

# The importance of estimating the contribution of the oceans to national economies

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## ABSTRACT

The oceans are in trouble. Poorly understood and unprecedented environmental and economic changes are underway in our world's oceans that will significantly affect life in the sea as well as on land. Only in the last thirty years has the contribution of the ocean sector to the economy been measured. An examination of these studies has exposed definitional, conceptual and methodological differences in measuring marine-related economic activity in the economy, making comparisons difficult. Both the ocean and the coastal economies face a world of volatile changes. In the ocean economy marine transport faces unpredictable fuel costs. Coastal tourism also faces losses from climate change impacts and sea level rise. Finally, a warming ocean and increasing acidification of the oceans from greenhouse gases is already affecting coral reefs and a range of fish stocks. Economic measures are important to predict these impacts, as are economic measures of the resilience of different areas of the ocean and coastal economies. This article demonstrates how knowledge of both the ocean, coastal and national economies can help governments address the future impacts and demands posed by nature and human populations on our coasts and oceans.

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## 1. Why estimate the contribution of the oceans?

The desire to estimate the ocean economy is driven by the effects this large segment has on the entire economy. Coastal tourism and marine transportation represent the largest sectors of the ocean economy, and rely on a huge number of suppliers as well as users, all of which are fed by the ocean. The size, nature and growth trends in these industries provide government a factual basis for tracking changes in the state of the ocean-related economy as well as those industries that are part of the inputs to and outputs from its activities. In addition, governments have large involvements in regulating offshore resources such as fisheries and oil and gas, as well as marine transportation, ship building and other marine construction activities.

The initial description of the production of ocean industries in the United States [1] was followed by an article in *Science* examining the economic contribution of the U.S. ocean to the national economy [2].

These initial studies recognized long-term dependence on the oceans, and noted that marine trade and marine resource trends and fluctuations could impact national economies, hence warranting programs that could track the data. A few of the initial studies led to repeat studies, so as to generate time series data enabling the trends and fluctuations of each sector of the ocean economy to be monitored over time.

These ocean economic studies also raised issues about the value of the coasts to the economy. By 1990, the coastal economy [3,4] was recognized as a significant driver of the national economy. How the coastal economy relates to the ocean economy was developed by Kildow and Colgan as discussed in Section 2.

There also have been a number of studies about the importance of the ocean economy to provinces or states. While these are not the focus for this paper, they are of interest here to demonstrate the range of issues defined by coastal geographies as they affect national economies. For example, in the United States, Florida represents a large segment of the U.S. national economy, because its coastal and ocean economies are so extensive. Yet, Florida is the most vulnerable state to climate change impacts, particularly sea level rise and coastal inundation from storms that protecting this economy should be of concern to the national government. However, details of these economies are not included

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in the current paper, which concentrates on valuing the national ocean economies and the international developments in this area.

In the late 1990s a range of other nations produced ocean valuation studies:

- The Canada Oceans Act was passed in 1997. This process generated two reports on Ocean Sector Canada [5] and Canada's Ocean Industries [6,7]
- In the United Kingdom, Pugh and Skinner [8] and Pugh [9] examined marine related activities in the United Kingdom;
- Australia produced two studies as part of its National Ocean Policy, with Allen [10] examining the economic contribution of marine based industries to the economy;
- France has a national study [11,12] developed in response to the European Commission which began work on an all embracing maritime policy; and
- New Zealand did a study to see how the marine environment is utilized to generate economic activity [13];
- The National Ocean Economics Program [14] released the State of the U.S. Ocean and Coastal Economy in June 2009.

A report of the economic value of the marine economy across the Asia Pacific Economic Cooperation (APEC) marine economies, compared the methodologies in the Australian, Canadian and U.S. studies [15].

The United Nations Law of the Sea Treaty, adopted in 1982, established national sovereignty for signatories over an exclusive economic zone (EEZ) of up to 200 miles offshore, giving nations jurisdiction over marine resources in that area. The formation of the EEZs was intended to assist coastal states to capture the economic benefits from their adjacent ocean territory. Although the Convention on the Law of the Sea came into force in 1994, there was not an immediate drive by governments to assess the value of their added territories in any systematic fashion, although in some cases, the amount of territory and value was a windfall. In the United States, for example, it doubled the land territory.

The existing national ocean economy studies mostly stemmed from the efforts of individuals and academics; governments, including agencies charged with management of the ocean have only come to this of late. Even at this time, ocean valuation studies in some nations, e.g. United States and Canada, have not been readily undertaken by staff within existing government national accounts agencies, but have required external consultant and academic input.

In the late 1990s the contribution of the ocean to the national economy was seen as information required for ocean policy and planning initiatives legislated in Canada, Australia and via the U.S. Ocean Act. In the United States, the Office of Management and Budget required ocean expenditure information from federal agencies to meet the legal requirement to annually publish a Federal Ocean Budget.

These studies have provided the governments with baseline information on the economic contribution from the oceans for national ocean investment, planning and protection strategies. As the ocean economy process has matured, a time series of ocean economy data has been developed to assist with analyzing trends in and impacts on the ocean economy. The studies have developed a range of information that has been used by marine policy-makers, politicians, lobbyists, industries and non-government organizations with oceans mandates. The most frequent use is quoting the total value of the ocean economy as an indicator of its societal and economic importance.

## 2. A comparison of how different countries have estimated the ocean economy

This section compares the different national studies and looks for common elements among studies. The studies have different origins and emphases.

In the U.S., Nathan and Associates [1] used the 1972 economic census data from the Bureau of Economic Analysis (BEA) to value industries that “utilized an ocean resource in a production process” or “produced a product or service that was demanded because of some quality attributable to the ocean”. Pontecorvo and Wilkinson [2] and Pontecorvo [16] estimated the contribution of the ocean to the U.S. economy using the sixty-six industries from the national income accounts for analysis.

In 1999, The National Ocean Economics Program (NOEP) initiated a website ([www.OceanEconomics.org](http://www.OceanEconomics.org)) featuring an economic time series focused on the ocean-dependent economy of the United States to determine its contribution to the national economy. The ocean economy is defined as the economic activity, which indirectly or directly uses the ocean (or Great Lakes) as an input. This research team selected four key indicators that tracked the growth and decline of six clearly defined ocean-dependent sectors that represented an ocean slice of the reliable National Income and Product Accounts compiled by the U.S. Bureau of Labor Statistics since 1933 as a way of monitoring the health of the national economy. Within a few years, it became clear to this team that many ocean issues affected another slice of the U.S. economy, the coastal economy, defined as all activity that takes place in coastal areas.

The difference in the ocean and coastal economies is shown in Fig. 1 and discussed below.

Colgan [17] noted that two concepts underlie the data on economic activity associated with the marine economy:

- “The *ocean economy* is that portion of the economy which relies on the ocean as an input to the production process or which, by virtue of geographic location, takes place on or under the ocean. It is a function of both industry and geography ... While most of the ocean economy is located in coastal regions, some of the ocean economy (for example, boat building, seafood retailers and many ocean instrumentation, equipment and surveying industries) may be located in non-coastal regions; and
- The *coastal economy* is that portion of economic activity which takes place on or near the coast (whether defined as coastal watershed, coastal zone, or near shore areas). *The coastal economy consists of all economic activity in the coastal region, and is thus the sum of employment, wages, and output in the region.* Some of the coastal economy is the ocean economy, but

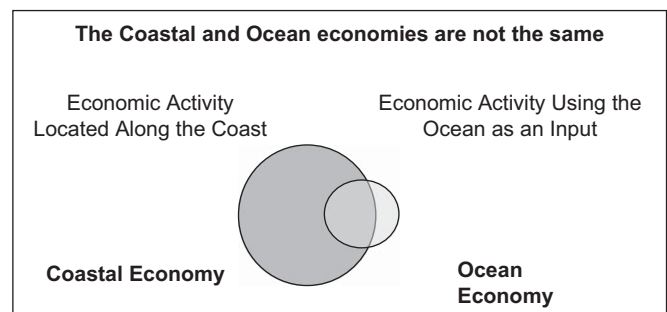


Fig. 1. Comparing the Ocean and coastal economies.

the coastal economy incorporates a broader set of economic activity” [17].

The terms “ocean” and “coastal” economy are not synonymous, and the ocean economy is considerably smaller than the coastal economy [17].

### 2.1. Studies in other countries

In Canada, *Ocean Sector Canada* [5] examined available ocean economy data and proposed further refinement of industrial categories based on actual survey data for the various industry segments, not the nationally compiled data of Canada’s national income and product accounts. In Canada’s Ocean Industries [7] “Ocean industries are defined as those industries that are based in Canada’s maritime zones and coastal communities adjoining these zones, or are dependent on activities in these areas for their income. Consistent with the mandate of the Oceans Act, the study excludes inland water industries, such as shipping and fisheries in the Great Lakes, canals and river systems of Canada”.

Pugh and Skinner [8,9] examined marine-related activities in the United Kingdom economy measuring “...activities which involve working on or in the sea. Also those activities that are involved in the production of goods or services that will themselves directly contribute to activities on or in the sea.”

The economic contribution of Australia’s marine industries by Allen [10] sought “... to compile data on those industries which have been categorised as a marine industry on the basis of their relationship with the marine environment—be that through the use of a marine resource (such as commercial fishing, offshore oil and gas), the provision of services through marine transportation (such as shipping and port based industries) or taking advantage of the positive attributes of the marine environment (such as marine tourism).”

Kalaydjian et al. [11,12] produced French marine-related economic data for 2003 and 2005. This builds on previous studies and is in response to the European Commission’s needs as it begins work on an all embracing maritime policy, stimulated by the publication of a green paper.

The aim of the New Zealand study [13] was “to enhance the understanding of how New Zealand’s marine environment is utilised to generate economic activity (measured as contribution to Gross Domestic Product (GDP)). This report, like, its counterparts in the previously mentioned studies, provides a view of National Accounts by cutting across traditional economic boundaries, using information from industries that specifically use the marine environment.”

#### 2.1.1. What have the studies measured?

As shown, the definitions of industries in the ocean economy vary among countries and the general approach has been to:

1. define industries that are part of the ocean economy;
2. identify those industries via the use of data from the national accounts;
3. estimate the proportion of total economic activity that is ocean /marine-related;
4. record the estimated expenditure and in the case of the USA (employment, number of establishments, earned wage, and productivity numbers) in the marine economy;
5. compare official government estimates with available information from industry sources.

Identifying the marine activity in national accounts may be difficult and require additional survey activity. For example, using only national accounts, marine construction, offshore minerals,

and fisheries categories suffer in the North American Industrial Categories (NAICS) from two problems: (1) incomplete data on the sectors because of the configuration of the category for identifying the full spectrum of offshore activities and the inconsistency of reporting from the fishing industry; (2) inability in some cases to distinguish what is land-based and ocean-based from the available information. Such surveying may (1) assist in defining the proportion of a national account’s total in the ocean economy; and (2) provide missing data not available in the national accounts. The survey estimates may be arbitrary, and thus not easy to replicate, and may be based on limited and inaccurate survey data, or information. There may also be industry pressure for the estimate of the value of the industry to be overestimated for lobbying purposes. Faced with these data issues Colgan [17], who is part of the U.S. team working with the National Ocean Economics Program, proposes the following principles for developing a methodology.

- *Comparability across industries and space.* The data should be consistent from the national to the local level and across all states. The metric for employment in one location should be the same as all other locations.
- *Comparability across time* The data should be sufficiently consistent over time that changes can be observed and measured with the same data at all points.
- *Theoretical and accounting consistency* The data should reflect standard economic theory describing the measurement of economic activity. It should not permit double counting of economic activity, meaning all measures can be summed across industries and geography.
- *Replicability* The assembly of the data should be done using a methodology that can be replicated by other researchers and that can form the basis for continued generation of data series into the future in order to establish long-term time series measures of the ocean economy [17].

The general approaches are assessing economic activity using standard measures related to production; output GDP, input and value added; and employment. Taxation revenue and Export revenue are also measured in the Australian study [10]. The U.S. study also measures flow values and volume of natural resource production of fisheries and offshore oil and gas to complement the flows of economic activity.

Gross domestic product (GDP) is a measure of the “value added” from economic activity and is preferred as it:

- Removes the danger of double counting (noted in all studies);
- Provides a meaningful basis for comparison across industries; and
- Simplifies analysis of regional impacts Kildow et al. [18] and [10,17].

Market indicators, as measured in the national accounts, are wages, employment and productivity GDP. The *gross value added* (GVA) is the value of outputs produced by an industry less the value of its inputs and can be directly compared with GDP, but GVA understates the economic importance of an industry to a region, because it excludes the value of inputs produced within the region [10].

In addition to market-based economic indicators, some national studies also have included “non-market” estimates, or values of goods and services not traded in the market place, and which do not have a societally-derived price. These estimates require specific measurement studies of specific sites, assets and services for particular purposes and are randomly produced

depending on funding sources and policy needs. Non-market estimates, which are snapshots in time, are quite separate from GDP measures that indicate changes over time. Their purpose is to estimate recreational and environmental asset and service values, which are not measured in the market place, but have unmeasured values, or consumer surplus values that provide benefits. Estuaries, beaches, watersheds, and mangroves are but a few of these assets. Pollution filtration, nursery grounds for fisheries and buffering from storms are examples of environmental services. The NOEP website has a full, heavily annotated collection of carefully reviewed studies, along with a summary sheet of estimated values from those studies that exemplifies one way a national study handles this extended valuation of the contribution of the ocean to the economy.

## 2.2. Industry categories

Issues of consistency in industry categories across national economic studies arise in comparing the marine economy in several Asia-Pacific Economic Cooperation (APEC) member economies [15]. The Marine Resource Conservation Working Group, Round Table Forum of the 21 APEC economies [19] identified the following guideline list of nine industry sectors as common in the APEC region [15].

The list is to promote consistency across different ocean valuation studies, reconciling national account systems interna-

tionally, for comparative purposes. Table 1a is an overview table comparing the categories studied in the different national ocean economy studies to date.

In Table 1a the APEC sectors indicate the emphasis of the different past ocean economy studies. All economies measure oil, gas, fisheries and shipping due to their role in production and trade. Government expenditure data on the oceans are not available in all economies due to national security or other concerns. The sectors lower down in Table 1 reflect service industries, such as marine tourism and transportation, which are common to most national studies.

There is less commonality in marine manufacturing, marine services and research and education. The UK and French studies prioritize research and education, which reflects the objective of these studies. Marine manufacturing and services sectors may not be categorized similarly among economies [19].

The U.S. studies through the National Ocean Economics Program have a more detailed comparison as reported in Table 1b.

In Table 1b, it appears there can be additional sub-categories added and that the degree of depth in each category can also vary in line with the objectives of the study and the information available.

The tables only indicate sectors or industry categories and require further detail on what is being measured. For example the use of GDP as a measure of market values from national accounts is common across all studies, but only the United States and New Zealand have included non-market values. Similarly the national

**Table 1**  
(a) Ocean economy industry sectors proposed by APEC [19] from six different national studies. (b) Ocean economy industry sectors and categories for six different international economies [14].

OCEAN ECONOMY—APEC Industry sectors							AU	CN	FR	NZ	UK	US
(a)												
Oil and gas (Minerals)							•	•	•	•	•	•
Fisheries/aquaculture (living resources)							•	•	•	•	•	•
Shipping (marine transportation and ship building)							•	•	•	•	•	•
Defence/government								•	•		•	n/a
Marine construction								•	•	•	•	•
Marine tourism (leisure services)							•	•	•	•	•	•
Manufacturing (equipment)								•		•	•	
Marine services (mapping surveying consulting)								•	•	•	•	
Marine research and education									•		•	
Key: AU Australia, CN Canada, FR France, NZ New Zealand, UK United Kingdom, US United States. n/a—Data not available.												
Category	AU	CN	FR	NZ	UK	US						
(b)												
Offshore minerals	FULL	•	FULL	•	FULL	•						
OE offshore oil & gas	FULL	•	FULL		FULL	•						
Sand and gravel			FULL		FULL	•						
Living resources—commercial	FULL	•	FULL	•	FULL	•						
OE recreation and sport fishing		•										
Aquaculture			FULL		FULL							
Marine transportation	FULL	•	FULL	•	FULL	•						
Type (i.e.Cargo)			•		FULL							
Ports	FULL	•	•		FULL							
Gov't/defense/security		•	FULL	•	FULL							
Environmental protection			FULL									
Marine construction		•	FULL	•	FULL	•						
Tourism & recreation	FULL	•	FULL	•	FULL	•						
Cruising/leisure boating			FULL		FULL							
Marine equipment/manufacturing		•		•	FULL		US includes in two separate categories.					
Ship & boat building	FULL	•	FULL		FULL	•	Buried in nativational equipment					
Ship & boat maintenance			FULL		FULL	•						
Marine services												
Marine science/technology		•	FULL		FULL							
Safety and salvage			•		FULL							
Crossings (i.e. tolls)					FULL							
Marine research and education												
Education and training			FULL		FULL							

Key: FULL indicates information covered in great depth.



studies may have states and regions that can be significant drivers of the ocean economy and are at a layer of disaggregation not addressed in Tables 1a and b. The development of the data into a time series is also important requiring repeat studies. The United States, France, Canada and Australia have had two or more studies to determine trends in sectors of the ocean economy. The NOEP website updates US coastal economy data every year.

The U.S. NOEP data also demonstrate the higher informational requirement for addressing the coastal economy, and the benefits to the ocean economy in pursuing this detail [14]. In the coastal economy the results are determined for areas such as shoreline adjacent zip-codes, shoreline coastal counties, coastal zone counties (those managed by states as part of Coastal Zone Management programs), coastal watershed counties, inland counties and extend the range of economic indicators to population and housing. In the coastal economy non-market values for beaches, boating, bird watching and wildlife viewing, scuba diving, surfing and marine protected areas can be evaluated [14]. In addition, time series on flows of natural resources characterize the U.S. work, complementing the market and non-market sector studies ([www.OceanEconomics.org](http://www.OceanEconomics.org)).

*The results from past ocean value studies:* The estimated national contribution of the ocean economy in various economies is reported in comparison of past results reported in Table 2.

In Table 2 the ocean economy GDP is presented as a percentage of total national GDP, indicating the percentage contribution of the ocean sector to the value added nationally in the whole economy.

The studies calculate the GDP, or value added, and present the results as a percentage ratio. The Canadian study [6] reports value added as 1.5% of GDP and the British study [ ] as 4.9% of GDP in 2000. The US study [17] reports that the ocean economy GDP was 1.15% in 2000, and 1.2% in 2004 of total GDP [14] (value added) in the US economy and the French contribution is similar at 1.4% in 2003 [11,12]. The Australian study [10] calculates value added and expresses it as 3.6% of gross value added in the national economy and New Zealand [13] has 2.9% of national GDP.

The differences in the ocean economy as a percentage of the total economy is potentially an indicator of national economic dependence on the ocean and of economic diversity within each nation. A high degree and diversity of industrialization and large population will dictate the value of the national economy and probably make the contribution from the ocean economy less. In contrast, a small island economy, or less developed economies with low levels and more concentration of industrialization, may have the ocean economy as a higher percentage of the national economy. It is also important to realize that the coastal economy is not being measured and compared. International comparisons of coastal economies are not available.

A time series of several studies enables sectors of the marine economy to be compared looking for growth or reduction in the

ocean sector contribution. Throughout several of the studies, growth and declines in the ocean economy tracked growth and declines in the service sectors versus the manufacturing and production sectors. The Canadian and NOEP studies noted a declining trend in fishing industry values over the last decade, and also an increase in the value of marine tourism during the same period, indicating a decline in the production/manufacturing sectors and a rise in the services sectors. Sectoral evaluation of trends in each specific ocean sector gives decision makers a more complete picture of the changes in the ocean economy and how the different economic activities compare with each other when trade-offs must be made.

What is not measured in the national accounts approach is the sustainability of ocean activities, e.g. fish catches may reduce stocks; oil and gas production is non-renewable. Using up stocks does not reflect the real price of depletion of a resource. Even in the service sectors, large activities such as tourism are volatile and vulnerable subject to intractable events of weather and the economy.

The GDP data do not include environmental stocks and ecosystem values, which are not direct goods and services. The international community has attempted to take wider environmental values into account in national accounting frameworks including the environment in measures of human well being. The value of the oceans to mankind has both use and non-use values. Many of these values are not captured in national accounts.

There also can be impacts from ocean economy activities such as growth in shipping, or oil production, which may increase pollution. These externalities are not measured. Uses of the sea, like waste disposal through runoff, may not be sufficiently included in measures of the ocean economy, being an external cost to producers, often being borne by the environment and the public who pays for the impacts and mitigation measures.

In Table 3 different potential types of marine valuation are presented. The available data for the US are used to illustrate the research areas covered to date.

Direct measurement of ocean and coastal GDP has been achieved with some non-market valuation of coastal economic issues for example, beach use. The total non-market values and values for ecosystem goods and services are unknown for both the ocean and coastal economies. In these columns, the direct GDP result percentage for the ocean economy (1.2%) is estimated. It is not known whether the non-market and ecosystem goods and services values will exceed this value.

In the case of the ocean economy both the non-market values and ecosystem goods and services contribution would be considerably higher than 1.2%. This would reflect the large contribution of the oceans to human welfare and ecosystem functions like processing carbon dioxide. In contrast, the coastal economy (coastal zone counties), at 50% of the total economy, may

**Table 2**

The national estimates of the ocean economy as a percentage of the total national economy from past studies.

Country	Author	Date of study	Date of data in study	\$ Marine sector GDP/GVA <sup>a</sup>	Percentage of national GDP/GVA
Australia	Allen	2004	1996–2003	A\$26.7bn	3.6% GVA
Canada	RASCL	2004	1988–2000	C\$22.7bn	1.5% GDP
France	Kalaydjian et al.	2006	2003	Eur18.9bn	1.4% GDP
France	Kalaydjian et al.	2008	2005	Eur21.5bn	1.2% GDP
NZ	Statistics NZ	2006	1997–2002	NZ\$3.3bn	2.9% GDP
UK	Pugh & Skinner	2002	1999–2000	GB£39bn	4.9% GDP
UK	Pugh	2008	2005–2006	GB£46bn	4.2% GDP
USA	Colgan	2004	2000	US\$118bn	1.2% GDP
USA	Kildow et al.	2009	2004	US\$138bn	1.2% GDP

<sup>a</sup> The Australian data is gross value added (GVA).

**Table 3**  
Ocean, coastal and ecosystem values.

Sector	Direct GDP	Other non market values	Ecosystem values
Ocean economy	GDP	Non market values	Ecosystem goods and services
Coastal economy	GDP	Non market values	Ecosystem goods and services
Total economy	GDP	Non market values	Ecosystem goods and services
US example			
Ocean economy	1.2%*	Unknown—(higher %?)	Unknown—(much higher %?)
Coastal economy (coastal counties)	50%**	Unknown—(lower %?)	Unknown—(lower %?)
Total economy	100%	100%	100%

Key: \* and \*\* from NOEP.

have a lower or equal percentage of total non-market values and ecosystem goods and services.

Sustainability is not included in the GDP approach and requires valuation of the stock values of ecological goods and services. Such valuation is required in managing depletable stocks such as fish, and in being able to control the increasing flows of carbon dioxide into the stock held by the oceans.

In summary, the past two decades have seen a range of valuation studies on the ocean economy. These ocean value studies have been noted by government, but as occasional studies have not as yet occupied an analogous place to national accounts data for the land-based national economy. This may be consistent with the relatively recent advent of national jurisdiction on the oceans in the past decades, but it is a short-sighted perspective given the role of the ocean in providing many goods and services for human welfare. There are large climatic changes looming in the next few decades and our information base on the ocean, coastal and national economies will be impacted by a range of possible events.

### 3. Why are the ocean and coastal economy important?

At least six economies internationally have had introductory studies on the contribution of the ocean economy to the national economy. The US team has also developed an approach to valuing the coastal economy and this has gained political credibility in providing data and estimates for climate change events, such as the impacts of hurricane Katrina.

It is now apparent that the oceans have a significant chemical role with ecological impacts in the absorption of greenhouse gasses and are rapidly increasing in acidity, with significant declines in pH already apparent in the past decades [20,21]. This increase has the capacity to impact the ecosystem services and goods provided by the ocean and negatively impact human welfare.

Current trends are: a global transition away from a carbon-based economy; a decline in ocean and coastal fish stocks; increasing occurrences of water shortages and declines in tillable soil on land. These changes portend food shortages, the oceans becoming a focal point for many new activities including wind and wave power, offshore aquaculture and other enterprises.

Along with the movement to create marine protected areas to preserve the important resources that are at risk, and which support society and the oceans, the value of old and new economic activities and their importance to sustaining both the economy, the oceans and the planet, will become increasingly crucial. The value of ecosystem goods and services provided by the oceans have gained a new significance and require an international effort to put a value to the oceans in the political and planning process.

Past research on ocean and coastal economies is the initial part of the information requirement needed to address these chal-

lenges. Non-market valuation of the oceans and its ecosystem goods and services also is required to face new challenges. Ocean management and spatial planning are in their infancy, and have yet to find a place in governance. One of the impediments to their development is lack of appropriate valuation data for decision making. The generation of this data framework has taken time and been low priority. This will change with coming climate change impacts on the coast. This information should be treated as a public good, as part of the public infrastructure. When it is in short supply, it becomes valuable. That time has come.

In the 1980s and 1990s, the studies to estimate the size of the ocean economy were to identify the extent and dependence of their role in national economic production. These trial studies were of interest to the governance process, but were not adopted by government policy makers. They were “nice to know” information, rather than the data required by government to address a crisis. By the end of the 1990s there was recognition of the role of services in the marine economy and the recognition of marine tourism as being among the top contributing industries. Colgan [17] suggests that “*knowledge of the marine economy is very imprecise because little has been invested in developing the needed data, especially in comparison with the investment in understanding of other natural resources.*” The current valuations are recognized as being limited in scope, using data on available transactions. Even studies of the marine or ocean economy are incomplete, leaving out many small pieces and some large ones because the data are not readily available in any consistent and usable form. Hence, this accounting is highly underrepresented.

Since 2000, further research by the NOEP [22] has indicated that the coastal economy is an important link between the ocean and land management and planning processes. Once economists focused on ocean-dependent activities, it naturally followed that these uses and services were dependent on the economic activities along coastal areas. From the research, it is apparent that some parts of the ocean economy do not necessarily depend on coasts (e.g. inland fish processing factory, boat builders). Hence, while most of the ocean economy is part of the coastal economy, there are parts of it that are not. (these are not reported in the US studies). In this way the ocean economy differs from the coastal economy, which relies on the coasts and supporting those who live near the coast.

In the past decade there have been shifts in the marine economy from production to service industries like marine tourism. Marine tourism can be impacted by poor weather, and can suffer labor supply issues, providing low-paying jobs in expensive destinations, and forcing workers to travel long distances.

In the post-2000 period, the coastal economy in the US has been 50% of a \$13 trillion economy [14]. It has been the major part of public infrastructure, ports, sewage, airports, power plants, refineries, water delivery systems, major services infrastructure along coasts and waterways. The coastal economy areas support entire populations along shorelines, towns and counties.

Economies in transition, the coastal county economies have 50% of jobs and GDP; coastal states generate 83% of the US economy on 20% of the land [14].

Three examples of how knowledge about the marine economy can assist policy makers:

- (1) The interrelationship between the ocean and coastal economy became poignantly clear during Hurricane Katrina in the United States and the devastating Tsunami in Asia in the past few years. Many national and regional economies were deeply impacted by these events. After hurricane Katrina, the information for the impacts on jobs and the region was produced within days, due to having the NOEP data available.
- (2) For the California coast, the importance of economic measurement was linked to multiple reasons. A study measuring ocean dependent activities Moeller and Fitz [23] for the state of California provided a comprehensive picture of California's coast and the infrastructure that supported it. This study spawned numerous pieces of legislation and informed policy makers who managed California's coast. The NOEP study of California that followed several years later, has added to the momentum of California's leadership in preserving its valuable coast through additional funds and legislation.
- (3) The US national contribution of the coast and coastal ocean to the U.S economy was recognized in 2000 [18], as one of ten priorities that President William Clinton announced during the Year of the Ocean celebration in Monterey, California. That priority spawned the NOEP the following year, which continues to this day. A federal mandate was added a year later in the Ocean Act of 2000 [24] that required an ocean budget to be prepared every two years by the President, with information on the amount of annual federal government civilian expenditure on the oceans. With these two accounting procedures in place, one should be able to scrutinize the US investment and determine if they are in line with returns.

It also is notable that, as total valuation of the ocean or coastal economy is sought, the decision process will require additional valuations for decision making. These are the marginal or added values of goods and services created by the ocean, as well as the values of economic activities that take place in or near the ocean [18]. Marginal valuation requires additional estimation and are site and resource specific and useful in planning and allocative processes. It has become clear globally, that environmental and recreational assets have values outside of the market place and are too often ignored because they do not have prices attached to them directly. Estuaries, wetlands, mangroves, beaches, surfing, swimming, and other recreational and environmental assets all have values that economists have been estimating for at least forty years, with increasing accuracy and legitimacy as methodologies become more sophisticated each year.

### 3.1. Policy questions

Estimates of the magnitude and importance of coastal industries are critical in tracking economic health in coastal nations. They become especially relevant to the emerging climate change and inundation issues facing coasts internationally. Economic measures are important to forecast implications from these impacts, as are economic measures indicating the vulnerability and resilience of different areas of the ocean economy.

The dollar values in the coastal economy arise from different consumer preferences. Measuring economic values indicates the most economically vulnerable impact areas, such as a petroleum refinery or an airport on low-lying coastal land. Strengths in the

coastal economy are also identified, indicating potential resilience.

The national decision maker is often advised about the physical vulnerability of the coasts, but really they need a measure of how much of the national economy can rest in vulnerable zones. How can this level of vulnerability be reduced and at what cost? Many areas are performing studies to get a sense of magnitude of coastal and ocean risks. California has just issued a report that indicates some of the potentially most impacted areas and probable costs of mitigation and adaptation [24].

Coastal values also have been increased greatly as the population seeks to live along the coast. With coastal real estate a high revenue area, governments need to know how storm events and climate change might impact the local, regional and national economy and what can be done to reduce this impact. Shore-side lodging and restaurants as well as beaches are at high risk in some locations.

In the ocean economy, marine transport and tourism may now face a new fuel crisis and the impacts on operating costs of regulations on shipping that reduce carbon dioxide emissions to address climate change. These impact both the ocean and the national economy and decision makers and planners can use the marine economy framework to identify the economic impacts from these marine drivers.

## 4. Conclusions

Until thirty years ago, no one had understood the magnitude of what might be affected by changes in the oceans and along the coasts, because the ocean-dependent economy had rarely been scrutinized or estimated separately from the national economy.

Differences in definitional, conceptual and methodologies in measuring marine-related economic activity are now in broad agreement on direct industrial or extractive uses of the sea, such as, oil production and fishing, but less common ground in direct services provided, such as marine transportation and tourism.

The early studies addressed the contribution of the oceans to national GDP by estimating the value of "ocean-dependent" economic activities in both production and service sectors. Several studies have also included non-market indicators giving estimates of environmental and other values not included in GDP.

The interrelationship of the ocean and coastal economy became poignantly clear during Hurricane Katrina in the United States and the devastating Tsunami in Asia, in the past few years. National and regional economies were deeply impacted by these events.

Economic estimates are an important tool for measurement and to reduce future impacts, as are economic estimates of the resilience of different areas of the ocean and coastal economies. This article demonstrates how knowledge of both the ocean, coastal and national economies can help governments address the future impacts and demands posed by nature and human populations along our coasts and oceans.

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