THE IMPACTS OF THE CRUISE SHIP INDUSTRY ON THE QUALITY OF LIFE IN KEY WEST

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City of Key West Naval Properties Local Redevelopment Authority

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3. THE IMPACT ON THE MARINE ENVIRONMENT

3.A Historical Review of Key West Channel and Harbor

This section focuses on the history of the main ship channel and harbor at Key West, and explores the historic and current use by large (greater than about 50 feet long), deep draft vessels and cruise ships. The main ship channel south of Key West is used by transit in and out of the Port of Key West and the harbor is used for turning of large vessels. Prior to formal settlement in the early 1800s, the deep natural channel and deep protected harbor were likely used by native Americans, pirates, Bahamian wreckers, and the Spanish while in transit from the Caribbean, Cuba and the Bahamas to parts north and into the Gulf of Mexico. Prior to the completion of the Overseas Railroad to Key West in 1912 all commerce in and out of Key West occurred via vessels of all sizes. From the beginning "Key West's early settlers found that the surrounding waters, at worst, provided a livelihood, and at best, brought them wealth. Few family heads arrived without some type of sailing craft, and owners of large sloops and schooners found wealth in Havana and the West Indies trade." (Langley 1973).

The long and interesting history of Key West has resulted in excellent chronicles of changes and transitions from one period to another - changes often defined by changes in the maritime industry and associated trades. As the island changed from boom to bust and back again on several occasions, its insular nature and the interest of its citizens appears to have provided for detailed documentation of events. The various volumes referenced and noted below are a great resource for this maritime history. The excellent historic resources at the Key West Public Library include considerable focus on the channel and harbor and its use. Authors such as Jefferson Browne, Stephen Nichols, Stan Windhorn, Joan and Wright Langley, John Viele, Chris Sherrill, Tom Haimbright, Dan Gallagher, Ed Little and others use photography (including from the 1800s) and old maps as a means of showing the true nature of the west part of the island and its change over time.

Following are general reviews of various aspects of the history of the channel and harbor concluded with a chronology of significant events related to the development and evolution of the Port of Key West. Sources of information are provided with the Chronology at Section 3.A.7 and in Section 3.B with the environmental assessment.

3.A.1 History of Use as a Navigational Channel and Anchorage as a Center of Commerce

Key West has a long history as a major center of maritime commerce and as a U.S. Navy port, and for many years it was one of the richest cities in Florida and the U.S. But it also has been one of the poorest, especially during the depression era when the military left and commerce slowed. But all the while, commerce, be it the shipment of goods and passengers, fishing, and the like, along with the military, plied the waters of the channel and harbor. The importance of maritime trade to the island, as well as the tremendous productivity of the surrounding marine resources is evidenced by the fact that in Key West there was a population at times over 20,000 people prior to Flagler's railroad reaching Key West in 1912 and connecting the island to the mainland. This review includes a general history of maritime

commerce in and out of Key West. A history of activity by the U.S. Navy and the cruise ship industry is reviewed in Sections 3.1.3 and 3.1.5 that follow.

The early days saw wrecking prosper and through wrecking "the richest cargoes in the world, lace, silks, wines, silverware - in fact everything that the commerce of the world afforded - reached Key West" (Browne 1912). In the mid-1800s in the Key West Federal Court "the amount of business on the admiralty side of the court was quite large, but as steamships took the place of sailing vessels and light-houses were built on the most dangerous points of the Florida Reefs, the number of wrecks gradually diminished" (Browne 1912). Sharing the port with the wreckers were fishermen who made up a large part of the population at the time.

The U.S. military, beginning in 1822, was instrumental is the early development of Key West as a port, and there were times when the naturally deep harbor was full of military sailing vessels (Figure 3.A.1), and commerce related to maintaining and provisioning those vessels was active. Sailing vessels of the 1800s using Key West took many forms and sizes and included deep well fishing boats, sponge boats, inter-island freight and passenger boats, pleasure boats, mail boats, pilot vessels, oceangoing schooners, and wrecking vessels, in addition to the ever present military. Commerce in and out of the port during the 1800s included salvage from wrecking, seafood of many types, beef cattle, freight, passengers, mail, salt, pineapples, vegetables, tobacco and cigars, ice, and charcoal. Vessel activity later came to include considerable more tourism, recreational fishing, and pleasure boating.

During the Civil War there were more ships stationed in Key West than at any other port in the U.S., and later in the 1800s large steamships began to frequent Key West and participate in the ever expanding maritime trades there. Passenger service to a number of ports had been established. Boat building and repair was an active local trade and the waterfront soon included wharfs, boatyards, marine railways, storage facilities, seafood markets and the like. By the late 1800s Key West was the wealthiest city in Florida, and one of the wealthiest in the U.S. Local fishing vessels were harvesting millions of pounds of seafood for local and other markets. Wrecking diminished after the reef lights were placed from 1852 to 1882 but there were still many wrecks of not only sailing vessels but also modern motor ships and wrecking remained an important part of the maritime commerce.

FIGURE 3.A.1. U.S. NAVY FLEET AT KEY WEST IN 1823 (STATE ARCHIVES OF FLORIDA).

By 1870, the cigar business in Key West, using tobacco imported mostly from Cuba on vessels, was the largest in the world. By 1880 there were 25 inter-Keys freight schooners carrying farm produce from Keys plantations to Key West for reshipment to other ports by steamship. During this period there were an estimated 450 sailing vessels, primarily spongers built in Key West, operating out of Key West. By 1884 Key West was the busiest port in Florida, and shortly thereafter, a line of steamers considered the very best and fastest steamships that could be built, begin running from Port Tampa to Key West and Havana. By the 1890s fifty to eighty foot schooners carrying up to 25 passengers each began running between Key West and Miami.

In about 1890 a factory for canning turtle soup from green turtles was constructed on the harbor and cigar tobacco importation and cigar production had reached its peak. By the turn of the century, the Key West sponging industry was very active, sales at sponge markets were brisk, and the industry employed a couple of thousand men and was earning about $1,000,000 per year (Figure 3.A.2).

By the early 1900s large propeller driven, deep draft commercial and Navy steamships were regularly coming and going in Key West. In 1907, "Mallory and Co." established a steamship line between New York and Mobile touching at Key West both ways - with 4 to 6 ships stopping at Key West weekly. Flagler completed the railroad to Key West in 1912, and channel commerce from large vessels loading and unloading from the end of the railroad at the newly expanded Trumbo Point increased. Around 1912 power vessels began replacing traditional sailing vessels for as fishing.

FIGURE 3.A.2. SPONGE MARKET ON KEY WEST HARBOR IN 1898 (STATE ARCHIVES OF FLORIDA).

Following World War I, Key West mariners were looking for new maritime activities. When prohibition was enacted, bootlegging liquor via vessels from Havana became big business. Commercial fishing based along the Harbor continued to be an active enterprise, and during the winter of 1919/1920 nearly 3,000,000 pounds of mackerel were landed at Key West. Other forms of commercial fishing continued out of Key West, including turtling, although this resource was by now becoming depleted. Active commerce in vegetables and fruits to and from distant ports was still taking place.

Passenger ships and ferries routinely traveled between Key West and Havana by 1928. In an effort to encourage new commerce during the depression, the Navy permitted private yacht owners to use the sub basin (Truman Harbor) for berthing. In 1938 the Overseas Highway was completed and a new era of transport of commerce began in Key West. Commercial fishing out of Key West remained an active industry and employed many people even though the sponge industry was decimated by the sponge blight in 1939. In 1949 pink shrimp (pink gold) were discovered in commercial quantities in the Tortugas and by 1954 shrimping - there and near Key West- involved as many as 500 shrimp boats catching over 30 million pounds per year. Many shrimp boats docked in Key West while not fishing and contributed significantly to the commerce there for many years.

In the mid 1950s the car ferry *City of Key West* carrying up to 50 autos and 700 passengers began running from between Key West and Cuba, and by 1956 Key West was one of the country's leading ports of foreign travel averaging about 13,000 passengers per month. In 1969, the Port of Key West received what is considered to be its first regularly scheduled cruise ship - the *Sunward*.

With an increase in tourism in the 1970s and 1980s, and with the growing popularity of scuba diving and salt water sport fishing, vessel traffic in Key West harbor became very busy with small commercial and recreational vessels of all sizes and power. Head boats carrying fishermen to the reef were common and used Key West Channel. Commercial and recreational fishing for snapper, grouper, mackerel, and spiny lobster took place inshore and on the reefs, while an active offshore blue water fishery was conducted by numerous large charter boats docked in Key West Harbor, Key West Bight, and Garrison Bight. By the 1990s recreational and pleasure vessels had mostly replaced the commercial vessels that historically dominated the harbors of Key West. Key West Bight and Garrison Bight were filled to capacity during the 1980s and 1990s with docking facilities, many of which now include large power vessels for pleasure use and fishing.

The use of large sailboats and schooners for tourism increased in the late 1990s and is common today. Large dive boats ferry upwards of 150 snorkelers and divers at a time to reefs off Key West. Many small vessels catering to the tourism related diving and fishing industry travel the various channels radiating out from Key West as do numerous private boats. During busy periods the Harbor becomes crowded with boats of all sizes and interaction between boats is routine. The U.S. Coast Guard is kept busy protecting navigation within the boundaries of the marked channel from vessels anchoring. Hundreds of live-aboard vessels of diverse character now encircle Key West, a significant increase compared to the 1970s when there were relatively few. Formal anchorages have been established by the City north of Key West in an attempt to manage live-aboards and their vessels.

The 2000s saw the reinstitution of ferry traffic between Key West and the west coast of Florida, with runs to Ft. Myers and Marco Island. Navy and Coast Guard vessels active in the area, continue to come and go for a variety of purposes, and are part of the Key West commerce related to use of the channel and harbor. Along with cruise ships, Navy vessels are the other truly large deep draft vessels that frequent the channel and harbor. Most of the historic maritime waterfront of Key West has been converted to hotel rooms, restaurants and bars (Figure 3.A.3), with Key West Bight retaining some of the types of establishments that support a maritime commerce. Commercial docking facilities are currently near the maximum that can safely be accommodated in the Harbor and the Bight.

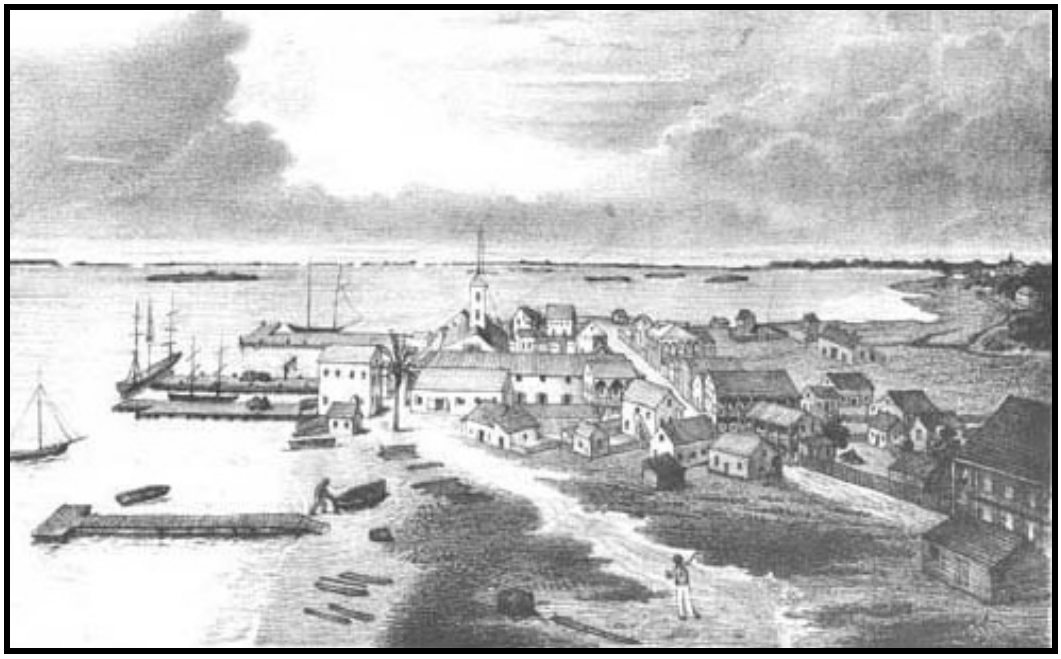
FIGURE 3.A.3. KEY WEST BIGHT (TOP) AND THE NORTHWEST CORNER OF KW IN 1987 (MCDONALD COLLECTION).

Extensive docks have been installed in Key West Bight since 1987.

3.A.2 History of Dredge and Fill and the Physical Alteration of the Key West Channel and Harbor

Jefferson Browne in 1912 described the uniqueness of Key West harbor prior to the large scale dredging and filling there - "It's harbor, landlocked by keys and reefs, in which the largest ships can float, has four entrances: the southwest passage has thirty-three feet of water on the bar; the main ship channel thirty feet; the southeast thirty-two feet and the northwest fourteen feet. A vessel leaving the harbor of Key West by the southwest passage has but seven miles to sail before she can shape her course to the port of destination, and through the main ship channel, but five miles. At very little expense the northwest passage can be deepened to twenty-four feet; this would enable the entire commerce of the gulf to pass through the harbor of Key West...." The dredging of the northwest channel never occurred although it was protected early on by long jetties. Early Key West settlers selected the high ridge on the northwest side of the island adjacent to deep water to build houses (Figures 3.A.4 through 3.A.6).

FIGURE 3.A.4. WHITEHEAD SKETCH OF THE NORTHWEST CORNER OF KEY WEST IN 1838 (STATE ARCHIVES OF FLORIDA).



The island of Key West nearly doubled in size by dredging and filling from about 1575 acres in 1829 to about 3000 acres in 1971 (Sherrill and Aiello 1978). Much of this increase was on the west shoreline including the creation of the Trumbo Point area in the early 1900s, the filling around Ft. Taylor that progressed through the mid 1900s, the filling of Truman Annex and the piecemeal filling of the shoreline for commercial uses that exist today. The filling of the Trumbo Point area of the north side of Key West was initiated in about 1911 to provide a terminus and offloading point for the Overseas Railroad (Figure 3.A.7). Commercial activity before the era of dredge and fill was concentrated on the north and northwest shorelines of the island (Figure 3.A.6).

FIGURE 3.A.5. 1855 NAVIGATIONAL CHART #469 OF THE WEST SIDE OF KEY WEST. AND THE HARBOR. DEPTHS ARE IN FATHOMS (NOAA).

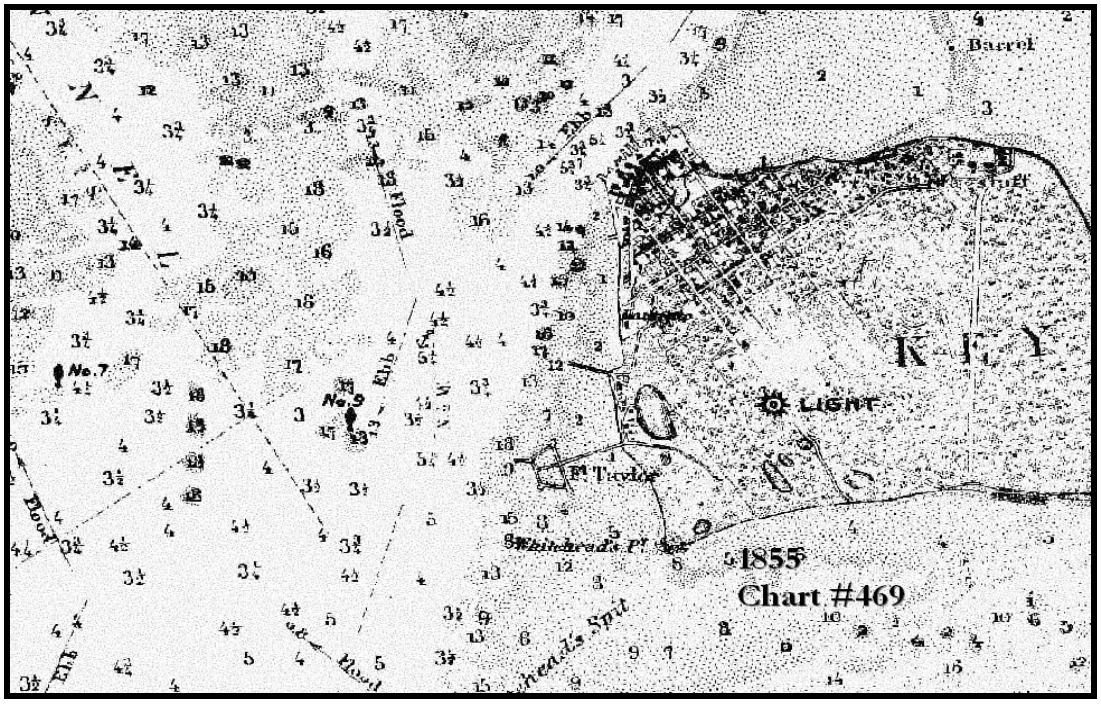


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FIGURE 3.A.6. 1870 SKETCH OF KEY WEST HARBOR WITH A VIEW TO THE SOUTHEAST. Ft. Taylor is on the extreme right and the Front Street area is in the foreground (state archives of Florida).

Hydraulic dredges were used to pump up baybottom in the area. Fleming Key was created by dredging and filling. The Outer Mole was constructed by the Navy sometime between 1923 and about 1929. During World War II the Navy extended the 30 foot deep channel north to Trumbo Point to expand its operation there, Truman Harbor (a submarine base) was deepened and the shoreside facility there improved. Ft. Taylor, originally built in the sea and connected by a long access way, was eventually surrounded by fill that progressed seaward after World War II. (Figures 3.A. 8 through 3.A.11).

Current conditions along the harbor are provided a portion of the 1989 navigational chart #11441 at Figure 3.A.12. The radical conversion of the spoil island on the west side of the harbor originally known as Tank Island can be seen in Figure 3.A.13. Locations of the 3 cruise ship berths discussed in this assessment (Outer Mole, Pier B, Mallory Dock) are provided in Figure 3.A..14.

FIGURE 3.A.7. 1919 NAVIGATIONAL CHART (NOAA).

Reflecting filling on the northwest corner of the island and the long structure extending NW from Ft. Taylor. - depths in feet

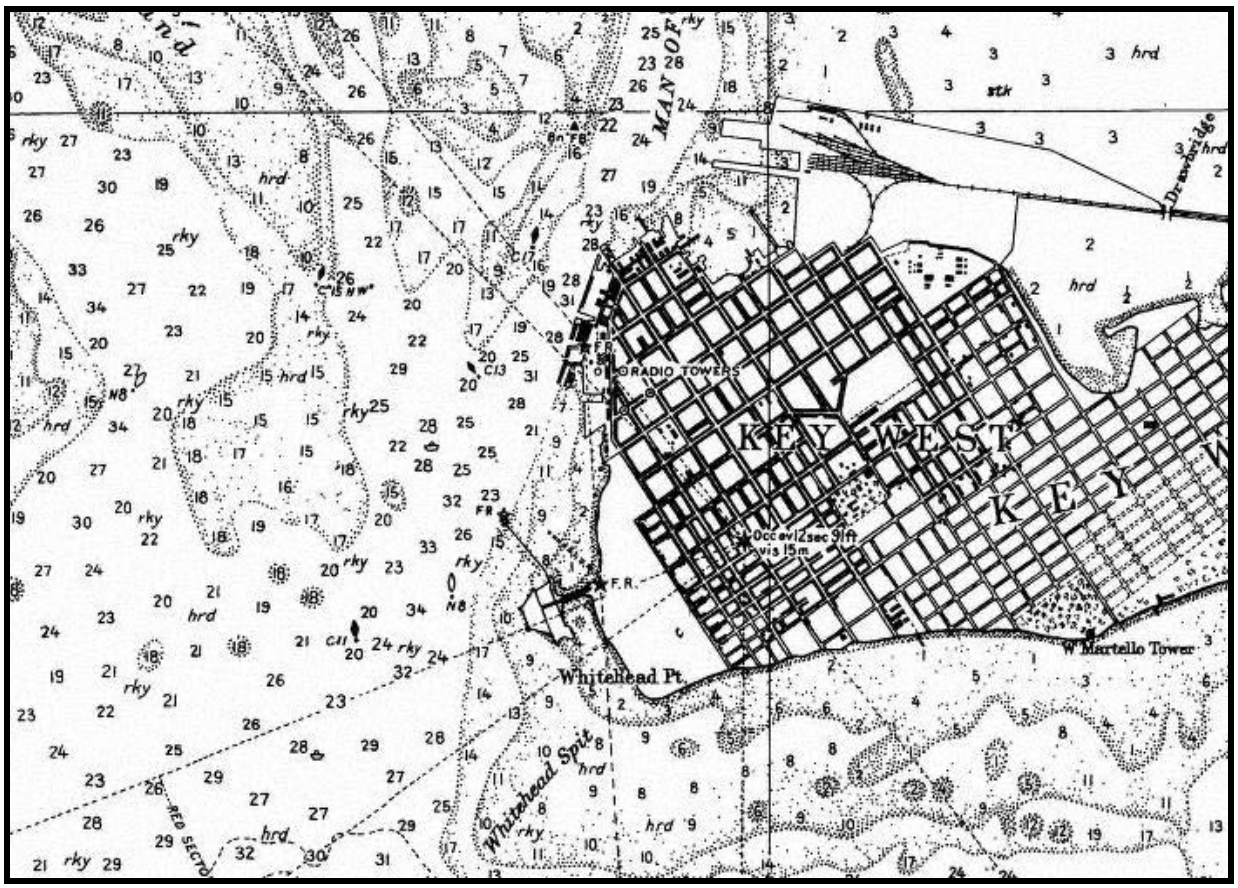


FIGURE 3.A.8. 1933 NAVIGATIONAL CHART (NOAA).

Showing Outer Mole connected to Ft. Taylor. The Trumbo Point complex has been filled and filling is progressing along the northwest corner of the island. Christmas Tree Spoil Island has been partly filled. Depths are in feet

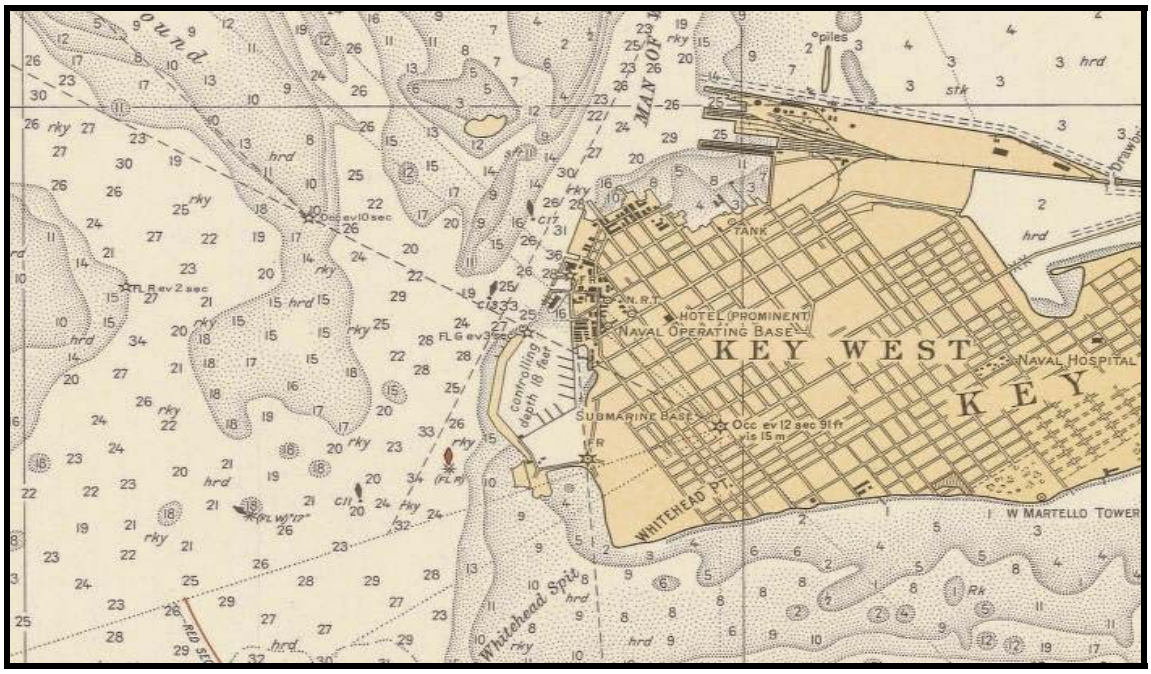


FIGURE 3.A.9. THE OUTER MOLE, SUBMARINE HARBOR, AND FILLING OF THE AREA AROUND FT. TAYLOR IN 1951 (FARALDO COLLECTION).

FIGURE 3.A.10. FILLING PROGRESSING OFFSHORE AROUND FT. TAYLOR AND ON TANK ISLAND IN THE 1950S (FARALDO COLLECTION).

FIGURE 3.A.11. 1966 NAVIGATIONAL CHART #576. (NOAA).

The era of large scale dredging and filling is nearly complete. Dredging of the channel and harbor recently completed. Depths are in feet

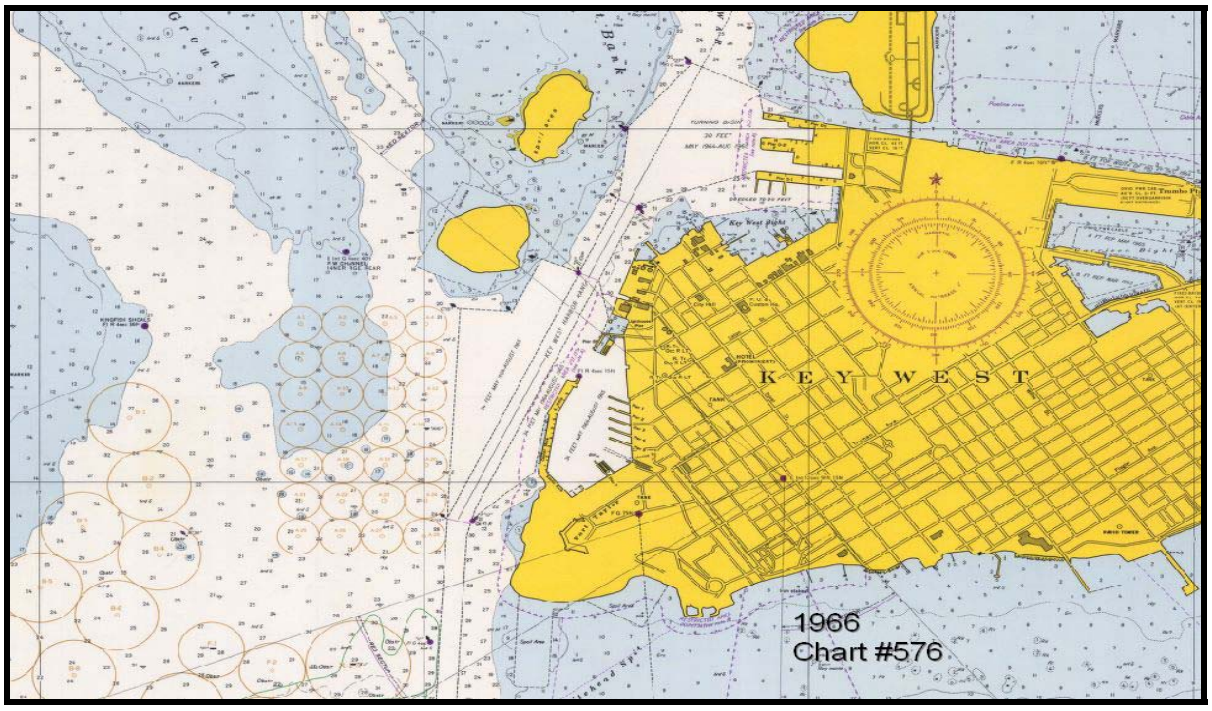


FIGURE 3.A.12. 1989 NAVIGATIONAL CHART REPRESENTS THE CURRENT EXTENT OF FILLING ALONG THE WEST SIDE OF THE ISLAND. DEPTHS ARE IN FEET (NOAA).

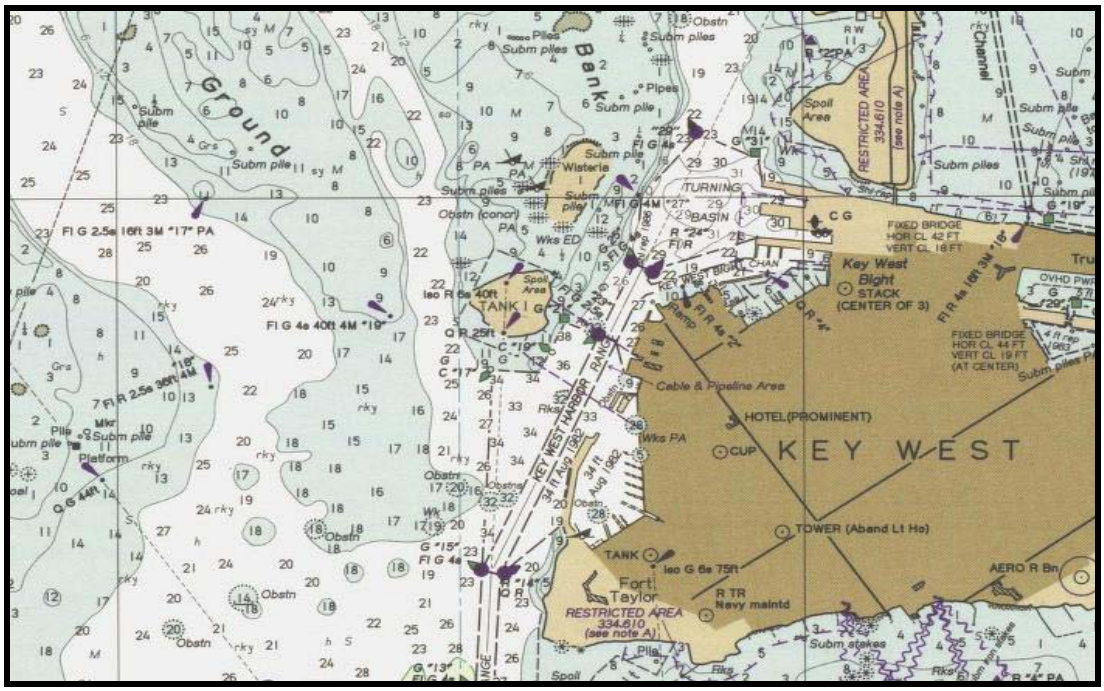


FIGURE 3.A.13. TANK ISLAND (SUNSET KEY), LATE 1990S VIEW. (MCDONALD COLLECTION).

On the west side of Key West Harbor, is a spoil island created by earlier dredging in the area later converted to luxury homes. The late 1990s view is towards the northwest corner of Key West across the channel. Anchored live-aboard vessels are common on the edge of the main channel

FIGURE 3.A.14. 1994 AERIAL VIEW OF KEY WEST CHANNEL AND HARBOR WITH CRUISE SHIP BERTHS NOTED.

A "Dredge History of Key West Ship Channel and Truman Harbor" was produced for the Navy by one of is contractors during the review of the Navy's permit application in 2003 (Anonymous 2003). It references old Navy permits and documents but includes little detail on when dredging actually occurred. The channel and harbor was designated a federal navigation channel in the early 1900s, to be managed by the Army Corps of Engineers. A long time resident of Key West, Ray Blazevic, relates that early harbor dredging occurred just after the turn of the century and the Dredge History refers to the removal of "reefs" in the main ship channel in 1908. Other references to the dredge history included early dredging in Truman Harbor in 1919; dredging during World War II, in the early 1950s, and large scale dredging again in the mid 1960s. Blazevic also relates that Tank Island was filled during World War II. Figure 3.A.8 shows that a small part of Wisteria (Christmas Tree) Island to the north had been filled as of 1933.

Major dredging took place in the mid 1960s and achieved controlling depths of about -34 feet mean low water (MLW). New dredging permits were issued to the Navy in 2004 by state and federal agencies, to include maintenance of previously dredged areas to the original design specifications, and new dredging that would remove a number of hardbottom areas in the main channel and remove an additional 2 feet of bottom as "advanced maintenance", with a 1 foot allowable over dredge. A maximum depth of -37 MLW was ultimately authorized over about 456 acres (Figure 3.A.15). The Navy's purpose for the dredging is discussed in Section 3.A.3 that follows. The Florida Department of Environmental Protection issued a Consolidated Environmental Resource Permit and Sovereign Submerged Lands Authorization (# 0207625-001-EI) in June 2003, and a permit was issued by the Army

Corps of Engineers (permit #200300203 (IP-PK)) in July of that year. The Florida Keys National Marine Sanctuary exempted the dredging from permit requirements and the need for formal authorization, considering it all maintenance work. They did review and comment on the Navy's 2003 draft Environmental Assessment (EA), and made recommendations for mitigation and monitoring.

A general description of the area to be dredged is included in the final Navy EA in 2003 - "The maintenance dredge of the Federal project channel in the waters off Key West would include the main Ship Channel beginning at its southern terminus, extending north and including cuts A, B, and C, the channel widener at cut C known as the turning basin, and Truman Harbor. The proposed maintenance dredge project would allow safe passage of additional types of Navy vessels making port calls to NAS Key West. Draft requirements of cruiser and destroyer class vessels preclude their entrance into Truman Harbor under existing conditions."

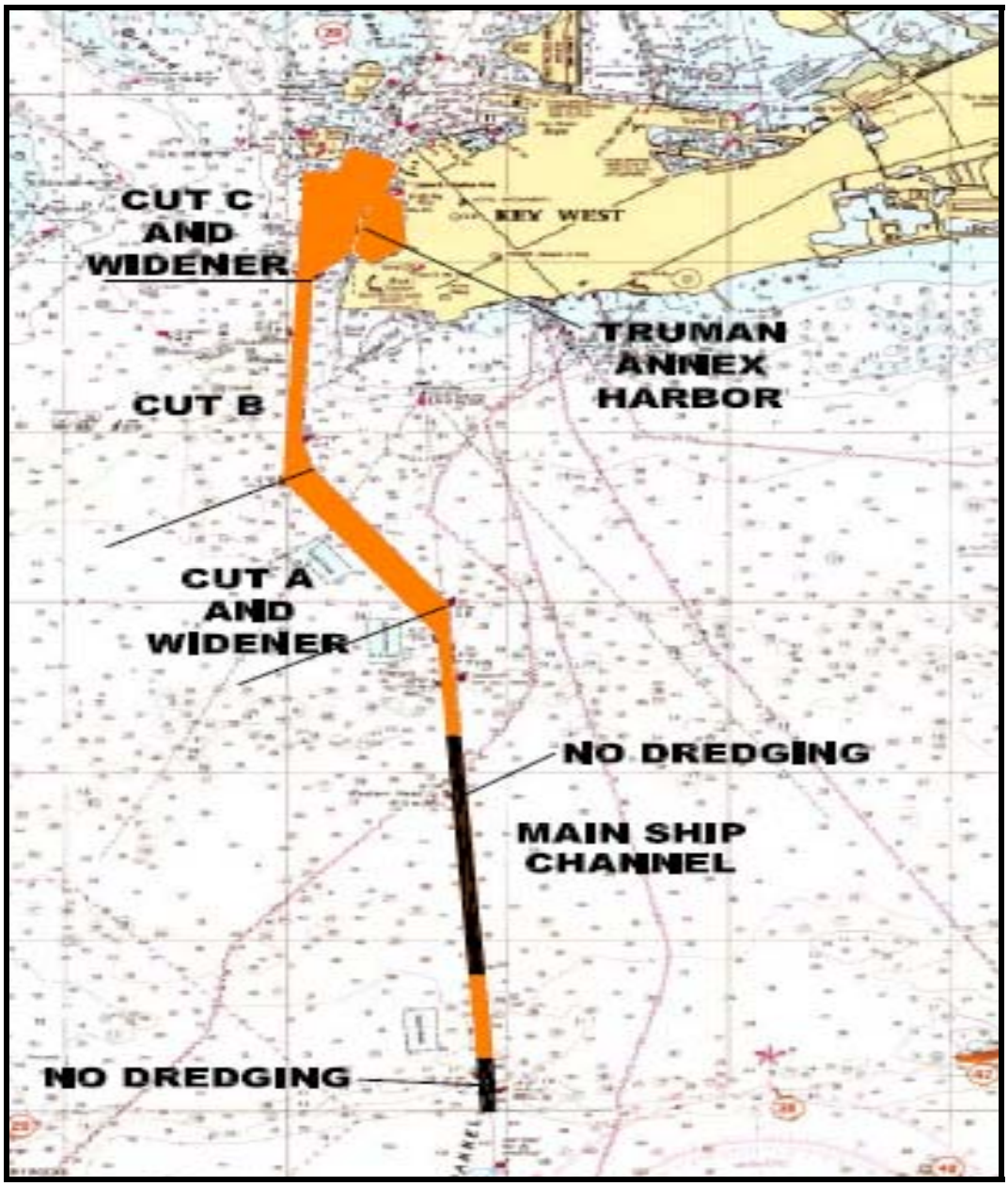
Pre-dredging bathymetry as of 2001 is reported in the 2003 Navy EA as "Depths in the Main Ship Channel range from about 32 ft to greater than 40. The depth less than 34 ft occurred along the sides of the north end of the Main Ship Channel. Depths in the next portion of the Ship Channel toward Key West (Cut A) range from less than 34 ft to over 40 ft. Depths in the center of the channel are generally greater than 35 ft In the next section of the channel toward Key West (Cut B), water depths in the channel were greater than 35 ft . In the basin outside of the Truman Annex Harbor (Cut C), water depths were typically greater than 35 ft. A contour plot of the depths in Truman Harbor was developed based on preliminary bathymetric data collected by Continental Shelf Associates, Inc. Water depths in the center of the harbor were greater than 35 ft. Shallower areas were observed along the eastern and southern boundaries of the harbor. Near the entrance of the harbor, depths of less than 34 ft were observed." The Navy's channel and harbor deepening project was initiated in 2004, is ongoing, and is expected to be completed later in 2005.

3.A.3 History of U.S. Navy Use of the Channel, Harbor, and Docks

The Navy provides summarizes its history in Key West in the 2003 EA for the current dredging project - "The U.S. Navy's presence in Key West dates to the early 1800s, when a Naval base was established to support the fledgling nation's war on piracy. The base expanded and contracted over the years until World War I, when a Naval Submarine Base and Naval Air Base were commissioned to support the effort to interdict the German Navy. During the period between WWI and WWII, the Navy presence was greatly reduced and facilities were abandoned or sold. Activity at NAS Key West increased at the outbreak of WWII, and it was designated as a NAS. Although the Navy presence in Key West was greatly reduced and consolidated after the war, the Navy retained NAS Key West as a training site. After the Cuban Missile Crisis and during the DOD Cold War build up, the NAS facilities and missions grew. In the last decade, the Station's Atlantic Fleet support missions have changed: various properties have been excessed and home ported aircraft and ship squadrons have been decommissioned or relocated. These downsizing efforts continued with the Base Realignment and Closure Commission determinations of 1995.".

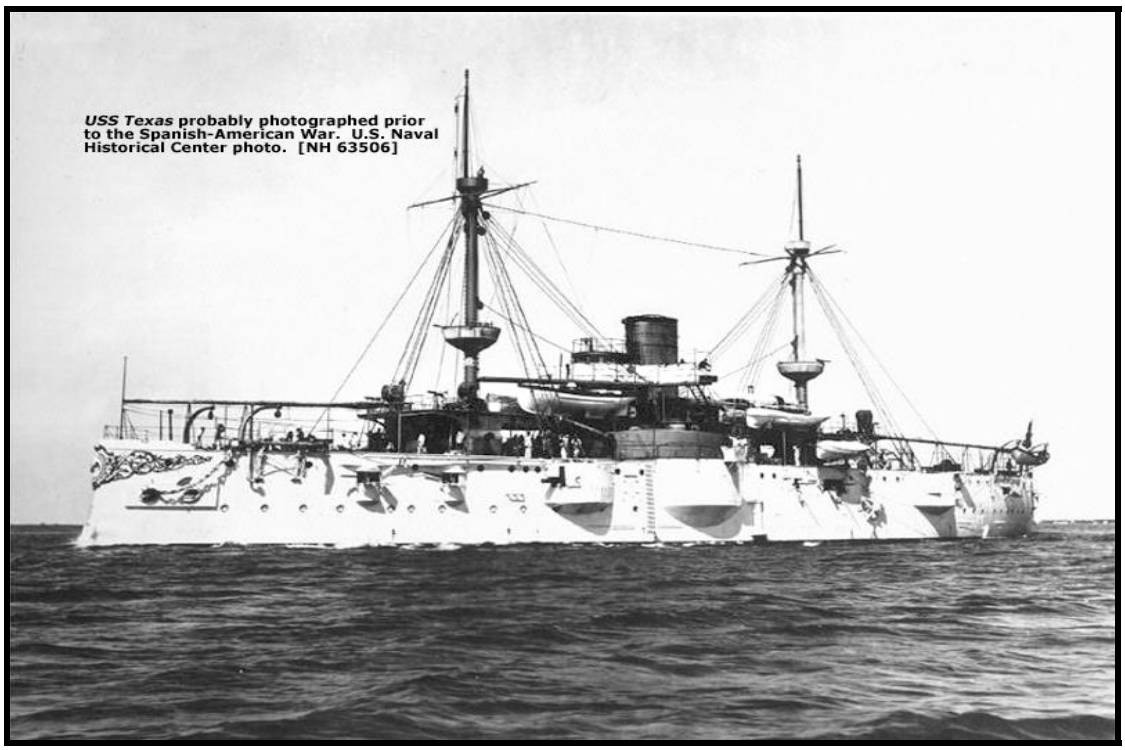
FIGURE 3.A.15. AREAS TO BE DREDGED IN CURRENT NAVY DREDGING PROJECT. (NAVY 2003.)

The main ship channel and cut b are 300 feet wide



The Navy presence in Key West was expansive and an impressive display of power at times, especially during periods of war or external threats, and usually included many of the largest and most capable vessels afloat. These periods include the days of piracy (Figure 3.A.1) and the Civil War when Key West was the headquarters of the Eastern Gulf Blockading Squadron, with more ships berthed than anywhere else in the U.S. The Spanish American War, as close as nearby Cuba in the very late 1800s, resulted in the American Battle Fleet being based in Key West along with steel cruisers and battleships from the North American Flying Squadron that was blockading Cuba. One of the large Navy vessels to visit Key West during the war was the *USS Texas* from the North Atlantic Squadron (Figure3.A.16). The steel *Texas* was 308 feet long, had a draft of nearly 23 feet, was rated at 6,315 tons, and had a top speed of about 17 knots.

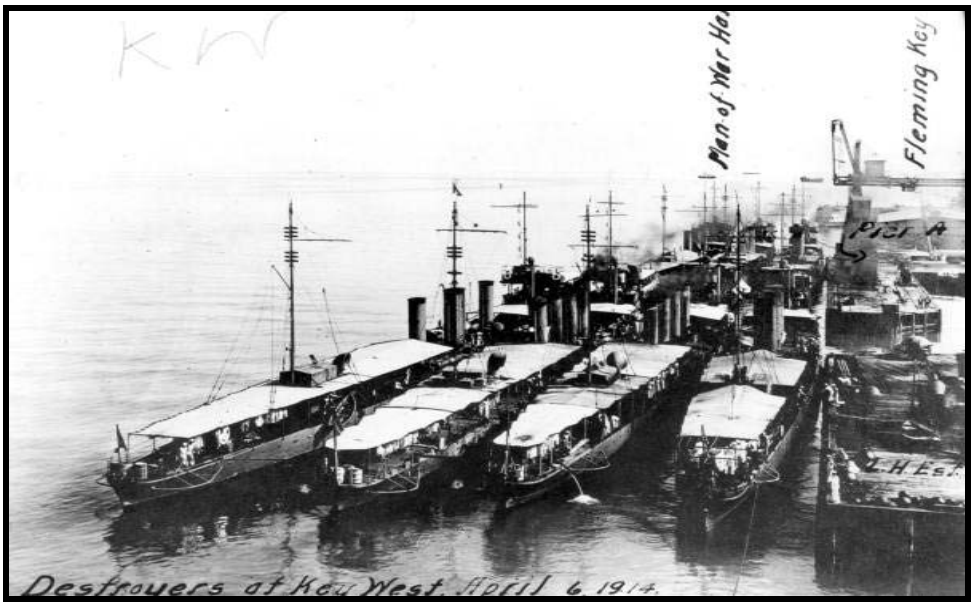
FIGURE 3.A.16. THE *USS TEXAS* IN THE LATE 1800'S (U.S. NAVY).



In 1902, the Navy condemned the southwest shore of Key West and began the construction of a Naval Base there. Naval use of the Trumbo Point area expanded around 1911 when Henry Flagler began dredging the harbor and filling baybottom there.

World War I saw Key West Naval Station activated as the Strategic Center of Caribbean Defense and docks and piers built at the Naval Station and Trumbo Point to berth coastal patrol vessels, submarines, destroyers (Figure 3.A.17), and battleships. German U-Boats patrolled water of the south Atlantic and Caribbean during World War II and from 1941 to 1945 Key West saw the busiest period for large vessels in its history when there were more than 14,000 visits by cargo and military ships. Anti-sub patrols were based out of Key West during the war and bar pilots had to be brought to Key West to help handle the large vessel traffic.

FIGURE 3.A.17. NAVY DESTROYER CLASS VESSELS IN KEY WEST IN 1914 (STATE ARCHIVES OF FLORIDA).



During the 1950s and 1960s the Naval Station was one of the largest submarine bases in the world. In 1962 Key West Naval Station supported the fleet blockading Cuba during the Cuban Missile Crisis. By 1973 all submarine activity had been discontinued and in 1974 the Naval Station closed, and all ships and shoreside facilities were closed. In 1980, the Navy assisted with handling the exodus of 125,000 Cubans traveling by sea from Cuba by all manner of crafts and vessels. Through the 1980s the Navy used the Outer Mole and other facilities for berthing military vessels in transit (Figure 3.A.18). In 1985, the Navy transferred a squadron of hydrofoils to Key West that remained until the 1990s when the squadron was decommissioned (Figure 3.A.19). In the 1990s a fleet of aerostat vessels assisted in drug interdiction as part of the Joint Interagency Task Force East based in Key West, as did other military and U.S. Coast Guard (USCG) vessels. Military vessel activity continues today for the war on drugs and terrorism.

FIGURE 3.A.18. THE U.S. NAVY VESSEL *SPIEGEL GROVE* DOCKED AT THE OUTER MOLE IN 1982 (MCDONALD COLLECTION).

This 510 foot long vessel was sunk in 2002 off Key Largo as an artificial reef.

FIGURE 3.A.19. NAVY AMPHIBIOUS SHIP AND HYDROFOILS AND USCG VESSELS BERTHED AT TRUMBO POINT IN 1988 (MCDONALD COLLECTION).

Through the 1800s the Navy's mission in Key West made use of the deep natural harbor. In the 1900s deepening and widening of the offshore main channel and the inner harbor and turning basin proceeded incrementally. The last large scale maintenance dredging by the Navy occurred in the mid 1960s with the full channel and harbor later first reflected in 1966 navigational charts (Figure 3.A.11).

The Navy's justification for the current dredging project and improvements to the Outer Mole is found in the 2003 EA - "The Navy proposes to modernize ship and aircraft support functions and facilities at the Naval Air Station (NAS) Key West including Boca Chica and Truman Harbor. The Navy needs to undertake such modernization to meet ongoing and new training readiness requirements. By making improvements to existing facilities, the Navy intends to build redundancy into east coast training locations and infrastructure support capability so that operational units can better achieve unit level, intermediate, or advanced qualifications at the most effective and efficient operations tempo. The proposed project would improve existing ship support by providing modern facilities designed for twenty-first century ships. Improvements at Truman Annex would provide modern ship berthing facilities, limited repair capability, force protection and improvements to navigational safety. Increased port visits at Truman Annex, by Naval ships are anticipated because the berthing and mooring will be designed to accommodate both cruisers and destroyers in addition to those ships that already visit (frigates, minesweepers, etc.), and the Annex would be able to accommodate more than one ship at a time. Key West's unique location between the Gulf of Mexico and the Atlantic Ocean, coupled with the capacity for upgraded/future technologies, afford the Navy efficient and effective means to support nearby at-sea readiness activities and to provide logistics and maintenance support for ships and aircraft. These support functions will facilitate timely Carrier Battlegroup (CVBG) certification before each overseas deployment. While the Navy will retain the property for Navy use, the Navy also proposes to lease the Outer Mole portion of the property to the City of Key West to allow cruise ships to moor and onload and offload tourists, in the same manner contemplated in the 2000 Draft EA. The Navy will retain priority use of the Outer Mole for occasions when needed for operational requirements. The proposed lease is incorporated herein by reference."

The Annex supports Atlantic Fleet ships with berthing, freshwater, and occasionally fuel and other support services. In addition, by agreement with the City of Key West, Truman Annex also serves as a cruise ship berth. NAS Key West at its various locations is the host facility for numerous tenant activities, including the U.S. Coast Guard, U.S. Army Special Forces Underwater Training School, and NOAA to name a few. Table 3.A.1 was derived from Navy data and their interviews with Coast Guard and Navy personnel as well as others and provides typical ship visits at Truman Annex. Combatant ships that visit Key West may be enroute to other parts of the globe or operating in the Florida area (Navy 2003).

TABLE 3.A.1.

Typical Annual Support Provided by NAF Key West: Ships (1997-2001)

Ship Type	Visits Per Year		Crew Size	Services*		
	Number	Duration (days)	(average)	Fuel	Water	Electric
U.S. Navy Small Combatant	8	3	316	O	Y	Y
U.S. Navy Mine Warfare	25	2	66	F	Y	Y
USNS	15	3	39	F	Y	Y
U.S. Coast Guard WMEC	8	3	87	O	Y	Y
NOAA	10	2	35	O	Y	Y
U.S. Navy Patrol Boats	5	2	39	F		Y
Foreign Combatants	5	5	320	O	Y	O
Other Use						
Research Vessels	5	2	25	O	Y	O
U.S. Army	4	4	16	O	Y	O
Cruise Ships	130	8-12 Hours	1,200	N/A	N/A	N/A
* O = Occasionally	F = Frequently	Y = Always	N/A = Not Applicable			

Navy combatants use NAS Key West to pick up mail, personnel and supplies and as a liberty port while operating independently or as part of a larger force. The Mine Warfare ships frequently use Key West as a way point while operating away from their home base, with typically more than one ship visiting at a time. Visiting Coast Guard Medium Endurance Cutters are usually in the area as part of JIATF interdiction patrols, and use Key West for the same purpose as the Mine Warfare ships as well as a local base of operations. They usually patrol for five to ten days and return to NAS Key West for three days. Navy Coastal Patrol Ships (PCs) and Coast Guard Patrol Boats usually patrol for three to four days and then return to Key West for two to three days. Navy ships visit Key West as part of the JIATF mission as well as other surveillance and oceanographic survey missions. Foreign Navy ships use Key West NAS as a liberty port when operating with US Navy ships and while operating independently enroute to South America and the Caribbean. Cruise ships berth at Truman Annex when the other city berths are being used. They stay about half a day and require no services (Navy 2003).

An example of large vessel activity associated with maritime activity of the U.S. Coast Guard in Key West is the vessel *Mohawk*, the last of the 270-foot "Famous" class cutters. Since the time of her commissioning in March of 1991, she has served the Coast Guard in a wide variety of missions out of Base Key West including Search and Rescue, Maritime Law Enforcement, and Alien Migrant Interdiction Operations.

The Navy's future plans for the Outer Mole and Annex is explained in a 2003 letter from the Navy to the State of Florida during the dredging permit review process ".....an expeditious review of these fast tracking repair projects is needed as they play a vital role in supporting the U.S Atlantic Fleet war fighter readiness by providing maximum support capacity for all existing operational requirements, newly generated Anti-Terrorism Force Protections initiatives and enabling the optimal use of continental U.S. based training locations and resources for Carrier Battle Groups, Amphibious Ready Groups and Marine Expeditionary Units."

3.A.4 History of the Key West Cruise Ship Industry and the Evolution of Industry Vessels Using Key West Channel and Harbor

Although passenger ships had been visiting Key West for many years picking up and delivering passengers, the initiation of the cruise industry at the Port of Key West is considered to have begun with a visit by the *Sunward* in 1969. It was the first regularly scheduled cruise ship; it moored at either the Outer Mole or Pier B, and visited about once a month *(www.keywestcity.com)*. In the next 15 years City records show that the Port received 266 calls by cruise ships, averaging about 1-2 visits per month. In the early 1970s the cruise ship *Bolero* (526 feet long, 23 foot draft, 15,781 gross tons and carrying up to nearly a 1,000 passengers) began weekly visits. There is some indication that cruise ships visiting during this period used Mallory Dock (but see Figure 3.A..20); other information suggests only Pier B and the Outer Mole were being used. In 1984 the City made much needed improvements to Mallory Dock making it a full cruise ship docking facility (Figure 3.A.21). During the 1992/1993 fiscal year 256,000 cruise ship passengers visited Key West and during the 2002/2003 fiscal year 1,122,200 passengers visited the 3 cruise ship berths in the harbor (Figure 3.A.22).

Visits by cruise ships to Key West have increased in number nearly every year since the early 1990s and the number of cruise ship passengers visiting Key West increased ten fold from 1990/91 to 2002/03. At the same time the size of cruise ships has increased in the Bahamas-Florida-Mexico-Caribbean route and some vessels currently under construction are even larger.

FIGURE 3.A.20. MALLORY SQUARE DOCK IN 1961 (STATE ARCHIVES OF FLORIDA).

FIGURE 3.A.21. MALLORY SQUARE AND CRUISE SHIP BERTH IN 1987 (MCDONALD COLLECTION).

FIGURE 3.A.22. CRUISE SHIPS BERTHED AT PIER B (FOREGROUND) AND ANOTHER AT THE OUTER MOLE IN 2004 (KEY WEST CITIZEN).

View is to the south.

Calling in 1935, the *Florida* was one of the earliest passenger-cruise ships to visit Key West. It had a gross tonnage of 4,302 tons, a steel hull, and a twin screw propulsion system powered by two geared steam turbines. It was 366 feet long, 57 feet wide, yet had a draft of nearly 29 feet. It was designed for passenger service with accommodations for 742 cruising passengers. The *Florida* was built in 1931 in Newport News, Virginia, at a cost of $2.6 million. It did the Port Tampa-Key West-Havana run for many years.

An example of the current size and power of cruise ships visiting Key West - the *Enchantment of the Seas* - is one of the largest cruise ships in the world. It was built in 1997 in Finland at a cost of $300 million. It's considered a mega-class cruise liner, is 916 feet long and 106 feet wide, is rated at 74,137 gross tons, has a draft of 25 feet, carries up to 2,440 passengers, and has a maximum speed of 24 knots. *Enchantment of the Seas* is equipped with diesel-electric power plant machinery with electric propulsion motors. The main engines are four diesel engines each generating maximum power of 12,600kW. There are two main stern propellers, two 1,750kW bow thrusters, and a single 1,750kW stern thruster (*http://www.ship-technology.com/projects/enchantment/*). But, as can be seen in the above descriptions and in Table 3.A.2 , smaller size vessels do not necessarily equate to shallower drafts, but smaller vessels are usually less powerful. From the summary provided in the following table the "average" large cruise ship visiting Key West in recent years is rated at about 63,000 tons, is 810 feet long with a 25 foot draft, and can carry nearly 2,000 passengers.

TABLE 3.A.2. INFORMATION ON 30 CRUISE SHIPS VISITING (OR PROJECTED TO VISIT) KEY WEST IN RECENT YEARS, SORTED BY GROSS TONS (WARD 2005).

Cruise Ship	Gross Tons	Length (ft)	Draft (ft)	Maximum # of Passengers
Summit	91000	965	26	2450
Radiance of the Seas	90090	962	28	2500
Jewel of the Seas	90090	962	28	2500
Costa Atlantica	85700	960	26	2680
Costa Mediterranea	85700	960	26	2680
Disney Magic	83338	965	26	3325
Westerdam	81769	960	26	2272
Zuiderdam	81679	951	26	2272
Rhapsody of the Seas	78491	915	24	2435
Mercury	77713	866	25	2681
Enchantment of the Seas	74137	916	25	2446
Grandeur	74137	916	26	2446
Majesty of the Seas	73941	880	25	2244
Century	70606	807	25	2150
Fascination	70367	855	26	2634
Imagination	70367	855	26	2634
Splendour of the Seas	69130	867	25	2064
Volendam	60906	781	26	1850
Veendam	55451	719	25	1627
Costa Romantica	53049	719	25	1779
Crystal Harmony	49400	790	25	1010
Seven Seas Mariner	48015	713	21	752
Celebration	47262	733	26	1896
Horizon	46811	681	24	1660
Zenith	42255	681	24	1800
Norwegian Majesty	40876	680	20	1790
Seven Seas Navigator	28550	560	21	530
Saga Ruby	24492	627	27	655
Radisson Diamond	20295	430	26	354
Wind Surf	14745	614	16	308
Average	62679	810	25	1947

A review of the current state of cruise ship construction is provided at *http://www.maritimematters.com/dakesnewships.html* - "The cruise ship industry is still considered to be a growth industry, and, as of January 2004, current tonnage on order worldwide was over 2 million gross tons. Cruise lines building vessels in European ports waiting for an improvement to the exchange rate of the Dollar to the Euro, only saw the dollar sliding further, and with their desire for more new tonnage combined with attractive multi-ship package deals, resumed placing orders for ever larger vessels at the end of 2004 and into 2005. As these new vessels come on line, the cruise industry will see significant growth from now through 2007."

The building of larger cruise ships in order to provide a better guest experience is expected to continue, but the number of smaller ships (of about 100 passengers) is also expected to increase. The larger ships are already constrained by draft so it is not expected that they will also be deeper draft vessels - they are expected to simply be longer. Some older ships will be "stretched" insofar as they will be cut, and a new midsection added, then put back together. The niche market of smaller cruise ships - more intimate and more unique in their itinerary (Galapagos Islands, ice breaking, river cruises, etc.) - is also expected to increase as eco-tourism continues to grow (S. Collins, pers. comm.).

The Berlitz *Ocean Cruising and Cruise Ships 2005* volume reports that twelve new large ocean-going cruise ships are predicted to debut from 2005 to 2007 - all are being built in European shipyards (Ward 2005*)*. They represent large investments by 11 different cruise lines, range from 81,000 to 160,000 tons, from 951 to 1,115 feet in length, and carry up to 3,600 passengers. Royal Caribbean International (RCI) recently announced the keel being laid on *Freedom of the Seas*, a cruise ship much like the RCI Voyager class vessels that will be the largest cruise ship in the world when completed. The large Royal Caribbean Cruise Lines ships now visiting Key West (*Enchantment of the Seas, Rhapsody of the Seas,* and *Majesty of the Seas*) are about one-half the size (~70,000+ tons) of the RCI Voyager class (~130,000 tons). Currently the Voyager class ships due to their 29 foot draft don't make port calls in Key West.

Pier B was renovated in about 2000 to better accommodate cruise ships and incorporated an engineered design hoping to reduce resuspended sediment from the movement of large ships due to changes in the angle of the berthing piers. Mallory Dock was renovated in 1984 and again in the 1990s to better accommodate large cruise ships and the Outer Mole was reconstructed in 2004 to better handle both military and cruise ships.

3.A.5 History of Use of the Outer Mole

Permits were issued in 1919 by the Department of the Army to the Navy "...to construct a breakwater, seawall, and piers, and to dredge a basin and fill behind the seawall at the proposed submarine base, Key West, Florida" (Anonymous 2003). The breakwater referred to is likely the beginning base section of the Outer Mole extending out from Ft. Taylor. Although some reference is made in the literature to construction of the Outer Mole during World War I, the full breakwater doesn't appear on 1919 (Figure 3.A.7) or 1923 navigational charts of Key West, but it does appear on a 1933 chart (Figure 3.A.8).

Operational use of the Outer Mole in its early years was likely strictly for military vessels but during the depression the Navy allowed private vessel owners to use the "sub basin" and probably the Outer Mole itself for private use. During World War II the Outer Mole was

undoubtedly a very active wharf as large numbers of military and convoy vessels visited and were home ported in the limited waters of Key West harbor and Truman Harbor as the sub basin came to be known later.

As Truman Harbor became one of the largest submarine bases in the world during the 1950s and 1960s, the Outer Mole was likely an integral part of the base, functioning as both a protective breakwater and a loading dock and berth for large vessels. There is some indication in the literature that the first true cruise ships to visit Key West, the *Sunward* and later the *Bolero*, might have docked at the Outer Mole at times beginning in about 1969.

In 1996 the Navy allowed the City to use the Outer Mole for dockage of cruise ships on an emergency basis. This led to a request from the City to the Navy to allow shared use of the Outer Mole and in 1998 scoping for the Draft Environmental Assessment - Disposal and Reuse of the Truman Annex Waterfront was conducted as part of the Key West Chapter 288 Base Reuse Plan as required by the City's Comprehensive Plan and Principles for Guiding Development.

A current description of the Outer Mole (Mole Pier) area and plans for its use and reuse is provided in the 2003 Navy EA - "The Truman Waterfront area consists of about 45 acres of land, including the Mole Pier. The 7.6 acre Mole Pier includes the pier facilities (breakwater, berthing wharf, electrical distribution line, sanitary sewer line, waste distribution line, pipeline, telephone lines, street lighting, paved roads) and two buildings totaling 1,679 square ft. The significant amount of infrastructure at the pier was constructed as part of a 1986 improvement plan to ready the basin to homeport a surface attack Fleet but the plan was never carried out. The Truman waterfront commands almost a mile of deepwater harbor waterfront, and must remain a port in perpetuity. The Mole Pier currently is used to berth cruise ships and military vessels. The City has a license with the Navy to provide cruise ship berthing at the outer Mole Pier. Berthing uses have also been granted to the inner Mole berths. In 1995, NOAA, the State of Florida and the city of Key West identified parcels for use and plans were developed to transfer ownership. In 2002, the Atlantic Fleet identified a possible need to retain approximately 30% of the 53 plus acres proposed for transfer to the city. The 16 acres the Navy proposes to retain include the Mole Pier and some buildings previously used for ship maintenance. The Navy is proceeding with transferring slightly more than 32 acres on the east side of the harbor for use as parkland and a marina by the City. Under the proposal, the Navy will maintain joint use privileges with the city for cruise ship berthing at the outer Mole Pier."

About $13 million of renovations to the Outer Mole by the Navy were initiated in mid 2004 and included strengthening the pier and installing ship services that will provide moored ships electrical power, telecommunications and sewage removal. A portion of the end of the pier was removed effectively widening the access channel into Truman Harbor.

3.A.6 History of Scientific Work Conducted in and Around Key West Channel and Harbor and Data Available from That Work

Benthic communities in the Key West and Lower Keys areas have been described, summarized, and mapped by marine scientists. Water quality has been monitored and physical processes investigated. Fishery resources have been inventoried and managed. Older surveys and assessments of existing marine habitats and resources in the area were probably conducted during the permitting review for previous Navy dredging work but were not available for this review. For purposes of this historical account and the more specific reviews in Section 3.B, the focus will be on studies that include the immediate vicinity of Key West, especially south of Key West and the channel and harbor area. Studies are noted and referenced here if they provided useful data bases to help synthesize information or determine changes over time and space - due to either natural or human causes. Those that only document conditions at one point in time have limited utility but can provide general information for specific sites.

A synthesis of available biological, geological, chemical, socioeconomic, and cultural resource information for the South Florida area, including around Key West, was developed in the late 1980s by the Federal Minerals Management Service in anticipation of oil leasing in the southeast Gulf of Mexico. Fishery Management Plans by the Gulf and South Atlantic Fishery Management Councils were developed for a number of species and habitats found near Key West including for coral (GMFMC 1982, SAFMC 1995). A community profile of the ecology of south Florida coral reefs was developed in 1984 (Jaap 1984), and a species profile on reef- building corals in 1987 (USFWS 1987). The 1985 Coastal and Ocean Zones Strategic Assessment Data Atlas prepared by NOAA includes distributional and biological data on many important species that occur in the Key West area, as well as information on the physical environment and human activity that shapes the marine environment of the region. Extensive water quality information was accumulated and reported by the State for the Outstanding Florida Waters (OFW) designation in the mid 1990s. Keys marine habitats and ecosystem processes were extensively described in the Final Management Plan and Environmental Impact Statement for the FKNMS in 1996. Compilation and synthesis of information on the biology, geology, oceanography, ecology, and history of the Florida Keys were undertaken by Chiappone (1996) and provides a detailed view of the Keys marine habitats and physical processes, including around Key West. In 1997, the Monroe County Environmental Story was updated and published through a community effort and includes many articles on the history, natural history and cultures of the Florida Keys, including those of Key West.

Management plans for neighboring the Key West National Wildlife Refuge and the Great White Heron National Wildlife Refuge include descriptions and information on marine and fish and wildlife resources of these unique areas (USFWS 1997). Detailed multi-species recovery plans produced by the U.S. Fish and Wildlife Service include descriptions of the biology and habitats of many listed species that occur in the Key West area (USFWS 1999). Ecological characterizations for the unique habitats of the south Florida area have been written. Socioeconomic monitoring of fisheries in the Florida Keys National Marine Sanctuary have been conducted including for the Key West area, and fisheries production in the area is well documented with annual statistics. The 2000 Atlas of Marine Resources

developed by the Florida Fish and Wildlife Commission includes data sets on important marine resources that occur near Key West.

In 2000, the Navy prepared a Final Environmental Assessment for Disposal and Reuse of Truman Waterfront that generally addressed resource issues in the area. In 2002, the Navy produced the Integrated Natural Resources Management Plan for Naval Air Facility Key West. The 2003 Navy EA provides a detailed review of what is known about the resources and habitats around the channel and harbor area. The Army Corps of Engineers contracted for turbidity monitoring and bathymetry survey work from 2001 through 2003. Two work groups addressed large vessel activity in the Key West area, reviewed information available, and provided summaries and recommendations (LVWG 2002-2004).

The FKNMS Water Quality Protection Plan began in 1994 and consists of status and trends monitoring of three components: water quality, coral reefs and hard-bottom communities, and seagrasses. Sanctuary-wide status and trends monitoring based on monitoring at many stations, including some near Key West, is designed to detect large-scale ecosystem changes associated with Everglades restoration and other regional-scale phenomena. A part of the WQPP, turbidity has been monitored along with other a number of water quality parameters at Western Head Reef off Key West and in the main ship channel offshore. Quarterly data collection began in 1995 and continues.

The second scale of monitoring is associated with the Sanctuary's 24 fully protected zones, including near Key West the Sanctuary Preservation Areas (SPA) at Eastern Dry Rocks, Rock Key, and Sand Key to the west of the main channel entrance, and the Western Sambos Ecological Reserve to the east. These are monitored through the Zone Monitoring Program (ZMP). The goal of this program is to determine whether the zones are effective in protecting marine biodiversity and enhancing human values of the FKNMS. Coral Reef Ecosystem Process Studies are another aspect of the long-term monitoring of resources in the FKNMS, including at reefs near Key West. Data are available for these variable scale monitoring projects through 2003 and 2004. Measures of management effectiveness include the abundance and size of fish, macroinvertebrates, and algae. The ZMP includes monitoring changes in ecosystem structure (size and number of invertebrates, fish, corals, and other organisms) and functions such as coral recruitment, herbivory, and predation. Routine and systematic coral monitoring, including for species cover, diversity, density and size, and species richness also take place offshore near the main channel at Western Head Patch Reef and Cliff Green Patch Reef (http://www.floridakeys.noaa.gov/research_monitoring/2001.htm).

Reef Fish Monitoring occurs at the SPAs near Key West. The goal of this monitoring is to assess changes in reef fish populations in zones under different levels of protective management. Field studies have been directed at comparing changes in fully protected areas to nearby reference areas that include fishing. FKNMS Volunteers assist with reef fish monitoring of species, abundance, and size at other nearby reefs. The Sentinel Lobster Fisheries project uses commercial fishing gear and techniques to evaluate the long-term effectiveness of the Western Sambo Ecological Reserve as a refuge for spiny lobster. Spiny lobsters have been monitored in the marine reserves of the FKNMS since they were closed to fishing in July 1997 with a goal of determining if the reserves are effective in protecting this highly mobile species from exploitation. Data available includes abundance, size, frequency of occurrence, habitats used, and other parameters.

The Queen Conch Marine Reserve Monitoring conducted by the Florida Fish and Wildlife Institute has a goal of determining the effects of the fully protected zones on queen conch. Data on the density, abundance, and distribution of queen conch, and habitats occupied in waters offshore of Key West are included in the monitoring.

The Florida Natural Areas Inventory in 1994 reported on an ecological survey of U.S. Navy Property in the Lower Keys and additional surveys have been conducted since then in the Key West that note occurrence records and locations of state listed species. Aerial surveys for manatees, sea turtles, and bottlenose dolphin have been reported for the Key West area.

Monitoring of geophysical processes, physical parameters, and water circulation occur in the area and throughout the FKNMS using real time data links. Goals include the assessment of the interaction and exchange of Florida Bay with the connecting coastal waters of the Gulf of Mexico and the Atlantic Ocean, and to provide necessary boundary conditions and validation for physical, water quality and biological models. Data on physical parameters including wave height and currents, water temperature, and salinity are provided in real time by sea buoys in waters offshore from Key West (see Section 3.B). Reef framework and the geologic record of reefs in the lower Keys and Key West have been studied for many years by the U.S. Geological Survey. The U.S. EPA studied the mixing of tidal currents and water masses offshore of Key West at the old sewage outfall in the 1990s and reported their findings as the "initial and near-field subsequent dilution at the Key West outfall" (Tsai et al 1997).

In 2001, Foresight Surveyors performed a "project condition survey" on the main ship channel through Key West Bight and Northwest Channel for the Corps of Engineers. Bathymetry of the channels and harbor was the main dataset reported. Also, in 2001, the NOAA Vessel *Whiting* used multi-beam sonar technology to develop imagery of the channel and harbor bottom as well as surrounding bottoms on either side of the channel. In 2003, Sea Systems, Inc., in advance of the Navy dredging project reported to the Corps on a Geophysical Data Acquisition and Hydrographic Survey of the Key West channel and turning basin and Truman Harbor. Side-scan sonar technology was used to create highly detailed maps of the channel and harbor bottoms, including bathymetry (See Sections 3.B.1 and 3.B.2).

Several studies have looked specifically at turbidity in waters of Key West, especially following complaints of increased turbidity and resuspended sediment to the City of Key West and the Army Corps of Engineers, the agency responsible for the federal navigation project in Key West Channel and Harbor. In 1953, a general study was made of turbidity in an active Key West channel and harbor using visual measurements of water clarity (secchi disk). In 1998 and 1999 the Florida DEP collected turbidity data from plumes resulting from cruise ship activity at and near the Outer Mole, Pier B, and in the anchorage offshore, as well as background levels at the time. As a monitoring requirement attached to a DEP Environmental Resource Permit to reconstruct and reconfigure the cruise ship berth at Pier B, turbidity monitoring was required on a near daily basis during the arrivals and departures from 1999 to about 2002 and then later (resulting from a permit modification) between 0800h and 1700h during the period November through February.

Results of a September, 2001, *Key West Harbor Turbidity Monitoring* effort was submitted to the Corps of Engineers in 2002 by PPL Environmental Labs and included datasets of turbidity,

tidal cycle, weather, and vessel traffic. The Corps sponsored project *Key West Harbor Area Background Turbidity Monitoring, October 2003*, was reported in 2004 by PPL Labs and included turbidity data on background conditions, turbidity associated with ship traffic, and currents. This monitoring was planned to continue through the life of the Navy's dredging project and is generating data on turbidity and other physical parameters in waters near Key West. Turbidity monitoring is being conducted 15 feet deep, or about mid-depth in the channel and harbor. Levels of sediment resuspension related to the dredging and other physical effects are being monitored in various habitat types near the channel and harbor and may provide unique datasets for assessment of the effects of settlement of resuspended sediment on biological processes along the channel. The Navy is also contracting other water quality and turbidity studies along Fleming Key north of the harbor.

3.A.7 Creation of an Annotated Chronology of Significant Events

1815 - private ownership of the island of Key West began with the grant by the Spanish government to J. Salas [14]

1818 - returning from the Bahamas, John Whitehead lay at anchor off Key West for several days while passing through to Mobile and acquired a knowledge of its "excellent harbor and other advantages." [2]

1821 - J. Whitehead purchases Key West from J. Salas in Havana [2]

1822 - Commodore Perry arrived to investigate potential of Key West as a Naval Station; Key West established as a Port of Entry and a Customs Officer appointed; by the end of the year the island was a regularly constituted naval depot and station; Simonton bought a share of the island from Whitehead - he could foresee development potential of a deep water port; the harbor entrance was marked [2 ,14]

1823 - Commodore David Porter sent to Key West with steam vessel *Sea Gull* with side paddle wheels and established a naval base with a unique squadron of fast, shallow draft vessels to pursue pirates in the Gulf of Mexico and Caribbean; argument made by Porter to keep Key West as a naval station due to it's strategic location and "excellence of its harbor" [2, 4, 6, 14]

1825 - wrecking takes off as a major economic influence, when not wrecking crews fished; Congress passed laws mandating that all salvage from wrecking on Florida's reefs and shoals be brought to a port of entry in the U.S.; nearly $300,000 of wrecked property was sold in Key West during year; the first Sand Key lighthouse was built; Naval Base moved to Pensacola due to summer diseases in Key West; wrecking soon defined the town - wharves, shipyards and chandleries lined the harbor shore [2, 7, 9, 10]

1826 - 167 ships enter Key West Harbor; during 1826-1828 on behalf of the Mexican government Porter used Key West as a staging post to raid Spanish shipping [6, 10]

1828 - Town of Key West incorporated; fishing vessels (smacks) hauled live grouper and snapper to Havana; of over 400 early settlers at Key West - about 100 were fishermen [2, 8]

1829 - Nearly $200,000 in export and import commerce shipped through Harbor; William Whitehead surveyed and mapped the City including the harbor shoreline; first mail service began between Key West and Charleston; Porter in support of keeping Key West as a Naval Base - "The advantages of its location as a military and naval station has no equal except Gibraltar" [2, 9]

1831 - 303 ships harbored in Key West during year; movement of very high quality tobacco from Cuba to Key West began when the first cigar plant was opened [2, 10]

1833 - Key West is the richest per capita community in the South; value of marine commerce reported was about $100,000 derived from 86,000 tons of shipping [2, 10]

1835 - About twenty good-sized sailing craft of 10 to 50 tons displacement engaged in wrecking, with a few smaller; a hurricane strands twelve to fourteen large vessels on the reefs near Key West and most Key West wrecking vessels suffered damage; boat building

and repair industry begins in Key West [2, 12]

1838 - Whitehead creates sketch of the west (harbor) shoreline of Key West [2, 7]

1839 - Wrecking going gangbusters; 130 foot cable laying schooner *Western Union* built in Key West [10, 12]

1845 - Construction of Ft. Taylor started - Navy calls Key West the "Gibraltar of the Gulf" [10]

1846 - Ft. Taylor under construction is destroyed by a major hurricane as are Key West lighthouse and the light on Sand Key; construction is begun again on Ft. Taylor, as well as Ft. Jefferson [2, 10]

1848 - A fast and comfortable steamer of about 1000 tons (*Isabel*) was put into mail and passenger service between Key West and Charleston [2]

1849 - A new taller and relocated lighthouse is built on Key West; the first sponge cargo is shipped to New York [10, 12].

1852 - The installation of reef warning buoys begins [14]

1853 - A marine railway and dry dock (first important public venture by private citizens) powered by horse power and capable of handling vessels to 100 tons is built; the current Sand Key lighthouse is constructed [2, 10]

1856 - The clipper ship *Stephen R. Mallory* (1000 tons displacement) is launched in Key West [2]

1859 - The entire waterfront district burns [10]

1861 - Ft. Taylor is completed and remained in service until 1949;, during the Civil War Key West was the headquarters of the Union's Eastern Gulf Blockading Squadron and more ships were stationed at Key West than at any other port in the U.S.; an average of 32 large ships and as many as nearly 300 captured blockade runners would be anchored in the harbor at one time [2, 6, 7, 10]

1867 - The telegraph cable is laid between Havana and Key West by large vessels

1870 - The cigar business mostly using tobacco from Cuba is the largest in the world [10]

1873 - Spain's seizure of the American-flagged steamer *Virginius* led to the Navy being ordered to Key West to prepare for war with Spain; at the time the fleet was a collection of obsolete Civil War vessels and the seizure led to the building of a modern navy that would again use Key West as a winter training ground; nearly every available ship in the Navy was hurried to Key West which was made the base of all operations related to Spain; the Mallory Steamship Co. begins service from Key West to New York and Galveston [2, 5, 6, 14]

1874 - The amount of goods imported via vessels through the Customs House was over $660,000 [2].

1875 - Key West served by steamers from Baltimore, Charleston, Havana and New Orleans [12]

1880 - there were 25 inter-Keys freight schooners carrying farm produce from Keys

plantations to Key West for reshipment by steamer, 450 sailing vessels, most spongers and most built in Key West, were operating out of Key West [12]

1881 - Under the supervision of Lt. Robert Peary the naval wharf was rebuilt and iron piles were substituted for the wooden one [2]

1884 - Key West is the busiest port in Florida [7]

1886 - The Key West waterfront district burns

1887 - a line of steamers, considered the very best and fastest steamships that could be built, begin running from Port Tampa to Key West and Havana [2]

1888-89 - Due to the "sponging, cigar making, salvage and wrecking, fishing, mercantilism and the military Key West is the wealthiest city in Florida"; all commerce is moved via vessels; 614 foreign and domestic ships use Key West Harbor during 1888; the Customs House with a concrete seawall is built on the harbor [2, 10, 11].

1890s - Fifty to eighty foot schooners carrying up to 25 passengers begin running between Key West and Miami [12]

1890 - In about 1890 a factory for canning turtle soup from green turtles was constructed; cigar tobacco importation and cigar production reached its zenith; Key West sponging industry earns about $1,000,000 per year, from sponging by about 350 boats [2, 5, 7]

1895 - The *City of Key West* was a large side-wheeled steamer that ran between Miami and Key West; local fishing vessels caught 2,400,000 pounds of fish and lobster for local and U.S. markets; this fishery formed the beginning of an infrastructure in Key West from which local contemporary fisheries evolved [1, 8]

1898 - The USS Maine departs Key West for Havana where it blows up and the Spanish-American War begins; nearly every available ship in the Navy is hurried to Key West; "For some time before the actual hostilities between the U.S. and Spain, Key West bore the appearance of a war port"; the American Battle Fleet was based in Key West and following Spain's surrender Key West continued to be used for winter training and to support operations in the Caribbean; the North American Flying Squadron including modern steel cruisers and battleships blockaded Cuba, many were based in Key West [1, 2, 6]

1899 - The marine railway was expanded to handle vessels to 1000 tons displacement and converted to steam power [2]

1900s - Large propeller driven deep draft steamships (commercial and Navy) were coming and going regularly; at the turn of the century more than 300 vessels employing nearly 2,000 men engaged in sponging from Key West; at the turn of the century Pilot Captain Clifton brought in a large ship drawing 31 feet [4, 12]

1902 - Navy condemns the southwest shore of Key West and begins construction of a Naval Base [10]

1905 - Flagler begins construction of the Overseas Railroad.

1907 - Mallory and Co. established a steamship line between New York and Mobile touching at Key West both ways - with 4 to 6 ships stopping at Key West weekly [2]

1909 - Most harbor docking facilities and structures were destroyed by a major hurricane with a great deal of loss to shipping [2]

1910 - Seven hundred feet of a new concrete dock at Ft. Taylor was destroyed in a hurricane [2]

1911 - Trumbo Point and Hilton Haven were constructed by dredge and fill to provide a marine terminal for Flagler's railroad; the terminal at Trumbo included a 1700 foot long 134 foot wide pier with steamships docked alongside; a concrete wharf was built by the Navy to replace the one destroyed the previous year [2, 10].

1912 - Flagler completed the railroad to Key West and with that use of the military facilities in Key West increases; Key West mail service by steamship ends; large railroad car ferry ships began carrying railroad cars between Key West and Cuba; an average of about eight to ten vessels a year are still stranded on the reef; power vessels began to replace traditional Key West sailing vessels for fishing [2, 4, 6, 8]

1914 to 1918 - During WWI Key West is activated as the Strategic Center of Caribbean Defense; new piers are built and Navy activity includes destroyers and submarines; the new Naval Air Station is a base for coastal patrol vessels, battleship berthing, and submarine training; regular steamship runs carried passengers and cargo between Key West, Havana, Tampa, New Orleans, Miami, Nassau and New York; the Key West Naval Base and Navy Shipyard were in full operation; Thomas Edison stays in Key West and works on experimental depth charges and mines with the Navy; one of the first offshore power boat races took place between Key West and Miami [2, 4, 6, 7, 10]

1920 - Key West mariners are looking for new maritime activity; nearly 3,000,000 pounds of mackerel are landed at Key West during the 1919/1920 winter; prohibition is enacted and bootlegging liquor via vessels from Havana becomes big business; the Coast Guard base in Key West was greatly expanded to combat smuggling and Navy patrol craft and destroyers were called to help [8, 10, 12]

1924-1925 - Active commerce in vegetables and fruits includes pineapples from Cuba; about this time the Outer Mole is created by the filling and creation of a breakwater around the west edge of what came to be called Truman Harbor [10]

1928 - Passenger ships and ferries routinely travel between Key West and Havana [14]

1931 - The 327 foot long passenger steamship *Florida* began calling at Key West [12]

1932 - Due to depression all military facilities except for the radio station are closed [6]

1934 - With maritime commerce and the military withdrawn Key West declares bankruptcy; the Civil Works Administration built sponge docks in the Harbor to try to revitalize the Key West sponge industry; the Navy permitted private yacht owners to use the sub basin (Truman Harbor) during the depression [10, 14]

1935 - The Overseas Railroad is destroyed by the Labor Day hurricane.

1938 - The Overseas Highway is completed.

1939 - The last large sailing vessel built in Key West - the *Western Union* - is launched; President Roosevelt visits Key West and orders the base reopened to support naval operations in the Caribbean [6, 10]

1941 to 1945 – The Navy extends the 30 foot deep channel north to the Trumbo Point turning basin; Port of Key West logs more than 14,000 military and cargo ships and was the center for the Fleet Sonar School that taught more than 18,000 sonar operators; there were 15,000 service personnel stationed in Key West; Key West becomes a major convoy center and the shipyards are kept busy with repairs of convoy and military vessels; Truman Harbor was deepened and 21 acres of land added to the Naval Base there;. large disabled ships damaged by German U-boats offshore are brought into Key West for salvage or grounded on the reefs to keep them from sinking; minefields are planted in surrounding waters; anti-submarine patrols are based in Key West; vessel pilots from all over Florida are brought to Key West to handle the increased traffic; a large marine railway is constructed by the Navy in 1942 [4, 6, 7, 10, 14]

1949 Shrimp are discovered in commercial quantities in the Tortugas and hundreds of shrimp boats swarm to Key West

1950s - 1960s - Navy forces remain in Key West in strength and the Naval Station is one of the largest submarine bases in the world.

1954 - Shrimping nears its peak with as many as 500 shrimp boats catching over 30 million pounds per year; the car ferry *City of Key West* capable of carrying 50 autos and 700 passengers begins operating between Key West and Cuba - it left from the Havana Dock at the foot of Duval St three times per week; the vessel *City of Havana* (carrying up to 125 autos and 500 passengers) launches three times per week ferry service between Key West and Havana, later moving to Stock Island [12]

1956 - Key West is becoming one of the country's leading ports of foreign travel averaging 12,900 passengers per month [10]

1962 - The Key West Naval Station supported the fleet blockading Cuba during the Cuban Missile Crisis

1968 - The Navy decommissions their ship repair facility in Key West [10]

1969 - The Port of Key West receives its first regularly scheduled cruise ship – the *Sunward* – it moored at either the Outer Mole or Pier B. City records show that in the next 15 years the Port received 266 calls by cruise ships; working out of Key West Harbor Mel Fisher begins his treasure hunt for the *Atocha* [3]

1970s - The cruise ship *Bolero* started calling weekly; emergency entry of large vessels and tows working in the transport of oil industry equipment between the Gulf of Mexico and the North Sea; turtling ends with passage of the Endangered Species Act and placement of size limits on turtles [4]

1973 - All submarine activity in Key West is discontinued [10]

1974 - The Naval Station closes and all ships and shore side facilities moved or closed [6]

1980 - The Mariel Boat Lift brings more than 125,000 Cuban refugees to the U.S., most through Key West by all manner of craft and boats [5]

1984 - Construction begins on a new Mallory Dock to provide secure dockage for visiting cruise ships [3]

1985 - The Navy transferred a squadron of hydrofoil gun boats to Key West, based at

Trumbo Point; Mel Fisher locates the mother lode of the *Atocha* and renews an old form of commerce in Key West Harbor - treasure [6]

1986 - Part of the Navy's Truman Annex and Tank Island are auctioned off.

1990 - The Florida Keys National Marine Sanctuary is designated.

1990s - Naval forces in Key West are again cut and the hydrofoil squadron decommissioned; Key West was and continues to be on the front line for the Department of Defense and U.S. Coast Guard war on drugs through the Joint Interagency Task Force East; a drug surveillance fleet of aerostat ships operated out of Key West for the Task Force often coming in and out daily, they are later removed [6]

1992/1993 - 256,000 cruise ship passengers visit Key West during fiscal year [3]

1994 - During the year 368 cruise ships visit Key West [10]

1996 - Outer Mole use as cruise ship dockage begins on an emergency basis; the FKNMS Management Plan is put in place.

1998 - Scoping begins for draft environmental assessment for the Disposal and Reuse of the Truman Annex waterfront property - including the Outer Mole [3]

1999 - Chapter 288 Military Base (Truman Harbor) Reuse Plan reviewed by state and federal agencies; Florida DCA recommends that the City fully evaluate the impacts of using the mole pier for regular cruise ship berths; City formally requests federal study and action regarding vessel generated turbidity in the Key West Federal Harbor Project; City eliminates second cruise ship berth initially proposed for Outer Mole; cruise ship docking facility reconstructed at Pier B (Hilton); utility and water lines laid on channel bottom connecting Sunset Island development to Key West [3]

2002 - The Florida Keys National Marine Sanctuary Advisory Council Committee organizes and initiates meetings of the Large Vessel Working Group (LVWG) to look at environmental issues related to cruise ship and other large vessel traffic in and around Key West

2002/2003 - 1,122,200 cruise ship passengers visit Key West during 02/03 fiscal year from 603 cruise ship visits, including 177 berthed at the Outer Mole and 24 anchored out; permit application is submitted by the Navy and approved by state and federal regulatory agencies for dredging of Key West Channel and Harbor and Truman Harbor [3]

2004 - Outer Mole reconstructed by Navy to better accommodate both military vessels and cruise ships; Navy contractor initiates dredging of Key West Channel and Harbor and Truman Harbor to -34 MLLW with 2 foot advance maintenance and 1 foot of overage authorized for a total allowable depth of -37 feet MLLW; the LVWG completes it's review after 2 years of meetings and makes recommendations to the FKNMS [3]

2005 - Maintenance dredging performed at Mallory Dock to a depth of about -30 MLW; City budgets for a total of 541 cruise ship arrivals in 2004/2005 fiscal year – 95 (18%) at Mallory Square, 264 (49%) at Pier B, 160 (30%) at the Outer Mole and 23 (4%) vessels will anchor out [3]

3.A.8 Endnotes - Sources of Information for Preceding History and Chronology:

1. Artman, L.P. Jr. 1995. Key West – Turn of the Century. publ. by P. Artman, Key West, FL.

2. Browne. J.B. 1912. Key West, The Old and the New. Republished in 1973 by the Bicentennial Comm. of Florida, Univ. of Florida Press, Gainesville, 227 pp plus index.

3. City of Key West

4. Crusoe. E. 1997. Chronology of steam and/or motor ships in Key West Harbor. Key West Bar Pilots Assoc., Key West, FL, 2 pp.

5. Gallagher, D. 1997. Timeline of events in the Florida Keys. Pp 63-67 in The Florida Keys Environmental Story, D. Gallagher ed., publ. by Seacamp Assoc. Big Pine Key, FL.

6. Haimbright, T. 1997. Military History of the Florida Keys. Pp 117-120 in The Florida Keys Environmental Story, D. Gallagher ed., publ. by Seacamp Assoc. Big Pine Key, FL.

7. Langley, J. and W. Langley. 1982. Key West, Images of the Past. publ. by Belland and Swift, Images of Key West, Inc., Key West, 132 pp.

8. Little, Ed. 1997. A History of the Fishing Industry in the Florida Keys. Pp 125-127 in The Florida Keys Environmental Story, D. Gallagher ed., publ. by Seacamp Assoc. Big Pine Key, FL.

9. Marzyck. M. 1997. Commodore David Porter. Pp 159-160 in The Florida Keys Environmental Story, D. Gallagher ed., publ. by Seacamp Assoc. Big Pine Key, FL.

10. Nichols, S. 1989. A Chronological History of Key West, A Tropical Island City. publ. by Key West Images of the Past, Inc., Key West, FL.

11. Sherrill, C. and R. Aiello 1978. Key West - The Last Resort. publ. by Key West Book and card Co., Key West, FL, 192 pp.

12. Viele, J. 1997. Sponging. Pp 130-131 in The Florida Keys Environmental Story, D. Gallagher ed., publ. by Seacamp Assoc. Big Pine Key, FL.

13. Wells, S. 1997. Notes on the History of Key West. pp 95-98 in The Florida Keys Environmental Story, D. Gallagher ed., publ. by Seacamp Assoc. Big Pine Key, FL.

14. Windhorn, S. and W. Langley. 1973. Yesterday's Key West. publ. by Langley Press, Inc., Key West, FL, 144 pp.

3.B Assessment of Real and Perceived Impacts From Cruise Ship Activity on the Marine Environment

Environmental degradation for purposes of this assessment is defined as direct, indirect, and cumulative impacts on natural and depletable resources, including impacts to flora and fauna and listed species, substrates and sediments, habitats including essential fish habitat, water quality, and adjacent environmentally-sensitive areas. A thorough literature review has been conducted to evaluate the real and potential impacts associated with cruise ship use of the Outer Mole and adjacent waters on environmental resources critical to the City. Reviewed is the considerable information (scientific and other) now available for the Key West channel and harbor area, including information provided during the permit review and environmental assessment process for the current Navy dredging project. Reviews, reports, summaries, and recommendations by others, including the FKNMS Large Vessel Working Group (LVWG) have been obtained and are summarized here where appropriate. Considerable use has been made of information provided in the Navy's 2003 Environmental Assessment (EA) and the 1996 FKNMS Final Management Plan and Environmental Impact Statement (EIS).

Although a number of other ports in the U.S. (including Alaska and Hawaii), Bermuda, Mexico, and the wider Caribbean have addressed or are addressing many similar environmental issues related to cruise ships, including adequate harbor depths and infrastructure, and potential environmental degradation, this review deals mainly with activities of cruise ships and other large vessels in Key West. The situation in Key West appears to be unique in that a relatively shallow and narrow main channel and harbor (relative to vessel size) exist in close proximity to coral reef ecosystem habitats and communities that depend on clean, clear water, and that are protected by a variety of state and federal laws and regulations.

A documented decline in water quality and the quality and health of environmental resources led to the designation of the Florida Keys as an Area of Critical State Concern in 1975, Keys marine areas as Outstanding Florida Waters in 1985, and a National Marine Sanctuary in 1990, and a determination in 2002 that aspects of the natural carrying capacity of terrestrial and nearshore habitats had been exceeded.

This section also addresses the overall goal of understanding the direct linkage between environmental degradation and adverse economic impacts resulting from the use of the Outer Mole and other cruise ship activity in Key West. Adverse economic impacts resulting from environmental degradation are considered for all stakeholder groups that depend directly on the resources affected - the City defines these groups as "environmentally sensitive businesses". Among the measures and factors that an assessment should consider is an inventory of such businesses, changes in employment rates specific to these businesses, and changes in employment categories specific to these businesses.

Public perceptions of the need to protect and manage marine areas for their health and productivity, and their ability to provide resources valuable to the public, have evolved over the last few decades as well. "It is important for the tourist industry to remember that many of the tourists of the Keys are here because the environment is special. Fishermen come here because there are fish to catch - and if fishing is bad, they will no longer spend their dollars in Monroe County. Snorkelers and divers come because the reef is alive and beautiful.

They will not come in the future if the reef dies. The bird watchers, the nature lovers, the beachwalkers - all those who seek natural beauty will no longer visit the Keys if these scenic delights are degraded. Whatever the industry does to improve the quality of the environment will be repaid tenfold over time in increased tourist revenues. By our very need for economic survival businessmen should be the greatest guardian of the Keys environment." (Swift 1997).

3.B.1 Physical Environment

The physical marine environment of the Key West area is defined by bathymetry (depths) and bottom topography, as influenced by tides and tidal currents, wind and wind generated water movement, and water quality. Waters of the Keys are characterized by complex water circulation patterns over both spatial and temporal scales with much of this variability due to seasonal influence in regional circulation patterns. They are directly influenced by the Florida Current, the Gulf of Mexico Loop Current, inshore currents of the SW Florida Shelf, discharge from the Everglades, and by tidal exchange with both Florida Bay and Biscayne Bay. Influence of these external sources has significant effects on the physical, chemical, and biological composition of waters around Key West (Boyer and Jones 2002). The Lower Keys and Key West area are most influenced by large gyres spun off the offshore Florida Current and are influenced by wind and tidally driven waters of Hawk Channel that parallels the Lower Keys.

Waters around Key West experience semi-diurnal tides (4 per day), and along with the influences of wind generated water movement, the area is very complicated hydraulically. According to NOAA information provided for its primary tidal station in Key West Harbor, the average mean tidal range is about 1.3 foot and the spring range is about 3 feet. At a station 0.3 mile out into the channel west of Ft. Taylor, NOAA reports that the average maximum flood current runs about 0.6 mph and average maximum ebb about 1.1 mph. Currents during spring tides are considerably stronger, especially the ebb current. Typical average current speeds in another study in the channel area were between 0.4 and 1.8 mph (Corps 2003).

The main ship channel into Key West is over 5 miles long, with a 1.2 mile long middle stretch (Cut A) that is 800 feet wide - the rest of the offshore channel south of Ft. Taylor is 300 feet wide. In the Harbor out from the 3 cruise ship berths (the Navy's Outer Mole, the commercial Pier B, and the City's Mallory Dock) the turning basin is irregularly shaped with a maximum width of about 1,800 feet, and is mostly about 1,000 wide (Figures 3.A.11 and 3.A.12). A detailed NOAA navigational chart (#11441) exists for *Key West Harbor and Approaches* at a scale of 1:30,000.

Water masses in Truman Harbor, inside the Outer Mole, are somewhat isolated from the tidal flushing of the harbor channel area. Current monitoring has shown, as expected, that water does not move in straight lines around the harbor and spoil island areas on the west side of the harbor. Flow directions between Key West and the two islands are predictable based on tides. Flow directions south of the island might be controlled by both wind and tides and are less predictable. Turbidity monitoring in the harbor by the Corps during October, 2003, provided basic information on current patterns and tidal influences there. During rising tides, water flows northward through the harbor; falling tides carry water masses southward through the harbor. During times of strong winds from the east and

south, distinctive, often turbid, water masses from south of the island are drawn into the harbor area during rising tides. In the winter, northerly winds associated with passing cold fronts push water masses from the southeastern Gulf of Mexico south through channels around Key West. Seasonal variation in wind direction and speed in the region are a major influence on water mass movement as well as the redistribution of fine sediment. Other information on the physical nature of the marine environmental surrounding Key West can be found in Chiappone (1996), Tsai et al. (1997), PPB (2002), Sea Systems (2003), Navy (2003).

Bathymetric data of the waters around Key West reflect a wide range of bottom contours and variable bottom elevations that create a wide range of benthic conditions and habitats (Figure 3.B.1). Bathymetric surveys of the proposed Navy dredged area in 2001 resulted in color contour maps of the entire dredge area, including pre-dredge conditions in the harbor and turning basin (Figure 3.B.2).

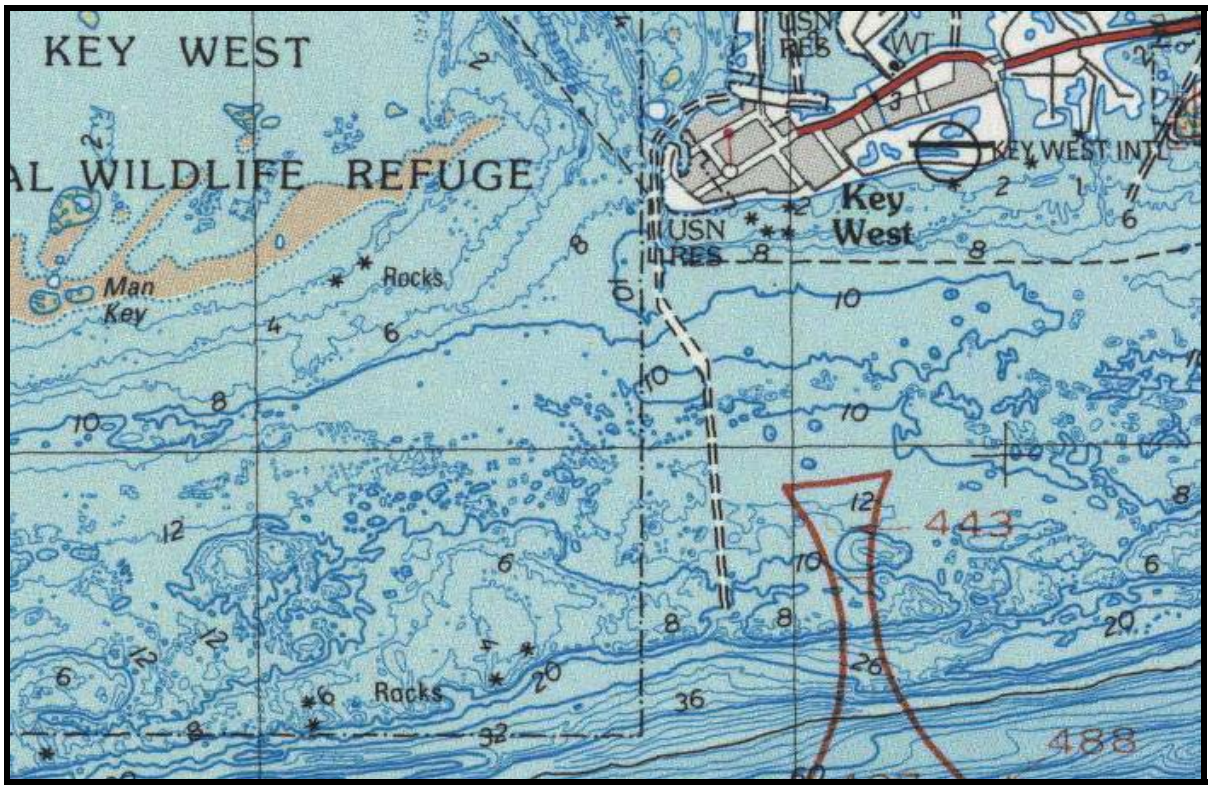
The most revealing bottom topography characterization of the channel and harbor area was collected by the NOAA vessel *Whiting* in 2001 using multi-beam sonar technology (Figure 3.B.3). The area surveyed west of the main channel and harbor is used as an anchorage for cruise ships by the Key West Bar Pilots (see Section 3.B.6).

The Corps provided the City a "Report of Channel Conditions" in December, 2001. The most detailed bathymetric data available for the channel and harbor area was collected in late 2002 and early 2003 by Sea Systems Corp. under contract to the Corps in advance of the Navy's dredging project (Sea Systems 2003). Sea Systems conducted a comprehensive survey of the full extent of the Key West Main Ship Channel and Harbor (inshore and offshore) and Truman Harbor. Specifically, the work included a bathymetric survey, side scan sonar survey, sub-bottom profile investigation and dive-supported groundtruthing operations. The objectives of the survey were to accurately map the bathymetric characteristics of the channel areas and turning basin, identify and map the horizontal extent of exposed hardbottom, rock outcrops, and manmade debris within these areas and to obtain sufficient sub-bottom data for assessment of sediment thickness over subsurface hardbottom.

Local information for a number of variables of oceanographic data including sea water temperature, salinity, and photosynthetically active radiation at different depths, air temperature, wind speed and direction, and barometric pressure is available as preliminary data provided in near real time from the Coastal-Marine Automated Network (C-MAN) Sand Key Station (http://www.coral.noaa.gov/seakeys/real_data.shtml). The Florida Institute of Oceanography's SEAKEYS project and the NOAA Atmospheric and Oceanographic Marine Lab CREWS network of remote monitoring stations maintains a 10 year dataset for Sand Key as part of its Coral Reef Watch Integrated Monitoring Network Database (http://www.coral.noaa.gov/imn/IMNQuery).

FIGURE 3.B.1. 1989 NOAA BATHYMETRIC MAP OF THE AREA WEST AND SOUTH OF KEY WEST (NOAA).

Showing a variety of bottom conditions and depths and the location of the main ship channel (dashed line). Depths in meters



Water quality in the Florida Keys has been an important issue for some time, especially those aspects related to nutrients and turbidity. An excellent review of the history of Keys water quality monitoring, including turbidity, can be found in Kruczynski and McManus (2002). The State of Florida has classified and manages waters surrounding the Keys, including Key West Channel and Harbor, as Class III waters but with an Outstanding Florida Waters (OFW) overlay (Rules 62-302 FAC). Specifically, (Rules 62-200 and 62-242 FAC), with limited exceptions, no significant degradation of OFW water quality is authorized to be permitted.[8] The regulatory significance of the OFW designation is that the Florida DEP cannot issue permits for direct pollutant discharges that would lower ambient (existing) water quality, or indirect discharges that would significantly degrade the OFW. In addition, permits for new dredging and filling must be clearly in the public interest.

[8] Burnaman,R. PA. Personal Communication.

FIGURE 3.B.2. COLOR DEPTH CONTOUR PLOT CREATED FROM 2001 PRE-DREDGING BATHYMETRIC SURVEYS IN THE TURNING BASIN OUT FROM THE OUTER MOLE AND IN THE TRUMAN HARBOR AREA.

Depths in feet at mean lower low water. Green areas are -36 to -37 feet deep, red areas are less than -34 feet.

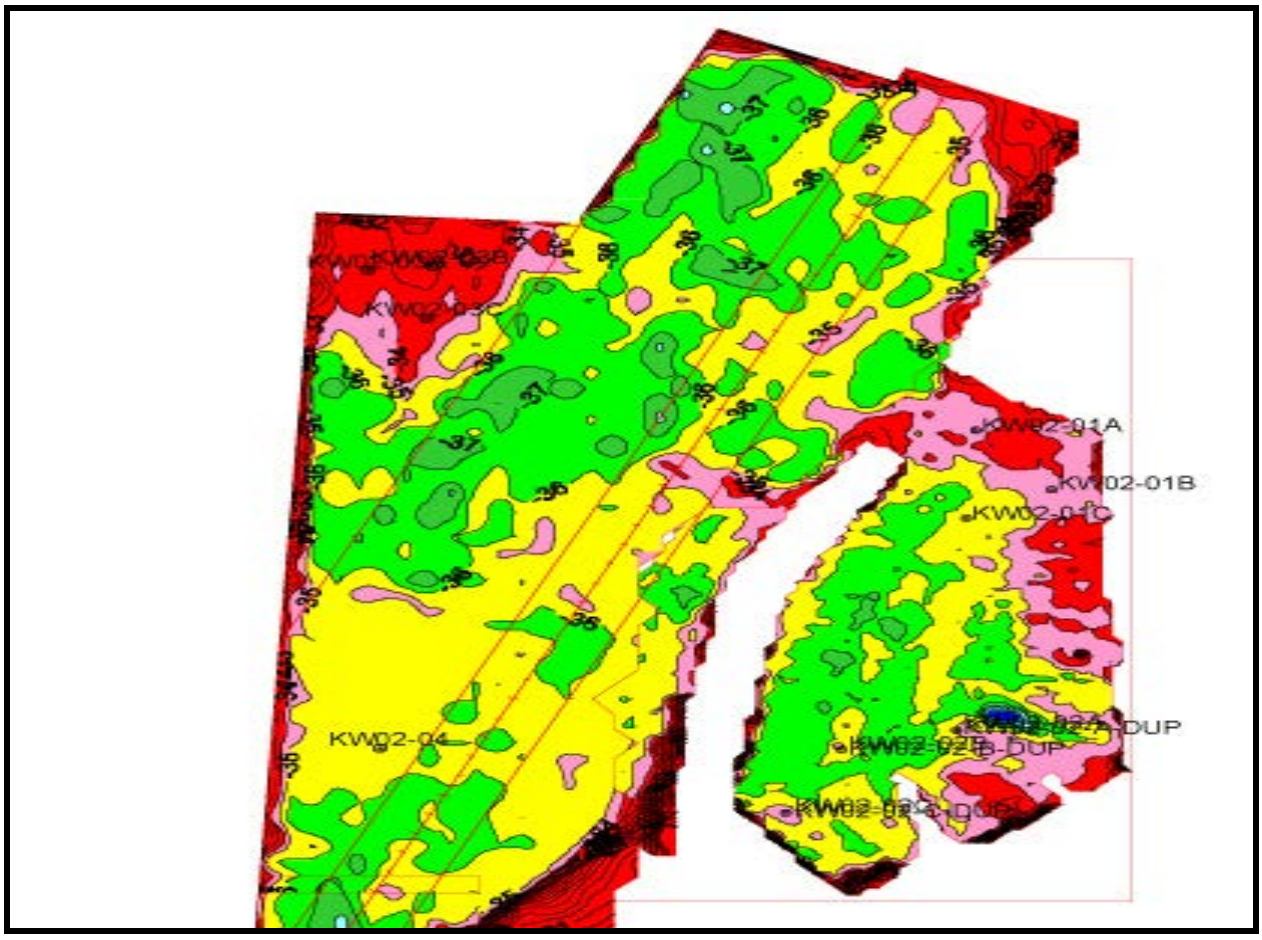
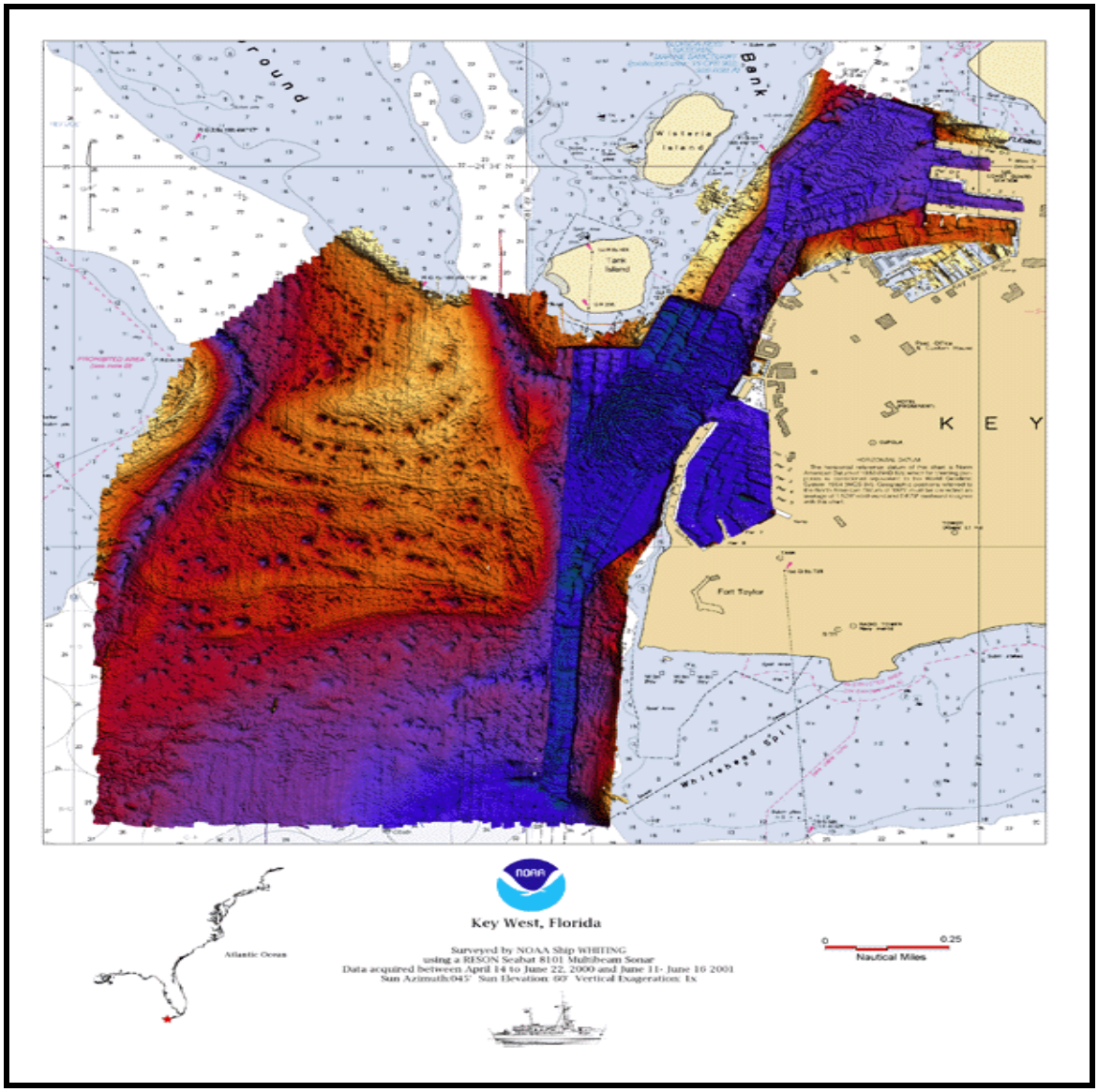


FIGURE 3.B.3. 2001 MULTI-BEAM SONAR IMAGE REFLECTING THE BOTTOM TOPOGRAPHY AND RELATIVE DEPTHS NEAR KEY WEST OBTAINED BY THE NOAA VESSEL WHITING (NOAA).

Bluish area corresponds to deeper water and previously dredged portion of the channel and harbor.



3.B.2 Substrates, Sediments, and Turbidity

For purposes of this review, substrates are defined as the type of bottom (typically hard vs. soft, consolidated vs. unconsolidated), sediments are defined as the unconsolidated portion of the bottom substrate, and turbidity is what results from resuspending unconsolidated bottom sediments. Carbonate (limestone) substrates mostly of biological origin and carbonate sediments typically with some organic matter predominate in the Key West area.

It is acknowledged that high winds and storms result in naturally occurring resuspended sediment and water column turbidity. And it is acknowledged that bottom sediments can be mobile in deep tidal channels as the result of natural processes - but typically submerged vegetation in the form of macroalgae and seagrass along with sessile invertebrates tend to stabilize channel bottoms and minimize movement of sediments. This review and assessment survey does not attempt to minimize the effects of these natural events but instead, since the very survival of the Keys coral reef ecosystem is dependant upon clear, low nutrient waters (Kruczynski and McManus 2002), focuses on human caused or induced resuspended bottom sediment and turbidity.

Turbidity is a measurement of the visibility and transparency of water and generally refers to water clarity. It can be measured based on the scattering of light by particles in the water (nephelometry), by filtering and weighing total suspended solids in the water, and direct observation of transparency. State water quality standards are measured as NTUs (nephelometric turbidity units). The U.S. Geological Survey considers turbidity a useful measurement that is growing in popularity and importance in scientific and resource monitoring programs. Uses of turbidity data include measuring water clarity for drinking water as well as ecological applications, indicating visual impairment in water, for real-time monitoring of conditions in watersheds, and as a means of measuring suspended-sediment concentration (Gray and Glysson 2003).

Along with phosphorus, turbidity is considered probably the second most important determinant of ecosystem health in the Florida Keys (Jones and Boyer 2002). Low-density carbonate sediments in the Keys are fine grained and, consequently, easily resuspended, rapidly transported, have a high light scattering potential, and increase local sedimentation rates. Presence of these resuspended sediments in the water column, as indicated by turbidity can interfere with feeding/respiration by aquatic organisms (FDEP 2005). Light levels are also reduced, which affects the health of seagrasses and corals as light extinction is directly related to water turbidity (Jones and Boyer 2002). Resuspended sediment and turbidity could also affect hard-bottom communities by smothering (Kruczynski and McManus 2002).

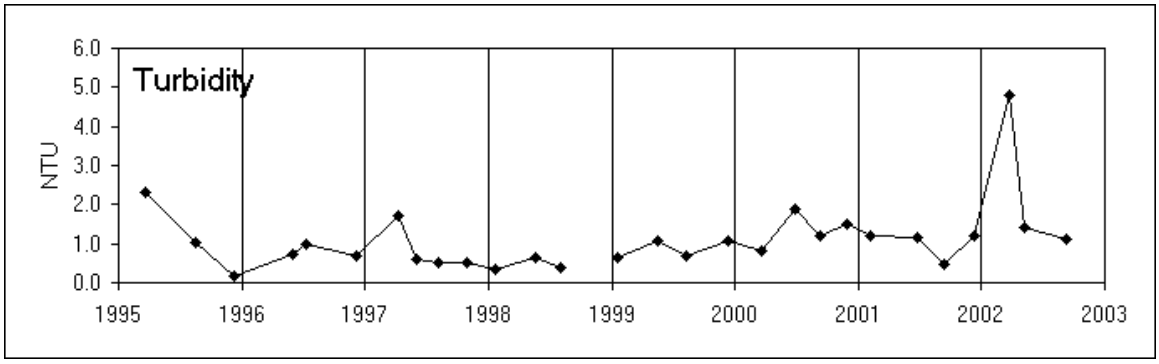
Research and reviews on the effects of suspended and redeposited sediments were conducted decades ago when large scale dredge and fill projects in the U.S. coastal zone resulted in serious biological effects such as direct habitat destruction and smothering. These lethal effects were known to result from excessively high sediment loads or high sedimentation that took place in a short period of time. More subtle lethal effects that can eliminate native species may occur at low but chronic sediment loads or sedimentation with long exposure. Under these conditions risks may exist to any life history stage, behavioral activity, reproductive ability, or metabolic function and result in decreased viability of any number of marine species in the vicinity of chronic resuspended sediment. (Sherk 1971).

There are a number of external sources that affect the water quality, including turbidity, of the lower Keys. These include Hawk Channel, Florida Bay, the Gulf of Mexico, and the boundary currents of the region. Water flow is generally westward in the nearshore areas, which can bring turbid water from these external sources to the Key West area. In addition, storms and currents move water from Florida Bay and the Gulf of Mexico, and this water exchange can affect turbidity levels in the Key West area. Another source of turbidity is stormwater runoff, which can introduce sediment into the marine environment. Increased nutrients from domestic wastewater can introduce nutrients into nearshore waters, in turn increasing concentrations of phytoplankton in the water and increasing turbidity (FKNMS 1996).

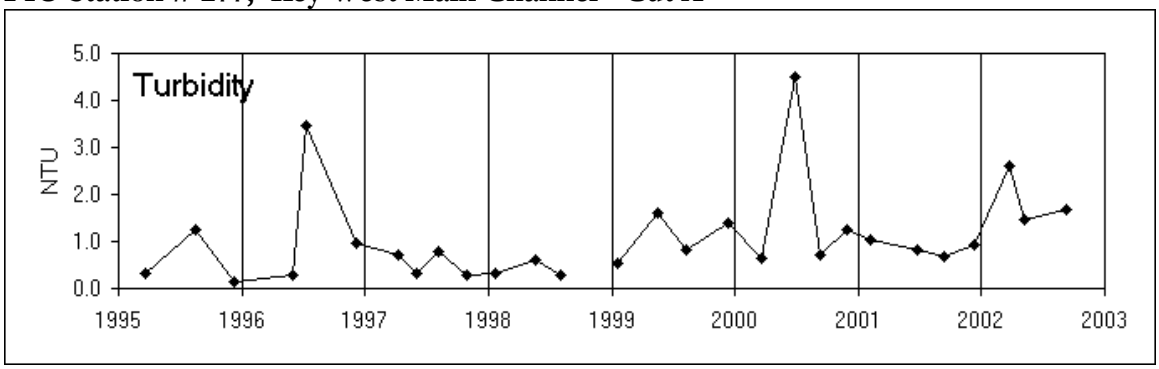
A reflection of low natural levels of turbidity in Key West waters can be found in nearly eight years of quarterly turbidity monitoring in the main ship channel offshore from Key West and adjacent to the channel (about 1/4 mile away) at Western Head Patch Reef. Monitoring by Florida International University (FIU) for the FKNMS WQPP revealed natural turbidity levels usually less than 2 NTU. Immediately outside the reef tract in deeper water measurements were usually less than 1 NTU (Figure 3.B.4).

Attempting to provide baseline data for dredging and post-dredging monitoring the Corps conducted a detailed assessment of turbidity and other conditions in the harbor in 2003. In October, a period was selected to represent calm weather days that came at the end of a several-day period of less than 5 mile per hour winds. Later that month, three days were selected during which winds generally 10 to 15 mph from the east and south created rough sea conditions. Out of 6,915 turbidity measurements made during the calm period, the mean turbidity value was 0.79 NTU, the median value was 0.70 NTU, and the maximum was 11.2 NTU. For the rough conditions, there were 5,545 measurements with mean, median, and maximum values of 3.72, 3.20, and 18.2 NTU, respectively. Turbidity levels were approximately three to four times higher during windy conditions than during the selected calm weather period (USACE 2003). Wind generated turbid water from the altered south shore of Key West was monitored as it entered the harbor area and flowed northward by the cruise ship docking area and then Fleming Key. These events sometimes would last through the entire rising tide with turbidity levels rising 5 to 10 NTUs above previous slack tide readings (USACE 2003).

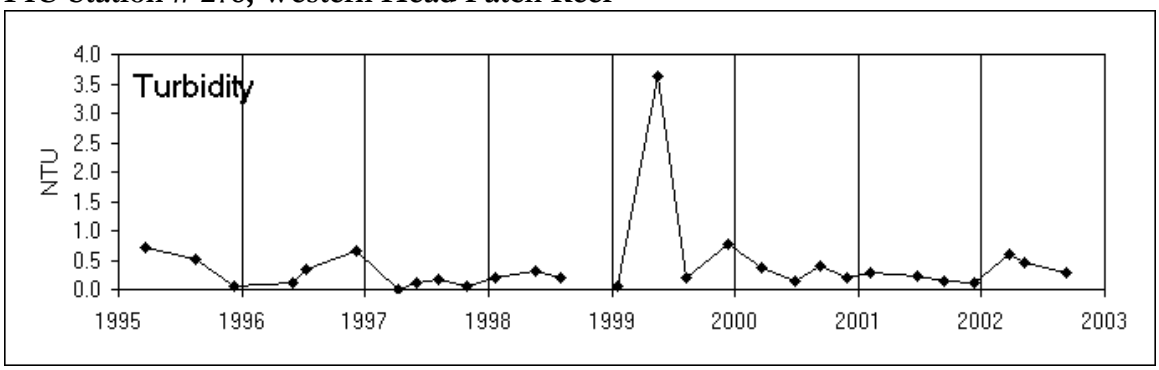
FIGURE 3.B.4. RESULTS OF QUARTERLY TURBIDITY MONITORING BY THE FKNMS WQPP NEAR KEY WEST 1995-2003 (FKNMS).



FIU Station # 277, Key West Main Channel - Cut A



FIU Station # 278, Western Head Patch Reef



FIU Station # 279, Main Ship Channel - Offshore

Results from the FKNMS WQPP monitoring showed strong onshore-offshore turbidity gradients for all Keys transects, but reef tract levels were remarkably similar (low) regardless of inshore levels. High nearshore turbidities are most probably the result of wave action resuspending sediments in shallow water but can also locally be related to human activity like dredging and filling, dock and pier construction, and vessel movement.

Natural processes that result in large scale disturbance in Keys waters are episodic, often with long intervals between events. Fine carbonate sediments in the Keys are easily resuspended by disturbances, including those caused by vessel traffic. The growing number, size, and draft of recreational and commercial vessels now using Keys waters, such as Key West channel and harbor, are creating turbid conditions considered to be chronic in places.

Vessel generated resuspended sediments is a growing concern in areas with high boat traffic, including open waters. Turbidity reduces water clarity, which reduces sunlight penetration through the water column (which can adversely affect the growth of submerged vegetation (Kruczynski and McManus 2002).

Due to the long history of maritime activity in Key West and Truman Harbor, sediment contamination has been an issue related to both sediment resuspension by large vessels and the Navy's dredging project. **S**amples were collected in September 2002 at 14 stations in Truman Harbor, the turning basin, and the Main Ship Channel. Samples from Truman Harbor and the northwest corner of the turning basin were dominated by fine-grained sediments. Coarse-grained sediments predominated in the Main Ship Channel except at a turn in Cut A where fine-grained sediments had accumulated. Overall, sediments in the project area were free of contaminants. This was substantiated by analyses performed for trace metals, cyanide, ammonia, organic pollutants, oil and grease, and total organic carbon. Trace metal concentrations varied primarily with grain size and did not reflect toxic levels. Concentrations of organic pollutants were not detected in the samples. A low concentration of oil and grease was detected at one station within Truman Harbor. Total organic carbon levels were low, as were levels of cyanide and ammonia in the sediment samples. The overall high sediment quality observed by Navy contractors was supported by previous sediment data reported by the Bar Pilots (1999) and was what might be expected in a well flushed tidal channel (Navy 2003).

Good summaries of the turbidity and sedimentation issues related to cruise ship and other large vessel traffic in the Key West area, and the associated environmental impacts, were prepared through the efforts of the LVWG organized by the FKNMS Sanctuary Advisory Council (SAC) in June 2002 (FKNMS 2003, LVWG 2002-2004). The general purpose of the Working Group initially was to investigate and then determine how best to mitigate the impacts of cruise ships and other large vessels in waters near Key West. Later a goal was identified to produce recommendations to the SAC for mitigating the impacts of large ship traffic on the marine environment and determining whether there is a basis for some perceived impacts. After two meetings the main interests and concerns were identified as turbidity, discharges, and vessel traffic (LVWG 2002-2004). The LVWG met on six occasions between October 2002 and February 2004. Meetings were daylong and attended by as many as 40-50 government agency representatives and scientists, NGO staffers, local boat captains and concerned members of the community. Full meeting transcripts are available for 4 meetings and contain a variety of useful information about the history of the channel and harbor and perceived changes over time, turbidity and sedimentation and the biological consequences of increasing levels over natural background levels, cruise ships, navigation, the Navy dredging project, future plans for the harbor, and more (LVWG 2002-2004, LVWG 2004)). Ultimately, the LVWG made the following recommendations to the SAC:

1). The SAC should receive regular updates on the Key West Harbor Dredging project from Sanctuary biologists and U.S. Army Corps environmental specialists.

2). The monitoring period for sedimentation and turbidity in the Harbor, channel and environs should be extended from the current one month to at least 12 months after completion of dredging, in order to capture a years seasonal tidal fluctuations.

3). The Sanctuary, Corps, and Navy should incorporate and evaluate existing physical oceanographic data, particularly satellite imagery, with data collected during the dredging project.

As a result, the SAC receives regular updates on the dredging project, the post-dredging monitoring was extended to 3 months as a compromise solution, and review of the dredging monitoring data is to occur in the future.

3.B.3 Environmental - Biological Resources

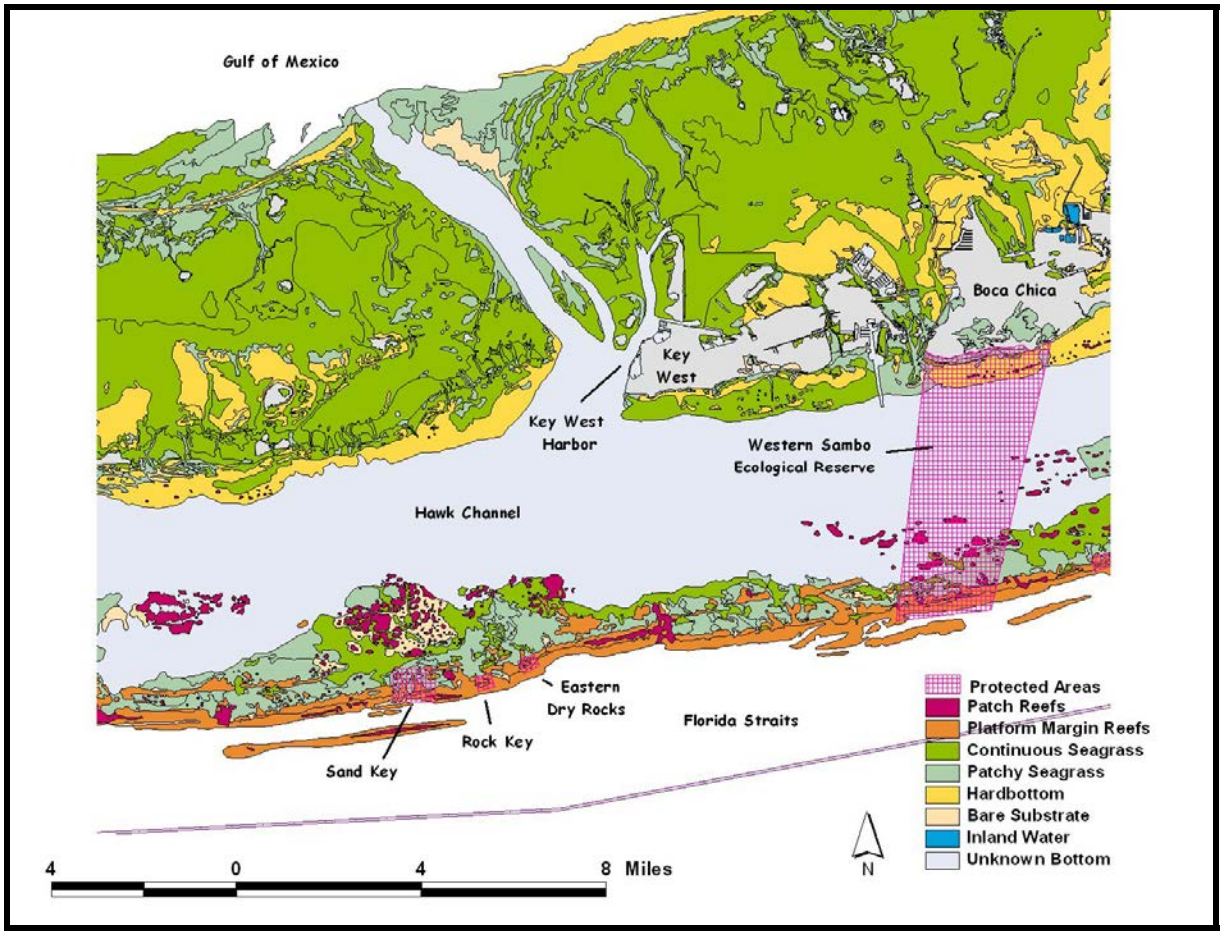
As noted in Section 3.A.6, the marine resources of the Keys and the Key West area have been documented, monitored, mapped, and described in detail as part of the various government programs implemented over the years. Probably no better source of information is available than the FKNMS Management Plan of 1996 and the Draft Revised Management Plan of 2005. Updated information and concerns are presented in these documents along with Action Plans and means of protecting and managing these public resources. An excellent set of links to other web sites containing information on the coral reef ecosystem resources of the Keys can be found at http://floridakeys.noaa.gov/links/reefs.html. The 2003 Navy EA for review of the Navy dredging project is also a good source of current information on the resources of the immediate area around Key West.

"The deterioration of the marine ecosystem in South Florida is no longer a matter of debate. Visitors, residents and scientists alike have noted the precipitous decline in the health of the coral reef ecosystem. The threats causing these visible signs of decline are numerous and often complex, ranging from direct human impacts to global climate changes. Direct human impacts include vessel groundings, anchor damage, destructive fishing, and damage to corals as a result of divers and snorkelers standing on them. Boat propellers and large ships have damaged over 30,000 acres of seagrasses and more than 20 acres of coral reef habitat in the Sanctuary. Most pressures stem from the 5 million annual visitors and 80,000 year-round residents. Their high levels of use in the Sanctuary have significant direct and indirect effects on the ecosystem. Sanctuary visitors primarily seek water-related recreation, including fishing, diving, snorkeling, and boating." (FKNMS 2005)

3.B.3.1 NATURAL HABITATS

Natural habitats and productive benthic communities surround the dredged channel and harbor used by cruise ships and other large vessels to enter and leave Key West. Benthic habitats visible in high quality aerial imagery were mapped in the mid 1990s (FMRI 1998, Zieman et al. 1995) - those mapped around Key West appear in Figure 3.B.5. General categories of these habitats include coral reefs (bank or platform margin reefs and patch reefs) hardbottom, seagrass, and bare or lightly vegetated substrates. These habitats, their functions and value to the public, have been described at length in scientific and resource management literature noted here. They are known to support important and economically valuable commercial and recreational fisheries and provide diving sites for a thriving dive industry around Key West. Much of the bottom of the deeper Hawk Channel offshore of

FIGURE 3.B.5. MAP OF BENTHIC HABITATS IN KEY WEST AREA WITH LOCATION OF SPECIALLY DESIGNATED REEF AREAS (FMRI 1998).



Key West was not mapped due to naturally turbid water that precluded a view of the bottom in the imagery. Artificial habitats in the form of sunken vessels, concrete rubble piles, bulkheads, seawalls, pilings, and rock walls and jetties also exist in the Key West area and can support important resources as confirmed by the removal and transplanting of about a thousand stony corals by the FKNMS from the concrete walls of the Outer Mole prior to its reconstruction and partial removal [9] Florida's coral reef tract is one of the largest bank-barrier reef systems in the world and contains one of nation's most diverse assemblages of flora and fauna - thousands of species of fish, mobile and sessile invertebrates, and plants. State and federal agencies address threats to reef resources in the Keys using a variety of management programs and by applying regulations intended to address both direct and indirect impacts (SAFMC 1995). In the FKNMS a network of no-take zones in mostly shallow bank reef habitats were implemented in 1997, and in 2001 the Tortugas Ecological Reserve at the Dry Tortugas west of Key West was established. Protection and wise use of

[9] McLaughlin, L, Personal Communication, FKNMS

Florida's coral reef habitat is a primary concern and the current long-term Coral Monitoring Project (CRMP) is the most comprehensive coral assessment program ever established in the Keys (FMRI 2005).

Long-term status and trends monitoring over the past eight years in the FKNMS identified the following trends in important coral reef resources (FKNMS 2005):

- Sanctuary-wide from 1996 to 2003 (105 stations), the number of stony coral species declined at 76 (72%) stations, increased at 15 (14%) stations, and remained unchanged at 14 (13%) stations.
- Sanctuary-wide, mean percent stony coral cover declined from 11.9 in 1996 to 7.4 in 1999, a decline of 38%. The greatest change occurred between 1997 and 1999 when mean percent stony coral cover declined from 11.3 to 7.4
- Sanctuary-wide, stony coral cover has not changed significantly since 1999. In 2003, mean percent stony coral cover sanctuary-wide was 7.2
- A decline in the number of stony coral species was recorded in all reef habitat types.
- In 1996, coral disease was observed at only five stations sanctuary-wide. By 2002, coral disease was observed at 102 stations. Incidences of stony coral disease were reported at 95 stations in 2003. Specifically, in 2003, White disease occurred at 72 stations, "Other disease" was recorded at 89 stations, and Black Band disease was recorded at seven stations.

Due to recent declines in populations of elkhorn coral, staghorn coral and fused staghorn coral (*Acropora* spp) in U.S. waters, including the lower Keys, and the lack of recovery from modern large scale die-offs, NOAA in 2005 proposed listing these corals and possibly designation critical habitat for them under the Endangered Species Act.

Patch reefs occur between the shoreline and outer reef line at water depths ranging from about 13 ft to nearly 40 ft, and may have heights of up to 23 ft above the surrounding seafloor. Many patch reefs occur throughout Hawk Channel off Boca Chica Key and Key West in the Lower Keys. Large, mature patch reefs are dominated by the massive stony corals as well as various species of sponges, octocorals, bryozoans, and ascidians.

CRMP monitoring at a patch reef next to the main channel offshore reveal that the number of stony coral species at 2 stations monitored at Cliff Green Patch Reef (about midway along the main offshore channel) declined by 29% from 1996 to 2004 and the total number of stony corals at 3 monitoring stations at nearby Western Head Patch Reef declined by 28% in the same time period. Cover of stony corals from 1996-2003 showed declines at the two stations at Cliff Green Patch Reef ranging from 18% to 28% while decline at the 3 Western Head stations ranged from 7% to 13% (CRMP 2005).

Optimal coral, survival, growth and recruitment occurs under low nutrient and low turbidity conditions, although coral decline in the Keys is considered to be a result of multiple stressors (Cook et al. 2002). Lower skeletal deposition of calcium carbonate in experimental transplants of hard corals into nearshore waters has been attributed to higher turbidity levels. Turbidity and water temperature have been described as major characteristics of nearshore waters that negatively affect corals on the Florida Reef Tract (Cook et al. 2002).

Seagrass communities are a dominant component of the underwater landscape of the Key West area and are found in a variety of habitat types, from large intertidal banks to deeper waters of the reef tract. Distribution of seagrasses is determined by a variety of factors including water quality, clarity, and depth, light, sediment type and thickness, exposure, wave energy and current velocities. Seagrasses near Key West include turtle grass (Thalassia testudinum), manatee grass, (Syringodium filiforme) shoal grass (Halodule wrightii), and star or paddle grass (Halophila spp.)

Seagrasses are one of the most productive natural habitats in the world. Seagrasses provide food and shelter for a majority of the economically important fish and invertebrates in the Keys (FMRI 1998). Important commercial and recreational marine species that rely on seagrass habitat during some part of their life cycle near Key West include pink shrimp, spiny lobster, stone crab, snapper, grouper, bonefish, permit, and tarpon. Some of those species use seagrass meadows for the duration of their life cycles, whereas others use them for only a distinct life-history stage (e.g., as juveniles for the purpose of refuge, or feeding as adults). Seagrasses are used as direct food source for protected species such as manatees, some sea turtles, and queen conch. Epiphytes, using seagrass blades as substrates, provide another primary food source for grazers, which in turn are consumed by larger species foraging in the beds. Seagrasses produce oxygen, which is released to the water during photosynthesis, and absorb some nutrients from the water column. Epiphytes may sequester additional nutrients from the water column. Water quality benefits also occur as seagrasses and associated epiphytes trap suspended sediment from the water-column. Finally, seagrasses stabilize sandy bottoms with roots and rhizomes, and decrease wave action where meadows are dense. These functions increase water clarity which is beneficial to primary production, species interaction, and in the recreational quality of coastal areas (USFWS 2003).

Seagrass habitats in many regions, including the lower Keys, are known to be at risk from many human induced environmental changes, including boating activity (FKNMS 2005). Seagrass habitats in Biscayne National Park and Everglades National Park are being degraded by vessel groundings and resuspended sediment from vessel passage in some areas.[10]

The Seagrass Outreach Partnership in the Keys, a collective effort of a number of local, state and federal agencies led by the FKNMS, publicizes some of the threats to seagrass habitats in its literature as follows:

- Seagrasses are disappearing at an alarming rate
- Threats to seagrass include dredge and fill projects, degraded water quality, sedimentation, and physical impacts by boat propellers and prop wash
- Seagrass destruction is a serious problem that has become more intense near shoreline communities and popular boat access areas
- Boat impacts can create barren areas where fish and other wildlife once flourished
- Boats are becoming more numerous, larger, and more powerful compounding the problem

[10] Lewis, R. Personal Communication, Lewis Environmental Services, Inc.

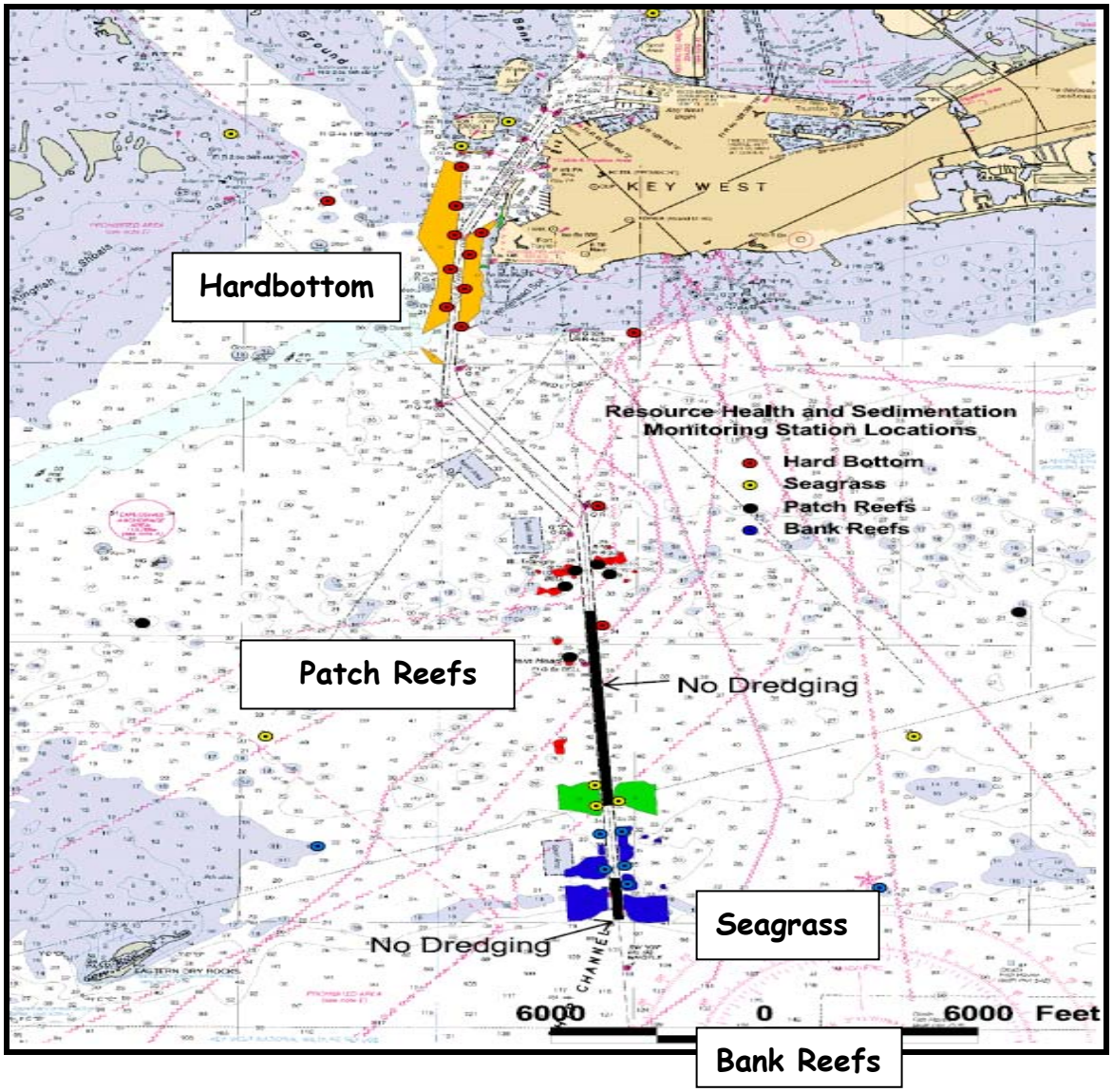
- Seagrass loss has a direct, long-term economic impact on commercial and recreational interests
- Sediment plumes behind boats are a sign of an inexperienced or careless boater
- Seagrasses are critical for stabilizing sediments and providing habitat for hundreds or thousands of associated plant and animal species. Without seagrasses there would be a seascape of unstable shifting sand and mud.

Hardbottom habitats of the Lower Keys are solid, flat, low relief, exposed oolitic limestone substrate that occur in relatively shallow depths often with a thin veneer or pockets of unconsolidated sediment. These pockets may support seagrass and the area is then more of a mosaic of hard features and seagrass habitat. Hardbottom habitats may be colonized by a high diversity of octocorals, stony corals, and sponges in areas of moderate to high water flow such as in channels or cuts. In sheltered areas adjacent to the north or south sides of landmasses, there may be minimal water movement and higher rates of sedimentation and the hard bottom community may be dominated by various species of algae (Navy 2003).

Areas of unconsolidated sediments cover a large majority of the bottom within the Hawk Channel and the channel and harbor dredged areas. Soft bottom habitats can support diverse infaunal assemblages including, polychaete worms, bivalves, gastropods, and crustaceans. Additionally, these areas may contain many epifaunal echinoderm species such as seastars, sea cucumbers, and echinoids. Calcareous mud bottom may be found in areas of high turbidity or with minimal water circulation. The substrate may have varying amounts of sand intermixed with silt- and clay-sized particles, and seagrass and algae may or may not be present. Sand bottom areas are found in locations with wave activity or high tidal flow. If water movement is not excessive, seagrasses and calcareous green algal communities can be dense (Navy 2003).

The 2003 Navy EA for the dredging project identifies and describes habitats within the dredged area based on diver observation and records. These habitats included hardbottom patches, seagrasses, macroalgae, rock rubble, and highly disturbed bottoms of rubble, sand, silt, and mud. The Navy's contractors also identified and mapped natural habitats alongside the channel and harbor for purposes of monitoring any damage from resuspended sediment, turbidity, dredge accidents during dredging, and for establishing habitat specific monitoring sites (Figure 3.B.6).

FIGURE 3.B.6. NATURAL HABITATS ALONG THE MAIN CHANNEL AND HARBOR AND LOCATION OF MONITORING STATIONS (NAVY 2003).



3.B.3.2 ENVIRONMENTALLY SENSITIVE CONSERVATION AREAS

The Key West National Wildlife Refuge (KWNWR) is one of the oldest National Wildlife Refuges in the U.S., designated in 1908, consists of nearly 200,000 acres of islands (including formal wilderness) and open water with unique, highly diverse marine habitats. The administrative boundaries extend from immediately west of the main channel and harbor at Key West to the Marquesas Keys (Figure 3.B.7). The KWNWR was created ".... as a preserve and breeding ground for native birds and other wildlife" and has "particular value in carrying out the national migratory bird management program (USFWS 1997). Objectives of the KWNWR include to provide protection and suitable habitats for listed species, management of feeding, nesting, and roosting habitats for a wide variety of shorebirds, wading birds, waterfowl, raptors and other migratory birds, and to provide wildlife-

dependent recreation and educational activities where compatible with refuge purposes (USFWS 1997). Incompatible uses in the past by large commercial tours out of Key West, especially related to illegal island use by customers, have been identified and addressed by Refuge Management.[11]

The Great White Heron National Wildlife Refuge is to the north and east of Key West and includes about 175,000 acres of productive shallow water seagrass flats, numerous tidal channels, and mangrove islands (Figure 3.B.7). It was established in 1938 as "....as a refuge and breeding ground for native birds and other wildlife" and is to be managed ".... as an inviolate sanctuary, or for any other management purpose, for migratory birds" with objectives similar to those of the KWNWR (USFWS 1997).

In addition, a number of specially designated Wildlife Management Areas (e.g. no motor, low speed, or no access zones) at Refuge islands near Key West that were originally established by the USFWS Refuge System were incorporated into the FKNMS Management Plan. Near Key West WMAs include various access restrictions around the Bay Keys, Boca Grande, Woman Key, Cayo Aqua Keys, Cottrell Key, Big Mullet Key, and Little Mullet Key (FKNMS 1996).

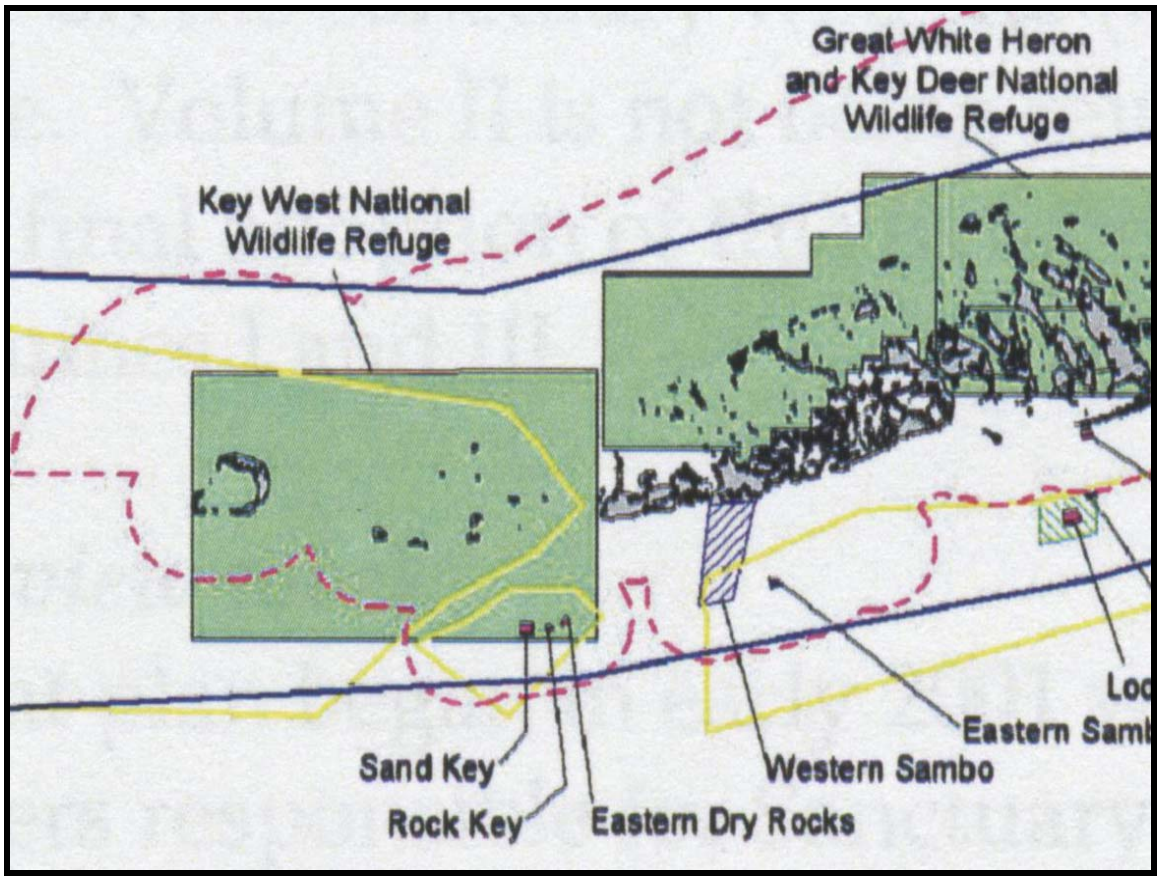
The consideration of temporal and geographic zoning to ensure the protection of Sanctuary resources was mandated under the Florida Keys National Marine Sanctuary and Protection Act of 1990. Three Sanctuary Preservation Areas (SPA) near Key West designated in the 1996 Management Plan are located to the west of the entrance to the main ship channel along the edge of the reef tract. The Sand Key SPA lies about 5 miles west of the entrance channel and comprises about 370 acres of shallow reef. The Rock Key SPA lies about 3.6 acres west of the main channel and consists of about 75 acres of shallow reef and the Eastern Dry Rocks SPA is located just over 2 miles from the entrance channel and consists of about 75 acres of shallow reef (Figure 3.B.7). The Western Sambos Ecological Reserve, about 5 miles east of the entrance channel extends from the south shore of Boca Chica Key to the reef tract (Western Sambo Reef) and includes about 7,600 acres that represent most Keys marine habitats. The Eastern Sambos Research Special Use Area is about 7 miles east of the ship channel and is composed of about 75 acres of shallow reef. Details about these specially protected zoned areas and their biota, and the goals and objectives of the zoning, can be found in 1996 FKNMS Management Plan.

Ft. Zachary Taylor State Historic State Park is a 58 acre facility immediately south of the adjoining Truman Annex and Outer Mole. The site was given to the State of Florida by the Navy in the 1960s. It consists totally of filled land and borders Key West channel on its west side. The south shoreline includes an artificial sand beach protected by rock groins, the west shoreline is stabilized with riprap boulders and it shares a small beach (Truman Beach) here with Truman Annex.

[11] Wilmers, T. Personal Communication, USFWS

FIGURE 3.B.7. LOCATION OF SPECIALLY DESIGNATED CONSERVATION AREAS AROUND KEY WEST.

The east boundary of the Key West NWR lies immediately to the west of Key West Channel and Harbor. Sand Key, Rock Key, and Eastern Dry Rocks are located west of the entrance to the main channel. The solid blue line represents FKNMS boundaries, the dashed red line represents State Waters off Key West, and the solid yellow line represents the Area To Be Avoided designation.



3.B.3.3 THREATENED AND ENDANGERED SPECIES

A detailed review was conducted by federal agencies on the methods proposed to be used for the Navy's dredging project in Key West. As a result, excellent information on the status of marine species found near Key West and listed under the federal Endangered Species Act (ESA) can be found in the Navy's 2003 EA and much of that information is directly excerpted here without reference to the original sources cited in the Navy EA.

Five sea turtle species are known to occur in waters near Key West (Table 3.B.1). In order of abundance, they are loggerhead, green, and hawksbill turtles, and occasionally Kemp's ridley and leatherback. Historic survey data suggest that shallow seagrass beds and hard bottom areas in the Florida Keys, including the project area, are important year-round habitats for loggerhead, green, and hawksbill turtles, and sightings of these species within these habitats are common (Navy 2003).

TABLE 3.B.1. EXCERPTED FROM THE 2003 NAVY EA AS INFORMATION ON SEA TURTLES FOUND IN THE KEY WEST AREA.

Common and Scientific Names	Status[a]	Life Stages Present	Seasonal Presence	Nesting Season
Loggerhead turtle (*Caretta caretta*)	T	Adults, subadults, juveniles, and hatchlings	Year-round (most abundant during spring and fall migrations)	April - August
Green turtle (*Chelonia mydas*)	T/E[b]	Adults, subadults, juveniles, and hatchlings	Year-round	June-August
Hawksbill turtle (*Eretmochelys imbricata*)	E	Adults, subadults, juveniles, and hatchlings	Year-round	Variable[c]
Kemp's ridley turtle (*Lepidochelys kempii*)	E	Juveniles and subadults	Year-round (most abundant during spring and fall migrations)	(no nesting in area)
Leatherback turtle (*Dermochelys coriacea*)	E	Adults, subadults, juveniles, hatchlings	March-October	(no nesting in area)

[a] Status: E = endangered, T = threatened under the ESA of 1973.
[b] Green turtles are listed as threatened except in Florida, where breeding populations are listed as endangered. Due to inability to distinguish between the two populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.
[c] Hawksbill turtle nesting in the Keys has been reported within the months of November, December, March, June, and July (Wilmers and Wilmers, 1999).

All marine turtles are protected under the ESA and under laws of the State of Florida. Hawksbill turtles, Kemp's ridleys and leatherbacks are listed as endangered and loggerheads as threatened. Atlantic green turtles also are threatened, except for the Florida breeding population, which is endangered. Due to inability to distinguish between the latter two populations away from the nesting beach, Atlantic green turtles are considered endangered wherever they occur in U.S. waters. Loggerhead, green, and hawksbill turtles are known to nest on beaches or dunes within the Keys, including the Marquesas and surrounding islands, and the Dry Tortugas (Navy 2003).

Loggerhead turtles are found throughout tropical, subtropical, and temperate waters of the Atlantic, Pacific, and Indian Oceans In the western Atlantic, it is found in estuarine, coastal, and shelf waters from South America to Newfoundland. Adult and subadult loggerhead turtles are generalist carnivores, feeding primarily on benthic crustaceans and mollusks. Loggerheads are present year-round in Florida waters, with peak abundance during spring and fall migrations. They are the most common marine turtle observed in the Keys, including both adult and subadult individuals. The loggerhead turtle is the only marine turtle species regularly utilizing local sandy beaches for nesting. Nesting activities have been reported along the Keys as far as the Dry Tortugas, including sandy beaches around Key West. Nesting activity in the area has been recorded between April and August, with peak activity from May through July. Two successful loggerhead turtle nests were recorded on beaches within Fort Taylor in 2002, and two on other Key West beaches in 2001. Hatchling loggerheads swim offshore and begin a pelagic existence within *Sargassum* rafts, drifting in current gyres for several years. At approximately 40 to 60 cm carapace length, juveniles and

subadults move into nearshore and estuarine areas, where they become benthic feeders for a decade or more prior to maturing and making reproductive migrations (Navy 2003).

The green turtle occurs worldwide in tropical and subtropical waters. The species is made up of several distinct populations. In the U.S., green turtles (part of the Atlantic green turtle population) occur in Caribbean waters around the U.S. Virgin Islands and Puerto Rico and along the mainland coast from Texas to Massachusetts. Green turtles occur throughout the Keys. Nearshore and inner shelf waters of the Keys provide crucial developmental foraging habitats for juvenile and subadult green turtles. Most commonly, these foraging habitats are seagrass and algae beds, though small green turtles also may be found over coral reefs, worm reefs, and exposed hardbottom.. Data suggest that some foraging habitats may only support certain size classes of green turtles and that the turtles apparently move among various foraging habitats as they grow. Subadult green turtles are commonly observed on seagrass beds inside of the reef tract, including those adjacent to Key West channel and harbor. Primary nesting sites in U.S. Atlantic waters are high-energy beaches along the east coast of Florida, primarily during July and August, with additional sites in the U.S. Virgin Islands and Puerto Rico. A few nesting sites have been identified within the Keys. These include Boca Grande Key, Sawyer Key, the Marquesas, and the Dry Tortugas. Nesting activity has been recorded from June through August, with peak activity between June and July (Navy 2003).

The hawksbill turtle occurs in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. In the western Atlantic, hawksbills are generally found in clear tropical waters near coral reefs, including the southeast Florida coast, Florida Keys, Bahamas, Caribbean, and southwestern Gulf of Mexico. Within the Keys, hawksbills are relatively common and are probably year-round residents, including adult, subadult, and juvenile life stages. Subadult hawksbills are found mostly year-round on shallow, offshore reef formations of the Lower Keys, including those in proximity to Key West, and especially the Eastern Dry Rocks area. Within the continental U.S., nesting beaches are considered rare and restricted to the southern coasts of Florida from Palm Beach to the Keys. Nesting near Key West has been recorded on Woman Key and the Marquesas Keys, west of Key West. Hawksbill nesting along the east Florida coast occurs between June and September. However, hawksbill nesting in the Keys appears to be not restricted to summer months only, with nests reported in November, December, March, June, and July. Adult hawksbills typically are associated with coral reefs and exposed hardbottom, where they forage on invertebrates, primarily sponges. Hatchlings are pelagic, drifting with *Sargassum* rafts. Juveniles shift to a benthic foraging existence in shallow waters, progressively moving to deep waters as they grow (Navy 2003).

In 2003, the FKNMS reported to the Navy's consultant, CZR, Inc., that there is a significant transient sea turtle population in the Lower Keys, such that collisions between boats and turtles and injured turtles are a regular occurrence. They noted that the prevalence of hawksbills along the local reef tract seemed underplayed in the Navy's draft EA (FKNMS 2003b).

The West Indian manatee is one of the most endangered marine mammals in coastal waters of the U.S. It is federally and state listed as endangered and is further protected as a depleted stock under the U.S. Marine Mammal Protection Act. Florida manatees of the Atlantic Region range along the entire Florida coast through the Florida Keys, including to Key West. Usually the manatee is a cold-intolerant species and requires warm water temperatures

generally above 20°C. Nearly all manatees winter in peninsular Florida and during warmer months expand their range north along the eastern U.S. and Gulf of Mexico coasts. Manatees inhabit both saltwater and freshwater of sufficient depth throughout their range. They are frequently found in fresh or brackish waters of canals, rivers, and estuarine habitats, but also frequent saltwater bays and other marine environments. On occasion, manatees have been observed as much as 7 miles off the Florida coast. In the lower Keys, including Key West, sightings of manatees are generally uncommon and usually consist of single to few individuals. Manatees prefer to feed on submerged and emergent vegetation. Therefore, movements of manatees often may be correlated with the distribution and availability of seagrasses. Under the ESA, there are no listings of critical habitat for manatees in the Keys (Navy 2003). Manatee "Caution" signs have been placed on the outside of Mallory Dock by the City, and presumably at the Outer Mole.

Although watercraft collisions account for about 25% of all manatee deaths and represent the single greatest threat to manatees (FWC 2002,) there appears to be no direct evidence of naval or other large vessel collisions with these mammals in waters near Key West. Low speeds typical of large commercial and naval vessels transiting the inner harbor at Key West are unlikely to result in collisions with both sea turtles and manatees. The Army Corps of Engineers and Florida DEP included a number of conditions regarding manatee protection and education in permits issued for the Outer Mole and Pier B reconstruction and the Navy's dredging. Displacement of sea turtles and manatees from preferred habitat by vessel traffic is possible, and chronic disturbance of manatees by vessels may alter and important activities such as feeding, suckling, or resting (FWC 2002).

On April 1, 2003, the National Marine Fisheries Service (NOAA Fisheries) announced its final determination to list smalltooth sawfish (*Pristis pectinata)* as an endangered species under the ESA. Sawfish are known to occur in waters around Key West and use a variety of habitats. Sawfish are extremely vulnerable to overexploitation because of their propensity for entanglement in nets, their restricted habitat, and low rate of population growth. The decline in smalltooth sawfish abundance has been caused primarily by bycatch in various fisheries, likely compounded by habitat degradation. Smalltooth sawfish has been reported in both the Pacific and Atlantic Oceans, but the U.S. population is found only in the Atlantic. Historically, the U.S. population was common throughout the Gulf of Mexico from Texas to Florida, and along the east coast from Florida to Cape Hatteras. The current range of this species has contracted to peninsular Florida, and smalltooth sawfish are relatively common only in the Everglades region at the southern tip of the state. Over the past century the population has been reduced by fishing and habitat alteration and degradation, and currently smalltooth sawfish are primarily found in southern Florida in the Everglades and Florida Keys (NOAA 2003).

The Florida Fish and Wildlife Commission (FWC) consolidates the official state and federal lists of endangered species, threatened species, and other species designated in some way by the respective jurisdictional agencies as meriting special protection or consideration (FWC 2004). The FWC maintains the state list of animals designated as endangered, threatened, or species of special concern, in accordance with Rules 68A-27.003, 68A-27.004, and 68A-27.005 FAC.

In addition to the sea turtles and Florida manatee noted above, other species listed by the State as warranting protection that may use the channel and harbor or immediately adjacent marine area, and that may be affected by cruise ship activity are (along with listing status):

Brown pelican (*Pelecanus occidentalis)* - Species of Special Concern

Black skimmer *(Rynchops niger)* - Species of Special Concern

Least tern (*Sterna antillarum)* - Threatened

Roseate tern (*Sterna dougalli)* - Threatened

Osprey (*Pandion haliaetus)* - Species of Special Concern

Pillar coral (*Dendrogyra cylindrus)* - Endangered

Pillar coral is rare in the Florida Keys and is currently the only local stony coral currently listed by state or federal agencies, although as noted above, NOAA has announced a review of *Acropora* spp. for possible listing under the ESA. NOAA is also involved in the protection of deep water *Occulina* coral beds elsewhere. Pillar coral is found only in limited offshore areas, including Hawk Channel and the lower Keys reef tract. This endangered coral is unusual in that its polyps are usually extended for feeding during the day while most hard corals feed at night. Pillar coral forms numerous heavy cylindrical spires that grow upward from an encrusting base.

In addition, and especially important to waters of the Keys, the State of Florida has a Marine Life Rule wherein the taking, destruction, and sale of many marine life species (including stony corals, soft corals, sea fans, reef fish, macroinvertebrates, and even live rock) are either prohibited or restricted (Chapter 46-42 FAC). The purpose and intent of these restrictions is to protect and conserve Florida's tropical marine life resources and assure the continuing health and abundance of these species. Further these rules are to assure that harvesters use methods for the maximum possible conservation and economic benefits.

Although many do not typically occur in waters near Key West, the 2003 Navy EA includes a review of other marine mammals (whales, bottlenose and other dolphin, etc.) that may potentially occur here and interact somehow with large vessel traffic in the area.

3.B.3.4 RECREATIONAL AND COMMERCIAL SPECIES

The high quality of recreational and commercial fishing in the Key West area is world renowned with a seemingly unlimited variety of species available for sport or harvest. These historic Keys and Key West industries significantly generate thousands of jobs in communities and tens of millions of dollars in income.

Important recreational species in the channel and harbor (and immediately offshore) that could be affected by local habitat or water quality degradation include snapper, grouper, dolphin, tunas, marlin, sailfish, mackerel, barracuda, jacks, sharks, bonefish, tarpon, permit, cobia, and spiny lobster. Important commercially harvested species include snapper, grouper, grunts, dolphin, mackerel, jacks, spiny lobster, stone crab, pink shrimp, and marine life for the aquarium industry. Food chain disruptions or changes that affect these species could occur if the abundance of prey items is altered by water quality or habitat modifications. Disruptions or degradation of benthic habitats that these important species depend on at various life stages and could directly affect targeted adult stages.

3.B.3.5 ESSENTIAL FISH HABITAT

Required by federal agencies reviewing their dredging permit application, the Navy provided an extensive and detailed review of Essential Fish Habitat (EFH) in the Key West area as part of the 2003 EA. A portion of that review is excerpted here:

"The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801-1882) established regional Fishery Management Councils and mandated that Fishery Management Plans (FMPs) be developed to responsibly manage exploited fish and invertebrate species in Federal waters of the United States. When Congress reauthorized this act in 1996 as the Sustainable Fisheries Act, several reforms and changes were made. One change was to charge the National Marine Fisheries Service (NMFS) with designating and conserving Essential Fish Habitat (EFH) for species managed under existing FMPs. This was intended to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or non-fishing activities, and to identify other actions that encourage conservation and enhancement of such habitat. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" [16 U.S.C. § 1801(10)]. The EFH Final Rule summarizing EFH regulations 50 CFR Part 600) outlines additional interpretation of the EFH definition. "Waters", as used previously, include "aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate." "Substrate" includes "sediment, hard bottom, structures underlying the waters, and associated biological communities." "Necessary" is defined as "the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem." "Fish" includes "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds," while "spawning, breeding, feeding or growth to maturity" cover the complete life cycle of those species of interest."

The South Atlantic Fishery Management Council (SAFMC) is the management council with jurisdiction over fisheries in federal waters near Key West. The SAFMC has produced several FMPs for single and mixed species groups. All of these FMPs, including those for shrimps, spiny lobster, and corals, coral reefs and live/hard bottom, reef fishes, and coastal migratory pelagics, were recently amended to further address EFH.

For example, seagrasses provide many biological, chemical, and physical functions for marine communities. They provide habitat for a myriad of fishes, shrimps, crabs, and other species, and therefore have been designated as Essential Fish Habitat (EFH) by the South Atlantic Fisheries Management Council. EFH has been also designated along the Keys reef tract for reef building stony corals. This area extends from nearshore areas to about 100 foot depth in areas where salinity is consistently above 30 ppt and water temperatures range from 15 to 35º C - both true near Key West . Much of the area adjacent to the Key West channel and harbor, and particularly in Hawk Channel, includes patch reefs and hardbottom. Designated also for some species or species groups within EFH are Habitat Areas of Particular Concern (HAPC). HAPCs either play critical roles in the life history (e.g., spawning, feeding) of federally managed species or are those areas vulnerable to degradation from fishing or other human activities. In many cases HAPCs are habitats where detailed information is available. HAPCs for coral, coral reefs, and hard bottom habitats of the Keys include the reef tract and Hawk Channel (Navy 2003).

Queen conch primarily inhabit back-reef zones, shallow hard bottom, seagrass, and coarse habitats in the lower Keys. Several spawning populations exist, and a large concentration of spawning adults is known for the back reef and hard bottom areas from Eastern Dry Rocks (offshore from Key West) east to Looe Key. Conch occur in two major zones - inshore and offshore. The inshore group rarely reproduces, whereas the offshore group is reproductively active. Spawning occurs from March through October with peak activity from April to July (Glazer 2001). HAPCs for queen conch exist in two areas near Key West, the hard bottom adjacent to the main channel, and off Fort Taylor and Boca Chica. Of the estimated 28,000 conch in the spawning stock from Eastern Dry Rocks to Looe Key during 2001, about 18,000 were found in the region extending from Eastern Dry Rocks to Eastern Sambo. This region, by far, represents the greatest reproductive output of Florida's queen conch population, and any impacts, particularly elevated turbidity, could impact planktonic larvae and newly settled individuals The southern portion of the channel intersects this area. In addition, juvenile and non-reproducing adult conch are common in hardbottom along the oceanside of Key West and on the west side of harbor (Navy 2003).

Spiny lobster (*Panulirus argus*) is a very important species near Key West and both commercial and recreational interests benefit from healthy spiny lobster populations. EFH for lobster as well as other valuable invertebrates has been defined (Table 3.B.2). Spiny lobster EFH for adults, subadults, and juveniles consists of hard bottom, coral reefs, seagrasses, macroalgae and mangroves. HAPCs for spiny lobster include coral and hardbottom habitats from Jupiter Inlet to the Dry Tortugas.

All life stages of the stone crab (*Menippe mercenaria*) occur near Key West, including commercial quantifies of adults. Highest local densities of adult stone crab exist to the north in Florida Bay. EFH for adults includes seagrasses, hardbottom, ledges, channel edges, and coral heads. Adults construct burrows and prefer areas with hard packed sand with scattered hard bottom covered with algae, soft corals, and sponges. Juveniles do not burrow but are found in seagrass, shell hash, sponges, and other structurally complex benthic habitats (Navy 2003).

The SAFMC also manages a "Snapper-Grouper Management Unit" that consists of 73 species from 10 families. Members of this management unit inhabit reefs and hard bottom areas as adults and are very important components of commercial and recreational fisheries of the Key West area. Because of their affinity for hardbottom and reefs, members this Unit are collectively referred to as reef fishes. HAPCs described for this Unit include high-relief offshore areas where spawning occurs and localities of known spawning aggregations. In addition, nearshore mangrove habitat, seagrass habitat, coral, coral reef, and hardbottom habitats, and artificial reefs compose HAPC for reef fishes. EFH has also been identified for a wide variety of coastal pelagic species - many of which are of commercial and recreational importance in the Key West area (Navy 2003).

Most importantly, it is maintenance of important and critical habitats and ambient water quality that is critical to the survival and maximum productivity of these species. Table 3.B.3 was provided in the Navy EA and summarizes effects from bottom disturbance and dredging on important habitats and species in the Key West area and their EFH.

TABLE 3.B.2. IMPORTANT COMMERCIAL INVERTEBRATES IN THE KEY WEST AREA FOR WHICH EFH HAS BEEN IDENTIFIED. BY LIFE STAGE AND HABITAT (NAVY 2003).

Invertebrate Species for Which EFH has been Identified in the Ship Channel, Turning basin, Truman Harbor, and Dead End Canals Near Key West, Florida (SAFMC 1998a).

Species	Life Stages	Habitat
Queen conch (*Strombus gigas)*	Adults; Juveniles; Larvae	Back-Reef Zones; Rubble-Sand; Coarse Sand; Pelagic
Pink shrimp (*Penaeus dourarum*)	Adults; Juveniles; Larvae	Soft Bottom; Seagrass; Pelagic
Rock shrimp (*Sicyonia brevirostris*)	Adults; Juveniles; Larvae	Soft Bottom (18 to 180 m); Pelagic
Stone crab (*Menippe mercenaria*)	Adults; Juveniles; Larvae	Hard Bottom; Seagrass; Mangrove; Sponges; Macroalgae; Pelagic
Spiny lobster (*Panulirus argus*)	Adults; Juveniles; Larvae	Hard Bottom; Seagrass; Mangrove; Sponges; Macroalgae; Pelagic

3.B.4 Cruise Ship Discharges

This section discusses the federal regulations, state regulations and cruise ship industry's policies regarding waste management practices in port and underway in the waters around Key West. Also discussed is research on cruise ship discharges and their impacts on natural resources resulting from the application of these practices in Key West. Recommendations to maintain and improve current waste management practices are proposed to further increase the protection of the Key West natural environment.

The main waste discharges generated by cruise ships are sewage/blackwater, graywater, oily bilge water, hazardous and solid waste and air emissions. Ballast water discharges are not considered a waste but improper discharges of ballast water can be a threat to the local marine environment.

TABLE 3.B.3. EXCERPTED INFORMATION ON POTENTIAL IMPACTS TO ESSENTIAL FISH HABITATS OF IMPORTANT MARINE SPECIES NEAR KEY WEST FROM SEAFLOOR DISTURBANCE AND TURBIDITY (NAVY 2003).

Species Group	Seafloor Disturbance	Turbidity	Entrainment
Sargassum Algae[1]	None expected	Potential mortality/ feeding impairment of associated juvenile fishes	None expected
Coral, Coral Reefs, and Hard/Live Bottom[2]	Detachment of individual colonies; direct physical damage	Suffocation of polyps and tissue	None expected
Queen Conch[5]	Adult habitat loss	Potential mortality of early lfe stages	Juveniles and adults susceptible
Penaeid and Rock Shrimps	None expected	Potential mortality of early life stages	All life stages susceptible
Spiny Lobster[2]	Adult and juvenile habitat loss	Potential mortality of early life stages	All life stages susceptible
Stone Crab[3]	None expected	Potential mortality of early life stages	All life stages susceptible
Coastal Sharks[4]	Adult and juvenile habitat loss (nurse sharks)	None expected	None expected
Highly Migratory Species[4]	None expected	Potential mortality/ feeding impairment of early life stages	Larvae and eggs susceptible
Reef Fishes (Snapper-Grouper Management Unit)[2]	Adult and juvenile habitat loss	Potential mortality/ feeding impairment of early life stages	Larvae and eggs susceptible
Coastal Migratory Pelagic Fishes[2]	None expected	Potential mortality/ feeding impairment of early life stages	Larvae and eggs susceptible

[1]-South Atlantic Fishery Management Council 1998b
[2]-South Atlantic Fishery Management Council 1998a
[3]-Gulf of Mexico Fishery Management Council 1998
[4]-NMFS 1999a
[5]-Robert Glazer (Florida Fish and Wildlife Conservation Commission pers. comm. 2003)

From 1993 through 1998 - the most recent year for which data are available - cargo ships, tankers, cruise ships, and other commercial vessels registered, or "flagged," in foreign countries have been involved in nearly 2,400 cases of illegally discharging oil, garbage, and other harmful substances into U.S. coastal waters. Cruise ships, nearly all of which are flagged in foreign countries, accounted for about 4% of all confirmed illegal discharges during this period. Although the more than 100 cruise ships operating in U.S. waters have been involved in a relatively small number of these pollution cases, several cruise ship cases have been widely publicized. In addition to Coast Guard, civil and administrative penalties against illegal discharges by cruise ships the Department of Justice prosecuted 10 criminal cases against cruise ship companies and levied penalties ranging from $75,000 to $18 million (GAO 2000). Officials from various government agencies acknowledge that cruise ship companies were making progress towards changing a maritime culture that once ignored discharges of oil and garbage at sea (GAO 2000). The existence of more and larger cruise ships accessing coastal communities warrants close attention to the issue of discharges.

In addition to cruise ships being subject to international and federal laws and regulations, the industry and the State of Florida entered into a specific waste management agreement for state waters. The State of Florida Department of Environmental Protection (FDEP), the Florida-Caribbean Cruise Association (FCCA) and the International Council of Cruise Lines (ICCL), as representatives for the cruise industry in Florida, signed a Memorandum of Understanding (MOU) in 2001. In the MOU, FDEP accepted the ICCL Industry Standards E-01-01, entitled Cruise Industry Waste Management Practices and Procedures (ICCL 2001). The MOU also states that the FCCA and ICCL members agree to discharge wastewater only outside of Florida territorial waters. The FDEP acknowledges that the waste management practices and procedures meet or exceed the standards set forth in Florida laws and applicable Florida regulations. Effective January 2004, the ICCL implemented a revision of the Cruise Industry Waste Management Practices and Procedures (ICCL 2003). The U.S. Coast Guard, who has federal jurisdiction over environmental matters in navigable waterways in the United States, is responsible for the monitoring and compliance of the ICCL Industry Standards in the MOU.

Within the cruise line industry, the major companies have implemented Safety Management System (SMS) Plans for: (1) developing enhanced waste management systems to implement the companies' environmental policies and highlight proper waste-handling procedures; (2) increasing internal and third-party audit oversight of environmental procedures to prevent illegal discharges; and (3) improving waste management and equipment to reduce or better treat waste. These plans are certified in accordance with the International Marine Organization's (IMO) International Safety Management (ISM) Code. (USEPA 2000)

Cruise lines that visit Key West practice self-imposed waste management policies that are more stringent than the standards in the MOU[12]. But even with implementation of more stringent industry standards there are waste discharge issues that need to be addressed for the cruise ships and all other vessels transiting the waters of Key West.

3.B.4.1 SEWAGE - BLACKWATER

The thousands of passengers on cruise ships can generate up to 30,000 gallons of sewage per day. However, the cruise ships are not subject to the same wastewater regulations that govern land-based facilities. The EPA does not require a National Pollutant Discharge Elimination System permit for cruise ships as mandated for land-based facilities.

This decision by EPA is based on studies that investigated the composition, dispersion and impacts of graywater and blackwater discharged from cruise ships. The findings concluded that the ICCL Cruise Industry Waste Management Practices and Procedures for blackwater resulted in high dispersion levels with minimal negative impacts on the environment (Sweeting and Wayne 2003).

In Florida, the FDEP incorporated the Cruise Industry Waste Management Practices and Procedures in the MOU between the State and the ICCL. The MOU states ICCL members will process blackwater through a certified Marine Sanitation Device (MSD) and discharge treated blackwater only when the ship is more than 4 miles from shore and at a speed of not less than 6 knots (ICCL 2003).

[12] Pruitt, Rich. Personal Communication. Royal Caribbean Cruises Lines

In June 2002, state waters within the Florida Keys National Marine Sanctuary (FKNMS) were designated as a No Discharge Zone (NDZ) by EPA, under Section 321 of the Clean Water Act, making it illegal for any vessel to discharge sewage. Offshore from Key West this NDZ extends about 2 miles beyond the reef tract, and a total distance of about 7 miles offshore. Directly south of Key West, state waters include most of the reef tract and as well as all of Key West channel (Figures 3.B.1 and 3.B.7). The FKNMS is proposing to initiate regulatory changes to expand the existing no-discharge zone in state waters in the Keys to include the entire FKNMS. NOAA will pursue a no-discharge zone regulation for the federal waters of the Sanctuary in 2005.[13]

Of the three cruise ship berths on Key West Harbor, pumpout facilities exist at Mallory Square and the Outer Mole. The City of Key West Environment Best Management Practices Committee is currently researching the feasibility of mandatory pumpout by cruise ships while in port at Key West as a means of reducing discharges offshore. The committee's recommendations to the City Council are due in Spring 2005. However, discussions with the city and cruise ship representatives indicate mandatory pumpout does not seem feasible due to as yet unresolved engineering, waste treatment, and cost issues.[14]

Royal Caribbean Cruises Ltd. (RCCL) and Carnival Corporation (CCL) represent the largest number of cruise lines that visit Key West. Each cruise line under RCCL and CCL, such as Celebrity Cruises, are members of the ICCL and the Florida-Caribbean Association. Over 90% of ships that visit Key West are from these two cruise ship companies.

In the Keys, RCCL vessels discharge only treated and screened black water 12 nautical miles from nearest land with ship's speed greater than 6 knots. If the treatment system is not operational, untreated black water is held for land disposal. A RCCL goal is to have its fleet retrofitted with Advance Wastewater Treatment Systems (AWT) within five years.[15] CCL has similar company discharge policies and AWT goals for all their cruise lines.[16]

AWT systems do not remove all nutrients from the discharge effluent. The dilution of wastewater from a single vessel transiting the Keys may be great. However, if discharges did occur the cumulative impact from many transiting vessels and vessels repeatedly using the same navigational route offshore from Key West could be cause for concern and assessment. Potential impacts are increased if the transiting vessels discharge in close proximity to coral reef, seagrass, or other colonized benthic habitats. Water current direction, speed, and variability near Key West are very complex and are just beginning to be understood in the Keys. Nutrients and other pollutants derived from other geographical areas undoubtedly reach waters surrounding the Florida Keys. (USEPA 2002)

Coral reef monitoring in the Keys indicates the presence of human waste on the reef tract in some areas of the Keys. The Executive Summary for the EPA/NOAA Coral Reef Evaluation and Monitoring Project states: "Beginning in 2002, a series of mid-water and

[13] Causey, Billy. Personal Interview, NOAA.

[14] Fernandez, David. Personal Communication. City of Key West.

Pruitt, Rich. Personal Communication. Royal Caribbean Cruises Lines.

[15] Pruitt, Rich. Personal Communication. Royal Caribbean Cruise Line.

[16] Mujwit, Joe. Telephone Interview. Carnival Corporation.

coral mucus samples were examined for presence of human enteroviruses commonly found in sewage. Human enteroviruses were detected in coral mucus from two Upper Keys sites (El Radabob and Conch Reef), one Lower Keys site (Jaap Reef), and surprisingly, one Tortugas site (Black Coral Rock). In addition, enteroviruses were detected in the mid-water samples from Black Coral Rock and Western Head off Key West and near the Key West Channel. It is unknown if the source of these pollutants is local or is the result of remote transport." (Beaver, et al. 2003). Additional analysis was planned for 2004 and may help define the source of this pollution.

3.B.4.2 GRAYWATER

Cruise ship graywater is defined in 33 CFR 1515.05 as drainage from dishwashers, showers, laundry, washbasins and galleys (ADEC 2000). Up to 1,000,000 gallons a week can be generated by a typical cruise ship (USEPA 2000). Except in the Great Lakes and waters of Alaska, there are no federal regulations prohibiting the discharge of graywater in state or U.S. waters. Based on EPA testing of graywater, the State of Alaska requires graywater be treated before being discharged due to the presence of fecal coliform and total suspended solids (ADEC 2000).

The current FKNMS State waters NDZ does not restrict graywater discharges. However, the State/ICCL MOU states graywater will not be discharged in port or within 4 nautical miles of shore and at a speed of 6 knots or greater (ICCL 2001, ICCL 2003).

Cruise ships do not discharge graywater while berthed or anchored in Key West.[17] The Royal Caribbean Cruise Line's graywater discharge policy is no discharge within 12 miles from any shore. Cruise ships retrofitted with AWT systems will treat graywater before discharging it.[18] However, AWT does not remove all nutrients and, as with blackwater, potential impacts may exist depending on where the discharges occur, and the frequency at which they occur.

3.B.4.3 SOLID WASTE

Cruise ships generate large volumes of solid waste while at sea. Problems associated with improper disposal of this waste includes, ingestion and entanglement by sea birds and many other marine species. The disposal of plastics and garbage is governed through the Marine Plastic Pollution and Control Act pursuant to ANNEX V of The International Convention for the Prevention of Pollution from Ships (MARPOL). Under these regulations the disposal of plastics is prohibited in any water. U.S. law prohibits the disposal of all garbage within three miles of shore and enforces MARPOL Annex V, which prohibits the dumping of garbage from three to 25 offshore unless it is ground to pieces smaller than one inch (Ocean Conservancy 2002). MARPOL Annex V also requires waste reduction through recycling, reuse, land disposal and onboard incineration. Onboard incineration is used for food waste, contaminated cardboard, some plastics, trash and wood (Monterey Bay 2003)

In State waters, the State of Florida/ICCL MOU that governs solid waste disposal follows MARPOL Annex V standards. Solid waste is not off loaded while cruise ships are berthed

[17] Pruitt, Rich. Personal Communication. Royal Caribbean Cruise Line.

Mujwit, Joe. Telephone Interview. Carnival Corporation.

[18] Pruitt, Rich. Personal Communication. Royal Caribbean Cruise Line.

in Key West and in accordance with an agreement between the City of Key West and ICCL members, incinerators are not used in port.[19] Any solid waste discharged at sea must be properly processed and discharged in accordance with MARPOL Annex V (ICCL Standards 9).

Solid waste generated by passengers while onshore in Key West and the Lower Keys is ultimately collected at a transfer station on Stock Island and then trucked to the mainland for disposal. The tonnage of solid waste collected is within the FDEP permit limit. The City of Key West and FDEP did not report any solid waste issues caused by cruise ships.[20]

3.B.4.4 HAZARDOUS WASTE

Hazardous waste produced on cruise ships include by-products of dry cleaning and photo processing operations, paints and solvents, batteries, fluorescent light bulbs containing mercury, waste pharmaceuticals, and waste from print shops.

The U. S. Resource Conservation and Recovery Act (RCRA) imposes management requirements on cruise ships and other vessels that generate or transport hazardous waste and requires that hazardous materials be offloaded to land based treatment or disposal facilities (Monterey Bay 2003).

The ICCL Industry Standards states hazardous waste and other waste streams will not be mixed (ICCL 2001). The Alaska Department of Environmental Conservation sampled various cruise ship waste streams and concluded there was no evidence of hazardous waste being mixed with other overboard discharges (ADEC 2000).

The State MOU includes the RCRA requirements and the ICCL Standards. Hazardous waste is currently not offloaded in Key West. However if there was a need to offload hazardous wastes in Key West, the FDEP would be the lead agency to ensure proper handling and disposal. [21]

3.B.4.5 OILY BILGE WATER

Bilge water contains oily residue from the operation of the ship's engines and machinery. A typical cruise ship can produce over 2,000 gallons of bilge water per 24 hours of operation (Sweeting and Wayne 2003). Before discharging oily bilge water, the effluent must meet international and federal regulation standards set by MARPOL. These regulations require that ships be underway at least 12 nautical miles from shore and that the oil content of the discharge effluent be less than 15 parts per million (ppm) and not leave a visible sheen on the surface of the water. Under U.S. law, oily bilge water with oil content greater that 100 ppm is prohibited between 12 and 200 miles - the limits of the U.S. Exclusive Economic Zone. MARPOL Annex 1 requires the maintenance of Oil Record Book that the US Coast Guard examines periodically (Ocean Conservancy 2002).

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[19] Archer, Raymond, Personal Communication. City of Key West

Collins, Steve, Personal Communication. Royal Caribbean Cruise Lines

[20] Rios, Gus, Personal Communication. Florida DEP

Fernandez, David, Personal Communication. City of Key West

[21] Rios, Gus, Personal Communication. Florida DEP

The MOU between the State and the ICCL adopted the discharge standards set forth in the international and federal regulations. In the Keys, the ICCL members comply with the MOU standards. The U.S. Coast Guard does not routinely inspect Oil Record Books in Key West. In addition, the U.S. Coast Guard has not received any complaints on cruise ship discharges in the Key West area.[22]

3.B.4.6 AIR EMISSIONS

Cruise ship engines produce the same chemical constituents of petroleum combustion emissions as from automobiles and buses. In addition to the engines, incinerators on cruise ships also produce air emissions. Cruise ship emissions contribute a very small percentage of air pollution that is emitted by commercial vessels (Sweeting and Wayne 2003).

In Alaska, the Northwest Cruise Ship Association and Alaska Department of Environmental Conservation Air Quality and Meteorological Monitoring Study concluded the highest recorded pollutant levels were far below the state and federal health based standards as listed in 18 AAC 50.010 (ADEC 2000). This study was not a cruise ship emissions specific monitoring study, but included cruise ships and all other land-based sources of air pollution in Juneau. Based on air monitoring studies in Alaska, the U. S. EPA determined air emissions from cruise ships were too insignificant to regulate.

In Florida, neither the State MOU nor state air quality standards address air emissions from cruise ships. According to the FDEP in Marathon, the state air regulatory agency, no complaints have been received related to cruise ships air emissions.[23] Also in accordance with an agreement between the cruise ship industry and the City of Key West, incinerators are not used in port.[24]

The major cruise ship engine manufacturers are reducing air emissions through the development of advanced technology. For instance, one cruise ship engine manufacturer has developed a smokeless gas turbine engine that greatly reduces nitrogen oxide and sulfur dioxide emissions (Sweeting and Wayne 2003).

3.B.4.7 BALLAST WATER

Ships use ballast water for stability. Ballast water often contains numerous marine organisms that can become invasive when discharged in non-native areas (Aquatic Nuisance Species 2000). Introduction of invasive species through the transport and release of ballast water is well documented in the United States and problem invasive species in Florida that apparently could have been introduced in ballast water include the Asian green mussel, Australian spotted jellyfish, and a non-native *Caulerp*a green algae (Santaniello 2003).

In August 2004, the U.S. Coast Guard (USCG) implemented a mandatory ballast water management regulation for all vessels entering the U.S. waters. The regulation mandates vessels to conduct ballast water exchange outside 200 nautical miles and requires ballast water management reporting to the USCG (USCG 2004). According to NOAA and the

[22] Hyil, Captain, Personal Communication , U.S. Coast Guard

[23] Rios, Gus Personal Communication. Florida DEP.

[24] Archer, Raymond Personal Communication, City of Key West

Collins, Steve. Personal Communication, Royal Caribbean Cruise Lines

Florida Invasive Species Working Group, introduction of invasive species in the Key West area has not yet been an issue except for a few aquaria raised exotic fish captured on the reef.[25]

The cruise industry and environmental regulators are testing a number of technologies for ballast water management. These technologies include ozone, ultraviolet, filtration, heat, chemical biocides and deoxygenation. Testing has not identified the most effective technology (Sweeting and Wayne 2003).

When asked by the FKNMS what were the ballast practices of large vessels using Key West Harbor Carnival Cruise Lines (CCL) responded that CCL ships take on ballast water more than 200 nautical miles from Key West and later discharge ballast in Miami which is allowable. CCL advises that although there are no federal regulations regarding the management of ballast water CCL ships do not discharge ballast in Key West or any other location in Monroe County (Spicer 2003).

The current practices of the cruise ship industry in Key West in regard to potential discharges are summarized in Table 3.B.4. The environment around Key West, and waters routinely traveled by local commercial and pleasure vessels appear to still be at some degree of risk from discharges.

3.B.5 Recreational Values

Recreational values associated with marine resources around Key West can be divided into two broad categories: consumptive users and non-consumptive users. Consumptive users or stakeholders are comprised of fishing interests, including charter boats, head boats, and flats guides. These operations often rely on extractive activities (harvest), but they may also exercise catch and release - or a mixture of the two. Moreover, their income is generated less from the product extracted, and more from the clients they take out fishing. "Non-consumptive" users are comprised of an array of environmentally-friendly (ecotourist) operations, including dive and snorkel charters, and kayak, canoe, bird watching, and nature excursion guides, among others. Small craft and personal watercraft rentals are usually not as environmentally friendly. All of these activities take place to some degree in the Key West area, some by cruise ship passenger, and interactions with the natural resources of the area are typically up close and direct. Some argue that diving and other waterborne activities in the Keys should not be considered non-consumptive and be immune from management and possible regulation, since some amount of impact is associated with many of these forms of recreation[26] Harbor tours, sunset trips, and sightseeing are additional types of waterborne activities that occur in the harbor, and appear to occur more all the time. Crowding at some diving and fishing sites near Key West are indications that levels of activity are high.

These recreational uses are promoted directly to cruise ship passengers that arrive in Key West and are also promoted on the internet and via other commercial advertising. A 2005 Royal Caribbean promotional brochure obtained in Montana for a cruise on *Majesty of the Seas* includes as a suggestion for a Day 7 stop in Key West a glass bottom boat eco-tour of

[25] Heck, Cheva. Personal Communication, FKNMS

Schmitz, Don. Personal Communication.. FDEP

[26] Davidson, Capt. Ed, Personal Communication

the "only living coral reef in the continental U.S.", with an underwater photo of a SCUBA diver on a reef.

Web sites linked to Key West cruise promotion suggest fishing, snorkeling, diving (including on shipwrecks), watersports and ecotours as popular activities in Key West. A Key West link on a *Cruisemates* website promotes affordable private charters to reefs and islands of the FKNMS, another promotes sailing charters in shallow draft vessels to visit areas that other boats cannot. Another suggests snorkeling on coral reefs and kayaking in mangrove islands to encounter many species of fish and wildlife with an experienced naturalist as your personal guide.

The Key West diving and ecotours industry promotes themselves directly to cruise ship passengers although as with other tours and resource based activities the relatively short stays by cruise ships limits the amount of time that a passenger can spend away from the ship or island. Charts of the reef tract west and east of the main channel are used online to show popular dive locations and distances from Key West .

TABLE 3.B.4. SUMMARY OF MANAGEMENT OF DISCHARGES IN AND NEAR KEY WEST.

POTENTIAL DISCHARGES FROM CRUISE SHIPS IN KEY WEST	REQUIREMENT (INCL MOUs AND AGREEMENTS)	VOLUNTARY	VULNERABLE AREAS AT KEY WEST
BLACKWATER/SEWAGE	NDZ IN STATE WATERS	RCCL AND CCL LIMIT DISCHARGES TO >13.8 MILES (12 NM) OUT	OUTSIDE OF STATE WATERS FROM DISCHARGES OF SOME LINES
GRAYWATER	NDZ WITHIN 4.6 MILES (4 NM)	RCCL LIMITS DISCHARGES TO > 13.8 MILES OUT	OUTSIDE OF 4.6 MILES FROM DISCHARGES OF SOME LINES
SOLID WASTE	NO OFFLOAD FROM SHIP NO INCINERATION IN PORT NO PLASTICS DUMPED ANYWHERE		WASTE FROM PASSENGERS IN CITY INCINERATION OUTSIDE OF PORT
	NO DISCHARGE WITH 3 MILES <1" PIECES DISCHARGED OUTSIDE OF 3 MILES		DISCHARGES OF SMALL GARBAGE PIECES OUTSIDE OF 3 MILES
HAZARDOUS WASTE	NO OFFLOAD IN KEY WEST NO DISPOSAL EXCEPT IN A PORT		
OILY BILGE WATER	NO DISCHARGE WITHIN 13.8 MILES OUTSIDE 13.8 MILES < 15 PPM WITH NO SHEEN		OUTSIDE OF 13.8 MILES AT LOW LEVELS
AIR EMISSIONS	NONE	NO INCINERATORS IN PORT	ENGINE EMISSIONS IN PORT INCINERATION OUTSIDE OF PORT
BALLAST WATER	USCG MANDATES NO DISCHARGE WITHIN 200 MILES		

3.B.6 Harbor Navigation and Vessel Traffic

Waters around Key West, especially the harbor and inner portion of the main channel, are at times extremely active with a wide variety of craft, from small sailboat dinghies traveling from anchored out vessels to cruise ships nearly 1,000 feet long turning in the harbor. Vessels are a mix of pleasure and commercial power boats, pleasure (local and transient)and charter sailboats, military and research vessels, cruise ships and ferries, and live-aboards. Vessels anchored out on the west and north sides of Key West have increased dramatically in the last 2 decades, and consist mainland of transient vessels and permanent live-aboards.

As of 2003 there were 4 state and federally licensed Bar Pilots in Key West and also a Navy pilot who handles government owned vessels. The deepest draft vessel the Pilots will bring into Key West carries 28.5 feet and they have refused pilotage to vessels considered too large for the channel as it is their obligation to protect the resources of the harbor (Bar Pilots 2003).

Three tug boats (65 feet to 110 feet long with drafts of 8 to 12 feet) operate in the Port on a regular basis as do two pilot boats (26 and 40 feet long with drafts of 5 and 4 feet). Those involved in the business of cruise ships and pilotage in Key West state that using tug boats to control and maneuver cruise ships in the harbor while berthing and turning is not practical, would not necessarily minimize turbidity and would possibly be unsafe. Even large tugboats cannot take the place of a ship's main engine (Bar Pilots 2003, Bar Pilots 2005, Crusoe 1997).

The U.S. Coast Guard presence in Key West includes patrolling Keys water for immigration, boating safety, and drug interdiction. They also maintain clear and safe zones in formally marked navigational channels, maintain safe zones around cruise ships, and enforce cruise ship operation regulations. At the October, 2002 meeting of the LVWG the Coast Guard identified four major agency concerns in Key West:

- shipboard regulatory and enforcement requirements, ranging from material requirements to equipment requirements
- navigation, from aids to navigation to regulations for mariners
- security
- qualifications for all personnel involved including mariners, port authorities, and agencies

The current formal safety/operating guidelines of the Key West Bar Pilots Association on file with the Florida Board of Pilot Commissioners are based on pre-dredging conditions and will be re-evaluated following dredging after an accurate bathymetric survey is completed. The guidelines used by the Bar Pilots are based on local knowledge and experience, Corps of Engineers surveys, NOAA soundings, periodic local surveys, and the fact that the channel and harbor are in the FKNMS (Bar Pilots 2003).

Those guidelines confirm that cruise ships comprise the bulk of large vessel traffic into the Port of Key West, and due to existing limiting harbor and channel depths, that conditions and limits must be placed on large vessels using the Port. The maximum draft of large vessels presently using the main ship channel to access Pier B, the Outer Mole, and the outer anchorages is 28.5 feet. In the past, due to shoaling off Pier A vessels bound for Pier B

greater than 750 feet in length and 24 feet draft would only dock starboard side in. Due to shoaling reported in 2003, they state that the maximum draft of vessels accessing Mallory Dock should be 26.5 feet for vessels greater than 550 feet in length. The area off of Mallory Dock has recently been maintenance dredged but less material than desired was removed and a bathymetric survey is to be conducted[27] According to the Bar Pilots, the Corps' 2001 depth data provide for a minimum under-keel clearance of 3.2 feet at mean lower low water while a vessel is navigating within the 300 to 800 foot wide main channel, from the channel entrance on the reef tract to the north end of the harbor (Bar Pilots 2003).

The Bar Pilots note that transits into the harbor may be restricted or limited due to wind, weather, tides, current conditions, dock assignment, vessels already moored, maneuvering characteristics, vessel deficiencies, vessel size and draft, navigational hazards, other vessel including small boat traffic, and tug and pilot availability. There are no set wind thresholds in effect for the Key West Channel. In high wind conditions the Bar Pilots take a very close look at all the parameters before committing to any ship movements (Bar Pilots 2005).

They note also that passing situations usually require one of the two vessels to "exit the channel" but as a routine operational procedure passing in the channel should not be scheduled due to the fact that planning and timing safe passing between inbound and outbound vessels is often difficult for a variety of reasons (Bar Pilots 2003). The International Rules of the Road apply on the waters of Key West.

Future large vessel traffic in Key West may increase following channel and harbor deepening and pier modifications at the Outer Mole. These projects may possibly result in up to a 15% increase in the annual naval traffic (Navy 2003). A reduction in use of Roosevelt Roads Naval Station in Puerto Rico may result in more Navy activity in the Gulf of Mexico and Key West. The level of future activity by large cruise ships in a Key West is a matter of discussion but the Bar Pilots believe "One thing the dredging will not do is allow larger cruise ships to enter the harbor. We are limited to the size of vessels that can enter the port by the width of the ship channel, not the depth. There are no plans to widen the channel." (Bar Pilots 2004).

3.B.7 Actual Impacts

Data and other available information indicate that impacts from cruise ship and other large deep draft vessels are occurring to water quality and benthic habitats in the area of the main channel and harbor in Key West. Bottom scouring, severe sediment resuspension and redistribution, plume turbidity far above background levels, interference with historic diving and fishing activities, and bottom excavation in the cruise ship anchorage are resulting from the passage of these vessels. State and federal laws and regulations related to the maintenance of water quality, protection of bottom habitats in the area, and protection of publicly owned submerged lands may be violated when these severe events occur.[28]

The fact that cruise ships and other large vessels resuspend bottom sediment in Key West channel and harbor and in the offshore anchorage and elevate turbidity levels in the water column is undisputed. What the consequences of that resuspended sediment and turbidity

[27] Jones, J. Personal Communication, City of Key West

[28] Burnaman, R., PA, Personal Communication

are in the area has been debated in public forums at length, as have realistic means of reducing it, and what conditions will be once the Navy's channel and harbor deepening project is complete (LVWG 2002-2004).

Measuring turbidity is in this case a surrogate for measuring sediment (silt, sand, rubble, organic matter, etc.) scoured off the bottom by vessel propeller generated turbulence and evidently by displacement pressure waves moving along the bottom. Simply, in waters 30+ feet deep, the level of turbidity measured in the upper water column is a function of what is happening to the bottom when a large vessel close to the bottom moves along or is turning. Measuring turbidity usually can confirm what can be seen visually from the waters surface by an observer. In clear water the resuspended sediment can be observed much deeper in the water column. Larger and heavier particles of resuspended sediment (especially inorganic particles) settle out first, with strength direction of currents and the amount of turbulence created by the ship being major controllers of where. In these situations, larger particle sizes when redistributed in heavy loads can result in the greatest consequence for colonized or vegetated benthic habitats. Sediment resuspension apparently occurs in two ways - directly from propeller and thruster wash and turbulence, the other is the little addressed phenomena of surge waves moving laterally away from a large displacement vessel that resuspend sediment closer to the bottom[29]

The Port of Key West was projected to receive 541 port calls (including the anchorage) by cruise ships in FY 2004/2005. That averages about 1.5 ships each day, or an average of 3 passages by cruise ships in and out of the channel each day. There have been times in recent years when 4 or 5 cruise ships visited in a day, resulting in 8 or 10 passages through the channel and harbor.

3.B.7.1 TURBIDITY AND SEDIMENT RESUSPENSION

The use of a cruise ship's main engines is by far the largest generator of turbidity. Use of main engines to slow and stop upon entering the Harbor and to turn in the Harbor along with vessel speed needed to handle cross currents and cross winds while in the narrow main channel result in most of the turbidity generated (Bar Pilots 2003). At the Outer Mole turbidity from use of side thrusters is minimal due to the vertical face of the seawall there. At Pier B and Mallory Dock, the sloping walls result in more turbidity from use of the thrusters until the vessels has moved out from the berth. By 2003 due to "shoaling" at the north end of Mallory Dock the Pilots had to change the draft restrictions for vessels berthing there from a 28.5 foot draft allowance to 26 feet. (Bar Pilots 2003). They noted in 2005 note that the more a dock is used by cruise ships the less sediment accumulates.

In April, 1999, due to complaints about high levels of turbidity in harbor water created by increasing numbers of large cruise ships, the City of Key West formally requested federal study and action regarding vessel-generated turbidity in the Key West Harbor Federal Project. The Corps advised that an updated survey of harbor conditions was planned and turbidity monitoring would be addressed. Later in 1999, the Florida Department of Community Affairs (DCA) reported that the Florida DEP had recently documented substantial turbidity caused by cruise ships in the area. On March, 1, 1999, the DEP and the FKNMS measured turbidity in the wake of a cruise ship at the Outer Mole at nearly 20 times

[29] Jaap, W. Personal Communication, FWCC

above background. The same day in the anchorage just west of Marker "9" (see Section 3.B.9) they measured turbidity at 7 locations within a plume from the *Enchantment of the Seas* that averaged 30 times the background average values of 3.7 NTU(FDEP 1999a). On March 3, 1999, FDEP monitoring of plumes created by cruise ship movement at the Outer Mole showed levels on average 11 times over background with many samples more than 29 NTUs (Class III standards) above background. Measurements in plumes offshore the same day showed levels as high as 193 NTUs while background levels were near 3 NTU (FDEP 1999b). On March 11, 1999 numerous measurements at the Outer Mole by FDEP (in plumes from cruise ships and tugboats) showed background levels averaging about 3 NTU and plume levels averaging nearly 50 NTU (FDEP 1999c).

Cruise ship traffic has been documented to create turbidity plumes during transit between the outer sea buoy and the docks in the harbor, a passage that is typically an hour long (Figure 3.B.8). In 2000 the FKNMS reported that there is evidence of a turbidity problem relative to movements of large vessels in the Key West area. Evidence included measurements of turbidity created by ship main engines and thrusters during docking maneuvers, visual observations of cruise ship-generated turbidity plumes and visual observations of seagrass and bottom damage from anchoring. The FKNMS also reports that measurements of ship-generated turbidity are orders of magnitude greater than measurements of background turbidity, and that these turbidity events last from one to several hours. FKNMS personnel in 2000 observed a cruise ship "generating a considerable amount of turbidity in its wake" in the offshore portion of Key West channel and then observed stony corals at Western Head Patch Reef adjacent to the channel that had been covered by resuspended silt (FKNMS 2000).

Divers performing the State's coral reef monitoring in recent years at these patch reefs about 1/4 mile from the main ship channel report both resuspended sediments from underwater surge associated with passage of cruise ships in the channel and siltation and redeposited sediments from drift of the turbid plumes created by the ships in the channel. As the dominant current direction in Hawk Channel is to the west, those patch reefs west of the channel are subject to the most siltation[30]

"Turbidity levels have heavily impacted corals adjacent to the harbor and ship channel, especially to the west. Ship generated turbidity is clearly differentiated and distinguished from natural background turbidity." (FKNMS 2003b). In 2002, the FKNMS reported to the LVWG that "large plumes of resuspended sediment are observed with each pass of a cruise ship or other large deep draft vessel in and out of the channel, particularly on low tide. Turbidity levels observed with docking cruise ships greatly exceed state water quality standards and local fishermen observe and report the direct effect of turbidity plumes on the fish they are targeting." (FKNMS 2002).

In 2003, the Corps photographed and measured turbidity plumes associated with the prop wash of cruise ship bow and stern thrusters (USACE 2003). They noted that turbid water masses resulting from vessel passage appeared to have higher maximum values than turbid water generated by high winds but were much shorter in duration. Elevated turbidity readings were observed to last for approximately 15 to 30 minutes after cruise ships passed

[30] Jaap, W. Personal Communication, FWCC

by monitoring stations on their way to or from the docking area. Since high winds are known to resuspend fine sediments from the bottom surface in shallow water, and considering that winds typically persist for extended periods, it is logical that finer sediments from storms would stay in suspension longer than heavier particles scoured off the bottom by strong vessel turbulence.

Resuspension of sediment that elevates turbidity levels occurs with the use of bow and stern thrusters during docking, undocking, and turning the ships during departures. As might be expected, stations near or at the docking areas recorded the greatest changes in turbidity over background levels (USACE 2003)(Figure 3.B.9 and Figure 3.B.10).

FIGURE 3.B.8. TIME SERIES OF A CRUISE SHIP TRAVELING THROUGH KEY WEST CHANNEL TOWARDS KEY WEST IN 2003 (D. KINCAID).

--While two others are docked at the Outer Mole and Pier B. In the bottom photo the vessel has turned into Cut A.

FIGURE 3.B.9. CRUISE SHIP ASSISTED BY TUG DOCKING AT MALLORY DOCK IN 2002 (KEY WEST CITIZEN)

A distinct turbidity plume associated with a cruise ship passing through the ship channel heading towards Key West was observed during a survey conducted by Continental Shelf Associates, Inc. on 15 September 2002 (Table 3.B.5). PPB (2002) showed that there is some correlation of elevated turbidity levels at the Outer Mole and adjacent to Tank Island with ship arrivals and departures.

Pier B obtained permits from DEP in 1999 to renovate and reconfigure the commercial cruise ship docking pier at the Hilton (FDEP 1999). Special conditions to that permit required turbidity monitoring during each coming and going of a cruise ship to that berth, no matter the time of day. It was hoped that the reconstruction and new configuration would change where vessel turbulence was directed (towards deeper water) thereby reducing turbidity levels in the harbor. Some of the data suggested this was the case and in 2002 DEP allowed Pier B to reduce the scope of the monitoring. However, although the dataset is extensive it not believed to be meaningful as all monitoring occurred at the waters surface instead of mid-depth or near the bottom and fixed stations apparently came to be used in lieu of actually tracking the plumes created by the vessels. And since at least 2002 or before there have been no quality assurance or quality control reviews of the monitoring methods as required of DEP[31]. Surface and bottom turbidity monitoring from 1995-1999 in the Key West channel area by the FKNMS WQPP monitoring program showed that at the 3 stations near Key West bottom measurements of turbidity on average ranged from 33% to 47% higher than measurements made at the surface.

[31] McMillan, T. Personal Communication, FDEP

TABLE_3.B.5 A PORTION OF A TABLE EXCERPTED FROM THE 2003 NAVY EA (NAVY 2003).

Turbidity monitoring was in Key West channel and harbor during water column profiling conducted by Continental Shelf Associates, Inc. on 15 September 2002.

Station	Depth (m)	Depth (ft)	Turbidity (NTU)
KW02-10	0.3	1	64.8*
	4.9	16	65.2*
	9.8	32	64.6*
KW02-11	0.3	1	2.6
	4.9	16	1.6
	9.8	32	2.9
KW02-12	0.3	1	57.0*
	4.9	16	49.6*
	9.8	32	49.0*
KW02-13	0.3	1	2.1
	4.9	16	1.6
	10.1	33	2.6
KW02-14	0.3	1	0.8
	4.9	16	0.5
	10.1	33	1.5

* Turbidity plume associated with passage of cruise ship through the Main Ship Channel.

FIGURE 3.B.10. AN UNDATED PHOTO OF CRUISE SHIP LEAVING THE OUTER MOLE AREA (KEY WEST CITIZEN).

In an April, 2003 letter to CZR, Inc., the consulting firm representing the Navy during the dredging permit review, the FKNMS advised - "Turbidity levels have heavily impacted corals adjacent to the harbor and ship channel, especially to the west. Ship generated turbidity is clearly differentiated and distinguished from natural background turbidity." and "Ship generated turbidity is an added stressor to natural systems above and beyond the background and storm event turbidity impacts."

Addressing its dredging project and the risks of elevated turbidity during dredging, the Navy reported in their 2003 EA that although increased turbidity was expected to be temporary and localized, several detrimental effects of turbidity on fish and invertebrates have been documented by prior research. Queen conch was one invertebrate they believed may be susceptible to elevated turbidity. Increases in suspended silt near the southern end of the Ship Channel could affect larval and newly settled stages during the March to October spawning season.

Examples of effects on fishes and a summary of impacts to corals and other benthic assemblages were provided in the 2003 Navy EA. They provided references for information demonstrating that fishes are primarily visual feeders, and when turbidity reduces light penetration, the individual's reactive distance decreases and that light scattering caused by suspended sediment also can affect a visual predator's ability to perceive and capture prey. Some species will actively avoid while others may be attracted to turbid water. Gill cavities can be clogged by suspended sediment preventing normal respiration and mechanically affecting food gathering in planktivorous species -high suspended sediment levels generated by storms have contributed to the death of nearshore and offshore fishes by clogging gill cavities and eroding gill lamellae. High concentrations of fine sediments can coat the gill respiratory surfaces and prevent gas exchange (Wilber and Clarke 2001). Consequences of such impacts to fishes depend on age or life stage of the fish and early life stages are less resilient to direct effects of turbidity than adults. Ultimately, effects on young individuals can be reflected in later life stages as reduced fecundity, low growth rates, and year class depression. Understanding and predicting effects of suspended sediments on fishes require some information on the range and variation of turbidity levels found at a project site prior to dredging - what background levels native species in an area are adapted to (Wilber and Clarke 2001). The Navy believed their activities "may adversely affect but are not likely to have a substantial adverse effect on EFH in the dredging area" (Navy 2003).

3.B.7.2 PROP WASH BOTTOM DISTURBANCE

Issues related to cruise ship and other large vessels activity at and near the Outer Mole and in the Harbor include more than only turbidity and degraded water quality. The type of turbidity addressed here is the result of displacement of large amounts of resuspended unconsolidated bottom sediments from excavation and scour of the bottom. Prop wash is defined here as the turbulent action of water ejected from a vessel's propeller and prop scour as the resultant condition of bottom sediments subject to intense prop wash turbulence. Dredging or excavation is the significant displacement of bottom sediments so as to create a discernable depression or hole. Filling of submerged lands results when displaced sediments from prop wash and prop scour settle on adjacent bottoms.

Displaced sediments in the channel and harbor have been described as mud, sand, and rubble of all sizes. The heavier displaced sediment particles from prop scour settle out the

quickest and, depending on water depth and the amount of turbulence and tidal current velocities, may settle out some distance from the site of excavation. The finer sediment particles resuspended by prop washing may stay suspended in the water column for a longer period, up to several hours (Walters 1999), and are typically what is measured in the type of turbidity monitoring conducted near Key West. Intermittent turbidity can often be tolerated by benthic communities, whereas chronic turbidity can smother marine life (Walters 1999). Excellent reviews of the state of knowledge about the biological effect of redistributed sediment and turbidity were provided to the LVWG by the EPA (LVWG 2002-2004).

Recent diver observations, reports, and sonar mapping reveal that the bottom of the harbor out from the Outer Mole and Pier B, in depths of up to -36 to -37 feet, have been severely impacted and the bottom sediments are continually being rearranged by prop wash and prop scour (Figures 3.B.11 and 3.B.12). The bottom of the turning basin in the harbor has been described as a "blasted moonscape" (FKNMS 2003). The bottom area that appears to be routinely impacted by prop wash scour covers roughly 150-175 acres.

The Navy EA reports "The central area of the turning basin, adjacent to the Mole Pier and extending north of the entrance to Truman Harbor and nearly to the western edge of the turning basin, was composed of mixtures of large rubble and gravel-sized rock fragments. There was minimal biofouling of the substrate material and only a very thin layer of fine sediments visible. Depressions several feet deep were observed along with waves and piles of rubble. The bottom appeared to be heavily impacted by ship propeller and thruster wash during ship docking procedures" (Navy 2003).

A diver benthic survey of the harbor in 1999 noted diverse benthic communities in areas of the channel and harbor not subject to routine physical disruption by turbulence from cruise ships and other deep draft vessels. But at stations (#s 152, 163, and 252; 38 to 40 feet deep) in the vessel turning area out from the Outer Mole and Pier B the bottom is variously described as rolling topography with muddy sand on rocks, mud, and drifts of rubble with some submerged vegetation in rocky areas, but otherwise very little flora and fauna (Fourqueran 1999).

A Navy contractor surveyed this area of the harbor in 2002 and reported on the condition of the bottom "It seemed somewhat unusual for relatively steep sand ripples to occur only in the center of the channel, as the normal tidal currents and recent wave activity could not support their height and wavelength. It also did not seem likely that under natural conditions they should only occur in the center of the channel, as sandy sediments also were present along the channel edges. One potential cause of both this shoaling and the maintenance of the steep sand ripples may be the somewhat regular usage of the ship channel by cruise ships and other large vessels. It is postulated that their deeper draft and thus closer proximity to the bottom is creating a higher current velocity along the channel bottom during their passage. The deeper draft also brings their propellers closer to the bottom, with the propeller wash suspending and removing fine sediments from along the channel centerline, while leaving finer sediments intact along the channel edges. This combination may be creating and maintaining these steep sand ripples. Divers also collected video data and coordinates from along an underwater cable route across Key West Harbor. The line extended from the southeast corner of Tank Island toward the southeast and made landfall at Key West in the vicinity of the cruise ship dock. The lines were covered by a flexible concrete mat, which rose from approximately 1 to 3 ft above the surrounding bottom. In many locations along

the line, the concrete mat was distorted or "wrinkled," and at several sites it was folded back over on itself. These areas of disturbed mat surface were more prevalent closer to the cruise ship dock and could be due to high water flow rates from ship thrusters during docking procedures" (CSA 2002). Similar diver surveys in the main channel offshore indicate that similar disturbance of the bottom is occurring but in a linear fashion instead of the circular signatures resulting from deep draft vessels turning using main engines.

FIGURE 3.B.11. AN ENLARGED VIEW OF THE 2001 MULTI-BEAM SONAR IMAGE OF KEY WEST CHANNEL AND TURNING BASIN OUT FROM THE OUTER MOLE AND PIER B. (NOAA).

Note the heavily disturbed bottom and arcs of ridges of bottom sediment where large vessels routinely turn. The Image is derived from work of the NOAA Vessel Whiting. Blue corresponds to the previously dredged portion of Key West Channel and Truman Harbor.

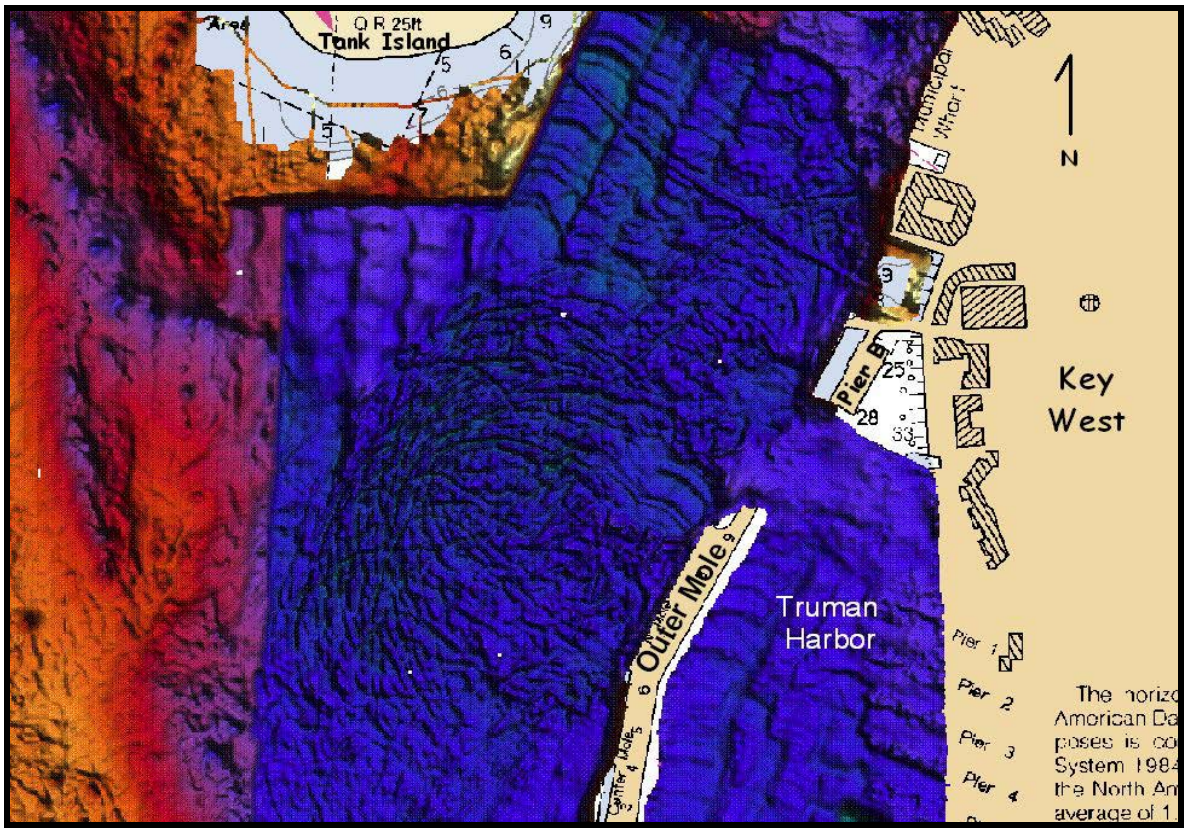
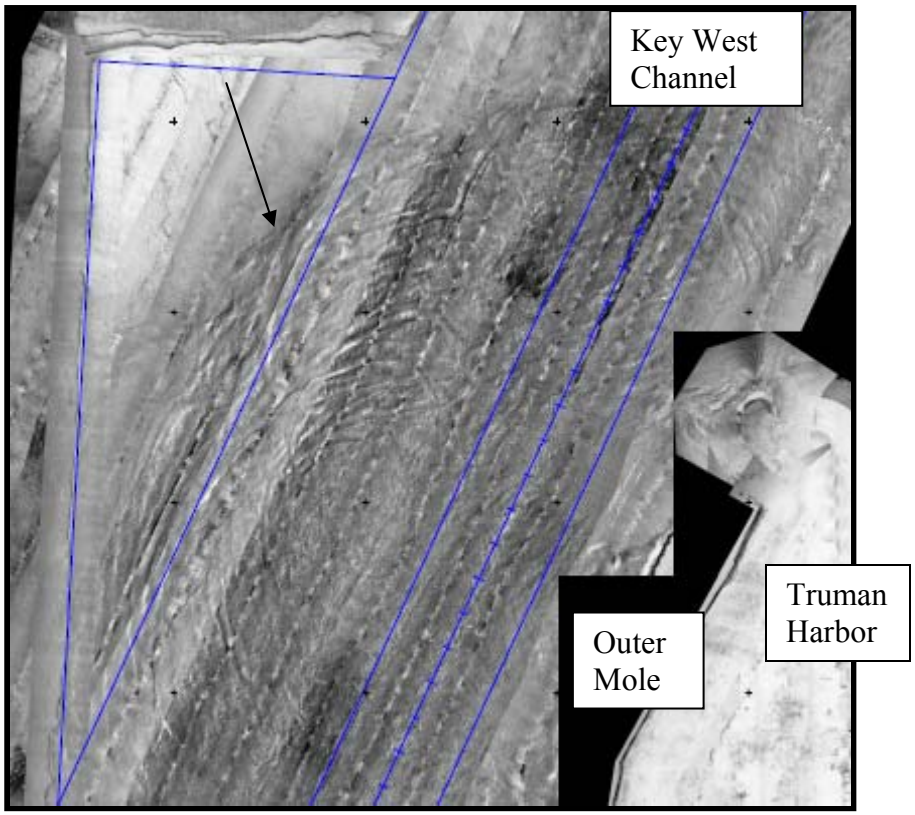


FIGURE 3.B.12. SIDE-SCAN SONAR IMAGE OF KEY WEST HARBOR AND TURNING BASIN AREA OUT FROM THE OUTER MOLE (SEA SYSTEMS CORP. 2003).

Arrow points to area of disturbance.



The displacement of bottom sediments via contact with propellers and the deposition of the sediment on adjacent sea grass beds may create liability under the Clean Water Act. The knowing or willful creation of a propeller-dredged channel creates liability under the River and Harbor Act and if large vessels in Key West harbor and channel create significant trenches or displace sediments onto adjacent habitat, an Army Corps of Engineers permit may be required.[32] FKNMS regulations arising from the National Marines Sanctuaries Act specifically describe as "prohibited activities" those related to the alteration of the seabed and the operation of vessels, and suggest that NOAA authorization is also required for cruise ship operation that causes dredging or turbidity within the FKNMS. In 1997, the use of prop wash deflectors (mailboxes) to blow holes in sand bottom and seagrass beds, and mound sediment as part of treasure salvage work, was found to have violated FKNMS laws and was stopped through a federal lawsuit.

State rules and regulations also address illegal dredging and pollution (fill) discharges related to some vessel operation. The channel and harbor bottom in Key West is state owned submerged land owned by the people of the State of Florida. The Board of Trustees of the Internal Improvement Trust Fund (and DEP) administer the state lands program and have

[32] Burnaman, R., PA, Personal Communication.

granted various leases and easements there - but ownership and requirements for proper management rest with the State.

During their review of the Chapter 288 Base-Reuse Plan, the FKNMS advised that the regulatory action plan of the FKNMS management plan pursuant to the National Marine Sanctuary Act prohibits adverse effects to Sanctuary resources, including alteration of the seabed and engaging in prop dredging and the operation of a vessel in such a manner as to injure corals or seagrasses, including damages by boat propellers (FKNMS 1999).

3.B.7.3 IMPACTS TO FISHERIES AND RECREATION

In addition to physical disturbance of benthic resources in the area by the movements of cruise ships there are substantiated reports of the "collapse" of a sizeable charter and recreational tarpon fishery that existed in the 1980s and early 1990s on the west side of the harbor and turning basin south of Tank Island. As many as 20 to 30 boats at a time would anchor or drift along the channel edge and fish for tarpon, permit, cobia, snapper, barracuda, jacks, and other species, especially later in the day. With the increase in size of cruise ships and the frequency of visits in the early 1990s this charter fishery "collapsed" due to displacement of the target fish from the area when a cruise ship would arrive and turn in the area[33] Fishermen believe that the presence of these very large vessels, the noise created, and the turbid plumes all acted to move fish out of the area. Many fewer charters now use the area and fishermen mostly fish a distance to the north requiring longer trips away from Key West, additional costs, and less production of desired fish.[34]

Public testimony by a number of commercial and recreational divers at meetings of the LVWG related that recreational diving along the edges of Key West channel and harbor has been greatly reduced in the last decade due to the chronic bottom disturbance created by cruise ships, the lack of target species due to the disturbance, and the increased levels of turbidity when large vessels are present (LVWG 2002-2004). Reports were also made that turbidity drifting from the main channel onto patch reefs near the main channel can be a chronic problem and as such discourages recreational divers and marine life collectors from using those reefs.

3.B.7.4 ANCHORAGE

The Bar Pilots take vessels to anchor in the area west of the channel and turning basin from the vicinity of buoy #9 to buoy #17 (Figure 3.B.13). Deeper draft vessels are usually anchored to the west of buoy #9 in this mostly undefined area. This area west of the channel and turning basin has historically been used as an anchorage for large vessels (Bar Pilots 2005). As part of the mitigative efforts required for the Corps dredging permit issued to the Navy, the FKNMS required general no anchor or no impact areas due to the presence of patch reefs along the edges of the dredge footprint of the main ship channel and Key West Harbor Turning Basin (FKNMS 2003b).

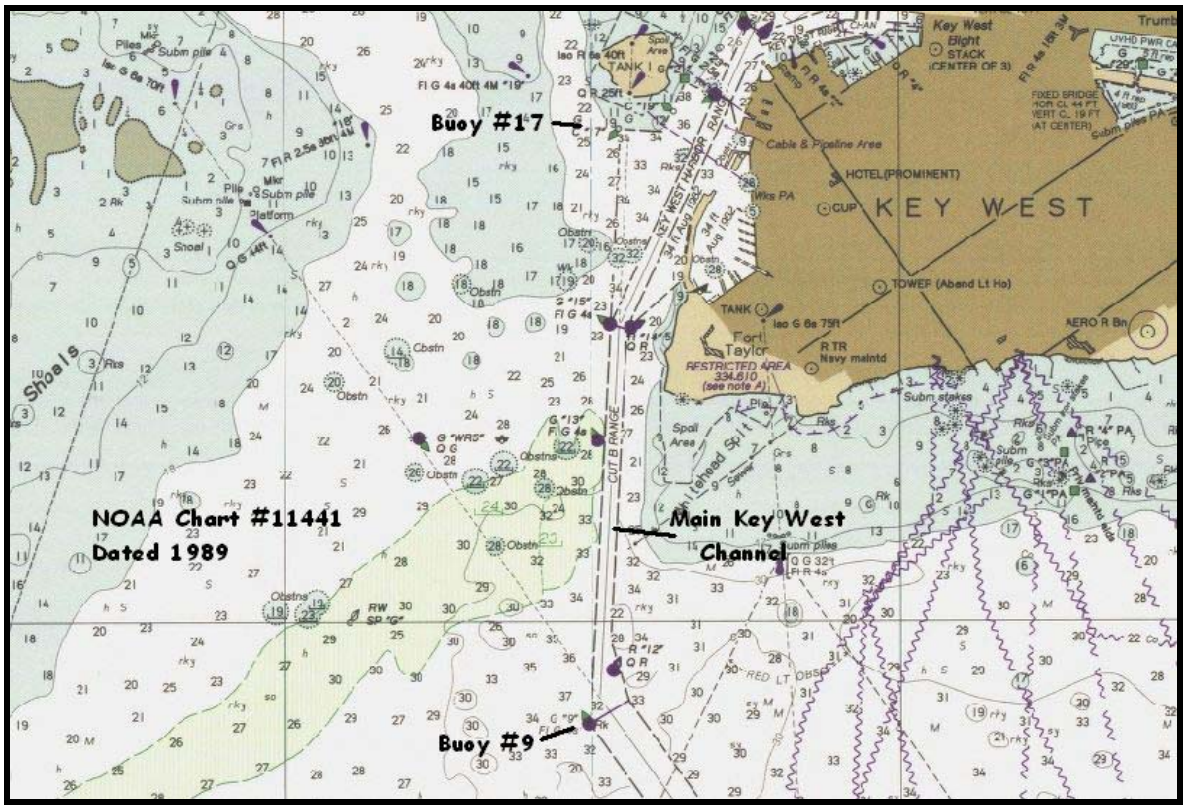
[33] Trossett, Capt. R.. Personal Communication

[34] Trossett, Capt. R. Personal Communication

Harris, Capt. K. Personal Communication

FIGURE 3.B.13. GENERAL LOCATION OF VESSEL ANCHORAGE USED FOR CRUISE SHIPS BY THE KEY WEST BAR PILOTS BETWEEN BUOYS #9 AND #17 WEST OF THE MAIN SHIP CHANNEL AND HARBOR.

Depths in feet at mean lower low water (NOAA).



Use of the offshore anchorage is by cruise ships that cannot or those that choose not to utilize the harbor piers for offloading passengers. Very large anchors and heavy chains are needed to anchor large cruise ships in open water. In March, 1999, the FDEP and the FKNMS documented movement of the 915 foot long, 26 foot draft *Enchantment of the Seas* that was anchored just west of channel buoy #9. GPS coordinates (24 31.88N, 81 49.29W) from the FKNMS vessel placed the *Enchantment* about 1/3 mile NW of Buoy #9 in a charted depth of about -33 feet MLW. Turbidity monitoring as it moved away showed gross violations of DEP turbidity standards with turbidity as much as 140 NTUs above background (Figure 3.B.14)(DEP 1999a). Upon pulling its anchor and moving off, freshly cut turtle grass blades were observed floating in the turbid plume behind the vessel[35]

The City tracks use of the anchorage by cruise ships. From FY 2001/2002 through FY 2003/2004 an average of 21 ships per year used the anchorage. Although the FKNMS is aware of the environmental issues related to the use of this anchorage by cruise ships including high levels of vessel generated turbidity and bottom disturbance, no review or

[35] Barbera, P. Personal Communication, FWCC

assessment has been conducted to date by the FKNMS.[36] Although the channel and harbor are being deepened to accommodate larger vessels, no plans exist to deepen the anchorage.

FIGURE 3.B.14. THE *ENCHANTMENT OF THE SEAS* UNDERWAY LEAVING THE ANCHORAGE WEST OF OFFSHORE CHANNEL BUOY #9 IN MARCH, 1999 (FDEP).

In 2004, in Ft. Lauderdale, a plan was developed by the U.S. Coast Guard and the Corps of Engineers to limit the size and number of large vessels, especially cargo ships that could anchor off the coast while awaiting access to the port there. Considered also to protect coral reefs in the area was total elimination of the anchorage zone.

Some reef ecologists believe, based on experience, that anchoring of large cruise ships close to reefs is always a problem. Reef damage has been documented in Ft. Lauderdale, Grand Cayman, St. John in the Virgin Islands, and at the Tortugas Banks. Issues include physical reef destruction by anchors and chains and groundings, as well as shading and discharge of cooling water. Cruise ship anchoring and a related grounding at Grand Cayman destroyed acres of a very spectacular reef habitat. The anchorage was over utilized and the ships could not maneuver which led to a grounding incident.[37]

A 2002 incident involved a freighter anchoring in a protected area and damaging coral in the Dry Tortugas about 70 miles from Key West. The owner agreed to pay more than $500,000 in fines. The anchor and its chain caused damage to about 0.3 acres of coral. The company reimbursed the federal government for the costs of damage assessment and response and for recovery efforts. The FKNMS estimated that the reattached corals could recover to their previous functional state in approximately five years, provided environmental conditions are good (NOAA 2005). Rogers and Garrison (2001) surveyed natural recovery of a cruise ship

[36] Kamphaus, R. Personal Communication, FKNMS

[37] Jaap. W. Personal Communication, FWCC

anchor scar in St. John, USVI, but found no significant increase in coral cover 10 years after the damage occurred. Allen (1992) addressed issues of anchor and other damage to reefs from increased tourism in the wider Caribbean.

3.B.8 Perceived Impacts

As expressed mostly through the LVWG, perceived impacts from cruise ship and cruise ship passenger activity include additional pressure on local resources from increased offsite nature tours, increased shallow water boating and fishing activity, increased pressure and diver damage to local reefs, contaminated sediments in the harbor, displacement of historic uses in the harbor area, and risks to Ft. Taylor State Park.

The local dive boat *Fury* reportedly carries up to 150 cruise ship passengers at a time to reef on half day snorkel trips. Recreational diving out of Key West has increased dramatically in the last few decades and passengers from cruise ships have undoubtedly contributed to that increase. Educational efforts by the industry to visiting snorkelers and divers may help to mitigate the impacts.

The perception that cruise ship passengers are participating in eco-tours in new areas around Key West may result from a well publicized effort by a kayak tour group in the late 1990s to gain commercial use permits from the City to conduct tours with cruise ship passengers into the Salt Ponds, taking as many as 20 or more kayakers at a time into this protected area. That request was turned down but kayak tours to other quiet locations in the lower Keys are currently offered to passengers. Staff of the U.S. Fish and Wildlife relate that they have never encountered cruise ship passengers at educational and visitor sites on Big Pine in the National Key Deer Refuge, nor in the Key West National Wildlife Refuge west of Key West where inappropriate visitation by boats to out islands has been a problem for years.[38] In an effort to address the activities of cruise ship passengers near coral reefs some cruise lines and conservation groups have initiated programs to educate passengers on means of protecting coral reefs and other areas of high biodiversity during their recreation (Sweeting and Wayne 2003).

Due to the long history of maritime activity in Key West harbor and Truman Harbor, concerns were expressed in the late 1990s about possible contamination of sediments being routinely resuspended by large vessels, and later proposed to be dredged by the Navy. Investigation by the Navy and others found the quality of the sediments near the Outer Mole and elsewhere in the harbor to be good, with no indication of pollutants levels creating a concern. Results indicated that resuspension of sediments during dredging operations in the channel, turning basin, and Truman Harbor will not have a significant impact on the water quality parameters measured (Navy 2003). The Navy EA concluded that the only impact to marine water quality from the dredging would be temporary and insignificant increases in turbidity from dredging operations.

As part of the Truman Annex base reuse review in the late 1990s concerns were expressed by agencies about erosion of the west shoreline of Ft. Taylor State Park, the disturbance of turtle use of Truman Beach and seagrass habitats just south of the Outer Mole, and possible

[38] Wilmers, T. Personal Communication, USFWS

Bell, J. Personal Communication, USFWS

negative impacts on Ft. Taylor from over visitation. None of these have proven to be a concern for the Park[39]

The City is working toward implementing solutions to address the community concern for increased vessel discharges due to the recent growth in the cruise ship industry that has made Key West now the most visited destination port in the U.S. Concerns for declining water quality demonstrated by the increased occurrence of beach closures, fish and coral diseases, and a reduction in visibility in the water column has led to beliefs that cruise ship discharges might be contributing[40] There appears to be no evidence that cruise ship discharges are either occurring or, other than through turbidity and resuspended sediment, contributing to water quality declines in the area. Belief by some that cruise ship turbidity in the channel and harbor was affecting the entire lower Keys region, or was responsible for the widespread reduction in visibility in waters around Hawk Channel and Key West, or in the Lakes region west of Key West, appear unfounded. Many other influences contribute to the water quality of the region, and the turbidity levels found.

Also difficult to address (or even study) was a perception that patch reefs miles away from Key West channel with recent high mortality of stony corals had suffered as a result of cruise ship turbidity.

3.B.9 Potential Impacts, Accidents, and Groundings

Accidental discharges of large volumes of contaminated or hazardous materials (See Section 3.B.4) from cruise ships could potentially occur in Key West and have occurred in waters elsewhere even where such discharges are prohibited by law and agreement (Sweeting and Wayne 2003). As recently as March, 2005, Norwegian Cruise Line's 853 foot long *Pride of Aloha* accidentally discharged about 18,000 gallons of treated effluent into Honolulu Harbor violating a voluntary agreement with the State of Hawaii (Cruise Junkie 2005). The well flushed nature of Key West channel could help ameliorate any such isolated accidental discharge, but also could make cleanup of some spills much more difficult.

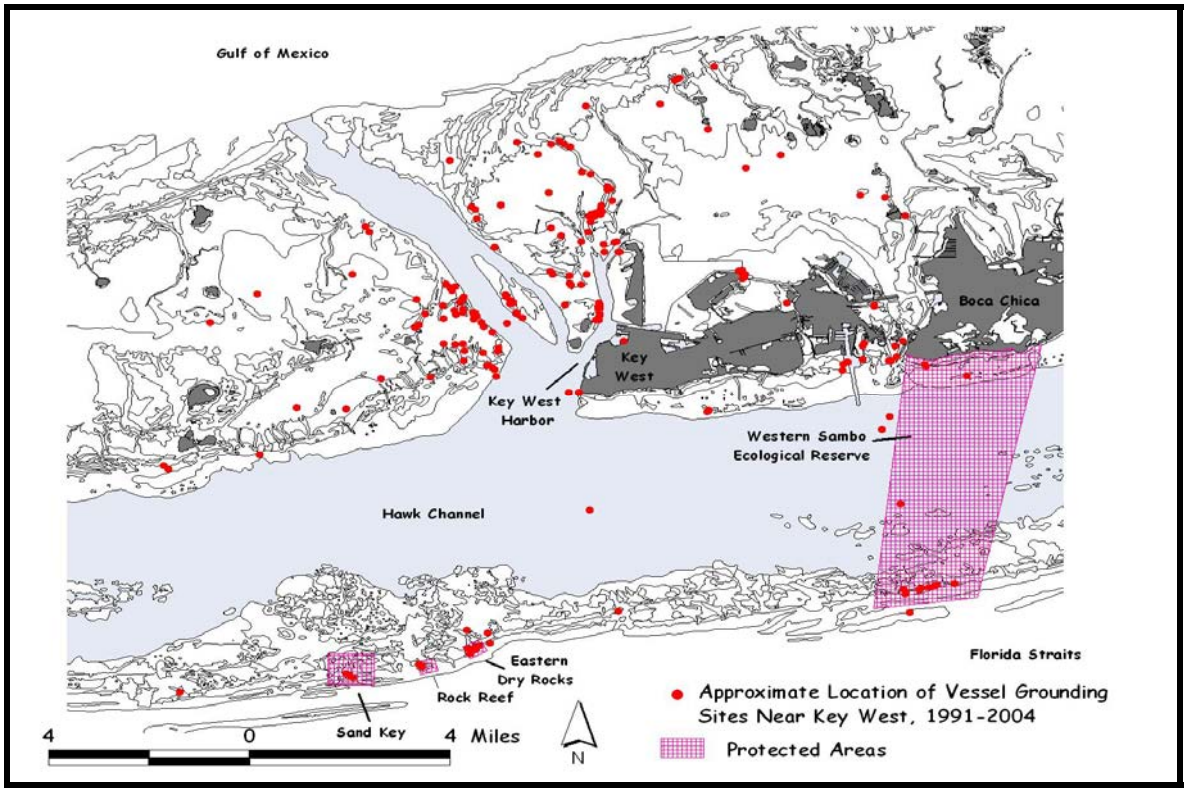
Accidents involving vessels can and do happen, especially in highly congested harbors or where navigation can be difficult or complicated - as it is in Key West channel and harbor. Possible accidents, groundings, and spills are all risks associated with a heavily traveled harbor such as the Port of Key West. Well developed accident and spill contingency plans involving the FKNMS, the Coast Guard and the Navy exist for dealing with the aftermath of accidents and groundings anywhere in the area. The risks appear to be real based on groundings and accidents that have occurred in the past in the FKNMS, and in other reef areas of the region. Figure 3.B.15 is created from GIS point data provided by the FKNMS. *Vessel Groundings in the Lower Keys and near Key West in the FKNMS* is used to map approximate locations of about 194 documented vessel groundings on hardbottom, coral, and seagrass habitats that have occurred near Key West since 1991, including along the edge of Key West channel (FKNMS 2005). Groundings likely occur in the area that are not documented by law enforcement agencies.

[39] Knapke, M. Personal Communication, Ft. Taylor State Park

[40] Quirolo, D. Personal Communication, Reef Relief

When vessels enter the main channel and head towards Key West the direction of travel is directly at Ft. Taylor State Park. Mechanical failure on a cruise ship or other large vessel resulting in a grounding or collision affecting Ft. Taylor is one of the biggest concerns of the Park.[41] An out of control, deep draft large vessel traveling from the south would ground out about 1/2 mile offshore of the south side of Key West depending on its draft, and on the leading edge of Kingfish Shoals southwest of Key West across the channel. The harbor turning basin is a small, irregularly shaped, heavily traveled area less than 2,000 feet across at its widest point (Figures 3.A.11 and 3.A.12). Even with highly trained commercial Bar Pilots and Navy pilots, as well as Coast Guard personnel available to assist large vessels traversing the area, realistically, potential exists for groundings or accidents there.

FIGURE 3.B.15. APPROXIMATE LOCATION OF VESSEL GROUNDING SITES IN SEAGRASS, HARDBOTTOM, AND REEF HABITATS NEAR KEY WEST FROM 1991-2004 (NOAA).



In its internet site titled *Vessel Groundings on Coral Reefs: Response and Prevention Strategies* NOAA notes that numerous vessel-related activities result in coral reef damage, with some of the worst damage resulting from vessel groundings. Groundings can cause serious harm to reefs as a result of the reef structure being dislodged, fractured or destroyed (NOAA 2004). The FKNMS reported over 4,000 boat and vessel groundings in Keys coral and seagrass habitats from 1997 to 2003 and initiated over 300 coral enforcement actions. There are between 500 and 600 reported vessel groundings within the FKNMS each year, plus many groundings that damage Sanctuary resources but are never reported (FKNMS 2004). Risks are increased

[41] Knapke, M. Personal Communication, Ft. Taylor State Park

by slow reef recovery following groundings that have been documented at some grounding sites, including the 1986 grounding site of the *M/V Wellwood* on Molasses Reef off Key Largo where reef recovery was low after 16 years (NOAA 2002).

Over 30,000 acres of seagrass flats in the Keys have been scarred by boat propellers (Sargent et al. 1995). No up to date assessment of this serious boating problem in the Keys has been conducted but boating activity has historically correlated with Florida's human population growth, expected to double within 25-50 years. As population increases, the pressure of boating activity on the marine environment - including groundings and bottom disturbance - is also expected to increase (FKNMS 2005). In 2004, there were over 32,300 registered vessels longer than 26 feet in length (over 6,000 greater than 40 feet long) from Palm Beach County south through the Keys[42] . The proposed Waterway Management Action Plan of the FKNMS includes the following goals designed to initiate actions to address the consequences of problems such as severe large vessel generated turbidity and resuspended sediment (FKNMS 2005):

- minimize resource damage from boating activities
- protect shallow-water resources
- provide reasonable and appropriate access while minimizing resource damage
- educate the public about safe and responsible boating practices

Other examples highlighting local risks exist. In the late 1990s the nuclear submarine *USS Memphis* grounded on a reef in southeast Florida off Ft. Lauderdale. In 2004, in Alaska, the 338 foot long cruise ship *Clipper Odyssey* carrying 126 passengers grounded on an uncharted rock and leaked fuel and gray from tanks that were damaged. Also in 2004, the Navy contractor's hopper dredge strayed outside the dredge zone in the offshore portion of Key West channel and caused impact to coral resources at several locations along the edge of the channel (FKNMS 2004). In Mexico in early 2005 the U.S. research ship *Maurice Ewing* ran aground on and damaged a coral reef about 30 miles off the Yucatan peninsula, after apparently relying on flawed or misleading navigational charts. In its online database entitled "Events at Sea - All the Things that Can Go Wrong On A Cruise" the Cruise Junkie documented 16 cruise ship groundings, 17 ship collisions with other vessels or piers and docks, and 2 cruise ship collisions with marine mammals from 2002-2005 worldwide (Cruise Junkie 2005).

In November, 2004, a tug towing a barge collided with the cruise ship *Enchantment of the Seas* while it was berthed at Pier B. The collision tore an 8 foot hole and left a 50 foot long mark on the ship above the waterline (Figure 3.B.16). On December 19, 2004 complaints and photos by locals were filed with the FKNMS and the Florida Wildlife Commission stating that the cruise ship *Sea Eagle* (about 700 feet long with a 23 foot draft) had traveled unusually far north in Key West channel. An investigation determined that although the ship used a portion of the harbor not commonly used by large cruise ships, it was being operated in a proper and correct manner (Roudebush 2004).

[42] Harvey, Kent. Personal Communication, FWCC

FIGURE 3.B.16. RESULTS OF A NOVEMBER, 2004 COLLISION IN KEY WEST HARBOR (KEY WEST CITIZEN).

A tug towing a barge collided with the cruise ship Enchantment of the Seas while it was berthed at Pier B.

From a historical perspective, undoubtedly there have been accidents, spills and collisions in the channel and harbor, especially when the military was at its most active in wartime. As an example, Figure 3.B.17 is an interesting 1914 photograph of a Navy vessel at Pier B after a collision with the pier. Other vessels of the period appear in the image as well. Two Navy PC boats ran aground near Mule Key west of Key West during World War II and had to be dredged out (Artman 1995). Steps have been taken by the FKNMS and other agencies to minimize the potential for groundings in the Keys and around Key West, especially on the reef. The FKNMS now has dual designations as an "Area to be Avoided" (ATBA) and a "Particularly Sensitive Sea Area" (Figure 3.B.18). The ATBA has resulted in a significant reduction of large vessel (>160 feet) groundings in the FKNMS since its designation in 1990 (Figure 3.B.19). The Sensitive Sea Areas designation ensures that the ATBA boundaries appear on international as well as U.S. nautical charts (FKNMS 2005). And, in a cooperative effort with other groups, radar transponder beacons have been placed along the reef tract as a means of electronically accurately locating the reef on radar screens of passing vessels.

FIGURE 3.B.17. 1914 PHOTO OF ACCIDENT INVOLVING PIER B AND NAVY VESSEL *TONAPAH* (STATE ARCHIVES OF FLORIDA).

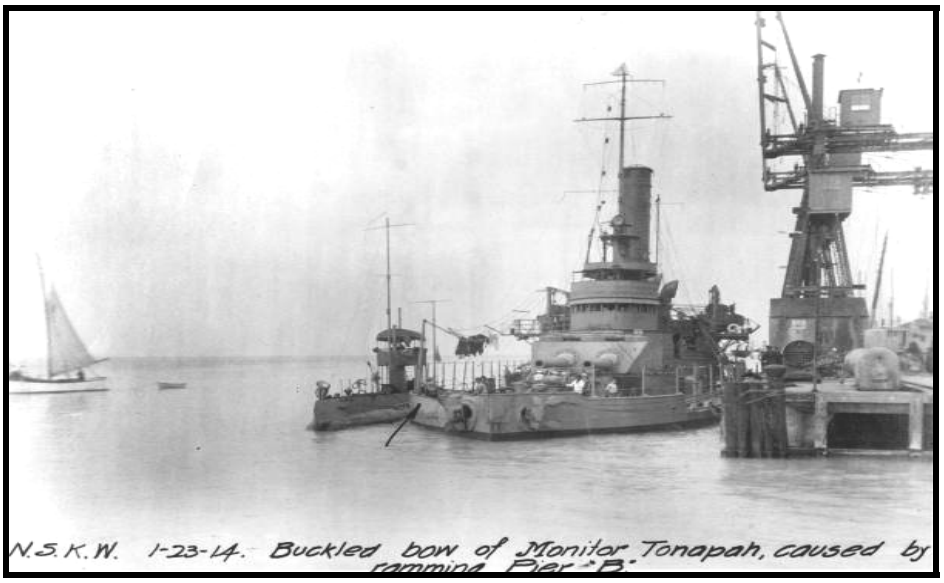
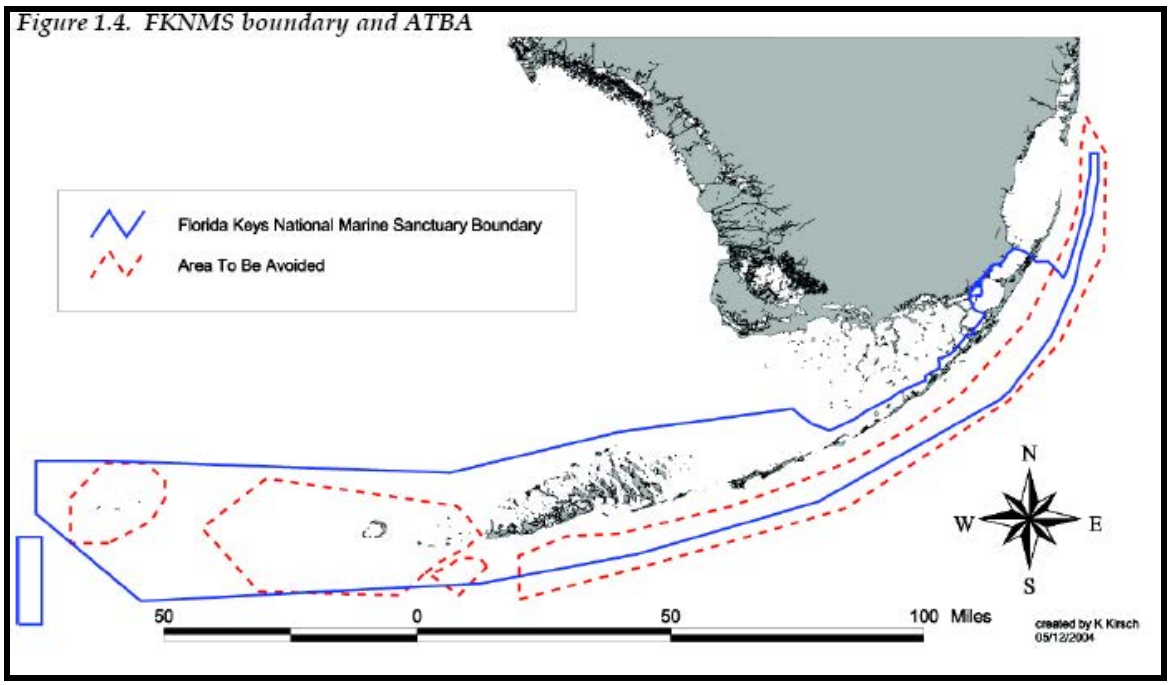


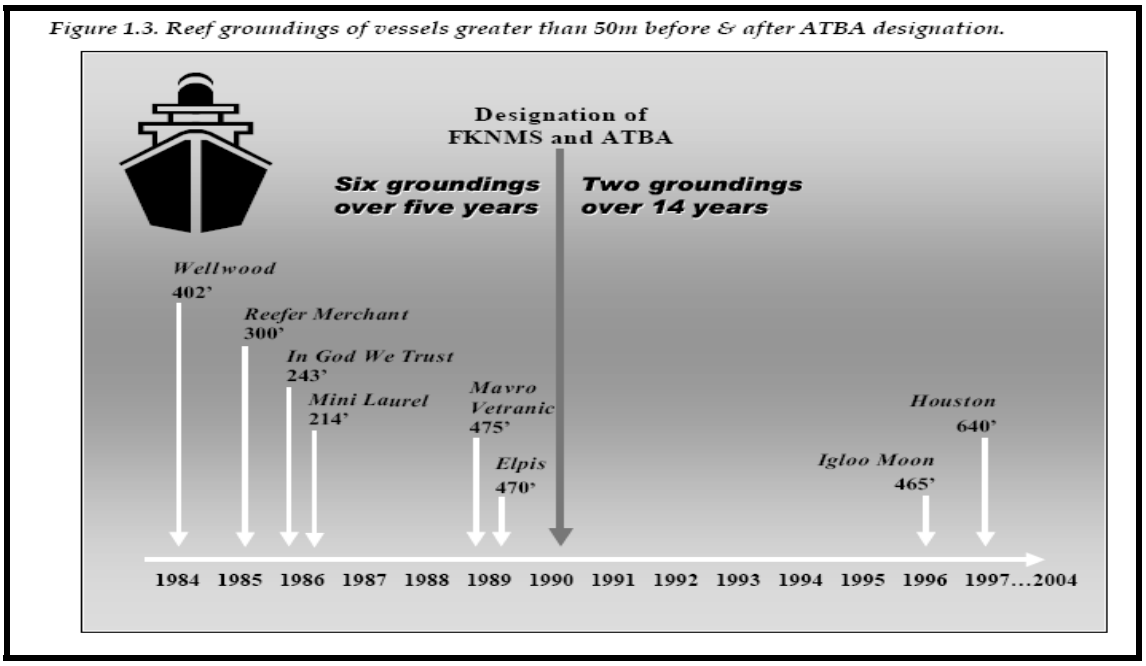
FIGURE 3.B.18. BOUNDARIES OF THE FKNMS AND THE AREA TO BE AVOIDED (ATBA). NOTE AREA EXCLUDED OFFSHORE FROM KEY WEST (FKNMS 2005)



Potential impacts from large vessel activity to biological resources of the channel and harbor area are reviewed in the Navy's 2003 EA and in FKNMS comment letters to the Navy's consultants during the dredging permit review (FKNMS 2003). Based on diver surveys by FKNMS staff and consultants, the FKNMS notes that important protected resources at risk include stony corals, octocorals, sponges, and seagrasses along the harbor and channel edges in a number of locations (especially along Cut B) and patch reefs, hardbottom and seagrass habitats immediately adjacent to the channel in a number of locations.

The vessel generated turbidity and resuspended sediment reflected in Figures 3.B.8 and 3.B.9 in the main channel offshore does not always remain in the channel but drifts away, and based on current patterns in this area typically drifts to the west. Figure 3.B.6 (produced for the 2003 Navy EA) shows sizeable patch reefs and hardbottom both to the west and east of the channel, as well as the stations currently being monitored. This detailed resource health monitoring required of the Navy before, during and following dredging (see Section 3.B.12.3) should prove to be important in assessment of the impact of vessel generated turbidity and resuspended sediment on these resources. Concerns of heavy sedimentation to stony corals include less species diversity, less cover, slower growth, reduced recruitment, decreased calcification and reef accretion, decreased net productivity, and alteration of complex relationships between reef animals (Rogers 1990). Sarkis (1999) reported that high levels of short pulse sedimentation during periods of high temperature may have a different effect on coral reefs than longer pulses of a lesser level during periods of colder temperatures- as for winter storms. As Rogers (1990) and Sarkis (1999) and others have suggested, coral coverage may not be the most sensitive method for assessing health of stony corals as the growth of a coral skeleton is very slow, and can be altered by other environmental conditions over time. Growth can vary greatly between colonies of the same species under similar environmental conditions and even within a single colony.

FIGURE 3.B.19. REDUCTION IN LARGE SHIP GROUNDINGS IN THE FKNMS ATTRIBUTED TO THE ATBA DESIGNATION IN 1990 (FKNMS 2005).



Another potential problem from increased large vessel activity in the Key West area relates to human noise in the marine environment. The issue is relatively little studied compared to other marine stressors but NOAA, the National Marine Fisheries Service and scientists from various academic institutions initiated a lecture series in 2004 with an objective of presenting current scientific information about human sources and uses of sound in marine environments, the physics of sound and hearing, and biological and behavioral factors that relate to noise impacts and especially affect marine mammals. NOAA provides "While we continue to work toward understanding some of these complex issues, much has been learned recently about the impact of noise on marine life. Our ultimate goal is to use a balanced approach to share the ocean with marine life, and to conserve and protect these incredible creatures for many years to come." (NOAA September 2004 press release - Lectures on Noise & Marine Mammals). In a review of the Navy dredging proposal the Florida DEP stated that unavoidable underwater noise, light, and visual disturbances during dredging and Outer Mole reconstruction would adversely affect fish, sea turtles, marine mammals and colonial seabird movements. They believed such affects as well as collision risks should decrease with project completion but might continue as secondary impacts from large vessel activity (FDEP 2003).

3.B.10 Cumulative Impacts

Cumulative impacts on the environment and on biological resources from human activity are very difficult to assess, under the best of circumstances. The diverse resources, diverse people and activities, and multitude of existing stressors on the resources of the Key West result in many confounding influences virtually impossible to sort out, or to determine when important cumulative thresholds have been reached. What is known is that many important habitats in the Key West area as well as water quality have seen changes and declines in "health" in recent years. Health is defined here as resilience, diversity, functions driven by natural processes, and lack of physical impact by humans. The cause of negative changes in the nearby reef ecosystem is generally believed to be a result of the multitude of damaging or degrading human activities and the long history of these activities, in combination with possible natural changes.

Involving 6 years of effort and expenditure of $6 million the Florida Keys Carrying Capacity Study was intended to view cumulative impacts from what has gone before and assess the ability of the Keys to absorb additional development. The Study reported in 2002 that the carrying capacity of certain aspects of the Keys terrestrial environment had been exceeded. An original intent was to "determine the ability of the ecosystem infrastructure to withstand all impact of additional land development activities.....". An original purpose was to perform ".....an analysis of consequences that may be used by local planners to determine the level of land development activities that will avoid adverse impacts to the Florida Keys ecosystem." (USACE 2002). Land development and other improvements associated with improving the 3 cruise ship berths in Key West, and a dramatic increase in cruise ship movements was occurring at the time, yet was not considered in the study.

The Study, led by the Army Corps of Engineers and the Florida Department of Community Affairs, ultimately did not address cumulative impacts affecting the Keys marine environment. Shortcomings in data for the Keys marine environment led the National

Research Council (2002) to recommend limitations in the use of the results from the Study and express opinions that the task was perhaps too ambitious an undertaking.

An effort was made in the 2003 Navy EA to address cumulative impacts related to their dredging and infrastructure improvements at the Outer Mole. In commenting on this effort the FKNMS suggested that in regard to benthic habitats (especially coral communities) in the area the cumulative impacts section could be enhanced by addressing the potential for overall cumulative effects with reference to turbidity, direct disturbance, and generally increasing stressors to an already stressed ecosystem. The FKNMS noted that benthic communities "are already dealing with induced stress from poor water quality (sewage, nutrient loading or toxins), storm water run off, coral disease, coral bleaching, vessel groundings and anchoring in addition to existing levels of large vessel generated turbidity. It must be emphasized that every effort to avoid or minimize additional stressors must be employed to reduce the cumulative impacts." (FKNMS 2003). This suggests that cumulative impacts in the area are a very real issue, but there is no easy answer or ready solution as to how to best establish thresholds that would allow agencies or groups to know when cumulative impacts have exceeded a natural systems or natural habitats (such as local hardbottom, patch reef, or seagrass bed) ability to tolerate additional impact.

The 2003 Navy EA noted that military vessel activity into Key West was expected to increase as a result of their work as was commercial and recreational vessel traffic. Statewide, vessel registrations continue to increase at about 2% per year. Even without navigational improvements in and around ports like Key West, navigation will likely continue to increase. The National Marine Fisheries Service, concerned about dredging as well as secondary impacts, advised the Navy during review of the draft EA that a more detailed discussion of the potential cumulative impacts of the project on EFH was needed. With few exceptions degrading impacts to natural habitats are cumulative - it's the degree of degradation (if any) that humans are willing to accept and our ability to measure the degradation that are difficult to establish. Again, the resource health and turbidity monitoring currently being conducted by the Navy may be the only opportunity to relate chronic turbidity and resuspended sediment from passing cruise ships and other large vessels to habitat quality of adjacent areas.

In regard to cumulative issues of the land based component of increased cruise ship and passenger activity at the Outer Mole, the Navy notes in the 2003 EA that the stormwater collection system at the Truman Annex dates back to World War II, and includes five drainage basins, four of which flow into the harbor basin. The fifth drainage basin flows southwest towards Fort Taylor. The Truman Annex discharges runoff to two outfalls along the east quay and five outfalls near the mouth of the harbor. There are no water retention or detention facilities at Truman Annex. Key West averages nearly 40 inches of rain per year.

Increased vehicular traffic to and from the Outer Mole during cruise ship visits may be cause for concern in regard to stormwater runoff. Ft. Taylor State Park reports no detrimental impacts to date from increased vehicular and pedestrian traffic [43]

[43] Knapke, M. Personal Communication, Ft. Taylor State Park

3.B.11 Existing Minimization and Mitigation Efforts for Cruise Ship Impacts

Known efforts include the $38 million ongoing Navy dredging and monitoring project, the reconfiguration of Pier B several years ago in an effort to reduce turbidity, limits on the size and draft of vessels brought into the harbor by the Key West Bar Pilots, managed use of the main engines of cruise ships by the Bar Pilots, and educational efforts of agencies and NGOs in the Key West area. The City's decision several years ago to preclude commercial kayak tours with cruise ship passengers in the Salt Ponds is a minimization effort to be acknowledged.

3.B.11.1 VALUE OF NAVY DREDGING IN ALLEVIATING CRUISE SHIP TURBIDITY

Permits issued to the Navy (and later modified in January 2005) authorize dredging of about 456 acres of submerged bottom in the main channel offshore (5+ miles long), the main channel inshore through the harbor north to Mallory Dock, the turning basin, and Truman Harbor.

The permits from the mid 1960s Navy dredging project in the channel and harbor authorized depths of -34 feet MLW and these depths were obtained in much of the area although some areas of hardbottom remained slightly shallower. The current dredging permits authorize depths of -37 feet MLW throughout the previously dredged portions of the channel and harbor, and -36 feet MLW in Truman Harbor. The permits included maintenance and additional dredging and the removal of about a dozen hardbottom patches left over from the 1960s dredging. Modified permits issued by the Florida DEP and the Army Corps of Engineers in January, 2005 (at the City's request) authorized an additional 7,500 cubic yards of maintenance dredging by the Navy's contractor (but paid for by the City) within the City's submerged lands lease in front of Mallory Dock to a maximum depth of -32 feet MLW. According to the City, dredging at Mallory was done at the request of the Key West Bar Pilots and the Navy to allow certain size frigates to dock at Mallory Dock on City leased bay bottom, and to remove accumulated silt and debris there[44]

In their January 11, 2005 permit modification, the Florida DEP stated "The Mallory Dock area is relatively shallow in comparison to the ship traffic in the area, which results in generation of turbidity plumes during ship movement in the area. Potential for impacts generated from ship traffic turbidity plumes is likely to exceed any potential impacts associated with dredging the area to depths more suitable for vessel traffic. It is not expected that elevated turbidity resulting from dredging will have any greater impacts on coral communities in the area than that which occurs during vessel ingress and egress. Once the maintenance dredging at Mallory Dock is complete, turbidity resulting from vessel activity should be greatly reduced."

On February 2, 2005, the dredging contractor advised the City and the Navy that dredging at Mallory was complete and that considerably less unconsolidated "maintenance" material and more solid rock bottom than expected had been encountered. They noted that much less material was removed than anticipated (only about 1,000 cy) and although the dredge being used was not suitable for the type of hardbottom encountered, multiple attempts were made to remove the hardest material, with minor success. The contractor advised that the dredge removed material until hard bottom refusal or the final authorized grade of -32 feet MLW

[44] Jones, J. Personal Communication, City of Key West

had been achieved. An official after dredge survey was to be performed by the contractor (Van Hoogstraten 2005).

A major determinant of the value of the Navy's channel and harbor deepening in alleviating large vessel turbidity will be the amount of unconsolidated material remaining in the dredged area when dredging is completed. The dredge used (Figure 3.B.20) for most of the dredging is designed to remove unconsolidated bottom sediments but limits exist on the size fractions that can be handled (finer sediments are more difficult to remove mechanically) and the dredge's ability to remove all loose material. And it is anticipated that natural processes of bedload movement due to tidal and wind generated currents along with storms will begin to deposit new unconsolidated material into the channel.

FIGURE 3.B.20. ACTIVE DREDGING BY THE NAVY CONTRACTOR OFFSHORE IN KEY WEST CHANNEL IN AUGUST 2004 (KRUER PHOTO).

Figure 3.B.2 reflects pre-dredged depths of -36 feet to -37 feet MLW in the area of the turning basin subject to prop wash scour by large vessels maneuvering (Figure 3.B.11). With dredging authorized to a maximum depth of -37 feet MLW little additional depth will be gained in this area, and a relatively small amount of unconsolidated material will be removed here.

Opinions vary in regard to what will be accomplished by the current Navy and City dredging. The Navy believes a beneficial impact to local benthic resources and a reduction in turbidity may occur as a result of less resuspension and redeposition of sediments during vessel movement resulting from the removal of fine sediments that are ".....now resuspended each time large vessels enter and leave port." (Navy 2003).

The Bar Pilots report in 2005 that they believe dredging will help reduce vessel generated turbidity but also believe that sediments will be re-deposited and regular maintenance dredging will be needed over time to keep turbidity levels at a minimum. To reduce turbidity in the main channel they recommend placement of out bound range markers in Cut B to allow large vessels to safely depart at slower speeds (Bar Pilots 2005). They also believe

widening the 300 foot wide channel entering Key West (north of buoy # 5) would allow large vessels to travel at slower speeds and help minimize turbidity levels generated by vessels stopping or accelerating. Earlier the Bar Pilots stated - "While the Pilots would not oppose maintenance dredging, they do not believe it is necessary, as depths in the harbor are still fully adequate for safe navigation of vessels. There are also several factors which lead us to believe that dredging would be of dubious value." (Walters 1999). In 2003, the Bar Pilots believed increasing the depths of the Harbor would make a noticeable difference in turbidity levels and that maintenance dredging around Mallory Dock would help greatly (Bar Pilots 2003). In 2004, they believed turbidity levels in the harbor should be reduced significantly after the dredging (Bar Pilots 2004).

An industry representative also suggested that by allowing ships to pass through the main channel at a higher rate of speed there would be a corresponding decrease in the amount of sediment displaced. He understood that the Navy's dredging would enhance the ability of the Bar Pilots to bring a vessel in more swiftly providing the relief (reduced turbidity) he expected[45]

In Tampa Bay, the channel passage of cruise ships heading to the Port of Tampa, along with other large vessel traffic, routinely increases turbidity and resuspends bottom sediments to the detriment of water quality and the adjacent benthic communities. There, maintenance dredging is not believed to mitigate the problem as it is too long between dredging events due to economic reasons. Maintenance dredging in Tampa Bay is believed driven by navigation and not water quality needs[46]

Prior to the initiation of the dredging a concern was expressed by the LVWG that dredging to a greater depth may simply encourage the use of still larger vessels than those using the area now thereby defeating a desired result of the dredging (LVWG 2002-2004). Little information was readily available on the type and size of large Navy vessels that might use Key West Harbor in the future but the Florida DEP has stated that waterway and Outer Mole improvements will allow access for more and larger Navy vessels, including cruisers and frigates (FDEP 2003). The National Marine Fisheries Service noted in a March 2003 dredging coordination letter to the Corps of Engineers that "draft requirements of cruiser and destroyer class vessels preclude their entry into Truman Harbor under the current channel conditions."

When dredging is completed new full bathymetric surveys will be conducted by the Navy. Depths achieved will be critical to future problems of prop wash scour, resuspended sediment, and turbidity from future use of the channel and harbors by large vessels. Turbidity monitoring in the channel and harbor is to continue for 3 months following completion of dredging.

3.B.11.2 LOCAL BASE REUSE AND LOCAL CONSERVATION INITIATIVES

The City's Land Development Regulations as they related to port improvements and expansion at Truman Annex required new activities and structures be assessed in terms of their impacts to wetlands, open water, wildlife habitat, and other environmentally sensitive

[45] Collins, S. Personal Communication, RCCL

[46] Lewis, R. Personal Communication, Lewis Environmental Services, Inc.

areas (Bermello et al 1999). A number of environmental issues were identified and assessed to some degree in the Key West Base Reuse Plan - these included water quality and vessel generated turbidity, natural habitats in the area, sea turtles and use of natural habitats in the area for feeding, possible use of a small beach just south of the Outer Mole by sea turtles for nesting, manatees, and management of sewage and graywater from cruise ships. In 1999, the Florida DCA noted a change in use of the Outer Mole that never underwent the required development review required by the Department and stated that the City should fully evaluate the impacts of using the Outer Mole for regular cruise ship visits. They also expressed concern at the time that a substantial increase of turbidity in the channel created by cruise ships could adversely affect water quality in and near the area (FDCA 1999).

Initiatives by the City in recent years to protect and improve water quality and marine resources in and near the City include advanced wastewater treatment for the island with deep well injection, upgrading the sewer system, no motor zones in important nearshore areas, management of some liveaboards through managed anchorages and pump out facilities, protection of the Key West Salt Ponds, and improved tidal flushing in interior wetlands of the City. The Port of Key West through the Key West Port Authority recommends the use of best management practices for environmental and water quality at City port and marine facilities around Key West including Key West Harbor. The City describes the mission of the Port of Key West as "A public benefit City department providing maritime, real estate services, and management of infrastructure to enhance the local economy, providing recreational opportunities for its citizens, and at the same time protecting both our heritage and the marine environment for future generations." (*http://www.keywestcity.com/depts/port)/cruiseships/cruiseships.asp*). The City and community groups help educate residents and visitors on ways to recreate, dive, fish, and boat in the Key West area while protecting and minimizing disturbance to marine resources.

In conjunction with the U.S. Coast Guard and the FKNMS, the Key West Propeller Club placed 8 radar transponder beacons along the Keys reef tract from the Dry Tortugas to the north end of Biscayne National Park. These beacons transmit a signal that is displayed on the radar screens of passing ships, warning them of the location of the reef tract (FKNMS 2005).

3.B.12.3 MONITORING PROGRAMS

Relative to issues of large vessel activity in the channel and harbor, the most important new monitoring is that being required of the Navy by state and federal agencies as conditions to the issued dredging permit. An extensive and detailed 99 page water quality and resource health monitoring plan titled *Key West Harbor Dredging Monitoring and Mitigation Plan* was developed in 2003 for the Army Corps of Engineers by the Navy, the Navy's consultants, and the regulatory agencies. In general, the monitoring during the dredging and for a limited period post-dredging include high frequency turbidity monitoring at surface and mid-depth while dredging is underway and during select vessel passages, benthic habitat assessment that includes monitoring of sedimentation near the dredge area and at control stations, and monitoring for injury to benthic resources during dredging. Although mostly designed to monitor and document any impacts resulting from the Navy's dredging, the data and results should prove valuable in assessing environmental issues related to cruise ship activity in the channel and harbor post-dredging. Specifically, the monitoring plan has various components designed to use best available technology and methods to protect and monitor resource

health in the area before, during, and after dredging, to provide a baseline for future comparisons. It includes, but is not limited to, the following elements.

The objective of the Resource Health and Sedimentation Monitoring Plan (RHSMP) is to use coral and seagrass health and sedimentation measurements at selected locations adjacent to the project area as indicators of potential impacts to benthic resources from dredging. This monitoring program was developed to respond to the following concerns from the Corps of Engineers and Florida DEP and other resource agencies:

- coral health adjacent to dredging;
- seagrass health adjacent to dredging;
- sediment characteristics in the dredging footprint and in areas downstream of turbidity plume, and at monitoring stations;
- background sedimentation in and adjacent to dredging footprint and at monitoring stations;
- during-dredging water quality for sedimentation from Key West Harbor and approaches from the outer coral reef tract;
- sedimentation on nearby seagrass and coral communities; and
- monitoring of sediment traps weekly at pre-arranged stations.

The RHSMP consists of the following efforts:

- monitoring of coral health at sites adjacent to the project area and at reference sites by repetitive diver observations of selected coral colonies for signs of bleaching, excess mucus production, coral polyp extension, and disease;
- monitoring of seagrass health within seagrass beds adjacent to the project area and at reference sites by diver observation of sediment buildup on blades and increased epiphytes or biofouling;
- monitoring of sedimentation adjacent to the dredging footprint within sensitive resources and at appropriate reference locations. The sedimentation monitoring will be conducted at permanent stations, and measurements will be made during dredging activities by using sediment accumulation blocks (weekly) and sediment traps (monthly); and
- monitoring of impacts to resources immediately adjacent to dredging activities using diver observations made during weekly drift dives along the channel edges.

The objectives of the Navy's Net Environmental Effects Monitoring Plan are to 1) show the effects of dredging Truman Harbor, the Truman Harbor turning basin, and the Key West ship channel on turbidity generated by ship traffic and 2) document sedimentation rates before and after dredging activities at stations along the Truman Harbor turning basin and Key West ship channel. This will be accomplished by the before and after monitoring of turbidity directly associated with ship activity along with sedimentation rates throughout the project area. The Net Environmental Effects Monitoring Plan consists of:

- sampling turbidity plumes associated with ship traffic using turbidimeters deployedfrom a small vessel following ships the length of the channel.
- placement of a remote drogue with attached turbidimeters in ship turbidity plumes and recording of data within the plumes as they dissipate.
- collection of sedimentation data before and after dredging from selected net sediment accumulation monitoring sites and sediment traps established as a component of the RHSMP.

The Large Vessel Turbidity Monitoring Plan is intended to monitor levels of turbidity associated with large vessel traffic within the Truman Harbor turning basin and ship channel. Monitoring was to occur before the initiation of dredging, during dredging, and after the completion of dredging for a period of 3 months. Measurements of turbidity will be made at surface and mid-water depths behind large vessels as they transit within the ship channel and turning basin. Ships will include military vessels, cruise ships, and large commercial freighters or tankers. The survey vessel will follow the ships at a fixed distance and record near-surface and mid-depth turbidity using two towed turbidimeters. Information recorded during each sampling will include vessel name and type, date, time interval, distance of turbidimeters from vessel, depth of instruments, continuous survey vessel position and speed, and turbidity levels. Either before or after each monitored vessel's passage down the channel, background turbidity readings will be collected along the channel for comparisons. Measurements will be made of ship passages during two separate 3-day periods prior to dredging and at least two 3-day periods after the completion of dredging. Turbidity data will be stratified by specific segments of the channel and vessel type and size to assess the net environmental effect of the dredging on ship-generated turbidity levels within various sections of the project area. By agreement, monitoring of post-dredge turbidity from vessels will continue for at least 3 months.

The FKNMS 1996 Final Management Plan required the FKNMS to have a Water Quality Protection Plan (WQPP) developed by EPA and the State of Florida. The Water Quality Protection Program continues to fund three long-term monitoring projects - overall water quality, coral reef and hardbottom community health, and seagrass community health. These three projects represent a long term commitment by the EPA to assess the health of coral reef, hardbottom, and seagrass communities within the FKNMS with a focus on resource and health issues and concerns related to water quality. There is also a research/special studies component which consists of a multitude of smaller, more focused studies looking at specific cause and effect relationships and the impacts of specific environmental perturbations (NOAA 2005)

The contract for the ongoing water quality monitoring component of the WQPP was awarded to the Southeast Environmental Research Program at FIU and the field sampling program began in March 1995. Research and monitoring activities were intended to focus on fundamental processes and specific management-driven topics. Information generated from such activities will be used to:

- provide the public with a means to evaluate the effectiveness of the Sanctuary;
- provide a means to distinguish between the effects of human activities and natural variability;

- develop hypotheses about causal relationships which can then be investigated; evaluate management actions; and verify and validate quantitative predictive models used to evaluate and select management actions.

Ongoing long-term monitoring within the FKNMS occurs at two scales. Comprehensive, long-term monitoring critical to achieving the FKNMS' primary goal of resource protection. is conducted through the WQPP. The purpose of the research and monitoring is to establish a baseline of information on the resource and the various components of the ecosystem, and how they interact. Two laws require that a research and monitoring program be implemented within the Sanctuary. Section 309 of the NMSA mandates that the "Secretary of Commerce shall take such action as is necessary and reasonable to promote and coordinate the use of national marine sanctuaries for research, monitoring, and education purposes. The 1992 amendments to the FKNMSPA (Section 7(a)(4)) are much more specific, calling on the Secretary of Commerce to:

- identify priority needs for research and amounts needed to improve management of the Sanctuary, and in particular, the coral reef ecosystem within the Sanctuary;
- identify clearly the cause-and-effect relationships between factors threatening the health of the coral reef ecosystem in the Sanctuary; and
- establish a long-term ecological monitoring program and database, including methods to disseminate information on the management of the coral reef ecosystem.

The Coral Reef and Hardbottom Evaluation and Monitoring Project began in the Keys in 1996 and is being led by the Florida Fish and Wildlife Conservation Commission (FWC) and the University of Georgia, Institute of Ecology. Initiated in 1996, this project examines coral and hardbottom communities at 41 fixed sites annually, including some next to the main channel at Western Head and Cliff Green Patch Reefs. The goal is to monitor the status and trends of coral reef and hardbottom communities in the FKNMS using repetitive underwater observations and video transects to provide estimates of biodiversity, distribution and coverage of stony reef coral, soft coral, sponge, algae, substrate and the incidence of selected coral diseases (Beaver 2003, FKNMS 2003a). The Project noted keyswide a 38% decline of stony corals between 1996 and 1999. However, coral cover has not significantly changed since 1999.

The Zone Monitoring Program is part of the Sanctuary wide status and trends monitoring. The primary object of this program is to annually sample permanently marked sites ranging from the northern Florida Keys to the Dry Tortugas, including outer reefs, patch reefs, and hardbottom communities. Site locations were chosen using a random stratified technique based on EPA survey procedures. Underwater Station Species Inventories survey coral biodiversity while image analysis of video transects provides estimates of planar coverage. The sampling design and broad coverage is intended to provide statistically sound estimates of the temporal stability of coverage and coral species richness. These observations are intended to be used to generate hypotheses to distinguish between local, regional, and larger-scale factors that may influence the health of the coral reef ecosystem (e.g., sewage, land use, visitation, Florida Bay water, global climate change). It is believed to be the most statistically rigorous and precise large-scale coral monitoring project in the world (FKNMS 2003).

Seagrass sites within the Sanctuary are monitoring quarterly for coverage, biomass, and productivity also by FIU. Seagrass habitats around Key West are known to be part of the largest continuous seagrass bed in the world. The most current general results of seagrass, coral, and water quality monitoring in the FKNMS is summarized in the 2003-2004 FKNMS Annual Report.

The Fisheries-Independent Monitoring Program of the Florida Fish and Wildlife Research Institute is a long-term project designed to evaluate fishery resources in Florida. Visual surveys are used to estimate relative abundance and to monitor the size class distribution of economically important fish species in coral reef areas of the FKNMS. Sites near Key West are included. The program uses stratified random sampling, a statistical means of resolving the complications caused by variations in habitat, to provide valuable information to fisheries managers on relative abundance, size structure, distribution, habitat use, and recruitment.

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