IWR Institute for Water Resources

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Environmental Impact Mitigation Needs of Future Port and Waterway Modernization Activities in the United States

2014-R-04

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In preparation for the increasing size of container vessels and enlargement of the Panama Canal, Congress asked IWR for an assessment of port and waterway modernization needs, including environmental impact mitigation. A draft of this report provided a comprehensive reference for the environmental aspects of the Congressional report. We focused on major container ports in the United States and locks in the Mississippi and Illinois Rivers. Container ports were selected to represent needs and impacts in the major coastal regions. Past environmental impacts of ports and waterways were reviewed to establish context and help identify representative data indicating impact vulnerability and impact sources. Vulnerability indicators included data on public health and safety, environmental justice; parks and other preserves; threatened and endangered species; commercial fisheries value; sportfishing activity; and public beaches. Impact sources were indicated by the amount of additional dredging needed, the regional population growth served by the ports, and the difference between percent population growth and percent unused port capacity. A small geographical area of the conterminous United States has been directly affected by ports, waterways, and connecting transportation corridors, but the cumulative adverse impact on natural systems and wild species is particularly intense (e.g., covered by concrete). Off-site impacts of systems operations on air and water quality are often far reaching. Ports and waterways occur in and near ecosystems that are among the scarcest and most damaged in the United States. This study indicates that the costs of environmental impact mitigation are likely to be substantial almost anywhere within and across regions impacted by transportation system modernization, but ports in the Southeast appear to be most in need of modernization attention and are most likely to require significant environmental mitigation. Pacific coast ports follow in order of potential impacts. Unused port and waterway capacity allows for considerable increase in freight movement without stressing port limits in all regions and the numbers of larger vessels are likely to increase gradually. Transportation changes may also increase the demand for grain shipments on the Mississippi River and the possible need for lock expansion requiring some environmental impact mitigation. Adaptive management is a wise strategy to use in future federal modernization investment considerations given the uncertainties associated with future actions and mitigation costs. Trends in transportation system change should be monitored more regularly to better manage the uncertainty and risks of environmental impact.

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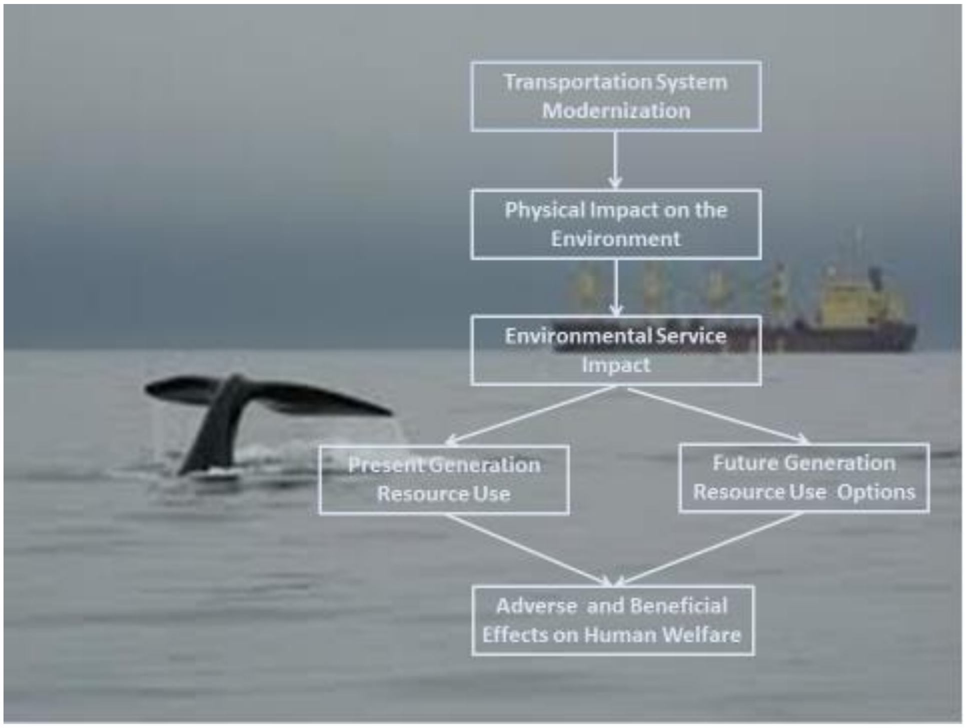

Richard A. Cole
Y. Jae Chung
Shawn B. Komlos

Institute for Water Resources,
U. S. Army Corps of Engineers

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Term Definitions

Adaptive management. Management that accommodates uncertainty by monitoring conditions and modifying management plans, as needed, as new information informs decisions.

Beneficial use of the environment. Any environmental use that improves human wellbeing

Container transport. Use of standard freight containers that can be efficiently stored, transported and transferred from one mode of freight transport to another.

Intermodal freight transport. Interlinked modes of freight transport, including ocean vessels, barges, railroads, and trucks.

Environmental Impact Statement. A report of anticipated environmental effects from alternative approaches to achieving federally financed or permitted project and program objectives, including an explanation, when appropriate, for why the approach with the least impact was not selected. The report is required by the National Environmental Policy Act.

Environmental impact mitigation. Avoidance, minimization, and repair of adverse environmental impact, when feasible, and compensatory replacement of unavoidably degraded environmental quality.

Environmental footprint. The cumulative effects of environmental impact.

Environmental Justice. Equitable protection of human health and safety from environmental degradation regardless of economic, cultural, minority, or other status.

Freight transfer hub. Ports designed to receive large ocean-going vessels and to transfer freight from them to smaller vessels.

Freight system modernization. Actions taken to maintain or increase the cost effectiveness of freight transportation.

Heritage preservation. Long-term maintenance of environmental qualities that provide diverse resource options for potential use by future generations.

Inland waterways. Rivers and coastal areas enhanced by locks and dams, dredging and other engineered improvements for barge transport of freight and other navigation use.

Panamax vessels. Oceanic vessels that can pass through the old locks in the Panama Canal. Panamax vessels are now able to call at all major coastal ports.

Post-panamax vessels. Large oceanic vessels that can pass through new Panama Canal locks. The new locks can pass vessels up to 40 % longer and 64 % wider with drafts up to 50 feet.

Unused port capacity. Surplus port space and processing capability available for receiving, storing, and transferring more freight between freight transport modes.

Executive Summary

Introduction

Since the 1970s, compliance with the National Environmental Policy Act (NEPA), Clean Water Act (CWA), Endangered Species Act (ESA) and other regulatory law has reduced the environmental impacts of many previous practices and contributed positively to a transformation in social attitudes toward the environment. Because of these commitments and positive attitudes, the adverse environmental impacts of proposed port and waterway modernization actions are likely to be mitigated, often at great expense. As a consequence, mitigation needs will play an important role in future port and waterway modernization decisions. Numerous recent studies address intermodal freight system modernization, but few address environmental concerns thoroughly.

In late 2011, Congress directed the Institute of Water Resources of the U. S. Army Corps of Engineers (USACE) to study the port and waterway modernization needs of the United States, including environmental impact and mitigation needs. The purpose of the analysis presented here is to provide a concise synthesis report on past and potential port and waterway environmental impacts and mitigation needs for Congressional study reference use and for the use of any interested person or organization.

The Transportation System

The American freight transportation system has continuously modernized to accommodate increased trade since colonial days. The most characteristic aspect of contemporary modernization is the transition of freight transport methods to standardized intermodal containers, which are more efficiently transferred among vessels, trains, and trucks. The sizes of container carriers have been steadily increasing —especially oceanic container vessels. The sizes of other classes of vessels have not changed as much as container vessels in recent decades so the need for new modernization investment is now focused largely on the ports, waterways, and intermodal rail and highway networks that support container-based freight transport.

Maritime trade with nations on the Pacific Rim has increased at the fastest rate. As a consequence, many port harbors on the Pacific Coast of North America are already capable of receiving the largest container vessels and transferring freight to rail or truck transport far into the U. S. interior. Expansion of the Panama Canal will allow “post-panamax” vessels larger than the capacity of the old canal to move more directly to the eastern United States from the Pacific Rim. Orders for new vessels indicate a gradual increase in the number of post-panamax vessels over the next two decades.

Because the cost per ton of freight shipped generally decreases with vessel size, much of the freight moved inland from Pacific Coast ports could shift to ports close to the Panama Canal on the East Coast. None of these ports are fully ready for the largest post-panamax vessels. Other freight transport scenarios are possible. Also, because of the potential for reduced shipping costs through the Panama Canal, waterway transport of grain and soybean export to Asia may increase in the Upper Mississippi and Illinois Rivers and Gulf ports. This prospect encourages investment in lock enlargement to pass large rafts of barges more efficiently. However, the efficiency of railroads and trucks is increasing and freight transfer hubs in the Caribbean may allow smaller feeder vessels to call at eastern ports. Past assessments differ over which scenario is most likely. These uncertainties, and the effects of other uncertain events (such as rates of sea level change), make precise forecasting of environmental impact and mitigation needs unrealistic. The approach taken here is to describe environmental impact and mitigation possibilities contingent on which scenario actually comes about at major container ports and locks in the upper Mississippi waterways.

Study Approach

A systems approach was used to conceptualize potential impact flows from port and waterway modernization sources through the environment to impacts on present and future public welfare. The environmental footprint of the intermodal transportation system was reviewed to identify possible sources of and vulnerabilities to future modernization impacts. The evaluation of future potential impacts relies on the use of indicators to characterize modernization impact sources and human health and resource vulnerabilities. We selected indicators based on our review of past impacts and data availability, reliability, comparability across sites nationally, and representativeness. In keeping with recent modernization emphases, we focused on major container ports in the United States and the one waterway most likely to be affected by international transportation changes. Both regional impact possibilities and variation among ports within coastal regions were evaluated. The five regions include Northeastern, Southeastern, Gulf, and Pacific Coasts and the Upper Mississippi-Illinois Rivers. We selected from four to seven ports in each of the coastal regions, based largely on present and potential container traffic, to evaluate potential environmental impact and mitigation needs. The waterway analysis concentrated on possible impacts from lock expansion on the upper Mississippi and Illinois Rivers in anticipation of increased barge traffic following lock expansion in the Panama Canal.

Eleven indicators were selected to represent three categories of vulnerability: health, safety and environmental justice; natural and cultural heritage; and economically valued use of resources. Three more indicators were selected to broadly represent potential impact sources. We selected the indicators based on availability, credibility, and national comparability of the indicator data as well as how well the vulnerabilities and impact sources were represented.

Health, safety, and environmental justice indicators include the number of days air quality did not meet health standards for vulnerable people within 10 km, the number of permits issued to release wastes into public waters within 10 km, the number of superfund sites within 10 km, and the percentages of nearby residents in low income and minority groups within 5 km. Heritage value in the port vicinity is represented by the geographical area (land & water area) of parks and other preserves within 10 km, wetland area within 10 km, and number of threatened and endangered species within the port county. Economic vulnerability is indicated by the value of state commercial fisheries divided by state shoreline length, the total reported days of state resident and nonresident salt water sportfishing divided by state shoreline length, and the geographical area of public beaches in the port vicinity. Adjusting for shoreline length indicates the accessibility to fishery resources through access points other than port areas. For comparability, the raw scores of indices were normalized within a range from 0 to 100 (assigned to the maximum raw score).

Selection of the potential impact indicators was based on a need to somehow characterize impacts from port and harbor expansion for larger vessels, port capacity expansion needed to accommodate increased freight movement, and increased operations based on freight movements. Relative impact from expansion for larger vessels is indicated by the length of the main channel into the port times the difference between existing depth and the 50-foot depth often targeted for large post-panamax vessels. Relative impact from port capacity expansion is indicated by the difference between the forecast percent growth in regional population served by ports over 30 years and the percent unused capacity at ports. Relative impact from increased freight transport operations, which is a function of population growth in the area most served by the port, is indicated by the total regional population growth forecast over 30 years. These also were normalized. We did not weight the importance of any of the vulnerability or impact-source indicators.

Environmental Footprint

The environmental footprint caused by cumulative environmental impact of the freight transportation system is significant. While a small geographical area of the conterminous United States has been directly affected, the cumulative adverse impact on natural systems and wild species has been particularly intense (e.g., covered by concrete). In addition, offsite impacts on air and water quality from systems operations have been far reaching, including costly invasive species transported via cargo and ballast water. Ports and waterways also occur in and near wetlands and rivers, which are among the scarcest and most damaged ecosystems in the United States. Past impact history has attracted the attention of those concerned about the cumulative impact of future modernization on vulnerable species, wetlands, and rivers. These impacts are described in this section.

The identified sources of past environmental effects indicate that future modernization impacts needing mitigation are most likely to come from expansion of harbor, port, waterway and intermodal infrastructure, and from increased levels of transportation system operations. If not fully mitigated, modernization could contribute to degraded air and water quality that threatens human health and safety, especially among low income and minority groups who tend to live nearest to ports. It could also contribute to loss of important natural and cultural heritage found in parks, refuges, wetlands and scarce species as well as to loss of recreational, commercial, and other economically important resources.

Past infrastructural and dredging improvements for navigation have had environmental impacts. Among infrastructural sources of impact, lock and dam impoundments have contributed substantially to the imperilment of numerous freshwater species by totally changing their river habitat. In general, dredging of uncontaminated river, lake, and estuary bottoms only temporarily affects biotic communities adversely since they typically colonize quickly following disturbance. In the past, about 10 % of bottom sediments were contaminated with toxic materials. Such sediments are now disposed of and treated in isolated containment areas. While many modifications have been made to avoid adverse impacts, dredging has had some persistent environmental effects, including some unavoidable, incidental take of imperiled species (mostly sea turtles and sturgeons) and some incidental damage to shallow-water estuarine ecosystems. Deepening coastal navigation channels also can increase the damages caused by saltwater intrusion into freshwater ecosystems, aquifers, and water supplies.

Some dredged material has been used beneficially for various purposes for many decades, thereby mitigating some of the impact. USACE was authorized to beneficially use dredged material for environmental improvement in 1992 and now uses about 20 to 30 % for habitat creation and other beneficial purposes.

With respect to operations, future emissions of potentially harmful materials into air and water, including greenhouse gasses, are a significant environmental concern. Since harbors typically concentrate transportation system operations in densely populated areas, they remain an important source of air quality degradation and inequitable impact on the low income and minority groups who tend to concentrate there. But greater reliance on oceanic shipment by large vessel and inland shipment by train and waterway is generally preferred over truck transport because trucks contribute much more than any other mode of transportation to atmospheric emissions. In response to environmental concerns, ports have made improvements to reduce emissions and are planning substantially more improvement.

Accidents may increase as freight transport operations increase. Human safety is particularly imperiled when systems operations are congested and stressed. Additionally, accidental collision of vessels with whales and other animals has been a significant mortality source, but recent limits on vessel speed may moderate the impact. Potential oil and other contaminants spills are associated with all transport modes and the local damages increase dramatically with carrier size.

Potential Environmental Impacts and Mitigation Needs

The study revealed the potential for greater environmental impact in the Southeast Atlantic Region and, to lesser extent, the Pacific Region, than the other regions. These regions are expected to see the greatest growth in freight transport development because of high regional population growth rate and less unused port capacity (which requires construction to increase capacity). The Southeast Atlantic Region requires the greatest amount of harbor expansion to receive the largest post-panamax vessels and has the greatest amount of wetland and preserve area vulnerable to impact. The Pacific ports are particularly vulnerable to increased impact on the health of low income groups and minorities, as well as significant economic loss from fisheries and recreation impacts. Assuming regional costs of mitigation actions are similar, the total cost of mitigation is likely to be greater at ports in the southeastern and Pacific regions than other ports in the United States.

The effects of Panama Canal expansion are uncertain, but have potential to redistribute some freight transport growth from Pacific ports to southeastern ports. That outcome would most likely increase impact at southeastern ports and moderate impact at Pacific ports. The canal expansion may also favor more transport of grains and soybeans on the Upper Mississippi and Illinois Rivers (IWR 2012), increasing the need for lock expansion on these rivers. Adverse impacts from possible lock construction are expected to be minor except for potential need to mitigate loss of riparian wetlands and to compensate for private property loss. Atmospheric emissions are expected to improve a bit since less time is needed for lock transit of barge rafts. Due to increased rail efficiency, railroads may dominate long-haul grain and soybean transport. But because the emissions differences between waterways and railroads are now small, this would have little overall impact on air quality unless rail emissions efficiency increases more than waterway efficiency. Past trends indicate that may happen, thereby favoring rail transport.

Within regions, the vulnerabilities of port areas to further impact are more similar among ports near each other than ports farther apart. But, in general, the regional port variation within categories of impact indication is quite high, often reaching category extremes (when normalized, the extremes are 0 to 100). However, the sum of indicator scores varies much less, indicating that impact mitigation needs are likely to be relatively consistent among ports even though the vulnerabilities to impact and sources of impact vary widely.

Conclusions

The costs of environmental impact mitigation are likely to be substantial almost anywhere within and across regions impacted by transportation system modernization. But the specifics are impossible to know without detailed information of the kind developed during environmental impact studies. Based on indicators used in this study, the Southeast Region appears to be most in need of modernization attention and is most likely to require environmental mitigation associated with modernization actions. But unused port and waterway capacity allows for considerable increase in freight movement without stressing port limits in all regions. Although the number is expected to grow gradually, relatively few vessels of post-panamax size are calling at ports that are now post-panamax ready. Adaptive management is a wise strategy to use in future modernization considerations, given the uncertainties held in future actions and mitigation costs, which depend on specific locations, form of actions taken, and other unknowns. Trends in transportation system change should be monitored more regularly to better manage the uncertainty and risks of unnecessarily impacting the environment.

"When the well's dry, we know the worth of water."

- ***Benjamin Franklin***, Poor Richard's Almanac

Introduction

Water and closely associated land resources are among our most fundamentally valuable environmental resources. Waterborne freight transport has long been one of many valued uses and potential uses of water resources. International waterborne trade has steadily increased through time as well. While maritime trade is essential for maintaining and improving human welfare in the United States and around the globe, sustaining options for other beneficial use of environmental resources is now viewed as equally essential. Achieving environmental sustainability requires long-term maintenance of desired environmental quality and improvement of degraded quality.

In late 2011, Congress directed the Institute of Water Resources of the U. S. Army Corps of Engineers (USACE) to study the port and waterway modernization needs of the United States, including environmental impact and mitigation needs. The report to Congress is entitled *U. S. Port and Inland Waterway Modernization: Options for the Future* (IWR 2012). The analysis presented here provided a distilled and integrated reference source on past and potential port and waterway environmental impacts and mitigation needs for the Congressional study.

Numerous studies on intermodal freight system modernization needs have been completed in the last decade, but few address environmental concerns thoroughly. The main intents of this report were to succinctly describe possible adverse environmental impacts and mitigation needs of port and waterway modernization based on past cumulative impact identified in the environmental footprint of the existing freight transportation system and to convey an analysis of future impact sources, vulnerabilities, and mitigation needs at selected ports and waterways in the United States. Because of the national scope and strict time limits on information compilation, the report is limited to readily available and reliable information about major ports and waterways.

Environmentally sustainable modernization of the national freight-transport system is critical for maintaining and improving the well-being of both present and future generations of Americans (Figure 1). Some form of intermodal freight transport system modernization is virtually inevitable in the United States over the next several decades because of nearly certain growth in imports and exports (EDRG 2012) and infrastructural repair and rehabilitation needs. Modernization also increases freight transport cost effectiveness, which improves competitiveness among port, vessel, rail and truck companies. Increasing vessel sizes and Panama Canal expansion may require some ports and waterways to modernize to adapt to changing traffic patterns and larger vessels (IWR 2012). If so, pollution restrictions will need to be met and other significant environmental effects may need to be mitigated.

Reducing fuel use per ton of freight moved is a major contribution to increased cost effectiveness and to meeting standards set for environmental quality. Other important strategies used for increasing fuel and emissions efficiency include moving larger quantities of goods per vessel, train, and truck and optimizing freight transport across transport modes and number of shipment transfers. Cost-saving strategies also include reducing the variability in freight containment for more efficient freight transfer among modes and increasing engine fuel use efficiency, including greater reliance on less polluting fuels and electricity.

Figure 1. Modernizing U.S. ports and waterways—while maintaining and improving environmental quality—is essential for improving citizen welfare now and in the future. This includes reducing vessel impacts on whales.

Environmental impact mitigation often is a large part of the cost of modernization and a critical consideration in future modernization investment decisions. Consistent with its interstate and international commerce authority, the federal government is deeply involved with developing and regulating the Nation's freight transportation system and is expected to ensure that national environmental policy is followed during modernization. Social attitudes toward environmental sustainability shifted positively during the environmental movement and unprecedented environmental legislation in the 1970s. The goals of the National Environmental Policy Act (NEPA), established in 1970, promote beneficial use of the environment by American citizens, a safe and healthful environment for all citizens, and preservation of important cultural and natural aspects of national heritage for future citizens. These three goals form the ideological foundation for evaluating future modernization impacts in this report. The Clean Air Act (CAA), Clean Water Act (CWA), Endangered Species Act (ESA) and other environmental laws followed soon after NEPA. Environmental laws and executive actions establish environmental standards and the authorities to enforce their achievement.

Consistent with NEPA and other law, the significance of environmental impacts and the need to mitigate them are determined by potential changes in human welfare, now and in the future. NEPA goals include beneficial use of the environment; a safe, healthful, and pleasant environment for all (a basis for environmental justice policies), and preservation of important cultural and natural aspects of national heritage. To be fully representative of impacts and mitigation needs, impact indicators should consider all of these goals to practical extent. Mitigation actions include total avoidance when the loss of environmental quality is irreplaceable, impact minimization, and repair or compensatory replacement of degraded environmental quality when repair and replacement are reliable alternatives.

Figure 2. International freight transport is increasing and transitioning, when possible, to shipment in standardized containers.

Intermodal system modernization is a continuous process that is recently characterized by transition to uniform freight containers (Figure 2), ports with efficient intermodal freight transfer equipment, and to larger vessels, barge rafts, trains, and trucks. The transition reduces costs by decreasing freight processing time and increasing energy efficiencies. The transition was also spurred by the environmental movement four to five decades ago, which culminated in more intense regulation of emissions in much of the developed world. Emissions should decrease as energy efficiencies increase. More efficient fuel use is expected to benefit transportation industry employees as well as investors. It is also expected to benefit the public regionally and nationally by decreasing the cost of goods and services and by providing better public health and safety. For these and other reasons, past freight transportation trends are expected to continue for decades to come (EDRG 2012).

In the approach used here to compare environmental impact potential regionally and nationally, impact indicators were developed based on quantitative data available from reliable sources. Even so, significant uncertainty remains in any such analysis. Reliable and comparable indictor data are limited. None were gathered specifically for the report purpose because of time limitations. In addition, the effects of local to global changes in environmental conditions and human preferences often are difficult to forecast accurately. The fundamental assumption here is that an analysis based on uncertain trends and imperfect indicators has strategic value—even if precise forecasts are impossible—as long as the results provide greater insight into environmental ramifications of transportation system modernization and mitigation needs.

Transportation System Status: Present and Future

Coastal Ports

Existing Condition

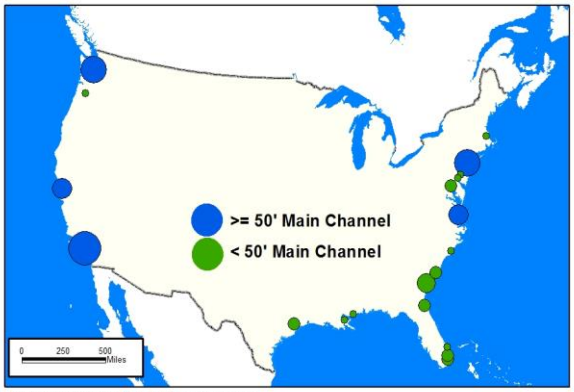
The international freight transportation system has continuously modernized to accommodate increased trade for many years. In recent decades, international maritime trade with nations along the western Pacific Rim has increased most rapidly (Knight 2008, EDRG 2012, IWR 2012). Intermodal freight transporters have progressively converted to equipment designed for uniform freight containers for many decades. While relatively few container vessels are now post-panamax size, container vessel size is increasing and will continue to increase based on past trends and shipyard orders (EDRG 2012). Because other classes of vessels have changed less in size and number, the primary focus of new modernization needs is on the intermodal container-transport network of ports, waterways, railroads, and highways.

Figure 3. Traffic congestion leading to gridlock and degraded air quality has been an issue at some ports.

Some freight movement through container ports and inland networks is limited by intermodal bottlenecks that can elevate consumer prices and degrade air and water quality. Larger container vessels require scaled-up freight transfer equipment and storage capacity at ports, navigation depths up to 50 feet or more (depending on tide), as well as wider and typically longer harbor channels, turn-around basins and berths. Other potential bottlenecks include poor port connection to interstate highways and railroads, tunnels too small to allow railroad container stacking, insufficient numbers of railroad tracks, outmoded rail intersections and switching methods, and highway congestion and air quality issues (Figure 3).

Freight originating in China, South Korea, Japan and other Asian nations enters the U. S. primarily through Pacific Coast ports where it is transferred to trucks and trains for transport across much of the country. Most large container ports on the Pacific Coast are post-panamax and container-ship ready, including ports at Long Beach-Los Angeles, Oakland, and Seattle-Tacoma (Figure 4) in the United States and at Vancouver and Prince Rupert in British Columbia. Some traffic also moves through the Panama Canal to ports along the Atlantic and Gulf coasts. But the dimensions of locks in the Panama Canal limit the size of vessels traveling in both directions to a "panamax" size. The existing locks are 45 feet deep and significantly narrower and shorter than the largest ocean-going vessels. The addition of wider and longer locks that are 50-feet deep was expected to be completed in 2014 (EDRG 2012) but has been delayed until at least 2016. The expansion is expected to change the dynamic for freight transportation from eastern Asia to the eastern United States. The largest ships passing through the new locks—the post-panamax vessels—will be able to carry nearly three times the freight as panamax vessels. The use of larger vessels is expected to significantly benefit American consumers by reducing freight-transport and commodity costs (EDRG 2012).

Figure 4. Location, size (indicated in the figure by circle size), and main channel depths of major U.S container ports were considered in port selection for in-depth analysis.



Note: Circle size is roughly proportional to 2010 container volume

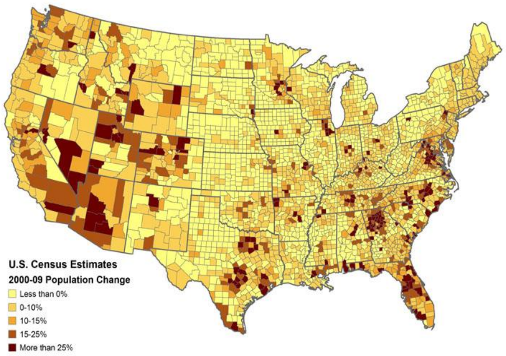
On the Atlantic Coast, only ports at Norfolk, Baltimore, New York-New Jersey, Halifax, and Nova Scotia are either ready to accept post-panamax container vessels or will be ready by 2016 (EDRG 2012 and unpublished USACE information). There are no physical barriers to westward movement of post-panamax vessels from Europe and Asia. Some post-panamax vessels already cross the Atlantic to call at post-panamax ready ports on the East Coast and a gradually increasing number are expected in the future.

Freight movement through all ports along the southeastern Atlantic and Gulf Coasts south of Norfolk is post-panamax limited by insufficient channel dimensions, port facilities, and/or intermodal links. The types and degrees of limitation vary significantly among ports. Several southeastern ports began modernizing in anticipation of the Panama Canal expansion, increasing regional population growth, and competition advantages. Such investments may be beneficial to many of these ports and the U. S. as a whole. Other events, described below, may influence the net benefits of port modernization as well.

Future Condition

The specific locations and types of future environmental impact depend on events that are difficult to predict reliably. There is little doubt that the demand for international freight will increase throughout the United States, especially in the southeastern and western United States where most population growth is expected to occur based on recent growth trends (Figure 5). Despite more rapid growth in those areas, much of the growth in freight transport over the next several decades may be accommodated with existing port and harbor capacities (Smith and Knight 2012). Still, U. S. consumers may significantly benefit from reduced freight shipment costs made possible by more post-panamax vessels calling at a larger number of ports. A shift of freight movement from Pacific ports to southeastern ports may occur as a consequence of Panama Canal enlargement (Knight 2008), especially at ports that can accept post-panamax container vessels. Assessments are mixed, but others in the industry believe that the freight transport balance between East and West Coasts will not change much as Pacific ports and railways adapt (Rodriguez 2010).

Figure 5. Future regional population growth is expected to favor the Southeast and the West as it has in the last few decades.



On the other hand, many ports may rely on existing post-panamax hub ports in the United States where shipments are transferred to feeder vessels that can call at ports with shallower harbors (Rodriquez 2010, EDRG 2012). A number of ports in the Caribbean could provide post-panamax hub transfer services for ports in North, Central, and South America (Rodriquez 2010, EDRG 2012), possibly at lower cost than shipment transfers in the United States.

Other uncertainties are environmental and demographic. A major environmental uncertainty is the possible effect of climate change on sea level and the frequency and intensity of destructive storms (IPCC 2007). Sea level rise would reduce the need for port deepening, but also may require port modifications with adverse environmental impacts. The effects of past hurricanes have demonstrated the costly delays that can occur at ports. Storms also interact with dredged channels and other human alterations of the environment to accelerate loss of scarce estuarine wetlands (Gosselink 1998, Dahl 2012). Population growth in the United States may not increase as much as a median projection assumes if immigration rates decrease as the economic conditions in other countries improve. Or more manufacturing may return to the United States as differences in international labor costs narrow. At a more technical level, the data available for indicating future environmental impacts is insufficiently representative and precise.

All of these and other uncertainties affect any analysis of environmental impact mitigation needs and costs, which depend on the number, location, and specific actions of ports that are modernized for increased freight movement and post-panamax container ships. For these and other reasons, pursuit of precise forecasts is ill advised and discussion is limited to broad consideration of the different future impact possibilities described above.

Waterways

Existing Condition

The inland waterways—including intracoastal, riverine, and Great Lakes waterways—have been major avenues of barge traffic linking coastal ports to inland locations for many decades. A significant national investment has been made in excavation, maintenance dredging, and lock-and-dam construction of over 12,000 miles of improved inland waterways (USACE 2010). The current waterway system was authorized in 1930 and completed during the 1970s. Much of this infrastructure is aging and needs some repair or rehabilitation (USDA and USDT 2010). Routine dredging is required to maintain waterway depths.

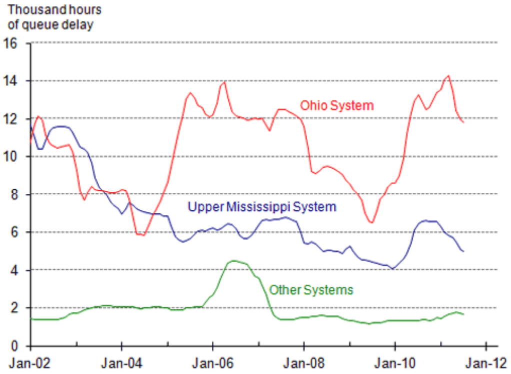
Many locks are too small (600 feet long; Figure 6) to avoid barge raft decoupling where barges are double-rafted. The small locks cause delays and possible congestion as barge rafts are decoupled, passed through the locks one at a time, and recoupled after passage. Newer locks generally are about twice as long. Increased lock size allows barges to push two rafts of barges through the locks instead of just one. A mix of lock sizes occur along the upper Mississippi and Illinois Rivers—two main routes for agricultural product export (USDA and USDT 2010). Congress recently authorized addition of seven large locks on the upper Mississippi and Illinois rivers to partially address the issue.

Figure 6. Small locks cause barge transport delays that can be alleviated by building larger locks.

Future Condition

Inland waterway traffic and lock delays on the Upper Mississippi have been decreasing for years (USDA and USDT 2010; Figure 7). But, because of decreased shipment costs through the Panama Canal, some of the grain, soybean, and other agricultural products now shipped westward by rail to Pacific Coast ports may move eastward to waterway barges on the Mississippi River and down to the port of New Orleans.

Figure 7. Barge traffic and lock delays have been decreasing for years (RITA 2012), but international grain demand and the Panama Canal expansion may change that trend.



Increased waterway shipment could have environmental implications because of impacts from increased barge traffic, primarily from modernization of lock and other waterway infrastructure. Consequently, the remaining small locks on the Mississippi and Illinois may come under closer scrutiny for enlargement. At 45 feet deep, the main channel into the Port of New Orleans has been able to receive panamax vessels for some time, but increasing the cost savings of grain and soybean transport to the maximum extent allowed by Panama Canal transit may ultimately depend on future channel deepening.

The inland waterway grain shipment scenario is as uncertain as coastal scenarios (USDA and USDT 2010). Grain sales to western Pacific rim countries is becoming increasingly competitive among a number of grain exporting nations and some may have advantages over any form of U. S. shipment. Rail transport efficiency has increased and is similar to freight movement on inland waterways in many places. A possible alternative to waterborne transport of grain and soybeans is to bypass a shipment transfer between rail and waterway, and transport grain and soybeans directly by rail to Gulf ports. Railroad transport costs are growing more competitive making this alternative scenario more possible (Economic Development Research, Inc. 2012). The increased cost advantages of shipping grain through the enlarged Canal via gulf ports are questionable if they remain at 45 feet or less. Also, more efficient railroad shipment westward may improve the competitive advantages of the Columbia River waterway and Pacific ports. Depending on various trade and transportation changes, less grain and soybeans may be shipped by barge in the future.

Rail and Highway Intermodal Links

Existing Condition

Rail and highway links between ports, inland freight destinations and freight origins have improved significantly over time (USDA and USDT 2010). Rail has been less subsidized with public funding than waterways and highways. After development began in the 1920s, more freight was moved by barge as the modern waterway system was completed. As public highways increased in quality more freight was moved by trucking firms. A major change in the proportion of freight moved by trains and trucks came after development of the interstate highway system. The advantages of trucking increased as the interstate system extended into ports and bypassed major congestion on city streets.

As railroads adapted to container shipment, shipment by rail began to regain some of its lost advantage for long hauls over 400 to 500 miles (Economic Development Research, Inc. 2012), especially after railroads were deregulated in the early 1980s. Truck transport on the East Coast has contributed to costly congestion on interstate highways, such as Interstate 95, and to associated environmental degradation. Truck transport continues to have a cost advantage for short hauls because container shipment by rail requires freight transfer from or to trucks at some point along the route. Rail is increasingly promoted over trucks by government agencies because of environmental advantages (USDA and USDT 2010). The fraction of freight shipped by container has grown at a faster rate than rapidly increasing trade with the western Pacific Rim nations. Because of their location advantage, Pacific ports modernized to accommodate the changes while eastern ports lagged behind. Most of the freight transported by rail originates or terminates on the Pacific Coast for that reason.

Figure 8. Double stacking containers on railroad cars is one of numerous tactics used to reduce rail transport costs and decrease atmospheric emissions per ton transported.

Future Condition

The advantages of direct shipment to the Atlantic Coast over the Pacific Coast may diminish as land transport across the continent is modernized. The big advantage of post-panamax vessels moving through the Panama Canal is reduced costs per unit of freight shipped due to the greater fuel savings. Intermodal transport through the Pacific ports could continue to have a shipping time advantage, which is important for many types of goods. Railroads in particular are reducing their disadvantage by double stacking shipment containers (Figure 8), assembling longer trains, improving delivery scheduling, doubling single tracks, and eliminating traffic bottlenecks (Economic Development Research, Inc. 2010). Trucking is less adaptable, but is using more double and triple-container trailers and considering alternative fuels and more efficient engines.

Another possible equalizer is increased Panama Canal fees to pay for the large investment in new locks (Resor and Gabler 2011).

Study Approach and Methods

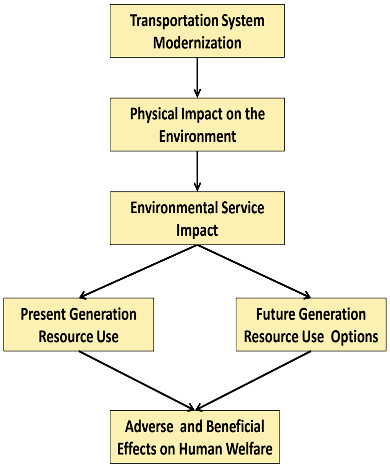
Report Focus

We used a simple systems approach to conceptualize and identify the potential impact flow from modernization action through alteration of environmental attributes to impacts on human service and welfare (Figure 9). The top container ports in the Nation were of particular interest because their freight import and export activity and harbor capacity is a generally reliable indicator of future activity and modernization needs. The Port of Tampa is an exception among the ports included in the analysis. It is a major port in terms of total freight volume, but is presently a second-tier container port for the Nation. Yet it is the most important container port on the eastern Gulf and its container shipment capacity is increasing rapidly (Smith and Knight 2012). The upper Mississippi Waterway was of secondary interest because of the potential for increased export of grains and soybeans via the Mississippi and the enlarged Panama Canal.

System Impact Pathway Analysis

Environmental impacts follow pathways from cause to effect. We focused on impact movement from past and potential transportation system modernization actions to accidents that directly impact human health and safety, or, more commonly, through various land, freshwater and estuarine pathways to resources used or preserved for human benefit. We assumed that the vulnerability to impact depends on the exposure to the impact and existing condition of exposed people and resources. We also assumed the degree of impact to human well-being depends on the degree of population and resource vulnerability to impact and the intensity and spatial dimensions of the impact sources. If a population or resource is already in a condition stressed by previous impacts, it is likely to be more vulnerable to impact than one that has not been stressed as much.

Figure 9. A generalized conceptual model was developed to help identify environmental impacts on human service and welfare.

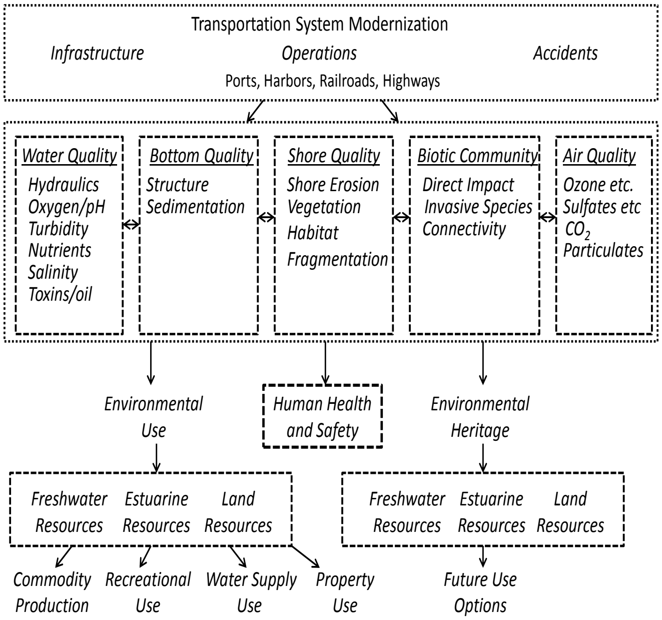


Ecological impact pathways are complex, interactive and typically difficult to capture without very detailed systems analysis beyond the scope of this study. Based in general scientific understanding, Figure 10 depicts elemental considerations during this assessment of environmental impacts. Some common impacts start with changes in the attributes of hydrology, geomorphology, and flow through secondary changes in biotic communities inhabiting river and estuarine bottoms and shores, as well as uplands some distance from impact sources. Atmospheric effects in particular can reach significant distances inland before being homogenized regionally. Contributions of greenhouse gasses increasingly are accepted as having important ecological and economic effects on global climate (IPCC 2007). Some accidents directly influence human health and safety, while the influences of other accidents move through atmospheric and hydrologic pathways. Other important impacts influence both present use of cultural and natural resources and potential resource use by future generations. The scarcest among potential resources are recognized for their importance by institutional protections, public sentiment, and technical identification The Nation most often recognizes sustainability needs through laws that set aside lands, waters, and species for heritage preservation purposes.

Environmental Footprint Assessment

The framers of NEPA were concerned about the cumulative adverse impact of human activity on the human environment. This sum of all impacts has left an environmental "footprint" on provision of environmental services to the public identifiable in changes represented geographically (footprint area) and by impact intensity (footprint depth) within the impacted geographical area (e.g., Ewing et al. 2010). Both areal and depth dimensions have been difficult to characterize accurately because of many indirect effects from activities that radiate from the point of impact and subtle but important impacts that are sometimes difficult to discern (e.g., chemical contaminants that endanger humans and other life). Data gathered by Lubowski et al. (2006) were used to characterize gross geographical impacts. Other data on U. S. land and water area were obtained from the USCB (2012a). More detailed information on port and waterway dimensions were based on data maintained by USACE (2010) and approximations made during this study.

Figure 10. The environmental impact sources and pathways considered in this analysis linked to economic wellbeing, human health and safety, and environmental heritage.



Impacts originate in infrastructure development, systems operations and maintenance, and transportation system accidents (Figure 10). The types of impacts considered include air, water, and land quality changes for which vulnerability and modernization impact indicators were determined. Geographical variation in impact intensity is difficult to discern without site-specific assessments. Data suitable for that purpose have rarely been assembled into national or regional databases. Estimates of past impact intensity have relied largely on assessments at sites not located at ports, but may also include some information obtained for environmental impact assessments at ports and waterways. Important sources are referenced in the report description of the environmental footprint and additional information is provided in Appendix A1.

The potential for future impact is also indicated by the geographic extent and proximity to the transportation system of environments that are naturally scarce and made scarcer by past human impact. Of particular concern are the Nation's wetlands and rivers.

Impact Indicator Selection

The detail typically provided in the environmental impact statements of individual project plans was not feasible for this national study. The purpose here is to broadly indicate and compare potential impact and mitigation-costs of modernization both regionally and at different sites within regions. For that purpose, broad indicators of human vulnerability, resource vulnerability, and potential impact sources were developed. Indicators were chosen based on the following criteria:

- Available data found in existing databases
- Nation-wide data allowing comparison across sites
- Credible data gathered by authorized federal agencies
- Reasonably representative data
- Balanced representation of concerns in indicators

Representativeness was the most difficult of the criteria to meet. Truly representative indicators require data gathered at the site of interest. This requires a local scale that may not be available in potentially useful national databases. This was particularly a problem for finding good indicators of potential adverse impact on environmental use, such as recreational/tourism use and commodity production. Data on health, environmental justice, and heritage impacts was determined from data gathered at a finer scale—typically the county level or smaller, or from property boundary maps—and capable of meaningful analysis using geographical information systems.

Probabilistic forecasts are rarely reliable because of unforeseen events that change the course of projections. Uncertainty is the general rule for many aspects of future port and waterway modernization impacts and mitigation needs. For that reason, future possibilities are discussed broadly, recognizing the limitations of data and analyses. The primary benefit gained from such an approach is awareness of some fundamentally important environmental considerations in decisions about where and when to invest in port and waterway modernization.

The discussion of mitigation possibilities is organized by port and separately by more general waterway modernization possibilities in regions along the Northeast Atlantic Coast, Southeast Atlantic Coast, Gulf Coast, Pacific Coast and the Mississippi and Illinois River waterways. These regions were defined by modernization expectations in ports and waterways. The 20 ports selected for detailed study are among the top container ports in the nation.

Ports Included in the Detailed Study

Northeast	**Southeast**	**Gulf**	**West**
Boston MA	Norfolk VA	Tampa FL	Los Angeles CA
New York-New Jersey NJ	Wilmington NC	Mobile AL	Long Beach CA
Philadelphia PA	Charleston SC	New Orleans LA	Oakland CA
Wilmington DE	Savannah GA	Houston TX	Tacoma WA
Baltimore MD	Jacksonville FL		
	Port Everglades FL		
	Miami FL		

The indicators used for human and resource vulnerability are organized by type of welfare impact. These include health and safety (including environmental justice), important natural heritage, and economically valued resource use. The indicators used for modernization-impact sources include harbor expansion, port facilities expansion, and freight transport operations effects associated with regional population growth. Each of the indicators is briefly described below.

Indicators of Potential Impact

Unhealthy air
Number of discharges into waters
Number of superfund sites
Minorities
Low income group
Parks and other preserves
Wetlands
Endangered species
Commercial fishing
Sportfishing
Public beaches
Harbor capacity
Regional population growth
Port capacity

Health, Safety and Environmental Justice

The major pathways for increased freight traffic and modernization effects are through air, water, and, to lesser extent, land quality. Three indicators were chosen to represent the potential for human impact through each of these three pathways. In addition, measures of potentially disproportionate impact on low income and minority groups were used to indicate inequitable distribution of environmental impacts.

Unhealthy Air. The Environmental Protection Agency (EPA) maintains data on atmospheric conditions that exceed standards set for the general population, the young and elderly, and for people with respiratory illnesses. The last of these categories requires the strictest standards, which were used here. They are set by the number of days that air quality standards were exceeded in counties within 10 km of the port (EPA 2012a). In general, people exposed to unhealthy air are more vulnerable to the effects of any further contribution to poor air quality.

Degraded Water Quality. Potential adverse impacts from altered water quality are inversely indicated by the total number of discharges permitted to enter waterways within 10 km of the port. These data are collected by EPA (2012b). The number of permitted discharges, although accurately counted, does not account for variation in the volume and quality of the discharged water or sources of discharge without permit. More precise data on port area water quality is not equally available for ports and is variable.

Land and Water Contamination. The number of superfund sites is another indicator of potential environmental issues in the vicinity of ports. The data are maintained by the EPA (2012b). Superfund sites usually indicate some form of existing chemical or other hazard. The total number within the port neighborhood is an indicator of vulnerability to additional impacts from port modernization. While superfund sites vary in degree of contamination and containment, port vicinities with a high number are more likely to suffer more generally from land, water, and air quality degradation, making people and other life forms particularly vulnerable to any additional impact.

Minority Status. The percentage of non-white people living within 5 km of the port compared to the Nation as a whole was used as an indicator of inequitable exposure of minorities to unhealthy air, water, and soil; noise; and unpleasant surroundings caused by port operations. The data were collected by the USCB Geographic Division (2012b). Environmental injustice of this kind is increasingly a factor in environmental assessments and mitigation requirements.

Low Income. The percentage of people living in poverty within 5 km of the port is another indicator of inequitable exposure of people to harmful environmental impacts simply because they cannot afford to avoid the area. NEPA establishes a national goal to provide a healthful, safe and pleasant environment for all, not just for those who can afford to move. The data were collected by the USCB Geographic Division (2012b).

Heritage Preservation

Heritage is preserved in diverse ways. It may be officially recognized in preserves, in Executive Order recognition of protection considerations (e.g. wetlands), or in individual species protections.

Geographical Area of Parks, Refuges, and Other Preserves. An indicator of potential adverse impact on natural and cultural heritage is the area set aside officially to conserve important natural and cultural resources locally and/or nationally. The geographical area of officially recognized preserves within 10 km was obtained from data collected by USGS (2012).

Wetland Area. Wetlands have been identified as ecosystems of particular importance for the functions they serve in their natural condition and their growing scarcity. The geographical area of wetlands within 10 km of the port is an indicator of their vulnerability to impacts. The data are from USGS (2010).

Vulnerable Species. The number of species in port neighborhoods that are determined to be threatened or endangered and protected under the Endangered Species Act is an indicator of the vulnerability of those and other species yet to be listed. These data are collected and maintained by FWS (2012).

Beneficial Use of the Environment

Beneficial use of the environment may take many forms including fishing, swimming, sightseeing, and aesthetic appreciation shown by property values. The three indicators of beneficial use of natural resources are often found in close proximity to ports. They include sportfishing, commercial fishing, and public beaches.

Saltwater Sportfishing. Saltwater sportfishing is an important indicator of ocean and estuary recreational use including closely related recreational boating. Data are periodically collected for each state by the U. S. Fish and Wildlife Service (FWS 2006). Both in-state and out-of-state anglers are included. Because the concentration of fishers is a function of shoreline length and local access sites are typically spaced out along the shoreline, the number of fishing days is divided by length of tidal shoreline in the state using data from the USCB (2012a). This accounts to some degree for the numerous fishing access alternatives to the container port area. Variability in the proximity of fishing access points to container points is not indicated in the data.

Commercial Fishing. This indicator of an important natural resource use (Figure 11) is based on the economic value of commercial fish landings—data collected by NOAA (2012). The data are reported by state. Because the concentration of fishing vessels is a function of shoreline length, the dock-side value is divided by state shoreline length (using data from the USCB 2012a). States with long shorelines are less likely to have a significant part of fishery harbor activities in close proximity to a port. Variability in the proximity of important commercial fishing harbors to container ports is not indicated in the data.

Beach Use. Another indicator of valued resource use is the geographical area of public beaches within 10 km of the port area. The data were obtained from EPA (2012c), which monitors water quality at public beaches.

Figure 11. The vulnerabilities of sport and commercial fishing to increased freight transport are indicators of possible adverse impacts on the local economy.

Potential Impact Sources from Port Modernization

Three metrics were chosen to indicate the potential amount of environmental impact mitigation required to achieve post-panamax readiness. The metrics include harbor capacity expansion needs, future growth of port operations, and port capacity expansion needs.

Post-panamax harbor expansion need. This metric is based on the 50-foot depth of the new locks built in the Panama Canal, the existing depth of main channels leading into ports, and the length of those channels. The widths of post-panamax channels are expected to be similar, so the difference between 50 feet and existing depths times the channel length is a reasonably good indicator of the total excavation and material disposal required to become post-panamax ready. It may also indicate maintenance dredging needs and possible alteration in salinity, oxygen, and other water quality attributes that can threaten bottom life, wetlands, and drinking water intakes. The data are collected by the USACE for agency use (unpublished data).

Future growth of port operations. Any increase of freight movement through ports and intermodal transport will be accompanied by an array of operations effects. The demand for more imported freight is a function of future growth of the population served and per capita increases in income. Regional population growth is the more predictable of the two variables and is the sole indicator used here to examine potential differences in air quality effects and other freight transport operations effects. The regional population was defined mostly by state populations within 500 miles of the port area, but also depended on route directness and the number of ports in a better position to serve the states (see Appendix A2). The data were median forecasts of state population growth estimated by the U. S. Census Bureau for the years 2000 to 2030 (USCB 2012c). This indicator has its limitations because some freight travels much longer distances than 500 miles. Ports in the future may wish to capture a larger market share, thereby reaching capacity sooner, or give up market share to more aggressive ports, thereby reaching capacity later.

Port Capacity Expansion Needs. Port expansion needs and potential impacts are indicated by the differences between the percent growth of the regional population over the next 30 years (USCB 2012c) and the percent of unused port capacity (Smith and Knight 2012). The mean of five port capacity indicators was used. These include berth size for vessels calling at the ports, number of berths serving calling vessels, freight transfer cranes, and port storage space (Figure 12), and average vessel use.

Figure 12. Container storage capacity is one of several indicators of future port capacity for processing greater freight volume.

We assumed that existing port capacity can absorb much of the increased growth in freight movement and areas around ports with high population growth and low capacity will be most vulnerable to actions taken to increase capacity.

The raw values of the indicators were normalized between 100 (assigned to the maximum raw score) and some lower value equal to or greater than 0. The normalized indicators were summed to provide an overall index to the potential relative impact of each port and region. No attempt was made to weight the relative impact importance of the indicators.

The indicators have their limitations. They were selected to be representative, quantifiable, reliable, and comparable across all sites and functioned well for their purpose. However, they are not as representative of environmental impacts and impact mitigation needs as data gathered for site-specific environmental impact assessments. They provide a broad indication of some major environmental concerns at ports, but do not represent all possible impacts or how impacts interact uniquely with conditions at individual ports. The indicators provide insights into environmental concerns that could arise at ports and should be addressed more specifically during environmental assessments at individual sites, but should be considered in the context of the data limitations and forecasting uncertainties.

The Environmental Footprint

Overview

The transformation of the American landscape by human development and use has come at significant environmental cost. Development of existing ports, waterways, and intermodal transport links has interacted cumulatively with other sources of environmental impact to adversely affect the Nation's lands, waters, and atmosphere. The total effect has degraded numerous commercial and recreational uses of water and associated land area (Millennium Ecosystem Assessment 2005), contributed to health and safety concerns (Frumkin 2010), and also contributed to the probable or possible extinction of at least 240 American species and the decline of many more (Master et al. 2000).

Sorting out the contribution of the transportation system to the Nation's environmental footprint is difficult, given poor records for ports and waterways and the complex interrelationships among all sources of environmental impact. The direct effects of port, waterway, highway, and railroad infrastructure development, operation, and use on the Nation's lands and waters makes up a small fraction of the geographical footprint of all human activity on the natural environment. However, the effects of land transport are particularly intense (the land surface is largely converted to concrete and other impermeable surface) and some indirect effects on air and water quality are far-reaching (EPA 1996, Hecht 1997).

The nation's freight transportation system geographically interfaces with and often overlies some of the Nation's most nationally scarce waters and wetlands. Air, water, land, and biological attributes of waterways and coastlines have been cumulatively altered by port development, harbor channel and basin excavation, maintenance dredging, dredged material disposal, lock and dam structures, intermodal rail and highway infrastructural links, and vehicular/vessel operations. Much of this impact occurred before major environmental legislation passed in the 1970s, starting with presidential approval of NEPA, followed soon after by the CAA, CWA, ESA and other significant environmental legislative and presidential directives.

As a consequence of these social commitments to environmental sustainability, the avoidance, repair, and compensatory mitigation of significantly adverse environmental impact is now unavoidable. Mitigation for environmental impacts integrates the costs of environmental protection into evaluations of the net benefits from investments. These costs may be substantial, sometimes totaling nearly half of the total project cost (e.g. Mayle and Landers 2012). Through the costs they entail, mitigation actions are a major determinant of forecast investment worth, and, therefore, are an important consideration in any strategic analysis of transportation system modernization needs.

Largely because of protective and restorative legislation, cumulative environmental impact has lessened in recent decades, and air and water quality have both improved significantly. In addition, ecological restoration programs administered by USACE, NOAA and other agencies and organizations have begun to reduce past damage done by physical impacts to lands and waters.

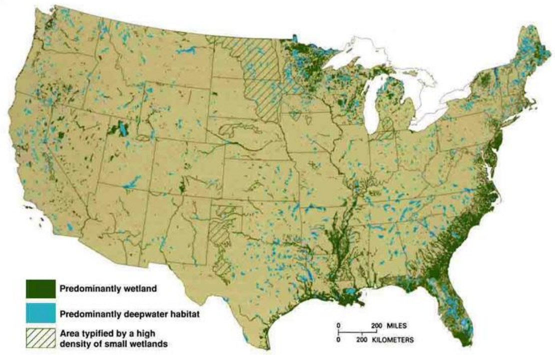
EPA's most recent report on the environment (EPA 2008) indicates major improvements in atmospheric quality. Except for green house gas emissions and atmospheric concentrations, which continue to increase, most indicators of poor air quality have been in decline over the past two decades despite substantial population increase. However, local concentrations of harmful pollutants remain problematic in some dense urban areas; sometimes where major ports are located.

Water trends are less definitive (EPA 2007). Stream discharge variability appears to be improving with fewer periods of no flow in indicator streams. However, nutrient concentrations, contaminants levels in fish, stream bottom stability and bottom-community integrity remain moderately to severely degraded in many locations. In recent decades, species diversity has been stable along most coasts, but decreased in the upper Mississippi and Ohio River watersheds (Chaplin et al. 2000). The large extent of coastal anoxia caused by nutrient enrichment is now widely recognized in many coastal areas (Diaz and Rosenberg 2008). Wetland loss has slowed, but significant losses continue in freshwater and estuarine marshes (Dahl 2012).

Natural Scarcity of Wetlands and Waters

Wetlands in the conterminous United States are concentrated along the coasts and in river floodplains (Figure 13). In floodplains, wetland areas join with other riparian ecosystems to provide corridors that are essential for species movement and survival. Geographically, wetland and surface-water ecosystems are among the scarcest in the conterminous United States (Table 1). Wetland and surface water impacts are of exceptional environmental concern—as identified in executive order and law—because they provide important natural services (e.g., for navigation, water supply, habitat of desired species, flood moderation, water treatment, property protection and enhancement) and were growing more scarce.

Figure 13. Wetland ecosystems are scare and some are vulnerable to port and waterway activities because they are concentrated along coasts and large rivers.



Wetland area has been reduced from about 11.1 % to 5.3 % of the conterminous states by filling, draining, excavating, and flooding (Dahl and Alford 1996). Many riparian corridors are badly fragmented. Tidal estuarine wetlands have been particularly vulnerable to coastal port development because of their location and natural scarcity. Estuarine wetlands occupy about 5.4% of the total wetland surface area and about 0.3% of the total land and water area. In recent

Table 1. Estimated geographical areas of land, wetland, and surface water in the conterminous United States

Geographical Area by Category	Area in Thousands of Square Miles	Percent of total Conterminous U. S.
Total Land and Water	3, 120[1]	100.0
Total Land (including wetlands)	2,955[1]	94.7
Original Total Wetlands	346[2]	11.1
Present Total Wetlands	166[3]	5.3
Present Estuarine Wetlands	9[3]	0.3
Total Surface Water (excludes wetlands)	165[4]	5.3
Marine Coastal (12 miles)	61[1]	2.0
Great Lakes	61[1]	2.0
Remaining Waters	44[6]	1.3
Reservoir Area	24[7]	0.7
Rivers and Natural Lakes	20[8]	0.6

1. USCB 2012s. Includes wetlands.
2. Dahl and Alford (1996). Much of this was converted to crop culture.
3. Dahl (2012). Roughly half of the wetlands are protected in parks, wildlife refuges and wilderness areas so the total land area undergoing light recreational use or no appreciable use is about eight percent.
4. Includes U. S. Great Lakes, other inland waters, and oceanic waters to the 12-mile territorial limit
5. U. S. waters only (Great Lakes Environmental Research Laboratory, NOAA)
6. Calculated by difference. Includes rivers, natural lakes and reservoirs but not most wetlands.
7. Martin and Hanson (1966). They calculated total reservoir area in1963. That has since changed somewhat as new reservoirs were built and old ones were drained or filled with sediment.
8. Estimated by difference between surface areas of remaining waters and reservoirs.

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years, estuarine wetlands have been lost at a rate of about 14,000 acres (0.28%) per year (Dahl 2012). The main causes were hurricanes interacting with rising sea level and man-made channels. Tidal wetlands once recovered quickly following hurricane damage but many no longer do because of reduced supplies of replacement sediments and salt water intrusion by way of dredged channels (Gossalink et al. 1998). The geographical area of nontidal wetlands is more stable but changing in character. Policy now promotes repair or replacement of significantly degraded wetlands and avoidance of any impact on irreplaceable wetlands.

The sum of all surface waters in lakes, rivers, estuaries and territorial oceans are as scarce as wetlands (Table 1). About three fourths of the total water surface area is nearly equally distributed among the Great Lakes and territorial oceanic waters within the 12-mile limit. The remaining area is in inland rivers, lakes, and reservoirs, which in total amount to about 1.3 % of the conterminous U. S. land and water surface. More than half of that total is reservoirs. Free-flowing rivers and natural lakes are much scarcer than nontidal wetlands. Each is nearly as scarce as estuarine wetlands and as aggressively protected from unmitigated impact.

Sources of Environmental Degradation

Major Land Use Impacts

Table 2 summarizes estimates of the geographical area of land and water impacted by use. About 10.3% of the conterminous United States is set aside in a largely wild state for light recreational or other low-impact use in officially designated public parks, wildlife refuges, and wilderness areas (Lubowski et al. 2006), and in wetlands outside those protected areas (Dahl 2012).

Table 2. Areas and percentages of the conterminous United States impacted directly by different land uses and transportation system infrastructure. Estimates do not include indirect effects (e.g., contaminated runoff effects).

Geographical Area by Category for the Conterminous U. S.	Area in Thousands of Square Miles	Percent of Total Conterminous U. S.
Total Land and Water	3, 120[1]	100.0
Noncrop Agriculture (includes forest use)	1,786[2]	57.2
Crop Agriculture	691[2]	22.1
Parks, wildlife refuges, wilderness	156[2]	5.0
Rural Residential	146[2]	4.7
Densely Urban (~10% transportation)	93[2]	3.0
Rural land transportation infrastructure	42[2]	1.3
Sediment disposal	~1.8[3]	0.06
Inland Waterway channels and reservoirs	~1.2[4]	0.04
Water Ports (landside)	~0.4[5]	0.01
Harbor channels	~.3[6]	0.01

1. USCB (2012a). Includes wetlands.
2. Lubowski et al. (2006). About 10% of the urban area is estimated to be devoted to transportation.
3. Approximated. The annual dredging between 1985 and now is between 200 and 300 million cubic yards based on several USACE estimates. While using the high estimates may result in an overestimate, the amount of material originally excavated is unknown and also contributes significantly. The estimate is based on 300 million cubic yards dredged annually since the 9-foot deep system was virtually completed in the 1970s and half that amount between then and1930 when the 9-foot systems began to be created (Dredging began nearly a century earlier but was a relatively small amount). Deposits were assumed to

average 10-feet deep. The area could vary significantly depending on mean depth of deposition and variation in actual amounts deposited.

4. Approximated. USACE has developed and maintained about 12,000 miles of inland waterways (USACE 2010). About 5,000 miles are impounded. Assuming a 500-foot average river width before impoundment, this amounts to about 500 square miles of altered river habitat. The remaining 7,000 miles is a channel impact area estimated to average about 500 feet wide (400 feet authorized by allowing for additional impacts on adjacent bottom). This approaches 700 square miles.

5. Approximated from areal estimates of port land area. Port landside areas for major ports range downward from about 5 square miles for the combined container ports of Los Angeles and Long Beach to less than 0.1square mile. All but about 50 of the 926 ports maintained by USACE are small and generally less than an approximate mean port area of 0.4 square miles. Includes marine coastal water to U. S. territorial limit, Great Lakes and artificial reservoirs (USCB 2012a).

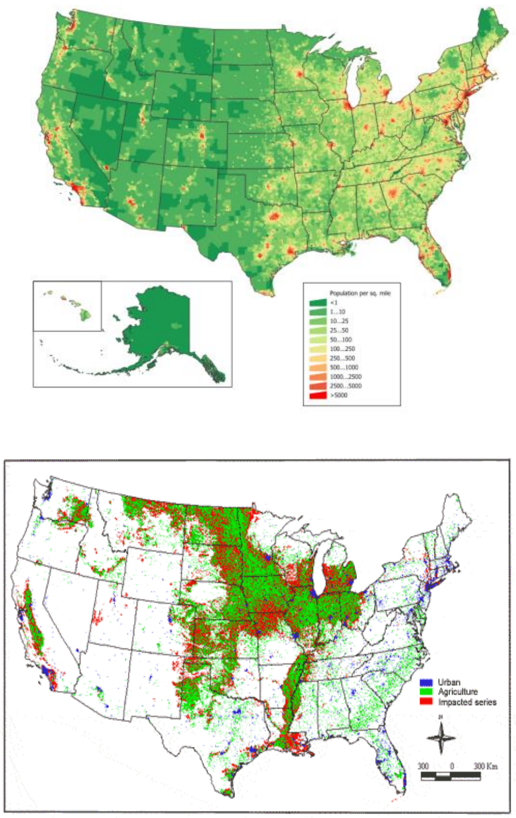
6. Based on 26 out of 63 major ports, mean channel length are estimated to be 25 miles and mean width is 700 feet (~200 square miles). The other 863 ports have much smaller needs and were estimated to occupy in total less than 100 square miles. Many of them receive very little commercial freight.

More intensively used agricultural and forest lands together make up the largest fraction of the conterminous United States. About 57% is lightly to moderately altered by forest and grazing uses and 22% is more intensively affected by crop culture (Figure 14). Nearly 8% is intensively altered by rural residential and urban development, of which 3% is densely urban (Figure 14).

Landside Transportation Infrastructural Impacts

Landside transportation system infrastructure includes platforms for port facilities and storage, parking lots, railroads, highways, pipelines, and numerous other artificial structures placed in and along rivers, coastal areas, and on land. Landscape changes caused by landside infrastructure amount to about 1.6% of the conterminous United States. The rural transportation system (sum of rail, highway, airports, water ports, etc.) directly impacts about 1.3% and urban transportation contributes another 0.3%. Freight transport uses a large fraction of the transportation system area, including household delivery and pick up. Roads contribute most to the transportation system footprint on land and coastal ports are among the least. An approximate estimate of landside port area converted to hard surface is less than 1% of the transportation system surface area and about 0.01% of the total land area. The major cause of wetland loss is associated largely with drainage for agricultural development (Dahl and Alford 1996) and urban development is a secondary cause.

Figure 14. Urban land use (upper map) and agricultural land use (lower map) are major sources of erosion and other environmental impacts



No comprehensive data exist for the contribution of coastal port and intermodal transportation links to past losses of estuarine wetlands, but they probably did not exceed 5% based on estimated geographical areas (and may have been substantially less because harbors were selected for access to deeper waters). While the infrastructure of landside transportation systems is much more geographically limited than agricultural impacts, the infrastructural impacts of transportation systems usually are more intense. They are associated largely with filling natural area and surfacing it with impermeable material or flooding it with impounded water.

Perhaps more damaging than direct geographical impact, the transportation system has caused habitat fragmentation that contributes to decline of numerous species (Fahrig et al. 1995, Forman and Alexander 1998, Trombulak and Frissell 2000, Watters 2000). On land, highways generally have more impact than railroads and pipelines because they stretch over many more miles and cover a much greater area of land surface. Highways and associated parking areas, in particular, alter hydrology and contribute contaminated runoff into fresh and estuarine waters (Gjessing et al. 1994, Jones et al. 2000). Impoundments isolate sections of natural flow in rivers.

Waterway and Harbor Infrastructural Impacts

The infrastructure of waterways and harbors includes impoundments (created by lock and dam structures), wing dams, jetties, revetments, retaining walls, docks, channels, turnaround basins and berths among other structural developments. Navigation impoundments are the largest single infrastructural alteration of aquatic environments. Navigation locks and dams have converted about 5,000 miles of the largest rivers to reservoirs and contributed to aquatic habitat fragmentation. Assuming that an average mean width of natural rivers before impoundment was 500 feet, about 500 square miles of natural habitat were transformed. Navigation impoundments physically alter a very small fraction of total stream and river length in the U. S. However, a significantly large fraction of the total river and stream area is impacted because the rivers that have been developed for navigation are much wider and longer than the small streams that comprise much of the total length (e.g., Strahler 1957).

In addition to commercial navigation benefits, reservoir construction increased the area of water available for recreational fishing and boating, and USACE provides access to more water-based recreation than any other federal agency (Cordell et al. 1990). But the benefits have been accompanied by environmental costs that were not accounted for at the times of waterway construction. Their effects on river hydraulics, light transmission to bottom, and erosion-deposition dynamics are frequently cited as among the major factors contributing to the decline of many freshwater species; especially freshwater mollusks (Richter 1997, Parmalee and Bogen 1998, Watters 2000, Cole 2009). As a consequence of these and other changes in freshwater ecosystems, over 138 freshwater species are presumed to be or are possibly extinct and about five times as many freshwater vertebrate and large invertebrate species are now threatened with extinction (Ricciardi and Rasmussen 1999, Cole 2009), many of them in large, warm-water rivers. Among endangered species, birds, reptiles, and marine mammals are particularly concentrated in coastal areas.

In addition to impoundment, large rivers and coastal wetlands were impacted by channel excavation to depths of 9 feet and more. Over 12,000 miles of waterways have been developed by USACE for commercial navigation (USACE 2010), including the 5,000 miles of impounded water. The total area actually excavated is not well documented. Original excavation depths varied widely depending on variation in river and estuary depth. Even where excavation has not occurred, channel bottoms are regularly disturbed by boat and barge traffic. Based on an estimated length of 7,000 miles and an average disturbance width of about 500 feet (the channel is authorized to be 400 feet wide but adjacent areas are also impacted), the disturbed area amounts to about 700 square miles. Impounded area is an estimated 500 square miles. In addition, the total area encompassed in coastal harbor excavation of channels, turn-around basins, and berths is estimated at about 300 square miles. The total area estimated to be directly impacted by excavation, impoundment, and use is about 1,500 square miles (0.05%).

Channel deepening causes hydraulic changes, which, in tidal environments, can lead to salt water intrusion into freshwater tidal environments (PIANC Working Group No. 6. 1993) where it may degrade the quality of domestic or industrial intake water, freshwater wetlands, and other habitats. Dredging also can create an environment more prone to severe oxygen depletion, which kills, harms, or repels many species (Diaz et al. 1992 and Diaz and Rosenberg 1995). This has been a major issue at the Port of Savannah, where channel deepening is anticipated to foster salt water intrusion (Savannah District Corps of Engineers 2011). In rivers, channel deepening concentrates more river flow in the channel, diverting flow from other parts of the river not directly impacted by the deepening. Concentrating flow in deep channels reduces the area of suitable habitat for many fish and molluscan species adapted to shallower riffles and shoals, especially during droughts.

Harbor jetties and other infrastructure that extends above the water line alter shore erosion and deposition (Dean and Dalrymple 2002). In some locations, these changes can influence barrier beach protection of estuarine wetlands. River revetments, wing dams, and other structures can contribute to river disconnection from floodplain habitats (Jurajda 1995) that act as fish nurseries (Holland 1986, Copp 1989) and support other species (e.g., Bodie and Semlitsch 2000**)**.

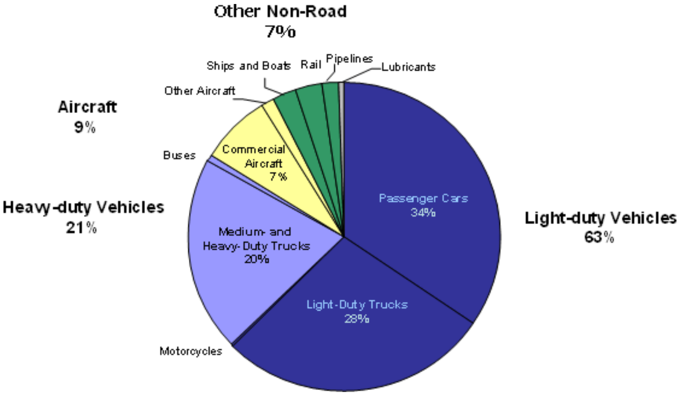
Transportation System Operations

Air Quality Effects

Atmospheric emissions, including greenhouse gasses, are among the most obvious sources of environmental impact associated largely with transportation (Figure 15). The land- and water-based freight transportation system consumes 8.6% of the total energy used in the Nation (from data reported in USDOE 2012), virtually all of it in the form of fossil fuel. Most of that is from passenger traffic in cars, light trucks, and aircraft. Less than 3% of the total energy use is for freight transport, but virtually all of that is from fossil fuel, much of which is from one of the most polluting sources—diesel fuel. Trucks consume over 72% of the freight-transport energy (data reported in USDOE 2012). One of the claimed benefits of maritime freight transport is cost savings from greater fuel efficiency and reduced atmospheric emissions, both of which improve with increased vessel size (Notteboom and Vernimmen 2009). However, vessels in ports and waterways can be major contributors to local atmospheric pollution (Corbett and Fischbeck 2000, PIANC Envicom Task Group 2 2011).

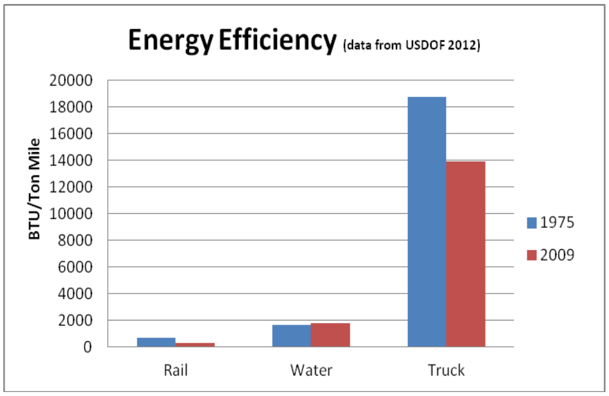
Fuel efficiency and atmospheric emissions are important considerations in seeking the most beneficial combination of freight transport modes. The high fuel efficiency of large ocean-going vessels (Notteboom and Vernimmen 2009) is a primary reason why they are the least costly for long-distance freight transport (EDRG 2012)—substantially less than land transport by rail and much less than trucks. The smaller vessels used on inland waterways are much less efficient than large vessels. Separate assessments by USDOE (2012) and OEE (2011) indicate freight trains now have somewhat greater fuel efficiency than waterway freight vessels and much higher efficiencies than trucks (Figure 16). Because the fuels are similar, the ratios are similar for greenhouse gas and other atmospheric emissions (OEE 2011, Baird et al 2011). Others conclude that barge tows still have some fuel and emissions efficiency advantage over railroads (Kruise et al 2009). But history indicates that the fuel efficiency of trains and trucks has steadily improved over the last several decades, while that of small vessels has not (USDOE 2012). The fuel efficiencies of all modes are likely to increase as new standards and regulations are put in place (Kruise et al. 2009)**.** There is no indication of how much these changes may alter the ratio of modal efficiencies.

Figure 15. Trucks make up nearly half of the emissions from different U.S. transportation sources (from EPA and DOT).



The optimum use of different transport modes in the intermodal system is very much influenced by the essential role of trucks in freight pickup and delivery and the cost of intermodal transfer. Despite higher fuel costs, trucks are the most cost-effective mode for short freight hauls (EDRG Group, Inc 2012) because an intermediate transfer to rail or barge before final transfer to ocean freighter adds significantly to the cost (and fuel inefficiency).

Figure 16. Railroads are slightly more fuel efficient than water transport and much more efficient than trucks.



Physical Effects of Maintenance Dredging

Maintenance dredging of navigation channels, turnaround basins, and berths not only disturbs the life on channel bottoms, but also impacts it wherever the dredged material is deposited. Some dredging has been done since the early 19th century and has increased as the navigation system was developed, mostly after a 9-foot channel depth 400 feet wide was authorized for construction in 1930 (USDA and USDT 2010). Maintenance dredging increased as the system was created until the 1970s and has remained relatively stable since then.

A geographical comparison of dredging impacts is desirable to show perspective, but long-term records of past amounts of dredging are spotty and approximate. Even though annual dredged material estimates have improved in recent years, the geographical area impacted by dredge material deposits can only be roughly approximated. Francinques et al. (1985), USACE Office of History (1998), EPA and USACE (2007), and USACE (2010) indicate that between 200 and 300 million cubic yards were dredged annually between 1985 and 2002. Similar amounts of dredged material are assumed to have been removed annually since the waterway system was completed about 40 years ago. To err on the high side, it was estimated at the high rate of 300 million cubic yards per year over the 40 years. The high annual estimate used since 1970 compensates to some degree for unknown amounts dredged earlier than 1930, before work began on the modern waterway. There is not much data for dredged material before 1970. The amount dredged was less during the period of major waterway development because there was less waterway area to maintain. It was crudely estimated to average about 150 million cubic yards per year. Assuming a 10-foot average deposition depth, about 1,800 square miles (0.06%) of aquatic and terrestrial habitat was covered at one time or another with dredged material (Table 2). While the estimate provides some perspective for comparison, the actual deposition depth is highly variable and the actual amount covered could be substantially more or less than the estimate.

While the geographical area covered with dredged material may be a good indicator of relative short-term impact, it is not a good indicator of long-term adverse impact to natural communities. Numerous studies of the effects of dredging and disposed dredged material completed not long after NEPA and the CWA act were passed indicate that adverse impacts on bottom organisms usually are temporary when the material is placed on similar bottom materials and is not contaminated with toxic material (Allen and Hardy 1980 and Weck and Crossan 1981). More recent studies generally confirm the temporary or minimal adverse effects of most dredging (Lewis et al. 2001, O'Donnell et. al. 2007, Crowe et al. 2010, Parsley et al. 2011). Dredging often adds to underwater relief, which, like other bottom structure (e.g. Turner et al 1999), may provide habitat diversity in support of a more diverse biotic community. Early disposal sometimes formed islands, which, from a positive standpoint, were frequently used by birds (Landin and Soots 1978). Dredged material habitats appear to be as useful as natural sites for some endangered birds, such as least terns (Krogh and Schweitzer 1999).

Some dredging in the past had more persistent adverse effects on productivity, scarce species and scarce ecosystems, such as shallow estuary wetlands, coral reefs (Erftemeijer and Lewis 2006, Ray 2007) and oyster reefs (Visel 1988), as well as some unavoidable take of endangered species, such as sea turtles and sturgeon. Dickerson (2012) reported that 26 threatened and endangered species may be affected by dredging in the southeastern United States, but sea turtle and sturgeon mortalities are most closely monitored. USACE has invested significantly in improvements to reduce dredging impacts on sea turtles (Dickerson et al. 2004) and they are now a very small fraction of the total number of turtles killed by other means, including commercial fishing (Finkbeiner et al. 2007). An average of 29 sea turtles per year made up the known casualties of USACE dredging from 2002 through 2011(USACE 2012).

Figure 17. In the past, some dredged material disposal unintentionally provided valuable habitat. Now 20-30 percent is intentionally used for habitat and other beneficial purposes.

Before 1970, the adverse impacts of dredging were largely left unmitigated. In the early 1970s, NEPA, the CWA, and the ESA contributed importantly to major changes in those practices, forcing more care with excavation and disposal. USACE began to research the use of dredged material for beneficial habitat creation during the 1970s (Lunz et al. 1978). Since then, USACE has increasingly sought deposition sites and means that would add more value than mitigation alone. In 1992, USACE was authorized to plan and implement projects to beneficially use dredged materials for various purposes. Habitat improvement for support of valued species has been the most common beneficial use (Figure 17). Such projects need to assure that any habitat destroyed in the newly created use of dredged material is more valuable than the existing use of the area where it is deposited. About 20 to 30% of dredged material is now used for beneficial purposes (EPA and USACE 2007) and USACE is seeking more opportunities. Appendix A1 provides more information about the environmental impacts of dredging and how USACE disposes of and uses dredged material.

Water Quality Effects

Despite improvement since the CWA was passed in 1972, EPA (2007, 2008, 2012) estimates that nearly half of all rivers and lakes continue to suffer from degraded water quality (Figure 18), as do estuaries. Degradation along the coasts is particularly concentrated in urban areas where large ports are located. Port operations are a significant source of estuarine water quality degradation (Bailey et al 2004). All contributions to water quality degradation are a concern even though they may play relatively small roles compared to major watershed sources of agricultural and municipal pollutants including nutrients, pesticides, pathogens, and turbidity-causing suspended sediment. Appendix A1 provides more information about urban runoff effects.

Figure 18. The distribution of impaired water quality is particularly concentrated in many areas near major ports (EPA data).

Maintenance dredging can impact water quality and bottom areas. About 10% of dredged material was contaminated enough with toxic materials in the 1980s and 1990s to take special precautions with its disposal (Francinques et al. 1985, EPA 1998). Toxic sediments are common near urban areas, mines and other sources of toxic materials where they may directly impact bottom organisms or indirectly impact fish and other species that eat them (Burton and Landrum 2005). Coastal waters near large cities are of particular concern (EPA 1998). Since the Clean Water Act was passed, bottom sediments are tested for contamination before dredging and contaminated dredged material is disposed of in containment areas designed to protect public health, fish, and wildlife. Dredging also elevates turbidity temporarily. By starving wetland plants of light, turbidity can contribute significantly to plant losses (Eldridge et al. 2004). But the temporary effect of turbidity caused by dredging probably pales compared to the widespread and more frequent effects of storms, watersheds with high erosion rates, and the chronic effects of eutrophication, which causes increased growth of light inhibiting algae that compete with submerged freshwater plants (Jones et al. 1983, Irfanullah and Moss 2004) and sea grasses (Eldridge et al. 2004, Kopecky and Dunton 2006). The turbidity effect of dredging in estuaries probably is a small fraction of the massive effect of fishing on the biomass of oysters and other shellfish, which reduce turbidity by filtering out algae and other organic matter (Newell 1988, Newell and Koch 2004, Cerco and Noel 2005).

Vessel-caused turbulence also disturbs bottom communities and contributes to turbidity (Allen and Hardy 1980, Weck and Crossan 1981), which can become chronic where traffic is dense. Vessel, port, train and truck operations often are sources of oil, metals, and other water pollutants (Bailey 2004, EPA 2007, PIANC Envicom Task Group 2 2011). Vessels contribute to harbor noise and cause subsurface noise with unknown consequences in marine ecosystems (PIANC 2011). Vessel and port impacts usually are localized in the immediate harbor area. Highways and associated parking areas are important sources of metals (tire wear and lubricant leaks), oils and various synthetic chemicals that wash into drainages entering public waters (EPA 2007).

Vessel wakes contribute to shoreline erosion and to wetland and bottom community changes (Koch 2002, Bishop 2005a and Bishop 2005b). Erosion destroys wetland directly and indirectly through increased turbidity. Displaced sediment may contribute to habitat degradation for some species. In waterways many species of freshwater mussels do not tolerate increased quantities of fine sediment (Neves et al. 1997).

Operations of the international freight transportation system are well-documented vectors for nonnative invasive species (Ruiz and Carlton 2003), some of which have or could cause costly damage. The two main avenues for invasive species entry via ports are vessel ballast water and freight. Vessel ballast water has been a major vector for non-native invasive species with adverse environmental effects (NRC 1996, Corn et al. 2002). San Francisco Bay and the Great Lakes (Wouters, 2010) are among the best documented examples of national waters w have been invaded by nonnative aquatic species transported in ballast water, including such costly species as the zebra mussel (Figure 19). Freight transferred from vessels to trucks and trains is a major source for terrestrial species invasion of inland areas (Greenberg et al. 1997). Numerous insect and plant species have entered U. S. ports with agricultural/forest goods. Some of the worst agricultural and forest pest species probably invaded the United States through this means (Pimentel et al. 2001). Increasing freight movement and future freight traffic changes among world ports could increase prospects for successful invasions (Kaluza 2010). But new regulations requiring old ballast-water release well off shore and biocide treatment of the new ballast water are expected to stem this source of invasive species.

Accidents

Accidents occur throughout the transportation system and contribute to human safety and health concerns as well as to wildlife threats (Figure 20). Accidents include ship, train, truck and car collisions, and pipeline breaks and leaks. Accidents often receive attention disproportionate to their contribution to all transportation system impacts, but can be locally to regionally costly as signified by large oil spills, which are mostly associated with vessel collisions and pipeline breaks (Etkins 2001). Accidents in and around ports are a function of increasing traffic rates and counteracting facilities and operations improvements (Etkin 2001). Collisions of vessels with endangered marine mammals (whales), reptiles (sea turtles), and fish (sturgeon) is a significant concern in some port areas (Vanderlann and Taggart 2006, Laist and Shaw 2006, Brown and Murphy 2010). Vessel strikes are the greatest known human-caused source of mortality for the highly endangered North Atlantic Right Whale (Silber and Bettridge 2012). Rules designed to reduce vessel speeds have been in place since 2008, but not enough time has passed to measure the effect (Silber and Bettridge 2012). Dredging has killed individuals of numerous species, some of which are imperiled (USACE 2008). Vehicular traffic is also recognized as a significant source of mortality for some endangered species (Fahrig et al. 1995).

Figure 19. Some of the invasive species introduced to the U. S. via ballast water and cargos have had costly impacts. The zebra mussel (below) is one example.

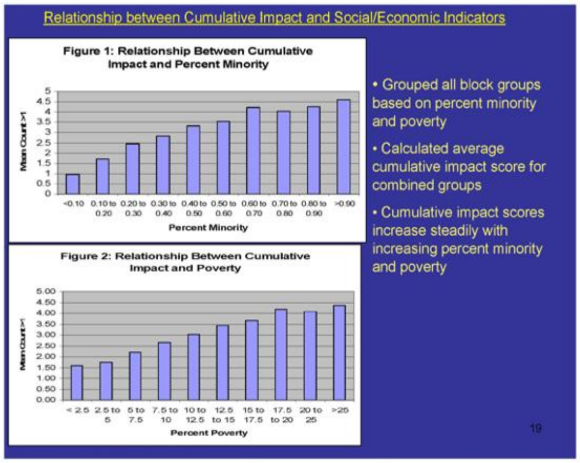
Figure 20. This large Atlantic sturgeon probably was cut in half by a container vessel propeller (from Mallin 2011)

Impact Distribution and Environmental Justice

The convergence of rail, highway, vessels, and freight transfer machinery at major ports concentrate emissions and noise locally. Large ports produce air pollutants at least equal to 500,000 cars or a power plant of average size (Bailey et al. 2004). Vessels, trucks, and shipment transfer equipment all contribute significantly. Port congestion intensifies the problem. Trains and employee’s vehicles play a smaller role. Truck traffic, in particular, contributes to congestion near busy ports, which not only inconveniences local drivers, but also elevates atmospheric emissions.

The relatively low value of adjacent property, which is more affordable for people in lower income brackets, is a reflection of the local air quality, noise, unpleasant appearance, and other environmental impact of large ports. Therefore the environmental impacts from port and waterway developments, operations, and maintenance often have disproportionate impacts on low income groups (Figure 21). Minority populations are also disproportionately impacted (Figure 21). Port expansion near population centers has more impact on human health, safety, and environmental resource use benefits than at more remote ports.

Figure 21. The disproportionate impact of emissions on low income and minority groups in New Jersey.



Relationship between Cumulative Impact and Social/Economic Indicators

- Grouped all block groups based on percent minority and poverty
- Calculated average cumulative impact score for combined groups
- Cumulative impact scores increase steadily with increasing percent minority and poverty

A review of port websites reveals that ports are trying to reduce these sources of problems in various ways. New rules are being established, for example, to reduce the time inert trucks are allowed to remain in idle. Ports are seeking corrective action to reduce congestion wherever access to major highways is less than optimal. The ports of Los Angeles and Long Beach now use subterranean trains to move freight to truck terminals outside the city. Miami is seeking a similar solution to its port-traffic issues. Port improvement plans rely more electricity to drive local shipment transfer operations and to provide energy for docked vessels.

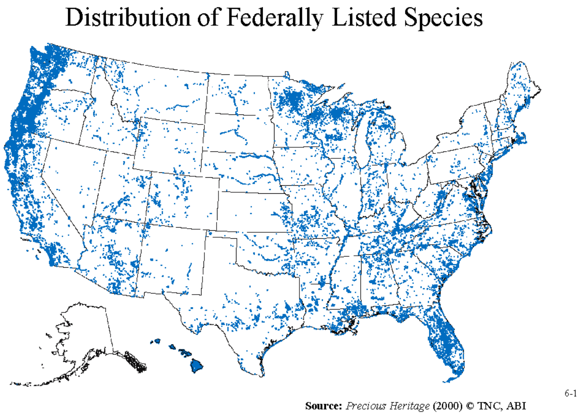
Net Effect of All Impacts on Native Species and Ecosystems

The net effect of all of the changes in land and waterscapes that have occurred in the United States has had major impacts on the condition of native ecosystem components, which are in decline (Master et al. 2000). By the end of the last century, 240 plant and animal species were possibly to probably extinct, and another 6,460 were vulnerable to extinction. Nearly 1,400 of them were seriously imperiled. Extinctions have been particularly high in southwestern states (especially California), southeastern states, and in central Midwestern states bordering the Ohio, Tennessee, and Mississippi rivers (regions where serious transportation system modernization is underway or contemplated). Species listed under protections of the Endangered Species Act (Figure 22) and species otherwise known to be imperiled are concentrated largely along the Pacific, Atlantic, and Gulf coasts (Stein et al. 2000). Inland states in the eastern Mississippi River watershed are hosts to a large concentration of imperiled aquatic species (fish and mussels).

Future Environmental Impact and Mitigation Needs

Given the uncertainty about where, what form and to what extent transportation system modernization takes place, specific forecasts of adverse impacts are highly uncertain and ill-advised. The uncertainties associated with other influential environmental and social changes only heightens that conclusion, including the potential effects of sea level change on post-panamax depth requirements and their associated beneficial and adverse impacts. Instead of

Figure 22. The distribution of U. S. endangered species is concentrated near coastal ports (from Stein et al. 2000).



Distribution of Federally Listed Species

Source: *Precious Heritage* (2000) © TNC, ABI

specific forecasts, indicators of human and resource vulnerabilities and possible sources of adverse impacts are used here to compare regions and ports within regions.

Regional Differences in Vulnerability to Environmental Impact

Indicators of impact source and vulnerability to impact sources are regionally summarized in Table 3 (see the methods section and table footnotes for indicator description). The modernization impact metrics indicate general sources of impact while the vulnerability metrics indicate the relative significance of the populations and resources that may be impacted. The vulnerability metrics indicate vulnerabilities of human populations, cultural and natural resources of heritage importance, and beneficial use of natural resources (commercial fishing, sportfishing, and public beach area). The metrics also indicate potential need to avoid or compensate for health, safety, environmental equity, heritage, and economic losses. Table 3 provides more information.

Other metrics were used to indicate the potential for significant environmental impacts of transportation system modernization on vulnerable people and resources. Growth of operations impacts is indicated by the regional population growth, which is a predictor of future freight movement through ports. The difference between the percentage of regional population growth and estimated percent of unused capacity was used as an indicator of port and intermodal expansion needs. The difference between the existing depth and length of harbor main channels and the 50-foot depth desired for post-panamax vessels was used as a general indicator of post-panamax expansion needs. Table 3 provides more information. In general, regional variations in vulnerability to impact were small. Total vulnerability scores were slightly lower than average in the Northeast largely because of low heritage impacts associated with endangered species and preserves. The Pacific Region vulnerability was slightly higher than average because of greater potential health and economic impacts. The Southeast stood out for its relatively low health and equity vulnerability and relatively high heritage vulnerability (high wetland area). Despite the importance of commercial fishing in the Gulf, its vulnerability to modernization was indicated by our method to be relatively low. This is a result of high shoreline length leaving many opportunities for access to fishery resources other than through port locations. Because vulnerability differences among regions are small, the impacts of modernization and impact mitigation cost, wherever they occur, are likely to be nearly equally high. However, mitigation cost would vary widely among ports within regions depending on their specific vulnerabilities and impact extents and intensities.

Table 3. Potential regional environmental impact from harbor and port modernization based on indicators of impact sources and possible human population and resource vulnerability to impact. A higher score indicates higher impact. Each value is the mean of raw data normalized between 0 and 100 for comparability. Raw data is in Appendix A3

Potential Impact Indicators	Port Regions[1]			
	NE	SE	Gulf	West
	Vulnerabilities			
Health, Safety & Equity[2]	44.2	35.7	45.7	48.9
Heritage Loss[3]	11.9	33.7	26.2	20.3
Economic Loss[4]	27.7	25.9	22.1	34.0
Subtotal	83.8	95.3	94.0	103.2
	Modernization Impact Sources			
Harbor Expansion[5]	33.2	16.6	29.8	0
Freight Transport[6]	17.8	73.7	43.3	76.0
Port Expansion [7]	44.0	90.6	60.2	74.6
Subtotal	128.0	180.9	133.3	150.6
Total	211.8	276.2	227.3	253.8

1. The Northeast Atlantic includes Boston, New York-New Jersey, Philadelphia, Wilmington, and Baltimore. The Southeast Atlantic includes Norfolk, Wilmington, Charleston, Savannah, Jacksonville, Port Everglades and Miami. The Gulf includes Tampa, Mobile, New Orleans, and Houston. The Pacific region includes Los Angeles, Long Beach, Oakland, and Tacoma.

2. Health and safety vulnerabilities are indicated for an area within 10 km of ports by 1) number of days air pollution exceeded limits for respiratory illness, 2) number of permitted waste water discharges, and 3) number of superfund sites (EPA 2012 a and 2012b). Potential for environmental injustice is indicated by the percentages below poverty level and in non-white minority groups within 5 km of the port (USCB Geographic Division 2012b).

3. Vulnerability to loss of important local and national heritage is indicated for an area within 10 km of the port by 1) the percentage of wetlands (USGS 2010); 2) the area encompassed in parks and other preserves (USGS 2012); and 3) the number of species listed as threatened or endangered (FWS 2012).

4. Vulnerability to a loss of natural resource economic value is indicated by 1) the state commercial fish dockside value divided by state shoreline length (NOAA 2012 and 2012a), 2) state saltwater fishing days divided by state shoreline length (FWS 2006 and 2012a), and 3) area of public beaches within 10 km of the port (EPA (2012c). State data were divided by shoreline length to account for large differences in the dispersal of fishing access along shore and away from ports.

5. Harbor channel expansion needed to accept the largest post-panamax vessels is indicated by the difference between existing depth and 50 feet times existing channel lengths. This metric indirectly indicates potential excavation and maintenance impacts.

6. Future rate of freight transport through ports is indicated by the 30-year population growth in states within 500 miles of the port. This metric indirectly indicates possible impacts from emissions and other operations effects.

7. Port expansion needs and potential impacts are indicated by the differences between percentage population growth over the next 30 years and the mean percentage of unused capacity for 1) berth size of vessels calling at ports, 2) number of berths serving calling vessels, 3) freight transfer cranes, 4) port storage space, and 5) average vessel utilization.

Potential infrastructural modernization and freight transport operations impacts are especially high in the Southeast and Pacific regions where regional population growth is equally high and port capacities are most used. Unused capacity is greater in the Pacific region, but little harbor expansion is needed because most major ports are already post-panamax ready. The harbors at two major ports in the Northeast are, or soon will be, ready for post-panamax vessel use, but the amount of dredging required for post-panamax development at other ports makes potential harbor expansion impacts the highest among regions. However, actual population growth and percent growth is quite low in the Northeast compared to the other regions, making future modernization needs among the lowest regionally.

The Gulf ports serve primarily Midwestern populations where regional population growth rate is not as high as in the Southeast or Pacific regions. That, and high unused capacity, indicate relatively little need for port or harbor expansion. If post-panamax readiness were pursued, it would include harbor expansion impacts nearly as great as in the Northeast.

The totaled vulnerability and potential modernization impact scores are highest for the Southeast and Pacific regions. Metric scores are not likely to be directly proportional to mitigation costs, however. For example, the physical need for harbor expansion in the Southeast Region is less than other regions (many of the ports are close to post-panamax depths), but the vulnerability of natural heritage to harbor expansion is comparatively high and mitigation costs could be quite high.

There are potential environmental benefits from increasing capacity for post-panamax vessels if, as expected, modernization leads to reduced impacts on air and water quality impact per ton of freight shipped. Assuming that the amount of freight transported will increase regardless of average vessel size calling at the ports, the increased vessel size expected from harbor expansion could reduce local emission impacts on human health and inequities among minority and low income groups near the ports. Other effects are harder to judge. While the frequency of ship passages may decrease, possibly lowering the number of harmful collisions with scarce species and other costly accidents, the increased size of the vessels may increase the likelihood of collisions when a vessel passes through the area. Accidents that damage larger vessels and their cargo may be more costly because proportionally more freight may be lost and more harmful pollutants may be released.

Other scenarios are also possible, as indicated in the review of transportation status near the beginning of this report. The analysis of Table 3 data assumed that regional population growth is the main driver of freight movement amounts and destinations. That assumption could be significantly altered by the effects of Panama Canal expansion, which may reduce freight transport costs below the costs of transporting freight from Pacific Rim nations to the Pacific Coast. Freight movement could significantly shift eastward in response, elevating the amounts of freight moved above that estimated by regional population growth alone and depressing amounts moved through Pacific ports. While total atmospheric emissions could be reduced because of the higher fuel efficiencies of larger vessels, local pollutant concentrations may increase more at southeastern ports than Pacific ports. The degree to which increases occur depends on how effectively emissions are reduced through port modernization actions.

Another possibility could alter the picture differently. Existing post-panamax ports on the East Coast and international ports in the Caribbean have potential for becoming deepwater transport hubs for vessels of all sizes. That may favor smaller vessel delivery of transferred freight to East Coast ports that are not ready for post-panamax vessels (EDRG 2012). If that happened, freight transport amounts and pollutant emissions may increase above regional population predictions while harbor expansion and its environmental impacts are largely avoided. It may also mean less improvement of total transportation-system emissions, which increases per ton of freight transported as vessel size decreases (Notteboom and Vernimmen 2009).

Improved performance of rail and highway freight transport from West Coast ports could also moderate a Panama Canal effect on port advantages. Rail transport in particular has shown significant improvement in recent decades. Pacific ports are better prepared than eastern and Gulf ports to accept post-Panamax vessel sizes and container traffic. They also have transport-time advantages and are projected to serve rapidly growing populations west of the Appalachians while becoming more competitive by cutting their costs (EDRG 2012). Such advantages could maintain the proportion of freight moving into eastern and western ports despite Panama Canal enlargement. More container stacking on railroad cars, increased truck-trailer lengths, improved scheduling and other cost cutting strategies could significantly reduce the growth in atmospheric emissions per ton of freight transported, but probably not enough to make up for the much greater efficiency of large vessels entering the eastern U. S. through East Coast ports. The tradeoffs are complicated by harbor enlargement impacts at southeastern ports and local air quality degradation and port congestion at some West Coast ports that are already stressed.

The potential effects of climate change are also important variables. Where ports are already within 5 feet of the 50 feet used to characterize post-panamax readiness, rising sea level can contribute significantly to the port capacity for post-panamax vessels, especially when considered with tidal effects on harbor depths. When combined with the effects of deepening channels and rising sea levels, hurricanes may drive salt water farther into freshwater environments, destroying more wetland (Dahl 2012). Climate change also has implications for port vulnerability to flooding and storm damage. A less certain consideration is the possibility of more powerful hurricanes energized by warmer oceans. Regardless of those possibilities, ports that are more exposed to adverse hurricane effects, which can interfere with freight movement for months, have less of a long-term advantage than more protected ports.

Variation in Port Vulnerability to Environmental Impact

Human and Resource Vulnerability

Regional summaries do not reveal the substantial variation among ports within regions. Table 4 reveals some of that variability among 20 large container ports in four coastal regions. It shows port variation for vulnerability and modernization impact indicators, as well as total potential impact from modernization activities. All indicators in Table 4 were normalized to a maximum of 100, which was assigned to the port with the greatest indicator value. The raw-score data are provided in Appendix A3. Appendix A4 summarizes environmental assessment and impact statement information to the extent it is available for the ports.

Health, Safety and Environmental Justice

Table 4. Indicators of relative vulnerability to environmental impacts at representative container ports in four coastal regions of the United States. Raw indicator values (reported in Appendix A3) were normalized between 0 and 100 for comparability.

	Health, Safety & Environmental Justice					Heritage Loss			Economic Loss			Total
Ports	Air	Water	Super-fund	Low Income	Minority Status	Percent Wetland	Parks	Rare Species	Comm. Fishing	Sport-Fishing	Beach	Total
Boston	4	27	7	67	50	11	1	14	100	47	85	413
NY/NJ	15	6	79	79	75	9	14	9	32	61	0	382
Philadelphia	27	12	100	75	58	15	2	6	1	0	0	296
Wilmington, DE	21	0	30	60	95	46	19	5	7	43	0	326
Baltimore	24	42	33	82	35	13	3	9	10	23	0	274
NE Atlantic	18.2	17.4	49.8	72.6	62.6	18.8	7.8	8.6	30.0	34.8	17.0	345.4
Norfolk	6	0	1	54	53	13	0	3	18	21	47	216
Wilmington, NC	18	0	11	61	44	52	1	18	8	13	2	228
Charleston	0	0	27	84	73	57	1	26	2	12	0	282
Savannah	9	5	19	66	73	100	100	21	2	17	0	412
Jacksonville	1	53	25	48	91	54	74	12	7	64	0	429
Port Everglades	1	65	19	63	56	24	0	26	7	64	89	414
Miami	3	36	4	100	81	61	0	62	7	64	100	518
SE Atlantic	5.4	22.7	15.1	68.0	67.4	51.6	25.1	24.0	7.3	36.4	34.0	357.0
Tampa	15	100	45	52	43	33	0	18	7	64	4	381
Mobile	5	29	16	42	94	57	23	29	14	29	0	338
New Orleans	78	89	12	85	60	46	33	17	10	1	0	431
Houston	35	11	5	53	46	40	4	17	19	100	21	351
Gulf	33.3	57.3	19.5	58.0	60.8	44.0	15.0	19.5	12.5	48.5	5.3	375.2
Long Beach	100	15	37	91	100	0	1	82	16	52	54	548
Los Angeles	100	14	33	75	91	0	1	100	16	52	20	502
Oakland	15	5	25	72	94	0	13	36	16	52	0	328
Tacoma	1	1	15	54	50	2	1	8	27	11	91	261
Pacific	54.0	6.3	27.5	73.0	83.8	0.5	4.0	56.5	18.8	41.8	41.3	409.7

The number of days that air quality exceeded standards set for people with respiratory difficulty was highly variable. The worst conditions were in the Pacific region, but only because the violation rate was very high at the two adjacent ports in Los Angeles. Air quality was much better farther north at the Oakland and Tacoma ports.

This finding was paired with relatively high fractions of low income and minorities within 5 km of the Los Angeles ports, which together contributed largely to high total scores at those ports. Southeastern ports had the best air quality followed closely by northeastern ports.

Water quality (indicated by the number of permitted discharges) also was highly variable and, in contrast to air quality, was particularly low at Pacific ports. Vulnerability to further degradation in water quality was highest at two of the Gulf ports and moderately high at two southeastern ports. Four of the five highest values were at ports in Florida. Elsewhere in the Southeast, the ports had exceptionally low scores. Northeast port scores were generally good, second to the Pacific in total score.

In contrast with water discharge permits, the number of superfund sites was greatest in the Northeast, reflecting its manufacturing history. But variation was very high there ranging from few superfund sites in the Boston port area to the most superfund sites in the Philadelphia port area. The number of superfund sites elsewhere was variable, but quite consistently lower than several of the northeastern ports. The major exceptions were at Jacksonville and Long Beach.

Indicators of potential environmental inequity were less variable than other indicators. A higher fraction of low income and minority groups consistently live near ports. Calculated poverty rates within 5 km of ports averaged about 38% higher than home states and 104% higher than the national average. The vulnerability of low income and minority publics to adverse impact from ports is in general quite high and a reason behind a push to clean up port air quality (Bailey et al. 2004).

Heritage Loss

The vulnerability to further loss of important local to national heritage was indicated by the percentages of wetland and officially preserved areas, as well as the numbers of threatened and endangered species (rare species) found within 10 km of the ports. In keeping with the high percentage of coastal wetland in the Southeast and Gulf regions, vulnerability to wetland degradation was relatively high on average at those ports, but especially so at Savannah. In contrast, wetland vulnerability was very low at Pacific ports where conditions do not support extensive coastal wetlands.

Parks and other preserves were scarce within 10 km of ports, but were most vulnerable in the Southeast Region because of high vulnerabilities at ports in Savannah and Jacksonville. Variation was very high, however. Most southeastern ports had little or no nearby preserve area. The Gulf Region was second highest in preserve vulnerability to port modernization and the Northeast and Pacific ports were quite consistently low. Low preserve number may reflect to some extent large city size and extensive manufacturing, which nearly eliminated natural environments many decades ago.

Rare species—indicated by the number of threatened and endangered species in the counties of port location—were particularly high in counties with California ports and particularly low in northeastern counties with ports. After southern California, ports in the Southeast Region tended to score moderately high. The tendency for Pacific and southeast ports to score highest is consistent with the distributions of threatened and endangered species described in the existing environmental footprint (Figure 21).

Economic Loss

Among indicators of economic losses from beneficial use of natural resources, the commercial fishing value was particularly high for Massachusetts and the port of Boston. A relatively short shoreline length concentrated the fishery closer to the port of Boston than many other states with highly valued fisheries and much longer coastlines. Variation among ports in the Northeast was very high, however. Values among most ports tended to be much lower than for Boston. Even New Orleans, in a state that depends greatly on its commercial fishery, was low because of the high shoreline length. On the Pacific Coast, Tacoma had a relatively high score.

Scores for sportfishing varied significantly from 0 at Philadelphia, which has little saltwater fishing close by, to the highest at Houston. Moderately high values occurred in Florida, where nonresidential as well as residential sportfishing is popular. The shoreline is long, however, increasing the probability of less conflict between ports and sportfishing than in Texas. The container port at Houston is located in Galveston Bay, which draws resident saltwater fisherman from an area of high population density. Ports at Boston and NY-NJ had moderately high scores largely because of the relatively low shoreline length of those states.

Public beach area within 10 km of ports scored high in south Florida ports and near Tecoma and Boston. Overall, southeastern and Pacific ports scored highest. The variation was high among ports within all regions, however.

Some General Observations

Port total scores varied between 216 at Norfolk and 548 at Long Beach, which is not as wide a spread as the variation in individual scores among ports might indicate. In general, ports had quite different combinations of vulnerabilities and none were consistently low or high. Ports in close proximity to one another had much more in common than ports farther apart. Among the three ports ranked above 500, two were next to each other at Los Angeles and Long Beach. Two other Pacific ports—Tacoma and Oakland—ranked relatively low by comparison. In the Southeast Atlantic region, the three northern ports were ranked about half as vulnerable as Miami and significantly lower than all ports south of Charleston. Each region had at least two ports that ranked highest among all of the ports for specific indicators and at least three ports that ranked among the lowest. Thus, the vulnerability of regions could be disproportionately influenced by high scores for certain ports, while other ports in the region ranked low. If one generality applies to port vulnerabilities, it would be about high variation among ports within regions. Concluding from regional studies that all ports are likely to reflect regional vulnerabilities would be wrong and misleading.

From the environmental standpoint alone, the differences at the regional level dampen potentially important differences at the port level. Regionally, the potential costs of mitigation for the same port modernization actions appear quite similar, but are in fact quite different among ports. Mitigation expenses may vary significantly among ports for the same actions taken.

These indicators of port vulnerability to modernization impacts and to environmental impact mitigation costs must be considered preliminary. The indicators imperfectly represent port vulnerabilities within categories and are an incomplete assessment of all possible vulnerabilities. Much more detailed study at each port would need to be completed to make more informed comparisons. In addition, the indicators of vulnerability to adverse impact do not indicate variations in the intensity and extent of modernization required at different ports to achieve post-panamax readiness. These are addressed in the next subsection.

Potential for Future Adverse Impacts at Ports

Table 5 summarizes data for indicators of potential adverse impacts in the future based on perceived modernization needs. Three indicators of modernization need were developed. All indicators were normalized to a maximum of 100, which was assigned to the port with the greatest indicator value.

The first metric indicates the needed modernization to accommodate the largest post-panamax vessels based on a 50-foot depth criterion and the length of the main channel into the port. The public may benefit from port expansion because freight shipment costs and atmospheric emission per ton of freight moved decrease with increased size of the transport vessel (Economic Development Research, Inc. 2012, Notteboom and Vernimmen. 2009). But, depending on location, deepening and widening, port expansion could also result in significant environmental impact that requires costly mitigation.

The indicated expansion needs based on this metric was highly variable. Pacific Coast ports are well prepared for post-panamax vessels and already receive them from Pacific Rim origins. The Pacific ports in this study consistently scored 0 because they are post-panamax ready. Ports in the Northeast exhibited the greatest variation because two are nearly ready and scored 0. Philadelphia and Wilmington, DE scored very high because of the length of the main channel that needs deepening. The most northern port in the Southeast Region scored 0, but all other ports required some excavation with the least in south Florida ports. Gulf ports also required excavation and, in the case of the port of New Orleans, the very long main channel required an exceptional amount.

Another metric indicates how well existing unused capacity could meet freight transport needs based on expected percent population growth over the next 30 years. Ports with large capacity surpluses compared to increases in freight movement through the port may need to invest less in modernization designed only to handle increased freight movement and storage needs. This metric varied less among ports within the same region than most metrics. The big need is in the Southeast which already makes relatively high use of port capacity and anticipates high regional population growth. The port in greatest need, however, is Oakland. The Northeast ports are quite consistently better provisioned for future population growth, which is expected to be the lowest among the regions.

The indicator chosen to forecast changes in the total amount of freight movement through ports is the actual expected growth in population. Total regional income growth probably is a better indicator, but is less reliable because of uncertainties about per capita income growth. Regional populations served by southeastern ports and Pacific ports are expected to grow similarly and most rapidly. The Northeast is likely to experience the least growth, especially in the service

Table 5. Indicators of port needs and relative environmental impact associated with modernization to meet those needs. Raw indicator values (see Appendix A3) were normalized between 0 and 100 for comparability.

	Harbor Expansion Need		Capacity & Growth				Population Growth		
Port	Depth (ft) x miles	Normal-ized (0-100)	% unused Port Capacity (A)	% Regional Population Growth(B)	% Capacity minus % growth (A-B)	Normal-ized (0-100)	1000s	Normal-ized (0-100)	Total
Boston	90	7	75	12	63	31	1,700	7	45
NY/NJ	0	0	49	13	36	53	4,811	20	73
Philadelphia	1070	84	57	14	43	48	4,528	19	151
Wilmington, DE	960	75	57	14	43	48	4,528	19	142
Baltimore	0	0	73	21	52	40	5,524	24	64
NE Atlantic	424.0	33.2	62	15	48	44	4,218.2	17.8	118.8
Norfolk	0	0	42	45	-3	88	11,085	47	137
Wilmington, NC	208	16	31	41	-10	92	13,584	58	166
Charleston	193	15	42	56	-14	95	23,540	100	200
Savannah	256	20	42	56	-14	95	23,540	100	215
Jacksonville	300	23	72	61	11	74	16.632	71	168
Port Everglades	32	3	54	68	-14	95	16,535	70	168
Miami	78	6	54	68	-14	95	16,535	70	171
SE Atlantic	152.4	16.6	48	56	-8	91	17,350.	73.71	175.0
Tampa	133	10	70	59	11	74	16,962	72	156
Mobile	78	6	81	29	52	40	6,198	26	72
New Orleans	1280	100	53	11	42	48	4,514	19	167
Houston	42	3	51	46	5	79	13,262	56	138
Gulf	383.25	29.8	64	36	28	60	10,234.0	43.3	133.3
Long Beach	0	0	59	48	11	74	23,463	100	174
Los Angeles	0	0	59	48	11	74	23,463	100	174
Oakland	0	0	57	77	-20	100	18,227	77	177
Tacoma	0	0	67	27	40	50	6,242	27	77
Pacific	0	0	61	50	11	75	17,487.8	76.0	150.5

area of the northern-most ports. Variation among ports within a region is relatively small in part because the regions served by the ports overlap. Appendix A2 summarizes the state populations included in port service regions.

The sum of indicator scores (Table 6) suggests the largest potential for environmental impact and mitigation cost at southeastern ports. The Northeast Region has the least potential. The variation for total scores (shown in Table 5) ranged from 45 at Boston to 215 at Savannah (followed closely by Charleston with 200). Ports in close proximity tended to have similar scores because of similar characteristics. The largest score differences seemed to be most related to harbor enlargement needs.

Some significant impact variables were difficult to capture in simple metrics. The environmental impacts of the mix of freight transport methods were difficult to measure, for example, because the different modes have different environmental impacts per ton shipped. Since truck impacts are much greater than rail and barge transport (which now have similar impacts), transportation investment decisions that contribute to minimizing truck use are environmentally preferable. As trains become more cost efficient, they may replace trucks for shorter hauls and reduce atmospheric emissions. Some ports are well prepared to transfer freight directly to trains while others are less prepared. Environmental improvements for all modes of transport have increased over the years as regulations became more demanding and new innovations were applied. Continuation of this trend should moderate the effect of increasing freight transport traffic.

Potential Environmental Impacts at Waterway Locks

The potential environmental impacts on the Mississippi and Illinois Rivers are most associated with increased atmospheric emissions along the waterways and building new locks large enough to pass doubled-up barge rafts. New locks would be built largely in areas located near local population centers in rural areas where health and safety concerns are relevant but much less likely to affect as many people as around large container ports.

Atmospheric emissions along the entire waterway route would increase as barge and intermodal transport increased, but lock expansion would moderate the increased impact from emissions by reducing barge congestion in lock vicinities. The trend could be further counterbalanced by replacement of old tugs with more fuel and emission efficient tugs and with new barges that carry more weight.

New locks may have impacts on wetlands and threatened and endangered species where they must be placed in riparian areas. Based on data from FWS (2012), 62% of the 100 meter riparian strip next to locks and dams on the upper Mississippi is wetland, which, if damaged, would most likely require compensatory mitigation. On the Illinois River, 42% is wetland. No critical habitat of threatened or endangered species is expected to be impacted, but one or more threatened prairie riparian species may live in or near counties where locks are located (e.g., *Asclepias meadii, Platanthera leucophaea*). The upper Mississippi and Illinois Rivers are home to a number of freshwater mussels and other threatened and endangered aquatic species, but, in general, adverse impacts on them are likely to be small. Locks constructed off shore in existing navigation pools would have little impact on endangered species, wetlands, and preserves because the impoundments have so altered original habitats. Agricultural and residential resource uses are the most likely to be impacted.

Table 6. Regional indication of potential environmental impact for the four most important container-port regions. The raw data for Individual metrics (Appendix A3) were normalized to values between 0 and 100 to allow regional comparison and summation.

Indicators	Port Regions			
	Northeast Atlantic	Southeast Atlantic	Gulf	Pacific
Vulnerabilities				
Health, Safety & Equity	44.2	35.7	45.7	48.9
Heritage Loss	11.9	33.7	26.2	20.3
Economic Loss	27.7	25.9	22.1	34.0
Subtotal	83.8	95.3	94.0	103.2
Modernization Sources				
Harbor Expansion	33.2	16.6	29.8	0
Freight Transport	17.8	73.7	43.3	76.0
Port Expansion	44.0	90.6	60.2	74.6
Subtotal	128.0	180.9	133.3	150.6
Total	211.8	276.2	227.3	253.8

The extent to which grain and soybean transport by barge increases greatly depends on what railroads and trucks do to compete. The main alternative to barge transport is rail or truck transport either to the West Coast or directly to Gulf ports, which would circumvent the need for a shipment transfer. If rail efficiencies continue to improve, the Pacific Coast ports (including Canadian ports) may continue to capture much of the grain and soybean traffic. Barge shipment no longer has an environmental advantage over railroads since they are now about equally fuel efficient (USDOE 2012 and OEE 2011). For these and other reasons, the anticipated reversal of past downward trends in barge traffic is uncertain and the net effect on air quality will likely be similar, as long as trucks do not take a much larger fraction of the grain and soybean transport.

Rapid improvements in rail emissions efficiency while waterborne freight transport has remained static (USDOE 2012) may have contributed to different conclusions about the effects of the Panama Canal on atmospheric emissions of grain and soybean transport. Conventional wisdom argues that atmospheric emissions will be improved over the present transport system because of the longer grain transport distance by large vessel through the Panama Canal (Energy Development Research, Inc 2012). However, Baird et al. (2011) concluded that grain and soybean transport down the Mississippi and through the Panama Canal will result in greater atmospheric emissions than overland transport to Pacific Ports.

Concluding Remarks

Resor and Gabler (2011) concluded that there is little agreement in recent reports about the future of trade routes and how they will respond to Panama Canal enlargement and other changes. Based on past trends, they also believed that changes in ship size and trade routes will be gradual. There is time for more careful assessment and adaptive decision making as changes become more certain. Environmental impact mitigation needs are also uncertain. While the costs of environmental impact mitigation are likely to be substantial most anywhere within and across regions affected by transportation system modernization, the specific impacts are impossible to estimate without detailed information developed during studies of project environmental impact.

Taking those uncertainties into consideration, the information developed here suggests that ports in the Southeast Region are the most likely to require environmental mitigation associated with modernization actions. But, unused port and waterway capacity at most ports generally allows for considerable increase in freight movement without stressing port limits for some time into the future. Relatively few vessels of post-panamax size are calling at ports that are now post-panamax ready. While the proportion is expected to grow, it is likely to be gradual.

The uncertainties associated with the results of a national study with limited resources point strategically to the use of a more informed adaptive approach to future investment in port and waterway modernization. Careful assessment of the environmental impacts of alternative approaches to transportation system modernization is needed as opposed to more disconnected studies of transportation system segments. Trends in transportation system change should be monitored and analyzed regularly to more adaptively manage the uncertainty and risks of unnecessarily impacting the environment through inefficient modernization decisions.

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Appendices

Appendix A1. Selected Topic Literature Reviews

Influence of Land Uses, Including Ports, on Coastal Waters

The chemical and ecological integrity of coastal open waters is largely influenced by surrounding land uses, including ports. Urban land use has adverse effects on water quality and sediment quality, particularly on levels of bacteria and nutrients (Holland et al. 2004; Deacon et al. 2005; Xian et al. 2007; Van Dolah et al. 2008) and more persistent pollutants such as metals and organics (Comeleo et al. 1996; Xian et al. 2007; Van Dolah et al. 2008). The high amount of impervious land cover in urban areas around and in many large ports contributes significantly to the elevated runoff of pollutants. Comeleo et al. (1996) indicated that land uses within a 10-kilometer radius of a sampling location explained much of the variation in sediment pollutant levels. In addition, these types of land uses have effects on benthic organisms (Hale et al. 2004; Holland et al. 2040; Deacon et al. 2005; Bilkovic et al. 2006) and fish (Deegan et al. 1997; Hale et al. 2004). There may even be an ecological threshold at 10% of developed shoreline and developed watershed of 12% (Bilkovic et al. 2006).

The strength of the relationship between urban land uses and chemical endpoints is supported by the moderate correlations between percent urban land uses and miles of shorelines or streams and rivers that have been designated as impaired waters. Analysis of rank order correlations shows a moderately strong relationship exists between urbanization within 10 kilometers of twenty large container ports in the United States and impaired shorelines within 10 kilometers of a port, particularly for metals and PCBs (Table A1.1). This type of relationship is similar to observations made by Comeleo et al. (2006). The relationship between streams/rivers and urbanization within 10 kilometers of a port are not as strong, most likely because the entire watershed draining to a stream/river was not analyzed.

Consequently, the extent of urban land uses within a coastal feature of interest such as a container port can provide insight into the quality of water/sediments and ecological condition. Activities near container ports with high levels of urban land uses are less likely to affect chemical and ecological endpoints whereas activities near container ports with low levels of urban land uses would more likely affect chemical and ecological endpoints. For this purpose, a radius of 10 kilometers serves as a useful indicator of potential impacts.

Table A1.1 Spearman's correlation coefficients between percent urbanization based on the 2006 National Land Cover Database and hydrological features listed as impaired for a pollutant under Section 303(d) of the Clean Water Act. Hydrologic features are within a 10-kilometer radius of twenty top container ports in the United States.

	Coastlines		Streams/Rivers	
	Spearman's Rho	#	Spearman's Rho	#
Dioxins	0.50	3	-	-
PAHs	0.06	6	-0.40	4
PCBs	0.65	9	-0.43	7
Pesticides	0.21	5	-0.52	9
Mercury	-0.24	6	0.17	9
Metals (other than Mercury)	0.69	6	-0.30	10
Pathogens	-0.03	6	-0.22	9
Nutrients/Ammonia	-	-	-0.05	12
Oxygen Depletion	-	-	0.33	18

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Dredging and Disposal of Dredged Materials

Dredging operations have effects on marine systems through suspension of dredged sediment or through the change in the bottom elevation through excavation or placement of dredged materials. From 1977 to 2010, within those Corps Districts including one of the top twenty U. S. container ports, dredging activities removed nearly 2000 million cubic yards of dredged material (1,551 million cubic yards by contractors and 407 million cubic yards directly by the Corps). Open ocean disposal was the most common means of disposal (Table A1.2). Contractors disposed About 550 million cubic yards into open water and the Corps directly disposed about 378 million cubic yards into the open ocean. It is expected that this trend will continue. It is important to note that these volumes represent dredging activities from all the ports in the district as well as all dredging activities to maintain design conditions.

Suspended sediments released from dredging and disposal operations tend to have localized effects. For both the dredged and disposal sites, a small fraction 1-3% would become suspended (Barnard 1978; Bohlen et al. 1979) with the vast majority settling within an hour (as reviewed by Anchor Environmental 2003). Suspended sediments generally settle rapidly out of the water column, with increased levels of suspended sediment observed at distances ranging from a few hundred meters from dredged or disposal sites (LaSalle 1988; Newel et al. 1998) to over 1,000 meters along the bottom of the seafloor for some dredge activities (Hayes 1986; Clarke and Wilber 2000). In general, mechanical dredging operations release more sediments than hydraulic dredging operations (Hayes 1986; Havis 1988). Levels of suspended sediments in salt water tends to be even less because the salt water ions induce flocculation and eventual sedimentation (Herbich and Brahme 1991; Wilber et al. 2005). However, even the small amount of the fine sediments that do get suspended can increase turbidity levels by two orders of magnitude (Bohlen et al. 1979). Documented adverse effects from laboratory studies include mortality, reduced growth, reduced feeding, damage to gills, and avoidance behavior (as reviewed by Clarke and Wilber 2000; Berry et al. 2003). For benthic fauna, there is a large data gap because controlled laboratory studies do not replicate field exposure levels and controlled field level studies examining the ecological effects of suspended sediment are rare (Clarke and Wilber 2000). In addition, exposure to toxic organic compounds and metals in the water column during dredging and disposal activities is expected to be minimal, since contaminants are less likely to be soluble than bound with sediment and suspended sediment usually settles out of the water column quickly (Anchor Environmental 2003).

Table A1.2. Mode of disposal of dredged materials by agent (Corps vs. Corps contractor) for Districts including one or more of the top container ports in the United States from 1977 to 2010.

District	**Upland**	**Beach / Upland**	**Beach**	**Wetland Creation**	**Confined**	**Open Water**	**Open Water / Upland**	**Underwater Confined**	**Mixed (>1 type)**	**Undefined**
Dredged by Corps Contractor										
Baltimore	0.3	0.1	6.1	0.3	33.4	6.3	0.0	0.0	0.3	2.0
Charleston	3.4	0.0	1.7	0.0	19.2	13.9	0.0	9.7	0.0	0.0
Galveston	13.9	5.7	4.0	19.8	76.4	78.1	18.0	0.0	35.7	27.0
Jacksonville	24.0	9.6	33.9	0.0	0.9	22.4	3.5	0.0	7.8	1.8
Los Angeles	0.0	0.0	11.0	0.0	0.0	0.5	0.0	0.0	1.9	0.0
New England	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.2	0.2	0.2
New Orleans	18.3	1.0	10.6	189.2	3.7	358.5	0.0	0.0	116.7	5.6
New York	2.5	0.7	16.2	0.0	0.0	3.2	1.3	2.1	0.0	1.9
Norfolk	17.3	0.7	6.4	0.0	0.6	8.0	2.4	0.0	1.7	0.4
Philadelphia	1.8	2.1	26.1	0.0	37.5	2.9	1.5	3.5	2.8	2.9
San Francisco	0.5	0.0	0.0	0.0	0.0	7.3	0.7	0.0	2.4	0.0
Savannah	43.8	0.0	2.7	0.0	0.4	14.8	0.9	0.0	11.4	0.0
Seattle	1.1	0.1	0.3	0.0	0.0	7.2	1.3	0.0	0.0	0.0
Wilmington	12.6	4.0	25.7	0.0	11.1	27.9	21.7	0.0	3.8	5.3
SUBTOTAL (% of Total)	139.7 (9%)	23.9 (2%)	145.0 (9%)	209.3 (13%)	183.3 (12%)	551.6 (36%)	51.2 (3%)	15.4 (1%)	184.8 (12%)	47 (3%)
Dredged by Corps										
New Orleans						53.5				3.1
Philadelphia	1.5				5.3	27.1	0.1	1.0		
Portland						115.6				3.4
St. Louis						40.2				1.7
St. Paul	3.5				0.6				4.6	2.1
Vicksburg						105.5				
Wilmington						36.2	1.3		0.1	1.0

SUBTOTAL *(% of Total)*	5.0 (1%)				5.9 (1%)	378.1 (93%)	1.4 (<1%)	1.0 (<1%)	4.7 (1%)	10.4 (3%)

For submerged aquatic vegetation, substantial sustained turbidity can depress growth and increase mortality (as reviewed by Erftemeijer and Lewis 2006). For common species found in the United States, the critical threshold range for percent surface irradiance was 5-30.5% for shoalweed (*Halodule wrightii*), 17.2-30.5% for manatee grass (*Syringodium filiforme*), 10-22% for turtle grass (*Thalassia testudinum*), and 11-37% for eelgrass (*Zostera marina*) (as reviewed by Erftemeijer and Lewis 2006). However, extended duration of low light levels was needed to produce adverse effects, including reported values of 9 months for shoalweed and 11 months for turtle grass (as reviewed by Erftemeijer and Lewis 2006).

At the dredge site, removal of sediment is expected to disturb benthic communities and submerged aquatic vegetation. McCauley et al. (1977) indicated that in areas normally subject to repeated disturbances (e.g., navigation channels) recovery of benthic infauna occurred in as little as 28 days. The recovery from dredging operations may vary from several months for estuarine mud substrates to a several years for gravel substrates (Newell et al. 1998). Areas that recover slowly would tend to be less dynamic substrates where shifting sediments would not replace sediments from dredged locations. There are documented cases in the United States where dredging was conducted in submerged aquatic vegetation, resulting in substantial impacts totaling thousands of acres, although occurring mostly before more stringent application of environmental laws (Erftemeijer and Lewis 2006).

At areas receiving dredged sediments, including both disposal sites and sites experiencing sedimentation of re-suspended sediments, deposition of sediment is expected to disturb benthic communities. However, benthic communities in shallow coastal waters experience natural deposition and re-suspension processes on a daily basis that would allow such organisms to acclimate to some small to moderate disposal activities (Wilber et al. 2005). For some life stages of aquatic organisms (e.g., eggs of marine fishes), burial by millimeters of sediment may be sufficient to induce mortality (as reviewed by Wilber et al. 2005). For adult stages of benthic organisms, burial can cause mortality in some species with as little as a few centimeters of sediment burial (Maurer et al. 1986, Hinchey et al. 2006), but recovery of benthic communities can occur quickly in areas that are normally experience repeated perturbations in as little as two weeks (McCauley et al. 1977) or up to three months (Smith and Rule 2001). The ability of a benthic species to survive and re-colonize depends on the species' ability to move vertically in response to the burial (Maurer et al. 1986, Hinchey et al. 2006). For submerged aquatic vegetation, studies in other countries indicate a few centimeters of sediment deposition may adversely affect seagrasses (as reviewed by Erftemeijer and Lewis 2006). When the deposited sediment is contaminated, effects to re-colonizing benthic species are expected. As evidenced by the previous review of disturbed land uses and ecological condition, exposure to pollutant sources can affect benthic organisms. Thus, disposal of contaminated sediments at a location could adversely affect benthic communities.

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Sea Turtles and Sea Mammals

Activities associated with shipping and port expansion can affect sea turtles. Monitoring of Corps dredging operations documented that hopper dredging using a trailing suction dragheads have resulted in incidental take of 508 sea turtles from 1980 to 2003 including 360 loggerhead, 37 Kemp’s, 50 green, and 61 unidentified sea turtle species (Dickerson et al. 2004). Of these, 363 occurred in the South Atlantic. Since 1992, implementation of turtle deflectors, relocation trawling and dredging windows has drastically reduced the rates of incidental take, even though dredging operations increased. Selective monitoring of other types of dredging operations had no recorded incidental take of sea turtles. Bolten et al. (2011) estimate dredging activities result in 11-100 annual deaths of loggerhead turtles within the Northwest Atlantic Ocean.

Ship strikes can also adversely affect sea turtles and sea mammals. Bolten et al. (2011) estimated ship strikes result in annual deaths of 101 to 1000 loggerhead turtles within the Northwest Atlantic Ocean. Collisions with green sea turtles in Australia increased for vessel velocities greater than 4 km/h, suggesting higher velocities elsewhere would increase vessel strikes with sea turtles (Hazel et al. 2007). In their global review of 292 large whale ship strikes from 1975 to 2002, Jensen and Silber (2004) documented close to 200 large whale ship strikes in United States coastal waters, including 38 North Atlantic right whales. Jensen and Silber (2004) documented a higher chance of collision at higher ship velocities. Of the 134 cases of known vessel types, there were 23 incidents involving Navy vessels, 20 incidents involving container/cargo vessels, 19 incidents involving whale-watching vessels, 16 incidents involving ferries, and 9 incidents involving Coast Guard vessels (Jensen and Silber 2004). Most of the vessel types were unknown. Also, many of the vessel strikes were only discovered when the ship arrived into the harbor with a dead whale on the bow. Many more are probably hit and killed without being impaled.

The contribution of container ship traffic to vessel strikes appears to be comparatively small. Bolten et al. (2011) concluded that worldwide fisheries caused the most whale deaths to both adults (about 3000) and juveniles (about 8600). Jensen and Silber (2004) indicate container and cargo vessels represent about 15% of known vessel strikes. But vessel collisions are the greatest known human-caused death of North American right whales (Silber and Bettridge 2012).

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Appendix A2. States Included in Regional Growth Estimates

Table A2.1. States included in regional growth estimates

Port	States[1]
Boston	MA, ME, CN, VT, NH, RI
NY/NJ	MA,CN,VT, NH, NY, PA, OH, RI, NJ, MD
Philadelphia	PA, MD, DE, NJ, OH, NY
Wilmington, DE	PA, MD, DE, NJ, OH, NY
Baltimore	MD, PA, VA, DE. NJ, OH, KY, TN, DC
Norfolk	VA, MD, NC, DE, WV, OH, KY, TN, DC
Wilmington, NC	NC, TN, VA, SC, GA
Charleston	FL, GA, SC, TN, NC
Savannah	FL, GA, SC, TN, NC
Jacksonville	FL, GA, SC, AL, TN
Port Everglades	FL, GA
Miami	FL, GA
Tampa	FL, GA, AL
Mobile	AL, MS, TN, GA
New Orleans	LA, MS, AR, MD, IA, MN, WI, TN, IL
Houston	TX, LA, OK
Long Beach	CA, NV, AZ, NM, UT, CO
Los Angeles	CA, NV, AZ, NM, UT, CO
Oakland	CA, NV, UT, OR, ID, WY
Tacoma	WA, OR, UT, ID, MT, WY

1. States included in the region generally were within 500 miles of the port but also depended on the closer proximity of competitor ports. For example, Boston is within 500 miles of NY, PA, and NJ but competes relatively little with the ports of NY-NJ, Philadelphia and Baltimore for that service area. Service area can vary significantly from this regional indicator, depending on port location, intermodal connections and other factors.

Appendix A3. Raw Data Used for Impact Analyses

Table A3.1 General land cover characteristics within 10 kilometers of 20 top container ports in the United States[1].

Ports	**Developed[2]**	**Agriculture[3]**	**Wetland[4]**
Boston, MA	91%	0%	5%
New York, NY and NJ	94%	0%	4%
Philadelphia, PA	87%	1%	7%
Wilmington, DE	63%	7%	21%
Baltimore, MD	89%	0%	6%
Norfolk, VA	84%	0%	6%
Wilmington, NC	44%	2%	24%
Charleston, SC	57%	1%	26%
Savannah, GA	38%	1%	46%
Jacksonville, FL	57%	1%	25%
Port Everglades, FL	88%	0%	11%
Miami, FL	71%	0%	28%
Tampa, FL	79%	1%	15%
Mobile, AL	64%	2%	26%
New Orleans, LA	77%	1%	21%
Houston, TX	63%	8%	17%
Long Beach, CA	98%	0%	0%
Los Angeles, CA	94%	0%	0%
Oakland, CA	99%	0%	0%
Tacoma, WA	84%	2%	2%

[1] Based on the 2006 National Land Cover Database (http://www.mrlc.gov)

[2] Developed land cover consists of developed open space, low intensity, medium intensity, and high intensity land cover.

[3] Agriculture land cover consists of pasture and row crops.

[4] Wetland land cover consists of forested and herbaceous wetlands. These wetlands were determined from remote sensing and may not be jurisdictional under the Clean Water Act (33 CFR (Code of Federal Regulations) Part 328)

Table A3.2. Acres of wetlands[1] within 10 kilometers of 20 top container ports in the United States.

	National Land Cover Database[2]				**National Wetlands Inventory[2]**							
Ports	**Image[3] Year**	**Emergent**	**Forested/ Shrub**	**Total**	**Image Year[3]**	**Emergent**			**Forested/Shrub**			**Total**
						Estuarine	Freshwater	Subtotal	Estuarine	Freshwater	Subtotal	
Boston, MA	2006	1,794	50	1,844	1992,1995	1,079	124	1,204	1	19	20	1,223
New York, NY and NJ	2005	904	1,378	2,282	1995,1994	1,320	300	1,620	0	203	203	1,822
Philadelphia, PA	2005	1,656	2,660	4,316	2002,1989	0	1,345	1,345	0	1,054	1,054	2,399
Wilmington, DE	2005	4,616	7,666	12,282	2007,2002,1999	2,082	1,838	3,920	33	5,685	5,718	9,638
Baltimore, MD	2005	716	2,727	3,443	1981,1988,1982	443	259	702	3	180	183	886
Norfolk, VA	2005	996	1,072	2,068	2000	801	177	977	37	438	476	1,453
Wilmington, NC	2007	7079	8,664	15,743	2010,1983	169	4,175	4,344	0	4,444	4,444	8,788
Charleston, SC	2006	12,658	2,268	14,926	1989,1990	12,211	499	12,709	165	1,233	1,399	14,108
Savannah, GA	2005	16,037	14,418	30,455	2006,2007	3,512	12,477	15,989	29	13,786	13,815	29,804
Jacksonville, FL	2006	8,957	5,510	14,467	1983	7,849	571	8,420	40	6,065	6,105	14,525
Port Everglades, FL	2006	1,022	3,242	4,263	1984,1985,1972	0	175	175	1,485	538	2,024	2,198
Miami, FL[4]	2006	7,786	1,535	9,320	1972,1984	0		0	352		352	352
Tampa, FL	2005,2006	2,037	5,607	7,644	1982	277	551	828	957	638	1,594	2,422

Mobile, AL	2005	7,108	3,982	11,090	2002,2001	4,821	289	5,110	815	3,000	3,815	8,925
New Orleans, LA	2005	4,563	9,512	14,075	1988	0	3,648	3,648	0	10,642	10,642	14,290
Houston, TX	2006	4,908	8,220	13,129	2006	1,366	744	2,110	1	3,192	3,193	5,303
Long Beach, CA	2007	57	37	95	2005,2002	14	164	178	0	67	67	245
Los Angeles, CA	2007	77	37	114	2002,2005	4	106	110	0	116	116	226
Oakland, CA	2006	32	15	47	1985	130	30	160	0	8	8	167
Tacoma, WA	2006	768	480	1,248	1980,1981	167	114	281	0	555	555	836

[1] Wetland land cover consists of forested and herbaceous wetlands. These wetlands were determined from remote sensing and may not be jurisdictional under the Clean Water Act (33 CFR (Code of Federal Regulations) Part 328)

[2] Based on National Land Cover Database (NLCD) (http://www.mrlc.gov) and the National Wetland Inventory (NWI) (http://www.fws.gov/wetlands)

[3] Year of the image ordered by extent of coverage from greatest to least coverage

[4] Miami had a large amount of seagrass areas interpreted as emergent wetlands under the NLCD

Table A3.3. Percent of main channel bordered by wetland within 10 km of 20 top container ports in the United States[1].

Ports	**Emergent (%)**	**Forested/Shrub (%)**	**Total (%)**
Boston, MA	41%	0%	41%
New York, NY and NJ	13%	2%	15%
Philadelphia, PA	22%	5%	27%
Wilmington, DE	32%	3%	35%
Baltimore, MD	6%	3%	9%
Norfolk, VA	14%	5%	19%
Wilmington, NC	78%	6%	84%
Charleston, SC	66%	2%	68%
Savannah, GA	71%	5%	76%
Jacksonville, FL	66%	1%	67%
Port Everglades, FL	20%	15%	35%
Miami, FL	52%	8%	59%
Tampa, FL	37%	28%	66%
Mobile, AL	22%	1%	22%
New Orleans, LA	4%	14%	17%

Houston, TX	26%	1%	27%
Long Beach, CA	4%	0%	4%
Los Angeles, CA	6%	0%	6%
Oakland, CA	1%	0%	1%
Tacoma, WA	10%	0%	10%

[1] Based on the 2006 National Land Cover Database (http://www.mrlc.gov)

Table A3.4. Properties of the navigable waterway between the container port and the open ocean for 20 top container ports in the United States. Confined channels are in rivers and canals.

Ports	Channel Type	Confined distance to Ocean	Wetlands Downstream of 10 km Radius
Boston, MA	Open	0	N
New York, NY and NJ	Confined (> Savannah)	13	N
Philadelphia, PA	Confined (> Savannah)	50	N
Wilmington, DE	Confined (> Savannah)	10	Y
Baltimore, MD	Open	0	N
Norfolk, VA	Open	0	N
Wilmington, NC	Confined (> Savannah)	40	Y
Charleston, SC	Confined (> Savannah)	14	Y

Savannah, GA	Confined (= Savannah)	31	Y
Jacksonville, FL	Confined (> Savannah)	21	Y
Port Everglades, FL	Confined (< Savannah)	3	N
Miami, FL	Confined (~ Savannah)	2	Y
Tampa, FL	Open	1	Y
Mobile, AL	Confined (~ Savannah)	3	N
New Orleans, LA	Confined (> Savannah)	190	N
Houston, TX	Confined (~ Savannah)	4	Y
Long Beach, CA	Open	0	N
Los Angeles, CA	Confined (~ Savannah)	7	N
Oakland, CA	Open	0	N
Tacoma, WA	Open	0	N

Table A3.5. Seagrasses, coral, and ecological open space within 10 kilometers for 20 top container ports in the United States. A blank is 0.

Ports	Seagrasses (acres)[1]	Coral (acres)[1]	Ecological Open Space (acres)[2]
Boston, MA	35		2
New York, NY and NJ			1,884
Philadelphia, PA			291
Wilmington, DE			2,535
Baltimore, MD			388
Norfolk, VA	6		
Wilmington, NC			5
Charleston, SC			8
Savannah, GA			13,314
Jacksonville, FL			9,877
Port Everglades, FL	11,612	7,624	
Miami, FL	27,619	4,381	
Tampa, FL			
Mobile, AL			3,074
New Orleans, LA			4,418
Houston, TX			479

Long Beach, CA			33
Los Angeles, CA			101
Oakland, CA	2,424		1,707
Tacoma, WA			424

[1] Based on United Nations Environment Programme-World Conservation Monitoring Centre database (http://data.unep-wcmc.org/datasets)

[2] Based on the United States Geological Survey's Gap Analysis Program Protected Areas Database of the United States (PADUS) v1.2 (http://gapanalysis.usgs.gov/PADUS). The ecological open space are areas identified as having permanent protection from conversion of natural land cover as well as a management plan to maintain natural conditions.

Table A3.6. Federally listed threatened, endangered, and candidate species in counties within 10 kilometers[1] of 20 top container ports in the United States.

	# of Species			**# of Species Using Freshwater Aquatic/ Riparian Habitat[2]**			**# of Species Using Coastal/Marine Habitat**			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Boston, MA	7	2	9	1	0	1	6	0	6	Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Piping Plover (Charadrius melodus), Roseate tern (Sterna dougallii dougallii)
New York, NY and NJ	6	0	6	2	0	2	4	0	4	Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta)
Philadelphia, PA	2	2	4	2	2	4	0	0	0	-
Wilmington, DE	1	2	3	1	1	2	0	0	0	-
Baltimore, MD	3	3	6	1	1	2	2	1	3	Sensitive joint-vetch (Aeschynomene virginica), Northeastern beach tiger beetle (Cicindela dorsalis dorsalis), Puritan tiger beetle (Cicindela puritana)
Norfolk, VA	2	0	2	0	0	0	2	0	2	Northeastern beach tiger beetle (Cicindela dorsalis dorsalis), Piping Plover (Charadrius melodus)

	# of Species			**# of Species Using Freshwater Aquatic/ Riparian Habitat[2]**			**# of Species Using Coastal/Marine Habitat**			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Wilmington, NC	9	3	12	0	2	2	8	1	9	Seabeach amaranth (Amaranthus pumilus), Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Kemp's ridley sea turtle (Lepidochelys kempii), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Piping Plover (Charadrius melodus), Wood stork (Mycteria americana), West Indian manatee (Trichechus manatus)
Charleston, SC	13	4	17	2	3	5	9	1	10	Seabeach amaranth (Amaranthus pumilus), Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Kemp's ridley sea turtle (Lepidochelys kempii), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Piping Plover (Charadrius melodus), Red knot (Calidris canutus rufa), Wood stork (Mycteria americana), West Indian manatee (Trichechus manatus)
Savannah, GA	11	3	14	1	3	4	8	0	8	Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Kemp's ridley sea turtle (Lepidochelys kempii), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Piping Plover (Charadrius melodus), Wood stork (Mycteria americana), West Indian manatee (Trichechus manatus)

	# of Species			**# of Species Using Freshwater Aquatic/ Riparian Habitat[2]**			**# of Species Using Coastal/Marine Habitat**			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Jacksonville, FL	8	0	8	2	0	2	6	0	6	Hawksbill sea turtle (Eretmochelys imbricata), Leatherback sea turtle (Dermochelys coriacea), Green sea turtle (Chelonia mydas), Loggerhead sea turtle (Caretta caretta), Wood stork (Mycteria americana), West Indian manatee (Trichechus manatus)
Port Everglades, FL	14	3	17	3	2	5	9	1	10	Beach jacquemontia (Jacquemontia reclinata), Hawksbill sea turtle (Eretmochelys imbricata), Leatherback sea turtle (Dermochelys coriacea), Green sea turtle (Chelonia mydas), Loggerhead sea turtle (Caretta caretta), American crocodile (Crocodylus acutus), Wood stork (Mycteria americana), Red knot (Calidris canutus rufa), West Indian manatee (Trichechus manatus), Southeastern beach mouse (Peromyscus polionotus niveiventris)
Miami, FL	23	18	41	6	4	10	10	1	11	Beach jacquemontia (Jacquemontia reclinata), Hawksbill sea turtle (Eretmochelys imbricata), Leatherback sea turtle (Dermochelys coriacea), Green sea turtle (Chelonia mydas), Loggerhead sea turtle (Caretta caretta), American crocodile (Crocodylus acutus), Cape Sable seaside sparrow (Ammodramus maritimus mirabilis), Wood stork (Mycteria americana), Piping Plover (Charadrius melodus), Red knot (Calidris canutus rufa), West Indian manatee (Trichechus manatus)

	# of Species			**# of Species Using Freshwater Aquatic/ Riparian Habitat[2]**			**# of Species Using Coastal/Marine Habitat**			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Tampa, FL	9	3	12	1	1	2	6	0	6	Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Wood stork (Mycteria americana), West Indian manatee (Trichechus manatus)
Mobile, AL	18	1	19	4	1	5	12	0	12	Gulf sturgeon (Acipenser oxyrinchus desotoi), Alabama red-belly turtle (Pseudemys alabamensis), Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Kemp's ridley sea turtle (Lepidochelys kempii), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Piping Plover (Charadrius melodus), Wood stork (Mycteria americana), Alabama beach mouse (Peromyscus polionotus ammobates), Perdido Key beach mouse (Peromyscus polionotus trissyllepsis), West Indian manatee (Trichechus manatus)
New Orleans, LA	9	1	10	0	0	0	8	0	8	Piping Plover (Charadrius melodus), Gulf sturgeon (Acipenser oxyrinchus desotoi), West Indian manatee (Trichechus manatus), Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Kemp's ridley sea turtle (Lepidochelys kempii), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta)

	# of Species			**# of Species Using Freshwater Aquatic/ Riparian Habitat**[2]			**# of Species Using Coastal/Marine Habitat**			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Houston, TX	11	0	11	3	0	3	8	0	8	Green sea turtle (Chelonia mydas), Hawksbill sea turtle (Eretmochelys imbricata), Kemp's ridley sea turtle (Lepidochelys kempii), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Eskimo curlew (Numenius borealis), Piping Plover (Charadrius melodus), West Indian manatee (Trichechus manatus)
Long Beach, CA	31	24	55	9	4	13	12	5	17	Brand's phacelia (Phacelia stellaris), Coastal dunes milk-vetch (Astragalus tener var. titi), Gambel's watercress (Rorippa gambellii), Salt marsh bird's-beak (Cordylanthus maritimus ssp. maritimus), Ventura Marsh Milk-vetch (Astragalus pycnostachyus var. lanosissimus), El Segundo blue butterfly (Euphilotes battoides allyni), Tidewater goby (Eucyclogobius newberryi), Green sea turtle (Chelonia mydas), Island night lizard (Xantusia riversiana), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Olive ridley sea turtle (Lepidochelys olivacea), California least tern (Sterna antillarum browni), Light-footed clapper rail (Rallus longirostris levipes), Marbled murrelet (Brachyramphus marmoratus), Western snowy plover (Charadrius alexandrinus nivosus), Pacific pocket mouse (Perognathus longimembris pacificus)

	# of Species			# of Species Using Freshwater Aquatic/ Riparian Habitat[2]			# of Species Using Coastal/Marine Habitat			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Los Angeles, CA	35	31	66	11	7	18	12	5	17	Brand's phacelia (Phacelia stellaris), Coastal dunes milk-vetch (Astragalus tener var. titi), Gambel's watercress (Rorippa gambellii), Salt marsh bird's-beak (Cordylanthus maritimus ssp. maritimus), Ventura Marsh Milk-vetch (Astragalus pycnostachyus var. lanosissimus), El Segundo blue butterfly (Euphilotes battoides allyni), Tidewater goby (Eucyclogobius newberryi), Green sea turtle (Chelonia mydas), Island night lizard (Xantusia riversiana), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Olive ridley sea turtle (Lepidochelys olivacea), California least tern (Sterna antillarum browni), Light-footed clapper rail (Rallus longirostris levipes), Marbled murrelet (Brachyramphus marmoratus), Western snowy plover (Charadrius alexandrinus nivosus), Pacific pocket mouse (Perognathus longimembris pacificus)
Oakland, CA	18	6	24	8	0	8	8	1	9	San Francisco lessingia (Lessingia germanorum), Myrtle's silverspot butterfly (Speyeria zerene myrtleae), Delta smelt (Hypomesus transpacificus), Green sea turtle (Chelonia mydas), Leatherback sea turtle (Dermochelys coriacea), Loggerhead sea turtle (Caretta caretta), Olive ridley sea turtle (Lepidochelys olivacea), Western snowy plover (Charadrius alexandrinus nivosus), Salt marsh harvest mouse (Reithrodontomys raviventris)

	# of Species			**# of Species Using Freshwater Aquatic/ Riparian Habitat**[2]			**# of Species Using Coastal/Marine Habitat**			
Ports	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Coastal/Marine Species**
Tacoma, WA	9	1	10	3	1	4	2	0	2	Marbled murrelet (Brachyramphus marmoratus), Streaked Horned lark (Eremophila alpestris strigata)

[1] Based on the U.S. Fish and Wildlife Service (http://ecos.fws.gov/ecos/indexPublic.do)

[2] Inland habitat, excluding Coastal or Marine Habitats

Table A3.7. Critical habitat of federally listed threatened and/or endangered species[1] within 10 kilometers and offshore of 20 top container ports of the United States.

Ports	**Polygon**	**Line**
Boston, MA	North Atlantic right whale (Eubalaena glacialis)	
New York, NY and NJ		
Philadelphia, PA		
Wilmington, DE		
Baltimore, MD		
Norfolk, VA		
Wilmington, NC		
Charleston, SC		
Savannah, GA		
Jacksonville, FL	West Indian manatee (*Trichechus manatus*), piping plover (*Charadrius melodus*), North Atlantic right whale (*Eubalaena glacialis*)	
Port Everglades, FL	Elkhorn coral (Acropora palmata), staghorn coral (Acropora cervicornis)	
Miami, FL	Elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicornis*), West Indian manatee (*Trichechus manatus*), johnson's seagrass (*Halophila johnsonii*)	
Tampa, FL	Piping plover (*Charadrius melodus*)	
Mobile, AL		
New Orleans, LA		

Houston, TX		
Long Beach, CA		
Los Angeles, CA		
Oakland, CA		Steelhead (*Oncorhynchus mykiss*)
Tacoma, WA	Chinook salmon (*Oncorhynchus tshawytscha*), killer whale (*Orcinus orca*)	Bull Trout (*Salvelinus confluentus*), chinook salmon (*Oncorhynchus tshawytscha*)

[1] Based on the U.S. Fish and Wildlife Service critical habitat database (http://criticalhabitat.fws.gov/crithab/)This dataset includes digitized maps of critical habitat for some listed species. Not all listed species have digitized critical habitat and this table probably excludes critical habitat for some species.

Table A3.8. Miles of beaches within 10 kilometers of 20 top container ports in the United States.

Ports	**Polygon (miles)**
Boston, MA	10.6
New York, NY and NJ	
Philadelphia, PA	
Wilmington, DE	
Baltimore, MD	
Norfolk, VA	5.9
Wilmington, NC	0.2
Charleston, SC	
Savannah, GA	
Jacksonville, FL	
Port Everglades, FL	11.1
Miami, FL	12.5
Tampa, FL	0.5
Mobile, AL	
New Orleans, LA	
Houston, TX	2.6
Long Beach, CA	3.7
Los Angeles, CA	2.5
Oakland, CA	
Tacoma, WA	11.4

[1] Based on EPA's BEACHES dataset (http://www.epa.gov/waters/data/downloads.html#BEACH Datasets)

Table A3.9. Total population, percent minority, and percent of individuals below federal poverty levels within 5 kilometers for 20 top container ports in the United States.

Ports	**Total Population[1]**	**% Minority[1,2]**	**% Below Federal Poverty Levels[1,2,3]**
Boston, MA	156013	39.7%	19.7%
New York, NY and NJ	153930	60.4%	23.2%
Philadelphia, PA	204135	45.9%	21.8%
Wilmington, DE	70963	75.9%	17.6%
Baltimore, MD	88082	27.9%	23.8%
Norfolk, VA	32158	41.7%	15.9%
Wilmington, NC	36696	34.7%	17.7%
Charleston, SC	27643	58.3%	24.5%
Savannah, GA	13714	73.2%	19.4%
Jacksonville, FL	31131	45.2%	13.9%
Port Everglades, FL	34502	38.7%	18.4%
Miami, FL	101037	64.6%	29.2%
Tampa, FL	18579	34.2%	15.2%
Mobile, AL	30297	74.8%	21.9%
New Orleans, LA	141562	48.1%	24.8%

Houston, TX	32079	36.7%	15.4%
Long Beach, CA	106858	80.2%	26.7%
Los Angeles, CA	123515	73.3%	22.0%
Oakland, CA	71121	74.9%	21.0%
Tacoma, WA	69254	39.8%	15.9%

[1] Based on U.S. Census Summary File and TIGER data (http://www.census.gov)

[2] All % data use the Total 2010 Population as the denominator.

[3] Based on Public Use Microdata Areas with 5% sampling (http://www.census.gov/geo/puma/puma2010.html)

Table A3.10. Indicators of pollution levels within vicinity of 20 top container ports in the United States.

	Unhealthy Air days in Counties within 10 km of port in 2010[1]			**Pollution Generating Facilities within 10 km of Port (Count)**[2]				
Ports	**General Population**	**Elderly and Children**	**Asthma/Other Lung Disease**	**Stationary Air Source (AIRS)**	**Brownfield Grant Recipients (ACRES)**	**Dischargers to Waterways (NPDES/PCS)**	**Superfund Sites (CERCLIS)**	**Solid Hazardous Waste Generators (RCRAInfo)**
Boston, MA	0	3	3	960	129	173	5	1820
New York, NY and NJ	1	12	12	993	49	321	59	3688
Philadelphia, PA	1	21	21	472	145	173	74	1912
Wilmington, DE	0	16	16	171	48	32	23	748
Baltimore, MD	1	19	19	1835	63	270	25	1415
Norfolk, VA	1	5	5	117	1	23	6	396
Wilmington, NC	0	1	14	101	5	74	8	211
Charleston, SC	0	0	0	273	10	52	22	479
Savannah, GA	0	0	7	142	0	31	14	362
Jacksonville, FL	0	1	1	135	1	327	19	660
Port Everglades, FL	0	0	1	144	4	389	14	1038
Miami, FL	0	2	2	112	317	219	5	895
Tampa, FL	0	2	12	276	74	599	33	1038
Mobile, AL	0	4	4	98	5	187	12	501

New Orleans, LA	16	19	61	226	40	530	10	2023
Houston, TX	1	27	27	98	0	85	5	383
Long Beach, CA	3	78	78	76	38	99	27	1380
Los Angeles, CA	3	78	78	76	22	92	24	1207
Oakland, CA	1	4	4	72	94	33	18	1615
Tacoma, WA	0	1	1	71	19	151	42	1165

[1] Based on EPA’s AIRNow data (http://www.epa.gov/aircompare/compare_by_state.htm)

[2] Based on EPA’s Facility Registry System (http://www.epa.gov/enviro/html/fii/prog_sys.html). Facilities includes data from separate media-specific programs including Aerometric Information Retrieval System (AIRS); Assessment, Cleanup and Redevelopment Exchange System (ACRES), National Pollutant Discharge Elimination System/Permit Compliance System (NPDES/PCS), Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), and Resource Conservation and Recovery Act Information (RCRAInfo).

Table A3.11. Length and cause of impairments of shorelines of beaches and bays within 10 kilometers of 20 top container ports in the United States.

		Length By Cause of Impairment							
Ports	**Total Length (km)**[1]	**Dioxins**	**PAHs**[2]	**PCBs**[3]	**Pesticides**	**Mercury**	**Metals (other than Mercury)**	**Oxygen Depletion**	**Pathogens**
Boston, MA	102.2		20.7	67.1					102.2
New York, NY and NJ	106.8	88.5	73.9	106.8	73.9	73.9	32.8		
Philadelphia, PA									
Wilmington, DE									
Baltimore, MD	7.7			7.7			7.7		
Norfolk, VA	25.5			25.5					
Wilmington, NC									
Charleston, SC									
Savannah, GA									
Jacksonville, FL									
Port Everglades, FL	21.9					21.9	21.9		
Miami, FL									
Tampa, FL	71.0					71.0		71.0	13.4
Mobile, AL									

New Orleans, LA									
Houston, TX	44.3	32.9		32.9					11.4
Long Beach, CA	89.4		10.3	73.5	71.8	0.9	63.8		74.5
Los Angeles, CA	83.0		10.9	77.0	77.4	0.9	64.2		63.2
Oakland, CA	57.4	57.1	5.5	55.6	57.1	57.1	52.9		0.3
Tacoma, WA	8.6		5.1	8.6	5.1				

[1] Based on EPA's Reach Address Database (http://www.epa.gov/waters/data/downloads.html#ATTAINS Datasets). The total length represents all features that are impaired. Many features have several sources of impairments.

[2] Polyaromatic hydrocarbons

[3] Polychlorinated biphenyls

Table A3.12. Length and cause of impairments of streams and rivers within 10 kilometers of 20 top container ports in the United States.

		Length By Cause of Impairment										
Ports	**Total Length (km)[1]**	**Dioxins**	**PAHs[2]**	**PCBs[3]**	**Pesticides**	**Mercury**	**Metals (other than Mercury)**	**Oil/ Grease**	**Nutrients/ Ammonia**	**Oxygen Depletion**	**Pathogens**	**Others**
Boston, MA	30.8		8.9	21.9	2.6		11.5	17.1	19.7	19.3	21.9	23.9
New York, NY and NJ	55.6	47.1	45.2	47.1	45.2	43.5	37.1		51.8	23.2	13.3	21.8
Philadelphia, PA	63.1		13.7	56.6	46.6	37.6	46.6		16.9		9.7	29.7
Wilmington, DE	62.7			49.3	35.1	19.9			25.8	21.5	31.9	
Baltimore, MD	32.4				21.2		9.4		21.2		1.7	21.2
Norfolk, VA	119.0			104.1	26.5					81.1	46.7	
Wilmington, NC	9.4											1.9
Charleston, SC	3.0										3.0	
Savannah, GA	6.4										6.4	
Jacksonville, FL	48.0					41.1	17.6			6.9	30.1	
Port Everglades, FL	26.2					20.2	8.1			18.1	26.2	
Miami, FL	2.2					2.2	2.2			2.2	2.2	
Tampa, FL	34.5					23.1	10.8			34.5	22.0	
Mobile, AL	40.8					20.3			10.8	9.8	20.5	

New Orleans, LA	66.5								47.3	47.3	59.8	
Houston, TX	38.3	17.8		17.8						17.5	33.7	
Long Beach, CA	8.5				5.5		3.0				5.5	
Los Angeles, CA	3.7				3.7						3.7	
Oakland, CA	3.6		3.6	1.7	3.6		1.7		3.6			
Tacoma, WA	11.7					1.6			0.4	1.9	11.7	

[1] Based on EPA's Reach Address Database (http://www.epa.gov/waters/data/downloads.html#ATTAINS Datasets). The total length represents all features that are impaired. Many features have several sources of impairments.

[2] Polyaromatic hydrocarbons

[3] Polychlorinated biphenyls

[4] Other source of impairments include pH, temperature, sedimentation, total dissolved solids/chlorides, turbidity, and taste/color/odor

Table A3.13. General land cover characteristics within 100-meters of open water areas and 5 km of major locks/dams along the Mississippi and Illinois Rivers in the United States[1].

	General Land Cover within 100 Meters of River Open Water		
Name	**Developed[2]**	**Agriculture[3]**	**Wetland[4]**
Mississippi River - Chains of Rocks Lock & Dam 27, IL & MO	30%	18%	42%
Mississippi River - Mel Price Lock & Dam, IL & MO	35%	5%	43%
Mississippi River - Lock & Dam 25, IL & MO	3%	21%	47%
Mississippi River - Lock & Dam 24, IL & MO	12%	14%	68%
Mississippi River - Lock & Dam 22, IL & MO	8%	9%	64%
Mississippi River - Lock & Dam 21, IL & MO	18%	6%	67%
Mississippi River - Lock & Dam 20, IL & MO	10%	27%	58%
Mississippi River - Lock & Dam 19, IA & IL	35%	11%	41%
Mississippi River - Lock & Dam 18, IA & IL	11%	5%	65%
Mississippi River - Lock & Dam 17, IA & IL	2%	4%	79%
Mississippi River - Lock & Dam 16, IA & IL	18%	7%	62%
Mississippi River - Lock & Dam 15, IA & IL	81%	0%	8%
Mississippi River - Lock & Dam 14, IA & IL	64%	0%	28%
Mississippi River - Lock & Dam 13, IA & IL	19%	3%	58%
Mississippi River - Lock & Dam 12, IA & IL	14%	3%	65%
Mississippi River - Lock & Dam 11, IA, IL, & WI	36%	3%	37%
Mississippi River - Lock & Dam 10, IA & WI	10%	3%	74%
Mississippi River - Lock & Dam 9, IA & WI	12%	4%	75%
Mississippi River - Lock & Dam 8, MN & WI	20%	1%	71%
Mississippi River - Lock & Dam 7, MN & WI	22%	3%	65%
Mississippi River - Lock & Dam 6, MN & WI	33%	0%	56%
Mississippi River - Lock & Dam 5a, MN & WI	16%	1%	75%

	General Land Cover within 100 Meters of River Open Water		
Name	**Developed**[2]	**Agriculture**[3]	**Wetland**[4]
Mississippi River - Lock & Dam 5, MN & WI	11%	0%	81%
Mississippi River - Lock & Dam 4, MN & WI	17%	7%	62%
Mississippi River - Lock & Dam 3, MN & WI	8%	1%	85%
Mississippi River - Lock & Dam 2, MN & WI	22%	8%	35%
Illinois River - Lagrange Lock & Dam, IL	5%	9%	82%
Illinois River - Peoria Lock & Dam, IL	33%	0%	57%
Illinois River - Starved Rock Lock & Dam, IL	15%	13%	30%
Illinois River - Marseilles Lock & Dam, IL	25%	9%	13%
Illinois River - Dresden Island Lock & Dam, IL	23%	11%	48%
Illinois River - Brandon Road Lock & Dam, IL	64%	5%	20%
Illinois River - Lockport Lock, IL	40%	1%	33%

[1] Based on the 2006 National Land Cover Database (http://www.mrlc.gov)

[2] Developed land cover consists of developed undeveloped, low intensity, medium intensity, and high intensity land cover.

[3] Agriculture land cover consists of pasture and row crops.

[4] Wetland land cover consists of forested and herbaceous wetlands. These wetlands were determined from remote sensing and may not be jurisdictional under the Clean Water Act (33 CFR (Code of Federal Regulations) Part 328)

Table A3.14. Percent of open waters with wetland borders within 5 kilometers of major locks/dams along the Mississippi and Illinois Rivers in the United States[1].

	Open Water with Wetland Borders[2]		
Name	**Emergent**	**Forested/Shrub**	**Total**
Mississippi River - Chains of Rocks Lock & Dam 27, IL & MO	36%	15%	52%
Mississippi River - Mel Price Lock & Dam, IL & MO	14%	31%	45%
Mississippi River - Lock & Dam 25, IL & MO	16%	25%	41%
Mississippi River - Lock & Dam 24, IL & MO	10%	60%	69%
Mississippi River - Lock & Dam 22, IL & MO	3%	72%	75%
Mississippi River - Lock & Dam 21, IL & MO	6%	62%	67%
Mississippi River - Lock & Dam 20, IL & MO	3%	65%	68%
Mississippi River - Lock & Dam 19, IA & IL	16%	34%	50%
Mississippi River - Lock & Dam 18, IA & IL	25%	47%	72%
Mississippi River - Lock & Dam 17, IA & IL	15%	69%	84%
Mississippi River - Lock & Dam 16, IA & IL	17%	50%	67%
Mississippi River - Lock & Dam 15, IA & IL	4%	10%	13%
Mississippi River - Lock & Dam 14, IA & IL	16%	19%	35%
Mississippi River - Lock & Dam 13, IA & IL	21%	42%	62%
Mississippi River - Lock & Dam 12, IA & IL	22%	50%	72%
Mississippi River - Lock & Dam 11, IA, IL, & WI	17%	32%	49%
Mississippi River - Lock & Dam 10, IA & WI	22%	61%	83%
Mississippi River - Lock & Dam 9, IA & WI	18%	69%	86%
Mississippi River - Lock & Dam 8, MN & WI	14%	57%	72%
Mississippi River - Lock & Dam 7, MN & WI	21%	56%	78%
Mississippi River - Lock & Dam 6, MN & WI	12%	61%	73%

	Open Water with Wetland Borders[2]		
Name	**Emergent**	**Forested/Shrub**	**Total**
Mississippi River - Lock & Dam 5a, MN & WI	20%	66%	86%
Mississippi River - Lock & Dam 5, MN & WI	9%	76%	85%
Mississippi River - Lock & Dam 4, MN & WI	12%	61%	73%
Mississippi River - Lock & Dam 3, MN & WI	18%	72%	90%
Mississippi River - Lock & Dam 2, MN & WI	7%	34%	41%
Illinois River - Lagrange Lock & Dam, IL	26%	64%	90%
Illinois River - Peoria Lock & Dam, IL	6%	51%	57%
Illinois River - Starved Rock Lock & Dam, IL	11%	24%	35%
Illinois River - Marseilles Lock & Dam, IL	0%	16%	16%
Illinois River - Dresden Island Lock & Dam, IL	0%	51%	51%
Illinois River - Brandon Road Lock & Dam, IL	0%	25%	25%
Illinois River - Lockport Lock, IL	1%	37%	37%

[1] Based on the 2006 National Land Cover Database (http://www.mrlc.gov)

[2] Wetland land cover consists of forested and herbaceous wetlands. These wetlands were determined from remote sensing and may not be jurisdictional under the Clean Water Act (33 CFR (Code of Federal Regulations) Part 328)

Table A3.15. Federally listed threatened, endangered and candidate species in counties within 5 kilometers of major locks/dams along the Mississippi and Illinois Rivers in the United States.[1]

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Mississippi River - Chains of Rocks Lock and Dam 27, IL & MO	11	4	15	11	2	13	Decurrent false aster (Boltonia decurrens), eastern prairie fringed orchid (*Platanthera leucophaea*), running buffalo clover (*Trifolium stoloniferum*), pink mucket (pearlymussel) (*Lampsilis abrupta*), scaleshell mussel (*Leptodea leptodon*), sheepnose mussel (*Plethobasus cyphyus*), snuffbox mussel (*Epioblasma triquetra*), spectaclecase (*Cumberlandia monodonta*), Illinois cave amphipod (*Gammarus acherondytes*), pallid sturgeon (*Scaphirhynchus albus*), least tern (*Sterna antillarum*), Gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Eastern Massasauga (*Sistrurus catenatus*)
Mississippi River - Mel Price Lock & Dam, IL & MO	10	4	14	10	2	12	Decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), running buffalo clover (Trifolium stoloniferum), pink mucket (*Lampsilis abrupta*), scaleshell mussel (Leptodea leptodon), sheepnose mussel (*Plethobasus cyphyus*), snuffbox mussel (Epioblasma triquetra), spectaclecase (*Cumberlandia monodon*ta), pallid sturgeon (*Scaphirhynchus albus*), eastern massasauga (*Sistrurus catenatus*), least tern (*Sterna antillarum*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*)
Mississippi River - Lock & Dam 25, IL & MO	2	3	5	2	3	5	Decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), running buffalo clover (*Trifolium stoloniferum*), spectaclecase (*Cumberlandia monodonta*), Indiana bat (*Myotis sodalis*)

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Mississippi River - Lock & Dam 24, IL & MO	6	2	8	6	2	8	Decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), fat pocketbook (*Potamilus capax*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*)
Mississippi River - Lock & Dam 22, IL & MO	6	3	9	6	3	9	Decurrent false aster (Boltonia decurrens), eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed orchid (Platanthera praeclara), Fat pocketbook (*Potamilus capax*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose fussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis)*
Mississippi River - Lock & Dam 21, IL & MO	6	1	7	6	1	7	Eastern prairie fringed orchid (*Platanthera leucophaea*), fat pocketbook (*Potamilus capax*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), pallid sturgeon (*Scaphirhynchus albus*), Indiana bat (*Myotis sodalis*)
Mississippi River - Lock & Dam 20, IL & MO	5	1	6	5	1	6	Eastern prairie fringed orchid (*Platanthera leucophaea*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase) (*Cumberlandia monodonta*), pallid sturgeon (*Scaphirhynchus albus*), Indiana bat (*Myotis sodalis*)
Mississippi River - Lock & Dam 19, IA & IL	6	3	9	6	2	8	Eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed Orchid (*Platanthera praeclara*), fat pocketbook (*Potamilus capax*), Higgins eye pearlymusse) (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), Topeka shiner (*Notropis topeka*), Indiana bat (*Myotis sodalis*)

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Mississippi River - Lock & Dam 18, IA & IL	4	3	7	4	2	6	Eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), Indiana bat (*Myotis sodalist*)
Mississippi River - Lock & Dam 17, IA & IL	5	3	8	5	2	7	Eastern prairie fringed orchid (*Platanthera leucophaea),* western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*), Indiana bat (*Myotis sodalist)*
Mississippi River - Lock & Dam 16, IA & IL	5	3	8	5	2	7	Eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*), Indiana bat (*Myotis sodalist*)
Mississippi River - Lock & Dam 15, IA & IL	5	3	8	5	2	7	Eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*), Indiana bat (*Myotis sodalist*)
Mississippi River - Lock & Dam 14, IA & IL	5	3	8	5	2	7	Eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii),* sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*), Indiana bat (*Myotis sodalist*)

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Mississippi River - Lock & Dam 13, IA & IL	5	3	8	4	2	6	Eastern prairie fringed orchid (*Platanthera leucophaea*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii)*, sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*), Indiana bat (*Myotis sodalist*)
Mississippi River - Lock & Dam 12, IA & IL	4	4	8	3	3	6	Eastern prairie fringed orchid (*Platanthera leucophaea*), northern wild monkshood (*Aconitum noveboracense*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), Indiana bat (*Myotis sodalis*)
Mississippi River - Lock & Dam 11, IA, IL, & WI	7	5	12	6	3	9	Eastern prairie fringed orchid (*Platanthera leucophaea*), northern wild monkshood (*Aconitum noveboracense*), western prairie fringed orchid (*Platanthera praeclara*), Hine's emerald dragonfly (*Somatochlora hineana*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (mussel) (*Cumberlandia monodonta*), whooping crane *(Grus americana*), Indiana bat (*Myotis sodalis*)
Mississippi River - Lock & Dam 10, IA & WI	6	4	10	5	2	7	Northern wild monkshood (*Aconitum noveboracense*), western prairie fringed orchid (*Platanthera praeclara*), Hine's emerald dragonfly (*Somatochlora hineana)*, Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), whooping crane (*Grus americana*)
Mississippi River - Lock & Dam 9, IA & WI	5	3	8	5	2	7	Northern wild monkshood (*Aconitum noveboracense*), western prairie fringed orchid (*Platanthera praeclara*), Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), spectaclecase (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*), whooping crane (*Grus americana*)

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Mississippi River - Lock & Dam 8, MN & WI	2	1	3	2	1	3	Northern wild monkshood (*Aconitum noveboracense*), Higgins eye pearlymussel) (*Lampsilis higginsii*), eastern mMassasauga (*Sistrurus catenatus*)
Mississippi River - Lock & Dam 7, MN & WI	5	0	5	4	0	4	Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel *(Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*), whooping crane (*Grus americana*)
Mississippi River - Lock & Dam 6, MN & WI	5	0	5	4	0	4	Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*), whooping crane (*Grus americana*)
Mississippi River - Lock & Dam 5a, MN & WI	4	0	4	3	0	3	Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*)
Mississippi River - Lock & Dam 5, MN & WI	4	0	4	3	0	3	Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*)
Mississippi River - Lock & Dam 4, MN & WI	3	0	3	3	0	3	Higgins eye pearlymussel (*Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*)
Mississippi River - Lock & Dam 3, MN & WI	4	2	6	4	1	5	Minnesota dwarf trout lily (*Erythronium propullans*), Higgins eye pearlymussel (*Lampsilis higginsii*), snuffbox mussel (*Epioblasma triquetra*), spectaclecase (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*)

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Mississippi River - Lock & Dam 2, MN & WI	5	1	6	5	0	5	Higgins eye pearlymussel *(Lampsilis higginsii*), sheepnose mussel (*Plethobasus cyphyus*), snuffbox mussel (*Epioblasma triquetra*), spectaclecase (*Cumberlandia monodonta*), winged mapleleaf (*Quadrula fragosa*)
Illinois River - Lagrange Lock & Dam, IL	2	3	5	2	2	4	Sheepnose mussel (*Plethobasus cyphyus*), decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), Indiana bat (*Myotis sodalis*)
Illinois River - Peoria Lock & Dam, IL	1	3	4	1	3	4	Decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), lakeside daisy (*Hymenoxys herbacea*), Indiana bat (*Myotis sodalis*)
Illinois River - Starved Rock Lock & Dam, IL	2	3	5	2	3	5	Decurrent false aster (*Boltonia decurrens*), leafy prairie-clover (*Dalea foliosa*), eastern prairie fringed orchid (*Platanthera leucophaea*), sheepnose mussel (*Plethobasus cyphyus*), Indiana bat (*Myotis sodalis*)
Illinois River - Marseilles Lock & Dam, IL	2	3	5	2	3	5	Decurrent false aster (*Boltonia decurrens*), leafy prairie-clover (*Dalea foliosa*), eastern prairie fringed orchid (*Platanthera leucophaea*), sheepnose mussel (*Plethobasus cyphyus*), Indiana bat (*Myotis sodalis*)
Illinois River - Dresden Island Lock & Dam, IL	5	4	9	5	3	8	Eastern prairie fringed orchid (*Platanthera leucophaea*), lakeside daisy (Hymenoxys herbacea), leafy prairie-clover (*Dalea foliosa*), Hine's emerald dragonfly (Somatochlora hineana), sheepnose mussel (*Plethobasus cyphyus*), Spectaclecase mussel (*Cumberlandia monodonta*), eastern massasauga (*Sistrurus catenatus*), Indiana bat (*Myotis sodalis*)

	# of Species			**# of Species using Freshwater Aquatic/Riparian Habitat**			
Name	**Animals**	**Plants**	**Total**	**Animals**	**Plants**	**Total**	**Names of Freshwater Aquatic/Riparian Habitat Species**
Illinois River - Brandon Road Lock & Dam, IL	4	4	8	4	3	7	Leafy prairie-clover (*Dalea foliosa*), eastern prairie fringed orchid (Platanthera *leucophaea*), lakeside daisy (Hymenoxys herbacea), Hine's emerald dragonfly (*Somatochlora hineana*), spectaclecase (*Cumberlandia monodonta*), sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus*)
Illinois River - Lockport Lock, IL	4	4	8	4	3	7	Leafy prairie-clover (*Dalea foliosa*), eastern prairie fringed orchid (*Platanthera leucophaea*), lakeside daisy (*Hymenoxys herbacea*), Hine's emerald dragonfly (*Somatochlora hineana*), spectaclecase (*Cumberlandia monodonta*), sheepnose mussel (*Plethobasus cyphyus*), eastern massasauga (*Sistrurus catenatus)*

[1] Data were obtained from http://ecos.fws.gov/ecos/indexPublic.do and http://www.natureserve.org/explorer/.

Table A3.16. Nationally registered historic properties within 5 km of 20 top U. S. container ports.[1]

Ports	Number
Boston, MA	114
New York, NY and NJ	6
Philadelphia, PA	64
Wilmington, DE	51
Baltimore, MD	6
Norfolk, VA	1
Wilmington, NC	3
Charleston, SC	2
Savannah, GA	0
Jacksonville, FL	1
Port Everglades, FL	5
Miami, FL	45
Tampa, FL	31
Mobile, AL	56
New Orleans, LA	52
Houston, TX	1
Long Beach, CA	7
Los Angeles, CA	11
Oakland, CA	32
Tacoma, WA	50

[1] Based on the National Register of Historic Places (http://nrhp.focus.nps.gov/natreg/docs/Download.html#spatial)

Appendix A4. Port EA, EIS, and Other Information Summaries.

Variable	**Port of Boston Container Terminal and Harbor**
Scarce species /ecosystem heritage in vicinity	Endangered species, preserves, and wetlands. Federally protected species that occur at least sometimes in the vicinity include North Atlantic right, fin, blue, humpback, sei, and sperm whales; and loggerhead, Kemp's ridley, leatherback and, rarely, green sea turtles.[1]
Important natural resource use in vicinity	Commercial and recreational fisheries. Important species in the port vicinity include softshell clams, blue mussels, razor clams, rock crabs, Jonah crabs, and American lobsters.[1] The state management area for lobster in the port vicinity ranked first in the state for coastal lobster harvest, but lobster harvest has undergone significant decline throughout state waters.[1] Commercial fishing does not exist for finfish in the harbor area because of shipping traffic, but does exist for lobster. Essential Fish Habitat is designated near the harbor for Atlantic sea scallop, Atlantic surf clam, ocean quahog, longfin and shortfin squid, Atlantic cod, haddock, Atlantic halibut, two hake species, four flounder species, blue fish, pollack and several other finfish species.[1]
Environmental quality of water, sediment, and air.	Historically extensive beds of seagrass existed near the harbor before it became turbid with suspended matter and phytoplankton generated largely by urban runoff. The Boston Harbor area has undergone extensive water quality improvement since 1985. The turbidity and nutrient concentrations in the harbor area have improved since relocation of treated wastewater outlets. Oxygen concentration range from about 5mg/liter in the inner harbor to 8 mg/liter farther offshore. Monitoring of channel dredging revealed no exceedence of water quality standards.[2] However, sediment toxicity to test organisms indicated a need for confined disposal of some sediment.[2] The area is considered to be in attainment with all national air quality standards with the exception of CO and O3 for which it is designated as "maintenance" and "non-attainment," respectively.[1]
Environmental justice	The percentages of people that live below the poverty line and nonwhite minorities in the port county are higher than the State average.[1]
Main channel length	About 9 miles[3].
Existing channel, basin and berth information	The main channel is dredged to 40 feet.[3]The Port of Boston has one container terminal and a total of 2 berths totaling 2000 feet and maintained at 45 feet deep.[4]
Availability of sediment disposal locations	Several dredge disposal and management options exist within and proximal to the harbor area, including the Massachusetts Bay Disposal Site and several proposed habitat improvement sites.[1]
Port Capacity	Container yard utilization is 31%, crane utilization is 22%, berth utilization (vessel calls) is 39%, berth utilization (percent discharge/load) is 37%, and berth utilization (average vessel size) is 37%.[4]
Capacity of intermodal transport links	Container terminal has direct access to interstate highway but no on-dock rail.[4]

Variable	**NY-NJ Container Port and Harbor**

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1 2008. Draft supplemental environmental impact statement, Federal deep draft navigation improvement project, Boston Harbor, MA, New England District, U. S. rAmy Corps of Engineers, Boston, MA

2 2006. Final supplemental environmental impact statement for the Boston Harbor Inner Harbor maintenance dredging project. New England District, U. S. Army Corps of Engineers, Boston, MA

3 Unpublished U. S. Army Corps of Engineers data

4 Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Scarce species /ecosystem heritage in vicinity	Species. Federally listed T & E and marine mammal species that may occur in the harbor area include green, Kemp's ridley, loggerhead, and leatherback sea turtles; northern Atlantic right , humback whale, and peregrine falcon, bald eagle, and least terns, shortnose sturgeon, and harbor seals.[5,6] The New Jersey state-listed yellow-crowned night heron also is present.[5] Numerous migratory birds use the area.
Important natural resource use in vicinity	Sport and commercial fishing and bird watching. Finfish and shell fish species documented in the area include striped bass, weakfish, winter flounder, summer flounder, Atlantic sea herring, bay anchovies, menhaden, rainbow smelt, blue crabs, American oyster, and soft-shelled clam. The harbor area provides Essential Fish Habitat for some of these and other species that may enter the area.[6] Many recreationally important waterfowl and shorebirds use the harbor area.
Environmental quality of water, sediment, and air.	Deepening effect models indicate little change in oxygen, salinity, water temperature, and hydrodynamics.[7] Low species of benthic fauna indicates a stressful environment[1]. Sediments generally are too contaminated with various heavy metals and organic compounds for ocean disposal.[8] The region was designated as a severe nonattainment area for ozone and a maintenance area for carbon monoxide (CO). The ozone quantity applies to ozone precursors as well, which are oxides of nitrogen (NOx) and volatile organic carbons (VOCs).[7] Studies in 2004 found no significant cumulative impact from deepening the harbor.[7]
Environmental justice	No issues indicated.
Main channel length	About 7.5 miles[9].
Existing channel, basin and berth information	The main channel is dredged to 50 feet.[9] The Port of NY-NJ has six container terminals and a total of 26 berths totaling 27,421 feet maintained at 35 to 50 feet deep[10].
Availability of sediment disposal locations	Various upland, island, and subaqueous sites were identified as available for confined disposal.[5]
Port Capacity	Container yard utilization is 75 %, crane utilization is 36%, berth utilization (vessel calls) is 45 %, berth utilization (percent discharge/load) is 53%, and berth utilization (average vessel size) is 45%.[10]
Capacity of intermodal transport links	Some container terminals have direct access to interstate highway and 2 terminals have on-dock rail.[10]

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[5] New York District, Army Corps of Engineers. 1997. Kill Van Kull-Newark Bay Channels phase II deepening project. Final environmental assessment**.** New York, **NY**

[6] New York District, Army Corps of Engineers. 2005. Essential fish habitat assessment for Newark bay maintenance dredging; Newark Bay—Port Newark Channel, Port Newark Pierhead Channel & Port Elisabeth Channel of Newark Bay, Hackensack & Passaic rivers Federal Navigation Project. New York, NY

[7] New York District, Army Corps of Engineers. 2004. Environmental Assessment on Consolidated Implementation of the New York and New Jersey Harbor Deepening Project. New York, NY

[8] Stern et al. 1998. Processing contaminated dredged material from the Port of New York-New Jersey. Estuaries 21:646-651.

[9] Unpublished U. S. Army Corps of Engineers data

[10] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Variable	**Philadelphia and Wilmington Container Ports and Harbors**
Scarce species /ecosystem heritage in vicinity	Species, preserves, and wetlands. Federally-protected species observed along the federal navigation channel include: Kemp's Ridley, green, hawksbill, leatherback, and loggerhead sea turtles [11,12]; fin, right, and humpback whales; shortnose sturgeon and Atlantic sturgeon[13]; bald eagle and peregrine falcon; and Virginia jointvetch[14]. New Jersey protects great blue heron, northern harrier, pied-billed grebe, and osprey[1]. Some concern exists about freshwater mussels and American eels[15]. Possible adverse effects of blasting would be coordinated with NOAA Fisheries[11], monitored and mitigated. Channel deepening is among factors expected to alter inland extent of saline water migration from Delaware Bay under conditions of drought and sea-level rise[11]. Hydrologic simulations indicate that increases in sea levels and deepening of the navigation channel will contribute to small increases in salinity, but have an insignificant impact on freshwater mussels[15].
Important natural resource use in vicinity	Sport and commercial fishing and wildlife-based recreation. Delaware Bay is a key stopover location for migratory shorebirds between April and June.[11] The Delaware River and Bay are essential fish habitat for federally-managed fish species.[15] Dredging-caused injury is expected to be minimal.[15]
Environmental quality of water, sediment, and air.	Sediment contaminants in the Delaware River could cause adverse biological effects and poor benthic habitat[6]. Mercury, zinc, phenanthrene and total PCBs exceed "effects range median" concentrations.[16] Various metals exceed "effects range low"[17] concentrations. A deepening project is expected to exceed annual emission thresholds for only NOx during every year over the project's duration. Requirements could be met by pre-construction acquisition of Emission Reduction Credits.[18]
Environmental justice	No environmental justice issues identified
Main channel length	About 107 miles[19]
Existing channel, basin and berth information	The main channel is 40 feet deep (mean low water) and averages 400 feet wide.[19] Two terminals (Philadelphia and Wilmington) have five container port berths totaling 5,300 feet long and ranging between 38 and 40 feet deep.[20]
Availability of sediment disposal locations	Seven existing federally-owned confined disposal facilities will satisfy sediment management needs during the 50-year project lifecycle[11,15]. Some sediment can be used for wetland and beach habitat restoration and creation at Kelly Island and Broadkill Beach in Delaware.
Port Capacity	Container yard utilization is 68%, Crane utilization is 29%, berth utilization (vessel calls)is 30%, berth utilization (percent discharge/load) is 46% , and berth utilization (average vessel size) is 40%.[20]
Capacity of intermodal transport links	There is no on-dock rail but good interstate highway connections.[20]

Variable	**Baltimore Container Ports and Harbor**
Scarce species	Species. No federally protected species were known to inhabit the inner harbor area in 1997[21].

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[11] 1997.USACE. Delaware River Main Channel Deepening Project. Supplemental Environmental Impact Statement. Philadelphia, Pennsylvania.

[12] Northwestern Distinct Population Segment of loggerhead sea turtle population listed as threatened per 58868 Federal Register / Vol. 76, No. 184 / Thursday, September 22, 2011. Rules and Regulations

[13] New York Bight Distinct Population Segment of Atlantic sturgeon listed as endangered per 5880 Federal Register / Vol. 77, No. 24 / Monday, February 6, 2012 / Rules and Regulations

[14] Reported in the 1997 EIS as "Sensitive Joint-Vetch (Asechynomene verginica)"

[15] 2011. USACE. Final Environmental Assessment, Delaware Main Channel Deepening Project. Philadelphia, PA

[16] 2005. Versar, Inc., Delaware River, Philadelphia, Pennsylvania to New Castle, Delaware Chemical Analysis of Dredged River Sediments. Columbia, Maryland.

[17] As described by USEPA (after Long et. al., 1995).

[18] 2009. USACE. Clean Air Act Final Statement of Conformity, Delaware River Main Channel Deepening Project. Philadelphia, PA.

[19] Unpublished U. S. Army Corp of Engineers data

[20] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

/ecosystem heritage in vicinity	However, loggerhead, Kemp's ridley, leatherback and, green sea turtles enter Chesapeake Bay.
Important natural resource use in vicinity	Commercial and recreational fisheries. Important species in the port vicinity include softshell clams, blue mussels, razor clams, rock crabs, Jonah crabs, and American lobsters.[21] The state management area for lobster in the port vicinity ranked first in the state for coastal lobster harvest, but lobster harvest has undergone significant decline throughout state waters.[21] Commercial fishing does not exist for finfish in the harbor area because of shipping traffic, but does exist for lobster. Essential Fish Habitat is designated near the harbor for Atlantic sea scallop, Atlantic surf clam, ocean quahog, longfin and shortfin squid, Atlantic cod, haddock, Atlantic halibut, two hake species, four flounder species, blue fish, pollack and several other finfish species. [21]
Environmental quality of water, sediment, and air.	The water quality in the harbor vicinity was poor in 1997, being impacted by the heavy volume of urban runoff in combination with industrial and commercial discharges[21] (no recent EIS data). Turbidity and nutrient levels are relatively high and algae blooms are frequent. Dissolved oxygen frequently fell to less than 2 mg/1iter below the pycnocline during summer.[21] Studies indicate that sediments in some areas of Baltimore Harbor exhibited toxic characteristics in the1990s (no recent EIS data), and sediment toxicity in tributary creeks and bays is patchy and the benthic fauna was clearly depauperate in those areas.
Environmental justice	No issues indicated.
Main channel length	About 87 miles.[22]
Existing channel, basin and berth information	The main channel is dredged to 50 feet.[22] The Port of Baltimore has two container terminals and a total of 10 berths totaling 8,815 feet maintained at 42 to 50 feet deep.[23]
Availability of sediment disposal locations	Disposal was a problem in 1997.[21] Poplar Island was proposed to contain 38 million cubic yards of uncontaminated sediment placed over 25 years and has become a large contained disposal area about as proposed. Other sites were identified as well.[21]
Port Capacity	Container yard utilization is 23 %, crane utilization is 18%, berth utilization (vessel calls) is 21%, berth utilization (percent discharge/load) is 60%, and berth utilization (average vessel size) is 14%.[23]
Capacity of intermodal transport links	Container terminals have direct access to interstate highway and one terminal with on-dock rail.[23]

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[21] 1997 Baltimore Harbor Anchorages and Channels, Maryland and Virginia Integrated Feasibility Report and Environmental Impact Statement. Baltimore District, U. S. Army Corps of Engineers, Baltimore, MD

[22] Unpublished U. S. Army Corps of Engineers data

[23] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Variable	**Virginia Container Port and Harbor**
Scarce species /ecosystem heritage in vicinity	Endangered species and preserves. Federally protected species include loggerhead, Kemp's ridley, leatherback, Atlantic hawksbill, and green sea turtles, and northern diamond-backed terrapin; Atlantic bottlenose dolphin and North Atlantic right whale; piping plover, least tern, black-necked stilt, Wilson's plover, yellow-crowned night heron, great blue heron, green heron, bald eagle, and peregrine falcon[24]. Virginia protected Atlantic sturgeon are nearby[24] , as are national wildlife refuges and state natural areas. Nearby shallow water and wetland habitats are expected to be impacted.[24,25]
Important natural resource use in vicinity	Habitats in the harbor has been designated Essential Fish Habitat for windowpane flounder, bluefish, Atlantic butterfish, summer founder, black sea bass, king mackerel, Spanish mackerel, cobia, red drum, dusky shark, sandbar shark, little skate, winter skate, and clear nose skate.[24] The National Marine Fisheries Service has designated an area in the harbor as Habitat of Particular Concern for the sandbar shark. Blue crab sanctuaries also exist in nearby tidally-influenced waters. Species of commercial interest include hard shell clams, oysters, and blue crab. There are three nearby state wildlife management areas (Ragged Island, Princess Anne, and Hog Island).[24]
Environmental quality of water, sediment, and air.	The water quality entering southern Chesapeake Bay from western tributaries has been characterized as poor to fair with the Elizabeth River characterized as one of the most impacted in the Chesapeake Bay Watershed and not suitable for supporting uncontaminated shellfish beds[26]. Leaking storage tanks and other discharges of hazardous substances are reported in the general area. [24] Sediment contaminants include various heavy metals and organic compounds, and PCBs occur in fish tissue.[24,25,27] As reported in the 2006 EIS, The Hampton Roads Air Quality Control Region has been in general compliance with the NAAQS for all criteria pollutants.[28] Although during the 1990s, the area had been characterized as a marginal non-attainment area with respect to the 1-hour ozone standard. Expanded port facilities are not to incur addition adverse air quality impacts.[24]
Environmental justice	No environmental justice issues were identified. [24]
Main channel length	About 22 miles.[29]
Existing channel, basin and berth information	The main channel is 50 feet deep and the width averages 1500 feet. [29] There are 10 berths totaling 11,460 feet at 3 terminals.[30] Berth depths range from 43 to 49 feet.[30]
Availability of sediment disposal locations	Dredge disposal options include the Norfolk Ocean Disposal Site, the Craney Island Dredged Material Management Area (with expansion options, and beneficial use for beach sand.[31]
Port Capacity	Container yard utilization is 83%, crane utilization is 30%, berth utilization (vessel calls) is 67%, berth utilization (percent discharge/load) is 28%, and berth utilization (average vessel size) is 83%.[30]
Capacity of intermodal transport links	The Port of Virginia is served by 3 railroads and two terminals have on-dock rail.[30] There is direct access to federal and state highways.[24]

Variable	**Wilmington, NC Container Port and Harbor**
Scarce species	Sea turtles (green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles); Atlantic

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[24] 2006.USACE. *Final Environmental Impacts Statement, Craney Island Expansion, Norfolk Harbor And Channels, Virginia*. Norfolk, VA.

[25] 2009. Craney Island Design Partners. *Wetland Mitigation Candidate Site Evaluation Report*. Norfolk, VA.

[26] EPA-842-R-10-003

[27] 2008. Malcom Pirnie, Inc. for USACE. *Final Data Characterization Report for the Pre-Drainage Area, Craney Island Eastward Expansion*. White Plains, NY.

[28] 2009. USACE. *Environmental Assessment, Supplemental Information to the Final Environmental Impacts Statement for the Craney Island Eastward Expansion, Norfolk Harbor and Channels, Hampton, Roads, Virginia*. Norfolk, VA.

[29] Unpublished USACE database

[30] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

[31] 2006. USACE. *Virginia Beach Hurricane Protection Project, Environmental Assessment*. Norfolk, VA.

/ecosystem heritage in vicinity	sturgeon, shortnose sturgeon; West Indian manatee; piping plover (for which monitoring plans associated with beach-placement of dredged material exist[32]); woodstork; red cockaded woodpecker; colonial water birds, and the plants, Seabeach amaranth; Cooley's meadowrue; and rough-leaved loosestrife[33,34,35,36] are among federally-protected species reported at/near Brunswick and New Hanover counties in North Carolina.[37]
Important natural resource use in vicinity	The water column, substrate, vegetation, and associated habitat in/proximal to Wilmington Harbor and its navigation channel have been designated essential fish habitat for a variety of shark species, snapper-grouper complex, penaeid shrimp, spiny lobster, and other coastal migratory pelagic species[38].
Environmental quality of sediment, water and air.	The Cape Fear River has elevated nitrate and low dissolved oxygen concentrations. The river is also known to experience periodic cyanobacteria blooms.[39] Dredged sediments disposed of in off-shore dredged material disposal sites are free of detectible contaminants except for some metals with concentrations less than that of natural sediments next to the off-shore dredged material disposal sites. [40,41]
Environmental justice	No issues identified.
Main channel length	About 26 miles.[42]
Existing channel, basin and berth information	Main channel is 42 feet deep.[42] One multipurpose terminal with three berths near the container yard, each 42 feet deep and totaling 2633 feet.[43]
Availability of sediment disposal locations	Placement of dredged material on approximately 14-miles of beaches is reported as associated with the Wilmington Harbor deepening project.[33] An active off-shore dredged material disposal site is located near the ocean end of the navigation channel.[40,41]
Port Capacity	Based on total container freight processing, 30.7% capacity.[43]
Capacity of intermodal transport links	Interstate highway access.

Variable	**Charleston Container Port and Harbor**
Scarce species /ecosystem heritage in	Species and wetlands. Federally protected species include shortnose sturgeon; green, leatherback, Kemp's Ridley, hawksbill, and loggerhead sea turtles; and North Atlantic right, blue, finback, sei,

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[32] http://www.frf.usace.army.mil/capefear/mon_birds.stm

[33] http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=37019

[34] http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_shortnose.pdf

[35] http://www.nmfs.noaa.gov/pr/pdfs/species/atlanticsturgeon_carolina_dps.pdf

[36] http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=37129

[37] Deaton, A.S., W.S. Chappell, K. Hart, J. O'Neal, B. Boutin. 2010. North Carolina Coastal Habitat Protection Plan. North Carolina Department of Environment and Natural Resources. Division of Marine Fisheries, NC. 639 pp.

[38] http://sharpfin.nmfs.noaa.gov/website/EFH_Mapper/EFH_Report.htm

[39] 2011. Mallin, Michael A., M.R.McIver, and J.F.Merritt. *Environmental Assessment of the Lower Cape Fear River System: CMS Report No. 11-02*. University of North Carolina Wilmington, Center for Marine Science. Wilmington, NC.

[40] 2010. U.S. EPA. *Wilmington ODMDS – Close-Out, May 2010*. U.S. Environmental Protection Agency, Region 4, Water Protection Division, Wetlands, Coastal & Oceans Branch, Wetlands & Marine Regulatory Section, SNAFC, 61 Forsyth St. SW, Atlanta, GA 30303.

[41] 2010. U.S. EPA. *New Wilmington ODMDS - Status and Trends, May 2010*. U.S. Environmental Protection Agency, Region 4, Water Protection Division, Wetlands, Coastal & Oceans Branch, Wetlands & Marine Regulatory Section, SNAFC, 61 Forsyth St. SW, Atlanta, GA 30303.

[42] Unpublished U. S. Army Corps of Engineers database

[43] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

vicinity	sperm and humpback whales; West Indian manatee; and woodstork, piping plover, gull-billed tern, and red knot.[44] A variety of other endangered bird, plant and reptile species inhabit rural upland areas that are less likely to be impacted. The harbor area is fringed with tidal low and high estuarine wetlands and tidal creeks.[44] There is potential for erosion of an existing bird nesting island in Charleston Harbor resulting from a deeper/wider channel and larger ships calling on the port.
Important natural resource use in vicinity	Fisheries and Potable water. The estuary supports large populations of penaeid shrimp and blue crabs. Fish of commercial or recreational value are commonly found in Charleston Harbor, including flounder, red drum, spotted seatrout, bluefish, spot, black drum, and striped bass. All of Charleston Harbor's tidally influenced reaches and adjacent wetlands are considered Essential Fish Habitat as defined by NOAA.[44]
Environmental quality of water, sediment, and air	The Charleston Harbor system is not considered to be impaired under criteria of Section 303(d) of the Clean Water Act except near Shem Creek, at the Ft. Johnson pier, and in the Navy Yard Reach of Cooper River.[1] Much of the system does not meet the applicable water quality standard for dissolved oxygen for significant periods of time and, therefore, is considered water quality limited for the purposes of wasteload allocation.[44] Salinity intrusion to the estuary can cause periodic increases in chloride concentration above acceptable limits at a freshwater supply reservoir.[1] Hazardous and toxic material is not present in the sediments.[45] EPA approved dredged material from all sites for ocean disposal except one in 1995.[46] The adverse water quality effects of dredging would likely be short term.[44] Since the channel is located near the center of the river, deepening the channel is not expected to have a significant impact on wetlands and marsh.[46] The region was in attainment of all National Ambient Air Quality Standards in November 2011.[44] Periodic maintenance will result in the temporary removal of benthic infauna and epifauna and temporary and minor change in air quality.[44] Charleston Harbor has the typical noise characteristics of a busy harbor.[44]
Environmental Justice	USACE is committed to the principles of environmental justice.[44]
Main channel length	About 38.6 miles.[47]
Existing channel, basin and berth information	The main channel depth is 45 feet deep and 800 to 1000 feet wide.[47] There are 9 berths at three terminals totaling 7,940 feet. All berths are 42 feet deep.[48]
Availability sediment disposal locations	There is an inland containment site, ocean deposition site[44], and potential for beneficial use of dredged material for bird habitat creation, marsh creation, or beach nourishment.
Port Capacity	Container yard utilization is 25%, crane utilization is 35%, berth utilization (vessel calls) is 85%, berth use (percent discharge/load) is 28%, and berth utilization (average vessel size) is 119%.[48]
Capacity of intermodal transport links	The port has two on-dock rail intermodal terminals and direct connection to interstate highways.[48] If freight processing increases significantly there is potential for substantially increased truck traffic entering and leaving port terminals and resulting congestion and degraded air quality[45].
Variable	**Savannah Container Port and Harbor**

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[44] U. S. Army Corps of Engineers, Charleston District. 2011. Charleston Harbor general reevaluation report Daniel Island reach turning basin. Charleston, SC

[45] U. S. Army Corps of Engineers, Charleston District. 2006. Final environmental impact statement: Proposed marine container terminal at the Charleston Naval Complex. North Charleston, SC

[46] U. S. Army Corps of Engineers. 1996. Environmental assessment: Charleston Harbor deepening and widening, Charleston, SC

[47] Unpublished U. S. Army Corps of Engineers database.

[48] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Scarce species /ecosystem heritage in vicinity	Species, preserves and wetlands. Federally protected species include shortnose sturgeon and Atlantic sturgeon; green, leatherback, Kemp's Ridley, hawksbill, and loggerhead sea turtles, and North Atlantic right and humpback whales[49]. Extensive wetlands are adjacent to the port including wetlands on the Savannah National Wildlife Refuge[1]. Dredging will reduce sturgeon habitat in the Savannah River. Channel deepening could increase salt water intrusion that would threaten sturgeon habitat and estuarine wetlands.[49] A loss of 233 acres of freshwater wetlands and 15.6 of salt marsh wetlands is expected from deepening 5 feet. To mitigate, river and ocean flows into the estuary would be rerouted to sustain the historic salinity.[49] Deepened channel waters would be aerated to sustain oxygen for sturgeon and other species[49]. A fish passage bypass is planned for sturgeon to establish in the area 20 miles above the New Savannah Bluff Lock and Dam.[49]
Important natural resource use in vicinity	Sport and commercial fishing. There is a potential loss of habitat for striped bass adults, spawning, habitat and juveniles. Proposed mitigation is provided by a bypass around New Savannah Bluff Lock and Dam and by channel aeration and flow modification. Important shrimp and crab fisheries occur in the estuary, but there is no indication of a significant impact by harbor development. Weakfish, spotted sea trout, and, black drum spawning in the lower estuary may be adversely effected.[49] The historic district of Savannah (one of largest National Historic Landmark Districts) is several miles from the port and channel.[49]
Environmental quality of water, sediment, and air.	The city drinking water could be influenced by increased saltwater intrusion without the planned mitigation (see species and ecosystems).[49] Sediments at certain sites are contaminated naturally with high levels of cadmium. Contaminated sediment will be consolidated and disposed of in an EPA approved upland contained site that is capped with a sealing layer[49]. Outer harbor sediments are uncontaminated sands that can be dumped in ocean sites. [49] To prevent nonnative species introduction, all ballast water of ships entering the port will be exchanged in mid-ocean or treated with a Coast Guard approved method[1]. No air quality issues were evident in the EIS.[49] No erosion is expected from ships[1]. The analysis did not identify any significant adverse impacts of vessels to air quality that would result from implementation of the proposed harbor deepening alternatives.[49]
Environmental Justice	Not addressed directly, but the district is committed to USACE policy. [49]
Main channel length	About 32 miles.[50]
Existing channel, basin and berth information	The main channel is 42 feet deep and 500 feet wide (average).[50] The terminal operates nine container berths with 9,693 feet of berth, all 42 feet deep.[51]
Availability of sediment disposal locations	Acceptable confined upland sites are available close to and along the inner harbor channel and basins and EPA accepted ocean sites are available close to and along the outer harbor.[49]
Port capacity	Container yard utilization is 36%, crane utilization is 45%, berth utilization (vessel calls) is77%, berth utilization (percent discharge/load) is 34%, and berth utilization (average vessel size) is 97%.[51]
Capacity of intermodal transport links	The port includes two on-dock rail intermodal terminals[51] and direct access to the interstate highway system.

Variable	**Jacksonville Container Port and Harbor**
Scarce species /ecosystem heritage in	Endangered species. Federally protected species include West Indian manatee and North Atlantic right whale; green, loggerhead, leatherback, and Kemp's Ridley sea turtles; smalltooth sawfish and;

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[49] Savannah District Corps of Engineers. 2011. Draft tier II environmental impact statement for the Savannah Harbor expansion: Chatham County, Georgia and Jasper County, South Carolina.

[50] Unpublished U. S. Army Corps of Engineers database

[51] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

vicinity	short-nosed sturgeon; piping plover (critical habitat is located less than 3-miles north of the navigation channel and wood stork.[52]
Important natural resource use in vicinity	The South Atlantic Fishery Management Council (SAFMC) has designated much of the habitat in or near the harbor as Essential Fish Habitat for brown, pink, and white shrimp; black seabass; gag; crevalle jack; spotted sea trout; weakfish; gray snapper; Atlantic spadefish; sheepshead; red and black drum; and associated prey fish. The Lower Saint Johns River, intersecting Intracoastal Waterway and adjacent lands experience high recreational boating, fishing, and land-based activities.[52]
Environmental quality of water, sediment, and air.	Sediment in and near the navigation channel is characterized as unconsolidated sand, silt, clay and shell and is generally characterized as being of good quality and supportive of good benthic habitat[53].
Environmental justice	No environmental justice concerns have been identified.
Main channel length	About 30 miles.[54,55]
Existing channel, basin and berth information	The Port of Jacksonville includes 3 terminals with 11 berths totaling 9,850 feet long and ranging from 38 to 40 feet deep.[56] Authorized to a depth of 40 feet, the main channel is subject to ebb tide restrictions on vessels entering and leaving with fresh-water drafts exceeding 33 feet and 36 feet respectively.[55] There are cross-currents, sharp turns, and rock formations along the main channel.[55]
Availability of sediment disposal locations	In addition to several dredge disposal sites located along the Saint Johns River, there are two near shore (pipeline and barge) disposal sites located along the Atlantic shoreline south of the channel inlet[57]. Beach-placement of suitable sand material from the navigation channel is consistent with authorized shore protection plans.[58]
Port Capacity	Container yard utilization is 24%, crane utilization is 17%, berth utilization (vessel calls) is 39%, berth utilization (percent discharge/load) is 22%, and berth utilization (average vessel size) is 39%.[56]
Capacity of intermodal transport links	Interstate connections. On-dock rail exists at one terminal and is being developed at another with connections to main railroad lines.[56,59]

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[52] 2012. USACE. *Jacksonville Harbor (Mile Point) Navigation Study, Duval County, Final Integrated Feasibility Report and Environmental Assessment*. Jacksonville, FL.

[53] EPA-842-R-10-003

[54] Unpublished U. S. Army database

[55] http://www.jaxport.com/cargo/facilities/technical-info

[56] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

[57] 2011.USACE. Draft Supplemental Environmental Assessment, Maintenance Dredging, Jacksonville Harbor, Duval County, Florida. Jacksonville, FL.

[58] 2002. USACE. *Jacksonville Harbor Duval County, Florida, Navigation Study Final General Reevaluation Report and Environmental Assessment*. Jacksonville, FL.

[59] http://www.jaxport.com/cargo/facilities/expansion-plans

Variable	**Port Everglades Container Port and Harbor**
Scarce species /ecosystem heritage in vicinity	Species, preserves, and wetlands. Protected species include West Indian manatee; loggerhead, green, leatherback, and hawksbill sea turtles.[60] finback, humpback, northern right, sei, and sperm whales; southeastern American kestrel, eastern brown pelican, least tern, little blue heron, snowy egret, tri-colored heron, roseate spoonbill, osprey, sanderlings, ruddy turnstones, royal terns, ring-billed gulls, laughing gulls, and herring gulls; elkhorn and staghorn coral; and mangrove trees. Critical habitat for elkhorn and staghorn corals has been established east of the port.[61] Reef flats and communities occur near the port and its channels.[62]
Important natural resource use in vicinity	Commercial fishing, sportfishing and water and beach recreation. The coastal lands and waters adjacent to Port Everglades support a variety of natural-resource-based activities including sun bathing, sportfishing, swimming, skin and SCUBA diving, surfing, and boating (private and chartered).[62] Important fish in the port vicinity include spiny lobster, pink shrimp, common snook (state-listed as of special concern), various snappers and groupers, king and spanish mackerel.[62] Nearby habitats have been designated as Essential Fish Habitat (EFH) by NOAA and as EFH-Habitat Areas of Particular Concern by the South Atlantic Fisheries Management Council. [62]
Environmental quality of water, sediment, and air	Water quality of the area has been designated as suitable for recreation, fish and wildlife, although some pesticide contamination in the port appears to come from runoff[62]. Placement of dredged material associated with maintenance of authorized depths is expected to result in temporary changes in turbidity and bottom fauna. Expansion would increase the spatial extent of deep water and could increase impacts associated with additional maintenance dredging. Sediment contamination seems not to be a concern in a 2003 EA, which indicated suitability for beach disposal. [62] No air quality permits were required for maintenance dredging in 2003.[62]
Environmental Justice	No indication of environmental justice issues.
Main channel length.	About 4 miles.[63]
Existing channel, basin and berth information	Main channel depth is 42 feet and the width averages 686 feet. [63] Turning basins are 750 by 1000 feet and 34 to 37 feet deep.[62] Port Everglades container terminals have 11 berths totally 7,345 feet and 43 feet deep (there are numerous other berths for other forms of shipment).[64]
Availability of sediment disposal locations	Disposal options include a ten-acre section near the entrance channel, a 251-acre barrier island immediately south of the entrance channel's south jetty; and an Ocean Dredged Material Disposal Site located about 4.5 nautical miles from the port.[62]
Port Capacity	Container yard utilization is 42%, Crane utilization is 49%, berth utilization (vessel calls) is 44%, berth utilization (percent discharge/load) is 46%, and berth utilization (average vessel size) is 61%.[64]
Capacity of intermodal transport links	While Port Everglades is within 2-miles of a Florida East Coast Railway hub[3] it does not have on-dock rail but is planned.[64] Interstate access is good.

Variable	**Miami Container Port and Harbor**
Scarce species	Protected species, preserves, and wetlands. Protected species in the vicinity include West Indian

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[60] Nesting season for sea turtles as defined by Florida Fish and Wildlife Conservation Commission is between 1-March and 31-October in Broward County.

[61] Critical habitat for elkhorn and staghorn corals as announced per 72210 Federal Register / Vol. 73, No. 229 / Wednesday, November 26, 2008 / Rules and Regulations 2005.

[62] USACE. Maintenance Dredging, Port Everglades, Broward County, Florida Final Environmental Assessment and Finding of No Significant Impact

[63] Unpublished USACE database

[64] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

/ecosystem heritage in vicinity	manatee; hawksbill, green, Kemp's ridley, leatherback, and loggerhead sea turtles; fin, humpback, North Atlantic right, sei, and sperm whales; bottlenose dolphin; smalltooth sawfish; elkhorn and staghorn corals; osprey, reddish egret, piping plover, southeastern American kestrel, white-crowned pigeon, and woodstork; American crocodile and eastern indigo snake; Schaus swallowtail butterfly; and Key Largo woodrat and Key Largo cotton mouse.[65,66] All waters of Miami-Dade County are designated critical habitat for the West Indian Manatee, and much of northern Biscayne Bay has been designated as critical habitat for Johnson's seagrass. Critical habitat for elkhorn and staghorn coral is about 6 miles east of the port. The port is in an area designated by Florida as the Biscayne Bay Aquatic Preserve.[66] Less than 0.5 mile south of the port is the Bill Sadowski Critical Wildlife Area.[67] Biscayne Bay National Park and the Florida Keys National Marine Sanctuary are about 8 miles south of the port. Recommended modifications to the entrance channel and harbor[65] are expected to affect about 419 acres of coastal habitat for which mitigation plans have been developed or recommended.[68] Blasting, which is claimed to be the most environmentally compatible method for excavating rock, would injure or kill species in the immediate vicinity and could adversely affect the behavior of other species.[67] Blast-related safety-zone requirements for manatees and whales were identified.[67]
Important natural resource use in vicinity	Fisheries and recreation. Nearshore habitats near the navigation channel have been designated by NOAA as Essential Fish Habitat (EFH).[67] Hard-bottom areas are designated as EFH-Habitat Areas of Particular Concern by the South Atlantic Fisheries Management Council. Biscayne Bay is designated as an Outstanding Florida Water in the Florida Administrative Code.
Environmental quality of, water, sediment, and air.	Port waters are characterized as generally good quality with some problems in northern Biscayne Bay.[67]Sediments are characterized as generally free of objectionable levels of contaminants and appropriate for ocean disposal, with 70 % no more than "slightly" toxic, and less than 6 % having "high" toxicity.[67]
Environmental justice.	Land adjacent to the port is generally characterized by a combination of low, medium, and high-density residential, commercial, office, and park/recreation uses.[67]
Main channel length	About 13 miles.[69]
Existing channel, basin and berth information	Main channel width averages 575 feet and is 50 feet deep.[69] Other channel range from 35 to 44 feet deep with widths ranging from 400 to 900 feet.[67] The 4 existing turning basins are 32 to 42 feet deep with radii from 600 to 900 feet.[67] Five container berths are all 42 feet deep and total 5,000 feet.[70]
Availability of sediment disposal locations	Disposal sites for dredged sediment and rock include a sea grass mitigation area 3 miles north of the port, 2 permitted artificial reef areas 3 miles east and 4 miles east-southeast of the port, the Virginia Key Confined Disposal Facility about 1 mile south of the port, and the Offshore Dredged Material Disposal Site about 6 miles east-southeast of the port.[67]
Port Capacity	Container yard utilization is 72%, crane utilization is 53%, berth utilization (vessel calls) is 31%, berth utilization (percent discharge/load) is 25% , and berth utilization (average vessel size) is 71%.[70]
Capacity of intermodal transport links	The port has no on-dock rail.[70] Access to the Port is via Port Boulevard which runs through the city of Miami. A major project is being advanced to develop a tunnel that would route port traffic around the city to US 41 and I-395.[67]

Variable	**Tampa Container Port and Harbor**
Scarce species /ecosystem	Species, Preserves, and wetlands. Federally protected species in the port vicinity include green, hawksbill, Kemp's ridley, loggerhead, and leatherback sea turtles; West Indian manatee and blue, fin,

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[65] http://www.nps.gov/bisc/naturescience/threatened-and-endangered-animals.htm

[66] Chapter 258.397, Florida Statutes

[67] 2004. USACE. *Miami Harbor General Reevaluation Report Study Final Environmental Impact Statement*. Jacksonville, FL

[68] 2004. USACE. *Miami Harbor General Reevaluation Report Study Final Environmental Impact Statement Revised Mitigation Plan*. Jacksonville, FL

[69] Unpublished USACE database

[70] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

heritage in vicinity	sei, humpback, and sperm whales; piping plover; wood stork; Florida scrub-jay; red-cockaded woodpecker; Gulf sturgeon and smalltooth sawfish; and Florida golden aster.[71] Critical habitat for manatees and piping plover are established in Tampa Bay[72] where the plovers forage [73] on various invertebrates species.[74] Loggerhead sea-turtles frequently nest in Tampa Bay area and other sea turtle species occasionally nest there.[71] Nine nesting colonies of wood storks are within a 15miles of the harbor. National, state, and local wildlife refuges, preserves, and management areas are neaby.[71]
Important natural resource use in vicinity	Commercial and sportfishing and water-based recreation. The region is a major tourist destination valued for sightseeing, swimming, fishing, scuba diving, and boating.[71] The Gulf of Mexico Fisheries Management Council (GMFMC) habitat in the vicinity as Essential Fish Habitat for shrimp, crab, red drum, spotted sea trout, snook, kingfish, flounder, cobia, snapper, and other reef ,coastal-migratory pelagic, and migratory pelagic fish[1]. Migratory birds are regularly observed nearby.[71]
Environmental quality of water, sediment and air	Sediment within Tampa Bay is generally good to fair quality and supportive of healthy benthic communities[75], with some exceptions near the Port of Tampa and developed shorelines in Tampa Bay.[76] Contaminants of concern include heavy metals, PAHs, PCBs, and pesticides.[77] Much of the contamination results from stormwater runoff.
Environmental Justice	Rapid population growth is an increasing source of tension between the port and nearby public.[71]
Main channel length.	About 19 miles.[78]
Existing channel, basin and berth information	The main channel is 600 feet wide and 43 feet deep.[78] The container port has 2 berths 43 feet deep.[79] Plans are for increasing salt-water channel depths to between 47 and 48 feet.[79]
Availability of sediment disposal locations	An ocean dredged material disposal site is located 21-miles offshore. Several confined dredged material placement areas and beneficial use opportunities exist in and near Tampa Bay. Several borrow pits in Tampa Bay are possible sites for dredged material placement and habitat restoration.[76]
Port Capacity	Capacity used based on maximum TEU is 30.5 %.[79] Port plans recommend quadrupling container port size.
Capacity of intermodal transport links	Population growth and associated traffic is challenging continued viability of good to excellent rail service.·[71]

Variable	**Mobile Container Port and Harbor**
Scarce species /ecosystem heritage in	Species, preserves, and wetlands. The following species listed under the ESA have been observed in or near Mobile Bay: West Indian manatee (occasional in summer); loggerhead, Kemp's ridley, and green sea turtles; blue, humpback, fin, sei, and sperm whales; and piping plover, least tern, bald eagle, red-

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[71] 2011. USACE. *Final Environmental Assessment, Tampa Harbor Federal Navigation Project, Operations Maintenance and Dredging*. Jacksonville, FL.

[72] "Unit FL–20: Shell Key and Mullet Key and Unit FL–21: Egmont Key. (Federal Register, Vol. 66, No. 132, July 11, 2001)

[73] 2005. Doonan, T.J., K.M. Lamonte, and N. Douglass. *Distribution and Abundance of Piping Plovers and Snowy Plovers in Florida*. Proceedings of the Symposium on the Wintering Ecology and Conservation of Piping Plovers.

[74] 1989. Nicholls, J. L. *Distribution and other ecological aspects of Piping Plovers (Charadrius melodus) wintering along the Atlantic Gulf coasts of the United States*. M.S. Thesis, Auburn Univ. Alabama.

[75] EPA-842-R-10-003

[76] 2006. Tampa Bay Estuary Program (TBEP). Charting the Course. Water and Sediment Quality: Address Hot Spots of Toxic Contamination in the Bay. Pp 62-67.

[77] 2011. Tampa Bay Estuary Program (TBEP). State of the Bay: Water and Sediment Quality

[78] Unpublished USACE database

[79] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

vicinity	cockaded woodpecker, Louisiana quillwort, flatwoods salamander, black pine snake, and eastern indigo snake. [80] Endangered Gulf sturgeon typically use Mobile Bay between September and June (yet it is not is not designate critical habitat). A 2003 Regional Biological Opinion[80] describes measures developed to minimize impact to sea turtles and Gulf sturgeon.
Important natural resource use in vicinity	Commercial fishing and wildlife-based recreation. Mobile Bay is listed as Essential Fish Habitat for gray snapper, Spanish mackerel, red drum, pink shrimp, brown shrimp, white shrimp, and stone crab, with waters of the Gulf of Mexico proximal to Mobile Bay listed as essential fish habitat for a variety of other reef and migratory pelagic fish species. [80] Gaillard Island is an upland disposal site used by colonial nesting seabirds and brown pelicans.
Environmental quality of water, sediment, and air.	Because of temporary elevation of nutrients, turbidity, and suspended sediments during dredging and dredged material disposal, only temporary losses of benthic fauna are expected as a consequence of any channel deepening and widening. Sediments and benthic communities in Mobile Bay have been characterized as degraded and poor, respectively[81]. Tissues of fish collected there exhibit detectible consecrations of PCBs, DDTs, mercury, and cadmium[82]. Sediment analysis in 2010 detected concentrations of arsenic, copper, nickel below their respective Probable Effects Levels in Mobile River and Mobile Bay sediments.[83] Individual and total PAH concentrations sampled in November/December, 2010 were similar to local background levels and no discernible change following the Deepwater Horizon Oil Spill.
Environmental Justice	No environmental justice issues were identified.
Main channel length.	About 38 miles.[84]
Existing channel, basin and berth information	Main channel is 45 feet deep and averages 400 feet wide.[84] The Port of Mobile has 2 terminals with 3 berths totaling 2,900 feet long and ranging between 40 and 45 feet deep.[85]
Availability of sediment disposal locations	Previously-approved upland disposal sites located adjacent to Mobile River or the Mobile-North Ocean Dredged Material Disposal Site (ODMDS) are available for use along the northern range of the federal navigation project with the Sand Island Beneficial Use Area identified as serving the southern range of the federal navigation project. The Deepwater Horizon Oil Spill introduced uncertainty about the acceptability of future ocean disposal of dredged material.
Port capacity	Container yard utilization is 14%, crane utilization is 12%, berth utilization (vessel calls) is 25%, berth utilization (percent discharge/load) is 20%, and berth utilization (average vessel size) is 25%.[85]
Capacity of intermodal transport links	There is direct interstate connectivity and on-dock rail at one terminal that connects to main lines.[85]

Variable	**New Orleans Container Port and Harbor**
Scarce species /ecosystem heritage in vicinity	Endangered species, preserves, and wetlands. federally-protected species that have been observed in or near the harbor include leatherback, hawksbill, Kemp's Ridley, loggerhead, and green sea turtles; Gulf sturgeon and pallid sturgeon; West Indian manatee and Louisiana black bear; and brown pelican, piping plover, and bald eagle[86,87]. South of the port are The Jean Lafitte National Park and the

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[80] Dredging of Gulf of Mexico Navigation Channels and Sand Mining ("Borrow") Areas Using Hopper Dredges by Corps of Engineers (COE) Galveston, New Orleans, Mobile, and Jacksonville Districts"

[81] EPA-842-R-10-003

[82] 2006. Alabama Department of Environmental Management. *The National Coastal Assessment Alabama 2000-2004 Final Report.*

[83] November 2011. United States Army Corps of Engineers. DRAFT Environmental Assessment and Section 404(b)(1) Evaluation: Environmental Certification Package: Mobile Harbor Operations and Maintenance, Mobile County, Alabama.

[84] Unpublished U. S. Army Corps of Engineers database

[85] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

[86] 2010. USACE. *Biological Assessment: Louisiana Coastal Area-Mississippi River Gulf Outlet Ecosystem Restoration Project*. New Orleans, LA.

	Barataria–Terrebonne National Estuary. Ten national wildlife refuges and seventeen state refuges and wildlife management areas are near the Mississippi River channel leading to the port.[87]
Important natural resource use in vicinity	The region in the port vicinity supports shellfish and finfish populations that form the basis for significant commercial and recreational fisheries.[86,88] The Gulf of Mexico Fisheries Management Council (GMFMC) has designated the habitat in and near the Mississippi River from the Port of New Orleans to the Gulf of Mexico as Essential Fish Habitat for brown shrimp, white shrimp, red drum, Gulf stone crab, king mackerel, cobia, lane snapper, dog snapper, bonnethead shark, and Atlantic sharpnose shark. There are opportunities for beneficial use of dredged material to restore marsh, islands and estuarine habitat but with possible temporary impacts on existing natural habitat.[87]
Environmental quality of sediment, water, and air.	Anoxic conditions and high turbidity that have been reported in and near Lake Pontchartrain and the mouth of the Mississippi River yielding fair to poor water quality conditions[4]. While benthic habitat is characterized generally as fair to poor, the degree of sediment contamination in the region is characterized as low[89]. However, because of the past and ongoing petroleum and natural gas exploration, industrial activity, and navigation near the Port of New Orleans and the Mississippi River from the port to the Gulf of Mexico, contaminated sediment is recognized as a notable because of the relative stresses on sediment-dependent habitat/systems.[87]
Environmental Justice	No issues identified.
Main channel length	About 256 miles.[90]
Existing channel, basin and berth information	The main channel is 45 feet deep.[90] The single container terminal has 2 berths 45 feet deep and 2000 feet long in total.[91]
Availability of sediment disposal locations	A variety of dredged material management options exist and have been proposed in the region ranging from upland, confined, and open-water disposal, to beneficial use.[87]
Port Capacity	Container yard utilization is 45%, crane utilization is 37%, berth utilization (vessel calls) is 54%, berth utilization (percent discharge/load) is 34%, and berth utilization (average vessel size) is 63%.[91]
Capacity of intermodal transport links	The terminal has on-dock rail [91] and direct access to Interstate 10.[88]

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[87] 2010. USACE. *Final Programmatic Environmental Impact Statement for the Beneficial Use of Dredge Material Program*. New Orleans, LA

[88] 2010. USACE. *Mississippi River Gulf Outlet (MRGO) Ecosystem Restoraiton Study Draft Environmental Impact Statement*. New Orleans, LA.

[89] EPA-842-R-10-003

[90] Unpublished U. S. Army Corps of Engineers database

[91] Smith, D. and K. Knight. 2012. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Variable	**Houston Container Port and Harbor**
Scarce species /ecosystem heritage in vicinity	Scarce Species. Federally protected species observed in or near the harbor in Galveston Bay include leatherback, hawksbill, Kemp's Ridley, loggerhead, and green sea turtles; West Indian manatee and blue, finback, humpback, sei, and sperm whales; gulf sturgeon and smalltooth sawfish; brown pelican; interior least tern; piping plover; whooping crane; Attwater's greater prairie chicken; bald eagle; Houston toad; and Texas prairie dawn (a plant) .[92,93] Galveston Bay supports other state-listed and state managed species.
Important natural resource use in vicinity	The Gulf of Mexico Fisheries Management Council (GMFMC) has designated habitat near the Shoal Point Container Terminal as Essential Fish Habitat for adult and juvenile brown and white shrimp, red drum, and Spanish mackerel. Galveston Bay is on an important migratory corridor for coastal and trans-oceanic bird migration.[92] Over 32,000 recreational boats use the bay.
Environmental quality of sediment, water and air.	Northern Galveston Bay is listed as an impaired[94] water body due to multiple pollutants including bacteria, dioxin, and PCBs with higher concentrations of dioxins and PCB's distributed in the upper tributaries of Galveston Bay. [95] Sediment quality is characterized as of poor to good quality with poor to fair benthic habitat. [96] The port is heavily industrialized with many generators or stores or hazardous materials and petroleum products[92] and is located in the Houston-Galveston-Brazoria Air Quality Control Region[97] which has been classified as in a severe state of nonattainment with National Ambient Air Quality Standards for ozone.[92] NOx emissions associated with different landside transportation assumptions have also been identified as possible air quality concerns.
Environmental justice	The percentage of the population characterized as minority or economically-stressed near the port is 1.33 to 2.00 times that of the State and some vulnerability may be associated with port activities.[92]
Main channel length	About 14 miles.[98] Several channels branch off to connect with other terminals.[92, 93]
Existing channel, basin and berth information	The main channel depth is 47 feet. [98] The Port of Houston has two terminals and a total of 8 births totaling 8000 feet and maintained at 40 feet deep[99]. There is a 1600 feet diameter turning basin. Branch channels into the two terminals total 4.8 miles, 40 feet deep and averages 300 feet wide.[93]
Availability of sediment disposal locations	Several dredge disposal and management options exist within and proximal to Galveston Bay.[95]
Port Capacity	Container yard utilization is 57 %, Crane utilization is 37%, berth utilization (vessel calls) is 49 %, berth utilization (percent discharge/load) is 52%, and berth utilization (average vessel size) is 44%[8]. The Port of Houston handles about 70% of the container cargo in the Gulf Region.[99]
Capacity of intermodal transport links	Container terminals have direct access to interstate highway and to two rail system,[92] but no on-dock rail.[99]
Variable	**Los Angeles/Long Beach Container Ports and Harbor**

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[92] 2002. USACE. *Galveston District Final Environmental Impact Statement for Texas City's Proposed Shoal Point Container Terminal, Volumes 1and 2*. Galveston, TX.

[93] 2007. USACE. *Texas City Channel Deepening Project General Reevaluation Report and Environmental Assessment*. Galveston, TX.

[94] 2008. Texas Commission on Environmental Quality. *2008 Texas 303 (d) list.* Austin, Texas.

[95] 2010. USACE. *Final Environmental Assessment. Expansion of Placement Areas 14 and 15, Houston Ship Channel, Chambers County, Texas.* Galveston, TX.

[96] EPA-842-R-10-003

[97] http://www.epa.gov/oaqps001/greenbk/anayo_tx.html

[98] Unpublished U. S. Army Corps of Engineers data

[99] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Scarce species /ecosystem heritage in vicinity	Species and wetlands. Federally protected species include loggerhead, green, leatherback, and olive ridley sea turtles; California least tern and western snowy plover; and blue, fin, humpback, and sperm whales.[100,101,102,103] Sea turtles and whales can be expected just outside the harbor. A variety of other endangered bird, plant and reptile species inhabit terrestrial or fresh water areas that are less likely to be impacted. The harbor area has very small amounts of wetlands and eelgrass.[99,100,101, 192]
Important natural resource use in vicinity	Fisheries and Potable water. The Port area supports a limited amount of natural resources. The port area lacks estuarine and wetland habitats and possesses limited eelgrass habitat. Fish of commercial or recreational value include ubiquitous pelagic species such as anchovy, sardines, Pacific mackerel, and jack mackerel with less common soft bottom species such as Pacific sanddab and English sole. There is a fish consumption advisory for fish caught in the harbor.[104] All waters in the harbor are tidally influenced and considered Essential Fish Habitat, as defined by NOAA for various species[99, 100, 101,102]
Environmental quality of water, sediment and air	Harbor waters and sediments are impaired under criteria of Section 303(d) of the Clean Water Act for DDT, PCBs, PAHs, multiple pesticides, mercury and other heavy metals, and bacteria.[99,100,101,102] Due to the high levels of contaminants, the local water board agencies have designated the harbor area as a toxic hot spot.[103] Future disposal operations would assume harbor sediments were contaminated.[5] Any adverse water quality effects of dredging would likely be short term with implementation of proper BMPs.[103] Regional air quality was in non-attainment status for ozone, PM-2.5, PM-10, and lead under the National Ambient Air Quality Standards as of March 2012.[99, 100]
Environmental Justice	Port operations expose low income/minority populations to poor air quality, which would partially be mitigated through fleet modernization, electrification, and additional BMPs.[99,100,101,102]
Main channel length	About 15 miles.[105]
Existing channel, basin and berth information	In main channel is 53 feet deep and averages about 600 feet wide.[104] Other basins and channels in the harbors vary from 45 to 81 feet deep.[106] In total, there are 55 berths at 15 terminals totaling 56,978 feet. The berths vary between 42 and 55 feet deep.[107]
Availability of sediment disposal locations	Due to the high level of sediment contamination, most sediment would be disposed in harbor infills and shallow water habitat creation projects within the Port of Los Angeles/Long Beach Harbor.[99,100,101,102] Suitable sediment may be disposed of at marine disposal site LA-2 (9 miles away).
Port Capacity	Container yard utilization is 75%, crane utilization is 43%, berth utilization (vessel calls) is 25%, berth utilization (percent discharge/load) is 112%, and berth utilization (average vessel size) is 25%.[106]
Capacity of intermodal transport links	Almost all the terminals have on-dock rail connections to the Alameda Corridor and a dedicated sub-surface rail cargo expressway connecting to railway mainlines near downtown Los Angeles. All terminals connect directly to interstate highways. There is potential for indirect and/or cumulative impacts as a result of the larger ships calling on the port associated especially with truck traffic[99,100,102]

Variable	**Oakland Container Port and Harbor**
Scarce species	Species and wetlands. Federally protected species include green sturgeon, tidewater goby, delta

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[100] U.S. Army Corps of Engineers and the Port of Los Angeles. 2009. Port of Los Angeles Channel Deepening Project – Final Supplemental Environmental Impact Statement/Supplemental Environmental Impact Report.

[101] U.S. Army Corps of Engineers and the Port of Los Angeles. 2011. Draft EIS/EIR – Berths 302-306 APL Container Terminal Project.

[102] U.S. Army Corps of Engineers and the Port of Long Beach. 2009. Middle Harbor Redevelopment Project – Final Environmental Impact Statement (FEIS)/Final Environmental Impact Report (FEIR) and Application Summary Report (ASR).

[103] U.S. Army Corps of Engineers and the Port of Long Beach. 2011. Pier S Marine Terminal + Back Channel Improvement Project – Draft Environmental Impact Statement (DEIS)/Draft Environmental Impact Report (DEIR).

[104] Los Angeles Region Contaminated Sediments Task Force. 2005. Los Angeles Regional Contaminated Sediments Task Force: Long-Term Management Stragey.

[104] Unpublished U. S. Army Corps of Engineers database.

[106] Marine Exchange of Southern California. 2011. Harbor Safety Plan 2011.

[107] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

/ecosystem heritage in vicinity	smelt, coho salmon, steelhead, and chinook salmon; western snowy plover, California clapper rail, and California least tern; salt marsh harvest mouse; and California sea blite[108]. A variety of other endangered bird, plant and reptile species inhabit terrestrial or fresh water areas that are less likely to be impacted. The harbor area has 5,000 square feet of eelgrass beds, with additional patches within a 200-foot buffer of the Inner Harbor channels.[107,109]
Important natural resource use in vicinity	Fisheries and Potable water. The study area supports ground fish including English sole, starry flounder, sand sole, lingcod, and brown rockfish, to name a few species[107]. Chinook salmon migrate through the area. San Francisco Bay is considered Essential Fish Habitat as defined by NOAA.
Environmental quality of water, sediment, and air	The Oakland Harbor system is considered to be impaired under criteria of Section 303(d) of the Clean Water Act for dioxins, polyaromatic hydrocarbons, polychlorinated biphenyls, pesticides, mercury, and other metals.[110] Some toxic material present in the sediments, limiting the disposal of about 0.5 million cubic yards to upland land disposal.[108] The adverse water quality effects of dredging would likely be short term and periodic maintenance will result in the temporary removal of benthic infauna and epifauna and temporary and minor change in air quality.[108] The region was in attainment of all National Ambient Air Quality Standards in 1998 except for carbon monoxide[111] and since then, has achieved non-attainment status for ozone and PM2.5.[112]
Environmental Justice	The nearby West Oakland community is a socially and economically disadvantaged community. The port would address traffic, air quality, and quality of life issues on an on-going basis. [110]
Main channel length	About 10 miles[113].
Existing channel, basin and berth information	The main Channel depth is 50 feet deep and averages about 900 feet wide[112]. The Outer Harbor Turning Basin is 1600 feet in diameter, and the Inner Harbor Turning Basin is 1500 feet in diameter. Port of Oakland has 21 berths at eight terminals totaling 22,454 feet. Thirteen berths are 50 feet deep, and eight are 42 feet deep.[114]
Availability of sediment disposal locations	As of 2009, dredged materials have been discharged to the adjacent Middle Harbor Enhancement Area (the Montezuma Wetlands Restoration Site) about 48 miles away, San Francisco Deep Ocean Disposal Site about 60 miles away, Hamilton Wetlands Restoration Site about 20 miles away and various upland disposal sites.[107] Disposal is available at the San Francisco Deep Ocean Disposal Site.[108] Maintenance dredging to 50 feetwould nearly double the cubic yards dredged per year. [109]
Port Capacity	Container yard utilization is 53%, Crane utilization is 29%, berth utilization (vessel calls) is 40%, berth utilization (percent discharge/load) is 28%, and berth utilization (average vessel size) is 40%.[113]
Capacity of intermodal transport links	The port has two near-dock rail intermodal terminals[113] and direct connection to interstate highway system.

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[108] U.S. Army Corps of Engineers, San Francisco District. 2010. Environmental Assessment for Fiscal Year 2010-12 Maintenance Dredging of Oakland Inner and Outer Harbors, Oakland, California.

[109] U.S. Army Corps of Engineers, San Francisco District. 1998. Oakland Harbor Navigation Improvement (~50 Foot) Project, Revised Final Feasibility Study.

[110] http://www.swrcb.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

[111] U.S. Army Corps of Engineers, San Francisco District. 1998. Oakland Harbor Navigation Improvement (~50 Foot) Project, Final Environmental Impact Study/Environmental Impact Report.

[112] http://www.epa.gov/oaqps001/greenbk/ancl3.html

[113] Unpublished U. S. Army Corps of Engineers database

[114] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

Variable	**Tacoma Container Port and Harbor**
Scarce species /ecosystem heritage in vicinity	Species and wetlands. Federally protected species in the vicinity of the project site include marbled murrelet , chinook salmon, steelhead trout, bull trout, and southern resident killer whales. A variety of other endangered bird, plant and reptile species inhabit rural upland areas that are less likely to be impacted. The harbor area has lost most of its marine wetlands and eelgrass, so almost no patches are left.[115,116] There are still some remnant freshwater wetlands of moderate to low quality.[115]
Important natural resource use in vicinity	Fisheries and Potable water. The aquatic environment supports tribal fishing for salmon, shellfish, and non-salmon fish resources.[117] There is some recreational fishing, but on tribal commercial fishing is allowed (treaty rights). Fishing occurs mostly away from the immediate port area. Notable resources include Dungeness crab, rock crab, shrimp, scallops, sea urchins, sea cucumbers, and squid as well as geoducks, clams, and oysters. The area is considered Essential Fish Habitat as defined by NOAA for salmon, groundfish, and pelagic species.[118]
Environmental quality of water, sediment and air	Parts of Port of Tacoma are considered impaired under the 2008 State of Washington 303(d) water quality assessment for several pollutants including PCBs, phthalates, and dieldrin.[119] Much of the Port of Tacoma was designated a Superfund site and contaminated sediments were removed. Sitcum Waterway is still designated a Superfund Site with impairments due to organics, PAHs, mercury, and other metals.[116] About eight million cubic yards of suitable sediments have been discharged to the Commencement Bay disposal area through 2009. The adverse water quality effects of dredging would likely be short term. The region was in non-attainment for PM-2.5 under the National Ambient Air Quality Standards as of March 2012.[120] Periodic maintenance will result in the temporary removal of benthic infauna and epifauna and temporary and minor change in air quality.
Environmental Justice	Minority and low income populations are not within the project area and in small numbers within the vicinity of the project area.[115]
Main channel length	About 2.7 miles.[121]
Existing channel, basin and berth information	The main channel depth is 51 feet deep and about 650-wide[7]. It has a 1,700-foot diameter turning basin. The Port of Tacoma has nine berths at five terminals totaling 10,860 feet. All berths are 51 feet deep.[122]
Availability of sediment disposal locations	Suitable sediments are disposed of in Commencement Bay about 4.5 miles away. In 2010, the capacity was expanded from 9 million cubic yards to 23 million cubic yards, which would extend the life to an additional 40 years.[123]
Port Capacity	Container yard utilization is 37%, crane utilization is 15%, berth utilization (vessel calls) is 23%, berth utilization (percent discharge/load) is 52% , and berth utilization (average vessel size) is 23%.[122]
Capacity of intermodal transport links	Most of the terminals have on-dock rail connections[122], and all have direct connection to interstate highway system. The most likely indirect/cumulative impacts are related to increased truck traffic .

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[115] David Evans and Associates. 1991. Commencement Bay Cumulative Impact Studies: Historic Review of Special Aquatic Sites.

[116] U.S. Army Corps of Engineers. 2009. Blair-Hylebos Terminal Redevelopment Project: Final Environmental Impact Statement.

[117] U.S. Army Corps of Engineers and Washington State Department of Natural Resources. 2009. Reauthorization of Dredged Material Management Program Disposal Site Commencement Bay, Washington: Supplemental Environmental Impact Statement.

[118] U.S. Army Corps of Engineers. 2005. Department of the Army Permit Evaluation and Decision Document for 200400818, Port of Tacoma, Blair Waterway Expansion.

[119] http://www.ecy.wa.gov/programs/wq/303d/2008/index.html

[120] http://www.epa.gov/oaqps001/greenbk/ancl3.html

[121] Unpublished USACE database

[122] Smith, D. and K. Knight. 2010. Container port capacity study. Draft IWR Report, Institute for Water Resources. U. S. Army Corps of Engineers. Alexandria, VA

[123] U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. 2010. Public Notice–Reauthorization of Dredged Material Management Program (DMMP) Disposal Site Commencement Bay, Washington.

IWR Institute for Water Resources

The Institute for Water Resources (IWR) is a U.S. Army Corps of Engineers (USACE) Field Operating Activity located within the Washington DC National Capital Region (NCR), in Alexandria, Virginia and with satellite centers in New Orleans, LA; Davis, CA; Denver, CO; and Pittsburg, PA. IWR was created in 1969 to analyze and anticipate changing water resources management conditions, and to develop planning methods and analytical tools to address economic, social, institutional, and environmental needs in water resources planning and policy. Since its inception, IWR has been a leader in the development of strategies and tools for planning and executing the USACE water resources planning and water management programs.

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The Director of IWR is Mr. Robert A. Pietrowsky, who can be contacted at 703-428-8015, or via e-mail at: robert.a.pietrowsky@usace.army.mil. Additional information on IWR can be found at: http://www.iwr.usace.army.mil. IWR's NCR mailing address is:

U.S. Army Engineer Institute for Water Resources
7701 Telegraph Road, 2nd Floor Casey Building
Alexandria, VA 22315-3868

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