Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Manzanillo

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National Oceanic and
Atmospheric Administration

Office of National Marine Sanctuaries
Daniel J. Basta, Director
Lisa Symons
John Wagner

Office of Response and Restoration
Dave Westerholm, Director
Debbie Payton
Doug Helton

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Project Background

The past century of commerce and warfare has left a legacy of thousands of sunken vessels along the U.S. coast. Many of these wrecks pose environmental threats because of the hazardous nature of their cargoes, presence of munitions, or bunker fuel oils left onboard. As these wrecks corrode and decay, they may release oil or hazardous materials. Although a few vessels, such as USS *Arizona* in Hawaii, are well-publicized environmental threats, most wrecks, unless they pose an immediate pollution threat or impede navigation, are left alone and are largely forgotten until they begin to leak.

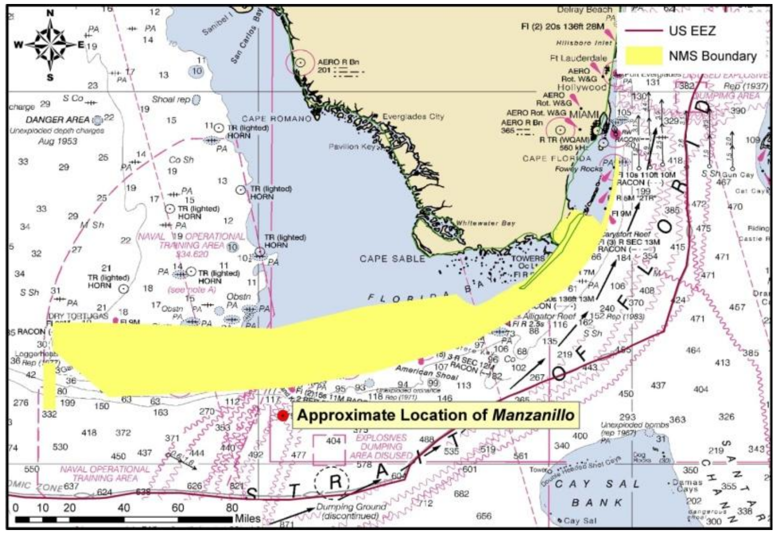
In order to narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to identify the most ecologically and economically significant potentially polluting wrecks in U.S. waters. This project supports the U.S. Coast Guard and the Regional Response Teams as well as NOAA in prioritizing threats to coastal resources while at the same time assessing the historical and cultural significance of these nonrenewable cultural resources.

The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

Initial evaluations of shipwrecks located within American waters found that approximately 600-1,000 wrecks could pose a substantial pollution threat based on their age, type and size. This includes vessels sunk after 1891 (when vessels began being converted to use oil as fuel), vessels built of steel or other durable material (wooden vessels have likely deteriorated), cargo vessels over 1,000 gross tons (smaller vessels would have limited cargo or bunker capacity), and any tank vessel.

Additional ongoing research has revealed that 87 wrecks pose a potential pollution threat due to the violent nature in which some ships sank and the structural reduction and demolition of those that were navigational hazards. To further screen and prioritize these vessels, risk factors and scores have been applied to elements such as the amount of oil that could be on board and the potential ecological or environmental impact.

Executive Summary: *Manzanillo*



The freighter *Manzanillo*, torpedoed and sunk during World War II off the Florida Keys in 1942, was identified as a potential pollution threat, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *Manzanillo*, the results of environmental impact modeling composed of different release scenarios, the ecological and socio-economic resources that would be at risk in the event of releases, the screening-level risk scoring results and overall risk assessment, and recommendations for assessment, monitoring, or remediation.

Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Manzanillo* scores Medium with 13 points; for the Most Probable Discharge (10% of the Worse Case volume), *Manzanillo* also scores Medium with 12 points. Given these scores, NOAA would typically recommend that this site be considered for an assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action. However, given the medium/low level of data certainty and that the location of this vessel is unknown, NOAA recommends that surveys of opportunity be used to attempt to locate this vessel and that general notations are made in the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the general area where the vessel is believed lost.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	Low	Low
	3B: Water Surface Resources	Med	Med
	3C: Shore Resources	Med	Low
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	Med	Med
	4C: Shore Resources	High	High
Summary Risk Scores		13	12

The determination of each risk factor is explained in the document. This summary table is found on page 38.

SECTION 1: VESSEL BACKGROUND INFORMATION: REMEDIATION OF UNDERWATER LEGACY ENVIRONMENTAL THREATS (RULET)

Vessel Particulars

Official Name: *Manzanillo*

Official Number: Unknown

Vessel Type: Freighter

Vessel Class: Unknown

Former Names: *Gharb*

Year Built: 1915

Builder: Forges & Chantiers de la Mediterranee SA, La Seyne

Builder's Hull Number: Unknown

Flag: Cuban

Owner at Loss: Empresa Naviera de Cuba S.A. Havana

Controlled by: Unknown **Chartered to:** Unknown

Operated by: Unknown

Homeport: Havana, Cuba

Length: 216 feet **Beam:** 34 feet **Depth:** 14 feet

Gross Tonnage: 1,025 **Net Tonnage:** 571

Hull Material: Steel **Hull Fastenings:** Riveted **Powered by:** Oil-fired steam

Bunker Type: Heavy fuel oil (Bunker C) **Bunker Capacity (bbl):** Unknown

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): Unknown **Dry Cargo Capacity:** 52,000 cubic feet bale space

Tank or Hold Description: Unknown

Casualty Information

Port Departed: Miami, FL

Destination Port: Havana, Cuba

Date Departed: August 8, 1942

Date Lost: August 12, 1942

Number of Days Sailing: ≈ 5

Cause of Sinking: Act of War (Torpedo)

Latitude (DD): 24.26667

Longitude (DD): -81.86667

Nautical Miles to Shore: 13

Nautical Miles to NMS: 9

Nautical Miles to MPA: 9

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 360-860

Bottom Type: Sand

Is There a Wreck at This Location? Unknown, the wreck has never been located or surveyed

Wreck Orientation: Unknown, but the vessel broke in half before sinking

Vessel Armament: None

Cargo Carried when Lost: Deck cargo of six large trucks; lead and general cargo below

Cargo Oil Carried (bbl): 0

Cargo Oil Type: N/A

Probable Fuel Oil Remaining (bbl): ≤ 5,000

Fuel Type: Heavy fuel oil (Bunker C)

Total Oil Carried (bbl): Likely ≤ 5,000 (based on gross tonnage)

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes

Reportedly Leaking: No

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

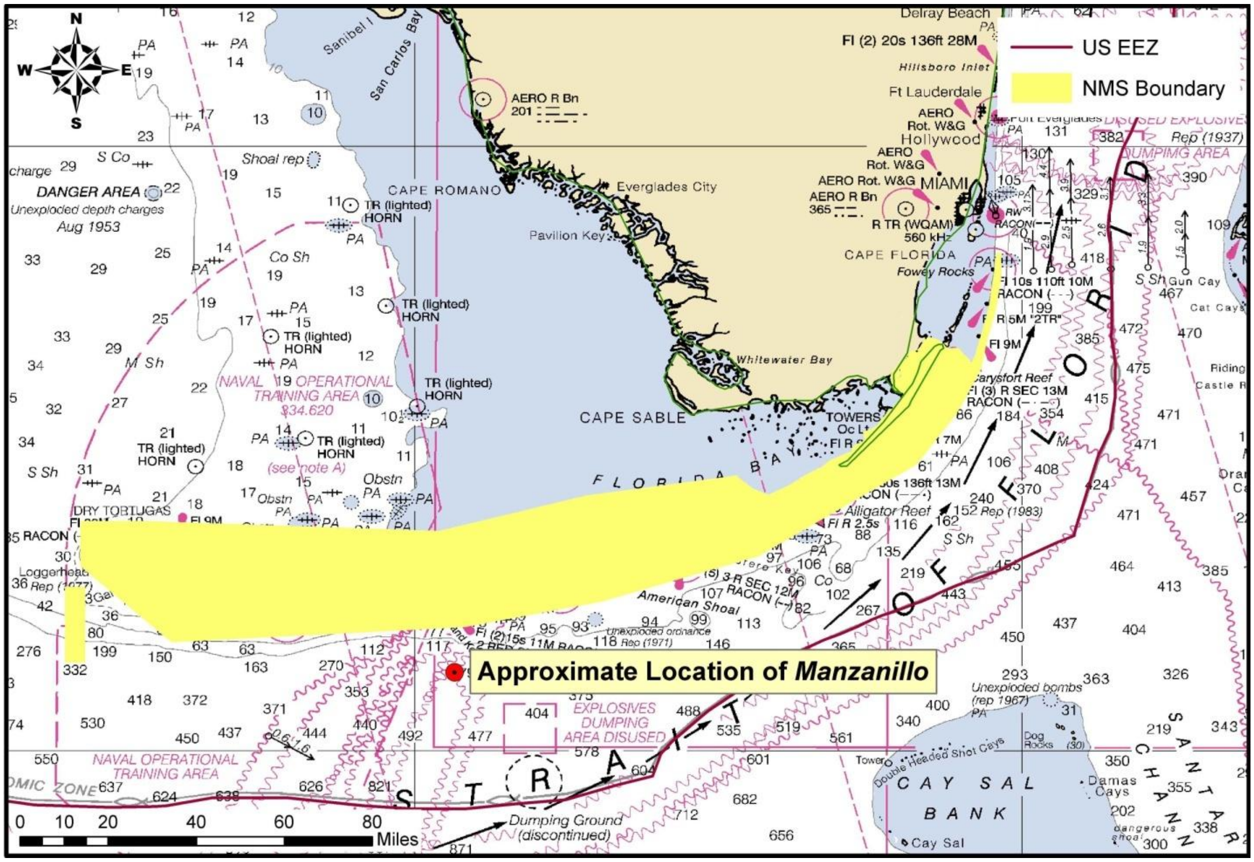


Chart Number: 411

Casualty Narrative

"1. The *MANZANILLO* was torpedoed without warning at 1200 GCT, August 12, 1942, at approximately $24^0$20' N, 81^o50' W (7 miles south of Sand Key) while enroute from Miami to Havana, via Key West, with a deck cargo of six large trucks; lead and general cargo below. The ship sank within 3 minutes, plunging stern first.

2. The freighter was on course 210^0 true, speed 9 knots, in 60 fathoms, not zigzagging, radio silent, there were no lookouts, but five men were topside, from 20 to 40 feet above the water. The weather was clear, sun at 45^0, light south wind, excellent visibility. The ship was second in the three ship port column of a seven ship, two column convoy, escorted by one "SC" and one "PC", which were patrolling at the head of each column. The SANTIAGO DE CUBA, which was the second ship in the starboard column, parallel to and 700 yards distant from the *MANZANILLO*, had been torpedoed and sunk a minute before.

3. The helmsman saw the track of the torpedo about 130 feet from the ship; but before avoiding action could be taken, the torpedo hit on the starboard side, ship broke in two, and quickly sank. Damage was believed complete, and fires broke out; but ship sank too quickly to observe details. The torpedo released considerable greenish smoke which had a pungent odor. No distress signals were sent. Confidentials, believed to have been in the safe, sank with the ship.

4. The ship's complement was 28 in the crew, all Cuban, and two U.S.C.G. signalmen. Five survivors were landed at Key West and two of those later died there in the Marine Hospital; three are believed to

have been picked up by the M/V ANNETTE bound for Havana, Cuba; five are known dead, and the remainder, including the U.S.C.G. signalmen, are missing and believed lost.
5. The sub was not seen."
-Office of the Chief of Naval Operations
1942 Summary of Statements of survivors of the SS *MANZANILLO*, Cuban freighter, 1025 G.T.; owners: Empresa Naviera de Cuba, Tenth Fleet ASW Analysis & Stat. Section Series XIII. Report and Analyses of U. S. and Allied Merchant Shipping Losses 1941-1945 Malox – Memphis City, Records of the Office of the Chief of Naval Operations, Box 237, Record Group 38, National Archives at College Park, MD.

The ship was torpedoed and sunk by a German U-boat, along with the *Santiago de Cuba.* Approximately 30 men were lost from both ships.
- CUBA BURIES SEA VICTIMS Special Cable to THE NEW YORK TIMES. New York Times (1857-Current file); Aug 21, 1942; ProQuest Historical Newspapers The New York Times (1851 - 2005) pg. 7.

-Sinkings Anger Cubans The Washington Post (1877-1954); Aug 15, 1942; ProQuest Historical Newspapers The Washington Post (1877 - 1992) pg. 2.

The ship was sunk by *U-508*, commanded by Georg Staats, with torpedoes. Smoke could be seen from the windows of the Key West Sound School.
-M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 154.

General Notes

None in the database.

Wreck Condition/Salvage History

Unknown; the wreck has never been located.

Archaeological Assessment

The archaeological assessment provides additional primary source based documentation about the sinking of vessels. It also provides condition-based archaeological assessment of the wrecks when possible. It does not provide a risk-based score or definitively assess the pollution risk or lack thereof from these vessels, but includes additional information that could not be condensed into database form.

Where the current condition of a shipwreck is not known, data from other archaeological studies of similar types of shipwrecks provide the means for brief explanations of what the shipwreck might look like and specifically, whether it is thought there is sufficient structural integrity to retain oil. This is more subjective than the Pollution Potential Tree and computer-generated resource at risk models, and as such provides an additional viewpoint to examine risk assessments and assess the threat posed by these shipwrecks. It also addresses questions of historical significance and the relevant historic preservation laws and regulations that will govern on-site assessments.

In some cases where little additional historic information has been uncovered about the loss of a vessel, archaeological assessments cannot be made with any degree of certainty and were not prepared. For vessels with full archaeological assessments, NOAA archaeologists and contracted archivists have taken photographs of primary source documents from the National Archives that can be made available for future research or on-site activities.

Assessment

NOAA archaeologists have located little additional historic documentation on the sinking of the freighter *Manzanillo*, and no site reports exist that would allow much additional archaeological assessment about the shipwreck on top of the casualty narrative included in this packet. Based on the lack of an accurate sinking location and the great depths the vessel sank in, it is unlikely that the shipwreck will be intentionally located.

This ship is one of the smallest ships in the RULET database, and it is likely that the ship had a relatively small bunker capacity. Recent research by BOEM also strongly suggests that vessels in great depths of water are generally found in an upright orientation. This orientation has often lead to loss of oil from vents and piping long before loss of structural integrity of hull plates from corrosion or other physical impacts. As it is believed that this vessel is in water depths between 360 and 860 feet, it is possible that the ship has settled upright and may no longer contain oil.

The only way to conclusively determine the condition of the shipwreck, however, will be to examine the site after it is discovered. Should the vessel be located in a survey of opportunity or due to a mystery spill attributed to this vessel, it should be noted that this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) and possibly the Sunken Military Craft Act (SMCA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Register of Historic Places. The site is also considered a war grave and appropriate actions should be undertaken to minimize disturbance to the site.

Background Information References

Vessel Image Sources: No image of this vessel has been located by NOAA.

Construction Diagrams or Plans in RULET Database? No

Text References:

-Office of the Chief of Naval Operations
1942 Summary of Statements of survivors of the SS *MANZANILLO*, Cuban freighter, 1025 G.T.; owners: Empresa Naviera de Cuba, Tenth Fleet ASW Analysis & Stat. Section Series XIII. Report and Analyses of U. S. and Allied Merchant Shipping Losses 1941-1945 Malox – Memphis City, Records of the Office of the Chief of Naval Operations, Box 237, Record Group 38, National Archives at College Park, MD.

-http://www.uboat.net/allies/merchants/ships/2036.html

-CUBA BURIES SEA VICTIMS Special Cable to THE NEW YORK TIMES. New York Times (1857-Current file); Aug 21, 1942; ProQuest Historical Newspapers The New York Times (1851 - 2005) pg. 7.

-Sinkings Anger Cubans The Washington Post (1877-1954); Aug 15, 1942; ProQuest Historical Newspapers The Washington Post (1877 - 1992) pg. 2.

-M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 154.

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Manzanillo* based on the information available. These factors are reflected in the pollution potential risk assessment development by the U.S. Coast Guard Salvage Engineering Response Team (SERT) as a means to apply a salvage engineer's perspective to the historical information gathered by NOAA. This analysis reflected in Figure 1-1 is simple and straightforward and, in combination with the accompanying archaeological assessment, provides a picture of the wreck that is as complete as possible based on current knowledge and best professional judgment.

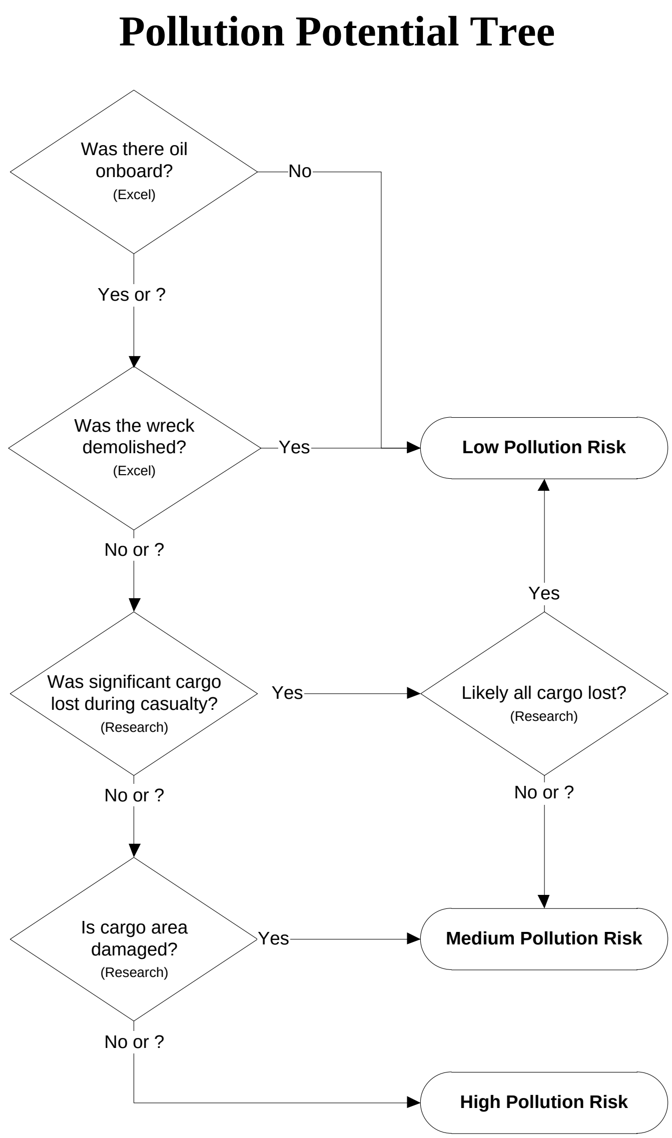


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

This assessment _does not_ take into consideration operational constraints such as depth or unknown location, but rather attempts to provide a replicable and objective screening of the historical date for each vessel. SERT reviewed the general historical information available for the database as a whole and provided a stepwise analysis for an initial indication of Low/Medium/High values for each vessel.

In some instances, nuances from the archaeological assessment may provide additional input that will amend the score for Section 1. Where available, additional information that may have bearing on operational considerations for any assessment or remediation activities is provided.

Each risk factor is characterized as High, Medium, or Low Risk or a category-appropriate equivalent such as No, Unknown, Yes, or Yes Partially. The risk categories correlate to the decision points reflected in Figure 1-1.

Each of the risk factors also has a "data quality modifier" that reflects the completeness and reliability of the information on which the risk ranks were assigned. The quality of the information is evaluated with respect to the factors required for a reasonable preliminary risk assessment. The data quality modifier scale is:

- **High Data Quality:** All or most pertinent information on wreck available to allow for thorough risk assessment and evaluation. The data quality is high and confirmed.
- **Medium Data Quality:** Much information on wreck available, but some key factor data are missing or the data quality is questionable or not verified. Some additional research needed.
- **Low Data Quality:** Significant issues exist with missing data on wreck that precludes making preliminary risk assessment, and/or the data quality is suspect. Significant additional research needed.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Manzanillo* is provided, both as text and as shading of the applicable degree of risk bullet.

Pollution Potential Factors

Risk Factor A1: Total Oil Volume

The oil volume classifications correspond to the U.S. Coast Guard spill classifications:

- **Low Volume: Minor Spill** <240 bbl (10,000 gallons)
- **Medium Volume: Medium Spill** ≥240 – 2,400 bbl (100,000 gallons)
- **High Volume: Major Spill** ≥2,400 bbl (≥100,000 gallons)

The oil volume risk classifications refer to the volume of the most-likely Worst Case Discharge from the vessel and are based on the amount of oil believed or confirmed to be on the vessel.

The *Manzanillo* is ranked as High Volume because it is thought to have a potential for up to 5,000 bbl, although some of that may have been lost at the time of the casualty or after the vessel sank. Data quality is low because the exact bunker capacity for the *Manzanillo* is not known.

The risk factor for volume also incorporates any reports or anecdotal evidence of actual leakage from the vessel or reports from divers of oil in the overheads, as opposed to potential leakage. This reflects the history of the vessel's leakage. There are no reports of leakage from the *Manzanillo*.

Risk Factor A2: Oil Type

The oil type(s) on board the wreck are classified only with regard to persistence, using the U.S. Coast Guard oil grouping[1]. (Toxicity is dealt with in the impact risk for the Resources at Risk classifications.) The three oil classifications are:

- **Low Risk: Group I Oils** – non-persistent oil (e.g., gasoline)
- **Medium Risk: Group II – III Oils** – medium persistent oil (e.g., diesel, No. 2 fuel, light crude, medium crude)
- **High Risk: Group IV** – high persistent oil (e.g., heavy crude oil, No. 6 fuel oil, Bunker C)

The *Manzanillo* is classified as High Risk because the bunker oil is heavy fuel oil, a Group IV oil type. Data quality is high.

Was the wreck demolished?

Risk Factor B: Wreck Clearance

This risk factor addresses whether or not the vessel was historically reported to have been demolished as a hazard to navigation or by other means such as depth charges or aerial bombs. This risk factor is based on historic records and does not take into account what a wreck site currently looks like. The risk categories are defined as:

- **Low Risk:** The site was reported to have been entirely destroyed after the casualty
- **Medium Risk:** The wreck was reported to have been partially cleared or demolished after the casualty
- **High Risk:** The wreck was not reported to have been cleared or demolished after the casualty
- **Unknown:** It is not known whether or not the wreck was cleared or demolished at the time of or after the casualty

The *Manzanillo* is classified as High Risk because there are no known historic accounts of the wreck being demolished as a hazard to navigation. Data quality is high.

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

This risk factor addresses any burning that is known to have occurred at the time of the vessel casualty and may have resulted in oil products being consumed or breaks in the hull or tanks that would have

[1] Group I Oil or Nonpersistent oil is defined as "a petroleum-based oil that, at the time of shipment, consists of hydrocarbon fractions: At least 50% of which, by volume, distill at a temperature of 340°C (645°F); and at least 95% of which, by volume, distill at a temperature of 370°C (700°F)."
Group II - Specific gravity less than 0.85 crude [API° >35.0]
Group III - Specific gravity between 0.85 and less than .95 [API° ≤35.0 and >17.5]
Group IV - Specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0]

increased the potential for oil to escape from the shipwreck. The risk categories are:

- **Low Risk:** Burned for multiple days
- **Medium Risk:** Burned for several hours
- **High Risk:** No burning reported at the time of the vessel casualty
- **Unknown:** It is not known whether or not the vessel burned at the time of the casualty

The *Manzanillo* is classified as Medium Risk because a fire was reported at the time of the casualty. Data quality is high.

Risk Factor C2: Reported Oil on the Water

This risk factor addresses reports of oil on the water at the time of the vessel casualty. The amount is relative and based on the number of available reports of the casualty. Seldom are the reports from trained observers so this is very subjective information. The risk categories are defined as:

- **Low Risk:** Large amounts of oil reported on the water by multiple sources
- **Medium Risk:** Moderate to little oil reported on the water during or after the sinking event
- **High Risk:** No oil reported on the water
- **Unknown:** It is not know whether or not there was oil on the water at the time of the casualty

The *Manzanillo* is classified as High Risk because no oil is known to have been reported spreading across the water as the vessel went down. Data quality is low because complete sinking reports were not located.

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

This risk factor addresses the means by which the vessel sank. The risk associated with each type of casualty is determined by the how violent the sinking event was and the factors that would contribute to increased initial damage or destruction of the vessel (which would lower the risk of oil, other cargo, or munitions remaining on board). The risk categories are:

- **Low Risk:** Multiple torpedo detonations, multiple mines, severe explosion
- **Medium Risk:** Single torpedo, shellfire, single mine, rupture of hull, breaking in half, grounding on rocky shoreline
- **High Risk:** Foul weather, grounding on soft bottom, collision
- **Unknown:** The cause of the loss of the vessel is not known

The *Manzanillo* is classified as Medium Risk because there was one torpedo detonation. Data quality is high.

Risk Factor D2: Structural Breakup

This risk factor takes into account how many pieces the vessel broke into during the sinking event or since sinking. This factor addresses how likely it is that multiple components of a ship were broken apart including tanks, valves, and pipes. Experience has shown that even vessels broken in three large sections can still have significant pollutants on board if the sections still have some structural integrity. The risk categories are:

- **Low Risk:** The vessel is broken into more than three pieces

- **Medium Risk:** The vessel is broken into two-three pieces
- **High Risk:** The vessel is not broken and remains as one contiguous piece
- **Unknown:** It is currently not known whether or not the vessel broke apart at the time of loss or after sinking

The *Manzanillo* is classified as Unknown Risk because it is not known whether additional structural breakup occurred since the location is unknown. Data quality is low.

Factors That May Impact Potential Operations

Orientation (degrees)

This factor addresses what may be known about the current orientation of the intact pieces of the wreck (with emphasis on those pieces where tanks are located) on the seafloor. For example, if the vessel turtled, not only may it have avoided demolition as a hazard to navigation, but it has a higher likelihood of retaining an oil cargo in the non-vented and more structurally robust bottom of the hull.

The location of the *Manzanillo* is unknown. Data quality is high.

Depth

Depth information is provided where known. In many instances, depth will be an approximation based on charted depths at the last known locations.

The *Manzanillo* is believed to be between 360 and 860 feet deep depending on the historic sinking coordinates that are used. Data quality is low.

Visual or Remote Sensing Confirmation of Site Condition

This factor takes into account what the physical status of wreck site as confirmed by remote sensing or other means such as ROV or diver observations and assesses its capability to retain a liquid cargo. This assesses whether or not the vessel was confirmed as entirely demolished as a hazard to navigation, or severely compromised by other means such as depth charges, aerial bombs, or structural collapse.

The location of the *Manzanillo* is unknown. Data quality is low.

Other Hazardous (Non-Oil) Cargo on Board

This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released, causing impacts to ecological and socio-economic resources at risk.

The *Manzanillo* also carried a cargo of lead. Data quality is high.

Munitions on Board

This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released or detonated causing impacts to ecological and socio-economic resources at risk.

The *Manzanillo* did not carry any munitions. Data quality is high.

Vessel Pollution Potential Summary

Table 1-1 summarizes the risk factor scores for the pollution potential and mitigating factors that would reduce the pollution potential for the *Manzanillo*. Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *Manzanillo* color-coded as red (high risk), yellow (medium risk), and green (low risk).

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	Maximum of 5,000 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Bunker fuel is a heavy fuel oil, a Group IV oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	A fire was reported	
	C2: Oil on Water	Low	No oil was reported on the water	
	D1: Nature of Casualty	High	One torpedo detonation	
	D2: Structural Breakup	Low	Unknown structural breakup	
Archaeological Assessment	Archaeological Assessment	Low	Limited sinking records of this ship were located and no site reports, assessment is of limited accuracy	**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown, potential to be upright	**Not Scored**
	Depth	Low	Between 360 ft and 860 ft	
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location unknown	
	Other Hazardous Materials Onboard	High	Lead	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

To help evaluate the potential transport and fates of releases from sunken wrecks, NOAA worked with RPS ASA to run a series of generalized computer model simulations of potential oil releases. The results are used to assess potential impacts to ecological and socio-economic resources, as described in Sections 3 and 4. The modeling results are useful for this screening-level risk assessment; however, it should be noted that detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Manzanillo* this would be about 5,000 bbl based on current estimates of the amount of oil remaining onboard the wreck (Table 2-1).

The likeliest scenario of oil release from most sunken wrecks, including the *Manzanillo*, is a small, episodic release that may be precipitated by disturbance of the vessel in storms. Each of these episodic releases may cause impacts and require a response. **Episodic** releases are modeled using 1% of the WCD. Another scenario is a very low chronic release, i.e., a relatively regular release of small amounts of oil that causes continuous oiling and impacts over the course of a long period of time. This type of release would likely be precipitated by corrosion of piping that allows oil to flow or bubble out at a slow, steady rate. **Chronic** releases are modeled using 0.1% of the WCD.

The **Most Probable** scenario is premised on the release of all the oil from one tank. In the absence of information on the number and condition of the cargo or fuel tanks for all the wrecks being assessed, this scenario is modeled using 10% of the WCD. The **Large** scenario is loss of 50% of the WCD. The five major types of releases are summarized in Table 2-1. The actual type of release that occurs will depend on the condition of the vessel, time factors, and disturbances to the wreck. Note that, the episodic and chronic release scenarios represent a small release that is repeated many times, potentially repeating the same magnitude and type of impact(s) with each release. The actual impacts would depend on the environmental factors such as real-time and forecast winds and currents during each release and the types/quantities of ecological and socio-economic resources present.

The model results here are based on running the RPS ASA Spill Impact Model Application Package (SIMAP) two hundred times for each of the five spill volumes shown in Table 2-1. The model randomly selects the date of the release, and corresponding environmental, wind, and ocean current information from a long-term wind and current database.

When a spill occurs, the trajectory, fate, and effects of the oil will depend on environmental variables, such as the wind and current directions over the course of the oil release, as well as seasonal effects. The magnitude and nature of potential impacts to resources will also generally have a strong seasonal component (e.g., timing of bird migrations, turtle nesting periods, fishing seasons, and tourism seasons).

Table 2-1: Potential oil release scenario types for the *Manzanillo*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	5 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	50 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	500 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	2,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	5,000 bbl	One-time release	Over several hours or days	Least likely	Tier 3

The modeling results represent 200 simulations for each spill volume with variations in spill trajectory based on winds and currents. The spectrum of the simulations gives a perspective on the variations in likely impact scenarios. Some resources will be impacted in nearly all cases; some resources may not be impacted unless the spill trajectory happens to go in that direction based on winds and currents at the time of the release and in its aftermath.

For the large and WCD scenarios, the duration of the release was assumed to be 12 hours, envisioning a storm scenario where the wreck is damaged or broken up, and the model simulations were run for a period of 30 days. The releases were assumed to be from a depth between 2-3 meters above the sea floor, using the information known about the wreck location and depth. It is important to acknowledge that these scenarios are only for this screening-level assessment. Detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Oil Type for Release

The *Manzanillo* contained a maximum of 5,000 bbl of heavy fuel oil (a Group IV oil) as bunker fuel. Thus, the oil spill model was run using heavy fuel oil.

Oil Thickness Thresholds

The model results are reported for different oil thickness thresholds, based on the amount of oil on the water surface or shoreline and the resources potentially at risk. Table 2-2 shows the terminology and thicknesses used in this report, for both oil thickness on water and the shoreline. For oil on the water surface, a thickness of 0.01 g/m^2, which would appear as a barely visible sheen, was used as the threshold for socio-economic impacts because often fishing is prohibited in areas with any visible oil, to prevent contamination of fishing gear and catch. A thickness of 10 g/m^2 was used as the threshold for ecological impacts, primarily due to impacts to birds, because that amount of oil has been observed to be enough to mortally impact birds and other wildlife. In reality, it is very unlikely that oil would be evenly distributed on the water surface. Spilled oil is always distributed patchily on the water surface in bands or tarballs with clean water in between. So, Table 2-2a shows the number of tarballs per acre on the water surface for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter. For oil stranded onshore, a thickness of 1 g/m^2 was used as the threshold for socio-economic impacts because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity beaches. A thickness of 100 g/m^2 was used as the threshold for ecological impacts based on a synthesis of the literature showing that shoreline life has been affected by this degree of oiling.[2] Because oil often strands onshore as tarballs, Table 2-2b shows the number of tarballs per m^2 on the shoreline for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter.

Table 2-2a: Oil thickness thresholds used in calculating area of water impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Sheen Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen	Barely Visible	0.00001 mm	0.01 g/m^2	~5-6 tarballs per acre	Socio-economic Impacts to Water Surface/Risk Factor 4B-1 and 2
Heavy Oil Sheen	Dark Colors	0.01 mm	10 g/m^2	~5,000-6,000 tarballs per acre	Ecological Impacts to Water Surface/ Risk Factor 3B-1 and 2

Table 2-2b: Oil thickness thresholds used in calculating miles of shoreline impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Oil Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen/Tarballs	Dull Colors	0.001 mm	1 g/m^2	~0.12-0.14 tarballs/m^2	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m^2	~12-14 tarballs/m^2	Ecological Impacts to Shoreline Habitats/Risk Factor 3C-1 and 2

Potential Impacts to the Water Column

Impacts to the water column from an oil release from the *Manzanillo* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi^2 that has been contaminated by 1 part per billion (ppb) oil to a depth of 33 feet. At 1 ppb, there are likely to be impacts to sensitive organisms in the water column and potential tainting of seafood, so this concentration is used as a screening threshold for both the ecological and socio-economic risk factors for water column resource impacts. To assist planners understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water column volume oiled using the five volume scenarios, which is shown in Figure 2-1. Using this figure, the water column impacts can be estimated for any spill volume.

[2] French, D., M. Reed, K. Jayko, S. Feng, H. Rines, S. Pavignano, T. Isaji, S. Puckett, A. Keller, F. W. French III, D. Gifford, J. McCue, G. Brown, E. MacDonald, J. Quirk, S. Natzke, R. Bishop, M. Welsh, M. Phillips and B.S. Ingram, 1996. The CERCLA type A natural resource damage assessment model for coastal and marine environments (NRDAM/CME), Technical Documentation, Vol. I - V. Office of Environmental Policy and Compliance, U.S. Dept. of the Interior, Washington, DC.

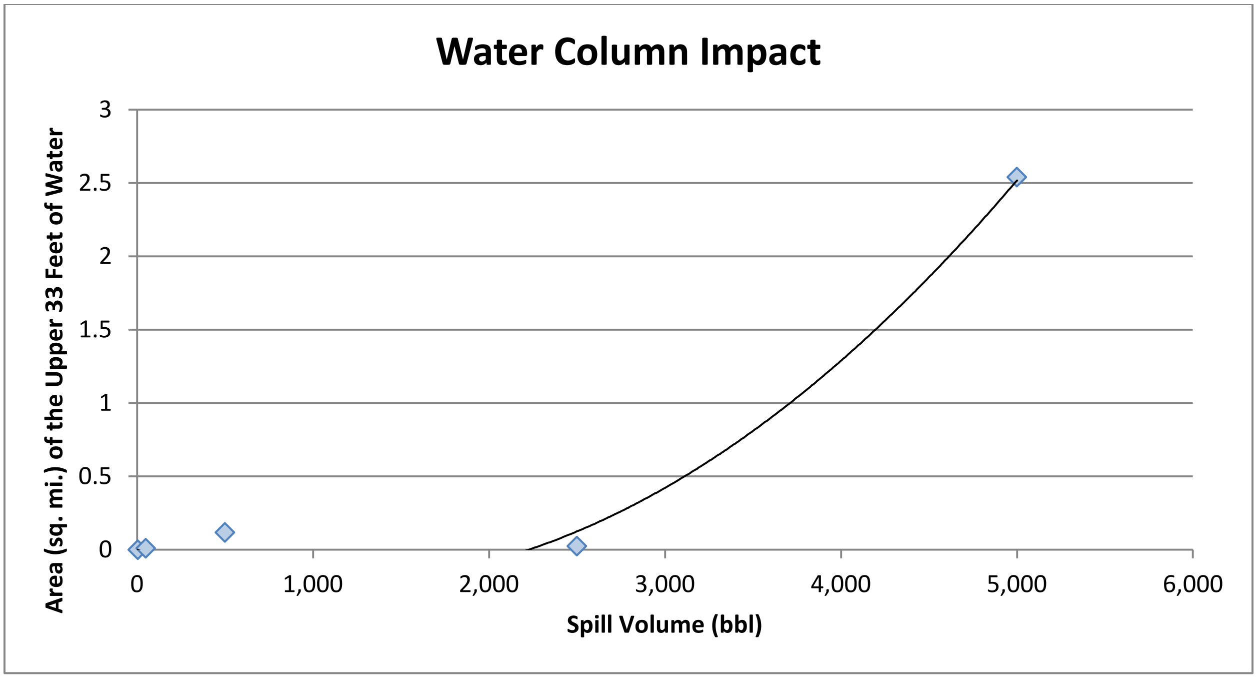


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted at or above the threshold of 1 ppb aromatics as a function of spill volume for the *Manzanillo*.

Potential Water Surface Slick

The slick size from an oil release from the *Manzanillo* is a function of the quantity released. The estimated water surface coverage by a fresh slick (the total water surface area "swept" by oil over time) for the various scenarios is shown in Table 2-3, as the mean result of the 200 model runs. Note that this is an estimate of total water surface affected over a 30-day period. In the model, the representative heavy fuel oil used for this analysis spreads to a minimum thickness of approximately 975 g/m^2, and is not able to spread any thinner. As a result, water surface oiling results are identical for the 0.01 and 10 g/m^2 thresholds. The slick will not be continuous but rather be broken and patchy due to the subsurface release of the oil. Surface expression is likely to be in the form of sheens, tarballs, and streamers.

Table 2-3: Estimated slick area swept on water for oil release scenarios from the *Manzanillo*.

Scenario Type	Oil Volume (bbl)	Estimated Fresh Slick Coverage Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	5	96 mi^2	96 mi^2
Episodic	50	320 mi^2	320 mi^2
Most Probable	500	1,000 mi^2	1,000 mi^2
Large	2,500	2,300 mi^2	2,300 mi^2
Worst Case Discharge	5,000	3,300 mi^2	3,300 mi^2

The location, size, shape, and spread of the oil slick(s) from an oil release will depend on environmental conditions, including winds and currents, at the time of release and in its aftermath. The areas potentially affected by oil slicks, given that we cannot predict when the spill might occur and the range of possible wind and current conditions that might prevail after a release, are shown in Figure 2-2 and Figure 2-3 using the Most Probable volume and the socio-economic and ecological thresholds.

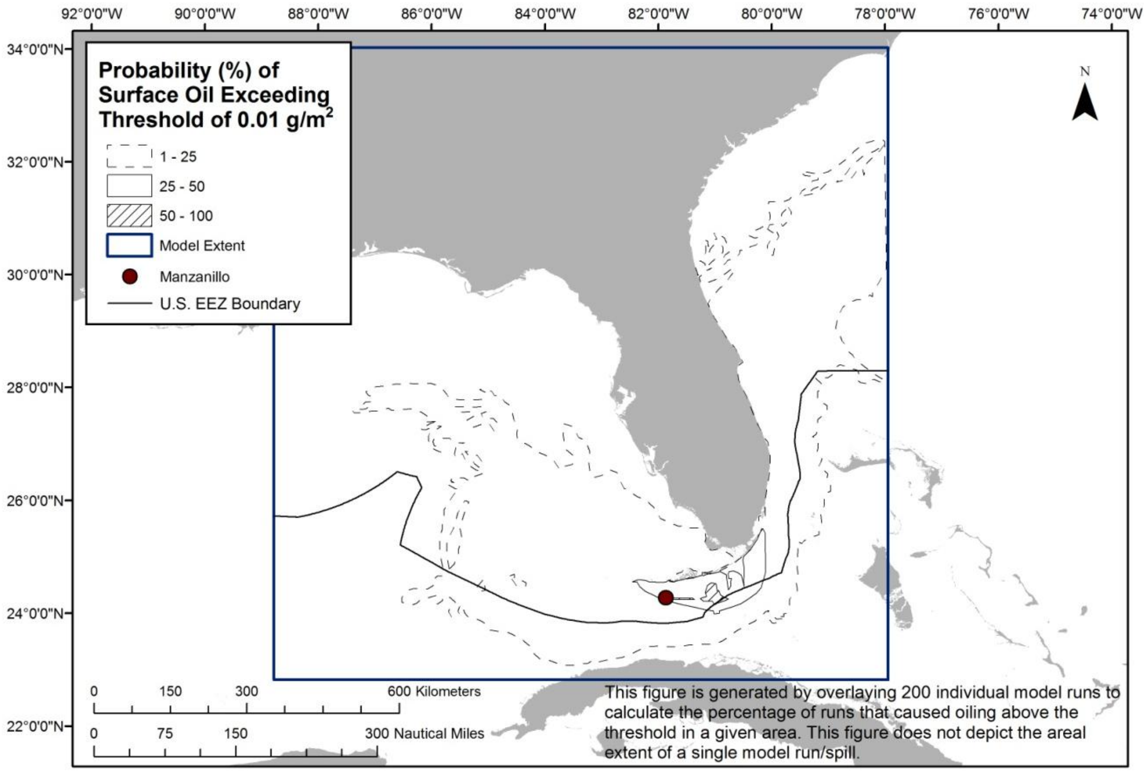


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 500 bbl of heavy fuel oil from the *Manzanillo* at the threshold for socio-economic resources at risk.

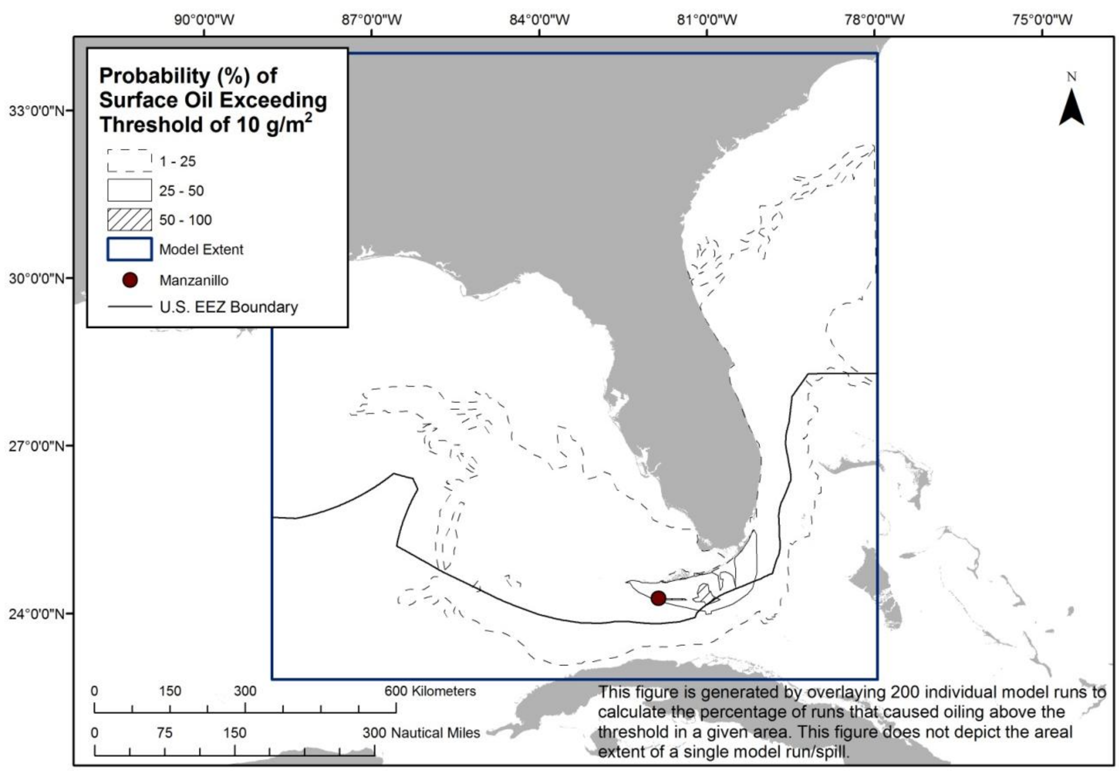


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 500 bbl of heavy fuel oil from the *Manzanillo* at the threshold for ecological resources at risk.

The maximum potential cumulative area swept by oil slicks at some time after a Most Probable Discharge is shown in Figure 2-4 as the timing of oil movements.

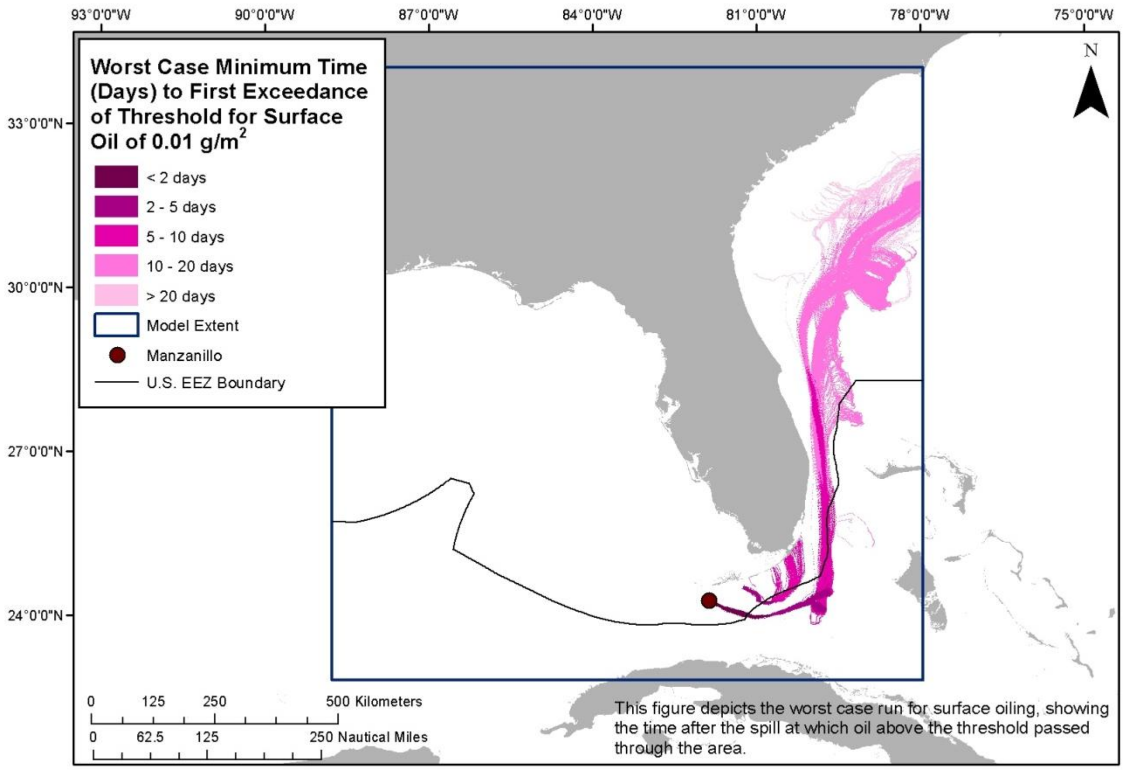


Figure 2-4: Water surface oiling from the Most Probable spill of 500 bbl of heavy fuel oil from the *Manzanillo* shown as the area over which the oil spreads at different time intervals.

The actual area affected by a release will be determined by the volume of leakage, whether it is from one or more tanks at a time. To assist planners in understanding the potential scale of impacts for different leakage volumes, a regression curve was generated for the water surface area oiled using the five volume scenarios, which is shown in Figure 2-5. Using this figure, the area of water surface with a barely visible sheen can be estimated for any spill volume.

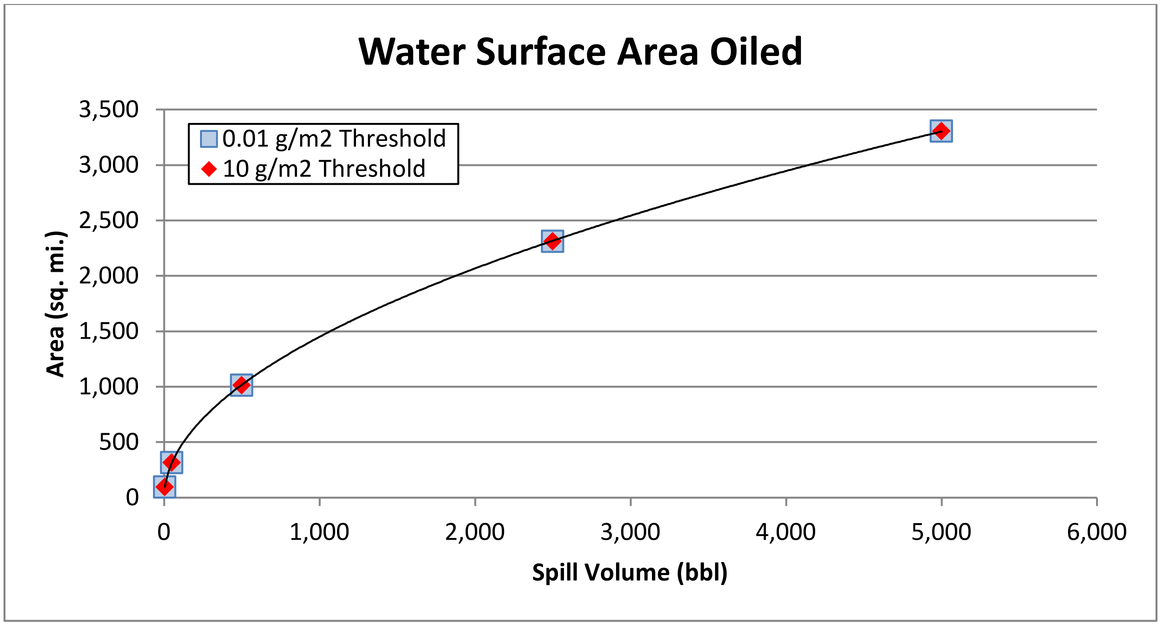


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Manzanillo*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2.

Potential Shoreline Impacts

Based on these modeling results, shorelines from Dry Tortugas to St. Augustine, Florida and parts of Cuba and Bermuda are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m^2, for the Most Probable release of 500 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. Estimated miles of shoreline oiling above the threshold of 1 g/m^2 by scenario type are shown in Table 2-4.

Table 2-4a: Estimated shoreline oiling from leakage from the *Manzanillo*. (U.S., Cuba, and Bermuda).

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	5	3	0	0	3
Episodic	50	5	4	3	12
Most Probable	500	7	10	15	32
Large	2,500	8	11	26	46
Worst Case Discharge	5,000	9	12	27	47

Table 2-4b: Estimated shoreline oiling from leakage from the *Manzanillo*. (U.S. only).

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	5	3	0	0	3
Episodic	50	5	4	3	12
Most Probable	500	8	9	15	32
Large	2,500	9	11	26	45
Worst Case Discharge	5,000	9	11	27	47

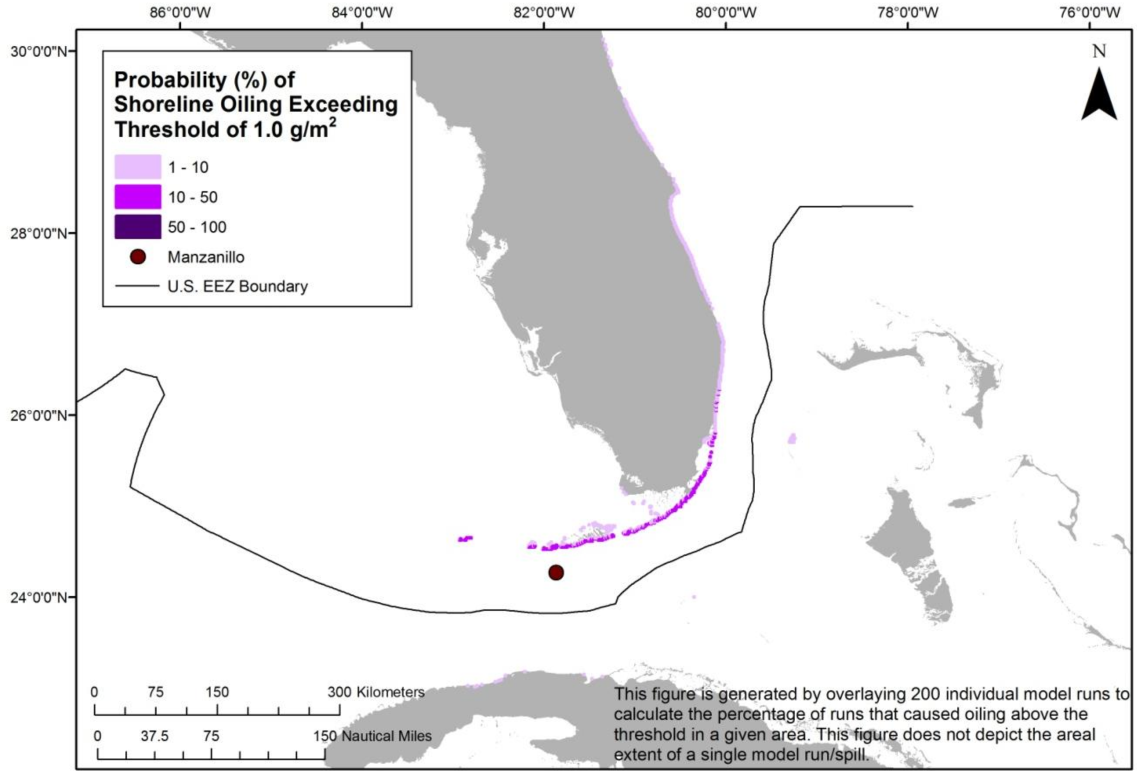


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 500 bbl of heavy fuel oil from the *Manzanillo*.

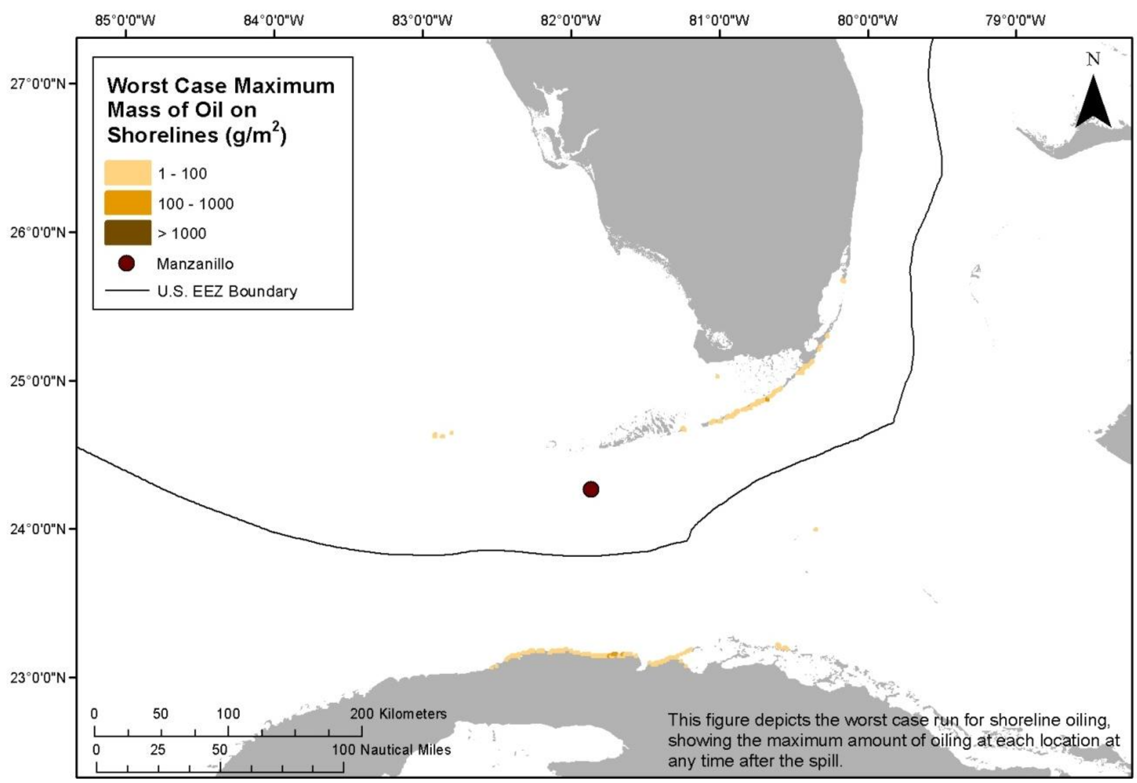


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 500 bbl of heavy fuel oil from the *Manzanillo* that resulted in the greatest shoreline oiling.

The actual shore length affected by a release will be determined by the volume of leakage and environmental conditions during an actual release. To assist planners in scaling the potential impact for different leakage volumes, a regression curve was generated for the total shoreline length oiled using the five volume scenarios, which is shown in Figure 2-8. Using this figure, the shore length oiled can be estimated for any spill volume.

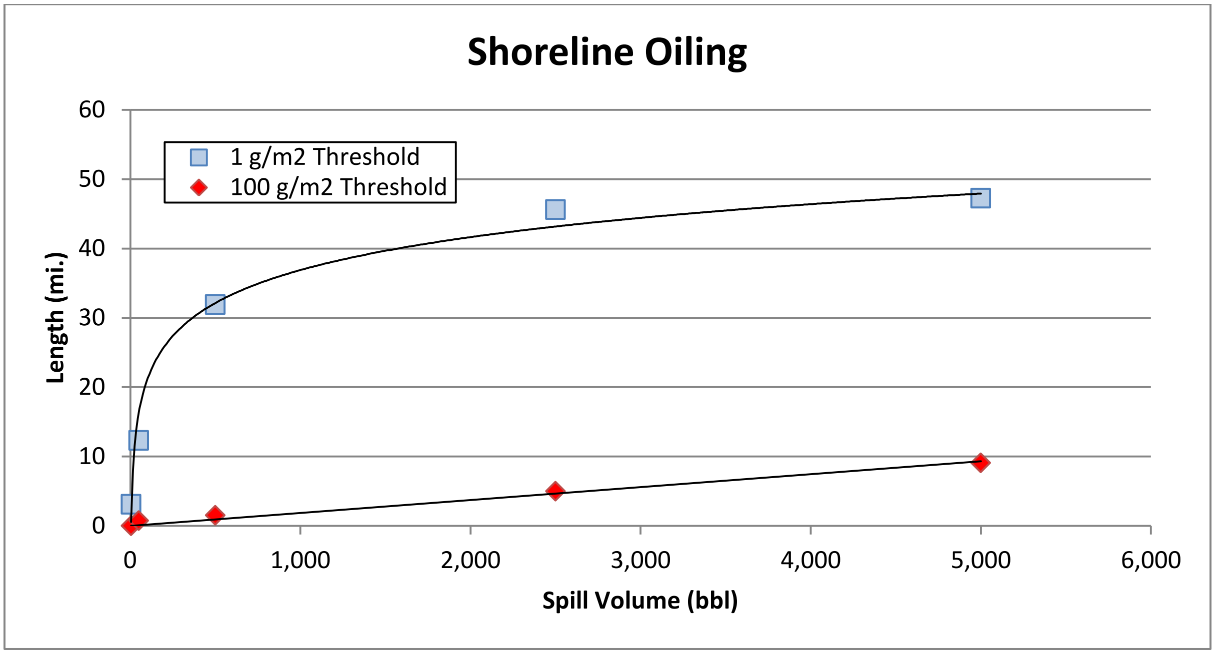


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Manzanillo*.

The worst case scenario for shoreline exposure along the potentially impacted area for the WCD volume (Table 2-5) and the Most Probable volume (Table 2-6) consists primarily of sand beaches and rocky shores. Mangroves are at risk of lighter oiling.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 5,000 bbl from the *Manzanillo*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	24 miles	1 mile
Sand beaches	94 miles	19 miles
Salt marshes and tidal flats	40 miles	0 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 500 bbl from the *Manzanillo*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	20 miles	0 miles
Sand beaches	74 miles	0 miles
Salt marshes and tidal flats	11 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Manzanillo* (Table 3-1) include numerous guilds of birds that are sensitive to surface or shoreline oiling. The Dry Tortugas support a unique seabird fauna that cannot be found elsewhere in the United States, and provide spawning and nursery habitat for nurse sharks. Nearshore hardbottom and seagrass habitats are important foraging and resting grounds for endangered sea turtles and nursery grounds for the finfish and invertebrate fisheries.

Table 3-1: Ecological resources at risk from a release of oil from the *Manzanillo*.
(FT = Federal threatened; FE = Federal endangered; ST = State threatened; SE = State endangered).

Species Group	Species Subgroup and Geography	Seasonal Presence
Birds	*Southern FL, Biscayne Bay, and FL keys hammocks* • Important stopovers for neotropical migrants in the spring and fall • Rookery and roosting for Wilson's plovers, least terns (ST), white ibis (SSC), brown pelicans (SSC) and magnificent frigatebirds • FL Keys essential to survival of white-crowned pigeon (ST) • Hundreds of colonial nesters in Biscayne Bay, including double-crested cormorant, white ibis (SSC), great white heron, great blue heron, reddish egret (SSC), osprey (SSC), tricolored heron (SSC) *Marquesas/Key West NWR/Great White Heron NWR* • Great White Heron NWR – breeding, foraging, roosting sites for wading birds; white crowned pigeon (1,608 nests), great blue heron (1-200 nests) • Nesting great white heron (2-300 nests), little blue heron (175 nests; SSC), great blue heron (265 nests), and white-crowned pigeon (2,000 nests), reddish egret, least tern (ST) • Wintering piping plovers • Sandwich tern and royal terns present in summer • Cottrell Key is important roosting ground for wading birds *Dry Tortugas* • Nesting sooty terns (30,000), roseate terns (20-30) bridled terns (<10), brown noddies (1,000), magnificent frigatebirds (300), masked boobies (50), brown pelicans (20) • Attracts neotropical migrants (tropicbirds, boobies, noddies) in spring and fall	Colonial and beach nesters peak Apr-Aug Wading birds and shorebirds typically present year round Overwintering shorebirds Aug-May Piping plovers present Jul-Mar *Nesting*: Brown pelicans in Nov-Sep Wading birds in Nov/Dec-Jun/Jul Brown noddies in Mar-Oct Royal terns in May-Aug Masked boobies in Apr-May
Reptiles	*Nesting* • High densities of loggerheads (FT; 232 nests/km) and greens (FE; 57 nests/km) in Palm Beach county • Leatherback (FE) nesting present in Palm Beach and Broward counties • Low concentrations of turtles nest in Monroe and Miami-Dade county • Nesting sites in the Florida Keys is concentrated in the Dry Tortugas *Distribution* • Hawksbills (FE) regularly found in the Marquesas • Subadult green turtle hotspot west of the Marquesas and in Key West NWR • Bays and sounds are foraging grounds for juvenile green, loggerhead, and Kemp's ridley (FE)	Loggerheads nest Apr-Sep, hatch May-Nov Greens nest May-Sep, hatch Jun-Oct Leatherbacks nest Feb-Aug, hatch Mar-Sep
Marine Mammals	West Indian manatees are present year round in high concentrations in mainland waters; not as common in the Keys as in mainland waters Bottlenose dolphins common in coastal waters. Many other species in offshore	Manatee calving peaks in spring Dolphins present year round

Species Group	Species Subgroup and Geography	Seasonal Presence
Terrestrial Mammals	Key deer (FE) present on 27 islands in Key Deer NWR Lower Keys marsh rabbit (FE) present in the Saddlebunch keys	Year round
Fish and Invertebrates	The Florida Keys support a unique marine fauna which is the basis of a valuable recreational fishing and dive tourism industry. Many of these species use nearshore mangroves and seagrasses as nursery and/or foraging grounds • Reef/structure/hardbottom associated: snappers, groupers, grunts, porgies, hogfish, jacks, barracuda, spiny lobster, stone crab • Inshore: snook, red drum, tarpon, spotted seatrout, cobia, bonefish, queen conch Important concentration/conservation areas: • Nurse sharks aggregate to mate in shallows near the Dry Tortugas and Marquesas and pup in shallow waters of Florida Bay • Riley's Hump and Pulley Ridge have been identified as spawning grounds for some snapper species • *Sargassum* is important habitat for juvenile of some pelagic fish species (i.e. dolphinfish, jacks, triggerfish)	Nurse sharks mate Jun-Jul, parturition occurs Nov-Dec Snapper spawn during summer Grouper spawn during winter
Benthic Habitats	Benthic habitats include abundant seagrass and hard-bottom sites • Keys reef tract stretches from the Marquesas to Key Biscayne and is the third longest contiguous barrier reef in the world, only living barrier reef in the U.S. Expansive seagrass beds are present in coastal waters south of Biscayne Bay and Florida Bay. Johnson's seagrass (FE, SE) can be found in northern Biscayne Bay.	Live corals spawn late summer Habitats present year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Manzanillo* are generally available at each U.S. Coast Guard Sector. They can also be downloaded at: http://response.restoration.noaa.gov/esi. These maps show detailed spatial information on the distribution of sensitive shoreline habitats, biological resources, and human-use resources. The tables on the back of the maps provide more detailed life-history information for each species and location. The ESI atlases should be consulted to assess the potential environmental resources at risk for specific spill scenarios. In addition, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on the nearshore and shoreline ecological resources at risk and should be consulted.

Ecological Risk Factors

Risk Factor 3: Impacts to Ecological Resources at Risk (EcoRAR)

Ecological resources include plants and animals (e.g., fish, birds, invertebrates, and mammals), as well as the habitats in which they live. All impact factors are evaluated for both the Worst Case and the Most Probable Discharge oil release from the wreck. Risk factors for ecological resources at risk (EcoRAR) are divided into three categories:

- Impacts to the water column and resources in the water column;
- Impacts to the water surface and resources on the water surface; and
- Impacts to the shoreline and resources on the shoreline.

The impacts from an oil release from the wreck would depend greatly on the direction in which the oil slick moves, which would, in turn, depend on wind direction and currents at the time of and after the oil release. Impacts are characterized in the risk analysis based on the likelihood of any measurable impact, as well as the degree of impact that would be expected if there is to an impact. The measure of the degree of impact is based on the median case for which there is at least some impact. The median case is the "middle case" – half of the cases with significant impacts have less impact than this case, and half have more.

For each of the three ecological resources at risk categories, risk is defined as:

- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be an impact to ecological resources over a certain minimal amount); and
- The **degree of oiling** (the magnitude or amount of that impact).

As a reminder, the ecological impact thresholds are: 1 ppb aromatics for water column impacts; 10 g/m^2 for water surface impacts; and 100 g/m^2 for shoreline impacts.

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Manzanillo* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 5,000 bbl and a border around the Most Probable Discharge of 500 bbl.

Risk Factor 3A: Water Column Impacts to EcoRAR

Water column impacts occur beneath the water surface. The ecological resources at risk for water column impacts are fish, marine mammals, and invertebrates (e.g., shellfish, and small organisms that are food for larger organisms in the food chain). These organisms can be affected by toxic components in the oil. The threshold for water column impact to ecological resources at risk is a dissolved aromatic hydrocarbons concentration of 1 ppb (i.e., 1 part total dissolved aromatics per one billion parts water). Dissolved aromatic hydrocarbons are the most toxic part of the oil. At this concentration and above, one would expect impacts to organisms in the water column.

Risk Factor 3A-1: Water Column Probability of Oiling of EcoRAR

This risk factor reflects the probability that at least 0.2 mi^2 of the upper 33 feet of the water column would be contaminated with a high enough concentration of oil to cause ecological impacts. The three risk scores for water column oiling probability are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3A-2: Water Column Degree of Oiling of EcoRAR

The degree of oiling of the water column reflects the total volume of water that would be contaminated by oil at a concentration high enough to cause impacts. The three categories of impact are:

- **Low Impact:** impact on less than 0.2 mi^2 of the upper 33 feet of the water column at the threshold level
- **Medium Impact**: impact on 0.2 to 200 mi^2 of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi^2 of the upper 33 feet of the water column at the threshold level

The *Manzanillo* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 5,000 bbl because 53% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 3 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 500 bbl, the *Manzanillo* is classified as Medium Risk for oiling probability for water column ecological resources because 13% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 mi^2 of the upper 33 feet of the water column.

Risk Factor 3B: Water Surface Impacts to EcoRAR

Ecological resources at risk at the water surface include surface feeding and diving sea birds, sea turtles, and marine mammals. These organisms can be affected by the toxicity of the oil as well as from coating with oil. The threshold for water surface oiling impact to ecological resources at risk is 10 g/m^2 (10 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to birds and other animals that spend time on the water surface.

Risk Factor 3B-1: Water Surface Probability of Oiling of EcoRAR

This risk factor reflects the probability that at least 1,000 mi^2 of the water surface would be affected by enough oil to cause impacts to ecological resources. The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3B-2: Water Surface Degree of Oiling of EcoRAR

The degree of oiling of the water surface reflects the total amount of oil that would affect the water surface in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 1,000 mi^2 of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi^2 of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi^2 of water surface impact at the threshold level

The *Manzanillo* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 83% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is Medium Risk for degree of oiling because the mean area of water contaminated was 3,310 mi^2. The *Manzanillo* is classified as Medium Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 46% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 1,010 mi^2.

Risk Factor 3C: Shoreline Impacts to EcoRAR

The impacts to different types of shorelines vary based on their type and the organisms that live on them. In this risk analysis, shorelines have been weighted by their degree of sensitivity to oiling. Wetlands are the most sensitive (weighted as “3” in the impact modeling), rocky and gravel shores are moderately sensitive (weighted as “2”), and sand beaches (weighted as “1”) are the least sensitive to ecological impacts of oil.

Risk Factor 3C-1: Shoreline Probability of Oiling of EcoRAR

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline organisms. The threshold for shoreline oiling impacts to ecological resources at risk is 100 g/m^2 (i.e., 100 grams of oil per square meter of shoreline). The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 3C-2: Shoreline Degree of Oiling of EcoRAR

The degree of oiling of the shoreline reflects the length of shorelines oiled by at least 100 g/m^2 in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 10 miles of shoreline impacted at the threshold level
- **Medium Impact:** 10 - 100 miles of shoreline impacted at the threshold level
- **High Impact:** more than 100 miles of shoreline impacted at the threshold level

The *Manzanillo* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 96% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 18 miles. The *Manzanillo* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 57% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Low Risk for degree of oiling because the mean weighted length of shoreline contaminated was 2 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 5,000 bbl of heavy fuel oil from the *Manzanillo* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Low, because the relatively small area of highest exposure occurs in deep waters without any known concentrations of sensitive upper water column resources
- Water surface resources – Medium, because heavy fuel oils tend to quickly break up into fields of tarballs and streamers that can still impact sea turtles, marine birds, and marine mammals, but at lower degrees
- Shoreline resources – Medium, because about half of the shorelines at risk are sand/shell beaches where cleanup can be effective, though mangroves are also at risk and shorebirds, wading birds, and gulls/terns can be present seasonally in high numbers

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 5,000 bbl** of heavy fuel oil from the *Manzanillo*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	**High**	53% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
3A-2: Water Column Degree EcoRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 3 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	83% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	Med
3B-2: Water Surface Degree EcoRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 10 g/m^2 was 3,310 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	**High**	96% of the model runs resulted in shoreline oiling of 100 g/m^2	Med
3C-2: Shoreline Degree EcoRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 100 g/m^2 was 18 mi	

For the Most Probable Discharge of 500 bbl, the ecological risk from potential releases of heavy fuel oil from the *Manzanillo* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because of the very low volume of water column impacts
- Water surface resources – Medium, because the area affected is smaller, but there are still a large number of birds and sea turtles at risk. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – Low, because fewer miles of shoreline are at risk

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 500 bbl** of heavy fuel oil from the *Manzanillo*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	13% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	46% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 1,010 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	57% of the model runs resulted in shoreline oiling of 100 g/m^2	**Low**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 2 mi	

SECTION 4: SOCIO-ECONOMIC RESOURCES AT RISK

In addition to natural resource impacts, spills from sunken wrecks have the potential to cause significant social and economic impacts. Socio-economic resources potentially at risk from oiling are listed in Table 4-1 and shown in Figures 4-1 and 4-2. The potential economic impacts include disruption of coastal economic activities such as commercial and recreational fishing, boating, vacationing, commercial shipping, and other activities that may become claims following a spill.

Socio-economic resources in the areas potentially affected by a release from the *Manzanillo* include recreational beaches from eastern Florida to the Florida Keys which are very highly utilized during summer, and are still in use during spring and fall for shore fishing. One national seashore and one national park would potentially be affected. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. The Florida Keys National Marine Sanctuary would also potentially be affected, along with a large number of coastal state parks.

A release could impact shipping lanes to several ports with a total of over 6,600 annual port calls annually with a total of over 140 million tonnage. Commercial fishing is economically important to the region. A release could impact fishing fleets where regional commercial landings for 2010 exceeded $72 million with fishing fleets from Florida potentially impacted by a release.

In addition to the ESI atlases, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on important socio-economic resources at risk.

Spill response costs for a release of oil from the *Manzanillo* would be dependent on volume of oil released and specific areas impacted. The specific shoreline impacts and spread of the oil would determine the response required and the costs for that response.

Table 4-1: Socio-economic resources at risk from a release of oil from the *Manzanillo*.

Resource Type	Resource Name	Economic Activities
Tourist Beaches	Fernandina Beach, FL Atlantic Beach, FL St. Augustine Beach, FL Daytona Beach, FL Palm Coast, FL Melbourne Beach, FL Cocoa Beach, FL Vero Beach, FL Key Largo, FL Miami Beach, FL Fort Lauderdale, FL Boca Raton, FL Boynton Beach, FL Palm Beach, FL Pompano Beach, FL	Potentially affected beach resorts and beach-front communities in eastern Florida and the Florida keys provide recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks) with substantial income for local communities and state tax income. Much of the coast is lined with economically valuable beach resorts and residential communities. Many of these recreational activities are limited to or concentrated into the late spring through the early fall months.

Resource Type	Resource Name	Economic Activities
	Coral Gables, FL Key West, FL	
National Marine Sanctuary	Florida Keys National Marine Sanctuary (FL)	The Florida Keys National Marine Sanctuary has the only barrier coral reef in North America. Visitors take advantage of many recreational activities, including world-class diving, swimming, snorkeling, and fishing.
National Seashores	Canaveral National Seashore, FL	National seashores provide recreation for local and tourist populations while preserving and protecting the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area.
National Parks	Biscayne National Park, FL	Two coastal national historic monuments provide education in Civil War history. The Biscayne National Park provides snorkeling in coral reefs among other recreational activities.
National Wildlife Refuges	Merritt Island NWR Archie Carr NWR Pelican Island NWR Hobe Sound NWR A.R. Marshall-Loxahatchee NWR Crocodile Lake NWR National Key Deer NWR Great White Heron NWR Key West NWR	National wildlife refuges in Florida maybe impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.
State Parks	Bulow Plantation Ruins SP, FL Washington Oaks Gardens SP, FL Amelia Island SP, FL Fort Clinch SP, FL Guana River SP, FL Anastastia SP, FL Faver-Dykes SP, FL Green Mound Archaeological SP, FL Bulow Creek SP, FL Tomoka SP, FL Sebastian Inlet SP, FL Fort Pierce Inlet SP, FL St. Lucie Inlet Preserve SP, FL John D. MacArthur Beach SP, FL Hugh Taylor Birch SP, FL John U. Lloyd Beach SP, FL Bill Baggs Cape Florida SP, FL John Pennkamp Coral Reef SP, FL Indian Key Historic SP, FL San Pedro Underwater Arch. SP, FL Bahia Honda SP, FL Fort Zachary Taylor Historic SP, FL	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). Some of Florida's state parks offer unique opportunities for wildlife viewing and snorkeling. They provide income to the states. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Commercial Fishing	A number of fishing fleets use potentially affected waters for commercial fishing.	
	Cape Canaveral, FL	Total Landings (2010): $6.5M
	Fernandina Beach, FL	Total Landings (2010): $4.7M
	Mayport, FL	Total Landings (2010): $11.0M
	Fort Pierce-St. Lucie, FL	Total Landings (2010): $2.6M
	Key West	Total Landings (2010): $50.0M
Ports	There are a number of significant commercial ports along the Atlantic coast that could potentially be impacted by spillage and spill response activities. The port call numbers below are for large vessels only.	

Resource Type	Resource Name	Economic Activities
	There are many more, smaller vessels (under 400 GRT) that also use these ports.	
	Fernandina, FL	3 port calls annually
	Jacksonville, FL	1,641 port calls annually
	Port Canaveral, FL	38 port calls annually
	Savannah, GA	2,406 port calls annually
	Miami, FL	1,030 port calls annually
	Palm Beach, FL	126 port calls annually
	Port Everglades, FL	1,386 port calls annually

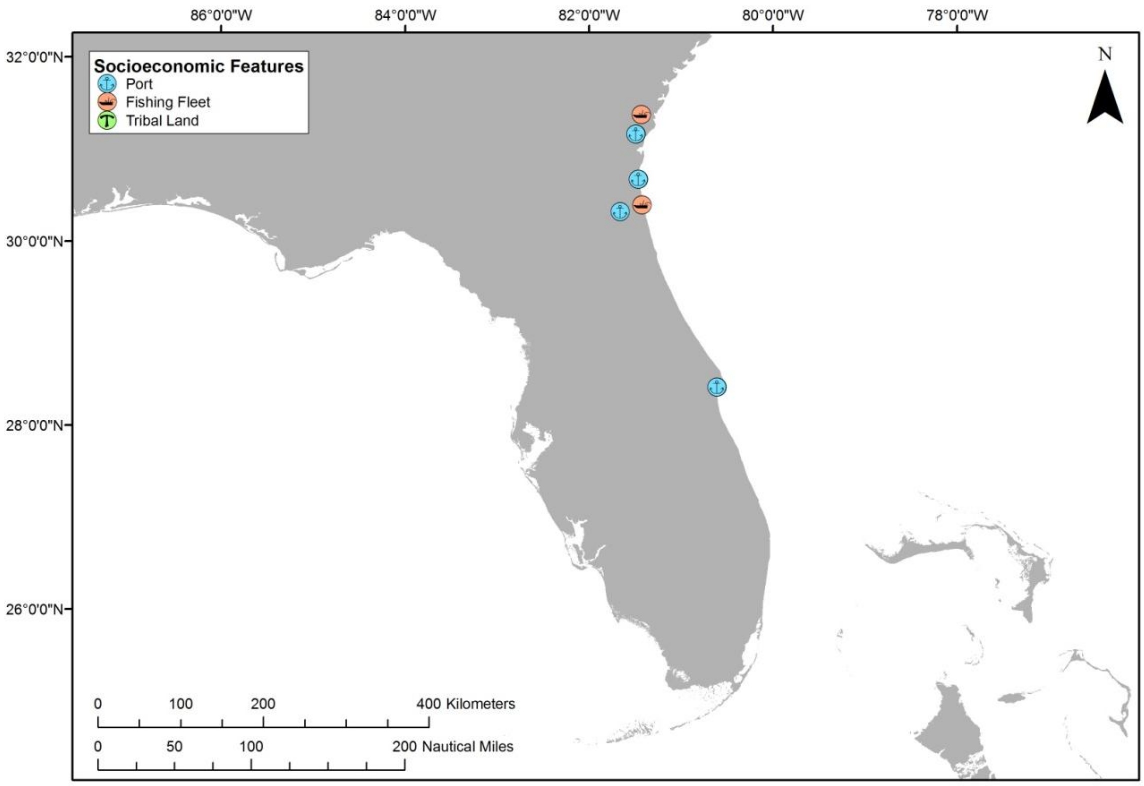


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Manzanillo*. (Note that there are no tribal lands at risk.)

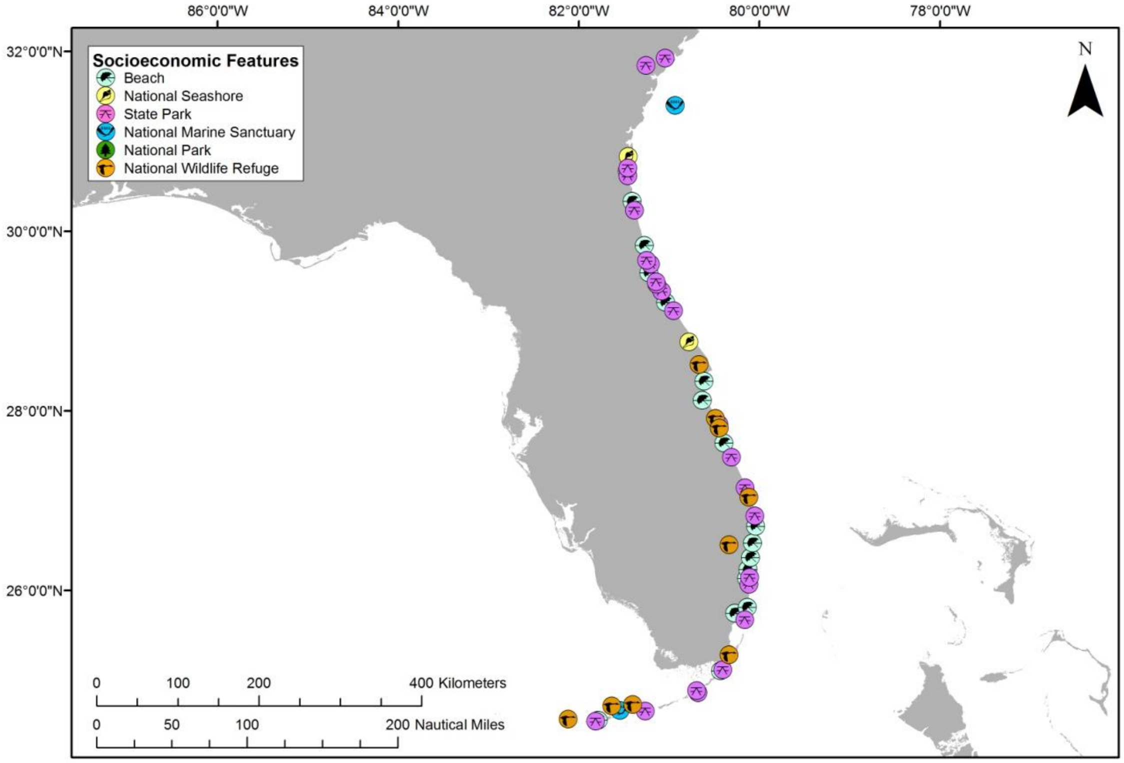


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Manzanillo*.

Socio-Economic Risk Factors

Risk Factor 4: Impacts to Socio-economic Resources at Risk (SRAR)

Socio-economic resources at risk (SRAR) include potentially impacted resources that have some economic value, including commercial and recreational fishing, tourist beaches, private property, etc. All impact factors are evaluated for both the Worst Case and the Most Probable Discharge oil release from the wreck. Risk factors for socio-economic resources at risk are divided into three categories:

- **Water Column:** Impacts to the water column and to economic resources in the water column (i.e., fish and invertebrates that have economic value);
- **Water Surface:** Impacts to the water surface and resources on the water surface (i.e., boating and commercial fishing); and
- **Shoreline:** Impacts to the shoreline and resources on the shoreline (i.e., beaches, real property).

The impacts from an oil release from the wreck would depend greatly on the direction in which the oil slick moves, which would, in turn, depend on wind direction and currents at the time of and after the oil release. Impacts are characterized in the risk analysis based on the likelihood of any measurable impact, as well as the degree of impact that would be expected if there were one. The measure of the degree of impact is based on the median case for which there is at least some impact. The median case is the "middle case" – half of the cases with significant impacts have less impact than this case, and half have more.

For each of the three socio-economic resources at risk categories, risk is classified with regard to:

- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be exposure to socio-economic resources over a certain minimal amount known to cause impacts); and
- The **degree of oiling** (the magnitude or amount of that exposure over the threshold known to cause impacts).

As a reminder, the socio-economic impact thresholds are: 1 ppb aromatics for water column impacts; 0.01 g/m^2 for water surface impacts; and 1 g/m^2 for shoreline impacts.

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, in the text classification for the *Manzanillo* shading indicates the degree of risk for the WCD release of 5,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 500 bbl.

Risk Factor 4A-1: Water Column: Probability of Oiling of SRAR

This risk factor reflects the probability that at least 0.2 mi^2 of the upper 33 feet of the water column would be contaminated with a high enough concentration of oil to cause socio-economic impacts. The threshold for water column impact to socio-economic resources at risk is an oil concentration of 1 ppb (i.e., 1 part oil per one billion parts water). At this concentration and above, one would expect impacts and potential tainting to socio-economic resources (e.g., fish and shellfish) in the water column; this concentration is used as a screening threshold for both the ecological and socio-economic risk factors.

The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

Risk Factor 4A-2: Water Column Degree of Oiling of SRAR

The degree of oiling of the water column reflects the total amount of oil that would affect the water column in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** impact on less than 0.2 mi^2 of the upper 33 feet of the water column at the threshold level
- **Medium Impact:** impact on 0.2 to 200 mi^2 of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi^2 of the upper 33 feet of the water column at the threshold level

The *Manzanillo* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for water column socio-economic resources for the WCD of 5,000 bbl because 53% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 2.5 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 500 bbl, the *Manzanillo* is classified as Medium Risk for oiling probability for water column socio-economic resources because 13% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 mi^2 of the upper 33 feet of the water column.

Risk Factor 4B-1: Water Surface Probability of Oiling of SRAR

This risk factor reflects the probability that at least 1,000 mi^2 of the water surface would be affected by enough oil to cause impacts to socio-economic resources. The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%
- **High Oiling Probability:** Probability > 50%

The threshold level for water surface impacts to socio-economic resources at risk is 0.01 g/m^2 (i.e., 0.01 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to socio-economic resources on the water surface.

Risk Factor 4B-2: Water Surface Degree of Oiling of SRAR

The degree of oiling of the water surface reflects the total amount of oil that would affect the water surface in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 1,000 mi^2 of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi^2 of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi^2 of water surface impact at the threshold level

The *Manzanillo* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for water surface socio-economic resources for the WCD because 83% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2, and the mean area of water contaminated was 3,310 mi^2. The *Manzanillo* is classified as Medium Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 46% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 1,010 mi^2.

Risk Factor 4C: Shoreline Impacts to SRAR

The impacts to different types of shorelines vary based on economic value. In this risk analysis, shorelines have been weighted by their degree of sensitivity to oiling. Sand beaches are the most economically valued shorelines (weighted as “3” in the impact analysis), rocky and gravel shores are moderately valued (weighted as “2”), and wetlands are the least economically valued shorelines (weighted as “1”). Note that these values differ from the ecological values of these three shoreline types.

Risk Factor 4C-1: Shoreline Probability of Oiling of SRAR

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline users. The threshold for impacts to shoreline SRAR is 1 g/m^2 (i.e., 1 gram of oil per square meter of shoreline). The three risk scores for oiling are:

- **Low Oiling Probability:** Probability = <10%
- **Medium Oiling Probability:** Probability = 10 – 50%

- **High Oiling Probability:** Probability > 50%

Risk Factor 4C-2: Shoreline Degree of Oiling of SRAR

The degree of oiling of the shoreline reflects the total amount of oil that would affect the shoreline in the event of a discharge from the vessel. The three categories of impact are:

- **Low Impact:** less than 10 miles of shoreline impacted at threshold level
- **Medium Impact:** 10 - 100 miles of shoreline impacted at threshold level
- **High Impact:** more than 100 miles of shoreline impacted at threshold level

The *Manzanillo* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 99% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is classified as Medium Risk for degree of oiling because the mean length of weighted shoreline contaminated was 72 miles. The *Manzanillo* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 99% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2, and the mean length of weighted shoreline contaminated was 53 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 5,000 bbl of heavy fuel oil from the *Manzanillo* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Low, because a relatively small area of water column would be impacted in important fishing grounds
- Water surface resources – Medium, because a moderate area of water surface would be impacted in offshore shipping lane areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – High, because a relatively large area of shoreline would be impacted in areas with high-value shoreline resources

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 5,000 bbl** from the *Manzanillo*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	**High**	53% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
4A-2: Water Column Degree SRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 2.5 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	83% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	Med
4B-2: Water Surface Degree SRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 0.01 g/m^2 was 3,300 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	99% of the model runs resulted in shoreline oiling of 1 g/m^2	High
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 72 mi	

For the Most Probable Discharge of 500 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *Manzanillo* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Low, because a relatively small area of water column would be impacted in important fishing grounds
- Water surface resources – Medium, because a moderate area of water surface would be impacted in offshore shipping lane areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of tarballs and streamers
- Shoreline resources – High, because a relatively large area of shoreline would be impacted in areas with high-value shoreline resources

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 500 bbl** from the *Manzanillo*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	**Medium**	High	13% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
4A-2: Water Column Degree SRAR Oiling	**Low**	Medium	High	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	**Medium**	High	46% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	Med
4B-2: Water Surface Degree SRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 0.01 g/m^2 was 1,010 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	99% of the model runs resulted in shoreline oiling of 1 g/m^2	High
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 53 mi	

SECTION 5: OVERALL RISK ASSESSMENT AND RECOMMENDATIONS FOR ASSESSMENT, MONITORING, OR REMEDIATION

The overall risk assessment for the *Manzanillo* is comprised of a compilation of several components that reflect the best available knowledge about this particular site. Those components are reflected in the previous sections of this document and are:

- Vessel casualty information and how the site formation processes have worked on this vessel
- Ecological resources at risk
- Socio-economic resources at risk
- Other complicating factors (war graves, other hazardous cargo, etc.)

Table 5-1 summarizes the screening-level risk assessment scores for the different risk factors, as discussed in the previous sections. The ecological and socio-economic risk factors are presented as a single score for water column, water surface, and shoreline resources as the scores were consolidated for each element. For the ecological and socio-economic risk factors each has two components, probability and degree. Of those two, degree is given more weight in deciding the combined score for an individual factor, e.g., a high probability and medium degree score would result in a medium overall for that factor.

In order to make the scoring more uniform and replicable between wrecks, a value was assigned to each of the 7 criteria. This assessment has a total of 7 criteria (based on table 5-1) with 3 possible scores for each criteria (L, M, H). Each was assigned a point value of L=1, M=2, H=3. The total possible score is 21 points, and the minimum score is 7. The resulting category summaries are:

Low Priority	7-11
Medium Priority	12-14
High Priority	15-21

For the Worst Case Discharge, the *Manzanillo* scores Medium with 13 points; for the Most Probable Discharge, the *Manzanillo* scores Medium with 12 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Manzanillo*. The final determination rests with the U.S. Coast Guard.

Manzanillo	Possible NOAA Recommendations
	Wreck should be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action
✓	Location is unknown; Use surveys of opportunity to attempt to locate this vessel and gather more information on the vessel condition
	Conduct active monitoring to look for releases or changes in rates of releases
✓	Be noted in the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source
✓	Conduct outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area, to gain awareness of changes in the site

Table 5-1: Summary of risk factors for the *Manzanillo*.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	Maximum of 5,000 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Bunker oil is heavy fuel oil, a Group IV oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	A fire was reported		
	C2: Oil on Water	Low	No oil was reported on the water		
	D1: Nature of Casualty	High	One torpedo detonation		
	D2: Structural Breakup	Low	Unknown structural breakup		
Archaeological Assessment	Archaeological Assessment	Low	Limited sinking records of this ship were located and no site reports, assessment is have limited accuracy		**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown, potential to be upright		**Not Scored**
	Depth	Low	Between 360 ft and 860 ft		
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location unknown		
	Other Hazardous Materials Onboard	High	Lead		
	Munitions Onboard	High	No		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Very small volumes of water column were above thresholds	**Low**	**Low**
	3B: Water Surface Resources	High	Persistent tarballs could pose risks to sea turtles and marine birds over long distances	**Med**	**Med**
	3C: Shore Resources	High	Larger releases have the potential for affecting mangroves and fouling turtle nests and shorebird habitats	**Med**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	A relatively small area of water column could be impacted in important fishing grounds	**Low**	**Low**
	4B: Water Surface Resources	High	A moderate area of water surface could be impacted in offshore shipping lane areas	**Med**	**Med**
	4C: Shore Resources	High	A relatively large area of shoreline could be impacted in areas with high-value shoreline resources	**High**	**High**
Summary Risk Scores				**13**	**12**