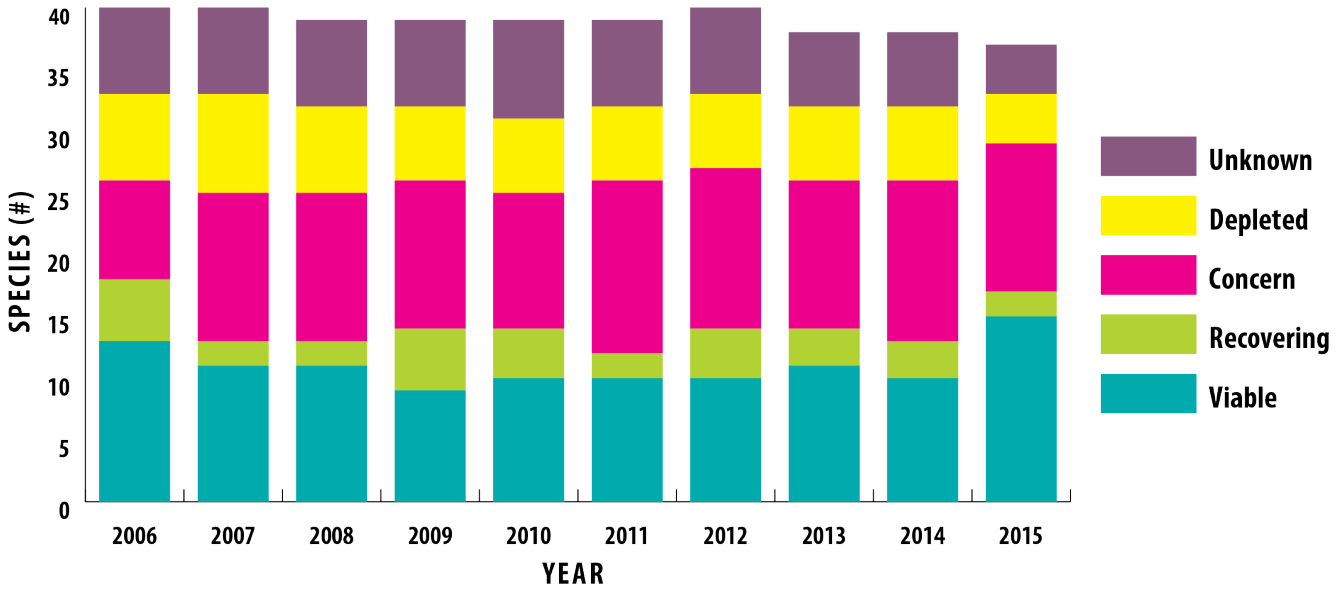


Figure 10. Status of North Carolina's fish stocks over time as determined by the North Carolina Division of Marine Fisheries. Source: NCDMF, 2015b.

Models of the blue economy would measure both the economic sectors of the ocean economy and the natural capital underpinning this activity. Simultaneously tracking metrics of economic growth and environmental sustainability in the state's ocean and coastal areas, together with clear investment principles, could help leverage greater investment in the ocean economy and increased benefits for North Carolina over the long term.

These examples demonstrate economic activities in line with the blue economy concept:

- A local eco-label, like the "NC Catch" brand, communicates sustainable commercial fishing products, bringing more shelf space or even a price premium for North Carolina seafood;
- Shellfish aquaculture enhances coastal water quality and produces valuable seafood that contributes to employment and GDP; and
- Offshore wind could generate thousands of new jobs and significant energy capacity, according to some estimates.

IV. CONCLUSIONS AND NEXT STEPS

Existing, widely available data (NOEP, 2016) suggest that North Carolina's ocean economy contributed $2.1 billion to state GDP and an estimated 43,385 jobs in 2013. Even these conservative estimates highlight the significant contribution of the ocean through the natural capital asset base to jobs and revenue along the coast, contributing 6.5 percent of GDP and 12.9 percent of employment in the 20 coastal counties.

The blue economy concept can be useful in measuring the state's ocean economy and connecting it to underlying ecological systems and resources. Models of the blue economy would facilitate understanding of a unique and discrete segment of the state's economy, particularly of the coastal region, and provide a basis for targeted policy, business clustering and increased investment.

Further development and application of the blue economy concept in North Carolina could provide a decision and communications tool for better understanding the impacts of potential policies upon discrete natural capital assets and the subsequent returns from the wider ocean economy. Building upon this first assessment, updated economic data from NOAA and NOEP could be supplemented by additional market data from recreational fisheries and coastal development in targeted ZIP codes. Non-market values for carbon sequestration, coastal protection and waste disposal could be included if available in the literature. Data on the state's natural capital asset base supporting the ocean economy could be compiled into an easily accessible format.

With this foundation of data on the economic activity and ecological functions in the state's coastal and ocean areas, a blue economy conceptual framework could be developed. This framework would provide a representation of:

1. Ocean economy services and sectors,
2. The natural capital asset base underlying this economy,
3. Material flows from natural capital to specific sectors of the ocean economy, and vice-versa, and
4. The governance structure influencing these flows.

The ultimate goal of this framework is to identify policy options and business opportunities to grow and transition the ocean economy to a blue economy. An ongoing research program is needed in North Carolina to develop and apply the blue economy framework, as well as monitor the transition.

ANNEX 1. NORTH CAROLINA COASTAL GDP AND EMPLOYMENT

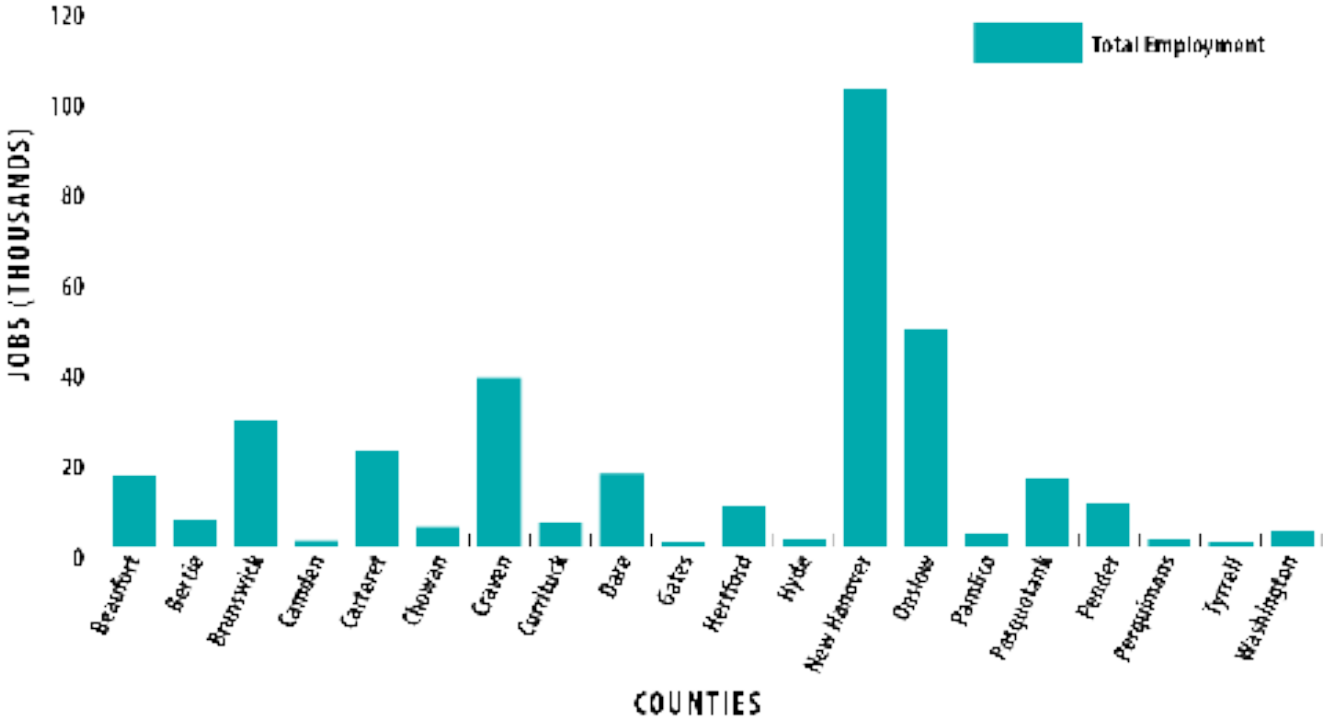


Figure A. Overall employment in North Carolina's 20 coastal counties in 2013. Source: NOAA, 2016; NOEP, 2016

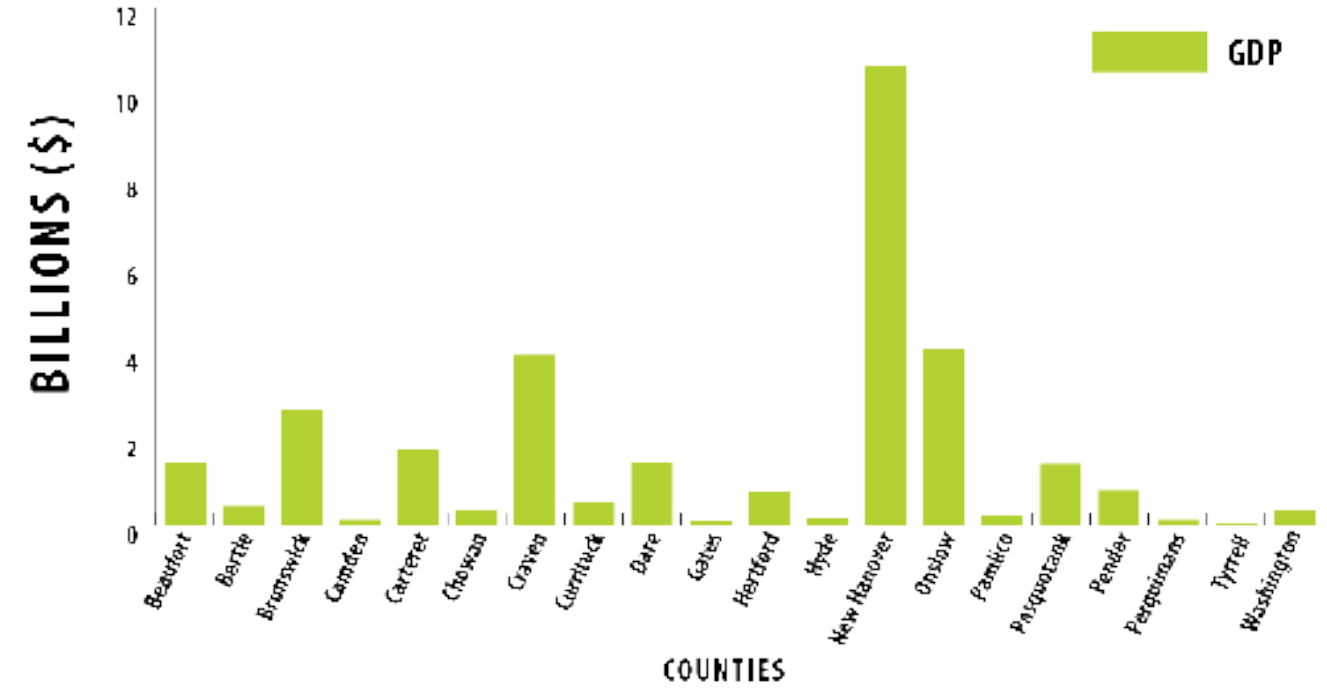


Figure B. Overall GDP in North Carolina's 20 coastal counties in 2013. Source: NOAA, 2016; NOEP, 2016

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