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Report to Congressional Requesters

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OREGON INLET JETTY PROJECT

Environmental and Economic Concerns Still Need to Be Resolved

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Abbreviations

CEQ Council on Environmental Quality
DOI Department of the Interior
EIS Environmental Impact Statement
FWS Fish and Wildlife Service
GAO General Accounting Office
GDM General Design Memorandum
NMFS National Marine Fisheries Service
NOAA National Oceanographic and Atmospheric Administration
NPS National Park Service
OMB Office of Management and Budget

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United States General Accounting Office
Washington, D.C. 20548

September 30, 2002

The Honorable Max Baucus
United States Senate

The Honorable John Edwards
United States Senate

Oregon Inlet is the primary route to the ocean for hundreds of commercial and recreational fishing vessels operating in the Outer Banks region of North Carolina. However, the inlet experiences more high winds, strong tides, and shifting sand than any other inlet on the Atlantic coast of the United States. This high-energy environment often creates sand bars and large breaking waves at the inlet's entrance to the ocean, commonly known as the ocean bar. These conditions, especially when combined with the severe storms that frequent the area, can swamp a boat or run it aground, imperiling both life and property. According to the U.S. Army Corps of Engineers and U.S. Coast Guard data, over the 40-year period 1961 through 2001, hazardous conditions in the inlet were a factor in 25 deaths and the loss of 22 vessels.

In 1950, in an attempt to improve navigation at Oregon Inlet, the Congress authorized the Corps to dredge a channel in the inlet—called the ocean bar navigation channel—to a depth of 14 feet.[1] From 1960 through 2001, the Corps' Wilmington District Office, which is responsible for maintaining the ocean bar navigation channel at Oregon Inlet, spent about $108 million dredging this channel.[2] Additional efforts to improve the safety of the channel are conducted by the U.S. Coast Guard, which is responsible for, among other things, maintaining the navigation aids that help guide vessels through the inlet. In 1970, in an effort to stabilize Oregon Inlet and in response to local concerns that a deeper channel was needed to accommodate fishing vessels and commercial traffic, the Congress authorized the construction of dual rock jetties and a 20-foot-deep ocean bar navigation channel for Oregon Inlet.[3] Since this authorization, the Corps has completed and updated numerous economic and environmental

[1] P.L. 81-516, the River and Harbor Act of 1950, authorized the project, officially titled the Manteo (Shallowbag) Bay, North Carolina, project.

[2] All dollars in this report are 1997 dollars unless otherwise noted.

[3] P.L. 91-611, River and Harbor and Flood Control Acts of 1970.

analyses to determine if construction of the project is justified. In the latest update of its economic analysis, completed in 2001, the Corps estimated that the project would yield annualized net benefits of about $7.2 million over 50 years, largely from savings that were projected to be attained from reduced operating costs for commercial fishing vessels and increased activity by recreational boaters. Annualized costs were estimated at about $4.5 million. As a result, annual net benefits (benefits minus costs) for the proposed jetty project were estimated at $2.7 million. However, although the Corps and others have completed many studies over the last 30 years, the Congress has never appropriated funds specifically to construct the project. During this period there have been major disagreements among federal, state, and local governmental entities, including the Departments of Commerce and Interior, as well as among environmental, fishing, and recreational groups, about whether the project is economically justified and whether it would harm the environment by, among other things, increasing beach erosion and restricting the migration of fish larvae from the ocean to the sounds inside the inlet, where the larvae develop into fish.

You asked us to review several issues related to the Corps' Oregon Inlet jetty project. Specifically, we agreed to (1) assess federal efforts to maintain the ocean bar navigation channel in Oregon Inlet, (2) assess the extent to which the Corps' 2001 economic analysis of the jetty project is useful for decision making, (3) provide information on the performance of similar jetty projects, that is, those constructed with dual jetties and a low section called a weir,[4] (4) determine whether the Corps' Wilmington District Office applied lessons learned from similar jetty projects in its design of the Oregon Inlet jetty project, and (5) identify and discuss concerns raised by the Departments of Commerce and Interior about development of the jetty project.

Results in Brief

During the past 19 years, the Corps has had difficulty maintaining the ocean bar navigation channel at Oregon Inlet at its authorized 14-foot depth. Specifically, from 1983 through 1994, the Corps spent on average about $4.1 million per year dredging the channel, but was only able to maintain the authorized 14-foot depth on average about 23 percent of the time. After 1994, the Corps spent an average of about $2 million per year, but the

[4] A weir is a section of a jetty that is lower than the rest of the structure. The weir is typically designed to allow water and sand to flow over it when the water level is greater than low tide.

percentage of time the channel depth was maintained at its authorized depth declined to about 15 percent. According to a 2001 engineering and design document issued by the Corps, its dredging efforts at Oregon Inlet have not provided a safe and navigable ocean bar navigation channel, and hazardous navigation conditions at the inlet will continue to cause the loss of human life and injuries as well as vessel losses and damages. Wilmington District Office officials said that the high-energy environment and storms associated with Oregon Inlet have often thwarted the Corps' plans and depleted its funding for dredging the inlet. In addition, the district has sometimes had to reallocate funds that were earmarked for dredging Oregon Inlet to other district projects in response to emergencies caused by the frequency and magnitude of area storms. Further, because of the Corps' limited dredging and the inlets high-energy environment, the Coast Guard has been unable to maintain and properly position its navigation buoys for the channel, which further increases the risk of damage to vessels and injuries to people.

The Corps' most recent economic analysis of the proposed Oregon Inlet jetty project, issued in 2001, has several limitations, and as a result, does not provide a reliable basis for deciding whether to proceed with the project. For example, the Corps relied on outdated data to estimate the benefits to large commercial fishing vessels (trawlers). More recent data indicates that trawlers currently use the inlet far less than the Corps estimated in its economic analysis. On the other hand, the Corps did not analyze the potential benefits the proposed jetty project may provide to smaller commercial fishing vessels. However, because these smaller vessels have shallower drafts than trawlers, the extent to which they might benefit from the jetty project is uncertain. The analysis also did not account for the economic value of the lives that might be saved by the jetty project, which could understate benefits; it also overstated the cost of the current dredging program, and it used an overly optimistic assumption concerning future dredging needs that would tend to understate the cost of the jetty project. We did not assess the net effects of all the limitations we found with the economic analysis because obtaining the necessary data would require an inordinate amount of time and expense. These limitations, however, can result in either overstated or understated estimated benefits and costs.

Of the eight completed jetty projects constructed similarly to the proposed Oregon Inlet jetty project, two are generally performing as planned. Of the six other similar projects, three have required more dredging and higher maintenance costs than expected, and two have had their weirs closed—

one because the responsible Corps' District did not accurately determine the direction of sand movement and constructed the weir on the wrong jetty, and the other because of problems with the instability of the channel and with boaters using the weir as a shortcut, creating a safety hazard. According to the Corps, the problems at these five projects stemmed from inaccurate information on sand movement when the projects were initially designed. At the sixth project, more sand has accumulated in the navigation channel than expected, but this occurred because the Corps did not fully construct the area designed to collect sand deposits. As a result, according to the Corps, the navigation channel has been available at its authorized depth only about 20 percent of the time.

In designing the proposed Oregon Inlet jetty project, the Corps' Wilmington District Office applied lessons learned from the construction of similar jetty projects and from internal Corps guidance. For example, the Wilmington District staff stated that from its construction and management of the Masonboro Inlet jetty project in North Carolina—one of two similar jetty projects that are generally performing as planned—it learned about the need for dual jetties, the proper length of a weir, and the effect of erosion on jetties. District staff stated that from internal Corps guidance they learned about, among other things, the importance of having accurate information on sand movement in designing the proposed Oregon Inlet jetty project. Nonetheless, the Corps stated that because each jetty project is designed for a unique environment, lessons learned from similar projects would not predict all aspects of the performance of the Oregon Inlet project. For example, the Corps incorporated a weir into the design of Oregon Inlet's northern jetty to allow fish larvae that migrate near the ocean shoreline to travel over the jetty, through the inlet, and into the sound. None of the eight similar jetty projects with weirs were designed to provide for fish larvae migration.

Both the Department of Commerce and the Department of the Interior support the goal of providing a safe navigation channel through Oregon Inlet for commercial and recreational fishing vessels. However, both departments support a dredging-only approach to achieve that goal in an environmentally acceptable manner. Commerce, which manages marine resources, including fisheries, and Interior, which manages the federally owned land upon which the jetties would be built, have raised several environmental concerns about the construction of the Oregon Inlet jetty project. For example, Commerce believes that constructing the project will cause unacceptable harm to commercial and recreational fishery resources by limiting the ability of fish larvae to reach habitat necessary for

their development. Commerce is also concerned that the jetties will significantly alter sand movement in the vicinity of Oregon Inlet and damage beaches, dunes, beds of submerged aquatic vegetation, salt marshes, shallow water habitats, and other aquatic sites and resources. Interior believes that the jetties will increase beach erosion, especially on the south side of the inlet, and that the project's sand bypassing system could harm coastline habitat and wildlife by depositing large quantities of sand onto Interior's land each year without allowing sufficient time for recovery of the ecosystem. For these and other reasons, Interior has maintained that constructing the jetties is not consistent with the missions of its National Park Service (NPS), which manages the Cape Hatteras National Seashore to the north and south of Oregon Inlet, and Fish and Wildlife Service (FWS), which manages the Pea Island National Wildlife Refuge to the south of the inlet, and has denied the Corps the permits needed to build the jetties on Interior's lands. To address the concerns of Commerce and Interior, the Corps revised its original jetty design to shorten the length of the jetties and incorporate a weir, which it believes will mitigate the concerns about fish larvae migration. The weir is also intended to facilitate the collection of sand, which the Corps plans to transport to adjacent beaches to address erosion. However, both Commerce and Interior have stated these actions will not achieve the desired results. In October 2001, because Commerce, Interior, and the Corps were unable to reach agreement on these issues, Commerce referred the matter to the Council on Environmental Quality—an entity established by the National Environmental Policy Act to resolve interagency disagreements concerning major federal actions that might cause negative environmental effects. Interior has also asked the council to consider its concerns. The Corps does not believe it should spend additional public resources to develop the project until it has assurances that the environmental issues will be favorably resolved.

Lacking resolution of environmental concerns from the council and construction permits from Interior, we agree with the Corps that it should not pursue further development of the Oregon Inlet jetty project. If, however, both of these issues are favorably resolved, we are recommending that in order to have a reliable economic basis for deciding whether to proceed with the project, the Secretary of the Army direct the Corps to prepare a new and comprehensive economic analysis of the project's costs and benefits that would provide the more current and complete information needed to justify construction of the project. In commenting on a draft of this report, the Departments of the Army, Commerce, and Interior generally agreed with our findings and

recommendations. The Department of Transportation did not comment on our overall findings and recommendations, but offered specific technical comments.

Background

The Corps' mission is both military and civilian and involves providing quality, responsive engineering services to the nation. The Corps' involvement in civil engineering projects, such as the proposed Oregon Inlet jetty project, comes under the auspices of the Director of Civil Works and falls into four broad categories: water infrastructure, environmental management and restoration, response to natural or man-made disasters, and engineering and technical services. The Corps is organized geographically into eight divisions and 41 districts that are responsible for implementing individual projects. The Corps' Wilmington, North Carolina, District Office, part of the South Atlantic Division, is responsible for maintaining a safe and navigable waterway at Oregon Inlet. Appendix I provides a description of the Corps' process for developing a water resource project.

Oregon Inlet provides the only access to the Atlantic Ocean from inland waters located between Rudee Inlet in Virginia Beach, Virginia, about 85 miles to the north of Oregon Inlet, and Hatteras Inlet in Hatteras, North Carolina, about 45 miles to the south. Oregon Inlet is located in the Outer Banks, a string of barrier islands along the coast of North Carolina. According to a study of Outer Banks sediment and inlet dynamics, these barrier islands and their migrating inlets consist of dynamic sedimentary deposits, which, left to nature, constantly move and change under the influence of waves, currents, and the change in sea level. Overall, these islands are slowly moving toward the mainland at an average rate of about 4.5 feet per year. In addition, along the ocean side of the Outer Banks, the sands flow predominantly toward the south. For this reason, the islands and Oregon Inlet naturally move in a southerly direction. At least a dozen separate inlets have naturally opened and closed along the Outer Banks' coastline over the three centuries that preceded the formation of Oregon Inlet.[5] Currently, there are three inlets along the Outer Banks: Oregon Inlet, Hatteras Inlet, and Ocracoke Inlet. Figure 1 shows the location of Oregon Inlet and its surrounding features.

[5] "The Outer Banks of North Carolina: Budget of Sediment and Inlet Dynamics Along a Migrating Barrier System" by Douglas L. Inman and Robert Dolan, *Journal of Coastal Research*, Spring 1989, Charlottesville, Virginia.

Figure 1: Oregon Inlet's Location Along the North Carolina and Virginia Coastlines

Source: Corps' Wilmington District Office.

Oregon Inlet experiences a combination of more high winds, strong tides, storms, and shifting sand than any other inlet along the Atlantic coast of the United States. These high-energy conditions often create hazards for vessels attempting to pass through the inlet to or from the ocean. Vessels making this passage use the ocean bar navigation channel, which extends from a point about 1,500 feet inside the Herbert C. Bonner Bridge (commonly known as the Bonner Bridge) to a point in the ocean called the ocean bar, about 10,000 feet outside the bridge.[6] At the ocean bar, sand naturally accumulates and waves break on the surface because of the shallow water. Nonetheless, hundreds of vessels pass through the inlet each year. In 1999 through 2001, according to North Carolina Division of Marine Fisheries data, on average, about 311 commercial fishing vessels used Oregon Inlet a total of about 3,900 times each year to access the ocean. During this period, commercial fishing vessels using the inlet landed more than 18 million pounds of fish at seafood dealers that operate inside the inlet.

The North Carolina Department of Transportation is currently evaluating preliminary plans for constructing a bridge that would replace the Bonner Bridge. The new bridge would be located farther west than the current bridge and may make landfall several miles farther south than the current bridge, possibly bypassing the Pea Island National Wildlife Refuge. According to a state engineer, the proposed elevated portion of the new bridge would be 5,000 feet long, which would allow the natural migration of Oregon Inlet to the south and also permit the navigation channel to be moved as conditions dictate. The proposed completion date for the new bridge is 2010. Figure 2 provides an aerial view of Oregon Inlet.

[6] The Herbert C. Bonner Bridge transverses Oregon Inlet and carries a highway that connects Bodie Island on the north side of the inlet to Pea Island on the south.

Figure 2: Aerial View of Oregon Inlet on September 18, 2001

Source: Adapted from a Corps' Wilmington District Office photo mosaic.

The safety and navigability of Oregon Inlet has been the subject of a series of engineering, economic, and environmental studies by the Corps' Wilmington District Office. In the 1960s, local officials and other interested parties told the Corps that the original 14-foot navigation channel authorized by the Congress in 1950 was not adequate because it was not deep enough to accommodate larger vessels and existing dredging was not sufficient to provide a stable channel at its authorized dimensions. Subsequently, the House and Senate Public Works Committees asked the Corps to study whether any modifications of the Oregon Inlet project were advisable. Based on this work, the Corps made recommendations that led the Congress to authorize the dual rock jetties and a 20-foot navigation channel for Oregon Inlet in 1970. The authorization increased the depth of the ocean bar navigation channel from 14 feet to 20 feet, in part to accommodate the use of larger, deep-draft commercial fishing vessels that were expected to use the inlet in the future.[7]

Between the 1970 authorization and September 30, 2001, the Corps' Wilmington District Office has spent about $10 million (current dollars) designing the project and studying whether it was economically and environmentally sound before construction could begin. These studies have included at least four updates of the district's economic analyses and four environmental impact statements, as well as various redesigns of the project. According to the Corps, it has also made a substantial effort to coordinate its efforts with other interested agencies. For example, the Corps stated that it has worked with the Department of Commerce's National Marine Fisheries Service and the North Carolina Division of Marine Fisheries to develop data on fish catch and associated use of the inlet by commercial fishing vessels. The Corps also participated in a joint task force with the Department of the Interior in 1991 to determine the effect of the jetties and the project's proposed sand bypass system on the adjacent shoreline. In response to concerns raised by the task force, the Corps revised the proposed project by, among other things, reducing the length of the jetties and incorporating a weir to facilitate sand bypass and fish larvae migration. On September 21, 2001, the Corps issued Supplement No. 2 General Design Memorandum (GDM) and Final Supplement III Environmental Impact Statement (EIS), which state that the dual jetties

[7] Draft is the distance between the water level on a loaded vessel and its keel (bottom). The channel depth is determined by the loaded draft of a typical vessel as well as by factors including wave action and the extent to which the vessel "squats" in the water when it is underway due to propeller action.

and the 20-foot navigation channel are economically justified and environmentally acceptable. The Corps document also found that current dredging efforts at Oregon Inlet have not provided a safe and navigable ocean bar navigation channel and concluded that hazardous navigation conditions at the inlet will continue to cause injuries and the loss of human life as well as vessel damages and losses. However, as of September 2002, the Congress had not appropriated funds to construct the jetty project.

Despite the many studies and modifications to the project that the Corps has made over the last 30 years, the Department of Commerce, the Department of the Interior, various environmental groups such as the Biodiversity Legal Foundation, and other interested parties such as the North Carolina Saltwater Fishing Club, do not believe their concerns have been adequately addressed by the Corps' analysis, and they have continued to oppose the project. In general, these entities contend that the Corps' economic analysis is unsound and that the jetty project will cause significant beach erosion and impede migration of fish larvae to habitat in the sound, potentially leading to a significant reduction in the overall fish supply. Further, these entities state that other factors, such as navigational errors, may contribute to the potential for loss of life at the inlet, a risk that would not be reduced by construction of the jetties. Commerce and Interior also anticipate that the project will have adverse impacts to designated Essential Fish Habitat in the immediate area of Oregon Inlet that is required by fish for spawning, breeding, feeding, or growing to maturity.[8] However, the jetty project is strongly supported by the state of North Carolina and the local commercial and recreational fishing industry, which contend that the project is needed to ensure safe passage for vessels through the inlet, particularly larger, deep-draft commercial fishing vessels.

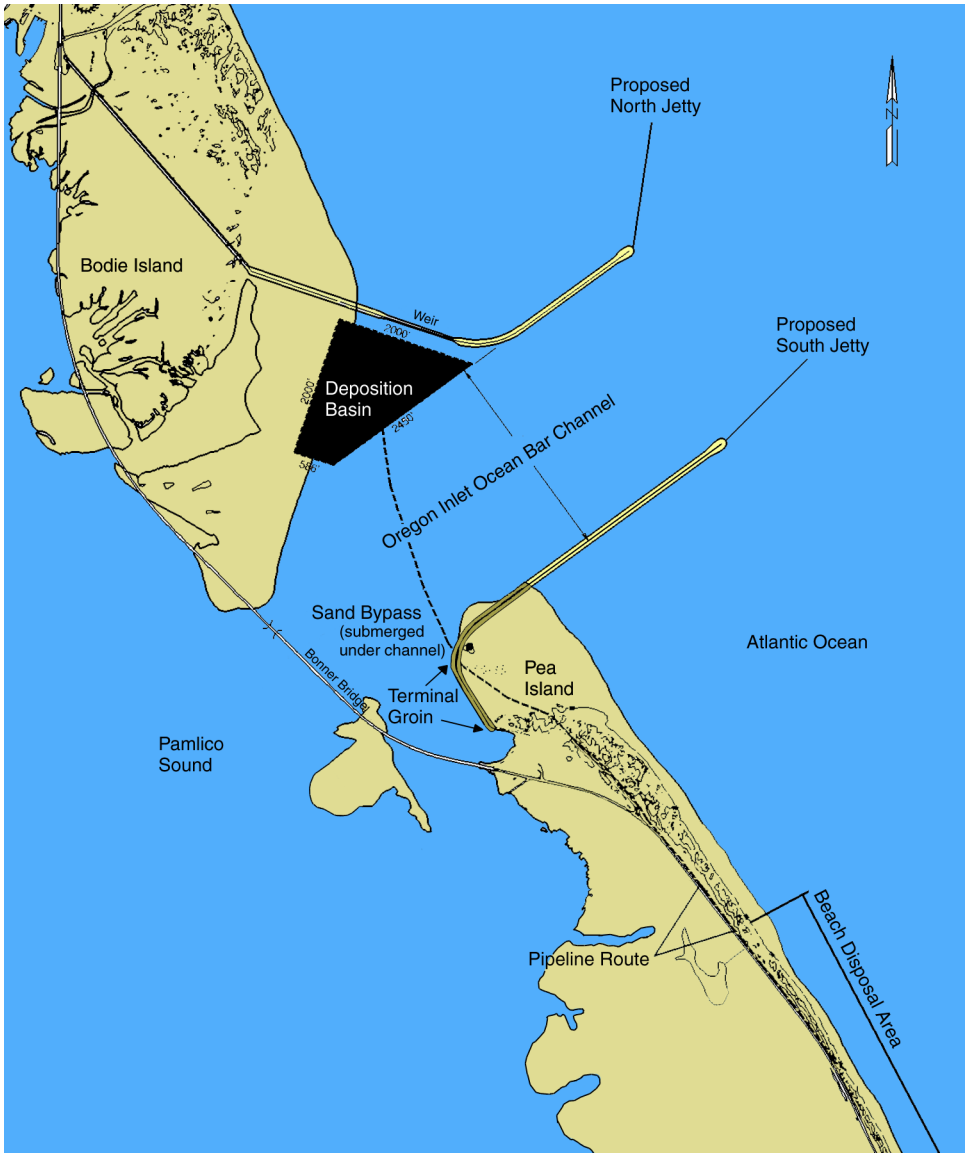
Although the U.S. Coast Guard has not taken an official position on the project, it is directly involved in issues concerning Oregon Inlet. The Coast Guard is responsible for maintaining the buoys and markers used to guide vessels through the ocean bar navigation channel and other channels in the sounds on the inside of the inlet. Coast Guard units located in Hatteras, North Carolina, and Portsmouth, Virginia, maintain the navigation aids at Oregon Inlet. In addition, the Coast Guard Station Oregon Inlet is responsible for, among other things, search and rescue and boating safety

[8] Identification of Essential Fish Habitat and requirements concerning its coordination and management are contained in the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (P.L. 104-297).

in coastal waters and sounds from the Virginia-North Carolina border to approximately Hatteras Island, North Carolina.

Figure 3 shows the Corps' current design for the proposed jetty project. The project includes construction of dual rock jetties about 3,000 feet apart. The north jetty would be approximately 10,000 feet long; the south jetty would extend about 3,500 feet beyond the Pea Island terminal groin, for a total length of about 6,600 feet. The terminal groin is a rock structure that was completed in 1991 to protect the southern end of the Bonner Bridge by stabilizing and restoring the tip of Pea Island. At the time, the erosion of Pea Island was threatening the southern end of the Bonner Bridge. The project also incorporates a weir in the north jetty that is designed to serve two basic purposes: 1) to facilitate sand bypassing from a deposition basin to adjacent beaches and 2) to aid fish larvae migration from the ocean past the jetties, through the inlet, and into the sound. A detailed chronology of significant events related to the development of the Oregon Inlet jetty project is provided in appendix II.

Figure 3: The Corps' Proposed Design for the Oregon Inlet Jetty Project as of September 2001



Source: Adapted from Supplement No. 2 General Design Memorandum, Manteo (Shallowbag) Bay, North Carolina, Corps' Wilmington District, September 2001. The map is based on May 26, 1996, aerial photography.

Corps Generally Has Not Maintained the Oregon Inlet Ocean Bar Navigation Channel at Its Authorized Depth

The Corps has had difficulty maintaining Oregon Inlet's ocean bar navigation channel at its authorized depth of 14 feet. According to officials in the Corps Wilmington District Office, from August 1983 through March 1994 the 14-foot depth was maintained about 23 percent of the time.[9] During this period, the Corps spent an average of about $4.1 million annually to dredge the channel. In recent years, however, expenditures on dredging the channel have declined to an average of about $2 million annually, and the Corps has been able to maintain the channel's authorized 14-foot depth only about 15 percent of the time. According to Wilmington District officials, the district has not been able to maintain the channel's authorized depth because the inlets' high-energy environment constantly moves sand back into the navigation channel and because funding limitations restrict the amount of dredging that can be performed. Officials said that the district does not get all of the funds it requests and often has to reallocate funds that are earmarked for dredging Oregon Inlet to respond to emergencies elsewhere in the district. The Corps' limited dredging and the high-energy environment of the inlet also affect the Coast Guard's ability to adequately maintain buoys that are supposed to mark the ocean bar navigation channel for vessels using Oregon Inlet. In fact, navigation charts for Oregon Inlet do not display the location of navigation aids, such as buoys, because they are frequently moved by the Coast Guard due to continuously shifting sand and by severe storms. These conditions increase the risk of danger to vessels and injuries to people.

The Inlet's Environment and the Corps Limited Resources Have Hindered Dredging of the Ocean Bar Navigation Channel

Oregon Inlet experiences more high winds, strong tides, and shifting sand than any other inlet on the Atlantic coast of the United States. This high-energy environment is magnified by a high incidence of storms, particularly those from the northeast (called nor'easters) during the fall and winter months. For example, between 1990 and 1998, the Oregon Inlet area was affected by more than 100 significant storms, some of them hurricanes. Storms heighten ocean waves and increase sand movement in the inlet. Based on Corps studies, an average of about 2.1 million cubic yards of sand move in and around Oregon Inlet each year.[10] In comparison, annual sand

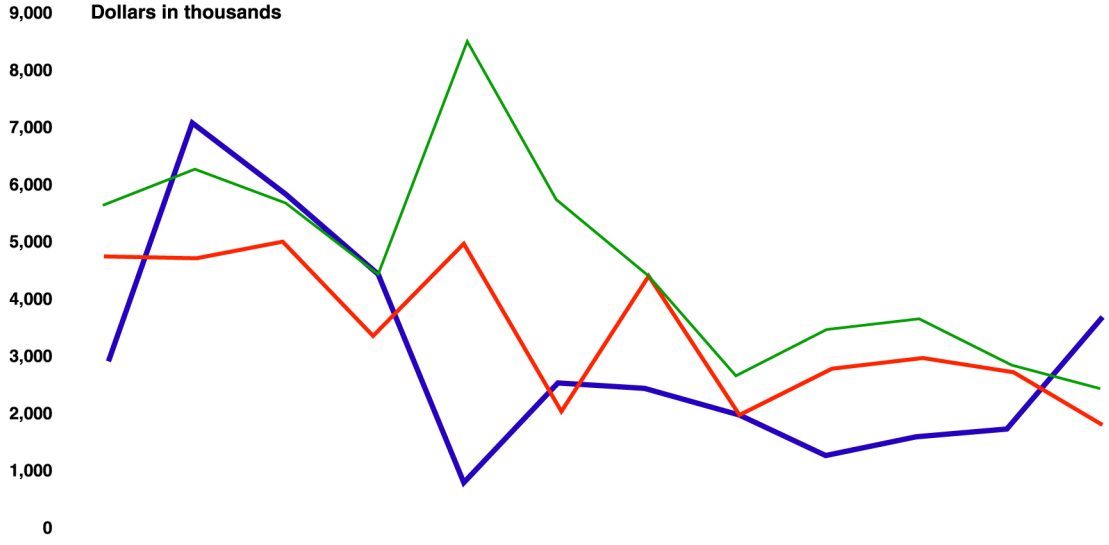
[9] The Corps calculates the percentage by periodically surveying the depth of the channel. If any portion is less than the authorized depth of 14 feet, the channel is considered unavailable.

[10] The Corps' estimate of sand movement is for the period 1956 through 1975 as presented in its September 2001 GDM on the jetty project.

movement for the two jettied inlets closest to the Oregon Inlet is about 471,000 cubic yards for Rudee Inlet in Virginia and about 700,000 cubic yards for Masonboro Inlet in North Carolina.

In addition to causing massive sand movement each year, district officials noted that the frequency and severity of storms at Oregon Inlet significantly affect the district's budget and dredging plans. Specifically, according to district officials, their budget and dredging plans are prepared 18 to 24 months in advance of the actual work. However, predicting storms that far into the future is impossible, and, for this reason, yearly budgets and dredging plans often differ significantly from actual needs. As a result, the district has often had to reallocate funds among its projects to meet immediate needs and is not able to perform all planned activities for Oregon Inlet, such as dredging. Figure 4 illustrates fluctuations in funding requested, approved, and expended to dredge the ocean bar navigation channel.

Figure 4: Funding Requested, Approved, and Expended for Dredging the Oregon Inlet Ocean Bar Navigation Channel, Fiscal Years 1990 through 2001



	FY1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
Funds requested	$5,623	$6,276	$5,714	$4,337	$8,311	$5,798	$4,345	$2,609	$3,468	$3,641	$2,803	$2,468
Funds approved	$4,678	$4,694	$4,941	$3,419	$4,897	$2,098	$4,345	$1,921	$2,795	$2,985	$2,803	$1,834
Funds expended	$2,973	$7,017	$5,792	$4,420	$849	$2,552	$2,497	$1,939	$1,203	$1,530	$1,788	$3,661

Note: Amounts are expressed in 1997 constant dollars.

Source: GAO analysis of data provided by the Corps of Engineers' Wilmington District Office.

As shown in figure 4, in some years from 1990 through 2001, the district did not spend all of the funds that had been approved for dredging the ocean bar navigation channel; in other years, it spent more. For example, for 6 of the 12 years, the district received approval to spend about $22.5 million, but spent about $10.8 million, or about $11.7 million less than the approved amount. In those years the district reallocated the $11.7 million budgeted for dredging the Oregon Inlet ocean bar navigation channel to address other higher-priority emergency needs in the district. For example, in fiscal year 1999, reallocated funds were used to remove sand bars and debris that were causing hazardous navigation conditions in the Atlantic Intracoastal Waterway. These hazards had unexpectedly accumulated after a severe storm. Conversely, in the other 6 years, the district spent more funds than were initially approved for dredging the ocean bar navigation channel. Specifically, the district spent about $25.4 million, or about $6.5 million more than the $18.9 million that had been initially approved during those years. For example, in fiscal year 1991, the district received approval for about $4.7 million to dredge the channel, but spent about $7.0 million, which it obtained by reallocating funds from other projects within the district. District Office officials explained that in many of these years the district experienced several hurricanes and other storms that necessitated redirecting funds from some projects to perform emergency work on other projects.

Wilmington District Office officials said that another reason they often need to reallocate funds is because they do not receive all of the funding that they request. Although district officials noted that getting requested funding would not ensure that the ocean bar navigation channel was always maintained at the authorized depth of 14 feet, it would ensure that the authorized depth was maintained more often and would also reduce the amount of funds that the district has to reallocate among its projects during emergencies. For example, between fiscal years 1990 and 2001, the district requested about $55 million for dredging the ocean bar channel and obtained approval to spend about $41 million, or 75 percent of what it requested.

For the most part, as shown in figure 4, the district has significantly reduced the amount of funds it has requested and spent on dredging the ocean bar navigation channel over the last few years. During this period there has also been a notable decline in the Corps' ability to maintain the channel's 14-foot depth. Specifically, between August 1983 and March 1994, when the Corps spent an average of about $4.1 million per year dredging the channel, it was able to maintain the authorized 14-foot depth about 23

percent of the time. However, between March 1994 and October 2001, the Corps has only maintained the channel at its authorized depth about 15 percent of the time. District officials explained that in the late 1980s and early 1990s, the district needed to dredge a large volume of sand that had accumulated in the navigation channel around the Bonner Bridge. Due to the location of this sand and the Corps' desire to place it on Pea Island to prevent erosion, the district used a pipeline dredge to remove the sand. Generally, a pipeline dredge is significantly more expensive to operate than other types of dredges because of the cost to set up the pipeline that transports the removed sand to a new location. By the end of 1995, the Corps had successfully removed the sand affecting the navigation channel and deposited it on Pea Island. As a result, according to district officials, the district reduced its funding requests for 1996 through 2001 because it did not expect to use an expensive pipeline dredge to remove that much sand again during that period. However, during that time, there was a reduction in the Corps' ability to maintain the ocean bar navigation channel at its authorized depth.

District officials also said that their budget requests have never included the total amount of funds needed to maintain the ocean bar navigation channel at its authorized depth 100 percent of the time. District officials stated that in the past they could not justify spending the time and money needed to prepare a request for such an amount because there was little likelihood that the amount would be received. However, district officials stated that in their fiscal year 2003 budget request they included a request for $10.9 million, which is an amount they believe is needed to maintain the channel at 14 feet 100 percent of the time.

Oregon Inlet's High-Energy Environment and the Corps' Limited Dredging Have Also Reduced the Coast Guard's Ability to Properly Mark the Ocean Bar Navigation Channel

The Coast Guard is responsible for maintaining the buoys that mark the Oregon Inlet channel. Coast Guard officials said that they have difficulty maintaining the buoys marking the location of deep water in the ocean bar navigation channel because the high-energy conditions in the inlet cause large amounts of sand to move in and out of the channel. This sand movement often changes the location of deep water and, when combined with the Corps' limited dredging, results in sand accumulation around the buoys. According to the Coast Guard, when sand accumulates on the channel side of the buoys to a depth that approaches the draft of a buoy tender, it becomes difficult and sometimes impossible to relocate the buoys to mark deeper water. For example, on October 30, 2001, the Coast Guard asked the Corps to provide a vessel to relocate 6 of the 13 buoys that were

located in the inlet at that time. The Corps vessel could operate in shallower water and had the lift capability to relocate the buoys.

In addition, as part of an ongoing waterway analysis and management program, the Fifth Coast Guard District reported on November 14, 2001, that the buoys in Oregon Inlet are always moving due to storms. The report states that after every large storm, several buoys at Oregon Inlet are either damaged, moved, or both, and it is difficult to maintain and keep these buoys in the proper location because of limited Coast Guard resources. According to the commanding officer of one of the Coast Guard vessels that services Oregon Inlet, there is no easy way to provide a reliable navigational aid system in Oregon Inlet. The commanding officer said that over the years buoys have been added and removed in attempts to properly mark the navigation channel, but the location of deep water changes regularly. The commanding officer also said that the north side of the channel is almost impossible to mark reliably because sand regularly shifts into and out of the channel as Bodie Island moves south, creating a constant navigational hazard.

The buoys that mark the deep water of the ocean bar navigation channel are frequently moved and are therefore not charted. According to Coast Guard officials, vessel operators who are not aware of the shifting sand conditions are susceptible to running their vessels aground. As a result, the Coast Guard suggests that vessel operators call its Coast Guard Station Oregon Inlet to obtain the most recent navigation data before attempting to traverse the ocean bar navigation channel.

Corps' Economic Analysis for the Proposed Oregon Inlet Jetty Project Has Several Limitations That Undermine Its Usefulness

We identified several limitations in the Corps' economic analysis that undermine its usefulness for assessing whether the Corps' preferred alternative of a dual jetty project with a 20-foot navigation channel is economically justified. For example, the analysis overstated the benefits to large commercial fishing vessels (trawlers) based on their current fishing activities, but did not analyze the potential benefits the proposed jetty project may provide to smaller commercial fishing vessels. However, because these smaller vessels have shallower drafts than trawlers, the extent to which they might benefit from the jetty project is uncertain. The analysis also did not account for the economic value of the lives that might be saved by the jetty project, which could result in understated benefits; it also overstated the cost of the current dredging program and used an overly optimistic assumption concerning future dredging needs that would tend to understate the cost of the jetty project. (See app. IV for more

details on these and other limitations to the economic analysis.) We did not assess the effects of all these limitations on the net benefits of the Corps' economic analysis because obtaining the necessary data would require an inordinate amount of time and expense. As a result, we cannot say what the net effect of addressing all the limitations would be on the net benefits and the benefit-cost ratio of the Corps' preferred jetty project alternative.

Corps Estimate of Benefits to Commercial Fishing Vessels Is Based on Outdated and Incomplete Data

The Corps estimated that the recommended jetty project would generate about $2 million in annualized benefits by reducing the operating costs of commercial fishing vessels. The Corps anticipates that the recommended project would reduce these costs by alleviating hazardous conditions in Oregon Inlet that sometimes force the vessels, especially trawlers, to detour to more distant inlets or ports. The Corps based its benefit estimate on the savings that would occur if the number of detoured trips and their related operating costs were reduced. In estimating operating cost savings, the Corps included savings in "fixed" operating costs, which it defined as including, among other things, depreciation charges on the vessel, insurance, interest on loans, and taxes.

In calculating the estimated benefit, the Corps relied on data provided in a 1987 consultant's report that studied the number of trips taken by trawlers during the mid-1980s.[11] However, these data do not reflect the fewer trips taken by trawlers in recent years. Further, the Corps overstated the operating costs savings that trawlers would likely achieve by including all the fixed-costs portions of their hourly operating costs. The appropriate measure of savings is variable costs (costs that vary with the length of fishing trips) that would be saved by reducing the number of detoured trips. This would include the cost of such items as fuel and oil but not such items as taxes and insurance, which likely would remain the same whether or not the jetty project is built.

In addition, by relying on the consultant's study, the Corps excluded from its analysis the trips taken by smaller (shorter than 55 feet) commercial fishing vessels. These vessels were excluded because the consultant's study did not assess the effect of inlet conditions on the operating costs of smaller fishing vessels.

[11] *A Reassessment of the Economic Feasibility of the Oregon Inlet Project*, Kearney/Centaur, a Division of A.T. Kearney, Inc., prepared for the Corps of Engineers, July 1987.

As shown in table 1, according to data from the North Carolina Division of Marine Fisheries, about 97 trawlers averaged 679 trips through Oregon Inlet from 1999 through 2001.[12] By contrast, the consultant's 1987 study found that about 234 trawlers averaged about 4,500 trips through Oregon Inlet from 1984 through 1986. Both the state's data and the 1987 consultant's study suggest that the number of smaller commercial fishing vessels using the inlet has significantly increased since the mid-1980s. State officials indicated, however, that because the state and the consultant used different methods to collect the data—the state's data are based on a census of commercial fish landings and the consultant's data were based primarily on interviews of selected seafood dealers and trawler captains—the state's data and the consultant's data may not be fully comparable.[13] We attempted to verify the data used by the consultant, but the Corps no longer has the supporting documentation for the study. Nonetheless, any assessment of the effect of the proposed jetty project on commercial fishing activities should be based on current commercial fishing trip data, which the state has collected through its trip ticket program. As a result, the Corps' reliance on the consultant's 1987 study calls into question the usefulness of the Corps' estimate of the benefits of the jetty project to commercial fishing vessels.

[12] Data for 1999 through 2001 include landings made by both in-state and out-of-state vessels to seafood dealers in Dare, Hyde, Pamlico, and Beaufort Counties. According to state officials, trawlers using specified gear that land ocean-caught fish in these counties are assumed to pass through Oregon Inlet. Trips made by North Carolina vessels to land fish in other states are not included. Data for smaller vessels exclude fish that were landed in Hatteras (Dare County) because these landings are assumed to have been made using Hatteras Inlet

[13] Under the North Carolina trip ticket program, which was begun in 1994, seafood dealers are required to report certain information about commercial fish landings, including the landing vessel's identification, the species of fish caught, and the type of fishing gear used.

Table 1: Estimated Average Number of Annual Trips Made by Commercial Fishing Vessels through Oregon Inlet, for the Periods 1984-1986 and 1999-2001

	Trawlers[a]				Smaller vessels[b]			
Time period	Number	Annual trips	Number of trips detoured	Landings (million lbs)	Number	Annual trips	Number of trips detoured	Landings (million lbs)
1994-1986[c]	234	4,498	1,896	15	25 - 30	[d]	[d]	2.8
1999-2001[e]	97	679	[d]	8.6	214	3,249	[d]	9.8

[a] Vessels that are at least 55 feet long

[b] Vessels that are shorter than 55 feet

[c] Source: 1987 Kearney/Centaur study

[d] Not available

[e] Source: North Carolina Division of Marine Fisheries.

According to an official with the North Carolina Division of Marine Fisheries, the change in trawler trips likely reflects changes in federal and state limits on the fish harvest. For example, in 1992, several management measures---including a moratorium on the issuance of new licenses for fishing and a 13-inch limit on the size of fish that can be harvested---were implemented to reduce over-fishing of flounder, a fish species traditionally caught by trawlers operating out of Oregon Inlet. During the mid-1980s, before these resource management measures were imposed, about 7.7 million pounds of flounder were landed annually through Oregon Inlet. By contrast, from 1999 through 2001, about 2.2 million pounds were landed annually through Oregon Inlet. According to Commerce, the size of the commercial fleet has declined due to a vessel reduction program implemented by the South Atlantic Fishery Management Council.

Corps officials said that they relied on the methodology of the consultant's 1987 report because they considered it "independent," and that even though the trips by smaller vessels were not explicitly included in the analysis, the difficulties experienced by the trawlers were indicative of all commercial fishing vessels. In addition, the officials said that the recent trawler trip activity reflects, at least in part, a decrease in the reliability of the channel due to the lack of adequate operation and maintenance funds. They also said that the deeper channel provided by the proposed jetty project might attract other trawler operators to relocate to the Oregon Inlet area. However, the Corps' assumption about the total hours delayed by inlet conditions is based on trawler trips, and it is not appropriate to apply the potential savings to smaller vessels without corroborating evidence

that they, too, are affected in the same way as trawlers. In addition, while the decrease in trawler traffic may reflect a number of factors, including fishery management measures and a decrease in the reliability of the 14-foot channel, the Corps' analysis is not useful for assessing these factors because it relies on data from the mid-1980s that do not reflect current commercial fishing vessel traffic, the fisheries management measures that have been put in place since the mid-1980s, or changes in the reliability of the channel.

To illustrate how using the more recent trawler trip data would affect the Corps commercial benefits estimate, we adjusted the Corps' analysis to account for the number of fishing trips that trawlers have recently taken. We also adjusted the Corps analysis to exclude certain fixed vessel costs. Based on these adjustments, we found that the annualized commercial fishing benefits would be reduced by about 90 percent, from about $2 million to $194,000. However, accounting for the effect of the proposed jetty project on smaller fishing vessels could increase this adjusted estimate of the benefits to commercial fishing vessels. Because these smaller vessels have a shallower draft than trawlers, they may not be as affected by the sand accumulations in the ocean bar navigation channel that can be hazardous to trawlers. For this reason, the extent to which smaller vessels might benefit from the jetty project is uncertain. We could not assess the effect of the proposed jetty project on the smaller commercial fishing vessels because there are insufficient data on the extent to which these vessels are delayed by conditions in the inlet.

Corps' Estimate of Benefits Did Not Incorporate the Economic Value of Accidental Deaths That Might be Prevented by the Proposed Jetty Project

The Corps did not incorporate the economic value of the lives that might be saved by the jetty project into its net benefit estimates. Consequently, to the extent that the jetty project reduces accidental deaths, accounting for the economic value of the lives saved could increase the benefits estimate (all other factors being the same). Federal guidance on water project analysis does not require that the economic value of the lives that might be saved by a project be included in the estimate of net benefits. Nonetheless, it is standard economic practice to incorporate this economic value into the benefits estimate so that decision makers can assess the full range of benefits that might be generated by a federal investment or regulation. For example, in assessing the benefits of safety improvements that reduce the risk of premature death, the Department of Transportation uses an

estimate of the "value of a statistical life," which is $3 million per averted death (2002 dollars).[14]

Corps officials said that their policy is to quantify the number of lives that might be saved by a project but not to estimate their economic value, because procedures for estimating the economic value of a life are not included in federal guidelines for analyzing water projects, and the Corps prefers that the project be assessed without the influence of the economic benefits attributable to lives saved. The officials said that they do consider the potential life-saving issues along with other factors, such as the benefit-cost ratio, in deciding whether to recommend that a project be implemented. Nonetheless, an alternative approach that does not require valuation but explicitly considers lives saved can be useful for assessing whether projects that have negative net benefits (that is, "net costs" when costs exceed benefits or the benefit-cost ratio is less than 1) may still be worth implementing. Under this approach, the net costs (exclusive of lives saved) are divided by the number of lives saved, and the estimate can be compared with other federal investments to ascertain whether the proposed project's estimate of net cost per life saved is comparable to that achieved by other federal investments or regulations.

The Corps estimated 14 accidental deaths would be prevented by the project. However, the Corps' analysis assumes that all prior vessel accidents that included deaths would be prevented by the jetty project and does not clearly control for factors that would be present with or without the jetty project. For example, Corps officials told us that under some weather conditions the inlet would be hazardous even with the recommended 20-foot channel and dual jetties in place. Further, the Corps did not control for factors that include changes in type of vessel traffic, operator experience, and vessel safety technology, all of which will continue to play a role in the number of accidents and deaths in the inlet with or without the jetty project. In commenting on a draft of this report, the Departments of Commerce and Interior noted that the economic costs of the potential effect of the jetties on accidental deaths, vessel damage, and personal injuries resulting from the construction of the jetties are not incorporated in the analysis.

[14] The value of a statistical life is derived from studies of individuals' willingness to pay for small reductions in the risk of dying. The estimate represents the value of the reduction in risk to a population and not the value of any identifiable individual.

Corps' Estimate of Project Cost Does Not Include More Recent Data on Lower Expenditures and Uses an Overly Optimistic Assumption on Future Dredging Needs

Using costs for dredging that the Wilmington District incurred from fiscal years 1983 through 1996, the Corps' economic analysis estimated that the annualized cost of the current 14-foot dredging program is about $8.4 million. The $8.4 million includes $6.5 million in average annual operation and maintenance (O&M) expenditures and about $1.9 million in other costs.[15] In contrast, the Corps estimated that the proposed jetty project would cost $12.9 million ($6.1 million in O&M costs and $6.8 million in other costs).[16] To determine the incremental or "net cost" that would be associated with implementing the jetty project alternative, the Corps appropriately subtracted the annualized cost of the current dredging program ($8.4 million) from the annualized cost of the proposed jetty project ($12.9 million). Based on this analysis, the Corps determined that implementing the jetty project alternative would cost $4.5 million more annually than the Corps spends on the current dredging program.

The Corps' $6.5 million O&M cost estimate for the current dredging program is based on expenditures from fiscal years 1983 through 1996. However, for fiscal years 1997 through 2001, the Corps spent only about $3.9 million per year on dredging. By updating the Corps' expenditure data through fiscal year 2001, we found that the Corps' annualized estimate of the current dredging program would be reduced from $8.4 million to $7.4 million.[17] Consequently, the net costs of the jetty project would increase from $4.5 to about $5.5 million. Corps officials agreed that dredging expenditures have declined to about $3.9 million annually in recent years for the reasons cited earlier in this report.

In addition, in estimating the cost of the jetty project, the Corps excluded $945,000 that it spent from 1983 through 2001 dredging in Pamlico Sound, which is not part of the ocean bar navigation channel. The Corps excluded this cost because it assumed that dredging this area in Pamlico Sound

[15] The $1.9 million represents the annualized amount, at 7.125 percent interest, of dredging costs during the 4-year period required to construct the jetty project.

[16] The $6.8 million is the annualized value of the jetty project's construction costs.

[17] The Corps made some computational errors in calculating the O&M costs for the current dredging program. Specifically, the Corps excluded $799,285 in costs that it had incurred dredging the ocean bar navigation channel in 1990, which it had inadvertently identified as an interior channel dredging expense. In addition, the Corps mistakenly double-counted $876,472 of costs incurred in 1991 to dredge the ocean bar navigation channel. We corrected for these two errors that essentially offset each other. Corps officials agreed with this correction.

would not be required as part of the recommended jetty project. Corps officials said that the source of the sand in this area is the ocean and, based on their best engineering judgment, this area will naturally flush itself after the jetties are built; therefore, this dredging cost will no longer be incurred.

However, several coastal engineers and geologists familiar with the Corps' proposed jetty project told us that the jetties would not eliminate dredging this area of the sound. In general, they believe that whether the source of the sand is the ocean or rivers that drain into the sound, the man-made channel will fill back in with the sand adjacent to it and require dredging. As a result, there is uncertainty about whether the Corps will continue to dredge this area. Nonetheless, if the Corps does have to dredge this area, then the cost of the jetty project would be higher than the Corps estimated in its economic analysis (all other factors being the same).

Performance of Similar Jetty Projects Has Been Mixed

Corps district officials identified eight jetty projects located on the Atlantic Ocean and Gulf of Mexico coastlines that are similar to the proposed Oregon Inlet project in that they incorporate dual jetties and a weir. According to data provided by the Corps, two of these jetty projects, both south of Oregon Inlet on the Atlantic coast, are generally performing as planned, and six others are not. Two projects are considered by the Corps to be performing as planned because the Corps has not had to dredge the project's navigation channel more than originally predicted. For the six jetty projects that are not performing as planned, one has a navigation channel that is frequently not at its authorized depth, three have required more dredging and higher dredging costs than expected,[18] and two have had their weirs closed. According to Corps officials responsible for these six jetties, a key factor in why these jetties have not performed as planned was inaccurate information on sand movement when the projects were initially designed. According to the Corps and other experts, good estimates of sand movement are essential to successfully designing a weir jetty project that will facilitate the bypass of sand to adjacent beaches while ensuring the availability of a navigation channel with minimum dredging costs. Table 2 summarizes the performance of the eight dual jetty projects that incorporate weirs.

[18] Even with the additional dredging, for one of the three projects the channel has been available less than the expected amount of time.

Table 2: Performance of the Eight Jetty Projects Incorporating Weirs

Jetty project	Location	More dredging than planned	Weir closed	Poor channel availability	Generally performing as planned
Murrells Inlet, SC	Atlantic Ocean Coast				X
Colorado River, TX	Gulf of Mexico Coast	X		X	
Ponce DeLeon, FL	Atlantic Ocean Coast		X		
St. Lucie, FL	Atlantic Ocean Coast			X	
Perdido Pass, AL	Gulf of Mexico Coast	X			
East Pass, FL	Gulf of Mexico Coast		X		
Rudee, VA	Atlantic Ocean Coast	X			
Masonboro, NC	Atlantic Ocean Coast				X

Source: GAO analysis of Corps data.

Two Projects Are Currently Performing As Planned

According to the Corps' Charleston District staff, which is responsible for the Murrells Inlet jetty project, the project has performed as expected because maintenance dredging of the navigation channel, which was planned for every 3 years, has only been needed once since the jetty project was built. That dredging occurred in 1988, and additional dredging is planned for 2002. District staff said the channel through the inlet has been kept open primarily by the flushing action of currents flowing through the jetties and has had lower maintenance costs than expected.

The Corps' Wilmington District staff, which is responsible for the jetty project at the Masonboro Inlet, said the project is considered to be performing as planned currently because they have only had to dredge the project's sand deposition basin every 3 or 4 years, which is less than the planned frequency of once a year. However, the Masonboro Inlet project was originally constructed in 1966 as a single jetty with a weir on the north side of the inlet, which did not perform effectively. The 1,000-foot weir was the first structure of its type to be constructed in the United States. Tides and current undermined the jetty because the inlet's channel continued to migrate. As a result, the Corps repaired the first jetty and, in 1980,

constructed a second jetty on the south side of the inlet, which stabilized the locations of the channel and the sand deposition basin. After the south jetty was built, however, sand that the Corps predicted would accumulate in the deposition basin instead began accumulating at the south end of Wrightsville Beach. This sand eventually formed a spit and required vessels entering the inlet to make a sharp turn in strong crosscurrents in order to stay in the navigation channel.[19] However, by using the sand spit as an extended deposition area, the Wilmington District has only had to dredge the deposition area every 3 or 4 years. According to district officials, this is also enough dredging to keep the spit from further encroaching into the navigation channel, which is otherwise kept open by the currents and tides passing between the jetties. (See fig. 5 for photographs of the Masonboro Inlet weir.)

[19] A spit is a narrow point of land or sand mass extending from the shore.

Figure 5: The Weir in the North Jetty at Masonboro Inlet, North Carolina

The picture on the left shows that high tide covers the weir, while the picture at the right shows that the weir is exposed at low tide. The weir's elevation is 2.16 feet above mean low water measured at the inlet.

Source: GAO.

Six Projects Are Not Performing As Planned

Project managers provided the following specific details about four jetty projects, including the jetty project that has incurred expected dredging costs, but whose navigation channel is frequently not maintained at its

authorized depth, and the performance of the three jetty projects that have incurred higher than expected dredging costs.

- At St. Lucie Inlet, Florida, the Jacksonville District was performing the amount of dredging expected, but more sand accumulated in the navigation channel than was anticipated because the Corps did not complete construction of the deposition basin that was to collect the sand that passes over the weir. As a result, since the jetty project was constructed, the Corps has been able to maintain the navigation channel at its authorized depth of 16 feet only about 20 percent of the time. Plans are under way to complete construction of the deposition basin. The Jacksonville District believes that construction of the deposition basin, as well as other modifications to the jetty project, will help maintain the channel at its authorized depth 100 percent of the time.

- For the jetty project at Rudee Inlet built by the City of Virginia Beach, Virginia, officials said they expected to dredge 100,000 cubic yards of material annually. However, according to the city staff, actual dredging at the inlet has averaged 300,000 cubic yards annually because more sand than expected has flowed over the weir. Although the project has required more dredging than planned, a consultant for the city of Virginia Beach states that even with higher dredging costs, the expenditures are justified, because the inlet provides many recreational and commercial benefits.

- For the jetty project at Perdido Pass (inlet) in Alabama, the Corps' Mobile District said that this project was designed for the Corps to dredge about 100,000 cubic yards of material annually; however, to keep the navigation channel at its authorized depth, the Corps has actually had to dredge about 361,000 cubic yards of material every 2 to 3 years.

- For the jetty project at the Colorado River Inlet in Texas, the Corps' Galveston District expected to dredge about 536,000 cubic yards of sand every 2 years, or an average of 268,000 cubic yards annually. However, the actual amount of material dredged annually was about 680,000 cubic yards, or about two and a half times what was planned. The need for this additional dredging occurred because the amount of sand flowing over the weir has been greater than expected, and the sand has tended to be deposited in the navigation channel rather than in the project's deposition basin. (See fig. 5 below for a photo of this project.) Despite the extra dredging, the Corps' Galveston District reported that the channel was available at its authorized depth only about 30 percent of

the time. The need for more dredging than planned has caused the responsible Corps districts to incur additional maintenance costs. For example, the Galveston District has spent about $1.9 million annually for dredging the Colorado Inlet, more than four times the $425,000 that it planned to spend for annual dredging when the project was designed.

Figure 6: The Dual Jetty Project at Colorado River Inlet, Texas

The east jetty is on the right and contains the weir, which is paralleled by a fishing walkway. More sand than expected has passed over the weir and been deposited in the channel, as indicated by the narrowing of the river in this view.

Source: The Corps of Engineers' Galveston District.

The Corps districts had to close the weirs for two of the jetty projects because they did not work as planned. Specifically, in 1985, at the East Pass, Florida, jetty project, the Mobile District decided to fill in the weir that was built in 1969 because the east side of the weir was eroding, and only a limited amount of sand was accumulating in the deposition basin. The problem arose because the predominant direction of the sand flow was opposite to what the Corps expected when the jetty project was designed. In 1985, after the Corps determined that the weir was constructed on the wrong jetty, it closed the weir. In another case, in 1984, the Corps' Jacksonville District closed the weir at Ponce DeLeon Inlet, Florida, because the weir was believed to be causing erosion problems north of the inlet and instability in the inlet's navigation channel. In addition, the weir caused safety concerns because boaters were attempting to cross over it to go to and from the ocean, instead of using the navigation channel. Appendix VI provides a comparison of the proposed Oregon Inlet jetty project to similar completed jetty projects.

Corps Applied Lessons Learned from Similar Jetty Projects in Designing the Oregon Inlet Jetty Project, but Information on Fish Larvae Migration Is Not Available

Corps officials at the Wilmington District Office stated that in designing the Oregon Inlet jetty project, they applied lessons learned from the construction and management of similar jetty projects and from internal Corps guidance. Specifically, from experiences gained in designing, constructing and managing the Masonboro Inlet jetty project in North Carolina, Wilmington District officials stated that they learned:

- how to construct dual jetties to avoid problems with channel migration and to ensure that sand accumulates in the intended area,
- how to determine the proper length of the weir section, and
- how to design jetties to prevent the structures from being undermined or weakened by erosion.

In addition to the lessons learned from this actual experience, Wilmington District officials stated that they used the Corps' internal guidance on the design of jetty projects, which is based on lessons learned from other Corps projects. Specifically, this guidance emphasizes the importance of having accurate information on sand movement in designing a sand bypass system such as the one proposed for the Oregon Inlet jetty project. Following this guidance, the district used 20 years of data on sand movement in designing the sand bypass system for the Oregon Inlet jetty project.

Although the Corps used these lessons in designing the Oregon Inlet jetty project, there are still some uncertainties about whether the project will perform as planned. For example, although the Wilmington District used measurements of sand movement taken over the 20-year period, these data were obtained from 1956 through 1975 and are now more than 25 years old. More recent data on sand movement at Oregon Inlet are available for the period from 1976 through 2001; however, the Wilmington District has not updated its estimates because it believes that the new data would not change its existing estimates significantly. Because this updated data was not included in the economic analysis, it is uncertain what effect the more recent data would have on the Corps' estimate of sand movement and dredging costs.

Another issue related to sand movement is the accuracy of the models used to make these estimates. Although the Corps used some of the best models available to estimate sand movement at Oregon Inlet, Corps officials acknowledged that these models are imprecise and generate results that could vary by as much as plus or minus 40 percent. This variation could affect the actual dredging and sand bypassing costs that would be incurred if the jetty project were built. To provide for this uncertainty, the Corps included additional dredging costs of about $288,000 annually in its economic analysis.

Another uncertainty relates to the impact of the proposed jetty project on the migration of fish larvae. Although none of the similar jetty projects with weirs were designed to facilitate fish larvae migration, the Corps believes that incorporating a weir into the Oregon Inlet jetty project will minimize the impact of the project on fish larvae. However, fisheries experts stated that there are no definitive data on how any jetty projects, with or without weirs, affect fish larvae migration.

Commerce and Interior Remain Concerned That the Oregon Inlet Jetty Project Will Harm the Environment

Both the Department of Commerce and the Department of the Interior support the goal of providing a safe navigation channel through the Oregon Inlet for commercial and recreational fishing vessels. However, both departments support a dredging-only approach to achieve that goal in an environmentally acceptable manner and have raised several concerns about the Corps' plans for stabilizing the inlet with jetties.

Commerce believes that the Corps' environmental impact statement (EIS) for the project is flawed and that the preferred jetty alternative would cause unacceptable environmental harm to commercial and recreational

fishery resources. Specifically, Commerce's National Oceanic and Atmospheric Administration (NOAA), which is mandated to manage the nation's living marine resources, believes that the Corps' jetty project would eliminate or degrade significant areas of highly productive fishery habitat, thereby reducing fishery resources. According to NOAA, such habitat is vital for the development of many marine species, including shrimp, red drum, summer flounder, and bluefish, which are found in the Outer Banks. NOAA maintains that the jetties would alter the near-shore currents and reduce successful movement of fish larvae, small juvenile fish, and invertebrates, which are dependent on the currents to carry them into the sheltered estuaries of the Albemarle and northern Pamlico Sounds. According to NOAA, this is a particular concern for the economically valuable fish that spawn offshore in the fall and winter, such as flounder. While raising these concerns, NOAA recognizes that current data on fish larvae migration are not sufficient to quantify the impact that the proposed Oregon Inlet jetties would have on fish larvae migration. However, NOAA points out that there are no studies or data available on how weirs or jetties in general affect fish larvae migration, and it believes that constructing the jetties without this information is an unacceptable risk. Commerce also noted that without construction of the jetties, the safety record of vessels using Oregon Inlet has increased dramatically over the past 20 years.

Interior, which manages the federally owned land on which the proposed jetties would be constructed, has long opposed the project.[20] Interior's National Park Service manages the Cape Hatteras National Seashore, where the proposed northern jetty would be built, and Interior's Fish and Wildlife Service manages the Pea Island National Wildlife Refuge, where the proposed southern jetty would be built.[21] Since the Corps first prepared an EIS for the project in 1979, both of these agencies have consistently raised concerns that the proposed jetties will adversely affect fish and wildlife habitat. In general, Interior has expressed the following concerns:

- The jetties will increase beach erosion. Interior stated that if the jetties are built, erosion and accretion patterns will be modified both north and

[20] In 1992, the Secretary of the Interior issued two conditional permits to the Corps for use of Interior lands for jetty construction contingent on completion of project plans and environmental studies. These conditional permits were rescinded in 1993.

[21] Pea Island National Wildlife Refuge is within the boundary of the Cape Hatteras National Seashore.

south of the inlet, which in turn will increase overwash of the islands, especially during storms. This overwash will harm valuable wildlife habitat, as well as plants and vegetation that provide food for waterfowl and other migratory birds. Interior also stated that this erosion could exceed the Corps' estimates and create a further real threat of additional construction on Interior land to save the jetties. Finally, Interior stated that the increased erosion would also threaten the infrastructure at and adjacent to Oregon Inlet, including state highway 12. Interior noted that the design of the Bonner Bridge requires the inlet's navigation channel to remain fixed under a single span of the bridge. However, the proposed replacement bridge currently being considered by the state has a proposed elevated portion 5,000 feet long that would allow the navigation channel to be moved as conditions dictate. According to Interior, this would eliminate the need for the jetties and an existing rock structure (known as the terminal groin) that was built to protect the southern end of the Bonner Bridge. Interior stated that under the terms of the permit it granted to the state to construct the terminal groin, the structure would probably be removed once the new bridge is constructed.

- The sand bypass system that was designed to mitigate the adverse effects of beach erosion will permanently alter existing shoreline habitat and disrupt shorebird nesting, resting, and feeding areas on a temporary, seasonal, or permanent basis. For example, Interior states that each sand bypass will harm invertebrate animals (small clams, worms, and crabs) that inhabit the shoreline and provide a valuable food source for shorebirds and fish. Interior stated that over the years frequent sand bypassing of large volumes might permanently eliminate these food sources and produce severe long-term adverse impacts on breeding, migrating, and over-wintering shorebirds. Among these birds are the Great Lakes piping plover population, which is federally listed as endangered, and the Atlantic/Canada coast piping plover population, which is federally listed as threatened. There is also concern that the perpetual placements of incompatible sands will diminish successful nesting by the threatened loggerhead sea turtle and green sea turtle. Nesting takes place south of the inlet on the refuge, which is an area expected to experience the greatest erosion due to the jetties and therefore would require the most sand placement. In addition, the trapping and bypassing of the sand will not allow the sand to naturally migrate into Pamlico Sound, which could have and adverse effect on intertidal marshes, sandflats, mudflats, and submerged aquatic vegetation, all of which are important fish and wildlife habitat.

- The weir will not function as planned. Interior stated that the Corps has not provided interested agencies with its analysis, studies, or other data that would support how the weir will perform and notes that the proposed weir design has not been field-tested. Interior also expressed concern that the Corps' planning has not adequately considered the impact of the Dare County beach replenishment project on the weir. Specifically, according to Interior, the project will take, on average, over one million cubic yards of sand from the ocean and place it on the beaches north of Oregon Inlet each year. The movement of this additional sand from the northern beaches southward toward Oregon Inlet would increase the likelihood of the weir becoming landlocked, which in turn would allow sand to pass around the north jetty and into the ocean bar navigation channel. This would increase the possibility that considerable supplemental dredging would be required and/or that the Corps may ultimately be required to build longer jetties, as originally planned. These actions would significantly increase the cost of the jetty project. Interior also said that if the weir were to become landlocked, it would nullify the expected benefit of facilitating the migration of fish larvae.

- Construction of the jetties will diminish much of the public's recreational use of the Bodie Island spit, which, according to Interior, is contrary to one of the legislative purposes of the Cape Hatteras National Seashore. Interior stated that the construction of the north jetty on land of the Cape Hatteras National Seashore would block access to a large portion of the spit currently used for recreational activities such as fishing, and a large section of the spit would be dredged away or used as the site of the proposed sand deposition basin.

- The jetty project may not significantly reduce the loss of life at Oregon Inlet. Interior points to data which shows that, in some cases, the loss of life is not due to conditions at the inlet but rather to such factors as alcohol consumption, unfamiliarity with the inlet, navigational errors, and the lack of life vests and survival suits. According to Interior, these factors would not be corrected by construction of the jetties. Interior also raised concerns that the construction of hard structures would introduce a new risk to vessels traveling through Oregon Inlet, based on accident data from other jettied inlets.

For these and other reasons, NPS does not support the construction of the proposed jetty project. NPS stated that the jetty project is not consistent with its mission of protecting, and it might actually impair, the resources

and values of the Cape Hatteras National Seashore. Further, in May 1982, the Fish and Wildlife Service issued a formal determination that the proposed jetty project was not compatible with the purposes of the Pea Island National Wildlife Refuge, which was established to manage, protect, and restore migratory birds and other wildlife.

In addition, in commenting on a draft of the Corps' August 2001 final EIS, the Environmental Protection Agency (EPA) expressed objections to the EIS that are similar to the concerns of Commerce and Interior. Specifically, in an October 19, 2001, memorandum to the Corps, EPA stated that it continues to have objections to the proposed jetty project. These include concerns about

- the potential long-term impacts of the project on a regionally important commercial fishery resource, especially disruptions to larval fish transport, which EPA believes will be difficult, if not impossible, to address;

- the adequacy of the Corps' proposed mitigation, including whether there will be sufficient sand available at critical periods to make the proposed sand management plan function as anticipated in preventing project-induced erosion of Bodie and Pea Islands;

- the need for the project because of uncertainties associated with whether the presumed safety benefits will be fully realized; and

- the assumed economic benefits due to professional disagreements regarding the assumptions used in the project justification.

EPA believes that the project would result in significant environmental impacts that should be avoided in order to ensure adequate protection of the environment and that these significant issues must be addressed more thoroughly in future deliberations on this project and in the Corps' Record of Decision.

The Corps asserts that in its final EIS it adequately addressed the concerns raised by Commerce and Interior. Specifically, the Corps said that it shortened the length of the jetties and incorporated a weir in the north jetty and a sand bypassing system to address the concerns raised about fish larvae migration and beach erosion. Furthermore, the Corps stated that it plans to monitor whether these actions will work and determine whether additional adverse impacts result from constructing the jetties. If so, the

project will require further mitigation. However, neither Commerce nor Interior believes that the Corps' proposed actions would satisfy their concerns.

Because of this impasse, in accordance with regulations under the National Environmental Policy Act, on October 16, 2001, Commerce formally referred its concerns about the adequacy of the Corps' EIS to the Council on Environmental Quality (CEQ) for its consideration and action. The referral process permits federal agencies to bring to CEQ interagency disagreements concerning proposed major federal actions that might cause unsatisfactory environmental effects. Although Interior did not formally refer its concerns to CEQ, it sent a letter to CEQ on November 15, 2001, asking the council to consider whether the Corps' final EIS adequately addressed Interior's environmental concerns.

CEQ may take one or more of several actions, including (1) concluding that the process of referral and response successfully resolved the problem; (2) initiating discussions with the agencies with the objective of mediation; (3) holding public meetings or hearings to obtain additional views and information; (4) determining that the issue is not of national importance and requesting the lead and referring agencies to pursue their own decision processes; (5) determining that the issue should be further negotiated by the lead and referring agencies and that the issue is not appropriate for CEQ's consideration until one or more heads of the agencies report to CEQ that the agencies' disagreements are irreconcilable; (6) publishing its findings and recommendations, including, where appropriate, a finding that the submitted evidence does not support the position of an agency; and (7) submitting, where appropriate, the referral and response, together with CEQ's recommendation, to the President for action. CEQ has initiated discussions with Commerce, Interior, and the Corps, and it held a public hearing on this issue in December 2001. CEQ is in the process of completing its assessment and has not established a date for announcing a final decision.

The Corps does not plan to issue its Record of Decision on the project until CEQ and GAO issue their final reports. However, the Corps stated that until these environmental concerns are resolved and Interior indicates it is willing to grant the Corps the permits needed to build the project on the federally owned land managed by Interior, the Corps does not intend to spend additional public resources to further study the economics of the jetty project for improving the safety and navigability of Oregon Inlet.

In the meantime, the Corps dredged the Oregon Inlet in 2001 in accordance with existing NPS and FWS special use permits. In preparation for the Corps' 2002 dredging effort, according to Interior, NPS and FWS assisted the Corps in the preparation of an environmental assessment. Based on the cooperatively prepared environmental assessment, NPS issued a finding of no significant impact and no impairment to park resources and values. NPS then issued a special use permit for the 2002 dredging program, which, according to Interior, includes a 400-foot wide channel that will require dredging away part of the Bodie Island spit. FWS, likewise, issued the Corps a special use permit for disposal of dredge material on refuge lands during the Corps' 2002 dredging effort. FWS's permit allows the Corps to deposit about 1 to 2 million cubic yards of dredge spoil on the oceanfront beaches of the Pea Island National Wildlife Refuge. According to the NPS special use permit, the dredging operation would also eliminate approximately 4 acres of wetlands, for which compensatory mitigation will be provided by the Corps in the form of enhanced wetlands habitat for migratory shorebirds elsewhere on the Bodie Island spit. The Corps' 2002 dredging effort is currently underway.

Conclusions

The Corps states that it has not been able to maintain Oregon Inlet's ocean bar navigation channel at its authorized depth because of the inlet's high-energy conditions, especially during storms, and because of funding limitations. While it is difficult, if not impossible, to predict the frequency and magnitude of storms that impact on the district's ability to dredge the channel, the district has not requested all of the funds it believes are needed to adequately perform the dredging. Beginning in fiscal year 2003, the district has decided to request the full amount of funds it believes will allow it to maintain the channel more reliably.

Although the inlet remains potentially hazardous, we believe that the Corps' economic analysis does not provide a reliable basis for deciding whether to proceed with the jetty project. We found significant problems with the analysis, including a reliance on outdated and incomplete data, the use of unsupported assumptions, and a lack of accounting for risk and uncertainty in key variables that could significantly affect the project's benefits and costs. In addition to these economic concerns, the Departments of Commerce and the Interior do not believe that the Corps has adequately mitigated for environmental concerns, including the project's impact on fish larvae migration, beach erosion, and wildlife habitat. Commerce has formally referred its concerns to the Council on Environmental Quality for resolution. Interior, which also asked the

council to consider its environmental concerns, has been unwilling to grant the Corps the permits needed to construct the project on Interior's lands. For this reason, the Corps does not believe it should spend additional public resources reassessing the project's economic analysis until it has assurances that this issue will be favorably resolved. We share the Corps' view that it would not be prudent to spend funds reassessing the economics of the project until the council resolves the project's environmental concerns and there is some assurance that the Corps will receive the permits needed to build the project.

Recommendations for Executive Action

Lacking resolution of environmental concerns from the Council on Environmental Quality and construction permits from the Department of the Interior, we agree with the Corps that it should not pursue further development of the Oregon Inlet jetty project. However, if CEQ favorably resolves the environmental issues regarding the proposed jetty project and the Corps receives assurance that it can obtain the permits from Interior that it needs to build the project, in order to have a reliable basis for determining whether the project is economically justified, we recommend that the Secretary of the Army direct the Corps of Engineers to

- prepare a new and comprehensive economic analysis of the navigation project's costs and benefits that incorporates updated and complete data and corrects all errors in calculations and assumptions;
- obtain the information, where possible, that is needed to address the uncertainties—such as the extent to which the jetty project could affect the activities of all commercial vessels and the extent to which areas outside the ocean bar navigation channel could require dredging—that could significantly affect project benefits and costs; and
- submit the revised analysis to the Congress for its use in considering future appropriations requests for the project.

Agency Comments and Our Evaluation

We provided a copy of our draft report to the Secretaries of the Army, Commerce, Transportation, and the Interior, for review and comment. Overall, the Army, Commerce, and Interior generally agreed with our findings and the recommendations of the report. The Department of Transportation did not comment on our overall findings and recommendations, but offered specific technical comments.

More specifically, the Assistant Secretary of the Army (Civil Works) stated that the Department concurs with our finding that the Corps has not been able to maintain a safe navigation channel because of the inlet's high-energy environment and the cost of channel dredging. The Assistant Secretary also agrees with GAO's conclusion and recommendation that a new economic analysis of the project is needed to address project uncertainties and provide a reliable basis for deciding whether to proceed with the project. However, the Assistant Secretary also agreed that it would not be prudent to expend additional public funds to conduct an economic reanalysis until CEQ resolves the environmental concerns about the project and Interior provides assurances that permits needed to construct the project will be granted. In addition, the Assistant Secretary concurred with the information GAO provided on the performance of eight similar jetty projects, their limitations, and the reasons for those limitations, and that the information was useful in designing the jetty project. Finally, the Assistant Secretary stated that the Corps continues to believe that it has made project design changes and taken adequate mitigation measures to accommodate Commerce's and Interior's concerns and that the jetty project is needed to safely accommodate the large trawlers that currently operate through the inlet. The Assistant Secretary stated that GAO's discussion of concerns raised by the other agencies repeats concerns raised in earlier comments and in the CEQ referral. Accordingly, the Assistant Secretary enclosed a copy of the Corps' response to CEQ. This document is not included with the Assistant Secretary's letter in the report but is available on the Web at http://www.whitehouse.gov/ceq/referrals.html.

The Department of the Interior generally agreed with our findings, stating that the report is an objective and thorough analysis of a complicated project with over three decades of development. It also agreed with our recommendations, stating that they are consistent with the departmental position and comments over the past 10 years. The department also provided clarifications on several technical points, which have been included in the report as appropriate.

The Department of Commerce noted that the report was thorough, and it concurred with our findings and recommendations, specifically that considerable revision of the Corps' economic and other analyses are needed before the feasibility and environmental effects of building jetties can be determined. The department also offered several specific comments, which we incorporated, as appropriate, in the report.

The Department of Transportation's U.S. Coast Guard provided oral comments on the draft report. Specifically, the Chief, Waterways Management Section, District 5, Portsmouth, Virginia, noted that neither the GAO report nor the Corps' economic analysis captured the Coast Guard's costs to maintain the navigation aids at Oregon Inlet with or without jetties. The official stated that the service the Coast Guard provides is not free, and that costs should be considered in the Corps' economic analysis of the project. The Chief also noted that during the past 3 years, the primary buoy-servicing vessel the Coast Guard uses at Oregon Inlet has increased in length from 157 feet to 175 feet, and its draft has increased from 7 to 9 feet. The Chief stated that this buoy tender may be the deepest-draft vessel using Oregon Inlet, and the Corps should consider the Coast Guard's operational needs in its design of a navigation channel. Otherwise, it will become prudent for the Coast Guard to stop servicing aids to navigation in Oregon Inlet. We agree that it would be important for the Corps to assess the Coast Guard's costs of maintaining the inlet's buoys, with or without the jetties, when updating its economic analysis. We also agree that it is important for the Corps to do sufficient dredging to allow Coast Guard vessels access to the buoys for maintenance.

The full text of the comments provided by the Army, Interior, and Commerce are included as appendixes VI, VII, and VIII, respectively, in this report.

Scope and Methodology

To assess federal efforts to maintain the authorized depth at Oregon Inlet's ocean bar navigation channel, we reviewed documents provided by the Corps' Wilmington District on the frequency and amount of dredging accomplished since 1960. We discussed this dredging history with district officials to better understand when and why dredging occurred and the types of dredges used to maintain the channel. We also reviewed Corps documents that discuss the dredging history of Oregon Inlet and show the percentage of time that the district has maintained the channel's authorized depth. We also discussed with district officials any circumstances that would affect the district's ability to dredge the channel more frequently and thus maintain the authorized depth more consistently. We also reviewed, analyzed, and discussed the district's budget and planning documents for fiscal years 1990 through 2001 to ascertain the funding that had been requested, approved, and expended for dredging the ocean bar channel at Oregon Inlet. We also discussed and obtained information from the Coast Guard regarding its maintenance of the navigation buoys at Oregon Inlet to learn of any impediments to its efforts.

To assess the extent to which the Corps' 2001 economic analysis is useful for decision making, we compared the Corps' economic methods and assumptions with standard principles of economic analysis, including whether the analysis considered reasonable alternatives, quantified and monetized all major categories of benefits and costs, measured benefits and costs relative to a baseline, used data based on current economic conditions, and accounted for risk and uncertainty associated with key assumptions and data. In addition, we compared the Corps' survey methods with standard principles for sampling populations and developing and conducting surveys. We focused our review on the Corps' estimates of dredging and jetty costs and on the estimated benefits that had the greatest impact on the Corps' benefit-cost ratio (commercial fishing, recreational boating, vessel losses and damages, accidental deaths averted, and land preservation). We discussed the benefit-cost analysis with Corps officials and, where possible, we collected supporting documentation from which to verify the Corps' analysis. In addition, we reviewed agency and public comments about the Corps' economic analysis. Moreover, we collected updated information pertaining to the various categories of benefits and costs to ascertain if conditions had changed that would alter the results of the Corps' analysis. For example, to verify Corps and consultant data on lives lost, vessels lost, and damage at Oregon Inlet and to develop new data, we obtained information from Coast Guard records to determine which cases were likely attributable to Oregon Inlet conditions. More details of our work on the components of the economic analysis are contained in appendix IV.

To obtain information on the performance of similar jetty projects, we obtained data from Corps researchers and Corps district offices on jetty projects at coastal inlets with design features similar to those planned for Oregon Inlet, mainly dual jetties and incorporated weirs. We identified eight similar jetty projects—seven built by the Corps and one built by the City of Virginia Beach, Virginia, for which the Corps maintains the navigation channel. The eight projects are under the jurisdiction of six Corps districts: Jacksonville, Florida; Mobile, Alabama; Wilmington, North Carolina; Galveston, Texas; Charleston, South Carolina; and Norfolk, Virginia. To collect information on how these similar jetty projects have performed, we developed a structured interview document that included a standard list of questions about each jetty's physical features, purpose, and performance characteristics, such as the operation of the weir and its impacts on dredging and beach erosion. We then interviewed staff responsible for the projects to obtain answers to the questions. We did not verify the answers that district officials provided.

To determine whether the Corps' Wilmington District applied lessons learned from similar jetty projects in its design of the Oregon Inlet jetty project, we interviewed its engineering staff about the information they used in developing designs for the proposed Oregon Inlet jetties. Wilmington staff said they relied in part on lessons learned from the operations of the jetty project at Masonboro Inlet, North Carolina, in designing the project for Oregon Inlet. The staff also identified the Corps' internal guidance as helping with the design. We discussed the lessons learned with the staff and reviewed Corps planning and engineering documents to verify that the lessons had been applied. We also discussed with Wilmington District staff, other federal agency officials, and academic experts (1) the accuracy of estimates of sand transport used in designing the jetty project and (2) the potential for applying lessons learned from one jetty project to another.

To identify concerns raised by the Departments of Commerce and the Interior about the development of the jetty project, we reviewed comments on the Corps' EIS and design documents and documents developed by Commerce and Interior that discussed their concerns. We discussed the concerns with officials in these departments to better understand the issues. We also met with Wilmington District staff and other project proponents, such as North Carolina state government officials and fishing industry representatives, and discussed the departments' concerns with them in order to determine the proponents' views of these concerns and to learn of any planned or completed mitigating actions. We also reviewed the Department of Commerce's referral and Department of the Interior's letter and supporting materials sent to the Council on Environmental Quality citing their objections to the Corps' EIS. We also discussed many of the environmental issues with various opponents of the project, such as environmental groups and some academic experts, in order to better understand the issues and their views.

We conducted our work between March 2001 and September 2002 in accordance with generally accepted government auditing standards.

As arranged with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the Secretaries of Defense, Commerce, and the Interior; the Director, Office of Management and Budget; and other interested parties. We also will make copies available to others upon request. In addition, the report will be

available at no charge on the GAO Web site at http://www.gao.gov. If you or your staffs have any questions, please call me at (202) 512-3841. Key contributors to this report are listed in appendix IX.

(Ms.) Gary L. Jones
Director, Natural Resources
and Environment

The Corps' Process for Developing Water Resource Projects

Generally, the Corps becomes involved in a water resource project when the local community perceives a need and contacts the Corps for technical assistance. If the Corps does not have the statutory authority required to study the project, the Congress must provide authorization. Generally, this begins with local officials contacting their congressional delegation. After receiving authorization, generally through a committee resolution or legislation, and an appropriation, a Corps district office conducts a preliminary (reconnaissance) study on how the problem could be addressed and whether further study is warranted.

If further study is warranted, the Corps typically seeks agreement from the local sponsor to share costs for a feasibility study. The Congress may appropriate funds for the feasibility study, including an economic analysis, which is conducted by the Corps district office. The feasibility report makes recommendations on whether the project is worth pursuing and how the water resource problem should be addressed. In conjunction with the feasibility study, the Corps must also perform the appropriate environmental study under the requirements of the National Environmental Policy Act. After public comments on the environmental study are considered, the Chief of Engineers transmits the final versions of the environmental and feasibility reports to the Congress through the Assistant Secretary of the Army for Civil Works and the Office of Management and Budget. As long as appropriations are available, the Corps will also prepare a preconstruction engineering and design report, which is provided to the authorizing committees. The Congress may authorize the construction of the project in a Water Resources Development Act or other legislation.

Project construction will occur once the authorized project is included in the President's budget and the Congress appropriates the federal share of funds to start the project. Upon appropriation of needed funds, and before construction can begin, the Secretary of the Army and nonfederal sponsors generally sign a formal project cooperation agreement. The Corps district office completes the necessary engineering and design work to develop plans and specifications for construction. Private contractors managed by the Corps do the construction work.

Chronology of Significant Events for the Oregon Inlet Jetty Project, 1950 through 2002

Date	Event
05/17/50	P.L. 81-516, The River and Harbor Act of 1950 authorized the Corps to dredge the ocean bar navigation channel to a depth of 14 feet.
04/17/63	Committee on Public Works of the U.S. Senate adopts a resolution to initiate a study of the Oregon Inlet Jetty Project.
09/26/63	Committee on Public Works of the U.S. House of Representatives adopts a resolution to initiate a study of the Oregon Inlet Jetty Project.
04/30/69	Corps submits a favorable report to the Secretary of the Army.
03/18/70	Secretary of the Army submits the Corps' report to the Congress recommending that the ocean bar navigation channel be deepened from 14 feet to 20 feet, stabilizing Oregon Inlet with jetties, providing a means for bypassing sand across the inlet, and creating a 15-acre harbor at Wanchese. The benefit-cost ratio is estimated to be 1.4.
12/31/70	The River and Harbor Act of 1970, Public Law 91-611, Section 101, authorizes the Oregon Inlet Jetty Project.
04/15/77	Corps releases drafts of the Phase I General Design Memorandum (GDM)–Plan Formulation and Environmental Impact Statement (EIS) for the project, supporting the basic plan authorized by the Congress.
06/17/77	Department of the Interior comments on the Phase I GDM and Draft EIS state that the principal issues involve jetty construction and impacts on fish larvae migration. The comments state that the proposed project would result in significant impacts on parklands and that documents do not adequately address sand bypassing.
07/29/77	Corps publishes Phase I of the GDM–Plan Formulation.
12/78	Contract is awarded by North Carolina to enlarge the harbor at Wanchese.
05/02/79	Interior meets with the Corps to inform it of the need for special use permits for construction on Interior lands. The Corps agrees to prepare a supplement to the Final Environment Impact Statement.

07/12/79	The Corps sends a letter to the Fish and Wildlife Service (FWS) Regional Director outlining right-of-way needs for construction, operation, and maintenance of the jetty project and requesting a Cooperative Use Agreement for placement of jetties on Pea Island National Wildlife Refuge.
08/03/79	The NPS initiates formation of a Coastal Advisory Committee, which would be known as the Inman Panel.[22] Later that month the panel issues a report outlining the deficiencies in the Corps' proposal and concluding that the project would adversely affect the shoreline environment.
09/21/79	The Corps distributes a draft of a Supplement to the Final EIS to federal agencies, which is later designated as Supplement I. The purpose of the supplement is to discuss refinement of project features, correct errors in the earlier EIS, and address environmental concerns.
12/03/79	Interior provides comments to the Corps on the draft Supplement to the Final EIS, stating that Interior is not "in accord with the current project design." The primary concerns of Interior are that (1) the jetties would accelerate already high rates of erosion near the inlet and (2) the jetties would alter normal longshore sand transport and likely cause "serious erosion problems well beyond the project area."
08/07/80	The Inman Panel releases a second report entitled *Potential Effects of the Proposed Oregon Inlet Jetties on Shore Processes Along the Outer Banks of North Carolina.*
09/80	The Corps publishes the Phase II GDM–Project Design.
09/09/80	Interior informs the Corps that neither the National Park Service nor the FWS finds the jetties consistent with the purpose for which land under its jurisdiction was established. DOI declines to issue permits for the jetties and remains opposed to the project.
12/03/80	The Corps provides Interior with the Phase II GDM. The document provides revised details on the design and construction of the dual jetty project and a sand bypassing plan.

[22] This panel was named for the first chairman, Dr. Douglas Inman, a coastal oceanographer with the Scripps Institution of Oceanography.

12/28/80	An Interior memo outlines serious environmental concerns regarding the construction of the jetties, for example, accelerated beach erosion and blockage of larval fish passage, and expresses doubts about the success of a Corps sand bypassing program. Interior supports a dredging-only alternative.
03/81	North Carolina completes construction of the harbor at Wanchese and a seafood industrial park.
07/06/81	Interior Secretary denies permits for the jetty project and states that this decision is based on the project's incompatibility with use of NPS and FWS lands. The Secretary directs the FWS and NPS to work with the Corps to develop an alternative to the jetties.
11/24/81	The Assistant Secretary of the Army (Civil Works) asks Interior for a decision on the Corps' request for permits to use FWS land and the transfer of jurisdiction of land from the NPS.
12/17/81	Interior requests that the Corps examine the feasibility of the dredging-only alternative and that the analysis of a dredging-only alternative be completed before the Corps pursues the option of jetty construction.
12/22/81	The Assistant Secretary of the Army (Civil Works) authorizes the Corps to undertake a comprehensive evaluation of a dredging-only alternative recommended by Interior.
05/11/82	The Corps holds a scoping meeting and announces its intention to prepare a second supplement to the Final EIS in order to evaluate the dredging-only alternative recommended by Interior and to design changes for the jetties.
04/01/83	The Corps releases its report on the DOI dredging-only plan. The report, entitled *Feasibility Study, Dredging/Near-Shore Disposal Plan, Oregon Inlet, North Carolina*, concludes that Interior's dredging-only alternative is "functionally infeasible" because it would produce "catastrophic and unacceptable" beach erosion.
04/21/83	Interior Secretary meets with the Assistant Secretary of the Army (Civil Works), the North Carolina governor, and the state's congressional delegation. Interior Secretary reiterates that the agency is unable to issue special use permits for jetty construction on its land.

06/14/83	Bills are introduced in the Congress (H.R. 3288 and S. 1471) to authorize the transfer of land from Interior to the Corps for construction of the jetty project. Neither bill passes.
09/83	The Corps publishes Supplement I to the Phase II General Design Memorandum addressing jetty spacing, structural design, hydraulic stability, subsurface analysis, sand bypassing, and a reanalysis of navigation channel dimensions.
02/84	The Corps publishes an economic analysis of the project as directed by the Assistant Secretary of the Army (Civil Works) to update an earlier analysis.
08/13/84	The Corps issues a draft of Supplement II to the Final EIS. The document states that the dredging-only alternative with near-shore disposal has been evaluated and found unacceptable. The preferred alternative is the dual jetty project with design modifications.
11/14/84	Interior's comments on the draft Supplement II to the Final EIS note that (1) the dredging-only alternative is not adequately addressed, (2) the project would accelerate erosion on Pea Island, and (3) the project may be referred to the Council on Environmental Quality.
12/05/84	An Office of Management and Budget (OMB) letter to the Corps states concern that project costs will substantially exceed benefits and that significant adverse environmental impacts could add to total project costs. OMB requests an independent analysis.
05/85	The Corps issues final Supplement II to the Final EIS finding the dredging-only alternative unacceptable and making the jetties the preferred alternative of the Corps.
08/14/85	Interior comments on the Final Supplement II to the Final EIS stating that, overall, Interior is still opposed to the jetties and supports a dredging-only alternative.
07/87	The Kearney/Centaur Company releases *A Reassessment of the Economic Feasibility of the Oregon Inlet Project.* This detailed evaluation of project economics by a consultant hired by the Corps at OMB's request concludes that project costs would exceed benefits.

04/88	The state of North Carolina submits a report responding to the economic analysis by Kearney/Centaur.
06/20/89	FWS issues a right-of-way permit to the North Carolina Department of Transportation for constructing a terminal groin[23] on the north end of Pea Island National Wildlife Refuge to protect the bridge over Oregon Inlet. Two days later, the Corps issues permits for construction.
11/89	North Carolina awards a contract for construction of the terminal groin to reduce erosion at north end of Pea Island and protect Bonner Bridge using the Corps' design for a 3,125-foot structure with the same dimensions and same location as the landward section of the proposed south jetty.
07/90	The Corps releases its third economic analysis of project, entitled *1990 Update of 1984 Economic Analysis*. This report shows lower initial construction costs due to the separate construction of the terminal groin.
12/90	The Secretary of the Interior sends a letter to the Secretary of the Army providing criteria the Corps needs to meet to obtain Interior's approval of the project. The criteria include (1) approval of the project by the Office of Management and Budget; (2) assurance that the project is legal and compatible with the park and refuge; and (3) assurance that the project's environmental impacts are assessed and found acceptable.
01/91	A joint Interior and Corps committee is formed to develop an acceptable sand management plan.
03/91	Construction of the terminal groin on Pea Island is completed.
12/31/91	The joint Interior–Corps committee releases a report evaluating their differences over the scientific and engineering aspects of the jetty project. A report by Interior consultants, issued on the same date to the Secretary of the Interior, concludes that the jetties would have significant unavoidable large-scale impacts on the inlet and the adjacent barrier islands and discusses the ecological implications of project, including the impact on fish larvae migration.

[23] The terminal groin at Oregon Inlet is a rock structure built perpendicular to the shoreline to protect the southern end of the Bonner Bridge by preventing the erosion of land on Pea Island, into which the bridge is anchored.

10/28/92	The Interior Secretary issues two conditional permits to the Corps for use of Interior lands for jetty construction, contingent on completion of project plans and environmental studies.
01/28/93	U.S. Senator Jesse Helms introduces S. 192, a bill that would require the Corps to carry out the construction and operation of the jetty and sand transfer system regardless of the final Interior position. The bill also would exempt the project from any permit requirements, including those issued by Interior.
06/15/93	A new Interior Secretary rescinds the conditional permits that would have allowed the Corps to use Interior lands for the construction of the Oregon Inlet jetties. The Secretary states that Interior would revisit this decision when environmental studies on the project have been completed.
10/94	The Corps initiates coordination with Interior on the design of a sand management plan for the Oregon Inlet Project.
01/31/95	U.S. Representative Walter Jones introduces H.R. 758 entitled the "Oregon Inlet Protection Act of 1995." The bill would require the Corps to carry out construction and operation of the jetties project. The bill would allow the Corps to designate the land required for the project and notify the Interior Secretary of the designation.
07/95	The Corps releases a Feature Design Memorandum on the sand management plan that recommends a sand bypassing system that will emulate natural shoreline processes when the jetties are in place.
07/18/96	The Senate Subcommittee on Parks, Preservation, and Recreation holds a hearing on S. 988, a bill directing Interior to transfer administrative jurisdiction over certain land to the Secretary of the Army to facilitate construction of the jetties and the sand transfer system. Interior opposes the bill because of its impact on park and refuge land. The Assistant Secretary of the Army (Civil Works) testifies that studies must be completed before construction of the project can begin, and that it would be premature for the Corps to accept jurisdiction of the land required for construction. The bill is not passed.
01/04/99	The Corps releases drafts of Supplement No. 2 to the GDM and Supplement III to the project EIS. In the EIS, the Corps' preferred alternative is construction of the dual jetty project and implementation of a sand

	management plan. In the GDM, the Corps proposes a new jetty design that shortens each jetty by approximately 1,000 feet, eliminates the sand-blocking central barrier within each jetty, and adds a 1,000-foot weir section in the north jetty over which sand is expected to move into a 60-acre deposition basin.
03/04/99	The National Marine Fisheries Service's (NMFS) comments on the January 1999 EIS state that "the potential for significant and adverse long-term impacts to nationally important living marine resources is such that the NMFS has no recourse but to recommend that the jetties not be built."
03/22/99	Interior's comments note deficiencies in Supplement III to the EIS and reiterate that project goals could and should be met with a dredging-only program rather than the dual jetty. The comments state that Interior will consider referring the jetty project to the Council on Environmental Quality.
05/09/00	U.S. Senator Jesse Helms attaches a rider (the Oregon Inlet, North Carolina, Flood Control Improvements) to the fiscal year 2001 Agriculture Appropriations Bill that would have transferred the land to build the jetties from the jurisdiction of Interior to the Corps.
07/12/01	FWS provides the Corps with a Final Fish and Wildlife Coordination Act report for the project. The report recommends that (1) the Corps abandon plans for a dual jetty project due to the magnitude of environmental consequences and (2) the Corps develop a dredging-only program to achieve project goals.
09/01	The Corps releases final versions of Supplement No. 2 to the GDM and Supplement III to the project EIS. The Corps' preferred alternative remains construction of the dual jetty project and implementation of a sand management plan.
10/16/01	Commerce refers the project to the Council on Environmental Quality (CEQ), stating that the project's construction would cause unacceptable environmental harm to commercial and recreational fishery resources.
12/12/01	CEQ holds a public meeting in Manteo, North Carolina, on the dual jetty and weir system project, receives briefings from involved agencies, and visits the site of the proposed project.

04/8/02	The Corps issues an Environmental Assessment for maintenance of the channel that includes dredging a 600-foot wider channel on the north side of the inlet, removing 26 acres of Bodie Island, and placing the dredged material on Pea Island. The assessment and draft Finding of No Significant Impact are released for a 30-day public comment period.
05/02	Interior submits comments on the Environmental Assessment for the channel maintenance, recommending that a 400-foot wider channel be selected as the preferred alternative in order to minimize ecological impacts.
07/02	Interior issues two Special Use Permits—one by NPS and one by FWS—to the Corps to construct a wider channel on the north side of the inlet, which would remove over 400 feet of the Bodie Island barrier spit within the Cape Hatteras National Seashore and deposit the 1 to 2 million cubic yards of dredge spoil on the oceanfront beaches of Pea Island. The construction would eliminate approximately 4 acres of wetlands, for which compensatory mitigation will be provided in the form of enhanced wetland habitat for migratory shorebirds elsewhere on the Bodie Island spit.

Approved Oregon Inlet Dredging Operations That Were Not Performed

As shown in table 3, for some of the fiscal years from 1990 through 2001, the Wilmington District Office did not perform numerous approved dredging operations in the Oregon Inlet ocean bar navigation channel and, as a result, did not remove thousands of cubic yards of sand from the channel. The District Office did not perform these operations because the funds were used on other, higher priorities within the district.

Table 3: Approved Oregon Inlet Dredging Operations That Were Not Performed for Some of the Fiscal Years from 1990 through 2001

Fiscal year	Operations not performed	Approved funding	Cubic yards of sand planned for removal
1990	Dredge channel with two Corps side-cast dredges	$860,000	Not available
	Dredge channel with a hopper dredge	$845,000	Not available
1994	Dredge channel with two Corps side-cast dredges	$1,239,000	Not available
	Dredge channel with a hopper dredge	$2,809,000	Not available
1996	Dredge channel with two hopper dredges	$1,848,000	622,216
1998	Dredge channel with a Corps side-cast dredge	$664,000	601,067
	Dredge channel with a hopper dredge	$929,000	362,279
1999	Dredge channel with a Corps side-cast dredge	$506,000	418,958
	Dredge channel with a hopper dredge	$949,000	164,629
2000	Dredge channel with three Corps side-cast dredges	$813,000	663,215
	Dredge channel with a hopper dredge	$201,000	187,984
Total		**$11,664,000**	**3,020,348[a]**

Note: Costs are expressed in constant 1997 dollars and reflect unspent amounts for dredging the ocean bar channel. In addition, there were some years when the Corps spent more funds than were made available for dredging but the quantity dredged was 1,889,504 cubic yards less than was planned. Totals may not add due to rounding.

[a]Actual total exceeds the amount shown because data from some years were not available.

Source: GAO analysis of data provided by the Corps' Wilmington District Office.

Review of Corps' Economic Analysis of the Proposed Oregon Inlet Jetty Project

This appendix reviews the Corps' analysis of the benefits and costs of the recommended jetty project for Oregon Inlet. In general, the Corps' analysis has limitations that undermine its usefulness for assessing the economic tradeoffs between the current 14-foot dredging program and the Corps' preferred alternative of a jetty system with a 20-foot navigation channel. Specifically, the Corps' analysis (1) failed to consider intermediate channel depths between 14 feet and 20 feet, (2) used outdated data to estimate the benefits to trawlers and did not account for the effects of the proposed jetty project on smaller commercial fishing vessels, (3) used some incorrect and outdated data to estimate vessel losses and damages, (4) used questionable survey and sampling techniques to estimate recreational benefits, (5) did not value land protected from erosion according to federal guidelines, and (6) did not fully account for risk and uncertainty in key variables used in the analysis. In addition, we also identified other limitations, including the fact that the Corps did not account for the economic value of the lives that might be saved by the jetty project; in addition, its estimate of project cost does not include more recent expenditures and is based on an overly optimistic assumption. These latter limitations are discussed in the report.

The Corps Did Not Consider Alternative Channel Depths between 14 Feet and 20 Feet

In conducting its economic analysis, the Corps considered three alternatives: (1) dredging a 20-foot channel in the spring, (2) dredging a 20-foot channel in the fall, and (3) constructing dual rock jetties with a sand bypassing system, along with a 20-foot channel. The Corps did not analyze intermediate channel depths between the current 14 feet and the authorized 20 feet. As shown in table 4, the Corps estimated the benefits and costs associated with three 20-foot channel alternatives—including the proposed jetty project—relative to the current 14-foot dredging program. Based on this analysis, the Corps determined that the proposed jetty project would provide greater net benefits and a higher benefit-cost ratio than either the current program or the other two 20-foot alternatives. Corps officials said they considered only alternatives that would achieve the 20-foot channel depth because analyses the Corps conducted in 1970 and again in 1984 demonstrated that the 20-foot channel was needed to reliably enable the existing fleet, including 75-foot commercial fishing vessels, to pass safely through the ocean bar navigation channel. The Corps' 1970 analysis, which served as the basis for the congressional authorization in 1970, found that that a 20-foot channel would be economically superior to other channel depths (including 14 feet) because it would accommodate existing trawlers and attract some additional trawlers and, therefore, result in the plan that has the greatest net benefits.

However, federal guidance for evaluating water resource plans such as the proposed Oregon Inlet jetty project states that alternative plans should not be limited to those that the Corps could implement under existing authorities. Alternative plans should be formulated in a systematic matter to ensure that all reasonable alternatives are evaluated.[24] In addition, according to the state of North Carolina, trawlers used the inlet far less frequently than smaller, shallower-draft vessels from 1999 through 2001. For example, of the approximately 3,900 average annual commercial fishing trips through the inlet from 1999 through 2001, 83 percent were by smaller commercial fishing vessels.[25] Because these vessels have a shallower draft, they may not be as dependent as trawlers upon the deeper channel depths.[26] Moreover, although the smaller vessels might benefit from an increase in the current 14-foot channel depth, the economically optimal depth, taking into account all vessels (commercial and recreational) currently using Oregon Inlet, may be less than 20 feet. Consequently, by not including an analysis of the benefits and costs of intermediate channel depths, the Corps' analysis is less useful for decision making because it does not clearly demonstrate that the 20-foot channel depth is economically superior to other depths.

[24] *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, U.S. Water Resources Council, 1983.

[25] Based on the state of North Carolina's commercial fish landings trip ticket program.

[26] According to the state of North Carolina, the smaller vessels averaged about 35 feet in length and trawlers averaged about 73 feet. Vessels that are 35 feet in length have a draft of approximately 4 to 5 feet.

Table 4: Comparison of Estimated Annual Benefits and Costs of Alternatives for Achieving a 20-Foot-Deep Navigation Channel for Oregon Inlet

		Alternatives for achieving 20-foot-deep channel		
Categories of impacts		**Dredging in fall**	**Dredging in spring**	**Jetty project**
Increased benefits	Reduced operating costs of commercial fishing vessels	$2,011,000	$2,011,000	$2,011,000
	Value of increased recreational boating trips	$3,367,000	$3,367,000	$3,367,000
	Reduced costs associated with reduced vessel losses and damages	$552,000	$552,000	$552,000
	Erosion protection	$0	$0	$1,000,000
	Value of other categories [a]	$307,000	$307,000	$307,000
	Accidental deaths prevented (over 50 years)	14	14	14
	Total increased benefits	$6,237,000	$6,237,000	$7,237,000
Increased costs	Construction and maintenance	$10,601,400	$8,148,400	$4,520,000
Net benefits (increased benefits minus increased costs)		**-$4,364,400**	**-$1,911,400**	**$2,717,000**
Benefit-cost ratio (increased benefits divided by increased costs)		**0.59**	**0.77**	**1.6**

[a] Includes categories such as charter boat income and reduced maintenance of navigation aids.

Source: U.S. Army Corps of Engineers 2001 General Design Memorandum.

Corps' Analysis of Benefits to Commercial Fishing Vessels Relied on Outdated Trip Data and Excluded Certain Vessels

In its 2001 General Design Memorandum, the Corps determined that the proposed jetty project would generate about $2 million in annualized commercial fishing benefits. To derive this estimate, the Corps relied primarily on a 1987 consultant's study of trawler trips taken in the mid-1980s. That study determined that 234 trawlers were forced to detour to alternative inlets or ports on average about 42 percent of the time, adding about 14 hours to the length of their fishing trips. Thus, the study estimated that trawlers lost about 27,163 hours detouring to alternative inlets. Assuming that the proposed jetty project would save commercial fishing vessels these hours, the Corps multiplied the hours by an estimate of the hourly cost to operate a commercial fishing vessel ($80.21, including fixed and variable operating costs) to estimate the value of the time savings as $2,179,000. The Corps divided $2,179,000 by the 17.9 million pounds of fish estimated to have been landed through Oregon Inlet by all commercial vessels in the mid-1980s to obtain the per-pound savings of 12.2 cents. The

Corps then applied the per-pound savings to two different estimates of long-term fish harvests: one based on projections developed by the National Marine Fisheries Service and one based on projections developed by the state of North Carolina. In addition, the Corps conducted an uncertainty analysis on each projection to incorporate variability in natural fish populations and the effectiveness of management plans. Based on the two projections and the uncertainty analysis, the Corps estimated that from 16,758,000 to 23,313,000 pounds of fish could be available for harvest annually over the 50-year life of the jetty project. Multiplying these projections by the per-pound savings of about 12.2 cents, the Corps estimated that annualized benefits of the proposed jetty project would range from $2,011,000 to $2,798,000.

However, recent data from the state of North Carolina Division of Marine Fisheries commercial fishing trip ticket program suggest that trawlers are taking fewer trips than they did in the mid-1980s. Moreover, trawlers would not likely save the fixed-costs portion of their hourly operating costs even if the proposed jetty project were built.[27] To illustrate how the Corps' benefit estimate would change using the more recent trawler trip data, we adjusted the Corps' commercial fishing vessel benefits analysis to account for trawler trips taken from 1999 through 2001. In addition, we adjusted the Corps' analysis to exclude the fixed costs that would not likely be affected by the proposed jetty project. After making these adjustments, we found that the Corps estimate of commercial benefits would be reduced by about 90 percent. Nonetheless, the Corps' analysis excludes smaller commercial fishing vessels; including these vessels could increase this adjusted estimate of benefits.

[27] Since the Corps assumes no change in the fish harvest, the appropriate measure of savings is the marginal cost of the resources, such as fuel and oil, which would be saved by the proposed project.

For example, according to data obtained from the state of North Carolina, vessels 55 feet or longer (defined by the Corps as trawlers) averaged 679 trips through the inlet from 1999 through 2001.[28] Based on these trips and the 1987 consultant's estimate of the fraction (0.42) of trips delayed and the average length of the delay (14 hours), trawlers might have been delayed by about 4,000 hours annually over this period. Multiplying the hours delayed (4,000) by the Corps' hourly operating cost for a trawler (about $68.00 per hour, exclusive of fixed costs) gives an estimated potential annual savings of about $272,000. Dividing the annual savings ($272,000) by the average number of pounds landed by trawlers through Oregon Inlet from 1999 through 2001 (8.6 million pounds or 39 percent of the total commercial landings) provides potential savings of about 3 cents per pound. We applied the fraction (0.39) of trawler catch to the Corps' two projections of future fish harvests to obtain an estimate of the pounds of fish that trawlers would be expected to harvest based on current data. For example, based on the current harvest data and the long-term projections developed by the Corps, trawlers might harvest from about 6,500,000 pounds to 9,100,000 pounds of fish annually. We multiplied the two estimates of the trawler harvest by 3 cents to obtain the estimate of annual operating cost savings. We then estimated the present value and annualized over the 50-year period using the Corps' discount rate of 7.125 percent. Thus, adjusting the Corps' analysis in this way generates annualized benefits ranging from about $194,000 to $270,000, or about 90 percent less than the Corps estimated.[29]

The Corps used two other methods to verify the analysis conducted using the consultant's 1987 study. First, the 2001 GDM refers to a 1990 Corps economic analysis that found commercial fishing vessels were delayed by 17,666 hours because of Oregon Inlet conditions, incurring additional costs of 11.4 cents per pound to land fish. However, the Corps estimate is not

[28] We used the period 1999 through 2001 because state officials said their vessel licensing data from before 1999 are less reliable. Vessel licenses were used to identify the county out of which each vessel operated in order to match the counties represented in the consultant's 1987 study. Nonetheless, regardless of the vessels' operating ports, landings data by type of fishing gear also suggest trawler trips have declined relative to the consultant's estimate from the mid-1980s. For example, for landings made in Dare, Hyde, Pamlico, and Beaufort Counties from 1994 through 1995, vessels using trawl gear landed about 9.3 million pounds of fish on 561 trips, while vessels using gill nets landed about 16.3 million pounds of fish on about 5,200 trips (including trips via Hatteras Inlet). Vessels using gill nets are generally smaller than trawlers.

[29] For the adjusted analysis, we assumed no change in the fraction of total trips forced to other inlets or ports or in the average length of time a vessel is delayed. Using alternative values for these assumptions would change the estimated benefits.

based on the number of trips or landings made by trawlers in recent years. Second, based on a 1995 study by a consultant, the Corps assumed that 56 full-time vessels were forced to detour eight trips per year. In addition, the Corps assumed that other vessels would use Oregon Inlet if the jetty project were built. For example, the Corps assumed that 100 additional part-time and/or transient vessels would use Oregon Inlet to land fish and another 100 vessels would use Oregon Inlet seeking a harbor of refuge during storms. However, the Corps could not provide us with the documentation to verify the number of full-time vessels, total trips taken, trips detoured, number of transient vessels using the inlet, or the number of vessels that might seek refuge during storms.

Accounting for the effect of the proposed jetty project on smaller fishing vessels could increase this adjusted estimate of the benefits to commercial fishing vessels. Nonetheless, because these smaller vessels have a shallower draft than trawlers, they may not be as affected by the sand accumulations in the ocean bar navigation channel that can be hazardous to trawlers. For this reason, the extent to which smaller vessels might benefit from the jetty project is uncertain. In addition, to the extent that trawlers relocate from other fishing ports (for example, Norfolk) to Wanchese, North Carolina, as a result of the jetty project, estimated benefits to trawlers could be higher (after netting out transfers between the two regions). Moreover, to the extent that trawler captains are detoured or delayed more or less often than we assumed, the estimated benefits could be higher or lower. Several trawler captains told us that there are fewer detours available to them than in the past. According to these captains, the Ocracoke Inlet and the Atlantic Intracoastal Waterway from Norfolk, Virginia, to Wanchese, North Carolina, are too shallow for trawlers to use as a way to avoid passing through Oregon Inlet. These captains said that instead of traveling to alternative inlets or ports, they often wait for high tide at Oregon Inlet in order to increase the distance between the keel of their vessel and the channel bottom. By waiting for high tide, vessels might be delayed less time per trip than is assumed in either the Corps' analysis or this adjusted analysis. However, no comprehensive data are available with which to verify the average length of time vessels are currently delayed or to evaluate the effects of conditions in Oregon Inlet on the operating efficiency of the current trawler fleet or smaller commercial fishing vessels.

Corps' Estimate of Vessel Losses and Damages Is Based on Unsupported Assumptions and Outdated Data

The Corps estimated that the recommended jetty project would generate annualized benefits of $552,000—$160,000 in reduced vessel losses and $392,000 in reduced damages to commercial fishing vessels. The Corps anticipates that the jetty project would generate these benefits by reducing the high waves and sand accumulations in the inlet that contribute to vessel losses and accidents. However, the Corps' estimate has limitations that raise questions about its reliability.

The first limitation is that the Corps' analysis assumes that all prior accidents would be prevented by the jetty project and does not clearly control for factors that would be present with or without the jetty project. For example, Corps officials told us that under some weather conditions the inlet would be hazardous even with the recommended 20-foot channel and dual jetties in place. Further, factors the Corps did not control for include changes in type of vessel traffic, operator experience, and vessel safety technology, all of which will continue to play a role in the number of accidents in the inlet, with or without the jetty project. For example, as mentioned earlier, the number of trips by trawlers between 1999 and 2001 is 85 percent less than the number of trips taken in the mid-1980s, and the Corps' analysis does not reflect this change.

Second, the Corps estimate of $160,000 in annualized benefits from reduced vessel losses is based on outdated data, some of which are incorrect and some of which we could not verify. The GDM states that the Corps' estimates of vessel losses and damages evolved from prior studies and the analyses of two consultants' reports. With regard to vessel losses, a consultant's report completed in 1987 attributed the loss of 21 vessels between 1961 and 1986 to conditions in Oregon Inlet.[30] The Corps used this information to estimate vessel losses in its 1990 economic analysis.[31] Subsequently, a 1995 consultant's report estimated that the jetty project would prevent the loss of 14 vessels during the 50-year life of the project.[32] This report updated data in prior studies, including the 1990 economic update by the Corps, and made adjustments because of reductions in the number of large fishing vessels using the inlet. However, unlike the 1987

[30] The Kearney/Centaur report, cited earlier.

[31] *1990 Update of 1984 Economic Analysis: Manteo (Shallowbag) Bay Project, North Carolina* by the Corps of Engineers' Wilmington District, July 1990.

[32] *An Assessment of the Regional Economic Benefits of the Oregon Inlet Stabilization Project* by the Horizon Planning Group, Wilmington, NC, January 1995.

consultant's report, the 1995 consultant's report did not identify specific vessels lost or explain its basis for arriving at its estimate of 14 vessels. For its 2001 economic analysis, the Corps relied on the 1995 consultant's report that assumed the 20-foot channel and dual jetties would prevent the estimated loss of 14 vessels.

We asked the Corps to provide us with the supporting documentation behind two previous economic analyses completed in 1987 and 1990. Corps officials could not provide this information, stating that the data may have been lost or discarded when the office relocated. The 1987 consultant report did, however, list the names of the vessels lost between 1961 and 1986 that it attributed to conditions in Oregon Inlet. Accordingly, we asked the Coast Guard for any available accident investigation reports regarding these vessels. The Coast Guard had no records for 12 of the 21 vessels that the consultant report listed as lost. As shown in table 5, of the nine accident investigation reports we reviewed, six of the losses were probably attributable to inlet conditions. Of the three losses that we found not attributable to the inlet, two occurred at locations other than Oregon Inlet and one was caused by mechanical failure. Because we found that three of nine vessel losses—33 percent—were not attributable to the inlet, we have concerns about the overall accuracy of the data in the report. Since it is unclear how information from the Kearney/Centaur report was used in updating the estimates of vessel losses for the Horizon Group report and the estimates of vessel losses in Corps' latest economic analysis, we cannot determine the exact impact of the errors from the 1987 report on the Corps' estimate.

Table 5: Summary of Information in U.S. Coast Guard Investigation Files on Vessel Losses at Oregon Inlet, 1961 through 1986

Date of the accident	Vessel name and identification number	Location of the accident	Estimated value of lost vessel and contents	Was the accident caused by Oregon Inlet conditions?	Value of the loss in constant 1997 dollars
10/13/77	M/V Tosco, 505450	The 7th span south of the center of Bonner Bridge at Oregon Inlet.	$100,000 for the vessel $9,000 for the fish catch	Yes	$246,830
11/01/77	F/V Miss Chievious Too, 582529	Not specific, assumed to occur in Oregon Inlet or Pamlico Sound as the vessel was entering to find safe moorage.	$40,000 for the vessel	Yes	$90,580
02/09/79	F/V Dolphin, 258728	The vessel sank in the Atlantic Ocean 9 miles southeast of Hatteras Inlet.	$40,000 for the vessel $2,000 for the fish catch	No. The accident did not occur in Oregon Inlet.	[a]
08/25/79	F/V Ole Ugly, 265219	After departing through Ocracoke Inlet, the vessel sank in the Atlantic Ocean.	$250,000 for the vessel	No. The accident did not occur in Oregon Inlet.	[a]
12/31/81	F/V Coral Breeze, 543963	At Oregon Inlet's ocean bar.	$170,000 for the vessel $6,500 for the fish catch	Yes	$288,493
12/07/81	F/V Lady Phyllis, 618355	The vessel hit the Bonner Bridge.	$4,000 for the vessel	No. Inlet conditions were calm. Incident was caused by mechanical failure.	[a]
12/12/82	F/V Lois Joyce, 605933	In the Oregon Inlet channel 150 feet outside buoy number 4.	$850,000 for the vessel	Yes	$1,307,894
12/04/85	F/V Elizabeth Christine, 277218	Within Oregon Inlet longitude and latitude coordinates.	$150,000 for the vessel	Yes	$207,526
06/22/86	F/V Marlina, 249132	Within Oregon Inlet longitude and latitude coordinates.	$35,000 for the vessel	Yes	$47,374
Total					**$2,188,697**

[a] Not calculated because the accident was not caused by Oregon Inlet conditions.

Source: Case files retrieved by Marine Casualty Investigation Division and printouts of electronic marine casualty reports from the Data Administration Division, U.S. Coast Guard.

Moreover, based on our review of more current Coast Guard records, from 1986 through 2001, we identified the loss of four vessels that were likely attributable to inlet conditions. These are listed in table 6. Therefore, based on our review of the Coast Guard reports that were located on past cases and by updating this data using more current records**,** we identified 10 vessel losses that occurred because of inlet conditions between 1977 and 2001. The total value of these 10 vessels is about $2.4 million, or roughly $96,000 per year over that 24-year period, which is 40 percent less than the Corps' estimate of $160,000 per year in annualized benefits.[33]

Table 6: Listing of Vessel Losses and Deaths Attributed to Conditions at Oregon Inlet, June 28, 1986, through November 27, 2001

Date of the incident	Vessel name and/or identification number	Type of vessel	Vessel length	Number of deaths	Value of the loss reported	Value of the loss in constant 1997 dollars
01/13/89	NC8559AS	Fishing	30	0	$30,500	$37,341
12/30/92	High Liner, D620483	Fishing	28	0	$50,320	$55,855
11/20/96	NC9186BK	Recreational	17	1	0	0
05/06/00	Little Fly Fisherman, D287083	Recreational	40	0	$130,000	$123,821
11/27/01[a]	NC9367DA	Recreational	16	1	$8,500	$7,934
Total				**2**	**$219,320**	**$224,951**

[a]While we reviewed U.S. Coast Guard records from June 28, 1986, through September 30, 2001, we included a fatal accident that occurred in November 2001.

Source: U.S. Coast Guard and North Carolina Wildlife Resources Commission.

[33] This calculation includes only the vessels listed as lost by the Corps consultant that we could verify and vessels identified as lost in our review of more recent Coast Guard records. Also, complete records were not available on state registered recreational boat accidents to determine how many were lost during the period we reviewed. The 1987 consultant apparently did not review such records when identifying vessel losses.

The third limitation we identified to the Corps' analysis involves the estimated annualized benefits of $392,000 in reduced vessel damages if the jetty project is built. Again, the Corps relied partly on data developed in the 1987 consultant's study.[34] To estimate the value of damages to vessels, the consultant interviewed vessel captains and marine repair yards and determined that the average annual damage per vessel due to inlet conditions was about $7,000. The Corps then multiplied this figure by the number of full-time commercial fishing vessels that it estimated were using the inlet, which it determined to be 56 full-time vessels, to arrive at $392,000 in reduced vessel damages. In its estimate, the Corps assumed that all trawlers using the inlet would sustain damages each year. The Corps could not provide documentation for this assumption. In contrast, as shown in table 7, our analysis of Coast Guard data over this period showed that only 10 commercial fishing vessels 55 feet and longer reported damages, which totaled on average about $1,700 per year.

[34] 1987 Kearney/Centaur study, cited earlier.

Table 7: Listing of Vessel Damages Attributed to Conditions at Oregon Inlet between June 28, 1986, and September 30, 2001

Date of the incident	Vessel name and/or identification number	Type of vessel	Vessel length	Number of injuries	Value of the damage reported	Value of the damage in constant 1997 dollars
07/04/86	Northerly Island, D664129	Dredge	194	0	$75,000	$101,516
10/14/86	Capt. Weddell, D654888	Fishing	74	0	0	0
06/12/87	God's Mercy, D561112	Fishing	77	0	0	0
04/04/88	Schweizer, CG010063	Dredge	133	0	$40,000	$50,832
05/05/88	Kokina, D585863	Fishing	72	0	0	0
05/26/88	Boss Lady, D505741	Fishing	82	0	$15,000	$19,062
04/15/89	Mermentau, D643740	Dredge	197	0	0	0
10/26/90	Northerly Island, D664129	Dredge	194	0	$6,500,000	$7,658,772
09/07/92	Uncloudy Day, D950979	Fishing	55	0	$3,000	$3,330
01/13/94	Louise, MS4131AP	Fishing	NA	0	0	0
04/27/94	Lucky Thirteen, D606275	Fishing	65	0	0	0
07/22/94	Gallant Fox, D567254	Fishing	72	0	$1,000	$1,062
04/07/95	Portugal, D608405	Fishing	74	0	0	0
10/08/95	Hoosier State, D581970	Tug	43	0	0	0
12/07/95	Clayton Reed, D683286	Fishing	45	0	$6,000	$6,236
12/11/95	Atchafalaya, D630005	Dredge	197	0	0	0
06/03/97	Hooker, D592896	Passenger	46	1	0	0
11/02/99	War Cry, D614462	Recreational	76	0	0	0
12/31/99	Capt. Malc, D607993	Fishing	81	0	$300	$292
02/22/00	Adrien Rose, D538410	Fishing	46	0	0	0
02/20/01	Snoopy II, D563195	Fishing	52	0	$500	$467
05/30/01	C-Venture, D539167	Fishing	73	0	$1,500	$1,400
Total					**$6,642,300**	**$7,842,969**
Average loss per year (15 years)					**$301,923**	**$356,499**
Total for 10 fishing vessels 55' and over					**$20,800**	**$25,146**
Average loss per year (15 years)					**$1,387**	**$1,676**

Source: Electronic marine casualty reports from the Data Administration Division, U.S. Coast Guard.

Finally, the Corps' analysis assessed damages to trawlers only and excluded potential damages to other vessels. Our analysis of Coast Guard records on reported incidents for all vessels from 1986 through 2001 showed that conditions in Oregon Inlet caused damages totaling about $7.8 million, or about $520,000 per year over that 15-year period, which is 25 percent more than the Corps estimate of $392,000 per year in annualized

benefits.[35] However, most of the total damages—$7.7 million—were attributable to one accident involving a dredge, which, torn from its anchor by a storm, struck and caused the collapse of a part of the bridge that spans Oregon Inlet. If the dredge accident were removed from the calculation, the average damages over the 15-year period would be about $12,000 per year, or nearly 98 percent less than the Corps' estimate.

Although we could verify some of the earlier estimates of vessel losses and damages and were able to provide more current data from a review of accident reports, the extent to which past deaths and vessel losses and damages might have been prevented by the Corps' proposed jetty project is not known. Consequently, we did not revise the Corps' estimate of benefits to include this more recent data.

Corps Did Not Clearly Explain How It Derived Its Estimate Of Lives That Might Be Saved by the Proposed Jetty Project

In addition to not incorporating the economic value of the lives that might be saved by the proposed jetty project in its estimate of benefits, the Corps did not clearly explain how it estimated that 14 lives might be saved over the 50-year life of the project. Corps' Wilmington District Office officials told us that they used their own studies and the 1987 Kearney/Centaur report as the basis for estimating that 14 lives might be saved by the project. The Kearney/Centaur report identified that 20 lives were lost with an associated loss of 21 vessels in Oregon Inlet from 1961 through 1986. We attempted to get data from the Corps that would document the 20 lost lives, but the Corps had not retained the supporting documentation for the Kearney/Centaur report. As a result, we asked the Coast Guard to provide any accident reports that it had relative to the vessel losses and 20 lost lives identified in the Kearney/Centaur report. The Coast Guard could only provide information on nine of the lost vessels. Based on our review of the nine cases, we found that the Kearney/Centaur report excluded four deaths resulting from a 1977 vessel loss even though information in the Coast Guard accident report implicated inlet conditions in the loss. In addition, we found that one death included in the Kearney/Centaur report did not occur in Oregon Inlet. Moreover, based on our review of more current Coast Guard records from 1986 through 2001 (see table 6 above), we identified two deaths—one in 1996 and the other in 2001—that were attributable to inlet conditions. Both of these accidents involved small recreational boats. Consequently, based on our review, we found that at

[35] Our estimate of damages is based on reported incidents and does not include any damages that were not reported to the Coast Guard.

least six deaths were attributable to conditions in Oregon Inlet over the 25-year period from 1977 through 2001, which is slightly less than the Corps estimate over a comparable period. However, whether these accidental deaths would have been prevented by the jetty project is uncertain. As mentioned above, the Corps' analysis assumed that all prior vessel accidents that included deaths would be prevented by the jetty project without clearly controlling for factors that would be present with or without the jetty project. For example, Corps officials told us that under some weather conditions the inlet would be hazardous even with the recommended 20-foot channel and dual jetties in place.

Corps Relied on Outdated Data Collected with Questionable Survey and Sampling Techniques to Estimate Recreational Benefits

The Corps estimated that the jetty project alternative would generate about $3.4 million dollars in annualized benefits for recreational boaters by reducing high waves and sand accumulation in the ocean bar navigation channel, thus allowing for more trips. This estimate includes an estimated $2.8 million in benefits for private recreational boats, with the remaining benefits for anglers on charter and party boats. We could not verify the Corps' estimates because it did not retain supporting documentation, and independently calculating the estimates would require an inordinate amount of time and resources. However, based on our review of the Corps' approach and methodology used in developing the estimates, we have identified three limitations that raise questions about the reliability and usefulness of the estimated benefits.

First, the Corps' original data collection effort, conducted in 1983, used a survey instrument that may have biased the boaters' responses in favor of the jetty project. For example, to estimate the additional trips that private recreational boaters might be willing to take if the jetty project were constructed, the Corps mailed a survey to 3,876 registered owners of recreational power and sail boats at least 19 feet long who were likely to have used Oregon Inlet in 1983. The Corps received 1,044 usable responses[36] and from them concluded that private recreational boaters would increase their average annual use of the inlet from 8.59 trips through the Inlet per year to 19.34 trips per year if the jetties were built. The cover

[36] In 1983, the Corps reported using 1,094 responses and a response rate of 46 percent. In 2001, the Corps reported using 1,044 responses, stating that 176 surveys were undeliverable and 681 others were considered "not usable." The Corps deemed a response "not usable" if the respondent no longer owned a boat, the boat was not used in the ocean, or because the information provided was "invalid" or appeared duplicative. The 2001 General Design Memorandum does not project the survey results to the entire population of respondents.

letter accompanying the mail survey included the following introduction to the topic, stating that "despite 22 years of intensive maintenance dredging, the Corps has been able to maintain the channel depth only 25 percent of the time and has never been able to maintain the 400-foot channel width" and that "numerous groundings, vessel losses, personal injuries, and deaths have occurred." In addition, the survey instrument asked respondents to estimate the number of days per year they "currently use" Oregon Inlet and the number of days per year they "would use Oregon Inlet if it were stabilized with dual jetties and a deeper, more reliable channel." The wording implied that the channel would be safely passable all of the time if the jetty project were built, which is not the case. Corps officials acknowledge that even with the jetty project there will be periods when weather conditions will make the inlet impassable.

Concerning the estimated use of the inlet, a 1987 consultant's report noted that some survey responses seemed too extreme to be credible. For example, on average, respondents indicated they currently used the inlet 11 days each year. However, a number of respondents indicated a substantially higher use, with the highest reported estimate being 250 days per year. To address this concern in its most recent economic analysis, the Corps calculated new estimates using only responses that indicated a use of 60 days or less. This resulted in the Corps excluding 23 responses that were above this number. However, the 60-day threshold was arbitrary, and it neither accounts for the possibility that some responses above the threshold may be legitimate nor addresses the problem that responses below the threshold may have also been subject to biased wording. While the overall estimated benefits are lower than they would be if all responses were included, we could not determine the reasonableness of these estimates. The Corps does not believe the surveys contained bias. They said that the Office of Management and Budget (OMB) approved the surveys and that the wording "deeper, more reliable channel" would be an accurate description of the channel with the implementation of the jetty project. Both the Paperwork Reduction Act and OMB's process for reviewing surveys have changed since 1983. However, the OMB official who currently reviews Corps surveys told us that the current OMB approval process does not ensure that a survey instrument is free from bias, although the reviewer may suggest changes if he or she detects bias, along with any other editorial comments. Because OMB does not keep records beyond 10 years, we could not determine the nature and extent of OMB's comments concerning the Corps' 1983 surveys.

Second, the Corps' 2001 economic analysis of recreational benefits relied on survey data from 1983 and 1984. These data are outdated and may not reflect the economic value that today's boaters would place on any additional trips they would be able to take if the jetty project were built. The demand for recreational fishing is dependent upon factors such as the current cost (for example, expenses and time incurred in traveling to the site) and the current availability of substitute fishing sites and other recreational opportunities.[37] For its most recent analysis, the Corps updated the original survey data by increasing the results by the rate of growth in regional tourism and visitation from 1984 through 1995. The Corps then used the updated survey data as a starting point for projecting recreational demand another 50 years into the future—the life of the jetty project—to 2051. However, changes in tourism and visitation primarily reflect changes in population rather than changes in relative prices or substitute recreational opportunities. Consequently, the reliability of the Corps' recreational demand projections is questionable. Corps officials acknowledged that their recreational benefit estimates are based on outdated data but said they had not received funding to update the data. In addition, they believe that recreational activity has increased at Oregon Inlet and that using data that are more current would not change estimated recreational benefits of the jetty project. Nonetheless, the Corps does not have current data on the economic value that recreational boaters would attribute to the jetty project alternative to support its contention.

Third, in estimating the economic value of the additional fishing trips, the Corps used data collected from anglers on private boats and charter boats during three 1-week periods in August, September, and October of 1983. The Corps used these data to estimate that the average value of a fishing trip was $22.56 per person per day. However, both the number of fishing trips and the type of catch vary considerably over the year. The 3-month period during which the data were collected is the highest-use period for recreational fishing. The value of a fishing trip, according to those fishing in August, September, and October, may differ from the value assigned by those fishing during other months because the number of boats and anglers varies by season, as does the type of fish caught and the severity of weather and sand accumulation in the inlet. Therefore, since data were gathered

[37] The Corps used a "travel cost" model to estimate the value of the additional trips. This is a technique for approximating the value that recreationists would be willing to pay for the use of a site, based on factors such as the expenses and value of the time required to travel to the site.

only from anglers during the peak recreational season, the Corps' estimate of the value of a fishing trip may not be a reasonable representation of the value of such a trip for the entire fishing season. Furthermore, there was no update of these data in the Corps' most recent economic analysis. Corps officials said that since most fishing trips occur during the months of August, September, and October, values for those months would be weighted most heavily, even if data from additional months were collected, and that there was no reason to believe that trips in other months would be less valuable. For example, they said charter boat fishing rates are the same in other months as they are in the highest-use months. Nonetheless, the Corps did not incorporate the value of the additional trips that recreational anglers fishing in lower-use months might be willing to take if the proposed jetty project were built. The value of the additional trips during lower-use months could be lower or higher than the value in higher-use months for several reasons, including the type of fish that are available, the weather, and the particular preferences of the angler.

Corps' Approach to Valuing Benefits Associated with Reduced Erosion Is Inconsistent with Federal Guidelines

The Corps estimated that the proposed jetty project would yield about $1 million in annualized benefits by preventing the erosion of beaches to the north and south of Oregon Inlet. Because the protected land to the north of the inlet is part of the national seashore and to the south of the inlet is part of a national wildlife refuge, the benefits derived from the jetty project would be the recreational opportunities generated from the public use of the protected land. However, the Corps used valuation techniques that are not consistent with federal guidelines for valuing recreational benefits. As a result, the reliability of the Corps' estimate of $1 million for erosion prevention is questionable and thus less useful because it does not reflect the value of the land as it is currently used for recreation and as wildlife habitat.

Federal guidance states that benefits arising from a project that generates recreational opportunities should be measured in terms of the willingness of users to pay for the recreational opportunity. For example, the fees users are willing to pay to visit a site and any unpaid value[38] enjoyed by the recreationist can be used to measure benefits. Although the Corps'

[38] This unpaid value is called "consumers' surplus" and is a standard measure of the net benefit derived from purchasing a good or service. Since the protected land is publicly provided and no fees are charged to enter the site, the value of the land can be estimated using indirect means such as the travel cost model.

economic analysis states that the protected land could be valued in terms of its use for recreation, the Corps chose not to do so because an earlier consultant's report[39] found drawbacks with an approach that based the value of the land on the willingness to pay for recreational opportunities. In particular, the consultant's report states that the land has a "uniqueness value" to the nation that would not be captured by techniques based on recreational visitation. As a result, the Corps did not use willingness to pay for recreational opportunities to calculate the value of the land. However, although the Corps agreed with the consultant's argument, neither of the two valuation methods used by the Corps measured the uniqueness value of the land.[40]

The Corps used two different methods to derive two separate estimates of the benefits associated with the land that would be "protected" by the jetty project. Under one method, the Corps assumed that the jetty project would protect 5 acres of land per year from natural erosion. To determine the benefits, the Corps used the per-acre cost of bypassing sand (about $200,000) instead of the land's value for recreational use. This method is inconsistent with federal guidelines, because the cost of preventing the erosion does not reflect willingness to pay for recreational use of the land. As a result, we could not determine whether the Corps' estimate overstates or understates the value of the land for recreational use.

Under the second method, the Corps assumed that the jetty project would prevent erosion of 9.5 acres from nearby beaches each year, or roughly twice as much land as would be protected under the first method. District officials said they used the market value of local, private, undeveloped, non-erodible, oceanfront property as a way to reflect the land's opportunity cost—the value of the land in its alternative best use—to initially value the protected land at about $426,000 per acre. However, because the protected land is erodible, the Corps reduced that value by 75 percent to make the land worth about $107,000 per acre. Under this method, the total value of the protected land was estimated to be roughly $1 million. However, Corps officials did not have documentation supporting the basis for reducing the value of the protected land by 75 percent. Moreover, since the land being protected is public land, it is not likely that the land will be sold for private

[39] The Kearney/Centaur report, cited earlier.

[40] Economic techniques that measure total economic value could assess whether the acres saved would add to the uniqueness value of the national seashore and the wildlife refuge (use and non-use values).

use. Further, this approach does not consider the land's use for recreation and is, therefore, inconsistent with federal guidelines for estimating recreational benefits. As a result, it fails to provide decision makers with reliable information regarding these potential benefits.

Corps officials said that their guidelines for conducting economic analysis allow the benefits of environmental protection projects to be judged equal to their costs, which is why the Corps used the cost of bypassing sand as the value of the land. Nonetheless, as mentioned above, the cost the Corps derived is not based on a measure of the willingness to pay, and, as a result, the extent to which the Corps' estimated benefits approximate the value of the land for recreation purposes is not known.

The Corps Did Not Account for Risk and Uncertainty Associated with All Key Variables

In developing its estimate of the benefits and costs of the jetty project alternative, the Corps did not fully account for the extent to which the net benefit estimates would be affected by the risk and uncertainty associated with potential measurement errors and variability in the underlying data and assumptions.[41]

The economic analysis did account for some risk and uncertainty for some variables. For example, in developing its estimate of the operating costs that trawlers would save in harvesting fish if the jetty project were built, the Corps adjusted its estimates to reflect the year-to-year variability in fish populations. In addition, in developing its estimate of the cost to construct the jetty project and operate the sand bypassing system, the Corps increased its estimate by about 15 percent to account for unforeseen events that might increase construction costs. The Corps also included additional costs for sand bypassing to ensure that neighboring beaches do not erode at a greater rate than anticipated.

However, the Corps did not assess the effect of risk and uncertainty for other key data and assumptions on the net benefit estimates. For example, the Corps used single or "point" estimates for the amount of sand estimated to pass over the weir; the trips and operating cost savings for commercial

[41] Federal guidance for water resources planning states that the effect of the risk and uncertainty should be examined. Risk reflects situations where potential outcomes can be described using reasonably well-known probability distributions. Uncertainty reflects situations where potential outcomes cannot be described in objectively known probability distributions.

fishing vessels; the additional trips that recreational boaters might take; the extent to which the jetty project might prevent vessel losses, damages, and accidental deaths; and the amount of dredging that might be required in the interior channels even with the proposed jetty project in place. For example, the amount of sand that is expected to pass over the weir and be used to reduce erosion on neighboring beaches is subject to some uncertainty because of errors inherent in modeling sand transport as well as variability in the frequency of storms and in ocean currents. By not fully assessing the effect of uncertainty, a decision maker might not be aware of the extent to which the net benefit estimates might change if the underlying assumptions deviate from the values assumed by the Corps.

Comparison of the Proposed Oregon Inlet Jetty Project to Similar Completed Jetty Projects

Table 8 compares key characteristics of the proposed Oregon Inlet jetty project to other similar jetty projects located on coastal inlets of the Atlantic Ocean and Gulf Coast of the United States.

Table 8: Key Characteristics of the Proposed Oregon Inlet Jetty Project and Similar Completed Jetty Projects

Key Characteristics:	Proposed for Oregon Inlet, NC	Murrells Inlet, SC	Colorado River, TX	Ponce DeLeon, FL	St. Lucie, FL	Perdido Pass, AL	East Pass, FL	Rudee, VA	Masonboro, NC
Number of jetties	2	2	2	2	2	2	2	2	2
Location of first jetty	North side of inlet	North side of inlet	East side of inlet	North side of inlet	North side of inlet	East side of inlet	East side of inlet	North side of inlet	North side of inlet
Year completed	Proposed	1979	1990	1971	1982	1969	1969	1968	1966
Length in feet	10,020	3,455	3,500	4,200	3,975	1,800	1,220	765	3,650
Location of second jetty	South side of inlet	South side of inlet	West side of inlet	South side of inlet	South side of inlet	West side of inlet	West side of inlet	South side of inlet	South side of inlet
Year completed	Proposed	1980	1990	1969	1982	1969	1969	1968	1980
Length in feet	6,575	3,319	2,900	2,700	1,000	1,800	3,400	815	3,450
Typical tidal prism[a] (in millions of cubic feet)	2,810.0	580.0	1.7	509.0	5.2	435.6	1,620.0	16.6	680.0
Sediment transport, in cubic yards, as viewed from land									
Left	611,000	54,000	0	348,000	72,600	130,000	65,000	378,000	200,000
Right	1,473,000	186,000	600,000	363,000	130,000	65,000	130,000	93,000	500,000
Net	862,000	132,000	600,000	15,000	57,400	65,000	65,000	285,000	300,000
Weir location	North jetty	North jetty	East jetty	North jetty	North jetty	East jetty	West jetty	South jetty	North jetty
Weir length in feet	1,000	1,880	1,000	Formerly 1,800	900	1,000	Formerly 1,000	475	1,000
Weir elevation in feet above mean low water	1.5	2.2	0.74	Closed	0	-0.5	Closed	2.15	2.16
Left	611,000	54,000	0	348,000	72,600	130,000	65,000	378,000	200,000
Right	1,473,000	186,000	600,000	363,000	130,000	65,000	130,000	93,000	500,000
After jetties, percentage of time channel less than authorized depth	N/A	1	70	10 or less	80	0	20	7 to 8	Less than 5

[a] Tidal prism is the volume of water flowing in or out of an estuary between high and low tides.

Source: GAO interviews with officials responsible for the projects.

Comments from the Department of the Army

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
108 ARMY PENTAGON
WASHINGTON DC 20310-0108

13 September 2002

REPLY TO
ATTENTION OF

Mrs. Gary L. Jones
Director
Natural Resources and Environment
U.S. General Accounting Office
441 G Street, NW
Washington, D. C. 20548

Dear Mrs. Jones:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, GAO-02-803, OREGON INLET JETTY PROJECT: Environment and Economic Concerns Still Need to be Resolved, dated August 28, 2002, (GAO Code 360049).

We appreciate the opportunity to comment on GAO's draft report as well as GAO's cooperation in the clarification of issues by the Army. The report is important to the Department because it provides a current and independent assessment of the Oregon Inlet jetty project. It is responsive to the issues you were charged to address, specifically, (1) assess Federal efforts to maintain the ocean bar navigation channel in Oregon Inlet; (2) assess the extent to which the Corps 2001 economic analysis of the jetty project is useful for decision making; (3) provide information on the performance of similar jetty projects; (4) determine whether the Corps applied lessons learned from similar jetty projects in its design of the Oregon Inlet jetty project; and (5) identify and discuss concerns raised by the Departments of Commerce and Interior about development of the jetty project. Our comments are ordered to address these five topics.

(1) The GAO report accurately assesses Federal efforts to maintain a reliable navigation channel. We concur in the GAO finding that because of the inlet's high-energy environment, dredging efforts have not provided a safe navigation channel and consequently loss of life, vessel losses, and vessel damages will likely continue. It is also likely that the Coast Guard will continue to have difficulty maintaining navigation buoys. The average cost of dredging to maintain a 14-foot navigation channel from 1983-1994 was $4.1 million per year, but this provided a reliable channel only 23 percent of the time. After 1994, the Corps spent about $2 million per year and maintained the channel depth about 15 percent of the time. Dredging has simply not been a reliable means of maintaining a safe channel.

(2) We believe that some differences in benefits result from differences in methodologies employed by the two agencies and a GAO auditing perspective versus a Corps project evaluation perspective. Since the Corps has not done any economic studies since 1999, it is difficult to evaluate GAO data that differs from data in the Corps study. Overall, the Corps agrees with GAO's conclusions and recommendations that GAO was unable to determine whether the proposed jetty system is economically justified at this time and that a new economic analysis of the project is needed to decide whether to proceed with the project. While GAO was unable to assess the effects of all the changes to net benefits, GAO's conclusions appear to be reasonable. Given the date of the Corps' most recent economic analysis of the jetty project, the Corps' own regulations require an economic reanalysis before starting construction.

(3) and (4) The GAO report provides information on similar jetty projects, such as those constructed with dual jetties and a low weir section. We concur in the GAO findings that the Corps applied lessons learned from construction of similar jetty projects and from internal Corps guidance. Masonboro Inlet in particular, which is located in the Wilmington District area and has performed as planned, provided valuable information on the need for dual jetties, the proper weir length, and the effect of erosion in this area. Finally, we concur that the information on eight similar jetty projects, their limitations, and the reasons for those limitations was useful. The information is helpful in maintaining our confidence that the Oregon Inlet project has adequate information on sand movement and should function as designed.

(5) The discussion of concerns of environmental resource agencies repeats concerns raised to the Feasibility Report, the Final Environmental Impact Statement, and in the referral to the Council on Environmental Quality (CEQ). Since the GAO report does not fully present the Corps position, we are enclosing the CEQ response package that addresses these issues for the record. We are especially pleased that GAO concurs with our recommendation that it would not be prudent to expend additional public funds to accomplish an economic reanalysis until CEQ favorably resolves the environmental concerns regarding the proposed jetty project and there are assurances from the Department of the Interior that permits will be granted. Despite 35 years of extensive studies, this project continues to show no progress, because of the environmental concerns and the reluctance of the Department of the Interior to provide approval for use of its lands to anchor any jetties. The Corps continues to believe that it has made project design changes and taken adequate mitigation measures to accommodate the environmental concerns of the Departments of Interior and Commerce. The Corps also believes that the jetty project is needed to allow large trawlers to navigate the inlet safely. We await CEQ's findings on the environmental issues for this potential project.

Sincerely,

R. L. Brownlee
Acting Assistant Secretary
of the Army (Civil Works)

Comments from the Department of the Interior

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

SEP 18 2002

Ms. Gary L. Jones
Director, Natural Resources and Environment
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Ms. Jones:

Thank you for providing the Department of the Interior the opportunity to review and comment on the Draft Report entitled "OREGON INLET JETTY PROJECT: Environmental and Economic Concerns Still Need to Be Resolved" (GAO-02-803) dated August 28, 2002. In general, we agree with the findings in the report. The report is an objective and thorough analysis of a complicated project with over three decades of development. In particular, we concur with the finding that an analysis of incremental channel depths to update the most economically beneficial channel depth is warranted. The current commercial and recreational fishing fleets differ from those used in the original economic analyses for the project, and the project economics should accurately reflect the needs of the vessels currently using the inlet. We also agree with the recommendations that are directed to the Army Corps of Engineers, as they are consistent with Departmental position and comments over the past 10 years.

Although we concur with the findings of the draft report, we would like to offer a few points of clarification. The enclosure provides specific comments from the U.S. Fish and Wildlife Service and the National Park Service. We hope our comments will assist you in preparing the final report.

Sincerely,

Assistant Secretary for Fish
and Wildlife and Parks

Enclosure

U.S. General Accounting Office Draft Report
"OREGON INLET JETTY PROJECT: Environmental and Economic Concerns Still Need to Be Resolved"
GAO-02-803

SPECIFIC COMMENTS

The report's statements concerning the U.S. Army Corps of Engineers' current position are inconsistent. On one hand, the draft report states that the Corps is currently unwilling to spend additional public resources on analysis of the jetty project (see page 9, paragraph 2; page 47, paragraph 2; and page 48, paragraph 1). On the other hand, the report describes the Corps as currently unwilling to spend additional public resources on analysis of alternatives for improving the safety and navigability of Oregon Inlet (see page 46, paragraph 2). The latter statement is much broader than those on pages 9, 47, and 48. Since the focus of this report is the jetty project rather than the overall management of Oregon Inlet, we suggest that the statement on page 46 should be modified to be consistent with the others and address only the jetty project. We further suggest that the second paragraph on page 46 should note that the Corps has not applied for Interior permits to construct the current dual jetty system.

The draft report notes that economic benefits may result from avoided accidental deaths at the proposed jettied inlet (see page 7, paragraph 1; and page 29, paragraphs 1 and 2). While we concur that this factor was not included in the current economic justification for the proposed project, we note that the economic costs of potential increases in accidental deaths, vessel damage, and other injuries resulting from the dual jetty and sand bypassing system are not incorporated either. The report should recommend that any further analysis of this project should include both the potential benefits and the increased risks to human life and vessel safety resulting from the jetties.

It would also be helpful if the report included a definition of the terms "commercial vessel" and "recreational vessel," since the report recommends that any further economic analysis of the project should be based on commercial fishing trip data (see page 26, paragraph 1).

The current statement regarding Interior's concern of "depositing too much sand onto its land" (see page 8, paragraph 2) does not adequately summarize our concerns about the sand bypassing system. We recommend that this statement be modified to read, "Interior believes that the jetties will increase beach erosion, especially on the south side of the inlet, and that the project's sand bypassing system could harm coastal habitat and wildlife by depositing large quantities of sand annually without allowing sufficient time for recovery of the ecosystem." Similarly, the last sentence on page 8 that continues on page 9, would be more accurate if stated "The weir is also intended to facilitate the collection of sand, which the Corps plans to bypass to beaches on the south side of the inlet to address erosion and interrupted sediment transport."

The draft report states that the National Park Service manages the Federal lands located on the north side of Oregon Inlet (see page 8, paragraph 2; and page 41, paragraph 1). The NPS requests that these statements be expanded to clarify that Pea Island National Wildlife Refuge

and lands south of the Refuge, which would be affected by project-caused erosion and perpetual sand placements, are likewise within the boundaries of Cape Hatteras National Seashore.

The report would more accurately describe the purpose of the terminal groin on PINWR if it stated that, "The terminal groin is a rock structure that was completed in 1991 to protect the southern end of the Bonner Bridge" (see page 16, paragraph 2). Additionally, we suggest that the report recommend that any further economic analysis of the jetty project should take into account the anticipated expiration of the right-of-way permit for the terminal groin in 2010, possible removal of the terminal groin, and resulting increased costs of the jetty project. Also in this paragraph, we recommend replacing "adjacent" with "downdrift" in the second to last sentence.

Interior does not agree that the Masonboro Inlet jetties should be considered "performing as planned" (see pages 31 through 34). The original project design utilized one jetty, constructed in 1966. In 1980, however, a second jetty was added to improve the performance of the managed inlet. Erosion of adjacent shorelines on Masonboro Island has also led to unanticipated supplemental dredging and beach fill activities to offset the interrupted sediment supply on Masonboro Island. Using one parameter to evaluate the overall performance of weir jetty projects, whether actual dredging needs are comparable to original project specifications, does not fully reflect the success or failure of those projects. We recommend that although Masonboro Inlet provides valuable lessons about weir jetties, the report should not characterize it as "performing as planned." Further, we urge caution in making any direct comparison of the processes at Masonboro and Oregon Inlets since Masonboro Inlet experiences only one third of the sediment transport (see page 19, paragraph 1) and a lower wave energy climate than Oregon Inlet.

There are a few points worth clarifying in the section on pages 41 through 43 that itemize Interior's concerns with the project. In the first bulleted concern, the second and third sentences would be improved by reading "Interior stated that if the jetties are built, erosion and accretion patterns will be modified both south and north of the inlet, which in turn will increase overwash of the islands, especially during storms. This overwash will harm valuable wildlife habitat as well as plants and vegetation that provide food for waterfowl and other migratory birds." The next sentence should replace the word "would" with "could" due to high levels of uncertainty regarding specific sediment transport volumes. We also recommend deletion of the phrase "the Bonner Bridge and" from the following sentence.

In the first bulleted point on page 42, we recommend that the 3rd sentence be amended to read "Interior stated that over the years frequent sand bypassing of large volumes might permanently eliminate these food sources and produce severe long-term adverse impacts on breeding, migrating and overwintering shorebirds." The latter part of that sentence can serve as an independent statement starting with "Among these birds are the Great Lakes piping plover ...". The last sentence of the bulleted point would be more accurate with the phrase "of incompatible sands" inserted after "perpetual sand placements."

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The second bullet on page 42 describes Interior's concerns about the performance of the weir. In particular, we remain concerned about the likely impacts of the Dare County Beaches Storm Damage Reduction Project, a large beach nourishment project immediately north of the Oregon Inlet jetties project area. While the draft report summarizes these concerns, the fifth sentence inaccurately attributes our concern over reduced sediment supply to aquatic habitats within Pamlico Sound to the offshore sand mining proposed for the beach nourishment project. In fact, the construction of the jetties and associated dredging and sand bypassing are the cause of our concern about reduced sediment supply to estuarine habitats, not the offshore sand mining. We recommend that this statement be moved to its own bullet as a separate Interior concern related to the jetties, separate from the Dare County beach nourishment project.

The NPS believes that the first complete bulleted point on page 43 does not fully describe the impact of the jetty project on public recreation at the Seashore. NPS therefore requests the addition of the following clause to the first sentence of this bullet point, "contrary to one of the legislated purposes of Cape Hatteras National Seashore."

The last sentence summarizing Interior's concerns (pages 43 and 44) should be modified to more accurately describe the purpose of the PINWR by ending with the phrase "to manage, protect, and restore migratory birds and other wildlife."

We request several clarifications in the last paragraph on page 46 before the Conclusions section. The fifth sentence would be more accurate if it read "FWS, likewise, issued the Corps a special use permit for disposal of dredge material on refuge lands during the Corps' 2002 dredging effort." The next sentence contains a typographical error, incorrectly referring to the Pea Island National Wildlife Reserve instead of the Pea Island National Wildlife Refuge. We recommend replacing the first two words ("FWS said") at the start of the seventh sentence with the phrase "According to the NPS special use permit, the dredging operation...".

3

Comments from the Department of Commerce

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
CHIEF FINANCIAL OFFICER/CHIEF ADMINISTRATIVE OFFICER

SEP 17 2002

Ms. Gary Jones
Director, Natural Resources
and Environment
United States General Accounting Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Jones:

Enclosed is the National Oceanic and Atmospheric Administration's response to the draft report OREGON INLET JETTY PROJECT: Environmental and Economic Concerns Still Need to Be Resolved (GAO-02-803). We appreciate the opportunity to provide comments.

Sincerely,

Sonya G. Stewart

Enclosure

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General comments

The Department of Commerce and the National Oceanic and Atmospheric Administration (NOAA) commend the General Accounting Office's (GAO) work in evaluating the issues surrounding the Oregon Inlet jetty construction project. Overall, we find that the report is thorough, and we concur with the determination that considerable revision of the economic and other analyses are needed before the feasibility and environmental effects of building jetties can be determined. We offer the following comments to clarify our position on some issues.

Specific comments

Pages 8-9 "Results in brief" and page 40 "Commerce and Interior remain concerned the Oregon Inlet project will harm the environment" The report states that the U. S. Army Corps of Engineers (COE) utilized lessons learned from other jetty projects by incorporating a weir into the design of the northern jetty to allow fish larvae to enter the sound. NOAA notes that the Corps originally found inclusion of a weir to be not acceptable based on considerable evidence indicating that such a structure could become blocked by sand. In such a situation, the weir would cease to function as a possible avenue for larvae movement, and also would cease to function as a sand bypass mechanism.

The concern about sand bypass is referenced as recently as 1995, wherein the Wilmington District's Feature Design Memorandum for Sand Bypassing Management states: "The major concerns, particularly with the weir jetty plan, were the high rates of littoral (sand) transport that could occur during singular or multiple storm events, and the possibility of reversals in the net direction of littoral transport during any year. Also, the amount of material available for bypassing would be limited to that retained in the sediment trap. With respect to storms, sand transport could be so large that the weir would become 'landlocked,' thus preventing the deposition of material in the sediment trap . . . " Considering the importance of successful weir design and function, NOAA is extremely concerned over the uncertainties associated with this key component of the project.

NOAA notes that no direct evidence exists demonstrating the effectiveness of this or any other weir for achieving larval ingress. With specific reference to the proposed Oregon Inlet jetties, NOAA has advised the COE that the current weir design is unacceptable since it may not be properly positioned to allow larval ingress. More specifically, the proposed weir would be located adjacent to the shoreline and would extend offshore, joining the main jetty at a water depth of around 1 meter (m) below mean sea level (based on the adjusted depth contours following filet formation at the north jetty). Mean tidal ranges in the inlet are 0.6-0.7 m, thus, maximum water depths at the seaward end of the weir would be approximately 2 m. Because species composition, distribution, and

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abundance of larval fishes in such shallow water outside of inlets are largely undetermined, there is no basis for the presumption larvae will be transported across the weir.

Larval transport through the inlet is no minor issue. For numerous species born in offshore waters of the Atlantic Ocean, it is essential that they successfully migrate inshore from these offshore locations, through coastal inlets, and into estuaries where growth and development are possible. They cannot survive and mature in the open ocean. This group includes such notable species as summer flounder, shrimp, spot, and Atlantic croaker. Summer flounder is a key target species of commercial fishers for which the jetty project is intended to aid.

Oregon Inlet, due to its location, is a key entrance way to Albemarle Sound, Roanoke Sound, and northern Pamlico Sound for planktonic larval fish and invertebrates seeking essential developmental grounds in estuarine waters. The inlet, in many respects, is a last chance at survival for these organisms, since there is little probability that they would survive the journey to other coastal inlets located to the north and south of Oregon Inlet. Any reduction in the number of larvae that migrate through Oregon Inlet and into Albemarle Sound would not be offset by those entering from other inlets, since the hydrological connection between Albemarle Sound and other inlets is only minor. Also, according to North Carolina State University professor Dr. John Miller, Albemarle Sound is under-colonized by larvae. It is therefore likely that any reduction in larvae passed through Oregon Inlet would result in a comparable reduction in fishery production and harvest.

With regard to Page 8 ("Results in brief"), it should be noted that NOAA, in addition to the U.S. Fish and Wildlife Service and the National Park Service, is concerned that the jetties will significantly alter sand movement in the vicinity of Oregon Inlet and damage beaches, dunes, beds of submerged aquatic vegetation, salt marshes, shallow water habitats, and other aquatic sites and resources. NOAA also raised many or these concerns in referring the project to the President's Council on Environmental Quality.

Pages 24-27: "Corps' Economic analysis for the proposed Oregon Inlet Jetty Project has several limitations that undermine its usefulness" and pages 66-69: "Corps analysis of benefits to commercial fishing vessels relied on outdated trip data and excluded certain vessels" NOAA agrees with the GAO that using data from the 1980s to estimate potential benefits results in unrealistic estimates. In support of GAO's findings, we note that since the 1980s, the size of the commercial fishing fleet has declined due to a vessel reduction program implemented by the South Atlantic Fishery Management Council. For this and other reasons, the foreseeable forecast for vessel numbers is one of fewer vessels rather than more.

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Pages 7, 28-29, 69, and 75: Vessel safety and loss of life The GAO report appears to contain conflicting statements regarding inlet safety. Page 28 states, "Corps estimates did not incorporate the economic value of accidental deaths that might be prevented by the proposed project." This statement implies that the Corps' estimate of 14 lives saved during 50 years is valid. However, on page 69 the report states the "Corps' estimates of vessel losses and damages are based on unsupported assumptions and outdated data."

NOAA places the utmost value on human life, and fully supports the goal of safe and reliable navigation. However, we question the Corps' estimates (as does the GAO draft report). We also note that the Corps did not assess the potential loss of life and related economic losses resulting from the presence of jetties. Based on information we examined, it is evident that jetties themselves may serve as a source of injury and accidental death. NOAA recommends that GAO consider revising these sections to address the potential dangers and economic costs that jetties present, and to specify that these considerations also require evaluation.

Page 32: "Two projects are currently performing as planned" NOAA does not agree that the Masonboro Inlet Project is generally performing as planned. Although the GAO report (page 33) accurately describes the many problems associated with the Masonboro Inlet Project, the overall impression is that the jetties are operating as planned, which is clearly not the case. An abbreviated list of problems includes:

- The original project design called for a single jetty with a weir, to be located on the north side of the inlet. After currents undermined the jetty, it was determined that a second jetty would be needed.

- Predicted sand accumulation in the designated sand accumulation basin did not occur but instead, accumulated at the south end of Wrightsville Beach, causing difficulties for vessels entering the inlet.

- Erosion on Masonboro Island, a National Estuarine Research Reserve, and Wrightsville Beach, a high-use municipal beach, are at least accentuated by the project since periodic sand bypassing involves use of heavy equipment and causes considerable disturbance of human and natural uses of the beach.

Additionally, it should be noted that unexpected problems such as those realized at Masonboro Inlet could have far greater consequences at Oregon Inlet where sand volumes, wave energy, and the tidal prism far exceed those at Masonboro Inlet. Further, even though the dredging frequency may be less than anticipated at Masonboro and Murrells inlets, this is still reflective of miscalculation by the COE and should not be regarded as expected or planned performance, even though the outcome is beneficial in these instances.

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Page 23: "Oregon Inlet's high energy environment and the Corps' limited dredging have also reduced the Coast Guard's ability to properly mark the ocean bar navigation channel" NOAA is pleased to note that the GAO addresses the current situation at Oregon Inlet relevant to placement of channel markers (buoys) by the U.S. Coast Guard. Given the location and natural conditions at this high energy inlet, it is likely that the location and depth of navigable waters will remain variable with or without jetties. However, as the GAO report implies, an improved dredging program could improve the ability of the Coast Guard to mark the channel, thereby improving navigation and safety at Oregon Inlet.

Page 15: Editorial comment Because it is describing a statutory definition in this case, NOAA recommends capitalizing the term "Essential Fish Habitat" in paragraph two.

Page 40: Editorial comment To be consistent with the rest of this section, NOAA suggests using bullets to separate the primary points in this section, i.e., habitat impacts, larval migration, and the safety record at Oregon Inlet.

Recommendations

Page 48: GAO Recommendations NOAA supports the recommendations made by the GAO in this report.

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