Boston

Overview

Boston Harbor is the largest seaport in New England. The harbor includes all the tidewater lying within a line from the southern extremity of Deer Island to Point Allerton, about four miles southeastward. Numerous dangers lie in the approaches to the harbor. Islands and shoals, which extend four miles from the entrance, obstruct the northeastern approach, and dredged channels that lead into the harbor lie between the islands and shoals. In the southeastern approach, broken ground extends as much as three miles from shore.

For the purpose of the Boston Ports and Waterways Safety Assessment, the port was defined as the area from the BG entrance buoy (five nautical miles offshore) inward along the North and South Approach Channels, as well as all of the tidewater lying within a line from the southern extremity of Deer Island to Point Allerton.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
Tour / commuter boats want to use docks although additional space is not available. Commercial traffic is moving in the port 24 hours a day, 7 days a week including weekends.	Improve rules and regulations. Establish a VTS. Coordinate vessel movements / dockings in high traffic areas as volume increases. Facility operators and pilots alter steaming schedules of commercial traffic to avoid times of heaviest recreational traffic. Establish regulated navigation areas.
Volume of Fishing & Pleasure Craft	
Volume of watercraft comes from in-water storage in marinas and yacht clubs throughout the port, not trailer launching. Hundreds of recreational boaters during the week, thousands on a good weekend in the summer. Recreational boating traffic (power & sail) is highly seasonal. 50 - 60 yacht clubs as well as marinas throughout the harbor.	Improve rules and regulations. Improve aids to navigation. Change regatta permit approval process – violations result in automatic denial of future regatta permit. Educate boating public to stay out of channels. Recommend that city increase the size of their marine police force to conduct more enforcement. Enforce boating laws, particularly in identified congestion areas. Limit times of recreational boat use in choke points.

Risks	New Mitigation Strategies
Traffic Density	
Congestion areas include anchorage 2 off Deer Island, off Long Wharf, and Rowes Wharf. Barge traffic in vicinity of Spectacle Island (dumping ground for the "Big Dig").	Improve dynamic navigational information. Establish a VTIS. Meetings with Massport Maritime and major shippers to project future ship traffic and impact on ship movements. Meetings with LNG / petroleum facility managers to project future product demands.
Bottom Type	
Hard ledges discovered during dredging in Chelsea River. Hard ledges around Reserve Channel mouth, in approaches to Boston, and across the President Roads main ship channel to just east of the Reserve Channel. Hard bottom in Mystic Channel at the bend. Buoys 13, 15, 17 in south channel are on a ledge. Accuracy of position of sunken barge on edge of President Roads is questionable.	Improve static navigation information. Improve dynamic navigation information. Update charting information.
Waterway Complexity	
Several bends, turns, and intersecting waterways. Sharp bends include Chelsea River entrance, Mystic River entrance, and Hull Gut. Lights on buoys at Boston North and South channel entrances from seaward can cause confusion. South channel was not lit in the past. Converging waterways: • Reserve Channel • Charles River locks should have passing arrangements. Crossing traffic occurs at the eastern end of President Roads. The waterway narrows north of George's Island.	Improve rules and regulations. Improve static navigation information. Improve dynamic navigation information. Establish a VTIS. Encourage the Port Authority to develop a master marine transportation plan taking into consideration limitations imposed by waterway complexity and future waterborne transportation requirements.

Risks	New Mitigation Strategies
Number of People on Waterway	
Number of cruise ships increasing. Around 3,000 cruise ship crew and passengers. Commuter ferry operations occur in the following areas: • Quincy (carries 200 passengers) • Salem (carries 200 passengers) • Cross channel airport ferry from Rowes Wharf • Back River • Hingham Cove Island ferries include Boston Light, George's Island, Lovell's Island, Peddocks Island. Whale watching boats. Booze cruises.	Improve rules and regulations. Improve dynamic navigation information. Establish a VTIS. Evaluate marine rescue and assistance response capability to groundings, collisions, and fires involving passenger craft. Evaluate traffic flow patterns involving / affecting passenger carrying craft.
Volume of Petroleum Cargoes	
If there is a major spill in the harbor, the entire waterway could be closed. Spills rarely occur from tank vessels in transit; usually come from shore facilities or during transfers. However, once in water, petroleum becomes a risk regardless of source. Chelsea River has two restrictive bridges, a narrow channel, and 35' controlling depth -- all of which magnify petroleum specific risks. 80% of cargo is petroleum but only 50% of the transits are petroleum ships. Petroleum terminals include: • Fore River • Towne River • Mystic River • Chelsea River -- preponderance of petroleum terminals Tugs and barges predominantly bring in oil from New York. Lightering from Anchorage #2, President Roads.	Improve rules and regulations. Establish a VTS. Establish a VTIS. Enforce existing certification requirements for operators. Carefully consider design of replacement for Chelsea Street Bridge. Pilots want bridge as is -- have procedures in place; assert that bigger bridge will bring bigger ships. Dredge Chelsea River channel to same depth as rest of harbor. However, pilots want left as is; assert that deeper channel will only bring in bigger ships. Emphasize dockside inspection of pipes, valves, catchments at oil transfer facilities. Verify during inspections that oily water separators are working properly and are being used.

Risks	New Mitigation Strategies
Economic Impacts	
If the port is closed, a 5-day heating oil and 7 - 8 day aviation fuel reserve will be used to depletion. If there is a major petroleum spill in the harbor, the entire waterway could be closed. If the waterway shuts down: • Petroleum terminals all along Chelsea River; terminals typically have a 5 - 6 day supply. • 8-day supply of jet fuel at Logan Airport. • Rail (tank car) and road (tank truck) capabilities are marginal in capability. Impact on tourism includes dollars lost by harbor cruise boats and cruise liners. If commuter boats cannot operate, there will be an increase in automobile traffic problems. Ferries may not be able to visit outlying island communities. If Mystic Lock shuts down, recreational boating and DUCKs are affected. Lobster fisheries in the harbor are impacted if an oil spill occurs.	Improve rules and regulations. Improve dynamic navigation information. Establish VTIS Identify critical parts of channels. Identify and catalog equipment to remove wrecks of selected dimensions based on traffic type through each choke point. Identify timetable to move salvage equipment from staging areas. Identify alternatives to enhance tank car and truck movement of oil.
Health & Safety Impacts	
Drinking water not an issue due to piping from inland reservoirs. Extremely large residential port population. Hazardous chemical activity mainly LNG. Closure of Chelsea River denies heating oil (price and availability) to poor. Water intakes for power plants vulnerable to spills: • Reserve Channel near where cruise liners moor. Mystic River near LNG facility.	Improve rules and regulations. Improve dynamic navigation information. Establish VTIS. Explore alternate logistics solutions for critical cargos such as petroleum products and LNG.

Conclusions

The participants considered the number of people on the waterway to be the number one risk in the port. The number of cruise ships, commuter ferries, and recreational boaters using the port all are increasing significantly. Because of this increase, the most significant short-term consequence is injuries to people.

The volume of petroleum was the second highest risk in the port. The principal petroleum facilities are all on the Chelsea River. A major spill could close that critical portion of the port and force reliance on a 5 - 8 day reserve fuel supply and other modes of oil transportation.

Trends show that the volume of shallow draft vessels and the volume of deep draft vessels are up although the participants still believe these risk categories pose a low to moderate risk to port safety. On the other hand, the volume of fishing and pleasure craft is increasing and currently represents the third highest risk factor for the port. Personal watercraft is restricted from operating in certain areas. However, there is pleasure boat congestion throughout the main ship channel; sailboats, in particular, impede traffic. Thus, significant attention was given to the development of mitigations in these and related risk categories.

The participants believed that the economic impacts within the port are highly important, tying for the third highest risk. Tourism and occupations will suffer only after a few days, and the fuel supplies will deplete in 5-8 days. Also, commuter boats cannot operate in a closed port resulting in an increase in automobile traffic problems.

The participants considered the risks associated with waterway complexity highly important. Visibility obstructions are known and mitigation practices have reduced risk to acceptable levels. Channel width may become a significant risk as the volume of deep draft shipping continues to increase. The participants considered risks associated with the channel and bottom the fifth highest for the port. Hard ledges and depth limits imposed by tunnels and underwater utilities are limiting factors for expansion.

Similarly, the participants considered risks associated with waterway complexity the sixth highest for the port. The port includes sharp bends, converging waterways and considerable crossing traffic. As the volume of traffic increases, traffic management will require careful planning since little can be done to improve waterway configuration. The Chelsea River, with its major petroleum facilities, warrants considerable planning due to the combination of a 90-degree turn at the river mouth, narrow channel, two aging bridges, and restricted depth.

Portland, ME

Overview

The principal approaches to Portland Harbor are the Portland Eastern Approach and the Portland Southern Approach, two unmarked traffic separation lanes which terminate in a precautionary area, thence northwestwards to Portland Head. Each traffic separation lane is approximately twenty nautical miles in length. The precautionary area has a radius of approximately 5½ nautical miles centered on Portland Lighted Horn Buoy P, a large navigational buoy. That buoy is approximately seven nautical miles southeast of Portland Head and is the point where the pilot boat meets inbound deep-draft traffic.

Portland Harbor, at the western end of Casco Bay, is the most important port on the coast of Maine. The ice-free harbor offers secure anchorage to deep-draft vessels in all weather. There is considerable domestic and foreign commerce in petroleum products and general cargo.

The outer harbor comprises the area from Portland Head, bending to the west around Spring Point, up the Fore River to the Casco Bay Bridge. The Casco Bay Bridge, joining the cities of Portland and South Portland, is a drawbridge with a196-foot horizontal clearance between the piers. Transit distance from Portland Head to the Casco Bay Bridge is approximately four miles. The deep draft channel in the outer harbor has a project depth of 45 feet. The outer harbor contains two deep draft anchorages and many commercial docks, including the Portland Pipeline Corporation Pier #2 on the south side of the harbor at Spring Point that handles a steady stream of large tank ships. Several other petroleum facilities line the waterfront on the south side of the harbor. Casco Bay Cruise Lines provides passenger and vehicle ferry service to the inhabited islands in Casco Bay, and the SCOTIA PRINCE ferry provides daily service to Nova Scotia, Canada; both of which use berths on the north side of the outer harbor. Large cruise ships regularly use the SCOTIA PRINCE's pier, particularly in late summer and early fall. A commercial fishing fleet of trawlers also has berths on the north side of the harbor. Several marinas, with associated mooring buoys, are located in the outer harbor. An extensive lobster fishery takes place throughout the port area as well.

The inner harbor consists of the Fore River from the Casco Bay Bridge to the head of navigation at a fixed railway bridge, a distance of approximately one mile. Project depth in the inner harbor is 35 feet. The inner harbor contains general cargo and additional petroleum facilities, which are used by deep-draft commercial traffic.

Northeastwards from Portland Harbor is Casco Bay, which is used primarily for recreational and fishing activities. Approximately six miles northeast of Spring Point lay Cousins Island, on which is a Florida Light and Power generating station. That facility receives petroleum fuel products via barges entering Casco Bay through Bussey Sound.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Fishing vessels sink, leak oil, and pollute the port. Fishing vessel operators under the influence of drugs and / or alcohol Recreational and fishing vessel operators do not have to meet any minimum qualifications. Huge number of kayaks and other small boats are being sold and used on Portland area waterways. Difficulty seeing kayaks and other small boats. Training / knowledge of kayak / small boat operators is an issue. Small boats not required to listen to marine channels. Small boats may not realize the capabilities and limitations of deep draft vessels.	Improve communications. Improve rules & regulations. Improve static navigation information. Improve dynamic navigation information. Support legislation to require licenses for recreational boat operators in Maine. Conduct public awareness campaign on rules of the road. Actively enforce Rules of the Road rule 9, especially in Spring Point / Fish Point area. Continue to distribute *Big Ships. Little Boats.* pamphlet via marinas; disseminate pamphlet to other ports in the COTP zone.
Volume of Deep Draft Vessels	
There are approximately 45 large passenger vessel visits annually. • Portland has the highest number of international cruise passengers in New England. Approximately 1,300 deep draft vessel movements per year. • Also approximately 650 deep draft inter-harbor movements. • A deep draft vessel is passing Portland Head about every 6 hours. Vessels sometimes need to anchor out of port while awaiting an open berth. Port capacity is constrained by shore-side infrastructure.	Improve static navigation information. Improve dynamic navigation information. Establish a VTS. Encourage tighter scheduling of tanker arrivals to avoid anchoring in exposed location off-shore while awaiting berth in port.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
Casco Bay Ferry operating year-round, all-weather, frequent service to islands throughout the port area. Portland is a good place to sell catch even if it is not the fishing vessel's homeport. • 55 million tons of fish landed in Portland annually. Portland does not have high speed craft operating at the present time.	Improve rules & regulations. Improve dynamic navigation information. Establish a VTS. Encourage adoption of Automated Identification System (AIS) technology by off-shore fishing vessels using the Port of Portland. If high speed ferry service is established, promulgate and advertise operating lanes like what was done for Frenchman's Bay. For high speed ferries, consider additional speed restrictions based on traffic density and weather conditions.
Volume of Fishing & Pleasure Craft	
Pleasure craft volume seasonal (May through September). 800 recreational berths plus 1,000 moorings in the port. Marinas are at maximum capacity. • This somewhat restricts the number of recreational vessels. Majority of marina locations are in vicinity of the harbor entrance. • Four marinas are in South Portland. • Two marinas are on the north side. • One small marina located in inner harbor. • One marina on Great Diamond Island. • One marina on Peaks Island. Two active boat ramps are Eastend Beach and Spring Point. Most recreational vessels operate in Casco Bay. Falmouth shore has a number of docks and moorings.	Improve communications. Improve rules & regulations. Increase dynamic information about port conditions / vessel movements on web sites. Place cameras linked to a website in various locations around the port to record and broadcast real-time information. Encourage future marina / boat launch ramp development to be in area north of Fish Point to minimize conflicts with commercial traffic.

Risks	New Mitigation Strategies
Traffic Density	
Recreational traffic increases May through September. Wednesday between 1600-1830 sailing races in channel between Spring Point and Fish Point conflict with deep draft / Casco Bay ferry traffic. Cruise ship traffic increases August through October. • Vessels arrive early in the morning and depart in the evening. • Departures conflict with sailing races. Lobster fishing increases dramatically throughout the harbor in the summertime. 4th of July fireworks festival. Diamond Cove is a risk area in summertime due to high volume of recreational vessels and limited movement area.	Improve rules & regulations. Improve static navigation information. Restrict deep draft traffic movements on Wednesday evenings to de-conflict with sail races or relocate sail races to the north of Fish Point to de-conflict with other traffic. Conduct Share the Waterways campaign to increase awareness. Continuously broadcast local notice to mariners on a specific marine channel.
Channel Width	
Inner harbor is narrow for deep draft vessels. Eastern Approach Channel too narrow for two deep draft vessels approaching each other. Channel width may be an issue with tugs / tows meeting in vicinity of Catfish Rock / Portland Head.	Improve aids to navigation. Improve communications. Improve rules & regulations. Improve dynamic navigation information. Encourage installation of AIS technology on all applicable commercial vessels visiting Portland.
Waterway Complexity	
90-degree bend in deep draft channel around Spring Point. In the past, Casco Bay Bridge has not always opened reliably on demand. Recreational boaters from Spring Point are crossing shipping channel and heading north or east. Casco Bay ferries also crossing traffic in a gradual manner. Hussey Sound / Soldier Ledge area may see crossing traffic between recreational vessels, ferries, and tugs.	Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Increase static port information on web sites. Discourage establishing new marinas or boat launch ramps on the south side of the harbor.

Risks	New Mitigation Strategies
Number of People on Waterway	
Typical Casco Bay ferry averages 250-300 passengers. Cruise ships average 3,500-4,000 passengers and crew. SCOTIA PRINCE averages 1,400-1,500 passengers and crew. Dinner cruises average 150 passengers. Whale watching excursions average 20-49 passengers.	Improve dynamic navigation information. To adequately test preparedness, minimize simulation during SCOTIA PRINCE mass rescue exercise. Review adequacy of contingency plans for firefighting and mass rescue involving a large cruise ship.
Volume of Petroleum Cargoes	
Petroleum is the largest volume commodity moving into the port with 30-35 million tons per year. The majority of marine petroleum terminals are on south side of port. On average one ship per day enters the port carrying 700,000 barrels of petroleum.	Improve aids to navigation. Improve communications. Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Improving marine fire fighting capability.
Economic Impacts	
Impact of sudden closure of port would be felt within days. Most of the oil terminals are located close together, likely that if one terminal were impacted they all would be impacted. Several weeks supply of JET-A fuel on hand; airport would not be significantly impacted. Islanders would be immediately affected: • Shipments of food and other necessities could be stopped • They may not be able to get to work on the mainland Casco Bay Ferries would be immediately affected. Ports to the north and south cannot handle diverted traffic if Portland closes. (continued on next page)	Improve rules & regulations. Establish a VTS. Develop a closed port contingency plan for heating oil / gasoline, conduct training, and hold a port contingency exercise to make sure plan works.

Risks	New Mitigation Strategies
Economic Impacts (continued)	
Oil tank farms would be empty within a week. • Exact amount of reserves depends on time of year • Majority of fuel used in the region comes from bulk shipments imported through the port • Heating oil for all of northern New England comes through this port The surrounding area would be impacted as prices would rise and quantity would drop dramatically. Tourism would be impacted as gasoline prices rise.	
Environment Impacts	
Endangered or sensitive species found in the Scarborough and Port Elizabeth area include piping plovers, least terns, and roseate terns. Important nesting sites and water fowl habitats as well as sensitive marshes and flats are located in the following areas: • South of Port Elizabeth • Ram Island • Fore River past inner harbor • Back Cove • Cousins Island Tourist beaches are not located in immediate port area but are in the vicinity.	Improve rules & regulations. Establish a VTS. Continue review and action planning process through Area Contingency Plan sub-committees.

Conclusions

The participants evaluated traffic conditions to be the highest risk category. All four risk factors in this category were evaluated as being at moderate levels. The volume of deep draft ships, particularly tank ships and cruise ships, is expected to increase. The amount of fish being landed in Portland from shallow draft commercial fishing vessels also is expected to increase, as is the Casco Bay ferry traffic to the islands. In addition, high speed ferry service is being contemplated. The participants considered risks associated with the volume of fishing and pleasure craft to be the highest risk factor in this particular

risk category. Included in this risk factor were lobster boats but not offshore trawlers. A new marina is being proposed near Back Cove, a new sailing school will be opening, and a growing population of Casco Bay island residents are using their own boats for commuting to work in Portland. Increasing volumes of traffic of all types will increase traffic density risks. Proposed infrastructure improvements will move the SCOTIA PRINCE, Casco Bay ferries, and the cruise ship berths to the site of the old Bath Iron Works drydock and ship repair facility, next to a marina, across the harbor from a second marina and the Portland Pipeline Corporation tank ship dock. Still, additional planning and communication will be necessary in order to ensure that current mitigations and proposed interventions are comprehensive enough to ensure that these risks in these areas are minimized.

The participants considered the waterway configuration risk category a major concern. This was driven by waterway complexity and channel width risk factors. There are three locations in the port area (i.e., Eastern Approach Channel, vicinity of Catfish Rock off Portland Head, and the inner harbor) where a voluntary one-way traffic rule is observed by deep draft and tug / tow traffic because of the channel width. The participants discussed risks associated with waterway complexity. The port includes one 90-degree turn at Spring Point, converging waterways, restricted turning basins, considerable crossing traffic, and a number of unpredictable recreational boaters. The marinas on the south side of the harbor sponsor sailing regattas that use the main channel buoys between Spring Point and Fish Point as turn marks. In spite of general perceptions, participants said that the bottom type in many areas of the port was mud and silt, not rock, and relatively forgiving of excursions outside the channel. Nonetheless, proposed interventions will include dredging projects and other waterway improvements.

Volume of petroleum is the highest risk factor in this port. Volume moving in the harbor is 30 – 35 million tons annually and increasing. On average, one ship per day enters the port carrying 700,000 barrels of oil. The number of people on the port's waterways also is a significant risk factor. This is a reflection of the considerable ferry operations and increasing numbers of cruise ships visiting Portland. There are no chemicals being moved in bulk in the port, making that the lowest-ranked risk factor.

Economic impacts follow closely behind volume of petroleum as a high risk factor. People living on the Casco Bay Island are immediately impacted by a sudden port closure. Oil tank farms would likely be empty within a week, affecting the entire Northern New England region. Ports to the north and south and alternative transportation modes (i.e., truck and rail) do not have the capacity to handle diverted traffic and the flow of cargo. Refineries in Canada are dependent on the oil pipeline whose terminus is in Portland.

Environmental impacts is a moderate risk factor for the port. Nesting areas, waterfowl habitats, and endangered species are located in or near the port area.

Baltimore

Overview

The Chesapeake Bay is the largest inland body of water along the Atlantic Coast. It is 168 miles long and 23 miles wide at its greatest width. The bay is the approach to Baltimore and many lesser ports. Deep-water vessels use the Atlantic entrance. Medium draft vessels can enter from Delaware Bay on the north via the Chesapeake and Delaware Canal.

The Canal is a sea-level waterway maintained and controlled by the U.S. Army Corps of Engineers. The Federal project provides a channel 35 feet deep and 400 feet wide. Tides average 5.5 feet on the east end and three feet on the west. The current floods at 2.6 knots and runs 2.1 knots on the ebb tide. Many traffic regulations are imposed for transit of the canal to ensure safe passage.

The two spans of the William P. Lane Memorial Bridge (Chesapeake Bay Bridge), 130 miles above the Virginia Capes are 3.7 miles shore-to-shore. The bridge is a major bay landmark and vehicular traffic artery. Its center span width is 1,500 feet with a clearance of 186 feet. Lights, fog signals, and a RACON mark the bridge.

The bay is environmentally sensitive as a breeding ground for many species of birds, fish, and shellfish in its many tributaries and wetlands. An immense population of recreational boaters shares the waterway with a declining commercial fishing fleet, and a moderate number of commercial tank and cargo vessel operators.

There are few hazards to navigation on the bay and the bottom is generally sand or soft ground. USCG, state, and private groups maintain aids to navigation throughout the bay.

Baltimore Harbor consists of the entire Patapsco River and its tributaries; a part of the waterfront thus included lies outside the municipal limits of Baltimore, but is within the jurisdiction of the Maryland Port Administration for the physical operation of the harbor and use of public wharves and piers. The City of Baltimore is at the head of tidewater navigation on Patapsco River. The mid-harbor point, at the intersection of Fort McHenry and Ferry Bar Channels is eight miles from the mouth of the river, 150 miles above the Virginia Capes and 62 miles from Delaware River. The Francis Scott Key Bridge spans the Patapsco about halfway to the river's mouth with a clearance of 185 feet.

Baltimore has more than 200 piers and wharves. Principle imports are general cargo, crude petroleum and petroleum products, iron ore, chrome and manganese, gypsum, lumber, motor vehicles, fertilizers, sugar, and bananas; exports are chiefly general cargo, grains, metal products, coal, and chemicals. Coastwise receipts are crude petroleum and petroleum products, fertilizers, sulfur, sugar, and lumber.

General, dead ship, and small craft anchorages are in Baltimore Harbor. Federal project channels are: 50 feet in the main channel between the Virginia Capes and Fort McHenry, Baltimore; thence 42 feet in Ferry Bar Channel; thence 49 feet in Northwest Harbor West Channel and turning basin; and 50 feet in Curtis Bay Channel. The Federal project in the

main channel between the Delaware Capes and Baltimore via the Chesapeake and Delaware Canal is 35 feet.

Pilotage is required for foreign and U.S. vessels registered in foreign trade bound to or from Baltimore. Pilotage is optional for coastwise U.S. vessels carrying federally licensed pilots. Pilots are available from several organizations in the tributaries of the Chesapeake, the District of Columbia and Chesapeake and Delaware Canal.

The mean range of tide is 1.1 feet, but prolonged winds of constant direction may cause substantial variation in the tide. Currents in the harbor are generally 0.8 knots on the ebb and flood. Baltimore's climate is moderate. Rainfall is rather uniformly distributed throughout the year. Thunderstorms can bring hurricane force winds, and the greatest damage by hurricanes is that produced along waterfronts and shorelines by the high tides and waves. Baltimore Harbor and Chesapeake tributaries can freeze during severe winters, but icebreakers and larger ships generally keep the dredged channels open.

The upper Potomac River in the vicinity of Washington, D.C. is 95 miles above the mouth of the Potomac. The river carries petroleum products, aggregates, newsprint, and fertilizers. The federal project depth is 24 feet to Hanes Point. Vessels go to the wharves, due to lack of sufficient anchorages. The mean range of tide is about three feet, but the tide and river current is greatly affected by wind and freshet conditions. Ice can close the river to navigation during severe winters, but generally powered vessels keep the channel open. Pilotage is required as noted above.

The Severn River, the approach to Annapolis, Maryland, empties into the Chesapeake 127 miles above the Virginia Capes. Commercial traffic chiefly consists of petroleum products and fish and shellfish. Naval craft and many pleasure craft use the river. The main channel depth is 15 feet and is well marked to Annapolis. The mean range of tide here is one foot with currents seldom over ½ knot.

Risks	**New Mitigation Strategies**
Volume of Fishing & Pleasure Craft	
Waterway conflicts occur on weekends with high recreational boat use. Over 200 special events occur between April - October. USCG permits number 120 a year. Concentration of recreational boats fishing / sailing at the Bay Bridge leading to ship / boat conflicts. The rivers are saturated with boat traffic. At Mattawoman / Dundee Cr. extra parking and ramps were added for the bass tournaments (26 per year) with 150 boats each. (continued on next page)	Improve rules & regulations. Consider the concept of small craft traffic separation lanes in highest density areas. Harbor Safety Committee (or equivalent) work with state, local, federal governments to effect solutions: • Enforce existing laws • Increase state / local law enforcement presence targeting high risk times / areas • Establish / enforce no wake zones • Encourage boating education • Support mandatory licensing

Risks	New Mitigation Strategies
Volume of Fishing & Pleasure Craft (continued)	
Greatly increased boat use on the Potomac River. Hart-Miller Island a popular destination. Annapolis & Baltimore Harbors, Severn, Gunpowder, South and Middle Rivers have exceeded capacity of the waterway. Dock-bars at Middle River and Solomon's Island. Offshore power boat race created a monster headache for ships that have to delay transits. Whitbread race two-week event from Baltimore to Annapolis. Inner harbor development increased Baltimore marina capacity 3 times more over 15 years on the upper Patapsco River and is moving out toward the marine terminals.	
Traffic Density	
Summer weekends are the only problem. Tuesday sailboat race at Seagirt impedes deep draft traffic in the channel. Conflict of various small boat users versus ships at the mouth of C&D Canal. Fishermen gathered around buoys obscure them. Mix of small boats, paddle boats at Baltimore's inner harbor. Bloody Point to Bay Bridge is carpeted with sailboats on a summer weekend. Annapolis sailboat races draw large fleets with little regard for commercial traffic safety.	Improve rules & regulations. Establish a VTIS. Establish local ordinances for jet skis defining where jet skis may / may not operate. Specifically address distance from piers & docks and distance from ships in channel. Regatta area set-asides, scheduled like softball / soccer fields. Control access to launching ramps in high-density areas to those boaters with proof of boating safety education.

Risks	New Mitigation Strategies
Waterway Complexity	
Hard east and west turns at Town Point on Brewerton East Extension Channel. BMI shipbuilding at Sparrows Point has a private channel with federal aids. Transit requires local knowledge and is used by 1,000-foot ships. Intersecting traffic at Brewerton, Tolchester, and Swan's Point channels requires planning. Dredging operations also increase the complexity of navigation throughout the port area. Cross-channel traffic: • Water taxis inside of Baltimore's Lazaretto Point and across C&D Canal. • Sailboats routinely crossing. • White Haven, Woodland and Trent Avon ferries. Hydrilla water plants in the Potomac River can affect navigation of recreational boaters and can cause ships to lose cooling water. Kent Narrows dogleg is a blind passage through two bridges. A mad rush of uncontrolled boat traffic ensues when the bridge is opened. State highway administration controls the bridge but will not take risk of liability by controlling traffic.	Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Facilitate resolution of boat traffic chaos at Kent Narrows associated with bridge openings.
Economic Impacts	
The ILA works 2 million man-hours in support of port activity. $6-7 million per day would be lost or deferred with any port closure. Local salvage vessels are not sufficient to resolve a port closing caused by a grounded vessel. Closest commercial resource is in New York about 2 days away. (continued on next page)	Improve rules & regulations. Improve dynamic navigation information. A Harbor Safety Committee effort to address mitigation of events that are likely to close the port to navigation: • Obstructions caused by bridge failure or terrorist act (continued on next page)

Risks	New Mitigation Strategies
Economic Impacts (continued)	
• Norfolk USN salvage equipment might be available • Tugs would come from Philadelphia in 9 hours to resolve less severe ship groundings Impact from a sudden closure begins immediately, affecting the maritime community servicing the port. Most carriers will look for alternative ports if the closure is greater than 72 hours, and it increases their costs significantly. Closed shellfish beds impact the fishing community immediately with longer-lasting public perceptions. • Grounding on an oyster bed can eliminate the bed forever A natural resource damage assessment can result in unlimited liability to polluters in addition to the cleanup costs. These are significant economic impacts. Baltimore's planning commission cannot control all the growth, and consequently the impact of growth upon the port. Lightering is not immediately available in the port.	• Grounding or spill of severely hazardous chemical cargo-carrying vessels Develop lightering capability.
Environment Impacts	
Very high concern for environmental affects throughout the Chesapeake Bay and Potomac River. Wetlands, estuaries, breeding grounds are highly vulnerable. The effects of a pollution incident also depend on the time of the year and material spilled. Scientists are unable to assign priorities within the region because everywhere is so sensitive. Eagles breed at the Aberdeen Proving Ground. Floods float barrels into the area with pollutants in them. No one really knows what's on the grounds. Estimates range from 3-30 million rounds of unexploded munitions. (continued on next page)	Improve rules & regulations. Improve dynamic navigation information. Review existing exercise plans, contingency plans, and stockpiled containment & cleanup equipment for adequacy. Periodically sample water at potential source of spill areas and at sensitive habitats for baseline data. Improve response command & control through tabletop exercises & limited field exercises. Determine what bay current models exist.

Risks	New Mitigation Strategies
Environment Impacts (continued)	
There is an environmental focus on Smith and Tangier Islands. A governor's task force identified that oil spill response command & control and planning were weak. • Response capabilities tested by the PEPCO spill showed chaotic response. OPA 90 planning in this area is far behind the West Coast in numbers of planners and commitment by the states.	
Health & Safety Impacts	
Calvert Cliffs nuclear power plant is located near Solomon's Island. The population in the port area is about 2.5 million people. Most drinking water is drawn from reservoirs except for intakes above Great Falls on the Potomac River. Cooling water is drawn from Morgantown (Route 301 bridge). There are cooling water intakes outside the Key Bridge.	Improve communications. Review exercises schedule; conducting those plans needed to validate emergency action plans. Ensure emergency evacuation plans are effective. Consider sheltering the population "in place" from toxic plumes. Locate future hazardous facilities away from population centers.

Conclusions

Environment and economic impacts were the two highest risk factors for the port. Between $6-7 million dollars a day would be lost with a port closing. If the port were closed for more than 72 hours, most carriers would look to alternate ports to conduct business. Baltimore does not have the sufficient resources to resolve a port closing due to a grounded vessel. Also, attention should be given to the development and implementation of mitigation strategies to prevent the destruction of the natural surroundings and quality of life on the waterway.

Volume of fishing and pleasure craft and traffic density were the third and fourth highest risk factors. Due to the varied nature and location of the Chesapeake Bay, seasonal and weekend vessel traffic is heavy. Recreational boaters frequently disobey rules and regulations. Further, because of the vastness of the waterway, it is difficult to enforce rules and take corrective actions on every offender. Coordinated vessel traffic movement and increased enforcement of rules and regulations should minimize risk in these areas.

Hampton Roads

Overview

Chesapeake Bay, the largest inland body of water along the U.S. Atlantic coast, is 168 miles long with a greatest width of 23 miles. The bay is the approach to Norfolk, Newport News, Baltimore, and many smaller ports. Deep draft vessels use the Atlantic entrance, which is about 10 miles wide between Cape Charles to the north and Cape Henry to the south. They are generally given the collective name of "the Capes." The Capes are low sandy coastlines that experience continual shoaling of the offshore waters. Light draft vessels also can enter directly into Norfolk from the south via the Intracoastal Waterway.

A traffic separation scheme provides for inbound-outbound traffic lanes to enter or depart Chesapeake Bay from the northeast or southeast. These buoyed traffic lanes converge upon a precautionary area with a radius of two nautical miles centered on Chesapeake Bay Entrance Junction Lighted Gong Buoy CBJ. The southeasterly approach traffic lanes are separated by a 50-foot deep water-route intended for deep draft vessels and naval aircraft carriers entering or departing Chesapeake Bay. Federal project main channel depths are 50 feet from the Virginia Capes to Baltimore and 55 feet from the Capes to Hampton Roads.

Pilotage is required for all foreign vessels and for U.S. vessels under register in the foreign trade, and is optional for U.S. vessels in coastwise trade if they have a federally licensed pilot for these waters on board. Three pilot associations service this waterway. Pilots generally board ships in the precautionary area. Masters and pilots of single hull tank ships are required to follow an underkeel clearance policy established by the local COTP.

The Chesapeake Bay Bridge-Tunnel extends across the bay entrance. The 15-mile crossing has vehicular tunnels under Chesapeake and Thimble Shoal Channels connecting to fixed bridges. This complex has suffered damage from vessels driven by strong northwest winds related to frontal systems.

Lynnhaven Roads is an open bight west of Cape Henry at the very south end of Chesapeake Bay. Within its bounds lie Lynnhaven Inlet, which is subject to very heavy boat traffic, and Little Creek, where the U.S. Naval Amphibious Base, marinas, and a Coast Guard Station are located.

Approaching Hampton Roads from the east, Thimble Shoal Channel extends from about 9.5 miles west-northwest of the Capes in a 55 foot channel that has a 32 foot deep auxiliary channel alongside. Thimble Shoal Channel is a regulated navigation area that excludes vessels drawing less than 25 feet from transit except for those crossing the channel.

Hampton Roads, at the southwestern corner of the Bay, is entered 16 miles west of the Capes. It includes the Port of Norfolk, which includes the cities of Norfolk, Portsmouth, and Chesapeake, and the Port of Newport News, which includes in the cities of Newport News and Hampton. Hampton Roads is the world's foremost bulk cargo harbor. Coal,

petroleum products, grain, sand and gravel, tobacco, and fertilizer constitute 90 percent of the cargo moved by water, although general cargo tonnage is increasing. Movements by U.S. naval ships equal commercial traffic. The port is free of ice. Tides range about 2½ feet, and currents throughout are about 1 knot. Numerous general, explosives, naval, and small craft anchorages are within the harbor. The port has a large fleet of naval and commercial tugs to assist ship movements.

Two channels lead through Hampton Roads. Leading southward from Sewells Point, the Elizabeth River and its Eastern and Southern Branches are the major waterways. Norfolk Naval Base, many wharves including Norfolk International Terminal (NIT), and Norfolk's popular tourist area, Waterside, occupy the eastern side of the channel. The city of Portsmouth is located on the western side of the Elizabeth River as is the Norfolk Naval Shipyard and Portsmouth Marine Terminal (PMT). A navy fuel depot is on Craney Island. Craney Island is being expanded with dredge spoils for future commercial use. The Southern Branch connects to the Intracoastal Waterway and thence to Albemarle Sound. Several rail and highway bridges cross both branches.

Newport News Channel is the second deep-water channel leading through the harbor. About 21 miles from the Virginia Capes on the north side of Hampton Roads, Newport News and Hampton are home to Newport News Shipbuilding and Drydock Company, Newport News Marine Terminal (NNMT), deepwater piers and wharves, and a city-owned small boat harbor. Newport News Point is also the entrance to the James River. A bridge-tunnel complex crosses Hampton Roads from Newport News to Suffolk.

Commercial navigation on the James River extends 74 miles to Richmond's Deepwater Terminal. Traffic consists chiefly of general cargo, sand and gravel, phenol, sulphur, petroleum, fuel oil, livestock, tobacco, and paper products. The Federal project for the James River provides 25 foot depths to the Richmond Deepwater Terminal. Tides range at about 3 feet. Freshets occur irregularly; their height at Richmond ranges from 6 to 32 feet. Of note along the river are the U.S. Maritime Administration's Reserve Fleet of mothballed ships and Surry Nuclear Power Plant.

The Chesapeake Bay Main Channel trends northward from the Capes with a federal project depth of 50 feet to Baltimore. The York River is on the western shore of the bay 26 miles northwest of Cape Henry. Traffic on the York River consists chiefly of pulpwood, petroleum products, military supplies, and shellfish. Notable installations along the river are the Amoco / BP petroleum refining facility, the Yorktown Naval Weapons Station, and Naval Supply Center (Cheatham Annex Depot).

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessel	
Recreational operators are inexperienced and uninformed. • Dangerous interactions with dredging operations. The material condition of uninspected vessels is notably poorer. • 90% of CG responses are to uninspected vessel casualties • Tug and barge allisions are frequent • Lower operator experience and machinery casualties are causing accidents Many recreational boats are not well maintained, especially those boats trailered into the area. • Use of non-marine components for mechanical / electrical replacement parts creates additional explosion hazards • Are not required to have, or often do not monitor, marine radios for important safety information Small boats may not realize the capabilities and limitations of deep draft vessels.	Improve rules & regulations. Establish a VTIS. Support legislation requiring education or licenses for recreational boat operators. Conduct public awareness campaign on rules of the road. Actively enforce Rules of the Road rule 9 (Narrow Channels). Consider adapting and distributing Portland's (ME) *Big Ships. Little Boats.* pamphlet.
Volume of Shallow Draft Vessels	
Tug & tow volume receding because less cargo is being shipped, with a notable decline this year. Commercial fishing is declining because of reduced fish stocks. Dinner cruise traffic is steady. A new boat was added this year in Norfolk.	Improve communications. Improve rules & regulations. Establish a VTIS. Establish a VTS.

Risks	New Mitigation Strategies
Volume of Fishing and Pleasure Craft	
Skyrocketing numbers of recreational boats. • New marinas and dredging in Little Creek create an attractive waterway Heavy spring & fall transient boat traffic on the ICW is increasing. • Lock transits bunch them together • Speeding to make the next bridge opening increases risk of collisions Fishing tournaments based from Little Creek, but do not interfere with commercial traffic. Recreational boat wakes create dangerous conditions for the dinner cruise ships. Conflicts between deep draft vessels and recreational fishermen in channels. • East end of Newport News Channel • Monitor-Merrimac Tunnel • James River Bridge	Improve rules & regulations. Establish a VTIS. Increase information about port conditions / vessel movements on web sites. Enforce Rules of the Road Rule 9 (Narrow Channel) violations.
Traffic Density	
Storms drive boats into Lynnhaven's safe harbor. • Dangerous conflicts at the bridge Fourth of July fireworks: • Portsmouth & Norfolk, York River • After-the-event mayhem ensues • Conflicts with commercial traffic ICW boat traffic is congested from Gilmerton Bridge as far north as Lambert Point. Trailered boats drawn by festivals & special events The locking process consolidates boat traffic, which then bolts into the waterway and races away.	Improve communications. Establish a VTIS. Establish a VTS. Consider possibility of widening the channel at the Lynnhaven Bridge to allow safer transits. Improve coordination of ship movements at times when there is a large recreation boat fleet assembled for an event. Consider establishing additional speed limit zones on the Southern Branch.

Risks	New Mitigation Strategies
Waterway Complexity	
Intersecting channels at: • Town Point Reach / Eastern Branch • ICW / Southern Branch • Norfolk Harbor Reach / Newport News Channel / Entrance Reach • York River / Chesapeake Ship Channel Crossing traffic at: • Downtown Norfolk has three ferries crossing the waterway • Ferry from Little Creek to Cape Charles crosses Thimble Shoals and Chesapeake Ship Channels Major bends in channels: • Gilmerton (Elizabeth River Southern Branch) • Thimble Shoal / Sewells Point • All of the James River	Improve communications. Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Target enforcement activities where there are potential conflicts between waterway users, e.g., intersections, major bends, ferry crossing points.
Volume of Petroleum Cargoes	
Yorktown BP / AMOCO facility receives weekly shipments of about 555,000 bbls of crude. • Use G anchorage to lighter tankers ITBs carry 150,000-500,000 bbls shipments biweekly. Craney Island is a major transshipment point from a Texas pipeline and also receives 5-6 tankership deliveries per year. 6 Military Sealift tankers homeported here, each with 7.5 million gallon capacity; also go to the shipyards for overhauls. Tank barge traffic is about 5% of total. Steady flow on York River. Some coastwise and bunker-barge movements through the area from Southern Branch of Elizabeth River. Barge traffic to Richmond & Chesterfield Power plant. Some shoreside storage and transfer locations.	Improve rules & regulations.

Risks	New Mitigation Strategies
Economic Impacts	
Port is vulnerable to bridge closures on the Southern Branch. High potential for this to occur at the Jordan Bridge. Other bridges are well maintained. • Immediate impact; every day = $100,000 in lost commerce below the Jordan Bridge • City of Chesapeake was asked for a Jordan Bridge failure plan. • Heavy lift resources from outside the area would be needed to resolve a bridge failure Closure of the port at Sewell's Point would have an immediate impact on payrolls, the movement of goods, and perhaps national security. The area's dependence on marine transportation is high. Yet, there seems to be a higher concern for smooth vehicular traffic flow over bridges. Truck and rail modes are not readily available to divert cargoes. NAS Oceana receives aviation fuels by barge.	Improve communications. Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Develop a multi-scenario closed-port contingency plan.
Environment Impacts	
High vulnerability and environmental sensitivity of the entire Chesapeake Bay watershed. Wetlands and breeding areas are abundant in all areas of the port. Endangered turtles, whales, dolphins, fishes, birds, blue crabs & oysters • James & Rappahanock Rivers • Elizabeth River (eastern branch) • The Yorktown area is especially sensitive • Lynnhaven & Little Creek Residential development along the waterway heightens awareness of well-heeled citizenry to environmental problems. (continued on next page)	Improve communications. Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Continue review and action planning process through Area Contingency Plan sub-committees. Periodically test water quality in sensitive habitats or areas vulnerable to spills. Encourage more multi-agency training and exercises.

Risks	New Mitigation Strategies
Environment Impacts (continued)	
East Coast has done far less environmental response planning than the West Coast. Similarly, resources allocated to environmental planning and response are far less than the West Coast. Available response capability is inadequate to the worst-case scenarios of a spill in the York & James Rivers or the Chesapeake Bay. Smaller companies hire out planning and response, and therefore are not familiar with their plans or how to implement them.	
Health & Safety Impacts	
About 1.5 million people live in the Hampton Roads area. Limited evacuation capability, with an associated fear-factor adding to the numbers of people trying to evacuate.	Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Evaluate adequacy of contingency planning throughout the port, especially emergency evacuation planning.

Conclusions

Environmental impacts is the highest risk category for the port. The rivers and that portion of the Chesapeake Bay within the port contain wetlands and breeding areas essential to many endangered species. Residential development of the shoreline increases general awareness of environmental concerns and places people directly at risk in the event of a major marine accident. Add to this the general sense of the group that emergency response planning needs more attention, and that the size and nature of the port precludes immediate response and pre-positioning of response resources everywhere an accident is possible.

Economic impacts is the second highest risk factor. This reflects the area's dependence upon marine transportation and its vulnerability to bridge closures. Closure of the port at Sewells Point would have an immediate impact on payrolls, movement of materials, and perhaps national security. The large military presence makes the entire port an attractive terrorism target. Even so, no specific intervention was sited to address this factor. The risks associated with health and safety impacts were moderate, generally reflecting the size of the surrounding community and the limited ability to readily evacuate the population.

Waterway complexity also is a high risk factor. There are four intersecting channels, two areas of crossing traffic, and three major bends in channels in the heart of the port of Hampton Roads. The port includes two 90-degree turns in the Elizabeth River Southern Branch at Gilmerton that is made more troublesome by two bridges with narrow spans that cross the river there. Deep draft vessels observe a voluntary one-way traffic rule on the James River. Several blind spots are located on the Elizabeth River or its tributaries, and background lighting obscures navigation at the Naval Station, Waterside, and Portsmouth Marine Terminal. The bottom type in most areas of the port is mud. Additional mitigation strategies such as improved communications, increased awareness and cooperation are necessary to minimize risks.

Volume of deep draft vessels, shallow draft vessels, and fishing and pleasure craft are moderate risk factors in the port. The volumes of coal shipments, tug & tow traffic and commercial fishing are receding. Container ship traffic fluctuates with the market. Naval traffic accounts for about half of ship movements, at times needing the entire waterway for fleet movements. Recreational boating is increasing dramatically, with conflicts of deep draft vessels in the channels. Boat traffic is expected to double in Little Creek, and also has been increasing on the Intracoastal Waterway. Large cruise ships are slated to begin calling on Norfolk.

Charleston

Overview

The entrance to Charleston Harbor is between converging jetties which extend nearly three miles seaward. The distance from the seaward end of the jetties to the southernmost wharves in Charleston is about seven miles. The Intracoastal Waterway (ICW) crosses Charleston Harbor inland of Sullivans Island and James Island at a point about 2 miles inward from the terminus of the entrance channel. Pilotage is compulsory for all foreign vessels and for U.S. vessels under register in the foreign trade. Pilotage is optional for U.S. vessels in the coastwise trade that have on board a pilot licensed by the U.S. government.

The tide range in Charleston is 5.2 feet in most locations. Maintained channel depth is currently 42 feet through the entrance channel and 40 feet inside the harbor. An USACE project is underway to deepen the entrance channel to 47 feet and the harbor to 45 feet. This project should be completed in 2002. Channel widths vary from 600 feet to 1,300 feet. Inside the bay, channels are well marked by buoys, fixed aids, and ranges. The bottom is generally soft mud referred to locally as "liquid mud." The topography of the entire harbor area is nearly flat and at sea level.

Risks	New Mitigation Strategies
Volume of Deep Draft Vessels	
Number of calling deep draft cargo vessels expected to increase. Future vessels expected to be longer, wider and higher (air draft).	Encourage expert-stakeholder group to monitor and propose mitigations if risk level changes.
Volume of Fishing & Pleasure Craft	
Numbers of pleasure craft increasing. Recreational boats now being leased, adding to the volume by making acquisition less costly. Recreational boats tend to tie off to jetties, bridges, and aids-to-navigation while fishing and shrimping creating hazards to other vessels due to inability to see the moored vessels. Small craft frequently block the channel and cause deep draft vessels to sound danger signals. Some small craft ignore deep draft vessel sound signals. Recreational boaters do not seem to know (or care) where the hazards are.	Encourage expert-stakeholder group to monitor and propose mitigations if risk level changes. Increase educational and enforcement efforts including coordination with local law enforcement agencies.

Risks	New Mitigation Strategies
Traffic Density	
Arriving vessels tend to "stack up" near the sea buoy awaiting pilot boarding to meet tight liner schedules. Recreational fishing vessels converge at the jetties on Saturday mornings during fishing season. Large volume of commercial boats leave for offshore fishing grounds at first light. Spectator fleet at marine events increases density of traffic in the immediate area of the events. Popularity of waters near Fort Sumter causes high density of recreation and commercial tour boats in an area shared with commercial traffic and where waterways (ICW and main ship channel) converge. Small craft using Wappoo Creek boat ramp increase risk by failure to yield to encumbered vessels in an area where a bridge crossing and strong currents impose difficulties for ICW traffic.	Consider establishment of TSS or RNA to organize vessel movements approaching the sea buoy. Support local VTIS initiative by Charleston Branch Pilots. Encourage expert-stakeholder group to monitor and propose mitigations if risk level warrants. Review adequacy of Special Event Permit process. Include examination of potential mitigation measures as part of the future deliberations of the expert-stakeholder group. Increase educational and enforcement efforts including coordination with local law enforcement agencies.
Tide & River Currents	
Up to six knots currents occur in Wappoo Creek at ICW where it meets Stono River. The shaping turn for the bridge over the ICW in this area can be a problem for tugs with tows. Vessels proceeding up the Cooper River routinely encounter three-four knots current, which causes handling problems particularly at bends. Meyers Bend at Drum Island causes problems for deep draft vessels. Shaping to clear the bridge is a problem in the unpredictable current conditions, which bounce off Drum Island causing a cross current which tends to push vessel opposite to their intended direction. Current at ebb is about three knots while current at flood is less than one knot. At South Channel off Battery Point, the converging currents of Ashley River and Cooper River cause maneuvering problems. (continued on next page)	Support installation of a Physical Oceanographic Real-Time System (P.O.R.T.S.).

Risks	New Mitigation Strategies
Tide & River Currents (continued)	
The natural ship channel (bypassed by the dredged channel) creates a cross current on ebb in the anchorage area that can cause handling problems with both anchoring and anchored vessels. A wind driven cross current impacts transiting vessels between the jetties along the entrance channel in the vicinity of buoys 7 and 8. Infrequently, outflow of local rivers, which are controlled by dams, will vary depending on the amount of rain. Increased outflow mixes with the tides to increase the ebb and decrease the flood. Tide and current prediction tables are believed to be in error as shown in tide tables and on charts.	
Channel Width	
Deep draft vessels cannot be turned at terminals, but rather must proceed up river to a turning basin and then return to the assigned mooring. 1,000 – 1,200 feet necessary to turn most vessels. Up the Wando River, width is limited to 400 ft and Tanker Row is only 500 ft. If passage is blocked, vessels must be backed to safe moorings to await clearance of obstruction. ICW is maintained to a 90-foot width. Tugs with tows avoid passing situations in Wappoo Creek.	Support Charleston Branch Pilot's establishment of a VTIS. Encourage expert-stakeholder group to monitor and propose mitigations if risk level changes.
Waterway Complexity	
Frequent high density of small craft and tour boat traffic in the vicinity of Fort Sumter. "Snowbird" traffic coming from the ICW is not familiar with the area. Recreational boats exiting Charleston Harbor marina have an obstructed view of approaching traffic. (continued on next page)	Include examination of potential mitigation measures as part of the future deliberations of the expert-stakeholder group. There are plans to construct a taller Cooper River Bridge. Encourage expert-stakeholder group to develop support for real time air draft measurement and straightening the dogleg in the approach to the Cooper River Bridge.

Risks	New Mitigation Strategies
Waterway Complexity (continued)	
Many small boats exit marina at Patriots Point near aircraft carrier Yorktown interfering with deep draft vessels. Three rivers (Cooper, Ashley and Wando) and the ICW converge in the harbor area. Air draft is a critical issue for deep draft vessels due to many low bridges. One ship scraped the centerline of the Cooper River bridge. Passage is not contingent solely on vessel draft, but also must consider air draft and vessel width. Visibility of other vessels is obstructed around islands and bridges. Narrow channels prevent turning deep draft vessels at berths requiring extended transits to turning basins.	Increase educational programs for recreational boaters including preparation of a handout discussing operations, communication, and precautions in and around Charleston Harbor.
Volume of Hazardous Chemical Cargoes	
A significant amount of HAZMAT arrives at the port as containerized cargo. Possible exposure to vapors and channel closure during clean up is a concern.	Encourage expert-stakeholder group to monitor and propose mitigations if risk level changes.
Economic Impacts	
A channel blockage will immediately affect the port. Cargo unloaded at the port more than 15 hours late can impact intermodal connections (primarily rail) and consequently directly impact many industries throughout the U.S. Letters of credit can be rejected if departing cargo arrives late overseas.	Include examination of potential mitigation measures as part of the future deliberations of the expert-stakeholder group. Support local VTIS initiative by Charleston Branch Pilots.
Environment Impacts	
Many wetland and marsh areas throughout the port area and particularly up the rivers and along the ICW. Endangered species can be impacted in wetland and marsh areas. (continued on next page)	Encourage expert-stakeholder group to monitor and propose mitigations if risk level changes.

Risks	New Mitigation Strategies
Environment Impacts (continued)	
The unrestricted use of waterways by recreational boaters during spill cleanup activities would be impacted. Fishing and shrimping activities inshore would be impacted by a serious spill. The development of port facilities on Daniel Island is moving forward.	
Health & Safety Impacts	
Many ship channels and waterfront facilities are near residential and tourist areas. Spent nuclear waste is being shipped through the port up the Cooper River to the Naval Weapons Facility. Allision of a vessel with bridge supports would impact people on the bridge. Allision of an underway vessel with a moored tanker along Tanker Row would impact people in North Charleston.	Include examination of mitigation measures as part of the future deliberations of the expert-stakeholder group.

Conclusions

Although risks associated with channel width have been reduced by the efforts of the Charleston Branch Pilots to control one-way traffic and meeting situations for deep-draft and tug and barge movements in most areas of the harbor, passing remains a major concern. Channel widths as narrow as 600 feet inside the harbor, 500 feet along tanker row, and narrower upriver coupled with a lack of turning basins in most critical areas create difficulty in scheduling transits to avoid hazardous passing situations. In addition, the narrowness of the waterways makes it impossible for vessels to turn in the channels excepts at turning basins. Finally, the high volume of pleasure craft in many areas of the harbor and near the intersection of the ICW with the entrance channel frequently creates difficult situations for commercial traffic. Commercial vessels often must resort to blowing danger signals to clear the channel ahead, but boaters frequently disregard the danger signals.

For example, while many hazardous materials are carried as relatively low-volume containerized cargo, the exposure hazard is great because the narrowness of channels can put passing vessels in harms way resulting in the closure of the port in the event of a pier-side spill. The large areas of marsh and wetlands adjacent to the harbor, rivers and ICW make the long term impacts of a serious spill in or adjacent to the waterway a major

concern. The destruction of habitat would directly impact fishing and shrimping as well as tourism interests. In addition, recreational boating interests would be impacted due to the long-term restrictions of shallow waterways to boating traffic.

Many of the other risks and associated mitigations identified in the study concentrate on the increasing numbers, size and mix of vessels in Charleston Harbor. High risk vessels, however, are not a major issue. Much of the traffic into Charleston is liner trade (including container vessels), resulting in a high percentage of "first rate vessels and crews." Commercial fishing boats are also not a problem, because the state prohibits commercial fishing and shrimping at night which generally checks the presence of vessels from outside the local area. Local commercial fishing operators are generally knowledgeable of local hazards and normally keep clear.

By increasing education and awareness within the local community, the risks associated with an increasing number of pleasure craft operators, including congestion associated with weekend and seasonal use, may be minimized. However, it was noted that pleasure craft operators tend to be unreceptive to some of the educational activities currently implemented. Thus, it may be prudent to include enhanced continuing education and awareness requirements in the licensing and renewal process, as well as implement stiffer penalties for non-compliance.

The ability to see vessels in the waterway beyond bridges and land obstructions creates concern. Also of concern is the inability to determine accurate underkeel clearance before commencing transits. Most of the risks identify, however, were related to the impact of environmental conditions (wind, tide, currents) upon the handling of vessels, particularly deep draft vessels in the narrower reaches of the harbor and Cooper River, and of fog upon vessel movements. Although risks have apparently been successfully mitigated (as reflected in the weighting assigned by the participants) through the efforts of the Charleston Branch Pilots and by the presence and professional operation of modern assist tugs (tractors), communications systems should be enhanced to provide real-time tidal, weather, current and visibility conditions information.

Effective implementation of a comprehensive mitigation plan should address each of the above noted risk categories interdependently. The plan should incorporate a recognition that local waterways' management, including identification and mitigation of unacceptable risks, is a joint public-private sector responsibility. Because of the shared responsibilities, mitigation measures may be accomplished by a combination of government alone, jointly by government in partnership with the private sector, and by the private sector without government participation. Such an approach should permit development of a comprehensive local action plan which takes into account both costs and benefits.

Miami

Overview

For the purpose of the Miami Ports and Waterways Safety Assessment, the participants defined the port area as having the following geographic boundaries:

- Approach to Miami (especially from the Bahamas due to crossing traffic and because cruise ships approaching the sea buoy have to line up and maintain station while they await their turn in the queue for pilots and entry time)
- Begin 4 NM east of sea buoy (10 miles off shore)
- Offshore anchorages
- Dodge / Lummus Island and adjacent waterways including Main Channel, Fisherman Channel (Dodge Island Cut and Lummas Island Cut), West Turning Basin
- Western limits of the port defined as the entrance to the Miami River
- Along the Intracoastal Waterway (ICW), the northern limit was defined as the MacArthur Causeway Bridge and the southern limit as the Dodge Island Bascule Bridge

The Miami River was not included due to the unique nature of its geography, trade, and attendant risks. Instead, that waterway will be the subject of a separate safety assessment workshop.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Majority of problems that pilots report are on coastal freighters –"river ships." • Experience engine & steering loss • Quality of crews is very poor and they often do not speak English Amphibian aircraft taxi and launch from the Main Channel. • Have to look for gaps in recreational boaters to land • Run risk of flying into a cruise ship while dodging recreational boaters Recreational boats: • Competence / ignorance of operators affecting operations in entrance channel & turning basin (continued on next page)	Improve communications. Improve rules & regulations. Keep unsafe coastal freighters from visiting Miami through vigorous PSC enforcement program as ISM Code requirements come into effect for freight vessels in 2002. Support commercial fishing vessel mandatory inspection program. Recreational vessels: • Encourage educational courses • Support mandatory licensing for operators • Establish more stringent requirements for vessel rental businesses (continued on next page)

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels (continued)	
• Lots of educational courses available, but few are taken • Material condition of recreational boats is poor; frequently break down; pilot boats have to tow them out of the way • Recreational boats ignore speed signs and show poor judgment Commercial wing-net shrimp boats fish along entire South Channel; shrimpers are not inspected now.	• Increase enforcement of existing boating safety laws and target high risk areas for enforcement activities • Increase number of enforcement officials on the waterways
Volume of Shallow Draft Vessels	
3,000 movements per year (a movement defined as one way transit) consisting of mostly Caribbean coastal freighters and ferries. Fisher Island Ferry crossings every 15 minutes; 1 millionth trip will happen this summer.	Improve rules & regulations Prepare to step up enforcement of exiting regulations as volume of traffic increases, especially of less well-maintained vessels. Coordinate vessel movements in high traffic areas as volume increases.
Volume of Fishing and Pleasure Craft	
50,000 registered small recreational fishing boats in Dade County. Marinas, yacht clubs, launch areas distributed throughout the port located at: Bay Side, Watson Island, north of MacArthur Causeway, Miami Beach, and Dinner Key. Most watercraft come from marinas and yacht clubs outside the port area but transit the port area from north and south on the ICW. FMP enforcement activities limited by availability of resources. Restrictions on jet skis to the north are driving them to port area; to the south, they are excluded from parks, which also drives them to port area. Advertisers claim Port of Miami is one of top ten places to use jet skis. Jet skis use Main Channel and Government Cut. Seasonal shrimping by recreational craft in middle of Fisher Island Ferry route.	Improve rules & regulations. Establish a VTIS. Establish speed zones for the port. Establish exclusion zones for jet skis in the port. Educate boating public to stay out of channels. Increase size of marine police force to conduct more enforcement. Step up enforcement of boating safety laws, particularly at known congestion areas. Limit times of recreational boat use in choke points.

Risks	New Mitigation Strategies
Traffic Density	
Limited access to ocean; next access is Haulover Inlet. Congestion areas / times: • Any major holiday • Fireworks at Bay Side and entrance of Miami River • Long spring / summer / fall for weekend boaters • East end of Lummus Island • Fishing tournaments on Watson Island • Offshore speedboats race through Main Channel • Miami Boat Show with multiple sites Hurricane port closures mean all deep draft vessels exiting the port. Hurricane port closures mean smaller and recreational vessel heading up the Miami River. Bertram Yacht Yard has large number of slips it rents as safe haven for hurricanes.	Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Consider need for moving security zones around high risk traffic (cruise ships and tankers) as traffic density increases. Prepare to step up enforcement of exiting regulations as volume of traffic increases, especially of less well-maintained coastal freighters. Coordinate vessel movements in high traffic areas as volume increases. Establish exclusion zones for jet skis in the port. Educate boating public to stay out of channels. Increase size of marine police force to conduct more enforcement. Step up enforcement of boating safety laws, particularly at known congestion areas. Limit times of recreational boat use in choke points.
Tide and River Currents	
At sea buoy a cross current makes approach to channel difficult at times. Sometimes get a counter current to the south. Jetties on a flood tide have two cross currents – inner to south, outer to north which creates turning vortex. Convergence of three currents in turning basin east of Lummus Island. Cross current from Norris Cut onto the gantry dock. Downtown turning basin cross current coming through ICW affects cruise ship movements. Heavy rains in summer create stronger than normal ebb tides. Everglades water management areas also impact ebb tide flow. (continued on next page)	Improve aids to navigation. Improve dynamic navigation information. Establish a VTIS. Encourage ship operators to install precision navigation equipment, such as DGPS or AIS. Step up safety patrols in area of jetties during ebb tide periods with strong on-shore winds.

Risks	New Mitigation Strategies
Tide and River Currents (continued)	
Cut to west of Dodge Island restricted. Ebb current generates rips and standing waves, which create dangerous situation for recreational boaters. Onshore wind with outgoing tide in entrance channel at jetties creates 6 to 7 foot waves and 4 knot current. Recurring casualties due to pleasure craft loose control in currents / seas in entrance channel, then swamp.	
Channel Width	
There are only certain areas where two deep draft ships can meet inbound / outbound the Entrance Channel. No room for deep draft meeting at beacon #15 or at the jetties. At southwest end of Dodge Island (junction of the ICW) pilots leave shallow draft freighters, tugs connect for dead ship tow, and river pilot gets aboard. Coastal barge at Fisher Island terminal got clipped by cruise ship. Shoals near buoy #1 have caused groundings of large cruise liners.	Improve communications. Improve rules & regulations. Establish a VTIS. Establish a VTS.
Bottom Type	
Hard rock banks, very sheer and unforgiving. Cannot use anchors in emergency without risk of snagging cable crossing areas off gantries. FPL power line off gantries restricts draft to 39 feet. Submerged sewer line under Government Cut channel. Ships could nick the pipe as it is exposed at one corner of the channel in 38 feet. Submerged power cable between ferry slip and east end of Lummus Island has been nicked by anchors.	Install real time current meter at sea buoy. Identify shoal spots through surveys and accurate charting. Conduct WAMS to determine whether aids to navigation properly mark shoal spots. Eliminate unsafe shoal spots by dredging (buoy #1, beacon #15). Channel widening and deepening involves moving rock with dynamite, which is now rarely acceptable environmentally. Technological alternatives need to be developed.

Risks	New Mitigation Strategies
Waterway Complexity	
Multiple traffic patterns converge at sea buoy. Miami has two 25-degree bends and several intersecting waterways. Once inside sea buoy, deep draft vessels are committed. Anchorages are limited and poor holding. Converging waterways: • Lummus Island Cut and Government Cut • Norris Cut into Lummus Island Cut • ICW at Dodge Island • Biscayne Bay short cut to Fishermans Cut Cruise ships turn at west end of Dodge Island – junction with ICW. Turning basin on cargo side of Dodge Island not dredged deep enough so commercial ships turn at confluence of Government Cut & Lummus Island Cut. Crossing traffic: • Fisher Island Ferry crosses channel every 15 minutes. • North and south bound traffic at sea buoy crosses traffic bound for the Bahamas South bound traffic tries to stay close in to avoid Gulf Stream.	Improve aids to navigation. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Explore alternatives to existing turning basin configurations. Make precautionary area around sea buoy larger; 4 NM suggested. Require larger recreational vessels to make security broadcasts as they transit. Control speeds of go fast vessels. Restrict jet ski use in areas of commercial traffic.
Number of People on Waterway	
3,000 passengers and crew on cruise ships. Eight T-boats with dinner cruises run down the Main Channel and around the residential islands. Four casino boats with up to 150 passengers operate off shore and through the Main Channel. Water taxis from Bay Side to hotels, Miami River, and Miami Beach Marina. (continued on next page)	Improve rules & regulations. Establish a VTIS. Establish a VTS. As number of people on waterway increase, ensure that response resources are sufficient to handle a worst-case marine casualty involving passenger carrying vessels.

Risks	New Mitigation Strategies
Number of People on Waterway (continued)	
Chalk's Airline operations. Some tour boats from the hotels. Harbor cruises and casino boats: Royal Star (100 passengers) and Princess (100 passengers). Fisher Island passenger ferry. Fisher Island commercial barge ferry (2 times daily for next 5 years).	
Economic Impacts	
Impact of closure is immediate. Passenger ships moving thousands of people in and out of port. Ships have alternate ports but have to match passengers to buses and air transit. One-week period before cargo delivery shortages felt. During a hurricane mass migration of traffic. COTP / PORT start warning 72-hour mark to 48-hour mark. After 36-hour mark, no more arrivals. After 24-hour mark, all out. Nobody let back in after storm until channels are surveyed. Two days prior and up to three days after for port closure. Tourism dollars lost by dinner cruise boats, gambling boats, tour boats, and cruise lines. Ferries may not be able to visit the outlying communities. Shrimp fisheries are impacted if an oil spill occurs. Economic impacts throughout Caribbean Islands who depend on receiving goods from Miami.	Improve rules & regulations. Improve dynamic navigation information. Ensure that local contingency plans have up-to-date information about location, capabilities, and responsiveness of salvage vessels.
Environment Impacts	
Marine sanctuaries: • South of Dodge Island to Virginia Key: sea grass beds are protected; environmentally sensitive area Coral reefs off shore, two shallow, one deep, run parallel to coast; ship channel is through them (continued on next page)	Improve rules & regulations. Improve dynamic navigation information. Review existing contingency plans and stockpiled equipment for adequacy with regard to currents in the port. (continued on next page)

Risks	New Mitigation Strategies
Environment Impacts (continued)	
Spawning grounds and nurseries for crustaceans. Miami Beach recreation / tourist area. Biscayne Bay aquatic preserve; entire bay is an environmentally sensitive area; manatee area. Spill booming strategies may not be adequate with regard to currents within port. History of groundings in approaches. Ships now required to hold gray water, which increases draft. Cannot discharge before they leave port because there is no adequate facility to accept gray water.	Identify bunker tank locations on cruise ships (bottom, side, double skin, or double hull). Establish mandatory regulations for invasive species. Establish shoreside facilities to accept gray water and black water.

Conclusions

The volume of deep draft traffic is increasing, especially for cruise ships, whose size also is increasing. The size of container ships is restricted by the depth of the Entrance Channel and the dimensions of the turning basin south of Dodge Island. The volume of shallow draft traffic also is increasing as a result of shifting from wood to steel coastal freighters and converted shrimp trawlers. Further substantial increases are anticipated when the Cuban embargo is lifted and the Miami River is dredged. The volume of fishing and pleasure craft is increasing significantly and is a moderately high factor for the port.

The participants considered the risks associated with waterway configuration worthy of considerable attention. The port includes two twenty-five degree bends, four converging waterways, restricted turning basins, and considerable crossing traffic, including regularly scheduled ferry service to Fisher's Island. The channel walls and bottom throughout the port are characterized as hard and unforgiving limestone. Consequently, the participants considered bottom type to be the second highest risk factor for the port. Channel width will become an increasingly significant risk as the volume and size of deep draft shipping increase.

As volume of traffic increases careful planning will have to go into traffic management since little can be done to improve waterway configuration, channel width or depth without blasting, which is environmentally challenging. The existing channel width and depth are potentially limiting factors to expansion.

While moderately high, the participants considered risks due to economic impacts to be better addressed by tools other than VTM tools. The participants considered environmental impacts to be the third highest risk factor for the port. The entire bay is an environmentally sensitive area; marine sanctuaries, spawning grounds, and water and beach recreation areas surround the port. Health and safety impacts were also perceived as posing moderately high risk.

Port Everglades

Overview

For the purpose of the Port Everglades Ports and Waterways Safety Assessment, the participants defined the port area as having the following geographic bounds:

- Approach to Port Everglades begins one nautical mile east of sea buoy
- Offshore anchorages to the north of the entrance channel
- Outer Bar Channel, Turning Basin, North Extension north to 17th Street Bridge, South Extension and Intracoastal Waterway (ICW) south to and including Dania Cut Off Canal up to Port Lau Dania

Risks	New Mitigation Strategies
% High Risk Deep Draft Cargo & Passenger Vessels	
12,000 ship movements per year in deep draft category; 85% of cargo vessels are deep draft. General grouping of potential problems affect 60 - 70% of deep draft ships: • Age of ship • 30% are higher risk due to size / draft of ship • Drug and alcohol abuse • Maneuvering characteristics Generally high quality, low risk ships using Port Everglades: • Very few PSC Category I vessels • Passenger ships are boarded quarterly and are Category III / IV. Majority of cargo ships are Category II or better (less than 10 deficiencies per year per average ship). At least one ship with a mechanical problem each day in the port; 10 % have mechanical problems. (continued on next page)	Improve rules & regulations. Improve static navigation information. Establish a VTIS. Establish a VTS. Review assist tug requirements for adequacy in handling single-screw, twin rudder deep draft ships.

Risks	New Mitigation Strategies
% High Risk Deep Draft Cargo & Passenger Vessels (continued)	
Crew competency problems on 15% of tank ships. • Do not conform to STCW • Language barrier significant problem for foreign flag tankers Older ships designed to go fast at sea, not designed to turn or otherwise maneuver at slow speed. Two passenger ships and some container ships use port that fit this category. Considered a very high risk. For these ships, tugs for assist are of marginal value in checking speed.	
% High Risk Shallow Draft Cargo & Passenger Vessels	
25 - 30% of recreational boaters (and 100% of jet skiers) do not demonstrate good boating safety knowledge, especially through cut. • During boardings 50% of boats have safety or other deficiencies • Once per day recreational boat puts itself at risk with Sun Cruz catamaran • Recreational boaters do not perceive themselves as causing risk or being in danger • Material condition of recreational boats is poor; frequently break down • Recreational boats ignore speed signs Sea-Tow and Offshore Towing assist 4,000 boats per year. Alcohol related accidents at 25 - 30% of total. Pilots report at least one incident during each ship movement where they have to reassure captain that his ship must keep going straight and the recreational boat will have to move. Cases where engines break down on boats in front of deep draft ships and people jump into water or pilot boat has to tow them out of the way. Educational courses available, but few taken. Coastal freighters and water-taxi boats do not present particular risks.	Improve rules & regulations. Establish a VTIS. Establish a VTS. Eliminate older, unsafe coastal freighters from the port through vigorous PSC enforcement of ISM Code requirements which go into effect in 2002. Encourage pilots to report ships where crews do not speak proficient English. Enforce STCW language requirements via PSC boardings. Encourage active USCG Auxiliary educational program for recreational vessels. Support mandatory licensing for recreational boat operators. Establish more stringent requirements for vessel rental businesses (state requirement). Target high risk areas / times for on the water enforcement activities.

Risks	New Mitigation Strategies
Volume of Deep Draft Vessels	
Weekends 4 - 6 cruise ships jockey for entrance or line up to depart within 2-hour period. Number of tank ship transits varies seasonally.	Improve dynamic navigation information. Establish a VTS.
Volume of Shallow Draft Vessels	
Caribbean coastal freighters and ferries. 3,000 shallow draft movements per year. Very little commercial fishing boat activity in Port Everglades.	Improve aids to navigation. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS.
Volume of Fishing and Pleasure Craft	
44,000 registered watercraft in Broward County. Many recreational craft are trailered in. Launch sites include 15th Street ramp, John Lloyd Park ramp, and Dania Cut Off Canal in Harbor Town. Dry storage at Hot Water Canal. Major sight seeing; transits from north and south ICW through port to entrance. Limited access to ocean. Next access is Haulover Inlet to south and Hillsboro Inlet to the north. Seasonal (especially during winter months).	Improve communications. Improve rules & regulations. Improve communications infrastructure between law enforcement agencies to improve background checks on boat operators. Establish county ordnance for jet skis defining where they can and cannot operate. Specifically address distance from piers / docks and distance from ships in channel.
Traffic Density	
High recreational boat traffic: 1,400 - 1,600 daily transits of recreational boat traffic including sport fishermen. Long spring / summer / fall for weekend boaters. Congestion areas and times: • Small boats: Any major holiday; winter season with snow birds; Winter Fest Boat parade, Air-Sea Show (May), boat shows (test-drive boats), lobster mini-season (July), fishing tournaments • Sunrise every Saturday and Sunday morning when recreational fishing boat traffic heads out the entrance – and also when cruise ships come in (continued on next page)	Improve rules & regulations. Establish a VTIS. Establish incentives for cruise ships to use facilities seven days a week rather than mostly during weekends. Review hurricane evacuation plan. Establish RNA and gated aids to navigation in entrance cut to keep small craft outside buoys and deep draft traffic between buoys.

Risks	New Mitigation Strategies
Traffic Density (continued)	
• Fishing boats run entrance channel for fishing and diving; best fishing is on the range • Major ship congestion at sea buoy due to single ship transit through entrance channel and approaches • Significant congestion at 17th Street Bridge, North Extension, and in Dania Cut Mega-yachts not piloted.	
Tide & River Currents	
Significant current through 17th Street Bridge on ebb tide. Cross current of 2-2.5 knots between sea buoy and jetties. • For large ships, that current represents 25% of approach speed and set significantly affects course (crab angle) • Can be north or south depending upon Gulf Stream • Sometimes get counter currents at lower depths; ship hull responds to stronger current • Can shift direction three times in the course of one transit Jetties on a flood tide have two cross currents: inner is to south outer is to north which creates turning vortex. Can set boats on beach at light #12. Heavy summer rains create strong ebb tides. Everglades water management areas also impact ebb tide flow through Dania Cut and New River. Tankers create swirls in basin as they enter tanker slips. Turning notch at Dania Cut-off Canal is confined area with both tidal and man-made currents which can be unpredictable. 1.2 million gallons of water in and out at power generation plant through Hot Water Canal.	Improve aids to navigation. Improve communications. Improve static navigation information. Improve dynamic navigation information. Install additional real time current meters in selected parts of the port. Coordinate with Everglades Water Management district for opening floodgates. Raise height of lower range light, which ships use to judge instantaneous current effects in Entrance Channel.

Risks	New Mitigation Strategies
Channel Width	
Channel width is 500 feet outside jetties, 450 feet inside jetties. ICW is 500 feet wide. LOA of ships using Port Everglades approaching 1,200 feet. Container ship size limited by depth of channel. Draft for tankers restricted to 38 feet except for Berth 5, which is 39 feet. DGPS plus / minus 3 meter accuracy is not sufficient for a 1,000 foot ship in the Entrance Channel; channel is too narrow for a ship that size to tolerate that much error.	Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Establish maximum length, beam, and draft limitations for the port. Carry out proposed dredging of outer channel to 700 feet and Entrance Cut to 500 feet.
Bottom Type	
Hard rock (limestone) banks, very sheer, and unforgiving. Vertical walls, blasted from outside jetties into and through the port. Anchor holding poor to non-existent. Cable crossing areas: • Buoy #3 • Just inside breakwaters across Inner Bar Cut • North Extension below 17th Street Bridge • Just south of knuckle in ICW • Extensive restricted area due to underwater cables outside and to south of port Channel depth and width limit use of port by new generation large ships.	Improve aids to navigation. Install real time current meter at sea buoy and real time tide gages in port.
Waterway Complexity	
One 90-degree turn in main channel at port basin. Converging waterways: • ICW and Dania Cut-off Canal • Turning notch at Piers 25 & 26 (continued on next page)	Improve aids to navigation. Improve rules & regulations. Improve static navigation information. Improve dynamic navigation information. (continued on next page)

Risks	New Mitigation Strategies
Waterway Complexity (continued)	
• Main port at entrance • Basin in Port Lau Dania Crossing traffic: • Northbound traffic offshore and southbound traffic at sea buoy crosses with traffic standing into or out of port • Southbound traffic tries to stay close in to dodge Gulf Stream Multiple traffic patterns converge at sea buoy and port basin.	Establish a VTIS. Establish a VTS. Establish county ordnance to provide moving safety zone around deep draft ships (500 feet ahead, 100 feet abeam and astern). News events to inform boating public on limited capabilities of large ships in restricted areas. Encourage marine industry to support wide-spread use of AIS.
Number of People on Waterway	
Passenger vessels move 3 million passengers a year. • 3,000+ crew and passengers in one hull • Sight seeing cruises carry up to 149 passengers • Daily Seascape cruises carry 500 passengers daily • Head boats &charter boats with up to 49 people	Establish a VTIS.
Volume of Petroleum Cargoes	
800 tank ship movements per year. 2 - 3 movements per day of which 30% are seagoing tank barges (200,000 bbls capacity) and integrated tug and barge (ITB). Still some “senior” tankers with single hulls using the port. Barges not yet double hulled.	Improve rules & regulations.

Risks	New Mitigation Strategies
Environment Impacts	
Ft. Lauderdale beach recreation. Plethora of diving and fishing activities. Spawning grounds and nurseries for crustaceans. Manatee areas everywhere, especially during cold weather in Hot Water Canal. No idea what to do with them in event of an oil spill – how to keep them there and get them food. Aquatic preserve. Turtle nesting areas. ICW has extensive mangrove areas. History of groundings in approaches. Three tiers of reefs parallel coast offshore at 30-60-90 foot depths. Effectiveness of oil spill contingency plans unknown – have not had a real serious spill.	No new mitigation strategies discussed.

Conclusions

Bottom type was evaluated as the highest risk factor for the port. The channel walls and bottom throughout the port are characterized as hard and unforgiving limestone. Waterway complexity is another high risk within the port. The port includes one 90-degree turn, three converging waterways, restricted turning basins, considerable crossing traffic, and numerous unpredictable recreational boaters. Channel width will become an increasingly significant risk as the volume and size of deep draft shipping grows. As volume of traffic increases careful planning will have to go into traffic management since little can be done to improve waterway configuration, channel width or depth without blasting, which is environmentally challenging. The existing channel width and depth are potentially limiting factors to expansion. Visibility obstructions, while not ranking in the top risks overall, still cause risk at an unacceptable level.

The participants believed that existing risk mitigation practices associated with the number of people on the port's waterways and the volume of hazardous chemicals lower these two risk factors to well within acceptable limits.

Environmental impacts is a high risk in the port. Marine sanctuaries, spawning grounds, endangered species (manatees) and water and beach recreation areas surround the port area. This entire section of coast and ICW is an environmentally sensitive area. The risks associated with economic and health and safety impacts were moderate and generally considered to be acceptable, given current mitigation strategies.

San Juan

Overview

San Juan is the most important commercial harbor in Puerto Rico and is situated on the north coast about 30 miles West of Cabo San Juan. It is well protected and is the only harbor on the North coast that provides all-weather shelter for vessels. The port is situated on the shores of Bahia de San Juan, which is about three miles long in a southeastern direction and of variable width (from about 0.6 to 1.6 nautical miles).

The Entrance Channel leads from sea to a deep-draft anchorage Southwest of Isla Grande, via Anegado Channel. San Antonia Channel leads from Anegado Channel to commercial piers and a Navy berthing facility on the south side of Isla San Juan, and to facilities on the north side of Isla Grande. The Army Terminal Channel leads from Anegado Channel to the Army Terminal and other facilities on the south side of the harbor.

The pilot boarding area is approximately three miles north of El Morro, a prominent fortress located just to the east of the entrance. The approach from seaward can be difficult at times because of quartering or following seas, coupled with a westerly current and prevailing northeasterly winds. During strong northerly winds entrance may become impossible.

An additional concern is a bend in the channel inside the entrance, which can be difficult to negotiate when the trade winds are strong. Vessels need to maintain speeds of no less then ten knots to insure adequate control during transit. The entrance speed can complicate shiphandling during the turn from the Entrance Channel into Anegado Channel, and further difficulty can be imposed because the aids to navigation on the north side of Anegado Channel are not visible until after the turn into that channel.

Climate is tropical marine with a relatively narrow range of temperatures. The average rainfall is nearly 60 inches per year with some periods of rainfall sufficiently intense and reducing visibility. The easterly trade winds insure that onshore breezes predominate during daylight with the winds shifting south or southeast after sunset.

Risks	New Mitigation Strategies
% High Risk Deep Draft Cargo & Passenger Vessels	
Crews from Eastern and Southeast Asian countries are reluctant to identify conditions affecting handling or response of their vessels. A percentage of the foreign-flag ships have performance and reliability problems stemming from maintenance / operating practices. (continued on next page)	Review Port State Control boarding practices. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. (continued on next page)

Risks	New Mitigation Strategies
% High Risk Deep Draft Cargo & Passenger Vessels (continued)	
Representative problems include failure to go asternback on command and need to recharge starting air flasks before responding to engine orders. "Problem" ships number 3-5 per week. Calling ships from the U.S. flag fleet are aging but are generally well maintained. Most are of an age not requiring the steering gear to operated from emergency diesel generators. Current level: Port State Control targets: Priority I, 5% or less; Priority II, 25%. Capabilities of port controllers (those on duty at signal station) add to risk posed. Cited shortfalls were inability to speak adequate English, insufficient training, lack of information about vessel movements and unfamiliarity with ship handling problems. Greatest risk undoubtedly stems from failure to exercise advertised degree of control over vessel movements. Deep draft ships can pose handling problems, compounded by wind and power of available tugs.	If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Encourage port community to develop appropriate operating practices including, but not limited to: • Use of standby tugs • Standard criteria for pilots to use in determining whether or not to move a vessel Communications and information exchange practices
Volume of Deep Draft Vessels	
The character of vessel traffic is changing. Volume of passenger ships is decreasing but ship size is increasing. "Eagle" class ships are projected to call in the near future (1080 ft. LOA). Current volume: 136 per month during winter season. Cargo ship size is increasing, as are the number of ship calls. Largest are container ships (c. 925 ft. LOA). Tanker traffic is increasing. Now 5-6 per week. Ships are 850-900 ft. LOA. Increases in volume and vessel size will add to the stress upon already inadequate vessel traffic management practices. Increased ship size is increasing need to use assist tugs.	Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Encourage port community to develop appropriate operating practices including, but not limited to: • Use of standby tugs • Standard criteria for pilots to use in determining whether or not to move a vessel • Communications and information exchange practices

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
The character of vessel traffic is changing. Feeder line operations are increasing, with some of the increase attributable to cargo for the outer islands and some feeder operations from Panama. Coastwise traffic is decreasing. The number of calls by small tank ships is increasing. There is a marked increase in large barges, primarily carrying containers. The tows enter without use of Commonwealth pilots, take a long period of time to maneuver, and shift at berth using own lines (causing damage to bollards). Increases in volume and vessel size will add to the stress upon already inadequate vessel traffic management practices.	Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Encourage port community to develop appropriate operating practices including, but not limited to: • Use of standby tugs • Standard criteria for pilots to use in determining whether or not to move a vessel • Communications and information exchange practices
Traffic Density	
Peak periods of vessel movement, as identified by the participants. Cruise ships movement is concentrated on Tuesdays and weekends. Frequency sometimes reaches peak of one every 15 minutes. The times of movement coincides with that of container ships. Barge schedules often coincide with cruise ship movements. The Golden Triangle area (Pier 1 to Pan American Dock) is reserved for cruise ships. Peak movement periods result in congestion in that area. The Commercial incentives for early morning arrival frequently creates congestion offshore as vessels await entry and pilots. Levy of port fees is governed by time of arrival, a condition causing congestion just prior to midnight. After hurricane passes there is pressure to move vessels in and out as quickly as possible (continued on next page)	Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Encourage port community to develop appropriate operating practices including, but not limited to: • Use of standby tugs • Standard criteria for pilots to use in determining whether or not to move a vessel • Communications and information exchange practices Encourage Puerto Rico Ports Authority to modify assessment practices in order to eliminate this safety problem. Control of post-hurricane movement is exercised by COTP, who is considered as an “honest broker.” No changes are necessary. (continued on next page)

Risks	New Mitigation Strategies
Traffic Density (continued)	
Poor administrative practices result in such problems as last minute notice to pilots and assist tugs, traffic waiting while agent clears ship, etc. Dredge(s) operating in the main channel creates an obstruction. Plans for development of Golden Triangle (Pier 1 to Pan American Dock) will increase congestion.	Encourage port community to improve administrative practices and exchange of information. Examine policies and fees associated with waiting time for pilots.
Visibility Obstructions	
Heavy rain restricts visibility. Periods are variable in duration but can last for entire day and occur about once per month. Occurrences of volcanic ash can reduce visibility to point where ranges cannot be seen.	In consultation with port community identify specific mitigation measures (if required).
Channel Width	
The width of the channels requires one-way traffic in most locations. Vessels using Mediterranean moors at Pier C, Puerto Nuevo encroach upon channel width, increasing hazards. Anchorage E – Shifting winds case anchored vessels to wing, blocking channel Moored tankers are encroaching into channel by up to 150 ft.	The problems will be eased to a limited degree by the projects increasing the width of the entrance channel to 800 feet and widening the channel in the vicinity of the Army Terminal Better information coupled with movement controls. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Encourage the port community to develop appropriate operating practices to minimize problems created by moored or anchored vessels.
Bottom Type	
Bottom is coral.	Pilots board ships before harbor.

Risks	New Mitigation Strategies
Waterway Complexity	
Transition from Entrance Channel to interior channels can be difficult, dependent upon vessel characteristics and wind conditions. Requirement to berth some ships port side adds to the problems created by one way traffic. Adverse meetings occur between vessels departing Army Terminal and Graving Dock Channel. Coordination and exchange of information within harbor is insufficient for safety. Ferry routes cross main shipping channels. De facto yacht anchorage is impinging upon areas required for maneuvering ships. Shoaling appears to be increasing in area of Pier 4. Berths A & B have oil lines under the dock.	Make provisions to update information about other traffic and control of vessel movements. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Reportedly incursions are occurring in an area where channel limits are not well marked. Improve existing aids to navigation. Enforce anchorage regulations. Bring to the attention of the Puerto Rico Port Authority. Encourage port community to develop appropriate operating practices to minimize problems created by moored or anchored vessels.
Number of People on Waterway	
Ferry operations carry over 6,000 people per day. Individual ferries carry 139 people. Movement is between Catano and Pier 2, San Juan. Concentration of cruise ship movements on weekends and Tuesdays increase number of people on waterway. Special events such as regattas and fishing tournaments add to the number of people on the waterway.	Make provisions to update information about other traffic and control of vessel movements. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Review adequacy of Special Event Permit practices.
Volume of Petroleum Cargoes	
Volume of petroleum moving as cargo or for bunkering is high. Risks posed incident to movement are unacceptably high. Response capabilities, especially fire response, are inadequate.	Make provisions to update information about other traffic and control of vessel movements. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine federal action. Review contingency planning to identify specific shortfalls.

Risks	New Mitigation Strategies
Volume of Hazardous Chemical Cargoes	
LPG in bulk comes into Catano every 10 days. Containerized acids and gasoline move to and from Puerto Nuevo every day.	Make provisions to update information about other traffic and control of vessel movements. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action.
Economic Impacts	
Since 98% of Puerto Rico's cargo requirements move through San Juan impact of port closure or significant delays in movement will have great economic consequences. Effect of suspension of movement will be felt immediately, with problem exacerbated by "just-in-time" inventory practices. Delays in movement of cruise ships will impact intermodal connections of passengers, with long-term effect of making calls at San Juan undesirable. Refineries will shut down within 4 days of port closure	Make provisions to update information about other traffic and control of vessel movements. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine appropriate federal action. Encourage port community to develop appropriate operating practices including, but not limited to: • Use of standby tugs • Standard criteria for pilots to use in determining whether or not to move a vessel • Communications and information exchange practices
Environment Impacts	
San Juan Bay Estuary is an EPA protected estuary. Endangered species of birds are present in the area. There are turtle nesting grounds to the east of San Juan. Western side of harbor (by Pier 16) requires environmental protection.	Make provisions to update information about other traffic and control of vessel movements. Improve Port Control capabilities and skill level to point where responsibilities can be properly discharged. If timely action to improve Port Control capabilities is not forthcoming determine federal action. Encourage port community to develop appropriate operating practices including, but not limited to: • Standard criteria for pilots to use in determining whether or not to move a vessel • Communications and information exchange practices

Conclusions

The primary focus of the study was the degree of risk stemming from a combination of fleet composition, traffic conditions and waterway configuration coupled with the probable magnitude of the short-term consequences of an incident. Although other locations were featured in the discussions the primary focus was the main channel from the sea to Bahia de San Juan. Transits can be challenging, dependent upon weather conditions and vessel type, and may be complicated by the actions of other shipping. The channel must be limited to one-way traffic for transit of a large ship or tug / barge combination, and the timing of passage through it in large measure governs the movements of vessels throughout the port. There is a presumption that movement through the channel is controlled. All vessels entering San Juan are required to obtain clearance to enter from Port Control while not less than three miles seaward of the entrance. Departing vessels are required to obtain clearance from Port Control before getting underway. The Puerto Rico Ports Authority (PRPA) operates Port Control located at Fort San Cristobal. The local executive of PRPA is the Commonwealth Captain of the Port of San Juan through the PRPA Maritime Director.

Discussions pointed to an immediacy of concern not conveyed by the scoring. The most extreme view was that vessel movement was at a point where additional stress would create "chaos", with potentially catastrophic impact upon marine safety within the port and upon the economy of San Juan. While not refuting that view, the general body of opinion focused on two perceptions. First, there is no cohesive system for the exchange of information, particularly about vessel movements planned or in progress. Second, that Port Control is responsible for controlling movement in the port and its approaches, and that responsibility is not being exercised.

- Without positive traffic vessel control or accurate information about movements planned or in progress mariners cannot adequately plan for safe passage of the entrance and main channel.
- There are no published or agreed-upon rules governing the granting of clearances, nor does Port Control consistently have the information necessary to base clearances upon existing or projected traffic conditions.
- There are no agreed-upon operating rules governing general vessel movement, such as (but not limited to) use of standby tugs, criteria for pilots to use in determining whether or not to move a ship, and communications/information exchange practices.

Thus, the participants identified interventions that would comprehensively address all risk categories simultaneously, focusing on developing and/or improving information / communications systems and strengthening and enforcing port rules and regulations. The study indicates that by implementing these interventions, risk in all areas will be significantly diminished. Further, it is anticipated that a recently enacted legislation creating a Pilotage Commission, which was signed into law but has not yet been stood up, will be the primary forum for the establishment of pilot-related operating rules governing general vessel movements.

Ponce

Overview

Puerto Yabucoa lies 23.5 miles southwest of Cabo San Juan Light and is essentially an open bay with numerous reefs and sunken rocks. The port is the site of a deep-draft oil-handling facility served by a privately dredged 500 ft. channel. Privately maintained buoys and a range mark the channel. The area seaward of the port is free of navigational hazards but care must be used during the approach because shoaling occurs near the channel entrance.

Laguna de Las Mareas also handles deep-draft petroleum tankers at a facility served by a private channel. The channel leads from deep water through reefs to a turning basin and pier, and is marked by privately maintained buoys and a range. Shoaling has been reported at several locations in the channel, and extreme caution is necessary when entering the port.

The principle entrance to Bahia de Jopos is from the west through a dredged channel leading to a turning basin and facilities of a power plant and then to a 1,000 ft. pier at the head of the channel at Central Aguirre. The channel has a controlling depth of 26 ft. Privately maintained lighted buoys mark the turning basin. Numerous wooded islands with reefs awash surround the South and Southwest approach to the bay and, although there are numerous small leads between the islands, commercial traffic is confined to the dredged channel.

Ponce is the most important harbor on the south coast of Puerto Rico. The port facilities are located on the eastern part of the 3.5 mile-wide bay. The principle entrance is through a Federal Project consisting of a 600 ft. wide entrance channel leading to a 200 ft. wide inner channel and an irregular shaped turning basin providing a 950 ft. turning diameter. Buoys and an entrance channel range mark the Project channel. The harbor is exposed to southerly winds. An extensive bank, Bajo Tasmanian, lies to the east of the main harbor entrance, with the western portion of the bank extending near the line marked by the entrance channel range. A bank also lies to the west of the entrance channel.

Bahia de Tallaboa is west of Ponce and is an open roadstead protected by islands and surrounding reefs. The shore area is heavily industrialized and large vessels call to deliver and load petroleum and chemical products. The entrance channel is marked by buoys and must be negotiated with care because of the proximity of shoal water.

Bahia de Guayanilla, eight miles west of Ponce, is a large hurricane harbor and one of the best for that purpose in Puerto Rico. The harbor is protected at its entrance by extensive reefs extending a mile or more offshore. The entrance channel is marked by buoys and a range, and leads to several privately maintained channels serving a number of commercial entities.

Risks	New Mitigation Strategies
% High Risk Deep Draft Cargo & Passenger Vessels	
50% of the arriving vessels are considered "problem" ships. Questions were raised about competency level of crews. 99% are foreign Flag, carrying Russian crews LNG ships will call at Guayanilla in future. Assist tugs currently available will be inadequate. Assist tugs are of marginal capability; may be inadequate for ships anticipated in the future. Communications problems exist between pilots, tugs and crews of calling vessels because of language differences.	Encourage expert-stakeholder group to take steps to improve teamwork and communications between ships, tugs and shoreside personnel Lead expert-stakeholder group in the establishment of guidelines for use of assist tugs. The guidelines should address factors such as required bollard pull, numbers of tugs required for various type ships, etc. Participants recommended a review of competency requirements, with changes as required, coupled with use of pre-arrival check lists to assess quality of ships & crews. Review the topics with the expert-stakeholder group to explore feasibility of implementing the suggestions.
Volume of Deep Draft	
Present-day risks were considered to be well balanced by existing risk mitigations.	Encourage expert-stakeholder group to monitor conditions for changes. Initiate review of risks if appropriate.
Tide & River Currents	
No risks identified.	No new mitigation strategies discussed.
Bottom Type	
Charted soundings in Bahia Jobos and Guayanilla are outdated and suspected to be incorrect. There is a hard 13 ft. spot in Jobos. In Guayanilla there is a 41 ft. spot North of Buoy 1 that represents hazard for deep-draft ships The two reefs either side of the Las Mareas channel are coral.	Advise NOAA of need for resurvey Realign aids to better mark channel. Complete WAMS for South Coast to address adequacy of buoyage and ranges.
Volume of Petroleum	
Tanker ports are Guayanilla, Ponce, Las Mareas, Jobos, Yabucoa, and Tallaboa.	Consider customizing reporting procedures to insure more rapid response in event of a grounding.

Risks	New Mitigation Strategies
Environment Impacts	
Effect of a spill is increased by lack of current in many areas (but containment is facilitated). A significant portion of the area is environmentally sensitive.	No new mitigation strategies discussed.

Conclusions

Given that this port primarily serves deep draft vessels carrying hazardous materials, a significant level of attention was given to the highest risk factors: percent high risk deep draft cargo and passenger vessels and volume of petroleum cargoes. The primary focus of this study was the risks to deep draft vessels stemming from a combination of navigational conditions and waterway configuration, coupled with the probable magnitude of the consequences to the economy and environment of an incident.

Thus, the VTM addressable risks associated with fleet composition are those posed with movement of large ships in a restricted waterway under conditions existent along Puerto Rico's South Coast. Concern for such things as the capabilities and number of assist tugs available, operator competency, and the paucity of communications between the diverse elements of the port community all contributed. The perceived shortfalls in aids to navigation are also a factor, compounded by the fact that many of those are privately maintained at doubtful standards.

Under the volume of petroleum cargoes risk factor, consideration was given to the disruption imposed by suspension of deliveries to power plants and refineries and the economic consequences thereof. The weighting supports significant preventative measures coupled with ensuring an adequate response capability.

Finally, the panel was clearly concerned about the effect of a spill of any size upon the environmentally sensitive areas of the South Coast. Discussions focused more upon after-event response rather than preventive VTM management measures, but it is clear that prevention could eliminate some of the difficult problems associated with after-incident response along this complex shoreline.

As a result, the interventions developed illustrate the participants' recognition of the fact that further review, analysis and planning coupled with additional education programs and enforcement of existing regulations will be necessary in order to minimize risks in these areas.

Berwick Bay

Overview

Berwick Bay is at the confluence of Atchafalaya River and the Intracoastal Waterway about 35 miles from deep water in the Gulf of Mexico. The port limits include the east quarter of St. Mary's Parish from 91-17.4W to Bayous Boeuf and Chene, and from Six Mile Lake to the mouth of the Atchafalaya River. Numerous inland waterways radiate from the port making it a center for offshore oil exploration and development.

For the purpose of this Ports and Waterways Safety Assessment, Berwick Bay was defined by the participants as area bounded by:

- From mile marker (MM) 85 to MM 110 on the Gulf Intracoastal Waterway;
- North along the Morgan City – Port Allen Route to MM 35; and
- South along the Atchafalaya River beyond Horse Shoe Bend through Eugene Island to the Gulf of Mexico.

An USCG Vessel Traffic Service (VTS) operates in Berwick Bay. The VTS covers the Atchafalaya River in the vicinity of Berwick Bay and Morgan City, primarily where three bridges span the waterway.

Three bridges across Berwick Bay link Morgan City and Berwick. The southern Pacific railroad vertical lift bridge has a clearance of four feet down and 73 feet up. U.S. 90, two fixed highway bridges, about 400 and 500 yards upriver from the railroad bridge, have clearances of 73 feet and 50 feet, respectively. A lighted approach danger range is shown from the western abutments of the fixed bridges. The range is visible only to down-bound vessels and is designed to mark the western boundary of the suggested down-bound course for approaching the bridges.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Small independent companies push crews beyond 12-hour limit causing crew fatigue. Independently operated vessels do not have bilge slop tanks, operating sewage treatment systems, or proper maintenance procedures. Low horsepower to weight ratio. Operator does not always know vessel air draft.	Horsepower to length of tow restrictions for VTS area of responsibility published in CFR. COTP examine crew and maintenance practices, within the limits of existing regulations, on tugs in the port area. Coordinate meetings with towboat operators to discuss the perceived problems and elicit solutions.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
Predominate traffic includes tugs and barges. Number of vessels seem to be unchanged and are forecasted to remain that way.	VTS monitoring of vessel traffic helps mitigate this problem. Oversize tow permit required when width of tow exceeds 55 feet.
Volume of Fishing & Pleasure Craft	
Craft run at high speed in low visibility in the vicinity of Rousseau's boat landing. High number on weekends and holidays. Tend to concentrate at main launching points. Hunting season – Wax Lake delta launching area is packed. Use the channel as a transit lane. Lose power while in the channel. Craft are susceptible to wake damage (big boats give big wake to little boats).	Expand safe boating education programs to reach more personal watercraft operators. Work with local law enforcement agencies to enforce safe boating laws and regulations.
Traffic Density	
Intersection of Atchafalaya River and Bayou Boeuf. Small boats crossing at intersection of Gulf Intracoastal Waterway (GICW) and river. Horse Shoe area – Crew Boat Cut and Horse Shoe channel cause confusion. Intersection of Mile 99 and Atchafalaya – collision (supply and crew boat) and grounding about 6 years ago. At Bayou Boeuf Forebay – trying to get through the locks. Intersection of Amelia and Sugar House Bend – congestion. Intersection of Bayou Boeuf and Intracoastal – congestion. Fishing tournaments during mass start. Duck season – opening day.	Establish buoys in Crew Boat Cut. Cut new GICW channel at Mile 104. Cut through the land and exit into Sweet Bay Lake, down the Atchafalaya River and cut across Bayton Island. VTS monitoring of vessel traffic and their knowledge of ferry routes / schedules and planned marine events. Expand safe boating education programs to reach more fishing vessel operators and recreational boat operators (including personal watercraft, sailboats and powerboats) Monitor the necessity for movements restricted to daylight hours only and consider what changes could be made in channel markings to enable additional night movements.

Risks	New Mitigation Strategies
Visibility Conditions	
Fog is a persistent problem at night. It occurs at least 15 percent of the time in the following areas: • Atchafalaya Bay with light south wind conditions • Bayou Chene where it empties into the Atchafalaya, above Horse Shoe Bend Summer squalls cause short term visibility problems of a duration no longer than 30 minutes. Dealing with small boats is a problem. The aluminum boats show up well on radar, but the FRP and wooden ones do not. Visually, the boats tend to blend into the background.	Frequent bridge-to-bridge communications are commonly used to alert vessels to locally troublesome fog conditions and all vessels generally slow down in reduced visibility. In addition, VTS monitors bridge-to-bridge communications and adds problem areas to periodic updates.
Tide & River Currents	
Not much tidal current. Seasonal river current during spring and fall. Max current speed is 5 - 6 knots depending on flood year. High current areas include: • MM 99 Atchafalaya and GICW – difficult turn at high water due to current • By the three Morgan City bridges • Wax Lake cut • Bayou Chene comes in to the Atchafalaya, just above Horse Shoe Bend USACE must maintain a 30% split of water diversion – mandated by law – a flood control measure on Atchafalaya and Mississippi. By the lighthouse – Eugene light – seems to be a steady setting current to the west.	In the vicinity of Wax Lake: • At GICW crossing – install light reflector signs to gauge speed and distance. • For tows, provide additional tugs when crossing the river. • Create a new lock and dam project. • Conduct more dredging. VTS to provide current speeds to the mariner. USGS has current meter information accessible through the internet. Provide current meters at high current locations. Consider a bumper system, mile 99 Atchafalaya and GICW, due to the difficult turn at high water because of high current. In the vicinity of the three bridges at Morgan City, realign and / or raise the bridge. Enforce horsepower requirements when transiting the triple bridges at high water. USACE should issue advanced warnings and sensors along the impacted waterways and provide 8-12 hours advance notice of increasing flow rates. Reroute the channel to reduce the current. Control the diversion of water to reduce the current.

Risks	New Mitigation Strategies
Visibility Obstructions	
GICW Canal from Bayou Boeuf Locks to Sugar House Bend have lights that are directed toward the bay and completely blind vessel operators. Intracoastal into the Wax Lake, blind corners all around, especially down stream and west bound (sharp intersection and high trees). East bound is rounded off and okay. Bayou Boeuf and Sugar House Bend has blind turn. 20 Grand Point is obstructed. Too many white lights at the bridges limit night vision. Around MM 88, point obscures visibility – Bayou Chene and Bayou Boeuf. Lighting in Sweet Bay lake – Oil rigs have a red beacon similar to red aids to navigation. Aids to navigation may be too far apart for low visibility – Shell Island pass to Big Island. Long stretch with no lighted aids to navigation between Big Island and the river entrance.	Conduct WAMS to assess the effectiveness of the aids to navigation along this stretch of the river. Remove the red light conflicts. Coordinate meetings with owners and operators of the locks and terminals in the impacted areas with a goal to get them to redirect or modify their yard lighting to reduce background lighting.
Channel Width	
The following are tight, narrow areas that required special attention: • The three bridges in Berwick Bay • Horse Shoe Bend – particularly for supply boats and research boats • 20 Grand • Wiggles – particularly at MM100 and Wax Lake • Wax Lake Narrow passage – Double wide tows meeting on Intracoastal are tight from MM 110 to MM 85.	Continue practice of allowing only one-way traffic through the bridges. Widen channels. Single up tows in tight spots. Over wide tow permit – identify conflicts and gain information – coordination effort.

Risks	New Mitigation Strategies
Waterway Complexity	
Waterway has many bends and curves. Changing bottom and channel limits due to erosion and water movement. Not all names for local marks are charted. • 20 Grand notation is not on the chart; adjacent to it, MM 95 notation is on the chart. Crossing traffic – Avoca Island – cable operated ferry.	Increase educational efforts aimed at shallow draft vessels which operate without benefit of pilots and who lack local knowledge Big Island and River. Consider providing more surveys of the changing areas of the waterway. Work with the local operators to identify those constantly changing areas. Conduct a WAMS of the area, in particular, examine the long stretch with no lighted aids to navigation. Consider adding more day boards in Bayou Shaffer at the Y at Sweet Bay. Provide channel information / current & weather information. Provide current meter at high current locations. Consider acquiring a real time wind conditions system similar to the information that is available from P.O.R.T.S. Consider cataloging additional wind data gathering facilities in the area to enable expanded use of data when necessary. Update the published charts.
Volume of Petroleum Cargoes	
Increasing trend for petroleum carried. 10 - 15 percent of vessels moving. One tow can carry 2.5 million gallons. Small oil spills occur continuously. USCG data charts are not complete. Traffic data is from the USACE, based on Bayou Boeuf Lock transits. Many petroleum products go up the river that are not tracked at the locks. Need information from Port Allen locks.	A dam could help to contain an oil discharge. Change in operating procedures. VTS to control the waterway until response is over. A VTIS could oversee response efforts. Response resources need better management. There apparently is a perceived shortage of resources in the Morgan City areas. Other agencies besides USCG need to be more closely involved in spill prevention and response. Review and monitor spill response effectiveness.

Risks	New Mitigation Strategies
Volume of Hazardous Chemical Cargoes	
Vessels carry propane, benzene, naphtha, and drilling wastes (the latter are not hazardous materials as defined in LA or U.S. law). Saltwater disposal wells are located in the risk area. Hazardous materials disposal pits – oil field waste – could overflow if low-lying area where they are located flooded during a hurricane. Hazardous waste dumping facility at Bateman Island.	Increase public education programs to achieve better public cooperation in the event of an evacuation order. Isolate future facilities far enough from public areas to minimize hazards. Other agencies besides the USCG need to be more closely involved in spill prevention and response. Review and monitor spill response effectiveness at future meetings.
Economic Impacts	
If Atchafalaya were blocked: • Supply boats, support people, and fabrication yards would be shut down. • Must go 30 miles east and 60 miles west to detour around any constriction – not completely isolated – will be draft constrained. • Morgan City has rail but no loading facilities. If Intracoastal were blocked: • It will take 40 percent of the jobs; this is an intrastate waterway. Alternate is down the Atchafalaya and up the Chene to get around. • Can block the entire GICW If blockage is worst case, economic impact is felt in one week due to ways to get around a blockage. At Amelia – a major fabrication – need 20 feet water depth to move a rig, which is a $1 billion impact when moved. If bridges are taken out, railroads are stopped; $7 million a week when bridge was last down.	Build a new Intracoastal waterway east of MM 99. This alternate waterway will bypass problem areas. Put in other infrastructure to take the transportation requirements. Establish a VTIS / VTS to provide information to organize the maritime traffic. Look at different traffic schemes. Ensure River Crisis Action Plan is up to date and viable AIS may help if all vessels underway are equipped since it will help identify vessels ahead to enable safer passing.

Risks	New Mitigation Strategies
Environment Impacts	
Environmentally sensitive areas home to species including: • Black bear • Sturgeon • Pelicans • A million or more waterfowl • Breeding grounds for brown shrimp • Primary winter-over areas for ducks on East Coast • Commercial fishermen operating from Morgan City for menhaden and shrimp Port is wildlife management area. It includes the Delta Islands and Eugene Island. Dead zone in Gulf growing every year.	Install pump out stations, solid waste holding facilities, and bilge slop pump out stations. Install and approve Type II MSD. Support AWO Responsible Carrier Program for uninspected towing vessels. Improve response capabilities. Designate an anchorage area in the Atchafalaya River. Accurately plot the pipelines on the chart. Physically mark the pipeline crossings along the bank. Check these crossings; they may be exposed due to erosion. Consider putting mooring buoys on Bayou Boeuf Locks.
Health & Safety Impacts	
Water intake on GICW near Rousseau Landing. Morgan City – population is 8,000 - 10,000 people; within a few miles – jumps to 20,000 people, along both sides of river. Protection levee currently exists around entire areas with pumping system to pull rain water out. Prevailing wind is from southeast.	Identify hazardous materials spill contaminant. Provide a viable means to alert emergency response people. Test evacuation plans.

Conclusions

Traffic density was a concerning risk factor for the participants. Tugs / barges meeting at the intersection of the Intracoastal Waterway with the main channel generate the highest risks. Recreational boaters and personal watercraft operators also cause traffic density and interference problems in several key deep draft transit areas of the port. There is some concern that the number of recreation boats is increasing, especially on the weekends and holidays. In the past, the recreational boat operators were locals, who grew up operating boats on the river and marshes. The influx of 'foreigners' with limited experience and local knowledge may pose additional problems.

Participants also were concerned with currents. While the river current runs constantly down stream, unaffected by the tidal action of the Gulf, its speed increases during the spring thaw and fall rains. The river current speed can reach as much as 5 - 6 knots. In the high current areas, tugs turning barges experience problems maintaining their position in the channel. The participants felt that risk due to currents was at the highest possible level.

The complexity of the waterway with many turns and narrow channels coupled with the difficulty of making satisfactory passing arrangements is a major concern of the participants. The VTS monitors traffic throughout the Berwick Bay area. The existing VTS has some radar coverage and very good camera coverage up to the three bridges. The frequency for bridge-to-bridge communications is crowded with voice traffic. Bridge abutments on the Atchafalaya River and its tributaries create problems for vessels both because of the narrow width of the openings (the narrowest is 320 feet wide) and because the current is typically strongest between the abutments where the channels are deepest. Underwater pipes that carry gas cross the channel at known and unknown locations. Sunken barges pose an allision problem. The bottom depth varies with the level of the river and the cut of the channel by the current. Sand shoals can be hard and unforgiving.

A large volume of crude oil and petroleum products are carried on barges as cargo in the port. Consequently, this risk factor was the highest concern to the participants, even though this risk is mitigated by vessel traffic management procedures and by pre-positioning of cleanup resources.

The participants judged the environmental impact of an incident in Berwick Bay to be the highest long-term consequence. Economic impacts were second. Berwick Bay contains many environmentally sensitive wetlands that are home to animals such as the black bear, sturgeon, brown shrimp, and pelicans. This is the primary gathering area for most ducks flying up to the east coast of the U.S. Closure of Berwick Bay to vessel traffic either as a result of heavy swells at the bar or by order of the COTP because of an incident that results in closure of one or more waterways within the port can create a nuisance as the supply boats and support people must go 30 miles east and/or 60 miles west to detour around any restriction. Forty percent of the jobs around Berwick Bay depend upon the traffic in the Intracoastal Waterway. Waterway closures would also adversely impact ferry schedules, tourism, and recreational boating.

Cincinnati

Overview

The Ohio River is navigable, and despite seasonal fluctuations that occasionally reach flood proportions, the river is fairly uniform flow has supported important commerce since settlement first began. Following destructive floods in 1889, 1913, and 1936-37 when the river reached 80 feet, the federal government built a series of 46 locks and flood-control dams assuring a 9-foot depth of navigability for the river's entire length. The Captain Anthony Meldahl Lock and Dam is 36 miles upriver and the Markland Lock and Dam is 60 miles downriver of Cincinnati. Navigation on the river is generally referenced to mile markers beginning at Pittsburgh, PA. Cincinnati is located at approximately mile 471, on the part of the river referred to as the Markland Pool. River current is typically 1 knot, but can reach up to 6 knots during flood stages.

Cargoes of coal, oil, steel, chemicals, and manufactured articles are carried on the river. In fact, the Ohio River carries significantly more tonnage than the Panama Canal. Barge fleeting areas line the banks of the river above and below "downtown" Cincinnati. The river also is a source of drinking and industrial water for municipalities.

The Cincinnati climate is temperate, but the weather is subject to sudden changes. The average January temperature in Cincinnati is 35^{o}F, and the July temperature averages 78^{o}F. Rainfall is about 37 inches per year, and only rarely does the Ohio River freeze.

For the purpose of the Cincinnati Ports and Waterways Safety Assessment, the participants defined the port area as that portion of the Ohio River between mile markers 436 (Zimmer power plant) to mile 500, including the Licking River to mile 7, the Great Miami River (for two miles), and Tanners Creek.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
Tug / tows: about 5,500 line haulers thru-transits annually. Fleeting movements are localized and are about 50 daily. Dinner cruise traffic / excursion boats move up to 35 times per day. Tug & barge shore infrastructure cannot absorb much more; demand is seasonal. Fleet areas hold barges for unloading, and are being moved farther away. (continued on next page)	Improve communications. Improve rules & regulations Improve static navigation information. Work with state, local governments to harmonize their jurisdictions and authorities. Encourage increased state / local law enforcement presence targeting high-risk times / areas. Establish / enforce no wake zone between Daniel Carter Beard and the Brent Spence Hwy bridges. (continued on next page)

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels (continued)	
Use of Markland and Meldahl Locks is at about 55% capacity; therefore the system has excess throughput capacity. But downtown area development between the Route 75 and I-471 bridges now limits this for fleeting tows.	Encourage boating education. Support mandatory licensing for boat operators. Study, recommend, and develop funding for solutions. Coordinate local Ohio River waterfront use & development plan addressing affect upon navigation of tug / barge fleeting areas and permanently moored vessels. Make resources available to resolve safety-of-navigation conflicts between recreational and commercial vessels.
Volume of Fishing & Pleasure Craft	
High (600+) recreational boat volume Major events at sports stadiums Riverbend and other music events Riverfest, fireworks, and Tall Stacks special events. A real problem with boats in the channel at Riverbend (mile 458). In Downtown area, recreational boaters cluster off the stadium to watch football games. Fast boats racing three abreast at high speed create the greatest hazard. Between the bridges, larger recreational boats causing wakes that hazard shore facilities, tugs with tows, and construction barges in operation. Fishermen hinder the channel at Tanners Creek (mile 458).	Improve rules & regulations. Work with state, local governments to harmonize their jurisdictions and authorities. Encourage increased state / local law enforcement presence targeting high-risk times/areas. Establish /enforce no wake zone between Daniel Carter Beard and the Brent Spence Hwy bridges. Encourage boating education. Support mandatory licensing for boat operators. Increase marine information broadcasts from USCG VHF-FM high sites advising commercial river traffic of unusual circumstances Review policy on MSD Cincinnati role during major marine events – USCG people are getting involved in law enforcement situations for which they are neither trained nor equipped.
Traffic Density	
Memorial to Labor Day higher traffic volumes with pleasure boating, fishing. Estimates of up to 25,000 boats at fireworks events. Recreation boater traffic is dense at Meldahl lock as fishermen await transit. Radio communication is poor because of geography and bends in the river. (continued on next page)	Improve communications. Improve rules & regulations. Establish a VTIS. Work with state, local governments to harmonize their jurisdictions and authorities. Encourage boating education. (continued on next page)

Risks	New Mitigation Strategies
Traffic Density (continued)	
There are several off-river marinas whose entrances are narrow and flanked by high banks. • Boats are often queued outside & in the channel awaiting entry • Operators exit marinas into the channel at high speed into the path of tows Shoreside events not subject to marine permit requirements attract large fleets; Sawyer Point, Serpentine Wall music events, football games, etc. After-event mayhem (usually at night) is very dangerous. Wakes damage shore facilities. • Many events are associated with heavy drinking and poor judgment. • Jet skis cause navigation problems at Aurora Park (mile 499). • Riverside ramp backups congest and block the channel. • Licking River: navigation conflicts between boaters, rowers and tugs. Fishing tournament fleets mass movements at Tanner and Hogan Creeks.	Establish /enforce no wake zone between Daniel Carter Beard and the Brent Spence Hwy bridges. Encourage increased state / local law enforcement presence targeting high-risk times/areas. Support mandatory licensing for boat operators. Increase marine information broadcasts from USCG VHF-FM high sites advising commercial river traffic of unusual circumstances Review policy on MSD Cincinnati role during major marine events – USCG people are getting involved in law enforcement situations for which they are neither trained nor equipped. Establish local ordnances for jet skis defining where jet skis may/may not operate. Specifically address distance from piers & docks and distance from ships in channel. Use CGAUX resources to target traffic density problems at the locks.
Visibility Obstructions	
Blind spots rounding the many bends in the river for visual, radar, and VHF communications. All structures in downtown area add to the limitation in visibility. In 1999, FCC tested from mile 463 to 474, finding interference problems from 7 pager frequencies. Vessels starting into the bridges cannot be heard by those between the bridges. Many dead communications sections and interference from Miami River to Anderson Ferry. USCG signal survey shows they can talk well everywhere from their high level site except between miles 484-512, where it is weak but readable. (continued on next page)	Improve communications. Conduct WAMS focusing on background lighting issues. Ensure that design of new shore facilities have minimal impact on visibility. Meet with site developers to mitigate existing backlighting problems. Review existing studies related to VHF-FM shortfalls. Re-evaluate and explore solutions to resolving these shortfalls including such measures as a repeater system, VTIS from high-level site, or some other method to resolve communications & navigation awareness problem. In working toward resolution, utilize all available avenues including local & state representatives and the applicable USCG District and/or HQ offices. (continued on next page)

Risks	New Mitigation Strategies
Visibility Obstructions (continued)	
No plan for a new high level site. Background lighting in downtown is trouble for commercial operators, but helps recreational boaters navigate. Paul Brown stadium lights blank out the suspension bridge from sight. Boaters rocket out of marinas, aren't looking & can't see beyond the hills flanking the marina entrances. These are also blind spots for towboats…very dangerous intersections.	Based on success / resolution of VHF-FM shortfalls, review pros and cons of AIS use in the defined area.
Waterway Complexity	
Several bends and 7 bridges that cross the river. Intersections of marina entrances and the river are dangerous due to high land on each side. Licking and Miami Rivers, Tanners, Hogans, and Laughery Creeks are dangerous intersections. Anderson Ferry makes many crossings daily, year-round. Wake induced chop develops and doesn't dissipate in the downtown area, especially on weekends. Fleeting services move barges across the river for unloading / loading. Little Miami River has a major bend that's a problem; as the channel narrows, boaters have trouble passing. There are no mile markers on the river. Waterway can handle the traffic anticipated, but shoreside development is restricting safe holding areas for tugs.	Improve communications. Improve rules & regulations. Establish a VTIS. Conduct WAMS. Encourage boating education. Support mandatory licensing for boat operators. Study, recommend, and develop funding for solutions. Coordinate local Ohio River waterfront use & development plan addressing affect upon navigation of tug / barge fleeting areas and permanently moored vessels. Make resources available to resolve safety-of-navigation conflicts between recreational and commercial vessels. Work with state, local governments to harmonize their jurisdictions and authorities. Encourage increased state / local law enforcement presence targeting high-risk times / areas. Establish / enforce no wake zone between Daniel Carter Beard and the Brent Spence Hwy bridges. Bridge-to-bridge radio communications.

Risks	New Mitigation Strategies
Number of People on Waterway	
15 dinner cruise ships operating several times a day during the season. Operating from Coney Island to Anderson Ferry (miles 458-480). About 1,000 people on board in the worst case, 300 on average. Two overnight steamboats carry 400 passengers each. Occasional visits. Permanently moored passenger vessels could be a problem if they break away or are hit.	Improve communications. Improve rules & regulations. Boater education & increased law enforcement. Review disaster contingency plans to ensure they address worst case passenger vessel scenario.
Volume of Petroleum Cargoes	
USACE statistics show about 65 million tons carried annually: 80 % coal, 15-18 % petroleum / chemical cargoes. Tows carry about 22,500 tons = less than 20,000 bbls. per average tow. Largest single unit in one barge is 30,000 bbls. • Plus fuel on the tugs of about 32,000 to 85,000 gallons BP petroleum at mile 474, Licking River facility, and the Chevron petroleum transfer facility down river.	Improve communications. Improve rules & regulations. Improve static navigation information. Improve dynamic navigation information.
Volume of Hazardous Chemical Cargoes	
Toluene, styrene, chlorine, and many other chemicals are traveling in bulk through the port.	Improve rules & regulations. Improve static navigation information. Improve dynamic navigation information. Validate Regional Contingency Plans for chemical spills. Maintain close liaison with Ohio & Kentucky Emergency Management Agencies. Isolate future facilities from population centers.

Risks	New Mitigation Strategies
Economic Impacts	
Closing this port affects up and downstream transportation of goods. Effects felt quickly; CG&E electric generation plant uses coal. A major shift in business inventory practices calls for just-in-time arrival of products. This results in limited stockpiles of goods and materials. A one-week shutdown will have major affect on the economic viability of the region. Local impacts on the maritime workforce are more immediate. Stockpiles of petroleum are very low, perhaps days.	Improve communications. Review contingency plans to ensure they have identified salvage equipment (location, POC, response times) that would be needed should a river-closing event occur: • Obstruction of the river caused by bridge failure or terrorist act • Grounding or spill of severely hazardous chemical cargo-carrying barges
Health & Safety Impacts	
Drinking water is drawn from the Ohio River and Licking River. Industries are also drawing for cooling water. Public gathering places and restaurants lining the downtown riverbank are vulnerable to river mishaps or chemical spills. About 1.3 million people live along the river. St. Luke's Hospital and several schools are within a mile of the river. Emergency response organizations have much more capability now, but the coordination between the groups must improve.	Improve communications. Improve rules & regulations. Establish a VTIS. More exercises; emergency management resolve. Consider regular exercise to validate emergency action plans. Conduct vulnerability assessment for permanently moored barges.

Conclusions

The participant teams in the study considered short term consequences to be the third highest category of risk. Each of the related risk factors considered within this category received moderately high ranking. Number of people on the waterway ranked sixth overall, while volume of petroleum, eighth, and volume of chemicals, ninth, trailed slightly behind. The study evaluated these risk factor to be interconnected, and thus developed a coordinated group of interventions to minimize risks in these areas.

Traffic conditions was considered to be the second highest risk factor in the study. The volume of fishing and pleasure craft was the fourth highest risk factor overall, and was a

predominant element of the fifth-ranked traffic density factor's discussion. Thus, the study participants concluded that further review and analysis is needed in order to address these risk factors, and to develop a comprehensive corrective action plan.

The second highest-ranking overall risk factor was health & safety impacts. The related categories, economic impacts and environmental impacts were moderate risk factors, ranking at tenth and fourteenth respectively. Together, these risk factors were clearly of great concern to the study participants. Once again, the participants determined that further review and analysis is needed in order to reduce these risks to an acceptable level.

Given the geographic location of the Port of Cincinnati, it is reasonable that the study participants concluded that waterway complexity was the highest overall risk factor. The interventions developed to address the high level of risk in this category again focused on planning and enforcement – additional studies are necessary, and in the mean time, encourage enforcement of current waterway rules and regulations.

In addition, the study participants strongly supported the need to improve communications to resolve the risk in navigation caused by the river's visibility obstructions - sinuous course, high hills and several bridges located at Cincinnati. Bridge-to-bridge radio communications, radar effectiveness, and visual line of sight sensory modes used in safe navigation are limited. A down bound tug and tow are irrevocably committed to transit the river at Cincinnati well before they have information about other river traffic or obstructions.

Finally, the participants recommended the following list of non-VTM tools to improve safety on their waterway. These were as follows:

- Volume of Petroleum – More exercises.
- Volume of Chemicals – More exercises.
- Volume of Fishing & Pleasure Craft – Increased law enforcement by the states of Kentucky and Ohio.
- Number of People on the Waterway – Education of boaters and greater law enforcement presence.
- % High Risk Shallow Draft Vessels – More law enforcement.
- Bottom Type – U.S Army Corps of Engineers survey.
- Traffic Density – More law enforcement.
- Health & Safety Impacts – More emergency management exercises.

Corpus Christi

Overview

Corpus Christi lies on the west side of Corpus Christi Bay, about 20 miles inland from the outer end of the Aransas Pass jetties, and is reached from the Gulf of Mexico by a narrow man-made and maintained deep draft channel. The bay is part of a waterway complex extending along the Texas coast from just southeast of Galveston to approximately the border with Mexico. This complex is separated from the Gulf of Mexico by a series of low-lying and elongated barrier islands. Although the bay gives the appearance of open water, its utility outside of the man-made channels is generally limited to craft drawing nine ft or less.

There are relatively frequent occurrences, during the winter months, of strong frontal action and fog. The winds during frontal passage can be strong enough to affect the handling of lightly laden or high-sided ships and barges, particularly since passage is likely to be accompanied by a radical shift in wind direction. Strong winds can modify the tidal range significantly, and winter northerly winds can depress the level of water inside the barrier islands by as much as two ft below mean low water. A real-time tidal and current measurement system is in operation.

Channel width is 600-700 feet, broadening briefly at several locations to form turning basins. In general, the channel is well marked by a combination of buoys, fixed aids and mid-channel ranges. The ranges are particularly important because of the long reaches of dredged channels and the general absence of prominent landscape features. The deep-draft channel is intersected by a series of shoal draft channels, including the ICW, some of which coincide for short stretches with the deep-draft channel. Barge traffic is moderately heavy. The area hosts significant recreational and fishing fleets.

A little over 1,500 yards inside the jetties the main entrance channel splits into three separate routes, and represents what is arguably the most difficult part of the entire waterway complex. The Lydia Ann Channel, branching to the north is a shoal-draft channel serving as an alternate leg of the ICW and is used by barge traffic. It also forms a route transited by fishing vessels enroute both to the Gulf and to the shrimping grounds of Aransas Bay. The Aransas Channel, essentially a shallow draft extension of the Jetty Channel, serves facilities located at Aransas Pass. The main channel turns westward. There is considerable vessel activity centered around or near the point of trifurcation. West of Harbor Island the main channel lies across the southern end of Redfish Bay where it intersects and crosses the ICW just to the east of Port Ingleside. In addition to crossing the ICW flow, barge traffic between Corpus Christi and the ICW joins deep-draft shipping at this point and shares the channels with it to the heads of deep-draft navigation.

The Corpus Christi Harbormaster provides an information service, with particular emphasis upon deep-draft vessel movements. The service might be termed an embryonic Vessel Traffic Information Service (VTIS).

Risks	New Mitigation Strategies
Volume of Fishing & Pleasure Craft	
Operators of trailered boats are unfamiliar with the area and the rules of the road.	Greater enforcement effort and on-the-water presence.
Tide & River Currents	
The Port Aransas area is subject to strong and unpredictable tidal currents.	Examine feasibility of increasing the number of tide and current meters to augment existing Corpus Christi real time system.
Waterway Complexity	
Aransas Pass - junction of four waterways and crossing traffic. The junctions of the La Quinta Channel and the ICW with the main channel. Movement of large rigs requires closure of the waterway.	Insure EAIS / VTIS planning addresses movement information requirements.
Volume of Petroleum	
No specific risk identified.	Establish EAIS / VTIS.
Economic Impacts	
Channel blockage affect area within 12 hours to 5 days, depending upon where the blockage occurs. Spills can adversely impact fisheries and tourism. A spill in Corpus Christi inner harbor could necessitate closing cooling water intakes.	Establish EAIS / VTIS.
Environment Impacts	
Numerous wetlands and environmentally sensitive areas. Hazardous chemicals can enter water column, resulting in significant long-term impacts upon fisheries.	Continue use of moving safety zones. Establish EAIS / VTIS.

Conclusions

Several areas of risk were identified in the survey to which no specific intervention has been assigned - Congestion; increasing numbers of crew & passengers; lack of lay berths; man-made obstructions /other vessels; and background lighting. Given the complexity of the Corpus Christi waterways, it would be prudent to, first, complete the risk intervention plan for this port to include the above categories. The combination of these risks alone – large and increasing numbers of vessels of varying types, coupled with a lack of lay berths, further complicated by numerous man-made obstructions, as well as a web of vessel traffic traveling through the vastly complex waterway system - seems to point to a high probability for disaster. The addition of educational programs for pleasure craft and fishing vessel operators along with more stringent enforcement of boating laws, as indicated in the interventions, should serve to minimize risks caused by inexperienced boaters. However, a comprehensive study should be conducted to develop a coordinated intervention plan to minimize hazards due to these risk categories.

Rapidly increasing and varied vessel traffic presents another challenge at Corpus Christi. The Harbormaster's current information service primarily reports deep draft vessel traffic movement. In order to minimize potential hazards due to traffic volume, efforts should be concentrated on enhancing this service to include the traffic movements of the other numerous types of vessels. Special attention should be given to the high-risk area at the channel's main entrance prior to its division into separate routes. This area has the highest concentration of vessel traffic at any given time, especially related to those merging upon exiting the harbor.

Strong and unpredictable winds seems to be the predominant challenge related to navigating Corpus Christi. Thus, the study indicated the need to encourage local broadcasts and use of BTM & NOAA radio announcements to improve weather alerts and current conditions and/or implement other means by which this information may be disseminated. Further, an evaluation of the cost-effectiveness of installing wind gauges as part of P.O.R.T.S. is in progress. In addition to these measures the stakeholders should consider the use and/or addition of visual navigational aides along the channels (i.e., flags, depth indicators) in order to provide vessel pilots with a real-time visual indication of the wind's impact at specific points along the channel.

Related to this issue is the prevalence of strong and unpredictable currents. Although a real-time tidal and current measurement system is currently in operation, the study indicated the need to install new or additional real time current meters in selected parts of the port. This, too, would help to minimize risks associated with wind conditions.

Houston / Galveston

Overview

Galveston Bay is the approach to the Houston Ship Channel and the ports of Houston, Galveston, and Texas City, as well as numerous smaller towns and bayous. The bay is about 30 miles long in a general north / northeastern and south / southwestern direction, about 17 miles wide at its widest part, and has general depths of about 7 to 9 feet. About midway of its length it is nearly divided into two parts by Red Fish Bar, a chain of small islets and shoals, through which the Houston Ship Channel has been dredged. North of Red Fish Bar the bay is known as the Upper Bay and south of Red Fish Bar as the Lower Bay.

Galveston Entrance, the approach to Galveston Bay, lies between two converging stone-rubble jetties about 4 miles long and 1.3 miles apart at the outer ends.

A mandatory (Coast Pilot incorrectly says "voluntary") vessel traffic service (VTS) has been established in the Houston-Galveston area and includes precautionary areas, reporting points and a vessel traffic center (voice call "Houston Traffic"). The vessel traffic center (VTC) is operated continuously by the U.S. Coast Guard and maintains voice communications with vessels via VHF-FM Channels 11 and 12 primary and Channel 13 secondary.

The diurnal range of tides at Galveston Entrance is 2.0 feet. The effect of wind on the water level in the Gulf of Mexico and adjoining bays may be considerable. East and southeast winds may cause a continuous flood current between the jetties for a day or more and may result in a 2-4 feet increase in the observed height of mean low tide. Conversely, a strong northern wind may lower the water levels in the bay by 2-3 feet below mean low tide and west / northwestern winds can cause a continuous ebb tide through the jetties. The average velocity of the current between the jetties at strength is 1.7 knots flood and 2.3 knots ebb.

The climate of the Houston / Galveston area is predominantly marine tropical. Poor visibility is sometimes a problem in winter with fog most often occurring November through April. Thunderstorms are common May through September. On average, the Houston / Galveston area experiences a hurricane about once every 5 years.

The diurnal range of tide in the Houston Ship Channel at Morgan's Point is about 1 foot. At Houston there is practically no periodic tide, but the waterfront is greatly influenced by winds. The terrain along the Houston Ship Channel includes numerous small streams and bayous, which together with the nearness of Galveston Bay favor the development of ground fogs. Prevailing winds are south / southeastern except in January when frequent passages of high-pressure areas bring invasions of polar air on prevailing northern winds. Heavy fog occurs on an average of 16 day a year and light fog about 62 days a year. Destructive windstorms are infrequent, but thunderstorms and tropical storms occasionally pass through the area.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Shallow draft vessel operators tend to have little local knowledge and typically do not utilize pilots to improve local knowledge. Inland tug / barge units create congestion problems in the Entrance Channel and at the intersection of the ICW with Houston Ship Channel and Texas City Channel. Commercial fishing vessels (predominantly shrimpers) lack radio communications (VHF transceivers are either broken or unattended), typically have unprofessional crews and receive low maintenance (economic issue). Recreational boaters lack basic competency in the operation of their boats (attributed to lack of training) Recreational boaters do not respect the hazardous environment in which they are operating, lack local knowledge, and frequently consume excessive alcohol while underway.	Coordinate meetings with towboat operators to discuss the perceived problems and elicit solutions. Monitor and review at future meetings of HOGANSAC. Review marking of approach channels and intersection of ICW and main channels. Consider a Regulated Navigation Area to closely control traffic. Monitor and review intersection congestion problems at future meetings of HOGANSAC. Encourage participation in training and education programs by small vessel operators. Encourage local law enforcement agencies to participate in education and enforcement actions and to send representatives to HOGANSAC meetings.
Volume of Deep Draft Vessels	
Dock congestion creates increases in transits due to tank vessels having to move long distances to lay berths to conduct gas free operations. General lack of lay berths within the ports.	Consider the provision of additional lay berths for tanker gas freeing operations.
Volume of Shallow Draft Vessels	
Tug and barge units compete with large seagoing vessels for waterway space.	Consider a barge lane as opposed to a barge shelf with to separate deep draft vessels from shallow draft vessels.
Volume of Fishing & Pleasure Craft	
Shrimp boats and recreational boats interfere with passage of vessels in the main channels.	The number of marina slips available limits the number of moored recreational boats. Encourage participation in training and education programs by all small craft operators. Encourage law enforcement agencies to participate in education programs and enforcement actions Send representatives to HOGANSAC meetings. Monitor and review effectiveness at future meetings of HOGANSAC.

Risks	New Mitigation Strategies
Traffic Density	
Problem areas are between Lynchburg and Shell, Bolivar Roads (Pelican Island) to Buoy 11, Clear Lake traffic entering at Red Fish, and 4 -5 Mile Pass. Increased density of daylight traffic due to restricted nighttime vessel movements. Vessels can't get enough "air time" to make passing arrangements on VHF-FM. Commercial fishing boats impede vessels in the precautionary area offshore and the channels inland. There are a large number of recreational boats in the waterways on weekends and the problem is increasing.	Consider sequencing movements for very large vessels such as tanker movements limited to one per hour. Considerer separating deep and shallow draft traffic with separately marked lanes on each side of the channel. Monitor the necessity for movements restricted to daylight hours only and consider what changes could be made in channel markings to enable additional night movements. Review the rationale for movement restrictions. Consider requesting additional VHF-FM channels for port operations from FCC. Install AIS on transiting vessels. Encourage participation in training and education programs by small vessel operators. Encourage local law enforcement agencies to participate in education programs and enforcement actions. Send representatives to HOGANSAC meetings. Monitor and review effectiveness at future meetings of HOGANSAC.
Channel Width	
Channels are narrow throughout the area. Berthed vessels restrict meeting and overtaking situations above Green's Bayou. Baytown is a high risk meeting and passing area because of the adjacent terminals. Dredges create problems in that they are essentially fixed and cannot maneuver to avoid traffic Crossing traffic at the intersection of the ICW and both the Houston Ship Channel and the Texas City Channel creates a high risk environment.	Participants feel the VTS and coordination between pilots have reduced the risk to a nearly acceptable level. Review marking of approach channels and intersection of ICW and main channels. Consider a Regulated Navigation Area to more closely control traffic. Monitor and review intersection congestion problems and passing arrangement issues at future meetings of HOGANSAC.

Risks	New Mitigation Strategies
Waterway Complexity	
Merging and crossing traffic creates problems in the ICW and Houston Ship Channel crossing, Lynchburg (ferry crossing), Carpenters Bayou, and Bayport. Underway vessels passing Aimcor tend to pull berthed vessels off their moorings and into the channel. Vessels can't get enough "air time" to make passing arrangements on VHF-FM. VTS is sometimes restricted in the information that can be passed by VHF-FM because of contention for limited frequencies.	Establish AIS to mitigate risk by providing better real time data on vessels ahead. Meet with terminal operator to review adequacy of line tending procedures. Have COTP personnel board ships at Aimcor to address necessary changes to line tending procedures. Request additional VHF-FM channels for port operations from FCC. Consider actions to reduce voice traffic on port operations frequencies.
Number of People on Waterway	
Cruise ship operations are currently at Barbers Cut, start in Galveston September 2000 and are planned for Bayport. Ferry operations in upper Bay (small) and from Galveston to Bolivar (large). Expansion of ferry service is expected. Party boats (up to 75 POB) currently operate out of Galveston to sea. Gambling boat operations are expected on this same route. Tour boat operations in the Turning Basin serve the USS Houston.	Crews require training in the actions required to minimize injuries and deaths. Response resources need to be identified and exercised. Review and monitor response effectiveness & contingency planning in future meetings of HOGANSAC.
Volume of Petroleum Cargoes	
Two thirds of cargo tonnage is petroleum and most is in the upper Bay up to 50 miles from the sea buoy creating risk exposure throughout the waterway.	Containment and cleanup resources are readily available along the Houston Ship Channel in the event of a spill, but the participants feel response resources need better management. There apparently is a perceived shortage of resources in the Galveston and Texas City areas. The participants feel other agencies besides USCG need to be more closely involved in spill prevention and response. Review and monitor spill response effectiveness at future meetings of HOGANSAC.

Risks	New Mitigation Strategies
Volume of Hazardous Chemical Cargoes	
Hazardous material carriers require lay berths in close proximity to unloading terminals. Lengthy passages to distant lay berths to gas free tanks increase risks. Inability to immediately identify hazardous materials carried in containers on container vessels causes problems if there is an accident.	Consider the provision of additional lay berths for tanker gas freeing operations to reduce transits and risks. Public education programs need to be increased to get better public cooperation in the event of an evacuation order. Isolate future facilities far enough from public areas to minimize hazards. Other agencies besides USCG need to be more closely involved in spill prevention and response. Review and monitor spill response effectiveness at future meetings of HOGANSAC. Consider training and education programs in hazardous chemical identification and handling for container terminal longshoremen.
Economic Impacts	
The Houston area can tolerate a port closure of about 3-4 days. Texas City refineries have no more than a two-day supply before shutting down. Refineries need to continue operations since shut downs are expensive in economic terms and increased risk since shut downs and startups are when most accidents occur. Beaches near Galveston and along the Bolivar Peninsula are of high economic value to the tourism business and beach closures would create a serious economic impact in those areas.	Establish an offshore terminal to significantly reduce the risks associated with the movement of hazardous cargoes through the waterways. Establish AIS since it will help identify vessels ahead to enable safer passing.
Environment Impacts	
Galveston Bay is reportedly the second most productive estuary in the U.S. The mud flats behind Bolivar Peninsula and Pelican Island are extremely sensitive areas. Pelican Island is a significant nesting area.	Response resources need better management. Increase resources in the Galveston and Texas City areas.

Risks	New Mitigation Strategies
Health & Safety Impacts	
Many people live near the waterways above Barbers Cut. Houston Light and Power at Dickinson Bay as well as other plants along the waterways use cooling water.	Increase public education programs. Response resources need better management. Meet with plant managers to educate in how to boom off areas vital to their plant operations. Encourage plant managers to have own resources available in order to quickly react to a spill.

Conclusions

The risks associated with the Houston / Galveston harbor are varied and, together, present a complex problem to the development of a complete and comprehensive mitigation plan. The participants identified heavy traffic conditions, waterway complexity, volume of chemicals and petroleum products, as well as specific areas within the category of navigational conditions as areas of risk requiring the implementation of mitigations.

Of the risks identified, traffic conditions was the highest risk factor identified in the Houston / Galveston study, with the volume of shallow draft vessels being the primary area of concern in this category. However, the mitigations measures currently in place should be quite sufficient to reduce the risk to an acceptable level.

Though navigational conditions, as a whole, was determined to be one of the lesser concerns of all risk factors, specific risks associated with currents, tides and rivers are considered among the highest risks. Under certain conditions, Galveston Bay and its tributaries can have significantly less depth than predicted by tide tables resulting in underkeel clearance problems. There can also be stronger than normal currents along and across waterways that impede the maneuvering of vessels and towboats. The narrow, twisting channels of Houston Ship Channel and the low topography that presents few radar targets for navigation create difficult passages in low visibility. For that reason, the waterways are occasionally closed to traffic due to low visibility. Such closures average 300 hours per year, and may have some associated economic and regional impact on the area. The sometimes geographically sporadic nature of the fog in the area results in good visibility in one part of the channel while other parts of the channel are in restricted visibility. The concern expressed by the participants is for vessels underway when the fog develops. The lack of anchorages and the narrow channels in the Houston Ship Channel require vessels to complete a passage once commenced and therein lies much of the risk. Seasonally high winds are also a concern. Given the significance of this risk, additional mitigations may be necessary in order to minimize potential far-reaching negative effects on the harbor.

Waterway complexity was another area identified as “high risk” in the study of Houston / Galveston because of the impact of narrow, twisting channels, numerous

meeting and passing situations, and the many reaches with berths in close proximity to passing vessels. Though a necessary mitigation sited in other risk categories, ongoing channel dredging also contributes to waterway complexity by restricting traffic to one way in the vicinity of dredging operations. In some instances, crowded communications frequencies increase the difficulty of making satisfactory passing arrangements and limit the ability of the vessel traffic center to provide complete information on waterway activity with scheduled broadcasts or in response to queries. In addition, background lighting and visual obstructions are a concern in that they make some range lights and/or daymarks difficult to locate visually. Mitigations currently in place should be sufficient to minimize risk in these areas.

Extremely high volumes of petroleum and chemical cargoes moving in close proximity to populated areas was identified as an area of concern to the participants in the study. They were particularly concerned with the inability to quickly identify hazardous liquid cargoes carried in containers on container vessels as opposed to more easily identifiable cargoes carried on tankers. Also, there is reportedly a shortage of lay berths close to terminals for tankers to gas free tanks.

These risks have a "ripple effect" on other risk categories. Since closure of waterways can cause shutdown of refineries because of lack of inbound cargoes. The shutdown and startup phases of refinery operations are historically when most accidents occur. Further, beaches near Galveston and the Bolivar Peninsula are important economic assets to the tourist industry. Galveston Bay is the reportedly the second most productive estuary in the U.S. and severe environmental damage could result from a major spill. The closeness of major population areas to the waterways is of concern to the participants because of the potential for long-term health problems from exposure to hazardous vapors and liquids. Although mitigations have been implemented to address these specific risks, additional mitigations should be developed to minimize the risks to environment and to the economic impact associated with hazardous materials spills, waterway closures, etc.

Given that the Houston / Galveston Harbor is one of the busiest in the U.S., and considering the complexity of its waterways, it is understandable that a comprehensive mitigation plan for this port will continue to expand and evolve over time. For now, there is an appropriate recognition of the issues facing the port, and it is readily apparent that substantive mitigations are currently being implemented to minimize risks.

Lake Charles

Overview

The City of Lake Charles is located around the east side of the lake from which the city takes its name, about 34 miles up the Calcasieu River from the Gulf of Mexico. The city is the center of large chemical, petroleum, natural gas, fish oil, synthetic rubber, salt, seafood, and rice industries. The major port area is opposite Clooney Island on the east bank of the Calcasieu River and the north bank of Contraband Bayou. Lake Charles is the only major port in western Louisiana. The principal imports are petroleum products, liquefied natural gas, creosote, and steel products. The principal exports are petroleum coke, petroleum products, chemicals, bulk and bagged grains, linerboard, plywood and other wood products, and urea. Other commodities handled at the port are canned foods, caustic soda, synthetic rubber, plastics, paper products, and other general cargo.

Three bridges cross the Calcasieu River in the port area:

- Interstate-210 fixed bridge with a horizontal clearance of 250 feet and vertical clearance of 135 feet;
- Interstate-10 fixed bridge with a horizontal clearance of 380 feet and vertical clearance of 95 feet, except that the bridge has a vertical clearance of 135 feet for the middle 200 feet of the channel; and
- Southern Pacific Railroad swing bridge with a vertical clearance of 1 foot when closed.

Deepwater access to the interior along the Calcasieu River is stopped at the Saltwater Barrier Lock, which has a controlling width of 56 feet and clearance at the sill of 13 feet MLG.

Risks	New Mitigation Strategies
Volume of Deep Draft Vessels	
85 ships per month now, and volume trend is increasing. There are infrastructure growth plans. Max limits on ships for two-way traffic are 400-foot length and 20-foot draft (pilot rule). CC sea buoy to CONOCO Wes Lake, full route capable of 36-foot draft traffic but one-way traffic when in transit. Three ships per day. 60-mile transit. One-way traffic most of the day with maxi ships. Speed = 10 knots or less. Limited anchorages. A-4 anchorage (off CITGO) not really an anchorage but used more so as a turning basin. Can hold 3 ships. Limited anchorages. Clooney Island anchorage can handle 4 maxi's. Limited anchorages. There are no designated federal anchorages on the Calcasieu River. No safe place to put ships other than at their berth. No written rules or regulations specifying the maximum size of ships. Perception is that pilotage practices keep changing. Anticipated increase in traffic. New traffic in oil rigs which will come into the industrial canal turning basin. East fork of Cameron is planning similar storage space for oilrigs; dredging basin.	Establish a VTS. Improve existing rules and apply them more uniformly. MSD initiate discussions and bring various parties together on the issue of pilotage rules and standard operating procedures for deep draft movements.
Volume of Shallow Draft Vessels	
Today volume is 13,000 tows crossing Calcasieu / GICW intersection annually. CONOCO handles tugs and barges as well as tank ships. Very heavy shallow draft traffic, especially in the lower river and around Cameron. Ferries cross the channel at Monkey Island and Cameron. (continued on next page)	Establish a VTS. Establish AIS for situational awareness. More aggressive enforcement of the bridge-to-bridge radio monitoring requirements. Encourage Lake Charles waterway users to respond fully to the Notice of Proposed Rulemaking concerning AIS domestic carriage requirements, which is due out shortly for public comment.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels (continued)	
Casino boats in Lake Charles. Not a problem because they avoid traffic. Impact of volume of shallow draft traffic is north of Calcasieu / GICW intersection. With the bends and turns, difficult to set up where to pass or meet – especially a problem with first-timers and GICW tows rather than the local operators who all possess good local knowledge. Limited fleeting areas for tugs and barges. North side of Calcasieu Locks – no place to tie up when you trip a tow. Tows generally are 2 wide by 1 deep, pushing ahead.	
Volume of Fishing & Pleasure Craft	
Very little fishing north of Calcasieu / GICW intersection. Lower river fishing is seasonal. May be as many as 30 at a time. Lower river not a problem. Recreational boats are there but more responsible (fishing rather than drinking and water skiing). Menhaden boats are seasonal and operate offshore, but they run in to Cameron to offload. High incidence of drunken operators, especially during two weeks of Contraband Days. Summertime density, especially weekends, thousands of boats and jet skiers in upper river, from turning basin off CITGO up to Lake Charles. Commercial traffic operates 7 days per week in this port so recreational boats do impact transits on weekends. Prien Lake is largest concentration for launching recreational boats.	Improve existing rules. Require licenses for recreational boat operators. Enforce radio procedures and keep fishing vessels out of channels. Enforce boating while intoxicated rules, especially during annual Contraband Days celebrations.
Traffic Density	
Freighters anchoring waiting berth space. Congestion and barge traffic at Calcasieu Lock. Congestion during storms / hurricanes Ships anchored in vicinity of sea buoy. East of 30 buoy waiting for the pilot.	Establish a VTS / VTIS. MSD work with local port community to either identify the compelling federal interest that necessitates a VTS or help them to establish a VTIS to monitor and coordinate traffic at the Four Corners, Calcasieu Lock, and entrance jetties.

Risks	New Mitigation Strategies
Visibility Obstructions	
Cannot see over bluff north bound and southbound at Calcasieu intersection. City docks due to obstructions on bank. Cannot see Clifton Ridge due to overgrowth at bend. Overgrowth at point on west side of Lake Charles. Halter shipyard lights mask lights, especially southbound. Inbound range lights masked by background lights. Bridge lights above the I-10 bridge going north are dimmer than the surrounding lights. LNG ships are going into the Industrial Canal. Entire north end of river is loaded with blind bends that you cannot see over.	Establish either AIS / EAIS or VTS / VTIS. MSD monitor progress in implementing planned improvements of background lighting.
Channel Width	
Everything above I-210 is too narrow to easily pass. Tightness of channel and volume of traffic is becoming an issue.	Improve existing rules. MSD initiate discussions and bring various parties together on the issue of pilotage rules and standard operating procedures for deep draft movements. MSD work with the local port community to either identify the compelling federal interest that necessitates a VTS or help them to establish a VTIS to monitor and coordinate passing arrangements for traffic using the port.
Waterway Complexity	
One significant intersection at Cameron, cross at ICW, contraband Bayou, reach approaching PPG terminal. Converging waterway at Calcasieu refinery. Small boat traffic in channel from Prien Lake. Blend of traffic coming together at jetties. Significant number of bends above Prien Lake. Outer Bar (CITGO) sees high risk area as requirement for pilot is reduced from 12-3 miles for mandatory pilotage. CC buoy to 3 miles off the jetty. Buoy channel runs 28 nm offshore.	MSD work with the local port community to either identify the compelling federal interest that necessitates a VTS or help them to establish a VTIS to monitor and coordinate traffic using the port.

Risks	New Mitigation Strategies
Number of People on Waterway	
Ferry operations: 50 cars, 100 people Casino boats: 200 to 1,500 per trip	No new risk mitigations discussed.
Volume of Petroleum Cargoes	
52 billion tons of petroleum is moving annually in the channel. 40% of traffic is petroleum vessels. 80% of tonnage is petroleum cargo. High risk due to high volumes of petroleum. Given lay of land, virtually no time to react if something happens on a ship.	Establish an EAIS to help predict oil spread. Improve existing rules. MSD work with the local port community to either identify the compelling federal interest that necessitates a VTS or help them to establish a VTIS to monitor and coordinate traffic using the port.
Volume of Hazardous Chemical Cargoes	
Mostly bulk cargoes. LNG: trend is increasing from current 30 transits to an estimated 50 transits per year. LNG facility just east of Four Corners. PPG facility takes tank ships and barges; 60 ships per year in and out of PPG in 1998. High volume of coastwise traffic carrying HAZMAT (transit, not stopping). Containerized cargo. 1900 TEUs. Very small amount, less than 1%. Big container ships will not come to this port due to the air draft restriction (135 feet).	Improve existing rules. MSD work with the local port community to either identify the compelling federal interest that necessitates a VTS or help them to establish a VTIS to monitor and coordinate traffic using the port.
Economic Impacts	
Port was closed at least 2 days in the past and no one was sent home. Tug sank in channel; it took 2 days to find and 2 more days to remove it. Movement in channel greatly restricted during the period. Rigs in Gulf of Mexico would feel the shut down - would be serviced by other ports. Jetty is critical risk area. Shallow draft could hit the rocks. (continued on next page)	Improve existing rules. Establish a VTS.

Risks	New Mitigation Strategies
Economic Impacts (continued)	
Deep draft must go through 300 feet of mud before hitting the rocks. There are no alternative entry points. Tugs are not deep-sea certified so they cannot go out and around to Sabine. If Four Corners is blocked there is no alternative route for GICW traffic.	
Environment Impacts	
Wildlife refuges on west side of Calcasieu Lake. Oyster beds at lower end of Calcasieu Lake. Tanks are being overfilled during oil transfer operation – refueling vessel at a dock most often. Endangered species include brown pelicans. Floating tops on petroleum storage tanks: no vapors allowed.	Improve existing rules. Establish a VTS.

Conclusions

The trend is for increases in the number of LNG ship transits, mobile offshore drilling unit services and storage, offshore supply vessels (OSVs) using the port, high capacity passenger vessel transits, and break-bulk operations. Anchorages for ships awaiting berths are very limited. Traffic density was a risk of particular concern to the participants, particularly where Calcasieu River channel traffic meets crossing tugs and barges at the GICW intersection (estimated 13,000 crossing per year). Recreational boats can create seasonal (summer) and some weekend problems on the river due to large numbers, lack of operator experience, water skiing activities, and alcohol abuse. This is a particular problem from the CITGO turning basin to Lake Charles. Other areas where traffic density was of concern to the participants were the Calcasieu Lock (tug and barge traffic waiting to use the lock) and the offshore anchorages where freighters await berthing space. Even so, no specific risk mitigations were identified, nor interventions developed during the study.

Complexity of the waterway with its many turns and narrow channels coupled with the difficulty experienced in making satisfactory passing arrangements made waterway configuration the third highest risk concern to the participants. High bluffs restrict visibility and background lights mask range lights and inbound traffic. Deep draft ships are restricted to the dredged channel; once committed they must proceed to berth. High risk intersections exist at Cameron, where the GICW crosses the river, and where the

Calcasieu refinery channel merges with the river. Traffic converging at the jetties severely impacts deep draft vessels' ability to maneuver. As deep draft traffic increases, so will conflicts. Still, no specific risk mitigations were identified. Additional interventions should be considered in order to minimize risk in this area.

The highest risk identified by the participants was the volume of petroleum carried in and out of the port. Product is carried by tank ship and barge. 40% of traffic is petroleum vessels, and 80% of the tonnage is petroleum cargo. Given the topography of the river system, there is virtually no time to react when something happens on a ship. The volume of hazardous chemical cargoes was deemed the fifth highest risk by the participants. Much of the chemical cargoes are bulk shipments. LNG ships are increasing from 30 to 50 transits per year. Still, no specific mitigations were sited, nor interventions developed during the study.

Environmental impacts were the second highest risk in the Lake Charles area. There are wildlife refuges through out the system, oyster beds at the lower end of Calcasieu Lake, and endangered species use the area as a breeding ground. The economic impacts of an incident on the Calcasieu River system were deemed the fourth highest risk. Vulnerabilities include a sinking in the channel (no way to pass the obstruction or the salvage craft; the jetties (no alternate entry points), and particularly the Four Corners (where the GICW crosses the Calcasieu). Once again, no specific mitigations were attributed to this risk factor, nor any interventions noted.

The results presented above for the Port of Lake Charles are not consistent with the discussion that occurred about how best to address the risks in the Calcasieu River system. Further discussion of this disparity and evaluation at the port level is warranted. A combination of VTS and non-VTS solutions should be considered in order to minimize risks in the port identified.

Mobile

Overview

Mobile is 28 miles inland from the entrance to Mobile Bay and is reached by a narrow man-made and maintained deep-draft channel. Its utility outside of the main channel is generally limited to craft drawing 9 feet or less. The volume of deep-draft traffic must be considered moderate but in 1987 the ports of Mobile Bay ranked 10th in the United States in terms of barge movements. The port lies inside a line of barrier islands, with the area between the barrier islands and Mobile constituting Mobile Bay. The Bay is crossed east and west by the Intracoastal Waterway (ICW).

Climate within the area classified as Sub-tropical Coastal. Two characteristics are important to vessel traffic management, the relatively frequent occurrence of strong frontal action and the occurrence of fog. About twenty significant frontal systems move through the area each year, usually accompanied by strong winds and heavy rain. The winds can be strong enough to affect the handling of lightly laden or high-sided ships and barges. Inshore, visibility drops to less than two miles about 5% of the time between December and April, with the worse conditions occurring in December and January.

The diurnal tidal range is very small, but strong winds can modify the tidal range significantly, and winter northerly winds can depress the level of water inside the barrier islands by as much as 1.5 feet below mean low water. Hurricane winds have been known to raise the Bay level 11.5 feet. Winds also have marked effect upon the predicted times of occurring high and low tides, and upon tidal current velocities. Normal tidal current velocities are less than 0.5 knot but reportedly can be increased in some areas to over ten knots by prolonged winds and heavy rain.

Entrance to Mobile Bay from the Gulf of Mexico is through a series of safety fairways. The Federal Project depth of the entrance channel is 42 feet over the bar, for a width of 600 feet, but is naturally wider and is currently deeper in spots. A Federal project provides 40 feet to Magazine Point at the head of the Mobile Ship Channel, with lesser depths in various branch channels. In general, channels throughout are too narrow to permit the meeting of ships whose beams exceed 115 feet. Inside the Bay, channels are well marked by buoyage, fixed aids and ranges. The bottom is soft mud and sand.

Pilotage is compulsory for all foreign-Flag ships and U.S. flag ships under register in the foreign trade, and optional for U.S. flag ships in the coastwise trade who have on board a pilot licensed by the Federal Government.

Risks	New Mitigation Strategies
Volume of Deep Draft Vessels	
No risks identified.	No new mitigation strategies discussed.
Volume of Fishing & Pleasure Craft	
Large pleasure craft move too fast in confined waterways. Fishing (shrimping) vessels in waterway. "Snowbird" recreational boaters not familiar with area.	Insure periodic Local Notice to Mariners publication of local area precautions. Support prohibition of fishing (shrimping) activities in federally marked channels. Assist in review of port tariff dealing with fishing in channels if requested. Increase educational activities within the local commercial fishing industry. Continue to enforce existing federal regulations.
Wind Conditions	
Unpredictable thunder showers cause strong winds. Strong seasonal winds in winter and squalls in summer. Real time wind conditions at Dauphin Island not available.	Support community agreement on assist tug requirements. Consider installation of real-time weather stations with direct access to data.
Waterway Complexity	
Deep draft vessels moving too fast in narrow channel can cause allisions with drydocks. Configuration of Theodore Channel and Mobile Ship Channel junction requires difficult turn for southbound traffic to Theodore. Tows frequently damage ICW fixed ATON structures.	Support USACE widening of Mobile Ship Channel to 550 ft. Examine necessity and realistic options to reconfigure Theodore intersection. Investigate feasibility of installing turning ranges for Theodore intersection. Investigate methods to improve Theodore range light visibility. Insure Local Notice to Mariners indicates the status of downed aids to navigation structures and that replacements are done in a timely manner.
Volume of Petroleum Cargoes	
No risks identified.	No new mitigation strategies discussed.

Risks	New Mitigation Strategies
Economic Impacts	
No risks identified.	No new mitigation strategies discussed.
Environment Impacts	
No risks identified.	No new mitigation strategies discussed.

Conclusions

Strong winds and strong, unpredictable currents are the predominant risks associated with Mobile. Visibility obstructions due to frequent occurrences of heavy fog were also of notable concern for the study participants. The study produced some initial recommendations for mitigations in these areas. These mitigations, however, are merely directed toward the development of a comprehensive mitigation plan. Thus, prior to drawing any conclusions regarding specific follow up actions in these areas, extensive work must first be directed toward organization and planning. Any specific actions taken at this point should be approached as short term or interim solutions in order to minimize risks while the plan is in development.

The study participants stated that the Mobile Bay is "crossed east and west by the ICW," and sited that "the entire area is environmentally sensitive, with large expanses of sensitive wetlands." While the risk analysis produced specific areas of risk associated with environmental impacts, no mitigations have yet been identified.

Further, the study identified channel width and depth as issues in need of mitigation. The participants recognized that environmental impacts of dredging and widening the channel should be considered in reconfiguration plans. Thus, the environmental impact study should be completed prior to making any final decisions regarding channel reconfigurations. Stakeholders should consider combining these issues and incorporating the risks associated with both into the development of a more comprehensive mitigation plan.

Though no risk was sited regarding bottom type, the study participants astutely recognized that mitigations for risks associated with channel width must incorporate issue associated with the channel bottom in order to ensure the inclusion of all related factors. On the other hand, the study produced other areas of risk for which there are no current mitigations including economic impacts, regional impacts, and the volume of oil and chemicals transported through the Mobile waterways. Future interventions efforts should include a review of these areas of risk prior to directing attention toward the "development of a detailed plan for addressing specific mitigations identified by the panel."

Pascagoula

Overview

Pascagoula lies on the Mississippi Sound about nine miles north of Horn Island Pass. The Port of Pascagoula includes the lower 5.9 miles of the Pascagoula River, the lower *5.2* miles of the Escatawpa River, and Bayou Casotte. Entrance from the Gulf of Mexico is through a series of Safety Fairways. The deep water entrance is through dredged cuts which form Horn Island Pass Channel and Pascagoula Channel. The entrance and Pascagoula channels are both well marked by ranges and buoys. Shoaling in certain areas of the channel restricts movement of larger vessels to daylight hours only and the narrowness of the channel limits ocean traffic to one way at all times. The Intercoastal Waterway (ICW) intersects and crosses the Pascagoula Channel approximately five miles south of Pascagoula itself. Pilotage is compulsory for all foreign vessels and all U.S. vessels over 250 tons under register in foreign trade.

Climate within the area is classified as sub-tropical coastal, with warm, humid summers and mild winters. About twenty significant frontal systems move through the area each year, usually accompanied by strong winds and heavy rain. The winds can be strong enough to affect the handling of lightly laden or high-sided ships and barges and the accompanying rain is often heavy enough to obscure aids to navigation and to render radar ineffective. Inshore, visibility drops to less than two miles about 5% of the time between December and April, with the worst conditions occurring in December and January.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Operator fatigue. Uncontrolled and unstructured movement of shallow-draft vessels outside of marked channels introduces unpredictability. Over 80% of shrimpers are difficult to communicate with. Many shallow-draft operators fail to communicated because of distractions. Many recreational craft do not follow rules of the road. Shrimpers from outside the local area and some ICW users not familiar with area.	Report concerns about impact of fatigue on safety to G-M. Increase educational effort. Bring problem to attention of management of the operating companies concerned. Disseminate existing standards / guidelines dealing with crew rest, etc. Consider rulemaking governing crew rest, etc. for shallow draft operators. Sponsor examination of practices by shallow draft managers and operators. Insure periodic Local Notice to Mariner publication of local area precautions..

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
Shrimping in marked channels increases risk. Fishing (shrimping) vessels in waterway.	Support port tariff prohibiting shrimping in marked channels. Increase educational efforts. Increase enforcement activities. Support prohibition of fishing (shrimping) activities in federally marked channels. Assist in review of port tariff dealing with fishing in channels if requested. Continue to enforce existing federal regulations. Increase educational activities within the local commercial fishing industry.
Volume of Fishing & Pleasure Craft	
Failure of recreational craft to observe rules of the road.	Support the recreational boating educational activities of the USCG Auxiliary, Power Squadron and other organizations.
Traffic Density	
Diverse mix of deep and shallow draft vessel types. Uncontrolled / unstructured movement of shallow draft vessels outside of marked channels introduces unpredictability.	Include fishing (shrimping) vessels and recreational boats for mandatory carriage requirements during USCG AIS implementation planning. Increase educational activities with the local and transiting shallow draft operators.
Wind Conditions	
Unpredictable thunder showers and squalls cause strong winds. Strong seasonal winds in winter and squalls in summer. Lack of real-time weather and forecast weather information. Wind caused breakaways from barge fleeting area in Pascagoula Harbor creates problems.	Support community agreement on assist tug requirements. Consider installation of real-time weather station(s) with direct access to data. Support planned movement of barge fleeting area to Bayou Casotte.

Risks	New Mitigation Strategies
Visibility Conditions	
Fog conditions vary in port (mostly in spring, fall and winter). Heavy rain reduces visibility. Lack of real-time weather and forecast weather information. Fog impacts scheduling of ship movements.	Consider RNA requiring precision navigation capabilities for low visibility movement within port areas. Broaden operating rules governing movement in low visibility to all vessels. Support planned movement of barge fleeting area to Bayou Casotte. Broaden operating rules governing movement in low visibility to all vessels.
Channel Width	
Dredges do not follow normal traffic flow. Movement of oil rigs require closure of waterway.	Examine possible corrective measures. Support the local practice of waterway closures during rig movement.
Waterway Complexity	
Narrow channel in Bayou Casotte causing vessel movement problems. Barge fleeting area in Pascagoula Harbor obstructs navigation tows frequently damage ICW fixed aids to navigation structures. Tows frequently damage ICW fixed aids to navigation structures. Westbound ICW and Bayou Casotte traffic cuts corner at "Y." Information about dredging operations not widely distributed.	Coordinate a study with the port stakeholders to determine how vessel movement can best be handled in confined waterways. Support movement of barge fleeting area to Bayou Casotte. Insure Local Notice to Mariners indicates the status of downed aids to navigation structures and that replacements are done in a timely manner. Bring problem to attention of USACE. Examine with the port stakeholders to determine the most effective way to control traffic cutting corners. Insure adequacy of dredging information published in Local Notice to Mariners.
Volume of Petroleum Cargoes	
No risks identified.	No new mitigation strategies discussed.
Volume of Chemicals	
No risks identified.	No new mitigation strategies discussed.

Risks	New Mitigation Strategies
Environment Impacts	
No risks identified.	No new mitigation strategies discussed.

Conclusions

Traffic condition and waterway configuration, combine to contribute nearly 50% of the overall scoring. During the study, mitigations were identified to address both. Similarly, individual scoring specifically highlighted the need to address the volume of petroleum. Although no specific interventions were identified to address the risks associated with volume of petroleum, the interventions sited for the waterway configuration issues seem to be sufficient to minimize the risks in both risk factors.

Further, the volume of petroleum is universally held to be the most significant sub-factor, receiving the highest possible weighting. In the absence of an economic sub-factor under short-term consequences it is probable that a large portion of that weighting reflects concern over the economic consequences, although not readily apparent, of interrupting the movement to the area's primary refinery.

The greatest concern under the category of fleet composition is high risk shallow draft vessels. Lack of knowledge of the area, unfamiliarity with the rules of the road, and failure to communicate intentions were other related and complicating factors found in the study. Participants noted that while practices followed by the pilots provide an appropriate management regime for deep-draft vessels, movement of shallow-draft traffic is not held to the same standard. In addition, fishing and recreational vessels represent a significant portion of the high-risk shallow draft category. Thus, interventions identified were concentrated, principally, in the areas of education and ensuring the competency of operators.

Discussions about navigational conditions focused upon the impact of environmental conditions (e.g., wind, tide, currents) upon the handling of vessels, particularly large shallow-draft tows, and of fog upon vessel movement generally. The weightings assigned under this risk factor are consistent with those discussions. The interventions assigned to visibility conditions, on the other hand, reflect the economic consequences of delays in movement upon operation of the Chevron plant in particular.

The panel considered environmental impacts as the most significant long term consequence, pointing to the need for an adequate response capability and also signaling the need for reducing the probability of such an accident. This is consistent with the discussions held, but the scoring does not reflect a stated concern for the almost immediate economic consequences stemming from suspension of movement.

Port Arthur

Overview

The waterway subject to this Ports and Waterways Assessment Workshop, as determined by the participants, comprised of the area between Sabine Bank Lighted Whistle Buoy "SB" (marking the entrance to Sabine Bank Channel), the Sabine River to a point approximately seven miles north of Orange, TX, and the Neches River to Beaumont, TX. Ocean-going shipping and barge tows use the waterway. Between Texaco Island and town of Orange, a reach of approximately 17 miles, the deep-water channel is shared with Intercoastal Waterway (ICW) traffic.

The area consists of improved natural channels augmented and connected by artificially created canals. The waterways are narrow, requiring careful management of inbound and outbound traffic movement in order to avoid hazardous meetings. In addition to being narrow, the channels have a limiting depth of 40 feet. Given the size of ships calling at ports within the area, pilots pay careful attention to timing movements, with the tides and wind conditions playing an important part in their decision-making process. The bottom is generally soft and vessels of all types can normally take the ground without consequence.

The tidal range averages 2.5 feet, but can be highly dependent upon wind direction and velocity. Wind can make a difference of up to 4 feet in tidal range. Tidal current velocities can exceed 2.5 knots between the Sabine Pass jetties and reportedly can reach upwards of 5-6 knots in some areas when augmented by heavy river flows.

The port area is approached from the Gulf of Mexico through a series of safety fairways established to reduce conflicts between offshore oil production / development and shipping. The final stages of the approach are through a channel restricted by spoil and dumping grounds to either side. The approach can be difficult during periods of low visibility because of the featureless nature of the low-lying land. One difficult characteristic of the waterway is the near-total absence of suitable anchorages, lay berths and passing areas for deep draft ships. The effect upon traffic management is to require that ships entering the system have a specific berth open to them before they enter or proceed without stopping from berth to sea, introducing a queuing problem that is currently resolved by the pilots.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Vessels	
Some operators are unfamiliar with the waterway, lacking local knowledge of currents and channel configuration. Tows experience control problems at junction of ICW and deep draft channel at Texaco Island. Uninspected tows increase risk. There is a lack of regulatory oversight of oversized tows. Many tugs have inexperienced or inadequately trained operators. Outbound shrimp boats extend outriggers while still in the channel.	Work with operators, encouraging better dissemination of information. Ascertain scope of problem and provide input to G-M if appropriate. Review adequacy of oversized tow permitting process. Increase educational efforts.
Volume Deep Draft	
Insufficient anchorages and / or lay berths.	Provide conclusions of risk assessment process to USACE as input to the Port Arthur feasibility study.
Volume of Shallow Draft Vessels	
No risk identified.	No new mitigation strategies discussed.
Traffic Density	
The mix of deep-draft and wide tows creates passing problems because of the channel width. The narrow channel width means that relatively low densities can create problems in specific areas. Moored vessels can be affected by passing ships.	Provide conclusions of risk assessment process to USACE as input to the Port Arthur feasibility study.
Channel Width	
Ships transiting too fast can affect moored vessels Risk is increased by tows entering main channel from ICW or terminals.	No new mitigation strategies discussed.
Waterway Complexity	
There is crossing traffic at Texaco Island. 90 degree turn at West Basin, Texaco Island requires tows to take up entire channel.	Provide conclusions of risk assessment process to USACE as input to the Port Arthur feasibility study.

Risks	New Mitigation Strategies
Volume of Petroleum Cargoes	
The high volume of petroleum movements increase potential for spills.	Consider establishment of safety zones when necessary.
Volume of Hazardous Chemical Cargoes	
Noxious plumes resulting from accidents could affect residential areas, schools.	No new mitigation strategies discussed.
Environment Impacts	
A significant portion of the area is environmentally sensitive. Effect of a spill is increased by lack of current in many areas (but containment is facilitated).	No new mitigation strategies discussed.

Conclusions

The area of primary concern in this study is the approximate 17 miles of waterway shared by deep-draft ocean-going shipping and ICW traffic (between the junctions with the ICW at Texaco Island and a point just down river from Orange). At present there is no coordination between shallow draft vessel and deep draft vessel movements. The participants focused principally upon the economic aspects rather than on vessel safety issues.

The stakeholders' concerns seem to be twofold. First, the current mitigation measures as practiced by the Sabine Pilots and reflected in the Sabine-Neches Waterway Navigation guidelines are seen as reducing risks to an acceptable level, but at a significant cost attributable to demurrage and limitations of facility management options. The desired goal, from the stakeholder perspective, is non-delayed, round-the-clock deep-draft movement while limiting risk to the present level or below. According to participant discussions, delays in deep-draft movement cost a little over $1,000 per hour and the inability to assure round-the-clock non-delayed movement limits full implementation of just-in-time inventories and similar management devices. Secondly, current mitigation measures do not extend to shallow draft ICW traffic. Therefore, the presence of large tows at times of deep-draft passage can create high risk situations. Thus, it will, in fact be most useful to do further, in-depth analysis of the information provided in the study in order to develop a comprehensive plan addressing both of these significant issues.

Further, it is clear that the volume of petroleum is the most significant sub-factor, receiving the highest possible weighting. In the absence of an economic sub-factor under short term consequences it is probable that a large portion of that weighting reflects concern over the economic consequences of interrupting the movement of

petroleum / petroleum products to and from the area's refineries and chemical facilities. Another incorporated issue is the potential of an incident resulting in suspension of ICW traffic. Such an incident would be one occurring in the portion of the waterway shared by shallow and deep draft vessels. Since the Houston / Galveston and New Orleans section of the ICW is arguably the busiest in the country, the economic impact of suspension of movement would be substantial. The degree to which such a blockage could be bypassed by routing tows around the shared waterway via the Gulf of Mexico is heavily weather-dependent, and therefore uncertain. The high weighting supports significant preventative measures coupled with ensuring an adequate response capability.

Overall, the desired mitigation outcomes appear to be the development of a system, which coordinates movement in the shared portion of the waterway combined with an ability to move deep draft vessels under conditions not now possible. Further effort should be invested to identify and obtain agreement about the nature of such a system. Representation by ICW users should have a prominent role in follow on deliberations.

Port Fourchon

Overview

Port Fourchon encompasses Pass Fourchon, Belle Pass, and Bayou Lafourche for about 4 miles above its entrance. The Greater Lafourche Port commission administers Port Fourchon. The port is the base of a large fishing fleet, offshore oil exploration and production, Louisiana Offshore Oil Port (LOOP) operations, and some shipping interests.

Bayou Lafourche, formerly an outlet of the Mississippi River at Donaldsonville, 70 miles above New Orleans, is blocked off from the river by a levee. The bayou extends from Donaldsonville, in a southeast direction for 93 miles, and empties into the Gulf at Belle Pass, 19 miles southwest of Barataria Bay Light. The Gulf Intracoastal Waterway (GICW) crosses the bayou at Larose. Bayou Lafourche is navigable to Thibodaux, about 63 miles above Belle Pass entrance. A dam closes the bayou above this point.

For the purpose of the Port Fourchon Port Risk Assessment, the panelists defined the port area as follows:

- From 3 miles south of Belle Pass entrance in the Gulf of Mexico northward up Bayou Lafourche to the Chevron docks in Leeville. Discussions centered on the Belle Pass and the main port area (located 4 miles north of the Belle Pass entrance).
- Deep draft vessels cannot go north of the Flotation Canal (northern boundary of the main port area).

Risks	New Mitigation Strategies
Traffic Density	
Vicinity of the Belle Pass entrance jetties – recreational and commercial fishing vessels heavily use the area to seaward (east and west sides) and between the jetties; ships anchoring offshore awaiting berth space in Port Fourchon Belle Pass congested year round due to the amount of traffic moving between the port area and the Gulf of Mexico; congestion seriously exacerbated by commercial fishing that occurs during certain times of the year Bayou La Fourche and Belle Pass intersection; there are a number of facilities in that area (continued on next page)	Encourage port users to vigorously support soon-to-be-released AIS domestic carriage requirements. Port authority provides informal VTIS functions. Extend the safety fairway. Work with the port authority to ensure that design of the port's waterways separates different categories of vessels to the extent feasible. Consider one-way traffic in narrow areas. Discuss the positioning of the mooring buoys and their attached vessels with the local operators and authorities.

Risks	New Mitigation Strategies
Traffic Density (continued)	
Bayou La Fourche between the E-slip and Flotation Canal; mooring buoys constrict the channel At the end of Stone Dock 20 or more crew boats and offshore supply boats are tied up together. When the inside boat moves away from the dock, the Fourchon shuffle ensues as boats jockey to moor against pier Traffic mixing • Fishing in the channel – Belle Pass and Bayou La Fourche up to Flotation Canal • End of E-slip – converging waterway Dredge in channel middle just inside/outside jetty	
Channel Width	
Belle Pass channel is currently 300 feet wide. Passing arrangements are not always made. Barges tied up along the mooring buoys cut down on the channel width. Turning basins are not wide enough. There is a barge moored perpendicular to the pier extending out into Bayou La Fourche.	Support efforts to widen the channel to 500 feet. Large rig movements currently are escorted. Consider one-way traffic in vicinity of the mooring buoys. Support eliminating the mooring buoys, but be aware that this may shift the congestion risk to another area or increase port safety risk if tugs do not have a place to tie up / anchor while awaiting a berth. Turn the offending barge around.
Economic Impacts	
No salvage equipment is readily available. Port closure would result in loss of millions of dollars a day (does not include the fishermen). The port would feel the impact within 4 hours. In the past, the port was closed for at least 4 days and no one was sent home. It is estimated that a week of closure would be necessary before it was really felt economically. Rigs would be serviced by other ports. The jetty is a critical risk area; shallow draft vessels could hit the rocks.	Crew boat / OSV operators could shift to Venice, Morgan City, New Iberia, etc. if a port closure lasts more than a couple of days. Deep draft vessels must go through 300 feet of mud before hitting the jetty rocks. Port has plenty of response equipment for simple grounding. Replace the unlit buoys off the jetty with lighted buoys. Angle the jetties to avoid straight approach by swell.

Environment Impacts	
Oyster leases – wherever there is open water and in the surrounding marshes and along the right side of the road. This is the fastest eroding area in world – 25 square miles per year; it is more exposed to hurricane damage. Tanks are being overfilled during oil transfers – most often while refueling the vessel at a dock.	Encourage owners to improve vessel design to internally contain overfills. Evaluate transfer procedures; watch for pressing up the tanks and operator fatigue. Encourage vessel operators to conduct pre-transfer meetings. • Improve shore side attention to refueling. • Improve level of employee motivation. • Do NOT top off tanks. When a storm is predicted, require the removal of hazardous materials from the port.

Conclusions

Most transits through Port Fourchon are by shallow draft vessels, most operated by very responsible companies using high value (and lower risk) vessels transiting to and from the Gulf of Mexico oil fields. Overall the rig tenders, shallow draft tugs, and fishing vessels operating in the port are generally well maintained and professionally operated. However, the study participants claimed that some of the fishing boat captains do not act responsibly when trawling in Belle Pass. Also, many owners are not happy with the quality of the captains they hire for the oil rig crew boats. Recreational boats can create problems in the port primarily because of the sheer numbers of registered boats in the area, but generally, the operators are at least moderately experienced. Alcohol consumption sometimes contributes to unsafe operation of recreational boats. Thus, education and regulation are the primary interventions implemented to reduce risk in these areas.

Further, the high volume of traffic results in very high traffic density, which was the risk of second highest concern to the study participants. Particularly high areas of vessel traffic density are detailed in the report. With the implementation of proper planning accompanied by improved navigational systems, as suggested by the study participants, risk in this category should be reduced to a manageable level.

The study participants judged the environmental impact of an incident in the port to be the highest overall risk and placed economic impacts a strong third. The Port Fourchon area is surrounded by environmentally sensitive wetlands, which are breeding areas for many animals, waterfowl, and fish, including some endangered species. Waterway closures would adversely impact commercial fishing and the ability to keep Gulf of Mexico oil rigs supplied with critical operational materials. Thus, a comprehensive plan, including short term and long term goals and milestones along with planning and proper allocation of resources, should serve to mitigate risks. It is imperative that efforts are concentrated in this area in order to minimize potential long term negative consequences in this category.

Port Lavaca

Overview

The waterway determined by the participants comprises of the approaches to Matagorda Bay north of Matagorda Ship Channel Approach Lighted Whistle Buoy MSC, Matagorda and Lavaca Bays, the Intercoastal Waterway (ICW) between Miles 457 to 492, San Antonio Bay east of ICW Mile 492, and the entrance to the Victoria Barge Canal. The area basically consists of improved natural channels augmented and connected by artificially created canals. In consequence, the waterways are narrow, requiring careful management of traffic movement in specific areas in order to avoid hazardous meetings. The bottom throughout is generally soft and vessels of all types can normally take the ground without consequence. Deep draft ocean-going ships approach the area from the Gulf of Mexico through a series of safety fairways established to reduce conflicts between offshore oil production/development and shipping. The final stages of the approach is through a channel restricted by spoil and dumping grounds adjacent to the western side. Matagorda Ship Channel is a 22-mile long deep water channel from the Gulf to and through a land cut in Matagorda Peninsula thence through Matagorda and Lavaca Bays to the industrial facilities and public terminal at Point Comfort. The entrance to the land cut is protected by jetties. The Federal project provides for a depth of 38 feet through the Sea Bar Channel and Jetty Channel, thence 36 feet through the land cut and Matagorda and Lavaca Bays to a turning basin of the same depth at Point Comfort. Ships having a beam greater than 102 feet or are more than 725 feet in length are piloted only during daylight hours.

Matagorda Bay itself is a large body of water separated from the Gulf by the Matagorda Peninsula. Depths in the bay range from 5 to 13 feet, averaging 10 to 12 feet over the greater part. The ICW crosses the bay, entering from the southwest just south of Port O'Conner, a small town located about three miles west / northwest of the land cut of the Matagorda Ship Channel. The ICW runs generally northeast to southwest through the Bay, crossing the Matagorda Ship Channel about two miles north of the land cut. The junction of the two channels is complicated by the presence of spoil areas and dredging ranges to the east of the intersection.

The diurnal range of tide is 0.5 foot at Port O'Connor, and 0.7 foot at Port Lavaca. The level of the water surface is largely dependent on the winds, and during strong northerly winds may be depressed 2 feet or more. It is reported to be very strong in the land cut through Matagorda Peninsula, especially on the runoff of the ebb after strong southern winds. The current in Matagorda Ship Channel may attain a velocity of over 3 knots, and has been reported as considerably stronger at times.

Lavaca Bay, an arm of Matagorda Bay at its northwest corner, has a general depth of 5 to 7 feet with several reefs near the head of the bay. Several shallow draft Federal project channels are maintained in Lavaca Bay. San Antonio Bay lies about 18 miles to the west of Matagorda Bay and is connected to it for navigational purposes by the ICW. The village of Seadrift is located on the northern shore of San Antonio Bay and it is in the bay proper that the Victoria Barge Canal joins the ICW.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Uninspected vessels increase risk. High risk movements stem from chemical and petroleum cargo.	Ascertain scope of problem and provide input to G-M if appropriate. Crew HAZMAT carriers with specially trained and qualified crews Place person with local area expertise on board for transits through this waterway. Revisit these recommendations with the local expert-stakeholder group to determine the feasibility of these recommendations.
Volume of Shallow Draft Vessels	
Current volume of traffic causes congestion at ICW locks. Barges are getting bigger and are carrying more diverse cargoes. There is a limitation on available tug horsepower while barges are increasing in size. Transient vessels from Houston and Brownsville have low level of local knowledge. Problem areas identified were the crossing at Towers, and the junction of the ICW and Matagorda ship Channel. The Port O'Connor area constitutes a bottleneck due to the presence of offshore supply vessels and fishing vessels. Wide tow configurations create risk when meeting ships particularly when bulk carriers "triple up", creating beams of 105 ft. Dry bulk, sand and gravel carriers are lax in observing tow-rigging regulations	Explore problems with expert-stakeholder group to determine the extent and specifics of these problems; bring concerns to the attention of managers of operating companies if appropriate. Include examination of available mitigation measures as part of the future deliberations of the expert-stakeholder group. Bring group's recommendations for channel reconfiguration to the attention of USACE. Encourage near-term response to request for USCG marking of cross-bay alternative route. Review adequacy of oversized tow permitting process. Bring problem to the attention of managers of operating companies. Determine adequacy of enforcement.
Volume of Fishing & Pleasure Craft	
Fishing vessels forecasted to increase by 15% over next few years. Communications with transiting fishing vessels is difficult to impossible. (continued on next page)	Increase educational efforts. Make effort to include fishing industry representatives in future meetings of the expert-stakeholder group. Consider issuing special event permits for organized boating activities (continued on next page)

Risks	New Mitigation Strategies
Volume of Fishing & Pleasure Craft (continued)	
Conflicts often develop when shrimpers try to overtake and pass tows (primarily in ICW). Shrimpers work in the channel primarily at night or early morning (before 0900). Many fishermen have limited ability to speak and understand English. Pleasure craft cause significant problems inside the jetties because of fishing near rocks. At night, florescent lights slung underneath the boats make it impossible to detect running lights. The majority of pleasure craft operators are unfamiliar with the waterway and the Rules of the Road. Use of personal watercraft increasing, with no restrictions on age of operators. There is a concentration of pleasure craft in the Port O'Conner area.	Review federal enforcement efforts for adequacy, increase on-the-water presence if feasible. Bring problems to the attention of state boating authorities.
Traffic Density	
The Port O'Conner-Seadrift areas are home to many recreational boats, causing congestion. Recreational boats fishing at the pass are anchoring to fish and will not move for other traffic. Oversized tows take up most of the channel.	Increase educational efforts. Review federal enforcement efforts for adequacy, increase on-the-water presence if feasible. Bring problems to the attention of state boating authorities. Review adequacy of oversized tow permitting process.
Tide and River Currents	
Currents at the pass are causing shoaling, moving buoys and other aids to navigation. Maximum current has been measured at 9 knots. Jetty failure is predicted as result of strong currents at the pass. No current meters are in use. Tug assistance has been required in Colorado River because of strong currents during periods of flooding. River currents are increased by heavy rainfall; can cause shoaling.	Include examination of mitigation strategies as part of the deliberations of the expert-stakeholder group. Include issue of support for current meters in deliberations.

Risks	New Mitigation Strategies
Channel Width	
Meetings in the vicinity of the Port O'Conner government mooring buoys are difficult and avoided when possible. There is concern that deep-draft vessel may ground on jetties as result of avoiding collision with recreational craft. Collisions have occurred in ship channel between Port O'Conner and Seadrift because of misjudgments when crabbing has required tows to pass starboard to starboard.	Bring urgency of relocating Port O'Conner mooring buoys to attention of USACE. Review adequacy of special event permitting. Improve if appropriate. Increase educational effort and on-the-water enforcement presence. Review oversize tow permitting process. Include examination of mitigation strategies as part of the deliberations of the expert-stakeholder group.
Waterway Complexity	
Complexity is the result of merging and crossing waterways combined with crossing traffic. The intersection of the ICW and ship channel combines current and traffic. Port O'Conner mooring buoys are located in high traffic area. Shoreside construction is encroaching waterway in Port O'Conner.	Include examination of mitigation strategies as part of the deliberations of the expert-stakeholder group. Bring urgency of relocating Port O'Conner mooring buoys to attention of USACE. Bring issue to the attention of USACE.
Volume of Petroleum Cargoes	
1 million short tons of petroleum moves through Point Comfort annually. 85K deadweight tons of naphtha moves at one time. There are significant amounts of hazardous materials in transit, increasing risk to populated areas. There were 210 spills in Calhoun and Matagorta Counties to date in 1999. Clean-up expertise, including that of Coast Guard, is being lost.	Develop traffic management system for use during spill clean-up. Include examination of other mitigation strategies as part of the deliberations of the expert-stakeholder group.
Volume of Hazardous Chemical Cargoes	
Ships carry hazardous cargoes not being offloaded in this area. High volume of hazardous material carried by transient tows passing through Port O'Conner. (continued on next page)	Develop traffic management system for use during spill clean-up. Include examination of other mitigation strategies as part of the deliberations of the expert-stakeholder group.

Risks	New Mitigation Strategies
Volume of Hazardous Chemical Cargoes (continued)	
Most handling facilities for hazardous cargo are along the Victoria Barge Canal. There is gaseous hazardous material being transported through the area.	
Economic Impacts	
Certain products must be moved by water; cannot transport overland. Ship channel blockage will cause impact within 2-3 days. Three days closure requires shutting down of plants. Plant managers are shifting to "just-in-time" inventories; do not keep large feed stock supplies on hand.	No specific mitigations were identified.
Environment Impacts	
There are a significant number of environmentally sensitive areas in the region There is no marine firefighting capability in the area Point Comfort marshes can be impacted by current-driven pollutant There is a bird nesting area near the ICE-Ship Channel intersection Whooping cranes nest in the area	No specific mitigations were identified.

Conclusions

The participants considered that 85% of the deep draft ship traffic falls into the high risk category. The risks posed are partially offset by the low volume of such traffic, currently in the order of 2-3 transits per day, and by a process of "vetting," implemented by the major shippers as a means of insuring the quality of the ships used. 70% of the total commercial traffic is shallow draft, a category including offshore support vessels (OSV) and tows, an appreciable number of which carry bulk chemical cargoes. The panel considered that 15-20% of the overall risk stemming from that category is due to lack of knowledge of the area.

The participants felt that neither the size of deep draft ships nor the numbers of such ships using the waterway are significant risk drivers. The volume of such traffic is predicted to

increase, however, and future increases in trade may require nighttime movement of deep draft ships of all sizes. The average deep draft ship requires three hours to transit the Matagorda Ship Channel. The volume of shallow draft traffic is currently expanding and it is expected that it will continue to do so. It is anticipated that there will be an increase in the numbers of commercial fishing boats based in the area, and it is expected that the increased growth in recreational boating will continue at or near the national rate.

The weightings assigned to the sub-factors reflect the participants' concern with the risks posed by vessels of diverse characteristics and, more specifically with the potential for fishing / recreational craft to trigger accidents involving commercial vessels.

Discussions about navigational conditions appeared to focus upon the impact of strong currents upon the handling of large shallow draft tows generally, and the effect upon deep draft shipping while in the vicinity of the Matagorda Ship Channel land cut. The weightings assigned under this risk factor are consistent with those discussions.

It is clear that waterway complexity is universally held to be the most significant sub-factor, receiving the highest possible ranking. This is consistent with the participants' discussions, and with the concern for the number of merging or crossing waterways in the area. Three areas of particular concern were noted: the intersection of the ICW and the Matagorda Ship Channel; those portions of the Ship Channel shared with by deep and shallow draft vessels; and points of congestion where the presence of large numbers of small craft impinge upon the maneuvering of ships and/or tows. At least two of those areas are also subject to strong currents, increasing the likelihood of an accident.

It is clear, also, that the volume of petroleum and the volume of chemicals are virtually tied for the most significant sub-factor under this risk category. The high weighting support a requirement for significant preventative vessel traffic measures coupled with adequate response planning and the capability to cope with a spill should one occur. Even though economic consideration is not a sub-factor under short-term consequences, the participants determined that short term disruptions to normal traffic movement would have significant impact. A two to three day disruption impacts some industries and a week's disruption would result in plant closures. The short-term impacts result from just-in-time inventory practices. It was also pointed out that some goods critical to the area's industries cannot be moved by other modes of transportation.

The effect of a spill of any size upon the environmentally sensitive areas within the region were clearly of greater concern. While this points to the need for an adequate response capability it also signals for reducing the probability of such an accident.

Finally, two categories of mitigation measures, Vessel Traffic Information Service (VTIS) and Enhanced Automatic Identification System (EAIS), received essentially identical high relative merit index weightings. Vessel Traffic Service (VTS) ranked just below those two, but can be set aside as a consideration because of the absence of a compelling Federal interest for direct involvement in traffic organization. The desired mitigation outcome therefore appears to be development of a system which coordinates movements in high-risk portions of the waterway combined with an ability to move vessels under conditions not now possible. Considerable effort will be required to identify specific measures and obtain agreement about the nature of such a system. Representation of ICW users must have a prominent role in follow-on deliberations.

Texas City

Overview

For the purpose of the Texas City Port Risk Assessment, the participant teams defined the port area as having the following geographic bounds:

1. Bolivar Roads and the junction of the Texas City Channel with the Houston Ship Channel
2. Texas City Channel
3. Texas City Harbor and Turning Basin
4. Industrial Canal to head of navigation

Risks	New Mitigation Strategies
Volume of Deep Draft Vessels	
1,750 deep draft ship visits per year (4 per day average). Run out of tugs before they run out of pilots. If no movement scheduled tugs may be as far away as Galveston. 8 deep draft transits per day through 5 NM channel with run time of 45 minutes to 1 hour means waterway can physically handle larger number of ships. Adequate dockside space today. Even with a tractor tug made up to the ship, at seven knots it still takes ½ NM to get ship back under control.	Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish a VTS. Harbor Master should consider scheduling arrival / departure times to satisfy growth in traffic. Consider need for additional tugs. Ensure new turning basin is clear of Texas City Channel. Consider use of tractor tugs, especially for chemical ships. Formalize relationships / authority / responsibilities of the Harbor Master.
Volume of Shallow Draft Vessels	
25 tow per day. Tows may have to wait as much as 36 – 48 hours because product has to go to specific docks. Tows will not wait in Texas City; wait in Bolivar Roads area instead due to rules established by former COTP. (continued on next page)	Improve communications. Improve rules & regulations. Establish a VTS. Address facilities issue in the harbor for tugs and barges. (continued on next page)

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels (continued)	
Some congestion in turning basin when barges depart facilities; traffic held in Texas City Channel. Facilities are limited so barges enter queue system for a turn.	Install pilings or moorings and establish a barge fleeting area to the east of Texas City harbor to relieve congestion in Boliver Roads without creating congestion in Texas City. Refine scheduling so that barges arrive when dock is available.
Traffic Density	
Congestion area for all sized traffic around the Horn in the port; have to wait for opposing traffic to clear. Y where ICW and Texas City Channel connect is a congestion spot. Two-way traffic permitted when just one large ship meeting tugs & tows in the Texas City Channel. Hydrodynamic problem in Industrial canal caused by deep draft movements. Traffic on channels 12 and 13 is worse than on channel 16.	Improve dynamic navigation information. Establish a VTIS. Establish a VTS. Trim NW corner at Shoal Point to widen channel and open visibility at entrance to harbor. Consider using alternate frequency for harbor control and bridge to bridge.
Channel Width	
400 feet wide Texas City Channel widens to 550 feet in turn around the Horn. Industrial Canal is 250 feet wide. Pipeline at Horn limits depth of inner harbor. Ships sometimes ground trying to cut the corner at junction of Texas City Channel and ICW.	Improve rules & regulations. Establish a VTIS. Establish a VTS. Dredge southeast corner of Texas City Y. Trim off NW corner of Snake Island at the Horn to ease turn angle. Encourage industry to review the potential for AIS to enhance situational and navigational awareness.
Waterway Complexity	
Two 90-degree turns in harbor. Merging traffic at Y. Crossing traffic with ICW. Rare but possible need for large ships to turn in Y from Texas City Channel into Houston Ship Channel northbound.	Improve static navigation information. Establish a VTIS. Dredge southeast corner of Texas City Y. Trim off NW corner of Snake Island at the Horn to ease turn angle. Encourage industry to review the potential for AIS to enhance situational and navigational awareness.

Risks	New Mitigation Strategies
Volume of Petroleum Cargoes	
50-60 million barrels of crude per year coming into the port. Refined product going out. 700 oil tankers per year (2 per day). Considerable amount of product entering port via barges.	Improve communications. Improve dynamic navigation information. Harbor Master coordinate after hours access to decision-making personnel from potential spill source companies.
Volume of Hazardous Chemical Cargoes	
A lot of traffic (both ships and barges) moving hazardous chemical cargoes in and out of the port, amount not specified. No concrete knowledge of specific cargoes of particular hazard (e.g., benzene, ethylene). Container ship manifests not trusted; element of doubt as to what is really in a container. Port's ability to respond to chemical spills has not been fully tested or experienced yet.	Improve communications. Improve dynamic navigation information. Complete area contingency plan for chemical spills. Work more closely with local Office of Emergency Management.
Economic Impacts	
Port facilities are dependent on just-in-time shipments to satisfy operations. Texas City is small and depends on constant turnover, so there is limited reserve storage capacity. Texas City has not had a bad hurricane since 1983. Tropical Storm Francis • Port was shut down for two days because pilots could not board or move vessels • Created 72 vessel backlog throughout the entire system (Houston Ship Channel, too) Created high tides, flooding, high winds for three days.	Improve dynamic navigation information. Study impact of storm surge on various parts of port area, particularly planned container terminal.

Risks	New Mitigation Strategies
Environment Impacts	
No wetlands in the defined port area but nearby sensitive areas could be affected by uncontained spills, e.g., Pelican Island, Swan Lake, Virginia Lake. Easy to keep oil confined within port, but once released, would quickly spread to wetlands areas. Roseate spoonbills nesting south of the Industrial Canal.	Improve dynamic navigation information. Improve marine fire fighting capability.

Conclusions

The participant teams evaluated traffic conditions to be the highest risk category. The volume of deep draft traffic is increasing. Plans to develop a new container terminal will double the number of deep draft ship visits per year. The participant teams considered risks associated with volume of shallow draft to be the fourth highest risk factor for the port and traffic density to be the fifth highest. Although no specific intervention was identified for volume of deep draft vessels, those developed for risks associated with the volume of shallow draft vessel traffic should minimize risks in both categories simultaneously.

The participant teams evaluated waterway configuration to be the second highest risk category. Teams considered risks associated with channel width to be the third highest risk factor for the port. Channel width will become an increasingly significant risk as the volume and size of deep draft shipping grows ever larger. The existing channel width will continue to be a limiting factor in the Texas City Channel. While the channel will be deepened from 40 to 45 feet as part of the container terminal project, there are no plans to widen it, except to create a new turning basin. The channel bottom has one hard spot at the entrance to the existing turning basin caused by spoil water pipes; remainder of channel bottom is mud and silt. Thus, additional mitigations should be considered in the future.

Volume of petroleum was the highest risk factor for the port. Related to this, volume of chemicals was the second highest risk factor. Risks and current mitigations are well balanced with respect to both factors. The participant teams did not reach consensus on an appropriate mitigation tool although discussions focused on improved response times. The number of people using the waterway is low and projected to remain so. Texas City is a commercial port.

The participant teams evaluated this risk category to be moderate in risk. Environmental impact was the sixth highest risk factor for the port. The port has no environmentally sensitive areas. However, spawning grounds, endangered species and water and beach

recreation areas (Swan Lake, Virginia Lake and Pelican Island) are not too far from the port area. Galveston Bay is an environmentally sensitive area and vulnerable to an uncontrolled spill or vapor release. The risks associated with economic and health and safety impacts were moderate and generally considered to be well balanced with current mitigation strategies.

Sault Ste Marie

Overview

Sault Ste. Marie, MI, is a city on the south side of the St. Marys River adjacent to St. Marys Falls Canal. The St. Marys River forms the outlet of Lake Superior, connecting it with Lake Huron. From Whitefish Bay at the southest corner of Lake Superior, the river flows in a general southeastern direction to empty into Lake Huron at Point Detour.

The International Boundary (the Boundary) enters the St. Marys River near the south tip of St. Joseph Island. The Boundary is approximately on centerline of the channel to the vicinity of the lower end of Sugar Island, MI. The Boundary departs from the ship channel, skirts the eastern shore of Sugar Island, and reenters the ship channel. The Boundary lies in St. Marys Falls with the American Locks to the south and the Canadian Locks to the north. From there, the Boundary lays roughly centerline between the land masses of Michigan and Ontario until it reaches Whitefish Bay of Lake Superior.

A series of dredged deep draft channels lead through the St. Marys River to connect the deep water of Lake Huron with that of Lake Superior.

Each year the St. Marys River rises and falls about 1 foot as measured by the monthly mean levels. Since 1900, the difference between the highest and the lowest monthly mean levels above the locks has been about 4 feet and below the locks about 6 feet. From day to day, the level changes somewhat due to changes of wind and barometric pressure; such fluctuations frequently amount to several inches and sometimes to 1 foot or more.

The swiftest currents in the navigable channels of the St. Marys River are found at Little Rapids cut. The amount of water released is controlled. For planning purposes, the maximum current expected is about 2.2 knots.

A Vessel Traffic Service (VTS) (St. Marys River), operated by the U.S. Coast Guard, has been established for St. Marys River and lower Whitefish Bay from Detour Reef Light to Ille Parisienne Light, except for the waters of the St. Marys Falls Canal. The VTS is designed to prevent collision and groundings and to protect the navigable waters concerned from environmental harm resulting form such collisions or groundings.

Risks	New Mitigation Strategies
Ice Conditions	
Ice congestion is prevalent in spring, with the current pushing ice into the locks. ACOE adding new bubbler system to flush ice through the locks but can cause loss of sea suction on vessels with low suction inlets.	Replace CGC MACKINAW with suitable heavy icebreaker. Replace ice buoys with structures (continued on next page)

Risks	New Mitigation Strategies
Ice Conditions (continued)	
Locks shut down 15 January to 25 March. Problem areas are located in all major turns in the channel and the following: • Sawmill Cut; • Moon Island Cut; • Winter Point turn; • Johnson Point; and • Lime Island. At Mission Point area, an ice boom removes the problem. One-way traffic. There are ice islands there. Some particular risks are: • Canadian ships that come into Soo do not use locks, but need icebreaker assist. • Vessels only use east Neebish channel in winter. • New ships have round bows and have tendency to sheer; older boats with pointed bow will cut into the ice shelf. In Rock Cut, ferry must shut down due to the compression of the ice in that area during the spring when that channel is breaking up.	Put ice island in (piles of rocks and rubble that anchors the ice in position) where there is a problem of ice breaking away from the shore. Locate in west Neebish channel above the Rock Cut. Establish AIS / EAIS. Use VTS at Soo Locks to direct cutter traffic and direct under-powered vessels to hold back until a cutter can assist.
Bottom Type	
Vital Shoals, just above the locks is rock bottom. Solid rock areas include Rock Cut; and Johnson Point (boulders). Pipelines (natural gas) off Point Louise (buried at unknown depth—estimated at 6 feet). When turning into Rock Cut, vessels pick up suction on red side; in shoal areas, vessels pick up mud as they go through. Anchoring over electric cables is a concern.	Encourage installation of ECDIS on ocean vessels. Put sounding informtion on CD; provide 3D picture of the river. See bad spots at a glance. (Consider DredgePac or High Sweep software). Provide real-time soundings at Rock Cut; consider PORTS. This is could be very useful in upper part of river. (Canadians have them for their part of the river). Consider EAIS to provide information. East Neebish channel is two-way traffic, two different depths. Consider marking the deeper parts and allow for an auxiliary channel. Consider regulated one-way traffic. Provide chart system similar to Canada's.

Risks	New Mitigation Strategies
Environment Impacts	
This is a pristine area – unspoiled and undeveloped. Specific areas: • Waiska Bay • Whitefish Bay • Upper Sugar Island • Mud Lake • Bei de Waisai Big area for nesting birds. Wakes in ice can shear off wetland areas. Dredge spoils contain so few contaminates that they can be open water dumped. High speed wakes erode the beaches. Recreation boats add to pollution.	Push all tanker traffic to the Poe Lock. Provide more information on impacts to the environment caused by vessel operations. Education effort to inform and enforce pollution rules for recreational boaters. Coordinate meeting with local waterway users to provide additional guidance on the location for proposed anchorages and markings of pipelines. EAIS could provide information on water level, temperature, and other environmental sensors during response operations.
Health & Safety Impacts	
Sault Ste. Marie is a population center in this area – around 100,000 people. Water supply comes from the river – off Big Point; Canadian side water intake is above Gros Cap.	Encourage local authorities to consider exercising an evacuation plan and a water intake contamination contingency response plan.

Conclusions

Traffic condition poses a moderate to low risk to port safety in the St. Mary's River. There are almost 100,000 transits by ferry in the port area and the trend is increasing, particularly at Detour. For the most part, the deep draft traffic is not changing in numbers; it may even be reducing slightly. The number of recreational boats appears to be increasing, and a major influx is expected during the upcoming Walleye Tournament. There is congestion at the locks, where arrival times are controlled by the Army Corps of Engineers (USACE). Even so, no specific mitigations and/or interventions were identified to address the increasing number of crew and passengers on the waterway. Participants seem to believe that improvements to navigational and other information systems along with the addition of educational programs and enforcement of rules and regulations should minimize risks to an acceptable level in this area as well.

Navigational conditions, primarily ice, were a major concern to the study participants. The risk due to ice occurs primarily during the early winter freeze-up periods and the

spring thaws. At those times, the channels are still passable, albeit by navigating around the ice and getting help from local icebreakers. The locks are closed from 15 January to 25 March. Wind also affects the area by piling up water on the lee side of Lake Superior. Currents are controlled by the USACE with water level-compensating gates. Seldom do the currents exceed 2.2 knots and they are predictable. Visibility closes in regularly due to fog; however, that is predictable. Thus, the study participants developed extensive interventions to address this issue. A comprehensive plan including each of the interventions sited should be sufficient to minimize risks.

The Sault Ste Marie waterway is almost 80 miles long. Channels are cut and well marked. Water depths are predictable. These channels are, however, somewhat narrow in various locations along the route. This risk, too, should be minimized by implementing the interventions noted above.

The most likely short term consequence would be injuries to people from a ferry mishap, as a very small amount of petroleum and hazardous materials move through the port area. Nevertheless, the participants judged that the most significant long-term consequences are environmental in nature. The waterway is pristine and home to a variety of birds and other wildlife. High speed wakes from recreational boats appears to be eroding the beaches. The interventions developed during the more than adequately address this risk and ensure that associated risks are minimized.

Los Angeles / Long Beach

Overview

One of the largest ports on the Pacific Coast, Los Angeles has a history of leading in terms of tonnage handled. The port has extensive facilities to accommodate all types of traffic, and is the only southern Californian port at which passenger vessels call regularly. Some of the principle exports are crude minerals, iron and steel scrap, coal and coke, inorganic chemicals, animal feeds, cotton, hides and skins, manufactured fertilizers, and fresh fruits and nuts. Currently, Los Angeles ranks as the nations #2 container cargo port with several of the largest and most efficient container terminals on the Pacific Coast, and is expected to overtake Long Beach as the #1 container port with the development of Pier 400. Some of the principle imports are iron and steel products, motor vehicles and parts, petroleum, organic chemicals, fresh fruits and nuts, paper and paperboard, sugar, molasses and syrups, glass, and fresh and frozen fish.

The Port of Los Angeles

Los Angeles has over 100 piers and wharves, including facilities for supertankers and liquefied hazardous gas tank vessels (LHG T/V). An extensive, and active, small boat moorings is located at the southwest corner of the port. Another marina is located at the junction of Cerritos Channel and East Basin.

Los Angeles Harbor is considered to be a relatively shallow, semi-enclosed coastal embayment. Three stone breakwaters extend along the 50-foot bottom contour, marking the seaward limits of Los Angeles Harbor. Multiple landfills have been constructed between these breakwaters and Terminal Island.

The Port of Los Angeles is completely industrialized with limited recreational usage. Commercial fishing within Los Angeles harbor is limited to a live-bait fishery, while a variety of commercial fisheries occur outside the harbors. Recreational fishing is primarily prevalent outside the harbor. Although a significant commercial fishing fleet is resident in the port along with some recreational boating facilities, the port is primarily an industrial facility.

The Port of Long Beach

Also one of the largest ports on the Pacific Coast, Long Beach has the reputation of being America's most modern port. The port has extensive foreign and domestic traffic with modern facilities for the largest vessels. Long Beach currently ranks as the nations #1 container cargo port moving over 4.6 million TEU (twenty foot equivalents) in calendar year 2000. Long Beach also hosts several of the largest and most efficient container terminals on the Pacific Coast. Some of the principle exports are bulk petroleum, bulk coke, steel and steel products, bulk potash, grains, fresh fruits, scrap steel, animal feed,

and copper concentrate. Some of the principle imports are crude petroleum, steel and steel products, motor vehicles and parts, machinery, bulk gypsum, newsprint, lumber, bulk salt, bananas, plywood, bulk molasses, and copra.

The Port of Long Beach is primarily an industrial facility with limited recreational use. Some sport fishing vessels are resident in the port along with some recreational boating facilities. Recreational fishing is primarily prevalent outside the harbor. A large recreational boat marina is located northeast of Pier H where its use does not interfere with ship operations.

The Port of Long Beach has 66 piers or wharves. Four oil production islands and an explosives anchorage are located inside the Long Beach breakwater east of Pier J.

Debris from throughout the Los Angeles River watershed is flushed through storm drains and ultimately to the mouth of the river during seasonal storms.

General Navigation Conditions

The mean range of tide in Los Angeles and Long Beach is about four feet, although a range of up to nine feet may occur at maximum tides. Tidal currents follow the axis of the channels and rarely exceed one knot. However, both harbors are subject to seiche and surge. The most persistent and conspicuous oscillation has a period of one hour. The hourly surge, together with other oscillations of shorter period and more irregular occurrence, at times causes a very rapid change both in height of the water and the velocity and direction of the current and may endanger vessels tied up at piers. A three-minute surge is reportedly responsible for major ship movements and damage.

Fog occurs most likely from October through February. Over San Pedro Bay, visibility drops below 0.5 mile on about 11 days per month during this period. Fog is worse late at night and early morning. Smoke from industrial activity adds to the thickness and persistence of the fog. Long Beach experiences half-mile-visibility fog an average of 18 more days per year than Los Angeles.

Gales are rare, but southern California experiences Santa Ana winds in excess of 50 knots along the coast with very little warning.

The annual precipitation in this area is less than twelve inches, occurring as rain only, over a period of about 60 days. Only trace amounts of snowfall have ever been recorded. The average temperature is 63^{o}F with an average low-to-high temperature range of about 15^{o}F.

Risks	New Mitigation Strategies
% High Risk Deep Draft Cargo & Passenger Vessels	
Foreign crews' proficiency is an issue, including language. 65% of the VTS's classified incidents are caused by a mechanical casualty. There are over 5,900 deep draft arrivals in the port annually, of which less than 1% are high-risk vessels. Discovering an increasing rate of falsified mariners' documents. Labor is coming from foreign labor pools without good controls. STCW requirements are discouraging experienced (older) crew from renewing licenses. Reduced manning of ships nearly eliminates any self-response to emergencies.	Improve rules & regulations. Improve dynamic navigation information. Improve VTIS.
% High Risk Shallow Draft Cargo & Passenger Vessels	
These vessels are not as controlled as are deep draft vessels in the VTS system. About 300 fishing vessels operate in the port. Fishing vessels are not inspected and seem to be of questionable quality. Seasonal activity. Urchin divers are coming into the port area. Recreational boaters not licensed. ~70% boaters may not have requisite nautical knowledge. T-boat operators carrying school groups.	Improve communications. Improve rules & regulations. Improve dynamic navigation information. Improve VTIS. Harbor Safety Committee (or equivalent) work with state, local, federal governments to effect solutions. Increase state / local law enforcement presence targeting high risk times/areas Support mandatory licensing / education program for boat operators.
Volume of Deep Draft Vessels	
Precautionary area has mix of all vessel types. Peak vessel movements are early morning and at end of the normal workday. Average 35-40 ships in port daily; highest was about 55 ships. Main channel is deeper than any anchorage available. Ships must commit to their transit without option of alternate route. New dredging plans will increase this risk.	Improve rules & regulations. Improve dynamic navigation information. Improve VTIS. Improve VTS. Evaluate the stevedore fee structure and work rules so that the motivation to have ships arriving and departing during compressed timeframes is reduced.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
About 200 local shallow draft vessels routinely work in the port. About 600 ferry transits per month to Catalina Island.	Improve communications. Improve rules & regulations. Improve VTIS. Improve VTS.
Volume of Fishing & Pleasure Craft	
Fishing vessel activities often interfere with traffic in the separation lanes. Sea urchin divers working at Horseshoe Kelp from October through March. Squid fleet shifting over to a sardine fishery. VHF-FM radio congestion is high. 250,000 registered boats within a 100-mile radius of the port. Seasonal recreational boating activity. Recreation boaters sitting in the gates and off the Naval Weapons Station Seal Beach. Regattas force traffic rerouting. USS CORONADO and SEA SHADOW port visits will require safety/security zones.	Improve communications. Improve rules & regulations. Targeted fishing vessel community outreach. Some ports have a Fisherman's Wives Assoc. Consider approaching them with your agenda if there is one in LA-LB
Traffic Density	
Very high recreational boater use on weekends. Focused at breakwater gates which causes conflicts with deep and shallow draft vessels. Cruise ship and ferry transits haven't been a problem.	Improve communications. Improve rules & regulations. Improve VTS. Conduct area-wide evaluation of future waterborne enforcement asset requirements.
Waterway Complexity	
There is a great deal of crossing traffic of every type vessel within the precautionary area (approaches to the harbor entrances). Several meeting intersections and turning basins within the harbors' waterways. Construction is constantly changing the configuration of the port.	Improve aids to navigation. Improve communications. Improve rules & regulations. Improve dynamic navigation information.

Risks	New Mitigation Strategies
Number of People on Waterway	
8% of arrivals are passenger ships. 1 million cruise-ship passengers per year. About 2,000 passengers per ship. Cruise ships moor at Berth 93. Ferry traffic carries over 1 million passengers per year from passenger berth 95 and the Queen Mary moorings.	Improve rules & regulations. Improve dynamic navigation information. Disaster, mass rescue contingency planning. Use the Vessel Mutual Assistance Plan from San Francisco as an exemplar for LA/LB.
Volume of Petroleum Cargoes	
Deep draft VLCC ships berth at pier 121. Spot market forces result in varying amounts of tanker traffic into the port. 15% of traffic is petroleum related. Submerged pipelines carrying product from the oil islands and offshore rigs through anchorage area E predominantly, and elsewhere throughout the port.	Improve rules & regulations. Improve dynamic navigation information. Refine plans for dispersant use. More multi-agency training and exercises.
Volume of Hazardous Chemical Cargoes	
The ports handle LNG, LPG, all petroleum distillates, caustic soda, jet fuel; essentially all types of chemicals. Can't be sure of action required in response to a chemical release event until the type of chemical is absolutely known. Good first-responder capability exists; however, there are conflicts between life-safety and economically driven operations. Good command and response system. Swirling winds affect evacuation plans in case of toxic plumes. SEA LAUNCH operations involve rocket fuel and liquefied oxygen. The Port handles explosive cargos. An explosives anchorage is designated inside the breakwall. (anchorage K-1).	Improve rules & regulations. Improve dynamic navigation information.

Risks	New Mitigation Strategies
Economic Impacts	
1 of 20 jobs in Southern California would be affected by port's closure. Consequences of a port closure would extend to states beyond California. One-week port closure would have international impact. The major impact would be upon container cargos. About 55% of ships could go through Cerritos Channel as an alternative.	Improve rules & regulations. Improve dynamic navigation information. Improve VTS. Explore capacity and mechanism to offload ships at anchor to barges.
Environment Impacts	
The entire port area is sensitive to environmental quality and vulnerability. Endangered species in the area include the California Brown Pelican, the California Least Tern, the Peregrine Falcon, the Marbled Murrelet and the Western Snowy Plover. There are sensitive wetlands at Seal Beach and Alamitos Bay. Beach closures would have a high impact on the tourism industry. Shallow water habitat at pier 400 and farther inside. Kelp beds are vulnerable.	Improve communications. Improve rules & regulations. Improve VTS. Periodically sample water at potential source of spill areas and at sensitive habitats.
Health & Safety Impacts	
Potential for hazardous gas plume from discharges and fires to affect millions of people	Improve rules & regulations. Improve VTS. Review exercises schedule; conducting those needed to validate emergency action plans. Ensure emergency evacuation plans are effective.

Conclusions

The participants evaluated risks attributable to traffic conditions to be the highest. Each of the associated risk factors received a moderately high rating. The volume of fishing and pleasure craft was the fourth highest risk factor overall. The volume of deep draft vessels factor ranked fifth highest. Although no mitigations/interventions were specifically sited for these risk factors, interventions noted in the table under high risk shallow draft vessels should help to minimize risks in these areas as well. However, additional consideration and analysis should be directed toward this category of risks.

The participants considered waterway configuration to be the fourth highest risk category, with waterway complexity being the third highest overall risk factor. Even so, no specific interventions were noted in the study. Additional review and evaluation for this risk category is necessary.

The volume of petroleum is the highest overall risk factor in the ports of Los Angeles-Long Beach.

Mitigations in this area as within the categories of volume of chemicals, environmental impacts, and health and safety seem to be in the initial stages, as interventions cited pertain to education and planning rather than to specific corrective actions necessary to minimize risks. More effort should be directed toward identifying specific solutions to minimize risks in these categories.

It is clear that minimizing risks in the ports of Los Angeles and Long Beach will require the significant and on-going participation of all stakeholders, including regulators, commercial entities, interested civilian groups and residents in order to ensure that a practical, comprehensive plan is implemented. In the mean time, educational, regulatory and enforcement initiatives should serve to lower risks while specific interventions are under development.

San Francisco

Overview

San Francisco Bay is the largest harbor on the Pacific Coast and is properly described as a series of connecting bays and harbors. Depths of 29 feet and over are available for deep draft vessels within the area and to Stockton and Sacramento on the principal navigable rivers feeding the bay. The extensive foreign and domestic commerce transiting San Francisco Bay is handled through several ports including Oakland, Redwood City, Richmond, Sacramento, San Francisco, and Stockton.

A USCG operated Vessel Traffic Service (VTS) operates in San Francisco Bay. The VTS covers the seaward approaches and all of the waters and tributaries as far inland as Sacramento and Stockton. Several Regulated Navigation Areas have been established within the seaward approaches and the waters of the Bay and its tributaries.

The entrance to the Bay is through the Gulf of the Farallones and the narrow Golden Gate. In clear weather, many prominent features are available for use in making San Francisco Bay, but in thick weather the heavy traffic and the currents, variable in direction and velocity, can render the approaches difficult and dangerous. Very dangerous conditions develop over the bar whenever large swells, generated by storms far out at sea, reach the coast and steep waves to 25 feet have been reported over the bar. Radar navigation on the approach to San Francisco Bay is not difficult because of the numerous distinctive and high relief of targets available. The principal approach to San Francisco Bay is through the buoyed Main Ship Channel over the bar. A Traffic Separation Scheme has been established throughout the Main Ship Channel and the Golden Gate into the Bay.

The currents at the entrance to the bay and at numerous locations within the bay and its tributaries are variable, uncertain and at time attain considerable velocity. Inside the Golden Gate bridge the flood current sets into all parts of the bay and causes swirls as far east as Alcatraz and Angel Islands and through Raccoon Strait north of Angel Island.

Winter winds in San Francisco Bay are variable and occur from about November through February. The procession of lows and highs brings frequent wind shifts and a great range of speeds with extreme winds of 50 knots and gusts to 68 knots. The strongest winds are often out of the southeast through southwest ahead of a cold front. Spring is the windiest season and June the windiest month. While the extremes of winter are less likely during spring, winds of 17-28 knots are common.

Fog is a problem in the San Francisco Bay area, particularly in and around the Golden Gate bridge, which experiences its foggiest months in July and August.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Vessels	
Problems occur between large vessels and small craft over right-of-way in the channels and Rule 9 violations. Commercial fishing vessels obstructing channels and docks are inattentive to approaching traffic, operators are distracted with fishing, boats are poorly maintained, and on some boats language problems prevent clear communications. Recreational boating is relatively unregulated with unlicensed operators, no competency testing, and poor maintenance on older boats.	Expand safe boating education programs to reach more fishing vessel operators and recreational boat operators (including personal watercraft, sailboats and powerboats).
Volume of Deep Draft Vessels	
Congestion of similar dockside arrival times of vessels going to the same port. Channel deepening projects in Oakland.	Monitor and review adequacy at future meetings of Harbor Safety Committee.
Volume of Shallow Draft Vessels	
Planned expansion of ferry fleets and higher speed ferries. Increase in the volume of ferries and construction tugs / barge units expected to create a shortage of experienced operators. High volume of shallow draft vessels.	Monitor and review planning for ferry expansion and construction activities at future meetings of Harbor Safety Committee. VTS monitoring of vessel traffic and their knowledge of ferry routes / schedules and planned marine events helps mitigate this problem.
Volume of Fishing & Pleasure Craft	
Wind surfers create maneuvering problems for deep draft vessels in the confined waters in and near the Golden Gate. Rowers / wind surfers create maneuvering problems for deep draft vessels and tug / barge units in Redwood Creek. (continued on next page)	Expand safe boating education programs to reach more personal watercraft operators. VTS monitoring of vessel traffic and their knowledge of planned marine events helps mitigate this problem.

Risks	New Mitigation Strategies
Volume of Fishing & Pleasure Craft (continued)	
Rowers are creating problems for maneuvering ferries in the Larkspur Ferry Channel. Organized and permitted marine events (increased from 400/year to over 1000/year last three years) crowd waterways and create maneuvering problems for larger vessels.	
Traffic Density	
The Central Bay Area near Alcatraz and Angel Islands attracts many recreational and tour boats and creates a congestion problem for maneuvering deep draft vessels, ferries and tug / barge units. Concentrations of recreational boats and fishing vessels with deployed nets in Carquinez Strait cause congestion problems for maneuvering deep draft vessels and tug/barge units. Oakland Estuary has a high concentration of recreational boat marinas and launching facilities. Anchorage 9 in South Bay may be impacted by increasing numbers of recreational boats and planned ferry routes in the vicinity. Ferry terminals at Piers 1 and 39. Congestion in the pilot boarding area offshore occurs when vessel arrival times coincide.	Expand safe boating education programs to reach more fishing vessel operators and recreational boat operators (including personal watercraft, sailboats and powerboats). Monitor and review at future meetings of Harbor Safety Committee.
Channel Width	
Areas of San Pablo Channel and Suisun Bay Channel are narrow, confined and shifting due to sand erosion. Southhampton Shoal Channel is very narrow with cross-currents. Frequent channel maintenance dredging in San Pablo Bay, Carquinez Strait, Oakland Harbor, and Redwood City.	Monitor and review problem at future meetings of Harbor Safety Committee. Expand existing VTS radar coverage. Monitor and review possible corrective actions at future meetings of Harbor Safety Committee. VTS radar coverage in these areas is adequate to impose order on covered vessels. VTS and pilots knowledge of planned dredging operations helps to mitigate this problem.

Risks	New Mitigation Strategies
Waterway Complexity	
Union Pacific Railroad bridge cannot always open on demand. Bridge abutments throughout the bay area cause narrowing of channels coincident with typically high currents. There is little room to maneuver between the Bay Bridge and Oakland Inner and Outer Channels when shaping for an approach. High incidence of crossing traffic and merging waterways. Narrow, twisting channels above San Pablo Bay create difficulty in visually sighting vessels ahead and in communicating to make passing arrangements. As vessel drafts get deeper, traffic lanes may be required south of Alcatraz Island and approaching Richmond Long Wharf.	Continue on-going discussions with Union Pacific on bridge notification procedures. Monitor and review problem at future meetings of Harbor Safety Committee. Expand VTS radar to uncovered areas beyond Carquinez Bridge. Consider installation of VHF repeaters to increase bridge-to-bridge communications capability in the area.
Number of People on Waterway	
Many people on bridges, particularly at rush hours, with an increased hazard due to allisions with bridge supports or earthquakes. Ferry operations increasing with significant passenger loads at rush hours. Many (over 3,000 in FY-1999) marine events in the Bay Area with significant numbers of participants and spectators on the waterways with specific concentrations during prom season, New Year's Eve, 4th of July, and other major holidays.	No new mitigation strategies discussed.
Volume of Petroleum Cargoes	
The largest arriving tank ships are about 200,000 dwt and are enroute Richmond Long Wharf and Carquinez Strait, frequently via Anchorage No. 9 for lightering. Bunkers on board transiting vessels (large container vessels may have up to 5000 barrels aboard) are considered a higher risk than tanker cargoes. Required tug escorts create a "fleet" of vessels that adds to the level of risk in the waterway.	Monitor and review problem at future meetings of Harbor Safety Committee.

Risks	New Mitigation Strategies
Economic Impacts	
Oil facilities in the bay are dependant on 2-7 day crude oil delivery schedules to avoid stoppage of production and layoffs of personnel. Many arriving containers are scheduled to meet just-in-time delivery schedules for production facilities (such as automobiles) and retailers throughout the Western U.S. and can absorb only a 2-3 delay in schedules without impacts. Recreational boating and tourism oriented industries impacted by closure. Ferries are on tight schedules and deliver many workers to and from employment.	Monitor and review problem at future meetings of Harbor Safety Committee.
Environment Impacts	
Entire bay and its environs are environmentally sensitive and contain over 85% of California's remaining wetlands. Bay does not clean itself through flushing in the South Bay and parts of San Pablo Bay which results in pollutants migrating to back areas. Many aquatic nuisance species have been found in the Bay which have presumably been brought in by vessels in International trade.	Spill cleanup resources are readily available. Port State Control does not adequately address the issue of the unintended import of nuisance species. Monitor and review problem at future meetings of Harbor Safety Committee.

Conclusions

Traffic density was a risk of significant concern to the participants, ranking second among the six factors. The risks are generated by container ships and ferries which operate on tight schedules and consequently tend to converge in waterways to similar destinations (e.g. container terminals and ferry terminals) at about the same time. There is some concern that as vessel drafts get deeper, the ability to move out of channels will become even more restricted than it is now. Expected increases in the volume of high speed ferries will create additional crossing and meeting situations with some increased risk. There is also concern that increased numbers of shallow draft vessels will place demands on the limited number of qualified and experienced operators thereby reducing crew competency levels. Recreational boaters and personal watercraft operators cause traffic density and interference problems in several key deep draft transit areas of the bay.

Wind, visibility, currents, and tides were all of concern to the participants. The installation of NOAA's Physical Oceanographic Real-Time System (P.O.R.T.S.) in many areas of the bay has helped to mitigate the risks to some extent. Wind, current, and tide

sensors provide knowledge of existing conditions to all who have a need for the information. The VTS also has access to the real-time data and regularly provides that information to waterway users. In spite of the sensors placed around the bay, currents and reduced visibility can still catch mariners by surprise and are perceived as the highest navigational risks.

The participants judged waterway configuration as the highest risk to vessel movement on San Francisco Bay. The complexity of the waterways with their many turns and narrow channels coupled with the difficulty experienced in making satisfactory passing arrangements made this factor a major concern to the participants. The VTS monitors traffic throughout the bay area, but the confined channels leading to the primary berths both within the bay and in the rivers still create risks that reportedly have yet to be sufficiently mitigated. VTS radar coverage does not currently extend beyond the Carquinez Bridge. Bridge-to-bridge communications is not reliable in some waterways where visibility ahead is also blocked by high terrain. Narrow bridge abutments, of which there are many in the bay and its tributaries, create problems for vessels both because of the width of the openings and because the current is typically strongest between the abutments where the channels are deepest.

The volume of passengers and petroleum carried on and over the bay was of further concern to the participants. The volume of passengers carried by ferries throughout the bay and the volume of passenger vehicles using the bridges (which are subject to risk from vessel collisions with bridge supports) was a concern. The population density of the bay area mandates the use or crossing of bay waters by most commuters going to and from work each day. Also, many marine events attract large numbers of participants and spectators who converge into concentrated areas of dense traffic in and near heavily traveled waterways. Crude oil and petroleum products are carried on large tankers as cargo and also on large cargo vessels as bunkers. Container ships can have up to 5,000 barrels of fuel oil on board. The short term immediate impact of either risks to people or risks to the fragile bay area environment (from oil spills) is a risk that, while mitigated by vessel traffic management procedures and by pre-positioning of rescue and cleanup resources, was of concern. Even so, no specific mitigations and/or interventions were identified to address these issues.

The participants judged the environmental impact of an incident on the bay to be the highest long-term consequence with economic impact a close second. The bay area contains 85% of California's remaining wetlands and damage to those resources would have both economic as well as political impacts. Closure of the bay to vessel traffic either by order of the COTP as a result of heavy swells at the bar or because of an incident that results in closure of one or more waterways within the bay can have far reaching economic impacts. A high volume of containerized cargoes must be delivered "just-in-time" to meet manufacturing requirements. These include auto parts to keep area assembly plants operating and crude oil to supply the local refineries to prevent production stoppages. Another major concern of the participants was the potential for closure of a waterway due to collapse of a bridge. Waterway closures would also adversely impact ferry schedules, tourism and recreational boating. Even though the participants recognize the severity of these potential risks, no specific interventions were identified to address these risk factors.

On the other hand, the scoring indicates the panelists overwhelming support of the continuation and enhancement of the USCG operated VTS. It should be noted that "VTS" and "improve present system" received equal scores, reflecting instructions to the participants in advance to consider the current VTS as part of the current vessel traffic management system (VTM). Discussions during the sessions confirmed that the participants believe VTS to be the single most effective means by which to reduce overall risk in the bay area.

In addition, enhanced AIS received the next highest rating. Discussions by the participants during the sessions indicated they fully support the use of AIS to transmit vessel identification, position and other data provided it also enables the reception of pertinent weather, current, tide and port specific data with the same system.

AIS was rated third best at mitigating overall risk in the bay. The participants acknowledged it would be a useful tool in determining who is in the waterways and what is their position and destination.

The participants concluded that sufficient mitigations have, in fact, been implemented to establish the foundation for a comprehensive mitigation plan to minimize risks. However, recommended interventions should concentrate on education, communications, and improvement of existing systems.

Coos Bay

Overview

For the purpose of this Ports and Waterways Safety Assessment, the participants defined the port area as including the following waterways:

- Main entrance channel from the sea buoy, approximately two miles off shore, inward
- South Slough past Joe Ney Slough to end of slough
- North Slough and Haynes Inlet to the tide gate
- Kentuck Slough to tide gate
- Willanch Inlet
- Marshfield Channel
- Coos River to head of tide water, eight miles upstream, including Catching Slough
- Isthmus Slough to tide gate (12 miles upriver)
- Coal Bank Slough

Risks	New Mitigation Strategies
Visibility Conditions	
Fog experienced nearly 15 days a month 15 May through 15 September. Offshore fog banks enter the lower bay, local fog in the upper bay. Fog typically comes at night and burns off mid-morning. Fog can cause ships and tugs to miss tide window, especially at the railroad swing bridge. Wintertime brings drizzle conditions which can restrict visibility.	Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Educate recreational boaters on hazards of operating in fog. More frequent radio station announcements on fog conditions and future predictions. Encourage industry to review the potential for AIS to enhance situational and navigational awareness.

Risks	New Mitigation Strategies
Tide & River Currents	
Currents 3 knots and can be 5 knots at buoy #4 in jaws of jetty entrance. Tidal range of 7 feet. Port area currents are tidal, not river driven. Less than 3 knots in sloughs and creeks. Winter winds and strong river flows can result in an ebb current all day. Cross current at railroad bridge coming out of North Slough. Cross current at Marshfield Channel junction coming down Coos River. Cross current at Charleston coming out of South Slough. Cross current at Jarvis Turn.	Improve communications. Improve static navigation information. Review U.S. Coast Pilot for accuracy of port information (anchorages, currents, wharves). Improve information exchange between members of port community • USACE share tide gauge information with other users • Sheriffs Department share remote transmitted river height gauge information currently collected for freshette flood predictions. Tug companies share vessel operations policy information with Harbor Safety Committee for distribution to other port users.
Waterway Complexity	
Numerous bends in waterways; 120 degree bend at North Bend. Blind bends at Charleston and North Point for tug & tows. Intersections at Marshfield Channel and Charleston. Air draft • 70' power line restriction at Charleston • ILS approach to airport takes planes low over channel; now a 200-foot decision height so does not affect ships Alignment issue with railway bridge at Charleston. Alignment issue in short distance with road and rail road bridge at North Slough. • Inbound ships have some time to line up • Out bound ships have no opportunity to line up Isthmus Slough draw bridge issue. Interactions of multiple risk factors in Charleston area.	Improve aids to navigation. Improve rules & regulations. Improve static navigation information. Improve dynamic navigation information. Install new inbound and outbound ranges at Jarvis Turn. Actively market education programs for recreational boaters. Conduct WAMS for Entrance Channel and Charleston Channel. Encourage industry to review the potential for AIS to enhance situational and navigational awareness. Ensure that airport plans do not conflict with waterway use by large air draft ships.

Risks	New Mitigation Strategies
Economic Impacts	
Port closure would have immediate impact on fisheries; boom would close down access to affected slough. An extended port closure would have a minimal impact on forest products; would continue to build inventory, just no distribution; no need for laying off employees. Major oyster producer in state is in Coos Bay; would loose market share because they could not harvest. Major claming industry in port around Clam Island (Empire Channel). Local restaurants unable to obtain fresh seafood if oil spill affects fishing in river and sloughs.	Improve communications.
Environment Impacts	
Mammals, breeding areas, wetlands, endangered species, oyster beds, clam beds throughout port. Seal colonies at Baltimore Rock offshore of Cape Arago. North Spit has plover (endangered species). Coho salmon is endangered species. Coos Bay eastern side and North Slough are breeding areas for endangered species. South Slough Research Reserve sites. Nearest ORSO is in Astoria. Very limited boom supplies in port. Coos Bay oil spill cooperative (COOP) is available for deep draft vessels and tugs/barges, but not fishing vessels or oyster/clam farmers • provides an initial response level of effort to get things stopped and under control • provides voluntary response by volunteers Port fees for deep draft ships are three times the Columbia River fees to pay for COOP.	Improve rules & regulations. Increase amount of response equipment available to port, particularly boom. Identify follow-on sources for oil spill clean-up equipment outside of port. Establish USCG / COOP BPA agreement. Establish dedicated COOP staff vice volunteers. Enhance training for COOP volunteers. Conduct cross-agency training and exercises. Expand COOP to include fishing vessels, shellfish harvesters, and recreational craft. Balance port fees so that port remains competitive with other ports.

Conclusions

The participants evaluated the quality of the calling fleet as the second lowest risk category overall. The quality of deep draft ships visiting the port is not a major risk factor. The presence of commercial and sport fishing vessels and other recreational boats which make unanticipated course changes contribute to elevating the % high risk shallow draft risk factor. The participants did not reach consensus on appropriate ways to reduce risks associated with these high risk shallow draft vessels.

The volume of fishing & pleasure craft and the volume of shallow draft vessels represented the highest risk factors in this risk category. Risks associated with the volume of deep draft, volume of shallow draft and traffic density were considered to be acceptable due to existing mitigation measures. The participants did not reach consensus on appropriate ways to reduce risks associated with the volume of fishing and pleasure craft.

Teams considered risks associated with visibility conditions to be the third highest risk factor for the port; risks associated with tide & river currents were the fifth highest risk factor for the port. Ice conditions are not a risk factor in the Port of Coos Bay. There was no consensus reached by the participant teams about appropriate ways to mitigate the other three risk factors in this category.

The participants evaluated this risk category to be the highest for the port. Participants considered risks associated with waterway complexity to be the second highest risk factor for the port. There was no consensus reached for an appropriate mitigation tool. Risks associated with bottom type were considered to be the sixth highest risk factor for the port. Teams considered existing risk mitigation activities adequate to make this risk acceptable. Teams did not reach consensus on an appropriate mitigation tool for risks associated with channel width or visibility obstructions.

The participants evaluated this risk category to be the lowest for the port. All risk factors were considered to be more than adequately mitigated by existing measures.

The participants evaluated this risk category to be the third highest for the port. Participants identified environmental impacts as the highest risk factor for the port. The mitigation factor selected to address environmental risks was other than a VTM tool. Economic impacts was the fourth highest risk factor for the port. There was no consensus as to the appropriate risk mitigation tool for that risk.

Although volume of fishing and pleasure craft and economic impacts were cited as risk factors, no specific risks were attributed to these categories, thus no interventions were ideintified. Similarly, no interventions were specifically attributed to risk factor associated with bottom type. It should be noted, however, that a few of the interventions cited for other risk categories will have a secondary, positive influence on risks in this area as well.

Lower Columbia River

Overview

For the purpose of the Lower Columbia River Ports and Waterways Safety Assessment, the participants defined the port area from the sea buoy to Bonneville Dam noting that deep draft traffic ends at the I-5 bridge. No other specific descriptive information was noted.

Risks	New Mitigation Strategies
Volume of Fishing & Pleasure Craft	
High volume, frequently impeding commercial traffic 150,000 registered pleasure craft in Tri-county area • 12% of boats in Washington State are along the Columbia River 350,000 to 500,000 unlicensed boats and watercraft (kayaks, etc) Numerous marinas for access to water Numerous boat ramps for launching • Enables anyone with a boat access to waterway Problems with commercial traffic more due to interaction than just volume Fishing in channels (sturgeon like deep water) Salmon fishing boats in shallow water but smaller boats risk being swamped by transiting ship wakes Education and awareness programs for boaters have not kept pace with tremendous increase in recreational boat and personal watercraft use Judges do not consider boating incidents that serious	Improve rules & regulations. Increase enforcement, i.e., writing tickets, for Rule 9 violations, especially anchoring or fishing in channels that impedes ship transits Review resource allocation priorities to ensure that sufficient assets are available for escort duty Actively market boater education programs; ensure education programs include charts, equipment, skills commensurate with intended use of the boat Encourage states to institute mandatory licensing that encompass essential core knowledge in safe boating

Risks	New Mitigation Strategies
Traffic Density	
Recreational fishing congestion areas: • Buoy 10 (15 NM area) • Astoria-Megler Bridge • Longview Bridge • Hump Island • Coffin Rock • Ahle • Martin Island • St Helens/Columbia City • Austin Point • Confluence of Columbia and Willamette Rivers • Above I-5 bridge • Chinook Landing • Washougal • Cape Horn/Sand Island • Multnomah Falls • Hamilton Reach • Light 40 • Tugs and tows crossing bar at high tide along with deep draft • Sailboarder congestion • Wallace Island • Rooster Rock • Times of congestion • Any holiday • July 4th at I-5 bridge (shut river to commercial traffic) First week of June for Rose Festival in Portland.	Improve rules & regulations. Improve dynamic navigation information Establish a VTIS. Provide seasonal cruise ships from Alaska with information on pilotage, safety, communications, and river transit requirements. Encourage commercial operators to support wide-spread carriage requirements for AIS transponders.

Risks	New Mitigation Strategies
Channel Width	
Federal channel width 600 feet from Astoria up to I-5; above there channel narrows, varies from 150-600 feet 200-foot horizontal clearance at Vancouver RR swing bridge Alignment between Vancouver RR and I-5 bridges due to proximity and use of auxiliary channel by tugs and tows Areas where deep draft try not to meet: • Skamokawa to Pillar Rock (Brookville) reach • Garrison below Bonneville Dam down to Cape Horn • Lower Reed Island to Government Island • Upper Willamette from Freemont Bridge to Ross Island • Mouth of Willamette River	Consider realigning / widening railroad bridge opening across Columbia River to accommodate tug and barge traffic, ensuring that such realignment does NOT adversely affect deep draft traffic safety Support efforts to widen main ship channel while satisfying environmental concerns
Waterway Complexity	
Crossing and meeting at mouth of Willamette River Tug / barge fleeting and merging traffic at Longview Small craft at Skipanon Waterway intersection Chinook Landing Swan Island Terminal into Willamette North Portland Harbor Both ends of Oregon Channel Ferry crossing Columbia River at Westport Recreational sailing regatta traffic crossing river at Longview, Portland, Vancouver between I-5 and RR bridges (continued on next page)	Improve aids to navigation. Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS. Modify rail and interstate bridges so that one bridge can accommodate both rail and auto under which ships can safely navigate Facilitate meeting between RR bridge operators, pilots, and tug / tow operators to resolve communications problems / misunderstandings of each party's capabilities and limitations / establish standard operating procedures

Risks	New Mitigation Strategies
Waterway Complexity (continued)	
Air draft issues occur at Longview, St John's, Freemont, Steel Bridge, I-5, and St. John's Willamette Railraod Bridge. RR bridges wait to last minute to open • Ships feel like they are "playing chicken" • AMTRAK passenger trains have priority over ships for RR bridge positioning Information provided to ships is not accurate, e.g., bridge operator say a train is 10 minutes away when in fact it is 20 minutes away.	
Volume of Petroleum Cargoes	
10% of total tonnage is petroleum 15 – 35 tank barges per month 8 tank barges moving per day for bunkering; average of 900 bunker movements per year Six small (to point of not even being recoverable) spills in last 2 years Concern for unattended barges left tied to ship being hit by debris or parting lines; barges occasionally being unloaded without tankermen onboard	Improve rules & regulations. Improve dynamic navigation information. Establish a VTIS.
Economic Impacts	
Have not had river closures. Have had restricted areas where river is open above and below affected area. Closing river would have immediate adverse consequences from public relations perspective – worldwide effect on how and where goods are shipped. Stigma of having river system shut down is long term and economically disastrous; some permanent shift in cargo likely. (continued on next page)	Improve communications. Improve dynamic navigation information. Vessel assist tug in Astoria needs more horsepower than current tug has

Risks	New Mitigation Strategies
Economic Impacts (continued)	
River closed during flood of 1996 with disastrous effects for port economy. If river were closed to navigation, impact would be immediate and national in scope • Immediate impact on international shipping community • Next pay day for ports • 2nd largest grain export port in the country • Intermodal transfer points for autos and containers • Portland moves 30M tons of cargo per year Longview and Vancouver each move about 6M tons per year.	
Environment Impacts	
Endangered Species Act in place throughout the river system; no specific endangered species habitats designated. Major pollution incident would have a very high impact on endangered species. 9 threatened / endangered water species in river. Drills / exercises being conducted to meet regulatory requirements, not to learn weak and strong areas . Dynamics of river currents could preclude complete capture of spilled oil.	Improve aids to navigation Improve communications. Improve rules & regulations. Improve dynamic navigation information. Establish longer term relationship with the regulatory body (USCG) whose people rotate every 4 years. Encourage use of 1-800 National Response Center number to report spills and generate response.

Conclusions

The volume of fishing and pleasure craft was the third highest risk factor overall. The volume of sport fishing and pleasure craft is increasing significantly. Similarly, the participant teams considered risks associated with traffic density to be the fifth highest risk factor for the port. Although this risk factor did score high enough to be illustrated in the above table, the interventions developed to address issues related to congestion should help to minimize risks in both categories.

Waterway complexity was the fourth highest risk factor. The river system has numerous turns, converging waterways, some crossing traffic and significant numbers of unpredictable recreational fishing vessels. Related to this, channel width was the sixth highest risk factor. Further, bottom type was a significant issue in those areas identified as rock rather than sand. Finally, visibility obstructions, while not ranking in the top risks overall, still cause problems that the participants want to see reduced through improved aids to navigation. Dredging and other port and waterway improvements identified should serve to significantly reduce risks in all of these risk categories.

Teams believed that existing risk mitigation practices associated with the number of people on the waterways and the volumes of petroleum and hazardous chemicals lower these three risk factors to acceptable limits. Thus, no additional interventions were specifically identified for these categories.

Environmental impacts was the highest risk factor over all. Marine sanctuaries, spawning grounds and threatened and endangered species are distributed throughout the river system. The entire river system is an environmentally sensitive area. The risks associated with economic impacts were the second highest risk factor. Even a partial closure of the Lower Columbia River system would cause an immediate impact on both domestic and international distribution of goods. Thus, in order to minimize risks, a comprehensive plan should be developed to identify additional interventions for the specific sub-factors identified under these risk factors.

Risks associated with health and safety impacts were considered to be adequately mitigated. Thus, no additional interventions were cited.

In comparison to those associated with the other risk factors, the mitigation activities identified to address the category of volume of fishing and pleasure craft do not seem to be in balance with existing mitigation activities. Interventions, as illustrated in the table, seem to be somewhat excessive. Improving rules and regulations would, most likely, be the most appropriate way to reduce risk to an acceptable level for this factor.

Honolulu

Overview

Honolulu Harbor is 5 miles northwest of Diamond Head and midway along the south coast of Oahu; the harbor is protected from all winds and is usually free of surge.

Sand Island, which borders the seaward side of Honolulu Harbor, is government-owned and has been built up mostly from harbor dredging. The Coast Guard base is on the northeastern side of the island.

Aloha Tower, a 193-foot cream-colored, square clock tower on Pier 10, is one of the most conspicuous objects in the harbor. The tall, square, twin white office buildings 300 yards east of Aloha Tower are prominent and provide excellent reference to ships approaching the harbor by day. Punchbowl Hill, 500 feet high and flat topped, is 1 mile inland from Aloha Tower. The horizontal blue lights of the Ala Moana Tower restaurant (21-17.8N. 157-50.7W.), 1.5 miles east of Honolulu Harbor entrance, are easily distinguished at night and provide an excellent navigation aid.

Honolulu Entrance Channel is marked by lights, buoys, and a 028 degree lighted range. The rear light and marker of the range is sometimes obscured when large ships are moored at Berth 8.

The mean range of tide is 1.3 feet, and the diurnal range of tide is 2.0 feet at Honolulu. It is reported that a tidal current floods west and ebbs east along the coast between Makapuu Point and Honolulu. In the vicinity of Honolulu, an east counter flow along the edge of the reef is reported to accompany the west flood.

Honolulu has over 60 piers and wharves around the harbor waterfront. The speed limit in Honolulu Harbor is 5 knots for all vessels and tows and 10 knots for motorboats, and other small craft.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels	
Tremendous amount of Tug and Barge activity Few foreign flag tugs – mostly local companies Inter island barge traffic High recreation vessel volume • Recreation boats use sea buoy as turn buoy for races off Honolulu Harbor • MSO inspectors seem to have the best perception of vessel condition (continued on next page)	Mitigation for Foreign Flag commercial fishing vessels: Recreation vessels • training is necessary • anticipate that rec boater does not know how much water area is needed Need more VHF radios / communications. Consider licensing.

Risks	New Mitigation Strategies
% High Risk Shallow Draft Cargo & Passenger Vessels (continued)	
Para sailors don't realize how much water they control. Divers. Sail boats. Lack of VHF radios. Accidents caused by operator area, not by density. Commercial fishing vessels: • Foreign Longline vessels – meet pilot at shore line, not pilot station; occasional bunker oil spills • Language problems in commercial fishing fleet (Vietnamese language) • Foreign Flag commercial fishing vessels – over 1000 movements of these type of vessels and decreasing • High risk, but low incident • Commercial fishing fleet – domestic Some recent casualties – fire, dock damage, grounding.	
Volume of Deep Draft Vessels	
Off Barbers Point – all deep draft – average 15 per month – for Tesoro and Chevron. Barbers Point Harbor – 8 – 10 per month; increasing. Honolulu Harbor – 100 – 125 oversees movements per month – 50 deepdraft per month. • Matson – 3 calls per week (draft 30-39 feet) • 5-7 movements per week total • Matson and Sealand use the entire harbor – not much room • Volume very small	Honolulu Harbor – movements limited to one vessel at a time.

Risks	New Mitigation Strategies
Volume of Shallow Draft Vessels	
1. Calls of vessels may not increase in volume 2. Pier 38-39 fishing village may cause number of fishing vessels to increase 3. 200 – 225 vessels call per month 4. Number of longliners have decreased • If provide additional lay over berthing for vessels…may increase • Honolulu used to ferry crews back and forth – based on airline availability and cost Barbers Point (barge) Harbor – number of slips for large vessels increasing.	No new mitigation strategies discussed.
Volume of Fishing & Pleasure Craft	
Stable due to lack of facilities. Many trailerable boats. Cannot accommodate world cruising yacht industry except, temporary, in Honolulu. Development of marina in Barbers Point will increase traffic. Facilities are underdeveloped. Some PC are constrained by regulation to a specific geo area – only five para-sailor groups allowed off Waikiki beach. Cruise ship – bring small ferry boats from ships to beach. Dinner cruise, whale watching boats appear to be increasing. Kewala Basin – no resolution; a commercial harbor for intermediate draft vessels.	No new mitigation strategies discussed.
Traffic Density	
At sea buoy, Honolulu Harbor – outbound and crossing traffic. Mix of commercial vessels, tugs, recreation vessels – canoes; wind surfers. Some vessels are converging, some crossing through. (continued on next page)	No new mitigation strategies discussed.

Risks	New Mitigation Strategies
Traffic Density (continued)	
Large ships awaiting another ship to clear. Long shoreman shifts. Divers in main ship channel. Emergency vessels. Mix of dinner cruises, board surfers, and body surfers in Kewala Basin. Not much volume in Pearl Harbor. Large ships turning across entrance to Pearl Harbor – subs surfacing.	
Channel Width	
Barbers Pt. The longer in the berth, the greater the risk. Length of exposure. Honolulu Harbor, pier 51-52, 31-33 with vessel berthed, waterway is constrained. Crabbing with wind further decreases width. Vessels also get sucked off the dock. Turning 900 foot vessel in 1100 foot turning basin. Not all berths have deep water alongside.	Spread out the transit times of the large ships using the waterway. Additional ranges for accurate navigation. Find a place to put idle barges. AIS provides a precise navigation system. VTIS provides a coordination function. VTS provides a coordination and enforcement function.
Waterway Complexity	
Converging at Honolulu Entrance. Use tugs to help turn into the harbor. Myriad types of vessels meeting – commercial and recreational. Diamond Head and Barbers Point are turning points for vessels sailing around the island. Pearl Harbor – a blind bend at Hospital Point. Buoy switch left of Ford Island. Few relatively immediate turns. Some ships go north of the island to avoid the traffic to the south.	Create a precautionary area around the sea buoy. Give Aloha Tower authority to say no to recreational, commercial boaters requesting permission to enter the harbor. Meet with representatives of groups who meet at the sea buoy. Give regatta permits. Educate the recreation boaters. Develop a harbor safety committee (HOST is a purely voluntary effort).

Risks	New Mitigation Strategies
Number of People on Waterway	
Cruise ships moving in harbor. Dinner cruises are hovering, awaiting dock space. Heavily populated surrounding the harbor. Ferry operations – intra island demo project – experimental – high speed – commuter ferry.	No new mitigation strategies discussed.
Volume of Petroleum Cargoes	
149,999 ton ships call at Barbers Point anchorage. More product increases exposure time due to longer loading, unloading. Refined products being shipped out. Hawaii is a bunkering port – in the middle of the ocean.	No new mitigation strategies discussed.
Volume of Hazardous Chemical Cargoes	
Containerized material is being moved and sits at Matson Container yard. Cannot transport hazmat cargo through tunnels. Not much coming in bulk – caustic soda.	No new mitigation strategies discussed.
Economic Impacts	
Honolulu Harbor is the hub of commerce. Instant reaction to harbor closure. 80% of the state's imports come through Honolulu Harbor.	Honolulu Harbor - Moor volatile ships away from Sand Island Bridge.
Environment Impacts	
Tourism Industry affected – off Waikiki Beach. Fish and bird sanctuary from Pearl to Diamond Head. Pipeline leak in Barge Harbor ended up in Kawaii. Keep the beaches clean – to sustain tourism.	Pre-position response equipment. Continue contingency planning. VTS can help to coordinate and speed up response to casualties.

Risks	New Mitigation Strategies
Health & Safety Impacts	
Honolulu – major metro population around the harbor. Harbor sustains the food for the population.	Consider evacuation plans. Install alarms to warn people of coming disaster.

Conclusions

Overall, the risk mitigation plan for Honolulu seems to be in the developmental stages. An adequate foundation for the development of a facility improvement and risk mitigation plan is currently in place. For those risks to which mitigations have been applied, concentration is appropriately centered upon organization, communication, education, and improving current processes. To many significant categories of risk, however, no current mitigations have yet been assigned.

Thus, future interventions should include giving consideration to the potential application of mitigations currently in place to other categories of risk for which these mitigation are relevant.

For example, educational programs for commercial and recreational fisherman and other boaters may be directed toward addressing issues with the increasing numbers of transits and pleasure craft. This same mitigation might incorporate methods by which information related to the effect of local wind conditions on navigation in the harbor may be disseminated.

Other risks originally identified, including those for which no mitigations have been developed, may not, in fact, require additional mitigations once the analysis has been completed. For example, although man-made obstructions was sited as a risk category in Honolulu Harbor, many of these (i.e. buildings) seem to be more of an overall help than a hindrance to vessel traffic pilots entering the harbor. It was noted that lights from the many tall, distinctive buildings provide "beacons" in the harbor similar to those provided by lighthouses. On the other hand, since much of the Hawaiian economy is influenced by tourism in Honolulu there is, understandably, an excessive number of piers and wharfs in the harbor's waterfront posing some navigational issues.

By implementing the proposed intervention, including the establishment of a central controlling body to implement new and improved policies and practices, should create a forum through which a needs analysis may be conducted to asses these and other issues as they arise. The final mitigation plan for Honolulu must give due consideration to each of these factors independently as well as to their interrelationships.

Cook Inlet

Overview

Cook Inlet, on the west side of the Kenai Peninsula, merges with the Shelikof Strait through a wide unobstructed passage west of the Barren Islands. Leading from the Gulf of Alaska to Cook Inlet are Kennedy Entrance and Stevenson Entrance, north and south of Barren Is., and Chugach Passage, inside the Chugach Islands. From the entrance, it is 48 miles to Seldovia, 59 miles to Homer, 110 miles to Kenai and Nikiski, and 175 miles to Anchorage. Navigation is assisted by DGPS, LORAN C, aids to navigation, and natural landmarks. The shore on both sides of the Cook Inlet can be seen in clear weather. Three volcanoes are prominent landmarks in lower Cook Inlet. There are six secure harbors within the inlet, and temporary anchorages can be selected in most places in the inlet. However, the great range of tide must always be kept in mind. Shoals are strewn with boulders that are not usually found unless directly over them. In places, these boulders rise as much as 30 feet above the general level bottom. Boulders can be moved by the action of strong currents and ice floes. Ice covers the upper inlet for about six months, moving on the tidal currents, and endangering ships alongside docks. About fifteen oil platforms are located in the upper inlet. In addition to natural resources, the inlet is also a rich habitat for marine wildlife, some of which is endangered. The human population is sparsely clustered along the Kenai Peninsula. Two fifths of Alaska's population lives in Anchorage. More complete information may be obtained by consulting the Coast Pilot, which was used as a reference.

Risks	New Mitigation Strategies
Volume of Petroleum Cargoes	
Tankers carrying less than 500,000 bbls; barges 150,000 bbls. Need consideration of ships' bunkers as de facto oil cargo. Non-tanker industry is not as well prepared. 40% of cargo into Anchorage is petroleum, two barges / week April-September. Nikiski & Drift R. tankers ship product outbound. Size restriction determined by oil spill response capability and draft limitations at dock Nikiski (-43 feet) Anchorage (-35 feet). Spot charters may not have tools or response capabilities to protect the environment. 400+ gross ton ships have financial responsibility certificates requirement.	To assess risks and subsequent mitigation planning for earthquakes and tsunamis coordinate with State Emergency Response Commission and Alaska Emergency Response System.

Risks	New Mitigation Strategies
Environment Impacts	
Cook Inlet is a waterway rich with marine life, some endangered species, and sensitive to pollution • Beluga whales / seal breeding areas • Salmon spawning rivers; coho is endangered Kachemak Bay critical habitat for shellfish; environmentally conscious population there. River mouths of Kenai, Kasilof and Susitna: salmon transits. Major clam beds at Ninilchik, Holly Creek, Clam Gulch. Other sensitive areas: • Neal River behind Augustine Island • Port Graham and English Bay because of subsistence fishing • East side of Kalgin I. • Ship Creek at Anchorage Using dispersants has adverse environmental consequences. Ice affects ability to clean up / maneuver, but also can limit spread of pollution. Underwater LNG leak renders surface area non-navigable.	To assess risks and subsequent mitigation planning for earthquakes and tsunamis coordinate with State Emergency Response Commission and Alaska Emergency Response System. Continue support for currents study & 3D dispersed plume model. Expand COOP to include fishing vessels and recreational craft Develop ecological baselines. Monitor health of fisheries. Sample water at potential spill areas, sensitive habitats.

Conclusions

The participants evaluated traffic conditions to be the fourth highest category, but in a near statistical tie with the long-term consequences category. The volume of fishing and pleasure craft factor was the fifth highest risk factor overall, and was a predominant element of the traffic density, number of people on the waterway and visibility conditions factors discussions.

The participants considered navigational conditions to be the highest risk category. The teams felt that risk associated with ice conditions was the third highest risk factor overall. The other factors in this category were relatively moderate and well balanced by existing risk mitigation activities.

The second highest-ranking overall risk factor was environmental impacts. Marine sanctuaries, spawning grounds and threatened and endangered species are distributed or migrate throughout the inlet. The entire inlet system is an environmentally sensitive area. The risks associated with economic impacts were a moderate, non-ranking risk factor.