AN ASSESSMENT OF THE VALUE OF THE PHYSICAL OCEANOGRAPHIC REAL-TIME SYSTEM (PORTS®) TO THE U.S. ECONOMY

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SCOPING STUDY TO ASSESS THE VALUE OF THE
PHYSICAL OCEANOGRAPHIC REAL-TIME SYSTEM TO THE US ECONOMY
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EXECUTIVE SUMMARY

This report estimates the economic benefits derived from a national implementation of NOAA's Physical Oceanographic Real-Time System (PORTS®) for the 175 most significant coastal ports. Benefits were defined for the 58 ports that had access to PORTS® data in 2010 and the 117 that didn't to identify the benefits PORTS® are and could be generating. The study was conducted in such a way as to be conservative in stating benefits, and well documented to enable the reader to evaluate the benefits of PORTS® for themselves.

From the beginning in 1991 with the first PORTS® in Tampa, Florida users have seen a benefit in having real-time environmental information first for safety and then secondly to improve the efficiency of their operations. The benefit was targeted but not limited to the marine transportation industry.

Marine transportation is vital to the nation's economy as the single largest mode of transportation for international trade. In 2010, the Gross Domestic Product (GDP) of the United States approximated $14.5 trillion[1] with the value of waterborne trade of imported and exported goods exceeding $1.43 trillion nearly 10 percent of GDP. Overall, international waterborne traffic represented about 76 percent of all imported and exported tonnage as well approximately 45 percent of the value of all imported and exported goods in 2010. It has also been estimated that the Marine Transportation System (MTS) supports more than 13 million jobs. (Martin, 2007 and Conway 2011)[2]

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[1] Source: U.S. Department of Commerce, Bureau of Economic Analysis, Gross domestic product (GDP) is the market value of all officially recognized final goods and services produced within a country in a given period. GDP per capita is often considered an indicator of a country's standard of living.

[2] Source: U.S. Department of Transportation, Maritime Administration. Also refer to Martin (2007) and Conway (2011). Conway estimated in excess of 13.2 million jobs were supported through the activity of U.S. ports.

While trade volume has increased the ships carrying it have gotten progressively larger – longer, wider, deeper, and taller stressing the bridge and channel infrastructure of the ports and challenging their ability to handle this vessel traffic it has become even more critical to maintain accurate real-time data to support waterborne commerce.

Shippers and marine pilots have found the PORTS® information to be the single most important source of information when they are working with ships that are operating very close to the channel bottom (depth constrained) or bridges spanning the channels and during times of adverse weather. In other words, when it gets difficult pilots turn to PORTS for their most important information. Anecdotal stories and empirical evidence abound of the uses mariners and shippers make of PORTS® information.

The benefits aren't limited to commercial marine transportation but extended literally to anyone operating on or near the water in areas covered by NOAA PORTS®. Anecdotal stories have been collected to augment empirical evidence indicating that the uses extend to hazardous material spill remediation, commercial and recreational fishing, recreational boating safety, recreational surfing and kite boarding, scuba diving, government agencies, operators of private industries, and municipal infrastructure, beach and wetland restoration operations, and even benefits to the academic community.

These stories along with four port case studies previously completed led to the development in this report of a series of logic modes which identify cause and effect relationships with user groups. Benefits resulting from the PORTS® data were identified and quantified employing a series of conservative assumptions based on previous academic studies, current empirical evidence, and expert experience. Secondary and tertiary economic benefits (e.g., employment and wages) from PORTS® were also estimated. These represent the levels of economic activity across four economic sectors (living resources, offshore minerals, tourism and recreation, and marine transportation) which are believed to be supported and made more resilient owing to PORTS® data (up to 1,700 firms, 46,000 jobs and $2.5 billion in wages).

Data employed in this valuation analysis came from several public, semi-public and private sources. Prominent among these were the NOAA Coastal Services Center's Digital Coast data Economics: National Ocean Watch (ENOW), National Ocean Economics Program (NOEP), United States Army Corps of Engineers' National Navigation Operation Management Performance Evaluation & Assessment System (NNOMPEAS) and Channel Portfolio Tool (CPT) data sets, Department of Labor (DOL), Bureau of Labor Statistics (BLS), the United States Coast Guard (USCG), the U.S. Department of Transportation (DOT), and the Census Bureau's U.S.A. Trade Online. Unlike previous studies, this analysis for the first time makes use of several proprietary data bases and analysis tools from the USACE. Pervious to this time, these data bases and analytical tools were only available to USACE personnel due to the sensitive nature of the data. They are still not available to non-Federal employees.

Employing this data the value of PORTS® data was estimated across five major beneficiary groups or sectors (commercial traffic, oil pollution remediation, fish catch, commercial marine accidents, and recreational boating accidents) on an annual basis. Finally, using the cost-of-capital specified by the Office of Management and Budget, a series of net present value calculations to estimate the benefits over the anticipated ten-year economic lifespan of PORTS® was performed.

Results expand the findings of four earlier studies which suggested total annual PORTS® benefits exceeded $100 million per year (2010 dollars). Exploring a wider array of beneficiaries this analysis conservatively indicates that PORTS® could potentially provide a total benefit of $300.0 million annually

TOTAL PORTS® Benefits for 175 ports[3]	**$300.0 Million**
PORTS® Benefits for 58 ports installed by 2010	$217.4 Million
PORTS® Benefits for 117 ports yet to be installed	$ 82.6 Million

Over the ten-year economic life of PORTS® this translates to a Net Present Value (NPV) of $2,456.0 million dollars.

TOTAL PORTS® NPV Benefits for 175 ports	**$2,456.0 Million**
PORTS® NPV Benefits for 58 ports installed by 2010	$1,779.3 Million
PORTS® NPV Benefits for 117 ports yet to be installed	$ 676.7 Million

The results of the study found that there were significant improvements in marine safety. There was an impressive reduction in the commercial marine accident rates.

- Groundings were reduced 59 %
- Overall accident rate (allisions, collisions and groundings) reduced 33 %
- Mortality reduced 60 %
- Morbidity reduced 45 %
- Property damage reduced 37 %

In addition, the socioeconomic effect from PORTS® if fully implemented at America's top 175 ports would be,

- PORTS® could help sustain 34,000 – 46,000 jobs.
- PORTS® could help support $1.6B - $2.4B in wages.

[3] Based on total tonnage handled in 2010.

CONCLUSION

PORTS® has been shown to have significant quantifiable benefits when examined over a range of users and from both safety and efficiency of operations. Appendix A includes the salient talking points for this valuation study of PORTS®**.**

This study of the benefits of PORTS to the nation was as thorough as time and the availability of data permitted. Several additional avenues of research may yield additional benefits.

- The benefit derived from air gap measurements was not completely examined for the lack of data. It appears that the USACE will be incorporating vessel and bridge height information in their analysis tools over the next year or two.
- The benefit of PORTS to industrial users may be very significant. There is anecdotal information that various industries located near the coast where a PORTS® exists to utilize this data to regulate their operations. This potential benefit warrants further study.

The benefit of PORTS could be further increased if potential users become aware of the availability of PORTS® data is available and how they could best use it to facilitate their operations.

PORTS® is not yet fully implemented with 117 (as of 2010) of the top 175 ports yet to have access to PORTS® data. The single greatest additional benefit that could be derived from PORTS® would be for NOAA to complete the implementation of PORTS® in all of the 175 most important ports. Full implementation of PORTS would increase the realized benefit of PORTS $82.6 million annually for a total of $300 million.

SUMMARY OF ANNUAL BENEFITS FROM PORTS®
(IN MILLIONS OF 2010 DOLLARS)

BENEFIT TYPE	BENEFITS FROM 58 PORTS WITH PORTS®	POTENTIAL BENEFITS FROM 117 PORTS WITHOUT PORTS®	TOTAL CURRENT AND POTENTIAL BENEFITS FROM 175 PORTS WITH PORTS®	CONFIDENCE LEVEL OF ESTIMATION
Commercial Traffic – Increased Cargo Capacity (Method 3[4]) (Use of smaller vessels to transport same traffic levels)	$119.6[5]	$40.7	$160.3	High
Commercial Traffic – Reduced Delays in Transit	$76.4	$28.8	$105.2	High
Oil Pollution Remediation	$3.5	$1.7	$5.2	Medium
Fish Catch:				
Commercial	$0.6	$1.2	$1.8	Low
Recreational	$0.1	$0.2	$0.3	Low
Commercial Marine Accidents - (including cargo, ferry, excursion & cruise - Associated with allisions, collisions and groundings)				
Property Damages	$5.2	$2.5	$7.7	High
Morbidity and Mortality	$11.8	$7.3	$19.1	Medium
Recreational Boating Accidents(Associated with weather and groundings)				
Property Damages	Less than 0.1[6]	Less than 0.1[7]	Less than 0.1[8]	High
Morbidity and Mortality	$0.2	0.2	0.4	Medium
Other Qualitative Benefits	Information only	Information Only	Information Only	
TOTAL	**$217.4**	**$82.6**	**$300.0**	

[4] Methods 1 and 2 suggested a larger annual potential benefit. Although Method 3 was not able to operationalize all benefits, it was supported empirically by the largest amount of objective rather than subjective data and thus considered the most supportable argument.

[5] Zero to four feet Depth Under Keel based on 74.6 percent of total tonnage under PORTS®

[6] Little more than $1,900 per year

[7] A little less than $2,900 per year

[8] Annual total of little more than $4,800

SUMMARY OF TEN-YEAR NET PRESENT VALUE FROM PORTS®
(IN MILLIONS OF DOLLARS)

BENEFIT TYPE	BENEFITS FROM 58 PORTS WITH PORTS®	POTENTIAL BENEFITS FROM 117 PORTS WITHOUT PORTS®	TOTAL CURRENT AND POTENTIAL BENEFITS FROM 175 PORTS WITH PORTS®	CONFIDENCE LEVEL OF ESTIMATION
Commercial Traffic – Increased Cargo Capacity (Method 3[9]) (Use of smaller vessels to transport same traffic levels)	$978.6[10]	$333.2	$1,311.8	High
Commercial Traffic – Reduced Delays in Transit	$624.8	$235.7	$860.5	
Oil Pollution Remediation	$28.5	$13.8	$42.3	Medium
Fish Catch:				
Commercial	$5.0	$10.1	$15.1	Low
Recreational	$0.9	$1.6	$2.5	Low
Commercial Marine Accidents (including cargo, ferry, excursion & cruise - Associated with allisions, collisions and groundings)				
Property Damages	$43.8	$20.6	$64.4	High
Morbidity and Mortality	$96.5	$59.8	$156.3	Medium
Recreational Boating Accidents(Associated with weather and groundings)				
Property Damages	Less than 0.1[11]	Less than 0.1[12]	Less than 0.1[13]	High
Morbidity and Mortality	$1.2	$1.9	$3.1	Medium
TOTAL	**$1,779.3**	**$676.7**	**$2,456.0**	

[9] Methods 1 and 2 suggested a larger annual potential benefit. Although Method 3 was not able to operationalize all benefits, it was supported empirically by the largest amount of objective rather than subjective data and thus cconsidered the most supportable argument.

[10] Zero to four feet Depth Under Keel based on 74.6 percent of total tonnage under PORTS®

[11] Less than $16,000 over ten years

[12] About $24,000 over ten years

[13] Less than $40,000 over ten years

REFERENCES:

Conway, K.C., *"U.S. Port Analysis"*, Colliers International Valuation & Advisory Services, Third Quarter, 2011.

Martin Associates, "*The Local and Regional Impacts of the U.S. Deepwater Port System, A report to the American Association of Port Authorities"*, Lancaster, PA., 2007.

APPENDIX A

TALKING POINTS FOR THE VALUATION STUDY OF PORTS®

I. BACKGROUND AND PERSPECTIVE

- **International Trade Vital To United States (2010)**
  - Imports to and exports from over 230 countries; equates to 22% of GDP.[14]
  - $1.9 billion metric tons imported and exported; 77 % handled via water (1.5 billion)[15]
  - $3.2 trillion in total value of imports and exports; 45 % handled via water ($1.4 trillion)

- **Constrained Traffic**
  - (0-2 Feet DUK[16]) – Great Lakes (107.7 million tons); All other (343.4 million tons)
  - (0-4 Feet DUK) – Great Lakes (154.6 million tons); All other (532.2 million tons)

- **The U.S. Has 360 Major Commercial Ports**
  - Top 175 handle over 96.6 % of all waterborne traffic; 92.4 % of Value; and, 56.2% of Transits

- **PORTS® AS OF 2010**
  - First implemented in 1991
  - Installed at 58 major U.S. ports through study period (1991 to 2010)
  - Ten year economic life of PORTS®
  - PORTS® currently covers 74.6 percent of all waterborne tonnage; 70.7 percent of all cargo value; and, 41.7 percent of ship transits

- **Vessels Calling on U.S. Have Increased In Size (2003-2010)**
  - Up 8.1 percent overall in terms of DWT[17]
  - Lead by containerships – up 18 % in terms of DWT; 25.1 % in terms of TEUs[18]
  - Containerships calls with over 5,000 TEUs increased 349 %
  - Panama Canal capacity will increase from 5,000 to 12,000 TEUs (2015)

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[14] Gross Domestic Product (GDP) is calculated as the sum of private consumption , gross investment , government spending plus the net of total exports less imports.

[15] Source: Department of Commerce, Census Bureau's Foreign Trade Division as reported by MARAD in U.S. Waterborne Foreign Trade by Custom Districts (Updated 7/29/13)

[16] Depth Under Keel (DUK)

[17] Dead Weight Tonnage (DWT) is a measure of how much weight a ship is carrying or can safely carry. It is the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew.

[18] Twenty-Foot Equivalent Unit (TEU) is an inexact unit of cargo capacity often used to describe the capacity of container ships as individual container height can vary. It is based on the volume of a 20-foot-long, 8 foot wide intermodal container, a standard-sized metal box which can be transferred between different modes of transportation, such as ships, trains and motor carriers.

II. REDUCTIONS IF PORTS® ARE PRESENT

- **Commercial Marine Accident Rates**
  - Mortality reduced 60 % (0.00012 with versus 0.00030 per trip without PORTS®)
  - Morbidity reduced 45 % (0.00121 with versus 0.00220 per trip without PORTS®)
  - Property damage reduced 37 % (0.033 with versus 0.052 per trip without PORTS®)
  - Groundings were reduced 59 % (0.011 with versus 0.027 per trip without PORTS®)
  - Overall allision, collision and grounding accident rates reduced 33 % (0.030 with versus 0.045 without PORTS®

III. BENEFIT ESTIMATIONS

- **TOTAL ESTIMATED BENEFITS**
  - $133.8[19] to $217.4[20] million per year;
    $1,095.1 - $1,779.3 million over ten years (current 58 PORTS®)[21]
  - $54.2 to $82.6 million per year;
    $443.7 - $676.7 million over ten years (117 future locations)[22]
  - ***$188.0 – $300.0 / year; $1,538.8 - $2,456.0 million over 10 years (total potential)***

- **Marine Transportation Savings**
  (Enhanced ladings and reduced delays)
  - $112.4 - $196.0 / year; $919.2 - $1,603.4 million over 10 years (58 current locations)
  - $41.0 - $69.5 / year; $335.9 - $568.9 million over 10 years (117 future locations)
  - ***$153.4 - $265.5 / year; $1,255.1 - $2,172.3 million over 10 years (total potential)***

- **Oil Pollution Remediation**
  - $3.5 million / year; $28.5 million over ten years (58 current PORTS®)
    21 percent reduction per vessel transit (2005 to 2011)
  - $1.7 million / year; $13.8 million over ten years (117 future locations)
  - ***$5.2 million / year; $42.3 million over 10 years (total potential)***

- **Fish Catch**
  Commercial
  - $0.6 million / year; $5.0 million over ten years (58 current PORTS®)
  - $1.2 million / year; $10.0 million over ten years (117 future locations)
  - ***$1.8 million / year; $15.1 million over ten years (total potential)***

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[19] Zero to two feet DUK (two feet of constraint)
[20] Zero to four feet DUK (four feet of constraint)
[21] Benefits estimated from 58 ports with PORTS® installed as of 2010.
[22] Benefits estimated if PORTS® installed at remaining 117 major U.S. port locations.

Recreational

- $0.1 million / year; $0.8 million over ten years (58 current PORTS®)
- $0.2 million / year; $1.6 million over ten years (117 Future locations)
- ***$0.3 million / year; $2.5 million over ten years (total potential)***

- **Commercial Marine Transportation**

Property Damage

- $5.2 million / year; $43.8 million over ten years (58 current PORTS®)
- $2.5 million / year; $20.6 million over ten years (117 future locations)
- ***$7.7 million / year; $64.4 million over the years (total potential)***

Morbidity and Mortality

- $11.8 million / year; $96.5 million over ten years (58 current PORTS®)
- $7.3 million / year; $59.8 million over ten years (117 future locations)
- ***$19.1 million / year; $156.3 million over ten years (total potential)***

- **Recreational Boating**

Property Damage

- LT $ 0.1 million / year; LT $ 0.1 million over ten years (58 current PORTS®)
- LT $ 0.1 million / year; LT $ 0.1 million over ten years (117 future locations)
- ***LT $0.1 million / year; LT $0.1 million over ten years (total potential)***

Mortality and Morbidity

- $0.2 million / year; $1.2 million over ten years (58 current PORTS®)
- $0.2 million / year; $1.9 million over ten years (117 future locations)
- ***$0.4 million / year; $3.1 million over ten years (total potential)***

- **Prevents DUK Constraints Related Issues**

- 470 - 1,510 fewer transits (58 current PORTS®); 160 - 514 fewer transits (117 Future locations);
- ***630 – 2,024 fewer transits (total potential)***

- 0.8 % – 2.5 % fewer transits (58 current PORTS®); 0.3 to 0.9 % fewer transits (117 Future locations)
- ***1.1 – 3.4% fewer transits (total potential)***

- ***Lower pollution, less congestion, reduced property damages, lower morbidity and mortality***

- **PORTS® Potential Influence and Support of Socioeconomic Factors**
  - 725 to 900 firms (58 current PORTS®); 650 to 800 firms (117 future locations)
  - 1,375 to 1,700 firms (total potential)
  - 19,000 to 26,000 jobs (58 current PORTS®); 15,000 to 20,000 jobs (117 future locations)
  - 34,000 to 46,000 jobs (total potential)
  - $1.0 to $1.5 billion in wages (58 current PORTS®); $0.6 to $0.8 billion in wages (117 future locations)
  - $1.6 to $2.4 billion in wages (total potential)

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CHAPTER 1 - PORTS® HISTORY

I. INTRODUCTION TO THE PHYSICAL OCEANOGRAPHIC REAL-TIME SYSTEM (PORTS®)[1]

The purpose of this study is to identify and assess monetary and demographic values to the data and information provided by the PORTS® managed by the Center for Operational Oceanographic Products and Services (CO-OPS) under the National Ocean Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA).

The National Ocean Service (NOS) is responsible for providing real-time oceanographic data and other navigation products to promote safe and efficient navigation within U.S. waters. The need for these products is great and rapidly increasing; maritime commerce has tripled in the last 50 years and continues to grow. Ships are getting larger, drawing more water and pushing channel depth limits to derive benefits from every last inch of draft. By volume, more than 95 percent of U.S. international trade moves through the nation's ports and harbors, with about 50 percent of these goods being hazardous materials. A major challenge facing the nation is to improve the economic efficiency and competitiveness of U.S. maritime commerce, while reducing risks to life, property, and the coastal environment. With increased marine commerce comes increased risk to the coastal environment, making marine navigation safety a serious national concern. From 1996 through 2000, for example, commercial vessels in the United States were involved in nearly 12,000 collisions, allisions, and groundings.

The NOAA Physical Oceanographic Real-Time System (PORTS®) is a collection of oceanographic and meteorological instruments integrated into a system to provide accurate,

[1] PORTS® is a registered trademark of the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS).

reliable, real-time, quality controlled information about the environment in which mariners and recreational personnel operate. PORTS® is a decision support tool that seeks to improve the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts and other geospatial information. PORTS® measures and disseminates observations and predictions of water levels, currents, salinity, and meteorological parameters (e.g., winds, atmospheric pressure, air and water temperatures) that mariners need to navigate safely.[2]

The system is designed to provide users with high quality information to support decision making (e.g., is there sufficient water for a ship to safely operate, can a ship safely transit under a bridge, are sea and weather conditions favorable to undertake a recreational boating trip, are conditions favorable for fishing near a port, etc.).

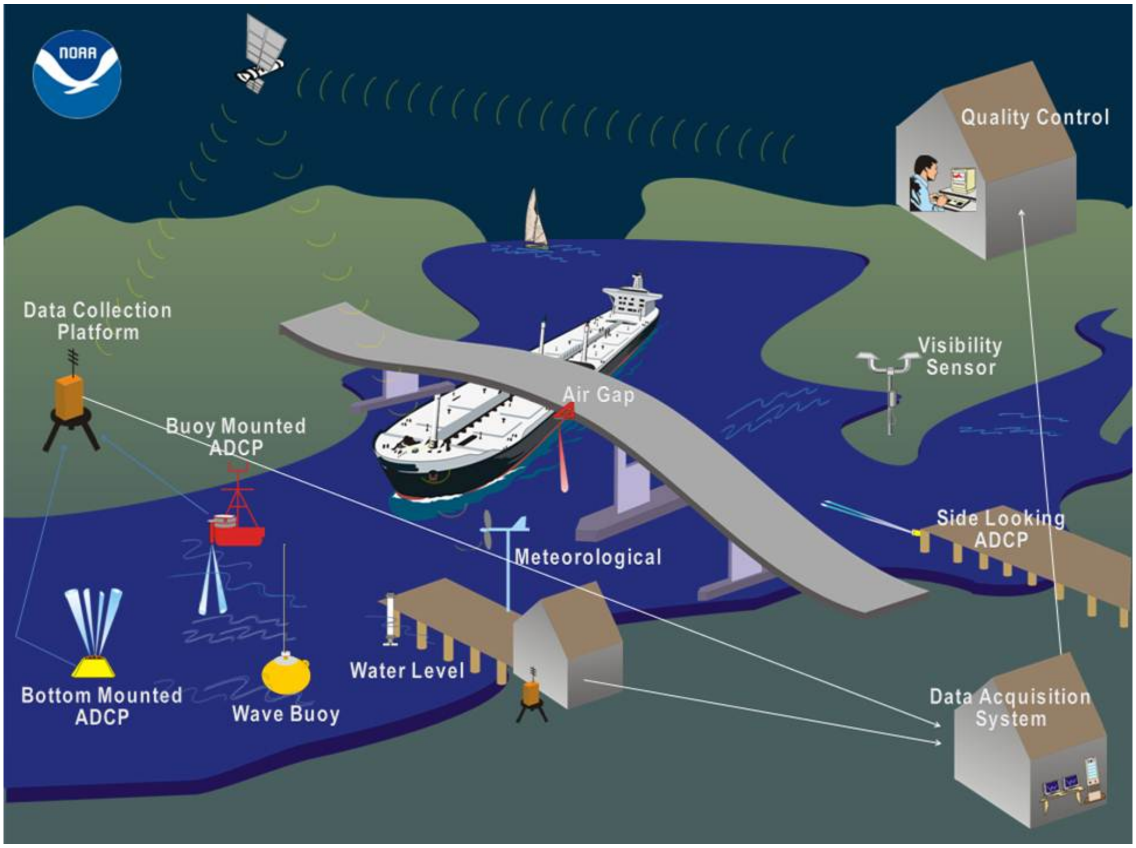
PORTS® provides accurate real-time oceanographic information, tailored to the specific needs of the local community. PORTS® come in a variety of sizes and configurations, each specifically designed to meet local user requirements. The largest of NOS's existing PORTS® installations is comprised of over 50 separate instruments; the smallest consists of a single water-level gauge and associated meteorological instruments (e.g., winds, barometric pressure, etc.). Refer to Figure 1. Regardless of its size, each PORTS® installation provides information that allows mariners to maintain an adequate margin of safety for the increasingly large vessels visiting U.S. ports, while allowing port operators to maximize port throughput.

[2] Edwing, Richard, Improving Safety and Efficiency Through PORTS®, AAPA Seaports Magazine, Summer 2013, p. 29.

PORTS® is accessible to maritime users in a variety of user-friendly formats, including telephone voice response and Internet. PORTS® also provides forecasts via numerical circulation models.[3]

Figure 1

DATA FLOWS WITHIN PORTS®



[3] NOAA also operates a series of long-term tide stations for the purpose of determining and maintaining the national water-level datum. The National Water Level Observation Network (NWLON) is a network of 210 long-term, continuously operating water-level stations throughout the USA, including its island possessions and territories and the Great Lakes. The National Water level Program (NWLP) consists of networks of long-term and short-term water-level stations and is an "end-to-end" system of data collection, quality control, data management and product delivery. The NWLP serves as a water level datum reference system for the Nation. The tide and water-level datums derived from the NWLP have traditionally been important primarily for navigation and shoreline boundary purposes. PORTS® include NWLON stations when they are located in a PORTS® area. Those NWLON/PORTS® stations serve a dual purpose providing real-time information to PORTS® users as well as serving as part of the national water-level system for the determination of the water-level datum. No attempt is made in this study to differentiate between the values a NWLON/PORTS® station provides to the two different programs.

A. Port Locations

PORTS® are presently operational in the following 22 locations[4]:

Atlantic Coast

1. Narragansett Bay, RI
2. New London, CT
3. New Haven, CT
4. New York/New Jersey Harbor
5. Delaware Bay and River
6. Chesapeake Bay VA & MD
7. Charleston, SC

Gulf of Mexico

8. Tampa Bay, FL
9. Mobile Bay, AL
10. Pascagoula, MS
11. Lower Mississippi River, LA
12. Lake Charles, LA
13. Sabine Neches, TX
14. Houston/Galveston, TX

Great Lakes

15. Soo Locks, MI

West Coast

16. Cherry Point, WA
17. Tacoma, WA
18. Humboldt, CA
19. Lower Columbia River, WA & OR
20. San Francisco Bay, CA
21. Los Angeles/Long Beach, CA

[4] From 1991, the year of the first PORTS® installation through 2010, the end year of this valuation study, PORTS® had been installed at 60 individual port locations. The difference in count between the number of locations and number of ports is that more than one port may be located in proximity of one another. For example in the Chesapeake Bay VA and MD region, there are a total of ten ports.

Alaska

22. Anchorage, AK

The following two PORTS® are in development at the time of this report.

1. Jacksonville, FL
2. Matagorda Bay, TX

II. BACKGROUND

Since 1830 NOAA and its predecessor organizations have been measuring tides and currents and developing predictions based primarily on astronomical forces.[5] These predictions of water level height and times of high and low water were critical for safe operations on the water. But, they were not always accurate. In areas of bays and inlets the water levels would at times be greatly affected by the direction and speed of the wind and river and storm runoff. But, while not perfect, the prediction tables were the best information available and mariners and those recreating near the shore used the information and planned accordingly. Mariners learned to employ safety factors to account for the uncertainty of the tide and current predictions. As newly built ships were constructed larger and larger to take advantage of the demand from a rapidly growing economy, shipping began to operate closer and closer to the bottom and more recently closer to the overhead bridges. Maintaining safety factors became an increasing problem as shippers competed for the use of that water. By the early 1980's pilots and ship masters were being put in difficult positions balancing the pressure from shipping companies to bring in more and more cargo while at the same time maintaining safe operations. Users needed more accurate and reliable information.

[5] *Tidal Datums and Their Applications*, NOAA Special Publication Center for Operational Oceanographic Products and Services , National Ocean Service, February 2001, P. A3.

In the mid-1980's NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) began developing real-time data products for users. Experimental applications from 1983 to 1989 provided the technological experience to develop the first real-time oceanographic system designed to improve safety and efficiency for the mariner.

The Delaware Bay pilots were aware that actual water levels frequently differed considerably from the NOAA predictions. In 1985 they requested NOAA provide access to the tide data directly from the NOAA gage at the end of their pier in Philadelphia. From that simple request NOAA developed the *Tides ABC system*, a precursor to PORTS® to provide requesters with the data from gauges in their ports. Maryland pilots requested similar access to real-time tides for Baltimore to expedite the shipping of coal. In the first 3 months coal exports had increased $70 million. This was at least partially due to the improved efficiency in loading vessels to take advantage of periods of higher than predicted water levels. It was expected by the developers and pilots that the Tides ABC would prove useful in improving maritime safety, search and rescue operations, hazardous material spills, and in improving the efficiency of marine transportation. A more advanced experimental system was installed in Charleston Harbor in from 1987 – 1989 until it was destroyed by Hurricane Hugo.[6] By 1990 the technology of oceanographic instrumentation, small computer capability, and communications in a marine environment had developed to the point that it was possible to field a long-term operational system to reliably provide real-time oceanographic information to users.

In 1990, Captain Steve Day, President of the Tampa Bay Pilots, approached NOAA's CO-OPS with a strong requirement for reliable real-time water level, current, and meteorological

[6] Interview with Dr. John Hayes, former manager with NOAA now living in Wilmington, North Carolina involved with the development of Tides ABC, July 9, 2013.

information in the vicinity of the relatively newly built Sunshine Skyway Bridge. Captain Day also had the money to pay for a system to be developed and installed.[7]

Tampa had experienced two very serious ship accidents in the vicinity of the Sunshine Skyway Bridge in 1980. On January 28th the United States Coast Guard cutter BLACKTHORN suffered a head on collision with a 600 foot tanker CAPRICORN resulting in the death of 23 USCG crewmen. On May 9th the inbound freighter SUMMIT VENTURE, in a blinding rain squall, struck a span of the Sunshine Skyway Bridge causing one of the bridge spans to collapse plunging six cars, a truck, and a bus 150 feet into the water killing 35 people. The USCG accident report identified eight primary causes of the SUMMIT VENTURE/Sunshine Skyway Bridge accident three of which had to do with the vessel master and pilot not being aware of the storms (heavy weather), the adverse weather, and unusual currents in time to take corrective action. The accidents underscored the need for real time information to provide a situational awareness of one's operating environment.

The discussions between Captain Day and the NOAA CO-OPS leadership was a timely convergence of expertise, and newly developed capability with strong user requirements and funding.

PORTS® was designed to fulfill the needs of the pilots for specific measurements at user selected locations. The instruments installed measured water levels, meteorological conditions (e.g., wind speed and direction, air temperature, and pressure), water temperature, salinity and currents. The pilots had a requirement that the data be available by phone as well as the internet. NOAA insisted that there be a robust quality control system that would prevent bad data from being disseminated to users. Many of these principles became foundational for all future

[7] Frey, Henry R., *Physical Oceanographic Real-Time For Operational Purposes*, IEEE Oceans Proceedings, Vol. 2, October 1-3, 1991, p. 856.

PORTS®: (1) a partnership agreement is developed between the local sponsor and NOAA; (2) the user design defines the type and location of the instruments to meet their unique needs; (3) NOAA provides a robust quality control system; (4) PORTS® information is made available to any user via the phone and internet; and, (5) the user pays for the installation and annual maintenance of the system. From the Tampa system with 26 instruments PORTS® was expanded to 22 systems covering 60 ports.[8] In this study, the 58 ports with PORTS® systems were employed as the basis of valuation analysis.

A. Program Objectives

The objectives of the PORTS® program are to promote navigation safety, improve the efficiency of U.S. ports and harbors, and ensure the protection of coastal marine resources.

1. Navigation safety

The real-time tide and current data provided through PORTS® represents one component of NOAA's integrated program to promote safe navigation. PORTS® data, when combined with up-to-date nautical charts and precise positioning information, can provide the mariner with a clearer picture of the potential dangers that may threaten navigation safety. NOAA fulfills its navigation safety mission in close concert with other federal agencies, such as the U.S. Coast Guard and the U.S. Army Corps of Engineers.

2. Improved economic efficiency

The nation's waterfronts, ports and harbors have historically been centers of rapid industrial and urban growth, and have advanced critical national objectives by promoting energy

[8] Through 2013. Jacksonville, Florida is scheduled to come online in 2014 as the 23rd PORTS®.

exploration, fishery production, commerce, and recreation.

"Public ports contribute significant benefits to local and regional economies, including generating business development and job opportunities. Commercial port activities in 2007 created employment opportunities for more than 13.3 million Americans, including nearly 12 million who were employed in exporter/importer-related businesses and support industries throughout the U.S. Business activities related to waterborne commerce contributed approximately $3.15 trillion overall to the U.S. economy, and those same businesses paid nearly $212.5 billion in federal, state and local taxes. Seaport activities alone in 2007 accounted for $31.2 billion in federal, state and local tax revenues." [9]

Increasingly, shipping companies are implementing new navigation systems aboard ships to maximize cargo load while reducing uncertainties in under keel clearances. These new systems rely on the availability of real-time tide/current and other information. One additional inch of draft may account for several millions of dollars in cargo value per transit (Appendix A). Knowledge of the currents, water levels, winds, and density of the water can increase the amount of cargo moved through a port by enabling mariners to safely utilize every inch of dredged channel depth.

3. Coastal resource protection

Most ports are located at the mouths of major estuaries, which provide critical habitat for many important biological resources. For example, coastal waters provide nurseries and spawning grounds for 70 percent of U.S. commercial and recreational fisheries. Commercial fishing employs over 350,000 people in vessel- and shore-related fisheries work. An additional 17 million people participate in recreational saltwater fishing, spending $7.2 billion annually. Activities at ports can greatly affect these critical resources; dredging is but one such activity.

[9] Martin Associates, Lancaster, PA; telephone number: 717-295-2428; http://aapa.files.cmslus.com/PDFs/MartinAssociates.pdf

Each year in the U.S., approximately 400 million cubic yards of dredged material are removed from navigation channels, berths, and terminals.

The prevention of maritime accidents is the most cost-effective measure that can be taken to protect fragile coastal ecosystems. In 2004 alone, NOAA's Office of Response and Restoration responded to over 120 events, including the release of 270,000 gallons of crude oil into the Delaware River near Philadelphia, and spill of over 400,000 gallons of bunker oil in Alaska. One major oil spill (e.g., the 1989 Exxon VALDEZ accident) can cost billions of dollars and destroy sensitive marine habitats critical to coastal ecosystems. PORTS® provides information to make navigation safer, thus reducing the likelihood of a maritime accident, and also provides information to mitigate the damages from a spill, should one occur.

PORTS® has the potential to save the maritime insurance industry from multi-million dollar claims resulting from shipping accidents. PORTS® allows U.S. port authorities and maritime shippers to make sound decisions regarding loading of tonnage (based on available bottom clearance), maximizing loads, and limiting passage times without compromising safety.

4. Partnership[10]

PORTS® implementation is a cost sharing, partnering effort based on extensive collaboration between NOAA and local maritime communities to identify and satisfy local needs in order to derive local economic and environmental benefits. These partnerships have been very successful. NOAA policy, starting with new installations, is to require that all costs to operate PORTS® be provided by the local user community pursuant to and in compliance with congressional direction. This policy enables the Federal government to pay for those aspects that

[10] CO-OPS, *Real Time Tide and Current Data Systems In United States Ports***,** A Report to Congress, July 2000, pp 8-9.

are national in scope (i.e. quality assurance) while allowing the user to pay for the local benefits derived from using PORTS®. The PORTS® partnership is founded on the principle that there are both local and national responsibilities.

B. Local Partner Responsibilities

As an essential member of the PORTS® partnership, the local sponsor's responsibilities include:

• Installation costs, including the purchase of all equipment and contractor support;

• Local operating and maintenance costs, including repair and preventive maintenance for all locally resident instrumentation and computer equipment;

• Telephone lines and communications equipment costs for local distribution of PORTS® Information; and,

• Spare parts and supplies, and the amortized costs to replace each piece of equipment when the system fails or at the end of its expected useful life.

The partner has the option of providing the money to NOAA to contract for these services or to arrange for the installation and maintenance of the systems to NOAA standards.

C. Federal Government Responsibilities [11]

1. Development of PORTS® national standards

Standardized data formats and baseline accuracy requirements enable the maritime community to utilize PORTS® information with confidence and anticipate seamless transitions when transiting between ports. Standardization also enables manufacturers of digital charts, vessel traffic information systems, and other related private sector products to hold down

[11] Ibid, pp 9-10.

equipment costs by not having to address variable or proprietary data formats.

2. Installation of PORTS®

Utilizing funds provided by the local user community, NOAA designs and implements new PORTS®. Installations are accomplished using, or in partnership with, private sector contractors as obtained by the local organization responsible for PORTS® operation, with or without NOAA assistance as desired by the local organization. Whenever possible, Federal installations (e.g., USCG Stations and USACE facilities) are used, saving local funds. USCG facilities may assist in cost savings by providing data networks, space, electrical power, and communications lines. NOAA also develops and maintains agreements with the local organization responsible for PORTS® operation. These agreements detail operations and maintenance requirements and the responsibilities of each organization.

3. Quality Assurance.

NOAA is responsible for the accuracy of information products and services that it provides to ensure safe navigation. Conducting centralized data quality assurance through the Continuous Operational Real-time Monitoring System (CORMS) on a national scale is a necessary and appropriate Federal Government role, and a significant contribution to the PORTS® partnership. CORMS ingests real-time information every six minutes from all sensors for each PORTS®, determines data quality, and evaluates each PORTS® performance.

4. Engineering/OSTEP

NOAA operates the Ocean Systems Test and Evaluation Program (OSTEP) as the second component of PORTS® quality control and quality assurance program. OSTEP tests and validates existing sensors and introduce new sensors to PORTS® applying oceanographic measurement quality assurance processes to ensure that the instruments used in PORTS® are providing safe and accurate information.

OSTEP objectives are to integrate and test field measurement systems, evaluate new technology for PORTS®, provide development test and evaluation support, conduct lifecycle evaluation of a PORTS®, and develop and maintain an effective end to end quality assurance process. New instrument technology are evaluated at OSTEP before incorporation into PORTS®, and system performance problems are diagnosed at OSTEP, in cooperation with the local PORTS® operator. OSTEP is critical for NOAA to design, integrate, test, and install new PORTS®, even though the local port provides all costs for the systems.

5. Research and development

There is an ongoing requirement for NOAA to be involved in the research and development necessary to continuously improve the accuracy, reliability, and applicability of PORTS® information. Research is conducted on sensor, communication, and product dissemination technology, as well as forecasting techniques. Research is conducted in partnership with academia and industry.

6. Quality management - CORMS[12]

The issue of liability (e.g., if a maritime accident should occur as a result of reliance on erroneous real-time PORTS® information) has been a central concern for local sponsors due to the potentially enormous costs of a marine accident. NOAA has established a rigorous quality control and quality assurance capability to ensure the accuracy of real-time data. Promoting quality assurance reduces the likelihood of maritime accidents resulting from inaccurate PORTS® information.

CORMS is a centralized quality control and decision support system, essential to the control of quality in PORTS®. CORMS ingests real-time information every six minutes from all sensors for each PORTS®, determines data quality, evaluates each PORTS®' performance, identifies and communicates the presence of suspect PORTS® information to users that rely on the information to ensure navigation safety, and provides decision making information needed by maintenance crews to affect repairs.

NOAA must ensure that PORTS® data will help to prevent, and not cause, maritime accidents. CORMS is a 24 hour per day seven days a week operation to monitor PORTS® information and notify any port or harbor site of difficulties with the data or the system. Implementing CORMS enables the maritime community to receive the most accurate real-time PORTS® data possible, thus reducing the potential for maritime accidents. The implementation and operation of CORMS is critical for NOAA to continue its involvement with PORTS®, and for any PORTS® to remain in operation.

The primary mission of CORMS is to perform thorough and robust QA/QC on all real-time data, systems, and products in the CO-OPS domain, ensuring that a reliable source of real-

[12] Ibid, pp. 10-11

time data is readily available, while not disseminating data of questionable quality. CO-OPS Data are available to the users in real-time (or near real-time) via various online graphical plots, simple text data, as well as telephone voice response. All data and products are monitored and reviewed on a 24x7 basis, automatically and by experienced CORMS operators working on 12-hour shifts. When a system and/or data problem is detected, CORMS either remedies the situation or forwards the information to the appropriate analysts, field technicians, or IT personnel to enable corrective action. The manner in which CORMS notifies CO-OPS personnel must be standardized to ensure the most efficient action can be taken to correct the issue.

III. IDENTIFICATION OF THE MOST IMPORTANT PORTS – TOP 175 PORTS[13]

Because the expansion of PORTS® is limited to partners willing to pay for the installation and the annual maintenance the system has not always grown in a prioritized manner focusing on the areas of greatest need or greatest benefit to the nation. The systems vary in size and coverage greatly depending on the requirements of the users and their funding. Chesapeake Bay has 115 instruments (Chesapeake Bay North 66 instruments, and Chesapeake Bay South 49 instruments) covering the 220 mile long bay while New Haven, Connecticut has only 5 instruments (a water level and 4 meteorological instruments) covering a 4 mile long bay. Systems cover the very large ports of Los Angeles and Long Beach, Houston, South Louisiana and New Orleans, the many ports on the Delaware River, and the Port of New York and New Jersey and the nearly unheard of areas of the Soo Locks in Michigan and the Cherry Point oil terminal in Washington. But whether large or small each of the system shares the unique trait that they are important to their users operations.

[13] *Commerce and Transportation Goal FY 2010 Program Decision Memorandum* (PDM) Deliverable, Richard Edwing, MTS Program Manager, August 4, 2008.

A. System of Prioritization

NOAA's Navigation Services have long used tonnage statistics compiled and maintained by the US Army Corps of Engineers as a key planning tool to identify, target and prioritize geographic areas for delivery of NOAA products and services. One of NOAA's two Corporate Performance Measures (Increase number of top 175 U.S. Seaports with access to Navigation Products and Services) is based on the US Army Corps of Engineers annual waterborne commerce statistics. The Corps statistics were selected given their national scope, annual updates, continuity, and quality. While the Corps tracks a variety of statistics for 360 US ports[14], NOAA's Marine Transportation System (MTS) program only includes the top 150 US seaports in the Corporate Performance Measures**.** The top 175 ports accounts for 96.6 percent of all tonnage. An additional 25 seaports were included to recognize commercial fishing and US Naval seaports not captured by the Corps statistics due to a lack of vessels bearing commodity tonnage but for which MTS has navigational requirements.

A PORTS® can service more than one seaport. For planning purposes, the 175 seaports are grouped into 50 PORTS® based on geographic proximity (Appendix B) and prioritized based on descending order of total tonnage. Tonnage is an indicator of both volume and frequency of vessel transits with higher tonnage equating to higher risk of maritime accident. Of these 50 PORTS®, 16 have been established and 4 are in progress. These 20 PORTS® cover 55% of the cargo transiting US seaports on an annual basis. The 58 ports covered by PORTS® in place during the time of this valuation study (2010) accounted for 74.6% of all tonnage, 70.7%

[14] The United States is served by some 360 commercial ports that provide approximately 3,200 cargo and passenger handling facilities, according to the U.S. Coast Guard. Refer to: http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=1032

http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=1032

of all value of cargo and 41.7% of all ship transits based on USACE CPT data. The 50 PORTS® listing reveals two key shortcomings/inefficiencies of a cost shared program approach:

- PORTS® have been established “haphazardly” throughout the list based on the first come, first serve nature of the program with many of the largest seaports by tonnage not having access to PORTS® safety and economic benefits, and;
- In some cases an existing PORTS® does not cover all of the seaports in the geographic groupings due to funding limitations or jurisdictional governance issues among the diverse maritime community.

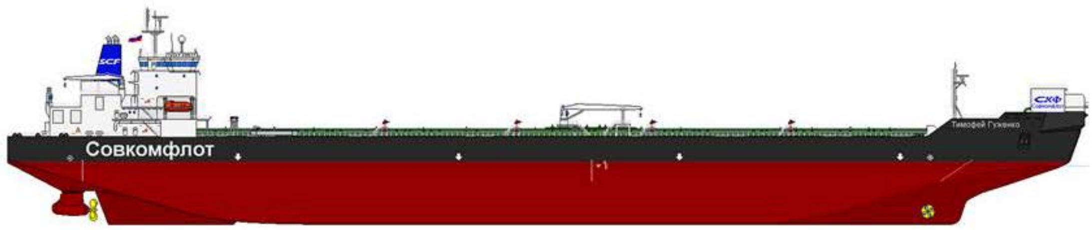
For more information on how the ports are prioritized the reader is directed to Edwing (2008).

IV. PHYSCIAL EFFECTS OF ENVIRONMENTAL FACTORS ON SHIPS

One of the hallmarks of safe marine operations is for the bridge crew (those in control of the vessel) to maintain situational awareness. Situational awareness means understanding what is going on in the vicinity of the vessel. With respect to marine vessels it means understanding what other vessels near you are doing. It also means being aware of environmental factors that may affect a vessels operations, safety or maneuverability. Common environmental factors that affect vessels are wind speed and direction, currents, the depth of water and the state of tide, and visibility. Other less commonly considered factors include the height of a bridge above water, the salinity of the water, the relative humidity of the atmosphere, and the air pressure. For the following three diagrams of vessels, the area on the bottom portion of each ship in red is typically the area that will be below the water level for a fully loaded ship. (Refer to Figure 2)

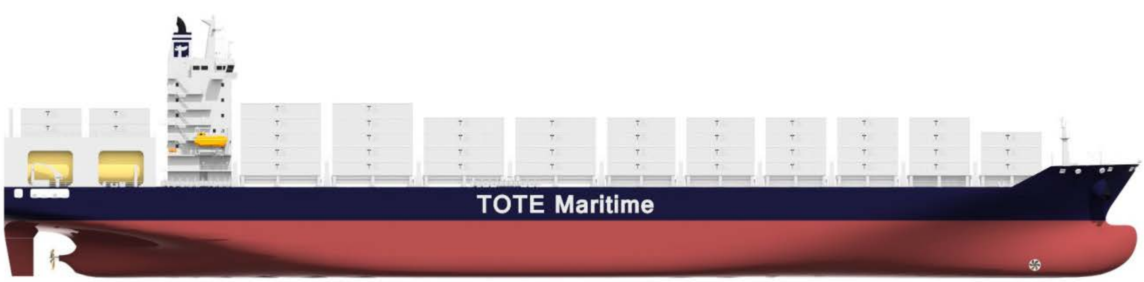
Figure 2

TYPICAL DRAFT AND FREEBOARD SCENARIOS



Tanker – Deep Draft/Shallow Freeboard

Cruise Ship – Shallow Draft/Tall Freeboard



Container Ship – Deep Draft/ Tall Freeboard & Superstructure

More lightly loaded vessels ride higher in the water and have less area below the waterline and more area above (greater freeboard and height above water).[15] (Bowditch, 2002, p. 548)

A. Effects of Wind

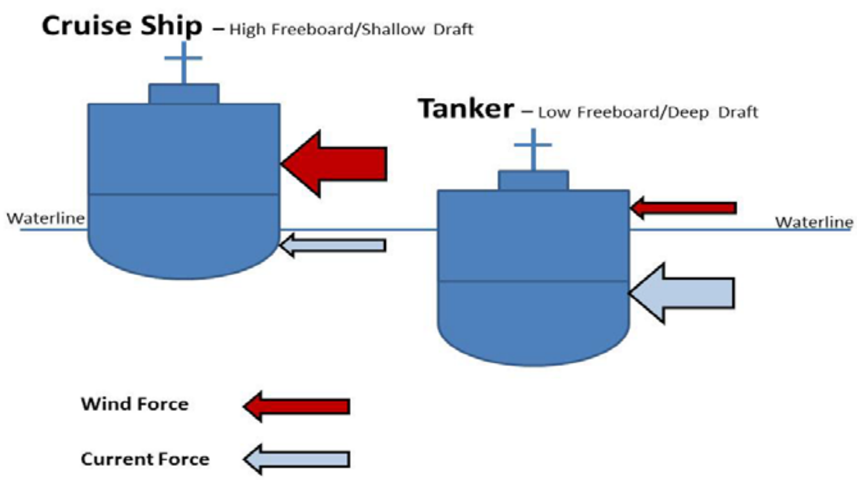
Wind has a significant effect on ship movements with the effect felt more strongly when the vessel has a higher freeboard and superstructure giving the wind more of an area to push upon. Winds also have a greater effect when the vessel speed is slow such as when it is operating in a port. Once a ship has been obliged to reduce to slow speed, the pressure of the wind on the hull will have an increased effect on the vessels handling qualities. The effect is greater if the ship is lightly laden, or is of shallow draft, or has large superstructures. (Figure 3) Typically cruise ships, auto carriers, and some container ships have very high freeboards and superstructures that offer considerable resistance to wind forces and are much more sensitive to increases in wind speed.[16]

[15] Freeboard (nautical) is the height of a ship's main deck (top most continuous deck above the water level). Generally, the taller the freeboard the more surface a vessel has for the wind to exert it force upon. http://en.wikipedia.org/wiki/Freeboard. Superstructure consists of the parts of the ship or a boat, including sailboats, fishing boats, passenger ships, and submarines, that project above her main deck. This does not usually include its masts or any armament. The superstructure also provides an area upon which the wind can exert a pushing force. http://en.wikipedia.org/wiki/Superstructure

[16] Bowditch, *The American Practical Navigator*, 2002 Bicentennial Edition, National Imagery and Mapping Agency, Bethesda, MD 2002., pp. 102 - 103

Figure 3

IMPACT OF WIND



B. Effects of Currents

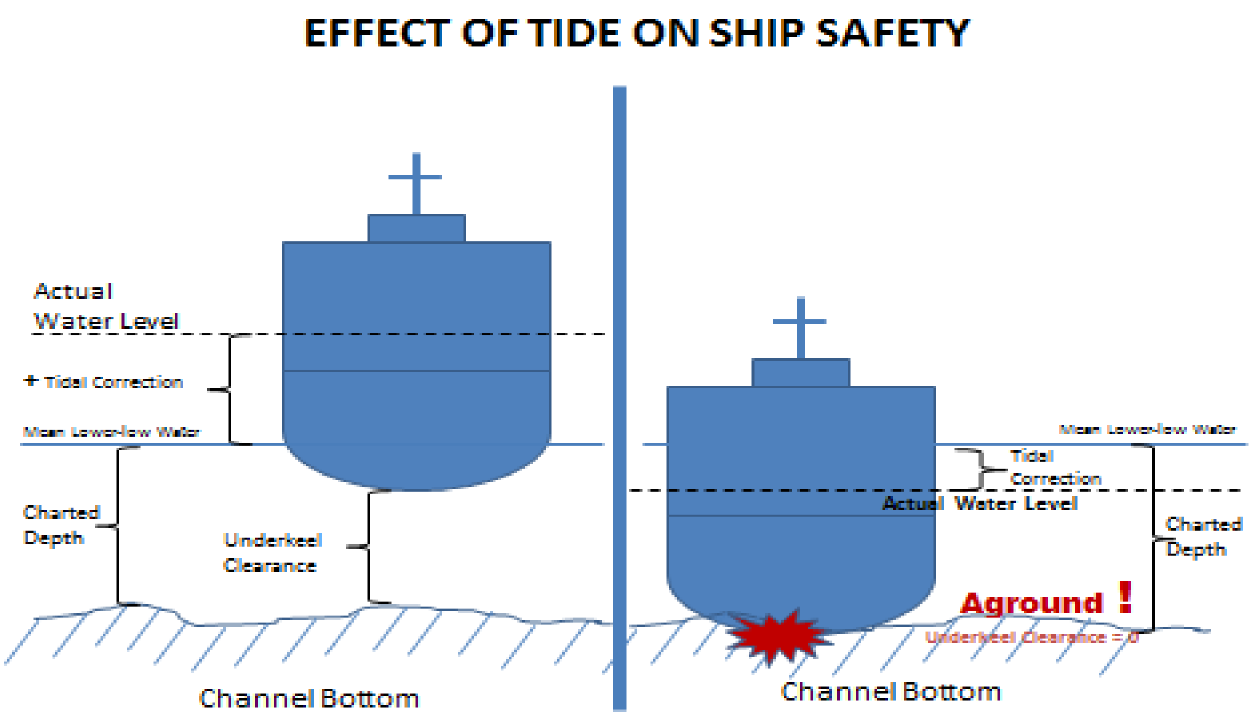
Currents have a similar effect on the areas below the water level that winds do above. The deeper the draft of the vessel the more area currents have to push upon. The slower the vessel speed the more apparent the effect of the current is. Typically tankers, and deeply laden bulk carriers have deep drafts offering considerable resistance to current forces. Failure to adequately account for the effect of wind and current can lead to significant problems in the vessel maneuverability and can have disastrous consequences for safety. Real-time in-situ measurements of wind and current speed and direction can give the mariner or pilot the necessary information to enable them to compensate for these forces and ensure a safe passage.[17]

[17] http://thenauticalsite.com/NauticalNotes/Manouev/MyMan-Lesson02-SHandling.htm

C. Effects of Water Levels

Knowledge of the level of water over the bottom is essential for safe passage. Water depth is reported on a nautical chart in the U.S. as a depth below the mean lower-low water datum. Tides are reported as values above (positive) or below (negative) the charting datum. Vessels with drafts less than the charted depth plus the effect of the tidal correction can generally pass safely. Allowances have to be made for obstacles rising from the bottom and for an adequate margin to account for the possibility of ship dynamics in shallow waters. Having real-time water level information available to the mariner or pilot is extremely important for vessel safety and efficiency. (Figure 4)

Figure 4



D. Effects of Atmospheric Measurements

Changes in barometric pressure are useful to mariners to indicate possible changes in weather especially to oncoming winds. Sudden declines in barometric pressure frequently presage a storm. Visibility is critical for safe vessel movements. Collisions are far more common during periods of low visibility. PORTS® has two instruments that can aid a mariner in determining the visibility. A relative humidity reading that nears 100% can be an indicator of fog and low visibility. PORTS® also offers a visibility instrument that measures visibility and reports readings to 0.01 nautical miles and provide readings to a range of 5.4 nautical miles from the instrument.

E. Effects of Waves

these are important to smaller vessels such as recreational and pilot boats, tugs and possibly to smaller commercial vessels. PORTS® provides wave measurements (direction, amplitude, and period) in some ports in partnership with the U.S. Army Corps of Engineers with real-time data observations from buoys operated by the Scripps Institution of Oceanography.

F. Water Salinity

Salinity is important to the buoyancy of the vessel. The greater the salt content of the water the greater the buoyancy and the higher a vessel will ride in the water. This correction needs to be made to determine the accurate under-keel and under-bridge clearances. Vessels usually have a look-up card on the bridge that enables mariners to make that buoyancy calculation.

G. Effects of Air Gap

An essential piece of information for mariners is the height of all bridges they must pass under. Even vessels as small as recreational boats are frequently are restricted in their movement by the height of bridges. In many of these cases involving recreational boats the bridges can be lifted or raised to permit a vessel to pass safely. However, there are many large bridges that cross waterways that are fixed and not able to lift. They were designed in times when vessels were smaller and had smaller superstructure. With the advent of larger and larger vessels not only have these newer vessels pushed the limits of the channel depths and widths but also the height of the bridge low-steel. Having accurate real-time instruments enables mariners and pilots to pass safely with only a couple of feet to spare. More commonly now vessels have to carefully adjust their loading to enable them to clear both the bottom of the channel and bridge at the same time. Such passages are only possible with real-time information.

H. The use of PORTS® Information to Achieve Specific Results

1. Avoiding Groundings[18]

- Real-time Tide/Water-level Data
- Real-time Salinity Data
- It is expected that by using real-time PORTS® data a mariner will significantly reduce their likelihood of grounding.

[18] Ship grounding is a type of marine accident that involves the impact of a ship on the water bottom or channel side. It may result in the damage of the submerged part of the ship's hull and in particular the bottom structure, potentially leading to water ingress, which may compromise the ship's structural integrity, stability and finally safety. Severe grounding applies extreme loads onto ship structures. In less severe accidents, it might result only in damage to the hull; however, in most serious accidents, it might lead to hull breaches, cargo spills, total loss of the vessel, and, in the worst cases, human casualties. From a global perspective, grounding accounts for about one-third of commercial ship accidents all over the world and it has the second rank in frequency, after ship–on–ship collision. http://en.wikipedia.org/wiki/Ship_grounding

2. Avoiding Allisions[19]

- Real-time Current Data
- Real-time Wind Data
- Real-time Air Gap Data
- It is expected that by using real-time PORTS® data a mariner will moderately reduce their likelihood of an allusion.

3. Avoiding Collisions[20]

- Real-time Current Data|
- Real-time Visibility Data
- Real-time Wind Data
- It is expected that by using real-time PORTS® data a mariner will slightly reduce their likelihood of a collision.

4. Maximizing Cargo Carried (EXPLAIN)

- Real-time Tide/Water-level Data
- Real-time Salinity Data
- It is expected that by using real-time PORTS® data a mariner will be able to significantly improve the efficiency of cargo carriage.

I. Anecdotal Evidence of the Benefits Derived From PORTS®

From the inception of PORTS® users have expected benefits from their use of real-time environmental information. In the case of the Tampa Pilots in 1990 they expected to use PORTS® information to better avoid catastrophic accidents of the type that had occurred in their port in 1980. Additionally they expected to be able to more economically load cargo aboard ships utilizing actual tidal heights that at times differed from the predicted tide tables. Often

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[19] Allision (*plural* allisions) - (*maritime*) The act of striking a fixed object, compare collision: the act of striking another vessel. Refer to: http://en.wiktionary.org/wiki/allision

[20] Ship collision is the structural impact between two ships or one ship and a floating or still object such as an iceberg. Ship collisions are of particular importance in marine accidents. Some reasons for the latter are: (1) the loss of human life; (2) the environmental impact of oil spills, especially where large tanker ships are involved; (3) financial consequences to local communities close to the accident; and, (4) the financial consequences to shipowners, due to ship loss or penalties. Source: http://en.wikipedia.org/wiki/Ship_collision

when NOAA personnel were discussing PORTS® with mariners or port authority personnel they would hear of examples of how the PORTS® information was being used and the benefits users were achieving. The examples weren't limited to just mariners and those involved in shipping goods. Government personnel, commercial fishermen, those involved in recreational activities on or near the water as well as industrial users shared stories of how they found PORTS® information to be of benefit to their specific needs. These stories proved to be good indicators of how various user communities utilized PORTS® information and how the information provided value. These stories along with the four case studies done by Kite-Powell discussed in Chapter 2 of this report provided the basis for investigating the benefits of PORTS®. The following are examples of uses various user groups find for PORTS® data.

1. Commercial Efficiency

- Pilots stated that PORTS® has a significant value in piloting all commercial vessels through their ports.

- Pilots value certain types of information more highly than other pilots depending upon the conditions in their ports. For example, ports like New York and New Jersey frequently deal with vessels that are both draft and height constrained. Passages that involve a vessel operating within 2 feet of the bottom and 2 feet from the bottom of the bridge are becoming more common. Other ports don't have as many air gap constrained passages and value water level or current information more.

- Delaware River and Bay ports are "tide bound" meaning that their vessel operations are often at the maximum operational limits of the channel depth. Pilots are frequently asked to bring in vessels more deeply laden than the channel should be able to support. They do this by scheduling the passage to take advantage of the extra water from a high tide. In one of the channels, New York pilots move ships with 37.5 feet of draft through a channel dredged to 35 feet if they can do so on a high tide of around 5 feet.

- Containerization, intermodalism, global alliances, vessel sharing, and just-in-time delivery have shaped the container shipping industry into what it is today. And in doing so, they have set the stage for what I have suggested is the next great maritime transportation productivity gain: that of maximizing the loading—and movement—of ships in and out of American harbors at will. This cannot be realized, or even considered, without real-time knowledge of weather and environmental conditions from the atmosphere to the sea floor. And, knowledge of these conditions must be available in real-time—on board—for immediate position of the ship when the vessel is operating in a harbor, bay or coastal ocean. [21]

- Captain James Lyon, Director and Chief Executive Officer at the Port of Mobile said "It's (PORTS®) very, very valuable information. We run a lot of deep-draft vessels in and out of here. It has been giving us invaluable information on the timing of arriving and sailing vessels from a safety standpoint. Having that accurate information also enables ships to put on just a little bit more cargo if we do have a good positive tide."[22]

2. Commercial Safety

- Pilots stated that PORTS® has a significant value in piloting all commercial vessels through their ports.

- PORTS® information is used in "go – no go" decisions. There are numerous stories of vessels that were allowed to proceed to dock because the PORTS® system showed that they had a few tenths of a foot of water to spare. In other cases ships didn't have enough water and had to be taken to anchorage to avoid a costly grounding.

- Captain John Kemmerley, Delaware Bay and River Pilot, stated at the June 13 2013 meeting of the Mariner's Advisory Committee for the Bay and river Delaware that "I can't imagine doing my job without PORTS®!"[23]

- All pilots interviewed told of instances where using PORTS® real-time water level information enabled them to make very accurate decisions on whether a vessel could transit to a berth without running aground. Prior to PORTS® pilots would have to use other indicators and add a safety factor to ensure the vessel didn't run aground. This limited the mass of cargo that was carried. The use of PORTS® enables Pilots and shipping companies to maximize the cargo carried.

- PORTS® are used in the ports of New York and New Jersey as the source of wind, current and tidal data for implementing the Coast Guard Advisory Notice (CGAN

[21] Woodill, R., The Needs of the Professional Master Mariner for Improved Weather and Environmental Prediction Services, address to the American Meteorological Society's Second Conference on Coastal Atmospheric and Oceanic Prediction and Processes, January 12, 1998, Phoenix, Arizona.

[22] Patrick Marshall, *Ride with the Tide*, GCN Technology, Tools and Tactics for Public Sector IT, February 14, 2008.

[23] Captain John Kemmerley statement made at Meeting of the Mariner's Advisory Committee for the Bay and River Delaware, June 13, 2013.

2013-012) - Subject: Hurricane Seasonal Alert Initiated in the Port of New York and New Jersey.

- "After the October 1995 Bolivar Roads current meter installation, VTS began communicating current velocities when they reached critical levels, as determined by a local tugboat operating company representative. During February and March of 1996, only two groundings occurred at the Bolivar entrance. This is a 54.6% decrease in groundings when compared to the historical annual average of 4.4 during these two months". Ford, S.F. and Bald, R. J., Houston/Galveston Safe Passage Into the 21st Century (USCG paper), p.7

- Captain Steve Roberts, Chairman, Mariners Advisory Committee for the Bay & River Delaware (MAC) wrote. The MAC uses PORTS® data to help prevent and/or recover from damage to our port complex. In 2011's Hurricane Irene the Coast Guard and MAC used PORTS® information to manage shipping traffic in the river above Philadelphia during the post storm period when tides were running far above normal preventing the possibility of hitting bridges or causing damage to other critical infrastructure. PORTS® data was used during and after Super-storm Sandy to help protect vessels seeking shelter and to keep the Port open minimizing the storm's economic impact on the Delaware Valley Region."[24]

- Captain Larry Stoltz, Master of the EDGAR B. SPEAR stated in a Captains meeting of the Great Lakes Carrier Association, "When we load, we call the voice system to see what the water level is doing. Every inch of draft is equal to 237 long tons (on the Lake Carrier (*EDGAR B. SPEAR*)." When we get closer to the Soo (locks) we call again. We use it (PORTS® at Sault Ste. Marie, Michigan) a lot and it's been invaluable.

3. Hazardous Material Spill Remediation

- NOAA and Coast Guard personnel responding to spills of hazardous materials have requested information on currents and wind conditions in the spill area.

- Captain Steve Roberts, Chairman, Mariners Advisory Committee for the Bay & River Delaware (MAC) wrote: "during the recovery of the ATHOS 1 oil spill in 2004, PORTS data was used to track the movement of the oil so as to help mitigate the spill's impact on the environment. The Final Report of the Delaware River and Bay Oil Spill Advisory Committee, published in December 2010 highlighted the importance of PORTS® to preventing maritime accidents and associated pollution releases. In fact, Recommendation 14 of that report was to "fund the upgrade, continued operation, and maintenance of PORTS®". That report indicates that PORTS® has the potential to prevent shipping accidents and subsequent

[24] Captain Stephen A. Roberts, Letter to Congressional Delegates, March 21, 2013.

environmental damage and save millions of dollars in response, restoration, and damage claims."[25]

4. Commercial Fishing

- Chesapeake Bay crab fishermen have told us that they check PORTS® for water conditions, currents, tides, and weather before beginning their day's operations. This is to ensure the safest operation and optimizing the vessels operations.

5. Recreational Fishing

- The recreational boating community and the recreational fishing community use PORTS® in many of the ports before leaving the dock checking weather, times of high and low water, and times and velocity of currents. This helps them in ensuring a safe boating experience and in optimizing the fishing operations

6. Recreational Boating Safety

- Sail boat and yacht clubs use PORTS® to help control their events safely.
- The recreational boating community and the recreational fishing community use PORTS® in many of the ports before leaving the dock.

7. Recreational Surfing and Kite Boarding

- NOAA has been told by those in Tampa Bay that the kite boarding recreational community are the largest (in numbers of web site queries) users of PORTS®. They use it to plan their day's recreational outings looking for wind conditions and times of actual high and low water events.

8. Recreational SCUBA Diving

- Divers use PORTS® in planning a dive to check tide, current and weather conditions. Also, one diver explained that they use PORTS® to determine the salinity in various parts of Chesapeake Bay. Visibility is better in more saline water.

[25] Ibid.

9. Government

- The US Army Corp of Engineers in Delaware Bay uses PORTS® water levels to control dredging in the river and bay. This eliminates their need to install water level sensors and thus reduces their project costs.

- In New York both the MTA and Port Authority have used PORTS® water level information for the last 15 years to warn them when flooding will occur and when to shut down the highway tunnels under their authorities.

- The US Coast Guard uses PORTS® currents and wind information to help control swimming and other special events. The events need to ensure current and wind velocities don't exceed certain maximums or the event must be canceled for the safety of the participants.

- The US Coast Guard uses PORTS® meteorological information to control certain anchorages where the bottom holding characteristics limit the use during high wind conditions (Appendix C - Coast Guard Advisory Notice (CGAN 2013-012)).

- Local NOAA National Weather Service facilities use PORTS® information in preparing local weather forecasts.

- John Yagacic, of the Delaware River Basin commission, wrote "NOAA PORTS® stations in the upper Delaware Estuary were critical to monitoring the impact of Hurricane Irene, Tropical Storm Lee, and Super storm Sandy on tidal flooding in the Delaware Estuary.

- NOAA PORTS are a key component in the efforts of the DRBC's Flood Advisory committee to develop a coastal storm-surge inundation and forecast system for the Delaware Bay and tidal Delaware River.

- Delaware River Basin Commission (DRBC) continuous real-time flow and transport model draws on data from PORTS® to simulate movement of contaminants during spill events to protect drinking water intakes."[26]

10. Industrial

- The Domino Sugar Company in Baltimore uses PORTS® to monitor the temperature of the water in the Chesapeake Bay. They also use it to monitor the height of water during storm surges to warn them when to shut their intakes and thus their plant down. It is very costly to shut the plant down and they want to avoid it if at all

[26] John Yagacic, Delaware River Basin Commission, Letter to Congressmen, March 21, 2013.

possible. Very accurate, real time information lets them make that call at the last possible moment.

- Power companies in many of the ports use PORTS® water level and water temperature information in their operations.

11. Restoration

- NOAA has been told several times that those doing beach restoration activities use PORTS® when available especially times and amplitudes of tides and weather conditions to plan restoration operations.

12. Academia

- Dr. Jonathan Sharp, University of Delaware, wrote "NOAA PORTS® is a vital information source for academic research on the Estuary of the Delaware River and Bay. It is critical that we in the research community, as well as the agency resource managers, be able to document and understand the dynamics of the Delaware Estuary. The NOAA PORTS® program is integral to this effort."[27]

V. EXPECTED BENEFITS

Based upon information derived from the above anecdotal information on how various user groups use and derive value from using PORTS® data and the four port area case studies discussed in Chapter 2 it is possible to identify categories of users along with hypotheses involving how PORTS® data was employed in the form of a logic model. From these physical counts, monetary equivalents would then be calculated. Potential beneficiary groups investigated in this valuation study included:

Commercial Efficiency
It is expected that PORTS® will provide shippers and port managers with a significant benefit in terms of being able to load as much cargo as the height of the tide will permit (assuming there is a need to move additional cargo).

[27] Dr. Jonathan H. Sharp, University of Delaware in a letter to congressmen, March 21, 2013.

Commercial Safety

It is expected that PORTS® will significantly reduce the rate of commercial shipping accidents principally for groundings and allisions. Pilots will be better able to make the best decisions if they know the actual water-levels and currents, if they know visibility conditions at various points along their transits, if they know exactly the distance from the bottom of a bridge to the water. Knowing actual conditions should remove the guess work from decision making and reduce accidents that have their basis in decisions based upon incorrect information.

Hazardous Material Spill Cleanup

It is expected that workers could respond more effectively to a spill if they had access to real-time information on weather, tides, and currents to better calculate the dispersion and drift of the spill. There should be a reduction in the number of instruments the cleanup personnel would have to establish reducing their costs.

Commercial Fishing

There should be an improvement in fishing efficiency if the vessel operators have access to real-time information on salinity, weather, tide and currents.

There should be a reduction in vessel accidents, injuries, and fatalities if fishing vessels have access to real-time information on winds, visibility, and waves.

Recreational Fishing

It is expected that recreational fishermen would use PORTS® information to maximize fish catch through their knowledge of what fish activities are during certain tide, current, salinity, and weather conditions. They would be able to better target their activities toward fish populations that would be more likely to feed during these conditions.

It is expected that recreational fishing boat accidents would be reduced as a result of operators being more aware of potentially dangerous weather, tide, current, and wave and visibility conditions. If they are aware of developing conditions before they become dangerous it could allow them to head to safety and avoid the dangerous conditions.

Recreational Boating Safety

Recreational boaters would be expected to utilize real-time information on the environment (tides, currents, weather conditions, waves, visibility) to avoid dangerous conditions.

Sail boat and yacht clubs are expected to use PORTS® to help control their events safely.

It would be expected that the frequency of boating accidents would be reduced as a result of the use of PORTS® information.

Recreation (Other)
Surfers and kite boarders would be expected to plan their recreational activities around real-time information on winds (speed and direction) as well as wave (height, period, and direction), stage of tide and current and expected time of the turn in both tide and current. It would be expected that they would better utilize the favorable times for their recreational activities as well as reduce the frequency of accidents that could be attributed to unexpected changes in environmental conditions.

SCUBA divers are interested in water and weather conditions in planning their recreational activity. They are interested from the perspective of safety in weather, tide, current, visibility, and wave information. It is expected that there would be a reduction in the frequency of diver accidents if they have access to and use PORTS® information.

Government
It would be expected that the effiency of government operations would be improved by the various agencies use of PORTS®. The frequency of accidents in their operations would similarly be expected to be reduced as a result of their use of PORTS® information. Refer to the anecdotal examples of government users of PORTS® for examples of user groups that should be able to benefit from the use of PORTS®.

Industrial
I would be expected that there would be a large number of industrial operations that could benefit from the use of real-time environmental information from PORTS®. The benefits could be accrued from maximizing the time they can operate in the marine environment or through the minimization of the times they have to shut down operations as the result of hazardous conditions. This should result in a reduction to their operational costs.

Restoration
The use of real-time environmental information should enable restoration operations to complete their operations more efficiently. If they were aware of real-time conditions they could plan operations around times of bad weather and waves or times of unusually high tides avoiding having to redo work destroyed by

adverse conditions. It is expected that the restoration costs would be reduced as a result of using PORTS® information.

REFERENCES

Bowditch, *The American Practical Navigator*, 2002 Bicentennial Edition, National Imagery and Mapping Agency, Bethesda, MD 2002, p. 548.

Edwing, Richard, *Commerce and Transportation Goal FY 2010* Program Decision Memorandum (PDM) Deliverable, August 4, 2008

Frey, Henry R., *Physical Oceanographic Real-Time For Operational Purposes*, IEEE Oceans Proceedings, Vol. 2, October 1-3, 1991.

Hydrographic Services Improvement Act of 1998, Section 305(a) of Public law 105-384, Title III.

Real Time Tide and Current Data Systems in United States Ports, Implementation Status, Safety and Efficiency Needs, Expansion Plan, a NOAA and U.S. Coast Guard Report to Congress, July 2000.

U.S. Coast Guard Marine Board of *Investigation Report on the M.S. SUMMIT VENTURE* collision with Sunshine Skyway Bridge, Tampa Bay, Florida on 9 May 1980 with multiple loss of life, February, 9, 1981.

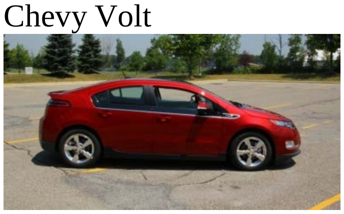
U.S. Department of Transportation, DOT, *An Assessment of The U.S. Marine Transportation System*, A Report to Congress, September 1999, p.26.

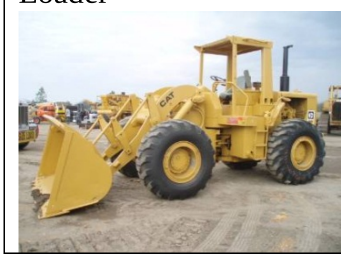
Woodill, R., *The Needs of the Professional Master Mariner for Improved Weather and Environmental Prediction Services*, address to the American Meteorological Society's Second Conference on Coastal Atmospheric and Oceanic Prediction and Processes, January 12, 1998, Phoenix, Arizona.

APPENDIX A

IMPACTS OF ADDITIONAL VESSEL DRAFT

U.S. EXPORTS – EFFECT OF AN ADDITIONAL ONE INCH OF VESSEL DRAFT

Product	Weight per inch of draft	Value of Product	Vessel type	# of Employees
Wheat	358,400 lbs. (162.6 Metric Tons) or 5,973.3 bushels Amount flour needed to bake 422,535 loaves bread	$31,360	Bulk Carrier Panamax	U.S. 950,600 producing grain. (2008)
Corn	358,400 lbs. (162.6 Metric Tons) or 6,400 bushels	$38,528	Bulk Carrier Panamax	U.S. 950,600 producing grain. (2008)
Soybeans	358,400 lbs. (162.6 Metric Tons) or 5,973.3 bushels	$82,312	Bulk Carrier Panamax	U.S. 950,600 producing grain. (2008)
Beef (Choice 1)	358,400 lbs.	$569,032	Refrigerated Bulk Carrier Panamax	U.S. 860,600 Animal production (2008)
Chevy Volt 	99	$3,987,720	Car Carrier	91,960 North America
Ford F150 	72	$2,647,944	Car Carrier	45,000 in U.S.

Product	Weight per inch of draft	Value of Product	Vessel type	# of Employees
John Deere 6140D Utility Tractor with cab 	36	$2,402,892	Car Carrier	55,700 world wide
Caterpillar 950H Wheel Loader 	12	$2,748,000	Bulk Carrier Panamax	43,251 in U.S.

1 Metric Ton = 2,204.6 lbs.

Wheat
Price of Wheat = $5.25/bushel
Source: http://www.quotewheat.com/ Wheat Quote Updated Jan-06-11 3:19 PM

1 bushel of wheat weighs approximately 60 lbs.
Source: Wheat Foods council web site http://www.wheatfoods.org/AboutWheat-wheat-facts/Index.htm

Panamax Bulk Carrier Ship Long Tons/inch draft = 160 average = 358,400 lbs.
Source: Captain John Betz, Los Angeles Pilots December, 2010.

Bushels/1" draft = 5,973.3 bushels

Calculation: 358,400 lbs./inch draft ÷ 60 lbs./bushel

Value of Wheat = $31,360

Calculations: 5,973.3 bushels × $5.25/bushel

How many loaves of white bread would this make:

> One bushel of wheat weighs approximately 60 pounds.
> One bushel of wheat yields approximately 42 pounds of white flour.
> One bushel of wheat yields approximately 60 pounds of whole-wheat flour.

Source:
http://wiki.answers.com/Q/How_many_pounds_of_wheat_does_it_take_to_make_one_pound_of_flour#ixzz1AffSsWO7

Calculation: (42 lbs. white flour ÷ 60 lbs. raw wheat) × 358,400 lbs. wheat = 250,880 lbs. white flour.
Approximately 2 cups of flour per loaf of white bread.
Source: http://wiki.answers.com/Q/How_much_flour_in_a_one_pound_loaf_of_bread

Weight of 2 cups of flour = 2 × 4.75oz./cup = 9.5 oz. ÷ 16oz./lb. = 0.59375 lbs./loaf white bread
Source: http://www.preparedpantry.com/how-to-measure-flour-convert-cups-ounces.aspx

loaves white bread / 1 inch draft = 422,535 loaves bread
(250,880 lbs. white flour/1 inch draft ÷ 0.59375 lbs./loaf bread)
EMPLOYMENT: U.S. = 950,600 agricultural workers producing grain. (2008)Source:
http://www.bls.gov/oco/cg/cgs001.htm

Corn

Panamax Bulk Carrier Ship Long Tons/inch draft = 160 average = 358,400 lbs.
Source: Captain John Betz, Los Angeles Pilots December, 2010.

1 bushel of corn weighs approximately 56 lbs.
Source: http://www.unc.edu/~rowlett/units/scales/bushels.html

Price of Corn (shelled) = $6.02/bushel
Source: http://www.quotecorn.com/ Corn Quote Updated Jan-06-11 3:19 PM

Bushels/1” draft = 6,400 bushels
Calculation: 358,400lbs./inch draft ÷ 56lbs./bushel
Value of Corn = $38,528
Calculations: 6,400 bushels × $6.02/bushel
EMPLOYMENT: U.S. = 950,600 agricultural workers producing grain. (2008)
Source: http://www.bls.gov/oco/cg/cgs001.htm

Soybeans

Panamax Bulk Carrier Ship Long Tons/inch draft = 160 average = 358,400 lbs.
Source: Captain John Betz, Los Angeles Pilots December, 2010.

1 bushel of soybeans weighs approximately 60 lbs.
Source: http://www.unc.edu/~rowlett/units/scales/bushels.html

Price of Soybeans = $13.78/bushel
Source: http://www.quotesoybeans.com/ Soybeans Quote Updated Jan-06-11 3:19 PM

Bushels/1" draft = 5,973.3 bushels
Calculation: 358,400lbs./inch draft ÷ 60lbs./bushel
Value of Soybeans = $82,312
Calculations: 5,973.3 bushels × $13.78/bushel
EMPLOYMENT: U.S. = 950,600 agricultural workers producing grain. (2008)
Source: http://www.bls.gov/oco/cg/cgs001.htm

Beef

2009 U.S. exported 1.868 billion pounds beef
Source: USDA web site http://www.ers.usda.gov/news/BSECoverage.htm

Price of beef = $1.5877/lb. (Choice 1 Carcass weight 600 – 900 lbs.)
Source: USDA report http://www.ams.usda.gov/mnreports/nw_ls410.txt

Food items like beef are carried in refrigerated cargo ships
Source: http://www.globalsecurity.org/military/systems/ship/break-bulk-reefer.htm

Panamax Bulk Carrier Ship Long Tons/inch draft = 160 average = 358,400 lbs.
Source: Captain John Betz, Los Angeles Pilots December, 2010.

Beef (lbs.)/1 inch of draft = 358,400 lbs.
Value of beef/1 inch draft = $569,032
Calculation: (358,400lbs. × 1.5877/lb)
EMPLOYMENT: U.S. 860,600 involve in animal production
Source: http://www.bls.gov/oco/cg/cgs001.htm

Chevy Volt

Weight = 3,500 lbs.
Source: http://www.chevy-volt.net/chevrolet-volt-weight-details.htm

Cost = $40,280 Manufacturers Suggested Retail Price (msrp)
Source: http://usnews.rankingsandreviews.com/cars-trucks/Chevrolet_Volt/

Ship Vehicle Carrier - ALLIANCE CHARLESTON TPC 61.92
Calculation: (61.92TPC × 2204.6 lbs./metric ton) × 2.54 cm/inch = 346,732 lbs./inch of draft# of cars per inch draft = 346,732 lbs./inch draft ÷ 3,500 lbs./car = 99 (99.07 rounded down)
Value of cars for 1 inch draft = 99 cars/inch × $40,280/car = $3,987,720
Employment: 91,960 (GM employs 209,000 people world wide of which 44% are North American employees)
Source: http://www.numberof.net/number-of-gm-employees/

Ford F150

Weight = 4,803 lbs.
Source: http://www.fordf150.net/2010/2010-ford-f150-specifications.php

Price - $36,777 (average)
Source : http://consumerguideauto.howstuffworks.com/all-ford-f-150s.htm

Ship Vehicle Carrier - ALLIANCE CHARLESTON TPC 61.92
Calculation: (61.92TPC × 2204.6 lbs./metric ton) × 2.54 cm/inch = 346,732 lbs./inch of draft
# of trucks per inch of draft = 346,732 lbs./inch draft ÷ 4,803 lbs./truck = 72 (72.19 rounded down)
Value of trucks for 1 inch draft = 72 trucks × $36,777/truck = $2,647,944
Employees = 45,000 in U.S.
Source: http://answers.yahoo.com/question/index?qid=20081119141833AAb71i9

John Deere Tractor

John Deere 6140 Tractor weight = 9,390 lbs.,
John Deere 6140 Tractor price = $66,747
Source: Call to John Deere Customer Service Department 1/11/2011

Ship Vehicle Carrier - ALLIANCE CHARLESTON TPC 61.92
Calculation: (61.92TPC × 2204.6 lbs./metric ton) × 2.54 cm/inch = 346,732 lbs./inch of draft

# of Tractors/inch of draft = 36 (36.9 rounded down)
Calculation 346,732 lbs./inch of draft ÷ 9,390 lbs./tractor)

Value of Tractors = 36 × $66,747 = $2,402,892

John Deere has Headquarters and manufacturing facilities in Illinois, Iowa, Wisconsin, Kansas, North Carolina, Georgia, Louisiana, and California.

Source: http://www.deere.com/en_US/compinfo/media/pdf/
publications/jd_journal/journal_no_vu_2002.pdf

Caterpillar 950H Wheel Loader

Panamax Bulk Carrier Ship Long Tons/inch draft = 160 average = 358,400 lbs.
Source: Captain John Betz, Los Angeles Pilots December, 2010.

Price: $229,000.00
Source: Milton CAT Equipment Dealer
http://www.equipmenttraderonline.com/find/listing/2010-CATERPILLAR-950H-97802699

Weight: 28,500 lbs.
Source: Richie Specs
http://www.ritchiespecs.com/specification?type=construction+equipment&category=Wheel+Loader&make=Caterpillar&model=950&modelid=91545

# of Caterpillar 950H Wheel Loader per inch of draft = 12 (12.58 rounded down) vehicles (358,400 lbs./inch of draft ÷ 28,500 lbs./vehicle)

Value of Cargo (Caterpillar 950H Wheel Loaders) = (12 × $229,000.00/vehicle) = $2,748,000

The 950H was manufactured in the USA, with a K5K serial number prefix
Source: http://www.ritchiewiki.com/wiki/index.php/Caterpillar_950H_Wheel_Loader

Caterpillar is the world's largest manufacturer of wheel loaders. The medium size (MWL) and large size (LWL) are designed at their Aurora, Illinois facility. Medium wheel loaders are manufactured at: Aurora, Illinois. Large wheel loaders are manufactured exclusively in the United States on three separate assembly lines at Aurora, Illinois. Caterpillar still has four major plants in the Peoria area: the Mapleton Foundry, where diesel engine blocks and other large parts are cast; the East Peoria factory, which has assembled Caterpillar tractors for over 70 years; the Mossville engine plant, built after World War II; and the Morton parts facility. As of December 31, 2009, Caterpillar employed 93,813 persons of whom 43,251 are located in the United States. Source: http://en.wikipedia.org/wiki/Caterpillar_Inc

U.S. IMPORTS - EFFECT OF AN ADDITIONAL ONE INCH OF VESSEL DRAFT

Cargo	Lbs. product /container	Units/container	#containers/ 1" draft	# of units/ 1" draft	Retail Cargo Value*	Ship
Athletic Shoes (pairs)	11,900 lbs.	5,292 pairs athletic shoes	11 containers	58,212 pairs athletic shoes / inch of draft Enough pairs to enable runners to run 23,284,800 miles, the equivalent distance of 48.7 round trips from the Earth to the Moon.	$5,355,504	Panamax Container Ship
Laptop Computers	14,176 lbs.	960 Laptop Computers	10 containers	9,600 laptop computers	$8,582,400	Panamax Container Ship
Coffee	Dry Bulk Cargo - No Container Required	Dry Bulk Cargo - No Container Required	Dry Bulk Cargo - No Container Required	358,400 lbs. coffee/ inch of draft Enough coffee to make 44,311,268 (6oz.) cups of coffee	$761,779	Panamax Bulk Carrier
LCD TV 55" Sony	23,318 lbs.	168 TVs	10 Containers	1,540 55" Sony TVs/ inch of draft	$2,925,985	Panamax Container Ship
Cargo	**Shipping Weight per unit**	**Units/container**	**#containers/ 1" draft**	**# of units/1" draft ****	**Retail Cargo Value****	**Ship**
2010 Toyota Prius	3042 lbs.	N/A	N/A	88 Vehicles	$2,094,400	Car Carrier
2011 Mercedes-Benz S600	4,950 lbs.	N/A	N/A	54 Vehicles	$8,534,700	Car Carrier
2011 Hyundai Sonata SE	3,199 lbs.	N/A	N/A	84 Vehicles	$1,897,980	Car Carrier

Cargo	# of gallons/ 1" draft	Retail Cargo Value*	Ship
Crude Oil (light sweet)	71,400.9 gallons	$151,013	Petroleum Tanker SANKO BLOOSOM
Heating Oil	69,417.5 gallons Enough to heat 173 average homes in New England for a year	$176,320	Petroleum Tanker SANKO BLOOSOM
Gasoline	82,340.4 gallons	$201,734	Petroleum Tanker SANKO BLOOSOM

*The value of manufactured goods was determined from official company web sites before any discounts. The value of coffee was determined from commodity prices on the New York Mercantile Exchange.

** Automobile Data is still being reviewed. Changes based on vessel tons per inch (TPI) are expected.

Athletic Shoes Calculation

Typical Panamax Container Ship 4,300 TEU's Long Tons/inch draft = 104
Source: Captain John Betz, Los Angeles Pilots December, 2010.

40 foot shipping container interior dimensions and weight – length 39.5ft, width 7.7 ft, height 7.8ft, empty weight 8,380 lbs..
Source: Wikipedia (http://en.wikipedia.org/wiki/Intermodal_container).

Shoe boxes are stacked in a shipping box. Shipping boxes are double stacked on a pallet.Shipping Box: box dimensions 60" long, 39" wide, 45" high, weight 23 lbs. (based on weight of S-4684)
Pallet H-1618 fits box S-4684, weight 60 lbs. Pallet 6" high
Source: Uline Shipping Supply Specialists, (http://www.uline.com/BL_430/350-Lb-Test-Double-Wall-Boxes)

Athletic Shoe boxes – Measured 4 boxes at Foot Locker – Average box size
13" long, 8.5" wide, 5" high , weight shoe box and packing material without shoes 4oz.
Source: MacFarland measurement Foot Locker, December 23, 2010.

Athletic Shoe Weight – average 16 oz./shoe Source: Tennis Company (http://www.tenniscompany.com/shoes_weight_comparison.html)

Price Athletic shoes = Average $ 92
Nike Tennis $120 - $64 = $92 Average

Source: Nike web site (http://store.nike.com/us/en_us/?&wfp=true#l=shop,pwp,c-1+100701/f-12001/hf-10002+4294967109/t-Men's_Tennis_Shoes/ipp-48/pn-1)

New Balance $120 - $78 = $99 Average

Source: New Balance web site (http://www.shopnewbalance.com/category.asp?type=MNFTTC)
Reebok $130 - $40 = $85 Average
Source: Reebok web site (http://www.reebok.com/US/mens/footwear)

CALCULATION: # pairs of shoes http://www.shopnewbalance.com/category.asp?type=MNFTTC per shipping box = 189 (packed 7 x 3 x 9high)

CALCULATION: Loaded weight per shipping box 425 lbs. (2 lbs. (shoes) + 0.25lbs. (packing)) x 189 boxes/shipping box)

CALCULATION: Number of shipping boxes per container = 28 boxes per container (packed 7 long x 2 wide x 2 tall)

CALCULATION: Number of shoe pairs per container (189 pair/shipping box x 28 boxes/container) = 5292 pairs of athletic shoes

CALCULATION: Weight of loaded container

Weight of Shoes – 425 lbs./shipping box x 28 boxes/container = 11,900 lbs.
Weight of Shipping boxes – 28 boxes x 23lbs./box = 644 lbs.
Weight of Pallets (first layer only) – 14 x 60 = 840 lbs.
Weight of Empty Container = 8,380 lbs.
TOTAL WEIGHT LOADED CONTIANER = 21,764 lbs.

CALCULATION: # of containers to reduce draft of ship 1”

(104 long tons x 2240 lbs./long ton) ÷ 21,764 lbs./container = 11 containers (10.7 rounded to 11) containers

CALCULATION**:** # of pairs of shoes to reduce ship draft by 1 inch = 58,212

(11 containers x 189 pairs of shoes/box x 28 boxes/container = 58,212)

CALCULATION: Value of athletic shoes = $5,355,504 ($92/pair shoes x 58,212 pairs of shoes)

How Many Miles Can Be Run With 58,212 Pairs of Running Shoes?

The generally accepted consensus is runners will require a new pair of running shoes every 300-500 miles.
Source: The Runners Guide - http://www.therunnersguide.com/howlongrunningshoeslast/

Calculation: # of Miles Run = 58,212 pairs of shoes × 400 miles (average of 300-500 mile spread) = 23,284,800 miles. This is the equivalent of 48.7 round trips between the Earth to the Moon.

Distance from Earth to Moon = 238,857 miles
Source: Universe Today http://www.universetoday.com/38128/distance-from-earth-to-moon/

Laptop Computer Calculation

Typical Panamax Container Ship 4,300 TEU's Long Tons/inch draft = 104
Source: Captain John Betz, Los Angeles Pilots December, 2010.

40 foot shipping container dimensions and weight – interior length 39.5ft, width 7.7 ft, height 7.8ft, empty weight 8,380 lbs..
Source: Wikipedia (http://en.wikipedia.org/wiki/Intermodal_container).

Shipping Box: box dimensions 57" long, 46" wide, 36" high, weight 23 lbs. (based on weight of S-4684)

Pallet H-1618 fits box S-4684, weight 60 lbs. Pallet 6" high

Source: Uline Shipping Supply Specialists, (http://www.uline.com/BL_430/350-Lb-Test-Double-Wall-Boxes)

Dell Latitude E5510 Laptop Computer Boxes (with computer inside/13.5 inch screen) – shipping dimensions: 19" long, 18" wide, 9" high, with a shipping weight of 14 lbs..
Source: Robert Gillium, Information Systems Division, CO-OPS/NOS/NOAA, December, 2010.

Price of Dell Latitude E5510 Laptop Computer = $894.00 (starting price without add-ons or discounts)
Source: Dell web site. http://www.dell.com/us/business/p/latitude-e5510/pd?refid=latitude-e5510&baynote_bnrank=1&baynote_irrank=0&~ck=baynoteSearch

CALCULATION: # of laptop computers per shipping box = 30 (packed 3 long x 5 wide x 2 high)

CALCULATION: Loaded weight per shipping box = 443 lbs. (30 computers x 14 lbs./computer + 23 lbs./shipping box)

CALCULATION: Number of shipping boxes per container = 32 boxes (packed 8 long x 2 wide x 2 tall + layer of 6" tall pallets on bottom layer)

CALCULATION: Number of laptop computers per container = 960 (30 computers/shipping box x 32 shipping boxes/container)

CALCULATION: The weight of the loaded container:

32 shipping boxes x 443 lbs./ loaded shipping box = 14,176 lbs.
16 pallets x 60 lbs./pallet = 960 lbs.
Weight of Empty Container = 8,380 lbs.
Total weight of loaded container = 23,516 lbs..

CALCULATION: # of containers to reduce draft of ship 1”

(104 long tons x 2240 lbs./long ton) ÷ 23,516 lbs./container = 10 containers (9.91 rounded to 10)

CALCULATION: # of laptop computers to reduce ship draft by 1” = 9,600 (960 computers/container x 10 containers)

CALCULATION: Value of computers = $8,582,400 ($894/computer x 9,600 computers)

CUPS of COFFEE Calculation

33oz. coffee makes 240 – 270 (average 255) cups (6oz.) Source: Maxwell House 33oz. coffee container December, 2010.

Panamax Bulk Carrier Ship Long Tons/inch draft = 160 average = 358,400 lbs.
Source: Captain John Betz, Los Angeles Pilots December, 2010.

Price of raw coffee beans $2.1255/lb
Source: New York Mercantile Exchange (NYMEX) December 29, 2010

http://www.cmegroup.com/trading/agricultural/softs/coffee.html

CALCULATION: 358400 lbs. * 16oz./lb. = 5,734,400 oz. of coffee per 1” ship draft

CALCULATION: 5,734,400 oz. X 7.727272 cups /oz. of coffee = 44,311,268 6 oz. cups of coffee / 1” ship draft

CALCULATION: Value of raw coffee beans = $761,779

LCD TV Calculation

55” Sony KDL 55EX500 Shipping Data dimensions 61”long, 9”wide, 34”tall, weight 81 lbs..
Source: Tiger Direct.Com Phone call with sales representative December 27, 2010.

Price Sony KDL 55EX500 retail non-discounted $1899.99

Source: Official Sony web site.
http://www.sonystyle.com/webapp/wcs/stores/servlet/ProductDisplay?catalogId=10551&storeId=10151&langId=-1&productId=8198552921666077656)

Typical Panamax Container Ship 4,300 TEU's Long Tons/inch draft = 104
Source: Captain John Betz, Los Angeles Pilots December, 2010.

40 foot shipping container dimensions and weight – interior length 39.5ft, width 7.7 ft, height 7.8ft, empty weight 8,380 lbs..
Source: Wikipedia (http://en.wikipedia.org/wiki/Intermodal_container).

TV boxes are stacked in a shipping box and placed on a pallet. Shipping boxes and pallets are double stacked.

Shipping Boxes 62" long, 45" deep, 36" high, pallet 6" high. Total empty weight 47 lbs..

Source: CS Packaging, Inc. customized box based on box AF584145 weight.

CALCULATION: # TVs per box = 5 (45"÷ 9")

CALCULATION: # boxes that can be packed in a container: 7 long, 2 wide, 2 tall =

28 boxes per container 140 TVs per container

CALCULATION: weight of loaded container

TV weight = 140 TVs/container X 81 lbs./TV = 11,340 lbs.

Weight of shipping boxes = 47lbs./box X 28boxes/container = 1316 lbs.

Weight of empty shipping container = 8,380lbs.

TOTAL WEIGHT LOADED CONTAINER = 21,036 lbs.

CALCULATION: # Containers required to reduce ship draft by 1"

(104 long tons X 2,240 lbs./long ton) ÷ 21,036 lbs./loaded container = 11 containers

CALCULATION: # TVs required to reduce ships draft by 1"

11 containers X 140 TVs/container = 1,540 TVs

CALCULATION: Value of TVs = $2,925,984.60

Automobile Calculations

Toyota Prius III 2010

Typical Car Carrier Ship 200 meters Tons (long 2,240lbs.) per inch (TPI) = 120 long tons/inch or 268,800 lbs./inch of draft
Source: Captain John Betz, Los Angeles Pilots January, 2011.

TOYOTA Prius 2010 weight = 3,042 lbs.

Source: Toyota web site http://www.toyota.com/prius-hybrid/specs.html

Calculation: # vehicles to lower ships draft by 1 inch = 268,800 lbs. (vessel TPI) ÷ 3,042 (vehicle weight) = 88.36 or 88 whole units. Need to round down to next whole unit.

88 Toyota Priuses per inch of draft

Retail value of 2010 Toyota Prius III = $23,800
Source: Toyota web site: http://www.toyota.com/prius-hybrid/trims-prices.html#/?view=showroom&vehicle=1

Calculation: Cargo Value = 88 Toyotas × $23,800 = $2,094,400

2011 Mercedes Benz S600

Typical Car Carrier Ship 200 meters Tons (long 2,240lbs.) per inch (TPI) = 120 long tons/inch or 268,800 lbs./inch of draft

Source: Captain John Betz, Los Angeles Pilots January, 2011.

Mercedes-Benz 2011 S600 weight = 4,950 lbs.
Source: Mercedes-Benz web site http://www.mbusa.com/mercedes/vehicles/explore/specs/class-S/model-S600V

Retail Value of 2011 Mercedes-Benz S600 = $158,050
Source: Yahoo Autos web site http://autos.yahoo.com/2011_mercedes_benz_s_class/

Calculation: # Vehicles to lower ships draft 1 inch = 268,800 lbs. (vessel TPI) ÷ 4,950 lbs./vehicle = 54.3 or 54 whole units Need to round down to next whole unit.

54 Mercedes-Benz S600 per inch of draft

Calculation: **C**argo Value = 54 Mercedes × $158,050/vehicle = $8,534,700

Hyundai 2011 Sonata SE

Typical Car Carrier Ship 200 meters Tons (long 2,240lbs.) per inch (TPI) = 120 long tons/inch or 268,800 lbs./inch of draft
Source: Captain John Betz, Los Angeles Pilots January, 2011.

Hundai Sonata SE

Weight = 3,199 lbs.
Retail price + $ 22,595
Source: Hyundai web site http://www.hyundaiusa.com/sonata/specifications.aspx

Calculation: # Vehicles to lower ships draft 1 inch = 268,800 lbs. (vessel TPI) ÷ 3,199 lbs./vehicle = 84.0 or 84 whole units Need to round down to next whole unit.

84 Hyundai 2011 Sonata SE per inch of draft

Calculation: Cargo Value = 84 Hyundai's × $22,595/vehicle = $1,897,980

Petroleum Calculations

Crude Oil

Weight of crude oil = 7 lbs./gal

Source: Wiki Answers web site
http://wiki.answers.com/Q/How_much_does_one_gallon_of_crude_oil_weigh

Typical Petroleum Tanker (*SANKO BLOSSOM*, 784 ft, 105,000 dwt) Tons Per centimeter (TPC) = 89.24 metric tons/cm or 499,806 lbs./inch of draft
Source: Crescent River Pilots, January, 2011.

# of gallons oil/barrel = 42
Source: Wikipedia web site http://en.wikipedia.org/wiki/Barrel_(volume)

Calculation: 89.24 cm/metric ton × 2,205 lbs./metric ton × 2.54cm/inch = 499,806 lbs./inch

gallons of crude oil/ inch of ship draft = 71,400.9 gallons

Calculation: 499,806 lbs. crude oil/inch draft ÷ 7 lbs./gal

Price of crude oil = $88.83/ barrel (1/6/2011 at 11:34:02)
Source Oil-Price.net web site http://www.oil-price.net/

Calculation: Value of cargo to lower ship draft by 1 inch = $151,013
(71,400.9 gals ÷ 42gals/barrel) × $88.83/barrel)

Heating Oil

Weight of heating oil = 7.2 lbs./gal.
Source: Wikipedia web site http://en.wikipedia.org/wiki/Heating_oil

Typical Petroleum Tanker (SANKO BLOSSOM, 784 ft, 105,000 dwt) Tons Per centimeter (TPC) = 89.24 metric tons/cm or 499,806 lbs./inch of draft
Source: Crescent River Pilots, January, 2011.

Calculation: 89.24 cm/metric ton × 2,205 lbs./metric ton × 2.54cm/inch = 499,806 lbs./inch# gallons of crude oil/ inch of ship draft = 69,417.5 gallons
Calculation: 499,806 lbs. crude oil/inch draft ÷ 7.2 lbs./gal

Price of heating oil = $2.54/gallon (1/6/2011 at 11:34:02)
Source Oil-Price.net web site http://www.oil-price.net/

Calculation: Value of cargo to lower ship draft by 1 inch = $176,320
(69,417.5 gals × $2.54/gal)

How many Homes in New England would 69,417.5 gallons heat?
New England medium sized 4 bedroom home required 1,500 liters or approximately 400 gallons to heat annually.
Source: http://www.answermefast.com/How_much_heating_oil_will_average_house_use-qna196910.html

Calculation: #homes heated/year = 69/417.5 gallons/1 inch draft ÷ 400 gallons/home = 173 New England homes/yr. This number can vary greatly by size, energy efficiency, weather conditions, and location.

Gasoline

Weight of gasoline = 6.07lbs./gal.Source: Wikipedia web site http://en.wikipedia.org/wiki/Gasoline

Typical Petroleum Tanker (SANKO BLOSSOM, 784 ft, 105,000 dwt) Tons Per centimeter (TPC) = 89.24 metric tons/cm or 499,806 lbs./inch of draft
Source: Crescent River Pilots, January, 2011.

Calculation: 89.24 cm/metric ton × 2,205 lbs./metric ton × 2.54cm/inch = 499,806 lbs./inch

gallons of crude oil/ inch of ship draft = 82,340.4 gallons

Calculation: 499,806 lbs. crude oil/inch draft ÷ 6.07 lbs./gal

Price of gasoline = $2.45/gal. (1/6/2011 at 11:34:02)
Source

Heating oil and Diesel oil are very similar
Source: http://en.wikipedia.org/wiki/Heating_oil
Specific Gravity of Fuel Oil and Crude Oil (API)

Information on Ship Loading Characteristics

As we discussed on the phone, the amount of weight necessary to sink a ship one inch is in direct relationship to the Area of the Ship's Waterplane (AWP**).**[28]

Where AWP = Area of the ship's waterplane in square feet, use the following formula:

AWP / (35 * 12) = X long tons per inch immersion (TPI)

Note: 35 cubic feet of salt water = 1 long ton

As a ship gets deeper in the water the AWP increases and so does the TPI. The ship's "Stability Curves" will show the TPI for various drafts.

As an example, the following vessels have TPI's as follows when at or near their load drafts:

EMMA MAERSK (very large containership)

LOA 397 Meters
Beam 56 Meters
12,000 Twenty Foot Equivalent Unit (TEU)[29]
TPI = 429 long tons

i.e., it takes 429 long tons to sink the ship an inch, or for every additional inch of draft the ship can carry an additional 429 tons of cargo.

Typical Panamax Containership

[28] Looking downward upon the ship, the water plane is the outline of the vessel where it intersects with the water surface.

[29] Domestic containers are of five standard lengths, 20, 40, 45, 48 and 53 feet. International containers are generally limited to 20 and 40 owing to limits on foreign infrastructure (highways, turn outs) to handle larger equipment. Most are 8 feet high but high cube ones measure 9 foot 6 inches and half height containers at 4 foot 3 inch. All 20 foot long are considered a TEU regardless of height.

LOA 292 Meters
Beam 32.3 Meters
4,300 TEUs
TPI = 104 long tons

Compare that to a tanker with a fuller form or higher Block Coefficient (which equals a larger AWP relative to size)

Typical Panamax Tanker (or bulk carrier)

LOA 228 to 246 Meters
Beam 32.3 Meters
TPI = 155 to 165 long tons

The value of cargo this equates to is more difficult to calculate. It is dependent on the Value per ton, which varies according to the commodity. Oil is pretty easy to calculate. Most liquid cargos run from about 6.5 barrels per ton (crude and other heavy oils) to about 7.5 barrels per ton for distillates, such as diesel to about 8.2 barrels per ton for gasoline. Dry cargo commodities, such as coffee, should be pretty easy to figure as well by finding out the dollar value of a ton of a particular commodity.

Lastly, US Flag ships use long tons per inch (TPI) while most other nationalities use metric tons per centimeter (TPC). One long ton is equal to 2,240 pounds (1,016 kg). 1.0 long ton / inch = 0.4 metric tons / centimeter

APPENDIX B

PORT CLUSTER PRIORITIES SPECIFIED IN CO-OPS PLAN (2008)

Port Cluster Priorities[30]

Port Names

1. Port of South Louisiana, LA
    - New Orleans, LA
    - Baton rouge, LA
    - Plaquemines, LA
    - Intracoastal City, LA
    - Empire/Venice, LA

2. Houston, TX
    - Texas City, TX
    - Galveston, TX

3. New York, NY & NJ
    - Leonardo, NJ

4. Long Beach, CA
    - Los Angeles, CA

5. Corpus Christi, TX
    - Matagorda Ship Channel, TX
    - Victoria, TX
    - Brownsville, TX
    - Freeport, TX

6. Philadelphia, PA
    - Paulsboro, NJ
    - Marcus Hook, PA
    - New Castle, DE
    - Camden – Gloucester, NJ
    - Wilmington, DE
    - Chester, PA
    - Trenton, NJ

7. Beaumont, TX
    - Port Arthur, TX
    - Orange, TX
    - Sabine Pass, TX

8. Baltimore, MD
    - Norfolk Harbor, VA
    - Newport News, VA

[30] Commerce and Transportation Goal FY 2010 Program Decision Memorandum (PDM) Deliverable, Richard Edwing, August 4, 2008

Annapolis, MD
Washington, DC
Hopewell, VA
Reedville, VA

9. Chicago, IL
   Indiana Harbor, IN
   Gary, IN
   Burns waterway, IN
   Escanaba, MI
   Port Inland, MI
   Milwaukee, WI
   Port Dolomite, MI
   Muskegon, MI
   Green Bay, WI
   Grand Haven, MI
   Charlevoix, MI
   Manistee, MI
   Buffington, IN
   St. Joseph, MI
   Waukegan, IL
   Ludington, MI
   Port Washington, WI
   Holland, MI

10. Detroit, MI
    Cleveland, OH
    Ashtabula, OH
    Toledo, OH
    Conneaut, OH
    Lorain, OH
    St. Clair, MI
    Marine City, MI
    Fairport Harbor, OH
    Marysville, MI
    Monroe, MI
    Sandusky, OH
    Marblehead, OH
    Huron, OH
    Buffalo, NY
    Erie, PA
    Kelly’s Island, OH

11. Seattle, WA
    Tacoma, WA
    Anacortes, WA

- Everett, WA
- Port Angeles, WA
- Olympia, WA
- Cherry Point, WA
- Bangor, WA
- Bremerton, WA
- Keyport, WA
- Manchester, WA
- Oak/Crescent Harbor, WA

12. Duluth-Superior, MN & WI
    - Two Harbors, MN
    - Silver Bay, MN
    - Taconite, MN

13. Mobile, AL

14. Lake Charles, LA

15. Tampa, FL
    - Port Manatee, FL
    - Weedon Island, FL
    - Charlotte, FL

16. Portland, OR
    - Vancouver, WA
    - Kalama, WA
    - Longview, WA
    - Astoria, OR

17. Richmond, CA
    - Oakland, CA
    - San Francisco, CA
    - Redwood City, CA

18. Pascagoula, MS
    - Biloxi, MS
    - Gulfport, MS

19. Honolulu, HI
    - Barbers Point, Oahu, HI
    - Kahului, Maui, HI
    - Hilo, HI
    - Nawiliwili, Kauai, HI
    - Kawaihae Harbor, HI

20. Valdez, AK
    Seward, AK

21. Savannah, GA
    Brunswick, GA
    Kings Bay, GA

22. Port Everglades, FL
    Miami, FL
    Palm Beach, FL

23. Portland, ME
    Searsport, ME

24. Charleston, SC
    Georgetown, SC

25. Presque Isle, MI
    Calcite, MI
    Stoneport, MI
    Alpena, MI
    Drummond Island, MI

26. Boston, MA
    Salem, MA
    New Bedford, MA

27. Jacksonville, FL
    Fernandina Beach, FL

28. New Haven, CT
    Bridgeport, CT
    Port Jefferson, NY
    Stamford, CT
    Norwalk, CT
    New London, CT
    Groton, CT

29. San Juan, PR
    Ponce, PR
    Fajardo, PR
    Roosevelt Road, PR

30. Providence, RI
    Fall River, MA
    Newport, RI

31. Nikishka, AK
    Anchorage, AK
    Homer, AK

32. Wilmington, NC

33. Panama City, FL
    Pensacola, FL

34. Portsmouth, NH

35. Port Canaveral, FL

36. Morehead City, NC

37. San Diego, CA
    Camp Pendleton, CA

38. Kivilina, AK

39. Coos Bay, OR

40. Port Hueneme, CA

41. St. Thomas, VI

42. Grays Harbor, WA

43. Humboldt, CA

44. Oswego, NY
    Rochester, NY
    Ogdensburg, NY

45. Ketchikan, AK
    Petersburg, AK

46. Juneau, AK

47. Kodiak, AK

48. Key West, FL

49. Dutch Harbor, AK

50. Apra Harbor, Guam
    Farallon De Medinilla, CNMI
    Saipan, CNMI

Commerce and Transportation Goal

FY 2010 Program Decision Memorandum (PDM) Deliverable

Develop a strategic plan for future installation of PORTS®, taking into account not only the tonnage shipped through the ports, but also the risk associated with types of goods (e.g. containers, oil, or chemical), draft of the particular seaway, currents, obstructions, and current accident rates. This plan should identify an end point for PORTS® expansion by using cost/benefit analysis to determine where it is no longer economically viable to install and operate PORTS®. Provide a copy of the plan to PA&E by August 4, 2008.

Richard Edwing, MTS Program Manager, August 4, 2008.

APPENDIX C

UNITED STATES COAST GUARD ADVISORY NOTICE

(CGAN 2013-012)

Commander
United States Coast Guard Sector New York

212 Coast Guard Drive Staten Island, NY 10305 Staff Symbol: (wwm) Phone: (718) 354-2353
Fax: (718) 354-4096

16465

U.S. Department of
Homeland Security

United States
Coast Guard

COAST GUARD ADVISORY NOTICE (CGAN 2013-012)

Subject: Hurricane Seasonal Alert Initiated in the Port of New York and New Jersey

Date: May 20, 2013 Revision No.: 0

In preparation for hurricane season, the Captain of the Port (COTP) New York recommends the following action to ensure the New York and New Jersey maritime communities are prepared in the event hurricane conditions affect this area. The following actions apply at this time:

1. Review Coast Guard Captain of the Port New York's Hurricane and Severe Weather Plan for the Port of New York and New Jersey. The plan is available to download at http://homeport.uscg.mil/newyork > Safety and Security > Local Contingency Plans.

2. Conduct training with vessel/facility personnel to ensure all employees are aware of the potential risks and responsibilities associated with hurricanes.

3. Standard Severe Weather Practices for the COTP New York Zone are outlined below. These standards apply year-round, whether resulting from a hurricane, tropical storm, Nor'easter, or any other adverse weather resulting in high winds. The COTP may, at his discretion, impose additional restrictions not specifically listed below and may enact these practices based on actual or predicted conditions. Consult the Captain of the Port New York Hurricane and Severe Weather Plan for additional requirements.

   a. **Winds sustained at 15 kts or gusting to 20 kts from the North or Northwest while on an ebb current**:

      (1) All barges in the Bay Ridge anchorage shall have tugs alongside.

   b. **Winds sustained at 25 kts regardless of the wind or current direction**:

      (1) All barges or “dead ships” in any anchorage not attached to a permanent mooring (i.e., Robbins Reef mooring ball) shall have tugs alongside.

      (2) All ships and tugs in an anchorage shall have their engines on-line.

      (3) All ships engaged in bunkering or lightering operations may have no more than one barge alongside.

c. **Gale Conditions: Winds sustained at 34 kts regardless of the wind or current direction**:

(1) All ships at anchor in Bay Ridge, Gravesend, Perth Amboy, or Anchorage 19 shall have a pilot aboard.

(2) All lightering and bunkering operations shall be suspended with all barges removed from anchored vessels.

(3) Based on their ship's particular characteristics and loading conditions, masters of ships at anchor should consider ordering tugs to assist their vessels in maintaining position in the anchorage.

(4) Vessels with a stability letter for protected waters route shall cease all passenger operations.

d. **Winds sustained at 40 kts regardless of the wind or current direction:**

(1) The transfer of hazardous cargo between vessels or barges and waterfront facilities shall be suspended.

(2) All ships in Stapleton Anchorage shall have a pilot aboard or on immediate standby. All ships in all other anchorages within the port shall have a pilot aboard.

(3) Barges may be ordered out of specific anchorages by the Captain of the Port. Tug/barge combinations may go to a berth or transit to an area, such as north of the George Washington Bridge, and anchor/ride out the storm. Tug/barge combinations will not be ordered out of the Port of New York and New Jersey.

(4) Depending on the actual harbor conditions, the Captain of the Port may impose restrictions on vessel movements into, out of, or within specific areas of the Upper or Lower Bay.

(5) Unattended barges attached to mooring balls shall have a tug standing by in the immediate vicinity.

e. **Winds sustained at 60 kts regardless of the wind or current direction**:

(1) The Captain of the Port may impose a complete harbor closure affecting all commercial operations. Light tugs assisting other vessels/barges and emergency vessels will normally be the only vessels allowed to operate during these conditions.

f. **Line of severe thunderstorms or Squall line approaching the area with expected winds greater than 25 kts**:

(1) The Captain of the Port may impose any of the restrictions outlined above as early as necessary to ensure safety measures are in place prior to the onset of the severe weather.

#

APPENDIX D

U.S. PORTS

II. U.S. PORTS

Technically speaking, a port is any location on a coast or shore containing one or more locations (harbors) where ships can dock and transfer people or cargo to or from land. Overall, ports may fall into one of three activity types: (1) commercial; (2) recreational; and, (3) armed forces. It is not uncommon for two or more of these activities to occur within a relatively small geographic area. For the purposes of this analysis, only those larger locations with physical infrastructures employed to load, handle and store goods were considered.

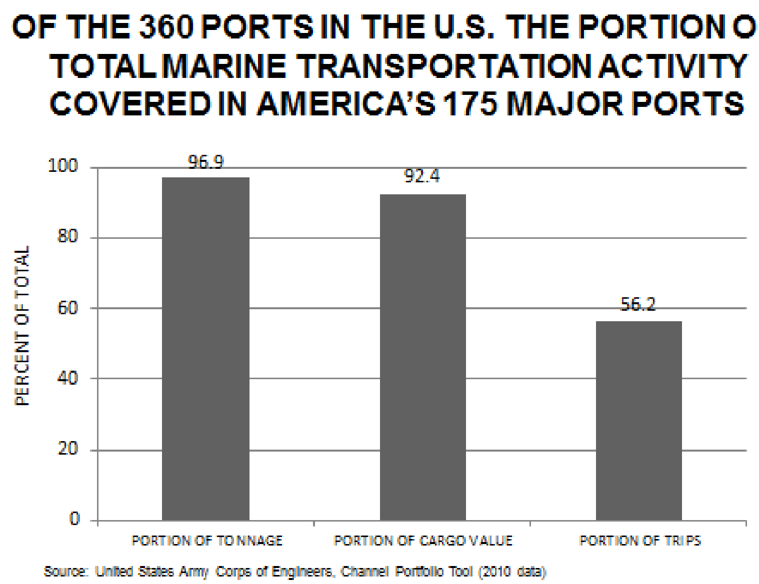
A. Selection of the Top 175 U.S. Ports

The top ports were selected from the USACE Waterborne Commerce Statistics Center (WCSC) list of ports prioritized by tonnage of cargo docked (import, export, or internal between U.S. ports). Only ports in areas that NOAA compiles nautical charts were considered for inclusion. Ports in the Inland Rivers and other areas the USACE have responsibility for charting were not considered even if they were relatively large ports. In the overall value of commerce shipped (tonnage and value) the total of all shipping was used including the effect of ports outside the top 175 list and including the Inland River ports[31]. The top 175 ports account for 96.6 percent of the cargo tonnage shipped in 2010 and 92.4 percent of the cargo value shipped in 2010.[32] (Refer to Figure 1)

[31] The United States is served by some 360 commercial ports that provide approximately 3,200 cargo and passenger handling facilities, according to the U.S. Coast Guard. http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=1032

[32] The reason why the top 175 ports only account for little more than 56.2 percent of total trips is the inclusion of small barge and lightering vessel movements. These typically transport the less valuable bulk cargos of coal, metallic and non-metallic minerals, grains and chemicals.

Figure 1



1. Combining the Ports of Stoneport and Presque Isle

The ports of Presque Isle and Stoneport are both located in Presque Isle Township, Michigan. (Refer to Figure 2) Although listed separately in the USACE Navigation Data Center database they are combined in the CPT database and appear to be the same port. Only one channel and one pier service the port (see images). Only one set of data is listed in the CPT database. This is probably an artifact from the way data was encoded by the shipping companies. Some may refer to the port by the facility name Stoneport while others by the village name of Presque Isle. The only commodity shipped is rock which clearly comes from the large quarry in southeast Presque Isle Township.

Figure 3 depicts a close up of the only commercial pier in the Presque Isle Township is in the Stoneport area. Note the large Lake Carrier vessel at the Stoneport Pier loading cargo. In the upper left is the Presque Isle channel that should obviously be relocated to show vessels moving to and from the pier at Stoneport. The USACE geographic coordinates for the channel are in error by about 1,000 yards.

B. Navy Ports

In addition, in the selection of the top 175 ports most important to the U.S. several factors were also considered other than their commercial value. Ports that are critical to the U.S. Navy for national defense were included. These ports have defense equipment and personnel transported through the port. None of that activity is identified as commercial transportation in the U.S. Army Corps of Engineers data system. Military vessels operating out of these ports

Figure 2

COMBINING THE PORTS OF STONEPORT AND PRESQUE ISLE

Source: Google Earth

Figure 3

PORT OF STONEPORT

Source: Google Earth

whether they are war ships, troop transports, or vessels delivering war and support goods will benefit by having real-time information on water levels, winds, visibility, waves, and bridge heights to enable personnel to navigate safely to and from the harbor. Some of these ports may serve both a Navy function as well as a commercial transportation function. In this case the value of their commercial cargo was identified through the U.S. Army corps of Engineers database.

Key West, FL
Newport, RI
Annapolis, MD
Apra Harbor, Guam
Bangor, WA
Bremerton, WA
Camp Pendleton, CA
Farallon De Medinilla, CNMI
Keyport, WA
Kings Bay, GA

Manchester, WA
Oak/Crescent Harbor, WA
Roosevelt Roads, PR
Saipan, CNMI
USNR Earle, Leonardo, NJ
New London/Groton, CT
Port Hueneme/Ventura, CA
Port Angeles, WA
Morehead City/Beaufort, NC
San Diego, CA
Everett, WA
Panama City, FL
Anchorage, AK
Port Canaveral, FL
Galveston, TX
Miami, FL
Newport News, VA
San Juan, PR
Jacksonville/Mayport, FL
Seattle, WA
Honolulu/Pearl Harbor, HI
Port Everglades, FL
Charleston, SC
Boston, MA
Baltimore, MD
Philadelphia, PA
Pascagoula/Moss Point, MS
Norfolk Harbor/Hampton Roads, VA
Savannah, GA
St. Thomas, VI
New York, NY and NJ
New Orleans, LA
Corpus Christi/Port Ingleside, TX
Tacoma, WA

The effect of the cruise ship industry was also considered in the selection of major ports. It was determined that all major cruise ship ports were included in the major commercial ports. Consequently, no additions were required to account for the cruise shipping industry.

C. **Commercial Fishing Ports (Top 10)**

Ports were also be selected as part of the top 175 U.S. ports because they are essential to the commercial fishing industry even if they had little in the way of commercial goods being transported to and from the port. Fishing vessels benefit from ports by having real-time information to enable them to navigate safely to and from the port facilities as well as making better informed decisions about safety considerations in departing the port. Some of these ports may serve both a commercial fisheries function as well as a commercial transportation function. In this case the value of their commercial cargo will be identified in the U.S. Army corps of Engineers database. At least the top ten fishing ports were included in the top 175 port list.

Top Commercial Fishing Ports

Dutch Harbor, AK
Empire/Venice, LA
Reedville, VA
Intracoastal City, LA
Petersburg, AK
Astoria, OR
New Bedford, MA
Lake Charles/Cameron, LA
Pascagoula/Moss Point, MS
Kodiak, AK

D. Regional Port Identification and Utilization

The proportionality of tonnage carried, cargo value and the number of trips made varies by USACE region. While NOAA's PORTS® utilize a system of 20 (as of 2010) geographic areas to identify installation locations, the USACE makes use of only eight regions to identify marine transportation activity. The two identification systems, shown in Table 2, were developed and used to relate marine traffic with specific PORTS®.

As expected, the ratio of tonnage handled and commercial value of the related cargo generally mirror one another with the exception of the south pacific region where a greater portion of the relatively-higher value container traffic is handled. (Refer to Figure 4) Given the larger number of smaller barge traffic in the Mississippi valley, it is unexpected to see its portion of total trips exceed all other regions.

Table 2

DISTRICT IDENTIFICATION OF U.S. PORTS

UNITED STATES ARMY CORPS OF ENGINEERS DISTRICTS	NOAA's PORTS® GEOGRAPHIC AREAS	NUMBER OF PORTS SERVED BY THE PHYSICAL OCEANOGRPHIC REAL-TIME SYSTEM (PORTS®)
	Chesapeake Bay	9
	Delaware Bay	9
	Houston/Galveston	3
	Humboldt	1
	Jacksonville	1
	Lake Charles	1
	Los Angeles/Long Beach	2
	Lower Columbia River	5
	Lower Mississippi	5
	Mobile Bay	1
	Narragansett Bay	3
	New Haven	1
	New London	1
	New York/New Jersey	1
	Pascagoula	1
	Sabine Neches	4
	San Francisco Bay	4
	Tacoma	1
	Tampa Bay	3
	Soo Locks	0
Lakes & Rivers		0
Mississippi Valley		6
North Atlantic		24
North Western		7
Pacific		2
South Atlantic		7
South Pacific		7
South West		7
CROSS REFERENCE		
Mississippi Valley	Lake Charles	1
Mississippi Valley	Lower Mississippi	5
North Atlantic	Chesapeake Bay	9
North Atlantic	Delaware Bay	9
North Atlantic	Narragansett Bay	3

North Atlantic	New Haven	1
North Atlantic	New London	1
North Atlantic	New York/New Jersey	1
North Western	Cherry Point	1
North Western	Lower Columbia River	5
North Western	Tacoma	1
Pacific	Anchorage	2
South Atlantic	Charleston	1
South Atlantic	Mobile Bay	1
South Atlantic	Pascagoula	1
South Atlantic	Tampa Bay	3
South Pacific	Humboldt	1
South Pacific	Los Angeles/Long Beach	2
South Pacific	San Francisco Bay	4
South West	Houston/Galveston	3
South West	Sabine Neches	4

Source: United States Army Corps of Engineers; NOAA, COOPS

Figure 4

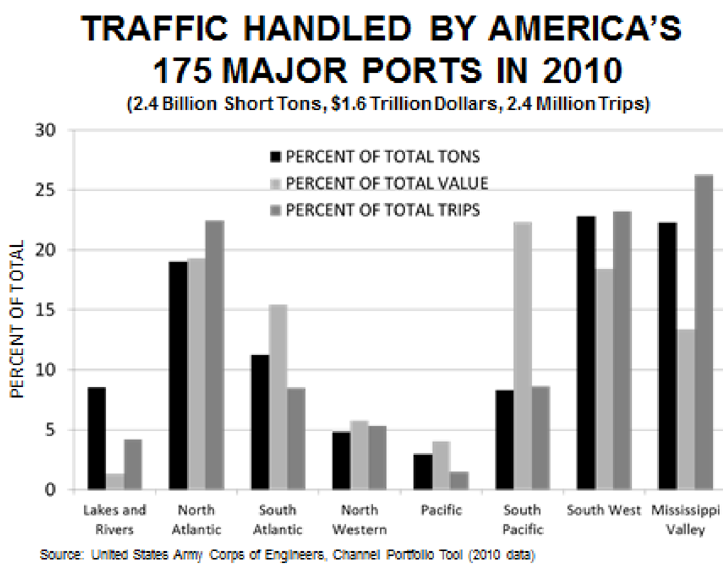
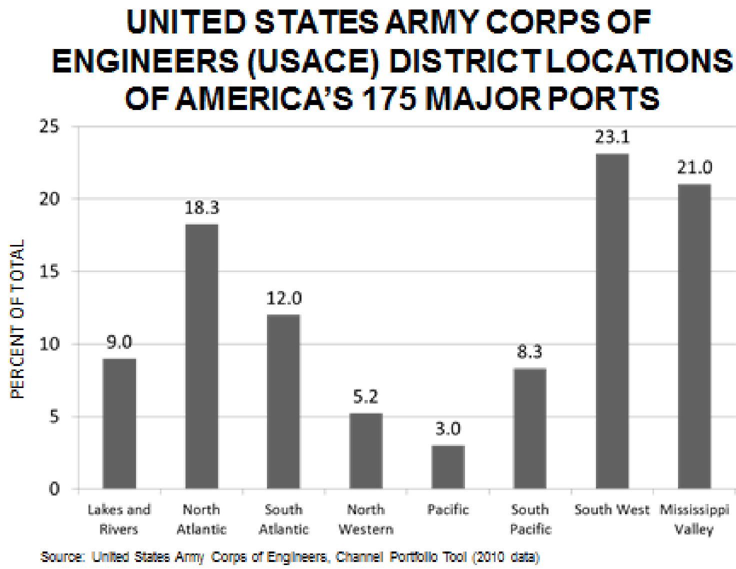


Figure 5

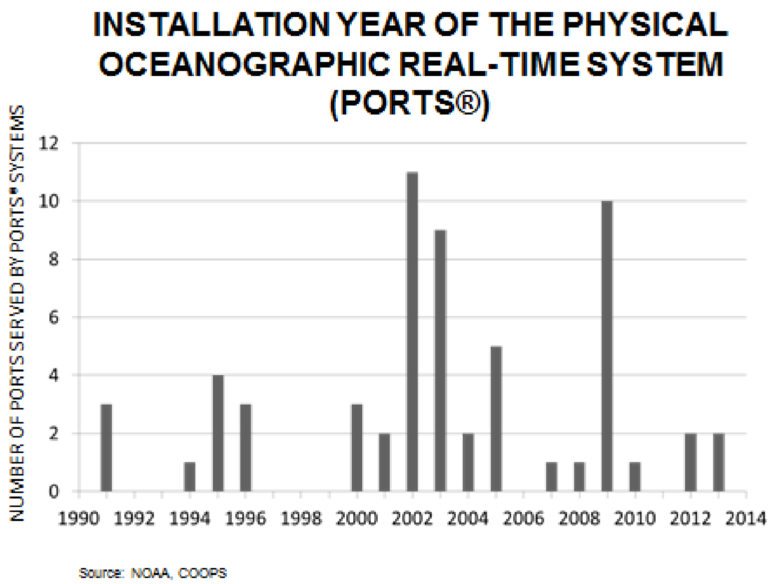


Overall, 23.1 percent of the top 175 ports are numerically located in the USACE's Southwest region, while 21 percent are in the Mississippi valley. (Refer to Figure 5)

III. PORTS® COVERAGE

Detailed in Chapter 3, PORTS® are currently installed at 60 physical port locations. Since their inception in 1991 PORTS® have been installed at a rate of normally one to two per year with 2002, 2003 and 2009 being significant exceptions. (Refer to Figure 6) Cumulatively, there has been a steady increase in PORTS® system installations. (Refer to Figure 7) Among current number of 60 PORTS(s) installations, 24 are installed in North Atlantic ports while about seven are equally installed at all other locations with the exception of the USACE's Lakes and Rivers district.[33] (Refer to Figure 8)

Figure 6



Overall this installation pattern results in a wide-variety of installation concentration as the Mississippi valley as almost 86 percent of their ports serviced by PORTS® while only 11 percent of Pacific ports have the same coverage by PORTS®. (Refer to Figure 9)

[33] As lakes and rivers are not impacted by high tides to the extent that locations next to open oceans are, the potential need for PORTS® is believed to be less than for ocean ports.

Figure 7

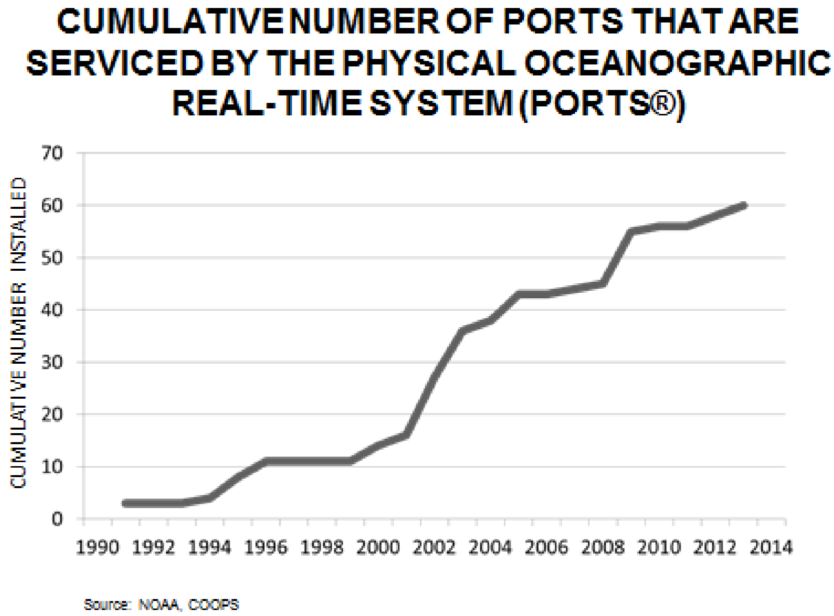


Figure 8

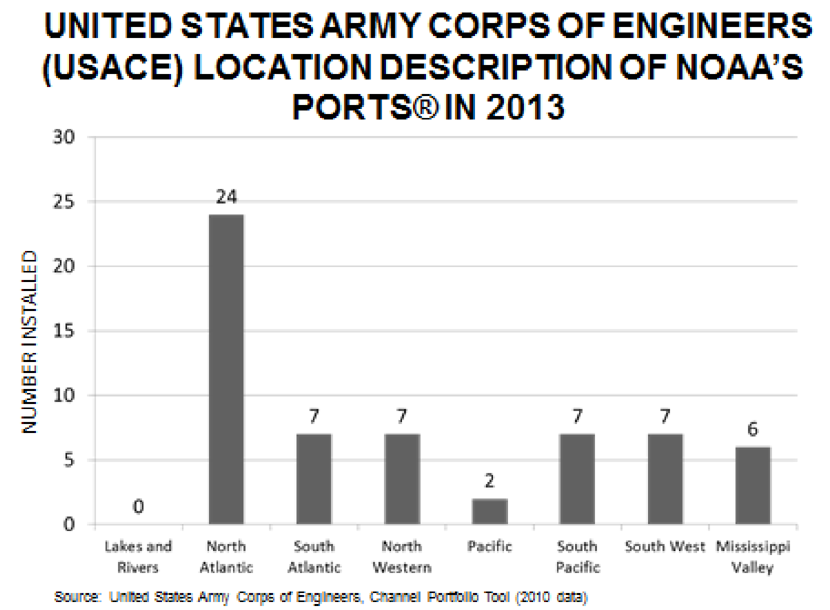
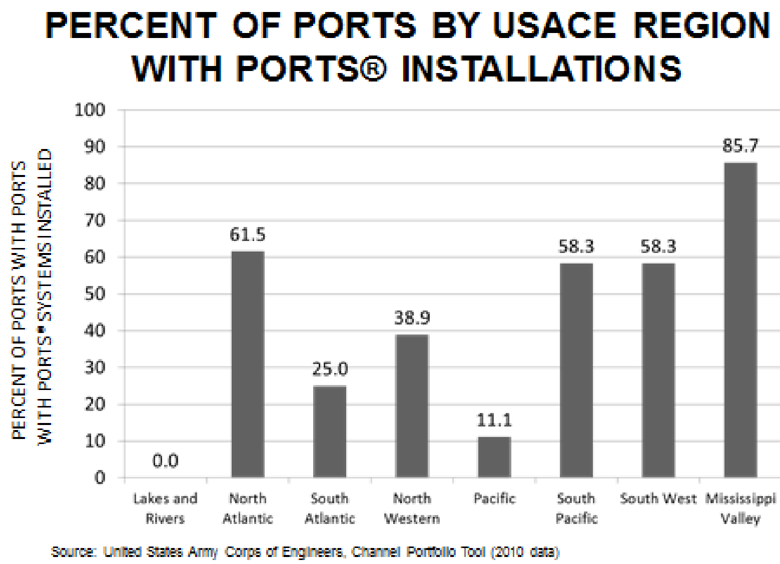


Figure 9



This analysis makes use of marine traffic data from 2010, the latest year which has been incorporated into the USACE's CPT application The incidence of PORTS® locations and physical ports by state are listed as Table 3.   During 2010, the number of total web hits to access PORTS® data exceeded 6.2 million. (Refer to Figure 13).

Figure 13

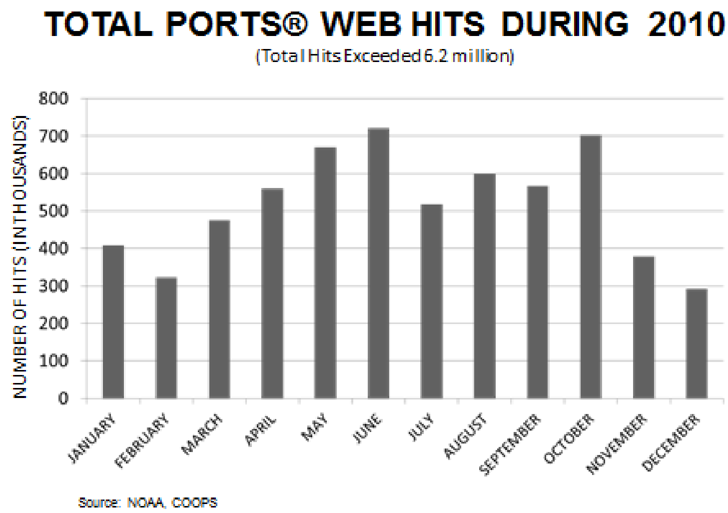


Table 3

SUMMARY OF U.S. PORTS AND PORTS® INSTALLATIONS THROUGH 2013

LOCATION OF PORT	NUMBER OF PORTS	NUMBER OF PORTS WITH PORTS®	NUMBER OF PORTS WITHOUT PORTS®
TOTAL	***175***	***58***	***117***
Alaska	8	2	6
Alabama	1	1	
California	12	7	5
Commonwealth of the Northern Mariana Islands[34]	2		2
Connecticut	4	2	2
District of Columbia	1	1	
Delaware	2	2	
Florida	12	3	9
Georgia	3		3
Guam[35]	1		1
Hawaii	7		7
Illinois	2		2
Indiana	4		4
Louisiana	7	6	1
Massachusetts	4	1	3
Maryland	2	2	

[34] A Commonwealth of the United States.

[35] An organized, unincorporated territory of the United States.

Maine	1		1
Michigan	19		19
Minnesota	4		4
Mississippi	3	1	2
North Carolina	2		2
New Hampshire	1		1
New Jersey	4	3	1
New York	6	1	5
Ohio	10		10
Oregon	3	2	1
Pennsylvania	6	4	2
Puerto Rico[36]	4		4
Rhode Island	2	2	
South Carolina	2		2
Texas	12	7	5
Virginia	6	6	
Virgin Islands[37]	1		1
Washington	15	5	10
Wisconsin	2		2

[36] The Commonwealth of Puerto Rico is an unincorporated territory of the United States.

[37] Commonly called the United States Virgin Islands, U.S. Virgin Islands, or USVI are a group of islands in the Caribbean that are an insular area of the United States. An insular area is a United States territory that is neither a part of one of the 50 U.S. states nor the District of Columbia, the federal district of the U.S

CHAPTER 2 – PREVIOUS PORTS® VALUATION STUDIES

I. PREVIOUS VALUATION STUDIES

Beginning in 1995, a series of investigations have been undertaken by Kite-Powell to assess the economic benefits derived from PORTS®. (Kite-Powell 2005a 2005b, 2007, 2009, 2010) In his analyses he notes that the potential sources of economic benefit from PORTS® information include:[1]

- Greater draft allowance/increased cargo capacity and reduced transit delays for commercial maritime transportation (water level information);
- Reduced risk of groundings/allisions for maritime traffic (currents and wind information);
- Enhanced recreational use of coastal waters boaters, windsurfers, etc. (winds, weather forecasts, and other information); and,
- Improved environmental/ecological planning and analysis, including hazardous material spill response.

Kite-Powell (2005b) shares that most information-based products are valuable because they reduce the user's uncertainty about a factor that is important to the physical outcome (such as weather, waves, or water level).[2]

II. CONCEPT OF DE MINIMIS VALUE SUBSTITUTION

Quantifying true economic benefits is difficult; and proxy measures are frequently used. The most appropriate measure of economic value of information resulting from a variation in user decisions or behavior is the change in what economists refer to as "social surplus." Social

[1] Refer to: Kite-Powell (2005b) page v.

[2] Ibid, pages 4-5.

surplus has two components: (1) producer surplus; and, (2) consumer surplus. Producer surplus in this case is generally a reduction in costs to businesses. Consumer surplus, as in the case of the angler, is the difference between what one would be willing to pay and what one actually pays for, for example, a recreational experience. "Social surplus" is the sum of producer and consumer surplus. It is the appropriate measurement because it assures that only the value in excess of costs is counted, making it a unique measure that avoid the artificial inflation of values by double counting.

The problem with social surplus and both of its elements is that they can only be measured using detailed, time-consuming, and costly techniques. Other measures of economic activity (broadly termed "economic impacts") such as the value of sales at the wholesale or retail level, or value added (the most common example of which is the Gross Domestic Product, or GDP), are widely available, but measure social surplus in a rather imperfect manner.

In other situations, estimates of social surplus may be available but data to support an explicit model of how PORTS® information is used in economic decisions are lacking. In such cases, an order-of-magnitude estimate of potential value of PORTS® data may be obtained by applying a rule of thumb developed by Nordhaus (1996) and others: the value of weather and climate forecasts to economic activities that are sensitive to weather/climate tends to be on the order of one percent of the economic activity in question. Ultimately, Kite-Powell delineates six major groups of potential benefits which can result from the installation and use of PORTS®. (Refer to Table 1)

Kite-Powell states in his paper "Estimating Economic Benefits from NOAA PORTS® Installations: A Value of Information Approach".[3]

> "In situations where data does not exist to enable one to calculate the benefit it may be possible to estimate at least the general scale of potential benefit by applying a "one percent proxy rule." Formulated by Nordhaus (1986) and other economists on the basis of experience with a number of forecast/nowcast value of information studies of industries and activities sensitive to weather, this rule suggest that the value of weather nowcast/forecast information to economic activity sensitive to weather conditions is generally on the order of one percent of the economic value generated by the economic activity. There is, of course, no guarantee that this rule will hold in all cases; but where no better estimate can be constructed, it provides an order of magnitude estimate of value that is likely to be reasonable. (Kite-Powel, 2005)"

The "one percent proxy rule" states that on the order of one percent of the economic value generated by the economic activity can be attributed to the information being studied, in this case PORTS®.[4] Kite-Powell states that:

> "There is no guarantee that this rule will hold in all cases; but where no better estimate can be constructed, it provides an order of magnitude estimate of value that is likely to be reasonable."[5]

This report makes use of this economics tool making sure that there is at least anecdotal evidence, if not empirical evidence that the subject user group in fact uses the data and achieves some benefit. A de minimis value of one percent (1.0%) is used when there is an indication that there the user achieves a significant benefit from the use of PORTS®. A smaller value of one tenth of one percent (0.1%) is used when the benefit to the user is not

[3] Kite-Powell, Hauke, Estimating Economic Benefits from NOAA PORTS® Installations: A Value of Information Approach", NOAA Technical Report NOS CO-OPS 044, 2005, p. 5.

[4] Kite-Powell, Hauke, "Estimating Economic Benefits from NOAA PORTS® Installations: A Value of Information Approach, NOAA Technical Report NOS CO-OPS 044, 2005, p.16.

[5] Ibid, p.16.

considered as great but yet is still of some importance. In all cases it is believed that the de minimis value used represents a significantly lower value than what would be calculated if the supporting data were available. In the absence of supporting economic data it is preferable that some attempt, even if imperfect, be used to estimate the benefit to a user group rather than just ignoring the benefit for lack of conclusive data.

III. KITE-POWELL STUDIES ON ESTIMATING ECONOMIC BENEFITS FROM PORTS®

Following this paradigm public data on traffic levels, safety records, and recreational activities were combined with the result of numerous individual and group interviews (employing a Delphi technique). From these activities, benefits estimates were developed for the ports of Tampa, Houston/Galveston, New York/New Jersey, and Columbia River ports. In each of his analyses, Kit-Powell grouped his benefit estimations based on the relative confidence he had in those numbers accurately reflecting benefits enjoyed owing to PORTS®. (Refer to Tables 2, 3, 4 and 5.) Employing nominal dollars, the total value of benefits from these four ports was estimated to range from \$42.8 to \$47.7 million per year. (Refer to Figure 1)

Table 1

POTENTIAL SOURCES OF PORTS® BENEFITS

BENEFIT GROUP	SPECIFIC BENEFIT ASSESSMENT
Improved Safety of Shipping and Boating	Avoided groundings, commercial vessels Avoided distress cases, recreational vessels
Improved Efficiency of Marine Operations	Increased cargo carried per ship call (greater loaded draft) Reduced delays (less allowance for error/margin in piloting decisions) Improved SAR performance (surface currents)
Improved Environmental Protection and Planning	Improved hazardous material spill response Improved environmental restoration/conservation activities
Improved Recreational Experiences	Enhanced value from boating decisions (power, sail, windsurfing, kayaking, etc.) Enhanced value from fishing decisions Enhanced value from beach visit decisions
Improved Weather and Coastal Marine Conditions Products	Improved general weather forecasts Improved coastal marine weather forecasts Improved storm surge forecasts
Science and Education	Use of PORTS® data in scientific research Use of PORTS® data in secondary education

Source: Kit-Powell, 2005b, page 7.

A. Estimating National Value

While no previously published analysis has been done to estimate the national value of benefits provided by the current PORTS® now installed at 60 locations, it is possible to make an initial estimate employing the four Kite-Powell’s analyses. Using the four individual studies previously undertaken and adjusted to 2010 dollars, it was estimated that between $45.4 and $50.8 million[6] in annual benefits are produced.[7] (Refer to Table 6) Collectively, these four sample ports handled almost 27.5 percent of all vessel movements

[6] Includes values that are characterized by Kite-Powell in his earlier work as “high confidence”, “low confidence” and “potential or speculative”.

[7] Employing Gross Domestic Product, Source: U.S. Department of Commerce, Bureau of Economic Analysis, July, 2013.

between 2005 and 2010.[8] (Refer to Figure 2)

Table 2

SUMMARY OF ESTIMATED ANNUAL BENEFITS FROM TAMPA BAY PORTS®

CONFIDENCE LEVEL	SOURCE OF BENEFIT	NATURE OF BENEFIT	APPROXIMATE ANNUAL VALUE (2005 DOLLARS)
High confidence reasonably good confidence and/or direct evidence for benefits	avoided groundings, commercial vessels	avoided costs (surplus)	$1,100,000 – $2,800,000
	increased draft, cargo loading	efficiency (surplus)	$1,100,000
	reduced delays, commercial vessels	avoided costs (surplus)	$10,000
	improved spill response (present practice)	avoided costs (surplus)	$200,000 - $900,000
Subtotal – high confidence benefits			**$2,400,000 -$4,800,000**
Lower confidence more significant assumptions required to estimate benefits; less direct evidence	reduced distress cases, recreational boats	avoided costs (surplus, value of life)	$200,000
	improved weather forecasts	non-market consumer surplus	$1,500,000
	improved storm surge forecasts	avoided costs (surplus)	$500,000
Subtotal – lower confidence benefits			**$2,200,000**
Potential or speculative these benefits could be realized with additional investment or a higher level of utilization of PORTS® data	improved spill response (with additional models & infrastructure)	avoided costs (potential; not realized at present)	$900,000
	enhanced recreational boating	non-market consumer surplus	$1,000,000
	enhanced recreational fishing	non-market consumer surplus (potential; not realized at present)	$100,000
	enhanced beach recreation	non-market consumer surplus	$200,000
Subtotal – potential or speculative benefits			**$2,200,000**
Non-quantified benefits	Educational use	Non-market	N/A
	Scientific research	Non-market	N/A

Source: Kite-Powell, 2005a, Table 1, page vi.

[8] Source: USACE, Channel Portfolio Tool (CPT) Database

Table 3

SUMMARY OF ESTIMATED ANNUAL BENEFITS FROM HOUSTON/GALVESTON PORTS®

CONFIDENCE LEVEL	SOURCE OF BENEFIT	NATURE OF BENEFIT	APPROXIMATE ANNUAL VALUE (2006 DOLLARS)
High confidence reasonably good confidence and/or direct evidence for benefits	avoided groundings, commercial vessels; PORTS® contributes 60% reduction in grounding risk	avoided costs (surplus)	$10,500,000
	increased draft/reduced lightering, inbound cargo	efficiency (surplus)	$250,000
	reduced delays, commercial vessels	avoided costs (surplus)	$125,000
	improved spill response (present practice)	avoided costs (surplus)	$1,000,000
Subtotal – high confidence benefits			**$11,900,000**
Lower confidence more significant assumptions required to estimate benefits; less direct evidence	reduced distress cases, recreational boats	avoided costs (surplus, value of life)	$200,000
	improved weather forecasts	non-market consumer surplus	$1,500,000 – 3,000,000
	improved storm surge forecasts	avoided costs (surplus)	$500,000
Subtotal – lower confidence benefits			**$2,200,000 - $3,700,000**
Potential or speculative these benefits could be realized with additional investment or a higher level of utilization of PORTS® data	improved spill response (with additional models & infrastructure)	avoided costs (potential; not realized at present)	$1,000,000 – 2,000,000
	enhanced recreational boating	non-market consumer surplus	$620,000
	enhanced recreational fishing	non-market consumer surplus (potential; not realized at present)	$30,000
	enhanced beach recreation	non-market consumer surplus	$120,000
Subtotal – potential or speculative benefits			**$1,800,000 - $2,800,000**
Non-quantified benefits	Educational use	Non-market	N/A
	Scientific research	Non-market	N/A

Source: Kite-Powell, 2007, Table 1, page v.

Table 4

SUMMARY OF ESTIMATED ANNUAL BENEFITS FROM NEW YORK / NEW JERSEY PORTS®

CONFIDENCE LEVEL	SOURCE OF BENEFIT	NATURE OF BENEFIT	APPROXIMATE ANNUAL VALUE (2007 DOLLARS)
High confidence reasonably good confidence and/or direct evidence for benefits	avoided groundings, commercial vessels; PORTS® contributes 50% reduction in grounding risk	avoided costs (surplus)	$7,500,000
	increased draft/reduced lightering, inbound cargo	efficiency (surplus)	$0
	reduced delays, commercial vessels	avoided costs (surplus)	$1,350,000
	improved spill response (present practice)	avoided costs (surplus)	$1,000,000
Subtotal – high confidence benefits			**$9,900,000**
Lower confidence more significant assumptions required to estimate benefits; less direct evidence	reduced distress cases, recreational boats	avoided costs (surplus, value of life)	$100,000
	improved weather forecasts	non-market consumer surplus	$0
	improved storm surge forecasts	avoided costs (surplus)	$300,000
Subtotal – lower confidence benefits			**$400,000**
Potential or speculative these benefits could be realized with additional investment or a higher level of utilization of PORTS® data	improved spill response (with additional models & infrastructure)	avoided costs (potential; not realized at present)	$1,000,000
	enhanced recreational boating	non-market consumer surplus	$500,000
	enhanced recreational fishing	non-market consumer surplus (potential; not realized at present)	$100,000
	enhanced beach recreation	non-market consumer surplus	$700,000
Subtotal – potential or speculative benefits			**$2,300,000**
Non-quantified benefits	Educational use	Non-market	N/A
	Scientific research	Non-market	N/A

Source: Kite-Powell, 2009, Table 1, page 3.

Table 5

SUMMARY OF ESTIMATED ANNUAL BENEFITS FROM PORTLAND / COLUMBIA RIVER PORTS®

CONFIDENCE LEVEL	SOURCE OF BENEFIT	NATURE OF BENEFIT	APPROXIMATE ANNUAL VALUE (2009 DOLLARS)
High confidence reasonably good confidence and/or direct evidence for benefits	increased draft, outbound cargo	efficiency (surplus)	$4,000,000
	reduced delays, commercial vessels	avoided costs (surplus)	$800,000
	improved spill response (present practice)	avoided costs (surplus)	$100,000
Subtotal – high confidence benefits			**$4,900,000**
Lower confidence more significant assumptions required to estimate benefits; less direct evidence	avoided accidents, commercial vessels	avoided costs (surplus)	$1,500,000
	Improved river flow management and flood warnings during major flood events	avoided costs (surplus)	$1,000,000
Subtotal – lower confidence benefits			**$2,500,000**
Potential or speculative these benefits could be realized with additional investment or a higher level of utilization of PORTS® data	improved spill response (with additional models & infrastructure)	avoided costs (potential; not realized at present)	$100,000
	enhanced recreational boating	non-market consumer surplus	$0
Subtotal – potential or speculative benefits			**$100,000**
Non-quantified benefits	Educational use	Non-market	N/A
	Scientific research	Non-market	N/A

Source: Kite-Powell, 2010, Table 1, page v.

Figure 1

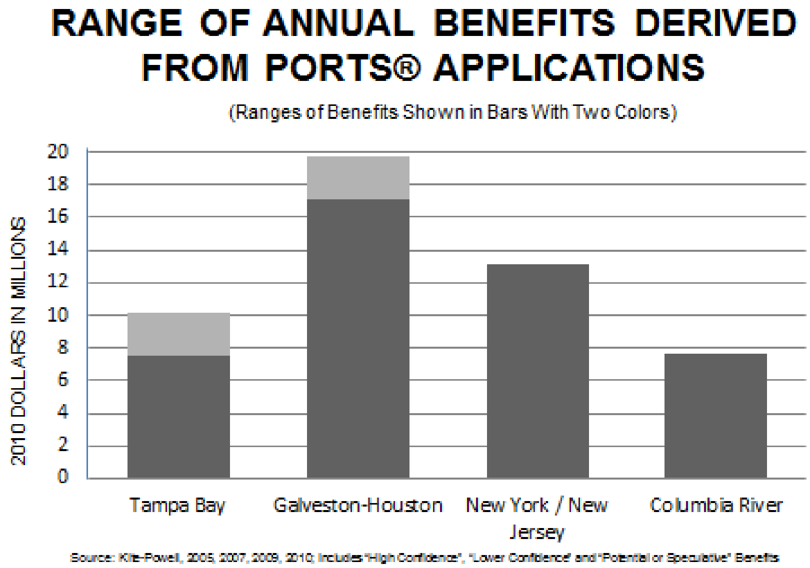


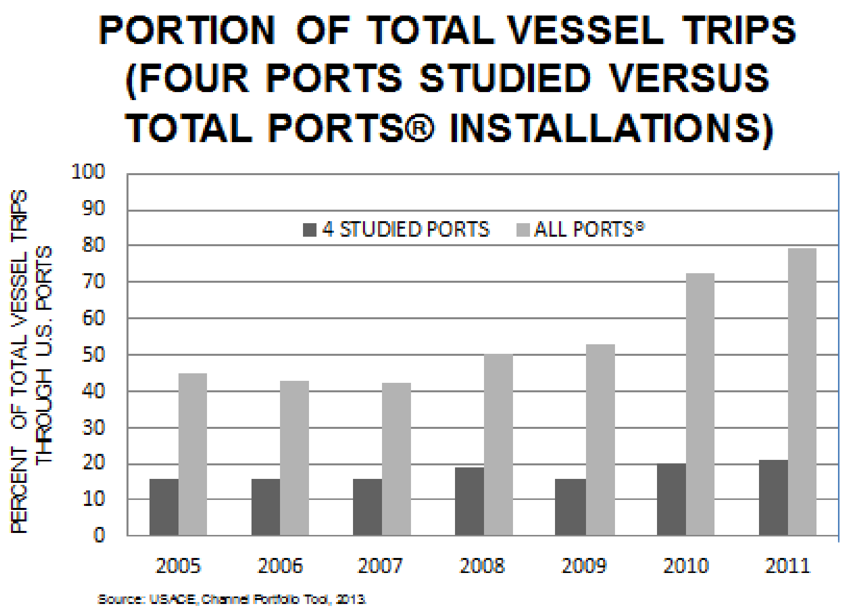
Table 6

SUMMARY OF PREVIOUS PORTS® BENEFITS
(Converted to 2010 Dollars)

YEAR	LOCATION OF BENEFIT ESTIMATE	LOW ANNUAL ESTIMATE ($ Millions)	HIGH ANNUAL ESTIMATE ($ Millions)
2005	Tampa Bay	$ 7.6	$ 10.2
2006	Galveston-Houston	$ 17.1	$ 19.8
2007	New York / New Jersey	$ 13.2	$ 13.2
2009	Portland / Columbia River	$ 7.6	$ 7.6
	TOTAL FOR SAMPLE OF PORTS®	**$ 45.4**	**$ 50.8**

Source: Kite Powell, Department of Commerce, U.S. Bureau of Economic Analysis (GDP deflator)

Figure 2



Employing the $ 45.4 to $ 50.8 million dollar range of potential benefits from the four port study to the national level could be simplistically accomplished based on vessel passings for two measures: (1) the value of the 58 port locations with PORTS® already installed through 2010; and, (2) the potential added benefit of installing PORTS® at the remaining major 117 port locations currently without such systems. (Refer to Table 7) Employing the most recent (2010-2011) ratios of total PORTS® coverage to those original four ports results in a four-fold increase in covered traffic. Using this multiplier, the original estimates are expanded to between about $172 and $192 million per year. As little more than 20 percent of traffic is still transported as of 2010 through the 117 ports without PORTS®, a simple estimate for added benefits resulting from their installation might range from an additional $43 to $48 million per year.[9] (Refer to Figure 3)

Table 7

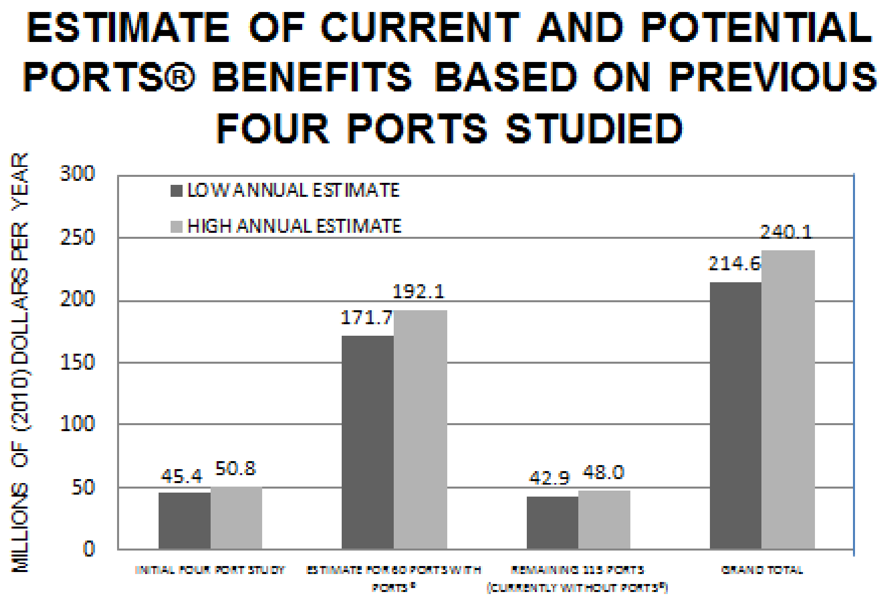
SUMMARIES OF PREVIOUS KITE-POWELL PORTS® BENEFITS STUDIES (CONVERTED TO 2010 DOLLARS)

SOURCE OF BENEFIT ESTIMATE	LOW ANNUAL ESTIMATE ($ Millions)	HIGH ANNUAL ESTIMATE ($ Millions)
From four port base studies (2005 – 2009)	$ 45.4	$ 50.8
Expanded to cover all current 58 ports with PORTS® installed through 2010	$ 171.7	$ 192.1
Estimated total from remaining 117 ports without PORTS®	$ 42.9	$48.0
Estimated total potential PORTS® benefits	$ 214.6	$ 240.1

Source: Kite Powell, Department of Commerce, U.S. Bureau of Economic Analysis (GDP deflator)

[9] Simply the assumption that the $171.7 and $192.1 million figures represent 80 percent of total benefits (e.g., $171.7 / 0.8 = $214.6 million and $192.1 / 0.8 = $240.1). The difference between the projected total and total for all existing PORTS® would be the estimated marginal benefit from universal installation of PORTS®.

Figure 3



Source: Kite-Powell, 2005, 2006, 2007, 2009; USACE Channel Portfolio Tool, 2013.

REFERENCES:

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of Tampa Bay"*, Report prepared for the Tampa Bay Harbor Safety and Security Committee, July 2005a.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Value of Information Approach"*, NOAA Technical Report National Ocean Service, Center for Operational Oceanographic Products and Services 044, Silver Spring, July 2005b.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of Houston / Galveston"*, Report prepared for the Houston Ship Channel users and Ports of Houston and Galveston, March, 2007.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of the Port of New York/New Jersey"*, Report prepared Center for Operational Oceanographic Products and Services, May, 2009.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of the Columbia River"*, Report prepared Center for Operational Oceanographic Products and Services, June 2010, 2010.

Nordhaus, W.D., "The Value of Information". In: R. Krasnow, ed., *Policy Aspects of Climate Forecasting*. Proceedings of a Seminar held in Washington, D.C., March 4, 1986. Resources for the Future, Washington.

CHAPTER 3 - DATA AND INFORMATION EMPLOYED

I. BACKGROUND

Data employed in this valuation analysis came from several public, semi-public and private sources. Prominent among these were the NOAA Coastal Services Center's Digital Coast data (CSC),[1] National Ocean Economics Program (NOEP), United States Army Corps of Engineers (USACE), Department of Labor, Bureau of Labor Statistics (BLS), the United States Coast Guard (USCG) and the U.S. Department of Transportation (DOT).

Unlike previous studies, this analysis for the first time makes use of several proprietary data bases and analysis tools from the USACE. Previous to this time, these data bases and analytical tools were only available to USACE personnel owing to the sensitive nature of the data.[2] Although two National Ocean Service staffers have been given access to these databases, assurance was required that results be aggregated in such a manner as to not divulge data to such a granular level as to violate the tenets of our non-disclosure agreement. As of this time, these data sets and analysis tools are not available to non-Federal employees.

In order to understand the strengths and weaknesses of this valuation project involving PORTS® it is necessary to assess and comprehend the potential power and limitations of the underlying data and information. Overall, in keeping with the conservative nature of this report, data was used as it was presented to the public. Aside from some cleanup involving misplaced decimal places, location spellings or reversed latitude and longitude figures, no modifications or

[1] Although CSC and NOEP data are similar, CSC employs revisions to two of the NOEP sectors. One revision corrects the accidental exclusion of natural gas liquid extraction from NOEP Offshore Mineral Resources data. The other presents a more comprehensive assessment of the marine transportation sector by adding data for pipeline transportation of crude oil, natural gas, and refined petroleum products. See: CSC, Frequent Questions, Page 5. Owing to the greater expansiveness of ENOW, it was employed in this analysis.

[2] Signature of non-disclosure forms was required by the USACE prior to release of the data to the authors of this study.

"fill-ins" to the data were made by the researchers.[3]

Given the time and budgetary constraints imposed on this investigation, there were few opportunities to develop original primary data. Instead, working with existing information from a number of Federal Agencies which represented state of the art in terms of data timeliness, completeness and accuracy, an original highly conservative "bottom-up" approach was developed. In this evaluative process, logic-models were first developed to identify the causal agents within PORTS® which facilitate benefits in the form of lower costs, enhanced safety and improved environmental protection. Once identified, the total level of benefits resulting from all supportive systems was initially estimated. Later, based on different weighting assessment methods which included DELPHI interviews of port pilots as well as subjective assessments based on NOAA staff experience, a range of benefits were estimated across both an annual basis and ten-year horizon (which reflected the empirical economic-life of the PORTS®.

Given the unknown nature of future transportation commodity flows, regulatory changes, authorizations of future allowances to modify channel depth and width (as well as the availability of related funding to bring such changes to fruition) as well as international issues (e.g., additional enlargement of the Panama Canal, foreign North American port tax and environmental policies, exchange rates, etc.) or knowledge of the number and type of instruments existing and potential PORTS® locations might require, no attempt was made at estimation of any cost models or assessment of any cost-benefit ratios. This was a benefits assessment study only.

[3] For example, in the Army Corps of Engineers (USACE) Channel Portfolio Tool, some observations at the port level did not include data for each field (tonnage carried, value of cargo, and the number of trips). While these did not occur in more than one percent of the time or have a major potential impact on the overall conclusions of the study, no attempt was made to insert figures in these instances.

II. COASTAL SERVICES CENTER DATA

Public data involving six sectors of the ocean economy were reviewed and included: (1) marine construction; (2) living resources; (3) minerals; (4) ship & boat building; (5) tourism & recreation; and, (6) transportation. These were identified through the North American Industrial Classification System (NAICS).[4] (Refer to Table 1) Specific NAICS industry definitions and associated codes are listed in Appendix A. For several years, NOAA's Coastal Services Center (CSC) has maintained a number of tools that are designed to help foster and sustain the economic and environmental well-being of the nation's coast.[5] Their Economics: National Ocean Watch (ENOW) data base contains data from the Bureau of Labor Statistics and Bureau of Economic Analysis involving the level of economic activity in coastal areas.

Although the NOEP and ENOW data bases contain similar data, the ENOW data contains two revisions which correct the accidental exclusion of natural gas liquid extraction from NOEP offshore mineral resources data and inclusion of data for pipeline transportation of crude oil, natural gas and refined petroleum products.[6] For this reason, ENOW was selected as the source of data in this analysis.

Three of the ocean economic sectors were selected for analysis as they appeared most potentially benefitted by the deliverables provided by PORTS®: (1) living resources; (2) marine

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[4] NAICS was developed in the 1990s as a part of the North American Free Trade Agreement (NAFTA) to provide a common basis for the U.S., Canada, and Mexico to measure their economic activity.

[5] The CSC operates as a line office under the National Ocean Service.

[6] Refer to: NOAA Coastal Services Center, *"Frequent Questions, Economics: National Ocean Watch (ENOW) Data*", November, 2012, page 5.

transportation; and, (3) tourism and recreation. Separate data for fisheries was obtained from the annual reports produced by the National Marine Fisheries Service (NMFS).[7] As certain

Table 1

ENOW OCEAN ECONOMY SECTORS

Construction	**Tourism & Recreation**
Marine Related Construction	*Amusement and Recreation Services*
Living Resources	*Boat Dealers*
Fishing	*Eating & Drinking Places*
Fish Hatcheries & Aquaculture	*Hotels & Lodging Places*
Seafood Markets	*Marinas*
Seafood Processing	*Recreational Vehicle Parks & Campgrounds*
Offshore Minerals	*Scenic Water Tours*
Limestone, Sand & Gravel	*Sporting Goods Retailers*
Oil and Gas Exploration	*Zoos, Aquaria*
Oil and Gas Production	**Transportation**
Ship & Boat Building	*Deep Sea Freight Transportation*
Boat Building and Repair	*Marine Passenger Transportation*
Ship Building and Repair	*Marine Transportation Services*
	Search and Navigation Equipment
	Warehousing

Source: NOAA Coastal Services Center, *"Frequent Questions, Economics: National Ocean Watch (ENOW) Data*", November, 2012. Pages 7-8

As certain ocean-related activities are excluded from the data such as fish harvesting (which is not covered by unemployment insurance laws), addition of separate NMFS data was not thought to constitute double counting of value added. Within each category, four economic indicators from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) were obtained: (1) number of establishments; (2) wage and salary employment[8]; (3) wages; [9] and,

[7] "NMFS, "Fisheries of the United States" for involved years.

[8] Measured by location of work and not by place of residence.

gross state product.[10]

While the data was available for 30 coastal states and territories and 448 coastal counties in the ENOW database, only those counties (using Google Earth®) identified as containing one of the United States 175 ports was included in benefit calculations.[11] Inland adjacent counties were also reviewed for economic activity in the three value added areas investigated.

III. CHANNEL PORTFOLIO TOOL (CPT) DATA

Critical to this investigation of PORTS® value is the Channel Portfolio Tool (CPT) developed by Dr. Ken Mitchell of the USACE. In essence, the CPT is a method to transform raw data involving water transportation into tabular and graphic representations of activity. Containing data on channel depth, commodity transported, vessel depth, cargo value, cargo weight, cargo type (container versus non-container), ship type and ship direction, it is possible to

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[9] This definition covers about 90% of employment in the U.S. It excludes farm employment, the military, railroads, and self-employment. The exclusion of self- employment excludes almost all the Fish Harvesting industry's employment, plus self-employed persons in the Tourism & Recreation sector among the ocean economy sectors

[10] The Bureau of Economic Analysis (BEA) defines Gross State Product (GSP) as the value added in production by the labor and property located in a state. GSP for a State is derived as the sum of the gross state product originating in all industries in a State. In concept, an industry's GSP, referred to as its "value added", is equivalent to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other U.S. industries or imported). Thus, GSP is often considered the state counterpart of the nation's gross domestic product (GDP), BEA's featured measure of U.S. output. In practice, GSP estimates are measured as the sum of the costs incurred and incomes earned in the production of GDP, e.g. the net cost of production.

[11] As information the USACE developed the Regional Economic System (RECONS) Program from funding under the 2009 American Recovery and Reinvestment Act (ARRA). It contains the same BLS data involving establishments and wags as does the ENOW database. This regional economic impact modeling tool was developed to provide accurate and defendable estimates of regional economic impacts associated with Corps spending and could be utilized to track progress and to justify continued operation, maintenance and construction work performed by the Corps. This modeling tool automates calculations and generates estimates of jobs and other economic measures such as income and sales associated with USACE's ARRA spending and annual Civil Work program spending, as well as stemming from effects of additional economic activities (for example, water transportations, tourism spending, etc.) associated with USACE's core programs. This is done by extracting multipliers and other economic measures from more than 1,400 regional economic models that were built specifically for USACE's project locations. These multipliers were then imported to a database and the tool matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. The model is available for Corps use only as per license agreement with the sources of data used to generate multipliers and other economic factors. Refer to: http://planning.usace.army.mil/toolbox/tools.cfm?Id=177&Option=RECONS

review actual movements and how those movements might be at risk owing to channel constraints[12]. In the current valuation analysis, ships transiting with a depth under keel measurements of less than four and less than two feet were analyzed. (Refer to Chapter 4 - Depth Under Keel) Central to the value of CPT is its ability to uniquely assess traffic by river or channel segment and provide summary origin or destination data without double counting ship passings, tonnages or values of cargo.

The CPT is a web-based decision-support package developed within the U.S. Army Corps of Engineers Coastal Inlets Research Program (CIRP) for determining the extent to which Corps-maintained navigation channel depths are utilized by commercial shipping. The CPT uses the proprietary, dock-level tonnage database maintained by the USACE's Waterborne Commerce Statistics Center (WCSC). A live web version of CPT is presently available to registered Federal government personnel.[13] Under Federal law, companies operating vessels must report domestic waterborne commerce movements to the Army Corps of Engineers. The data collected includes the type, weight, type, and value of the cargo, and movements and dockings of the vessel, and the location and depth of the channels. The data is collated to the channel and channel reach (subset of a channel) level and to the five digit commodity code level.

The commodity code structure is unique to the USACE and doesn't translate well to other more commonly used codes like the Harmonized System (HS) Commodity Code system. The USACE stores its commodity code data to five digits. While not as detailed as the Census Bureau's seven-digit commodity data the CPT data is detailed enough for nearly all research.

All CPT data is related to the navigational channel and channel reach through which vessels transit. The USACE actively maintains navigation channels in over 360 individual

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[12] Non-container traffic included tank, dry bulk, RO-RO, general and combination carriers.

[13] Access and registration can be found at http://www.cpt.usace.army.mil/

projects nationwide. The projects are an assemblage of channels which are themselves collection of segments referred to as “reaches”. The hierarchy then goes from the large area project to the more site specific channel to the very specific location of the reach. The research for this project was conducted at the reach level to assure greatest location accuracy. Ports are defined as a collection of associated reaches and channels that lead to and encompass a port facility.

The CPT provides decision makers and researchers with relevant data concerning commercial shipping activity that is supported by Corps dredging activities. CPT conducts nearest-neighbor matching of WCSC’s Master Docks database with a spatial network representing Corps-maintained channels and waterways. Entries in the tonnage database are routed from origin to destination docks through this network using well-established shortest-path logic. The cumulative statistics for tons, dollar value, vessel draft, commodity types and traffic types are then compiled for each individual reach (channel segment) in the network. The web-based CPT interface provides a straightforward means of querying and filtering the resulting data to suit user specifications, such as tonnage totals transiting at depths most vulnerable to shoaling.

The CPT output can be selected from a large number of options to enable the researcher to focus on specific aspects of vessel and commodity movements. A particularly important option is that which enables one to compile the data on vessel movements within a certain number of feet from the channel bottom. Useful products that can be generated includes draft profile charts showing the cumulative annual commercial tonnage transiting selected navigation projects at each 1-ft increment of maintained channel depth (Figure 3). Present channel conditions and historical shoaling rates are compared to the draft profile to determine the amount of cargo that is directly impacted by channel shoaling conditions. A detailed description of the capabilities of the CPT system is provided as Appendix B.

IV. **UNITED STATES COAST GUARD (USCG)**

The Marine Casualty and Pollution Database contain data related to commercial marine casualty investigations reportable under 46 C.F.R. 4.03 and pollution investigations reportable under 33 C.F.R. 153.203. [14] The data reflect information collected by U.S. Coast Guard personnel concerning vessel and waterfront facility accidents and marine pollution incidents throughout the United States and its territories. Containing over 10 years of data in the new format, in December 2001, the U.S. Coast Guard transitioned from the Marine Safety Information System (MSIS) to the Marine Information for Safety and Law Enforcement (MISLE) information system. The redesigned system better supports the collection and analysis of data. In this analysis, data involving monetary damages related to vessels, cargo, facilities and other were joined with instances of injuries and deaths.[15] A second database was formed which contained instances of water pollution. In the latter analysis releases from fixed facilities (e.g., docks, platforms, etc.) were analyzed along with losses from ships, barges, tugs, etc. the theory being that PORTS® information involving tides, currents and temperature could help speed locating and remediating such spills.[16]

Based on location, a number of socio-economic data fields were added from CSC's ENOW database and the USACE's RECON data base at the county level. Data from adjacent

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[14] The marine casualty reporting requirements are in 46 CFR 4.03, but that rule exempts vessels covered by 33 CFR 1783.51, which are recreational vessels. The USCG office of Boating Safety works with the various state agencies that have jurisdiction over recreational boating to ensure accurate record keeping on recreational boating accidents.

[15] MISLE data is presented to the public as a series of 10 files which contain 1,532,668 records as of January 8, 2013.

[16] Overall, the database provides details on over 1,100,000 vessels and 54,000 facilities.

counties to port locations was also added. Finally, using ArcGIS, the "operational area" of each port was identified using a "lasso" technique where industry experts reviewed port maps and identified the relative jurisdictional area of each port.

V. MORBIDITY AND MORTALITY (UNITED STATES DEPARTMENT OF TRANSPORTATION)

A. Value of a Life

In assessing the potential benefits associated with reductions in injuries and deaths resulting from groundings, allisions and collisions, values must be assigned. In performing analysis of their programs, many Federal agencies have sought to identify these values through two major methodologies: (1) Quality-adjusted life year (QALY); and, (2) Value of Statistical Life Year (VSLY).

Developed by Cundell and McCartney (1956) QALYs are often employed in cost-utility analysis to calculate the ratio of cost to QALYs saved for a particular health care intervention. This is then used to allocate healthcare resources, with an intervention with a lower cost to QALY saved (incremental cost effectiveness) ratio ("ICER") being preferred over an intervention with a higher ratio.[17] The QALY is a measure of the value of health outcomes. Since health is a function of length of life and quality of life, the QALY was developed as an attempt to combine the value of these attributes into a single index number. The basic idea underlying the QALY is simple: it assumes that a year of life lived in perfect health is worth 1 QALY (1 Year of Life × 1 Utility value = 1 QALY) and that a year of life lived in a state of less than this perfect health is worth less than 1. In order to determine the exact QALY value, it is sufficient to multiply the utility value associated with a given state of health by the years lived in that state. QALYs are therefore expressed in terms of "years lived in perfect health": half a year lived in

[17] Refer to: http://en.wikipedia.org/wiki/Quality-adjusted_life_year

perfect health is equivalent to 0.5 QALYs (0.5 years × 1 Utility), the same as 1 year of life lived in a situation with utility 0.5 (e.g. bedridden) (1 year × 0.5 Utility). QALYs can then be incorporated with medical costs to arrive at a final common denominator of cost/QALY. This parameter can be used to develop a cost-effectiveness analysis of any treatment.[18]

Value of a Statistical Life Year (VSLY) represents another methodology to view the risks that people are voluntarily willing to take and how much they must be paid for taking them Mankiw (2012). If, for instance, each member of a population of a hundred thousand was willing to pay $50 on average for a one in one hundred thousand decrease in his risk of dying during the next year, the corresponding Value per Statistical Life (VSL) would be $50×100,000 or $5 million. The value per statistical life year (VSLY) is an approach for adjusting VSL estimates to reflect differences in remaining life expectancy and involves calculating the value of each year of life extension. Because the degree of life extension is usually closely related to the age of the affected individuals, VSLY is often interpreted as an approach for adjusting VSL to reflect age differences.[19] It is generally derived by applying simple assumptions to VSL estimates based on Moore and Viscusi (1988).

Another method employed to estimate the VSLY is by simply asking people (e.g., through

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[18] A problem of the QALY calculation relies on the numerical nature of its constituent parts. The appropriateness of the QALY arithmetical operation is compromised by the essence of the utility scale: while life-years are expressed in a ratio scale with a true zero, the utility is an interval scale where 0 is an arbitrary value for being dead. In order to be able to obtain coherent results, both scales would have to be expressed in the same units of measurement. See Prieti (2003), Schlander (2007) and Mortimer (2007).

[19] The relationship between VSL and VSLY may be clarified by recognizing that any change in an individual's mortality risk can be described by a corresponding shift in her survival curve, which can be summarized by the expected number of lives saved (as a function of time or within a specified time period) or by the expected number of life-years saved. An individual's willingness to pay (WTP) for a shift in her survival curve can be summarized by her average VSL or VSLY for that change. Economic theory suggests that both VSL and VSLY may depend on the individual's initial survival curve, characteristics of the shift, and individual characteristics such as health and income. Neither VSL nor VSLY is likely to be constant across changes in mortality risk. Therefore, accurate valuation requires the use of scenario-specific values. The choice between VSL and VSLY summary measures is largely one of convenience. Refer to: Hammitt (2007) and http://reep.oxfordjournals.org/content/1/2/228.abstract

questionnaires) how much they would be willing to pay for a reduction in the likelihood of dying, perhaps by purchasing safety improvements. These types of studies are referred to as stated preference studies[20]

At a recent workshop several Federal agencies delineated their methodologies to value lives.[21] From their discussions and presentations, it was learned that three agencies employed the VSLY approach while one utilized the QALY approach. (Refer to Table 2) When adjusted to constant 2010 dollars, the VSL across agencies ranged from $4.3 at the Nuclear Regulatory Commission’s Headquarters and National Nuclear Security Agency to $8.2 million at the Food and Drug Administration’s Food Safety Inspection Service. Given the transportation-related nature of the deaths which could be reduced through timely accurate and complete use of real-time and near-real time port data, the Department of Homeland Security’s United States Coast Guard’s figure of $6.3 million and the U.S. Department of Transportation’s (DOT) figure of $6.1 million were further considered.[22] Ultimately, in keeping with the overall conservative nature of this valuation study, the more moderate $6.1 million dollar DOT figure was employed. Referring to Table 2, this was based on their (DOT) 2011 study which estimated the loss at $6.2 million in 2011 dollars.[23]

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[20] A well-known problem with this method is the so-called "hypothetical bias", whereby people tend to overstate their valuation of goods and services.

[21] Interagency Regulatory Analysis Workshop: Cost-Benefit Analysis, Value of a Statistical Life, Hyatt Regency, Bethesda, March 19-20, 2012.

[22] The DOT figure (released in 2011) was $6.2 million. It was adjusted to 2010 dollars ($6.1 million)

[23] Back in 2008, the Department of Transportation (DOT) issued guidelines for valuing the nation’s willingness to pay (WTP) to avert a transportation-related fatality by proposing a new value of $5.8 million as the best estimate of the VSL for measuring the economic value of preventing a human fatality. This was later updated to $6.2 million for 2011. Refer to: “Treatment of the Economic Value of a Statistical Life in Departmental Analysis,” Tyler D. Duval, Assistant Secretary for Transportation Policy, Office of the Secretary of Transportation, DOT, 2008.

Table 2

SUMMARY OF FEDERAL AGENCY VALUATION PROCESSES

AGENCY	DOLLAR VALUE PER YEAR (BASE YEAR)	IF ADJUSTED TO 2010 DOLLARS[24]	METHOD (VSLY or QALY)	ANNUALLY ADJUSTED? (If so, how?)	COMMENTS
U.S. Environmental Protection Agency	$7.9 million (2008 dollars)	$7.8 million	N/A	Yes - Inflation using GDP deflator - Real income growth (either CPI or GDP) - Income elasticity (0.50)	Emphasizes importance of consistency and challenge of communication; working to change to Value of Risk Reduction
U.S. Department of Transportation	$6.2 million (2011 dollars)	$6.1 million	QALY - when applicable	Yes - Inflation (CPI-U) - Income growth (1.6% annual growth in labor productivity) - Income elasticity (0.55)	VSL basis is five-meta-analysis studies from 2000-2004
U.S. Food & Drug Administration	$7.9 million (2011 dollars)	$7.8 million	VSLY	Yes - Inflation (GRP deflator) - Not for income growth	Uses EPA's base VSL; uses VSLY more frequently than VSP (due to the characteristics of FDA's regulations)
U.S. Department of Homeland Security/Customs and Border Protection	$6.8 million (2011 dollars)	$6.7 million	No	Yes (every time VSL is used for regulation): - Inflation (CPI-U) - Real income growth - Income elasticity (0.47)	Established VSL in 2008 (had used EPA or DOT previous to that)
U.S. Department of Homeland Security/United States Coast Guard	$6.3 million (2008 dollars)	$6.3 million	No	No	Uses Customs and Border Protection 2008 study as basis

[24] Employing overall Gross Domestic Product Deflator (GDP).

AGENCY	DOLLAR VALUE PER YEAR (BASE YEAR)	IF ADJUSTED TO 2010 DOLLARS[25]	METHOD (VSLY or QALY)	ANNUALLY ADJUSTED? (If so, how?)	COMMENTS
U.S. Department of Agriculture/Headquarters	N/A	N/A	N/A	N/A	Role is to review regulatory analyses of other offices within USDA so no established VSL
U.S. Department of Agriculture / Economic Research Service	$6.9 million (2003 dollars)	$7.6 million	VSLY	Yes - Inflation only	Does not apply for rulemaking; uses calculator which uses VSL as an input to calculate costs of food borne illnesses and pathogens. $VSL=(P/r)[1-(1+r)^{-1}]$ P = annual payment (VSLY); r = interest rate; t = average life expectancy in years
U.S. Department of Agriculture / Food Safety Inspection Service	$5.0 million (2000 dollars)	$8.2 million	VSLY	Yes - inflation only - no formalized process	Used VSL directly or indirectly for 6 rules
National Oceanic and Atmospheric Administration	N/A	N/A	N/A	N/A	Working to learn more about VSL and how it may be applied at NOAA
U.S. Department of Energy / Headquarters and National Nuclear Security Agency	N/A	N/A	N/A	N/A	No official VSL; on occasion uses NBC's dollar per person-rem value of $2,000 / person-rem
Nuclear Regulatory Commission	$3.0 million (1995 dollars)	$4.3 million	Neither; Uses Dollar per person-rem[26] ($2,000)	No	Actively working to update VSL and corresponding dollar per person-rem factor as well as establish systematic process for updating in the future

Source: U.S. Nuclear Regulatory Commission, *"Cost-Benefit Analysis – Value of Statistical Life Workshop Report*", Office of Nuclear Regulatory Research, Cost Table 2, Summary, 2012, page 9

[25] Employing overall Gross Domestic Product Deflator (GDP).

[26] Represents the product of the average (radiation) dose per person times the number of persons exposed.

B. Value of Injuries

The empirical measurement of the society's WTP to avoid catastrophic transportation accidents is based on a combination of the economic losses from the accidents and the broader societal values held in support of social justice and equity. In this context, the value of a life to a society cannot be fully represented by direct costs and lost earnings alone. This approach to assessing the value of life – also referred to as the "comprehensive" model – represents the values citizens themselves would assign to a reduced risk of death if they were purchasing the protection directly. This approach estimates accident costs in reference to the values attached to a broad array of costs – property damages, delays, fatalities involved in each reported accident, plus an estimated measure of Quality-Adjusted Life Years lost (QALY) for the injuries resulting from each accident. Using the QALY lost as an additional measure of the comprehensive cost of transportation-related accidents, the National Highway Transportation Safety Administration (NHTSA) has calculated the comprehensive accident costs through the "Maximum Abbreviated Injury Scale" (MAIS).[27] For estimating the WTP to avoid a severe transportation-related injury, the Office of the Secretary of Transportation (OST) has proposed the following relationships between the MAIS indicating injury severity and the WTP value (based on the adjusted $6.1 million in 2010 dollars) for injuries averted.[28] (Refer to Table 3)

[27] National Highway Transportation Safety Administration, *The Economic Impact of Motor Vehicle Crashes 2000*, May 2002; FHWA, "Treatment of Value of Life and Injuries in Preparing Economic Evaluation", January 8. 1993.

[28] See VOLPE Study, 2009.

Table 3

MAIS VALUES FOR SOCIETAL WILLINGNESS TO PAY TO AVERT INJURIES

MAIS SCALE FOR LEVEL OF SEVERITY	INJURY SEVERITY	FRACTION OF THE WTP VALUE OF AN AVERTED FATALITY	WTP VALUE FOR AN AVERTED INJURY (2010 Dollars)
MAIS 1	Minor	0.0020	$12,200
MAIS 2	Moderate	0.0155	$94,550
MAIS 3	Serious	0.0575	$350,750
MAIS 4	Severe	0.1875	$1,143,750
MAIS 5	Critical	0.7625	$4,651,250
MAIS 6	Fatal	1.0000	$6,100,000[29]

Source: Adapted from U.S. DOT, "Treatment of the Economic Value of a Statistical Life in Departmental Analysis," Office of the Secretary of Transportation, February 5, 2008.

Note: the total WTP values do not add up to $6.1 million due to the rounding of the MAIS fractions.

While the Nation's WTP to save a life has been widely accepted as a valid measure of the value the society attaches to saving a life, the issue of valuing "avoided accidents" remains a difficult one. How can "avoided accidents" be explained or counted within a cause and effect analytical framework? How do we know with any certainty the magnitude of the "averted risks" attributable to implementation of navigation safety measures? While we have statistics on the past trends about actual occurrences, how can we predict the future trends? Federal authorities have for long recognized the links between added risks of navigation and the growth in maritime commerce. For instance, the 2000 Technical Report issued by NOAA notes that the rapid growth in maritime commerce has been accompanied by increasing rates of tanker accidents and spills, stressing the Nation's need to remain economically competitive must not be at variance with our desire to

[29] Adjusted 2011 DOT number for 2010.

protect the coastal marine environment. [30] The NOAA report makes the following statement about the availability of real-time PORTS® data and avoidance of the grounding of a tanker:

> "….. in 1993, a 634 foot tanker, Potomac Trader, while maneuvering in the NY harbor using "predicted Tides Tables" ran aground in Hells Gate. Had the tanker had access to a real-time NOAA PORTS, this near-disaster could have been averted. The vessel master would have obtained information about an abnormally large tidal range that caused the actual tide to be 3 feet lower than the predicted tide. Fortunately, the vessel was a double-hull tanker and none of its cargo of over 7 million gallons of crude oil spilled." [31]

In keeping with the conservative approach of this report and lacking more precise information from the USCG's MISLE database, an approximate normal distribution was assumed among the five levels of injury shown in Table 3. Based on this assumption, the expected value of the "average" accident would approximate $613 thousand. (Refer to Table 4).

VI. ArcGIS

ArcGIS, developed by ESRI, is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.

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[30] NOAA Technical Report NOS CO-OPS 031 – National PORTS Management Report, October 2000

[31] USCG Marine Casualty Investigation Report #MC93004342, as reported in NOAA Report to Congress, 2000.

Table 4

EXPECTED COST OF AN INJURY

MAIS SEVERITY SCALE	INJURY SEVERITY	WTP VALUE FOR AN AVERTED INJURY (2010 Dollars)	PROBABILITY OF OCCURANCE	EXPECTED COST (2010 Dollars)
MAIS 1	Minor	$12,200	5%	$610
MAIS 2	Moderate	$94,550	12%	$11,346
MAIS 3	Serious	$350,750	66%	$231,495
MAIS 4	Severe	$1,143,750	12%	$137,250
MAIS 5	Critical	$4,651,250	5%	$232,563
			TOTAL	**$613,264**

Working with several members of the Special Projects Branch (SPO) within the Office of the National Ocean Service (NOS) of NOAA, individual accident and pollution cases categorized by the USCG by latitude and longitude were related to county and state names.[32] Using ArcGIS logic which allowed creation of polygons, appropriate geographic areas were identified as "associated" with each of the operational 175 ports in the United States, its commonwealths and territories. In addition, a series of socio-economic factors (e.g., Gross Domestic Product (GDP), employment, number of firms and wages across several marine-based enterprises to each county and adjacent counties to where ports were physically located.[33]

[32] A special thanks is extended to Percy Pacheco (Environmental Engineering) and Robert Wilson (Spatial Information Technology Branch Chief) from the Special Projects Unit of the National Ocean Service (NOS) for their help in assigning coordinates to areas influenced by PORTS® applications as well as those that could be influenced by future PORTS(s) installations.

[33] This data included information from the Coastal Services Center ENOW database, USACE's RECONs data as well as additional data from the Bureau of Economic Statistics.

VII. DISCOUNT RATE

The General Accountability (nee Accounting) Office (GAO) revised its discount rate policy in 1983 (GAO 1983).[34] At that time, GAO employed a rate based on the Treasury borrowing rate for all types of discounting problems, including those related to public investment, regulatory, lease-purchase, and asset divestiture decisions. In 1991 this was refined to state that the "base case discount rate should be the interest rate for marketable Treasury debt with maturity comparable to the program being evaluated. Sensitivity analysis should also be employed to address issues such as differing expectations about inflation and interest rates, private sector opportunity costs, and intergenerational effects of policies on human life."[35]

At the same time, the Congressional Budget Office (CBO) annually distributes its discount rate through Circular No. A-94, Appendix C.[36] (Refer to Table 5) The CBO discount rate employed to cover the ten-year economic life of PORTS® was 3.9 percent for the 2010 base year of analysis. Daily ten-year nominal treasury rate suggests a figure not much different at 3.73 percent as of January 1, 2010.[37] In this valuation analysis, the CBO approach was employed using a discount rate of 3.9 percent. The actual discount factors covering the ten-year benefits valuation period are shown in Table 6.

[34] U.S. General Accounting Office (GAO), Project Manual, Washington, D.C., 1983, pages 17-18. The GAO's name was changed in 2004 by the GAO Human Capital Reform Act. Refer to: Walker, David M. (July 19, 2004). "GAO Answers the Question: What's in a Name?, *Roll Call*

[35] GAO, "Discount Rate Policy", Office of the Chief Economist, May 1991, Chapter I, Overview.

[36] Revised in December 2010, the CBO employs a forecast of nominal or market interest rates for 2011 based on the economic assumptions for the Fiscal Year 2012 budget.

[37] See: http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/Historic-LongTerm-Rate-Data-Visualization.aspx, January 29, 2013 and http://www.economagic.com/em-cgi/data.exe/fedstl/gs7+2

VIII. DELPHI INTERVIEWS

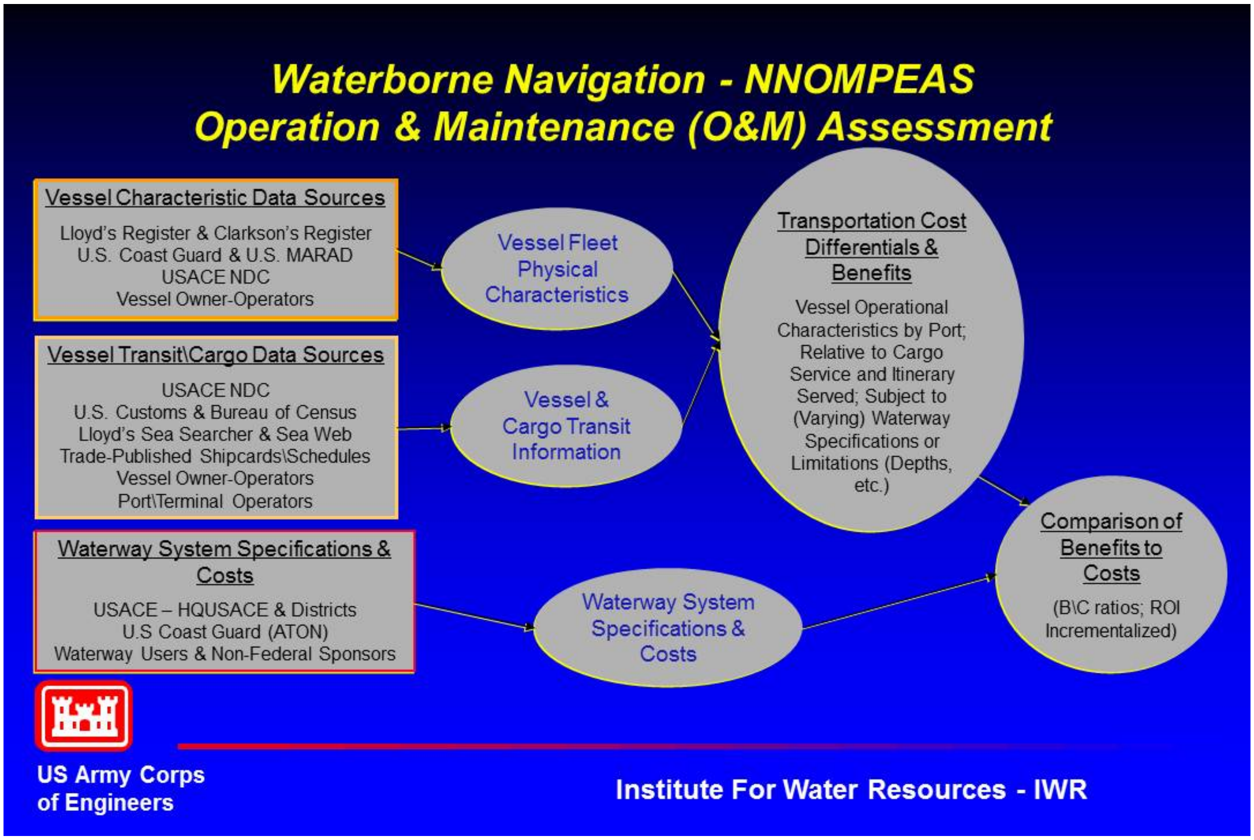
Finally, employing a Delphi technique, a series of questions were presented to experienced port pilots related to their relative valuation of PORTS® and other navigational aids using the contingent valuation method (CV). (Refer to Chapter 4 Section IV for discussion on DELPHI Survey of pilots and Appendix D for survey questions.

IX. NATIONAL NAVIGATION OPERATION AND MAINTENANCE PERFORMANCE EVALUATION AND ASSESSMENT SYSTEM (NNOMPEAS)

NNOMPEAS is a U.S. Army Corps of Engineers (USACE) tool for estimating marine transportation costs and performing economic analyses on USACE waterway projects. It is the standard source for all marine transportation cost data and is employed as the basis for considering the benefits of proposed USACE projects. (Refer to Figure 1) Interestingly, the data doesn't represent actual expenses to the firms for the shipment of the goods. It is a construct from a large number of variables (e.g. vessel length, breath, draft, engine horsepower, crew, distance traveled, cost of fuel, engine fuel efficiency, diameter of the propeller, etc.) all of which affects the costs of operating the vessel. It does not include profit margin, market pricing decisions, competitive pricing strategies, etc. Actual transportation cost rates are highly sensitive and not shared by marine transportation companies for competitive reasons. The best that can be done is the very detailed NNOMPEAS model. This gives the Corps a more stable platform upon which to make comparisons across multiple years without having to consider the competitive elements of cost.

Figure 1

USACE NNOMPEAS DATA FLOW



Source: USACE, 2013

Even though the cost data does not represent actual costs it is still comprised of highly sensitive information that could be used to give a company, port or even a nation a competitive advantage. Therefore, the information derived from NNOMPEAS and much of the information used as input to the NNOMPEASE model is restricted to use by authorized USACE employees and a few other Federal employees with authorization from the USACE. Appropriate efforts have been taken to ensure that sensitive information has not been divulged in this report.

NNOMPEAS combines data from four sources:

1. Lloyd's Register of Shipping (LRS) & Lloyd’s Maritime Intelligence Unit (LMIU) SEAWEB.[38] LRS provides information on vessel characteristics (vessel type, size class, physical dimensions, capacities and speed) while SEAWEB provides information on vessel itinerary for estimation of vessel transit distances over time or period of service.

2. USACE Institute for Water Resources (IWR) \ Navigation Data Center (NDC) - Waterborne Commerce Statistics Center (WCSC) Statistics
    a. Vessel information broken down by individual vessel name and identification by IMO\LRS number, tonnage handled, and transit draft, prior and post port information where available.
    b. PIERS[39] (Port Import\Export Research service), which contains information on nature of cargo, cargo weight, and origins\destinations of cargo as well as to some extent vessel itinerary.
    c. Available information on project specifications from port series investigations.
    d. Estimated vessel operating costs per unit of time as assembled by IWR.

3. Computerized\GIS generated voyage distance tables reconciled with both rhumb line heading and course plots for transit as well as great distance calculators respective of ocean and waterway boundaries.

4. The evolving TEC (Topographic Engineering Center) project database on project specifications for depth and available information from condition surveys.

The vessel service data includes information about the frequency of service, route or itinerary (with particular attention to time at sea or in service for cargo forwarding and transport),

[38] An extensive ship database covering over 180,000 ships over 100 gross tons. Refer to: http://www.sea-web.com/seaweb_welcome.aspx

[39] A proprietary product of the Journal of Commerce

type of vessel and corresponding costs per unit of time and mode of operation, vessel physical specifications for cargo capacity by weight and volume, and cargo carried by weight.

Vessel characteristics fields extracted from IWR's vessel operating costs are merged with Lloyd's Register of Ships (LRS), and Lloyd's Maritime Intelligence Unit (LMIU) electronic databases with transit and tonnage records from WCSC (with cross matching and tabulation performed via either the International Maritime Organization (IMO) vessel identification number, the Lloyd's Registry number, or the U.S. Coast Guard's vessel identification number), the resulting composite database(s) gives most of the information needed to estimate cargo unit cost trade-offs relative to vessel capacity utilization, transit draft and available waterway depth.

The data for the assessment of the economic benefit of PORTS® was less involved. The data for all 175 ports was not available but data for all the major ports was. The cost per ton of cargo carried for a representative 1000 miles was calculated for every foot of draft for all major U.S. ports. The data was further broken out by U.S. and Foreign registered (flagged) vessels. The results were averaged for two regions, Great Lakes ports and Coastal ports.

NNOMPEAS is continuing to be expanded in capability and quality of data. Many of the problems that plagued this analysis are being resolved. The system is being expanded to include data for domestic shipping including tug and barge and Great Lakes shipping, cruise shipping, and even military vessels will be added to the NNOMPEAS capability. In the future it will be possible to look at individual ports in much more detail although researchers will have to be careful not to violate USACE data non-disclosure agreements.

REFERENCES:

Coastal Services Center, *"Frequent Questions, Economics: National Ocean Watch (ENOW) Data"*, National Oceanic and Atmospheric Administration, November, 2012.

Colgen, Charles S., *"A Guide to the Measurement of the Market Data for the Ocean and Coastal Economy in the National Ocean Economics Program"*, National Ocean Economics Program January, 2007.

Cundell and McCartney (1956), Secondary citation only as listed in Visnjic (2011).

Hammitt, James K., *"Valuing Changes in Mortality Risk: Lives Saved Versus Life Years Saved"*, Review of Environmental Policy, Volume 1, Number 2, 2007, pages, 228-240.

Mankiw, Gregory, *"Principles of Economics"* Sixth Edition, South-Western Cengage Learning, Mason, OH, 2012.

Mathis, Ian, Draft Paper *Operations & Maintenance Performance Assessment System (OMPAS)* , USACE , 2002.

Mathis, Ian, PowerPoint Presentation, *Waterborne Navigation – NNOMPEAS Operation & Maintenance (O&M) Assessment*, USACE, 2007.

Moore, M. J., and W. K. Viscusi. 1988. *"Doubling the estimated value of life: Results using new occupational fatality data"*, Journal of Policy Analysis and Management Volume 7, Number, 1988, pp. 476–90.

Mortimer, D. and Segal, L., *"Comparing the Incomparable? A Systematic Review of Competing Techniques for Converting Descriptive Measures of Health Status into QALY-Weights"*, Medical Decision Making, Volume 28, Number 1, 2007, Pages 66–89.

National Marine Fisheries Service, *"Fisheries of the United States", 2005, 2006, 2007, 2008, 2009, 2010, 2011*, U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

NOAA Technical Report NOS CO-OPS 031 – *National PORTS Management Report*, October, 2000.

Prieto, Luis and Sacristán, José A., *"Problems and solutions in calculating quality-adjusted life years (QALYs)"*, Health and Quality of Life Outcomes, Volume 1, Number 80, 2008.

Schlander, Michael (2007-07-09). *"Lost in Translation? Over-Reliance on QALYs May Lead to Neglect of Relevant Evidence"*. Copenhagen, Denmark: Institute for Innovation & Valuation in Health Care, 2007.

United States Army Corps of Engineers, *"Regional ECONomic System ((RECONS)", User Guide, Institute for Water Resources"*, prepared by the Louis Berger Group, Inc., 2009.

Visnjic, Aleksandar, Velickovic, Vladica, and Milosavljevic, Natasa Selmic, *"QALY – Measure of Cost-Benefit Analysis of Health Interventions"*, Scientific Journal of the Faculty of medicine in Nis, Serbia, Volume 28, Number 4, pp. 195-199, 2011.

Volpe National Transportation Systems Center (the Volpe Center), *"Valuation of the NOS Navigational Products"*, Final Report, Task 4 – Benefit-Cost Analysis (BCA) Model Estimates, Prepared for the National Ocean Service (NOS), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce, March 23, 2009.

APPENDIX A

OCEAN ECONOMY SECTORS AND INDUSTRIES BY NAICS CODE UTILIZED BY ECONOMICS: NATIONAL OCEAN WATCH (ENOW) DATA

Table A-1

Ocean and Great Lakes Economy Sectors and Industries by NAICS Codes			
Sector	Industry	NAICS Code	NAICS Industry (1997 NAICS)
Living Resources	Fish Hatcheries and Aquaculture	112511	Finfish Farming and Fish Hatcheries
		112512	Shellfish Farming
	Fishing	114111	Finfish Fishing
		114112	Shellfish Fishing
	Seafood Processing	311711	Seafood Canning
		311712	Fresh and Frozen Seafood Processing
	Seafood Markets	445220	Fish and Seafood Markets
Marine Construction	Marine Related Construction	237990	Other Heavy and Civil Engineering Construction
Marine Transportation	Deep Sea Freight	483111	Deep Sea Freight Transportation
		483113	Coastal and Great Lakes Freight Transportation
	Marine Passenger Transportation	483112	Deep Sea Passenger Transportation
		483114	Coastal and Great Lakes Passenger Transportation
	Marine Transportation Services	488310	Port and Harbor Operations
		488320	Marine Cargo Handling
		488330	Navigational Services to Shipping
		488390	Other Support Activities for Water Transportation
	Search and Navigation Equipment	334511	Search, Detection, Navigation, Guidance, Aeronautical and Nautical System and Instrument Manufacturing
	Warehousing	4931	Warehousing and Storage

Source: NOAA Coastal Services Center, *"Frequent Questions, Economics: National Ocean Watch (ENOW) Data"*, November, 2012. Pages 7-8

Ocean and Great Lakes Economy Sectors and Industries by NAICS Codes			
Sector	**Industry**	**NAICS Code**	**NAICS Industry (1997 NAICS)**
Offshore Mineral Resources	Limestone, Sand and Gravel	212321	Construction Sand and Gravel Mining
		212322	Industrial Sand Mining
	Oil and Gas Exploration and Production	211111	Crude Petroleum and Natural Gas Extraction
		211112	Natural Gas Liquid Extraction
		213111	Drilling Oil and Gas Wells
		213112	Support Activities for Oil and Gas Operations
		541360	Geophysical Exploration and Mapping Services
Ship and Boat Building	Boat Building and Repair	336612	Boat Building and Repair
	Ship Building and Repair	336611	Ship Building and Repair
Tourism and Recreation	Boat Dealers	441222	Boat Dealers
	Eating and Drinking Places	722110	Full Service Restaurants
		722211	Limited Service Eating Places
		722212	Cafeterias
		722213	Snack and Nonalcoholic Beverage Bars
	Hotels and Lodging	721110	Hotels (except Casino Hotels) and Motels
		721191	Bed and Breakfast Inns
	Marinas	713930	Marinas
	Recreational Vehicle Parks and Campsites	721211	RV Parks and Recreational Camps
	Scenic Water Tours	487210	Scenic and Sightseeing Transportation, Water
	Sporting Goods	339920	Sporting and Athletic Goods Manufacturing
	Amusement and Recreation Services	487990	Scenic and Sightseeing Transportation, Other
		611620	Sports and Recreation Instruction
		532292	Recreation Goods Rental
		713990	Amusement and Recreation Services Not Elsewhere Classified
	Zoos, Aquaria	712130	Zoo and Botanical Gardens
		712190	Nature Parks and Other Similar Institutions

Source: NOAA Coastal Services Center, "*Frequent Questions, Economics: National Ocean Watch (ENOW) Data*", November, 2012. Pages 7-8

APPENDIX B

CPT BACKGROUND AND PORT, PORTS® AND USACE CPT LOCATION CROSS-WALK DEFINITIONS AND USAGE PROCEDURES

IDENTIFICATION OF PORTS AND PORTS® SYSTEMS BY CHANNEL PORTFOLIO TOOL LOCATIONS

Table B-1

PORT NAME	PORTS® SYSTEM LOCATION NAME	UNITED STATES ARMY CORPS OF ENGINEERS DISTRICT	WHERE FOUND IN CHANNEL PORTFOLIO TOOL (CPT)
Calcite, MI		Lakes and Rivers	Rogers City
Marblehead, OH		Lakes and Rivers	Detroit District - Marblehead Outer Harbor 616900
Duluth-Superior, MN and WI		Lakes and Rivers	Duluth - Superior Harbor
Chicago, IL		Lakes and Rivers	Chicago River Main and North Branch, Chicago Sanitary & Ship Canal, Calumet Harbor & River, Lake Calumet
Two Harbors, MN		Lakes and Rivers	two Harbors
Cleveland, OH		Lakes and Rivers	Cleveland
Toledo, OH		Lakes and Rivers	Toledo
Marine City, MI		Lakes and Rivers	St Clair River (0-39) 615925
Indiana Harbor, IN		Lakes and Rivers	Indiana Harbor
Detroit, MI		Lakes and Rivers	Detroit River 616110
Gary, IN		Lakes and Rivers	Non-Project (Gary)
Ashtabula, OH		Lakes and Rivers	Ashtabula
Silver Bay, MN		Lakes and Rivers	Non-Project (Silver Bay)
Burns Waterway Harbor, IN		Lakes and Rivers	Burns Harbor

Presque Isle & Stoneport, MI		Lakes and Rivers	Presque Isle
Escanaba, MI		Lakes and Rivers	Naturally Deep - LRE Escanaba 611600
Port Inland, MI		Lakes and Rivers	Naturally Deep - LRE Gulliver 662400
Conneaut, OH		Lakes and Rivers	Conneaut
Port Dolomite, MI		Lakes and Rivers	Naturally Deep - LRE Cedarville 630900
Milwaukee, WI		Lakes and Rivers	Milwaukee
Monroe, MI		Lakes and Rivers	Monroe
Sandusky, OH		Lakes and Rivers	Sandusky
Drummond Island, MI		Lakes and Rivers	Drummond Island
Alpena, MI		Lakes and Rivers	Alpena
Green Bay, WI		Lakes and Rivers	Green Bay
Fairport Harbor, OH		Lakes and Rivers	Fairport Harbor
Muskegon, MI		Lakes and Rivers	Muskegon Harbor
Buffington, IN		Lakes and Rivers	East Chicago, In (608300)
Marysville/Port Huron, MI		Lakes and Rivers	St Clair river (0-39) 615925
Marquette, MI		Lakes and Rivers	Marquette
Lorain, OH		Lakes and Rivers	Lorain
Grand Haven, MI		Lakes and Rivers	Grand Haven

Huron, OH		Lakes and Rivers	Huron
Taconite, MN		Lakes and Rivers	Taconite
Kelleys Island, OH		Lakes and Rivers	Kelleys Island
St. Joseph, MI		Lakes and Rivers	St Joseph’s Harbor
Holland, MI		Lakes and Rivers	Holland
Manistee, MI		Lakes and Rivers	Manistee
Charlevoix, MI		Lakes and Rivers	Charlevoix
St. Clair, MI		Lakes and Rivers	St Clair River 615950
Waukegan, IL		Lakes and Rivers	Non-Project - Zion, Ill (607200)
South Louisiana, LA, Port of	Lower Mississippi	Mississippi Valley	Lower Mississippi (104.3 - 141.6 & 141.6 - 175.3)
Empire/Venice, LA	Lower Mississippi	Mississippi Valley	Waterway from Empire to Gulf of Mexico - Empire (8.1 - 9.4) , Mississippi River Gulf Outlet via Venice
New Orleans, LA	Lower Mississippi	Mississippi Valley	Lower Mississippi (39.4 - 88.0, 88.0 - 92.5, 92.5 - 98.1, 98.1 - 104.3)
Plaquemines, LA, Port of	Lower Mississippi	Mississippi Valley	Lower Mississippi (175.3 - 208.6, 208.6 - 228.1)
Baton Rouge, LA	Lower Mississippi	Mississippi Valley	Baton Rouge
Lake Charles/Cameron, LA	Lake Charles	Mississippi Valley	Calcasieu River & Pass
Intracoastal City, LA		Mississippi Valley	GIWW MNV (reaches 241601 & 208900) & Bayou Teche and Vermillion river (reach 241500)
USNR Earle, Leonardo, NJ		North Atlantic	No Data

New York, NY and NJ	New York/New Jersey	North Atlantic	Sandy Hook Bay, Shrewsbury River, Shoal Harbor & Compton Creek, Raritan River, New York and New Jersey Channels, Newark Bay, New York Harbor, Jamaica Bay, Bay ridge and Red Hook Channels, Gowanus Creek Channel, Buttermilk Channel, East river, Hudson River Channel, Newton Creek, Flushing Bay and Creek, East Chester Creek)
Norfolk Harbor/Hampton Roads, VA	Chesapeake Bay	North Atlantic	Norfolk Harbor, Hampton Creek, Non-project Phoebus
Baltimore, MD	Chesapeake Bay	North Atlantic	Baltimore Harbor
Philadelphia, PA	Delaware Bay	North Atlantic	Delaware River (91-92,93-95,96-104,104-109)
Marcus Hook, PA	Delaware Bay	North Atlantic	Delaware River (79-82)
Portland, ME		North Atlantic	Portland
Boston, MA		North Atlantic	Boston Harbor, Low Use-NAE (Allerton Harbor, Quincy Bay, Weir River), Winthrop Harbor, Dorchester Bay, Waymouth Fore river, Waymouth Back River, Hingham Harbor and Bay
Paulsboro, NJ	Delaware Bay	North Atlantic	Delaware river (85-88)
New Haven, CT	New Haven	North Atlantic	New Haven Harbor
Albany, NY		North Atlantic	Hudson River (126-152)
Providence, RI	Narragansett Bay	North Atlantic	Providence River and Harbor
Bridgeport, CT		North Atlantic	Bridgeport
Camden-Gloucester, NJ	Delaware Bay	North Atlantic	Delaware River (96 - 104)
Wilmington, DE	Delaware Bay	North Atlantic	Wilmington Harbor
Washington, DC	Chesapeake Bay	North Atlantic	Anacostia River, Potomac River, Washington Channel (515800)
Portsmouth, NH		North Atlantic	Portsmouth
Port Jefferson, NY		North Atlantic	Port Jefferson
Fall River, MA	Narragansett Bay	North Atlantic	Fall River Harbor
New London/Groton, CT	New London	North Atlantic	New London
Pennsbury Manor, PA	Delaware Bay	North Atlantic	Delaware River 110-115
Searsport, ME		North Atlantic	Searsport
New Castle, DE	Delaware Bay	North Atlantic	Del River 66-69
Chester, PA	Delaware Bay	North Atlantic	Delaware River (83 - 84)
Buffalo, NY		North Atlantic	Buffalo
Hempstead, NY		North Atlantic	Hempstead Harbor

Richmond, VA	Chesapeake Bay	North Atlantic	Port of Richmond
Salem, MA		North Atlantic	Salem
Erie, PA		North Atlantic	Erie
Trenton, NJ	Delaware Bay	North Atlantic	Delaware River (110 - 115, 116 - 140)
Stamford, CT		North Atlantic	Stamford
Hopewell, VA	Chesapeake Bay	North Atlantic	Appomattox River (0-11)
Oswego, NY		North Atlantic	Oswego
New Bedford, MA		North Atlantic	New Bedford & Fairhaven Harbor
Newport, RI	Narragansett Bay	North Atlantic	Newport Harbor
Newport News, VA	Chesapeake Bay	North Atlantic	Deep Creek, Newport News
Annapolis, MD	Chesapeake Bay	North Atlantic	Annapolis Harbor & Severn River
Reedville, VA	Chesapeake Bay	North Atlantic	Low Use-NAO cockerel's Creek (0-2) 457000
Keyport, WA		North Western	No Data
Oak/Crescent Harbor, WA		North Western	No Data
Seattle, WA		North Western	Seattle, Lake Washington
Portland, OR	Lower Columbia River	North Western	Columbia and Lower Willamette Rivers - Willamette River (00-03, and 04-13) 847420, 847440, 847500
Tacoma, WA	Tacoma	North Western	Tacoma Harbor
Kalama, WA	Lower Columbia River	North Western	Columbia and Lower Willamette River WA-NWP (69-86) 846710
Anacortes, WA	Cherry Point	North Western	Anacortes
Longview, WA	Lower Columbia River	North Western	Columbia and Lower Willamette River WA-NWP (50-68) 846500
Grays Harbor/Westport, WA		North Western	Grays Harbor
Coos Bay/Charleston, OR		North Western	Coos Bay
Everett, WA		North Western	Everett Harbor
Olympia, WA		North Western	Olympia
Port Angeles, WA		North Western	Port Angeles
Bremerton, WA		North Western	Puget Sound Deepwater-NWS Bremerton 841400 - 50% divided with Manchester
Manchester, WA		North Western	Puget Sound Deepwater-NWS Bremerton 841400 - 50% - divided with Bremerton
Vancouver, WA	Lower Columbia River	North Western	Columbia and Lower Willamette River WA-NWP (102-105, 106, 107-192 (848220))

Bangor, WA		North Western	Low Use NWS
Astoria, OR	Lower Columbia River	North Western	Columbia and Lower Willamette River WA-NWP (13-21), and Young's Bay and Young's River (00-15) 845100
Apra Harbor, Guam		Pacific	No Data
Farallon De Medinilla, CNMI		Pacific	No Data
Saipan, CNMI		Pacific	No Data
Valdez, AK		Pacific	Valdez
Honolulu/Pearl Harbor, HI		Pacific	Honolulu
Barbers Point, Oahu, HI		Pacific	Barbers Point
Kivilina, AK		Pacific	Non Project Kivilina
Anchorage, AK	Anchorage	Pacific	Anchorage
Kahului, Maui, HI		Pacific	Kahului
Hilo, HI		Pacific	Hilo
Nawiliwili, Kauai, HI		Pacific	Nawiliwili
Dutch Harbor, AK		Pacific	UnAlaska Island
Kawaihae Harbor, HI		Pacific	Kawaihae
Ketchikan, AK		Pacific	Non - Project (Tongass Narrows)
Juneau, AK		Pacific	Juneau
Petersburg, AK		Pacific	Wrangle Narrows
Kodiak, AK		Pacific	Kodiak
Nikishka/Kenai, AK	Anchorage	Pacific	Low Use POA Kenai, Non Project (Nikishka)
Roosevelt Roads, PR		South Atlantic	No Data
Mobile, AL	Mobile Bay	South Atlantic	Mobile
Pascagoula/Moss Point, MS	Pascagoula	South Atlantic	Pascagoula Harbor
Savannah, GA		South Atlantic	Savannah
Tampa, FL	Tampa Bay	South Atlantic	Old Tampa (331700, Big Bend Channel (257200, alfia River (25710), Port Sutton channel (25700), East Bay Channel (257100), East Bay Channel (256910), Sedon Channel (256700 and 256820), Hillsborough Bay channels (256600), Sporkman - YBOR Channels (333120 and 333110)
Port Everglades, FL		South Atlantic	Port Everglades Harbor
Jacksonville/Mayport, FL	Jacksonville	South Atlantic	Jacksonville Harbor
Charleston, SC	Charleston	South Atlantic	Charleston
San Juan, PR		South Atlantic	San Juan
Wilmington, NC		South Atlantic	Wilmington Harbor
Miami, FL		South Atlantic	Miami Harbor

Morehead City/Beaufort, NC		South Atlantic	Morehead City
Port Manatee, FL	Tampa Bay	South Atlantic	Port Manatee and Little Manatee River (0 - 4)
Biloxi, MS		South Atlantic	Biloxi Harbor
Port Canaveral, FL		South Atlantic	Canaveral Harbor
Brunswick, GA		South Atlantic	Brunswick
Palm Beach, FL		South Atlantic	Palm Beach Harbor
Gulfport, MS		South Atlantic	Gulfport Harbor
Ponce, PR		South Atlantic	Ponce Harbor
Panama City, FL		South Atlantic	Panama City Harbor
Fajardo, PR		South Atlantic	Fajardo
Pensacola, FL		South Atlantic	Pensacola Harbor
St. Thomas, VI		South Atlantic	St Thomas
Weedon Island/St. Petersburg, FL	Tampa Bay	South Atlantic	Weedon Island (331600)
Georgetown, SC		South Atlantic	Georgetown
Kings Bay, GA		South Atlantic	St Marys River
Key West, FL		South Atlantic	Key West
Fernandina Beach, FL		South Atlantic	Fernadina Harbor
Long Beach, CA	Los Angeles/Long Beach	South Pacific	Long Beach Harbor, South East Basin San Pedro Bay, Inner Harbor Channel 3, Inner Harbor Channel 2, Los Angeles-Long Beach Channel (0 - 3) 875114
Los Angeles, CA	Los Angeles/Long Beach	South Pacific	West Basin LA, Los Angeles - Long Beach Harbors, Los Angeles Harbor, South West Slip - Los Angeles, Main Channel Turing Basin, East Basin - Los Angeles, Los Angeles - Long Beach (0-3) 875120
Richmond, CA	San Francisco Bay	South Pacific	Richmond
Oakland, CA	San Francisco Bay	South Pacific	Oakland Harbor
San Francisco, CA	San Francisco Bay	South Pacific	San Francisco Harbor
Stockton, CA		South Pacific	San Joaquin River
San Diego, CA		South Pacific	San Diego
Port Hueneme/Ventura, CA		South Pacific	Port Huneme
Redwood City, CA	San Francisco Bay	South Pacific	Redwood City
Sacramento, CA		South Pacific	Sacramento
Humboldt/Eureka, CA	Humboldt	South Pacific	Humbolt
Camp Pendleton, CA		South Pacific	Non-Project Camp Pendleton Harbor, 873900
Houston, TX	Houston/Galveston	South West	Houston Ship Channel
Beaumont, TX	Sabine Neches	South West	Neches River Channel (00 - 20.5)
Corpus Christi/Port Ingleside, TX		South West	Corpus Christi
Texas City, TX	Houston/Galveston	South West	Texas City
Freeport, TX		South West	Freeport

Galveston & Bolivar, TX	Houston/Galveston	South West	GIWW 333.4-350.4 (244680), Galveston Channel (8.1-9.6, 9.6-11.2, 11.2-12.5)
Port Arthur, TX	Sabine Neches	South West	West GIWW (276.8 - 288.8), SNW - Port Arthur Canal, Port Arthur (2910100 - 300)
Matagorda Ship Channel, TX		South West	Matagorda Ship Channel
Brownsville/Port Isabel, TX		South West	Brownsville, Pr Isabel (665 - 668), GIWW SWG
Victoria, TX		South West	Channel to Victoria
Sabine Pass, TX	Sabine Neches	South West	SNW Sabine Pass, SNW Port Arthur Canal 26860002
Orange, TX	Sabine Neches	South West	Sabine River Channel (4.3 - 6.1,6.5 - 15.8) & Orange Harbor

I. CPT USAGE PROCEDURES

A. Use of the "Rollup" and "Docked" Features

The CPT data is very complex and unless the researcher is extremely careful it is very likely that vessel cargoes will be doubly counted yielding erroneous results. To avoid this CPT provides two tools the "Rollup" and "Docked" options. The CPT "Rollup" feature is essential for evaluating dredging work packages that cover more than a single reach or channel. Using this powerful feature, consolidated statements of commerce can be generated for entire areas with many channels and reaches. The central concept underlying CPT is that the USACE portfolio of maintained navigation channels and waterways is an interconnected transportation system. That is, waterborne traffic utilizing any one portion of the system likely also transits other portions during the course of its journey. Likewise, the impacts to waterborne commerce from the physical condition (i.e. channel controlling depth) of any given navigation channel are not isolated within just that channel; they are realized system wide, in all other portions of the waterway network through which transiting tonnage also travels. It is only by utilizing the "Rollup" feature of CPT that the analysis can avoid counting the same vessel cargo multiple times.

The "Docked" feature is also required in calculating data for a port. Only cargo that was being offloaded or loaded aboard a vessel was counted for the port. Cargo that remained aboard a vessel bound for another port was not counted in determining the value of marine transportation for that port.

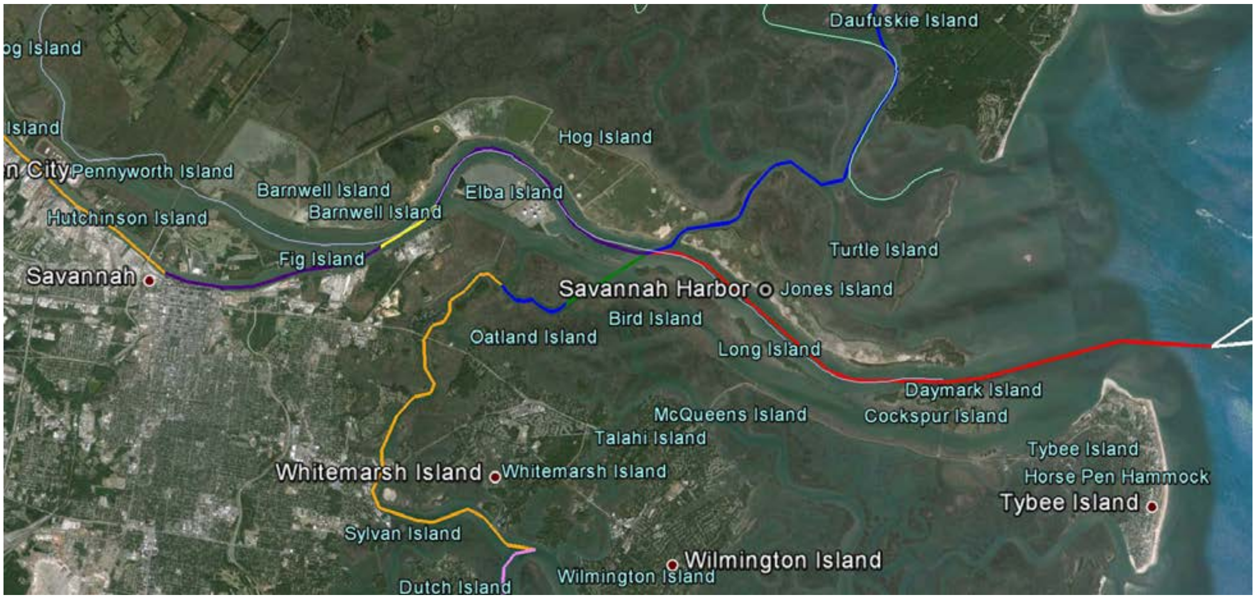
B. Port Definition in the CPT System

Calculating total system tonnage and value for ports using the CPT tools is not always straightforward. The Corps is interested in the use of channels and channel reaches in the USACE system. In some cases it is clear that one or a few channel reaches lead to a port so the sum of their activity can reasonably be considered the total activity for that port. Other ports are more complex and involve many channels and segments of channels. In other ports several ports lie in the same geographic area and the activity in the channel reaches have to be carefully separated to give accurate information at the port level. To assist the research effort, CPT offers a tool to export the selected projects, channels, and reaches to Google Earth so that the researcher can visually decide which channels to include in the analysis of the port. The definition of each of the ports is documented in the spreadsheet developed for this study.

1. Example of a simple port

Figure B-1 illustrates The Port of Savannah which is defined as all the commercial traffic operating in this channel.

Figure B-1



The Port of Savannah is defined as the shipping activity on the following channel reaches:

Savannah Harbor, GA (mile 00 to mile 10) 496900 (reach number)

Savannah Harbor, GA (mile 11 – 26) 497066

Savannah Harbor, GA (mile 11 – mile 26) 497033

Savannah River Below Augusta, GA (mile 26 – mile 203) 497120

Savannah River Below Augusta, GA (mile 26 – 2003) 497110

2. Example of a complex port

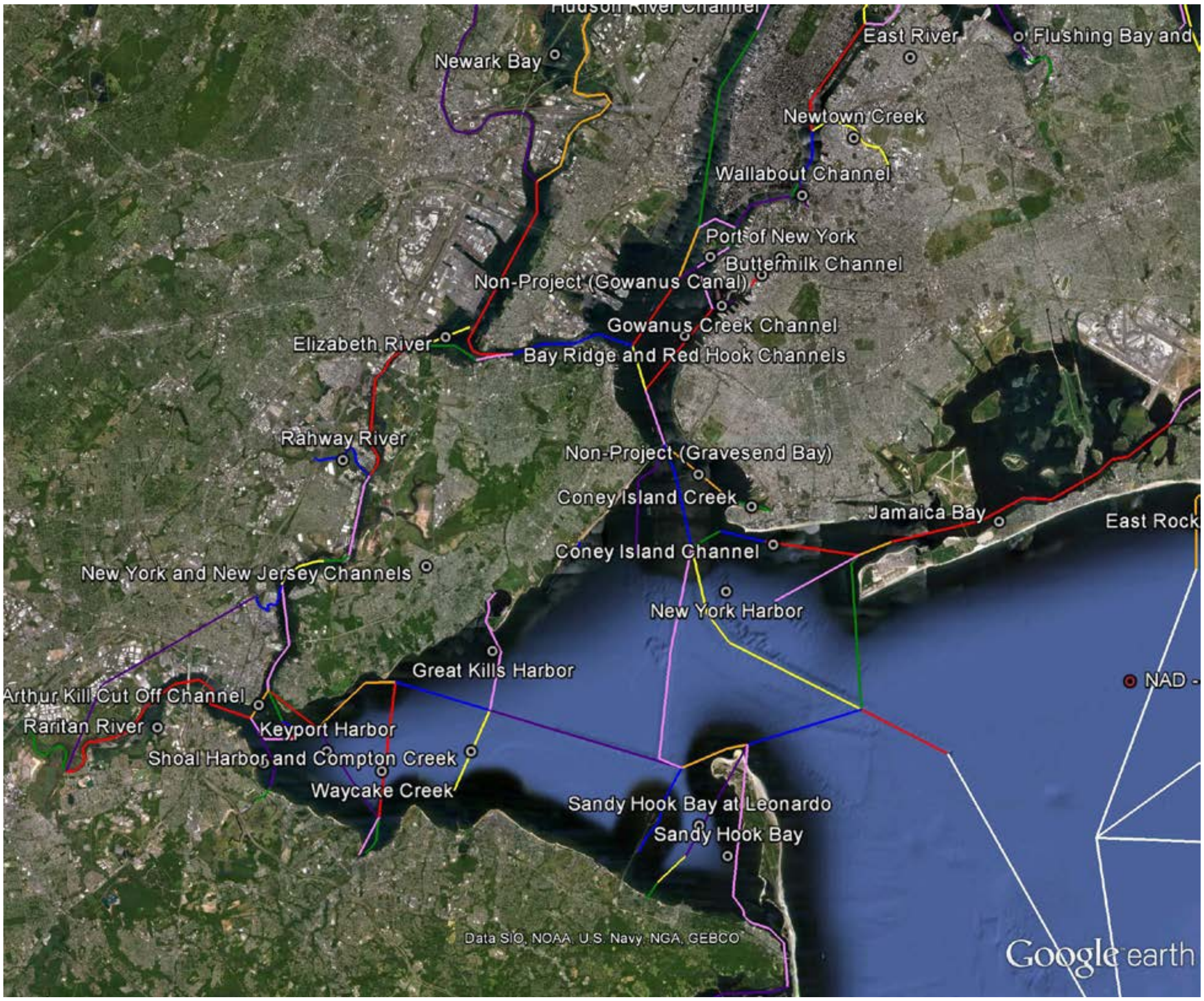
The Port of New York & New Jersey is defined as all the commercial traffic operating in these channels and reaches. (Refer to Figure B-2)

- Sandy Hook Bay
- Shrewsbury river
- Shoal Harbor and Compton Creek
- Raritan River
- New York and New Jersey Channels
- Newark Bay
- New York Harbor
- Jamaica Bay
- Bay Ridge & Redhook Channels
- Gowanus Creek Channel
- Buttermilk Channel
- East River
- Hudson River Channel
- Flushing Bay & Creek
- East Chester Creek

Each of the colored sections represents a separate channel reach. The port then is a collection of all the vessel activities and cargo carried on these reaches. The system looked at all data on vessels and cargoes involved in imports and exports to foreign nations, all coastwise vessel movements between U.S. ports via ocean routes, all internal movements via navigable rivers, as well as ferry movements. The data for this study used only docked cargo, and only data that was first rolled up to avoid duplicate counting of cargoes.

Figure B-2

PORT of NEW YORK and NEW JERSEY



3. Problem in dealing with river systems in CPT

REMOVED OWING TO MOU

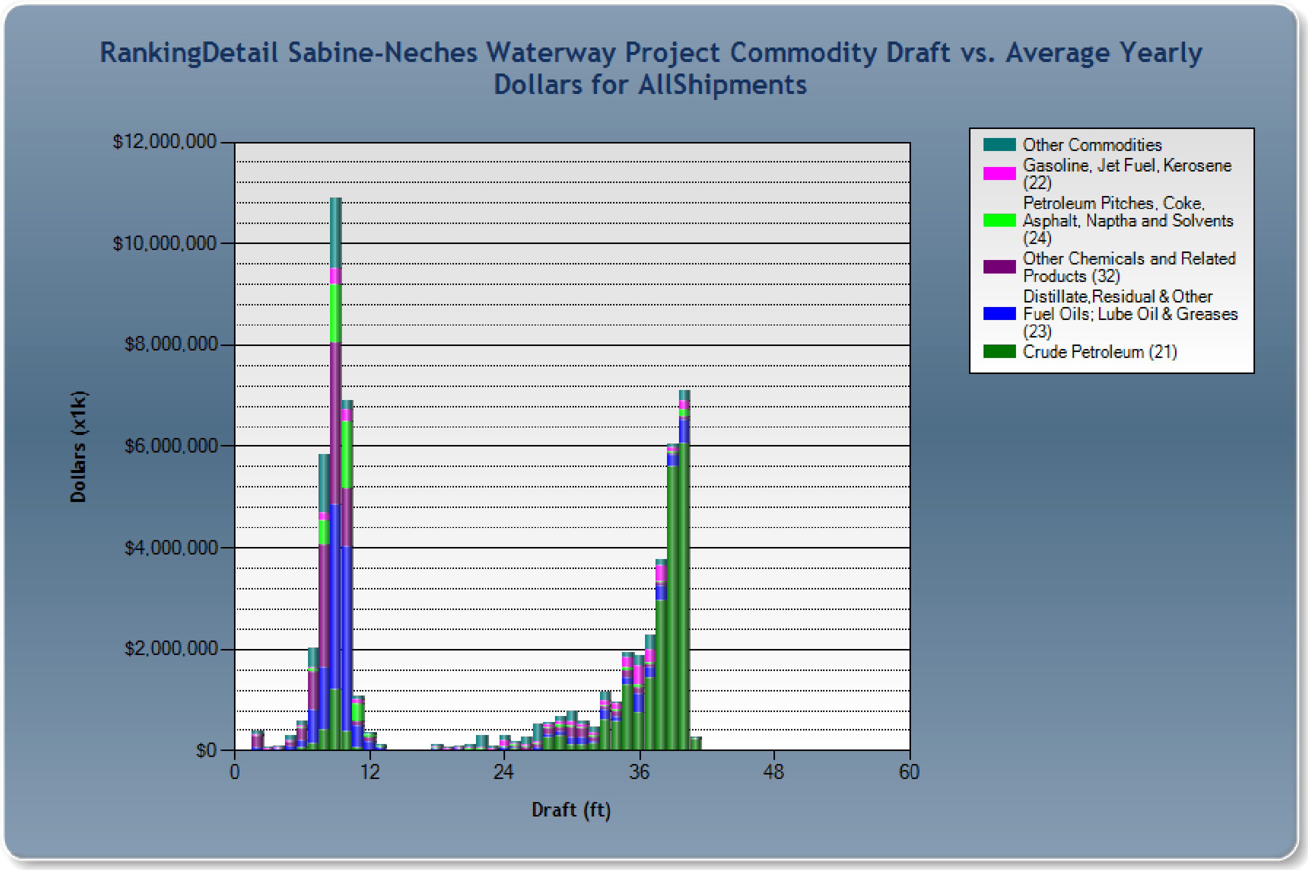
4. CPT capabilities

The user of CPT can identify vessel cargo by its commodity codes (e.g. crude oil, or machinery) and as imports, exports, or as domestic movements. CPT can also output graphs showing top commodity movements by the draft of the vessel transporting the goods.

The Figure B-3 graph of marine transportation traffic in the Sabine-Neches waterway shows a bi-modal distribution of vessel drafts. The first grouping represents the barge traffic utilizing the waterway. The barges have drafts in the 8-12 foot range and carry predominantly fuel and lube oils and chemical products. The second clustering of vessels represents the deep draft ships mostly with drafts between 32-40 feet carrying crude petroleum. The controlling depth for the main channel is 41 feet meaning that pilots are relying heavily on the accuracy and timeliness of the water level data.

Figure B-3

SAMPLE OF CPT GRAPHIC DETAIL OF TRAFFIC MOVEMENTS



APPENDIX C

OMB COST OF CAPITAL REGULATIONS

Table C-1

OMB Circular No. A-94

(Revised December 2009)

DISCOUNT RATES FOR COST-EFFECTIVENESS, LEASE PURCHASE, AND RELATED ANALYSES

Effective Dates. This appendix is updated annually. This version of the appendix is valid for calendar year 2010. A copy of the updated appendix can be obtained in electronic form through the OMB home page at http://www.whitehouse.gov/omb/circulars_a094_a94_appx-c/, the text of the main body of the Circular is found at http://www.whitehouse.gov/omb/assets/a94/a094.pdf, and a table of past years' rates is located at http://www.whitehouse.gov/omb/assets/a94/dishist.pdf. Updates of the appendix are also available upon request from OMB's Office of Economic Policy (202-395-3381).

Nominal Discount Rates. A forecast of nominal or market interest rates for 2010 based on the economic assumptions for the Fiscal Year 2011 Budget are presented below. These nominal rates are to be used for discounting nominal flows, which are often encountered in lease-purchase analysis.

Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
2.3	3.1	3.5	3.9	4.4	4.5

Real Discount Rates. A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2011 Budget is presented below. These real rates are to be used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.9	1.6	1.9	2.2	2.7	2.7

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than 30 years may use the 30-year interest rate. Calculation of the specified 3.9 percent for projects with ten year economic lives is shown in Table C-2.

Table C-2

CALCULATION OF DISCOUNT RATE

YEAR	DISCOUNT FACTOR (3 %)	DISCOUNT FACTOR (4 %)	DISCOUNT FACTOR (3.9 %)
1	0.971	0.962	**0.963**
2	0.943	0.925	**0.927**
3	0.915	0.889	**0.892**
4	0.889	0.885	**0.885**
5	0.863	0.822	**0.826**
6	0.838	0.790	**0.795**
7	0.813	0.760	**0.765**
8	0.789	0.731	**0.737**
9	0.766	0.703	**0.709**
10	0.744	0.676	**0.683**

Source: Engler, George, "*Business Financial Management*", Business Publications Incorporated, Table B, Present Value of $1, p. 639, 1975.

APPENDIX D

SURVEY PROVIDED TO PORT PILOTS

BENEFITS OF A FULLY IMPLEMTENED PORTS® TO THE NATION

NOAA is developing a report on the economic benefits of PORTS® to the nation. The report will examine the many uses of PORTS® information from the transport of commerce to the many recreational uses of real-time oceanographic information. While there is a great deal of economic data available for this analysis it is essential that there be some effort to ground truth the results with knowledgeable users of PORTS® information. Pilots represent that pinnacle of expert user responsible for moving large commercial vessels through the most treacherous waters of a ships journey.

Narrow channels barely deeper than the ship's draft over hung by older bridges that are barely higher than the ships that need to pass underneath coupled with traffic, visibility and tidal current issues make the movement of these large ships the job of only the most highly experienced mariners, the pilots. Pilots are the experts that are able to integrate the best available information to assure a safe passage.

I propose to seek the opinions of about 5 experts on how they would value the various types of information they use to navigate a vessel to and from the pier. The results will be kept confidential and aggregated so that no attribution to an individual or geographic area is possible. The results will be attributed to regional experts. I am interested in determining any differences in the value of the information with differences in ship draft. (Refer to Table D-1)

- 0' – 2' off the bottom
- 2' – 4' off the bottom
- 4' or more off the bottom

VALUE OF INFORMATION PILOTS USE TO BRING VESSLES INTO PORT Table D-1

	A	B	C
1. Channel construction and maintenance	______	______	______
2. Aids to Navigation	______	______	______
3. PORTS® Information	______	______	______
a. Real-time Water levels			
b. Real-time Currents			
c. Real-time wind speed and direction			
d. Real-time air gap (bridge height above water)			
e. Real-time Salinity			
f. Real-time visibility			
4. Vessel operational characteristics/information	______	______	______
5. Up to date Nautical Chart (electronic or paper)/ECDIS	______	______	______
6. Radar information	______	______	______
7. Communications with other vessels	______	______	______
8. AIS Information	______	______	______
9. Notice to Mariners Information	______	______	______
10. Master – Pilot Exchange	______	______	______
11. ____________________	______	______	______
12. ____________________	______	______	______
13. ____________________	______	______	______
14. ____________________	______	______	______
TOTAL	100	100	100

CHAPTER 4 – INTRODUCTION TO TRANSPORTATION

I. INTRODUCTION

For over 200 years, the National Oceanic and Atmospheric Administration and its predecessors along with the United States Army Corps of Engineers have been assigned responsibility by the President and Congress of the United States to survey and maintain ports and navigable water ways. Although NOAA was not officially established until October 3, 1970, it was developed from several earlier groups which were among the oldest Federal agencies in the United States.[1] The US Coast Survey began on February 10, 1807 when President Thomas Jefferson and Congress authorized a survey to be taken of coasts of the "United States". It was later joined by the Weather Bureau (1870) and the Bureau of Commercial Fisheries (1871). The survey of the Coast changed its name to the Coast and Geodetic Survey in 1878 to reflect role in geodesy.

The United States Army Corps of Engineers traces its history to 1775, when Congress established the Continental Army with a provision for a Chief Engineer to oversee the construction of fortifications for the Battle of Bunker Hill. An Act of Congress permanently established the Corps in 1802. The Corps' civil works role and mission is grounded in a series of laws enacted since 1824.[2] Subsequent Acts of Congress expanded the Corps' responsibilities for navigation.

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[1] President Nixon originally envisioned the concept of NOAA in July, 1970. proposed creating NOAA to serve a national need "...for better protection of life and property from natural hazards...for a better understanding of the total environment...[and] for exploration and development leading to the intelligent use of our marine resources..." Source: http://www.history.noaa.gov/legacy/30year.html

[2] The General Survey Act of 1824 authorized the President to have surveys made of routes for roads and canals of national importance, in a commercial or military point of view, or necessary for the transportation of public mail. A second act, also signed in 1824, appropriated $75,000 to improve navigation on the Ohio and Mississippi rivers by removing sandbags, snags and other obstacles, and was subsequently amended to include other rivers such as the

Without the combined work of NOAA's National Ocean Services' (NOS) Office of Coast Survey (OCS), CO-OPs and National Geodetic Survey (NGS) along with support of NOAA's Office of Marine and Aviation Operations (OMAO) and ultimately the U.S. Army Corps of Engineers (USACE) operators of international trade vessels critical to the economy and security of the United States would operate far less efficiently, without real and near-real time provision of demographic data involving deep-water ports. In essence, the ability to operate international traffic is due to reliance on products and services from several Federal agencies that provide knowledge that U.S. ports are capable, safe and efficient.

With forecast increases of 100 percent in import-export container traffic by 2019 and overall worldwide water commerce by 2025 based on expansion of the Panama Canal in 2014, the need for timely and accurate navigational information becomes even more imperative. This is already reflected in the increases in depth recently authorized by the Congress for the ports of Miami, Savannah and Charleston.[3]

This study concentrates on the benefits PORTS® as a centralized repository and clearinghouse of data involving water levels, meteorological conditions, salinity and water temperature, currents and air gaps[4]

Missouri. This work was also given to the Corps of Engineers.

[3] Increases up from 42, 42 and 45 feet, respectively to a new authorized depth of 50 feet.

[4] Air gap refers to a tool that measures the clearance between the water surface and bridges or other overwater obstructions (e.g., power lines).

II. MARITIME TRADE IS ESSENTAIL TO THE U.S. ECONOMY

Traditionally, the largest portion of total logistics costs are those related to direct transportation expense.[5] Clearly, if transportation becomes safer and more efficient due to improved data (e.g., maps and local demographic conditions (e.g., water levels, tides, air gaps, etc.), there could be downward pressure on other parts of the logistics model (e.g., more reliable transport costs providing more reliable supply could, in turn, lower inventory carrying costs).

While noted by a variety of authors over time, Henry (2007) succinctly states that "Transportation networks are the life blood of the nation and its economy."[6] Total international traffic in 2010 rose to over 1.88 billion tons with about 1.44 billion imported and exported via water. (Refer to Figure 1) In 2011, these figures had increased to 1.97 billion and 1.48 billion tons, respectively. (Refer to Figure 1) At the same time, the value of that traffic in 2010 was almost $3.19 trillion with over $1.43 trillion handled via water which increased to 3.69 and 2.21 trillion, respectively in 2011. (Refer to Figure 2)

In looking at the longer-term, with the exception of imported tonnage, all waterborne traffic levels increased over the 2003 to 2011 period. (Refer to Table 1)

[5] 63 percent of total costs are due to direct transportation costs, 33 percent from inventory carrying costs and the remaining four percent to administrative costs. Source: Federal Highway Administration, 2005.

[6] Dr. Vincent Henry, Director, Long Island University Homeland Security Management Institute, July 31, 2007. On their website: http://www.southampton.liu.edu/homeland/index.html. Also see Stromberg, R.E., (American Association of Port Authorities) 1990, "*Statement before the Subcommittee on Water Resources*", Committee on Public Works and Transportation, U.S. House of Representatives, March 7.

Figure 1

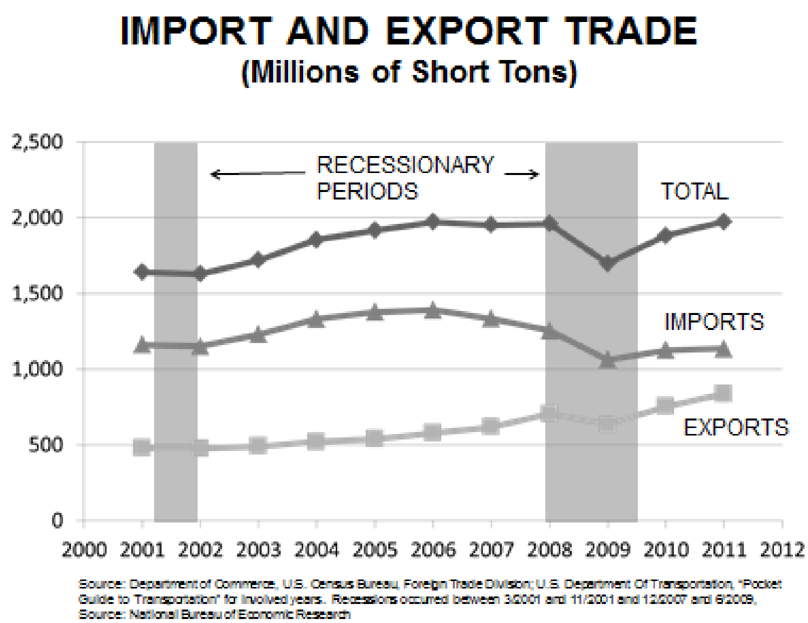


Figure 2

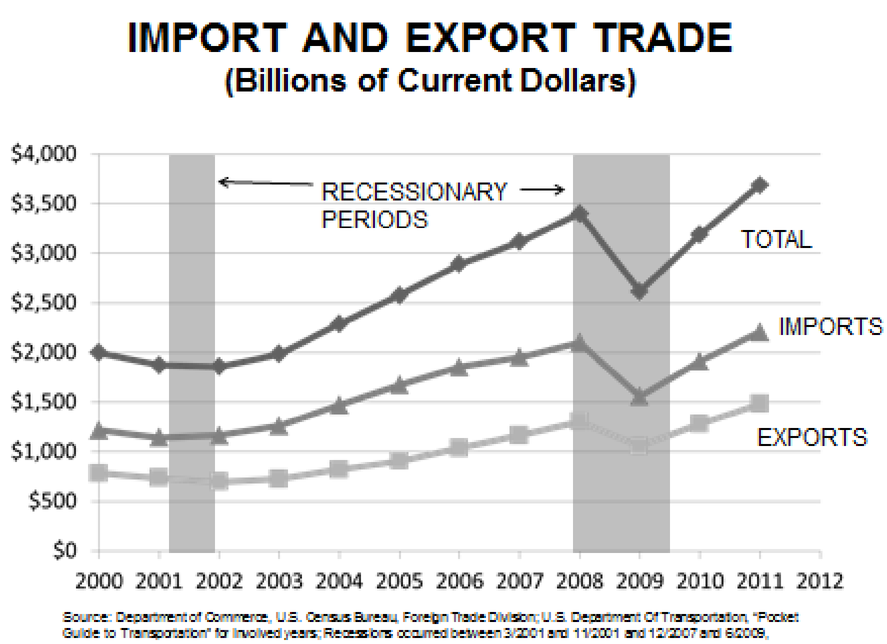


Table 1

ONLY IMPORTED TONNAGE HAS NOT REBOUNDED TO PRE-RECESSIONARY LEVELS

YEAR COMPARISON	CHANGE IN IMPORTED TONNAGE	CHANGE IN EXPORTED TONNAGE	CHANGE IN TOTAL IMPORTED AND EXPORTED TONNAGE
2003 - 2008	102.1%	143.3%	113.9%
2003 - 2009	86.3%	129.5%	98.6%
2003 - 2010	91.6%	153.6%	109.3%
2003 - 2011	92.4%	170.2%	114.6%

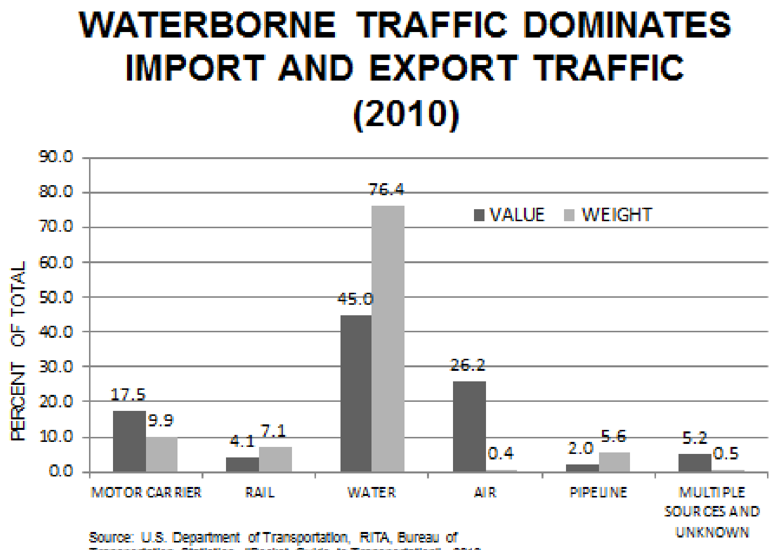
YEAR COMPARISON	CHANGE IN NOMINAL VALUE OF IMPORTS	CHANGE IN NOMINAL VALUE OF EXPORTS	CHANGE IN NOMINAL VALUE OF IMPORTS AND EXPORTS
2003- 2008	166.8%	179.6%	171.5%
2003- 2009	123.7%	146.6%	131.9%
2003 -2010	151.8%	176.5%	160.8%
2003- 2011	175.3%	204.6%	186.0%

Source: U.S. Department of Commerce, U.S. Census Bureau, *"U.S. Trade in Goods and Services";* Department of Transportation (DOT), *"Pocket Guide to Transportation"* (for involved years); DOT Maritime Administration annual publications.

Of the five methods employed to handle imported international traffic, water traffic dominates all other modes in terms of tonnages handled and associated revenues.[7] In 2010, over 76 percent of all international tonnage representing 45 percent of all import and export values

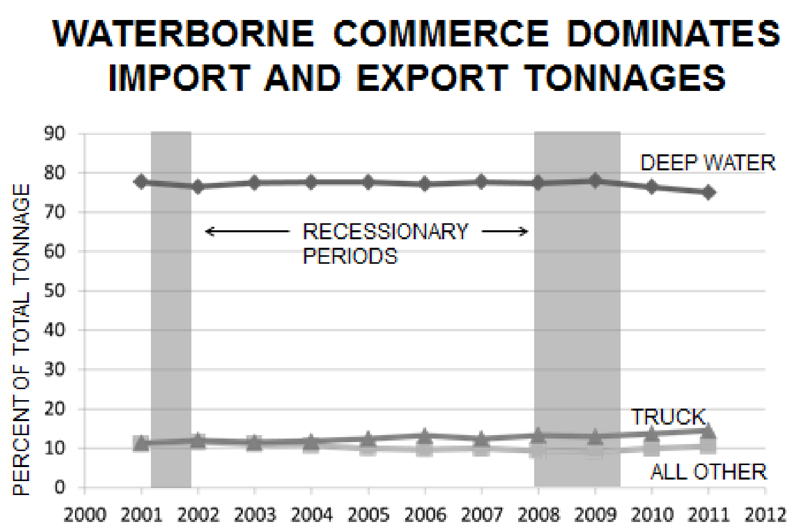
[7] Transportation modes include: (1) waterborne; (2) air; and, (3) truck; (4) rail; and, (5) pipeline – with the last three referred to as "surface modes".

Figure 3



Source: U.S. Department of Transportation, RITA, Bureau of Transportation Statistics, "Pocket Guide to Transportation", 2012.

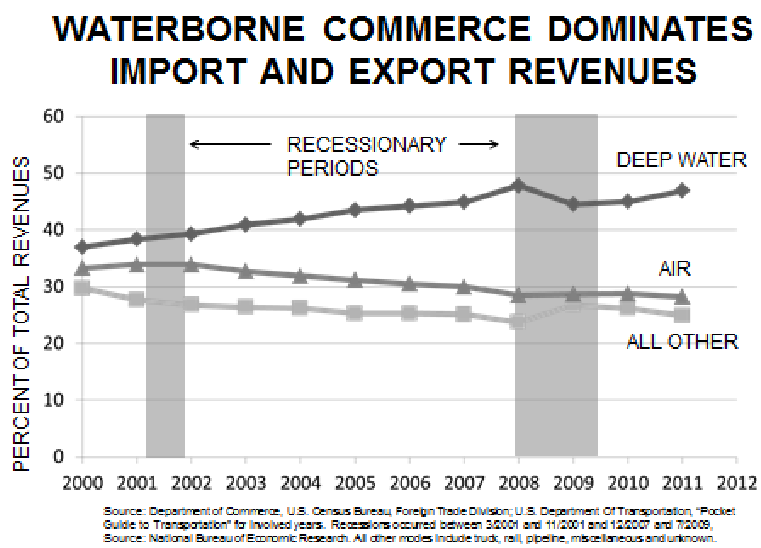
Figure 4



Source: Department of Commerce, U.S. Census Bureau, Foreign Trade Division; U.S. Department Of Transportation, "Pocket Guide to Transportation" for involved years. Recessions occured between 3/2001 and 11/2001 and 12/2007 and 6/2009, Source: National Bureau of Economic Research. All other modes include rail, pipeline, miscellaneous, air and unknown.

were handled via deep water.[8] (Refer to Figure 3) Over time the dominance of deep-water transportation supporting international trade as remained largely consistent representing between 75 and 78 percent of total tonnage and 37 to 48 percent of total revenue.[9] Note that while tonnage has remained essentially constant, revenues have generally increased as a portion of total transportation expense. (Refer to Figures 4 and 5)

Figure 5



A. Major U.S. Exports[10]

Under the North American Industry Classification System (NACIS) 33 commodity groups are identified. In 2010, of these 33 groups the top ten exports in terms of revenues represented

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[8] In this analysis, deep water was defined as ships with displacements of at least 15 feet.

[9] During the 2003 to 2011 study period. Source: Department of Transportation, "Pocket Guide to Transportation", for involved years; Department of Commerce, US Trade On-Line.

[10] Source: U.S. Department of Commerce, Census, U.S.A. Trade On Line

almost 81 percent of the total value of all exported goods and included:

1. Transportation equipment - 14.94%
2. Computer & electronic products – 14.90%
3. Chemicals – 14.05%
4. Machinery, except electrical – 10.78%
5. Petroleum & coal products – 4.81%
6. Miscellaneous manufactured commodities – 4.78%
7. Agricultural products – 4.71%
8. Primary metal manufacturing – 4.19%
9. Food & kindred products – 4.06%
10. Special classification provisions, Nesoi[11] – 2.80%

B. Major US Imports[12]

In 2010, the top ten imported NACIS commodity groups accounted for almost 80 percent of all imported (weighted by value) and included:

1. Computer & electronic products – 16.99%
2. Oil & gas - 14.65%
3. Transportation equipment – 12.6%
4. Chemicals - 9.22%
5. Machinery, except electrical – 5.52%
6. Miscellaneous manufactured commodities – 5.11%
7. Primary metal manufacturing – 4.13%
8. Apparel & accessories – 3.95%
9. Petroleum & coal products – 3.68%
10. Electrical equipment, appliances and components – 3.62%

C. Trading Partners and Major Commodities[13]

During the last ten years, the US has traded goods with many countries. In 2010, the US imported goods from 215 countries and exported goods to 231 countries. Leading trading partners with America in 2010 based on value of imported and exported merchandise were: (1)

[11] Not elsewhere specified or included.

[12] Source: U.S. Department of Commerce, Census, U.S.A. Trade On Line

[13] Ibid.

China (21.5%); (2) Japan (8.0%); (3) Germany (4.5%); (4) Mexico (3.8%) and, (5) South Korea (3.5%). Highly concentrated, the top 10 countries account for almost 55 percent of all value of imports and exports while the top 20 account for almost 72 percent.[14]

In terms of tonnage exchanged, major trading partners in 2010 were: (1) China (9.8%); (2) Mexico (8.2%); (3) Canada (6.4%); (4) Venezuela (5.5%); and, (5) Saudi Arabia (4.4%). In terms of tonnage, the top 10 countries accounted for over 53 percent of all tonnage while the top 20 accounted for over 71 percent of tonnage.[15]

President Obama's recent call for doubling exports during the next five years looked to spur the economy and ease joblessness.[16] Since his inaugural address, the President has ordered federal agencies to zero in on export promotion, expanding trade-finance opportunities for small- and medium-sized businesses, and move to overhaul an outdated export-control system. The Chamber of Commerce is on record to say that doubling exports in five years is an achievable goal. It happened in the 1970s and early 1980s, and almost occurred in the five years ending in 2008.

[14] Of the counties importing and/or exporting goods to the United States in 2010, the top 60 accounted for 95 percent of total value. Source: U.S. Waterborne Freight Trade by Trading Partners. Department of Commerce, Department of the Census, Census Bureau's Foreign Trade Division.

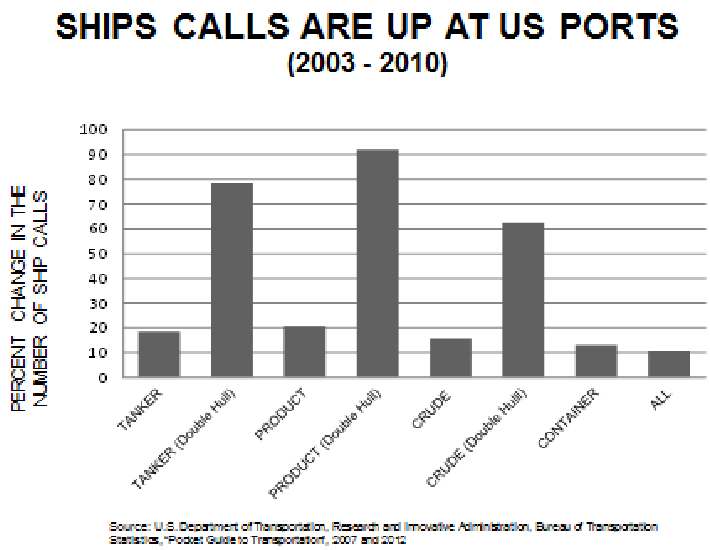
[15] 95 percent of all tonnage was exchange with 61 other countries. Source: U.S. Waterborne Freight Trade by Trading Partners. Department of Commerce, Department of the Census, Census Bureau's Foreign Trade Division.

[16] January 27, 2010, in promising Wednesday night to double the United States' export growth over the next five years, President Obama set an ambitious goal for American trade policy that, he said, could create two million jobs. Source: The New York Times, Refer to: http://www.nytimes.com/2010/01/29/business/29trade.html.

III. SHIP CALLS ARE UP AT U.S. PORTS

Overall, port calls by ships of all sizes, increased by 10.5 percent between 2003 and 2010.[17] (Refer to Figure 6) Significant increases were seen in the use of double hulled tanker, product and crude oil vessels – up 78.6, 92.9 and 62.3 percent respectively during the same period reflecting the mandatory use of doubled hauled ships.[18]

Figure 6



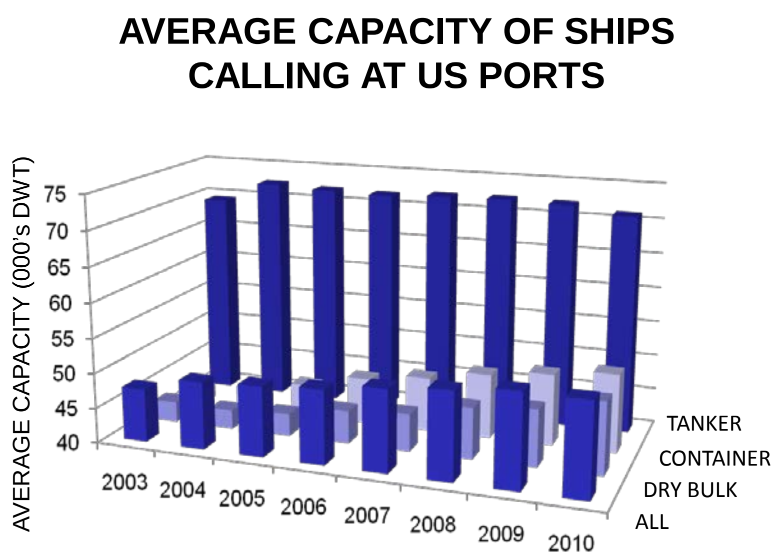
Overall, water transportation is dominated by three general ship types: (1) tankers; (2) dry-bulk; and, (3) containerships. Collectively, they typically account for over 90 percent of all capacity

[17] Source: Department of Commerce, Maritime Administration, *"Vessel Calls at U.S Ports Snapshot"*, 2007 and 2011.

[18] A single hull vessel (contracted before June 30, 1990, or delivered before January 1, 1994) must meet the U.S. double hull standards of 33 CFR 157.l per the date required by 33 CFR157 Appendix G. The phase-out schedule of 33 CFR 157 Appendix G, for single hull vessels over 5,000 gross tons begins January 1, 1995, and ends January 1, 2015

and 80 percent of the number of port calls which illustrates the larger nature of these types of vessels.[19] (Refer to Figure 7) These types of carriers are often referred to as: (1) Liner; (2) Tanker; and, (3) Tramp. While there are exceptions, liner service (ships belonging to a regular line) is largely synonymous with containerized freight as is tanker with bulk crude and refined oil products. Tramp service, performed by ships not making regular port calls but taking cargo where it offers to any port is often related to dry-bulk shipments.

Figure 7



Source: U.S. Department of Transportation, Maritime Administration, *Vessel Calls at U.S. Ports By Vessel Type,* 2008, 2009, 2010 and 2011 editions

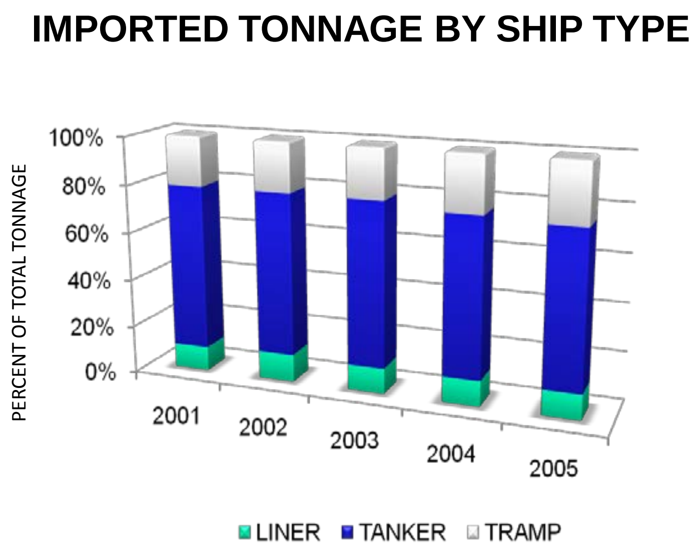
A. Vessel Types Employed In International Service

Due to the higher density per cubic foot and greater volume of products transported in tankers, it is not surprising that they dominate import traffic. (Refer to Figure 8) Machinery and transportation equipment and parts dominate export traffic in both liner and tramp service. (Refer to Figure 9). Due to the imbalance of total import versus export trade along with the different mix of import and export commodities results in a situation where tanker and tramp

[19] Other vessel types include Roll-on Roll-Off, Liquid Petroleum Gas carriers, combination and general carriers.

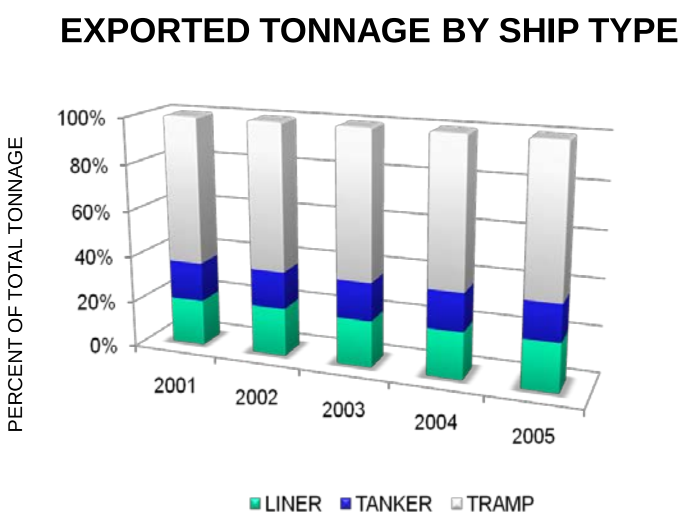
service dominate international trade flow – at least in terms of volume. (Refer to Figure 10)

Figure 8



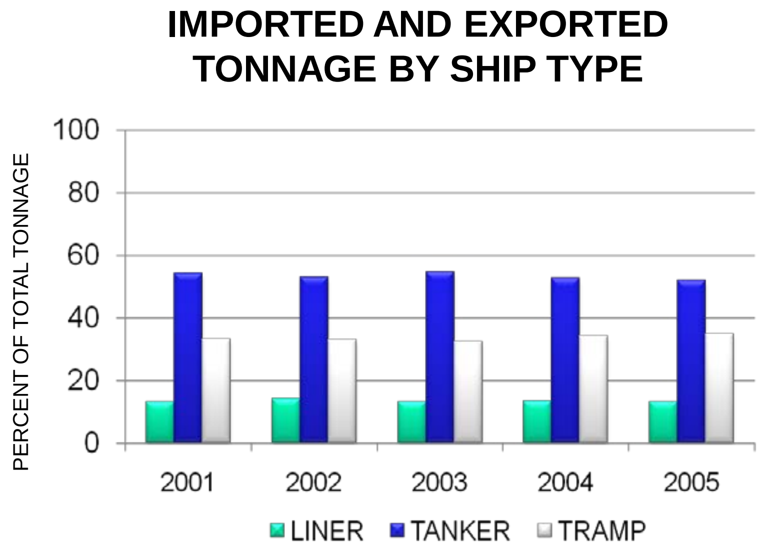
Source: U.S. Army Corps of Engineers, Institute for Water Resources, Navigational Data Center. Series discontinued in 2006.

Figure 9



Source: U.S. Army Corps of Engineers, Institute for Water Resources, Navigational Data Center. Series discontinued in 2006.

Figure 10



Source: U.S. Army Corps of Engineers, Institute for Water Resources, Navigational Data Center. Series discontinued in 2006.

In terms of value, the situation is largely reversed. Owing to the significantly higher value of containerized freight, it is not surprising that liner traffic represents the dominant revenue portion of all import and export traffic. (Refer to Figures 11, 12 and 13).

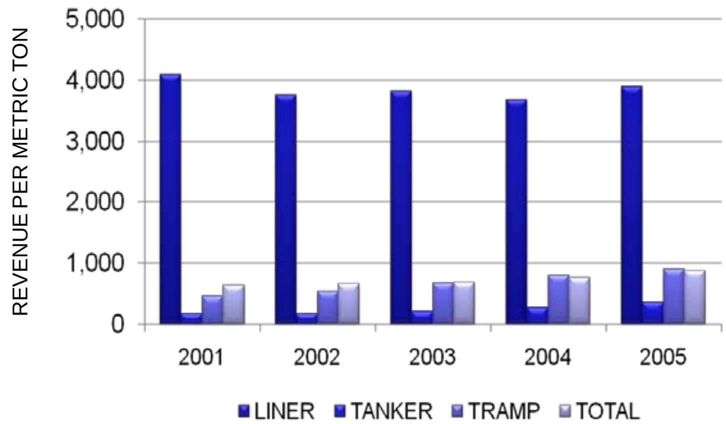
While the average size of ships calling at U.S. ports as measured by deadweight tonnage (DWT)[20] increased by 8.1 percent during the 2003 to 2010 period, container ships grew by 18.8 percent in terms of DWT and 25.1 percent in terms of TEUs.[21] (Refer to Figure 14) As larger containerships are already in world-wide service and plans for even larger containerships are under development, it appears prudent to assess these trends in greater detail in order to better

[20] DWT is a measure of how much weight a ship is carrying or can safely carry. It is measured by the sum of weights of fuel, cargo, fresh water, ballast water, provisions, passengers and crew.

[21] A TEU (or Twenty Foot Equivalent Unit) represents the cargo capacity of a standard intermodal container (20 feet long and 8 feet wide. There is a lack of standardization of height which can range from 4 feet three inches and 9 feet six inches. The most common height is 8 feet and 6 inches. A 40 foot container would be considered as 2 TEUs as would a 45 foot container. Source: Intermodal Association of North America.

Figure 11

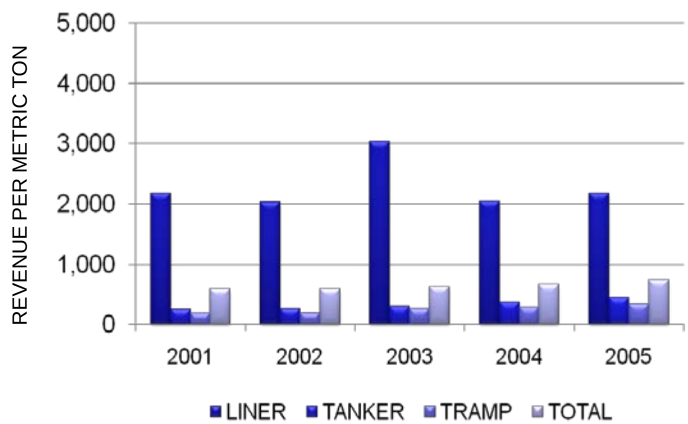
NOMINAL DOLLAR VALUE PER IMPORTED METRIC TON BY SHIP TYPE



Source: U.S. Army Corps of Engineers, Institute for Water Resources, Navigational Data Center. Series discontinued in 2006.

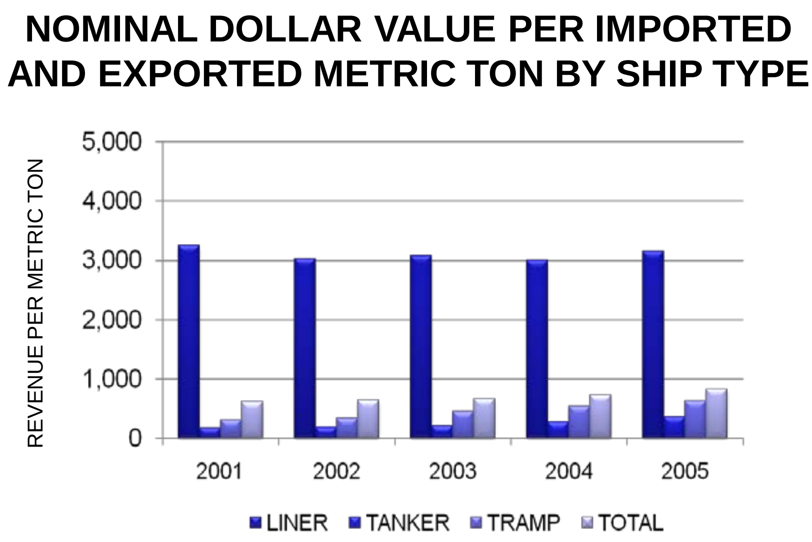
Figure 12

NOMINAL DOLLAR VALUE PER EXPORTED METRIC TON BY SHIP TYPE



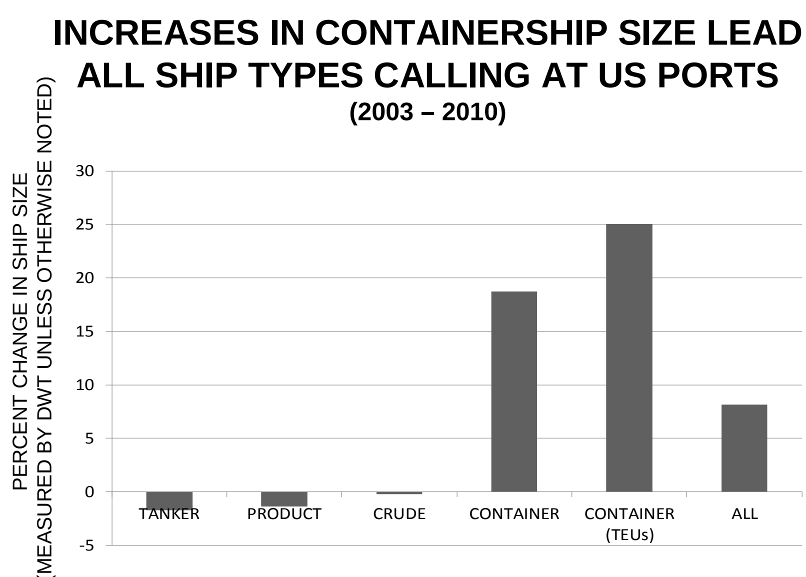
Source: U.S. Army Corps of Engineers, Institute for Water Resources, Navigational Data Center. Series discontinued in 2006.

Figure 13



Source: U.S. Army Corps of Engineers, Institute for Water Resources, Navigational Data Center. Series discontinued in 2006.

Figure 14



Source: U.S. Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2007", May, 2008, "Vessel Calls Snapshot, 2008, July, 2009, "Vessel Calls Snapshot, 2009", August, 2010, and "Vessel Calls Snapshot, 2010", May, 2011.

appreciate the potential impact of Panama Canal expansion in 2014 as well as the need to expand and better utilize US port capabilities.[22]

IV. CONTAINER TRAFFIC IS RAPIDLY INCREASING IN IMPORTANCE

Modern containerization can trace its roots to the early 19th century where containers were transported on railroads and were transferrable among ships, surface carts and wagons. Varying widely in share and size, most early containers were employed in the shipment of coal. In 1906 containers measuring 8 by 9 by 18 feet were transferrable among truck, rail and ship. (Van Den Berg, 1969).

By mid-century these open-top wooden boxes were replaced with ones of iron construction. Beginning in the 1920's forms of intermodalism began with railroads such as The Chicago North Shore and Milwaukee Railroad began to carry finished automobiles on railroad flatcars. Later in 1929 Seatrain Lines carried railroad boxcars between New York and Cuba. Following up on work begun in 1935 by the Chicago Great Western Railway and New Haven Railroad, "piggy back" service (where motor carrier trailers were placed on railroad flatcars) was expanded by the Southern Pacific in the 1950s. Over 25 railroads participated in some form of piggy-back service by the mid-1950s.[23]

It was not until World War II that the use of containers was employed to expedite the transfer of needed materials. At that time, containers were referred to as "transporters". Made of steel, they were capable of handling up to 4.5 tons and measured 8.5 feet long by 6.25 feet wide

[22] For example, a larger portion of ship calls will need to more closely assess their depths under keel than ever before owing to their ever-larger displacements.

[23] Later referred to as Trailer –On-Flat-Car or TOFC.

and 6.8 feet high. These, however, were mainly loaded and unloaded at the docks and not used in among separate modes of transit. (Muller 1989)

During the Korean War the term transporter was changed to CONEX for “Container Express”. It was during this time that the US Army began standardization of container size with 8 foot high, 8 foot wide and 10 foot lengths being “standard”. (US Army Transportation School 2007)

Ships built to specifically carry containers began to appear in the early 1950s. Begun in 1955, the Clifford J. Rogers carried 600 containers on routes between Vancouver, British Columbia and Skagway, Alaska. These trips represented the first true intermodal service where motor carriers, ships and railroads employing purpose build equipment operated together to provide transportation service.

Later in 1956, Malcolm McLean transported 58 containers domestically between Newark and Houston upon the *SS Ideal-X*. (Levinson 2006). McLean’s idea was innovative in that it the containers were not opened between shipper and consignee and could be transferred among motor carriers, ships and railroads. While these “roll on – roll off” configurations were originally envisioned to use trailers, improved space utilization was seen in the transport of only the container portion of the load.

Up to this time, break bulk cargo unloading had been performed for centuries before the development by McLean of the shipping container. Goods often had to wait in warehouses for the next stage of logistics. Those transfers and delays made shipping slow and schedules uncertain. They also created opportunities for damage, mistakes and more than a little theft. Bonded spirits were one of the first products shipped by container because it was so subject to pilferage. Different companies in different industries facing different price regulations for different goods handled each step. Costs were extremely high, much cargo was lost, damaged or stolen and inefficiency was rife, since a slower loading and unloading process benefitted the long-shore workers through less physical exertion and more guaranteed work time.

For much of the first decade, the 1960's, containerized traffic was almost exclusively an American pursuit. With the exception of bulk cargo, by 1973 Muller reports than over 50 percent of all traffic consisted of containerships and roll-on/roll-off vessels (Muller 1989, p 17.) Today that figure has expanded to closer to 100 percent in terms of trade with Europe and the Far East – the two largest trading areas. In total, it has been estimated that over 90 percent of non-bulk cargo moves via container today.

Standardization of container size was an early problem. While some firms operated 24 foot containers, others utilized 35 foot or larger configurations. To remedy this problem a series of recommendations from 1968 to 1970 from the International Organization for Standardization (ISO) defined and standardized container terminology and dimensions (R-668, January, 1968), identification markings (R-790, July 1968), stipulated corner fittings (R-1161, January, 1970) and established minimum internal dimensions (R-1897, October, 1970). (Rushton 2004).

Beginning in 1984, railroads introduced double-stack cars which enabled efficient mixing of different sized containers as well as reducing the platform tare weight of the railcars. By 1990, the double-stack fleet was comprised of over 3,000 car sets which could carry 20 TEUs or 10 - 40 to 48 Foot containers. Employing low tare weight double stack cars, dedicated unit trains can transport over 200 TEUs.[24]

In recent years, the United States has imported and exported containers into 170 of 234 countries in the world. In the mid-1990s China became our largest containerized trading partner

[24] Use of permanently attached 5-platform (Type "Q") cars with individual platform tare weights of less than 33,000 pounds can facilitate transport of up to 20 TEUs.

with about 14 percent of all total TEU activity. By 2010, that figure had grown to over 37 percent. By way of comparison, the next four largest trading partners (Japan, Hong Kong, South Korea and Taiwan) were reduced in importance from 29 to 17 percent of total U.S. commerce.[25]

A. Recent Containership Trends

In 2010, a total of 7,579 ocean going vessels made 62,747 calls at U.S. Ports.[26] This represented an increase over the recessionary year of 2009 when almost 7,000 oceangoing vessels (down from 7,100 in 2008) made nearly 55,600 calls at ports in the United States (down from 60,578 in 2008). From 2003 to 2010, the total number of vessel calls increased from 56,759 to 62,747 – almost 11 percent. (U.S. DOT, 2010 and 2011) At the same time, container TEU weights increased and in 2010 represented about 16 percent of total international traffic's (import and export) weight and 21 percent of revenue.[27] Refer to Table 2.

In 2010, 76.4 percent of all imports and exports (by weight) are through U.S. Ports. (DOT 2008, 2009, 2010, McCrimmon, 2007, FHWA, 2009).[28] While there are 121 customs ports, activity among U.S. container ports is highly concentrated among the top 22 where 98 percent of all TEUs are handled. (American Association of Port Authorities (2009), Journal of Commerce, (2009), DOT MARAD (2011).

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[25] Since the return of Hong King to China in 1999, an increasing portion of traffic is being released through other Chinese ports.

[26] U.S. Department of Transportation, *"Vessel Calls Snapshot, 2010"*, Maritime Administration 2011, Page 1.

[27] U.S. Department of Transportation, Maritime Administration, U.S. Water Transportation Statistical Snapshot - 2010, May 2011, page 1.

[28] Department of Transportation, Federal Highway Administration, Freight Management and Operations, National Statistics and Maps; http://ops.fhwa.dot.gov/freight/freight_analysis/, February 11, 2011. Water revenues accounted for 44 percent of all import/export activity in 2008.

Other than double hulled tank vessels built to meet compliance issues with the Oil Pollution Act of 1990, LNG and vehicle carriers, container ships were the youngest ships to call on US ports with an average age of 10.1 years.[29] (US DOT (2000), (2009), (2010) and (2011)). Between 2003 and 2010, while total containership calls at U.S. ports increased by 8.5 percent. Container vessels with lesser capacity made even fewer calls at U.S. ports, declining between 10 and 49 percent for vessels with less than 4,000 TEU capacities. (Refer to Table 3) At the same time ships with between 4,000 and 4,999 TEU capacities and those above 5,000 TEUs increased by 49 and 349 percent, respectively. Likewise, total calls at US ports per containership increased significantly for 4,000 and above TEU capacities (60 and 270 percent, respectively), while smaller ships called between 10 and 49 percent fewer times. (Refer to Table 4).

[29] A single hull vessel (contracted before June 30, 1990, or delivered before January 1, 1994) must meet the U.S. double hull standards of 33 CFR 157.l per the date required by 33 CFR157 Appendix G. The phase-out schedule of 33 CFR 157 Appendix G, for single hull vessels over 5,000 gross tons begins January 1, 1995, and ends January 1, 2015. In 2010 97 percent of all tanker calls were doubled hulled up for 78 percent five years earlier.

Table 2

SUMMARY ECONOMIC STATISTICS (2010)[30]

MEASURE	2010	
U.S. GROSS DOMESTIC PRODUCT	$14,498.9 trillion	
Total Exports of Goods and Services	$1,842.5 trillion	
Total Exports of Goods	$1,288.9 trillion	
Total Imports of Goods and Services	$2,337.2 trillion	
Total Imports of Goods	$1,934.0 trillion	
TRANSPORTATION MODE VALUE		
Imports via deep water	51.2%	
Containers		23.2%
Bulk		28.0%
Imports via air	23.2%	
Imports via surface (rail, motor carrier, pipeline, other, unknown)	25.6%	
Exports via deep water	35.6%	
Containers		16.5%
Bulk		19.1%
Exports via air	30.7%	
Exports via surface (rail, motor carrier, pipeline, other, unknown)	33.6%	
Total traffic via deep water	45.0%	
Containers		20.6%
Bulk		24.4%
Total traffic via air	26.2%	
Total traffic via surface (rail, motor carrier, pipeline, other, unknown)	28.8%	
TRANSPORTATION MODE WEIGHT		
Imports via deep water	76.6%	
Containers		13.3%
Bulk		63.3%
Imports via air	0.4%	
Imports via surface (rail, motor carrier, pipeline, other, unknown)	23.0%	
Exports via deep water	76.1%	
Containers		19.6%
Bulk		56.5%
Exports via air	0.5%	
Exports via surface (rail, motor carrier, pipeline, other, unknown)	23.4%	
Total traffic via deep water	76.4%	
Containers		15.8%
Bulk		60.6%
Total traffic via air	0.4%	
Total traffic via surface (rail, motor carrier, pipeline, other, unknown)	23.2%	

[30] Source: Sources: U.S. Department of Commerce, Bureau of Economic Analysis and U.S. Census Bureau, U.S. Trade online Revisions as of August 10, 2012.

Table 3

CONTAINERSHIPS WITH INCREASED TEU CAPACITY REPRESSNT A LARGER PORTION OF CALLS ON US PORTS (TOTAL VESSEL CALLS)

VESSEL SIZE (TEUs)	2003	2004	2005	2006	2007	2008	2009	2010	PERCENT CHANGE (2003-2010)
LT 1,000	626	443	394	332	372	464	N/A	N/A	N/A
1,000 – 1,999	3,492	3,463	3,600	3,814	3,532	3,029	N/A	N/A	N/A
LT 2,000	4,118	3,906	3,994	4,146	3,864	3,493	3,290	3,709	-10%
2,000 – 2,999	4,032	4,541	4,410	3,986	4,099	3,347	2,677	2,761	-32%
3,000 – 3,999	4,050	3,888	3,624	3,333	2,866	2,460	2,500	2,053	-49%
4,000 – 4,999	3,945	3,210	4,226	4,782	5,033	5,121	5,305	5,881	49%
GT 5,000	1,142	1,734	2,288	3,344	3,961	4,314	4,434	5,126	349%
TOTAL	17,287	17,279	18,542	19,591	19,863	18,735	18,206	19,530	13%

Source: U.S. Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2007", May 2008, "Vessel Calls Snapshot, 2008", July 2009, and "Vessel Calls Snapshot, 2009", August 2010. Note: The categories of "less than 1,000" and "1,000 to 1,999" were combined in 2009 as "less than 2,000 TEUs."

Table 4

LARGER CONTAINERSHIPS REPRESENT AN INCREASING PORTION OF CALLS ON US PORTS (NUMBER OF VESSELS)

NUMBER OF VESSELS	2003	2004	2005	2006	2007	2008	2009	2010	PERCENT CHANGE (2003-2010)
LT 1,000	28	30	24	23	28	33	N/A	N/A	N/A
1,000 – 1,999	234	185	183	189	168	163	N/A	N/A	N/A
LT 2,000	262	215	207	213	196	196	179	178	-32%
2,000 – 2,999	258	266	259	257	230	219	220	206	-20%
3,000 – 3,999	201	191	189	177	166	141	147	130	-35%
4,000 – 4,999	197	207	234	258	271	284	306	315	60%
GE 5,000	107	160	193	260	277	326	366	396	270%
TOTAL	1,025	1,039	1,082	1,164	1,140	1,166	1,218	1,225	20%

Source: U.S. Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2007", May 2008, "Vessel Calls Snapshot, 2008", July 2009, and "Vessel Calls Snapshot, 2009", August 2010. Note: The categories of "less than 1,000" and "1,000 to 1,999" were combined in 2009 as "less than 2,000 TEUs."

Although the recent recession has reduced the number of new ships built in recent years, the aggregate capacity of new containerships continues to rise – up almost 27 percent from 2005 to 2009 and is forecast to increase by an additional 37 percent during the 2010 to 2014 period. (Refer to Table 5)

Table 5

AGGREGTE CONTAINERSHIP TEU CAPACITY HAS CONTINUED TO INCREASE (in Thousands)

YEAR	FLEET ADDITION	FLEET REPLACED	WORLD OUTPUT	END-YEAR FLEET SIZE
1990	415	390	805	6,375
1991	530	390	920	6,905
1992	725	410	1,135	7,630
1993	480	495	975	8,110
1994	690	460	1,150	8,800
1995	930	465	1,395	9,730
1996	820	470	1,290	10,550
1997	935	545	1,480	11,485
1998	960	520	1,480	12,445
1999	1,025	515	1,540	13,470
2000	1,405	525	1,930	14,875
2001	655	625	1,280	15,530
2002	1,030	710	1,740	16,560
2003	1,525	875	2,400	18,085
2004	1,880	1,080	2,960	19,965
2005	1,450	1,150	2,600	21,415
2006	1,920	1,180	3,100	23,335
2007	2,900	1,350	4,250	26,235
2008	1,900	1,350	3,250	28,135
2009	-1,000	1,350	350	27,135
PROJECTED				
2010	200	1,400	1,600	27,335
2011	1,850	1,550	3,400	29,185
2012	2,700	1,600	4,300	31,885
2013	2,750	1,650	4,400	34,635
2014	2,700	1,800	4,500	37,335

Source: Containerisation International, Market Analysis: World Container Census 2010.

Average deadweight tonnage of these ships and number of TEUs of vessels calling at US Ports has accordingly increased to record capacities. (Refer to Table 6 and Figure 15) Commensurate with this increase in tonnage is an increase in vessel draft and height which further stresses infrastructure capacity. In actuality, due to US port constraints, the average size of all containerships in world service is even larger and pressures for even larger vessels will result from the expansion of the Panama Canal in 2015.

In 1990 it was estimated that the total number of containers in world-wide use exceeded 6.3 million TEUs. By 2002, that number had more than doubled to 15.5 million TEUs. Later 2008 figures placed total TEU counts approaching 25 million. (Containerization International Yearbook 2008)

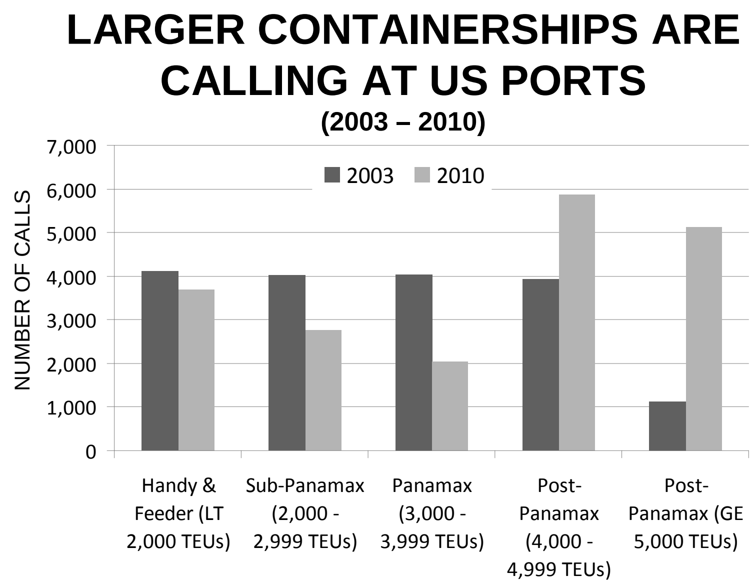
Table 6

CONTAINERSHIP CAPACITY TRENDS AT U.S. PORTS

YEAR	NUMBER OF NON-CONTAINER SHIP CALLS	NUMBER OF CONTAINER SHIP CALLS	ALL SHIP CALLS	AVERAGE DWT PER CONTAINER SHIP CALL	MAXIMUM TEUs PER CONTAINER SHIP CALL (Assumes 14 tons per Container)
2002	39,458	17,138	56,596	42,158	3,011
2003	39,472	17,287	56,759	43,168	3,083
2004	31,606	18,279	49,885	43,610	3,115
2005	42,505	18,542	61,047	44,593	3,185
2006	45,406	19,591	64,997	46,598	3,328
2007	44,041	19,863	63,904	47,720	3,409
2008	41,843	18,735	60,578	49,213	3,515
2009	37,354	18,206	55,560	50,202	3,586
2010	43,217	19,530	62,747	51,263	3,662

Source: U.S. Department of Transportation, Maritime Administration, “Vessel Calls Snapshot, 2007”, May 2008, “Vessel Calls Snapshot, 2008”, July 2009, and “Vessel Calls Snapshot, 2009”, August 2010, “Vessel Calls Snapshot, 2010, May 2011.

Figure 15



Source: U.S. Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2007", May, 2008, "Vessel Calls Snapshot, 2008, July, 2009, "Vessel Calls Snapshot, 2009", August, 2010, and "Vessel Calls Snapshot, 2010", May, 2011.

Based on interviews with more than 10,000 firms providing services to the cargo and vessels handled at the U.S. deepwater ports, Martin estimated that deep-draft seaports and seaport-related businesses in the United Stated generated approximately 13.3 million jobs and added nearly $3.15 trillion to the economy. (Martin, 2007)[31] This is nearly 425 percent higher than the dollar value of $742 billion estimated in 1999 during which time overall producer prices rose just 38 percent. (U.S. DOT, 1999)

[31] In updating an earlier study from 2000, Martin investigated addition from direct jobs (firms providing support services to the sea port), induced jobs (local and national jobs from the purchase of goods and services by those directly employed), indirect jobs (national jobs generated as a result of local purchases by firms dependent upon seaport activity) and related jobs (manufacturing and distribution benefiting from deepwater ports). Special care was exercised to avoid double counting.

B. Containerized Freight Productivity Issues

Herod (1998) determined that containerized cargo could be transported twenty times faster than pre-container break bulk. The economic superiority of container traffic was stated in a 1980 decision by the Supreme Court.

> "Because cargo does not have to be handled and repacked as it moved form warehouse by truck to the dock, into the vessel, then from the vessel to the dock and by truck or rail to its destination, the costs of handling are significantly reduced. Expenses of separate export packaging, storage, losses from pilferage ad breakage, and costs of insurance and processing cargo documents may also be decreased. Perhaps most significantly, a container ship can be loaded or unloaded in a fraction of the time required for a conventional ship. As a result, the unprofitable in-port time of each ship is reduced and a smaller number of ships are needed to carry a given volume of cargo." (U.S. Supreme Court 1980)

Various groups have estimated significant savings per TEU owing to economies of scale. Drewry Shipping Consultants in 2001 estimated cost differences between a Panamax unit of 4,000 TEUS and the mega port-Panamax unit of 10,000 as around 50 percent. (Notteboom, 2004) Samsung Heavy Industries estimated that a moving 500,000 boxes per year that a 12,000 to 14,000 TEU vessel could reduce costs by 17 percent on a 9,000 TEU vessel than and two 4,500 TEU vessels on the same route. The same 9,000 TEU vessel would have an 11 percent advantage over an 8,000 TEU vessel and 23 percent compared with a 4,000 unit vessel.[32] A 9,000 TEU vessel has 10 cargo holds and a total loaded weight of close to 150,000 dwt. It dimensions measure 1,082 feet (330 meters in) length, is 149.6 feet (45.6 meters beam) and draws 47.6 feet (14.5 meters). It also features a double-hull configuration for the bunker tanks to

[32] Source: www.motorship.com/news101/samsung-hi-on-song, November 1, 2001. Vessel speed is expected to be 26 knots.

lessen the risk of an oil spill in the event of damage to the hull.

Panamax is a popular term for the size limits for ships traveling through the Panama Canal. Formally, the limits and requirements are published by the Panama Canal Authority (ACP) titled "Vessel Requirements"[33] These requirements also describe topics like exceptional dry seasonal limits, propulsion, communications and detailed ships design.

The allowable size is limited by the width and length of the available lock chambers, by the depth of the water in the canal and by the height of the Bridge of the Americas. (Refer to Table 7) Consequently, ships that do not fall within the Panamax-sizes are called Post Panamax. Panamax has been in effect since the opening of the canal in 1914. In 2009 the Canal management published the "New Panamax", that will be in effect when the third lane of locks, larger than the current two, are operational in 2014.[34] The increasing prevalence of vessels of

Table 7

PANAMA CANAL SIZE CHANGES

	LOCKS	**PANAMAX**	**NEW LOCKS**	**NEW PANAMAX**
LENGTH	1,050 feet (320.04 meters)	965 feet (294.13 meters)	1,400 feet (427 meters)	1,200 feet (366 meters)
WIDTH	110 feet (33.53 meters)	106 feet (32.31 meters)	180.5 feet (55 meters)	160.7 feet (49 meters)
DEPTH / DRAFT	41.2 feet (12.56 meters)	39.5 feet (12.04 meters)	60 feet (18.3 meters)	49.9 feet (15.2 meters)
NUMBER OF TEUs		5,000		12,000

the maximum size is a problem for the canal as a Panamax ship is a tight fit that requires precise

[33] http://www.pancanal.com/eng/maritime/notices/n01-05.pdf by the Panama Canal Authority, "*Vessel Requirements*".

[34] Manuel E. Benítez, (ACP) (19-01-2009). *"Dimensions for Future Lock Chambers and "New Panamax" Vessels*"; http://www.pancanal.com/common/maritime/advisories/2009/a-02-2009.pdf. as of 02-05-2010.

control of the vessel in the locks, possibly resulting in longer lock time, and requiring that these ships transit in daylight. Because the largest ships traveling in opposite directions cannot pass safely within the Gaillard Cut, the canal effectively operates an alternating one-way system for these ships. Panamax is determined principally by the dimensions of the canal's lock chambers, each of which is 110 feet (33.5 meters) wide by 1,050 feet (320.0 meters) long, and 85 feet (25.9 meters) deep. The usable length of each lock chamber is 1,000 ft (304.8 meters). The available water depth in the lock chambers varies, but the shallowest depth is at the south sill of the Pedro Miguel Locks and is 41.2 feet (12.56 meters) at a Miraflores Lake level of 54 feet 6 inches (16.6 meters). The height of the Bridge of the Americas at Balboa is the limiting factor on a vessel's overall height. The maximum dimensions allowed for a ship transiting the canal are:

Length - Over all (including protrusions): 950 ft (289.56 m)

Exceptions:

Container ship and passenger ship: 965 ft (294.13 m)
Tug-barge combination, rigidly connected: 900 ft (274.32 m) over all
Other non-self-propelled vessels-tug combination: 850 ft (259.08 m) over all

Width (beam)

Width over outer surface of the shell plating: 106 ft (32.31 m) General exception: 107 ft (32.61 m), when draft is less than 37 ft (11.3 m) Tropical freshwater.

Depth (draft)

In tropical fresh water 39.5 ft (12.04 m). ACP uses the freshwater Gatun Lake as a reference. The salinity and temperature of water affect its density, and hence how deep a ship will float in the water. When the water level in Lake Gatún is low during an exceptionally dry season the maximum permitted draft may be reduced.

Air draft

190 ft (57.91 m) measured from the waterline to the vessel's highest point; limit also pertains to Balboa harbor. Exception: 205 ft (62.5 m) with passage at low water (MLWS) at Balboa is possible.

A Panamax cargo ship would typically have a dead weight tonnage of between 65,000 to 80,000 metric tons but its maximum cargo would be about 52,500 metric tons during a transit due to draft limitations in the canal.[35] The longest ship ever to transit was the *San Juan Prospector*, now *Marcona Prospector,* is an ore-bulk-oil carrier that is 973 feet (296.6 meters) long, with a beam of 106 feet (32.3 meters). The widest ships to transit the canal are two of the North Carolina class battleships, USS *North Carolina* (BB-55) and USS *Washington* (BB-56), which have beams of 108 feet (32.9 meters).

Post-Panamax or over-Panamax denotes ships larger than Panamax that do not fit in the canal, such as supertankers and the largest modern container ships. The 'largest oil tanker in the world' - whichever ship held the title at the time - has not been able to transit the Panama Canal at least since the 'Idemitsu Maru' was launched in the 1960s; she was about 150,000 deadweight tons. U.S. Navy supercarriers are also in the post-Panamax class; the *Nimitz* class aircraft carriers are 1,092 feet (332.8 meters) long overall with a beam of 134 feet (40.84 meters), while the flight deck is 252 feet (76.81 meters) wide.

The plans to build bigger locks led to the creation of "New Panamax", based on new lock dimensions of 1,400 feet (427 meters), beam 180 feet (55 meters) and depth 60 feet (18.3 meters). Naval architects and civil engineers are already taking into account these dimensions for container ships. The world's largest cruise ship *Oasis of the Seas* has almost New Panamax dimensions with height difficult to pass under the Bridge of the Americas even at low tide. After

[35] Dead Weight Tonnage (DWT) refers to the entire weight of the ship, its lading, fuel, ballast, etc. It is identical to tare plus lading weight in the railroad industry.

this expansion, the Panama Canal will be able to handle vessels of cargo capacity up to 13,000 Twenty-foot equivalent units (TEU); currently, it can only handle vessels up to about 5,000 TEU. A third set of locks – 1,400 feet (426.7 meters) long, 180 feet (54.9 meters) wide, with a draft of 60 feet (18.3 meters) – will supplement the two existing sets.[36]

By comparison, the *Emma Mærsk* is 1,302.5 feet (397 meters) in length, with a beam of 184 feet (56 meters) and draft of 51 feet (15.5 meters) with a DWT of 170,974 and is able to carry 11,000 TEUs. In actuality, her cargo capacity is much bigger - between 13,500 and 14,500 TEU.[37] The difference between the official and estimated number results from the fact that Maersk calculates the cargo capacity of a container ship by using the number of containers with a weight of 14 tons that can be carried on a vessel. For the *Emma Maersk*, this is 11,000 containers. Other companies calculate the cargo capacity of a ship according to the maximum number of containers that can be put on the ship, independent of the weight of the containers. These numbers are always greater than the number calculated by the Maersk company.

C. Container Ship Size Limits

Some say only limited in size by the Straits of Malacca linking the Pacific and Indian oceans (470 meters long by 60 meters wide), designs for ships up to 18,000 TEUs have been developed (United Nations 2007)[38] However, these ships may not be able to pass even the expanded Panama Canal when it opens in 2015. Currently, containerships as large as 14,300

[36] Another limit on ship size is the "Suezmax" standard, or the largest theoretical ship capable of passing through the Suez Canal. This measurement is used almost exclusively for tanker vessels. Such a vessel would displace 150,000 metric tons deadweight (DWT), with a beam of 150.9 feet (46 meters). In addition owing to the Suez Canal Bridge, clearances are limited to 223 feet (68 meters) above the water line

[37] In May, 2010 she set a record carrying a total of 15,011 TEUs.

[38] Malacca-max 18,154 TEUs, 1,312 foot length, 69 foot draft, 197 foot breath, 243,600 DWTs.

TEUs are in world-wide service.

However, there are no insurmountable technical barriers: concept designs already exist for ships over 18,000 TEUs . Certainly there does not appear to be any clear indication that the trend to even-larger container ships has as yet run its course. The limits to growth, if there are any, will be market-determined[39] It has been argued by some analysts that the search for economies of scale is inexorable, and will continue to drive vessel size increases. Larger ships typically have a lower cost per TEU than smaller units with the same load factor: Samsung demonstrated that a vessel of 12,000 TEU on the Europe-Far East route would generate an 11 per cent cost saving per container slot compared to an 8,000 TEU vessel, and 23 per cent when compared to a 4,000 TEU unit. Drewry Shipping Consultants (2001) also made similar calculations to point to potential cost differences of around 50 per cent between a Panamax unit of 4,000 TEU and a mega post-Panamax unit of 10,000 TEU (Notteboom, 2004). One source estimates that savings of up to 16 per cent could be made on the Asia to Europe route through the deployment of vessels of up to 18,000 TEU (the so-called Malacca-max vessels). (Containerisation International, 2002)

[39] Refer to: Chapter 2, Changes in International Container Shipping and Port Environment, 2.1 Changes in International Container Trade 2.1.1 Increasing role of international trade. www.unescap.org/ttdw/Publications/TIS.../pub_2484_CH2.pdf

D. Port Utilization, Capacity and Maintenance Issues

Prior to the recent recession, Drewry (2007a, 2007b) estimated that terminal capacity utilization rates of 72 percent in 2006 could rise to 97.5 percent in 2012. This was validated through recent measurements of North American railroad container traffic which was up 16.5 percent (2009 to 2010 levels) and an additional six percent (2010 to 2011) in 2011. This more than restores railroad container movements to 2008 levels which saw a 14 percent decline in 2009.[40]

Ocean transportation rates however will decline as increased capacity (8 percent) is added to the fleet. (Drewry, 2010) Orders for new capacity expected to be needed in 2012 was recently reported at 324 ships with an aggregate capacity of over 2.6 million TEU – some 8,100 per vessel among the top ten container lines. (Journal of Commerce, 2009d) Earlier it was also reported that the top 50 container lines, with over 600 new ships under contract, would increase their existing fleet by 35 percent. (Journal of Commerce, 2009b) Due to the recession, later reports show a 6.7 percent reduction of the 6.51 million TEUs previously ordered.[41] (Journal of Commerce, 2010) As long-term or "cold" layups can cost $50,000 per month in addition to a one-time cost of $50,000 plus dry dock and cost of capital costs, extreme due diligence is undertaken in the decision making process. While the recession has delayed critical port capacity issues for some time, the emergence of China and India as major trading entities will

[40] Source: Association of American Railroads, December 5, 2010.

[41] 140 containerships with a combined capacity of 436,000 TEUs were cancelled. Ships of 1,000 to 1,999 TEUs accounted for the largest share of cancellations. Overall, the cancelation rate for container vessels was less than the rate for bulk carriers and tankers.

undoubtedly fuel similar concerns in the near future. Commensurate with the economic recovery concerns in late 2010 began to focus on potential shortage of container ships by 2012.[42]

In order to handle 10,000 TEU or larger ships, ports will need water depths of up to 50 feet and cranes that can reach across 20 to 22 rows (compared with 13 for existing Panamax vessels). Drewry (2011) stated that the global fleet above 8,000 TEUs would grow by 25 percent alone in 2012.[43]

Post-Panamax ships make up 16 percent of the world's container fleet today but carry 45 percent of the cargo. By 2030, it has been estimated that these ships will carry 60 percent of the cargo "so having ports to handle them is essential".[44]

In many U.S. ports, main navigation channels are not deep enough to accommodate the latest generation of containerships, let alone ones that only in the design state of development. In addition, bad weather can adversely impact the ability of ships of any type to safely reach port as the Associated Press reported that high winds had delayed a cruise ship and five cargo ships from getting into Tampa Bay.[45]

Before dredging can begin, permits must be obtained from the USACE with concurrence from the Environmental Protection Agency (EPA). In many cases, local, regional and state water control agencies must also provide their approval. Moreover, disposal of the dredged materials is often the most difficult problem associated with channel improvements (Stromberg 1990).

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[42] Source: Transport News, October 2, 2010.

[43] Drewry Maritime Research, LPG Forecaster, downloaded March 7, 2012; Refer to: http://www.drewry.co.uk/news.php?id=108

[44] Washington Post, *"Expanded Panama Canal sparks race to be ready for bigger cargo ships"*, January 13, 2013

[45] AP, December 14, 2010.

In anticipation of the expansion of Panama Lock capacity in 2015 which will require a 50 foot channel depth as well as upwards of 150 feet of vertical clearance, many east coast ports are already planning or have undertaken expansion. By comparison, of the world's 419 major ports, only 62 had channel depths in excess of 50 feet in 2005. Today many world ports already enjoy channel depths in excess of 60 or more feet (e.g., Rotterdam). The ports of Virginia and Charleston already have 50 foot channels and Baltimore is deepening its channel. (Journal of Commerce, 2009e)

While the Port of New York and New Jersey is on schedule to also expand to 50 feet by 2013, potential height restrictions (151 foot clearance) under the Bayonne Bridge remain an issue. (Journal of Commerce, 2009c)[46] To remediate this problem, the port needs to spend up to $3.3 billion or risk losing billions more from lost big ship traffic. (Journal of Commerce, 2009c) Recently, the United States Army Corps of Engineers estimated that U.S. ports are now spending $6 to $8 billion annually in federal, local and private monies to modernize.[47]

Though increasing the depths of U.S. ports has the potential of enhancing international trade and the benefits of micro-bridge and mini-[48]bridge service, the mere existence of an improved Panama Canal has been forecast to result in losses between ten and 15 percent of the cargo currently handled by the ports of Los Angeles and Long Beach which currently handle

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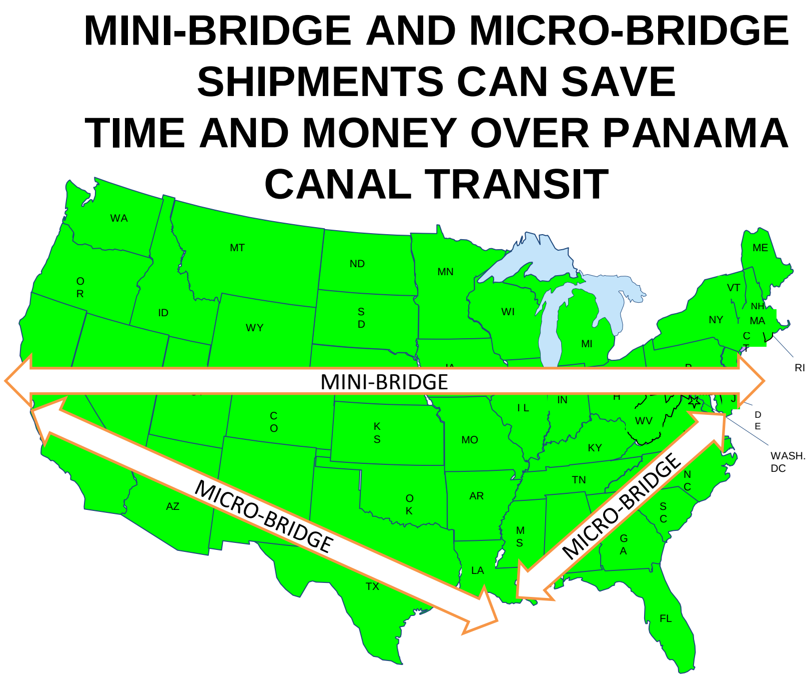
[46] At an estimated cost of $1 billion. Source: Washington Post, *"Expanded Panama Canal sparks race to be ready for bigger cargo ships"*, January 13, 2013

[47] Ibid.

[48] Mini and micro-bridge refer to the use of railroad and motor carrier transportation across the continental US to substitute for passage through the Panama Canal. (Refer to Figure 16)

about 40 percent of the nation's imported Asian goods.[49] Even when the newest locks in the enhanced Panama Canal open in mid-2015, experts believe the Canal is not through expanding. (Journal of Commerce, 2012). Former administrator of the Panama Canal Alberto Aleman Zubieta recently stated that the Canal will have to expand one more time after that to serve the more efficient 18,000 TEU containerships now under construction.[50] Such increases will only add increasing pressure on infrastructural constraints (DAVE PLEASE WORDSMITH)

Figure 16



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[49] Source: Jobs 1st Alliance (a coalition of business, government, and labor leaders pushing for port modernization)

[50] The current $5.25 billion upgrade to the Panama Canal will facilitate handling of container ships up to 13,000 TEUs – up from the current limit of about 5,000 TEUs. Source: Journal of Commerce, 2012. Page 6.

V. TOTAL LOGISTICS COST

Although navigational aids provided through PORTS® can result in a wide-array of benefits to transportation, secondary and tertiary benefits can also be enjoyed by other entities involved in total logistics.[51] In other words, enhancement of the transportation portion of total logistics can add value to the other portions of inventory and overall management processes.

Logistics costs include more than just the costs of transportation. Heskett (1962) originally put forward the concept of macroeconomic logistics cost and developed a methodology to measure them. Logistics was once simply defined as "getting the right product to the right place at the right time." Other dimensions of quantity and quality were added as the definition matured, including the "right" condition, "right" volume, and "right" price. Today, all definitions of logistics include reference to the need to meet consumer requirements. One recent example states:

> "Logistics Management is that part of Supply Chain Management that plans, implements and controls the efficient and effective flow forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements".[52]

The Council of Supply Chain Management Professionals' (CSCMP) definition of logistics cited in the introduction includes all activities concerning the movement and storage of goods between the point of origin and the point of consumption of the goods.[53] According to this definition, logistics includes freight movement and excludes people movement.

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[51] Recent studies show that about seven percent ($6 billion dollars per year in 2011) of all railroad container revenues result from imports or exports. Source: Surface Transportation Board, Carload Waybill Sample.

[52] Council for Supply Chain Management Professionals (CSCMP).

[53] Council of Supply Chain Management Professionals, *Supply Chain and Logistics - Terms and Glossary*, Updated February, 2005.

Using the United Nation's 2002 guide, logistics costs include three broad cost components comprising the business logistics system. They are: (1) inventory-carrying costs; (2) transportation costs; and, (3) and logistics administration costs. These valuation systems include the following:

- Inventory Carrying Cost
  - Capital cost for inventory investment
  - Inventory service costs
  - Storage space costs
  - Inventory risk costs

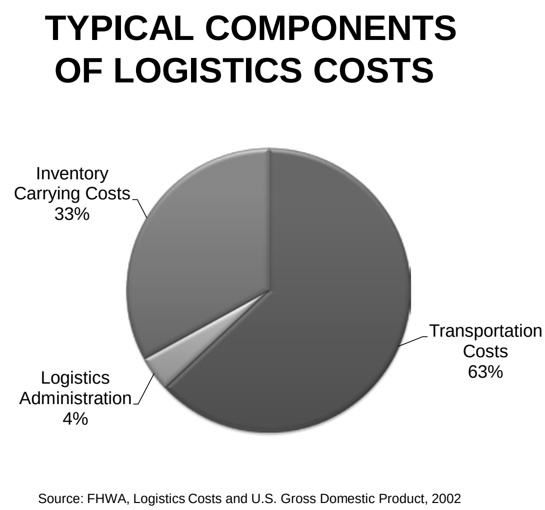
- Transportation Costs
  - Rail
  - Motor carrier
  - Deepwater water carrier
  - Pipeline
  - Inland water carrier
  - Mixed carriers

- Logistics Administration Costs
  - Administrative overhead

A. Logistics

Of the three components of logistics, the relative importance of each sector has been driven by different factors: (1) transportation costs (63 percent); (2) inventory carrying cost (33 percent); and, (3) logistics administration or overhead (four percent). (Refer to Figure 17)

Figure 17

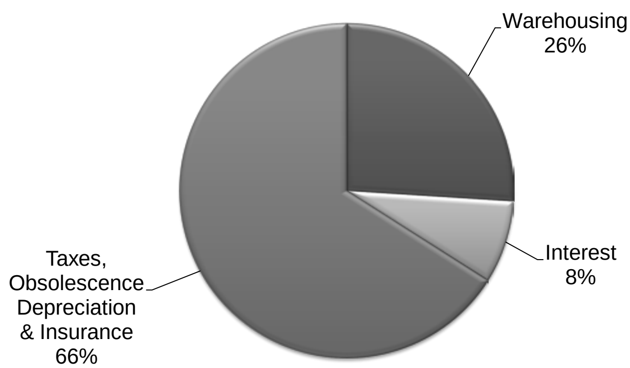


Inventory carrying costs, which account for about one-third of total logistics cost are driven by taxes, obsolescence, depreciation and insurance (66 percent), warehousing (26 percent) and interest charges (8 percent). (Refer to Figure 18).

Total transportation cost itself is generally a function of modal share, value of the commodity carried and length of haul. Once the goods are here (regardless of domestic or international source), motor carriers represent over 77 percent of all costs (50 percent intercity and 27 percent local or drayage) while railroads and logistics administrative overhead account for six percent each, inland waterways and air with four percent each. The remaining seven percent is shared between forwarders and administrative costs. Pipelines which carry primarily crude oil, refined petroleum products and natural gas account for one percent of costs. (Refer to Figure 19)

Figure 18

TYPICAL COMPONENTS OF INVENTORY CARRYING COST



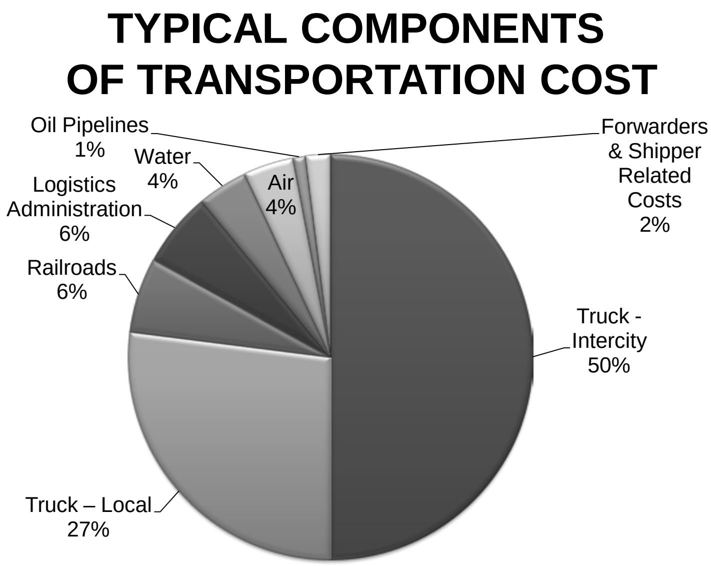
Source: FHWA, Logistics Costs and U.S. Gross Domestic Product, 2002

The Federal Highway Administration (FHWA) states that all purchases for transportation purposes by consumers, governments, and businesses (investment), and foreign users (export) can be put together and be called total transportation final demand.[54] When literature states that transportation accounts for 11 percent of the US Gross Domestic Product (GDP), it means that all the final users purchase or consume X percent of the goods and services in the GDP basket to serve their transportation needs.[55] It is not correct to say that logistics costs account for X percent of GDP.

[54] Refer to: http://www.ops.fhwa.dot.gov/freight/freight_analysis/

[55] To be precise, the import of goods and services for domestic transportation needs has to be deducted from exports to get the net export so that the total is comparable to GDP.

Figure 19



Source: FHWA, Logistics Costs and U.S. Gross Domestic Product, 2002

Transportation's vital importance to the U.S. economy is underscored by the fact that about one out of every ten dollars produced in U.S. GDP is related to transportation and related logistical activity.[56] In another recent study, logistics cost savings has been recently estimated to exceed $7.5 billion for every one percent reduction in cost. (KPMG 2009) This number, reported by the Department of Commerce has remained fairly constant, if not in a little decline over the last 20 years at about 10 percent.[57] (Refer to Figure 20)

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[56] This includes all aspects of transportation, including the movement of goods and the purchase of all transportation-related products and services as well as the movement of people. Source: U.S. Department of Transportation, Research and Innovative technology Administration, Bureau of Transportation Statistics, *"The Nation's Freight"*. See: http://www.bts.gov/publications/freight_in_america/html/nations_freight.html

[57] Trends suggest a polynomial function with an R^2 of 0.72. Some of this decline could be due to the continuing impact of railroad and motor carrier deregulation which began in the early 1980's. Modal mergers which could also reduce costs through elimination of overhead duplication could also be responsible.

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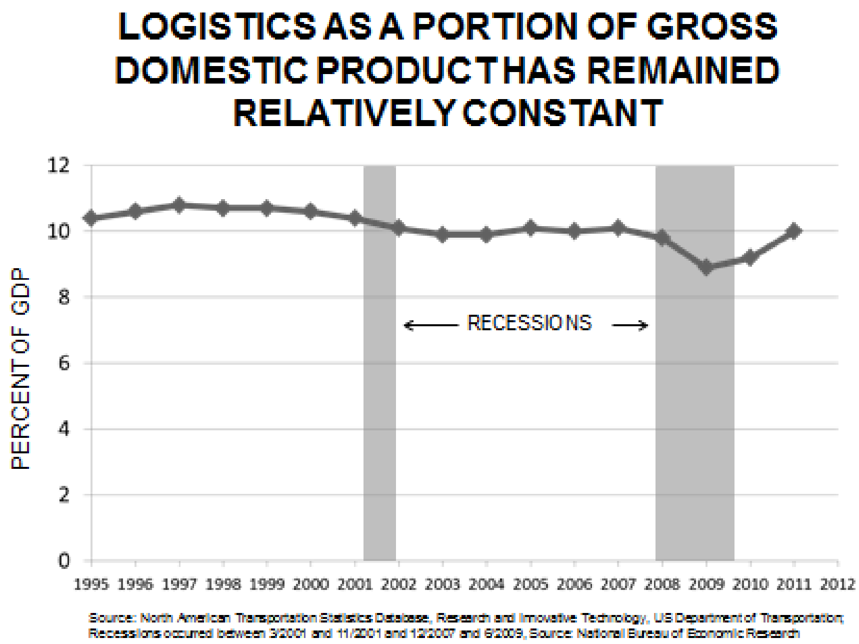
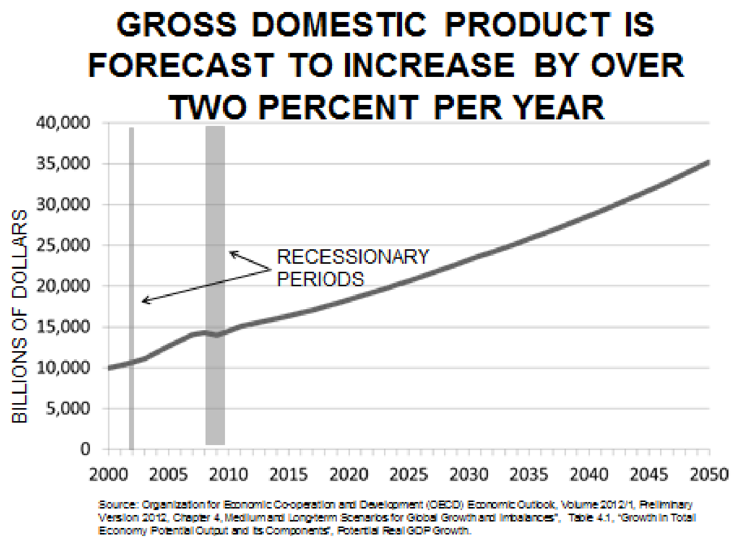
Figure 20



In turn, as forecasters have called for increases in the GDP over the next 30 years of between 2.1 and 2.4 percent annually, the nation's total international transportation bill and associated logistics costs will certainly increase. As a result, the benefits of PORTS® and related systems to improve port productivity and safety will also increase over time. (Refer to Figure 21)

Figure 21



Normally, historical declines in the total percentage represent improvement in productivity, which was often passed onto purchasers of logistics services. (Wilson 2011) However, declines during the last three years from historically higher levels reflect the basic state of the U.S. economy where logistic services are not in demand due to a lack of demand for the physical goods which ordinarily would be transported. Only in 2010 has the total cost of logistics begun to return to historical levels.

Another historical "swing" factor has been interest rates. Although obsolescence is often the largest portion of inventory carrying cost, the cost of capital which impacts inventory carrying costs can also have a large impact. (Refer to Table 8) Witness the ascent of inventory carrying costs from 1960 to 1980, where interest rates ranged from 4.5 to 5.0 percent and 11.5 to 21.5 percent, respectively.[58] At that time, inventory carrying costs exceeded transportation costs.

While not delineated in this report, as information, beginning with a series of

[58] Monthly prime rate figures. Source: Federal Reserve Board

deregulatory acts involving the motor, rail and inland waterway industries, real transportation costs were muted and sometimes declined owing to enhanced productivity gained through increased abilities to respond to market needs. Upward price pressures caused by increased energy costs would have been even larger if modal deregulation, in several steps, had not occurred.[59]

Table 8

LOGISTICS COST PROPORTIONALITY OVER TIME
(Bold indicated highest proportion of each category across decades)

YEAR	INVENTORY CARRYING COST	TRANSPORTATION COST	ADMINISTRATIVE COSTS
1960	40 %	56 %	**4 %**
1970	37 %	60 %	3 %
1980	**49 %**	48 %	3 %
1990	43 %	53 %	4 %
2000	37 %	59 %	4 %
2010	33 %	**64%**	3 %

Source: Rosalyn Wilson and Robert Delaney, *"Twelfth Annual State of Logistics Report, 2001";* James A. Cooke in DC Velocity online story "State of Logistics Report: U.S. Logistics Costs Hit $1.2 Trillion in 2010", reported June 15, 2011. See: http://www.dcvelocity.com/articles/20110615_sol_us_logistics_costs/.

VI. CONCLUSIONS

Reflecting the nature of global economies, international trade among the United States and the rest of the world will continue to increase. While the number of ship calls at US ports have and will continue to increase, the rate at which the size of these ships increase will be even larger reflecting the inherent economics of scale present in the waterborne industry. Of all traffic, containerized transportation is forecast to continue to surpass growth among all other types of ocean transport. Owing to the higher value cargos traditionally carried by containerized

[59] The 3-R (1973) and 4-R (1976) Acts and Stagger's Acts (1980) deregulated the railroad industry while a series of Motor carrier acts beginning in 1980 and Intermodal Surface Transportation Act of 1991 did the same for the trucking industry.

vessels, the relative value of container traffic as a portion of all waterborne traffic is also expected to rise over time.

Unified instrumentalities as represented by PORTS® can provide benefits arising from improved safe and efficient passage of waterborne freight. In addition, enhanced secondary and tertiary benefits are also thought to be enjoyed as a result of lower-cost, safer waterborne commerce. Among these beneficiaries are the domestic surface transportation industries of rail and motor carrier as well as the myriad of firms supporting jobs to produce goods for export or processing imported goods.

REFERENCES

American Association of Port Authorities (2009), *"U.S. Public Port Facts"*, website, August 10

American Association of State Highway and Transportation Officials (2008), *"Executive Summary: Transportation Invest in America, Freight-Rail Bottom Line Report"*, Washington, DC, p. 8.

Central Intelligence Agency (2010), "The World Fact Book", www.cia.gov/library/publications/the-world-factbook.

Coastal States Organization, (2003) "*Travel Industry of America Domestic Travel Market Report"*.

Congressional Budget Office, (2010), *"The Budget and Economic Outlook; Fiscal Years, 2010 to 2020"*, Summary Table 1.

Containerisation International Yearbooks, 1972-2008, National Magazine Company, Ltd, Unwin Brothers Ltd., Old Woking, UK .

Containerisation International, 2008, *Market Analysis World Container Census 2008*, Unwin Brothers Ltd., Old Woking, UK

Coyle, J., Bardi, E., & Novack, R.(1994), *Transportation*. West Publishing Company, St. Paul, Minnesota.

Drewry Shipping Consultants Limited (2007a) "*Annual Container Market review and Forecast 2007/2008" ,* London UK

Drewry Shipping Consultants Limited (2007b) "*Annual Review of Global Container Terminal Operators 2007",* London UK

Drewry Shipping Consultants Limited (2010) "*Container Market Annual Review and Forecast*", London UK

Henry, Vincent, (2007) Web Page Director, Long Island University Homeland Security Management Institute, July 31. See: http://www.southampton.liu.edu/homeland/index.html.

Herod, Andrew, (1998), *Discourse on the Docks: Containerization and Inter-Union Work Disputes in US Ports 1955-1985*", Transactions of the Institute of British Geographers (United Kingdom: the Royal Geographical Society, Volume 23, and Number 2, pp. 177-191.

Heskett, James L., "*Macroeconomic Cost of Physical Distribution,*" Australasian Transport Research Forum (ATRF), 1962.

Journal of Commerce, Inc (2009), "Redrawing Trade Winds", March 23 p 11.

Journal of Commerce, Inc. (2009a), "*Terminal Waiting Game"*, August 3, p 21.

Journal of Commerce, Inc. (2009b), "*Here they Come*", September 21, p 23.

Journal of Commerce, Inc. (2009c), "*Fixing the Bayonne Bleeder"*, September 28, p 42.

Journal of Commerce, Inc. (2009d), "*After Two-Year Hiatus, Evergreen is Ready to Order Ships"*, October 26, p 6.

Journal of Commerce, Inc. (2009e), "*50 Years, 50 Feet at Baltimore*, November 30, p 34.

Journal of Commerce, Inc. (2010). *"Owners Canceled 140 Container Ship Orders*", February 23.

Journal of Commerce, Inc. (2012), *"Another Expansion for Panama Canal?*", December 17, page 6.

KPMG in association with CII Institute of Logistics, *"Competitiveness Through Efficient Logistics", 2009*

Larkin, Fran and K. Eric Wolfe, (1983) "*Rail Competitive Truck Characteristics (1977-1982)",* paper presented at the TRF, Crystal City, VA, November, published in the 24th annual journal.

Levinson, Mark, (2006), "*The Box: How the Shipping Container made the World Smaller and the World Economy Bigger"*, Princeton University Press, p. 1.

McCrimmon, Warren D., (2007), (American Association of Port Authorities) "*Testimony Before of House Appropriations Committee, Subcommittee on Energy and Water Development"*, February 16. P. 1

Martin Associates, (2007) "*The Local and Regional Impacts of the U.S. Deepwater Port System, A report to the American Association of Port Authorities"*, Lancaster, PA.
Muller, G., (1989) "*Intermodal Freight Transportation"*, 2nd Edition, Eno Foundation, Westport Conn.

Muller, G., (1989) "*Intermodal Freight Transportation"*, 2nd Edition, Eno Foundation, Westport Conn.

National Oceanic and Atmospheric Administration, (2002), "*Office of Response and Restoration Policy Working Paper 02-1"*, Silver Spring, MD.

National Oceanic and Atmospheric Administration, (2008), *"Transition Package: NEP Content Review",* Silver Spring, MD, October 14, p. 14.

National Oceanic and Atmospheric Administration, National Marine Fisheries Service, (2005), "*Fisheries Economics of the United States, Economics and Sociocultural Status and Trends Series"*.

Notteboom, Theo. (2004) "Container Shipping and Ports: An Overview", *Review of Network Economics*, June, Vole 3, Number 2.

Rushton, A., Oxley, J. and Croucher, P., (2004) "*The Handbook of Logistics and Distribution Management"* Kogan Page, London

Schieterman, Joseph, P. (2003) "State Railroad Branchline Investments and Community Employment Problems in Benefit Cost Analysis", *Journal of The Transportation Research Forum*, Volume 33, Number 1, pp. 14 -23.

Strategic Petroleum Reserve (2008), Analysis Division of Management Operations, *"Crude Oil Prices"*.

Stromberg, R.E., (American Association of Port Authorities) 1990, "*Statement before the Subcommittee on Water Resources"*, Committee on Public Works and Transportation, U.S. House of Representatives, March 7.

Transportation Research Board of the National Academies, Commodity Flow Survey Conference (2006), Transportation Research Circular Number E-C-088, January, held July 8-9, Boston, Massachusetts.

U.S. Army Corps of Engineers, Institute for Water Resources, Navigation Data Center, Alexandria 22315 (Discussions with staffers)

United States Army Transportation School (2007), *"History & Development of the Container"*, U.S. Army Transportation Museum", Fort Eustis, Virginia.

U.S. Department of Commerce, Bureau of Economic Analysis (2009), U.S. International Transactions Accounts, September 10.

Department of Commerce, Bureau of Labor Statistics, Producer Price Index for various cost series.

U.S. Department of Commerce (2009), U.S. Census Bureau, Foreign Trade Division *"Foreign Trade Statistics"*, May 12.

U.S. Department of Commerce (2010), U.S. Census Bureau, Foreign Trade Division, Foreign Trade Statistics, "*U.S Trade in Goods and Services – Balance of Payments (BOP) Basis*", June 10, 2010.

U.S. Department of Energy (2010), U.S. Energy Information Administration, www.tonto.eia.doe.gov/pet/history

U.S. Department of Labor (2009), *"Employment Outlook: 2008-2018"*, Monthly Labor Review, November, pp 11-29.

U.S. Department of Homeland Security, (2010) *"Import Trade Trends", Fiscal Year 2009 Year End Report"*, March.

U.S. Department of Homeland Security, (2010) *"Import Trade Trends", Fiscal Year 2010 Mid-Year Report"*, June.

U.S. Department of Transportation, (1999) "*An Assessment of the U.S. Marine Transportation System, A Report to Congress"*, September.

Department of Transportation, Federal Highway Administration, Freight Facts and Figures, Table 2-8.

U.S. Department of Transportation, Bureau of Transportation Statistics (2003), Felix Ammah-Tagoe PhD, Senior Research Consultant. *"Freight Data Decision-Making Tools"*, Talking Freight Seminar Series, September 17.

U.S. Department of Transportation (2009), Bureau of Transportation Statistics, *"America's Container Ports: Freight Hubs That Connect Our National to Global Markets"*, June.

U.S. Department of Transportation (2003), Maritime Administration, *"Industry Survey Series: Mainstream Container Services"*.

U.S. Department of Transportation (2007), Maritime Administration, Office of Policy and Plans, *"U.S. Water Transportation Statistical Snapshot"*, May.

U.S. Department of Transportation (2008), Maritime Administration, Office of Policy and Plans, *"U.S. Water Transportation Statistical Snapshot"*, July.

U.S. Department of Transportation, (2008), Maritime Administration, Office of Policy and Plans, "*Vessel Calls at U.S. Ports Snapshot 2007"*, August.

U.S. Department of Transportation (2009), Maritime Administration, Office of Policy and Plans, *"U.S. Water Transportation Statistical Snapshot"*, July.

U.S. Department of Transportation, (2009), Maritime Administration, Office of Policy and Plans, *"Vessel Calls at U.S. Ports Snapshot 2008"*, August.

U.S. Department of Transportation (2010), Maritime Administration, "*U.S. Waterborne Trade by U.S. Custom District*", (2010), August, 20, Washington, D.C.

U.S. Department of Transportation, (2010), Maritime Administration, Office of Policy and Plans, *"Vessel Calls by Vessel Type"*, April 14, 2010.

U.S. Department of Transportation (2010), Maritime Administration, Office of Policy and Plans, *“U.S. Water Transportation Statistical Snapshot”*, August.

U.S. Department of Transportation (2010), Research and Innovative Technology Administration (2010), “*Freight Transportation: Global Highlights, 2010*, Washington D.C.

U.S. Department of Transportation, Maritime Administration, Office of Policy and Plans, *“U.S. Water Transportation Statistical Snapshot”*, February, 2011.

U.S. Department of Transportation, United States Coast Guard, (2000), “Guidance for determination and documentation of the Oil Pollution Act of 1990 (OPA 90) phase out schedule for existing single hull vessels carrying oil”, Navigation and Vessel Inspection Circular No. 10-94, CH-2. August 11.

U.S. Supreme Court (1980) “*National Labor Relations Board v. International Longshoremen’s Association*”, 447, June 20.

Van Den Berg, G. (1969), “*Containerisation: A Modern Transport System”*, Hutchinson and Company, London.

Wilson, Rosalyn A.*,” Transportation in America”*, (2001) Eighteenth Edition, ENO Transportation Foundation, Washington, D.C.

Wilson, Rosalyn, CSCMP *“2010 State of Logistics Report”*, interview, Delcan Corporation, June 9, 2010; See: http://www.dcvelocity.com/dcvtv/viewercontributed/115556503001/

CHAPTER 5 – MARINE TRANSPORTATION - UNDERKEEL CLEARANCE

I. INTRODUCTION

The benefit of PORTS® to marine transportation occurs from both a safety and effiency of operation aspect. The safety benefits are addressed in Chapter 6 Commercial Marine Accidents. This chapter will deal with the benefits derived from improvements to the efficiency of the marine transportation.

Effiency benefits come principally from the ability of a cargo vessel utilizing the available water depth to carry the maximum amount of cargo without running aground. The more cargo carried per trip the less the transportation costs per ton.

The anecdotal evidence cited in Chapter 1 indicates that pilots and shipping companies are utilizing PORTS® real-time water level information to move additional cargo.

- "Delaware River and Bay ports are "tide bound" meaning that their vessel operations are often at the maximum operational limits of the channel depth. Pilots are frequently asked to bring in vessels more deeply laden than the channel should be able to support. They do this by scheduling the passage to take advantage of the extra water from a high tide." Chapter 1 PORTS® History

- "Captain James Lyon, Director and Chief Executive Officer at the Port of Mobile (Alabama) said "It's (PORTS®) very, very valuable information. We run a lot of deep-draft vessels in and out of here. It has been giving us invaluable information on the timing of arriving and sailing vessels from a safety standpoint. Having that accurate information also enables ships to put on just a little bit more cargo if we do have a good positive tide." Chapter 1 PORTS® History

Beyond anecdotal testimonials the issue becomes how to assign a value to this benefit that is being experienced. In determining the benefit of PORTS® it is necessary to look at that portion of vessel cargo that is being carried most closely to the bottom of the channel that most benefits from the real-time information on the height of tide. Three methods are developed in this chapter:

- Assignment of a de minimis percentage of the value of cargo carried close to the bottom;
- Development of a more accurate percentage of cargo carried close to the bottom based on the expert opinion of marine pilots; and,
- Determination of the difference between transportation costs if PORTS® is available in the 175 major ports and if PORTS® is not available in these ports.

II. UNDER KEEL CLEARANCE

Understanding the exact depth of water under the deepest part of the vessel is essential to planning cargo loading and executing a safe passage.

New vessel design and construction has followed a trend for years of increasing length, width, depth and height. Larger vessels can generally be made and operated more efficiently with lower transportation costs. This is illustrated in the overall increase in average vessel size which rose from 47,625 Dead Weight Tons (DWT) in 2002 to 53,593 DWT in 2010 – a 12.5 percent increase.[1]

While some bulk carriers have slightly declined in size, hazardous materials such as Liquefied Natural Gas (LNG) and the more highly valued containerized cargos have exceeded industry averages. (Refer to Table 1) With the opening of the expanded Panama Canal in 2014 container ships are forecast to get even larger.[2] Today post-Panamax ships alone make up only

[1] DWT is a measure of how much weight a ship is carrying or can safely carry. It is the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew. Refer to Turpin and McEwen, pages 14-21, 1980.

[2] At the current time the maximum size ship that can transverse the Canal range between 3,400 and 4,500 TEUs. The new Panamax ships which will be accommodated by the expanded Canal will handle between 12,000 and 14,000 TEUs in 2015.

16 percent of the world's container fleet but carry 45 percent of the cargo.[3]

Table 1

ABOVE AVERAGE CHANGES IN AVERAGE VESSEL SIZE PER CALL
(Dead Weight Tons unless otherwise specified)

SHIP TYPE	2002	2010	PERCENT CHANGE
ALL SHIP TYPES	47,625	53,592	12.5%
CONTAINER	42,158	51,263	21.6%
CONTAINER TEUs[4]	3,020	3,932	30.2%
LNG	56,290	74,445	32.3%
LNG (Cubic Meters)	104,879	137,028	30.6%
DRY BULK	42,876	50,298	17.3%
GAS	32,009	43,092	34.6%
GAS (Cubic Meters)	43,774	64,433	47.2%

Source: Department of Transportation, Maritime Administration, 2007 & 2011.

The Hydrographic Dictionary (S-32) provides a number of definitions for underkeel clearance and underkeel allowance. For example, S-32 contains the following definitions:

a) 5731 underkeel clearance - The distance between the lowest point of the ship's hull, normally some point on the keel, and the sea bottom. Figure 1.

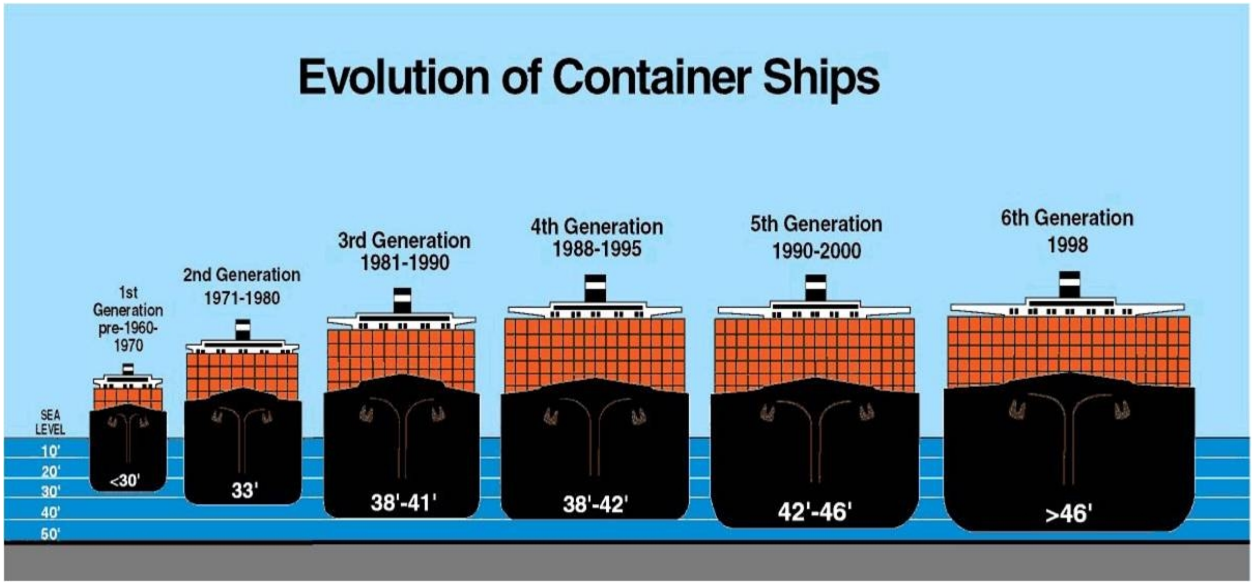
b) 5732 underkeel allowance - The estimated minimum underkeel clearance in a given channel accounting for the ship's squat, movement due to swell, tide height etc.[5]

[3] Source: The Washington Post, "As Panama Canal grows, so do cargo-hungry ports", January 13, 2013. Page 1.

[4] The number of Twenty-Foot Equivalent (TEU) Containers. One twenty foot container equals one TEU. One 40 foot container equals 2 TEUs.

[5] Squat is defined for a ship underway, the change of level of the bow and stern from the still water condition in response to the elevation and depression of the water level about the hull resulting from the bow and stern wave systems.

Figure 1[6]



The next generation of ships will require deeper drafts and more costly dredging to maintain coastal entrance channels to insure safe navigation. Under keel clearance (UKC) is the required minimum distance between the ship's keel and the bottom of the channel (Figure 2). The UKC is a function of the ship size and hydrodynamic characteristics, the channel cross-section and shape, and the ship speed. Since every foot of dredging costs millions of dollars, considerable savings can be realized if a minimum safe UKC can be reliably determined.[7]

In this analysis, two UKCs were selected to estimate the value added by the PORTS® system. The first UKC of two feet was selected based on a combination of written guidelines by several port authorities as well as the consensus of industry experts developed through a Delphi

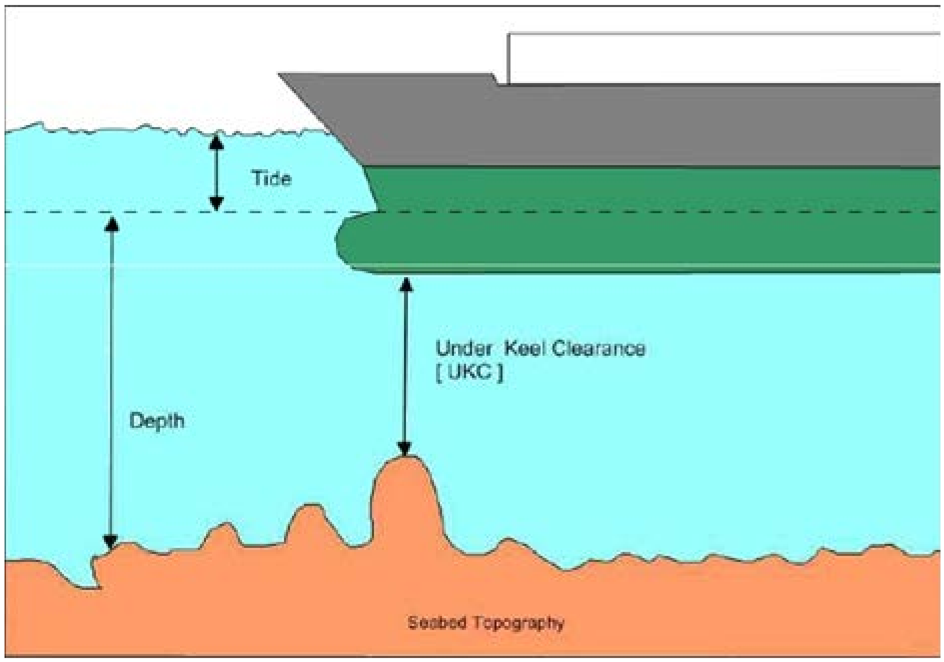
[6] Source: Free Association Design http://freeassociationdesign.wordpress.com/2010/05/26/fluid-topographies/

[7] Refer to United States Army Corps of Engineers at http://chl.erdc.usace.army.mil/chl.aspx?p=s&a=Projects;87

survey of marine pilots. While the United States Coast Guard does not regulate UKC because it is such a political issue in ports, some of ports define a recommended minimum UKC and state

Figure 2[8]

UNDER KEEL CLEARANCE



it in their Harbor Safety Plans.[9] West coast and Hawaiian ports have developed recommended UKCs for their plans. (Refer to Appendix A) For example, as early as 1997 the Hawaii Ocean Safety Team suggested establishment of a 2-foot UKC.[10] More recently, San Francisco, San Pablo and Suisan Bays Harbor Safety Committee voted on June 14, 2012 to establish a two foot

[8] Source: KeelClear http://keelclear.com/about-keelclear.html

[9] From conversations between Mike Sollosi, Chief, Office of Navigation Systems (USCG) and David MacFarland (NOAA) on January 15, 2013.

[10] Hawaii Ocean Safety Team (HOST), Safe Operating Practice 4-97, Minimum Under-Keel Clearance in Commercial Ports, Approved October 30, 1997

depth for tank vessels which has been interpreted to be in effect for all commercial vessels.[11] (Refer to Appendix B)

As a result of budget constraints the Port of New York and New Jersey had considered cessation of their funding of the PORTS® system effective March 31, 2013. Before this occurred, a meeting took place between NOAA representatives and the NYNJ Harbor Safety Steering Committee and Economic Development Corporation on February 6, 2013. In the summary note from that meeting it was stated:

> "There was great concern over (the) system shutting down. If Bayonne air gap (was) shutdown certain ship traffic would have to stop. Vessels are brought in with 2 foot air gap and 2 foot under keel clearance".

The commercial implications of that decision are far reaching as it would result in a change to the recommended DUK from 2 feet to 4 feet. The new regulation would require vessels to reduce their draft 2 feet by carrying less cargo. In addition, the draft regulation added additional clearances (air gaps) that would also be imposed. In that draft, the United States Coast Guard (2013) stated:[12]

> "The Harbor Safety, Navigation and Operations Committee currently recommends that mariners maintain at least two feet under keel at all times, except for transits within Ambrose Channel where three feet under keel clearance is recommended due to wave and sea action. In addition, mariners are advised to maintain an air gap clearance of two feet while traveling under the bridges within the port. When a PORTS water level or air gap sensor becomes unavailable,

[11] Pursuant to the California Oil Spill and Prevention Act of 1990, Submitted by the Harbor Safety Committee of the San Francisco Bay Region, c/o Marine Exchange of the San Francisco Bay Region, 505 Beach Street, Suite 300, San Francisco, California, 94133-1131.

[12] U.S. Department of Homeland Security, United States Coast Guard, "Coast Guard Advisory Notice CGAN 2013-008) – DRAFT", February 22, 2013.

> the existing guidance will immediately increase to four feet under keel clearance, with five feet under keel in the Ambrose Channel, and four feet air draft clearance in the vicinity of that sensor."

The second UKC of four feet was also selected based on the upper bound of some port authority recommendations and the previously mentioned draft USCG regulation. While the contribution of PORTS® will be different in its role of confirming a two foot versus four foot UKC, the use of these two values reflects current operational port practices.[13] In addition, calculation of traffic levels impacted by two and four foot UKC can provide an illustration of a potential range of benefits provided by PORTS® instrumentalities.

Using the USACE Channel Portfolio Tool (CPT) it was determined that in 2010, a total of 11.4 percent of all tons and 8.6 percent of all cargo value were moved in circumstances where two or fewer feet of water existed between the ship's keel and channel bottom.[14] (Refer to Figure 3). This is the area where a ship is most vulnerable to grounding and where the value of real-time water level information from PORTS is most valuable to a mariner.

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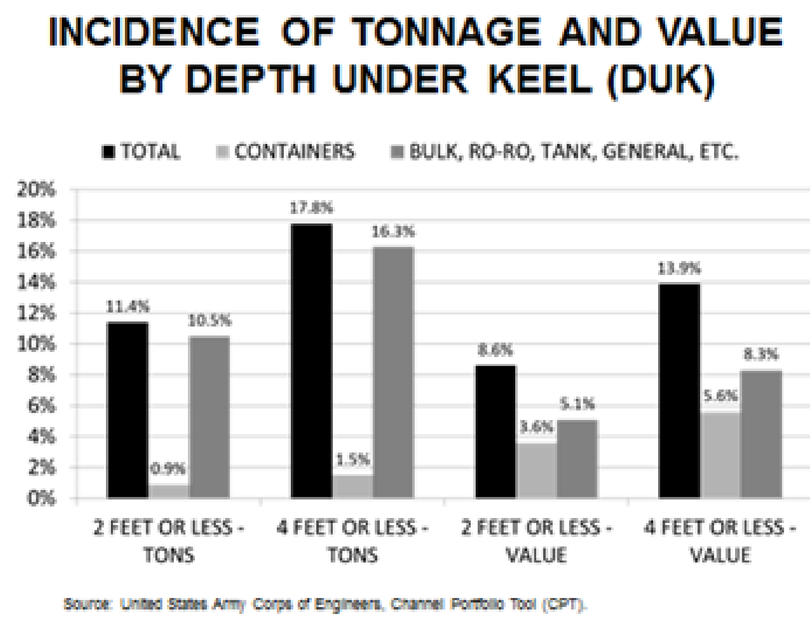
[13] For example, at two feet, PORTS® may be responsible for ten percent of the certainty associated with that UKC while it might be understandably responsible for a lower percentage of accuracy given a larger UKC (e.g., three percent).

[14] 17.8 percent of tonnage and 13.9 percent of the value of all cargo was transported at depths-below-keel of between zero and four feet. Source: USACE, CPT, 2010 data.

Figure 3



III. VALUE OF PORTS®

In this analysis, the potential benefit from PORTS® installations was assessed employing three methods all of which were based on those traffic segments (i.e., zero to two and zero to four feet DUK) which could be most significantly impacted by the loss of PORTS® real-time water level information.

The first assessment method employed the de minimis support approach (Refer to Chapter 2, Section II) where a mere 0.1 percent of all activity was attributable to PORTS® activities. The second assessment method which based its findings on a survey of port pilots employed the Nordhaus de minimis contribution figure of 1.0 percent of total benefit.[15] While

[15] Employed the rule of thumb developed by Nordhaus (1996) and others: the value of weather and climate

both of these methods provided reasonable estimates of what the potential impact could be if PORTS® data were not available, a third method was developed which is based upon an approach that calculates the added marginal cost which could result from the requirement of using ships with either lesser capacities (less deadweight tonnage and commensurate depths under keel) or restrictions on loading large ships as to reduce their depth under keel. In either event, the cost to transport the same volume of cargo using a larger number of smaller vessels was calculated using transportation cost data from the USACE's National Navigation Operation and Maintenance performance Evaluation and Assessment System (NNOMPEAS).[16]

A. De Minimis PORTS(s) Valuation

In some situations, data are lacking to support an explicit benefit model of how PORTS® information is used in economic decisions. In such cases, an "order-of-magnitude" estimate of potential value of PORTS® data may be obtained by applying a rule of thumb developed by Nordhaus (1996) and others. Refer to Chapter 2 Section II. Concept Of De Minimis Value Substitution.

Kite-Powell states in his paper "Estimating Economic Benefits from NOAA PORTS® Installations: A Value of Information Approach".[17]

> "In situations where data does not exist to enable one to calculate the benefit it may be possible to estimate at least the general scale of potential benefit by applying a "one percent proxy rule." Formulated by Nordhaus (1986) and other economists on the

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forecasts to economic activities that are sensitive to weather/climate tends to be on the order of one percent of the economic activity in question. (Refer to Chapter 2, page 2).

[16] Refer to Chapter 3, Section IX.

[17] Kite-Powell, Hauke, *Estimating Economic Benefits from NOAA PORTS® Installations: A Value of Information Approach"*, NOAA Technical Report NOS CO-OPS 044, 2005, p. 5.

> basis of experience with a number of forecast/nowcast value of information studies of industries and activities sensitive to weather, this rule suggest that the value of weather nowcast/forecast information to economic activity sensitive to weather conditions is generally on the order of one percent of the economic value generated by the economic activity. There is, of course, no guarantee that this rule will hold in all cases; but where no better estimate can be constructed, it provides an order of magnitude estimate of value that is likely to be reasonable. (Kite-Powel, 2005)"

The "one percent proxy rule" states that on the order of one percent of the economic value generated by the economic activity can be attributed to the information being studied, in this case PORTS®.[18] Kite-Powell states that "There is no guarantee that this rule will hold in all cases; but where no better estimate can be constructed, it provides an order of magnitude estimate of value that is likely to be reasonable."[19]

This report makes use of this economics tool making sure that there is at least anecdotal evidence that the subject user group in fact uses the data and achieves some benefit. A de minimis value of 1.0% is used when there is an indication that the user achieves a significant benefit from the use of PORTS®. A smaller value of 0.1% is used when the benefit to the user is not considered as great but yet is still of some importance. In all cases it is believed that the de minimis value used represents a significantly lower value than what would be calculated if the supporting data were available. In the absence of supporting economic data it is preferable that some attempt, even if imperfect, be used to estimate the benefit to a user group rather than just ignoring the benefit for lack of conclusive data.

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[18] Ibid., p 6.

[19] Ibid, p.16.

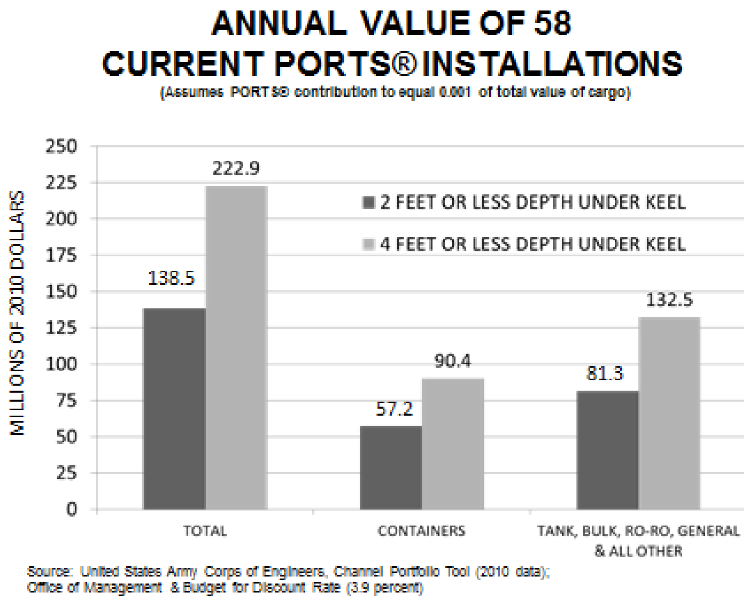
In brief, the data provided by PORTS® systems are responsible for facilitating the safe and efficient transportation of marine traffic. The central question is what is the amount of that benefit? In this investigation, the value of cargo transported was employed as the basis for valuing PORTS®. Also, in keeping with the highly conservative nature of this investigation, several benefits, while identified, were not quantified owing to lack of direct empirical evidence. Such benefits included reduced operating costs owing to reductions in transit times, overhead and insurance rates as well as instances of "riding the high water" where ships wait until high tide to access ports with drafts nominally "too deep" to transit the channel.

It is also well understood that secondary suppliers also represent a small market which provides the most up to date information about the marine industry. For example, PortVision® provides data on weather and marina data and obtains some of the information to which it adds value from PORTS®.[20]

Using the CPT (described in Chapter 3 – Data and Information Employed), traffic which reported movements within two feet and four feet of the bottom were identified for total traffic, container traffic and all other traffic. (Refer to Appendix C). The overall results are summarized in Figure 4.

[20] Refer to: http://www.portvision.com/. The deliverables Port Vision Plus® and PortVision Advantage® and PortVision® include some data similar to PORTS®.

Figure 4



B. Method 1 – Estimating Value of PORTS® to Marine Transportation Efficiency (58 Ports with PORTS®)

The first attempt at developing a value for the benefit of PORTS information to marine transportation used the de minimis value substitution method described in Chapter 2 Section II, Concept Of De Minimis Value Substitution employing a multiplier of 0.1%.

Conservatively, it was assumed that only 0.001 of the only that portion of the cargo value that was carried by ships operating within 2 or 4 feet of the bottom (referred to as draft constrained). This is the area where it is most important to know the exact water level and the area that would most benefit by having real-time water level information from PORTS®. The small di minimis value of 0.1% was used to reflect the lack of understanding (at the time of this analysis) of the importance of PORTS® to the efficiency of marine transportation.

The annual value of draft constrained cargo transported through the 58 ports with PORTS® (as of 2010) ranged from $139 to $223 billion per year. (Refer to Appendix C) Employing the de minimis multiplier of 0.1% of cargo value results in a PORTS® benefit of $139 to $223 million per year (Figure 4). The same percentage was applied to both two and four feet of DUK movements.

As each PORTS® system has an effective economic life of ten years, a net-present value assessment of the benefits over the lifespan of a PORTS® system was also made. Employing the ten-year cost of capital mandate by the Office of Management and Budget for projects in 2010 (the year of our data), the total Net-Present-Value (NPV)[21] is estimated to range between $1.1 and $1.8 billion could be enjoyed.[22] (Refer to Table 2)

Calculated in a similar manner, the ten-year NPV for container traffic could range between $0.47 and $0.74 billion, while bulk traffic including tank, RO-RO, general cargos could range between $0.67 and $1.08 billion. (Refer Tables 3 and 4)

[21] NPV compares the present value of a monetary benefit today to the present value of that monetary benefit in the future, taking inflation and returns into account. According to the OMB, a discount rate of 3.9 percent should be used for 2010 based analysis.

[22] In keeping with the conservative nature of this analysis, no changes were assumed in traffic value over the ten year period of the study.

Table 2

ESTIMATED TOTAL NET PRESENT VALUE OF PORTS® BENEFITS AT 58 CURRENT LOCATIONS (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$138,507,538	$ 133,382,759	$222,854,167	$ 214,608,563
2	0.927	$138,507,538	$ 128,396,488	$222,854,167	$ 206,585,813
3	0.892	$138,507,538	$ 123,548,724	$222,854,167	$ 198,785,917
4	0.885	$138,507,538	$ 122,579,171	$222,854,167	$ 197,225,938
5	0.826	$138,507,538	$ 114,407,226	$222,854,167	$ 184,077,542
6	0.795	$138,507,538	$ 110,113,493	$222,854,167	$ 177,169,063
7	0.765	$138,507,538	$ 105,958,267	$222,854,167	$ 170,483,438
8	0.737	$138,507,538	$ 102,080,056	$222,854,167	$ 164,243,521
9	0.709	$138,507,538	$ 98,201,844	$222,854,167	$ 158,003,604
10	0.683	$138,507,538	$ 94,600,648	$222,854,167	$ 152,209,396
TOTAL NET PRESENT			**$ 1,133,240,975**		**$1,823,392,794**

Table 3

ESTIMATED NET PRESENT VALUE OF PORTS® BENEFITS AT 58 CURRENT LOCATIONS FROM CONTAINER TRAFFIC (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$57,198,226	$55,081,892	$90,361,318	$87,017,949
2	0.927	$57,198,226	$53,022,756	$90,361,318	$83,764,942
3	0.892	$57,198,226	$51,020,818	$90,361,318	$80,602,296
4	0.885	$57,198,226	$50,620,430	$90,361,318	$79,969,766
5	0.826	$57,198,226	$47,245,735	$90,361,318	$74,638,449
6	0.795	$57,198,226	$45,472,590	$90,361,318	$71,837,248
7	0.765	$57,198,226	$43,756,643	$90,361,318	$69,126,408
8	0.737	$57,198,226	$42,155,093	$90,361,318	$66,596,291
9	0.709	$57,198,226	$40,553,542	$90,361,318	$64,066,174
10	0.683	$57,198,226	$39,066,388	$90,361,318	$61,716,780
TOTAL NET PRESENT			**$467,995,885**		**$739,336,304**

Table 4

ESTIMATED NET PRESENT VALUE OF PORTS® BENEFITS AT 58 CURRENT LOCATIONS FROM BULK CARGO TRAFFIC (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$81,309,312	$78,300,867	$132,492,849	$127,591,577
2	0.927	$81,309,312	$75,373,732	$132,492,849	$122,821,798
3	0.892	$81,309,312	$72,527,906	$132,492,849	$118,184,513
4	0.885	$81,309,312	$71,958,741	$132,492,849	$117,257,056
5	0.826	$81,309,312	$67,161,492	$132,492,849	$109,439,919
6	0.795	$81,309,312	$64,640,903	$132,492,849	$105,332,610
7	0.765	$81,309,312	$62,201,624	$132,492,849	$101,357,794
8	0.737	$81,309,312	$59,924,963	$132,492,849	$97,647,967
9	0.709	$81,309,312	$57,648,302	$132,492,849	$93,938,139
10	0.683	$81,309,312	$55,534,260	$132,492,849	$90,493,299
TOTAL NET PRESENT			**$ 665,272,791**		**$1,084,064,673**

C. Method 1 – Estimating Potential Value of PORTS® to Marine Transportation Efficiency (117 Ports without PORTS®)

Employing this methodology to assess the value of current PORTS® installations, the value of cargo transported with DUKs of two or fewer and four and fewer feet were identified and totaled for each of the 117 ports without PORTS®. Refer to Appendix D.

For the remaining 117 ports without PORTS® between $50 and $89 million in annual benefits could be realized from two and four foot under keel passages and a ten-year NPV value ranging between 405 million and 727 million. (Refer to Table 5). Tables 6 delineates additional potential benefit from universal PORTS® implementation at all 117 additional locations for container traffic. Here annual benefits could range between $11 and 28 million with a 10 year NPV of between $88 and $231 million. Table 7 suggests an annual added benefit of between

$39 and $61 million for bulk traffic at an additional 117 port with a ten-year NPV of $318 and $496 million. (Refer to Appendix E) Major PORTS Benefiting from PORTS® provides an interesting analysis of the 117 remaining ports where PORTS provides the greatest value for both the 2 and 4 foot UKC. (Refer to Appendix F)

Table 5

**ESTIMATED TOTAL NET PRESENT VALUE OF PORTS® BENEFITS
AT 117 ADDITIONAL LOCATIONS
(METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)**

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$49,542,333	$47,709,266	$88,839,057	$85,552,012
2	0.927	$49,542,333	$45,925,742	$88,839,057	$82,353,806
3	0.892	$49,542,333	$44,191,761	$88,839,057	$79,244,439
4	0.885	$49,542,333	$43,844,964	$88,839,057	$78,622,566
5	0.826	$49,542,333	$40,921,967	$88,839,057	$73,381,061
6	0.795	$49,542,333	$39,386,154	$88,839,057	$70,627,050
7	0.765	$49,542,333	$37,899,884	$88,839,057	$67,961,879
8	0.737	$49,542,333	$36,512,699	$88,839,057	$65,474,385
9	0.709	$49,542,333	$35,125,514	$88,839,057	$62,986,892
10	0.683	$49,542,333	$33,837,413	$88,839,057	$60,677,076
TOTAL NET PRESENT			**$405,355,366**		**$726,881,165**

Table 6

ESTIMATED TOTAL NET PRESENT VALUE OF PORTS® BENEFITS FOR CONTAINER TRAFFIC AT 117 ADDITIONAL LOCATIONS (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$10,729,909	$10,332,902	$28,203,184	$27,159,666
2	0.927	$10,729,909	$9,946,626	$28,203,184	$26,144,352
3	0.892	$10,729,909	$9,571,079	$28,203,184	$25,157,240
4	0.885	$10,729,909	$9,495,969	$28,203,184	$24,959,818
5	0.826	$10,729,909	$8,862,905	$28,203,184	$23,295,830
6	0.795	$10,729,909	$8,530,278	$28,203,184	$22,421,531
7	0.765	$10,729,909	$8,208,380	$28,203,184	$21,575,436
8	0.737	$10,729,909	$7,907,943	$28,203,184	$20,785,747
9	0.709	$10,729,909	$7,607,505	$28,203,184	$19,996,057
10	0.683	$10,729,909	$7,328,528	$28,203,184	$19,262,775
TOTAL NET PRESENT			**$87,792,115**		**$230,758,451**

Table 7

ESTIMATED TOTAL NET PRESENT VALUE OF PORTS® BENEFITS FOR BULK TRAFFIC AT 117 ADDITIONAL LOCATIONS (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$38,812,423	$37,376,363	$60,635,872	$58,392,345
2	0.927	$38,812,423	$35,979,116	$60,635,872	$56,209,453
3	0.892	$38,812,423	$34,620,681	$60,635,872	$54,087,198
4	0.885	$38,812,423	$34,348,994	$60,635,872	$53,662,747
5	0.826	$38,812,423	$32,059,061	$60,635,872	$50,085,230
6	0.795	$38,812,423	$30,855,876	$60,635,872	$48,205,518
7	0.765	$38,812,423	$29,691,504	$60,635,872	$46,386,442
8	0.737	$38,812,423	$28,604,756	$60,635,872	$44,688,638
9	0.709	$38,812,423	$27,518,008	$60,635,872	$42,990,833
10	0.683	$38,812,423	$26,508,885	$60,635,872	$41,414,301
TOTAL NET PRESENT			**$317,563,245**		**$496,122,705**

IV. PORT PILOT USE OF PORTS® IN NAVIGATING LARGE COMMERCIAL SHIPS IN PORTS

In the first analysis, the portion of total potential benefits attributed to the PORTS® system was a de minimis 0.1 percent. While the precise level of benefits from all physical port locations will probably never be known, the conservative nature of this estimate is illustrated through the results of a recent series of surveys returned from five port pilots who serve the Atlantic and Gulf coasts of the United States.

While there is a great deal of economic data available for the analysis of the benefit of PORTS® to commercial shipping it is essential that there be some effort to ground truth the results with knowledgeable users of PORTS® information. Pilots represent that pinnacle of expert user thoroughly knowledgeable about conditions in a port area. They are responsible for moving large commercial vessels safely through the most treacherous waters of a ships journey - the port.

Pilots typically convey large ships from 400 to well over 1,000 feet in length through narrow channels barely deeper than the ship’s draft over hung by bridges that are barely higher than the ships. This coupled with the challenges from heavy traffic, periods of reduced visibility, low bridges, high winds and strong currents make the movement of these large ships the job for only the most highly skilled mariners. Pilots are the experts that are able to integrate the best available information to assure a safe passage.

A. Role Of The Pilot

> **"I can't imagine doing my job without PORTS®"**
> Captain John Kemmerley, Delaware Bay and River Pilot at meeting of the Mariner's Advisory Committee
> for the Bay and River Delaware, June 13, 2013.
>
> **"We use PORTS® data on the Bayonne Bridge and nearby Bergen Point to bring in vessels within 2' of the bridge and 2' under keel clearance at the same time. If PORTS® sensors were shut down, there are 3-4 classes of vessels we will not be able to bring to the Port."**
> Comment from a NY Harbor Pilot

Every foreign-flag vessel and every United States-flag vessel engaged in international trade moving in the waters of a state is required by the state to take a pilot licensed by the state. Each U.S. flag coastwise vessel is required by federal law to use a pilot with a federal license issued by the United States Coast Guard. Pilots direct the movements of vessels while they are within ports or large bays or rivers leading to ports. They direct the movements of all the vessels moving cargoes examined in this study. A summary of comments by port pilots is provided in Appendix G.

To assess the importance of PORTS information to these pilots a survey form was prepared (Refer to Chapter 3, Appendix D, "Survey Provided to Port Pilots") and the instructions were given to the participant during an initial meeting. The participant was given a chance to ask clarifying questions only. They were told that there wasn't a right or wrong answer and that there wasn't an answer we were looking for. We were merely seeking their professional opinion of the importance of PORTS® information to their execution of their pilot duties with respect to the conditions they would expect to encounter.

Five pilots representing four large pilotage areas on the east and gulf coasts were interviewed to determine how they utilize the PORTS® information and their opinion on how important PORTS® information is for a safe passage to and from the pier.[23] Collectively they pilot ships to and from 21 of the individual ports that were examined in this study presently covered by PORTS®. They are considered experts in the use of PORTS® for commercial maritime transportation. To ensure those questioned would speak candidly they were informed that their responses would be kept confidential and the results would not reference their name or the name of their pilot organization. Each of these pilots had multiple decades of experience serving as a pilot and many years in using PORTS® information. All respondents had learned over years to be able to rely on the accuracy of PORTS® information. All respondents had a good understanding of how to utilize the PORTS® data to ensure a safe passage as well as to use the data to maximize the tonnage of cargo transported.

B. Alternative Valuation of PORTS® - Method 2

In March, 2013, the Port of New York / New Jersey contemplated ending their arrangement with NOAA for the provision of real time and near-real time data from their PORTS® instrumentalities. As aforementioned, both the NYNY Port authority and USCG were highly concerned over this potential outage of information from PORTS(s) and recommended significant restrictions on depth-under-keel and air gap standards should such revocation had taken place.

From the USACE’s CPT 2010 data on marine shipments, 8.6 percent of the total value of goods transported moved in vessels with depths-under-keel of between zero and two feet. This equated to more than $188 billion in commodity value. When the depth-under-keel is enlarged

[23] Including the port systems of New York and New Jersey, Delaware River and Bay, Chesapeake Bay, Galveston Bay, and Tampa Bay. Collectively they represented 21 separate ports.

to between zero and four feet, this figure rises to 13.9 percent of total commodity value. This equated to almost $312 billion in commodity value. (Refer to Tables 8 and 9)

Responses from the DELPHI survey suggested that in general overall conditions that PORTS® instrumentalities provided between five and 30 percent of total navigational benefits. (Refer to Table 10) Overall an average of 14.4 percent of total navigational benefits were attributed to PORTS® data with a standard deviation of 9.4 percent. (Refer to Table 11) Illustrating the enhanced value of PORTS® in cases where depth constraints were involved (e.g., cases where the depth-under-keel was less than two feet) the relative value of PORTS® increased to 27 percent (with a standard deviation of 9.7 percent.)

Finally, in cases of adverse weather, PORTS® was reported to be valued at 20 percent of total information value with a standard deviation of 14.1 percent.[24] Referring to the Department of Commerce, adverse weather occurs at U.S. ports as measured by: (1) winds in excess of 33 knots (2.4 percent of the time); (2) waves greater than nine feet (5.1 percent of the time); and, (3) visibility less than two nautical miles (7.6 percent of the time).[25]

Unfortunately no data is available which could delineate marine vessel passings at various depths-under-keel with specific weather conditions. Although it is apparent that the value of PORTS® increased in the sample of port pilots surveyed in this analysis, no attempt and augmenting the overall estimate of benefits attributable to PORTS(s) data during adverse weather conditions were made. Consequently, the final estimate is believed to be conservative in keeping with the overall stance of this report.

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[24] Note: this measure was exclusive of constrained waterway importance estimates.

[25] United States Department of Commerce, National Oceanic and Atmospheric Administration, “United States Coast Pilot”.

Table 8

VALUE OF MARINE TRAFFIC AT DIFFERENT DEPTHS-UNDER-KEEL

	0 TO 2 FEET DEPTH UNDER KEEL	**0 TO FOUR FEET DEPTH UNDER KEEL**
58 PORTS WITH PORTS®	$ 138,507,538,072	$ 222,854,166,599
117 PORTS WITHOUT PORTS®	$ 49,542,332,624	$ 88,839,057,134
TOTAL VALUE OF TRAFFIC (175 PORTS)	$188,049,970,696	$311,693,223,733

Source: USACE, CPT Data, 2010

Table 9

ANNUAL BENEFIT VALUE RANGES OF MARINE TRAFFIC (METHODS 1 and 2)

	0 TO 2 FEET DEPTH UNDER KEEL	**0 TO FOUR FEET DEPTH UNDER KEEL**
58 PORTS WITH PORTS®		
0.1 PERCENT BENEFIT – Method 1	$ 138,507,538	$ 222,854,166
1.0 PERCENT BENEFIT – Method 2	$ 1,385,075,380	$ 2,228,541,665
117 PORTS WITHOUT PORTS®		
0.1 PERCENT BENEFIT – Method 1	$ 49,542,332	$ 88,839,057
1.0 PERCENT BENEFIT – Method 2	$ 495,423,326	$ 888,390,571
TOTAL VALUE OF TRAFFIC (175 PORTS)		
0.1 PERCENT BENEFIT – Method 1	$188,049,970	$311,693,223
1.0 PERCENT BENEFIT – Method 2	$1,880,499,706	$3,116,932,237

Source: USACE, CPT Data, 2010

As a result of the Delphi survey of marine pilots it is clear that PORTS® is the most important source of information for the pilots. As a result thee de minimis value of PORTS was increased from 0.1% to 1.0% for this Method 2 analysis. While the preponderance of evidence from the result of the port pilots survey and enormous size of the traffic segment being transported with two or fewer feet depths-under-keel, employment of a simple arithmetic calculation multiplying the value of that traffic times the portion of traffic impacted by PORTS® data could form an alternative valuation. Using the one percent suggested by Nordhaus, the annual value of existing PORTS® could be construed as approaching $1.4 billion per year with a ten-year NPV of over $11 billion when depths-under-keel ranged from zero to two feet. These figures for existing ports (when traffic was between zero and four feet depth-under-keel) would increase to $2.2 billion per year and over $18 billion during the ten-year economic life of a PORTS® system. (Refer to Table 12) If installed at the remaining 117 ports, an annual benefit of $0.5 million and $0.9 million could be achieved (for two and four feet DUK, respectively, and equate to an additional $4.0 to $7.3 billion over ten years. (Table 13)

Table 10

PILOTS SURVEY RESULTS
(Percent of Total Value to Safe and Efficient Navigation)

PILOT	1	1	2	2	3	3	4	4	4	6	6	6
PILOTAGE REGION	Chesapeake Bay	Chesapeake Bay	Chesapeake Bay	Chesapeake Bay	Delaware Bay	Delaware Bay	New York & New Jersey	New York & New Jersey	New York & New Jersey	Tampa Bay	Tampa Bay	Tampa Bay
PILOTAGE SITUATION	General	Draft Constrained (0-2 Feet)	General	Draft Constrained (0-2 Feet)	General	Draft Constrained (0-2 Feet)	General	Draft Constrained (0-2 Feet)	Special Situation Weather or Bridge	General	Draft Constrained (0-2 Feet)	Weather Conditions
INFORMATION TYPE												
CHANNEL CONSTUCTION AND MAINTENANCE	20		50		10		22			15		
AIDS TO NAVIGATION	6		5		8		12			15		
PORTS® INFORMATION	**15**	**30**	**10**	**20**	**30**	**40**	**12**	**30**	**30**	**5**	**15**	**10**
VESSEL OPERATIONAL CHARACTERISTICS / INFORMATION	15		5		5		5					
NAUTICAL CHARTS/ ECDIS	5		2		7		2			10		
RADAR INFORMATION	7		10		7		5			15		
COMMUNCIATIONS WITH OTHER VESSELS	10		2		10		15			10		
AIS INFORMATION	7		2		5		5			10		
NOTICE TO MARINERS	5		5		5		5			5		
MASTER-PILOT EXCHANGE	10		2		5		12			15		

PILOT	1	1	2	2	3	3	4	4	4	6	6	6
PILOTAGE REGION	Chesapeake Bay	Chesapeake Bay	Chesapeake Bay	Chesapeake Bay	Delaware Bay	Delaware Bay	New York & New Jersey	New York & New Jersey	New York & New Jersey	Tampa Bay	Tampa Bay	Tampa Bay
PILOTAGE SITUATION	General	Draft Constrained (0-2 Feet)	General	Draft Constrained (0-2 Feet)	General	Draft Constrained (0-2 Feet)	General	Draft Constrained (0-2 Feet)	Special Situation Weather or Bridge	General	Draft Constrained (0-2 Feet)	Weather Conditions
PILOT WRITE-IN CATEGOREIS												
MACHINERY CONDITIONS			5									
TRIM / CONDITION			2									
PORTABLE PILOT UNIT					8							
VTS							5					
TOTAL GENERAL CONDITIONS	**100**		**100**		**100**		**100**			**100**		

Table 11

SUMMARY OF PORT PILOTS SURVEY
(Standard Deviation in Parenthesis)

PILOTAGE SITUATION	General Conditions Average	Draft Constrained (0-2 Feet) Average	Special or Weather Conditions Average
INFORMATION TYPE			
CHANNEL CONSTUCTION AND MAINTENANCE	23.4 (15.6)		
AIDS TO NAVIGATION	9.2 (4.2)		
PORTS® INFORMATION	**14.4 (9.4)**	**27.0 (9.7)**	**20.0 (14.1)**
VESSEL OPERATIONAL CHARACTERISTICS / INFORMATION	7.5 (5.0)		
NAUTICAL CHARTS/ ECDIS	5.2 (3.4)		
RADAR INFORMATION	8.8 (3.9)		
COMMUNCIATIONS WITH OTHER VESSELS	9.4 (4.7)		
AIS INFORMATION	5.8 (2.9)		
NOTICE TO MARINERS	5.0 (0.0)		
MASTER-PILOT EXCHANGE	8.8 (5.3)		
PILOT WRITE-IN CATEGORIES[26]			
MACHINERY CONDITIONS	5.0		
TRIM / CONDITION	2.0		
PORTABLE PILOT UNIT	8.0		
VTS	5.0		
TOTAL GENERAL CONDITIONS	100	100	100

[26] Only one response in each category

Table 12

NET PRESENT VALUE OF 58 CURRENT PORTS® INSTALLATIONS
(METHOD 2 – 1.0 Percent)

YEAR	NPV FACTOR	0-2 FEET DUK VALUE	NPV 0-2 FEET DUK VALUE	0-4 FEET DUK VALUE	NPV 0-4 FEET DUK VALUE
1	0.963	$1,385,075,381	$1,333,827,592	$2,228,541,666	$2,146,085,624
2	0.927	$1,385,075,381	$1,283,964,878	$2,228,541,666	$2,065,858,124
3	0.892	$1,385,075,381	$1,235,487,240	$2,228,541,666	$1,987,859,166
4	0.885	$1,385,075,381	$1,225,791,712	$2,228,541,666	$1,972,259,374
5	0.826	$1,385,075,381	$1,144,072,264	$2,228,541,666	$1,840,775,416
6	0.795	$1,385,075,381	$1,101,134,928	$2,228,541,666	$1,771,690,624
7	0.765	$1,385,075,381	$1,059,582,666	$2,228,541,666	$1,704,834,374
8	0.737	$1,385,075,381	$1,020,800,556	$2,228,541,666	$1,642,435,208
9	0.709	$1,385,075,381	$982,018,445	$2,228,541,666	$1,580,036,041
10	0.683	$1,385,075,381	$946,006,485	$2,228,541,666	$1,522,093,958
		TOTAL	**$11,332,686,765**		**$18,233,927,911**

Table 13

NET PRESENT VALUE OF AN ADDITIONAL 117 PORTS® INSTALLATIONS
(METHOD 2 – 1.0 Percent)

YEAR	NPV FACTOR	0-2 FEET DUK VALUE	NPV 0-2 FEET DUK VALUE	0-4 FEET DUK VALUE	NPV 0-4 FEET DUK VALUE
1	0.963	$495,423,326	$477,092,663	$888,390,571	$855,520,120
2	0.927	$495,423,326	$459,257,423	$888,390,571	$823,538,059
3	0.892	$495,423,326	$441,917,607	$888,390,571	$792,444,389
4	0.885	$495,423,326	$438,449,644	$888,390,571	$786,225,655
5	0.826	$495,423,326	$409,219,667	$888,390,571	$733,810,612
6	0.795	$495,423,326	$393,861,544	$888,390,571	$706,270,504
7	0.765	$495,423,326	$378,998,844	$888,390,571	$679,618,787
8	0.737	$495,423,326	$365,126,991	$888,390,571	$654,743,851
9	0.709	$495,423,326	$351,255,138	$888,390,571	$629,868,915
10	0.683	$495,423,326	$338,374,132	$888,390,571	$606,770,760
		TOTAL	**$4,053,553,653**		**$7,268,811,652**

V. ADDED MARGINAL COST DUE TO CECESSATION OF PORTS® - METHOD 3

The fallacy in both of the first two approaches where a simple percentage (regardless of its amount) is employed is the "unknowns" that are embodied in the marine transportation markets. Faced with revocation of the ability to utilize certain ships with a range of depths-under-keel, changes in transportation patterns would result. Traffic may well shift to other domestic or Canadian ports, changes in mini-bridge and micro-bridge traffic in lieu of the Panama Canal, lightering (although expensive) may increase, but more than likely, the number of less laden ships will increase. While no empirical evidence is available to precisely estimate the gross benefits from reduction or elimination of PORTS® information, following the overall PORTS® logic model, it is highly probable that the following would occur if there was no PORTS®:

- Given an increased number of trips necessary to handle marine traffic at greater depths-under-keel greater groundings, allisions and collisions could occur;
- Increased traffic might result in enhanced mortality and morbidity rates as a result of these accidents;
- Increased instances of oil pollution could result as well as reduced capacity to remediate such occurrences on a timely, accurate and complete level;
- Commercial fishing catch might either be less or be more difficult to find without information on environmental conditions; and,
- Secondary and tertiary benefits as measured through the four ocean economic measures employed in this report could the curtailed.

Given the derived demand nature of (marine) transportation, it is more likely that shippers will want to minimize the economic impact of losses of PORTS® information through the use of the largest vessels that could be handled.[27] An additional method of benefit assessment involves estimation of the added number of marine trips which would be required to transport current levels of material as compared with current transportation patterns should the minimum depths-under-keel be restricted.

The third and final method of valuation assessment originates from the simple calculation of the additional cost which would be associated with transporting the same level of cargo in vessels which could not come within two or four feet of the channel's depth owing to lack of support from PORTS®. Both the USCG and port pilots are on record as stating they would restrict navigation of vessels near the channel bottom of ports were PORTS® not available. Employing the proprietary engineering costing model NNOMPEAS managed by the USACE, the following assumptions were made: (Refer to Tables 14 and 15)

- Costs from non-US flag vessels only were utilized as they represent the preponderance of international shipping and deeper draft vessels (as compared with relatively few U.S. flagged vessels)[28];
- Normal DUKs on the Great Lakes are 28.5 feet[29] (based on examining all available data);
- Normal DUKs at all other coastal ports are 44.5 feet (based on examining all available data); and,
- Restrictions of two and four feet DUK were implementing which resulted in maximum DUKS of:
  - 24.5 to 26.6 Feet DUK on the Great Lakes
  - 40.5 to 42.5 Feet DUK on all other ports

[27] Transportation in and of itself has no value. It is the desire by the consigner and consignee to place specific goods at specific locations in specific time frames which provides the basis for transportation and ultimately total logistics demand.

[28] Generally lower cost non-US flag vessel costs were employed in this study in keeping with the conservative nature of this analysis. Moreover, current USACE data does not contain cost data for US flag vessels at this time.

[29] The USACE data was reported in single foot ranges (e.g., 28 to 29 feet). The mid-points of all ranges (e.g., 28.5) were used in this analysis.

- In keeping with the conservative approach of this study average length of haul was estimated to be:
  - 850 Nautical Miles (Great Lakes)[30]
  - 6,000 Nautical Miles (All Other)[31]

- Added mortality and morbidity owing to increased number of vessel transits
  - $6.1 million per death
  - $613,246 per injury

- Added costs for oil spills and sheens exist but where considered too small to add measurably to the resulting benefit

A. **Port Costs**

A survey of the ports of Norfolk, Miami, New Orleans, Houston, Long Beach, and Seattle was conducted September 13, 2013 by personnel from the USACE to determine typical port costs that a vessel would expect to incur when calling on a port to load or unload cargo. Most of the ports were unwilling to supply values for all the types of costs claiming that it was proprietary information. However enough information was obtained to enable the researchers to develop a composite set of port costs for a typical coastal port and make an educated estimate of the port costs for a Great Lakes port. Where multiple responses were received for a cost category an average was used for the composite typical coastal port. It is believed that these costs are typically low especially for the pilotage fees.

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[30] 850 miles was selected as a conservative estimate given dominate traffic flows. National distance examples include; Chicago to Detroit (550 miles); Buffalo to Milwaukee (719 miles); Milwaukee, WI and Erie, PA (747 miles), Duluth to Ashtabula (876 miles), Atlantic ocean to Duluth, MN (2,038 miles) Source: Sea distances.com and http://www.greatlakes-seaway.com/en/seaway/facts/ Iron ore is the dominate commodity carried representing 37 percent of total traffic. Coal represents 25 percent of traffic while limestone accounts for 23 percent. In 2007 a total of 164.6 million tons were transported. Source: Lake Carriers' Association *Great Lakes Dry-Bulk Commerce*, 2007 Statistical Annual Report.

[31] 6,000 miles was selected as a conservative estimate given dominate traffic flows. International distance examples include: Hong Kong China to Long Beach - 6,363 miles; Rotterdam to New York - 3,383 Miles); Singapore to New York (10,133 miles); Bombay India to Tacoma, US (9,517 miles) Refer to sea distances.com.

Fees associated with cargo handling (removal and loading), storage, and moving away from the port facility were not considered in these costs. The rational for this was that only the numbers of ship transits were changing in this analysis and not the amount of cargo. We wanted to look at what additional costs would be incurred as a result of vessels having to transit with a greater under keel clearance. (Refer to Table 14)

Table 14

ADDITIONAL MARINE TRANSPORTATION COST PER TRIP OWING REDUCED DEPTH UNDER KEEL

COST CATEGORY (Per Arrival or departure)	COASTAL PORT ASSUMPTIONS	COSTS	GREAT LALES PORT ASSUMPTIONS	COSTS
Tug Fee/arrival	2 tugs, 2 hours each	$5,550	2 tugs, 1 hour each, $1,000/hour	$2,000
Pilotage Fee/arrival	Average 2 hour trip	$2,375	0$, Vessel Masters are usually have their pilotage license	$0
Stevedore Line Handling/arrival	Average of survey data	$558	Average of survey data	$558
TOTAL Round Trip (arrival + departure)		$16,966		$5,116
Dockage Fee	800' vessel 2 day stay at dock	$9,741	Estimate based on Houston which was the smallest encountered in this survey. Fees in Great Lakes are typically small	$1,727
Fresh Water	Average of survey data	$92	Average of survey data	$92
Administrative	Average of survey data	$388	Average of survey data	$388
TOTAL Port Fees for Round Trip		$27,187		$7,323

If capacities were constrained by two feet, an additional $11.2 million could be added to the nation's transportation bill due to extra dockage costs (Refer to Table 16 Extra Dockage Costs). If capacities were constrained by four feet, an additional $36.5 million could be added to marine transportation costs due to extra dockage costs (Refer to Table 16 Extra Dockage Costs).

B. Vessel Capacity

In investigating the number of additional vessels which would be required to transport all current traffic should greater DUKs be required, the average capacity of vessels calling on US ports in 2010 was calculated from MARAD vessel call data.[32] Overall a total capacity in excess of 3.2 billion metric tons was exhibited by almost 60,000 ships calling on US ports. This averaged slightly less than 53,700 metric tons per ship.[33] As tonnage reported by the USACE was also listed by metric tons, no conversion was required.

Using the dominate displacement of 44.5 feet shown by all ships in US ports as the basis, calculations suggest that over 1,200 tons of capacity equate to one foot of vessel draft.[34] (Refer to Table 15) This suggests the maximum capacity of shipping given capacity constraints of zero to two feet and zero to four feet DUK to range from 48,370 to 51,028 metric tons, respectively – down from the dominate 53,686 metric tons per vessel. Similarly, using the dominate 28.5 foot displacement for Great Lakes ports, capacity constraints of zero to two feet and zero to four feet

[32] Potentially capacity was employed (rather than historical actual lading weights) to minimize the additional number of vessels that would be required to transport existing levels of materials if deeper draft vessels were banned. Source: MARAD, Vessel Calls at U.S. Ports by Vessel Type (Updated 3/28/13)

[33] Ibid, Page 2.

[34] Assumes a linear relationship.

Table 15

ESTIMATED TONNAGE CAPACITY OF SHIPS CALLING AT US PORTS

DRAFT	ESTIMATED TONNAGE CAPACITY OF VESSEL	GROUPING
19.5	20,461	
20.5	21,790	
21.5	23,119	
22.5	24,448	
23.5	25,777	
24.5	**27,106**	**4 FT DUK - GREAT LAKES**
25.5	28,435	
26.5	**29,764**	**2 FT DUK - GREAT LAKES**
27.5	31,093	
28.5	**32,422**[35]	**DOMINATE - GREAT LAKES**
29.5	33,751	
30.5	35,080	
31.5	36,409	
32.5	37,738	
33.5	39,067	
34.5	40,396	
35.5	41,725	
36.5	43,054	
37.5	44,383	
38.5	45,712	
39.5	47,041	
40.5	**48,370**	**4 FT DUK - ALL OTHER**
41.5	49,699	
42.5	**51,028**	**2 FT DUK - ALL OTHER**
43.5	52,357	
44.5	**53,686**[36]	**DOMINATE - ALL OTHER**
45.5	55,015	
46.5	56,344	
47.5	57,673	
48.5	59,002	
49.5	60,331	
50.5	61,660	
51.5	62,989	

Source: MARAD, Vessel Calls at U.S. Ports by Vessel Type (Updated 3/28/13)

[35] The overall average capacity of all Great Lakes vessels was about 33,336 metric tons in 2010 and 33,575 tons in 2012. Source: MARAD, *Status of the U.S. Flag Great Lakes Water Transportation Industry*. Table 1, Page 9, February, 2013.

[36] Assumes about 1,200 metric tons are displaced on average for each additional foot of draft.

would result in capacity limits of between 27,106 and 29,764 metric tons, respectively – down from the dominate 32,422 metric tons per vessel.[37]

C. Vessel Costs

The final area of augmented costs owing to imposition of DUK constraints deals with the increased marginal cost per ton-mile which would result from imposition of smaller capacity vessels. In keeping with the conservative nature of this analysis, only the largest capacity ship allowed under varying DUK constraints were analyzed. For example, on the Great Lakes, if four feet DUK were removed, ships could be no larger than 24.5 feet (four feet less than the currently dominantly seen displacements.)

While shippers would probably want to utilize the largest ships available under DUK constraints to take advantage of economies of size, it is unlikely that there would be sufficient supply in the short-run. This would result in use of even smaller ships with larger operating costs per ton-mile.

Although the Great Lakes are fresh water and less dense, this linear formula would tend to slightly overstate the capacity of vessels and hence understate the number of added vessels required if DUK constraints were enacted. However, recent reports tend to support the accuracy of this form of capacity draft estimation:[38]

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[37] It is recognized that fresh water (e.g., Great Lakes) increases the depth ships with similar ladings as compared with salt water operation under ceteris paribus conditions. In this analysis, no distinction was made between the two types of water as the difference is relatively small. The density of pure water is 1,000 kilograms per cubic meter. The density of ocean water at the sea surface is about 1,027 kilograms per cubic meter. Source: http://www.csgnetwork.com/h2odenscalc.html

[38] While the newer Great Lakes Trader's capacity of 39,600 tons, the model calculates 32,422 as the dominate tonnage capacity of Great Lakes shipping based on all (older and smaller) existing ships, the estimate appears appropriate.

> "The self-unloading barge Great Lakes Trader has the distinction of being the last major vessel built for Great Lakes service. Built for Great Lakes Marine Leasing and operated by VanEnkevort Tug and Barge of Escanaba, MI. Great Lakes Trader is pushed by the 135-foot tug Joyce L. Van Enkevort, which was built in 1998 by Bay Shipbuilding Co., Sturgeon Bay, WI. The tug is powered by two 5,100 brake horsepower Caterpillar 3612 12-cylinder diesel engines.
>
> Great Lakes Trader was constructed in two halves at Halter Marine's yard in Pearlington, MS and then towed to the New Orleans yard to be joined together and outfitted. The tug sailed from the Great Lakes to New Orleans to be mated up with the newly finished barge for the return trip back to the Great Lakes. The pair departed the Gulf on May 28, 2000, and arrived on the lakes in mid-June after transiting the St. Lawrence Seaway. Special care had to be used in transiting the locks because of her size.
>
> The Trader is the 16th largest carrier on the Great Lakes, with maximum seaway dimensions of 740 x 78 feet. Her cargo capacity is 39,600 tons. The Great Lakes Trader loaded its first cargo, taconite, for Indiana Harbor, June 23, 2000 in Escanaba. Since then she has been a frequent visitor, not only to Escanaba, but to Lake Superior ports, carrying ore for various customers around the lakes and stone cargoes to various ports."
>
> Source: http://www.boatnerd.com/pictures/fleet/gltrader.htm

1. Number of ship transits needed

Based on the average ship capacity, and the known amount of tonnage carried in ships with potentially constrained DUKs, it is possible to estimate the added number of ships which would be required to transport that constrained cargo. This would be calculated as number of ships with lesser capacity transits less the current number of ship transits. This marginal increase in the number of ships would also impact the fixed costs for each ship transit as well as the level of morbidity and mortality which result from the increased number of vessel trips and are based on the number of ship transits. In this instance, a total of 630 (if constrained by two feet) and 2,024 (if constrained by four feet) added vessel transits would be required on the Great Lakes and all other US coastal ports, respectively. These increases would represent increases of total vessel trips by 1.1 and 3.4 percent, respectively based on a total of 59,871 total vessel calls[39] on US ports in 2010.

Assuming a conservative average length of haul for Great Lakes ports of 850 miles and 6,000 miles for all other US coastal ports, the marginal cost per ton could increase based on the USACE'S NNOMPEAS model. (Refer to Figure 5)[40] Also note that as the NNOMPEAS data did not contain cost information on vessel movements under the Jones Act as of this time, less expensive costs associated with international shipments were employed.[41] This again was in keeping with the conservative nature of this analysis.

D. Morbidity and Mortality

Shown to be a function of the number of vessel transits (Refer to Chapter 6) the addition number of ship transits (between 630 and 2,024) are certain to increase the number of deaths and injuries in commercial marine transportation as both are a function of the number of vessel transits. Employing the more conservative morbidity and mortality rates per vessel transit seen

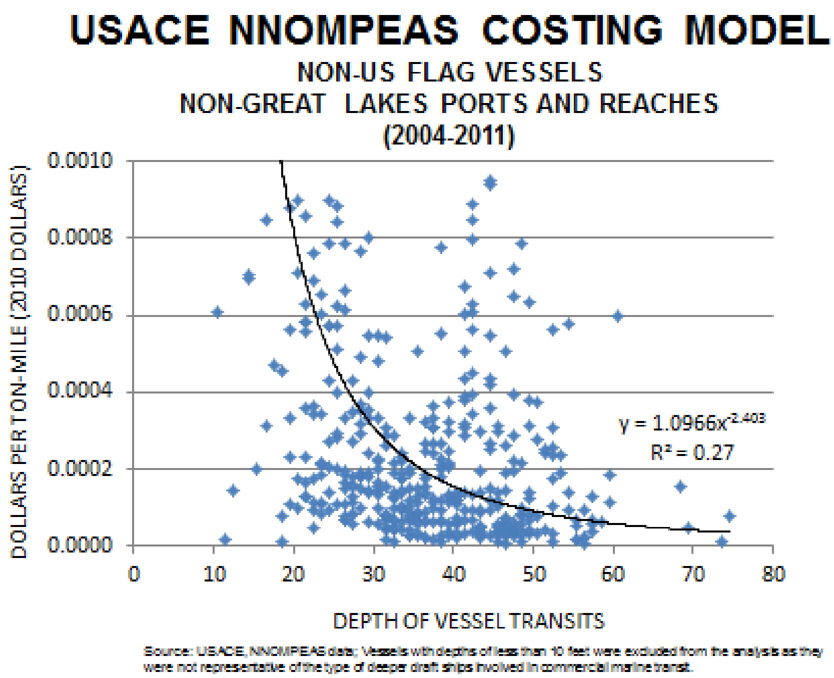
[39] MARAD, *Vessel Calls Snapshot*, 2011, Page1, March, 2013.

[40] Vessels transits with drafts of less than ten feet were removed as were several outliers as they were not believed to be representative of deeper-draft vessel movements.

[41] The Merchant Marine Act of 1920 (P.L. 66-261), also known as the Jones Act, is a United States federal statute that regulates maritime commerce in U.S. waters and between U.S. ports. Section 27 is part of the Jones Act that deals with cabotage (i.e., coastal shipping) and requires that all goods transported by water between U.S. ports be carried in U.S.-flag ships, constructed in the United States, owned by U.S. citizens, and crewed by U.S. citizens and U.S. permanent residents.

at locations with PORTS®,[42] the cost of additional deaths and injuries could range from \$2.0 million per year if DUKs were constrained from zero to two feet and \$6.4 million if DUKs were

Figure 5



constrained from zero to four.

Overall Table 16 summarizes the marginal costs which could arise owing to constraints placed on DUKs at two and four feet, respectively at an additional \$48.2 million and \$160.3 million. These figures equate to almost \$395 million and \$1.3 billion over the ten-year economic

[42] The mortality rate with PORTS® is 0.0001 deaths per vessel transit; the morbidity rate with PORTS® is 0.0012. Refer to Chapter 6, Table 4, Page 27.

Table 16

BASED ON 2 FEET UKC - MARGINAL COSTS RESULTING FROM DEPTH-UNDER KEEL RESTRICTIONS ($48,231,143 ANNUAL ADDITIONAL COSTS)

	GREAT LAKES BEFORE	**GREAT LAKES AFTER**	**GREAT LAKES COSTS**	**ALL OTHER COASTLINES BEFORE**	**ALL OTHER COASTLINES AFTER**	**ALL OTHER COASTLINES COSTS**
DEPTH OF VESSEL ALLOWED	28.5	26.5		44.5	42.5	
COST PER TON-MILE	$0.000350	$ 0.000417		$0.000120	$ 0.000134	
TONNAGE PER SHIP	32,422	29,764		53,686	51,028	
CONSTRAINED TONNAGE	107,650,236	107,650,236		343,420,214	343,420,214	
LENGTH OF HAUL	850	850		6,000	6,000	
TON-MILES	91,502,700,600	91,502,700,600		2,060,521,284,000	2,060,521,284,000	
ADDED TRANSPORTATION COST			$6,118,596			$28,880.417
SHIP TRANSITS	3,320	3,617		6,397	6.730	
EXTRA DOCKAGE COSTS	$7,323 per ship	$7,323 per ship	$2,171,340	$27,187 per ship	$27,187 per ship	$9,058,839
ADDED MORTALITY			$542,613			$609,765
ADDED MORBIDITY			$400,003			$449,540
TOTAL ADDED COSTS			**$9,232,582**			**$38,998,561**

BASED ON 4 FEET UKC - MARGINAL COSTS RESULTING FROM DEPTH-UNDER KEEL RESTRICTIONS ($160,338,275 ANNUAL ADDITIONAL COSTS)

	GREAT LAKES BEFORE	GREAT LAKES AFTER	GREAT LAKES COSTS	ALL OTHER COASTLINES BEFORE	ALL OTHER COASTLINES AFTER	ALL OTHER COASTLINES COSTS
DEPTH OF VESSEL ALLOWED	28.5	24.5		44.5	40.5	
COST PER TON-MILE	$0.000350	$0.000503		$0.000120	$0.000150	
TONNAGE PER SHIP	32,422	27,106		53,686	48,370	
CONSTRAINED TONNAGE	154,552,810	154,552,810		343,420,214	343,420,214	
LENGTH OF HAUL	850	850		6,000	6,000	
TON-MILES	131,369,888,500	131,369,888,500		3,193,055,292,000	3,193,055,292,000	
ADDED TRANSPORTATION COST			$ 20,148,680			$97,289,331
SHIP TRANSITS	4,767	5,702		6,397	6.730	
EXTRA DOCKAGE COSTS	$7,323 per ship	$7,323 per ship	$ 6,846,138	$27,187 per ship	$27,187 per ship	$29,618,530
ADDED MORTALITY			$ 1,710,883			$1,993,670
ADDED MORBIDITY			$ 1,261,287			$1,469,805
TOTAL ADDED COSTS			**$29,966,940**			**$130,371,335**

life of PORTS®. (Refer to Table 17) Table 18 estimated the apportionment of potential benefit among current locations with and without PORTS® based on tonnage handled.

Table 17

NET PRESENT VALUE OF MARGINAL MARINE TRANSIT COSTS

YEAR	NPV FACTOR	0-2 FEET DUK CONTRAINED	NPV 0-2 FEET DUK VALUE	0-4 FEET DUK CONSTRAINED	NPV 0-4 FEET DUK VALUE
1	0.963	$48,231,143	$46,441,768	$160,338,275	154,389,725
2	0.927	$48,231,143	$44,700,624	$160,338,275	148,601,513
3	0.892	$48,231,143	$43,002,887	$160,338,275	142,957,606
4	0.885	$48,231,143	$42,703,854	$160,338,275	141,963,509
5	0.826	$48,231,143	$39,843,748	$160,338,275	132,455,449
6	0.795	$48,231,143	$38,334,113	$160,338,275	127,436,861
7	0.765	$48,231,143	$36,911,294	$160,338,275	122,706,882
8	0.737	$48,231,143	$35,536,706	$160,338,275	118,137,241
9	0.709	$48,231,143	$34,210,350	$160,338,275	113,727,938
10	0.683	$48,231,143	$32,932,225	$160,338,275	109,478,974
		TOTAL	**$394,617,568**		**$1,311,855,698**

Table 18

APPORTIONMENT OF BENEFITS ARISING FROM MARGINAL MARINE TRANSIT COSTS[43]

	LEVEL OF CONSTRAINED TRAFFIC	CURRENT 58 PORTS® INSTALLATIONS	POTENTIAL 117 PORTS® INSTALLATIONS	TOTAL
ANNUAL VALUE	2 Feet	$35,980,433	$12,250,710	$48,213,143
10 YEAR NET PRESENT VALUE	2 Feet	$294,384,706	$100,232,862	$394,617,568
ANNUAL VALUE	4 Feet	$119,612,353	$40,725,922	$160,338,275
10 YEAR NET PRESENT VALUE	4 Feet	$978,644,351	$333,211,347	$1,311,855,698

[43] Apportionment based on total tonnage covered by each group. As of 2010 PORTS® covered 74.6 percent of total tonnage.

VI. CONCLUSIONS

The intent of this scoping study was to first identify and later quantify benefits which are enjoyed by recipients of PORTS® data and information. In this study three levels of benefits were estimated. The first two utilized the de minimis methods previously employed by Nordhaus, Kite-Powell and others. Lacking specific empirical data, these initial two methods were designed, based on a highly generalized theory to develop a realistic range of costs which society might pay in the event of loss of PORTS® data. In both estimations it was theorized to encompass the totality of all primary, secondary and tertiary costs which society might face. Such costs are designed to include the direct costs associated with employment of a larger number of vessels with lower drafts and per vessel transit fees (e.g., pilotage, stevedores, tug support, etc.) but additional costs related to port congestion, direct and indirect pollution[44], accident cost in the form of property damage, loss of life and injuries, enhanced port-based logistics costs as well as enhanced surface transportation costs owing to lower economies of size. Consequently, benefit estimated from the first two methods ($188 to $312 million (at 0.1 percent) for two and four feet, respectively and $1.9 to $3.2 billion (at 1.0 percent) for two and four feet, respectively) could be envisioned as a potential range of total societal benefits from PORTS® related to the commercial transportation of goods. Given the USCG's Notice of Potential Rulemaking which would restrict vessel drafts by four feet, the latter numbers ($312 million to $3.2 billion) related to 4 feet UKC should be the potential benefit range retained from

[44] Added pollution in the form of a large number of vessels required to transport the cargo but oil leaks (discharge of bilge water, leaks, etc.) as well as the potential for a greater number of grounding, allisions and collisions from which petroleum products might be released into the environment.

these two initial estimation methods.[45]

The third method was much more focused and employed an attempt to estimate costs should depth constrictions be imposed (through USCG's Notice of Potential Rulemaking) using a series of USCG and USACE data sets and models. Here, costs for only four areas were estimated: (1) marginal water-borne transportation cost; (2) added vessel transit costs; (3) and added costs owing to morbidity; and, (4) mortality costs from the additional accidents anticipated to occur as a result of increased numbers of ship transits. Collectively, these costs totaled $160 million if revocation of four feet of vessel drafts were imposed. (Refer to Table 18) Following the conservative treatment employed in all benefit calculations in this study, the $160 million (as compared with the $312 million obtained in Method 1) can be characterized as the minimum primary cost associated with a four foot reduction in vessel draft as it does not include the plethora of other resultant costs which would follow such a change in operational procedures. At the other end of the estimation, the $3.2B in annually avoided costs could be construed as the upper limit.

[45] All in 2010 dollars.

APPENDIX A

EXAMPLES OF UNDERKEEL CLEARANCES SPECIFIED IN PORT AUTHORITY OPERATIONAL PLANS

Table A-1

SPECIFIED CLEARANCES AT MAJOR PORTS

PORT LOCATION	MINIMUM UNDERKEEL CLEARANCE REQUIRED
San Diego, CA	1 foot
Oakland, CA	2 feet
San Francisco, CA	2 feet
Richmond, CA	2 feet
Martinez, CA	2 feet
Stockton, CA	2 feet
San Pablo Bay, CA	2 feet
Carquinez Strait, CA	2 feet
San Joaquin River, CA	2 feet
Selby, CA	2 feet
Crockett, CA	2 feet
Redwood City, CA	2 feet
Humboldt, CA	2 feet
Los Angeles, CA	3 feet
Long Beach, CA	3 feet
Seattle, WA	3 feet
Tacoma, WA	3 feet
Anacortes, WA	3 feet
Everett, WA	3 feet
Blaine, WA	3 feet
Bellingham, WA	3 feet
Grays Harbor, WA	3 feet
Port Townsend, WA	3 feet
Olympia, WA	3 feet
Point Roberts, WA	3 feet
Port Hueneme, CA	3.5 feet

Source: Port Authority operational plans for respective ports effective in 2012.

APPENDIX B

SAN FRANCISCO, SAN PABLO AND SUISUN BAYS
HARBOR SAFETY PLAN

Voted on and approved by the Harbor Safety Committee of the San Francisco Bay Region
June 14, 2012
Pursuant to the California Oil Spill and Prevention Act of 1990
Submitted by the Harbor Safety Committee of the San Francisco Bay Region
C/o Marine Exchange of the San Francisco Bay Region
505 Beach Street, Suite 300
San Francisco, California 94133-1131
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UNDERKEEL CLEARANCE

Many of the navigation channels within the Bay are subject to shoaling because of the nature of the Bay system, which is more fully described in Chapter V, Surveys, Charts and Dredging. Accurate tidal information is essential in order to calculate required underkeel clearances for vessel transit. This is particularly critical in the Bay region where minimal clearances may occur in certain channels. The committee reiterates its support for "real time" accurate measurement of tides, such as the P.O.R.T.S. system recommended in Chapter II, General Weather, Tides and Currents. Underkeel clearance is the distance between the deepest point on the vessel and the bottom of the channel in still water conditions. Tank vessels carrying oil or petroleum products as cargo should maintain minimum underkeel clearances as listed below. The underkeel clearances are minimum standards during normal, calm conditions. Masters and pilots should use prudent seamanship and should evaluate the need for additional clearance to accommodate squat rolling, listing, sink and pitch. The following are guidelines for underkeel clearance of tank vessels:

a. Tank vessels west of the Golden Gate Bridge: Ten percent (10%) of the vessel's draft.

b. Tank vessels under way east of the Golden Gate Bridge: Two feet (2).

c. Tank vessels at final approach to berth and at berth: Always afloat.

Regarding single hull tankers, on July 30, 1996, the Coast Guard published the Final Rule (33 CFR 157.455, effective November 27, 1996) on Operational Measures to Reduce Oil Spills for Existing Tank Vessels of 5,000 gross tons or more without double hulls. In part, the regulations require the Master to calculate the vessel's deepest navigational draft, the controlling depth of the waterway and the anticipated underkeel clearance. In addition, the Master and Pilot are to discuss the tanker's planned transit. The regulations can be found on the web in the Code of Federal Regulations at www.gpoaccess.gov. A Working Group was formed with representatives from the San Francisco Bar Pilots, Coast Guard, Port authorities and the maritime industry to evaluate the process of calculating, in a dynamic condition, underkeel clearances. The above guidelines on minimum clearances for the San Francisco Bay Area were established Captain of the Port. This is interpreted to be 2 feet for all commercial vessels.

APPENDIX C

Calculations of 58 port benefits where PORTS® have been installed

Total Traffic
Container Traffic
Bulk Traffic

Table C-1

DEMOGRAPHICS OF ALL MARINE TRAFFIC AT LOCATIONS WITH PORTS®
(PERCENT OF EACH PORT TOTAL WITH TWO FEET OR LESS DEPTH UNDER KEEL)

ALL TRAFFIC	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 2 FEET	% OF VALUE 2 FEET	% OF TRIPS 2 FEET
GRAND TOTAL – ALL TRAFFIC	271,483,773	138,507,538,072	76,628			
Lake Charles/Cameron, LA	30,166,393	13,405,769,600	1,589	1.3%	0.8%	0.1%
New York, NY and NJ	22,672,050	23,774,438,400	46,091	1.0%	1.5%	2.0%
Pascagoula/Moss Point, MS	21,380,166	8,535,240,989	407	0.9%	0.5%	0.0%
Newport News, VA	20,716,909	3,594,652,782	2,728	0.9%	0.2%	0.1%
Norfolk Harbor/Hampton Roads	17,729,780	11,237,976,450	979	0.7%	0.7%	0.0%
Houston, TX	15,947,024	8,607,582,432	443	0.7%	0.5%	0.0%
Mobile, AL	13,961,934	2,718,529,053	478	0.6%	0.2%	0.0%
Texas City, TX	12,540,716	5,655,104,545	176	0.5%	0.4%	0.0%
Philadelphia, PA	12,264,481	5,659,728,065	142	0.5%	0.4%	0.0%
Tampa, FL	12,041,450	2,106,528,210	363	0.5%	0.1%	0.0%
Marcus Hook, PA	7,905,970	3,648,392,543	92	0.3%	0.2%	0.0%
Kalama, WA	7,858,736	2,400,867,410	126	0.3%	0.1%	0.0%
Charleston, SC	7,130,959	17,789,880,384	1,798	0.3%	1.1%	0.1%
New Orleans, LA	6,829,241	1,623,631,157	375	0.3%	0.1%	0.0%
Paulsboro, NJ	6,305,566	2,909,849,125	73	0.3%	0.2%	0.0%

Portland, OR	5,314,390	1,336,129,890	110	0.2%	0.1%	0.0%
Jacksonville/Mayport, FL	5,133,561	1,153,189,718	18,379	0.2%	0.1%	0.8%
Providence, RI	4,107,625	1,017,084,190	238	0.2%	0.1%	0.0%
Tacoma, WA	4,030,320	5,021,049,000	126	0.2%	0.3%	0.0%
South Louisiana, LA, Port	3,250,655	392,923,460	65	0.1%	0.0%	0.0%
Plaquemines, LA, Port of	2,941,408	517,269,083	460	0.1%	0.0%	0.0%
Baton Rouge, LA	2,827,649	856,094,113	195	0.1%	0.1%	0.0%
Long Beach, CA	2,782,660	3,403,539,240	8	0.1%	0.2%	0.0%
Los Angeles, CA	2,662,420	3,405,279,620	6	0.1%	0.2%	0.0%
Vancouver, WA	2,592,900	614,202,700	60	0.1%	0.0%	0.0%
Richmond, CA	2,281,500	1,039,011,650	18	0.1%	0.1%	0.0%
Fall River, MA	1,984,027	225,094,239	54	0.1%	0.0%	0.0%
Baltimore, MD	1,947,575	295,914,134	33	0.1%	0.0%	0.0%
Camden-Gloucester, NJ	1,934,694	892,809,493	22	0.1%	0.1%	0.0%
Galveston & Bolivar, TX	1,872,951	461,597,437	36	0.1%	0.0%	0.0%
Wilmington, DE	1,738,579	802,307,472	20	0.1%	0.0%	0.0%
Nikishka/Kenai, AK	1,425,973	647,075,432	160	0.1%	0.0%	0.0%
Beaumont, TX	815,823	378,661,392	10	0.0%	0.0%	0.0%
Redwood City, CA	794,860	199,131,180	16	0.0%	0.0%	0.0%
Pennsbury Manor, PA	792,771	365,842,641	9	0.0%	0.0%	0.0%
Longview, WA	685,070	61,605,235	17	0.0%	0.0%	0.0%

Port Manatee, FL	663,210	251,103,790	13	0.0%	0.0%	0.0%
New Castle, DE	579,662	267,498,403	7	0.0%	0.0%	0.0%
Chester, PA	517,180	238,664,732	6	0.0%	0.0%	0.0%
Oakland, CA	495,410	447,033,550	36	0.0%	0.0%	0.0%
New Haven, CT	438,397	122,932,596	110	0.0%	0.0%	0.0%
Hopewell, VA	390,005	3,276,039	376	0.0%	0.0%	0.0%
Anchorage, AK	330,647	58,430,078	14	0.0%	0.0%	0.0%
Trenton, NJ	214,603	99,033,328	2	0.0%	0.0%	0.0%
Empire/Venice, LA	173,480	57,515,070	46	0.0%	0.0%	0.0%
Weedon Island/St. Petersburg	121,846	53,399,018	23	0.0%	0.0%	0.0%
New London/Groton, CT	55,866	57,047,269	19	0.0%	0.0%	0.0%
Richmond, VA	54,465	71,018,832	34	0.0%	0.0%	0.0%
Port Arthur, TX	41,908	13,045,541	1	0.0%	0.0%	0.0%
Reedville, VA	13,889	6,047,934	29	0.0%	0.0%	0.0%
Anacortes, WA	13,490	2,835,600	3	0.0%	0.0%	0.0%
Humboldt/Eureka, CA	6,940	1,157,770	2	0.0%	0.0%	0.0%
San Francisco, CA	3,870	2,065,660	1	0.0%	0.0%	0.0%
Newport, RI	119	1,450,398	4	0.0%	0.0%	0.0%
Annapolis, MD	-	-	-	0.0%	0.0%	0.0%
Astoria, OR	-	-	-	0.0%	0.0%	0.0%
Orange, TX	-	-	-	0.0%	0.0%	0.0%
Sabine Pass, TX	-	-	-	0.0%	0.0%	0.0%

Washington, DC	-	-	-	0.0%	0.0%	0.0%
Alexandria, VA	-	-	-	0.0%	0.0%	0.0%

Source: USACE, CPT

Table C-2

DEMOGRAPHICS OF ALL MARINE TRAFFIC AT LOCATIONS WITH PORTS®
(PERCENT OF EACH PORT TOTAL WITH FOUR FEET OR LESS DEPTH UNDER KEEL)

ALL TRAFFIC	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 4 FEET	% OF VALUE 4 FEET	% OF TRIPS 4 FEET
GRAND TOTAL – ALL TRAFFIC	422,238,993	222,854,166,599	76,628			
Houston, TX	40,588,674	24,038,175,800	1,290	9.6%	10.8%	1.4%
Lake Charles/Cameron, LA	38,132,398	17,489,360,000	5,142	9.0%	7.8%	5.5%
New York, NY and NJ	31,023,790	37,087,753,360	47,197	7.3%	16.6%	50.6%
Pascagoula/Moss Point, MS	26,432,410	10,139,682,200	570	6.3%	4.5%	0.6%
Beaumont, TX	25,348,023	11,828,466,200	394	6.0%	5.3%	0.4%
Mobile, AL	23,371,293	4,674,548,506	3,789	5.5%	2.1%	4.1%
Texas City, TX	23,152,106	10,557,282,900	343	5.5%	4.7%	0.4%
Norfolk Harbor/Hampton Roads	21,087,380	19,514,619,020	1,693	5.0%	8.8%	1.8%
Newport News, VA	20,724,783	3,597,394,116	2,986	4.9%	1.6%	3.2%
Philadelphia, PA	14,125,101	7,000,157,779	226	3.3%	3.1%	0.2%
Tampa, FL	13,851,410	2,562,128,860	457	3.3%	1.1%	0.5%
Port Arthur, TX	12,680,630	5,144,949,020	207	3.0%	2.3%	0.2%
Baltimore, MD	11,145,992	1,364,596,983	147	2.6%	0.6%	0.2%
New Orleans, LA	9,294,084	2,231,393,779	2,614	2.2%	1.0%	2.8%
Marcus Hook, PA	9,105,369	4,512,464,760	146	2.2%	2.0%	0.2%

Kalama, WA	8,025,485	2,446,493,240	132	1.9%	1.1%	0.1%
Charleston, SC	7,637,968	18,314,504,274	1,868	1.8%	8.2%	2.0%
Jacksonville/Mayport, FL	7,356,642	2,914,661,247	18,648	1.7%	1.3%	20.0%
Paulsboro, NJ	7,262,171	3,599,007,365	116	1.7%	1.6%	0.1%
Tacoma, WA	7,227,910	8,261,203,000	254	1.7%	3.7%	0.3%
Richmond, CA	7,001,170	3,257,421,590	74	1.7%	1.5%	0.1%
Portland, OR	6,782,330	1,675,181,940	148	1.6%	0.8%	0.2%
South Louisiana, LA, Port	5,636,838	533,744,558	74	1.3%	0.2%	0.1%
Baton Rouge, LA	5,599,682	1,650,860,741	1,655	1.3%	0.7%	1.8%
Plaquemines, LA, Port of	4,398,004	821,232,596	1,044	1.0%	0.4%	1.1%
Providence, RI	4,319,326	1,104,783,480	306	1.0%	0.5%	0.3%
Galveston & Bolivar, TX	3,323,156	805,442,643	76	0.8%	0.4%	0.1%
Los Angeles, CA	3,055,680	3,852,976,650	28	0.7%	1.7%	0.0%
Vancouver, WA	2,999,840	790,491,830	102	0.7%	0.4%	0.1%
Long Beach, CA	2,993,190	3,521,099,710	11	0.7%	1.6%	0.0%
Camden-Gloucester, NJ	2,228,203	1,104,259,294	36	0.5%	0.5%	0.0%
Wilmington, DE	2,002,335	992,323,099	32	0.5%	0.4%	0.0%
Fall River, MA	1,988,646	225,137,196	58	0.5%	0.1%	0.1%
Nikishka/Kenai, AK	1,829,249	782,833,000	170	0.4%	0.4%	0.2%
New Haven, CT	1,235,348	254,867,340	150	0.3%	0.1%	0.2%
Longview, WA	1,235,022	128,818,996	33	0.3%	0.1%	0.0%

Oakland, CA	1,209,550	1,548,553,500	158	0.3%	0.7%	0.2%
Port Manatee, FL	1,172,350	464,726,810	32	0.3%	0.2%	0.0%
Pennsbury Manor, PA	913,041	452,487,501	15	0.2%	0.2%	0.0%
Redwood City, CA	870,760	215,334,510	18	0.2%	0.1%	0.0%
Sabine Pass, TX	802,580	267,012,007	10	0.2%	0.1%	0.0%
New Castle, DE	667,601	330,851,766	11	0.2%	0.1%	0.0%
Chester, PA	595,641	295,189,232	10	0.1%	0.1%	0.0%
Hopewell, VA	466,127	3,915,465	490	0.1%	0.0%	0.5%
Anchorage, AK	415,311	63,925,619	18	0.1%	0.0%	0.0%
Trenton, NJ	247,160	122,488,026	4	0.1%	0.1%	0.0%
Empire/Venice, LA	173,480	57,515,070	48	0.0%	0.0%	0.1%
San Francisco, CA	123,540	29,807,340	2	0.0%	0.0%	0.0%
Weedon Island/St. Petersburg	121,846	53,399,018	36	0.0%	0.0%	0.0%
Washington, DC	104,869	25,123,467	35	0.0%	0.0%	0.0%
New London/Groton, CT	64,582	61,009,650	23	0.0%	0.0%	0.0%
Richmond, VA	54,479	71,018,844	36	0.0%	0.0%	0.0%
Reedville, VA	13,889	6,047,934	29	0.0%	0.0%	0.0%
Anacortes, WA	13,490	2,835,600	5	0.0%	0.0%	0.0%
Humboldt/Eureka, CA	6,940	1,157,770	2	0.0%	0.0%	0.0%
Newport, RI	119	1,450,398	7	0.0%	0.0%	0.0%
Annapolis, MD	-	-	-	0.0%	0.0%	0.0%

Astoria, OR	-	-	-	0.0%	0.0%	0.0%
Orange, TX	-	-	-	0.0%	0.0%	0.0%
Arlington, VA	-	-	-	0.0%	0.0%	0.0%

Source: USACE, CPT

Table C-3

DEMOGRAPHICS OF MARINE CONTAINER TRAFFIC AT LOCATIONS WITH PORTS® (PERCENT OF EACH PORT TOTAL WITH TWO FEET OR LESS DEPTH UNDER KEEL)

CONTAINERS ONLY	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 2 FEET	% OF VALUE 2 FEET	% OF TRIPS 2 FEET
TOTAL (CONTAINER TRAFFIC)	21,478,748	57,198,225,609	7,850			
Charleston, SC	6,740,432	17,669,701,764	1,718	31.4%	30.9%	21.9%
New York, NY and NJ	5,722,500	18,196,180,530	5,261	26.6%	31.8%	67.0%
Norfolk Harbor/Hampton Roads	3,008,390	7,642,172,800	548	14.0%	13.4%	7.0%
Tacoma, WA	1,852,866	4,095,510,332	114	8.6%	7.2%	1.5%
Long Beach, CA	1,226,480	2,648,571,370	-	5.7%	4.6%	0.0%
Houston, TX	1,197,733	2,749,573,678	74	5.6%	4.8%	0.9%
Los Angeles, CA	520,460	2,403,462,910	1	2.4%	4.2%	0.0%
Jacksonville/Mayport, FL	281,878	646,927,467	73	1.3%	1.1%	0.9%
Oakland, CA	257,160	433,261,231	32	1.2%	0.8%	0.4%
Pascagoula/Moss Point, MS	163,860	79,594,995	1	0.8%	0.1%	0.0%
Philadelphia, PA	154,871	180,457,946	7	0.7%	0.3%	0.1%
Marcus Hook, PA	99,833	116,327,396	5	0.5%	0.2%	0.1%
Paulsboro, NJ	79,624	92,779,263	4	0.4%	0.2%	0.1%
Lake Charles/Cameron, LA	41,682	23,010,817	3	0.2%	0.0%	0.0%

Richmond, VA	33,715	70,530,281	1	0.2%	0.1%	0.0%
Camden-Gloucester, NJ	24,431	28,466,839	1	0.1%	0.0%	0.0%
Wilmington, DE	21,954	25,581,222	1	0.1%	0.0%	0.0%
Tampa, FL	11,240	23,415,500	2	0.1%	0.0%	0.0%
Pennsbury Manor, PA	10,011	11,664,732	-	0.0%	0.0%	0.0%
Mobile, AL	8,584	30,603,672	1	0.0%	0.1%	0.0%
New Castle, DE	7,320	8,529,069	-	0.0%	0.0%	0.0%
Chester, PA	6,531	7,609,720	-	0.0%	0.0%	0.0%
Trenton, NJ	2,710	3,157,634	-	0.0%	0.0%	0.0%
New Orleans, LA	2,340	3,634,000	1	0.0%	0.0%	0.0%
Vancouver, WA	2,110	7,208,500	1	0.0%	0.0%	0.0%
Newport News, VA	30	279,420	1	0.0%	0.0%	0.0%
San Francisco, CA	3	12,521	-	0.0%	0.0%	0.0%
Alexandria, VA	-	-	-	0.0%	0.0%	0.0%
Anacortes, WA	-	-	-	0.0%	0.0%	0.0%
Anchorage, AK	-	-	-	0.0%	0.0%	0.0%
Annapolis, MD	-	-	-	0.0%	0.0%	0.0%
Astoria, OR	-	-	-	0.0%	0.0%	0.0%
Baltimore, MD	-	-	-	0.0%	0.0%	0.0%
Baton Rouge, LA	-	-	-	0.0%	0.0%	0.0%
Beaumont, TX	-	-	-	0.0%	0.0%	0.0%

Empire/Venice, LA	-	-	-	0.0%	0.0%	0.0%
Fall River, MA	-	-	-	0.0%	0.0%	0.0%
Galveston & Bolivar, TX	-	-	-	0.0%	0.0%	0.0%
Hopewell, VA	-	-	-	0.0%	0.0%	0.0%
Humboldt/Eureka, CA	-	-	-	0.0%	0.0%	0.0%
Kalama, WA	-	-	-	0.0%	0.0%	0.0%
Longview, WA	-	-	-	0.0%	0.0%	0.0%
New Haven, CT	-	-	-	0.0%	0.0%	0.0%
New London/Groton, CT	-	-	-	0.0%	0.0%	0.0%
Newport, RI	-	-	-	0.0%	0.0%	0.0%
Nikishka/Kenai, AK	-	-	-	0.0%	0.0%	0.0%
Orange, TX	-	-	-	0.0%	0.0%	0.0%
Plaquemines, LA, Port of	-	-	-	0.0%	0.0%	0.0%
Port Arthur, TX	-	-	-	0.0%	0.0%	0.0%
Port Manatee, FL	-	-	-	0.0%	0.0%	0.0%
Portland, OR	-	-	-	0.0%	0.0%	0.0%
Providence, RI	-	-	-	0.0%	0.0%	0.0%
Redwood City, CA	-	-	-	0.0%	0.0%	0.0%
Reedville, VA	-	-	-	0.0%	0.0%	0.0%
Richmond, CA	-	-	-	0.0%	0.0%	0.0%
Sabine Pass, TX	-	-	-	0.0%	0.0%	0.0%

South Louisiana, LA, Port	-	-	-	0.0%	0.0%	0.0%
Texas City, TX	-	-	-	0.0%	0.0%	0.0%
Washington, DC	-	-	-	0.0%	0.0%	0.0%
Weedon Island / St. Petersburg	-	-	-	0.0%	0.0%	0.0%

Source: USACE, CPT

Table C-4

DEMOGRAPHICS OF MARINE CONTAINER TRAFFIC AT LOCATIONS WITH PORTS®
(PERCENT OF EACH PORT TOTAL WITH FOUR FEET OR LESS DEPTH UNDER KEEL)

CONTAINERS ONLY	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 4 FEET	% OF VALUE 4 FEET	% OF TRIPS 4 FEET
TOTAL (CONTAINER TRAFFIC)	35,861,134	90,361,317,835	4,899			
New York, NY and NJ	10,285,320	30,332,727,550	881	28.7%	33.6%	18.0%
Charleston, SC	6,891,446	18,095,470,629	1,747	19.2%	20.0%	35.7%
Norfolk Harbor/Hampton Roads	6,324,820	15,914,825,500	1,252	17.6%	17.6%	25.6%
Houston, TX	3,403,753	7,853,695,574	263	9.5%	8.7%	5.4%
Tacoma, WA	3,332,643	7,009,660,175	214	9.3%	7.8%	4.4%
Long Beach, CA	1,226,480	2,648,571,370	-	3.4%	2.9%	0.0%
Oakland, CA	971,302	1,534,781,179	154	2.7%	1.7%	3.1%
Port Arthur, TX	799,834	388,519,366	1	2.2%	0.4%	0.0%
Jacksonville/Mayport, FL	745,044	1,839,477,287	239	2.1%	2.0%	4.9%
Los Angeles, CA	607,540	2,710,157,420	11	1.7%	3.0%	0.2%
Philadelphia, PA	370,707	652,028,430	43	1.0%	0.7%	0.9%
Marcus Hook, PA	238,967	420,312,714	28	0.7%	0.5%	0.6%
Paulsboro, NJ	190,593	335,228,890	22	0.5%	0.4%	0.4%
Pascagoula/Moss Point, MS	163,960	79,901,204	1	0.5%	0.1%	0.0%
Camden-Gloucester, NJ	58,478	102,856,032	7	0.2%	0.1%	0.1%

Wilmington, DE	52,550	92,429,756	6	0.1%	0.1%	0.1%
Lake Charles/Cameron, LA	43,932	32,648,197	9	0.1%	0.0%	0.2%
Richmond, VA	33,715	70,530,281	1	0.1%	0.1%	0.0%
Pennsbury Manor, PA	23,962	42,146,866	3	0.1%	0.0%	0.1%
New Orleans, LA	18,640	25,328,790	3	0.1%	0.0%	0.1%
New Castle, DE	17,521	30,817,128	2	0.0%	0.0%	0.0%
Chester, PA	15,632	27,495,348	2	0.0%	0.0%	0.0%
Mobile, AL	15,238	47,071,722	2	0.0%	0.1%	0.0%
Tampa, FL	11,680	23,912,260	2	0.0%	0.0%	0.0%
Vancouver, WA	10,650	38,271,690	1	0.0%	0.0%	0.0%
Trenton, NJ	6,487	11,409,125	1	0.0%	0.0%	0.0%
Kalama, WA	130	74,962	1	0.0%	0.0%	0.0%
Providence, RI	62	493,626	1	0.0%	0.0%	0.0%
Newport News, VA	30	279,420	1	0.0%	0.0%	0.0%
Port Manatee, FL	15	182,823	1	0.0%	0.0%	0.0%
San Francisco, CA	3	12,521	-	0.0%	0.0%	0.0%
Alexandria, VA	-	-	-	0.0%	0.0%	0.0%
Anacortes, WA	-	-	-	0.0%	0.0%	0.0%
Anchorage, AK	-	-	-	0.0%	0.0%	0.0%
Annapolis, MD	-	-	-	0.0%	0.0%	0.0%
Astoria, OR	-	-	-	0.0%	0.0%	0.0%

Baltimore, MD	-	-	-	0.0%	0.0%	0.0%
Baton Rouge, LA	-	-	-	0.0%	0.0%	0.0%
Beaumont, TX	-	-	-	0.0%	0.0%	0.0%
Empire/Venice, LA	-	-	-	0.0%	0.0%	0.0%
Fall River, MA	-	-	-	0.0%	0.0%	0.0%
Galveston & Bolivar, TX	-	-	-	0.0%	0.0%	0.0%
Hopewell, VA	-	-	-	0.0%	0.0%	0.0%
Humboldt/Eureka, CA	-	-	-	0.0%	0.0%	0.0%
Longview, WA	-	-	-	0.0%	0.0%	0.0%
New Haven, CT	-	-	-	0.0%	0.0%	0.0%
New London/Groton, CT	-	-	-	0.0%	0.0%	0.0%
Newport, RI	-	-	-	0.0%	0.0%	0.0%
Nikishka/Kenai, AK	-	-	-	0.0%	0.0%	0.0%
Orange, TX	-	-	-	0.0%	0.0%	0.0%
Plaquemines, LA, Port of	-	-	-	0.0%	0.0%	0.0%
Portland, OR	-	-		0.0%	0.0%	0.0%
Redwood City, CA	-	-	-	0.0%	0.0%	0.0%
Reedville, VA	-	-	-	0.0%	0.0%	0.0%
Richmond, CA	-	-	-	0.0%	0.0%	0.0%
Sabine Pass, TX	-	-	-	0.0%	0.0%	0.0%
South Louisiana, LA, Port	-	-	-	0.0%	0.0%	0.0%

Texas City, TX	-	-	-	0.0%	0.0%	0.0%
Washington, DC	-	-	-	0.0%	0.0%	0.0%
Weedon Island/St. Petersburg	-	-	-	0.0%	0.0%	0.0%
TOTAL	35,861,134	90,361,317,835	4,899			

Source: USACE, CPT

Table C-5

DEMOGRAPHICS OF MARINE BULK TRAFFIC AT LOCATIONS WITH PORTS®
(PERCENT OF EACH PORT TOTAL WITH TWO FEET OR LESS DEPTH UNDER KEEL)

TANK, BULK, RO-RO, GENERAL AND ALL OTHER THAN CONTAINER ONLY	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 2 FEET	% OF VALUE 2 FEET	% OF TRIPS 2 FEET
TOTAL (NON CONTAINER TRAFFIC)	250,005,025	81,309,312,463	68,778			
Lake Charles/Cameron, LA	30,124,711	13,382,758,783	1,586	12.0%	16.5%	2.3%
Pascagoula/Moss Point, MS	21,216,306	8,455,645,994	406	8.5%	10.4%	0.6%
Newport News, VA	20,716,879	3,594,373,362	2,727	8.3%	4.4%	4.0%
New York, NY and NJ	16,949,550	5,578,257,870	40,830	6.8%	6.9%	59.4%
Houston, TX	14,749,291	5,858,008,754	369	5.9%	7.2%	0.5%
Norfolk Harbor/Hampton Roads	14,721,390	3,595,803,650	431	5.9%	4.4%	0.6%
Mobile, AL	13,953,350	2,687,925,381	477	5.6%	3.3%	0.7%
Texas City, TX	12,540,716	5,655,104,545	176	5.0%	7.0%	0.3%
Philadelphia, PA	12,109,610	5,479,270,119	135	4.8%	6.7%	0.2%
Tampa, FL	12,030,210	2,083,112,710	361	4.8%	2.6%	0.5%
Kalama, WA	7,858,736	2,400,867,410	126	3.1%	3.0%	0.2%
Marcus Hook, PA	7,806,137	3,532,065,147	87	3.1%	4.3%	0.1%
New Orleans, LA	6,826,901	1,619,997,157	374	2.7%	2.0%	0.5%
Paulsboro, NJ	6,225,942	2,817,069,862	69	2.5%	3.5%	0.1%
Portland, OR	5,314,390	1,336,129,890	110	2.1%	1.6%	0.2%
Jacksonville/Mayport, FL	4,851,683	506,262,251	18,306	1.9%	0.6%	26.6%
Providence, RI	4,107,625	1,017,084,190	238	1.6%	1.3%	0.3%
South Louisiana, LA, Port	3,250,655	392,923,460	65	1.3%	0.5%	0.1%
Plaquemines, LA, Port of	2,941,408	517,269,083	460	1.2%	0.6%	0.7%
Baton Rouge, LA	2,827,649	856,094,113	195	1.1%	1.1%	0.3%
Vancouver, WA	2,590,790	606,994,200	59	1.0%	0.7%	0.1%

Richmond, CA	2,281,500	1,039,011,650	18	0.9%	1.3%	0.0%
Tacoma, WA	2,177,454	925,538,668	12	0.9%	1.1%	0.0%
Los Angeles, CA	2,141,960	1,001,816,710	5	0.9%	1.2%	0.0%
Fall River, MA	1,984,027	225,094,239	54	0.8%	0.3%	0.1%
Baltimore, MD	1,947,575	295,914,134	33	0.8%	0.4%	0.0%
Camden-Gloucester, NJ	1,910,263	864,342,654	21	0.8%	1.1%	0.0%
Galveston & Bolivar, TX	1,872,951	461,597,437	36	0.7%	0.6%	0.1%
Wilmington, DE	1,716,625	776,726,250	19	0.7%	1.0%	0.0%
Long Beach, CA	1,556,180	754,967,870	8	0.6%	0.9%	0.0%
Nikishka/Kenai, AK	1,425,973	647,075,432	160	0.6%	0.8%	0.2%
Beaumont, TX	815,823	378,661,392	10	0.3%	0.5%	0.0%
Redwood City, CA	794,860	199,131,180	16	0.3%	0.2%	0.0%
Pennsbury Manor, PA	782,760	354,177,909	9	0.3%	0.4%	0.0%
Longview, WA	685,070	61,605,235	17	0.3%	0.1%	0.0%
Port Manatee, FL	663,210	251,103,790	13	0.3%	0.3%	0.0%
New Castle, DE	572,342	258,969,334	7	0.2%	0.3%	0.0%
Chester, PA	510,649	231,055,012	6	0.2%	0.3%	0.0%
New Haven, CT	438,397	122,932,596	110	0.2%	0.2%	0.2%
Charleston, SC	390,527	120,178,620	80	0.2%	0.1%	0.1%
Hopewell, VA	390,005	3,276,039	376	0.2%	0.0%	0.5%
Anchorage, AK	330,647	58,430,078	14	0.1%	0.1%	0.0%
Oakland, CA	238,250	13,772,319	4	0.1%	0.0%	0.0%
Trenton, NJ	211,893	95,875,694	2	0.1%	0.1%	0.0%
Empire/Venice, LA	173,480	57,515,070	46	0.1%	0.1%	0.1%
Weedon Island/St. Petersburg	121,846	53,399,018	23	0.0%	0.1%	0.0%
New London/Groton, CT	55,866	57,047,269	19	0.0%	0.1%	0.0%
Port Arthur, TX	41,908	13,045,541	1	0.0%	0.0%	0.0%
Richmond, VA	20,750	488,551	33	0.0%	0.0%	0.0%
Reedville, VA	13,889	6,047,934	29	0.0%	0.0%	0.0%

Anacortes, WA	13,490	2,835,600	3	0.0%	0.0%	0.0%
Humboldt/Eureka, CA	6,940	1,157,770	2	0.0%	0.0%	0.0%
San Francisco, CA	3,867	2,053,139	1	0.0%	0.0%	0.0%
Newport, RI	119	1,450,398	4	0.0%	0.0%	0.0%
Annapolis, MD	-	-	-	0.0%	0.0%	0.0%
Astoria, OR	-	-	-	0.0%	0.0%	0.0%
Orange, TX	-	-	-	0.0%	0.0%	0.0%
Sabine Pass, TX	-	-	-	0.0%	0.0%	0.0%
Washington, DC	-	-	-	0.0%	0.0%	0.0%
Alexandria, VA	-	-	-	0.0%	0.0%	0.0%

Source: USACE, CPT

Table C-6

DEMOGRAPHICS OF MARINE BULK TRAFFIC AT LOCATIONS WITH PORTS®
(PERCENT OF EACH PORT TOTAL WITH FOUR FEET OR LESS DEPTH UNDER KEEL)

TANK, BULK, RO-RO, GENERAL AND ALL OTHER THAN CONTAINER ONLY	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 4 FEET	% OF VALUE 4 FEET	% OF TRIPS 4 FEET
TOTAL (NON CONTAINER TRAFFIC)	386,377,859	132,492,848,764	88,140			
Lake Charles/Cameron, LA	38,088,466	17,456,711,803	5,133	9.9%	13.2%	5.8%
Houston, TX	37,184,921	16,184,480,226	1,027	9.6%	12.2%	1.2%
Pascagoula/Moss Point, MS	26,268,450	10,059,780,996	569	6.8%	7.6%	0.6%
Beaumont, TX	25,348,023	11,828,466,200	394	6.6%	8.9%	0.4%
Mobile, AL	23,356,055	4,627,476,784	3,787	6.0%	3.5%	4.3%
Texas City, TX	23,152,106	10,557,282,900	343	6.0%	8.0%	0.4%
New York, NY and NJ	20,738,470	6,755,025,810	46,316	5.4%	5.1%	52.5%
Newport News, VA	20,724,753	3,597,114,696	2,985	5.4%	2.7%	3.4%
Norfolk Harbor/Hampton Roads	14,762,560	3,599,793,520	441	3.8%	2.7%	0.5%
Tampa, FL	13,839,730	2,538,216,600	455	3.6%	1.9%	0.5%
Philadelphia, PA	13,754,394	6,348,129,349	183	3.6%	4.8%	0.2%
Port Arthur, TX	11,880,796	4,756,429,654	206	3.1%	3.6%	0.2%
Baltimore, MD	11,145,992	1,364,596,983	147	2.9%	1.0%	0.2%
New Orleans, LA	9,275,444	2,206,064,989	2,611	2.4%	1.7%	3.0%
Marcus Hook, PA	8,866,402	4,092,152,046	118	2.3%	3.1%	0.1%
Kalama, WA	8,025,355	2,446,418,278	131	2.1%	1.8%	0.1%
Paulsboro, NJ	7,071,578	3,263,778,475	94	1.8%	2.5%	0.1%
Richmond, CA	7,001,170	3,257,421,590	74	1.8%	2.5%	0.1%
Portland, OR	6,782,330	1,675,181,940	None Reported	1.8%	1.3%	0.0%
Jacksonville/Mayport, FL	6,611,598	1,075,183,960	18,409	1.7%	0.8%	20.9%
South Louisiana, LA, Port	5,636,838	533,744,558	74	1.5%	0.4%	0.1%

Baton Rouge, LA	5,599,682	1,650,860,741	1,655	1.4%	1.2%	1.9%
Plaquemines, LA, Port of	4,398,004	821,232,596	1,044	1.1%	0.6%	1.2%
Providence, RI	4,319,264	1,104,289,854	305	1.1%	0.8%	0.3%
Tacoma, WA	3,895,267	1,251,542,825	40	1.0%	0.9%	0.0%
Galveston & Bolivar, TX	3,323,156	805,442,643	76	0.9%	0.6%	0.1%
Vancouver, WA	2,989,190	752,220,140	101	0.8%	0.6%	0.1%
Los Angeles, CA	2,448,140	1,142,819,230	17	0.6%	0.9%	0.0%
Camden-Gloucester, NJ	2,169,725	1,001,403,262	29	0.6%	0.8%	0.0%
Fall River, MA	1,988,646	225,137,196	58	0.5%	0.2%	0.1%
Wilmington, DE	1,949,785	899,893,343	26	0.5%	0.7%	0.0%
Nikishka/Kenai, AK	1,829,249	782,833,000	170	0.5%	0.6%	0.2%
Long Beach, CA	1,766,710	872,528,340	11	0.5%	0.7%	0.0%
New Haven, CT	1,235,348	254,867,340	150	0.3%	0.2%	0.2%
Longview, WA	1,235,022	128,818,996	33	0.3%	0.1%	0.0%
Port Manatee, FL	1,172,335	464,543,987	31	0.3%	0.4%	0.0%
Pennsbury Manor, PA	889,079	410,340,635	12	0.2%	0.3%	0.0%
Redwood City, CA	870,760	215,334,510	18	0.2%	0.2%	0.0%
Sabine Pass, TX	802,580	267,012,007	10	0.2%	0.2%	0.0%
Charleston, SC	746,522	219,033,645	121	0.2%	0.2%	0.1%
New Castle, DE	650,080	300,034,638	9	0.2%	0.2%	0.0%
Chester, PA	580,009	267,693,884	8	0.2%	0.2%	0.0%
Hopewell, VA	466,127	3,915,465	490	0.1%	0.0%	0.6%
Anchorage, AK	415,311	63,925,619	None Reported	0.1%	0.0%	0.0%
Trenton, NJ	240,673	111,078,901	3	0.1%	0.1%	0.0%
Oakland, CA	238,248	13,772,321	4	0.1%	0.0%	0.0%
Empire/Venice, LA	173,480	57,515,070	48	0.0%	0.0%	0.1%
San Francisco, CA	123,537	29,794,819	2	0.0%	0.0%	0.0%
Weedon Island/St. Petersburg	121,846	53,399,018	36	0.0%	0.0%	0.0%
Washington, DC	104,869	25,123,467	35	0.0%	0.0%	0.0%

New London/Groton, CT	64,582	61,009,650	23	0.0%	0.0%	0.0%
Richmond, VA	20,764	488,563	35	0.0%	0.0%	0.0%
Reedville, VA	13,889	6,047,934	29	0.0%	0.0%	0.0%
Anacortes, WA	13,490	2,835,600	5	0.0%	0.0%	0.0%
Humboldt/Eureka, CA	6,940	1,157,770	2	0.0%	0.0%	0.0%
Newport, RI	119	1,450,398	7	0.0%	0.0%	0.0%
Annapolis, MD	-	-	-	0.0%	0.0%	0.0%
Astoria, OR	-	-	-	0.0%	0.0%	0.0%
Orange, TX	-	-	-	0.0%	0.0%	0.0%
Alexandria, VA	-	-	-	0.0%	0.0%	0.0%

Source: USACE, CPT

APPENDIX D

Calculations of 117 port benefits where PORTS® could be installed

Total Traffic
Container Traffic
Bulk Traffic

Table D-1

**POTENTIAL PORTS® BENEFITS AT 117 NON-PORTS® LOCATIONS FOR ALL TRAFFIC
(PERCENT OF EACH PORT TOTAL WITH TWO FEET OR LESS DEPTH UNDER KEEL)**

ALL TRAFFIC	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 2 FEET	% OF VALUE 2 FEET	% OF TRIPS 2 FEET
TOTAL WITHOUT PORTS	179,586,678	49,542,332,624	22,600	100.0%	100.0%	100.0%
Freeport, TX	18,693,467	9,166,484,605	813	10.4%	18.5%	3.6%
Portland, ME	7,470,950	3,632,630,978	65	4.2%	7.3%	0.3%
Savannah, GA	2,065,361	3,325,203,174	262	1.2%	6.7%	1.2%
Corpus Christi/Port Ingle	6,581,761	2,908,158,719	76	3.7%	5.9%	0.3%
Valdez, AK	5,800,998	2,817,834,778	31	3.2%	5.7%	0.1%
Duluth-Superior, MN and W	26,989,953	2,811,967,590	1,014	15.0%	5.7%	4.5%
Albany, NY	7,355,935	2,186,468,908	1,198	4.1%	4.4%	5.3%
Wilmington, NC	1,531,181	2,130,897,525	149	0.9%	4.3%	0.7%
Seattle, WA	1,299,190	1,580,105,080	74	0.7%	3.2%	0.3%
Honolulu/Pearl Harbor, HI	999,299	1,459,258,525	66	0.6%	2.9%	0.3%
Kivilina, AK	2,162,783	1,248,233,469	1,469	1.2%	2.5%	6.5%
Chicago, IL	7,784,320	1,230,727,700	3,516	4.3%	2.5%	15.6%
Morehead City/Beaufort, N	1,659,294	1,215,286,271	157	0.9%	2.5%	0.7%
Boston, MA	1,464,060	965,269,360	377	0.8%	1.9%	1.7%
Dutch Harbor, AK	354,491	929,829,764	165	0.2%	1.9%	0.7%
Brownsville/Port Isabel,	1,683,630	847,339,910	111	0.9%	1.7%	0.5%
Indiana Harbor, IN	8,955,233	824,464,366	754	5.0%	1.7%	3.3%
St. Clair, MI	9,222,471	761,266,017	209	5.1%	1.5%	0.9%
Toledo, OH	5,277,898	713,076,717	None reported	2.9%	1.4%	0.0%
Miami, FL	256,201	691,367,062	74	0.1%	1.4%	0.3%

Port Everglades, FL	828,579	507,376,069	190	0.5%	1.0%	0.8%
Two Harbors, MN	5,478,827	497,203,552	126	3.1%	1.0%	0.6%
Cleveland, OH	2,372,453	459,077,155	160	1.3%	0.9%	0.7%
Brunswick, GA	263,510	458,516,412	47	0.1%	0.9%	0.2%
Burns Waterway Harbor, IN	4,374,138	431,245,887	86	2.4%	0.9%	0.4%
Detroit, MI	4,784,321	423,292,746	166	2.7%	0.9%	0.7%
Fajardo, PR	295,613	415,877,323	2,109	0.2%	0.8%	9.3%
Ashtabula, OH	3,957,503	362,298,048	278	2.2%	0.7%	1.2%
Silver Bay, MN	3,627,182	338,305,183	143	2.0%	0.7%	0.6%
Milwaukee, WI	2,104,620	257,283,032	1,464	1.2%	0.5%	6.5%
Portsmouth, NH	1,334,879	250,101,045	45	0.7%	0.5%	0.2%
Escanaba, MI	2,872,224	248,197,885	78	1.6%	0.5%	0.3%
Stockton, CA	612,449	226,846,129	31	0.3%	0.5%	0.1%
Barbers Point, Oahu, HI	444,229	215,784,237	7	0.2%	0.4%	0.0%
Matagorda Ship Channel, T	218,569	210,252,196	144	0.1%	0.4%	0.6%
Gary, IN	1,635,768	157,715,341	38	0.9%	0.3%	0.2%
Gulfport, MS	163,993	155,851,671	8	0.1%	0.3%	0.0%
Panama City, FL	170,610	152,086,460	22	0.1%	0.3%	0.1%
Bridgeport, CT	1,035,153	134,674,210	89	0.6%	0.3%	0.4%
Green Bay, WI	1,909,845	128,466,673	1,911	1.1%	0.3%	8.5%
Sacramento, CA	183,410	126,522,170	46	0.1%	0.3%	0.2%
Buffalo, NY	1,206,110	126,031,350	135	0.7%	0.3%	0.6%
San Juan, PR	355,259	119,727,132	11	0.2%	0.2%	0.0%
Muskegon, MI	1,304,261	103,427,460	57	0.7%	0.2%	0.3%
Ponce, PR	304,126	101,779,294	9	0.2%	0.2%	0.0%
Grays Harbor/Westport, WA	428,790	97,898,830	67	0.2%	0.2%	0.3%
Sandusky, OH	848,114	96,430,564	53	0.5%	0.2%	0.2%
Oswego, NY	174,142	94,296,101	32	0.1%	0.2%	0.1%
Monroe, MI	828,070	94,151,560	42	0.5%	0.2%	0.2%

Kahului, Maui, HI	224,563	87,353,777	7	0.1%	0.2%	0.0%
Everett, WA	162,370	84,546,570	36	0.1%	0.2%	0.2%
Port Canaveral, FL	655,999	82,269,858	26	0.4%	0.2%	0.1%
Kawaihae Harbor, HI	45,889	80,654,789	391	0.0%	0.2%	1.7%
Coos Bay/Charleston, OR	1,256,403	79,749,791	76	0.7%	0.2%	0.3%
Conneaut, OH	906,347	71,490,826	24	0.5%	0.1%	0.1%
Salem, MA	570,079	64,835,435	11	0.3%	0.1%	0.0%
Taconite, MN	539,138	61,299,992	9	0.3%	0.1%	0.0%
Intracoastal City, LA	347,850	58,821,820	384	0.2%	0.1%	1.7%
Marine City, MI	675,800	55,783,728	15	0.4%	0.1%	0.1%
Palm Beach, FL	128,946	54,531,731	14	0.1%	0.1%	0.1%
Alpena, MI	728,240	46,532,076	114	0.4%	0.1%	0.5%
San Diego, CA	107,940	46,067,130	8	0.1%	0.1%	0.0%
Port Jefferson, NY	118,836	35,685,533	9	0.1%	0.1%	0.0%
Searsport, ME	213,808	32,167,569	4	0.1%	0.1%	0.0%
Stamford, CT	91,618	28,187,132	174	0.1%	0.1%	0.8%
Lorain, OH	274,201	18,422,584	19	0.2%	0.0%	0.1%
Olympia, WA	74,780	15,718,130	2	0.0%	0.0%	0.0%
Grand Haven, MI	383,631	14,182,619	31	0.2%	0.0%	0.1%
Ketchikan, AK	39,818	14,088,484	853	0.0%	0.0%	3.8%
Victoria, TX	40,633	13,283,907	40	0.0%	0.0%	0.2%
Marquette, MI	355,069	13,002,782	23	0.2%	0.0%	0.1%
Holland, MI	175,719	11,082,199	24	0.1%	0.0%	0.1%
Huron, OH	651,540	9,388,667	43	0.4%	0.0%	0.2%
New Bedford, MA	9,410	7,156,650	3	0.0%	0.0%	0.0%
St. Joseph, MI	87,072	4,411,465	24	0.0%	0.0%	0.1%
Erie, PA	111,653	2,257,769	6	0.1%	0.0%	0.0%
Presque Isle & Stoneport,	2,407,358	2,142,551	147	1.3%	0.0%	0.7%
Calcite, MI	2,045,681	1,820,656	105	1.1%	0.0%	0.5%

Marysville/Port Huron, MI	20,272	1,673,352	None reported	0.0%	0.0%	0.0%
Port Dolomite, MI	1,674,482	1,624,528	77	0.9%	0.0%	0.3%
Hempstead, NY	4,851	1,189,145	2	0.0%	0.0%	0.0%
Port Inland, MI	899,453	800,514	35	0.5%	0.0%	0.2%
Biloxi, MS	6,400	727,680	9	0.0%	0.0%	0.0%
Manistee, MI	28,526	580,219	2	0.0%	0.0%	0.0%
Drummond Island, MI	634,970	565,124	59	0.4%	0.0%	0.3%
Hilo, HI	7,727	478,147	1	0.0%	0.0%	0.0%
Buffington, IN	527,785	469,730	30	0.3%	0.0%	0.1%
Petersburg, AK	93	344,481	5	0.0%	0.0%	0.0%
Marblehead, OH	236,906	210,846	18	0.1%	0.0%	0.1%
St. Thomas, VI	140	51,217	14	0.0%	0.0%	0.1%
Kelleys Island, OH	54,448	48,458	4	0.0%	0.0%	0.0%
Pensacola, FL	36,109	32,137	5	0.0%	0.0%	0.0%
Fairport Harbor, OH	16,397	14,593	1	0.0%	0.0%	0.0%
Nawiliwili, Kauai, HI	200,494	-	132	0.1%	0.0%	0.6%
Kings Bay, GA	82,011	-	1,410	0.0%	0.0%	6.2%

Source: USACE, CPT

Table D-2

POTENTIAL PORTS® BENEFITS AT 117 NON-PORTS® LOCATIONS FOR ALL TRAFFIC (PERCENT OF EACH PORT TOTAL WITH FOUR FEET OR LESS DEPTH UNDER KEEL)

ALL TRAFFIC	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 4 FEET	% OF VALUE 4 FEET	% OF TRIPS 4 FEET
TOTAL WITHOUT PORTS	264,489,700	88,839,057,134	41,458	100.0%	100.0%	100.0%
Freeport, TX	19,372,666	9,516,633,677	1,444	7.3%	10.7%	3.5%
Savannah, GA	4,139,576	7,471,295,353	529	1.6%	8.4%	1.3%
Seattle, WA	3,759,400	5,636,653,000	196	1.4%	6.3%	0.5%
Corpus Christi/Port Ingle	12,025,053	5,266,055,643	155	4.5%	5.9%	0.4%
Intracoastal City, LA	1,112,840	5,083,670,520	4,697	0.4%	5.7%	11.3%
Portland, ME	8,823,330	4,289,549,564	82	3.3%	4.8%	0.2%
Honolulu/Pearl Harbor, HI	2,196,941	3,945,795,018	228	0.8%	4.4%	0.5%
Duluth-Superior, MN and W	33,315,080	3,687,161,766	1,355	12.6%	4.2%	3.3%
Wilmington, NC	2,384,155	3,278,045,599	243	0.9%	3.7%	0.6%
Valdez, AK	6,641,472	3,226,095,024	36	2.5%	3.6%	0.1%
Chicago, IL	11,933,530	3,022,346,560	7,195	4.5%	3.4%	17.4%
Kawaihae Harbor, HI	775,151	2,415,401,299	681	0.3%	2.7%	1.6%
Miami, FL	815,826	2,409,343,648	320	0.3%	2.7%	0.8%
Albany, NY	7,663,688	2,290,861,207	1,400	2.9%	2.6%	3.4%
Boston, MA	3,671,090	2,280,374,360	566	1.4%	2.6%	1.4%
Brownsville/Port Isabel,	3,013,760	1,741,289,680	587	1.1%	2.0%	1.4%
Brunswick, GA	805,298	1,382,517,640	133	0.3%	1.6%	0.3%
Kivilina, AK	2,176,335	1,252,452,071	2,008	0.8%	1.4%	4.8%
Two Harbors, MN	13,617,973	1,235,831,056	344	5.1%	1.4%	0.8%

Morehead City/Beaufort, N	1,771,144	1,234,288,389	175	0.7%	1.4%	0.4%
Gulfport, MS	1,179,435	1,194,640,621	207	0.4%	1.3%	0.5%
Port Everglades, FL	1,648,251	1,193,925,166	467	0.6%	1.3%	1.1%
Victoria, TX	2,085,218	1,000,818,156	1,095	0.8%	1.1%	2.6%
St. Clair, MI	9,043,248	991,723,535	328	3.4%	1.1%	0.8%
Dutch Harbor, AK	390,359	973,902,692	174	0.1%	1.1%	0.4%
Toledo, OH	7,487,829	867,090,881	438	2.8%	1.0%	1.1%
Indiana Harbor, IN	8,970,662	823,294,037	794	3.4%	0.9%	1.9%
Detroit, MI	9,401,108	779,914,103	334	3.6%	0.9%	0.8%
Matagorda Ship Channel, T	4,089,294	740,866,863	261	1.5%	0.8%	0.6%
Panama City, FL	483,940	722,526,660	53	0.2%	0.8%	0.1%
Gary, IN	7,380,942	679,280,638	203	2.8%	0.8%	0.5%
Ashtabula, OH	5,453,313	554,136,320	414	2.1%	0.6%	1.0%
Barbers Point, Oahu, HI	1,055,196	512,561,458	11	0.4%	0.6%	0.0%
Cleveland, OH	3,298,033	507,673,043	284	1.2%	0.6%	0.7%
Silver Bay, MN	5,101,118	470,840,195	239	1.9%	0.5%	0.6%
Burns Waterway Harbor, IN	4,965,746	454,740,150	126	1.9%	0.5%	0.3%
San Juan, PR	740,720	424,472,991	27	0.3%	0.5%	0.1%
Fajardo, PR	329,390	415,877,323	2,317	0.1%	0.5%	5.6%
Everett, WA	188,130	367,046,530	85	0.1%	0.4%	0.2%
Stockton, CA	1,115,400	361,445,996	63	0.4%	0.4%	0.2%
Biloxi, MS	2,611,200	296,893,440	1,685	1.0%	0.3%	4.1%
Conneaut, OH	3,409,739	285,136,153	97	1.3%	0.3%	0.2%
Milwaukee, WI	2,154,392	264,669,704	1,478	0.8%	0.3%	3.6%
Escanaba, MI	2,872,224	248,197,885	78	1.1%	0.3%	0.2%
Ponce, PR	839,291	246,342,509	26	0.3%	0.3%	0.1%
Palm Beach, FL	429,662	164,435,057	68	0.2%	0.2%	0.2%
Grays Harbor/Westport, WA	719,210	160,018,270	98	0.3%	0.2%	0.2%
Sacramento, CA	234,146	151,052,573	52	0.1%	0.2%	0.1%

Bridgeport, CT	1,035,153	134,674,210	89	0.4%	0.2%	0.2%
Port Canaveral, FL	902,893	132,757,748	38	0.3%	0.1%	0.1%
Green Bay, WI	1,909,845	128,466,673	1,911	0.7%	0.1%	4.6%
Buffalo, NY	1,206,110	126,031,350	147	0.5%	0.1%	0.4%
Coos Bay/Charleston, OR	1,586,404	118,217,899	None reported	0.6%	0.1%	0.0%
Monroe, MI	1,033,720	117,533,965	48	0.4%	0.1%	0.1%
Sandusky, OH	1,021,560	116,151,374	99	0.4%	0.1%	0.2%
Oswego, NY	336,396	115,295,376	74	0.1%	0.1%	0.2%
Muskegon, MI	1,365,617	104,717,582	98	0.5%	0.1%	0.2%
Port Jefferson, NY	449,561	101,054,217	70	0.2%	0.1%	0.2%
Searsport, ME	499,010	98,853,348	17	0.2%	0.1%	0.0%
Kahului, Maui, HI	247,862	90,002,873	8	0.1%	0.1%	0.0%
Olympia, WA	386,380	83,201,470	13	0.1%	0.1%	0.0%
Alpena, MI	1,150,014	78,870,126	183	0.4%	0.1%	0.4%
Marine City, MI	662,667	72,671,096	24	0.3%	0.1%	0.1%
Taconite, MN	633,586	71,187,217	15	0.2%	0.1%	0.0%
Salem, MA	570,079	64,835,435	11	0.2%	0.1%	0.0%
Stamford, CT	505,710	58,292,078	618	0.2%	0.1%	1.5%
San Diego, CA	110,643	50,206,315	11	0.0%	0.1%	0.0%
Grand Haven, MI	730,552	34,582,811	86	0.3%	0.0%	0.2%
Lorain, OH	617,700	34,115,175	43	0.2%	0.0%	0.1%
New Bedford, MA	27,700	20,936,290	12	0.0%	0.0%	0.0%
Ketchikan, AK	56,560	18,413,479	925	0.0%	0.0%	2.2%
Marquette, MI	355,069	13,002,782	23	0.1%	0.0%	0.1%
Holland, MI	194,064	12,566,236	31	0.1%	0.0%	0.1%
Calcite, MI	4,284,597	10,885,292	242	1.6%	0.0%	0.6%
Huron, OH	651,540	9,388,667	57	0.2%	0.0%	0.1%
St. Joseph, MI	241,985	6,447,133	46	0.1%	0.0%	0.1%
Kodiak, AK	23,241	6,386,897	2	0.0%	0.0%	0.0%

Erie, PA	403,702	4,589,341	32	0.2%	0.0%	0.1%
Presque Isle & Stoneport,	4,361,990	3,882,178	303	1.6%	0.0%	0.7%
Fairport Harbor, OH	506,493	2,476,531	42	0.2%	0.0%	0.1%
Hempstead, NY	10,074	2,348,662	4	0.0%	0.0%	0.0%
Marysville/Port Huron, MI	19,878	2,179,924	1	0.0%	0.0%	0.0%
Marblehead, OH	1,695,577	2,026,440	190	0.6%	0.0%	0.5%
Port Dolomite, MI	1,674,482	1,624,528	77	0.6%	0.0%	0.2%
Manistee, MI	52,623	1,605,752	4	0.0%	0.0%	0.0%
Drummond Island, MI	983,823	1,478,000	113	0.4%	0.0%	0.3%
Buffington, IN	1,046,590	931,468	67	0.4%	0.0%	0.2%
Port Inland, MI	899,453	800,514	35	0.3%	0.0%	0.1%
Hilo, HI	7,727	478,147	2	0.0%	0.0%	0.0%
Petersburg, AK	93	344,481	63	0.0%	0.0%	0.2%
Nawiliwili, Kauai, HI	362,586	330,028	211	0.1%	0.0%	0.5%
Pensacola, FL	114,824	102,194	11	0.0%	0.0%	0.0%
St. Thomas, VI	180	64,988	14	0.0%	0.0%	0.0%
Kelleys Island, OH	54,448	48,458	4	0.0%	0.0%	0.0%
Kings Bay, GA	82,011	-	1,410	0.0%	0.0%	3.4%

Source: USACE, CPT

Table D-3

POTENTIAL PORTS® BENEFITS AT 117 NON-PORTS® LOCATIONS FOR CONTAINER TRAFFIC (PERCENT OF EACH PORT TOTAL WITH TWO FEET OR LESS DEPTH UNDER KEEL)

CONTAINER TRAFFIC	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 2 FEET	% OF VALUE 2 FEET	% OF TRIPS 2 FEET
TOTAL WITHOUT PORTS	5,306,173	10,729,909,048	864	100.0%	100.0%	100.0%
Savannah, GA	1,972,797	3,279,019,034	258	37.2%	30.6%	29.9%
Wilmington, NC	732,310	1,792,008,543	120	13.8%	16.7%	13.9%
Seattle, WA	918,501	1,451,617,056	64	17.3%	13.5%	7.4%
Honolulu/Pearl Harbor, HI	402,165	1,280,292,651	21	7.6%	11.9%	2.4%
Dutch Harbor, AK	338,173	924,940,374	159	6.4%	8.6%	18.4%
Miami, FL	256,201	691,367,062	74	4.8%	6.4%	8.6%
Boston, MA	286,000	681,399,280	82	5.4%	6.4%	9.5%
Port Everglades, FL	184,273	342,305,546	44	3.5%	3.2%	5.1%
Everett, WA	12,369	83,286,566	5	0.2%	0.8%	0.6%
Kahului, Maui, HI	161,924	80,231,722	5	3.1%	0.7%	0.6%
Kawaihae Harbor, HI	17,714	78,911,320	7	0.3%	0.7%	0.8%
San Juan, PR	4,530	10,548,701	2	0.1%	0.1%	0.2%
Stockton, CA	165	8,322,654	None reported	0.0%	0.1%	0.0%
Kivilina, AK	1,850	7,924,068	1	0.0%	0.1%	0.1%
Ketchikan, AK	2,432	6,229,947	7	0.0%	0.1%	0.8%
Palm Beach, FL	2,174	4,992,186	1	0.0%	0.0%	0.1%
Gulfport, MS	8,206	3,474,933	1	0.2%	0.0%	0.1%
Freeport, TX	3,792	1,425,134	1	0.1%	0.0%	0.1%
San Diego, CA	282	746,190	2	0.0%	0.0%	0.2%
Petersburg, AK	93	344,481	4	0.0%	0.0%	0.5%
Albany, NY	130	249,830	1	0.0%	0.0%	0.1%

Toledo, OH	16	89,227	1	0.0%	0.0%	0.1%
Corpus Christi/Port Ingle	31	87,517	1	0.0%	0.0%	0.1%
Marine City, MI	22	60,673	1	0.0%	0.0%	0.1%
Morehead City/Beaufort, NC	4	23,397	1	0.0%	0.0%	0.1%
Milwaukee, WI	19	10,956	1	0.0%	0.0%	0.1%

Source: USACE, CPT

Table D-4

POTENTIAL PORTS® BENEFITS AT 117 NON-PORTS® LOCATIONS FOR CONTAINER TRAFFIC (PERCENT OF EACH PORT TOTAL WITH FOUR FEET OR LESS DEPTH UNDER KEEL)

CONTAINER TRAFFIC	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 4 FEET	% OF VALUE 4 FEET	% OF TRIPS 4 FEET
TOTAL WITHOUT PORTS	12,697,442	28,203,184,549	2,200	100.0%	100.0%	100.0%
Savannah, GA	3,987,002	7,398,476,738	518	31.4%	26.2%	23.5%
Seattle, WA	2,057,142	4,852,060,359	147	16.2%	17.2%	6.7%
Honolulu/Pearl Harbor, HI	1,281,814	3,694,379,038	88	10.1%	13.1%	4.0%
Wilmington, NC	1,086,974	2,615,951,543	176	8.6%	9.3%	8.0%
Kawaihae Harbor, HI	746,976	2,413,657,830	268	5.9%	8.6%	12.2%
Miami, FL	812,616	2,403,409,657	235	6.4%	8.5%	10.7%
Boston, MA	669,140	1,572,344,450	182	5.3%	5.6%	8.3%
Port Everglades, FL	604,676	941,543,487	180	4.8%	3.3%	8.2%
Dutch Harbor, AK	338,254	925,008,254	164	2.7%	3.3%	7.5%
Gulfport, MS	890,210	891,233,140	192	7.0%	3.2%	8.7%
Everett, WA	37,638	361,812,736	15	0.3%	1.3%	0.7%
Kahului, Maui, HI	161,924	80,231,722	5	1.3%	0.3%	0.2%
Palm Beach, FL	8,157	14,413,052	1	0.1%	0.1%	0.0%
San Juan, PR	5,384	12,087,944	6	0.0%	0.0%	0.3%
Stockton, CA	165	8,322,654	None reported	0.0%	0.0%	0.0%
Kivilina, AK	1,850	7,924,068	1	0.0%	0.0%	0.0%
Ketchikan, AK	2,432	6,229,947	7	0.0%	0.0%	0.3%
Freeport, TX	3,916	1,613,812	1	0.0%	0.0%	0.0%
San Diego, CA	282	746,190	2	0.0%	0.0%	0.1%
Cleveland, OH	52	388,685	1	0.0%	0.0%	0.0%
Petersburg, AK	93	344,481	4	0.0%	0.0%	0.2%

Corpus Christi/Port Ingle	82	289,962	1	0.0%	0.0%	0.0%
New Bedford, MA	472	280,717	1	0.0%	0.0%	0.0%
Albany, NY	130	249,830	1	0.0%	0.0%	0.0%
Toledo, OH	16	89,227	1	0.0%	0.0%	0.0%
Marine City, MI	22	60,673	1	0.0%	0.0%	0.0%
Morehead City/Beaufort, N	4	23,397	1	0.0%	0.0%	0.0%
Milwaukee, MI	19	10,956	1	0.0%	0.0%	0.0%

Source: USACE, CPT

Table D-5

POTENTIAL PORTS® BENEFITS AT 117 NON-PORTS® LOCATIONS FOR BULK TRAFFIC (PERCENT OF EACH PORT TOTAL WITH TWO FEET OR LESS DEPTH UNDER KEEL)

BULK TRAFFIC (BULK, TANK, RO-RO, GENERAL, OTHER)	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 2 FEET	% OF VALUE 2 FEET	% OF TRIPS 2 FEET
TOTAL WITHOUT PORTS	174,280,505	38,812,423,576	21,737	100.0%	100.0%	100.0%
Freeport, TX	18,689,675	9,165,059,471	812	10.7%	23.6%	3.7%
Portland, ME	7,470,950	3,632,630,978	65	4.3%	9.4%	0.3%
Corpus Christi/Port Ingle	6,581,730	2,908,071,202	75	3.8%	7.5%	0.3%
Valdez, AK	5,800,998	2,817,834,778	31	3.3%	7.3%	0.1%
Duluth-Superior, MN and W	26,989,953	2,811,967,590	1,014	15.5%	7.2%	4.7%
Albany, NY	7,355,805	2,186,219,078	1,197	4.2%	5.6%	5.5%
Kivilina, AK	2,160,933	1,240,309,401	1,468	1.2%	3.2%	6.8%
Chicago, IL	7,784,320	1,230,727,700	3,516	4.5%	3.2%	16.2%
Morehead City/Beaufort, N	1,659,290	1,215,262,874	156	1.0%	3.1%	0.7%
Brownsville/Port Isabel,	1,683,630	847,339,910	111	1.0%	2.2%	0.5%
Indiana Harbor, IN	8,955,233	824,464,366	754	5.1%	2.1%	3.5%
St. Clair, MI	9,222,471	761,266,017	209	5.3%	2.0%	1.0%
Toledo, OH	5,277,882	712,987,490	None reported	3.0%	1.8%	0.0%
Two Harbors, MN	5,478,827	497,203,552	126	3.1%	1.3%	0.6%
Cleveland, OH	2,372,453	459,077,155	160	1.4%	1.2%	0.7%
Brunswick, GA	263,510	458,516,412	47	0.2%	1.2%	0.2%
Burns Waterway Harbor, IN	4,374,138	431,245,887	86	2.5%	1.1%	0.4%
Detroit, MI	4,784,321	423,292,746	166	2.7%	1.1%	0.8%
Fajardo, PR	295,613	415,877,323	2,109	0.2%	1.1%	9.7%
Ashtabula, OH	3,957,503	362,298,048	278	2.3%	0.9%	1.3%
Wilmington, NC	798,871	338,888,982	29	0.5%	0.9%	0.1%

Silver Bay, MN	3,627,182	338,305,183	143	2.1%	0.9%	0.7%
Boston, MA	1,178,060	283,870,080	295	0.7%	0.7%	1.4%
Milwaukee, WI	2,104,601	257,272,076	1,463	1.2%	0.7%	6.7%
Portsmouth, NH	1,334,879	250,101,045	45	0.8%	0.6%	0.2%
Escanaba, MI	2,872,224	248,197,885	78	1.6%	0.6%	0.4%
Stockton, CA	612,284	218,523,475	31	0.4%	0.6%	0.1%
Barbers Point, Oahu, HI	444,229	215,784,237	7	0.3%	0.6%	0.0%
Matagorda Ship Channel, T	218,569	210,252,196	144	0.1%	0.5%	0.7%
Honolulu/Pearl Harbor, HI	597,134	178,965,874	45	0.3%	0.5%	0.2%
Port Everglades, FL	644,306	165,070,523	146	0.4%	0.4%	0.7%
Gary, IN	1,635,768	157,715,341	38	0.9%	0.4%	0.2%
Gulfport, MS	155,787	152,376,738	7	0.1%	0.4%	0.0%
Panama City, FL	170,610	152,086,460	22	0.1%	0.4%	0.1%
Bridgeport, CT	1,035,153	134,674,210	89	0.6%	0.3%	0.4%
Seattle, WA	380,689	128,488,024	10	0.2%	0.3%	0.0%
Green Bay, WI	1,909,845	128,466,673	1,911	1.1%	0.3%	8.8%
Sacramento, CA	183,410	126,522,170	46	0.1%	0.3%	0.2%
Buffalo, NY	1,206,110	126,031,350	135	0.7%	0.3%	0.6%
San Juan, PR	350,729	109,178,431	9	0.2%	0.3%	0.0%
Muskegon, MI	1,304,261	103,427,460	57	0.7%	0.3%	0.3%
Ponce, PR	304,126	101,779,294	9	0.2%	0.3%	0.0%
Grays Harbor/Westport, WA	428,790	97,898,830	67	0.2%	0.3%	0.3%
Sandusky, OH	848,114	96,430,564	53	0.5%	0.2%	0.2%
Oswego, NY	174,142	94,296,101	32	0.1%	0.2%	0.1%
Monroe, MI	828,070	94,151,560	42	0.5%	0.2%	0.2%
Port Canaveral, FL	655,999	82,269,858	26	0.4%	0.2%	0.1%
Coos Bay/Charleston, OR	1,256,403	79,749,791	76	0.7%	0.2%	0.3%
Conneaut, OH	906,347	71,490,826	24	0.5%	0.2%	0.1%
Salem, MA	570,079	64,835,435	11	0.3%	0.2%	0.1%

Taconite, MN	539,138	61,299,992	9	0.3%	0.2%	0.0%
Intracoastal City, LA	347,850	58,821,820	384	0.2%	0.2%	1.8%
Marine City, MI	675,778	55,723,055	14	0.4%	0.1%	0.1%
Palm Beach, FL	126,772	49,539,545	13	0.1%	0.1%	0.1%
Alpena, MI	728,240	46,532,076	114	0.4%	0.1%	0.5%
Savannah, GA	92,564	46,184,140	4	0.1%	0.1%	0.0%
San Diego, CA	107,658	45,320,940	6	0.1%	0.1%	0.0%
Port Jefferson, NY	118,836	35,685,533	9	0.1%	0.1%	0.0%
Searsport, ME	213,808	32,167,569	4	0.1%	0.1%	0.0%
Stamford, CT	91,618	28,187,132	174	0.1%	0.1%	0.8%
Lorain, OH	274,201	18,422,584	19	0.2%	0.0%	0.1%
Olympia, WA	74,780	15,718,130	2	0.0%	0.0%	0.0%
Grand Haven, MI	383,631	14,182,619	31	0.2%	0.0%	0.1%
Victoria, TX	40,633	13,283,907	40	0.0%	0.0%	0.2%
Marquette, MI	355,069	13,002,782	23	0.2%	0.0%	0.1%
Holland, MI	175,719	11,082,199	24	0.1%	0.0%	0.1%
Huron, OH	651,540	9,388,667	43	0.4%	0.0%	0.2%
Ketchikan, AK	37,386	7,858,537	846	0.0%	0.0%	3.9%
New Bedford, MA	9,410	7,156,650	3	0.0%	0.0%	0.0%
Kahului, Maui, HI	62,639	7,122,055	2	0.0%	0.0%	0.0%
Dutch Harbor, AK	16,318	4,889,390	6	0.0%	0.0%	0.0%
St. Joseph, MI	87,072	4,411,465	24	0.0%	0.0%	0.1%
Erie, PA	111,653	2,257,769	6	0.1%	0.0%	0.0%
Presque Isle & Stoneport,	2,407,358	2,142,551	147	1.4%	0.0%	0.7%
Calcite, MI	2,045,681	1,820,656	105	1.2%	0.0%	0.5%
Kawaihae Harbor, HI	28,175	1,743,469	384	0.0%	0.0%	1.8%
Marysville/Port Huron, MI	20,272	1,673,352	None reported	0.0%	0.0%	0.0%
Port Dolomite, MI	1,674,482	1,624,528	77	1.0%	0.0%	0.4%
Everett, WA	150,001	1,260,004	31	0.1%	0.0%	0.1%

Hempstead, NY	4,851	1,189,145	2	0.0%	0.0%	0.0%
Port Inland, MI	899,453	800,514	35	0.5%	0.0%	0.2%
Biloxi, MS	6,400	727,680	9	0.0%	0.0%	0.0%
Manistee, MI	28,526	580,219	2	0.0%	0.0%	0.0%
Drummond Island, MI	634,970	565,124	59	0.4%	0.0%	0.3%
Hilo, HI	7,727	478,147	1	0.0%	0.0%	0.0%
Buffington, IN	527,785	469,730	30	0.3%	0.0%	0.1%
Marblehead, OH	236,906	210,846	18	0.1%	0.0%	0.1%
St. Thomas, VI	140	51,217	14	0.0%	0.0%	0.1%
Kelleys Island, OH	54,448	48,458	4	0.0%	0.0%	0.0%
Pensacola, FL	36,109	32,137	5	0.0%	0.0%	0.0%
Fairport Harbor, OH	16,397	14,593	1	0.0%	0.0%	0.0%
Nawiliwili, Kauai, HI	200,494	-	132	0.1%	0.0%	0.6%
Kings Bay, GA	82,011	-	1,410	0.0%	0.0%	6.5%
Petersburg, AK	-	-	1	0.0%	0.0%	0.0%

Source: USACE, CPT

Table D-6

POTENTIAL PORTS® BENEFITS AT 117 NON-PORTS® LOCATIONS FOR BULK TRAFFIC (PERCENT OF EACH PORT TOTAL WITH FOUR FEET OR LESS DEPTH UNDER KEEL)

BULK TRAFFIC (BULK, TANK, RO-RO, GENERAL, OTHER)	TOTAL TONS	TOTAL VALUE	TOTAL TRIPS	% OF TONS 4 FEET	% OF VALUE 4 FEET	% OF TRIPS 4 FEET
TOTAL WITHOUT PORTS	251,792,258	60,635,872,585	39,043	100.0%	100.0%	100.0%
Freeport, TX	19,368,750	9,515,019,865	1,443	7.7%	15.7%	3.7%
Corpus Christi/Port Ingle	12,024,971	5,265,765,681	154	4.8%	8.7%	0.4%
Intracoastal City, LA	1,112,840	5,083,670,520	4,697	0.4%	8.4%	12.0%
Portland, ME	8,823,330	4,289,549,564	82	3.5%	7.1%	0.2%
Duluth-Superior, MN and W	33,315,080	3,687,161,766	1,355	13.2%	6.1%	3.5%
Valdez, AK	6,641,472	3,226,095,024	36	2.6%	5.3%	0.1%
Chicago, IL	11,933,530	3,022,346,560	7,195	4.7%	5.0%	18.4%
Albany, NY	7,663,558	2,290,611,377	1,399	3.0%	3.8%	3.6%
Brownsville/Port Isabel,	3,013,760	1,741,289,680	587	1.2%	2.9%	1.5%
Brunswick, GA	805,298	1,382,517,640	133	0.3%	2.3%	0.3%
Kivilina, AK	2,174,485	1,244,528,003	2,007	0.9%	2.1%	5.1%
Two Harbors, MN	13,617,973	1,235,831,056	344	5.4%	2.0%	0.9%
Morehead City/Beaufort, N	1,771,140	1,234,264,992	174	0.7%	2.0%	0.4%
Victoria, TX	2,085,218	1,000,818,156	1,095	0.8%	1.7%	2.8%
St. Clair, MI	9,043,248	991,723,535	328	3.6%	1.6%	0.8%
Toledo, OH	7,487,813	867,001,654	437	3.0%	1.4%	1.1%
Indiana Harbor, IN	8,970,662	823,294,037	794	3.6%	1.4%	2.0%
Seattle, WA	1,702,258	784,592,641	49	0.7%	1.3%	0.1%
Detroit, MI	9,401,108	779,914,103	334	3.7%	1.3%	0.9%
Matagorda Ship Channel, TX	4,089,294	740,866,863	261	1.6%	1.2%	0.7%
Panama City, FL	483,940	722,526,660	53	0.2%	1.2%	0.1%

Boston, MA	3,001,950	708,029,910	384	1.2%	1.2%	1.0%
Gary, IN	7,380,942	679,280,638	203	2.9%	1.1%	0.5%
Wilmington, NC	1,297,181	662,094,056	67	0.5%	1.1%	0.2%
Ashtabula, OH	5,453,313	554,136,320	414	2.2%	0.9%	1.1%
Barbers Point, Oahu, HI	1,055,196	512,561,458	11	0.4%	0.8%	0.0%
Cleveland, OH	3,297,981	507,284,358	283	1.3%	0.8%	0.7%
Silver Bay, MN	5,101,118	470,840,195	239	2.0%	0.8%	0.6%
Burns Waterway Harbor, IN	4,965,746	454,740,150	126	2.0%	0.7%	0.3%
Fajardo, PR	329,390	415,877,323	2,317	0.1%	0.7%	5.9%
San Juan, PR	735,336	412,385,047	21	0.3%	0.7%	0.1%
Stockton, CA	1,115,235	353,123,342	63	0.4%	0.6%	0.2%
Gulfport, MS	289,225	303,407,481	15	0.1%	0.5%	0.0%
Biloxi, MS	2,611,200	296,893,440	1,685	1.0%	0.5%	4.3%
Conneaut, OH	3,409,739	285,136,153	97	1.4%	0.5%	0.2%
Portsmouth, NH	1,725,424	264,816,363	58	0.7%	0.4%	0.1%
Milwaukee, WI	2,154,373	264,658,748	1,477	0.9%	0.4%	3.8%
Port Everglades, FL	1,043,575	252,381,679	287	0.4%	0.4%	0.7%
Honolulu/Pearl Harbor, HI	915,127	251,415,980	140	0.4%	0.4%	0.4%
Escanaba, MI	2,872,224	248,197,885	78	1.1%	0.4%	0.2%
Ponce, PR	839,291	246,342,509	26	0.3%	0.4%	0.1%
Grays Harbor/Westport, WA	719,210	160,018,270	98	0.3%	0.3%	0.3%
Sacramento, CA	234,146	151,052,573	52	0.1%	0.2%	0.1%
Palm Beach, FL	421,505	150,022,005	67	0.2%	0.2%	0.2%
Bridgeport, CT	1,035,153	134,674,210	89	0.4%	0.2%	0.2%
Port Canaveral, FL	902,893	132,757,748	38	0.4%	0.2%	0.1%
Green Bay, WI	1,909,845	128,466,673	1,911	0.8%	0.2%	4.9%
Buffalo, NY	1,206,110	126,031,350	147	0.5%	0.2%	0.4%
Coos Bay/Charleston, OR	1,586,404	118,217,899	None reported	0.6%	0.2%	0.0%
Monroe, MI	1,033,720	117,533,965	48	0.4%	0.2%	0.1%

Sandusky, OH	1,021,560	116,151,374	99	0.4%	0.2%	0.3%
Oswego, NY	336,396	115,295,376	74	0.1%	0.2%	0.2%
Muskegon, MI	1,365,617	104,717,582	98	0.5%	0.2%	0.3%
Port Jefferson, NY	449,561	101,054,217	70	0.2%	0.2%	0.2%
Searsport, ME	499,010	98,853,348	17	0.2%	0.2%	0.0%
Olympia, WA	386,380	83,201,470	13	0.2%	0.1%	0.0%
Alpena, MI	1,150,014	78,870,126	183	0.5%	0.1%	0.5%
Savannah, GA	152,574	72,818,615	11	0.1%	0.1%	0.0%
Marine City, MI	662,645	72,610,423	23	0.3%	0.1%	0.1%
Taconite, MN	633,586	71,187,217	15	0.3%	0.1%	0.0%
Salem, MA	570,079	64,835,435	11	0.2%	0.1%	0.0%
Stamford, CT	505,710	58,292,078	618	0.2%	0.1%	1.6%
San Diego, CA	110,361	49,460,125	9	0.0%	0.1%	0.0%
Dutch Harbor, AK	52,105	48,894,438	10	0.0%	0.1%	0.0%
Grand Haven, MI	730,552	34,582,811	86	0.3%	0.1%	0.2%
Lorain, OH	617,700	34,115,175	43	0.2%	0.1%	0.1%
New Bedford, MA	27,228	20,655,573	11	0.0%	0.0%	0.0%
Marquette, MI	355,069	13,002,782	23	0.1%	0.0%	0.1%
Holland, MI	194,064	12,566,236	31	0.1%	0.0%	0.1%
Ketchikan, AK	54,128	12,183,532	918	0.0%	0.0%	2.4%
Calcite, MI	4,284,597	10,885,292	242	1.7%	0.0%	0.6%
Kahului, Maui, HI	85,938	9,771,151	3	0.0%	0.0%	0.0%
Huron, OH	651,540	9,388,667	57	0.3%	0.0%	0.1%
St. Joseph, MI	241,985	6,447,133	46	0.1%	0.0%	0.1%
Kodiak, AK	23,241	6,386,897	None reported	0.0%	0.0%	0.0%
Miami, FL	3,210	5,933,991	85	0.0%	0.0%	0.2%
Everett, WA	150,492	5,233,794	70	0.1%	0.0%	0.2%
Erie, PA	403,702	4,589,341	32	0.2%	0.0%	0.1%
Presque Isle & Stoneport, MI	4,361,990	3,882,178	303	1.7%	0.0%	0.8%

Fairport Harbor, OH	506,493	2,476,531	42	0.2%	0.0%	0.1%
Hempstead, NY	10,074	2,348,662	4	0.0%	0.0%	0.0%
Marysville/Port Huron, MI	19,878	2,179,924	1	0.0%	0.0%	0.0%
Marblehead, OH	1,695,577	2,026,440	190	0.7%	0.0%	0.5%
Kawaihae Harbor, HI	28,175	1,743,469	413	0.0%	0.0%	1.1%
Port Dolomite, MI	1,674,482	1,624,528	77	0.7%	0.0%	0.2%
Manistee, MI	52,623	1,605,752	4	0.0%	0.0%	0.0%
Drummond Island, MI	983,823	1,478,000	113	0.4%	0.0%	0.3%
Buffington, IN	1,046,590	931,468	67	0.4%	0.0%	0.2%
Port Inland, MI	899,453	800,514	35	0.4%	0.0%	0.1%
Hilo, HI	7,727	478,147	None reported	0.0%	0.0%	0.0%
Nawiliwili, Kauai, HI	362,586	330,028	None reported	0.1%	0.0%	0.0%
Pensacola, FL	114,824	102,194	11	0.0%	0.0%	0.0%
St. Thomas, VI	180	64,988	14	0.0%	0.0%	0.0%
Kelleys Island, OH	54,448	48,458	4	0.0%	0.0%	0.0%

Source: USACE, CPT

APPENDIX E

Calculations of Net Present Value Benefits

Table E-1

ESTIMATED TOTAL METHOD 1 NET PRESENT VALUE OF PORTS® BENEFITS AT 117 ADDITIONAL LOCATIONS (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$49,542,333	$47,709,266	$88,839,057	$85,552,012
2	0.927	$49,542,333	$45,925,742	$88,839,057	$82,353,806
3	0.892	$49,542,333	$44,191,761	$88,839,057	$79,244,439
4	0.885	$49,542,333	$43,844,964	$88,839,057	$78,622,566
5	0.826	$49,542,333	$40,921,967	$88,839,057	$73,381,061
6	0.795	$49,542,333	$39,386,154	$88,839,057	$70,627,050
7	0.765	$49,542,333	$37,899,884	$88,839,057	$67,961,879
8	0.737	$49,542,333	$36,512,699	$88,839,057	$65,474,385
9	0.709	$49,542,333	$35,125,514	$88,839,057	$62,986,892
10	0.683	$49,542,333	$33,837,413	$88,839,057	$60,677,076
TOTAL NET PRESENT			**$405,355,366**		**$726,881,165**

Table E-2

ESTIMATED TOTAL METHOD 1 NET PRESENT VALUE OF PORTS® BENEFITS FOR CONTAINER TRAFFIC AT 117 ADDITIONAL LOCATIONS (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$10,729,909	$10,332,902	$28,203,184	$27,159,666
2	0.927	$10,729,909	$9,946,626	$28,203,184	$26,144,352
3	0.892	$10,729,909	$9,571,079	$28,203,184	$25,157,240
4	0.885	$10,729,909	$9,495,969	$28,203,184	$24,959,818
5	0.826	$10,729,909	$8,862,905	$28,203,184	$23,295,830
6	0.795	$10,729,909	$8,530,278	$28,203,184	$22,421,531
7	0.765	$10,729,909	$8,208,380	$28,203,184	$21,575,436
8	0.737	$10,729,909	$7,907,943	$28,203,184	$20,785,747
9	0.709	$10,729,909	$7,607,505	$28,203,184	$19,996,057
10	0.683	$10,729,909	$7,328,528	$28,203,184	$19,262,775
TOTAL NET PRESENT			**$87,792,115**		**$230,758,451**

Table E-3

ESTIMATED TOTAL METHOD 1 NET PRESENT VALUE OF PORTS® BENEFITS FOR BULK TRAFFIC AT 117 ADDITIONAL LOCATIONS (METHOD 1 - ASSUMING 0.1 PERCENT CONTRIBUTION)

YEAR	NPV FACTOR	CARGO VALUE 2 FOOT DUK OR LESS	NPV CALCULATION	CARGO VALUE 4 FOOT DUK OR LESS	NPV CALCULATION
1	0.963	$38,812,423	$37,376,363	$60,635,872	$58,392,345
2	0.927	$38,812,423	$35,979,116	$60,635,872	$56,209,453
3	0.892	$38,812,423	$34,620,681	$60,635,872	$54,087,198
4	0.885	$38,812,423	$34,348,994	$60,635,872	$53,662,747
5	0.826	$38,812,423	$32,059,061	$60,635,872	$50,085,230
6	0.795	$38,812,423	$30,855,876	$60,635,872	$48,205,518
7	0.765	$38,812,423	$29,691,504	$60,635,872	$46,386,442
8	0.737	$38,812,423	$28,604,756	$60,635,872	$44,688,638
9	0.709	$38,812,423	$27,518,008	$60,635,872	$42,990,833
10	0.683	$38,812,423	$26,508,885	$60,635,872	$41,414,301
TOTAL NET PRESENT			**$317,563,245**		**$496,122,705**

APPENDIX F

Major Ports Potentially Benefiting From PORTS®

Major PORTS® Beneficiaries

Potential PORTS® beneficiaries are highly concentrated. Among the 117 U.S. ports without official PORTS® systems, the top seven port locations are calculated to account for almost 78 percent of potential benefits ($49.5 million per year) at two feet or less DUK. This figure increases to almost 89 percent at 4 feet DUK ($88.8 million per year). Refer to Figures F-1 and F-2.

Only 28 of the 117 ports without PORTS® reported the movement of container traffic in 2010. Nevertheless, there is also substantial concentration involving the potential benefits which could arise from the installation of PORTS® systems. An annual increase of between $10.7 and $28.2 million could result depending on the level of constrained traffic (e.g., two or four feet) (Refer to Figures F-3 and F-4)

Figure F-1

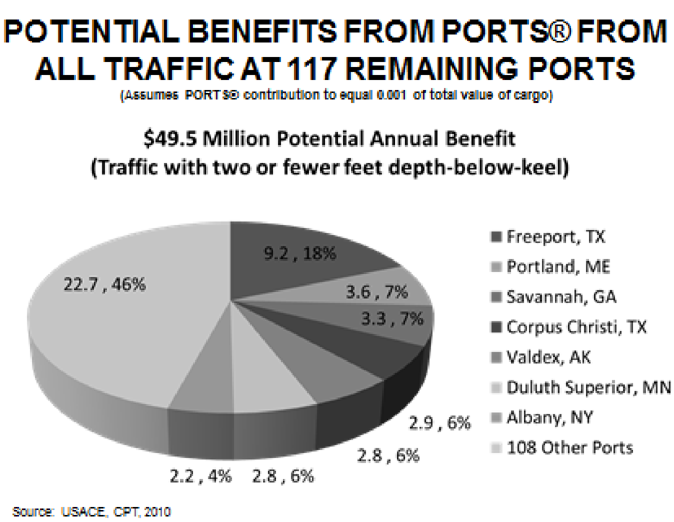


Figure F-2

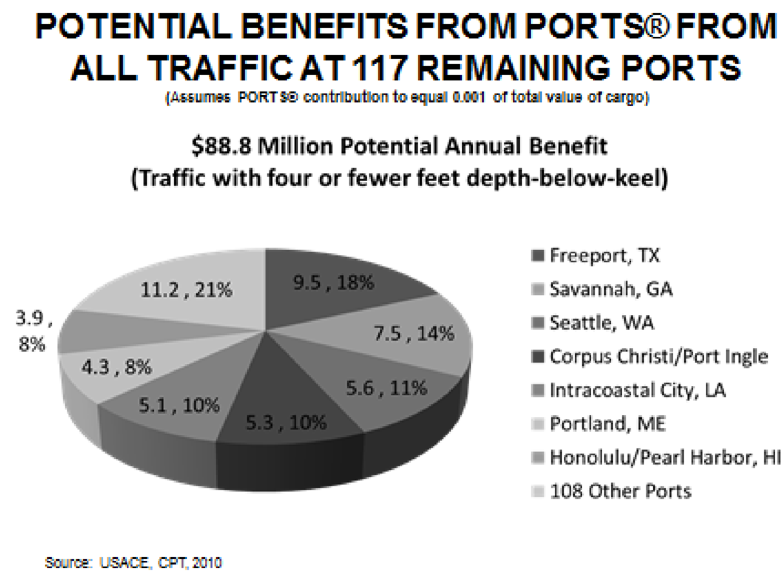


Figure F-3

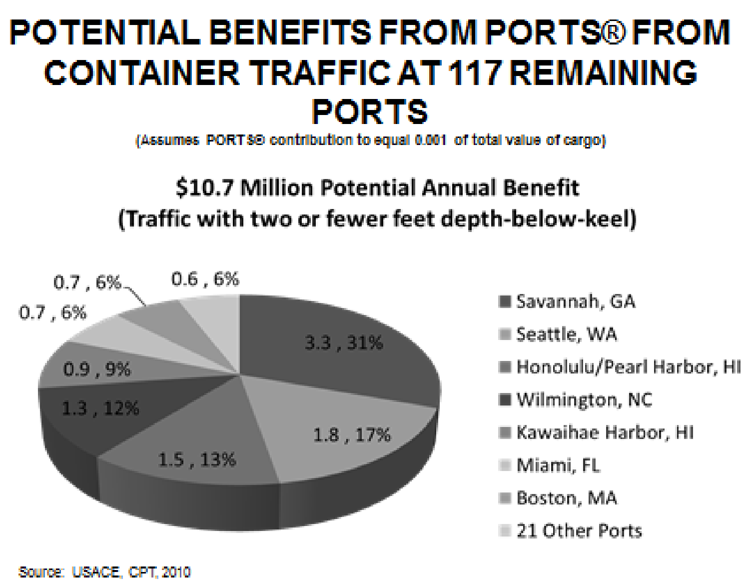
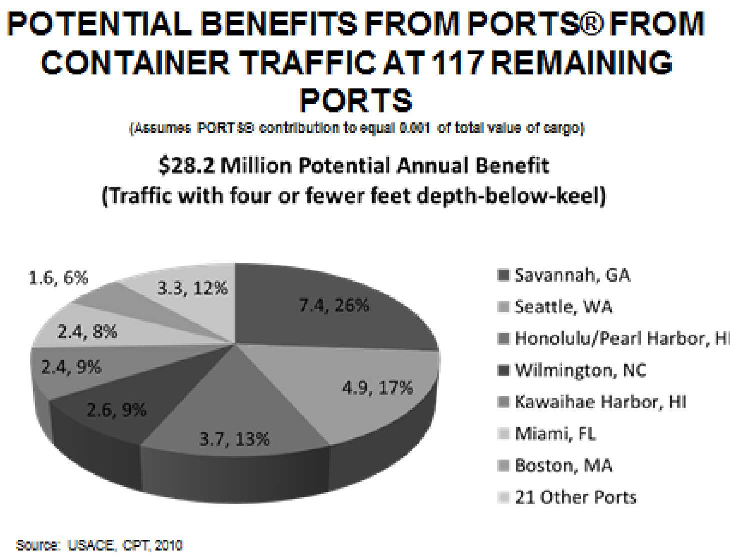


Figure F-4



Figures F-5 and F-6 illustrate the potential benefits for non-containerized movements among the 117 ports without PORTS® systems. Here annual benefits could range between $38.8 million to $60.6 million, dependent upon the level of constrained traffic.

Figure F-5

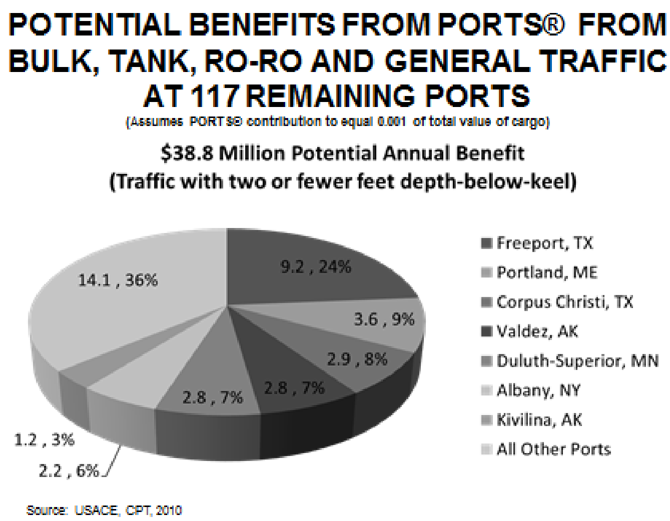
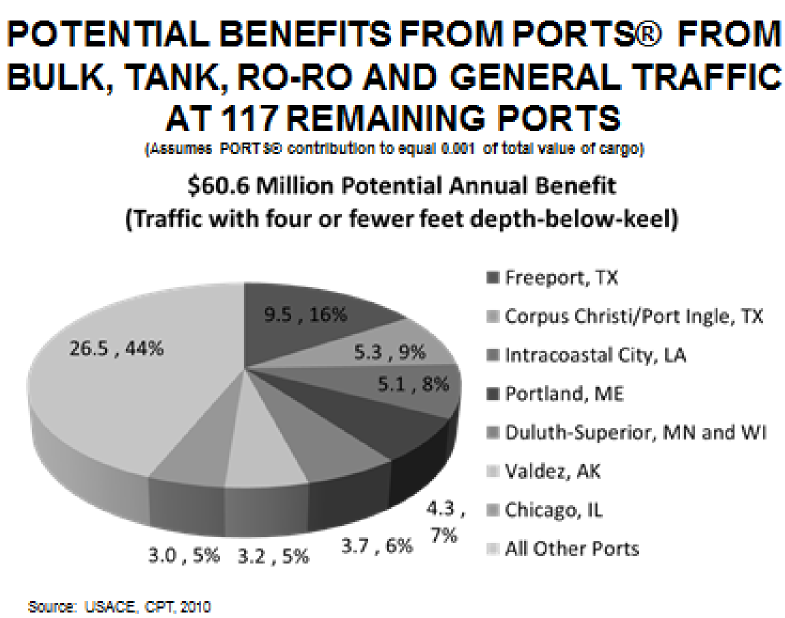


Figure F-6



APPENDIX G

Summary Observations by Pilots –

Navigation Decisions

Summary Observations by Pilots – Navigation Decisions

- Pilots stated that PORTS® has a significant value in piloting all commercial vessels through their ports. The first number indicates the value they assign to PORTS® information during a routine transit that is not draft or special situation constrained. The second value is that they assigned to a special situation (draft constrained 2' or less from the bottom, or 2' from the bottom of a bridge, or a challenging weather event).

- Pilots value certain types of information more highly than other pilots depending upon the conditions in their ports. For example, ports like New York and New Jersey frequently deal with vessels that are both draft and height constrained. Passages that involve a vessel operating within 2 feet of the bottom and 2 feet from the bottom of the bridge are becoming more common. Other ports don't have as many air gap constrained passages and value water level or current information more.

- Special situations where a vessel is draft constrained, or height limited, or the wind conditions are lowering the water or create maneuvering conditions that could make it dangerous to maneuver a vessel are becoming more prevalent. One port estimates that special conditions occur in 70% of the vessel transits.

- PORTS® information is used in "go – no go" decisions. There are numerous stories of vessels that were allowed to proceed to dock because the PORTS® system showed that they had a few tenths of a foot of water to spare. In other cases ships didn't have enough water and had to be taken to anchorage to avoid a costly grounding.

- Delaware River and Bay ports are "tide bound" meaning that their vessel operations are often at the maximum operational limits of the channel depth. Pilots are frequently asked to bring in vessels more deeply laden than the channel should be able to support. They do this by scheduling the passage to take advantage of the extra water from a high tide. In one of the channels in New York pilots move ships with 37.5 feet of draft through a channel dredged to 35 feet if they can do so on a high tide of around 5 feet.

- Several of the pilots mentioned that before PORTS® they used to use land marks to indicate how much water was available. When the "roots of a cottonwood tree" on a certain point or an abandoned tire on a tidal flat lay bare it would indicate that a certain type of passage might not be possible.

- Pilots mentioned that predicted tides from the Tide Tables were good for long range planning purposes only. Companies were warned that the pilots would make the final decision on whether a ship could move safely based on PORTS data the day of the passage. Some ports use the CO-OPS model to do accurate planning up to 2 days before a ship movement. Other ports have not yet learned to rely on this tool.

- All pilots interviewed told of instances where using PORTS® real-time water level information enabled them to make very accurate decisions on whether a vessel could transit to a berth without running aground. Prior to PORTS® pilots would have to use other indicators and add a safety factor to ensure the vessel didn't run aground. This limited the mass of cargo that was carried. The use of PORTS® enables Pilots and shipping companies to maximize the cargo carried.

- PORTS® are used in the ports of New York and New Jersey as the source of wind, current and tidal data for implementing the Coast Guard Advisory Notice (CGAN 2013-012) - Subject: Hurricane Seasonal Alert Initiated in the Port of New York and New Jersey.

All respondents rated PORTS® as an important source of information that a pilot relies upon in directing a ships movements. Comments from pilots during the interviews concerning users of PORTS® in ways other than for ship navigation

- The Domino Sugar Company in Baltimore uses PORTS® to monitor the temperature of the water in the Chesapeake Bay. They also use it to monitor the height of water during storm surges to warn them when to shut their intakes and thus their plant down. It is very costly to shut the plant down and they want to avoid it if at all possible. Very accurate, real time information lets them make that call at the last possible moment.

- The US Army Corp of Engineers in Delaware Bay uses PORTS water levels to control dredging in the river and bay. This eliminates their need to install water level sensors and thus reduces their project costs.

- In New York both the MTA and Port Authority have used PORTS water level information for the last 15 years to warn them when flooding will occur and when to shut down the highway tunnels under their authorities.

- Power companies in many of the ports use PORTS water level and water temperature information in their operations.

- The US Coast Guard uses PORTS currents and wind information to help control swimming and other special events. The events need to ensure current and wind velocities don't exceed certain maximums or the event must be canceled for the safety of the participants.

- Sail boat and yacht clubs use PORTS to help control their events safely.

- The US Coast Guard uses PORTS meteorological information to control certain anchorages where the bottom holding characteristics limit the use during high wind conditions. Refer to: Coast Guard Advisory Notice (CGAN 2013-012)).

- Local NOAA National Weather Service facilities use PORTS information in preparing local weather forecasts.

- The recreational boating community and the recreational fishing community use PORTS in many of the ports.

REFERENCES:

International Hydrographic Organization (IHO) Standardization of Nautical Publications Working Group (SNPWG), Hydrographic Dictionary, IHO Publication S-32, 1994.

Turpin, Edward A.; William A. McEwen (1980). *Merchant Marine Officers' Handbook* (4th ed.). Centreville, Maryland: Cornell Maritime Press

United States Department of Homeland Security, United States Coast Guard, *"Coast Guard Advisory Notice (CGAN 2013-012)"*,
May 20, 2013.

United States Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2007 August 2008

United States Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2010, May 2011

CHAPTER 5A – MARINE TRANSPORTATION – TRIP DELAYS

I. INTRODUCTION

PORTS® provides benefits to marine transportation from two major operational aspects: (1) enhanced ship lading; and (2) improved transit times. The benefits associated with enhanced lading through reduced depth under keel are addressed in the study performed by Wolfe and MacFarland (2013) in Chapter 5 *Underkeel Clearance Benefits* of the *(2013)*. This chapter will deal with the benefits derived from improvements to the efficiency of the marine transportation resulting from reductions in transit time.

II. BACKGROUND

As waterborne transportation is often defined as being purchased by the hour and sold by the ton, information which can improve the overall speed of the vessel or reduce its delay can significantly add monetary benefits to marine transportation. While issues related to groundings, allisions, collisions and depth under keel requirements no doubt represent the major source of such cost savings from avoidance of delays due to lack of data regarding wind, current and air gaps also can make significant contributions toward increased marine transportation efficiency.[1] Kite-Powell (2009) states:

> *"Coast Guard VTS officers and pilots who work in the Port of New York / New Jersey indicate that certain vessel movements in the port – primarily involving container ships and cruise ships – are sometimes delayed by water level, wind, current speed or air draft (bridge clearance) considerations. These delays are particularly prevalent*

[1] These costs are in apart and in addition to those resulting from restrictions on depth-under keel delineated in Chapter 5 of the main report.

during bridging projects"[2]

Kite-Powell (2009), in investigating the Port of New York and New Jersey assumed if PORTS® reduced delays in only three percent of ship passings by 90 minutes (given an average operating cost of $2,000/hour) $1,350,000 per year in cost savings would occur.[3] (Refer to Table 1).[4] In his later investigation of the Columbia River, Kite-Powell (2010) estimated that $800,000 in annual benefits due to reduced delays resulted from PORTS®. Employing lower cost per operation hour he previously estimated benefits from reduced transit delays ranging between $13,400 and $125,000 for the ports of Tampa (2005) and Houston/Galveston (2006), respectively.

III. BENEFIT ESTIMATION

Based on the empirical evidence provided by Kite-Powell which included any array of different kinds of ports with differing demographics (e.g., channel depth, width, prevailing winds and currents, etc.) his analysis suggests that PORTS® had an impact on about 2.5 percent of all vessel transits.[5] (Refer to Table 2)

The CPT reported that in 2010 a total of 1.67 million vessel transits occurred where one of the 58 physical ports with PORTS® has been installed – with an additional 0.62 million vessel transits located at one of 117 ports without PORTS®. Employing the overall weighted average

[2] Page 15.

[3] Ibid.

[4] Based on the documentation provided, later calculation would place this number at $810,000.

[5] Weighted average of estimated percentage of PORTS® impact times the number of vessel transits. Source: United States Army Corps of Engineers, Channel Portfolio Tool (CPT) for involved years.

Table 1

SUMMARY OF PREVIOUS VALUATION STUDY TIME-DELAY COST ESTIMATES

PORT SYSTEM (MONTH & YEAR OF STUDY REPORT)	DATA YEAR	PORTION OF VESSEL TRANSITS IMPACTED BY PORTS® DATA	NUMBER OF VESSEL TRANSITS IMPACTED PER YEAR	AVERAGE TOTAL TRANSPORT DELAY (MINUTES)	HOURLY COST OF VESSEL OPERATION	REPORTED TOTAL BENEFIT	CORRECT TOTAL BENEFIT
Portland / Columbia River (June 2010)	2009	10 %	400	60	$2,000	$800,000[6]	$800,000
New York / New Jersey (May 2009)	2007	3%	270	90	$2,000	$1,350,000[7]	$810,000[8]
Houston / Galveston (March 2007)	2006	1%	250	60	$500	$125,000[9]	$125,000
Tampa Bay (July 2005)	2005	1%	67	60	$200	$10,000[10]	$13,400[11]

Table 2

WEIGHTED AVERAGE IMPACT OF PORTS® ON VESSEL TRANSITS

PORT	PORTS® IMPACT (PERCENT OF TOTAL VESSEL TRANSITS	YEAR	TOTAL NUMBER OF VESSEL TRANSITS	ESTIMATED IMPACTED VESSEL TRANSITS
Portland	10%	2009	27,022	2,702
New York / New Jersey	3%	2007	384,868	11,546
Houston / Galveston	1%	2006	234,890	2,349
Tampa	1%	2005	7,021	70
TOTAL	2.5% (Overall average)		653,801	16,667

6 Kite-Powell, June 2010, pages v and 13.

7 Kite-Powell, May 2009, pages 3 and 15.

8 Calculation error in the 2009 study may have occurred as using the stated 270 vessel transits times $3,000 per transit ($2,000 per hour for 1.5 hours) equates to $810,000.

9 Kite-Powell, March, 2007, pages v and 14-15.

10 Kite-Powell, July 2006, reported as $10,000 on summary page vi. Assume to be a typographical error due to rounding.

11 Kite-Powell, July 2006, correctly reported on page 14.

from the earlier Kite-Powell work, it is estimated that more than 42,000 vessel transits are currently aided by PORTS(s) with the potential to aid an additional 16,000 vessel transits if PORTS® were installed at the 117 locations currently without them. (Refer to Table 3)

Table 3

ESTIMATED OVERALL IMPACT OF PORTS® ON VESSEL TRANSIT DELAYS

PORT	NUMBER OF LOCATIONS	TOTAL VESSEL TRANSITS	PERCENT OF TRIPS IMPACTED BY PORTS®	ESTIMATED IMPACTED VESSEL TRANSITS
Physical ports with PORTS®	58	1,664,235	2.5%	42,426
Physical ports without PORTS®	117	627,766	2.5%	16,004
TOTAL	175	2,292,001	2.5%	58,540

Adjusting for inflation, the hourly costs Kite-Powell employed in his value estimations ranged from $504 and 2,049 dollars (2010 dollars). Recent estimations of costs per hour for container ships underway by the United States Army Corps of Engineers (USACE) ranged from about $700 to over $3,300 for the sizes of ships which frequently call at ports in the United States. (Refer to Table 4)

According to the Department of Transportation's Maritime Administration, between 2003 and 2010, containerships which are among the most directly impacted (according to Kite-Powell 2009) which carried 5,000 or more TEUs increased their calls on United States ports by 349 percent while smaller vessels carrying less than 4,000 TEUs declined up to 49 percent. (Refer to

Table 5) Hourly operating costs for these ships at sea ranged were estimated to range from $2,078 to $3,310.[12]

Table 4

ESTIMATED HOURLY VESSEL OPERATING COSTS (2010 DOLLARS)

TYPE OF SHIP	NAME OF SHIP CLASS	TEUs[13]	DEADWEIGHT TONNAGE[14]	COST PER HOUR
Container		LT 1,000	15,000	$ 698
		1,000 – 1,999	15,000 – 30.700	$ 698 - $ 1,181
		2,000 - 2,999	30,700 – 42,800	$ 1,181 - $ 1,456
		3,000 – 3,999	42,800 – 55,600	$ 1,456 - $ 1,852
	Panamax	4,000 – 4,999	55,600 – 65,000	$ 1,842 - $ 2,078
		5,000 – 8,999	65,000 – 103,000	$ 2,078 - $ 3,310
	Panamax 1	9,000 – 12,000		
	Panamax 2	GE 12,001		
Dry Bulk	Handy		10,000 – 35,000	$ 424 - $ 662
	Handymax		35,000 – 60,000	$ 662 - $ 807
	Supramax		45,000 – 60,000	$ 744 - $ 807
	Capesize		100,000 – 180,000	$ 994 - $1,355
Tank	Product		10,000 – 60,000	$ 605 - $ 952
	Seawaymax		20,000 – 70,000	$ 659 - $ 1,001
	Panamax		60,000 – 80,000	$ 952 - $ 1,058
	Aframax		80,000 – 120,000	$ 1,058 - $ 1,227
	Suezmax		120,000 – 200,000	$ 1,227 - $ 1,624
	Very Large Crude Carrier (VLCC)		200,000 – 320,000	$ 1,624 - $ 2,152
	Ultra Large Crude Carrier (ULCC)		320,001 – 550,000	
RO-RO			25,000	$ 1,150
			50,000	$ 1,980

Source: USACE, Kevin Knight, March 15, 2011 correspondence

[12] The average cruise ship carries about 3,000 passengers while large vessels (e.g., MS Oasis of the Seas and MS Allure of the Seas measure 16 decks high, nearly four football fields long and carry 6,000 passengers each). While representing far fewer vessel transits, cruise vessels can cost between $10,000 and 40,000 per hour to operate. Source: http://listverse.com/2013/09/16/ten-fascinating-facts-about-cruise-ships/ . In 2010 114 vessels made a total of 4,216 cruises. Source: DOT, MARAD *"North American Cruise Statistical Snapshot, 2011"*, March 16, 2012, page 2.

[13] Twenty-Foot Equivalent (TEUs) units. Each container is 20 feet long, 8 feet wide and nominally 8.5 feet high (although it can vary between 4.25 and 9.5 feet).

[14] Deadweight tonnage is the sum of the weights of cargo, fuel, fresh water, ballast water, provisions, passengers, and crew. Blanks indicate too few vessels in the USACE's database for definitive estimate at this time.

Table 5

CONTAINERSHIPS WITH INCREASED TEU CAPACITY REPRESENT A LARGER PORTION OF CALLS ON US PORTS (TOTAL VESSEL CALLS)

VESSEL SIZE (TEUs)	2003	2004	2005	2006	2007	2008	2009	2010	PERCENT CHANGE (2003-2010)
LT 1,000	626	443	394	332	372	464	N/A	N/A	N/A
1,000 – 1,999	3,492	3,463	3,600	3,814	3,532	3,029	N/A	N/A	N/A
LT 2,000	4,118	3,906	3,994	4,146	3,864	3,493	3,290	3,709	-10%
2,000 – 2,999	4,032	4,541	4,410	3,986	4,099	3,347	2,677	2,761	-32%
3,000 – 3,999	4,050	3,888	3,624	3,333	2,866	2,460	2,500	2,053	-49%
4,000 – 4,999	3,945	3,210	4,226	4,782	5,033	5,121	5,305	5,881	49%
GT 5,000	1,142	1,734	2,288	3,344	3,961	4,314	4,434	5,126	349%
TOTAL	17,287	17,279	18,542	19,591	19,863	18,735	18,206	19,530	13%

Source: U.S. Department of Transportation, Maritime Administration, "Vessel Calls Snapshot, 2007", May 2008, "Vessel Calls Snapshot, 2008", July 2009, and "Vessel Calls Snapshot, 2009", August 2010. Note: The categories of "less than 1,000" and "1,000 to 1,999" were combined in 2009 as "less than 2,000 TEUs."

Employing a conservative figure for operating costs at sea of $1,800[15] per hour from the USACE[16] for a Panamax containership carrying 5,000 TEUs, current benefits from PORTS® are annually suggested to exceed $76 million. An additional $29 million could be added if PORTS® were installed at the remaining 117 locations. Collectively, annual benefits from full implementation could exceed $105 million. (Refer to Table 6)

Over the ten-year economic life of PORTS®, the Net Present Value of for existing PORTS® installations could approach $625 million while installation of PORTS® at the remaining 117 ports could add an additional $236 million over 10 years. (Refer to Tables 7 and 8) Full implementation of PORTS® could save a total of almost $861 million over ten years.

[15] Over 86 percent of all TEUs are transported on ships with costs of at least $1,800 per hour. Source: Calculated from MARAD operational data and USACE cost data.

[16] USACE, Kevin Night, correspondence, March 15, 2011.

Table 6

ESTIMATED ANNUAL BENEFITS FROM PORTS® OWING TO REDUCTIONS IN VESSEL TRANSIT DELAYS

PORT	NUMBER OF LOCATIONS	ESTIMATED IMPACTED VESSEL TRANSITS	SAVINGS PER VESSEL TRANSIT	TOTAL ANNUAL ESTIMATED SAVINGS
Physical ports with PORTS®	58	42,426	$1,800	$76,367,422
Physical ports without PORTS®	117	16,004	$1,800	$28,806,551
TOTAL	175	58,540	$1,800	$105,173,973

Table 7

ESTIMATED TOTAL NET PRESENT VALUE OF PORTS® BENEFITS AT 58 CURRENT LOCATIONS FROM REDUCING VESSEL TRANSIT DELAYS

YEAR	NPV FACTOR	ANNUAL BENEFIT	NPV CALCULATION
1	0.963	$ 76,367,422	$ 73,534,191
2	0.927	$ 76,367,422	$ 70,777,327
3	0.892	$ 76,367,422	$ 68,089,194
4	0.885	$ 76,367,422	$ 67,615,716
5	0.826	$ 76,367,422	$ 63,087,127
6	0.795	$ 76,367,422	$ 60,696,827
7	0.765	$ 76,367,422	$ 58,443,988
8	0.737	$ 76,367,422	$ 56,267,517
9	0.709	$ 76,367,422	$ 54,167,413
10	0.683	$ 76,367,422	$ 52,143,676
		TOTAL NET PRESENT	**$ 624,822,975**

Table 8

**ESTIMATED NET PRESENT VALUE OF PORTS® BENEFITS
AT 117 POTENTIAL LOCATIONS
FROM REDUCING VESSEL TRANSIT DELAYS**

YEAR	NPV FACTOR	ANNUAL BENEFIT	NPV CALCULATION
1	0.963	$ 28,806,551	$ 27,737,828
2	0.927	$ 28,806,551	$ 26,697,912
3	0.892	$ 28,806,551	$ 25,683,921
4	0.885	$ 28,806,551	$ 25,505,321
5	0.826	$ 28,806,551	$ 23,797,092
6	0.795	$ 28,806,551	$ 22,895,447
7	0.765	$ 28,806,551	$ 22,045,654
8	0.737	$ 28,806,551	$ 21,224,667
9	0.709	$ 28,806,551	$ 20,432,487
10	0.683	$ 28,806,551	$ 19,669,113
		TOTAL NET PRESENT	**$ 235,689,443**

IV. CONCLUSIONS

With the deepening of many channels at United States ports and the inherent economies of scale which larger ships offer, the trend toward use of larger and larger container and other ship types will undoubtedly continue. Added congestion from this increased traffic in the channels and reaches will necessitate even greater reliance on real time data involving environmental conditions (current direction and speed, wind speed, air gap, etc.) as to operate safely.

Separate and apart from issues related to potential limitations on depth of keel, collisions, allisions and groundings, significant costs can result from delays in vessel transit. While individual delays per ship may characterized by relatively short time periods (e.g., 60 minutes), when all ship movements are considered, the total cost of such delays can be considerable.

From this analysis, delays impact approximately 2.5 percent of all vessel transits with containerships and cruise vessels being among the greatest impacted portion of the maritime industry. Based on previous empirical research and employing a conservative average hourly operating cost of $1,800 per hour, it is estimated that PORTS® currently provides in excess of $76 million in benefits arising from reduced delays in transit. Installation of PORTS® at the remaining 117 major ports in the United States could add an additional annual benefit approaching $29 million for a total of $105 million per year.

Over the estimated ten-year economic life of PORTS® current benefits are thought to approach $625 million with a potential of an additional $236 million if installed at the remaining 117 ports. If fully implemented, an additional $861 million in savings is believed to be possible.

REFERENCES:

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of Tampa Bay"*, Report prepared for the Tampa Bay Harbor Safety and Security Committee, July 2005.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of Houston / Galveston"*, Report prepared for the Houston Ship Channel users and Ports of Houston and Galveston, March, 2007.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of the Port of New York/New Jersey"*, Report prepared Center for Operational Oceanographic Products and Services, May, 2009.

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of the Columbia River"*, Report prepared Center for Operational Oceanographic Products and Services, June 2010, 2010.

Wolfe, K. Eric and David MacFarland, *"An Assessment of the Value of the Physical Oceanographic Real-Time System (PORTS®)"*, Internal White Paper, National Oceanic and Atmospheric Administration, National Ocean Service, September 30, 2013.

CHAPTER 6 – COMMERCIAL MARINE ACCIDENTS

I. INTRODUCTION

In this analysis, the incidence of property losses and the loss of life and injuries among passengers, crews and others associated with commercial marine activities that occurred within the area of a port was investigated employing the United States Coast Guards, Marine Information for Safety and Law Enforcement (MISLE) information system.[1] In keeping with the conservative nature of this review, specific identification of ship type had to be made. In instances where the ship type was unknown or recreational craft were mistakenly included, those observations were removed from further analysis. Other craft such as U.S. Navy warships were also excluded. Employing the United States Coast Guard's Boating Accident Data, available from 2005 to 2012, recreational boating accident injuries and deaths were analyzed but treated separately. (Refer to Chapter 7)

In keeping with the transition to the MISLE system in 2001, data from the 2002 to 2011 period was selected for analysis.[2] Given the random and relative rare instance of commercial waterborne accidents, such a ten-year period was employed to more accurately provide a long-term assessment of losses owing to morbidity and mortality.

Finally, in keeping with the nature of PORTS® and the data they can provide which could help prevent or lessen the impact of accidents only instances that specifically identified the

[1] The area assigned to a port can significantly differ owing to the local geographic conditions. For example, while area governed by the port of Savannah, GA can be arrayed as an arc swath from the central point of the port seaward, the port of Baltimore, MD includes not only the inner and outer harbor but the entire Chesapeake Bay area. Assignment of port areas and linkage with USCG's MISCLE latitude / longitude co-ordinance was performed using ArcGIS mapping software.

[2] Data for 2011 was added to provide as great an exposure period as was possible with the data.

accident as an: (1) allision; (2) collision; and, (3) grounding were retained for observation where:[3]

- Allisions are collisions between ships and fixed facilities (e.g., docks, bridge, etc.);
- Collisions are instances that result from a ship crashing into a floating object (e.g., ship to ship, ship to floating object); and,
- Groundings involve instances where the ship impacts the seabed or channel / waterway side.

Commercial boating accidents retained for use in this analysis were limited to those which were reported to have occurred within the vicinity of the existing PORTS® or what area PORTS® would cover if it has been installed at the port.

Chapter 4 Section IV discussed the shipping of freight and the ships involved in its movement. Space will now be devoted to discuss the passenger shipping to provide a background to better understand marine accidents and the potential for very large damages resulting from a single accident.

II. COMMERCIAL CRUISE SHIP INTRODUCTION

Mayntz (2013) reports that a cruise ship or cruise liner is a passenger ship used for pleasure voyages, where the voyage itself and the ship's amenities are a part of the experience, as well as the different destinations along the way. Transportation is not the prime purpose, as cruise ships operate mostly on routes that return passengers to their originating port, so the ports of call are usually in a specified region of a continent. There are also "cruises to nowhere" or "nowhere voyages" where the ship makes 2-3 day round trips without any ports of call.

Cruising has become a major part of the tourism industry, accounting for U.S. $29.4

[3] Other instances included mechanical failure, fires, abandonment, etc.

billion with over 19 million passengers carried worldwide in 2011.[4] The industry's rapid growth has seen nine or more newly built ships catering to a North American clientele added every year since 2001, as well as others servicing European clientele.

Although generally luxurious, ocean liners had characteristics that made them unsuitable for cruising, such as high fuel consumption, deep drafts that prevent them from entering shallow ports, enclosed weatherproof decks that are not appropriate for warmer tropical weather, and cabins designed to maximize passenger numbers rather than comfort (e.g., a high proportion of interior windowless suites).

The gradual evolution of passenger ship design from ocean liners to cruise ships has seen passenger cabins shifted from inside the hull to the superstructure with private balconies. Modern cruise ships, while sacrificing some aspects of seaworthiness, have added amenities to cater to tourists, and recent vessels have been described as "balcony-laden floating condominiums".[5]

Delineation between ocean liners and cruise ships has blurred, particularly with respect to deployment, although the differences in construction remain. Larger cruise ships have also engaged in longer trips such as transoceanic voyages which may not lead back to the same port for months (longer round trips).[2] Some former ocean liners operate as cruise ships, such as *Marco Polo* and *Mona Lisa*. This number is diminishing. The only dedicated transatlantic ocean liner in operation as a liner, as of February 2010, is the *Queen Mary 2* of the Cunard fleet. She also has the amenities of contemporary cruise ships and sees significant service on cruises.

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[4] "Cruise Market Watch Announces 2011 Cruise Line Market Share and Revenue Projections". Cruise Market Watch. 2010-12-11.

[5] Refer to: http://en.wikipedia.org/wiki/Cruise_ship

III. HISTORY

The cruise of the Augusta Victoria in the Mediterranean and the Near East from 22 January to 22 March 1891, with 241 passengers is often stated to have been the first ever cruise. The first vessel built exclusively for cruise operations was the *Prinzessin Victoria Luise* of Germany, designed by Albert Ballin, general manager of Hamburg-America Line. The ship was completed in 1900.

The practice of cruising grew gradually out of the tradition of transatlantic crossings, which never took fewer than four days. In the competition for passengers, ocean liners added luxuries—the *Titanic* and her sister ships (the Olympic and Britannic) being famous examples—such as fine dining and well-appointed staterooms.

In the late 19th century, Albert Ballin, director of the Hamburg-America Line, was the first to send his transatlantic ships out on long southern cruises during the worst of the winter season of the North Atlantic. Other companies followed suit. Some of them built specialized ships designed for easy transformation between summer crossings and winter cruising.

With the introduction of larger fleets of passenger jets with higher capacities in the 1960s, intercontinental travelers largely switched from ships to planes, which sent the ocean liner trade into a slow decline. Certain characteristics of older ocean liners made them unsuitable for cruising duties, such as high fuel consumption, deep draught preventing them from entering shallow ports, and cabins (often windowless) designed to maximize passenger numbers rather than comfort. Ocean liner services aimed at passengers ceased in 1986, with the notable exception of transatlantic crossings operated by the Cunard Line, catering to the niche market who appreciated the several days at sea.

In comparison to liner crossings, cruising voyages gained popularity; slowly at first but at an increased rate from the 1980s onwards. Initially the fledgling industry was serviced primarily by small redundant liners, and even the first purpose built cruise ships were small. This changed after the success of the SS *Norway* (originally the ocean liner SS *France*, which was converted to cruising duties) as the Caribbean's first "super-ship".

Contemporary cruise ships built in the late 1980s and beyond, such as *Sovereign*-class which broke the size record held for decades by *Norway*, show characteristics of size and strength once reserved for ocean liners—some have undertaken regular scheduled transatlantic crossings.[6] The *Sovereigns* were the first modern "megaships" to be built; they also were the first series of cruise ships to include a multi-story atrium with glass elevators. They also had a single deck devoted entirely to cabins with private balconies instead of ocean-view cabins. Other cruise lines soon launched ships with similar attributes, such as the *Fantasy* class and *Crown Princess*. As the veranda suites were particularly lucrative for cruise lines, something which was lacking in older ocean liners, recent cruise ships have been designed to maximize such amenities and have been described as "balcony-laden floating condominiums".

Until 1975-1980, cruises offered shuffleboard, deck chairs, "drinks with umbrellas and little else for a few hundred passengers." After 1980, they offered increasing amenities. As of 2010, city-sized ships have dozens of amenities which can include: casinos, spas, fitness centers, shops, libraries, theaters, movies, indoor and outdoor swimming pools, restaurants, lounges, clubs, etc.[7]

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[6] Roughan, John, "The ocean-going stretch limo". *The New Zealand Herald, February 16, 2007.*

[7] Best, Keilani, "Cruise group celebrates growth of 'floating cities'", Melbourne, Florida: *Florida Today*. March 17, 2010, p. 6C.

IV. STABILITY AND SAFETY

Walker (2012) and others have stated concerns regarding the stability of cruise ships given their changes in design in recent years.[8] One of the biggest design changes has been moving the passenger cabins from inside the hull to the superstructure and adding individual balconies both due to customer demand and because, from a business standpoint, the cruise line can charge passengers much more than for inside staterooms. This has considerably increased the overall height of the ships, making them more susceptible to wind and wave forces. As a result, there have been concerns about the stability of modern passenger ships especially in heavy weather because there is much more ship above the surface than beneath it — especially modern cruise ships may appear top-heavy to some.

Despite the large superstructure, the center of gravity of modern cruise ships is relatively low. This is due to large open spaces and the extensive use of aluminum, high-strength steel and other lightweight materials (e.g., carbon fiber) in the upper parts, and the fact that the heaviest components — engines, propellers, fuel tanks and such — are located in the lower parts of the ship. Thus, even though modern cruise ships may appear top-heavy, proper weight distribution ensures they are not.[9] Furthermore, large cruise ships also tend to be very wide, which considerably increases their initial stability by increasing the metacentric height.[10]

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[8] Refer to: Walker, Jim, "Are Cruise Ships Dangerously Top Heavy?", Cruise Law News, 29 March 2012 and "Modern cruise ships: Are their designs dangerous?", Humans Invent, 20, January 2012.

[9] Refer to: "Why aren't cruise ships top heavy?", Beyond Ships. 2012. See: http://www.beyondships2.com/faq-top-heavy-cruise-ships.html (retrieved March 20, 2013).

[10] Is a measurement of the initial static stability of a floating body. It is calculated as the distance between the center of gravity of a ship and its metacentre. Metacenter is determined by a ratio of the inertia resistance of the boat divided by the volume of the boat. (The inertia resistance is a quantified description of how the waterline width of the boat resists overturning.) Wide and shallow or narrow and deep hulls have high transverse metacenters (relative to the keel), and the opposite have low metacenters; the extreme opposite is shaped like a log or round bottomed

Although most passenger ships utilize stabilizers to reduce rolling in heavy weather, they are only employed for crew and passenger comfort and do not contribute to the overall intact stability of the vessel. The ships must fulfill all stability requirements even with the stabilizer fins retracted.

For the *Oasis*-class cruise ships, currently the largest passenger ships ever built, the designers created a wide hull to keep the ship stable without excessively increasing the ship's draft. About 30 feet (9 meters) of the ship sits beneath the water, a small percentage of the ship's overall height. Although wide, shallow ships such as the *Oasis of the Seas* tend to be "snappy", meaning that they have a short rolling period and thus will snap back upright after a wave has passed, this uncomfortable effect is mitigated by the size of the vessel.[11] The cruise ship's officers were pleased with the ship's stability and performance during the transatlantic crossing, when the vessel, in order to allow finishing work to go on, slowed and changed course in the face of winds "almost up to hurricane force" and seas in excess of 40 feet (12 m).[12] Despite this, the *Oasis*-class vessels have so far operated out of the relatively calm waters of the Caribbean, while only ocean liners such as the RMS *Queen Mary 2* have been deployed on transatlantic service.

Overall, the international cruise industry has been very safe. In the eight years between 2005 and 2012 (excluding the *Costa Concordia* grounding) out of more than 100 million

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boat.

[11] Bryner, Jeanna , "How the World's Largest Cruise Ship Floats", *Livescience.com*, November 3, 2009)

[12] Wright, William S. (Captain), "Blue Seas, Green Practices", *Captain's Log, Day Six*, video at Oasis of the Seas, Royal Caribbean, 2009 and Wright, William S. (Captain), "Back to the Bridge", *Captain's Log, Day Ten*, video at Oasis of the Seas. Royal Caribbean, 2009.

individuals taking cruises only 16 fatalities occurred.[13] The *Costa Concordia* disaster added 32 live lost in January 13, 2012.[14]

However, considering the large costs involved in morbidity and mortality (Chapter 3 Section V) a single accident can result in very large costs. The prevention of a single, infrequent accident can then potentially be cost effective.

V. COMMERCIAL CRUISE TRENDS

According to the Cruise Lines International Association, Inc. (CLIA) (2013), the cruise line industry generated more than $40 billion in total economic activity to the US economy in 2011. This economic activity generated 350,000 jobs which paid $16.5 billion in wages to American workers while a record number of 20 million passengers were carried globally on cruise lines in 2011.[15] Of this number, 10.9 million passengers were from North American departure points. An earlier CLIA report in 2006 suggested that the total impact on the US economy had been $35.7 billion.[16]

MARAD (2012) reported that in 2011 a total 0f 71.8 million passenger nights were booked on cruise lines – up 2.8 percent from the year before. Since 2006, the average number of nights approximated 6.7 and has increased since the December 2007 to June 2009 recession.[17]

[13] Lucy Carne (21 January 2012). "Cruising into turbulent waters". *The Advertiser* (Adelaide). Retrieved 21 January 2012.

[14] Two passengers are missing and are presumed deceased.

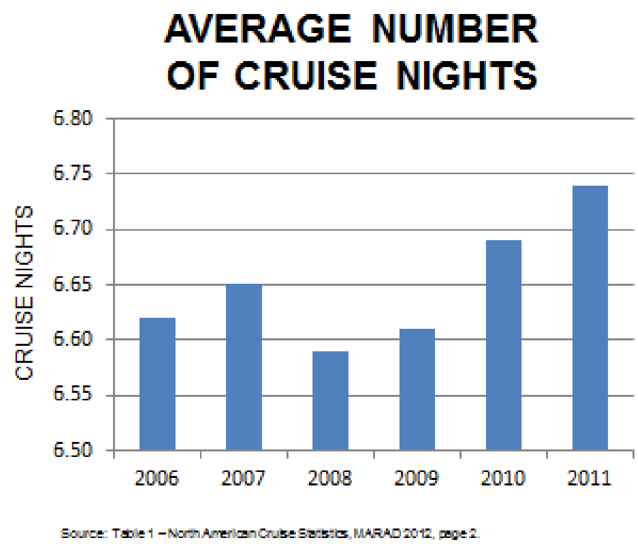
[15] CLIA "Issues and Facts", Refer to: http://www.cruising.org/regulatory/issues-facts, March 21, 2013.

[16] Refer to: CLIA study results detail cruise industry's $35.7 billion contribution to U.S. economy, 2006.

[17] Average nights is calculated as the total number of passenger nights divided by the number of passengers.

(Refer to Figure 1) Moreover, the occupancy of these movements continues to exceed 100 percent.[18] (Refer to Figure 2.) Overall, the Caribbean in 2011 was the most popular North American cruise destination.[19] (Refer to Figure 3).

Figure 1

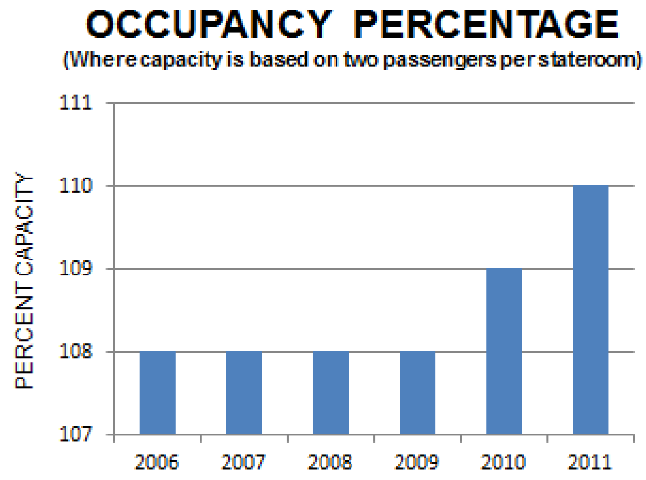


In 2011, the top ten departure ports represented 79 percent of all North American cruise passenger departures with the top three (Miami, Fort Lauderdale and Port Canaveral) representing 49 percent of the total. (Refer to Figure 4).

[18] Where capacity is based on two passengers per stateroom).

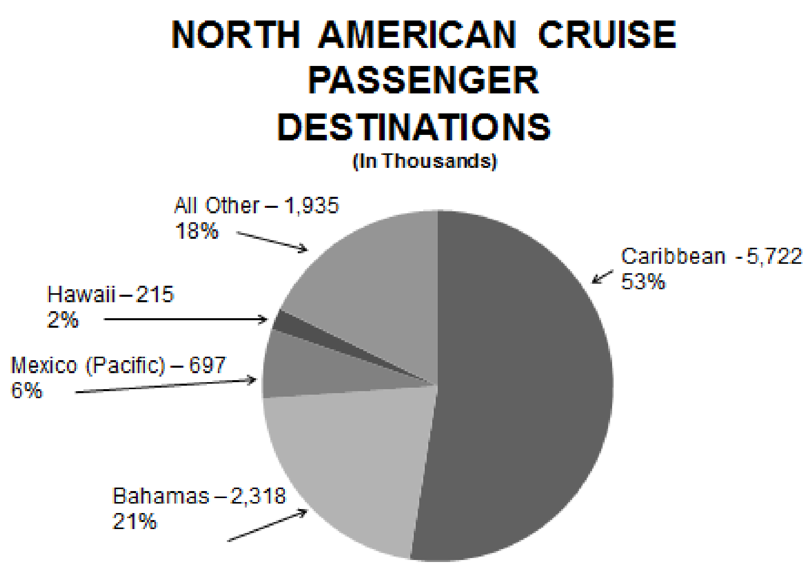
[19] The western Caribbean represented 59 percent of all Caribbean destinations with Eastern destinations representing 25 percent and Southern destinations representing the remaining 17 percent. Source: MARAD, 2012.

Figure 2



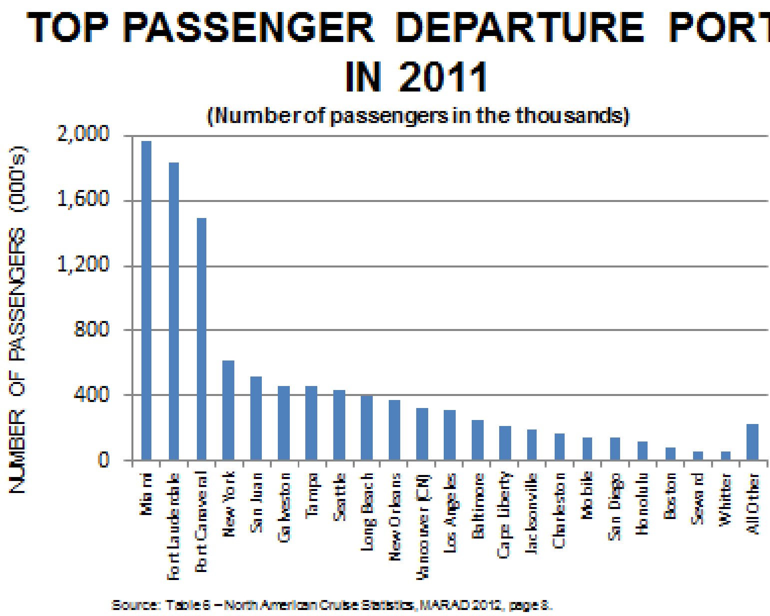
Source: Table 1 – North American Cruise Statistics, MARAD 2012, page 2.

Figure 3



Source: US Department of Transportation, MARAD, North American Cruise Statistical Snapshot, Table 4, 2012.

Figure 4



A. Size Trends

Similar to increases in ship capacity as seen in the containerized freight industry, cruise ships have gotten ever larger to take advantage of economies of size. For example, when launched in 2004, the *RMS Queen Mary 2* displaced 148,528 gross tons with a length of 1,132 and beam (width) of 148 feet.[20] By 2011, *the Allure of the Seas* had a gross tonnage of 225,282 feet and beam of 213 feet. This represented a 44 percent increase beam and was not a unique occurrence (Refer to Table 1) Ever widening of cruise liners results in tighter channel clearances which requires as never before more real time and near real time data concerning water levels, tides, currents, salinity and similar measures to help ensure safe passage. In addition, with the

[20] United States Coast Guard Maritime Information Exchange;,Queen Mary 2; Queen Mary 2, *Ships in Class*. Lloyd's Register; and "Queen Mary 2 Fact Sheet". *Cunard*. 2011.

overall height of these vessels increasing, clearance problems have arisen at several ports with respect to the height (or air gap) of bridges at various times during the day. Unified instrumentalities provided by PORTS® can provide this essential data to port pilots.

Table 1

PARTIAL LIST OF LARGEST CRUISE SHIPS IN SERVICE

RANK	SHIP	CRUISE LINE	YEAR	GROSS TONNAGE	LENGTH	BEAM	STATE ROOMS
1	*Allure of The Seas*	Royal Caribbean International	2011	225,282 GT	1,187 feet (362 m)	213 feet (65 m)	2,706
1	*Oasis of the Seas*	Royal Caribbean International	2011	225,282 GT	1,187 feet (362 m)	213 feet (65 m)	2,706
3	*Norwegian Epic*	Norwegian Cruise Line	2010	155,873 GT	1,081 feet (329 m)	133 feet (41 m)	2,114
4	*Freedom of the Seas*	Royal Caribbean International	2006	154,407 GT	1,112 feet (339 m)	184 feet (56 m)	1,817
4	*Liberty of the Seas*	Royal Caribbean International	2007	154,407 GT	1,112 feet (339 m)	184 feet (56 m)	1,817
4	*Independence of the Seas*	Royal Caribbean International	2008	154,407 GT	1,112 feet (339 m)	184 feet (56 m)	1,817
7	*RMS Queen Mary 2*	Cunard Line	2004	148,528 GT	1,132 feet (345 m)	148 feet (45 m)	1,296
8	*MSC Divina*	MSC Cruises	2012	139,400 GT	1,093 feet (333 m)	125 feet (38 m)	1,739

RANK	SHIP	CRUISE LINE	YEAR	GROSS TONNAGE	LENGTH	BEAM	STATE
8	*MSC Preziosa*	MSC Cruises	2013	139,400 GT	1,093 feet (333 m)	125 feet (38 m)	1,739
10	*Navigator of the Seas*	Royal Caribbean International	2002	138,279 GT	1,020 feet (310 m)	161 feet (49 m)	1,557
10	*Mariner of the Seas*	Royal Caribbean International	2003	138,279 GT	1,020 feet (310 m)	161 feet (49 m)	1,557
12	MSC *Fantasia*	MSC Cruises	2008	137,936 GT[	1,093 feet (333 m)	124 feet (38 m)	1,637
12	MSC *Splendida*	MSC Cruises	2009	137,936 GT	1,093 feet (333 m)	124 feet (38 m)	1,637

Source: http://en.wikipedia.org/wiki/List_of_the_world's_largest_cruise_ships#cite_note-rcclliberty-6

VI. COMMERCIAL FERRIES

A ferry (or ferryboat) is a boat or ship (a merchant ship) used to carry (or ferry hence the name) primarily passengers, and sometimes vehicles and cargo as well, across a body of water. [21]As juxtaposed with cruise lines, the majority of ferries operate on regular, frequent, return services. Used in many nations in the world, a passenger ferry with many stops, such as in Venice, is sometimes called a water bus or water taxi.

Ferries form a part of the public transport systems of many waterside cities and islands, allowing direct transit between points at a capital cost much lower than bridges or tunnels.

[21] Refer to: https://en.wikipedia.org/wiki/Ferry

However, ship connections of much larger distances (such as over long distances in water bodies like the Mediterranean Sea) may also be called ferry services, especially if they carry vehicles.

There are also several commuter passenger ferry services operated in major cities, such as Metro Transit in Halifax, Toronto Island Ferry in Toronto and SeaBus in Vancouver. The Spokane sailing from Edmonds to Kingston, one of ten routes served by Washington State Ferries. Washington State Ferries operates the most extensive ferry system in the United States, with ten routes on Puget Sound and the Strait of Juan de Fuca serving terminals in Washington and Vancouver Island. In fiscal year 1999, Washington State Ferries carried 11 million vehicles and 26 million passengers.

The Staten Island Ferry in New York City, sailing between the boroughs of Manhattan and Staten Island, is the nation's single busiest ferry route by passenger volume. New York City also has a network of smaller ferries, or water taxis, that shuttle commuters along the Hudson River from locations in New Jersey and Northern Manhattan down to the midtown, downtown and Wall Street business centers. The New Orleans area also has many ferries in operation that carry both vehicles and pedestrians. Most notable is the Algiers Ferry. This service has been in continuous operation since 1827 and is one the oldest operating ferries in North America.

Vehicle-carrying ferry services between mainland Cape Cod and the islands of Martha's Vineyard and Nantucket are operated by The Woods Hole, Martha's Vineyard and Nantucket Steamship Authority, which sails year-round between Woods Hole and Vineyard Haven as well as Hyannis and Nantucket. Seasonal service is also operated from Woods Hole to Oak Bluffs from Memorial Day to Labor Day. As there are no bridges or tunnels connecting the islands to the mainland, The Steamship Authority ferries in addition to being the only method for transporting private cars to or from the islands, also serves as the only link by which heavy freight and supplies such as food and gasoline can be trucked to the islands.

Hy-Line Cruises operates high speed catamaran service from Hyannis to both islands, as well as traditional ferries, and several smaller operations run seasonal passenger only service primarily geared towards tourist day-trippers from other mainland ports, including New Bedford, (New Bedford Fast Ferry) Falmouth, (Island Queen ferry and Falmouth Ferry) and Harwich (Freedom Cruise Line).

The San Francisco Bay Area has several ferry services, such as the Blue & Gold Fleet, connecting with cities as far as Vallejo. The majority of ferry passengers are daily commuters and tourists. A ferry serves Angel Island (which also accepts private craft). The only way to get to Alcatraz is by ferry.

Until the completion of the Mackinac Bridge in the 1950s, ferries were used for vehicle transportation between the Lower Peninsula of Michigan and the Upper Peninsula of Michigan, across the Straits of Mackinac in the United States. Ferry service for bicycles and passengers continues across the straits for transport to Mackinac Island, where motorized vehicles are almost completely prohibited. This crossing is made possible by three ferry lines, Arnold Transit Company, Shepler's Ferry, and Star Line Ferry.

A. **Ferry Types and Designs**

Ferry designs depend on the length of the route, the passenger or vehicle capacity required, speed requirements and the water conditions the craft must deal with. Among the most common designs are:

- Double ended - Double-ended ferries have interchangeable bows and sterns, allowing them to shuttle back and forth between two terminals without having to turn around.

- Hydrofoil - a hydrofoil is a foil which operates in water. They are similar in appearance and purpose to airfoils. The term "hydrofoil" is often used to refer to boats using hydrofoil technology.

- Hovercraft – a hovercraft, also known as an air-cushion vehicle or ACV, is a craft capable of travelling over land, water, mud or ice and other surfaces both at speed and when stationary. Hovercrafts are hybrid vessels operated by a pilot as an aircraft rather than a captain as a marine vessel.

- Catamaran - A catamaran is a geometry-stabilized boat or ship. It is usually multihulled, consisting of two hulls, or vakas, joined by some structure, the most basic being a frame, formed of akas.

- Ro-ro - Roll-on/roll-off (RORO or ro-ro) ships are vessels designed to carry wheeled cargo such as automobiles, trucks, semi-trailer trucks, trailers or railroad cars that are driven on and off the ship on their own wheels.

- Cruise ferry - A cruise ferry is a ship that combines the features of a cruise ship with a RoRo ferry.

- RoPax - The acronym ROPAX (roll on/roll off passenger) describes a RORO vessel built for freight vehicle transport along with passenger accommodation. Technically this encompasses all ferries with both a roll on/roll off car deck and passenger-carrying capacities, but in practice ships with facilities for more than 500 passengers are often referred to as cruise ferries.

- RoLo - A RoLo (roll-on lift-off) vessel is another hybrid vessel type with ramps serving vehicle decks but with other cargo decks only accessible when the tides change or by the use of a crane.

- LMSR - Large, Medium-Speed Roll-on/Roll-off (LMSR) refers to several classes of Military Sealift Command (MSC) roll-on/roll-off type cargo ships. Some are purpose-built for military cargo, while others were converted.

VII. EXCURSION AND GENERAL COMMERCIAL PASSENGER SHIPS

While separately mentioned, at least two additional types of passenger ships trade in commercial coastal waters. These involve excursion and passenger ships that are described as “general” in nature. Often constituted as trips of one day or less, commercial marine trips involving whale or other flora or fauna watching (e.g., ice flows or icebergs) can be described as extrusion trips. Often the specific distinction among commercial marine transport can be narrow.

General passenger transport (aside from ferries) often involves the transport of personnel to and from oil platforms or other off-shore facilities.

VIII. COMMERCIAL CARGO SHIPS

Finally, the group of commercial ships which accounts for the largest portion of trips are those carrying commercial cargo. Aside from tankers, dry bulk carriers, container ships and roll on-roll-off vessels, a significant number of tugboats and barges ply their trade into and out of ports. Additional information regarding the size and importance of commercial marine trade is delineated in Chapter 4.

IX. COMMERCIAL ACCIDENT INCIDENCE

Fortunately, the incidence of overall accidents and accidents where injuries and deaths occur are relatively rare events. Consequently, use of a data from a single year or small group of years does not necessarily represent the long-run incidence of commercial marine accidents. In this study, a ten-year horizon was employed as the basis of analysis.[22]

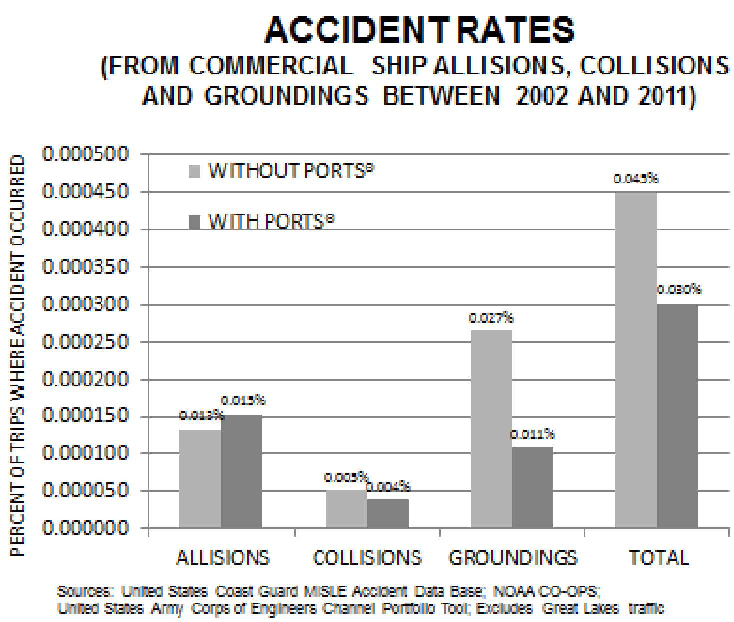
A. Accident Rates

While the USCG's MISLE data base contains a count of accidents and associated deaths and injuries, it does not contain the population count of the number of marine cargo vessels over

[22] Except where noted data from 2002 to 2011 was available and employed in this study. In certain cases, data while only available beginning in 2005 was considered capable of providing a study period of sufficient length to capture long-term trends.

which the accidents occurred.[23] Consequently, other data had to be employed. As the USACE's CPT data base provides a count of the entire population of marine cargo transits, it was employed as the base is for calculating the relative accident rates for collisions, allisions and groundings. To place the calculations on an equal basis, the total number of marine transits were employed for locations with and without PORTS® during the 2002 to 2011 study period. Please note that during this investigation, a total of 9.6 million trips occurred at the 58 locations with PORTS® while 8.3 million occurred through the 117 ports without PORTS®. (Refer to Figure 5)

Figure 5



Results suggest that the rate of overall grounding, allision and collision-based accidents at locations with PORTS® occurred at only 67 percent of the rate which was calculated for

[23] With certain assumptions, it might be inferred through the number of records in the file.

locations without PORTS®. This represents a reduction of 33 percent of total accidents involving collisions, allisions and groundings. Groundings in areas where PORTS® were in use were over 59 percent less than in areas without PORTS®.[24] Collisions were also lower (0.0052 percent to 0.0039 percent) -- a 25 percent difference. Only in the case of allisions was the opposite seen where locations with PORTS® posted a 15 percent high accident rate than locations without PORTS®. This is assumed to be due to natural variability in the rate of accidents rather than a causal effect. It would be difficult to conceive of a situation where the availability of real-time environmental information would lead to an increase in vessels striking fixed objects

B. Mortality and Morbidity Rates

During the 2002 to 2011 study period, a total of 35 deaths and 284 injuries were reported. This equates to less than 4 deaths and little more than 28 injuries that resulted from allisions, collisions and groundings within relative close proximity of a port on an annual basis. (Refer to Figure 6.) During the study period, accidents identified as collisions resulted in the largest number of injuries and deaths. Allisions appeared to be the second most severe overall. (Refer to Figures 7 and 8).

Further examination of the data showed that only 10 of the 35 fatalities and 101 of the 183 injuries occurred at port locations where PORTS® had been installed. (Refer to Figure 9)

[24] This figure closely mirrored the 60 percent reduction in grounding risk identified by Kit-Powell (2007) in the ports of Houston and Galveston.

Figure 6

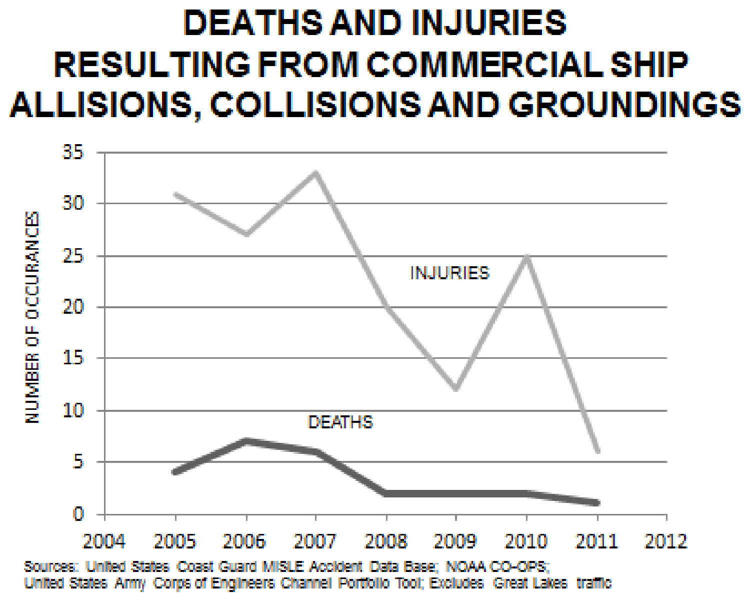


Figure 7

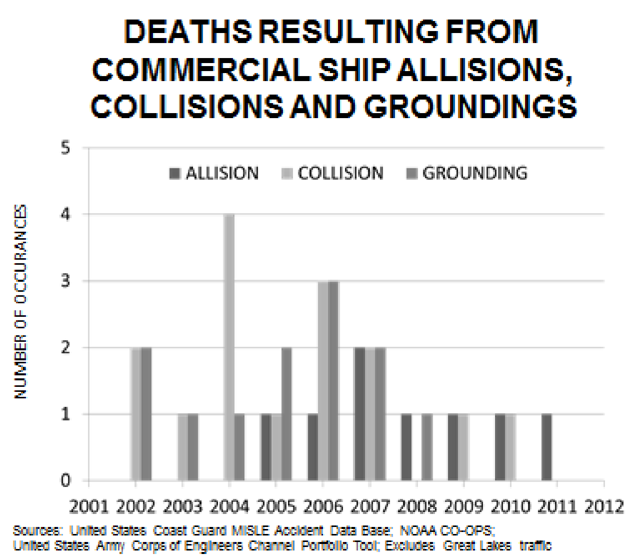


Figure 8

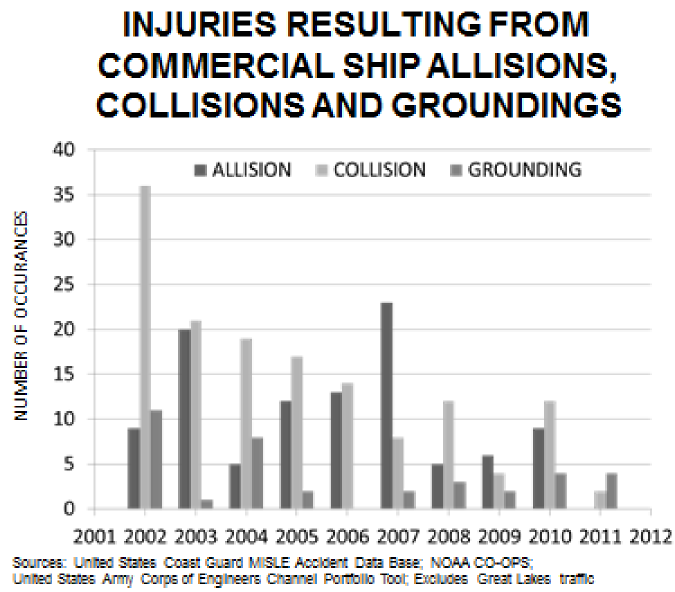
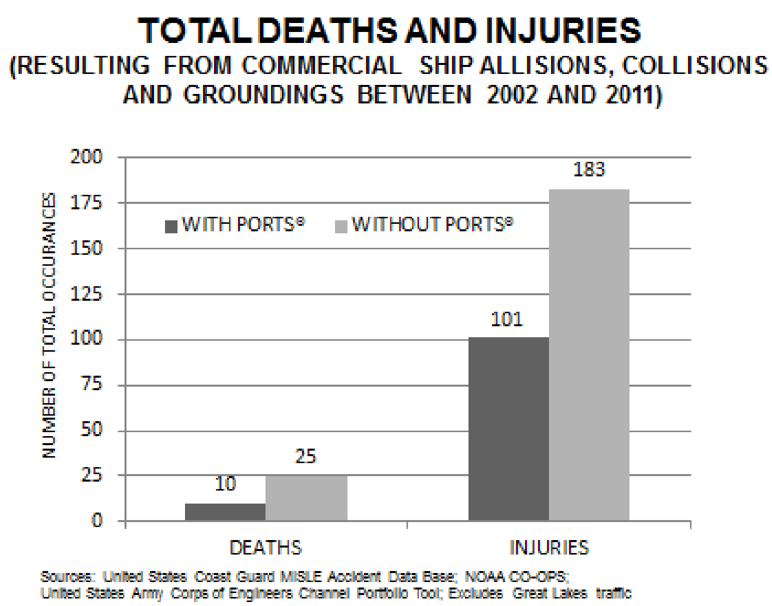
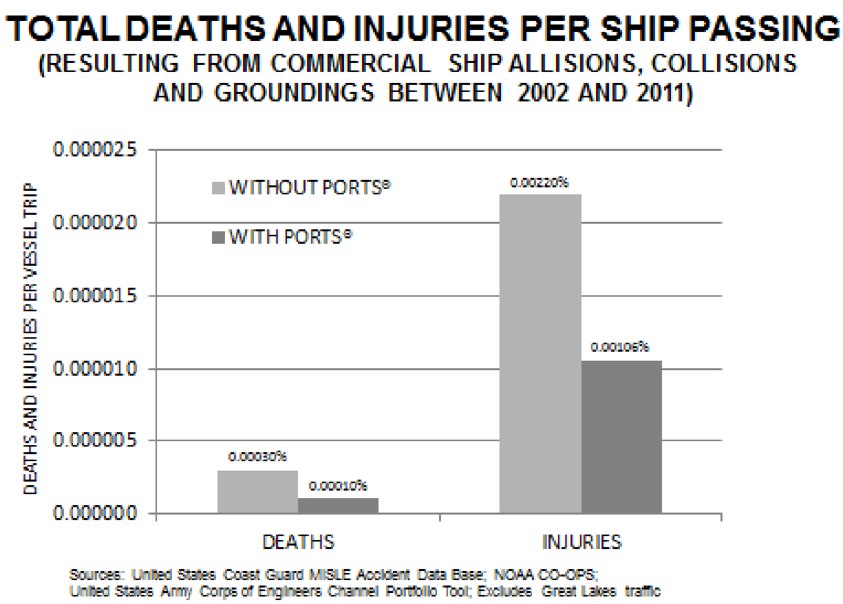


Figure 9



During the study period of 2002 to 2011 the relative incidence of deaths and injuries as measured by events per trip were lower in instances where PORTS® had been installed. Overall, almost three time the number of deaths per trip occurred when PORTS® were not installed while injuries were over twice the rate in instances where PORTS® had not been installed.[25] (Refer to Figure 10) The difference in mortality and morbidity rates could be the result of not only more PORTS® provision of data in a timely, accurate and complete manner but also reflect an overall more prudent supervision of the vessel. In other words, having the knowledge is one thing but comprehension of its importance and its implementation through more thorough due diligence could have resulted in more careful vessel operation**.**

Figure 10



[25] Collectively, during the study period there were 14 percent more trips in areas with PORTS® than in areas where no PORTS® had been installed.

Overall, normalized by the number the trips, death rates per trip over the ten –year study period at locations without PORTS® were 2.5 times the level experienced at PORTS® equipped locations. Injury rates were seen to be over 1.8 times the level observed at locations without PORTS®.

Over the ten year study period 13 fewer deaths and 63 fewer injuries were experienced which employing previously discussed costs of $6.1 and $0.6 million for each instance, resulted in a total cost approaching $118 million dollars or about $12 million per year. Refer to Figure 11 and Table 2. A $12 million dollar per year savings would equate to a present value over ten years of almost $96 million. (Refer to Table 3)

Figure 11

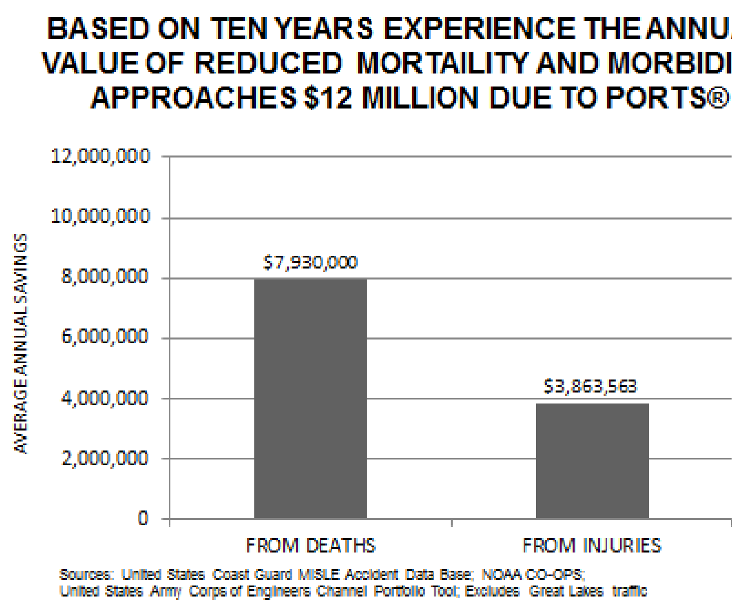


Table 2

TOTAL COST OF COMMERCIAL MARINE ACCIDENTS

CHANGE IN ACCIDENT COUNT	TOTAL COST PER ACCIDENT	COST OVER 10 YEAR STUDY PERIOD	ANNUAL COST
13 FEWER DEATHS	COST OF DEATH @ $6.1 MILLION EACH	$ 79,300,000	$ 7,930,000
63 FEWER INJURIES	COST OF INJURY @ $613,264 EACH	$ 38,635,632	$ 3,863,563
	TOTAL	**$ 117,935,632**	**$ 11,793,563**

Table 3

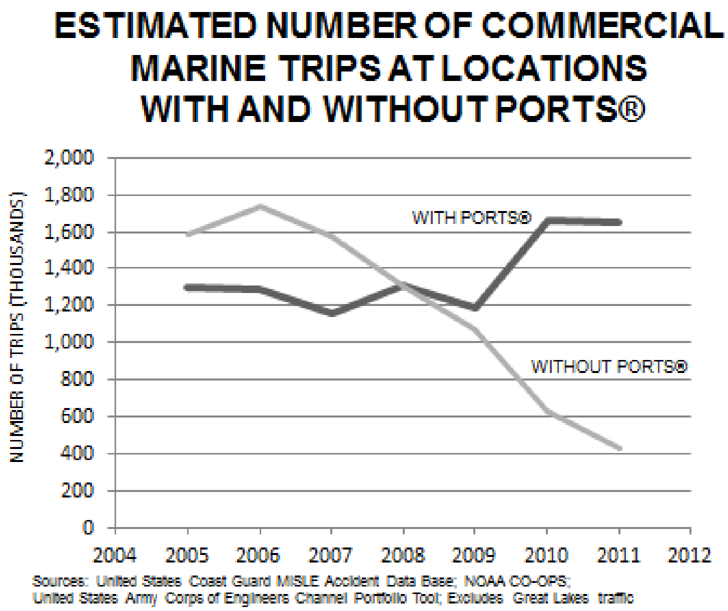
NET PRESENT VALUE OF REDUCED MORTALITY AND MORBIDITY
NET PRESENT VALUE BENEFIT OVER TEN YEARS FROM 58 EXISTING PORTS®

YEAR	ANNUAL VALUE OF DEATH AND INJURY	NPV FACTOR	VALUE
1	$ 11,793,563	0.9629	$ 11,356,022
2	$ 11,793,563	0.9268	$ 10,930,274
3	$ 11,793,563	0.8916	$ 10,515,141
4	$ 11,793,563	0.8854	$ 10,442,021
5	$ 11,793,563	0.8261	$ 9,742,663
6	$ 11,793,563	0.7948	$ 9,373,524
7	$ 11,793,563	0.7653	$ 9,025,614
8	$ 11,793,563	0.7368	$ 8,689,497
9	$ 11,793,563	0.7093	$ 8,365,174
10	$ 11,793,563	0.6828	$ 8,052,645
		TOTAL	**$ 96,492,575**

Over the 2005 to 2011 period, the number of trips at locations without PORTS® dropped from about 55 percent of total trips to little more than 20 percent.[26] (Refer to Figure 12)

[26] The commercial vessel trip data was obtained from two sources. The data for years 2005 – 2010 are from the U.S. Army Corps of Engineers Channel Portfolio Tool (CPT). The CPT data is organized by channel and channel reach. The definition of a port is therefore a collection of channels and channel reaches that make up that port. All searches for port data using CPT used the same port definition (same collection of channels and channel reaches). At the time of this study the U.S. Army Corps of Engineers had not updated the CPT with the 2011 data but had posted trip data on the Navigation Data Center's site 2011 Waterborne commerce of the United States Waterways and Harbors. While nearly all vessel trip data agreed between these two data sets there were eight exceptions. The 2011 may not have included a port that was included in the CPT data. In two cases the 2011 data had unusually low

Figure 12



Employing an estimate of 430,000 annual trips at the remaining 117 ports without PORTS® suggested a reduction in both deaths and injuries if the (adjusted) long term accident rate at locations with PORTS® could be realized at locations without PORTS® following universal installation of such a system. (Refer to Figure 13)

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numbers for these ports. In these eight instances an adjustment based on an average of the 2005 – 2010 CPT data was deemed the best representation of the vessel trip traffic for those eight ports in 2011.

Port Name	**2011 Pre-Adjustment**	**2011 Post-Adjustment (Average of CPT 2005-2010)**
New York/New Jersey	62,113	339,780
Chester, PA	0	1,123
Sabine Pass, TX	0	418
Kings Bay, GA	0	1,712
Intercoastal City, LA	0	12,900
Corpus Christi, TX	17,781	152,083
Bangor, WA	0	120
Bremerton, WA	0	42,423

Under these assumptions, the number of future deaths could drop from a historically anticipated number of 13 to five (a savings of eight lives) while injuries might fall from 94 to 52 (a savings of 42 injuries). (Refer to Table 4.) This would equate to an annual savings of over $3 million in terms of reductions in mortality and $1.9 million in reductions in morbidity. (Refer to Figure 14) Over the next ten years, if PORTS® were implemented the remaining 117 locations, the net present value could approach $60 million dollars (Refer to Table 5).

Figure 13

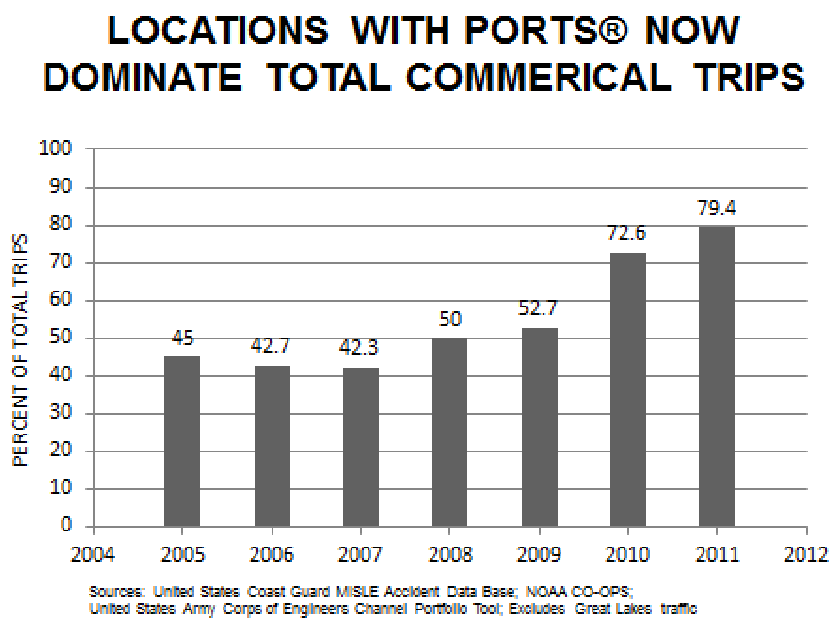


Table 4

**POTENTIAL REDUCTION IN FUTURE DEATHS AND INJURIES
(LOCATIONS WITH PORTS® VERSUS LOCATIONS WITHOUT PORTS®**

	DEATHS	**INJURIES**
NUMBER OF FUTURE TRIPS IN 10 YEARS (320,000 per year)	4,300,000	4,300,000
HISTORICAL 2005-2011 ACCIDENT RATE WITH PORTS®	0.00012%	0.00121%
HISTORICAL 2005–2011 ACCIDENT RATE WITHOUT PORTS®	0.00030%	0.00220%
NUMBER OF ACCIDENTS WITH HISTORICAL ACCIDENT RATE	13	94
NUMBER OF ACCIDENTS WITH PORTS® ACCIDENT RATE	5	52
SAVINGS OWING TO POTENTIAL PORTS® INSTALLATIONS	8	42
TOTAL SAVINGS OVER TEN YEARS		
8 FEWER DEATHS @ $6,100,000 PER OCCURRENCE	$ 47,193,218	
49 FEWER INJURIES @ $613,246 PER OCCURRENCE		$ 25,952,933
POTENTIAL DOLLAR SAVINGS PER YEAR	**$4,719,322**	**$2,595,293**

Figure 14

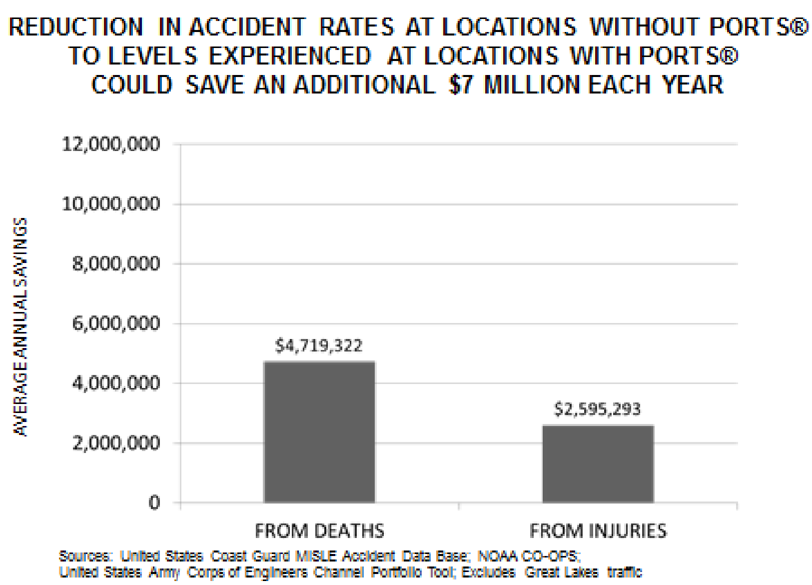


Table 5

NET PRESENT VALUE OF POTENTIAL ANNUAL BENEFIT OVER TEN YEARS OWING TO PORTS® INSTALLATIONS AT REMAINING 117 PORTS

YEAR	POTENTIAL ANNUAL VALUE OF DEATH AND INJURY	NPV FACTOR	VALUE
1	$ 7,314,615	0.9629	$7,043,243
2	$ 7,314,615	0.9268	$6,779,185
3	$ 7,314,615	0.8916	$6,521,711
4	$ 7,314,615	0.8854	$6,476,360
5	$ 7,314,615	0.8261	$6,042,604
6	$ 7,314,615	0.7948	$5,813,656
7	$ 7,314,615	0.7653	$5,597,875
8	$ 7,314,615	0.7368	$5,389,408
9	$ 7,314,615	0.7093	$5,188,257
10	$ 7,314,615	0.6828	$4,994,419
		TOTAL	**$59,846,718**

X. COMMERCIAL MARINE PROPERTY LOSSES

During the ten-year (2002 – 2011) study period, a total of 6,641 accidents involving commercial shipping involved allisions, collisions and groundings. (Refer to Figure 15) Of these groundings were the most prevalent with almost 3,300 occurrences. (Refer to Figure 16) Allisions were second in terms of the number of accidents with almost 2,600. Groundings represented over 800 accidents.

In terms of monetary losses owing from accidents, allisions dominated losses at $224 million over the study period or about 57 percent of total constant dollar losses (Refer to Figure 17). Of all accident types, vessel damage led the way with $224 million (or 57 percent of total losses). Facilities losses totaled $120 million while cargo losses totaled only 7 million. (Refer to Figure 18) Losses by other third party entities added an additional 44 million in losses.

During this time the number of trips which moved through locations with PORTS® rose commensurate with the installation of additional facilities in 2007 (one new location), 2008 (2 new locations), and 2009 (9 new locations). Consequently, the portion of trips with access to PORTS® information grew from 45 percent in 2005 to over 79 percent in 2011. (Refer to Figures 12 and 18) During the 7 years for which data was available, the total number of trips at locations with PORTS® exceeded those at locations without ports by 15 percent (9.6 million versus 8.3 million).

When compared on the basis of the number of trips, the allision, collision and grounding accident rate for locations with PORTS® was 0.033 percent. The rate per trip at non-PORTS® locations was 0.052 percent…a 37 percent difference. During the study period total losses from

Figure 15

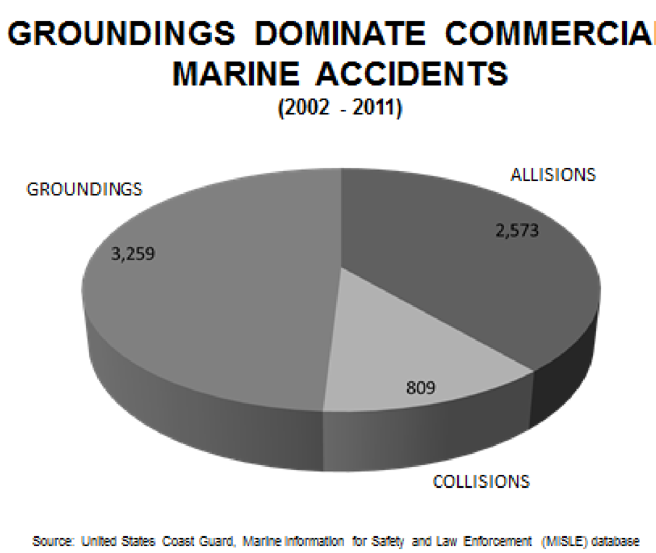


Figure 16

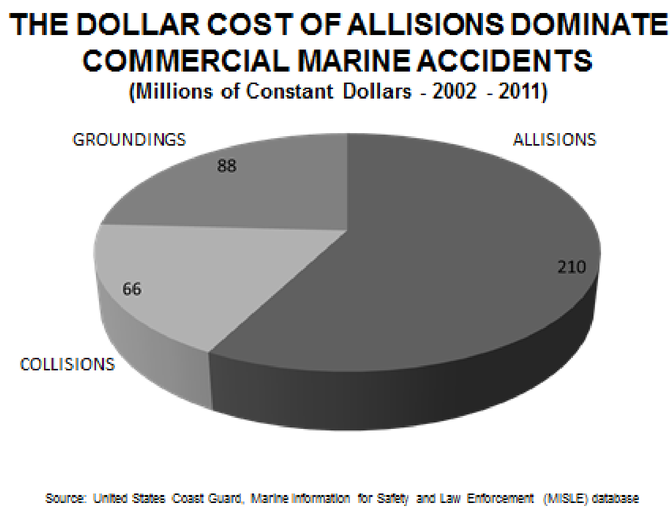


Figure 17

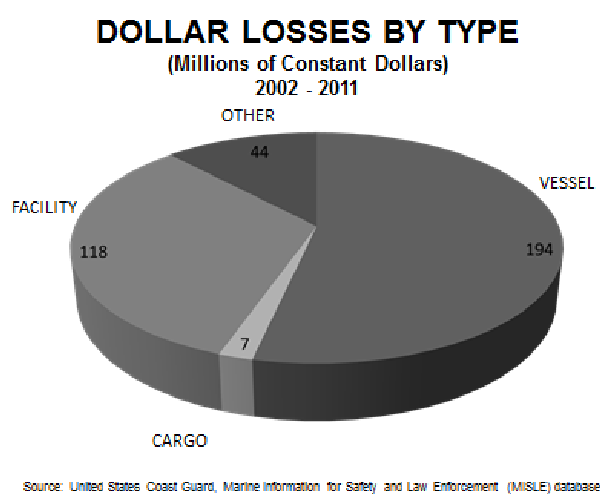
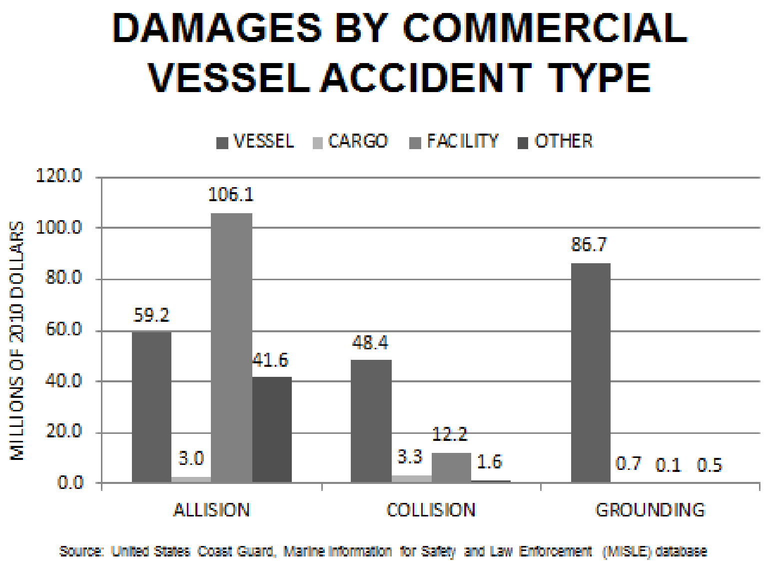


Figure 18



vessel damage, cargo damage facility and other damages (e.g., by-standers) totaled $93.5 million (over seven years) while total losses from locations without PORTS® totaled in excess of $130.1 million (over seven years). (Refer to Table 6)

A. Savings From PORTS®

From this data, a difference in total accident cost (over the seven year period in which the number of vessel trips were available) of $36.7 million was seen. This equates to more than $5.2 million per year or almost $43 million NPV over a ten year period. (Refer to Tables 6 and 7.)

Table 6

HISTORICAL DIFFERENCE IN ALLISION, COLLISION AND GROUNDING ACCIDENT COSTS (2010 CONSTANT DOLLARS)

PORTS® STATUS	TOTAL PROPERTY DAMAGES	PROPERTY LOSS PER TRIP	NUMBER OF ACCIDENTS PER TRIP
WITH PORTS®	$ 93,448,338	$9.77	0.033%
WITHOUT PORTS®	$ 130,103,813	$15.62	0.052%
PORTS® SAVINGS	$ 36,655,475	$ 5.85	0.019%
AVERAGE ANNUAL SAVINGS	$ 5,236,496		

B. Potential Savings From Universal PORTS® Installations

If PORTS® systems were installed at the remaining 117 port locations it is estimated that additional savings could be obtained. Employing the historical (2010 dollar) savings of $5.85 per trip at locations with PORTS® due to a lower rate of allision, collision and grounding accidents, if a total of 430,000 trips were to continue to be processed through non-PORTS® locations, a total of $25 million over ten years could be saved (or a little more than $2.5 million per year).[27] Refer to Table 8. This could equate to almost $21 million over 10 years.

[27] The unknown factor is the number of commercial vessel trips in the future. An annual total of 430,000 trips were employed as the base in this study.

Table 7

ESTIMATED NET PRESENT VALUE OF 58 CURRENT PORTS® INSTALLATIONS OVER TEN YEARS

YEAR	ESTIMATED ANNUAL HISTORICAL SAVINGS	NPV FACTOR	VALUE
1	$ 5,236,496	0.9629	$ 5,042,222
2	$ 5,236,496	0.9268	$ 4,853,184
3	$ 5,236,496	0.8916	$ 4,668,860
4	$ 5,236,496	0.8854	$ 4,636,394
5	$ 5,236,496	0.8261	$ 4,325,869
6	$ 5,236,496	0.7948	$ 4,161,967
7	$ 5,236,496	0.7653	$ 4,007,490
8	$ 5,236,496	0.7368	$ 3,858,250
9	$ 5,236,496	0.7093	$ 3,714,247
10	$ 5,236,496	0.6828	$ 3,575,479
		TOTAL	**$ 42,843,963**

Table 8

ESTIMATED POTENTIAL NET PRESENT VALUE OF FUTURE 117 PORTS® INSTALLATIONS OVER TEN YEARS

YEAR	ESTIMATED POTENTIAL FUTURE ANNUAL SAVINGS	NPV FACTOR	VALUE
1	$ 2,514,783	0.9629	$2,421,484
2	$ 2,514,783	0.9268	$2,330,701
3	$ 2,514,783	0.8916	$2,242,180
4	$ 2,514,783	0.8854	$2,226,589
5	$ 2,514,783	0.8261	$2,077,462
6	$ 2,514,783	0.7948	$1,998,749
7	$ 2,514,783	0.7653	$1,924,563
8	$ 2,514,783	0.7368	$1,852,892
9	$ 2,514,783	0.7093	$1,783,735
10	$ 2,514,783	0.6828	$1,717,094
		TOTAL	**$20,575,448**

REFERENCES:

Kite-Powell, Hauke, *"Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of Houston / Galveston"*, Report prepared for the Houston Ship Channel users and Ports of Houston and Galveston, March, 2007.

Mayntz, Melissa. "Cruise to Nowhere". Cruises.lovetoknow.com

United States Department of Transportation, Maritime Administration, *"North American Cruise Statistical Snapshot, 2011"*, Office of Policy and Plans 2012.

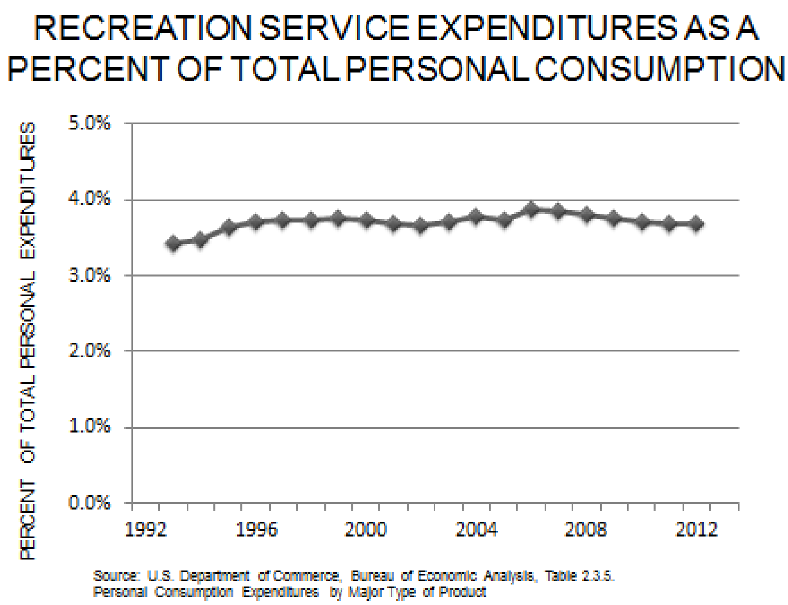
United States Department of Transportation, Maritime Administration, Maritime Statistics, Cruise Statistics, Summary Table (Updated 6/15/2012) and Detail Table (Updated 6/15/2012). Note: Both series have been discontinued effective March 2012.

CHAPTER 7 – RECREATIONAL BOATING ACCIDENTS

I. INTRODUCTION

Over the last twenty years, the demand for recreational activity has been fairly constant at a little less than four percent of total personal consumption expenditures. (Refer to Figure 1)

Figure 1



Recreational boating is a popular pastime with the U.S. population. According to the National Marine Manufacturer's Association (NMMA 2012) and the 2011 Recreational Boating Economic Survey, a total of almost 12.2 million recreational boats are in the United States.[1] Of

[1]The National Marine Manufacturers Association compiles recreational boating statistics by U.S. Congressional District State Congressional District maps were overlaid with the locations of the 175 ports schedule to have PORTS installed. A port would be assigned the number of recreational boats located in the Congressional District in which the port was located. In the rear situation when two ports were located in the same Congressional District the number of recreational boats were apportioned based on 2010 U.S. Census population figures for the port cities. National Marine Manufacturers Association (NMMA), 2012 Recreational Boating Economic Study, http://www.nmma.org/assets/cabinets/Cabinet432/NMMA_ecoimpact_booklet_optimized.pdf

these it has been estimated that 53.7 percent of all recreational boats are located in coastal states with over 45 percent operating out of an area identified as a one of the 175 major ports in America reviewed in this study[1]. The remaining 55 percent of recreational craft are located in inland Congressional Districts or in coastal districts not covered by one of the existing or planned PORTS®**.**

Overall, the average numbers of days in which all recreational boats are used was 16.7 in 2011.[2] On average recreational boats are used 4.5 hours per day and carry an average of 2.4 people. This equates to nearly 3 billion person-hours on recreational boats each year. Of this exposure about two-thirds is due to power boats. Gwet (2010) reported that according to the National Marine Manufacturer's Association (NMMA), a total of nearly $50 billion was spent on recreational boating sales and services along with trip expenses. Overall this would suggest that recreational boating was responsible or almost 13 percent of all recreational expenditures. Latest figures suggest that the boating industry is valued at $72 billion annual economic impact on the U.S. economy (American Boating Congress, 2013). In 2009 the Recreational Boating and Fishing Foundation stated that 25.8 million fishing participants were boating. (Gwet, 2010). In 2010 the U.S. recreational boating participation was 75 million which included 32.4 percent of the adults in the U.S. (NMMA, 2011). Looking forward to 2020, the United States Coast Guard (USCG) forecast that over 179 million recreationists will be involved with motor boats (34 percent), personal watercraft users (12 percent) and sailing (6 percent).[3]

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[2] Source: National Recreational Boating Survey, 2011, Page 45.

[3] Some individuals will be involved in more than in one type of watercraft. Other types of watercraft include canoers (13 percent), rafters (12 percent), water skiers (11 percent), kayakers (8 percent) and rowers (5 percent)

At the current time it is believed that over 2.2 million recreational boats are operated out of ports with PORTS® installed. This represents about 41 percent of all such domiciled craft which totals about 5.5 million. Like any other mariner recreational boaters can benefit from the use of real-time environmental information that PORTS® provides. Recreational boaters recreate in waters throughout all 50 states and territories of the United States. But, PORTS®, even when fully implemented to cover the 175 most major ports will only cover a portion of the waters used by recreational boaters. PORTS® only covers the coastal counties of the coastal states. But for those boaters in areas covered, PORTS® offers a real advantage in obtaining real-time information about parameters especially important to boaters namely weather and tides.

II. DATA COLLECTION

The USCG has the legal responsibility to collect, analyze, and publish recreational boating accident data and statistical information for the fifty states, five U.S. territories, and the District of Columbia. Federal law requires the operator – or owner to file a boating accident report with the State reporting authority when, as a result of an occurrence that involves a boat or its equipment:

- A person dies;
- A person disappears from the vessel under circumstances that indicate death or injury;
- A person is injured and requires medical treatment beyond first aid;
- Damage to vessels and other property totals $2,000 (lower amounts in some states and territories) or more; or,
- The boat is destroyed.

Annually, the USCG compiles statistics on reported recreational boating accidents. These statistics are derived from accident reports that are filed by the owners / operators of recreational vessels involved in accidents. The fifty states, five U.S. territories and the District of Columbia submit accident report data to the USCG for inclusion in the annual Boating Statistics publication and the USCG boating recreational accident database. While the USCG has maintained the boating accident data it hasn't been until 2005 that the data can be considered reliable from all states and territories.

The database contains information on:

- Year – of the accident
- State – in which accident took place
- Water – name of the body of water the accident occurred in
- City – nearest city or town
- County – name of the county nearest the accident
- Additional Location Information – a more exact descriptor of the location
- Dead – number of deaths attributed to the accident
- Injuries – number of injuries attributed to the accident
- Damage – damage estimate
- Cause 1 – major result from accident (e.g. grounding, collision[4], flooding, etc.)
- Cause 2 – major reason directly leading to the accident
- Cause 3-5 – issues leading up to the accident. Cause 3 issues are more significant to the accident than are those for Cause 4 and 5.

A. Importance of Weather

Weather was an important factor in boating accidents being the 5th of 31 most common primary contributing factors of recreational boating deaths in 2010, the 10th and 11th most

[4] In this database allisions were not separately identified but included with collisions.

common primary contributing factor in boating accidents and boating injuries respectively. Of all the types of accidents and primary contributing factors there are only two, groundings and weather related accidents, that PORTS® data could possibly be used to reduce the number of recreational boating accidents, injuries and deaths.

For this study the USCG accident data from calendar years 2005 – 2012 was obtained from the USCG Boating Safety Office. The USCG Boating Safety Office advised that only data from 2005 and beyond was considered to be of sufficient quality to be used for this report. Data prior to 2005 was considered suspect. There were 38,354 accident records in the data set for those eight years.

A boating accident can be thought of as a chain of events leading up to the actual incident. Breaking one or two of the links in the accident chain can potentially prevent the accident from occurring. We can say that logically a mariner when aware of dangerous weather or shoaling waters will choose to take corrective action. Groundings and weather related accidents frequently occur when the mariner doesn't have the information to take early corrective action to avoid the danger. Access and use of real-time information from PORTS® will potentially result in a reduction of both groundings and weather related accidents.

The use of real-time environmental data from PORTS® is logically presumed to have a beneficial effect on accident chain of events when applied under the following conditions.

- Only those boating in areas with PORTS® can benefit from this real-time information. Only accident records that occurred in counties that would be covered by a PORTS® as part of the 175 port implementation were considered. All other data was deleted;
- Only mariners with unimpaired judgment were considered. All accidents involving drugs or alcohol as one of the major causes were eliminated from the data set;

- Only mariners using sound judgment were considered. All accidents involving reckless behavior or excessive speed as a primary cause were eliminated from the data set;

- Only accidents that could benefit from PORTS® data were considered. Accidents that had weather or weather related issues like low visibility, fog, or high seas identified as one of the causes were kept as a "Weather" related data set. There are 212 records in this file; and,

- Of the remaining accident data those related to groundings that might benefit from having access to real-time water level information were kept in a "Grounding" related data set. There are 638 records in this file.

From a total of 38,354 accidents that occurred over 8 years it was determined that the use of real-time meteorological and water level data from PORTS could have had a beneficial effect in 850 of the accidents. That is an average of about 71 accidents per year. 638 of those accidents involved boats grounding resulting in 17 deaths, 336 injuries, and $14 million in property damage (2010 dollars). 212 of the accidents involved weather as a primary cause which resulted in 32 deaths, 120 injuries, and $2.5 million in property damage (2010 dollars).

B. Weather Related Accidents

Mariners of sound judgment would typically check a marine or local area weather forecast prior to planning a boating event. That would be their primary source of weather information for planning a boating activity. During the boating activity mariners need to be alert for changing weather conditions that might develop into a dangerous situation (e.g. reduced visibility, high winds, heavy seas, heavy rain, etc.).

The local forecasts are only updated a few times a day and in certain areas maybe generalized to cover large areas. Mariners with access to PORTS® real-time meteorological information (wind speed and direction, air temperature, sea temperature, and barometric pressure, or visibility) updated every six minutes can spot local changes that deviate from the days initial forecast long before an updated broadcast could provide a warning. For a mariner using sound judgment that more frequent update could enable them to reach their home port or at least a safe shelter before high winds, seas, or low visibility create conditions favorable for a weather related boating accident. The further a boater has ventured from their home port the more vulnerable they are to any change in weather requiring them to cease their boating activity. They have less time to make a decision and change their operations.

Mariners will access weather forecasts via the internet, news programs, at home and at their marina before leaving the dock. They will access weather apps on their cell phone or by marine weather radio broadcasts as their primary source of information. But, they will also have access to PORTS® real-time information via their internet, updates at their marina, and by cell phone apps. PORTS® is considered a secondary source of initial weather information for the recreational boater but a primary source for real time information. From Table 1 weather plays a part in a small number of the recreational boating accidents that occurred in 2010.

- Weather was the primary contributing factor in deaths 6.1% of the time.
- Weather was the primary contributing factor in injuries 3.2% of the time.
- Weather was the primary contributing factor in accidents 4.5% of the time.

As it was beyond the scope of this study to obtain primary data from recreational boat operators as to their use and value of PORTS® data to their boating operations, assumptions had to be made. However, logically it can be argued that having real-time PORTS® weather information available could provide the information the mariner needed to prevent an accident from occurring in one of the potential weather related incidents.

Again, it can be logically argued that a mariner when aware through real-time information (PORTS®) of dangerous weather will choose to take corrective action. While most of the weather related accidents could be prevented , the data is not available to support a larger number for the percent of accidents avoided. Instead, using the de minimis PORTS® valuation argument (Refer to Chapters 2 and Chapter 5) it is argued that at least one percent (1.0%) of the accidents could be prevented by the use of real-time PORTS weather information. In calculating the benefit from preventing weather related accidents the annual value of weather related boating accidents was multiplied by the expected one percent benefit factor. The real benefit is expected to be at least this large and probably significantly larger and suggests the need for further research.

C. Grounding Accidents

PORTS® information can be of help to recreational boaters in avoiding groundings but probably only in a small number of cases. Vessel groundings usually occur when the mariner becomes disoriented and navigates into an area with a shoal. Proper use of a navigational chart and accurate positional information could prevent that type of accident. There are a smaller number of grounding cases where the mariner is unaware that the tide has changed or is dropping more rapidly than expected and they can find themselves aground. Those cases are not common and might occur when a mariner is pushing the safety envelop to fish in a shoal area or are engaged in other recreational activity in waters they would normally consider safe. Tides can change

Table 1

PRIMARY CONTRIBUTING FACTOR OF RECREATIONAL BOATING ACCIDENTS (2010)

RANK	NUMBER OF DEATHS	NUMBER OF INJURIES	NUMBER OF ACCIDENTS
1	Alcohol Use (126)	Operator Inattention (457)	Operator Inattention (759)
2	Hazardous Waters (100)	Other (325)	Other (414)
3	Unknown (64)	Excessive Speed (324)	Improper Lookout (375)
4	Operator Inattention (49)	Alcohol Use (293)	Operator Inexperience (358)
5	Weather (41)	Improper Lookout (266)	Excessive Speed (337)
6		Operator Inexperience (265)	Alcohol Use (330)
7		Force of Wave/Wake (252)	Force of Wave/Wake (272)
8		Rules of the road Infraction (202)	Hazardous Waters (265)
9		Hazardous Waters (156)	Machinery Failure (257)
10		Weather (102)	Rules of the road Infraction (211)
11			Weather (209)
Total Number	672	3,153	4,606
Weather as Percent of Total	6.1%	3.2%	4.5%

significantly from their published predictions in both amplitude and time of low water when winds blow water out of a bay unexpectedly reducing the water level. A knowledgeable mariner would use all the tools available to ensure a safe boating event. That would include up to date charts to warn them of shoal areas and real-time water level information from PORTS® to warn them of dangerous water level events.

Just as with weather related accidents we know that logically mariners, when aware through real-time information (PORTS®) of dangerous water level conditions, will choose to take corrective action avoiding the grounding. Access to real-time PORTS water level information should have the effect of reducing the rate of groundings.

In the course of operation, recreational boaters have often tended to pay greater attention to weather conditions than they do state of the tide. Consequently, it is logical to assume that the availability of real-time water level information would not be referred to at the same rate as real time weather information. Because of this practice it would be expected that PORTS® real time water level data would have a lower impact on preventing the frequency of grounding accidents than having access to weather information from PORTS® would have on reducing weather related accidents. As a result, using the de minimis logic employed previously the weight of PORTS® data associated with grounding prevention was assigned a lesser value (estimated that at least one tenth of one percent (0.1%)).

III. ANALYSIS OF RECREATIONAL BOATING ACCIDENTS

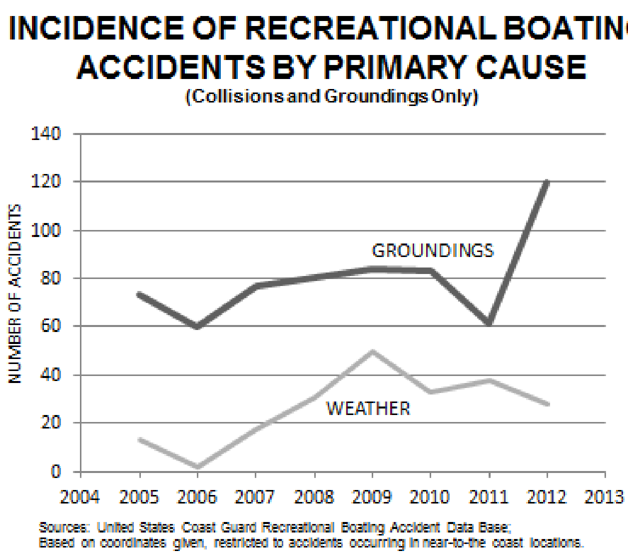
To determine the benefit to recreational boaters from access to real-time environmental data derived from the NOAA PORTS® an analysis was made of the boating accidents experienced over the past eight years (2005-2012).[5] As there is no direct recreational boating data base which records the number of mariners which use PORTS® or specifically where the

[5] Although some data is available prior to 2005, its consistency and quality is questionable and was not included in this study.

accident occurred (e.g., use of latitude and longitude), the analysis was conducted in two parts.[6] First was to ascertain the potential benefit that all recreational boaters might obtain from use of a PORTS® system; and, (2) estimate the exposure of total recreational boating activities which might occur with proximity of an existing PORTS® installation.

The USCG counted 4,604 recreational boating accidents that resulted in 672 deaths 3,153 injuries and approximately $35.5 million dollars of damage to property as a result of recreational boating accidents in 2010 from all causes. (USCG, 2010) As in vehicular driving, impaired (alcohol and drugs), distracted and inexperienced operators were among the most often cited reasons for recreational boating accidents.

Figure 2



[6] While the name of the body of water, nearest city, county and additional information was provided, specific latitude and longitude data akin to the USCG's commercial accident database was not provided. Using maps and knowledge of port locations, specific accidents were selected based on their estimated proximity to a port area and whether that port had a PORTS® system in place at the time (year) of the accident.

Figure 3

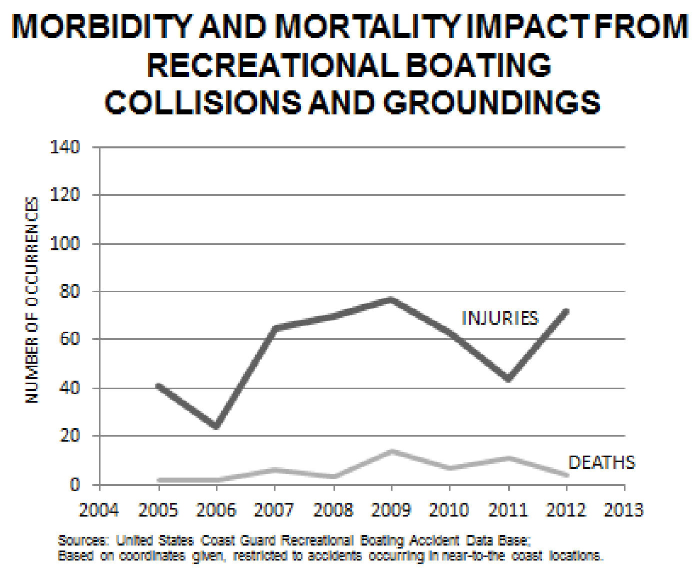
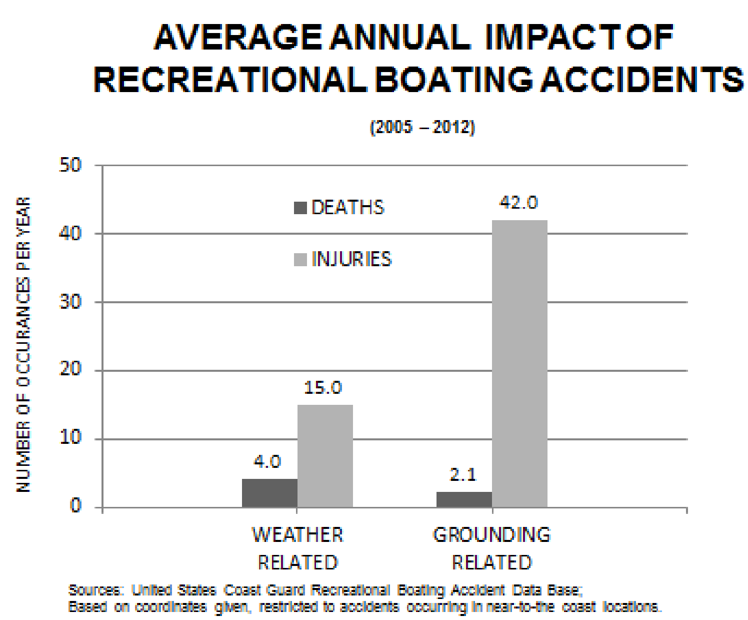


Figure 4



During the study period, there appeared to be a slight increase in the number of accidents associated with weather and groundings as their primary cause. (Refer to Figure 2) During that time, the number of average annual deaths from weather was twice that in the event of groundings while the number of injuries was almost three times higher in the case of groundings than in weather situations. (Refer to Figure 3 and 4) At the same time, the number of injuries was nearly three times as great in grounding accidents. Overall, while some accidents included both deaths and injuries, there were over three times as many grounding accidents as weather-related ones during the 8-year study period.

Employing the value of a life (Refer to Chapter 3, Section V) as determined by the U.S. Department of Transportation of $6.1 million and the expected severity of an injury of $613,264 (through the MAIS)[7], the annual costs fluctuated significantly in the cast of mortality costs (Refer to Figure 5). Injury costs also varied on an annual basis but to a lesser extent (Refer to Figure 6). Total costs, driven by mortality costs, were also observed to fluctuate across years (Refer to Figure 7)

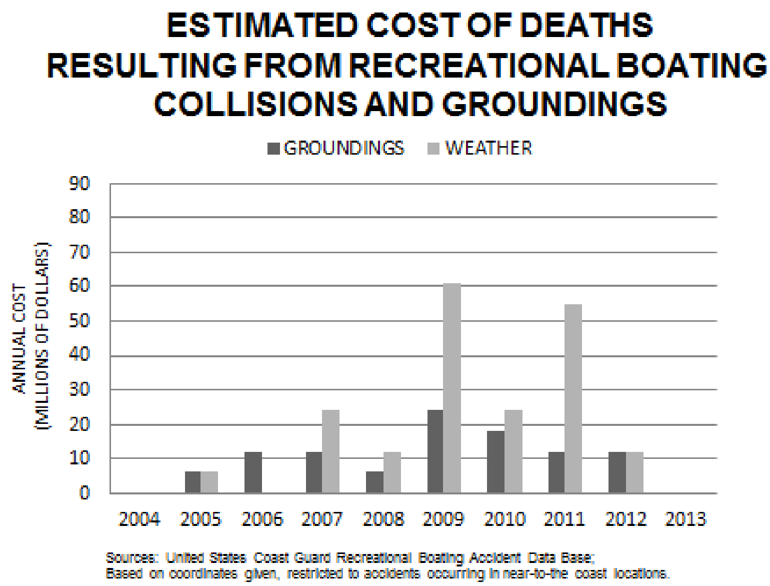
IV. ESTIMATED PORTS® BENEFITS TO RECREATIONAL BOATING

During the study period recreational boating accidents due to groundings resulted in losses of approximately $14 million. Employing the previously identified de minimis factor of one tenth of one percent if that portion could be saved owing to PORTS®, a total of $14,000 over eight years or $1,750 per year might be avoided. (Refer to Table 2) Similarly, reductions in the costs association with reduced morbidity and mortality could total almost $310 thousand or

[7] Refer to Chapter 3.

almost $39,000 per year. (Refer to Table 2) In total, over $40,000 might be saved through universal implementation of PORTS® at all 175 port locations.

Figure 5



In terms of weather-related recreational boat accidents, the portion (based on an assumption of one percent of total benefits could be attributable to PORTS® if universally implemented at all 175 ports suggests total benefits over 8 years to exceed $2.7 million or about $340 thousand per year. (Refer to Table 3) Collectively, the potential benefits from PORTS® from reduced weather and grounding caused accidents at all 175 locations could approach $380 thousand per year. (Refer to Table 4)

Figure 6

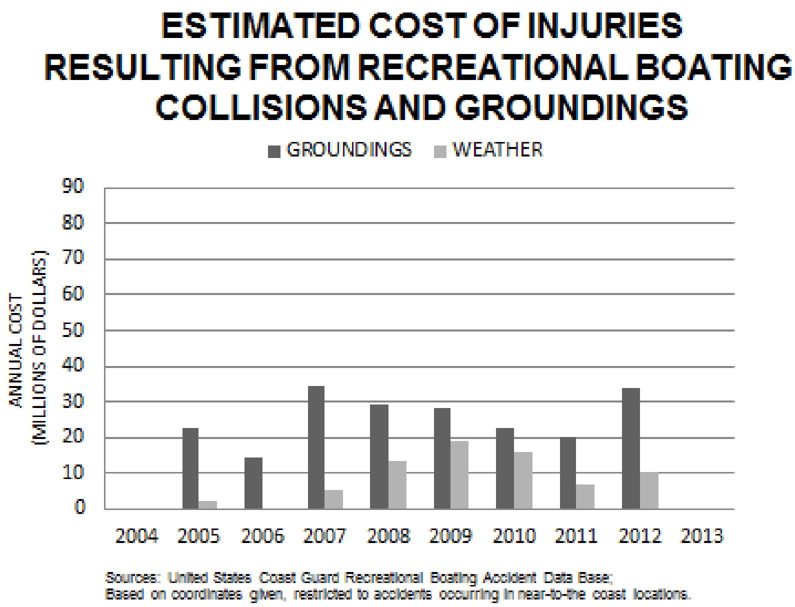
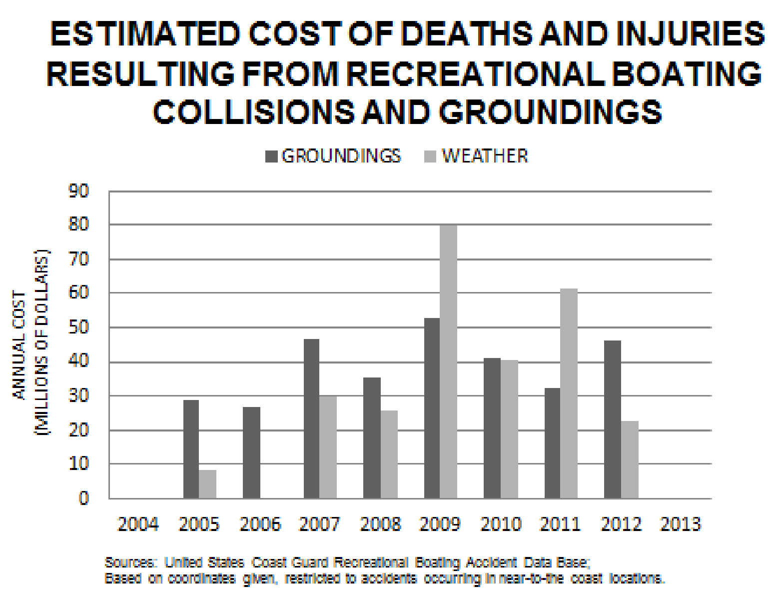


Figure 7



A. Net Present Value of Benefits

Employing the CBO's cost of capital the 10-year net present value of potential PORTS® installation at all 175 ports, the net present value of potential grounding benefits could be in excess of $330 thousand dollars while weather-related benefits could approach $2.8 million for a total of over $3.1 million. (Refer to Tables 5, 6 and 7.)

Table 2

POTENTIAL BENEFITS FROM PORTS® INVOLVING GROUNDING ACCIDENTS IF INSTALLED AT ALL 175 LOCATIONS OF PORTS

	COST PER OCCURANCE	**TOTAL COST (Over 8 Years)**	**PERCENT DUE TO PORTS®**	**PORTS® AMOUNT (TOTAL)**	**PORTS® SHARE PER YEAR**
PER DEATH	$ 6,100,000	$ 103,700,000	0.10%	$ 103,700	$ 12,963
PER INJURY[8]	$ 613,264	$ 206,056,704	0.10%	$ 206,057	$ 25,757
SUBTOTAL		$ 309,756,704	0.10%	$ 309,757	$ 38,720
PROPERTY	2010 DOLLARS	$ 13,999,897	0.10%	$ 14,000	$ 1,750
	TOTAL GROUNDINGS	**$ 323,756,601**		**$ 323,757**	**$ 40,470**

[8] Expected value using MAIS process.

Table 3

POTENTIAL BENEFITS FROM PORTS® INVOLVING WEATHER ACCIDENTS IF INSTALLED AT ALL 175 LOCATIONS OF PORTS

	COST PER OCCURANCE	**TOTAL COST (Over 8 Years)**	**PERCENT DUE TO PORTS®**	**PORTS® AMOUNT (TOTAL)**	**PORTS® SHARE PER YEAR**
PER DEATH	$ 6,100,000	$ 195,200,000	1.00%	$ 1,952,000	$ 244,000
PER INJURY	$ 613,264	$ 73,591,680	1.00%	$ 735,917	$ 91,990
SUBTOTAL		$ 268,791,680	1.00%	$ 2,687,917	$ 335,990
PROPERTY	2010 DOLLARS	$ 2,452,244	1.00%	$ 24,522	$ 3,065
	TOTAL WEATHER	**$ 271,243,924**		**$ 2,712,439**	**$ 339,055**

Table 4

POTENTIAL BENEFITS FROM PORTS® INVOLVING WEATHER AND GROUNDINGS ACCIDENTS IF INSTALLED AT ALL 175 LOCATIONS OF PORTS

<table>
<tr><th></th><th>COST PER OCCURANCE</th><th>TOTAL COST (Over 8 Years)</th><th>PERCENT DUE TO PORTS®</th><th>PORTS® AMOUNT (TOTAL)</th><th>PORTS® SHARE PER YEAR</th></tr>
<tr><td>PER DEATH</td><td>$ 6,100,000</td><td>$ 298,900,000</td><td rowspan="7">WEIGHTED AVERAGES .01 and .001 PERCENT</td><td>$ 2,055,700</td><td>$ 256,963</td></tr>
<tr><td>PER INJURY</td><td>$ 613,264</td><td>$ 279,648,384</td><td>$ 941,974</td><td>$ 117,747</td></tr>
<tr><td>SUBTOTAL</td><td></td><td>$ 578,548,384</td><td>$ 2,997,674</td><td>$ 374,709</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PROPERTY</td><td>2010 DOLLARS</td><td>$ 16,452,141</td><td>$ 38,522</td><td>$ 4,815</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>TOTAL ALL ACCIDENTs</td><td>$ 595,000,525</td><td>$ 3,036,196</td><td>$ 379,524</td></tr>
</table>

Table 5

POTENTIAL NET PRESENT VALUE OF RECREATIONAL BOATING GROUNDING SAVINGS (MORBIDITY, MORTALITY & PROPERTY DAMAGE) IF PORTS® WERE INSTALLED AT ALL 175 PORTS

YEAR	TOTAL BENEFIT	AVERAGE ANNUAL BENEFIT	PORTS® SHARE (0.1 PERCENT)	NPV FACTOR (3.9%)	VALUE
1	$ 323,756,601	$ 40,469,575	$ 40,470	0.9629	$ 38,968
2	$ 323,756,601	$ 40,469,575	$ 40,470	0.9268	$ 37,507
3	$ 323,756,601	$ 40,469,575	$ 40,470	0.8916	$ 36,083
4	$ 323,756,601	$ 40,469,575	$ 40,470	0.8854	$ 35,832
5	$ 323,756,601	$ 40,469,575	$ 40,470	0.8261	$ 33,432
6	$ 323,756,601	$ 40,469,575	$ 40,470	0.7948	$ 32,165
7	$ 323,756,601	$ 40,469,575	$ 40,470	0.7653	$ 30,971
8	$ 323,756,601	$ 40,469,575	$ 40,470	0.7368	$ 29,818
9	$ 323,756,601	$ 40,469,575	$ 40,470	0.7093	$ 28,705
10	$ 323,756,601	$ 40,469,575	$ 40,470	0.6828	$ 27,633
				TOTAL	**$ 331,114**

Table 6

POTENTIAL NET PRESENT VALUE OF RECREATIONAL BOATING WEATHER SAVINGS (MORBIDITY, MORTALITY & PROPERTY DAMAGES) IF PORTS® WERE INSTALLED AT ALL 175 PORTS

YEAR	TOTAL BENEFIT	AVERAGE ANNUAL BENEFIT	PORTS® SHARE (1.0 PERCENT)	NPV FACTOR (3.9%)	VALUE
1	$ 271,243,244	$ 33,905,406	$ 339,054	0.9629	$ 326,475
2	$ 271,243,244	$ 33,905,406	$ 339,054	0.9268	$ 314,235
3	$ 271,243,244	$ 33,905,406	$ 339,054	0.8916	$ 302,301
4	$ 271,243,244	$ 33,905,406	$ 339,054	0.8854	$ 300,198
5	$ 271,243,244	$ 33,905,406	$ 339,054	0.8261	$ 280,093
6	$ 271,243,244	$ 33,905,406	$ 339,054	0.7948	$ 269,480
7	$ 271,243,244	$ 33,905,406	$ 339,054	0.7653	$ 259,478
8	$ 271,243,244	$ 33,905,406	$ 339,054	0.7368	$ 249,815
9	$ 271,243,244	$ 33,905,406	$ 339,054	0.7093	$ 240,491
10	$ 271,243,244	$ 33,905,406	$ 339,054	0.6828	$ 231,506
				TOTAL	**$ 2,774,072**

Table 7

POTENTIAL NET PRESENT VALUE OF RECREATIONAL BOATING GROUNDING AND WEATHER SAVINGS (MORTALITY, MORBIDITY & PROPERTY DAMAGES) IF PORTS® WERE INSTALLED AT ALL 175 PORTS

YEAR	TOTAL BENEFIT	AVERAGE ANNUAL BENEFIT	WEATHER SHARE	GROUNDING SHARE	TOTAL POTENTIAL
1	$ 594,999,845	$ 74,374,981	$ 326,475	$ 38,968	$ 351,743
2	$ 594,999,845	$ 74,374,981	$ 314,235	$ 37,507	$ 338,383
3	$ 594,999,845	$ 74,374,981	$ 302,301	$ 36,083	$ 336,030
4	$ 594,999,845	$ 74,374,981	$ 300,198	$ 35,832	$ 313,524
5	$ 594,999,845	$ 74,374,981	$ 280,093	$ 33,432	$ 301,645
6	$ 594,999,845	$ 74,374,981	$ 269,480	$ 32,165	$ 290,449
7	$ 594,999,845	$ 74,374,981	$ 259,478	$ 30,971	$ 279,633
8	$ 594,999,845	$ 74,374,981	$ 249,815	$ 29,818	$ 269,196
9	$ 594,999,845	$ 74,374,981	$ 240,491	$ 28,705	$ 259,139
10	$ 594,999,845	$ 74,374,981	$ 231,506	$ 27,633	$ 351,743
		TOTAL	**$2,774,072**	**$ 331,114**	**$ 3,105,186**

B. Allocation of Benefits to Non-PORTS® Areas

Of the over 12 million total recreational boating craft in operation, it has been estimated that about 5.5 million (45 percent) are operated into and out of one the proximity of America's top 175 major physical port areas. (Refer to Table 8) Of these, about 2.2 million are operated from areas with existing PORTS® systems. From these figures, it has been estimated that about 40 percent (2.2 million out of 5.5 million) of recreational boaters could currently enjoy benefits from PORTS®.

Consequently, it is believed that a current annual benefit of $152 thousand is enjoyed by recreational boaters due to reductions in grounding and weather related accidents and that an additional $228 thousand could be enjoyed if PORTS® were universally implemented at all 175 major U.S. ports.[9] (Refer to Tables 9, 10, 11 and 12)

When analyzed over the ten-year economic life of the PORTS® system, the current NPV could exceed $1.2 million while the additional potential could be an additional $1.8 million for a total of almost $3.1 million dollars. (Refer to Tables 13, 14, 15 and 16)

Table 8

CALCULATION OF CURRENT AND ESTIMATED REMAINING BENEFIT FROM PORTS®

TOTAL NUMBER OF RECREATIONAL BOATS	NUMBER	PERCENT OF TOTAL
IN THE U.S.	12,128,157	100.0%
IN COASTAL STATES	6,544,255	53.8%
IN PROXIMITY OF 175 MAJOR PORTS	5,490,309	45.1%
IN PROXIMITY OF 58 PORTSWITH PORTS®	2,235,463[10]	18.4%

Table 9

ESTIMATED PORTION OF CURRENT AND POTENTIAL PORTS® FROM REDUCED GROUNDINGS

BENEFIT AREA	TOTAL ANNUAL POTENTIAL	AMOUNT OF BENEFIT CURRENTLY ENJOYED (40%) FROM EXISTING 58 PORTS®	AMOUNT OF BENEFIT POTENTIALLY ENJOYED FROM PORTS® INSTALLATIONS AT 117 REMAINING LOCATIONS (60%)
MORBIDITY AND MORTALITY	$38,720	$15,488	$23,232
PROPERTY DAMAGE	$1,750	$700	$1,050
TOTAL	$40,470	$16,188	$24,282

[9] We are speaking of implementation at the remaining 117 ports without PORTS®

[10] Represents about 40 percent (2.2 million out of 5.5 million) of total recreational boat registrations in areas with PORTS®

Table 10

ESTIMATED PORTION OF CURRENT AND POTENTIAL PORTS® FROM IMPROVED RESPONSE TO WEATHER CONDITIONS

BENEFIT AREA	TOTAL ANNUAL POTENTIAL	AMOUNT OF BENEFIT CURRENTLY ENJOYED (40%) FROM EXISTING 58 PORTS®	AMOUNT OF BENEFIT POTENTIALLY ENJOYED FROM PORTS® INSTALLATIONS AT 117 REMAINING LOCATIONS (60%)
MORBIDITY AND MORTALITY	$335,990	$134,396	$201,594
PROPERTY DAMAGE	$3,065	$1,226	$1,839
TOTAL	$339,055	$135,622	$203,433

Table 11

ESTIMATED PORTION OF CURRENT AND POTENTIAL PORTS® FROM IMPROVED RESPONSE TO WEATHER CONDITIONS AND REDUCED GROUNDINGS

BENEFIT AREA	TOTAL ANNUAL POTENTIAL	AMOUNT OF BENEFIT CURRENTLY ENJOYED (40%) FROM EXISTING 58 PORTS®	AMOUNT OF BENEFIT POTENTIALLY ENJOYED FROM PORTS® INSTALLATIONS AT 117 REMAINING LOCATIONS (60%)
MORBIDITY AND MORTALITY	$374,710	$149,884	$224,826
PROPERTY DAMAGE	$4,815	$1,926	$2,889
TOTAL	$379,525	$151,810	$227,715

Table 12

ESTIMATED PORTION OF CURRENT AND POTENTIAL PORTS® BENEFITS

BENEFIT AREA	TOTAL ANNUAL POTENTIAL	AMOUNT OF BENEFIT CURRENTLY ENJOYED (40%) FROM EXISTING 58 PORTS®	AMOUNT OF BENEFIT POTENTIALLY ENJOYED FROM PORTS® INSTALLATIONS AT 117 REMAINING LOCATIONS (60%)
REDUCED GROUNDING LOSSES	$ 40,470	$ 16,188	$ 24,282
REDUCED WEATHER LOSSES	$ 339,054	$ 135,622	$ 203,432
REDUCED TOTAL LOSSES	$ 379,524	$ 151,810	$ 227,714

Table 13

ESTIMATED NET PRESENT VALUE OF THE PORTION OF CURRENT AND POTENTIAL PORTS® BENEFITS (MORTALITY, MORBIDITY AND PROPERTY DAMAGE)

BENEFIT AREA	NPV OF CURRENT BENEFITS	NPV FROM IMPEMENTATION AT ALL PORT LOCTIONS	ESTIMATED TOTAL
REDUCED GROUNDING LOSSES	$ 132,447	$ 198,670	$ 331,117
REDUCED WEATHER LOSSES	$ 1,109,632	$ 1,664,440	$ 2,774,072
REDUCED TOTAL LOSSES	**$ 1,242,079**	**$ 1,863,110**	**$ 3,105,189**[11]

[11] Difference of three dollars between totals in Table 7 and Table 13 is due to rounding.

Table 14

ESTIMATED NET PRESENT VALUE RESULTING FROM PROPERTY DAMAGES

YEAR	NPV FACTOR	ANNUAL VALUE CURRENT 58 PORTS®	ADDITIONAL 117 PORTS	TOTAL 175 PORT POTENTIAL	NPV 58 PORTS®	NPV 117 PORTS	NPV TOTAL 175 PORTS
1	0.963	$1,926	$2,889	$4,815	$1,855	$2,782	$4,636
2	0.927	$1,926	$2,889	$4,815	$1,785	$2,678	$4,463
3	0.892	$1,926	$2,889	$4,815	$1,717	$2,576	$4,293
4	0.885	$1,926	$2,889	$4,815	$1,705	$2,558	$4,263
5	0.826	$1,926	$2,889	$4,815	$1,591	$2,387	$3,978
6	0.795	$1,926	$2,889	$4,815	$1,531	$2,296	$3,827
7	0.765	$1,926	$2,889	$4,815	$1,474	$2,211	$3,685
8	0.737	$1,926	$2,889	$4,815	$1,419	$2,129	$3,548
9	0.709	$1,926	$2,889	$4,815	$1,366	$2,049	$3,415
10	0.683	$1,926	$2,889	$4,815	$1,315	$1,973	$3,288
				TOTAL NPV	**$15,758**	**$23,637**	**$39,395**

Table 15

ESTIMATED NET PRESENT VALUE RESULTING FROM MORBIDITY AND MORTALITY LOSSES

YEAR	NPV FACTOR	ANNUAL VALUE CURRENT 58 PORTS®	ADDITIONAL 117 PORTS	TOTAL 175 PORT POTENTIAL	NPV 58 PORTS®	NPV 117 PORTS	NPV TOTAL 175 PORTS
1	0.963	$149,884	$224,826	$374,710	$144,323	$216,485	$219,266
2	0.927	$149,884	$224,826	$374,710	$138,912	$208,369	$211,045
3	0.892	$149,884	$224,826	$374,710	$133,637	$200,455	$203,030
4	0.885	$149,884	$224,826	$374,710	$132,707	$199,061	$201,618
5	0.826	$149,884	$224,826	$374,710	$123,819	$185,729	$188,115
6	0.795	$149,884	$224,826	$374,710	$119,128	$178,692	$180,987
7	0.765	$149,884	$224,826	$374,710	$114,706	$172,059	$174,270
8	0.737	$149,884	$224,826	$374,710	$110,435	$165,652	$167,780
9	0.709	$149,884	$224,826	$374,710	$106,313	$159,469	$161,518
10	0.683	$149,884	$224,826	$374,710	$102,341	$153,511	$155,483
				TOTAL NPV	**$1,226,321**	**$1,839,481**	**$3,065,802**

Table 16

ESTIMATED NET PRESENT VALUE RESULTING FROM PROPERTY, MORBIDITY AND MORTALITY LOSSES

YEAR	NPV FACTOR	ANNUAL VALUE CURRENT 58 PORTS®	ADDITIONAL 117 PORTS	TOTAL 175 PORT POTENTIAL	NPV 58 PORTS®	NPV 117 PORTS	NPV TOTAL 175 PORTS
1	0.963	$151,810	$227,714	$374,710	$146,178	$219,266	$365,444
2	0.927	$151,810	$227,714	$374,710	$140,698	$211,045	$351,743
3	0.892	$151,810	$227,714	$374,710	$135,354	$203,030	$338,384
4	0.885	$151,810	$227,714	$374,710	$134,413	$201,618	$336,031
5	0.826	$151,810	$227,714	$374,710	$125,410	$188,115	$313,525
6	0.795	$151,810	$227,714	$374,710	$120,659	$180,987	$301,646
7	0.765	$151,810	$227,714	$374,710	$116,180	$174,270	$290,450
8	0.737	$151,810	$227,714	$374,710	$111,854	$167,780	$279,633
9	0.709	$151,810	$227,714	$374,710	$107,679	$161,518	$269,196
10	0.683	$151,810	$227,714	$374,710	$103,656	$155,483	$259,139
				TOTAL NPV	**$1,242,079**	**$1,863,110**	**$3,105,189**

REFERENCES:

American Boating Congress, *"U.S. Recreational Boating Industry Gathers in Washington, DC for Face-to-Face Congressional dialog during American Boating Congress"*, Press Release, May 8, 2013).

Gwet, Philippe, and Glenn Haas, *"The National Recreational Boating Survey, Improving risk Assessment to Guide Safety Efforts"*, United States Coast Guard Proceedings, Fall 2010.

United States Coast Guard, *"Recreational Boating Statistics 2010"*, Washington, D.C., 2011, p. 6

United States Department of Commerce, Bureau of Economic Analysis, Table 2.3.5., *"Personal Consumption Expenditures by Major Type of Product"*, Last revised May 30, 2013.

National Marine Manufacturers Association, *"Recreational Boating Statistical Abstract,"* 2011, p. IV-V).

National Marine Manufacturers Association, *"2012 Recreational Boating Economic Study"*, http://www.nmma.org/assets/cabinets/Cabinet432/NMMA_ecoimpact_booklet_optimized.pdf.

CHAPTER 8 - RECREATIONAL AND COMMERCIAL FISHING

I. INTRODUCTION

Tides and currents created by tides are of utmost importance inshore. Data provided by PORTS® can provide fisherman with information that can enhance their productivity. The following discussion on fish behavior is offered to show how physical characteristics, some of which are measured by PORTS®, affect the location and feeding activities of fish and the potential efficiency of fishing operations.

Fish feed into the current, simple as that. They face into the current to maintain position and to intercept food washed by the current. This is especially true on the falling tide. Fish that feed on the flats are more affected by water depth (tide height) than by the current flow. “If there isn’t any water on the flat, the only fish there will be dead ones.”[1] As the water level drops with a falling tide, the fish leave the flats and take up positions along channel edges to ambush prey that also have to leave the flat.

The stage of the tide, and how hard the current runs has a definite impact on fishing, both inshore and offshore. Knowing how to read tide charts correctly and apply that data can determine how successful a fishing day on the water might be. All tide charts show the date and time of the high and low waters but not all show the height of the tide. The height above mean low water can be significant. The height makes a difference because the flow of the current becomes stronger as the height increases, which causes the water to become turbid. Turbidity is suspended silt which has been stirred up from bottom sediment. Turbid water reduces the chances of the fish seeing the bait. This is especially important when fishing artificial lures. Scent and sound become more important as turbidity of the water increases. The larger the

[1] Captain Ken Roy Refer to “Tides and currents; Their effect on Fishing”, Refer to: http://www.bigbendsportsman.com/stories/ken_tides_currents.htm

difference between the high tide and the low tide, the faster the tidal current.[2]

Jones (2013) reports that tides and currents so important to understand.[3] Fish are easier to catch when they are feeding and it's the tide and currents that dictate this. This means the tide and current will concentrate the bait and the movement of water will initiate and stimulate feeding activity. As the water begins to move, smaller baitfish are at the mercy of the current and get confused in the turbulent water. Larger game fish have an advantage because they are equipped to feed in this turbulent water. As such, moving water is often best for fishing.

Becker (2013) states that fish can be caught on a rising or falling tide, but not a time of high or low water when there is little water movement.[4] When the tide is at its high or low point, there is very little water movement, and when there is little or no water movement, fish do very little feeding. There can be days when there is considerable water movement, and there are days when there is an absence of currents. On some days the currents are strong, while on others they are reasonably mild.

Nix (2010) reports that many marine organisms can only survive within a particular salinity range, which makes salinity a notable factor in determining the types of potentially commercial organisms found in the Gulf of California. The mean annual ranges of salinity of the Sea of Cortez are between 3.5 to 3.58% at the surface.[5] Earlier Brusca (1973) noted that, the

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[2] Ibid.

[3] Randy S. Jones "Tides and Habitats", Leadertec downloaded 2/26/13, Refer to: http://www.leadertec.com/tipsandtechniques/Tides_habitats.html

[4] A.C. Becker, Jr. "The Role of Tidal Currents in Fishing", Gulf Coast Fisherman, Refer to: http://www.gulffishing.com/cevnt931.html downloaded 2/26/13

[5] Rebekah K. Nix. "The Gulf of California: A Physical, Geological, and Biological Study" (PDF). University of Texas at Dallas. Retrieved April 10, 2010.

salinity of the water of the Northern Gulf of California is generally higher than the central and Southern faunal regions due to the increased amount of evaporation that occurs in that region.[6]

In more wide-ranging analysis, Love (1997) observed that:

> "Fishes are extremely sensitive to their environment. If you think about it, a fish's life is divided into only three parts: (1) Eating; (2) Avoiding being eaten; and, (3) Reproducing. Everything else is just window dressing for these three activities. What I will do is go through various environmental factors in a fish's life and explain how it might react, and how this impacts a fisherman."[7]

Love states the major environmental factors in a fish's life are: (1) water temperature; (2) water clarity; (3) water motion; (4) water salinity; and, (5) light levels (both daily and seasonally). He attributed these five parameters to six phenomena: (1) currents; (2) waves and swells; (3) time of day; (4) time of year; (5) tides; and, (6) rainfall. Obviously, some of these phenomena produce more than one effect. For instance, when an El Niño occurs, water temperature rises, but also water clarity. During storms, waves cause more water motion near shore, which causes sand and mud to be kicked up, resulting in a decline in water clarity. Time of year influences rainfall, light levels, water motion, water clarity, water temperature etc. A full moon produces more light at night, but it also produces larger tides.

Currents are a major factor in a fish's life for a number of reasons. Off California, there are two major currents. First, there is the California Current, a cold current which sweeps down the coast as far south as Pt. Conception, then swings offshore. During winter and spring, the

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[6] Richard C. Brusca (1973). A Handbook to the Common Intertidal Invertebrates of the Gulf of California. Tucson, Arizona: University of Arizona Press. pp. 10–15. ISBN 0-8165-0356-7.

[7] Love, Milton, "Effects of Water Movement and Other Parameters on fishes and Fisheries", California Seafood Council, 1997. Refer to: http://ca-seafood.ucdavis.edu/educate/effects.htm

California Current is at its strongest and parts of it enter southern California waters. There is also the Davidson Current, a flow of warmer water which moves northward from Baja California and primarily bathes southern California and parts of central California during summer and fall. Periodically, there is an El Niño, which is a mass of warm water that moves northward from a region near the equator.

A. Water Temperature

In any part of the ocean, water temperature is controlled by three major factors: (1) water depth; (2) energy from the sun; and, (3) currents. In the case of water depth, the deeper the water, generally the colder it is. Energy from the sun warms the water; during summer there is more energy available than during the winter. Currents also tend to be seasonal in nature. The cold California Current is strongest in winter and spring, and the warmer Davidson Current is strongest in summer and fall.

In addition, the ocean waters near the coast of California are sometimes subject to upwelling, a special kind of current. In upwelling, winds help blow surface ocean water away from the coast and cold deep water replaces it. This occurs primarily during winter and spring and may cause a very rapid decrease in temperature. Tides also influence water temperature, because they influence current speed and direction.

For instance, as the tide goes out, warm inshore water may be transported offshore. By the same token, incoming tides may bring in cold water. Surprisingly, tides can influence water miles offshore and many hundreds of feet down.

Most fishes are cold-blooded. That is, their body temperature is the same as their environment. This means that the chemical processes in their bodies are greatly influenced by water temperature. When the water is warm, their internal processes tend to speed up. This means they tend to be more active and require more food. On the other hand, when temperatures decrease fishes often slow down and become torpid, they require less energy and they feed less. Fishes often seek out the temperatures they prefer.

Changes in water temperature are also often cues for reproduction. Many fishes start to develop eggs and sperm during either spring or fall, when there tend to be either rapid increases or decreases in water temperature. In turn, fishes often change their behavior when they are breeding. For instance, they may migrate to spawning grounds, change their position in the water column or form large schools.

Fish may also be attracted to particular water temperatures because food may be more available there. For instance, areas where two water masses meet (these are called oceanic fronts) are characterized by places where surface water temperature changes very rapidly. During the summer and fall off California, a typical oceanic front may exist perhaps 100 miles from the coast, where the California Current and Davidson Current brush against each other. These areas tend to have large amounts of plankton, which in turn attract small fishes, such as anchovies and sardines, and these attract large fishes, such as tunas and swordfishes.

Many fishermen, particularly those chasing pelagic fishes such as tunas and swordfish, now use satellite images of the California coast which show sea surface temperatures. They look for regions where warm and cold oceanic fronts meet and they fish there. Mako shark and swordfish fishermen know that these species tend to stay on the warmer side of the temperature break, while blue sharks often remain on the cooler edge. This knowledge helps them target makos or swordfish but avoid blues, which are largely unmarketed.

During the 1983 El Nino, California halibut moved northward from southern California into central California following the warm current. Catches of California halibut in central

California were higher than they had ever been before, while those in southern California decreased dramatically. In a future El Niño, halibut fishermen who recognized this movement might increase their effort off central California.

Fishermen from the beginnings of time have recognized spawning aggregations and many have used an increase (or decrease) in water temperature to begin searching for these schools. Herring fishermen in San Francisco Bay harvest fish which come into the Bay to spawn, and their spawning is partially a response to changes in water temperature. Hook and line fishermen, who depend on fishes being hungry, are particularly sensitive to temperature fluctuations. Fishes such as barracuda will virtually stop feeding when temperatures suddenly drop. In the past, large numbers of barracuda were taken by trolling lures and troll fishermen were acutely aware of temperature changes. Often they did not even try trolling when cold water set in. On the other hand, as temperatures rose, their effort increased.

Fish behavior may also vary with temperature. Swordfish harpooners capture swordfish as they lay on the surface. However swordfish may not come to the surface if water temperatures stay high. Rather, they will stay underwater, where temperatures are cooler. Harpooners may look for cooler water, avoiding too warm conditions.

B. Water Clarity

Water clarity, which is basically how far a fish can see, is dependent on the amount of suspended material in the water. This material may be sediment (sand, mud etc.) or it may be plankton. There are a number of factors which influence water clarity. Tidal action is a major factor. For instance, a patch of clear water offshore can quickly become turbid as a receding tide brings out sand or mud. Similarly, an incoming tide may bring clear offshore water into cloudy near shore areas. Currents are a major determinant of water clarity. For instance, the waters of El Niños tend to be clear. Upwelled water (water brought up from deep depths to the surface by winds) starts off very clear. However, this water contains huge amounts of nutrients and, within a few days, plankton starts to grow, which makes the water cloudy. Particularly in shallow water, winds and waves stir up the bottom, making the water cloudy. Similarly, periods of calm help the sand and mud to settle out, and water visibility increases. Sediment-carrying river water may cloud the ocean for miles.

Some fish are attracted to cloudy water, while others tend to avoid it. Small species, such as white croakers, northern anchovies and sardines, often seek out turbid water because it helps protect them from predators. Lobsters are another species that defend themselves against predation by hiding in crevices by day and foraging by night; lobsters prefer to feed in muddy water. For the same reason, some predators, such as salmon and California halibut, may congregate in this water, attracted there by fishes on which they feed. However some species, particularly oceanic ones such as tunas and swordfishes, are usually found in clear waters. These are animals that depend heavily on vision for survival, and they are rarely found in cloudy near shore waters.

Fishermen are keenly aware of water clarity. A good example is salmon trollers. Fishermen know that salmon may be found in turbid water, called "coffee water" or "salmon water." Trollers will actively seek out these conditions to find fish. It is likely that salmon are attracted to "coffee water" because their foods, anchovies, sardines and other small fish are hiding in this habitat. Tuna fishermen tend to avoid cloudy water and search for "tuna water", very clear, deep blue water. Gillnetters have found that turbid water is best for capturing their quarry (white sea bass, California halibut, angel sharks, thresher sharks etc.). This may be because the nets are less visible in cloudy water. Also, small prey species are usually found in the turbid water, and their presence attracts the larger fish.

C. Water Motion

Water motion may be seen in a number of phenomena. Currents are large-scale horizontal movements of water caused by prevailing winds. Most currents are relatively slow and most are somewhat predictable. Swells and waves may move water about, usually more in a vertical dimension than in a horizontal one. Tides move great amounts of water inshore and offshore and, as mentioned before, the effects of tides can be seen in water many hundreds of feet down.

Overall, water movement may be the most important influence in a fish's life, primarily because it controls so many other critical factors. First, fishes have to be able to control their position. If water movement is too intense (say near a beach during a massive storm), many species will move out of the area, into calmer water. This is one of the reasons that smaller or medium-sized schooling fishes (such as white croakers, northern anchovies and Pacific sardines) tend to move away from very shallow water during the winter. They are at a disadvantage in turbulent conditions. By the same token, their predators (such as California halibut or White Sea bass) probably could withstand the rough, winter conditions, but they too move offshore following their food supply.

During the fall, lobsters are found in shallow water, often in depths of only a few feet. But as winter storms batter the coast, the water near shore becomes rough and lobsters move offshore. Lobster fishermen often start the season in the fall by setting their traps in shallow water, but they know that as the season progresses they will likely have to set them deeper.

On the other hand, some fishes seek out rough water because their food may be exposed or at a disadvantage there. California halibut sometimes congregate at the mouths of estuaries, where currents can momentarily disorient small fishes. A number of fishes inhabit the surf zone, right in the largest waves, where they pick off those sand crabs that have been exposed by the surf.

Currents also can bring in or take away food, particularly for those fishes (such as Pacific herring and Pacific sardines) that eat plankton. Nutrient-rich upwelled water contains high concentrations of plankton and these fishes will concentrate in areas of upwelling. When the upwelling stops, this current and the plankton dissipate, and the fishes move on. An even more striking example is an El Niño current, which contains very little plankton and may bathe hundreds of miles of California coast. When this occurs, fishes may not find enough to eat, causing their growth to slow and their reproduction to be impaired. If plankton-eating fishes move out of an area or do not reproduce well due to lack of food, this in turn has a negative effect on larger predatory fishes.

Currents have a profound effect on reproduction. Many fishes spawn near the surface to take advantage of currents. First, the currents take the eggs or larvae away from the immediate vicinity, which is often a place where there are many organisms waiting to eat the newly-spawned animals. Second, the currents may carry the young to nursery areas, where more food is available. What happens is that currents vary between years, in speed and direction, and in some years the young are carried where they should be and in others they are not. Thus, some years produce lots of young fishes and other years do not.

Reef fishes often station themselves at the up-current side of the reef, in order to be the first predators to get a crack at whatever food is carried onto the reef by the current. Thus, often there will be a school of fishes on one end of the reef, but few on the other. In turn, the species which prey on these fishes may concentrate on the up-current end. Water motion also influences both temperature and water clarity. Currents bring with them warmer or colder water and water of different clarity.

D. Tides

An incoming tide may bring in clear offshore water, while an outgoing one may carry sand or mud and cause increased turbidity. Salmon trollers sometimes find that the salmon bite changes with the change of tide. Perhaps this is due to sudden changes in water clarity. Fishermen pay close attention to water movement and often take advantage of the way that fishes respond to it. For instance, California scorpion fish are a popular food fish in southern California. Some fishermen have noted that, while this species normally lives on the bottom, during the night from June to September it predictably comes to the surface to spawn, probably to take advantage of the currents. These fishermen know the scorpion fish spawning grounds and fish for them at night, at the surface.

Fishermen are often keenly aware of the inshore-offshore movements of fishes and invertebrates and these movements are often associated with increased swells and turbidity inshore during winter. As mentioned before, winter storms seem to drive lobsters into deeper water, as well as small schooling fishes and their predators. Halibut fishermen may quit fishing in shallow water as soon as storm-driven heavy swells hit a beach. Not all fishes seem to be influenced by intense water motion, however. Fishermen report that swordfish will often stay right at the surface and catches will remain good even in very heavy seas and high winds.

E. Water Salinity

In most of the ocean, salinity is fairly constant. For this reason, most fishes have very little tolerance for changes in salinity. Only at the mouths of rivers and streams does salinity vary significantly, and it varies with the time of year and distance from the mouth. The high water period, usually in winter and spring, brings with it increased runoff and increased water flow. In these circumstances, the freshwater plume is greater and extends to sea farther. In many circumstances, marine fishes are driven away from low salinity environments and fishermen may avoid them. However, there are some instances when the opposite is true. California halibut are often more abundant around river and stream mouths, and fishermen will often seek out these sites when pursuing halibut. The halibut are probably there because ocean waters around river mouths are typically cloudy from river sediment and stirred up bottoms. As mentioned before, cloudy water attracts white croakers, northern anchovies etc. and the halibut are attracted to these prey.

E. Light levels

Light varies greatly in the ocean. First, light only penetrates a relatively short distance into the water. Below about thirty feet, red light does not penetrate and by about 400 feet all that remains of the color spectrum is green and blue. By 1,000 feet, even that light from the sun is gone. Second, the amount of light available to organisms is dependent on the turbidity of the water. Water clarity is discussed above, but basically the more material in the water (sand, mud, plankton etc.), the more light will be scattered or absorbed, and the darker the water will be. Third, moon phase is a major factor in influencing light levels; full moons produce considerable light, while new moons produce relatively dark nights. Light levels also change with time of day and with time of year.

Fishes are very sensitive to light and often link their behavior to light levels. Many fishes are most active during the crepuscular periods (e.g., at dawn and dusk). That is when they tend to feed most readily and often school most tightly. However, some species are diurnal (most active during the day) and some are nocturnal (active at night). Seasonal light level changes (lengthening light periods during spring and shortening periods during fall) are also one of the cues marine organisms use to begin migrations and to reproduce.

Knowledge of fish behavior as it is influenced by light levels is often crucial to successful fishing. For instance, during the night anchovies often swim about individually or in small groups. During this time they are not easy to catch in quantity by purse seine or lampara nets. However, just as light levels begin to increase with dawn, the fish school up and are most susceptible to capture. Fishermen know that this period may be quite limited, because when the sun comes up the fish school may travel into the kelp beds or swim downward, both activities making them virtually impossible to catch.

Gillnetters have found that White Sea bass can often see a gill net in the daylight and on very dark nights. On dark nights the bioluminescence in the water (produced by certain planktonic organisms) causes the net to glow and the sea bass avoid it. However, when the moon is full, the moonlight counteracts the glow and helps decrease the net's visibility. Sea bass also tend to be caught in gillnets more readily at dawn and dusk, probably because the fish are actively feeding then and do not notice the net. The periods around the new and, particularly, full moons seem to produce the best fishing in many fisheries. Fishermen may set more nets or spend more time fishing during these periods.

Opposite from sea bass, swordfish catches are often lower during the full moon, peaking when nights are darkest. Salmon trollers sometimes catch fewer salmon during the days following full or nearly full moons, perhaps because the fish are feeding at night and are not hungry during the day.

Sometimes feeding fish are actually less susceptible to capture. For instance, California halibut draggers have found that, in general they catch more fish during the day, because halibut often feed at night. However, on those occasions when the fish feed during the day, night catches increase.

II. RECREATIONAL FISHING BENEFITS FROM PORTS®

Detailed information on marine recreational fishing is required to support a variety of fishery management purposes and is mandated by the Sustainable Fisheries Act, 1996 (PL 104-297) and the Magnuson-Stevens Fishery and Conservation Act of 2006 (PL109-479).[8] No survey of the use of PORTS® data by recreational fishermen has been attempted in this analysis. Instead, this study extrapolated data for recreational fishing activity within three miles of the coast printed by the National Marine Fisheries Service.

Each year, a comprehensive survey is undertaken which covers all fishing modes (e.g., private/rental boat, party/charter boat and shore). Literally millions of recreational anglers are annually monitored in order to accurately assess the stocks of many fish species as recreational

[8] Refer to: U.S. Department of Commerce, *"Fisheries of the United States 2010"*, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Current Fishery Statistics NO. 2010, August 2011, Page 20.

fishing significantly impacts the stocks of many finfish species as well as the fact that recreational landings of some finfish actually surpass commercial landings.[9]

Data on the Atlantic and Gulf coasts is collected via a coastal household telephone survey as well as a field survey of completed angler fishing trips. This information is augmented with state and local records. In Oregon and Washington ocean boat surveys are used to develop catch estimates. Alaskan data is collected through an annual mail survey administrated by the Alaska Department of Fish and Game.

A. Trends

It was been estimated that in 2011, the second full non-recessionary year since 2006, ten million angles made more than 69 million marine recreational fishing trips.[10] Over 201 thousand pounds were landed.

During the period 2006 to 2011, total recreational landings declined in terms of metric tonnage and numbers of fish. At the same time, the average weight of those fish retained and not released increased from 1.22 to 1.46 pounds each. (Refer to Table 1) During the 2006 to 2011 study period, more than one-quarter of all fish in terms of weight and numbers were caught three and fewer miles from shore. (Refer to Figure 1).

[9] Ibid, Page 20.

[10] The recession lasted from December, 2007 to June, 2009.

Table 1

U.S. RECREATIONAL FISH HARVEST BY DISTANCE FROM SHORE

YEAR	METRIC TONS	NUMBER OF FISH LANDED (THOUSANDS)	AVERAGE WEIGHT PER FISH (POUNDS)	METRIC TONS	NUMBER OF FISH CAUGHT (THOUSANDS)	AVERAGE WEIGHT PER FISH (POUNDS)
	CAUGHT 0 TO 3 Miles FROM U.S. SHORES			**TOTAL**		
2006	34,487	71,237	1.08	116,640	213,493	1.22
2007	32,439	57,786	1.26	115,703	196,375	1.32
2008	28,663	55,160	1.16	112,310	196,659	1.28
2009	23,224	45,687	1.14	96,195	172,609	1.25
2010	22,957	37,327	1.38	89,278	142,873	1.40
2011	25,358	41,275	1.38	91,182	139,491	1.46

Source: NOAA, National Marine Fisheries for involved years

Figure 1

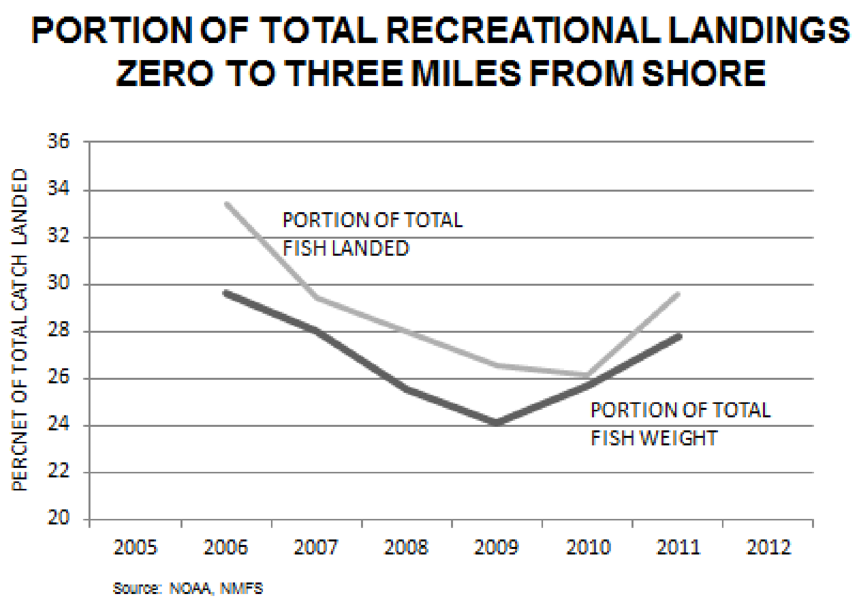
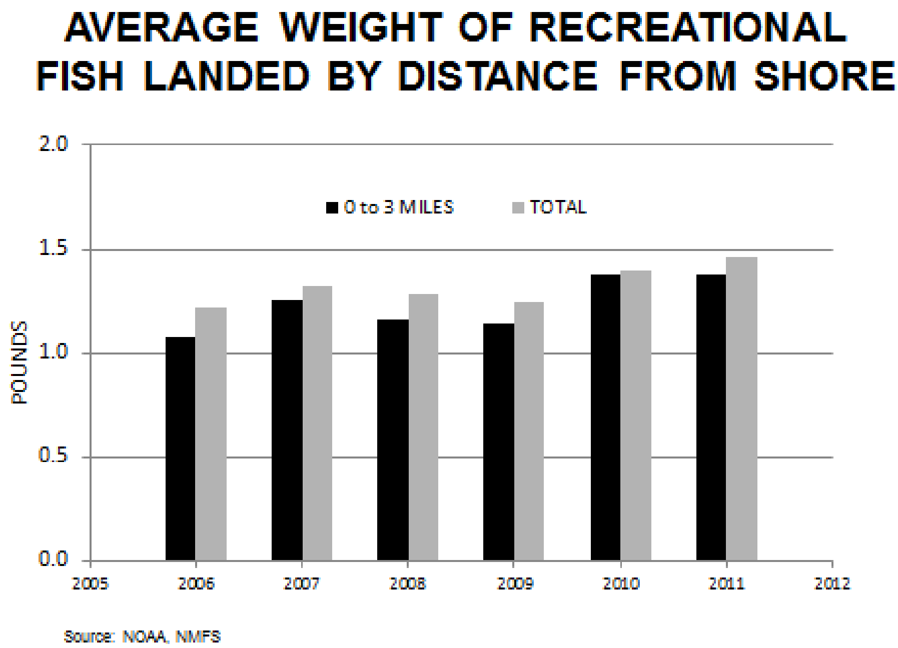


Figure 2



Given the larger size of deep-sea fish it is not surprising that the greater distance from shore, the average size of fish harvested is larger than those caught zero to three miles from shore. (Refer to Figure 2)

Although numerous academic writings and practitioner anecdotes describe and support logic models which document the optimum environments in which to catch fish, no current data set is collected which specifically relates fish catch by species by specific ecological situations. Clearly, as PORTS® provides data on issues related to currents, tides, salinity, etc., prudent use of its data could logically enhance recreational catch experiences. Value from PORTS® need not directly come from PORTS® but may also be distributed from other entities which make use of PORTS® data.

Moreover, as recreational landings are not often resold in formal markets, their value has historically been calculated on a non-market basis which has included a number of factors involving the value of recreation, vacation, value of "living simply or getting back to nature", etc.[11] Consequently, several assumptions have to be made in order to estimate the value of benefits provide by PORTS® to recreational fishing.

In commercial fishing, the value of landed finfish catch approached $1.3 trillion dollars

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[11] See: Pendleton, Linwood, and J. Rooke, *Understanding the Potential Economic Impact of Recreational Fishing*, National Oceanic and Atmospheric Administration, March, 2006. Fishing represents a large portion of marine recreation in the United States. Saltwater fishing alone draws nearly 21.3 million participants nationwide which accounts for 10.3 percent of the population age 16 or older. Saltwater fishing ranked third most popular activity in marine recreation in the United States. Saltwater fishing is expected to attract over 24 million participants by 2010. California ranks second in the nation in terms of participation in saltwater fishing with more than 2.7 million participants, falling only behind Florida. Texas is ranked third with more than 1 million fewer saltwater fishing participants than in California. Based on the 2000 participation estimates and an estimated value range of $75 to $200 per participant per year, the annual expenditures associated with recreational fishing in California ranged from $205 million to $545 million in the year 2000. …in the span of ten years (2005-2010), the nation will see an increase in fishing participation of 12%. Based on these national estimates, the expenditures associated with marine recreational fishing in California could increase to between $230 and $610 million. Based on the 2000 participation estimates (20.3 million person-days) and an estimated value range of $15 to $90 per person day, the annual [non-market] value of recreational fishing in California likely ranged from $305 million to $1.83 billion in the year 2000. In the span of ten years (2005-2010), the nation will see an increase in recreational fishing activity of 12%. Based on these national estimates, the non-market value of marine recreational fishing in California could increase to $342 million to over $2 billion annually by the year 2010. Nationally, non-market values for marine recreational fishing range from $17 per day in Delaware to $146 per person day in Alaska. (2005 dollars).

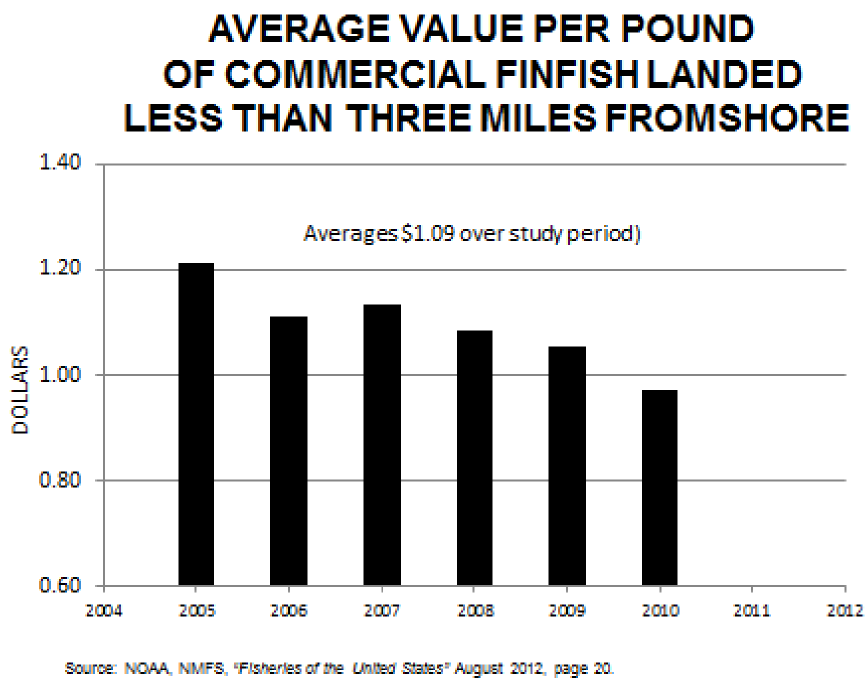
Refer to: Volpe National Transportation Systems Center, Valuation of the NOS Navigational Products, *Final Report, Task 4 – Benefit-Cost Analysis (BCA) Model Estimates*, March 23, 2009. Three NOS products integral to the $13 billion marine transportation information technology and communication infrastructure were evaluated. Annual value of electronic navigational charts, tides and currents/ PORTS® data and the Navigation Response Team were estimated to approach $1.2 billion with net benefits approaching $1.15 billion. Overall benefit costs ratios of 24 to 1 were estimated.

Refer to: Bell, F.W., M.A. Bonn and V. R. Leeworthy, 1998. In 1997-1998, recreational fisherman and divers that used artificial reefs off Northwest Florida spent $415 million in the five-county area of Bay, Walton, Okaloosa, Santa Rosa and Escambia counties. This spending generated $83.66 million in wages and salaries, which supported 8,163 full and part-time jobs in the five-county area.

Refer to: Leeworthy, NOAA, 2000. Travel and tourism is the Nation's largest employer and second largest contributor to the GDP, generating over $700 billion annually. Beaches are the leading tourist destination, with coastal states earning 85 percent of all U.S. tourism revenues. Approximately 89.3 million people vacation and recreate along U.S. coasts every year.

in 2010. During the 2005 to 2010 period, the value per pound of commercial finfish averaged $1.09 per pound.[12] Refer to Figure 3.

Figure 3



When adjusted for 2010 dollars, the average commercial value increased to $1.10 per pound.[13]

In this investigation it was assumed that the "value" of landed recreational catch was $0.50 cents per pound – well less than the commercial side (of $1.10 per pound). The value to the recreational fisherman is probably well in excess of $0.50 per pound as evidenced by their willingness to charter private or group party vessels or operate their own craft for fishing trips. Employing this assumption and this benefit transfer approach would range between $25 and $38 million dollars per year in benefits. However as PORTS® is not responsible for all the catch

[12] Refer to NMFS Annual report for 2011. http://www.st.nmfs.noaa.gov/st1/fus/fus11/FUS_2011.pdfNOAA, NMFS, page 20.

[13] Using the overall Gross Domestic Product Deflator.

value within three miles of shore, an additional adjustment must be made. If data from PORTS® is either directly or indirectly employed by recreational fishermen as a group in only one percent of the time in locations within three miles of shore, the annual benefit from PORTS® could range between $250 and $380 thousand per year. (Refer to Table 2) Over the six year study period the annual average benefit could exceed $307,000.

Table 2

ESTIMATION OF RECREATIONAL FISHING BENEFITS
(ZERO TO THREE MILES FROM SHORE)
DUE TO PORTS®

YEAR	POUNDS LANDED	VALUE ($0.50 PER POUND)	PORTS® VALUE (1% OF TOTAL)
2006	76,043,835	$38,021,918	$380,219
2007	71,527,995	$35,763,998	$357,640
2008	63,201,915	$31,600,958	$316,010
2009	51,208,920	$25,604,460	$256,045
2010	50,620,185	$25,310,093	$253,101
2011	55,914,390	$27,957,195	$279,572

Source: NOAA, NMFS

Over the ten-year economic life of a PORTS®, the Net Present Value (NPV) of PORTS® could exceed $2.5 million. (Refer to Table 3)

As we do not have information of the specific port location of recreational catch, some form of further apportionment must be made to account for 58 locations that have PORTS® versus those 117 ports which currently do not have them. Lacking more specific information a simple allocation of the total potential annual and 10-year benefit streams depicted in Table 3 based on the proportionality of ports with PORTS® -- 33.1 percent (58 with PORTS® out of 175 total ports). Hence, the portion of potential benefits which are assigned in this analysis to PORTS® is $101,649 annually and $831,692 over ten years. The remaining annual $205,449 and ten-year

$1,680,984 are assigned to the additional potential should the remaining 117 ports receive PORTS®. (Refer to Table 4)

Table 3

NET PRESENT VALUE ESTIMATION OF PORTS® BENEFITS TO RECREATIONAL FISHING FROM CATCHES THREE OF FEWER MILES FROM SHORE

YEAR	AVERAGE ANNUAL PORTS® BENEFIT	NET PRESENT VALUE FACTOR (3.9 PERCENT)	NET PRESENT VALUE OF PORTS® OVER 10-YEAR LIFE
1	$307,098	0.963	$295,704
2	$307,098	0.927	$284,618
3	$307,098	0.892	$273,808
4	$307,098	0.885	$271,904
5	$307,098	0.826	$253,693
6	$307,098	0.795	$244,081
7	$307,098	0.765	$235,022
8	$307,098	0.737	$226,270
9	$307,098	0.709	$217,824
10	$307,098	0.683	$209,686
		TOTAL	**$2,512,612**

Following the logic model, one would expect that the total value of recreational fishing benefits derived from PORTS® information could significantly exceed the mere value of the catch itself. The recreational experience, aside from the psychic “income” associated with the freedom of the outdoors experience would include the amortized value of the boat and its fishing equipment, the expendables of food, fuel, beverages, the cost of the charter and assessorial costs such as dockage fees, marina costs. In keeping with the conservative nature of this analysis, these benefits were not estimated or included in this study.

Table 4

**TOTAL POTENTIAL RECREATIONAL FISHING VALUE DUE TO PORTS®
(THREE MILES OR LESS FROM SHORE)**

YEAR	VALUE LANDED 58 CURRENT PORTS®	VALUE OF LANDING AT REMAINING 117 PORTS WIHTOUT PORTS®	NET PRESENT VALUE FACTOR (3.9%)	NET PRESENT VALUE OF PORTS® OVER TEN-YEAR LIFE CURRENT 58 PORTS®	NET PRESENT VALUE OVER TEN-YEAR LIFE 117 POTENTIAL PORTS®
1	$101,649	$205,449	0.963	$97,888	$197,847
2	$101,649	$205,449	0.927	$94,229	$190,451
3	$101,649	$205,449	0.892	$90,671	$183,261
4	$101,649	$205,449	0.885	$89,959	$181,822
5	$101,649	$205,449	0.826	$83,962	$169,701
6	$101,649	$205,449	0.795	$80,811	$163,332
7	$101,649	$205,449	0.765	$77,761	$157,168
8	$101,649	$205,449	0.737	$74,915	$151,416
9	$101,649	$205,449	0.709	$72,069	$145,663
10	$101,649	$205,449	0.683	$69,426	$140,322
	$101,649	$205,449	**TOTAL**	**$831,692**	**$1,680.984**

Source: NOAA, NMFS

III. COMMERCIAL FISHING BENEFITS FROM PORTS®

Unlike recreational fishing, NOAA's Fisheries records the market value of commercial fishing catch. While not broken down between finfish and non-finfish catch (e.g., crab, lobsters, clams, oysters, etc.) by distance from shore, total commercial catch has ranged between 3.8 and 4.7 million metric tons with an associated value of between $4.0 and $5.6 billion dollars during the 2005 to 2011 period. (Refer to Table 5.) Overall, an average of over 34 percent of the tonnage and 41 percent of the value of commercial fishing comes from distances of between zero and three miles from shore during the 2005 to 2011 period. (Refer to Figure 4)

Although commercial fishermen may utilize PORTS® data either directly or indirectly from another source, no empirical data exists as to the extent of that usage. Again, based on the logic model for the situation, if even a de minimis subjective evaluation of 0.1 percent of all close to shore activity was due to PORTS®, an average annual benefit in excess of $1.8 million could be in order.[14] Over the ten-year economic life of PORTS® the NPV could exceed $15 million. (See Table 6).

Table 5

SUMMARY OF COMMERCIAL FISHING CATCH

YEAR	METRIC TONS LANDED (0 to 3 MILES FROM SHORE)	VALUE (THOUSANDS OF DOLLARS) (0 to 3 MILES FROM SHORE)	TOTAL METRIC TONS LANDED	TOTAL VALUE (THOUSANDS OF DOLLARS)
2005	1,423,012	$1,734,741	4,463,184	$3,995,968
2006	1,210,526	$1,714,988	4,373,958	$4,054,521
2007	1,401,878	$1,775,675	4,284,465	$4,254,700
2008	1,407,652	$1,888,203	3,890,450	$4,473,748
2009	1,565,131	$1,730,591	3,819,678	$4,062,374
2010	1,324,587	$1,802,925	3,952,394	$4,793,840
2011	1,768,304	$2,263,109	4,781,119	$5,629,620

Source: NOAA, NMFS

[14] Nominal dollar average for landed fish between 2005 and 2011.

Figure 4

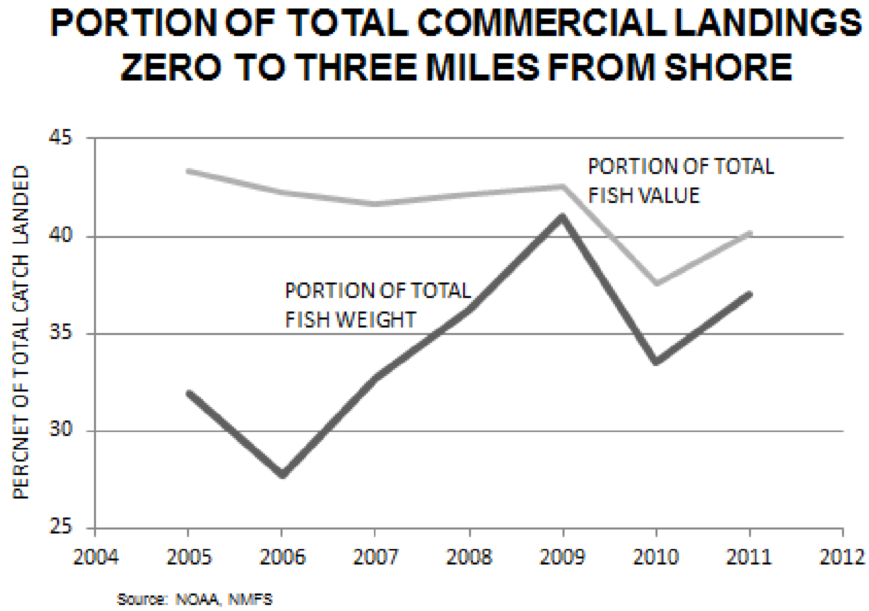


Table 6

TOTAL POTENTIAL COMMERCIAL FISHING VALUE DUE TO PORTS®
(THREE MILES OR LESS FROM SHORE)

YEAR	AVERAGE VALUE LANDED (2005 to 2011)	PORTION OF VALUE LANDED DUE TO PORTS (0.1 PERCENT)	NET PRESENT VALUE FACTOR (3.9 PERCENT)	NET PRESENT VALUE OF PORTS® OVER TEN-YEAR LIFE
1	$1,844,318,857	$1,844,319	0.963	$1,775,895
2	$1,844,318,857	$1,844,319	0.927	$1,709,315
3	$1,844,318,857	$1,844,319	0.892	$1,644,395
4	$1,844,318,857	$1,844,319	0.885	$1,632,960
5	$1,844,318,857	$1,844,319	0.826	$1,523,592
6	$1,844,318,857	$1,844,319	0.795	$1,465,865
7	$1,844,318,857	$1,844,319	0.765	$1,411,457
8	$1,844,318,857	$1,844,319	0.737	$1,358,894
9	$1,844,318,857	$1,844,319	0.709	$1,308,175
10	$1,844,318,857	$1,844,319	0.683	$1,259,301
			TOTAL	**$15,089,849**

Source: NOAA, NMFS

As was the case with recreational fishing we do not have information of the specific port location of commercial catch, some form of further apportionment must be made to account for 58 locations that have PORTS® versus those 117 ports which currently do not have them. A simple allocation of the total potential annual and 10-year benefit streams depicted in Table 5 based on the proportionality of ports with PORTS® -- 33.1 percent (58 with PORTS® out of 175 total ports). Hence, the portion of potential benefits which are assigned in this analysis to PORTS® is $610,470 annually and $4,994,740 over ten years. The remaining annual $1,233,849 and ten-year $10,095,109 are assigned to the additional potential should the remaining 117 ports receive PORTS®.

CHAPTER 9 - OIL POLLUTION REMEDIATION

I. BACKGROUND

The National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the National Contingency Plan or NCP, is the federal government's blueprint for responding to both oil spills and hazardous substance releases.[1] The National Contingency Plan is the result of our country's efforts to develop a national response capability and promote overall coordination among the hierarchy of responders and contingency plans.

The first National Contingency Plan was developed and published in 1968 in response to a massive oil spill from the oil tanker Torrey Canyon off the coast of England the year before. More than 37 million gallons of crude oil spilled into the water, causing massive environmental damage. To avoid the problems faced by response officials involved in this incident, U.S. officials developed a coordinated approach to cope with potential spills in U.S. waters. The 1968 plan provided the first comprehensive system of accident reporting, spill containment, and cleanup, and established a response headquarters, a national reaction team, and regional reaction teams (precursors to the current National Response Team[2] and Regional Response Teams).

The Department of Commerce, through the National Oceanic and Atmospheric Administration (NOAA), provides scientific support for resources and contingency planning in coastal and marine areas including hazard assessment and spill trajectory (direction) monitoring

[1] Refer to: http://www.epa.gov/osweroe1/content/lawsregs/ncpover.htm

[2] Response planning and coordination is accomplished at the federal level through the U.S. National Response Team (NRT), an interagency group co-chaired by the EPA and the U.S. Coast Guard. Although the NRT does not respond directly to incidents, it is responsible for three major activities related to managing responses: (1) distributing information; (2) planning for emergencies; and (3) training for emergencies. The NRT also supports the Regional Response Teams. Members include: (1) The U.S. Coast Guard (USCG); (2) Federal Emergency Management Agency (FEMA); (3) Department of Defense (DOT; (4) U.S. Department of Agriculture (USDA); (5) Department of Commerce’s (DOC) National Oceanic and Atmospheric Administration (NOAA); (6) Department of Health and Human Services (HHS); (7) Department of Interior (DOI); (8) Department of Justice (DOJ); (9) Department of Labor (DOL); (10) Department of Transportation (DOT); (11) Nuclear Regulatory Commission (NRC); (12) Department of State; (13) General Services Administration; and, the (14) Treasury Department.

to predict movement and dispersion of oil and other hazardous substances. NOAA contributes information about sensitive coastal environments, and furnishes data about actual and predicted meteorological, hydrological, ice, and oceanographic conditions. NOAA also serves as the natural resource trustee for the living marine resources it manages and protects.[3]

Congress has broadened the scope of the National Contingency Plan over the years. As required by the Clean Water Act of 1972, the NCP was revised the following year to include a framework for responding to hazardous substance spills as well as oil discharges. Following the passage of Superfund legislation in 1980, the NCP was broadened to cover releases at hazardous waste sites requiring emergency removal actions. Over the years, additional revisions have been made to the NCP to keep pace with the enactment of legislation. The latest revisions to the NCP were finalized in 1994 to reflect the oil spill provisions of the Oil Pollution Act of 1990. (Refer to Appendix A.)

II. OIL SHEEN REPORTING

Additional regulation requires that even de minimis amounts of oil released into the environment must be reported.[4] Under the legal authority of the Clean Water Act, the Discharge of Oil regulation, more commonly known as the "sheen rule", provides the framework for determining whether an oil spill to inland and coastal waters and/or their adjoining shorelines should be reported to the federal government. In particular, the regulation requires the person in charge of a facility or vessel responsible for discharging oil that may be "harmful to the public health or welfare" to report the spill to the federal government. The regulation establishes the

[3] Refer to: http://www.epa.gov/osweroe1/content/partners/nrtroles.htm

[4] Refer to: http://www.epa.gov/osweroe1/content/lawsregs/sheenovr.htm

criteria for determining whether an oil spill may be harmful to public health or welfare, thereby triggering the reporting requirements, as follows:

- Discharges that cause a sheen or discoloration on the surface of a body of water;
- Discharges that violate applicable water quality standards; [5]and
- Discharges that cause a sludge or emulsion to be deposited beneath the surface of the water or on adjoining shorelines.

Because the Oil Pollution Act of 1990, which amended the Clean Water Act, broadly defines the term "oil," the sheen rule applies to both petroleum and non-petroleum oils (e.g., vegetable oil). The regulation also provides several exemptions from the notification requirements.

Any person in charge of vessels or facilities that discharge oil in such quantities is required to report the spill to the federal government. EPA provides several exemptions from the oil spill reporting requirements.

The requirement for reporting oil spills stems from the Discharge of Oil Regulation, known as the "sheen rule." Under this regulation, oil spill reporting does not depend on the specific amount of oil spilled, but on the presence of a visible sheen created by the spilled oil. Reporting oil discharges may also be required under the Spill Prevention, Control, and Countermeasure (SPCC) Rule.

III. USE OF PORTS® DATA IN OIL SPILL REMEDIATION

From an interview with Debbie Payton, Chief of Emergency Response Division, NOAA's Office of Response and Restoration OR&R uses real-time information on winds, currents, visibility, water levels, waves, salinity when responding to spill events whenever they

[5] See: [61 FR 7421, Feb. 28, 1996]

can get access to the data.[6] It helps them in the containment and cleanup as well as planning for the restoration efforts. In other words, PORTS® information involving tides, currents and temperature could help speed locating and remediating such spills. NOAA responds to about 104 of the largest events annually while the USCG responds to about 10,000 events of all sizes annually.[7] Groundings make up about 2-5% of the response cases.

Payton mentioned that they are usually very good at getting access to real-time data from a large variety of sources. In those areas where PORTS is available they find it very useful. In about five percent of the cases they have to install temporary instruments to provide the needed information because there isn't a PORTS® or other suitable sources of information. The five percent figure represented Paytons' *subjective* estimate as OR&R does collect empirical data to estimate another figure.[8] It could only be considered an estimate by an authoritative person. To support OR&R's tasks, CO-OPS has developed a portable current meter that can be installed when OR&R requests.

IV. CONSIDERATIONS IN OIL SPILL REMEDIATION COSTS

Given the potential environmental impact which can result from the release of petroleum, the prospective value of PORTS® can be much larger than for shipments of non-hazardous or environmentally sensitive materials. An example of the value of such an accident avoidance related to grounding was delineated by the United States Coast Guard (USCG) in 1993:

[6] Conversation took place on March 18, 2013.

[7] Overall, the database provides details on over 1,100,000 vessels and 54,000 facilities.

[8] "I did a quick check on whether we could pull anything from our records to indicate which spills we used real-time oceanographic data and it doesn't look like there is any way to "glean" that from what we have (other than the anecdotal "if we can find it we always use it")." Debbie Payton, OR&R, NOAA; spoken on March 18, 2013.

> ".... in 1993, a 634 foot tanker, *Potomac Trader*, while maneuvering in the New York harbor using "predicted Tides Tables" ran aground in Hells Gate. Had the tanker had access to a real-time NOAA PORTS, this near-disaster could have been averted. The vessel master would have obtained information about an abnormally large tidal range that caused the actual tide to be 3 feet lower than the predicted tide. Fortunately, the vessel was a double-hull tanker and none of its cargo of over 7 million gallons of crude oil spilled." [9]

The USCG has long collected data on marine collisions, allisions, groundings, and other incidents under their Marine Safety Information System (MSIS). In December, 2001 the USCG transitioned from the MSIS to the Marine Information for Safety and Law Enforcement (MISLE) information system.[10] The redesigned system better supports the collection and analysis of data.

Pollution data was obtained from three files within the MISLE system. These included pollution from vessels, fixed facilities and other sources.[11] Although some data in these files carried dates before its inception in late 2001, those records were removed from analytical consideration in order to obtain a better conception of annual losses. Overall only 646 instances prior to 2002 were removed in this process. An additional 542 were removed as they represented only a partial reporting for the year 2012.

Accidents are rare and random events. Consequently, analysis of any one year or short period of time could lead to erroneous conclusions based on such random occurrences. Use of a longer time period can help eliminate year-to-year variations and reveal more accurate long

[9] USCG Marine Casualty Investigation Report #MC93004342, 1993.

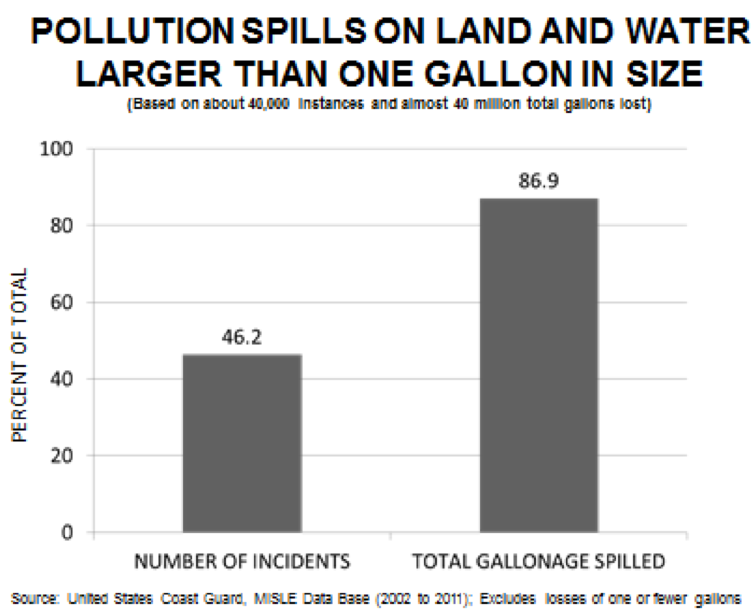
[10] USCG, *Marine Information for Safety and Law Enforcement (MISLE) Marine Casualty and Pollution Database* documentation. January 8, 2013.

[11] Other sources included instances where vehicles were driven into the water, oil drums were found floating, etc.

term trends. (Refer to Figures 5 and 6)

All subsequent analysis was based on complete annual data from a ten year period (2002 to 2011). Overall a total of about 40,000 observations were employed in this analysis. While the largest number of total pollution releases (about 54 percent) involved amounts of one or less gallons, in keeping the conservative nature of this investigation and considering that relatively little remedial action may be taken in these instances, they were removed from future calculations.[12] (Refer to Figure 1) These small releases accounted for only 13 percent of the total gallonage spilled.

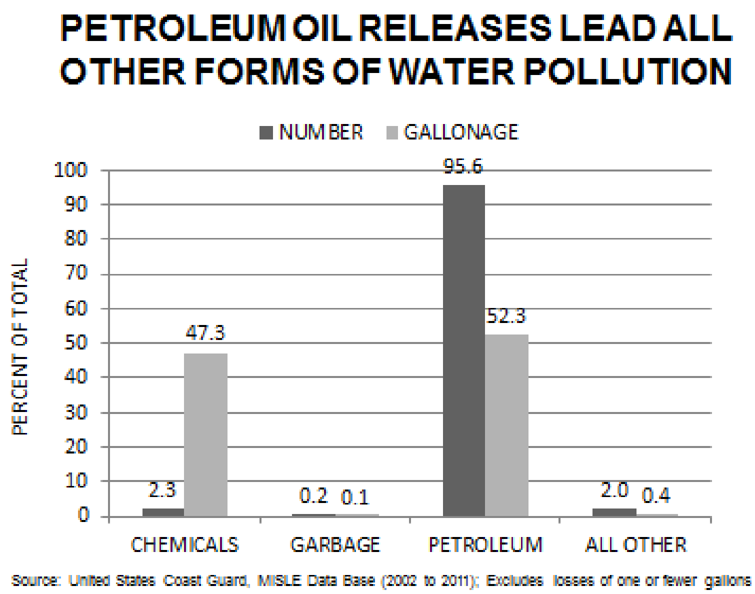
Figure 1



[12] Before estimating the potential benefit from the provision of real-time or near real-time data involving currents and tides from PORTS® the size of the spill was considered a factor. As even de minimis oil spills of less than one gallon can initially appear innocuous, it takes only one of oil to contaminate 50 gallons of fresh water.[12] Even a one gallon spill can result in an oil sheen with a thickness of between 0.01 to 0.001 millimeters across up to four acres of water surface.

Of the remaining spills, the vast majority of incidents (almost 96 percent) involved release of petroleum products. (Refer to Figure 2) However, given several large chemical releases in recent years, the proportion of total polluted gallonage released was 52.3 percent petroleum based with chemicals representing 47.3 percent. Garbage and unknown sources represent the remaining 0.4 percent.

Figure 2



During the ten-year study period of 2002 to 2011, the number of chemical and petroleum spills has generally declined. (Refer to Figures 3 and 4). Trends in total petroleum and chemical gallonage lost are more difficult to assess as individual major losses have skewed long-term trend analysis.[13] (Figures 5 and 6)

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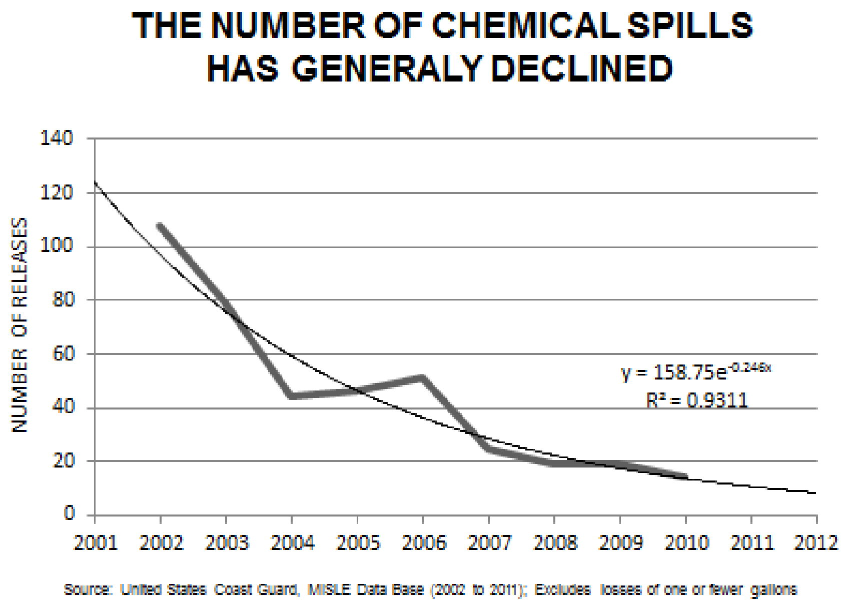
[13] Part of this downward trend may be due to hull regulations. A single hull vessel (contracted before June 30, 1990, or delivered before January 1, 1994) must meet the U.S. double hull standards of 33 CFR 157.l per the date

Prior to the estimation of benefits from PORTS®, all chemical releases were excluded from final analysis as when reported, there is little remedial action taken to “collect or absorb” the chemicals that had been released. The solubility of most chemicals in water makes

Figure 3



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required by 33 CFR157 Appendix G. The phase-out schedule of 33 CFR 157 Appendix G, for single hull vessels over 5,000 gross tons begins January 1, 1995, and ends January 1, 2015

Figure 4

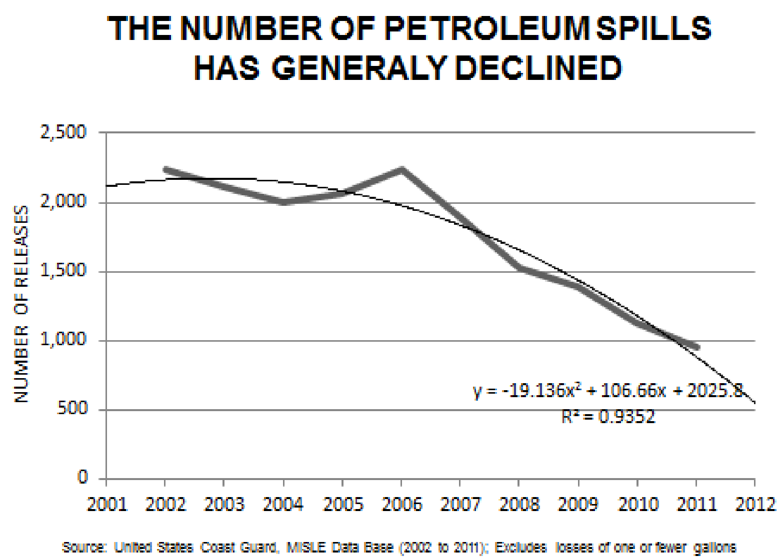


Figure 5

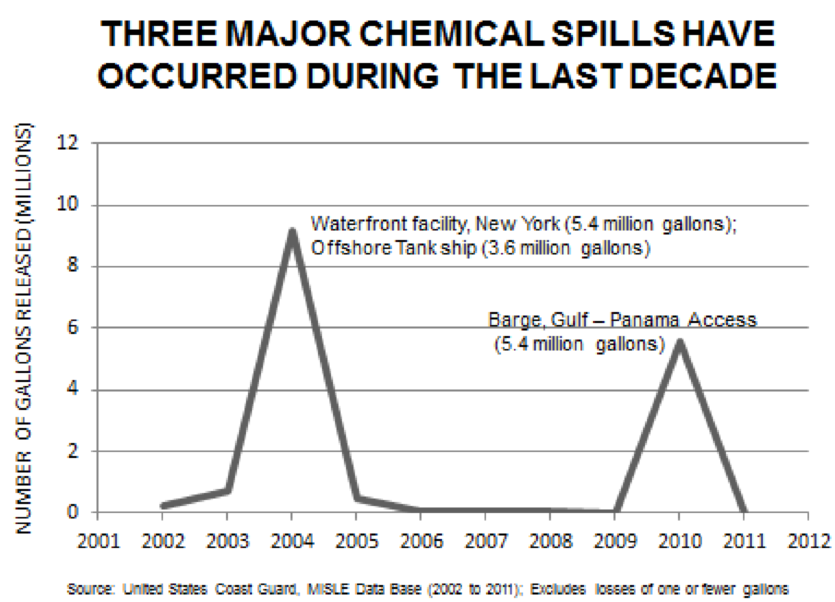
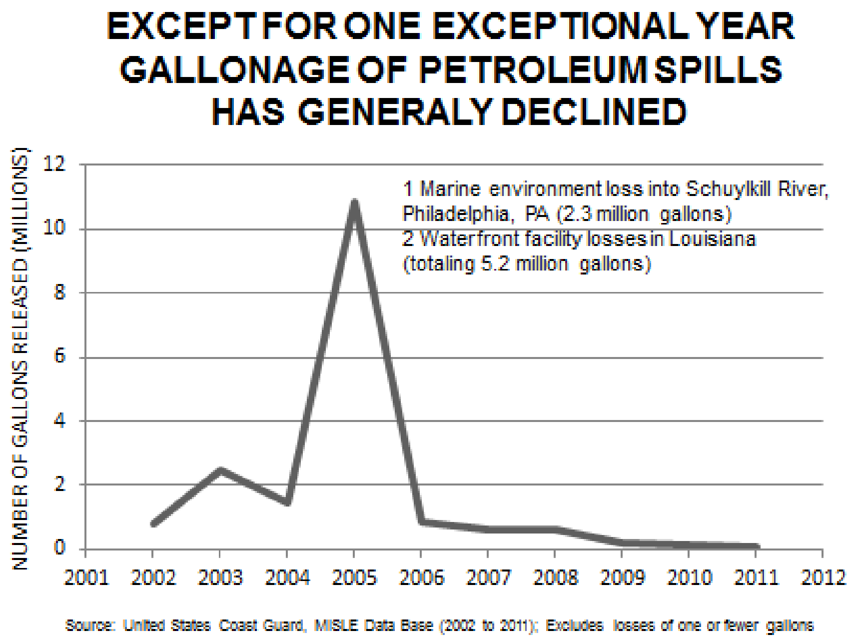


Figure 6



this type of remediation task, especially in relatively open water, extremely difficult.

Finally only those spills which had been recorded as lost in the water (as compared with land or air) were included in benefits estimation. Overall, during the study period 90.9 percent of all petroleum releases into the environment ended up in the water. (Refer to Figure 7). With the exception of 2005 when 74.6 percent of all petroleum pollution made its way to water, the level has remained fairly constant.[14]

A. Trends

Reflecting the overall trend depicted in Figures 4 and 6, the number of petroleum releases into the environment has generally declined for locations both with and without PORTS®. When normalized for ship transits over a seven year 2005 to 2011 study period a 21 percent

[14] In 2005, a 5.2 million gallon loss of petroleum was experienced by a waterfront (land based) facility in Louisiana.

lower rate in oil pollution releases at locations with PORTS® was shown. (Refer to Figure 8) Concurrently, with the exception of 2005, the volume of petroleum releases to the environment has also generally declined. (Refer to Figure 9)

Figure 7

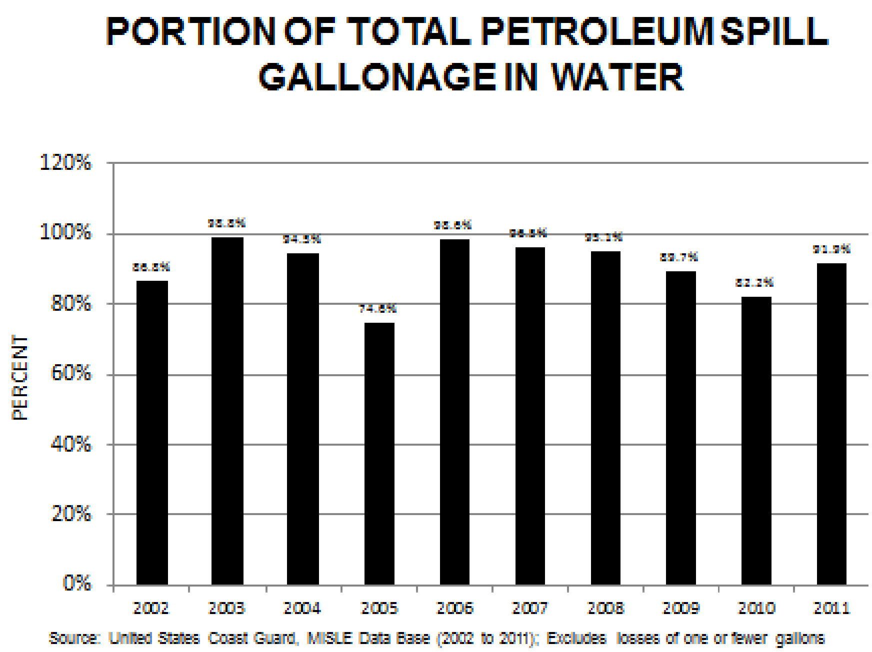


Figure 8

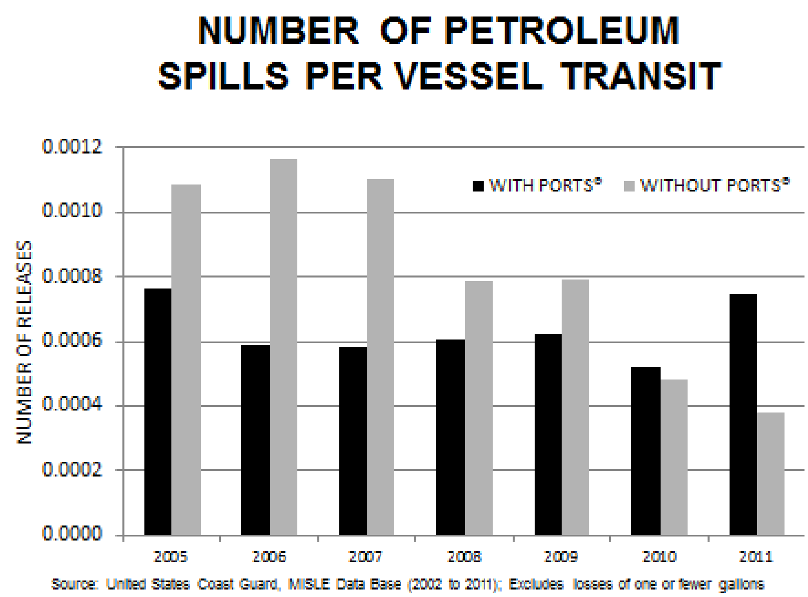
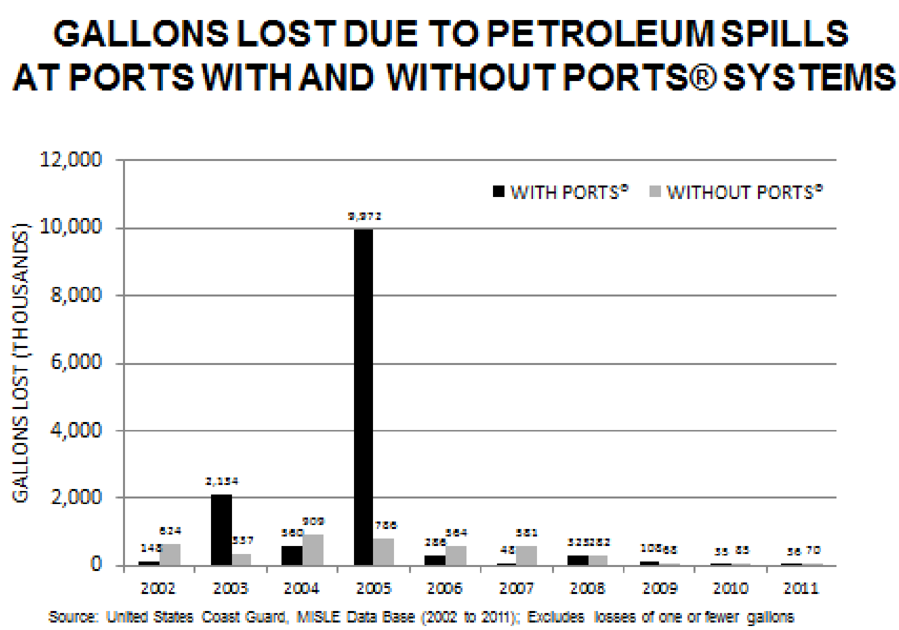


Figure 9



V. BENEFITS ESTIMATION FROM PORTS®

Recently, the USCG in a Notice of Proposed Rulemaking (NPR) estimated the full cost of remediating one gallon of spilled petroleum product.[15] The costs of petroleum clean-up has several components and previous estimates of such costs have varied considerably.

In its report to Congress on the costs and benefits of Federal Regulations, the Office of Management and Budget (OMB) valued each barrel of oil that was prevented from being spilled at $2,000. In addition to clean-up costs, costs associated with the loss of the product should also be considered. Estimates have placed those costs between $1,600 and $7,500 per barrel.[16] Brown et al. (1996) argued that legal settlement costs should be added to the equation and re-estimated previous studies by concluding that costs could range between $6,600 and $12,700 per barrel.[17]

Ultimately in their 2011 NPR, the USCG chose $10,700 as the cost per barrel of spilled oil. Refer to Table 1. In this analysis, a value of $10,700 per 42-gallon barrel was employed to assess the cost of every petroleum spill reported to exceed one gallon in volume. Comparisons were made between those 58 ports with and 117 ports without PORTS® installed.

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[15] USCG, Inspection of Towing Vessels, Notice of Proposed Rulemaking, *Preliminary Regulatory Analysis and Initial Regulatory Flexibility Analysis*, USCG-2006-24412, July 2011.

[16] One barrel equals 42 US gallons

[17] Brown, Robert Scott and Ian Savage, *"The Economics of Double-Hulled Tankers"*, Maritime Policy and Management, 1966, Volume 23 number 2, pp. 167-175. They valued a gallon of oil spilled at between $119.50 and $228.50. Also refer to "Appendix G. Estimation of Costs per Barrel of Oil Spilled" in the USAG Inspection of towing Vessels", page 270.

Table 1

SUMMARY OF AVERAGE COST PER BARREL CALCULATION
(Oil Spill Liability Trust Fund)

ITEM	COST
Total Gallons of Oil Spilled	1,873,421
Total Costs	$475,973,423
Average Cost Per Gallon	$254
Average Cost Per Barrel	$10,671

Source: USCG, Inspection of Towing Vessels, Figure G.2., page 271, Oil Spill Liability Trust Fund (OSLTF)

Data from the USCG's MISLE data base ultimately suggested that the ten year total of water-borne petroleum release remediation could exceed $457 million dollars. (Refer to Table 2)

Table 2

SUMMARY OF MISLE DATA INVOLVING
WATER-BORNE PETROLEUM RELEASES

ITEM	WITHOUT PORTS®	WITH PORTS®	GRAND TOTAL
Total Gallons of Petroleum Lost into a water environment[18]	4,304,693	13,650,068	17,954,761
Average loss per year (gallons)	430,469	1,365,007	1,795,476
Average loss per year (barrels)	10,249	32,500	42,749
Total Cost to Remediate ($10,700 per barrel)	$109,667,179	$347,751,732	$457,418,911
PORTS® Contribution (0.1 percent) per year	$1,096,673	$3,477,517	$4,574,189

If data from PORTS® (e.g., current and wind speed and direction, salinity, tides, water levels, etc.) were used to only enhance the capture of 0.1 percent of the total petroleum losses, an annual average benefit approaching $3.5 million could be enjoyed.

[18] When petroleum losses of less than or equal to one gallon are removed, the average loss per incident was 444 gallons for locations without PORTS® and 3,245 gallons in instances where PORTS® were present which is understandable as those physical locations with higher traffic levels are more prone to have such installations.

A**. Potential Value of PORTS®**

On average about five percent of the incidents where no PORTS® are in place are considered serious each year. In five percent of those cases where no PORTS® are in place, NOAA's Office of Response and Restoration (OR&R) pays to install an alternative buoy system to provide critical data.[19]

The Quick Response Estuarine Buoy (QREB) system deployed for the Safe Sanctuary 2005 drill is a prototype oceanographic buoy that will provide responders with needed environmental information at critical locations. During many emergency events the oceanographic and meteorological conditions at the response site are unknown or are different from the nearest PORTS®, NWLON or other observational system. In this situation CO-OPS can deploy a temporary buoy within a couple days of notification that measures currents, winds, air temperature and barometric pressure. Data from this system is transmitted via satellite every 6 minutes to CO-OPS for processing, quality control, web display and dissemination to responders in various formats. The system is designed to be deployed for up to 30 days before the batteries need to be replaced. The buoy is designed to be modular to meet the various conditions expected in near shore waters up to a depth of 100 meters. For example, if the system is required in a shallow, protected environment the sensors can be deployed in a small three foot diameter package that easy to transport and deploy. If the system is needed in a harsher coastal environment then the same sensor and electronics package can be installed in either a four or five foot diameter buoy that will be able to withstand higher wind and wave forces. The prototype system used for the Safe Sanctuary 2005 drill is a three foot buoy that only measures currents from the surface to the bottom. The full system will be delivered later this spring and will then

[19] Such installations are made in about 0.5 percent (ten percent of five percent) of all pollution cases. Source: Conservation with Debbie Payton, OR&R, NOAA March 18, 2013.

be tested during the summer at the mouth of the Chesapeake Bay. (Refer to Figures 10 and 11)

In 2005, the costs for buoy construction (current meter and anemometer) were about $55,000 in addition to the cost for shipping and deployment which added about $10,000 per incident. In more exposed waters, the costs in 2005 could have ranged between $100 to $150 thousand dollars with deployment costs adding an additional $20,000. Employing the GDP price deflator, these total costs in 2010 could range between over $62,000 and almost $176,000 per installation. For the purposes of this benefits estimation, the average of these two figures, $119,000 was employed. During the study period, the total number of pollution releases that occurred in areas that would have been covered by PORTS® had they been installed

Figure 10

QUICK RESPONSE ESTUARINE BUOY (QREB) SYSTEM

Source: NOAA, CO-OPS

Figure 11

DEPLOYED QUICK RESPONSE ESTUARINE BUOY SYSTEM

Source: NOAA, CO-OPS

approached 9,700 instances or 970 per year. Hence, additional costs for the 5 losses which would be augmented by QREB technology could approach $0.6 million (2010) dollars per year.[20] On an annual basis the cost which could be reduced through the employment of PORTS® could approach $1.7 million dollars.[21]

Over the ten-year anticipated economic life of a PORTS®, the NPV of its benefit could exceed $28 million where such systems had been installed. (Refer to Table 3)

If PORTS® were installed at all remaining 117 locations, the annual benefit could approach $1.7 million through more timely, accurate and complete responses to oil pollution

[20] 970 annual instances of which five percent are of the serious level (48 per year). Of these annual 48 losses, ten percent (about five) would have QREB technology assigned to the spill at a cost of $119,000 each. Consequently, the total annual cost for QREB technology could approach $0.6 million.

[21] $1,096,673 plus $600,000 dollars or $1,696,673.

releases. If the full cost avoidance of QREB installations were avoided, the ten year value could approach $14 million. Complete benefits (including savings from cessation of QREB use) could exceed $42 million over ten years for universal implementation of PORTS®.

Table 3

THE VALUE OF PORTS® SYSTEMS ASSOCIATED WITH WATER-BORNE PETROLEUM RELEASES

YEAR	ANNUAL BENEFIT DUE TO PORTS®	NPV FACTOR (3.9 %)	NPV VALUE OF 58 EXISTING PORTS®	POTENTIAL ANNUAL VALUE 117 ADDED OF PORTS®	POTENTIAL TOTAL ANNUAL VALUE OF PORTS® INCLUDING QREB COST REDUCTION
1	$3,477,517	0.963	$3,348,501	$1,691,672[22]	$4,977,412
2	$3,477,517	0.927	$3,222,963	$1,691,672	$4,790,804
3	$3,477,517	0.892	$3,100,554	$1,691,672	$4,608,849
4	$3,477,517	0.885	$3,078,994	$1,691,672	$4,576,800
5	$3,477,517	0.826	$2,872,777	$1,691,672	$4,270,267
6	$3,477,517	0.795	$2,763,931	$1,691,672	$4,108,471
7	$3,477,517	0.765	$2,661,344	$1,691,672	$3,955,980
8	$3,477,517	0.737	$2,562,235	$1,691,672	$3,808,658
9	$3,477,517	0.709	$2,466,603	$1,691,672	$3,666,506
10	$3,477,517	0.683	$2,374,449	$1,691,672	$3,529,522
	TOTAL		**$28,452,349**	**$13,840,922**	**$42,293,271**

[22] $1,096,673 is the base amount calculated in Table 2 plus $595,000 in QREB costs for a total of $1,691,672.

APPENDIX A

OIL POLLUTION REPORTING REQUIREMENTS

Key Provisions of National Contingency Plan include:

§300.110
Establishes the National Response Team and its roles and responsibilities in the National Response system, including planning and coordinating responses to major discharges of oil or hazardous waste, providing guidance to Regional Response Teams, coordinating a national program of preparedness planning and response, and facilitating research to improve response activities. EPA serves as the lead agency within the National Response Team (NRT).

§300.115
Establishes the Regional Response Teams and their roles and responsibilities in the National Response System, including, coordinating preparedness, planning, and response at the regional level. The RRT consists of a standing team made up of representatives of each federal agency that is a member of the NRT, as well as state and local government representatives, and also an incident-specific team made up of members of the standing team that is activated for a response. The RRT also provides oversight and consistency review for area plans within a given region.

§300.120
Establishes general responsibilities of federal On-Scene Coordinators.

§300.125(a)
Requires notification of any discharge or release to the National Response Center through a toll-free telephone number. The National Response Center (NRC) acts as the central clearinghouse for all pollution incident reporting.

§300.135(a)
Authorizes the predesignated On-Scene Coordinator (OSC) to direct all federal, state, and private response activities at the site of a discharge.

§300.135(d)
Establishes the unified command structure for managing responses to discharges through coordinated personnel and resources of the federal government, the state government, and the responsible party.

§300.165
Requires the On-Scene Coordinator to submit to the RRT or NRT a report on all removal actions taken at a site.

§300.170
Identifies the responsibilities for federal agencies that may be called upon during response planning and implementation to provide assistance in their respective areas of expertise consistent with the agencies' capabilities and authorities.

§300.175
Lists the federal agencies that have duties associated with responding to releases.

§300.210
Defines the objectives, authority, and scope of Federal Contingency Plans, including the National Contingency Plan (NCP), Regional Contingency Plans (RCPs), and Area Contingency Plans (ACPs).

Oil Removals

§300.317
Establishes national priorities for responding to a release.

§300.320
Establishes the general pattern of response to be executed by the On-Scene Coordinator, including determination of threat, classification of the size and type of the release, notification of the RRT and the NRC, and supervision of thorough removal actions.

§300.322
Authorizes the OSC to determine whether a release poses a substantial threat to the public health or welfare of the United States based on several factors, including the size and character of the discharge and its proximity to human populations and sensitive environments. In such cases, the OSC is authorized to direct all federal, state, or private response and recovery actions. The OSC may enlist the support of other federal agencies or special teams.

§300.323
Provides special consideration to discharges which have been classified as a spill of national significance. In such cases, senior federal officials direct nationally-coordinated response efforts.

§300.324
Requires the OSC to notify the National Strike Force Coordination Center (NSFCC) in the event of a worst case discharges, defined as the largest foreseeable discharge in adverse weather conditions. The NSFCC coordinates the acquisition of needed response personnel and equipment. The OSC also must require implementation of the worst case portion of the tank vessel and Facility Response Plans and the Area Contingency Plan.

§300.355
Provides funding for responses to oil releases under the Oil Spill Liability Trust Fund, provided certain criteria are met. The responsible party is liable for federal removal costs and damages as detailed in section 1002 of the Oil Pollution Act (OPA). Federal agencies assisting in a response action may be reimbursed. Several other federal agencies may provide financial support for removal actions.

Subpart J
Establishes the NCP Product Schedule, which contains dispersants and other chemical or biological products that may be used in carrying out the NCP. Authorization for the use of these products is conducted by Regional Response Teams and Area Committees, or by the OSC in consultation with EPA representatives.

Hazardous Substance Removals

§300.415(b)
Authorizes the lead agency to initiate appropriate removal action in the event of a hazardous substance release. Decisions of action will be based on threats to human or animal populations, contamination of drinking water supplies or sensitive ecosystems, high levels of hazardous substances in soils, weather conditions that may cause migration or release of hazardous substances, the threat of fire or explosion, or other significant factors effecting the health or welfare or the public or the environment.

§300.415(c)
Authorizes the OSC to direct appropriate actions to mitigate or remove the release of hazardous substances.

The National Response System (NRS) routinely and effectively responds to a wide range of oil and hazardous substance releases. It is a multi-layered system of individuals and teams from local, state, and federal agencies, industry, and other organizations that share expertise and resources to ensure that oil spill control and cleanup activities are timely and efficient, and that they minimize threats to human health and the environment.

At the heart of the system is the National Contingency Plan (NCP), which ensures that the resources and expertise of the federal government are available immediately for oil or hazardous substance releases that are beyond the capabilities of local and state responders. The NCP provides the framework for the NRS and establishes how it works.

When releases are serious enough to be considered "Nationally Significant Incidents," the National Response Framework (NRF) is activated, and works in conjunction with the NRS and NCP. The NRF is the federal government's comprehensive, all-hazard approach to crisis management, and provides a mechanism for coordinating federal assistance to state governments and localities.

A. Amendments SPCC

On December 5, 2008, the Federal Register published EPA's amendments to the Spill Prevention, Control and Countermeasure (SPCC) rule in order to provide increased clarity, to tailor requirements to particular industry sectors, and to streamline certain requirements for those facility owners or operators subject to the rule, which should result in greater protection to human health and the environment.

On April 1, 2009, the Federal Register published EPA's delay of the effective date of the December 5, 2008, Oil Spill Prevention, Control, and Countermeasure final rule. This delay is in response to public comments and the Office of Management and Budget's January 21, 2009, memorandum regarding regulatory review.

The December 5, 2008, amendments became effective on January 14, 2010. The delay, nor the December 5, 2008, final rule remove any regulatory requirement for owners or operators of facilities in operation before August 16, 2002, to maintain an SPCC Plan in accordance with the SPCC regulations.

On November 5, 2009, the EPA Administrator signed a notice amending certain requirements of the Spill Prevention, Control, and Countermeasure (SPCC) rule in order to address additional areas of regulatory reform that have been raised by the regulated community. This action promulgates revisions to the December 2008 amendments as a result of EPA's review of comments and consideration of all relevant facts. EPA is either taking no action or providing minor technical corrections on the majority of the December 2008 provisions. However, this action modifies the December 2008 rule by removing the provisions to: exclude farms and oil production facilities from the loading/unloading rack requirements; exempt produced water containers at an oil production facility; and provide alternative qualified facilities eligibility criteria for an oil production facility. This rule became effective January 14, 2010.

B. Oil Reporting Requirements

If a facility or vessel discharges oil to navigable waters or adjoining shorelines, waters of the contiguous zone, or in connection with activities under the Outer Continental Shelf Lands Act or Deepwater Port Act of 1974, or which may affect natural resources under exclusive U.S. authority, the owner/operator is required to follow certain federal reporting requirements.[23] These requirements are found in two EPA regulations – 40 CFR part 110, Discharge of Oil regulation, and 40 CFR part 112, Oil Pollution Prevention regulation. The Discharge of Oil regulation provides the framework for determining whether an oil discharge to inland and coastal waters or adjoining shorelines should be reported to the National Response Center. The Oil Pollution Prevention regulation, part of which is commonly referred to as the "SPCC rule," identifies certain types of discharges from regulated facilities that also need to be reported to EPA. Although these reporting requirements were not changed by EPA's recent modifications of the Spill Prevention, Control, and Countermeasure (SPCC) rule, this Fact Sheet will help facilities with the Reportable Discharge History criterion associated with the qualified facility option and the oil-filled operational equipment option offered in the recent SPCC modifications. Specifics include:

1. Who is subject to the discharge of oil regulation?

Any person in charge of a vessel or of an onshore or offshore facility is subject to the reporting requirements of the Discharge of Oil regulation if it discharges a harmful quantity of oil to U.S. navigable waters, adjoining shorelines, or the contiguous zone, or in connection with activities

[23] Refer to: http://www.epa.gov/osweroe1/content/spcc/factsheet_spill_reporting_dec06.htm below

under the Outer Continental Shelf Lands Act or Deepwater Port Act of 1974, or which may affect natural resources under exclusive U.S. authority.

2. What is a "harmful quantity" of discharged oil?

A harmful quantity is any quantity of discharged oil that violates state water quality standards, causes a film or sheen on the water's surface, or leaves sludge or emulsion beneath the surface. For this reason, the Discharge of Oil regulation is commonly known as the "sheen" rule. Note that a floating sheen alone is not the only quantity that triggers the reporting requirements (e.g., sludge or emulsion deposited below the surface of the water may also be reportable).

Under this regulation, reporting oil discharges does not depend on the specific amount of oil discharged, but instead can be triggered by the presence of a visible sheen created by the discharged oil or the other criteria described above.

3. To whom do I report an oil discharge?

A facility should report discharges to the National Response Center (NRC) at 1-800-424-8802 or 1-202-426-2675. The NRC is the federal government's centralized reporting center, which is staffed 24 hours per day by U.S. Coast Guard personnel.

If reporting directly to NRC is not practicable, reports also can be made to the EPA regional office or the U.S. Coast Guard Marine Safety Office (MSO) in the area where the incident occurred.

4. When must I report to NRC?

Any person in charge of a vessel or an onshore or offshore facility must notify NRC immediately after he or she has knowledge of the discharge.

5. What information do I need to report?

NRC will ask a caller to provide as much information about the incident as possible including:

Name, organization, and telephone number
Name and address of the party responsible for the incident
Date and time of the incident
Location of the incident
Source and cause of the discharge
Types of material(s) discharged
Quantity of materials discharged
Danger or threat posed by the discharge

Number and types of injuries (if any)
Weather conditions at the incident location
Other information to help emergency personnel respond to the incident
How are reports to NRC handled?

NRC relays information to an EPA or U.S. Coast Guard On-Scene Coordinator (OSC), depending on the location of the incident. After receiving a report, the OSC evaluates the situation and decides if federal emergency response action is necessary.

6. If I report a discharge to NRC, do I also report to EPA?

If a facility is regulated under the SPCC rule and has a reportable discharge according to EPA regulations (see below), it must be reported to both NRC and EPA.

7. What are the oil discharge reporting requirements in the SPCC rule?

Any facility owner/operator who is subject to the SPCC rule must comply with the reporting requirements found in §112.4.

A discharge must be reported to the EPA Regional Administrator (RA) when there is a discharge of:

More than 1,000 U.S. gallons of oil in a single discharge to navigable waters or adjoining shorelines
More than 42 U.S. gallons of oil in each of two discharges to navigable waters or adjoining shorelines occurring within any twelve-month period
When determining the applicability of this SPCC reporting requirement, the gallon amount(s) specified (either 1,000 or 42) refers to the amount of oil that actually reaches navigable waters or adjoining shorelines, not the total amount of oil spilled.

8. What do I need to submit to EPA?

The owner/operator must provide the following:

Name and location of the facility
Owner/operator name
Maximum storage/handling capacity of the facility and normal daily throughput
Corrective actions and countermeasures taken, including descriptions of equipment repairs and replacements
Adequate description of the facility, including maps, flow diagrams, and topographical maps, as necessary
Cause of the discharge to navigable waters, including a failure analysis
Failure analysis of the system where the discharge occurred

Additional preventive measures taken or planned to take to minimize discharge reoccurrence
Other information the RA may reasonably require
An owner/operator must also send a copy of this information to the agency or agencies in charge of oil pollution control activities in the state in which the facility is located.

9. What happens after a facility submits this information to EPA?

The EPA Regional Administrator will review the information submitted by the facility and may require a facility to submit and amend its SPCC Plan. Facilities and equipment that qualified for the new streamlined requirements may lose eligibility for those options as determined by the Regional Administrator. A state agency may also make recommendations to EPA for a facility to amend its Plan to prevent or control oil discharges.

CHAPTER 10 – SUPPORTIVE SOCIOECONOMIC BENEFITS

I. INTRODUCTION

Aside from the direct or primary benefits provided by PORTS®, the logic models which detail the economic and socioeconomic inputs and outputs from domestic and international marine traffic suggests the existence of additional benefits that can be either directly supported or influenced by PORTS® installations. While the previously estimated benefits were based on the traffic which PORTS® were suggested to support from both an economic and safety perspective, activities at PORTS can go far beyond the basic transportation function in the form of logistics and support of associative and supportive industries and endeavors.[1] This chapter makes a high level assessment of benefits believed to be enjoyed by a variety of ocean marine economies as a result of PORTS® operation.

II. DATA EMPLOYED

Data employed to estimate the secondary and tertiary benefits from PORTS® was based on the data for business establishments, employment and wages in NOAA's Economics: National Ocean Watch (ENOW) data base maintained by the National Ocean Service's Coastal Services Center.[2] ENOW describes six economic sectors that depend on the oceans and Great Lakes.[3] (Refer to Chapter 3) The data base contains annual data for 448 coastal counties, 30 coastal states, and eight regions for the years 2005 through 2010. ENOW obtains its data from

[1] Refer to Chapter 4, *Introduction to Transportation*

[2] Refer to Chapter 3, *Data and Information Employed* for a more detailed explanation of the data and its source.

[3] Although the National Ocean Economics Program (NOEP) and ENOW data bases contain similar data, the ENOW data contains two revisions which correct the accidental exclusion of natural gas liquid extraction from NOEP offshore mineral resources data and inclusion of data for pipeline transportation of crude oil, natural gas and refined petroleum products. For this reason, ENOW was selected as the source of data in this analysis.

the Department of Labor's Bureau of Labor Statistics and the Department of Commerce's Bureau of Economic Analysis.

Economic activity is included in ENOW if the establishment is either: (1) associated with an industry whose definition explicitly ties the activity to the ocean, or is (2) located in an industry which is partially related to the ocean and is located in a shore-adjacent zip code.[4]

Although the ENOW data base contains data on six economic sectors, in this analysis, it was hypothesized PORTS® were only responsible developing or supporting measurable benefit in four of the sectors. (Refer to Table 1) The impact was hypothesized to range from 0.1 percent (for living resources) , 1.0 percent for offshore minerals and tourism and recreation and between 8.6 and 13.9 percent for marine transportation.[5]

A. Data Limitations

In an ideal world, data for each of the descriptive socioeconomic statistics would be available in such a manner that comparisons across years, ports and socioeconomic areas could be made so that before and after PORTS® installations could be compared and the causal relationships quantitatively proven. Unfortunately, a large number of data are not publically identifiable owing to confidentiality concerns. As with many governmental databases, data that could identify a specific firm or individual or that could result in the release of that might damage or alter the relative competitive position of such cannot be divulged. In those cases, the data is "suppressed" by the Department of Labor and/or the Department of Commerce by listing "-9999" in the value field. In almost 28 percent of the cases in the 2005 to 2010 ENOW data base, the data was suppressed. (Refer to Table 2).

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[4] Refer to "*Frequent Questions*", ENOW Data basics, November 2012, page 2.

[5] Reflecting zero to two and zero to four feet DUK, respectively.

Table 1

ECONOMIC SECTORS IMPACTED BY PORTS®
(Based Zero to Three Miles from Shore)

OCEAN ECONOMIC SECTOR	WEIGHT ASSIGNED TO PORTS® ACTIVITIES	ECONOMIC AREAS INCLUDED	RATIONALE
Living Resources (Group 2)	0.1 Percent (Refer to Chapter 8)	Fishing Fish Hatcheries & Aquaculture Seafood Markets Seafood Processing	Helps to identify in situ conditions conducive of commercial fish catch
Offshore Minerals (Group 3)	1.0 Percent	Limestone, Sand & Gravel Oil and Gas Exploration Oil and Gas Production	Safe and economically efficient passage to and from platforms and exploration sites
Tourism & Recreation (Group 5)	1.0 Percent	Amusement and Recreation Services Boat Dealers Eating & Drinking Places Hotels & Lodging Places Marinas Recreational Vehicle Parks & Campgrounds Scenic Water Tours Sporting Goods Retailers Zoos, Aquaria	Helps to identify in situ conditions conducive of safe and effective recreational fish catch, watching experiences, on-water recreational activities.
Marine Transportation (Group 6)	8.6 Percent (0-2 Feet DUK) 13.9 percent (0-4 Feet DUK) (Refer to Chapter 5)	Deep Sea Freight Transportation Marine Passenger Transportation Marine Transportation Services Search and Navigation Equipment Warehousing	Supports surface transportation and overall logistics based on augmentation of freight (tons, value, trips) allowed under the auspices of PORTS® data

As only data for 2010 was utilized in the traffic estimation portion of this analysis, all records for years other than 2010 were removed leaving 465 records. Overall, Table 3 delineates the number of observations available for the 58 ports with PORTS® and the 117 ports without PORTS®.

Table 2

**THE AMOUNT OF DATA AVAILABLE
(REDUCTIONS REQUIRED TO OBTAIN BASE 2010 DATA)**

ISSUE	RECORD COUNT	PERCENT OF TOTAL
Total Direct and Adjacent County Information (2005 – 2010)	8,419	100%
Remove Summary Categories Not Applicable to Analysis “1 - Marine Construction” 2005-2010 “4 – Ship and Boat Building“ 2005-2010 “9 - All Ocean Sectors” 2005-2010 “10 – All Industry Records” 2005-2010	4,266	51%
Remove records coded (-9999) due to confidentiality concerns (2005- 2010)	1,316	16%
Remaining Data (2005 - 2010)	2,836	34%
Retain only data from 2010	465	6%

Source: NOAA, CSC, ENOW Database

Table 3

NUMBER OF RECORDS AVAIABLE FOR SOCIOECONOMIC ANALYSIS

AREA OF INVESTIGATION	NUMBER OF RECORDS AVAILABLE[6]
Ports with PORTS® In County	114
Ports with PORTS® All Adjacent Counties[7]	78
Ports without PORTS® In County	219
Ports without PORTS® All Adjacent Counties	54

Source: NOAA, CSC, ENOW Database

B. Calculation Assumptions

Due to these data limitations it would be disingenuous to compare individual ports with and without PORTS®. This would be equally true within a socioeconomic expenditure group as well as across years. However, it is possible to develop some initial conceptions of the contribution of PORTS® to the US economy from a number of less granular perspectives. In

[6] The total number of non-zero records reported in 2010 that are not identified with -9999 in establishment, employment or wage statistics to ensure confidentiality.

[7] No duplication of data where an adjacent county was shared by two or more ports was seen.

this analysis, the following conservative assumptions were made which mirrored the assumptions in previous chapters when dealing with commercial fishing, recreation, marine cargo transportation. While not previously addressed individually, support of offshore minerals (and oil) exploration and production, PORTS® was assigned a relation of one percent of total activity. Overall the weighting was (Refer to Table 1)

- The overall portion of marine freight value which arrived zero to two (8.6 percent) DUK were assumed as the lower range of potential benefits from PORTS®[8];
- The overall portion of marine freight value which arrived zero to four (13.9 percent) DUK were assumed as the upper range of potential benefits from PORTS®;
- Commercial fishing (living resources) was assigned a value of 0.1 percent;
- Tourism and Trade was assigned a value of 1.0 percent; and,
- Offshore Minerals was assigned a value of 1.0 percent.

Table 4 summarizes the secondary socioeconomic benefits which were estimated to be derived from PORTS® activity in 2010 associated with traffic carried zero to two feet DUK. Current locations with PORTS® are believed to contribute to 726 establishments covering over 19,000 employees who are paid over $1 billion in annual salaries. (Refer to Figures 1, 2 and 3) When movements with DUK of between zero and four feet are considered, the support of 900 establishments, 26,000 jobs and over $1.5 billion in annual salaries is possible. (Refer to Figures 4, 5 and 6)

Overall, PORTS® assists in supporting marine transportation and tourism and recreation more than living resources and offshore mineral extraction although the latter pays a

[8] As described earlier, this proposed USCG DUK restriction in DUK when threatened with the loss of PORTS® in the port authority of New York and New Jersey was employed as the minimum benefit provided by PORTS®.

significantly higher wage than do the other three ocean sectors combined ($150 thousand versus $22 thousand for tourism and recreation, $41 thousand for living resources and $62 thousand for marine transportation).[9]

Table 4

SUMMARY OF PORTS® SECONDARY CURRENT BENEFIT ESTIMATE
(58 Ports within counties and adjacent counties – 0-2 Feet DUK)

BENEFITS AREA	NUMBER OF ESTABLISHMENTS	NUMBER OF JOBS SUPPORTED	TOTAL WAGES ($Millions)[10]
FOUR OCEAN SECTORS	726[11] / 900[12]	19,259 / 26,270	$ 1,059.2 / $ 1,525.1
Living Resources	1	6	$ 0.3
Marine Transportation (0-2 feet DUK)	282	11,377	$ 756.0
Marine Transportation (0-4 feet DUK)	456	18,389	$ 1,221.8
Offshore Minerals Extraction	25	909	$ 139.4
Tourism and Recreation	418	6,966	$ 163.6

[9] Covers all locations reviewed (with and without PORTS® both in county and in adjacent counties). The overall average wage per person was $40,735 (in 2010 dollars)

[10] Totals for the number of business establishments, employment and wages are based on the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) data (also known as ES-202 data). Employment and wage information is based on those covered under state and Federal unemployment insurance laws. This covers about 90 percent of all U.S. businesses.

[11] Zero to two feet DUK totals

[12] Zero to four feet DUK totals

Figure 1

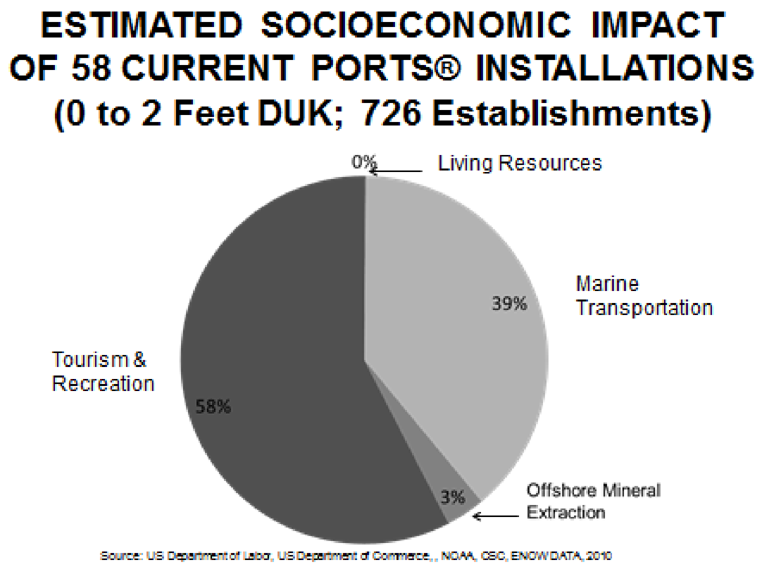


Figure 2

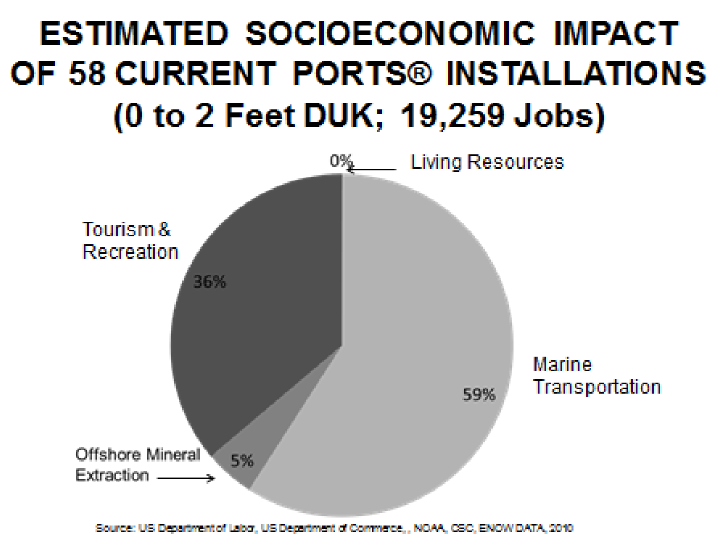


Figure 3

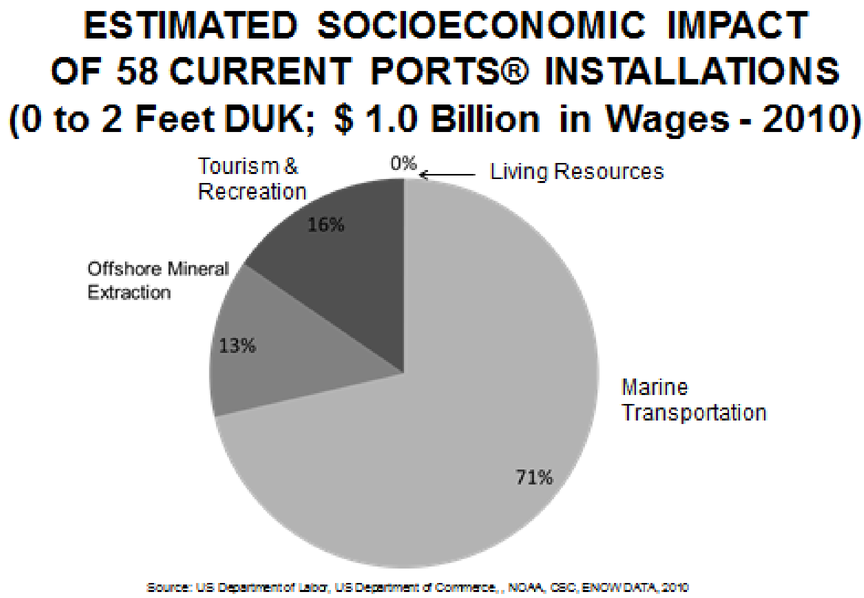


Figure 4

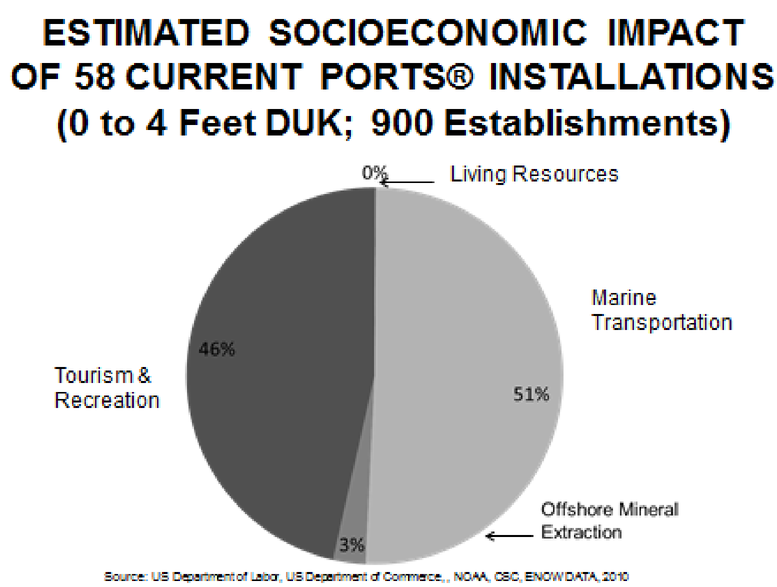


Figure 5

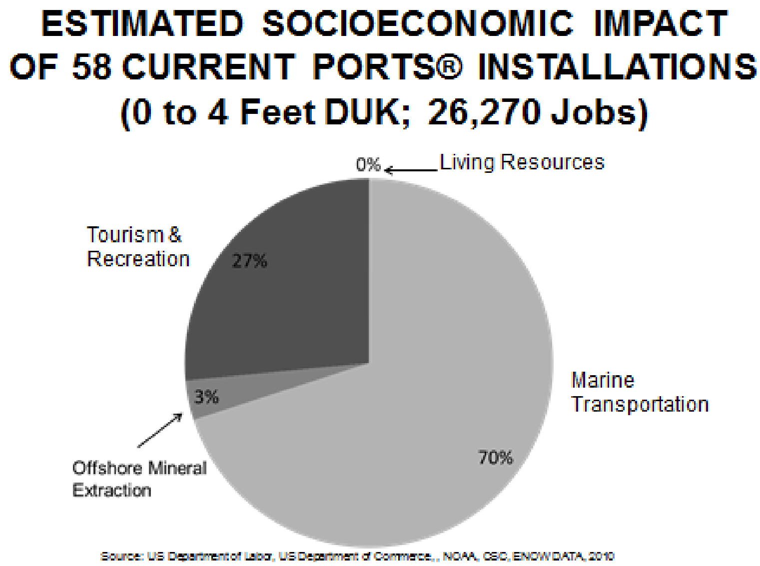
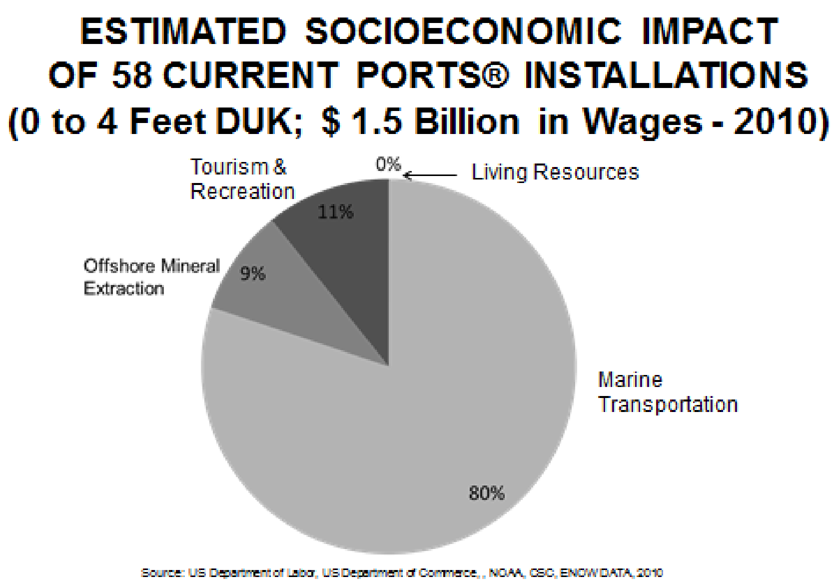


Figure 6



C. Additional PORTS® Benefits

Based on improvements in safety and operational efficiency, it is logical to assume that if PORTS® were installed at the remaining 117 port locations currently without PORTS® that some additional economic activity could result. (Refer to Table 5) Employing the same weights as delineated in Table 2, If PORTS® were installed at the remaining 117 port locations currently not served with traffic within two feet DUK, an additional 653 establishments covering over 15,000 employees could be supported.[13] (Refer to Figures 7, 8 and 9) When the DUK is increased to zero to two feet to zero to four feet, the level of support increases to 800 firms, 19,900 jobs and $841 million in annual wages. (Figures 10, 11 and 12)

Table 5

SUMMARY OF PORTS® SECONDARY POTENTIAL BENEFIT ESTIMATE
(117 Ports within counties and adjacent counties – 0-2 Feet DUK)

BENEFITS AREA	NUMBER OF ESTABLISHMENTS	NUMBER OF JOBS SUPPORTED	TOTAL WAGES ($Millions)[14]
FOUR OCEAN SECTORS	653[15] / 800[16]	15,045 / 19,879	$ 576.6 / $ 840.7
Living Resources	2	10	$ 0.4
Marine Transportation (0-2 Feet DUK)	238	7,843	$ 428.5
Marine Transportation (0-4 Feet DUK)	384	12,677	$ 692.6
Offshore Minerals Extraction	5	44	$ 3.2
Tourism and Recreation	409	7,148	$ 144.5

[13] These staffers would be paid almost $577 million per year.

[14] Totals for the number of business establishments, employment and wages are based on the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) data (also known as ES-202 data). Employment and wage information is based on those covered under state and Federal unemployment insurance laws. This covers about 90 percent of all U.S. businesses.

[15] Zero to two foot DUK total

[16] Zero to four foot DUK total

Overall, expansion into the remaining 117 ports would appear to support marine transportation and tourism and recreation much more than supporting either living resources or offshore mineral extraction although releases of areas currently closed off to offshore oil exploration and production could change these figures.

Figure 7

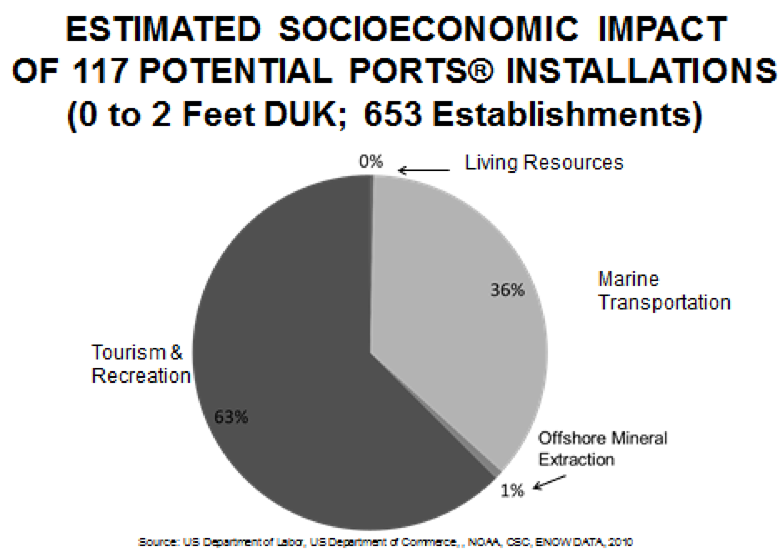


Figure 8

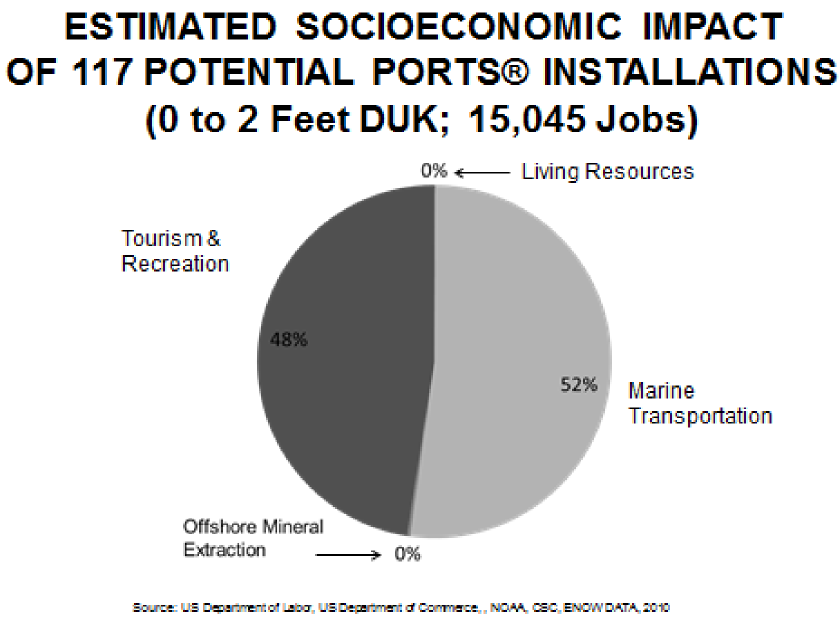


Figure 9

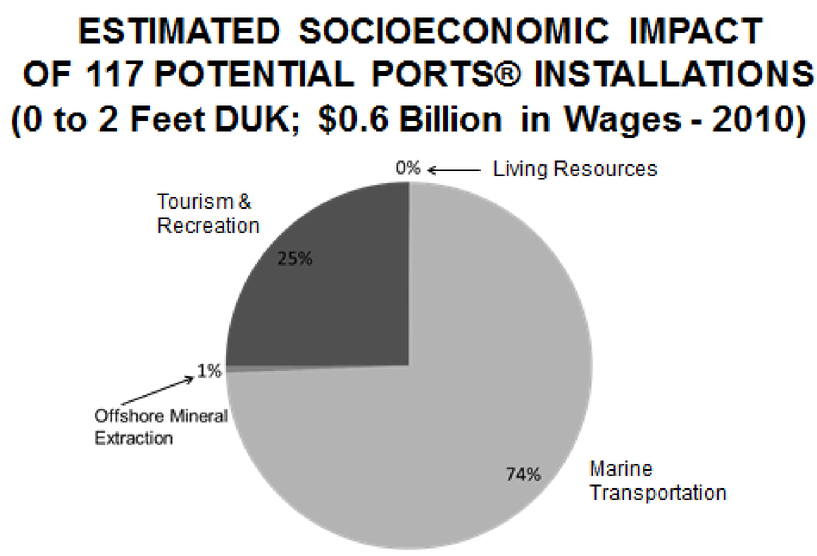


Figure 10

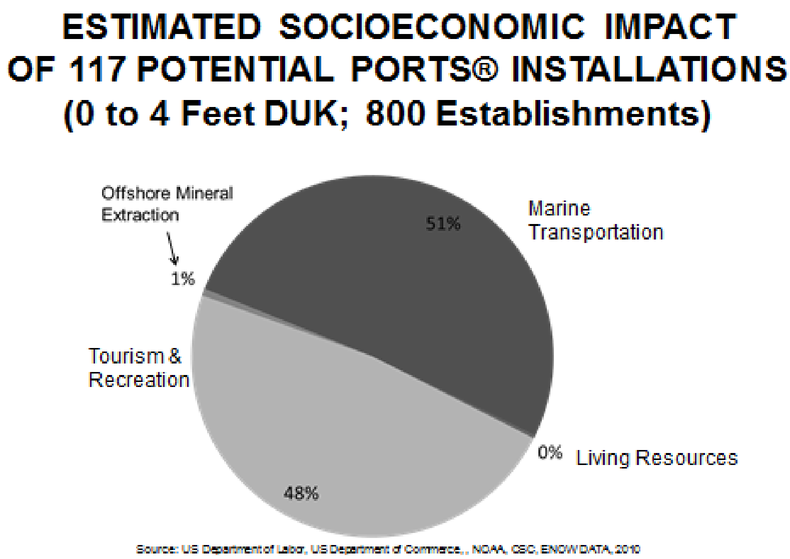


Figure 11

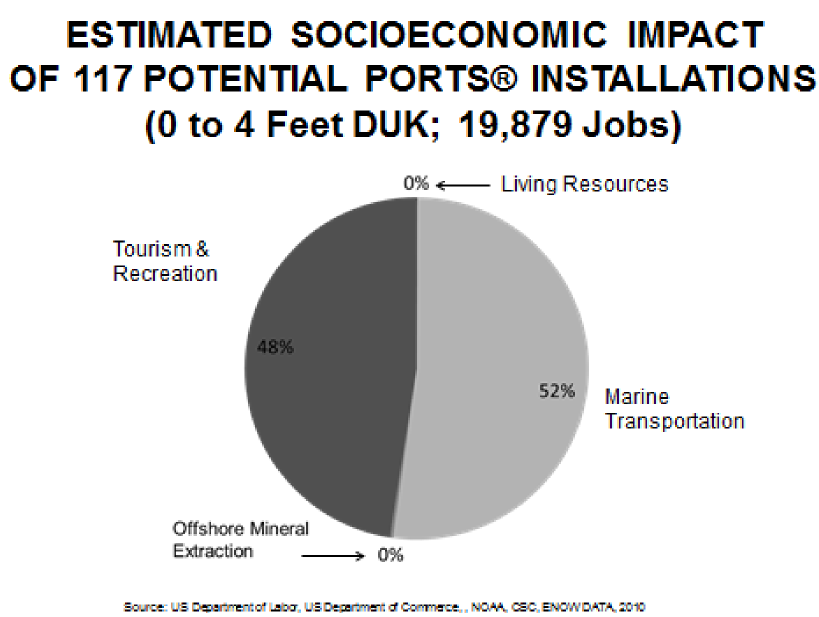
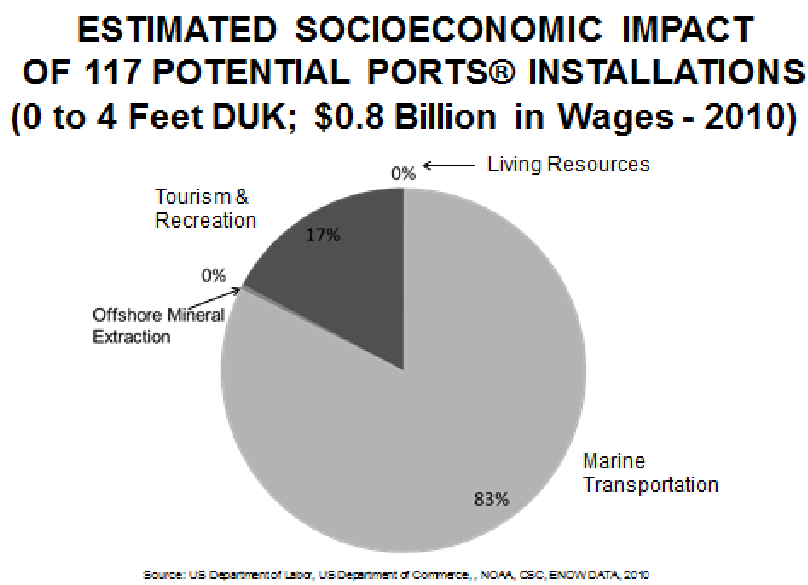


Figure 12



D. Summary

As PORTS® clearly provides a wide-array of real-time data to both commercial and recreational activities, loss of this information could likely result in heightened levels of groundings, allisions and collisions which in turn could lead to increased levels of morbidity and mortality among users both on and offshore.

Use of de minimis levels of support in those areas of living resources (0.1% of total economic value as measured by the Gross Domestic Product), marine transportation (8.6% of total traffic arriving within two feet of the channel's bottom and 13.9% of total traffic arriving within four feet of the channel's bottom), offshore minerals extraction (1.0% of the economic value) and tourism and recreation (1.0% of the economic value) were employed to suggest what portion of the U.S. economy might be made more resilient and sustained regardless of tides or weather conditions. In other words, it is believed that if PORTS® were to vanish, continued sustainability and resiliency of a portion of the local economies might be at risk. Without PORTS® it is suggested that it would cost more to support these industries which would in turn make them more expensive and less competitive and attractive to domestic and international users.

If PORTS® were installed at all 175 port locations in 2010, the societal value of transportation efficiency, operational safety and environmental resilience influenced could:

- Impact between 1,400 and 1,700 establishments;
- Help support among 34,000 to 46,000 jobs; and,
- Maintain wages in from $1.6 and $2.4 billion per year.

APPENDIX A

LIST OF U.S. PORTS WITH PORTS®

WITH ASSOCIATED ENOW

SOCIOECONOMIC ACTIVITY DATA

(2010)

PORT LOCATION	HAS PORTS® ?	N = IN COUNTY; Y = ADJACENT COUNTY	COUNTY NAME	STATE	SOCIOECONOMIC SECTOR	ESTABLISMENTS	JOBS	WAGES
PORTS WITH PORTS® (IN COUNTY)								
OAKLAND, CA	Y	N	Alameda County	CA	Living Resources	7	17	$260,503
OAKLAND, CA	Y	N	Alameda County	CA	Offshore Mineral Extraction	13	138	$10,774,076
OAKLAND, CA	Y	N	Alameda County	CA	Marine Transportation	119	2,960	$212,147,234
OAKLAND, CA	Y	N	Alameda County	CA	Tourism and Recreation	1,697	23,626	$450,319,347
ALEXANDRIA, VA	Y	N	Alexandria city	VA	Living Resources	-	-	$0
ALEXANDRIA, VA	Y	N	Alexandria city	VA	Tourism and Recreation	-	-	$0
ANCHORAGE, AK	Y	N	Anchorage County	AK	Living Resources	15	188	$7,103,656
ANCHORAGE, AK	Y	N	Anchorage County	AK	Tourism and Recreation	665	12,695	$259,180,389
ANCHORAGE, AK	Y	N	Anchorage County	AK	Offshore Mineral Extraction	61	2,689	$480,225,705
BALTIMORE, MD	Y	N	Baltimore County	MD	Living Resources	15	81	$1,690,393
BALTIMORE, MD	Y	N	Baltimore County	MD	Marine Transportation	58	823	$38,666,048
BALTIMORE, MD	Y	N	Baltimore County	MD	Tourism and Recreation	370	4,697	$69,034,712
PENNSBURY MANOR, PA	Y	N	Bucks County	PA	Tourism and Recreation	-	-	$0
PENNSBURY MANOR, PA	Y	N	Bucks County	PA	Offshore Mineral Extraction	5	5	$143,677
PENNSBURY MANOR, PA	Y	N	Bucks County	PA	Living Resources	10	46	$1,117,520
PENNSBURY MANOR, PA	Y	N	Bucks County	PA	Marine Transportation	48	1,688	$69,665,068

CHARLESTON, SC	Y	N	Charleston County	SC	Living Resources	12	62	$1,117,948
CHARLESTON, SC	Y	N	Charleston County	SC	Marine Transportation	65	1,879	$68,774,287
CHARLESTON, SC	Y	N	Charleston County	SC	Tourism and Recreation	934	20,841	$382,012,504
ASTORIA, OR	Y	N	Clatsop County	OR	Offshore Mineral Extraction	-	-	$0
ASTORIA, OR	Y	N	Clatsop County	OR	Marine Transportation	6	10	$813,606
ASTORIA, OR	Y	N	Clatsop County	OR	Living Resources	43	61	$3,285,442
ASTORIA, OR	Y	N	Clatsop County	OR	Tourism and Recreation	254	3,436	$59,905,591
RICHMOND, CA	Y	N	Contra Costa County	CA	Living Resources	6	20	$698,050
RICHMOND, CA	Y	N	Contra Costa County	CA	Marine Transportation	45	380	$17,486,049
RICHMOND, CA	Y	N	Contra Costa County	CA	Tourism and Recreation	692	9,560	$156,331,719
MARCUS HOOK, PA	Y	N	Delaware County	PA	Living Resources	8	46	$1,599,270
MARCUS HOOK, PA	Y	N	Delaware County	PA	Marine Transportation	25	487	$24,536,970
MARCUS HOOK, PA	Y	N	Delaware County	PA	Tourism and Recreation	107	1,545	$24,898,461
JACKSONVILLE, FL	Y	N	Duval County	FL	Living Resources	32	106	$1,802,438
JACKSONVILLE, FL	Y	N	Duval County	FL	Tourism and Recreation	665	9,817	$154,300,650
JACKSONVILLE, FL	Y	N	Duval County	FL	Marine Transportation	136	5,903	$266,375,007
TEXAS CITY, TX	Y	N	Galveston County	TX	Living Resources	14	275	$4,544,217
TEXAS CITY, TX	Y	N	Galveston County	TX	Offshore Mineral Extraction	49	235	$18,317,989
TEXAS CITY, TX	Y	N	Galveston County	TX	Marine Transportation	48	885	$42,798,529

TEXAS CITY, TX	Y	N	Galveston County	TX	Tourism and Recreation	407	9,135	$149,412,730
PAULSBORO, NJ	Y	N	Gloucester County	NJ	Offshore Mineral Extraction	6	137	$6,980,010
PAULSBORO, NJ	Y	N	Gloucester County	NJ	Marine Transportation	23	424	$17,718,321
PAULSBORO, NJ	Y	N	Gloucester County	NJ	Tourism and Recreation	88	1,202	$18,460,326
HOUSTON, TX	Y	N	Harris County	TX	Living Resources	31	104	$3,766,393
HOUSTON, TX	Y	N	Harris County	TX	Tourism and Recreation	400	7,089	$109,492,868
HOUSTON, TX	Y	N	Harris County	TX	Marine Transportation	348	14,925	$767,780,076
HOUSTON, TX	Y	N	Harris County	TX	Offshore Mineral Extraction	1,619	76,754	$12,380,946,861
HUMBOLDT BAY, CA	Y	N	Humboldt County	CA	Living Resources	51	53	$3,138,875
HUMBOLDT BAY, CA	Y	N	Humboldt County	CA	Marine Transportation	14	148	$6,177,566
HUMBOLDT BAY, CA	Y	N	Humboldt County	CA	Tourism and Recreation	278	3,938	$57,989,398
PASCAGOULA, MS	Y	N	Jackson County	MS	Marine Transportation	21	132	$3,169,913
PASCAGOULA, MS	Y	N	Jackson County	MS	Tourism and Recreation	257	3,746	$52,852,099
SABINE PASS, TX	Y	N	Jefferson County	TX	Living Resources	16	213	$4,696,063
SABINE PASS, TX	Y	N	Jefferson County	TX	Marine Transportation	33	466	$16,744,569
SABINE PASS, TX	Y	N	Jefferson County	TX	Tourism and Recreation	87	1,863	$25,699,519
SABINE PASS, TX	Y	N	Jefferson County	TX	Offshore Mineral Extraction	36	130	$16,708,495
NEW ORLEANS, LA	Y	N	Jefferson Parish	LA	Living Resources	32	102	$2,092,715
NEW ORLEANS, LA	Y	N	Jefferson Parish	LA	Offshore Mineral Extraction	85	1,231	$105,679,147
NEW ORLEANS, LA	Y	N	Jefferson Parish	LA	Marine	116		$112,755,041

					Transportation		2,146	
NEW ORLEANS, LA	Y	N	Jefferson Parish	LA	Tourism and Recreation	849	14,348	$241,589,973
NIKISHKA, AK	Y	N	Kenai Peninsula County	AK	Marine Transportation	18	45	$2,351,920
NIKISHKA, AK	Y	N	Kenai Peninsula County	AK	Living Resources	41	12	$737,713
NIKISHKA, AK	Y	N	Kenai Peninsula County	AK	Tourism and Recreation	267	2,034	$38,806,391
NIKISHKA, AK	Y	N	Kenai Peninsula County	AK	Offshore Mineral Extraction	32	293	$36,565,340
NEW YORK, NY	Y	N	Kings County	NY	Living Resources	101	368	$6,998,287
NEW YORK, NY	Y	N	Kings County	NY	Marine Transportation	55	490	$19,586,076
NEW YORK, NY	Y	N	Kings County	NY	Tourism and Recreation	2,398	16,421	$302,596,329
LOS ANGELES, CA	Y	N	Los Angeles County	CA	Living Resources	109	968	$25,932,803
LOS ANGELES, CA	Y	N	Los Angeles County	CA	Offshore Mineral Extraction	108	1,377	$98,026,482
LOS ANGELES, CA	Y	N	Los Angeles County	CA	Tourism and Recreation	1,985	42,264	$929,494,268
LOS ANGELES, CA	Y	N	Los Angeles County	CA	Marine Transportation	582	42,673	$3,753,921,745
PORT MANATEE, FL	Y	N	Manatee County	FL	Marine Transportation	13	73	$3,029,578
PORT MANATEE, FL	Y	N	Manatee County	FL	Tourism and Recreation	558	7,996	$152,650,106
WILMINGTON, DE	Y	N	New Castle County	DE	Offshore Mineral Extraction	4	5	$194,928
WILMINGTON, DE	Y	N	New Castle County	DE	Marine Transportation	49	422	$19,030,984
WILMINGTON, DE	Y	N	New Castle County	DE	Tourism and Recreation	350	5,512	$83,854,721
NEW HAVEN, CT	Y	N	New Haven County	CT	Living Resources	12	26	$641,429
NEW HAVEN, CT	Y	N	New Haven County	CT	Marine Transportation	44	1,112	$55,539,092

NEW HAVEN, CT	Y	N	New Haven County	CT	Tourism and Recreation	739	9,439	$167,830,904
NEW LONDON, CT	Y	N	New London County	CT	Marine Transportation	19	5	$178,421
NEW LONDON, CT	Y	N	New London County	CT	Living Resources	13	56	$1,148,732
NEW LONDON, CT	Y	N	New London County	CT	Tourism and Recreation	434	6,348	$124,696,812
NEWPORT, RI	Y	N	Newport County	RI	Living Resources	17	45	$763,881
NEWPORT, RI	Y	N	Newport County	RI	Tourism and Recreation	415	6,093	$125,160,731
NEWPORT NEWS, VA	Y	N	Newport News city	VA	Offshore Mineral Extraction	-	-	$0
NEWPORT NEWS, VA	Y	N	Newport News city	VA	Living Resources	8	15	$293,551
NEWPORT NEWS, VA	Y	N	Newport News city	VA	Marine Transportation	17	945	$30,370,496
NEWPORT NEWS, VA	Y	N	Newport News city	VA	Tourism and Recreation	367	5,997	$77,520,246
REEDVILLE, VA	Y	N	Northumberland County	VA	Living Resources	19	14	$212,568
REEDVILLE, VA	Y	N	Northumberland County	VA	Tourism and Recreation	28	169	$1,908,208
CORPUS CHRISTI, TX	Y	N	Nueces County	TX	Marine Transportation	32	307	$14,576,154
CORPUS CHRISTI, TX	Y	N	Nueces County	TX	Tourism and Recreation	526	11,174	$187,131,633
CORPUS CHRISTI, TX	Y	N	Nueces County	TX	Offshore Mineral Extraction	192	2,764	$222,822,667
ORANGE, TX	Y	N	Orange County	TX	Tourism and Recreation	-	-	$0
ORANGE, TX	Y	N	Orange County	TX	Marine Transportation	11	131	$5,134,134
ORANGE, TX	Y	N	Orange County	TX	Offshore Mineral Extraction	16	275	$17,395,690
PHILADELPHIA, PA	Y	N	Philadelphia County	PA	Offshore Mineral Extraction	-	-	$0
PHILADELPHIA, PA	Y	N	Philadelphia County	PA	Living Resources	35		$1,693,494

							109	
PHILADELPHIA, PA	Y	N	Philadelphia County	PA	Marine Transportation	59	4,120	$150,777,913
PHILADELPHIA, PA	Y	N	Philadelphia County	PA	Tourism and Recreation	1,593	26,575	$585,814,931
TACOMA, WA	Y	N	Pierce County	WA	Offshore Mineral Extraction	9	147	$7,957,953
TACOMA, WA	Y	N	Pierce County	WA	Living Resources	38	482	$27,399,598
TACOMA, WA	Y	N	Pierce County	WA	Marine Transportation	54	2,635	$160,740,497
TACOMA, WA	Y	N	Pierce County	WA	Tourism and Recreation	545	7,477	$131,795,318
WEEDON ISLAND/ST PETERSBURG, FL	Y	N	Pinellas County	FL	Offshore Mineral Extraction	12	45	$1,935,214
WEEDON ISLAND/ST PETERSBURG, FL	Y	N	Pinellas County	FL	Living Resources	28	107	$2,014,190
WEEDON ISLAND/ST PETERSBURG, FL	Y	N	Pinellas County	FL	Marine Transportation	43	2,586	$189,796,666
WEEDON ISLAND/ST PETERSBURG, FL	Y	N	Pinellas County	FL	Tourism and Recreation	2,103	30,431	$560,356,774
PORT OF PLAQUEMINES, LA	Y	N	Plaquemines Parish	LA	Tourism and Recreation	55	368	$4,978,010
PORT OF PLAQUEMINES, LA	Y	N	Plaquemines Parish	LA	Offshore Mineral Extraction	44	659	$43,113,861
PORT OF PLAQUEMINES, LA	Y	N	Plaquemines Parish	LA	Marine Transportation	52	1,045	$63,052,925
SAN FRANCISCO BAY, CA	Y	N	San Francisco County	CA	Living Resources	23	148	$4,697,228
SAN FRANCISCO BAY, CA	Y	N	San Francisco County	CA	Marine Transportation	35	350	$19,225,246
SAN FRANCISCO BAY, CA	Y	N	San Francisco County	CA	Tourism and Recreation	2,453	52,214	$1,537,994,300
REDWOOD CITY, CA	Y	N	San Mateo County	CA	Offshore Mineral Extraction	6	30	$1,791,809
REDWOOD CITY, CA	Y	N	San Mateo County	CA	Marine Transportation	30	381	$18,382,450
REDWOOD CITY, CA	Y	N	San Mateo County	CA	Tourism and Recreation	1,338	22,842	$512,585,683

ANACORTES, WA	Y	N	Skagit County	WA	Tourism and Recreation	207	2,384	$42,356,944
					TOTAL	**29,362**	**564,490**	**$27,509,342,037**

PORT LOCATION	HAS PORTS® ?	N = IN COUNTY; Y = ADJACENT COUNTY	COUNTY NAME	STATE	SOCIOECONOMIC SECTOR	ESTABLISMENTS	JOBS	WAGES
PORTS WITH PORTS® (ADJACENT COUNTIES)								
BALTIMORE, MD	Y	Y	Anne Arundel County	MD	Offshore Mineral Extraction	7	4	$356,218
BALTIMORE, MD	Y	Y	Anne Arundel County	MD	Living Resources	15	166	$4,026,362
BALTIMORE, MD	Y	Y	Anne Arundel County	MD	Marine Transportation	77	1,382	$104,649,101
BALTIMORE, MD	Y	Y	Anne Arundel County	MD	Tourism and Recreation	936	17,602	$358,741,543
ALEXANDRIA, VA	Y	Y	Arlington County	VA	Tourism and Recreation	-	-	$0
BALTIMORE, MD	Y	Y	Baltimore city	MD	Offshore Mineral Extraction	-	-	$0
BALTIMORE, MD	Y	Y	Baltimore city	MD	Living Resources	19	64	$1,539,753
BALTIMORE, MD	Y	Y	Baltimore city	MD	Marine Transportation	48	1,850	$93,616,372
BALTIMORE, MD	Y	Y	Baltimore city	MD	Tourism and Recreation	780	12,291	$281,400,370
CHARLESTON, SC	Y	Y	Berkeley County	SC	Living Resources	-	-	$0
CHARLESTON, SC	Y	Y	Berkeley County	SC	Tourism and Recreation	-	-	$0
CHARLESTON, SC	Y	Y	Berkeley County	SC	Marine Transportation	15	325	$9,342,847
NEW YORK, NY	Y	Y	Bronx County	NY	Living Resources	41	165	$8,363,513
NEW YORK, NY	Y	Y	Bronx County	NY	Marine	24		$12,416,659

					Transportation		342	
NEW YORK, NY	Y	Y	Bronx County	NY	Tourism and Recreation	455	3,193	$53,704,112
PENNSBURY MANOR, PA	Y	Y	Burlington County	NJ	Tourism and Recreation	-	-	$0
PENNSBURY MANOR, PA	Y	Y	Burlington County	NJ	Living Resources	3	11	$201,543
PENNSBURY MANOR, PA	Y	Y	Burlington County	NJ	Marine Transportation	33	1,752	$73,534,204
ORANGE, TX	Y	Y	Calcasieu Parish	LA	Tourism and Recreation	-	-	$0
ORANGE, TX	Y	Y	Calcasieu Parish	LA	Living Resources	6	25	$264,007
ORANGE, TX	Y	Y	Calcasieu Parish	LA	Marine Transportation	24	97	$5,015,349
HOPEWELL, VA	Y	Y	Charles City County	VA	Living Resources	-	-	$0
HOPEWELL, VA	Y	Y	Charles City County	VA	Tourism and Recreation	-	-	$0
HOPEWELL, VA	Y	Y	Charles City County	VA	Marine Transportation	-	-	$0
LONGVIEW, WA	Y	Y	Columbia County	OR	Tourism and Recreation	75	798	$10,291,175
ALEXANDRIA, VA	Y	Y	Fairfax County	VA	Tourism and Recreation	-	-	$0
ALEXANDRIA, VA	Y	Y	Fairfax County	VA	Marine Transportation	34	254	$12,204,380
HOPEWELL, VA	Y	Y	Hopewell city	VA	Living Resources	-	-	$0
HOPEWELL, VA	Y	Y	Hopewell city	VA	Offshore Mineral Extraction	-	-	$0
HOPEWELL, VA	Y	Y	Hopewell city	VA	Tourism and Recreation	-	-	$0
NEW YORK, NY	Y	Y	Hudson County	NJ	Living Resources	9	25	$1,003,563
NEW YORK, NY	Y	Y	Hudson County	NJ	Tourism and Recreation	1,109	11,383	$230,338,393
NEW YORK, NY	Y	Y	Hudson County	NJ	Marine Transportation	118	5,689	$246,186,892

NEWPORT NEWS, VA	Y	Y	Isle of Wight County	VA	Living Resources	-	-	$0
NEWPORT NEWS, VA	Y	Y	Isle of Wight County	VA	Tourism and Recreation	39	618	$7,891,599
TACOMA, WA	Y	Y	King County	WA	Offshore Mineral Extraction	26	61	$3,311,968
TACOMA, WA	Y	Y	King County	WA	Living Resources	179	939	$98,995,897
TACOMA, WA	Y	Y	King County	WA	Marine Transportation	204	8,055	$564,129,331
TACOMA, WA	Y	Y	King County	WA	Tourism and Recreation	1,735	27,773	$656,524,441
ANCHORAGE, AK	Y	Y	Matanuska-Susitna County	AK	Tourism and Recreation	138	1,486	$23,710,137
VANCOUVER, WA	Y	Y	Multnomah County	OR	Living Resources	8	41	$1,114,404
VANCOUVER, WA	Y	Y	Multnomah County	OR	Marine Transportation	97	2,622	$134,707,959
VANCOUVER, WA	Y	Y	Multnomah County	OR	Tourism and Recreation	574	8,315	$145,975,957
NEW YORK, NY	Y	Y	New York County	NY	Offshore Mineral Extraction	5	13	$2,337,953
NEW YORK, NY	Y	Y	New York County	NY	Living Resources	61	338	$10,367,931
NEW YORK, NY	Y	Y	New York County	NY	Marine Transportation	44	655	$49,385,133
NEW YORK, NY	Y	Y	New York County	NY	Tourism and Recreation	7,544	158,348	$5,319,933,701
LOS ANGELES, CA	Y	Y	Orange County	CA	Living Resources	15	41	$678,193
LOS ANGELES, CA	Y	Y	Orange County	CA	Offshore Mineral Extraction	39	232	$17,720,639
LOS ANGELES, CA	Y	Y	Orange County	CA	Marine Transportation	141	10,657	$896,382,162
LOS ANGELES, CA	Y	Y	Orange County	CA	Tourism and Recreation	1,670	37,244	$823,030,870
NEW ORLEANS, LA	Y	Y	Orleans Parish	LA	Living Resources	21	67	$1,012,760
NEW ORLEANS, LA	Y	Y	Orleans Parish	LA	Marine	52		$99,520,141

					Transportation		1,725	
NEW ORLEANS, LA	Y	Y	Orleans Parish	LA	Tourism and Recreation	791	18,231	$411,103,926
NEW ORLEANS, LA	Y	Y	Orleans Parish	LA	Offshore Mineral Extraction	73	3,182	$435,030,045
ASTORIA, OR	Y	Y	Pacific County	WA	Offshore Mineral Extraction	-	-	$0
ASTORIA, OR	Y	Y	Pacific County	WA	Living Resources	74	359	$10,369,973
ASTORIA, OR	Y	Y	Pacific County	WA	Tourism and Recreation	112	728	$10,829,066
HOPEWELL, VA	Y	Y	Prince George County	VA	Living Resources	-	-	$0
HOPEWELL, VA	Y	Y	Prince George County	VA	Offshore Mineral Extraction	-	-	$0
HOPEWELL, VA	Y	Y	Prince George County	VA	Tourism and Recreation	-	-	$0
HOPEWELL, VA	Y	Y	Prince George County	VA	Marine Transportation	8	1,362	$50,027,660
ALEXANDRIA, VA	Y	Y	Prince George's County	MD	Tourism and Recreation	-	-	$0
ALEXANDRIA, VA	Y	Y	Prince George's County	MD	Living Resources	15	55	$1,028,791
ALEXANDRIA, VA	Y	Y	Prince George's County	MD	Marine Transportation	59	2,651	$177,158,314
NEW YORK, NY	Y	Y	Queens County	NY	Living Resources	61	159	$2,944,513
NEW YORK, NY	Y	Y	Queens County	NY	Offshore Mineral Extraction	7	87	$4,808,536
NEW YORK, NY	Y	Y	Queens County	NY	Marine Transportation	61	1,929	$64,993,783
NEW YORK, NY	Y	Y	Queens County	NY	Tourism and Recreation	867	6,414	$112,070,244
NEW YORK, NY	Y	Y	Richmond County	NY	Offshore Mineral Extraction	-	-	$0
NEW YORK, NY	Y	Y	Richmond County	NY	Living Resources	9	14	$403,810
NEW YORK, NY	Y	Y	Richmond County	NY	Marine Transportation	23	373	$25,654,482

NEW YORK, NY	Y	Y	Richmond County	NY	Tourism and Recreation	670	6,639	$109,356,538
WILMINGTON, DE	Y	Y	Salem County	NJ	Offshore Mineral Extraction	-	-	$0
WILMINGTON, DE	Y	Y	Salem County	NJ	Tourism and Recreation	67	922	$12,410,883
CORPUS CHRISTI, TX	Y	Y	San Patricio County	TX	Living Resources	-	-	$0
CORPUS CHRISTI, TX	Y	Y	San Patricio County	TX	Tourism and Recreation	84	1,342	$17,054,433
CORPUS CHRISTI, TX	Y	Y	San Patricio County	TX	Offshore Mineral Extraction	37	401	$24,354,567
			TOTAL			**19,438**	**361,496**	**$11,833,527,096**
			TOTAL PORTS WITH PORTS®			**48,800**	**925,986**	**$39,342,869,133**

APPENDIX B

LIST OF U.S. PORTS WITHOUT PORTS®

WITH ASSOCIATED ENOW

SOCIOECONOMIC ACTIVITY DATA

(2010)

PORT LOCATION	HAS PORTS® ?	N = IN COUNTY; Y = ADJACENT COUNTY	COUNTY NAME	STATE	SOCIOECONOMIC SECTOR	ESTABLISMENTS	JOBS	WAGES
PORTS WITHOUT PORTS® (IN COUNTY)								
ALBANY, NY	N	N	Albany County	NY	Tourism and Recreation	-	-	$0
ALBANY, NY	N	N	Albany County	NY	Marine Transportation	26	255	$11,717,356
DUTCH HARBOR, AK	N	N	Aleutians West County	AK	Tourism and Recreation	7	10	$208,757
DUTCH HARBOR, AK	N	N	Aleutians West County	AK	Living Resources	15	2,084	$70,613,521
ALPENA, MI	N	N	Alpena County	MI	Living Resources	-	-	$0
ALPENA, MI	N	N	Alpena County	MI	Tourism and Recreation	56	407	$4,583,599
CONNEAUT, OH	N	N	Ashtabula County	OH	Living Resources	-	-	$0
CONNEAUT, OH	N	N	Ashtabula County	OH	Marine Transportation	6	182	$6,707,806
CONNEAUT, OH	N	N	Ashtabula County	OH	Tourism and Recreation	126	1,883	$22,193,036
ST JOSEPH, MI	N	N	Berrien County	MI	Living Resources	-	-	$0
ST JOSEPH, MI	N	N	Berrien County	MI	Marine Transportation	7	58	$2,166,857
ST JOSEPH, MI	N	N	Berrien County	MI	Tourism and Recreation	197	2,580	$34,597,972
FREEPORT, TX	N	N	Brazoria County	TX	Tourism and Recreation	55	489	$6,783,017
FREEPORT, TX	N	N	Brazoria County	TX	Offshore Mineral Extraction	52	590	$37,700,415
PORT CANAVERAL, FL	N	N	Brevard County	FL	Offshore Mineral Extraction	8	4	$167,299
PORT CANAVERAL, FL	N	N	Brevard County	FL	Living Resources	11		$256,956

							10	
PORT CANAVERAL, FL	N	N	Brevard County	FL	Marine Transportation	46	120	$4,679,485
PORT CANAVERAL, FL	N	N	Brevard County	FL	Tourism and Recreation	1,048	15,379	$248,564,995
PORT EVERGLADES, FL	N	N	Broward County	FL	Offshore Mineral Extraction	19	54	$2,026,333
PORT EVERGLADES, FL	N	N	Broward County	FL	Living Resources	30	63	$2,923,157
PORT EVERGLADES, FL	N	N	Broward County	FL	Marine Transportation	222	4,263	$177,437,445
PORT EVERGLADES, FL	N	N	Broward County	FL	Tourism and Recreation	1,817	29,123	$670,370,098
GREEN BAY, WI	N	N	Brown County	WI	Living Resources	-	-	$0
GREEN BAY, WI	N	N	Brown County	WI	Marine Transportation	17	538	$21,066,916
GREEN BAY, WI	N	N	Brown County	WI	Tourism and Recreation	242	4,550	$55,316,191
MATAGORDA, TX	N	N	Calhoun County	TX	Tourism and Recreation	54	273	$3,228,944
CAMDEN-GLOUCESTER, NJ	N	N	Camden County	NJ	Living Resources	6	15	$374,146
KINGS BAY, GA	N	N	Camden County	GA	Tourism and Recreation	53	555	$6,726,347
CAMDEN-GLOUCESTER, NJ	N	N	Camden County	NJ	Tourism and Recreation	124	1,678	$21,928,707
CAMDEN-GLOUCESTER, NJ	N	N	Camden County	NJ	Marine Transportation	58	993	$46,596,079
BROWNSVILLE, TX	N	N	Cameron County	TX	Living Resources	47	21	$424,252
BROWNSVILLE, TX	N	N	Cameron County	TX	Marine Transportation	47	461	$15,657,111
BROWNSVILLE, TX	N	N	Cameron County	TX	Tourism and Recreation	227	4,255	$61,671,315
MOREHEAD CITY, NC	N	N	Carteret County	NC	Living Resources	13	22	$580,835
MOREHEAD CITY, NC	N	N	Carteret County	NC	Tourism and Recreation	269	3,067	$45,439,177

CHARLEVOIX, MI	N	N	Charlevoix County	MI	Tourism and Recreation	39	389	$7,376,278
SAVANNAH, GA	N	N	Chatham County	GA	Living Resources	13	57	$1,036,383
SAVANNAH, GA	N	N	Chatham County	GA	Tourism and Recreation	381	6,546	$103,274,482
SAVANNAH, GA	N	N	Chatham County	GA	Marine Transportation	77	4,270	$152,627,245
PORT ANGELES, WA	N	N	Clallam County	WA	Marine Transportation	6	63	$4,312,797
PORT ANGELES, WA	N	N	Clallam County	WA	Tourism and Recreation	237	2,287	$39,892,243
TACONITE, MN	N	N	Cook County	MN	Offshore Mineral Extraction	-	-	$0
TACONITE, MN	N	N	Cook County	MN	Marine Transportation	-	-	$0
CHICAGO HARBOR, IL	N	N	Cook County	IL	Living Resources	40	424	$13,257,563
CHICAGO HARBOR, IL	N	N	Cook County	IL	Offshore Mineral Extraction	28	297	$22,037,658
CHICAGO HARBOR, IL	N	N	Cook County	IL	Marine Transportation	208	14,411	$599,253,802
CHICAGO HARBOR, IL	N	N	Cook County	IL	Tourism and Recreation	1,769	55,576	$1,429,897,799
COOS BAY, OR	N	N	Coos County	OR	Living Resources	27	48	$1,832,471
COOS BAY, OR	N	N	Coos County	OR	Marine Transportation	8	36	$1,662,569
COOS BAY, OR	N	N	Coos County	OR	Tourism and Recreation	196	2,172	$38,603,758
PORTLAND, ME	N	N	Cumberland County	ME	Living Resources	72	115	$2,697,262
PORTLAND, ME	N	N	Cumberland County	ME	Marine Transportation	37	2,338	$82,944,925
PORTLAND, ME	N	N	Cumberland County	ME	Tourism and Recreation	723	12,161	$214,415,562
CLEVELAND, OH	N	N	Cuyahoga County	OH	Living Resources	8	27	$560,985
CLEVELAND, OH	N	N	Cuyahoga County	OH	Marine	77		$121,746,765

					Transportation		2,912	
CLEVELAND, OH	N	N	Cuyahoga County	OH	Tourism and Recreation	576	10,071	$177,585,457
ESCANABA, MI	N	N	Delta County	MI	Tourism and Recreation	86	795	$9,037,280
STURGEON BAY, WI	N	N	Door County	WI	Tourism and Recreation	232	2,429	$36,646,612
SANDUSKY, OH	N	N	Erie County	OH	Offshore Mineral Extraction	-	-	$0
BUFFALO, NY	N	N	Erie County	NY	Offshore Mineral Extraction	19	36	$1,886,403
SANDUSKY, OH	N	N	Erie County	OH	Marine Transportation	7	27	$1,521,581
ERIE, PA	N	N	Erie County	PA	Offshore Mineral Extraction	18	72	$4,269,497
BUFFALO, NY	N	N	Erie County	NY	Marine Transportation	56	616	$24,245,977
ERIE, PA	N	N	Erie County	PA	Tourism and Recreation	166	2,378	$28,843,098
SANDUSKY, OH	N	N	Erie County	OH	Tourism and Recreation	230	5,359	$77,192,107
BUFFALO, NY	N	N	Erie County	NY	Tourism and Recreation	608	11,084	$157,245,855
PENSACOLA, FL	N	N	Escambia County	FL	Living Resources	7	124	$2,131,932
PENSACOLA, FL	N	N	Escambia County	FL	Offshore Mineral Extraction	10	46	$1,385,608
PENSACOLA, FL	N	N	Escambia County	FL	Marine Transportation	15	271	$6,882,047
PENSACOLA, FL	N	N	Escambia County	FL	Tourism and Recreation	621	10,539	$155,277,191
SALEM, MA	N	N	Essex County	MA	Offshore Mineral Extraction	7	41	$2,329,628
SALEM, MA	N	N	Essex County	MA	Living Resources	122	1,178	$64,874,511
SALEM, MA	N	N	Essex County	MA	Tourism and Recreation	729	10,232	$181,703,669
STAMFORD, CT	N	N	Fairfield County	CT	Offshore Mineral Extraction	11	5	$2,722,091

STAMFORD, CT	N	N	Fairfield County	CT	Living Resources	26	100	$3,281,934
STAMFORD, CT	N	N	Fairfield County	CT	Marine Transportation	57	945	$77,407,697
STAMFORD, CT	N	N	Fairfield County	CT	Tourism and Recreation	1,017	12,506	$310,155,482
GEORGETOWN, SC	N	N	Georgetown County	SC	Living Resources	7	45	$1,191,129
GEORGETOWN, SC	N	N	Georgetown County	SC	Tourism and Recreation	180	2,984	$48,542,609
BRUNSWICK, GA	N	N	Glynn County	GA	Tourism and Recreation	295	5,866	$114,626,063
GRAYS HARBOR, WA	N	N	Grays Harbor County	WA	Living Resources	71	652	$16,498,902
GRAYS HARBOR, WA	N	N	Grays Harbor County	WA	Tourism and Recreation	173	1,515	$22,179,913
GULFPORT, MS	N	N	Harrison County	MS	Living Resources	16	321	$7,889,691
GULFPORT, MS	N	N	Harrison County	MS	Marine Transportation	25	388	$16,646,624
GULFPORT, MS	N	N	Harrison County	MS	Tourism and Recreation	416	7,451	$106,490,973
KAWAIHAE, HI	N	N	Hawaii County	HI	Living Resources	17	71	$3,304,227
KAWAIHAE, HI	N	N	Hawaii County	HI	Tourism and Recreation	539	10,725	$302,498,140
TAMPA BAY, FL	N	N	Hillsborough County	FL	Offshore Mineral Extraction	17	37	$1,115,337
TAMPA BAY, FL	N	N	Hillsborough County	FL	Living Resources	31	46	$1,012,065
TAMPA BAY, FL	N	N	Hillsborough County	FL	Marine Transportation	85	1,687	$71,992,241
TAMPA BAY, FL	N	N	Hillsborough County	FL	Tourism and Recreation	1,144	18,746	$397,892,288
HONOLULU, HI	N	N	Honolulu County	HI	Living Resources	111	501	$14,145,998
HONOLULU, HI	N	N	Honolulu County	HI	Marine Transportation	67	1,956	$143,263,385
HONOLULU, HI	N	N	Honolulu County	HI	Tourism and	2,203		$724,690,859

					Recreation		39,615	
OAK HARBOR, WA	N	N	Island County	WA	Tourism and Recreation	160	1,663	$24,292,718
JUNEAU, AK	N	N	Juneau County	AK	Living Resources	7	125	$3,734,003
JUNEAU, AK	N	N	Juneau County	AK	Tourism and Recreation	101	853	$17,776,874
NAWILIWILI KAUAI, HI	N	N	Kauai County	HI	Offshore Mineral Extraction	-	-	$0
NAWILIWILI KAUAI, HI	N	N	Kauai County	HI	Tourism and Recreation	288	3,461	$62,006,233
KETCHIKAN, AK	N	N	Ketchikan Gateway County	AK	Tourism and Recreation	73	311	$5,507,846
MANCHESTER, WA	N	N	Kitsap County	WA	Tourism and Recreation	493	6,362	$102,730,571
KODIAK, AK	N	N	Kodiak Island County	AK	Offshore Mineral Extraction	-	-	$0
KODIAK, AK	N	N	Kodiak Island County	AK	Tourism and Recreation	36	443	$7,138,311
FAIRPORT HARBOR, OH	N	N	Lake County	OH	Living Resources	-	-	$0
INDIANA HARBOR, IN	N	N	Lake County	IN	Living Resources	-	-	$0
TWO HARBORS, MN	N	N	Lake County	MN	Offshore Mineral Extraction	-	-	$0
TWO HARBORS, MN	N	N	Lake County	MN	Marine Transportation	-	-	$0
INDIANA HARBOR, IN	N	N	Lake County	IN	Offshore Mineral Extraction	4	20	$1,393,052
FAIRPORT HARBOR, OH	N	N	Lake County	OH	Marine Transportation	8	90	$4,932,420
INDIANA HARBOR, IN	N	N	Lake County	IN	Marine Transportation	19	273	$10,270,568
INDIANA HARBOR, IN	N	N	Lake County	IN	Tourism and Recreation	125	1,342	$17,721,397
WAUKEGAN, IL	N	N	Lake County	IL	Marine Transportation	18	914	$53,704,599
FAIRPORT HARBOR, OH	N	N	Lake County	OH	Tourism and Recreation	400	7,608	$100,393,496

WAUKEGAN, IL	N	N	Lake County	IL	Tourism and Recreation	289	5,975	$142,575,839
LORAIN, OH	N	N	Lorain County	OH	Marine Transportation	8	27	$904,991
LORAIN, OH	N	N	Lorain County	OH	Tourism and Recreation	115	1,623	$20,397,709
TOLEDO, OH	N	N	Lucas County	OH	Marine Transportation	33	467	$20,551,669
TOLEDO, OH	N	N	Lucas County	OH	Tourism and Recreation	234	4,478	$59,983,412
PORT INLAND, MI	N	N	Mackinac County	MI	Tourism and Recreation	108	1,138	$26,272,402
MANISTEE, MI	N	N	Manistee County	MI	Marine Transportation	-	-	$0
MANISTEE, MI	N	N	Manistee County	MI	Tourism and Recreation	55	451	$5,007,136
MARQUETTE, MI	N	N	Marquette County	MI	Tourism and Recreation	117	2,054	$24,505,012
KAHULUI MAUI, HI	N	N	Maui County	HI	Tourism and Recreation	590	18,453	$602,025,331
MIAMI, FL	N	N	Miami-Dade County	FL	Offshore Mineral Extraction	31	45	$2,749,089
MIAMI, FL	N	N	Miami-Dade County	FL	Living Resources	56	158	$8,263,439
MIAMI, FL	N	N	Miami-Dade County	FL	Marine Transportation	245	9,494	$522,769,974
MIAMI, FL	N	N	Miami-Dade County	FL	Tourism and Recreation	2,531	50,152	$1,262,243,574
MILWAUKEE, WI	N	N	Milwaukee County	WI	Living Resources	4	27	$404,296
MILWAUKEE, WI	N	N	Milwaukee County	WI	Marine Transportation	43	1,069	$38,071,828
MILWAUKEE, WI	N	N	Milwaukee County	WI	Tourism and Recreation	502	10,512	$157,603,210
MOBILE, AL	N	N	Mobile County	AL	Living Resources	49	628	$12,668,286
MOBILE, AL	N	N	Mobile County	AL	Tourism and Recreation	330	6,127	$89,732,389

MOBILE, AL	N	N	Mobile County	AL	Marine Transportation	75	2,145	$103,316,728
MOBILE, AL	N	N	Mobile County	AL	Offshore Mineral Extraction	25	333	$37,066,653
KEY WEST, FL	N	N	Monroe County	FL	Marine Transportation	23	20	$1,283,813
KEY WEST, FL	N	N	Monroe County	FL	Living Resources	31	112	$3,511,152
MONROE, MI	N	N	Monroe County	MI	Marine Transportation	12	720	$25,177,828
MONROE, MI	N	N	Monroe County	MI	Tourism and Recreation	131	1,770	$29,424,692
KEY WEST, FL	N	N	Monroe County	FL	Tourism and Recreation	724	10,688	$277,657,295
MUSKEGON, MI	N	N	Muskegon County	MI	Marine Transportation	10	353	$18,161,691
MUSKEGON, MI	N	N	Muskegon County	MI	Tourism and Recreation	133	2,232	$27,610,070
FERNANDINA BEACH, FL	N	N	Nassau County	FL	Offshore Mineral Extraction	-	-	$0
HEMPSTEAD, NY	N	N	Nassau County	NY	Offshore Mineral Extraction	9	12	$467,319
HEMPSTEAD, NY	N	N	Nassau County	NY	Living Resources	36	111	$2,499,455
HEMPSTEAD, NY	N	N	Nassau County	NY	Marine Transportation	54	644	$31,965,455
FERNANDINA BEACH, FL	N	N	Nassau County	FL	Tourism and Recreation	140	3,162	$69,943,928
HEMPSTEAD, NY	N	N	Nassau County	NY	Tourism and Recreation	1,090	12,089	$240,304,666
WILMINGTON, NC	N	N	New Hanover County	NC	Offshore Mineral Extraction	4	30	$1,486,261
WILMINGTON, NC	N	N	New Hanover County	NC	Marine Transportation	26	104	$3,687,112
WILMINGTON, NC	N	N	New Hanover County	NC	Tourism and Recreation	474	9,457	$133,871,039
NORFOLK, VA	N	N	Norfolk city	VA	Offshore Mineral Extraction	-	-	$0

NORFOLK, VA	N	N	Norfolk city	VA	Living Resources	8	24	$633,138
NORFOLK, VA	N	N	Norfolk city	VA	Marine Transportation	51	884	$45,678,790
NORFOLK, VA	N	N	Norfolk city	VA	Tourism and Recreation	478	8,800	$133,486,487
KIVILINA, AK	N	N	Northwest Arctic County	AK	Living Resources	-	-	$0
KIVILINA, AK	N	N	Northwest Arctic County	AK	Offshore Mineral Extraction	-	-	$0
OSWEGO, NY	N	N	Oswego County	NY	Marine Transportation	4	26	$1,053,173
OSWEGO, NY	N	N	Oswego County	NY	Tourism and Recreation	139	1,372	$15,908,975
HOLLAND, MI	N	N	Ottawa County	MI	Offshore Mineral Extraction	11	27	$1,430,015
HOLLAND, MI	N	N	Ottawa County	MI	Tourism and Recreation	132	2,181	$28,669,510
PALM BEACH, FL	N	N	Palm Beach County	FL	Living Resources	19	73	$2,459,422
PALM BEACH, FL	N	N	Palm Beach County	FL	Offshore Mineral Extraction	22	106	$4,955,211
PALM BEACH, FL	N	N	Palm Beach County	FL	Marine Transportation	84	1,055	$41,408,745
PALM BEACH, FL	N	N	Palm Beach County	FL	Tourism and Recreation	1,547	29,151	$673,810,912
BURNS WATERWAY HARBOR, IN	N	N	Porter County	IN	Living Resources	-	-	$0
BURNS WATERWAY HARBOR, IN	N	N	Porter County	IN	Marine Transportation	14	376	$13,224,382
BURNS WATERWAY HARBOR, IN	N	N	Porter County	IN	Tourism and Recreation	134	2,631	$31,497,365
PRESQUE ISLE/STONEPORT, MI	N	N	Presque Isle County	MI	Tourism and Recreation	23	170	$1,941,487
PROVIDENCE, RI	N	N	Providence County	RI	Living Resources	10	26	$604,692
PROVIDENCE, RI	N	N	Providence County	RI	Marine Transportation	17	44	$1,763,498
PROVIDENCE, RI	N	N	Providence County	RI	Tourism and	775		$211,134,251

					Recreation		12,181	
RICHMOND, VA	N	N	Richmond city	VA	Tourism and Recreation	-	-	$0
RICHMOND, VA	N	N	Richmond city	VA	Marine Transportation	23	185	$9,086,745
PORTSMOUTH, NH	N	N	Rockingham County	NH	Offshore Mineral Extraction	11	29	$1,244,618
PORTSMOUTH, NH	N	N	Rockingham County	NH	Marine Transportation	20	868	$35,931,962
PORTSMOUTH, NH	N	N	Rockingham County	NH	Tourism and Recreation	436	6,351	$112,896,211
SACRAMENTO, CA	N	N	Sacramento County	CA	Tourism and Recreation	-	-	$0
SACRAMENTO, CA	N	N	Sacramento County	CA	Living Resources	4	28	$1,911,009
SACRAMENTO, CA	N	N	Sacramento County	CA	Marine Transportation	54	2,026	$91,774,726
SAN DIEGO, CA	N	N	San Diego County	CA	Living Resources	38	74	$1,666,875
SAN DIEGO, CA	N	N	San Diego County	CA	Offshore Mineral Extraction	33	431	$24,898,524
SAN DIEGO, CA	N	N	San Diego County	CA	Marine Transportation	134	7,600	$664,635,366
SAN DIEGO, CA	N	N	San Diego County	CA	Tourism and Recreation	3,133	76,810	$1,733,896,092
STOCKTON, CA	N	N	San Joaquin County	CA	Tourism and Recreation	-	-	$0
STOCKTON, CA	N	N	San Joaquin County	CA	Offshore Mineral Extraction	12	75	$5,370,493
STOCKTON, CA	N	N	San Joaquin County	CA	Marine Transportation	83	4,488	$218,375,465
EVERETT, WA	N	N	Snohomish County	WA	Marine Transportation	26	247	$9,758,757
EVERETT, WA	N	N	Snohomish County	WA	Living Resources	35	174	$12,554,694
EVERETT, WA	N	N	Snohomish County	WA	Offshore Mineral Extraction	12	242	$14,390,259
EVERETT, WA	N	N	Snohomish County	WA	Tourism and Recreation	560	6,577	$110,107,399

ST CLAIR, MI	N	N	St. Clair County	MI	Tourism and Recreation	196	2,684	$32,722,401
SOUTH LOUISIANA, LA	N	N	St. John the Baptist Parish	LA	Tourism and Recreation	-	-	$0
SOUTH LOUISIANA, LA	N	N	St. John the Baptist Parish	LA	Marine Transportation	15	181	$8,360,032
DULUTH-SUPERIOR, MN	N	N	St. Louis County	MN	Offshore Mineral Extraction	6	8	$400,195
DULUTH-SUPERIOR, MN	N	N	St. Louis County	MN	Tourism and Recreation	247	5,440	$70,644,202
PORT JEFFERSON HARBOR, NY	N	N	Suffolk County	NY	Offshore Mineral Extraction	25	34	$1,562,616
BOSTON, MA	N	N	Suffolk County	MA	Marine Transportation	39	95	$6,922,718
PORT JEFFERSON HARBOR, NY	N	N	Suffolk County	NY	Living Resources	81	257	$7,371,402
BOSTON, MA	N	N	Suffolk County	MA	Living Resources	34	420	$18,263,507
PORT JEFFERSON HARBOR, NY	N	N	Suffolk County	NY	Marine Transportation	82	3,354	$283,949,990
BOSTON, MA	N	N	Suffolk County	MA	Tourism and Recreation	679	14,775	$384,070,508
PORT JEFFERSON HARBOR, NY	N	N	Suffolk County	NY	Tourism and Recreation	1,860	20,811	$420,775,535
OLYMPIA, WA	N	N	Thurston County	WA	Tourism and Recreation	-	-	$0
OLYMPIA, WA	N	N	Thurston County	WA	Marine Transportation	7	316	$13,515,984
VALDEZ, AK	N	N	Valdez-Cordova County	AK	Tourism and Recreation	61	331	$6,608,744
VENTURA HARBOR, CA	N	N	Ventura County	CA	Living Resources	12	21	$585,924
VENTURA HARBOR, CA	N	N	Ventura County	CA	Marine Transportation	51	749	$48,096,780
VENTURA HARBOR, CA	N	N	Ventura County	CA	Offshore Mineral Extraction	46	800	$71,945,204
VENTURA HARBOR, CA	N	N	Ventura County	CA	Tourism and Recreation	677	12,128	$230,574,575
INTERCOASAL CITY, LA	N	N	Vermilion Parish	LA	Tourism and	54		$7,426,592

					Recreation		600	
INTERCOASAL CITY, LA	N	N	Vermilion Parish	LA	Living Resources	15	305	$16,055,610
INTERCOASAL CITY, LA	N	N	Vermilion Parish	LA	Offshore Mineral Extraction	42	577	$56,393,552
VICTORIA, TX	N	N	Victoria County	TX	Marine Transportation	5	43	$1,245,221
PANAMA CITY, FL	N	N	Wakulla County	FL	Offshore Mineral Extraction	-	-	$0
PANAMA CITY, FL	N	N	Wakulla County	FL	Tourism and Recreation	45	477	$5,202,459
SEARSPORT, ME	N	N	Waldo County	ME	Tourism and Recreation	84	798	$13,651,690
DETROIT, MI	N	N	Wayne County	MI	Living Resources	18	48	$651,334
DETROIT, MI	N	N	Wayne County	MI	Marine Transportation	74	2,648	$139,726,035
DETROIT, MI	N	N	Wayne County	MI	Tourism and Recreation	425	8,414	$125,509,822
			TOTAL			**41,899**	**761,542**	**$18,386,903,483**

PORT LOCATION	HAS PORTS® ?	N = IN COUNTY; Y = ADJACENT COUNTY	COUNTY NAME	STATE	SOCIOECONOMIC SECTOR	ESTABLISMENTS	JOBS	WAGES
PORTS WITHOUT PORTS® (ADJACENT COUNTIES)								
MOBILE, AL	N	Y	Baldwin County	AL	Offshore Mineral Extraction	7	3	$127,866
MOBILE, AL	N	Y	Baldwin County	AL	Living Resources	15	49	$823,017
MOBILE, AL	N	Y	Baldwin County	AL	Marine Transportation	14	86	$4,422,931
MOBILE, AL	N	Y	Baldwin County	AL	Tourism and Recreation	454	7,528	$116,723,799
PROVIDENCE, RI	N	Y	Bristol County	RI	Offshore Mineral Extraction	-	-	$0
PROVIDENCE, RI	N	Y	Bristol County	RI	Living Resources	8	5	$93,850
PROVIDENCE, RI	N	Y	Bristol County	RI	Tourism and Recreation	122	1,543	$25,548,756
PROVIDENCE, RI	N	Y	Bristol County	MA	Marine Transportation	42	841	$40,174,036
PROVIDENCE, RI	N	Y	Bristol County	MA	Tourism and Recreation	192	2,714	$45,441,355
PROVIDENCE, RI	N	Y	Bristol County	MA	Living Resources	268	991	$91,525,478
WILMINGTON, NC	N	Y	Brunswick County	NC	Offshore Mineral Extraction	-	-	$0
WILMINGTON, NC	N	Y	Brunswick County	NC	Marine Transportation	6	27	$1,459,864
WILMINGTON, NC	N	Y	Brunswick County	NC	Living Resources	12	59	$825,765
WILMINGTON, NC	N	Y	Brunswick County	NC	Tourism and Recreation	209	2,442	$35,897,528
PORT ARTHUR, TX	N	Y	Cameron Parish	LA	Marine Transportation	4	46	$1,809,586
RICHMOND, VA	N	Y	Chesterfield County	VA	Tourism and	-		$0

					Recreation		-	
RICHMOND, VA	N	Y	Chesterfield County	VA	Marine Transportation	15	486	$17,499,196
PORT DOLOMITE, MI	N	Y	Chippewa County	MI	Tourism and Recreation	94	397	$5,173,186
DULUTH-SUPERIOR, MN	N	Y	Douglas County	WI	Offshore Mineral Extraction	-	-	$0
DULUTH-SUPERIOR, MN	N	Y	Douglas County	WI	Tourism and Recreation	86	1,347	$16,480,108
RICHMOND, VA	N	Y	Henrico County	VA	Tourism and Recreation	-	-	$0
SAVANNAH, GA	N	Y	Jasper County	SC	Marine Transportation	-	-	$0
SAVANNAH, GA	N	Y	Jasper County	SC	Tourism and Recreation	51	567	$7,380,094
PROVIDENCE, RI	N	Y	Kent County	RI	Tourism and Recreation	357	6,054	$100,379,256
BOSTON, MA	N	Y	Middlesex County	MA	Tourism and Recreation	-	-	$0
BOSTON, MA	N	Y	Middlesex County	MA	Living Resources	23	79	$2,161,764
BOSTON, MA	N	Y	Middlesex County	MA	Offshore Mineral Extraction	18	139	$7,346,495
BOSTON, MA	N	Y	Middlesex County	MA	Marine Transportation	64	6,128	$606,611,516
BOSTON, MA	N	Y	Norfolk County	MA	Living Resources	15	155	$4,719,819
BOSTON, MA	N	Y	Norfolk County	MA	Marine Transportation	30	932	$53,488,218
BOSTON, MA	N	Y	Norfolk County	MA	Tourism and Recreation	348	5,920	$117,708,783
TOLEDO, OH	N	Y	Ottawa County	OH	Tourism and Recreation	180	1,800	$34,731,525
NORFOLK, VA	N	Y	Portsmouth city	VA	Offshore Mineral Extraction	-	-	$0
NORFOLK, VA	N	Y	Portsmouth city	VA	Tourism and Recreation	158	2,590	$34,260,943
NORFOLK, VA	N	Y	Portsmouth city	VA	Marine Transportation	21	595	$44,237,586

ALBANY, NY	N	Y	Rensselaer County	NY	Tourism and Recreation	-	-	$0
ALBANY, NY	N	Y	Rensselaer County	NY	Offshore Mineral Extraction	8	114	$5,053,606
PENSACOLA, FL	N	Y	Santa Rosa County	FL	Offshore Mineral Extraction	9	13	$523,926
PENSACOLA, FL	N	Y	Santa Rosa County	FL	Tourism and Recreation	275	3,798	$52,402,612
PORT INLAND, MI	N	Y	Schoolcraft County	MI	Marine Transportation	-	-	$0
PORT INLAND, MI	N	Y	Schoolcraft County	MI	Tourism and Recreation	22	149	$1,603,987
SOUTH LOUISIANA, LA	N	Y	St. James Parish	LA	Tourism and Recreation	-	-	$0
SOUTH LOUISIANA, LA	N	Y	St. James Parish	LA	Marine Transportation	11	150	$8,633,340
TOLEDO, OH	N	Y	Wood County	OH	Living Resources	-	-	$0
TOLEDO, OH	N	Y	Wood County	OH	Tourism and Recreation	-	-	$0
TOLEDO, OH	N	Y	Wood County	OH	Marine Transportation	11	1,204	$42,448,840
SACRAMENTO, CA	N	Y	Yolo County	CA	Living Resources	-	-	$0
SACRAMENTO, CA	N	Y	Yolo County	CA	Tourism and Recreation	-	-	$0
SACRAMENTO, CA	N	Y	Yolo County	CA	Offshore Mineral Extraction	13	130	$7,213,040
SACRAMENTO, CA	N	Y	Yolo County	CA	Marine Transportation	27	2,093	$88,413,154
PORTSMOUTH, NH	N	Y	York County	ME	Living Resources	15	24	$784,893
PORTSMOUTH, NH	N	Y	York County	ME	Marine Transportation	7	320	$13,813,125
PORTSMOUTH, NH	N	Y	York County	ME	Tourism and Recreation	562	7,188	$131,667,095
PORTSMOUTH, NH	N	Y	York County	ME	Offshore Mineral Extraction	4	8	$315,825

					TOTAL	**3,777**	**58,714**	**$1,769,925,763**
					TOTAL PORTS WITHOUT PORTS®	**45,676**	**820,256**	**$20,156,829,246**

CHAPTER 11 – CONCLUSIONS

I. SUMMARY

Estimated annual direct benefits in 2010 dollars across the five areas investigated totaled $141 million from the existing ports with the Physical Oceanographic Real-Time System (PORTS®). If PORTS® were expanded to include the remaining 117 largest ports[1], an additional $54 million could be experienced per year. (Refer to Table 1.) If installed at all the top 175 ports total annual benefits from PORTS® could approach $195 million.

Secondary and tertiary economic benefits (e.g., employment and wages) from PORTS® were estimated in Table 2. These represent the levels of economic activity across four economic sectors which are believed to be supported and made more resilient owing to PORTS® data.

Employing these figures over the estimated ten-year economic life of PORTS®, the NPV from the current group of 58 PORTS® could approach $1,155 million while installation at the remaining 117 larger ports could add an additional $441 million for a total of $1,597 million. (Refer to Table 3)

REDUCTIONS IN COMMERCIAL ACCIDENT RATES IF PORTS® ARE PRESENT:

- **Mortality reduced 60 %** (0.00012 with versus 0.00030 per trip without PORTS®)
- **Morbidity reduced 45 %** (0.00121 with versus 0.00220 per trip without PORTS®)
- **Property damage reduced 37 %** (0.033 with versus 0.052 per trip without PORTS®)
- **Groundings were reduced 59 %** (0.011 with versus 0.027 per trip without PORTS®)
- **Overall allision, collision and grounding accident rates reduced 33 %** (0.030 with versus 0.045 without PORTS®)

[1] In terms of annual tonnage handled.

Table 1

SUMMARY OF ANNUAL BENEFITS FROM PORTS®
(IN MILLIONS OF 2010 DOLLARS)

BENEFIT TYPE	BENEFITS FROM 58 PORTS WITH PORTS®	POTENTIAL BENEFITS FROM 117 PORTS WITHOUT PORTS®	TOTAL CURRENT AND POTENTIAL BENEFITS FROM 175 PORTS WITH PORTS®	CONFIDENCE LEVEL OF ESTIMATION
Traffic (Use of smaller vessels to transport same traffic levels)	$119.6[2]	$40.7	$160.3	High
Oil Pollution Remediation	$3.5	$1.7	$5.2	Medium
Fish Catch:				
Commercial	$0.6	$1.2	$1.8	Low
Recreational	$0.1	$0.2	$0.3	Low
Commercial Marine (including cargo, ferry, excursion & cruise - Associated with allisions, collisions and groundings)				
Property Damages	$5.2	$2.5	$7.7	High
Morbidity and Mortality	$11.8	$7.3	$19.1	Medium
Recreational Boating (Associated with weather and groundings)				
Property Damages	LT 0.0[3]	LT 0.0[4]	LT 0.0[5]	High
Morbidity and Mortality	$0.2	0.2	0.4	Medium
Other Qualitative Benefits	Information only	Information Only	Information Only	
TOTAL	**$141.0**	**$53.8**	**$194.8**	

[2] Zero to four feet Depth Under Keel based on 74.6 percent of total tonnage under PORTS®

[3] Little more than $1,900 per year

[4] A little less than $2,900 per year

[5] Annual total of little more than $4,800

Table 2

ESTIMATED ANNUAL SOCIOECONOMIC BENEFITS FROM PORTS®
(IN MILLIONS OF 2010 DOLLARS)

BENEFIT TYPE	BENEFITS FROM 58 PORTS WITH PORTS®	POTENTIAL BENEFITS FROM 117 PORTS WITHOUT PORTS®	TOTAL CURRENT AND POTENTIAL BENEFITS FROM 175 PORTS WITH PORTS®	CONFIDENCE LEVEL OF ESTIMATION
Socioeconomic Benefits Secondary Supportive Benefits	725 – 900 establishments; 19,000 - 26,000 jobs; $1.0 to $1.5 billion in wages	650 – 800 establishments; 15,000 – 20,000 jobs; $0.6 to $0.8 billion in wages	1,400 – 1,700 establishments; 34,000 - 46,000 jobs; $1.6 - $2.4 billion in wages	Medium

Begun in 1991 in response to the need for real-time navigational data, PORTS® was developed under the auspices of the Center for Operational Oceanic Products and Services (CO-OPS) within the National Ocean Service (NOS) of the National Oceanic and Atmospheric Administration (NOAA). Systems are designed with the local users to meet their unique needs.

From the very first PORTS® users have reported anecdotal stories of benefits they have achieved through the use of their PORTS® data. Stories abound of the avoidance of ship groundings and allisions with bridges, the avoidance of hazardous weather conditions, as well as ships being able to carry an addition inch or two of cargo draft when the tide is running above prediction. Other uses of PORTS® have been told in these stories. PORTS® is a benefit to hazardous material spill remediation, commercial and recreational fishing, recreational boating safety, recreational surfing and SCUBA diving, government agencies, industrial operations, beach and wetland restoration activities, and academia. All of these reports and stories indicate ways in which users gain value from PORTS® information.

Table 3

SUMMARY OF TEN-YEAR NET PRESENT VALUE FROM PORTS®

(IN MILLIONS OF DOLLARS)

BENEFIT TYPE	BENEFITS FROM 58 PORTS WITH PORTS®	POTENTIAL BENEFITS FROM 117 PORTS WITHOUT PORTS®	TOTAL CURRENT AND POTENTIAL BENEFITS FROM 175 PORTS WITH PORTS®	CONFIDENCE LEVEL OF ESTIMATION
Traffic (Use of smaller vessels to transport same traffic levels)	$978.6[6]	$333.2	$1,311.9	High
Oil Pollution Remediation	$28.5	$13.8	$42.3	Medium
Fish Catch:				
Commercial	$5.0	$10.1	$15.1	Low
Recreational	$0.9	$1.6	$2.5	Low
Commercial Marine (including cargo, ferry, excursion & cruise - Associated with allisions, collisions and groundings)				
Property Damages	$43.8	$20.6	$64.4	High
Morbidity and Mortality	$96.5	$59.8	$156.3	Medium
Recreational Boating (Associated with weather and groundings)				
Property Damages	LT 0.0[7]	LT 0.0[8]	LT 0.0[9]	High
Morbidity and Mortality	$1.2	$1.9	$3.1	Medium
TOTAL	**$1,154.5**	**$441.0**	**$1,595.6**	

[6] Zero to four feet Depth Under Keel based on 74.6 percent of total tonnage under PORTS®

[7] Less than $16,000 over ten years

[8] About $24,000 over ten years

[9] Less than $40,000 over ten years

From this information a logic model was developed and formalized which identified specific outputs received by varying user groups and detailed how PORTS® data was or could be put to use based on physical measurements (e.g., tonnage transported, number of individuals killed or injured, etc.).

Overall, data that PORTS® can provide related to currents, salinity, channel depth, winds, atmospheric pressure, air and water temperatures, air gap (if appropriate) can be relied upon to enhance the: (1) economic efficiency of commercial marine transportation; (2) safety of commercial and recreational operations; and, (3) operations related to remediation of environmental pollution.

Based on the logic model, the monetary value of PORTS® was estimated through a denial-of-service approach which resulted from the assumption that the real-time data provided by PORTS® was unavailable. In addition in this valuation study, the cost of obtaining and employing PORTS® data was not assessed, as such, valuation levels should be thought of as gross rather than net benefits.[10] During this valuation, a variety of external data bases were employed which housed information related to marine traffic, accidents, morbidity, mortality and environmental (oil) pollution. In keeping the overall conservative stance of this report, only accidents related to allisions, collisions and groundings were investigated as was marine traffic which transited within four feet of the channel bottom.

From these databases which housed population (rather than samples of data), portions of activity were assigned to the instruments provided by PORTS®. In some cases, direct calculations could be undertaken as was the case in evaluating the vessel transits, morbidity and mortality levels, etc. In these cases, accident rates per transit could be constructed at locations

[10] Such costs would involve not only the cost borne by the ports and NOAA itself but also on end-users (e.g., recreational boaters) who would likely have to acquire the technology to receive and interpret PORTS® data.

with and without PORTS®.

Just as it would be disingenuous to overly estimate the value of the relationships, it would be equally incorrect to ignore them. When precise or exact quantifiable relationships may not be known, economists have resorted to acceptable educated estimates where a de minimis value or percent of total value is substituted. In these cases where the logic model depicted a causal relationship between PORTS® outputs and a level of activity (e.g., oil pollution remediation) a de minimis portion of the total potential benefit was assigned to PORTS®.

The next step involved converting physical units into monetary value or benefits. In this study a direct relationship between the producer and consumer of benefits is both theoretically detailed as are the volume or magnitude of those benefits which can be transformed from physical units to annualized monetary value (e.g., dollars, employment, etc.)

Recognizing the economic life of a PORTS® installation, annualized monetary benefits were calculated over a ten-year period using the cost of capital specified by the Office of Management and Budget.

II. ESTIMATING CONFIDENCE LEVELS

To assist the reader in comprehension of the impact on the value of PORTS® which the authors may have influenced though assignment of the levels of causal relationships, all estimated have a subjective level of confidence assigned to them based on the relationship between the number of “known values” versus the number of “estimated values”. The following provides a description of that subjective evaluative process. (Refer to Table 4)

Table 4

ESTIMATED CONFIDENCE IN PORTS® VALUATION ESTIMATES

DESCRIPTION OF POTENTIAL BENEFIT DATA	PORTION OF ACTIVITY UNDER POTENTIAL AUSPICES OF PORTS®	USE OF NORDHAUS DE MINIMUS RULE (e.g., 1.0 %, 0.1%, 0.001%)	SUBJECTIVE LEVEL OF CONFIDENCE IN ESTIMATION
Population data	Population date	Not Used	High
Population data	Cost Models[11]	Not Used	High
Population data	Population data with assumptions	Not Used	Medium
Population data	Mix of empirical portion and use of Nordhaus for remaining portion	Employed at levels between 1.0 and 0.1 percent and empirical population data	Medium
Population data	Estimated using Nordhaus Technique	Employed at levels between 1.0 and 0.1 percent	Medium
Subjective sample of data	Estimated using Nordhaus Technique	Employed at levels between 1.0 and 0.1 percent.	Low
Estimation of population data	Estimated using Nordhaus Technique	Employed at levels between 1.0 and 0.1 percent.	Low

For example, in developing estimates regarding the value of denial of service owing to prohibition of vessel transits less than two feet depth under keel, the USACE's CPT data base which represents a population count of total commercial marine transportation activity could be internally compared to related potentially constrained traffic from total traffic levels. In this instance, the estimated level of confidence in the benefits estimate was "high". Similarly, use of proprietary USACE marine traffic data along with their internal NOPEAS costing model resulted in the cost differentials which would have to be paid to transport materials currently carried in vessels which travelled within two feet of the channel's depth and lower draft ships with higher average costs per ton structures. This result would also be deemed of "high" confidence.

In cases where population data was known for the weight and value of fish caught within three miles of shore, the precise contribution of PORTS® to this result is not known. It was

[11] NOPEAS engineering marine transportation cost model….Explain what it is and how it is used by USACE.

estimated to be one percent of the total value. In this case, mixing a known total with a de minimis proportional estimation was thought to be of “medium” confidence. Medium in terms that the estimate was not overstated and as best as one can obtain given current data limitations.

Another example of an estimation with a medium level of confidence involves the concept of PORTS® influencing or sustaining benefits. The secondary benefits associated with on-shore ocean economic activity are a combination of known benefit totals (as measured through Gross State Product figures) and an estimated level of support provided through PORTS®. In this case, the proportion of actual marine commercial traffic travelling within two feet of the bottom was utilized along with de minimis levels of contribution provided to three other economic sectors. While the absence of PORTS® may not eliminate these benefits, the existence of PORTS® can logically be related to the potential for greater growth and resiliency.

In the case of recreational fishing, a number of assumptions had to be made involving the value of landed catch as well as the level of influence that PORTS® may have had on catch levels that occurred within three miles of shore. Here an estimated population value was multiplied by a de minimis portion (one percent) of total activity which was hypothetically attributed to PORTS®. In this case, the confidence in the final estimate was considered “low”.

In addition to these quantitative estimates of benefits associated with PORTS®, a large number of other beneficiaries were not investigated owing to time and resource limitations. Among these qualitative benefits are many resulting from anecdotal evidence as well as a myriad of additional groups and individuals at the Federal, state and local level. The United States armed forces, Federal Emergency Management Agency, U.S. Coast Guard, Environmental Protection Agency are just a few of the Federal programs, let alone similar programs at the state level, which benefit from PORTS® information.

Finally, it must be stressed restrictions, due to confidentiality concerns and use of de minimis figures at all instances of estimation in keeping with current academic thought and practice that the conclusions of this report are conservative.

III. RECOMMENDATIONS

A. Additional Study of the Economic Benefits of PORTS®

A number of groups for which there was anecdotal information that a benefit from the use of PORTS® data was being achieved were not examined as part of this study. This was due largely in part for lack of time to research all possible beneficiary groups and because of the lack of readily available data to determine the quantifiable benefit that had been derived. There are probably significant benefits that could be documented if NOAA desired to continue this investigation.

The economic benefits of air gap monitoring have not been adequately determined. This is due to the lack of information on which ships are constrained by bridge heights. The managers of the USACE restricted data tools CPT and NNOMPEAS recognize the desirability of measuring the impact of air draft on vessel movements and have proposed developing tools to do such an analysis. When complete in 12 to 18 months it would be good to complete that analysis and add the results to the benefits of PORTS®.

The USACE data analysis tool NNOMPEAS has the ability to determine which ships are tide constrained for their operations. By the time we discovered this capability there was not enough time remaining in the project to fully explore the tool. It may be that there is a benefit that could be added to the total PORTS® list of benefits. It is also possible that this benefit has been captured by the draft constrained analysis completed in Chapter 5 of this report.

1. Industrial benefits

There is anecdotal information that various industries located near the coast where a PORTS® exists to utilize this data to regulate their operations by shutting down when water levels reach dangerously high levels. Shutting down operations is expensive in terms of lost productivity and the expense of shutting down and restarting operations. Even more expensive would be failing to shut down operations until the facility is damaged by flooding waters. The optimal timing of a decision requires accurate and real-time information from PORTS® or a PORTS®-like system. Real-time PORTS data can provide a sizable benefit.

2. Government benefits

Government agencies (e.g., U.S. Army Corps of Engineers, U.S. Coast Guard, FEMA, U.S. Geological Survey, NOAA Weather Service, etc.) use PORTS® information now. The value of their use could be captured in an additional study.

3. Recreational benefits

Recreational users (e.g. surfing, kite boarding, SCUBA diving) also require additional study.

4. Restoration benefits

Federal, state and local entities could also benefit in their efforts to restore beach and wetlands.

5. Research benefits

Difficult to quantify, research performed by academics, practitioners and lay personnel can also benefit from timely, accurate and complete PORTS® data.

B. Improvement to PORTS® Operations

1. **Improve user awareness and user education**

This study has documented sizable benefits that users are able to realize as a result of utilizing PORTS® real-time environmental information. To maximize the benefit of PORTS® it is desirable to ensure potential users understand the uses and limitations of PORTS® data as soon as possible. Pilots seem to be early adopters of PORTS® information quickly learning to use it to avoid difficult and dangerous situations. Nearly as quickly they seem to learn to utilize the data to maximize the carriage of cargo. Other groups such as recreational boaters, surfers, and SCUBA are much slower to become aware that PORTS® data is available and how they could best use it to facilitate their operations. It would be to NOAA's benefit to ensure that all potential users are aware of the availability of PORTS® information and the potential benefits they could derive from its use.

NOAA could document best practices in the use of PORTS® data and share the results with users via the internet, printed materials, articles in trade publications, and through training seminars. NOAA could work with existing user organizations such as the Pilots, harbor safety committees, and U.S. Coast Guard to inform users about the uses of PORTS® data. Collaborating with Boat US, and the boating education courses taught by the U.S. Power Squadrons, and U.S. Coast Guard Auxiliary as well as state certified boating safety training courses could enable NOAA to quickly get the boating public to more effectively utilize the PORTS® information.

2. **Complete Implementation of PORTS® and Determine User Satisfaction**

The hallmark of a great system is one that provides information that is timely, accurate, complete, and reliable. PORTS® data is nearly real-time delayed only long enough to go through a thorough quality control process to ensure erroneous data is not disseminated. PORTS® is highly timely and accurate. NOAA should survey the customers from all major groups to determine if users are satisfied with the timeliness, accuracy, completeness and reliability of their PORTS®.

PORTS® is not yet complete in its deployment with 117 (as of 2010) of the top 175 ports yet to have access to PORTS® data. The systems are being installed as quickly as the users are allocating funding for the implementation and operations of a PORTS®. The single greatest additional benefit that could be derived from PORTS® would be for NOAA to complete the implementation of PORTS® in all of the 175 most important ports.

If NOAA expects users to change their operating practices to best utilize PORTS® information and gain the greatest benefit for the Nation, the system must be fully implemented in U.S. ports. All potential users must also be aware of the existence of the PORTS®, how to best utilize the information, and be satisfied that the data is meeting their requirements for timeliness, accuracy, completeness, and reliability.