Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Joseph M. Cudahy

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National Oceanic and
Atmospheric Administration

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Photo: Photograph of *Joseph M. Cudahy*
Courtesy of The Mariners' Museum Library, Newport News, VA

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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.

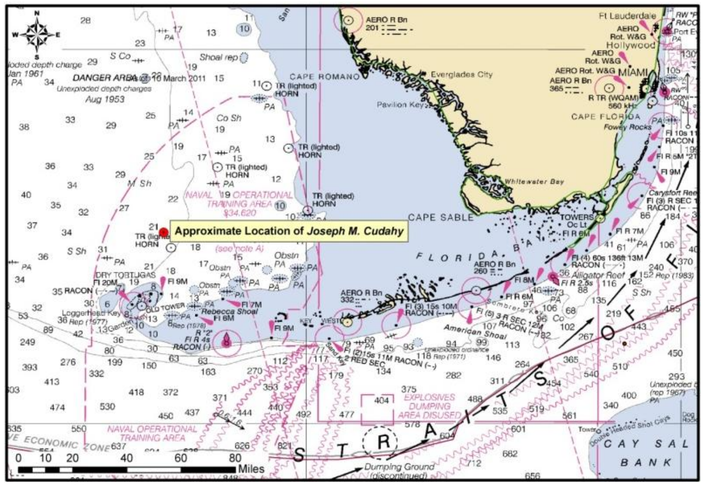
In order to narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to identify the most ecologically and economically significant potentially polluting wrecks in U.S. waters. This project supports the U.S. Coast Guard and the 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: *Joseph M. Cudahy*



The tanker *Joseph M. Cudahy*, torpedoed and sunk during World War II northwest of Key West, Florida 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 *Joseph M. Cudahy*, 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.

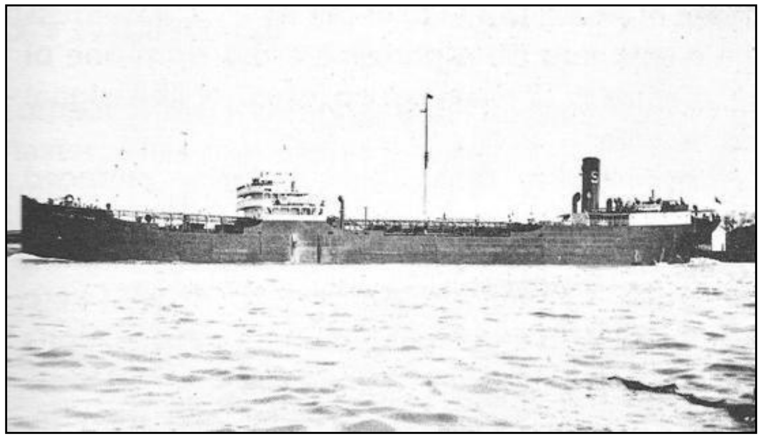
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Joseph M. Cudahy* scores High with 16 points; for the Most Probable Discharge (10% of the Worse Case volume), *Joseph M. Cudahy* also scores High with 15 points. Given these scores and the higher level of data certainty for the *Joseph M. Cudahy*, NOAA recommends that this site be reflected within the Area Contingency Plans and be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action. At a minimum, an active monitoring program should be implemented to detect possible leakage. 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 changes in the site.

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	High	High
	3C: Shore Resources	High	Med
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	High	High
	4C: Shore Resources	High	High
Summary Risk Scores		16	15

The determination of each risk factor is explained in the document. This summary table is found on page 41.

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

Vessel Particulars



Official Name: *Joseph M. Cudahy*

Official Number: 220956

Vessel Type: Tanker

Vessel Class: 7,053 gross ton class Tanker (10,440 dwt)

Former Names: N/A

Year Built: 1921

Builder: Sun Shipbuilding & Dry Dock Company (Sun Ship), Chester, PA

Builder's Hull Number: 35

Flag: American

Owner at Loss: Sinclair Refining Company, 630 Fifth Avenue, New York, NY

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

Operated by: Sinclair Refining Company

Homeport: Wilmington, DE

Length: 430 feet **Beam:** 59 feet **Depth:** 32 feet

Gross Tonnage: 6,950 **Net Tonnage:** 4,295

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

Bunker Type: Heavy Fuel Oil (Bunker C) **Bunker Capacity (bbl):** 12,141

Average Bunker Consumption (bbl) per 24 hours: 148

Liquid Cargo Capacity (bbl): 78,000 **Dry Cargo Capacity:** Unknown

Tank or Hold Description: Unknown

Casualty Information

Port Departed: Houston, TX

Destination Port: Marcus Hook, PA

Date Departed: May 1, 1942

Date Lost: May 4, 1942

Number of Days Sailing: ≈ 4

Cause of Sinking: Act of War (Torpedoes)

Latitude (DD): 25.0228

Longitude (DD): -82.7563

Nautical Miles to Shore: 25

Nautical Miles to NMS: 15

Nautical Miles to MPA: 6

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 145

Bottom Type: Sand

Is There a Wreck at This Location? Yes, the wreck at this location (known as the "Oil Wreck") has not been positively identified but has been tentatively labeled the wreck of *Joseph M. Cudahy* by recreational divers

Wreck Orientation: Resting on its starboard side

Vessel Armament: None (if actually the wreck of *Joseph M. Cudahy*)

Cargo Carried when Lost: 78,000 bbl of oil (one half lubricating and one half fuel oil or crude oil depending on the report)

Cargo Oil Carried (bbl): 78,000

Cargo Oil Type: Multiple Types

Probable Fuel Oil Remaining (bbl): Unknown ≤ 12,000

Fuel Type: Heavy Fuel Oil (Bunker C)

Total Oil Carried (bbl): ≤ 90,000

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes, partially

Reportedly Leaking: Yes, has been for past 60+ years

Historically Significant: Yes

Gravesite: Yes (if actually the wreck of *Joseph M. Cudahy*)

Salvage Owner: Murel Goodell of Houston, TX

Wreck Location

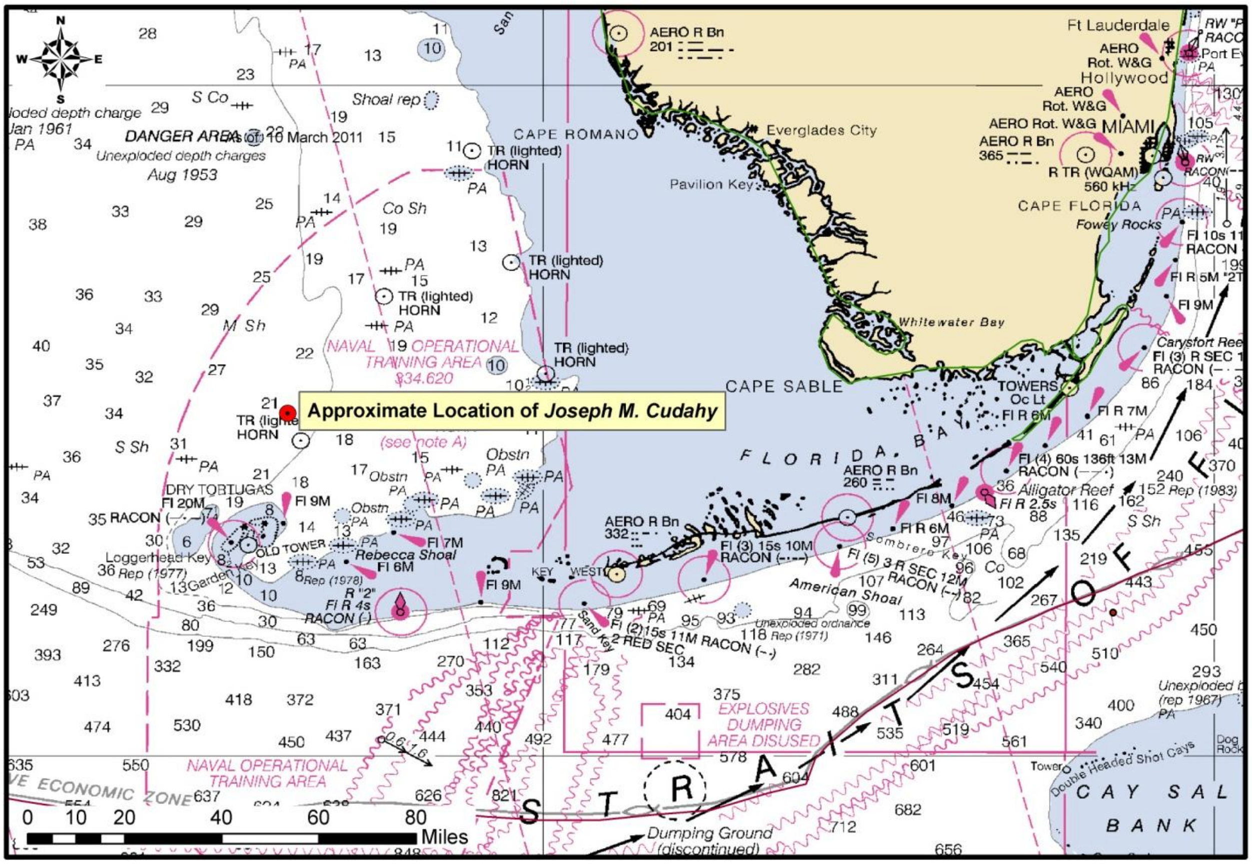


Chart Number: 411

Casualty Narrative

"At 04.15 hours on 5 May 1942, the unescorted and unarmed *Joseph M. Cudahy* (Master Walter Edmund Reed) was torpedoed by *U-507* about 125 miles west of Naples, Florida. Lookouts on the tanker had spotted the burning *Munger T. Ball*, which had been torpedoed by the same U-boat at 01.32 hours, 74 miles northwest of the Dry Tortugas Light and the master changed course for Tampa and steered a zigzag pattern at 11 knots. One torpedo struck at the waterline on the starboard side at the #4 main tank, just after the third officer had spotted the conning tower and saw the torpedo track about 20 feet from the tanker. The explosion blew a large hole in the side and started a fire in the midships house. The master steered into the wind to allow the crew of eight officers and 29 crewmen to abandon ship. The master and eight men on the forepart of the tanker left in one lifeboat and were sighted by PBY Catalina aircraft of the U.S. Navy. A fishing schooner offered to help the men, but they declined. These men were picked up by a PBY about 12 hours after the attack and taken to Key West, Florida. One other survivor was picked up by another PBY the same morning and also taken to Key West. Three officers and 24 crewmen were lost.

On 7 May, the gutted and still burning *Joseph M. Cudahy* was sighted by the American patrol yacht USS *Coral* (PY 15) in 24°57N/84°10W and was sunk by gunfire, because she was beyond salvage and a menace to navigation."
-http://www.uboat.net/allies/merchants/ships/1605.html

Under Captain Walter Edmund Reed, the *Cudahy* sailed from Houston, TX to Marcus Hook, PA. She was torpedoed by *U-507* (Schact) 74 miles northwest of Dry Tortugas Light. One torpedo struck at the waterline on the starboard side at the #4 main tank. An explosion blew a hole in the ships side. 27 were lost.

-B.M. Browing Jr., "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 90-91.

The *Cudahy* was on a trip from Galveston to Philadelphia according to Hocking.

-C. Hocking, "Dictionary of Disasters at Sea During the Age of Steam: Including sailing ships and ships of war lost in action 1824-1962" (Lloyd's Register of Shipping, 1969), 364.

At 6pm, *U-507* commander Harro Schact hit the *Cudahy* with a torpedo. The ship exploded and burst into flames. After resurfacing, the sub saw that part of the tanker was still afloat, but it sank quickly. The sea all around the ship was burning, and "a giant mushroom could of smoke" rose above. The U.S. Coast Guard recorded on the 5th of May that the ship was burning and would sink.

---- M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 24, 52.

General Notes

Known as Joseph M. Cuda in AWOIS.

AWOIS Data: 00102
HISTORY
LNM23/83--WK SUNK IN 1942 STILL PRESENT IN APPROX. LAT.25-57N, LONG.83-57W.

DESCRIPTION
24 NO.542; TANKER, 6950 GT; 5/5/42 BY SUBMARINE; POSITION ACCURACY 1-3 MILES.
27 NO.511; 4295 NT, SUNK 5/5/42 IN 50 FATHOMS. NAME: *JOSEPH M. CUDAHY*

SURVEY REQUIREMENTS
NOT DETERMINED

Wreck Condition/Salvage History

"The “Oil Wreck” was an oil tanker that was sunk on May 5, 1942 by the U-507 during WWII. The ship was transporting oil in its large cargo holds when it was sunk. Still today, and for the past 60+ years, the wreck leaks its cargo oil marking the surface with an oil slick and giving the wreck it’s name, “Oil Wreck,” because the official name of the wreck is still unknown.

The wreck lies on the bottom with a 120-degree list to starboard, almost upside down. The starboard side is buried in the sand, with the port side rising enough off the bottom that divers can enter the wreck. The bow is mostly intact but damaged. Amidships, the wreck is broken in two just in front of the boilers. One of the boilers is dislodged and now sits upright in the wreckage, while the other sits as it did when the ship was in service. From the boiler area to the stern, the ship is badly broken up. The hull still rises off the bottom, but the superstructure is broken and scattered. The engine room area is open allowing access and a swim-through. One blade of the prop still exists and both windlasses are visible, one lying in the sand next to the wreck and the other still on the ship.

Due to the location of the wreck being in the shrimp grounds, nets drape parts of the wreck. Sea turtle remains are stuck in the nets, revealing just how deadly these nets can be to all wildlife in the sea."
-http://wreckdiveguide.com/oil-wreck/

The tanker was sighted 5 days later on May 7th gutted and still burning, so USS Coral (PY-15) sank her by gunfire. Wreck is known by divers as the "oil wreck."

-B.M. Browing Jr., "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 90-91.

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

The tanker *Joseph M. Cudahy* has been listed as a higher priority shipwreck because it is one of the shipwrecks in U.S. Coast Guard District 7 that NOAA has confirmed contains oil. Local divers and boaters know the shipwreck as the “oil wreck” due to an oil sheen that has commonly been observed above the wreck for over 60 years. Although the ship is known to contain oil and was carrying a cargo of 78,000 bbl of oil (half lubricating oil and half fuel oil or crude oil depending on the report) and had a bunker capacity of 12,141 bbl of Bunker C fuel oil, the violent nature in which the tanker was lost makes it appear unlikely that much recoverable oil remains.

On the night of 4 May 1942, the tanker was hit by one torpedo in the number four starboard tank (Fig. 1-1), which was loaded with lubricating oil. At the torpedo impact point, hull plates were blown outwards and a fire broke out amidships. As the surviving members of the crew abandoned ship, the fire spread across the entire length of the vessel and caused multiple explosions in tanks five through nine, which were carrying fuel oil or crude oil. Three days later, on 7 May 1942, USS *Coral* spotted the tanker "completely gutted and burning" and sank it with gunfire because it was a hazard to navigation and beyond salvage.

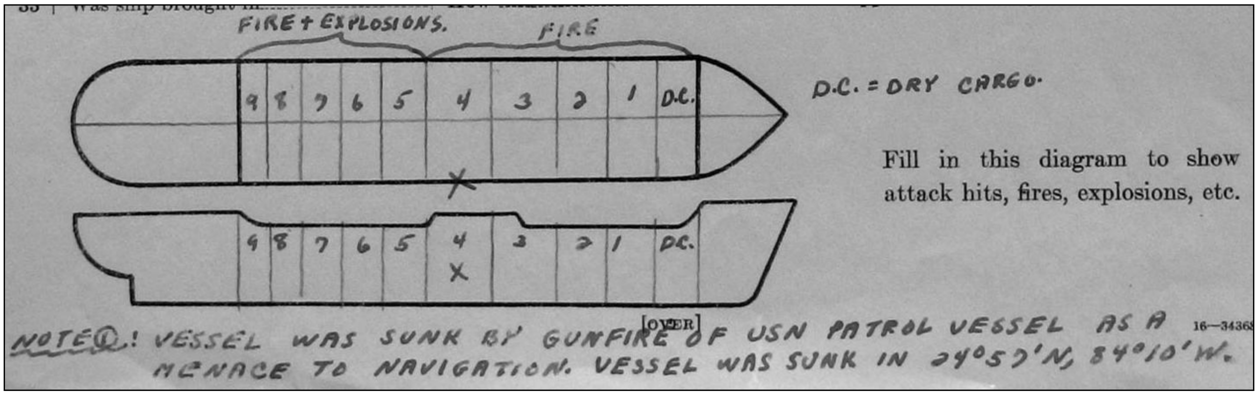


Figure 1-1: U.S. Coast Guard diagram of the location of torpedo impact and fires aboard *Joseph M. Cudahy* (Image courtesy of National Archives, Washington, DC).

Today the wreck believed to be *Joseph M. Cudahy* (the wreck has never been positively identified) lies almost completely upside down but is propped up enough that divers report it is possible to enter the inverted cargo tanks. The bow section is reportedly unremarkable, but the stern offers divers with a view of the engines and the boilers. Although divers have not reported where the oil on the wreck is located, there are reports that the surface sheen is often larger after a storm or after divers enter the wreck and their bubbles seemingly stir up oil remaining in the tanks. Other reports have also mentioned that oil is sometimes found on SCUBA diving equipment after divers complete a penetration dive into the shipwreck.

From these reports, it appears likely that any oil remaining in the shipwreck is residue that has been trapped in the inverted tanks of the wreck and is stirred up by storms and diving activity. A determination of how much oil could remain inside the tanker cannot be made with any degree of accuracy without an in water examination. Based on how often SCUBA divers and fishing charter boats visit this site, it may be more reasonable and practical for the U.S. Coast Guard to continue to engage with these communities to obtain additional information about the wreck than to conduct an in-water assessment of the vessel. The shallow depth and relatively good visibility on the site may make it a good candidate for a simple site reconnaissance and survey.

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: Mariners Museum Library, Newport News, VA)

Construction Diagrams or Plans in RULET Database? Yes, midship section plan

Text References:
http://www.uboat.net/allies/merchants/ships/1605.html
http://wreckdiveguide.com/oil-wreck/
http://uwex.us/061907.htm
AWOIS database No. 102
NIMA database WK_No 36012
Global Wrecks database NSS_ID 549503
Coast Guard database ID 5728
B.M. Browing Jr., "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 90-91.
C. Hocking, "Dictionary of Disasters at Sea During the Age of Steam: Including sailing ships and ships of war lost in action 1824-1962" (Lloyd's Register of Shipping, 1969), 364
M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 24, 52.

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Joseph M. Cudahy* 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 1-2 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. 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 either 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 1-2.

Pollution Potential Tree

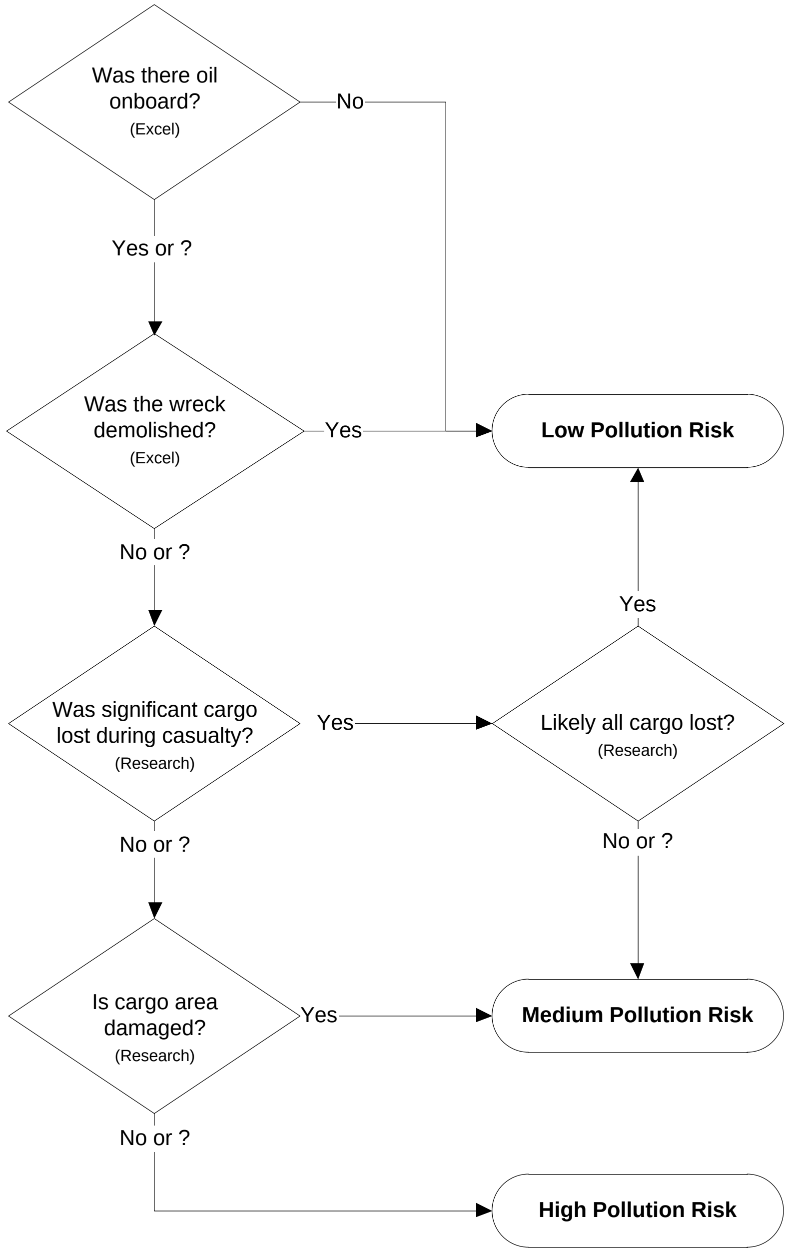


Figure 1-2: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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 *Joseph M. Cudahy* 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 *Joseph M. Cudahy* is ranked as High Volume because it is thought to have a potential for up to 90,000 bbl, although some of that was lost at the time of the casualty due to the fire on the vessel. Data quality is medium.

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 reports from recreational divers of leakage from the *Joseph M. Cudahy*.

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)

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[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]

The *Joseph M. Cudahy* is classified as High Risk because the cargo is heavy fuel oil, a Group IV oil type. Data quality is medium because some sources state the ship carried crude oil instead of heavy fuel oil.

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 wreck 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 *Joseph M. Cudahy* is classified as High Risk because the vessel was not 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 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 *Joseph M. Cudahy* is classified as Low Risk because it burned for two days. 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 known whether or not there was oil on the water at the time of the casualty

The *Joseph M. Cudahy* is classified as Medium Risk because the sea around the ship was reported to be burning, which would suggest oil on the water at the time of the casualty. Data quality is high.

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 *Joseph M. Cudahy* is classified as Low Risk because there were two torpedo detonations, and an explosion. 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 *Joseph M. Cudahy* is classified as Medium Risk because it is in two pieces. Data quality is high.

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 *Joseph M. Cudahy* lies on the bottom with a 120-degree list to starboard, almost upside down. 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 depth for *Joseph M. Cudahy* is 145 feet. Data quality is high.

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 *Joseph M. Cudahy* is a well known “oil wreck” visited by recreational fishermen and divers. Data quality is high.

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.

There are no reports of hazardous materials onboard. 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 *Joseph M. Cudahy* had no munitions onboard. 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 *Joseph M. Cudahy*. Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *Joseph M. Cudahy* 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)	Medium	Maximum of 90,000 bbl, reported to be leaking	**Med**
	A2: Oil Type	Medium	Bunker C or combination of Bunker C and fuel or lubricating oil (possibly crude instead of fuel oil)	
	B: Wreck Clearance	High	Not cleared	
	C1: Burning of the Ship	High	Burned for two days	
	C2: Oil on Water	High	Water around ship burned, therefore oil in the water	
	D1: Nature of Casualty	High	Hit by two torpedoes, explosion	
	D2: Structural Breakup	High	In two sections	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports exist, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	120-degree list	**Not Scored**
	Depth	High	145 feet	
	Visual or Remote Sensing Confirmation of Site Condition	High	Recreational dive site, recreational fishing site	
	Other Hazardous Materials Onboard	High	No	
	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 of the discharges would tend 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 *Joseph M. Cudahy* this would be 90,000 bbl based on estimates of the maximum amount of oil that could be onboard the wreck.

The likeliest scenario of oil release from most sunken wrecks, including the *Joseph M. Cudahy* 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 *Joseph M. Cudahy*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	90 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	900 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	9,000 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	45,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	90,000 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 *Joseph M. Cudahy* contained a cargo of 78,000 bbl, of which half as lubricating oil and half was fuel oil or crude oil depending on the report, and 12,000 bbl of bunker fuel oil (a Group IV oil). Because the bulk of the oil likely remaining on board is the cargo and crude oil is more persistent than either lubricating or fuel oil, the oil spill model was run using medium crude 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 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 ecological and socio-economic risk factors for water column resources. To assist planners in 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. Final Report. Office of Environmental Policy and Compliance, U.S. Dept. Interior, Washington, DC.

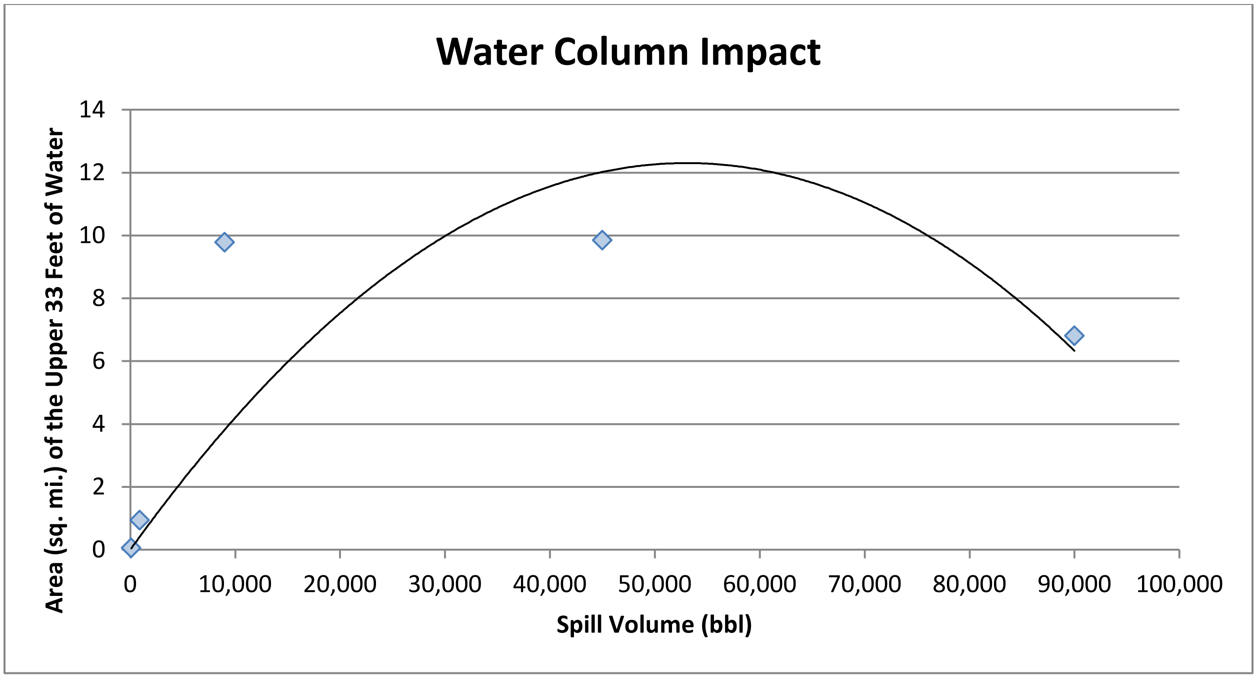

Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Joseph M. Cudahy*.

Potential Water Surface Slick

The slick size from an oil release from the *Joseph M. Cudahy* 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 *Joseph M. Cudahy*.

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	90	1,880 mi^2	1,880 mi^2
Episodic	900	4,700 mi^2	4,700 mi^2
Most Probable	9,000	12,560 mi^2	12,540 mi^2
Large	45,000	28,920 mi^2	28,890 mi^2
Worst Case Discharge	90,000	40,960 mi^2	40,930 mi^2

The location, size, shape, and spread of the oil slick(s) from an oil release from the *Joseph M. Cudahy* will depend on environmental conditions, including winds and currents, during and after a release. 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.

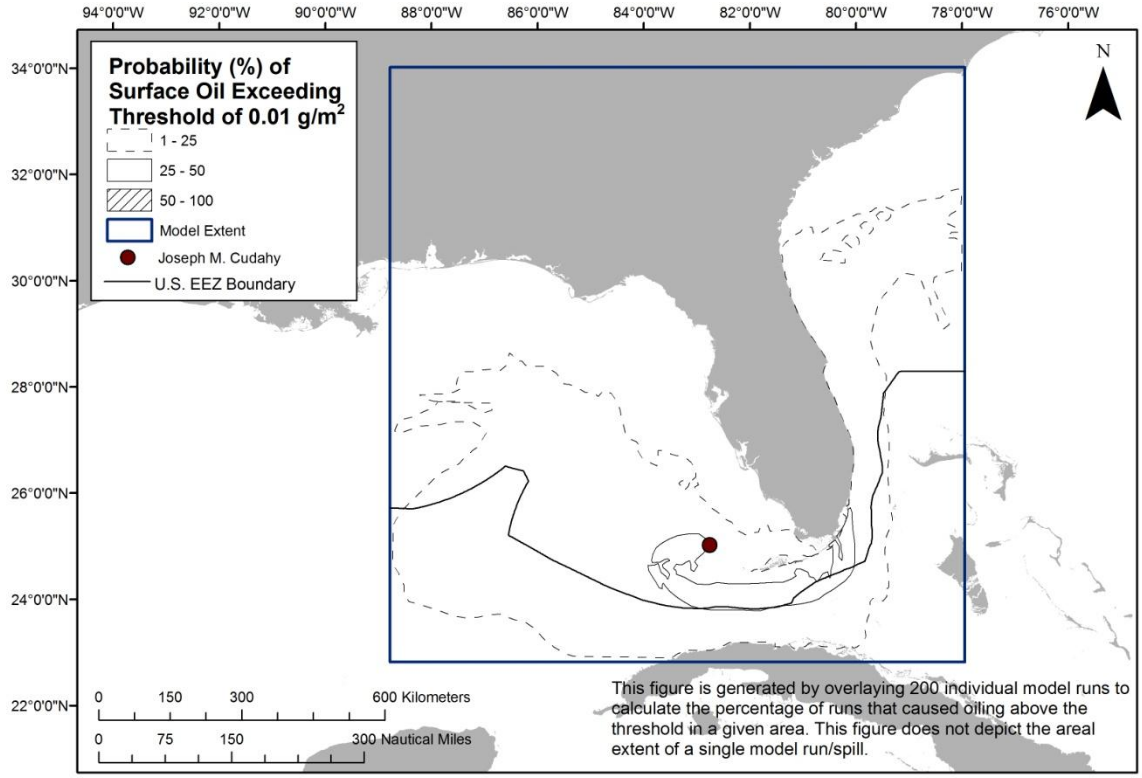

Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 9,000 bbl of crude oil from the *Joseph M. Cudahy* at the threshold for socio-economic resources at risk.

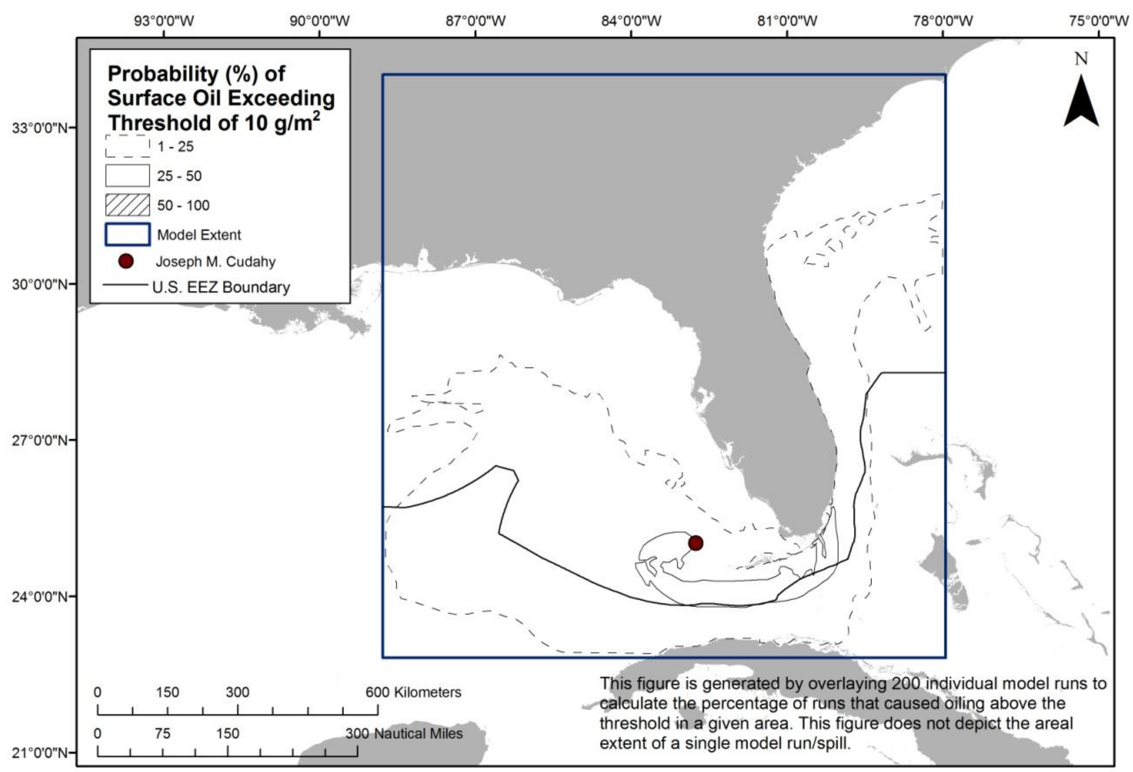

Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 9,000 bbl of crude oil from the *Joseph M. Cudahy* at the threshold for ecological resources at risk.

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.

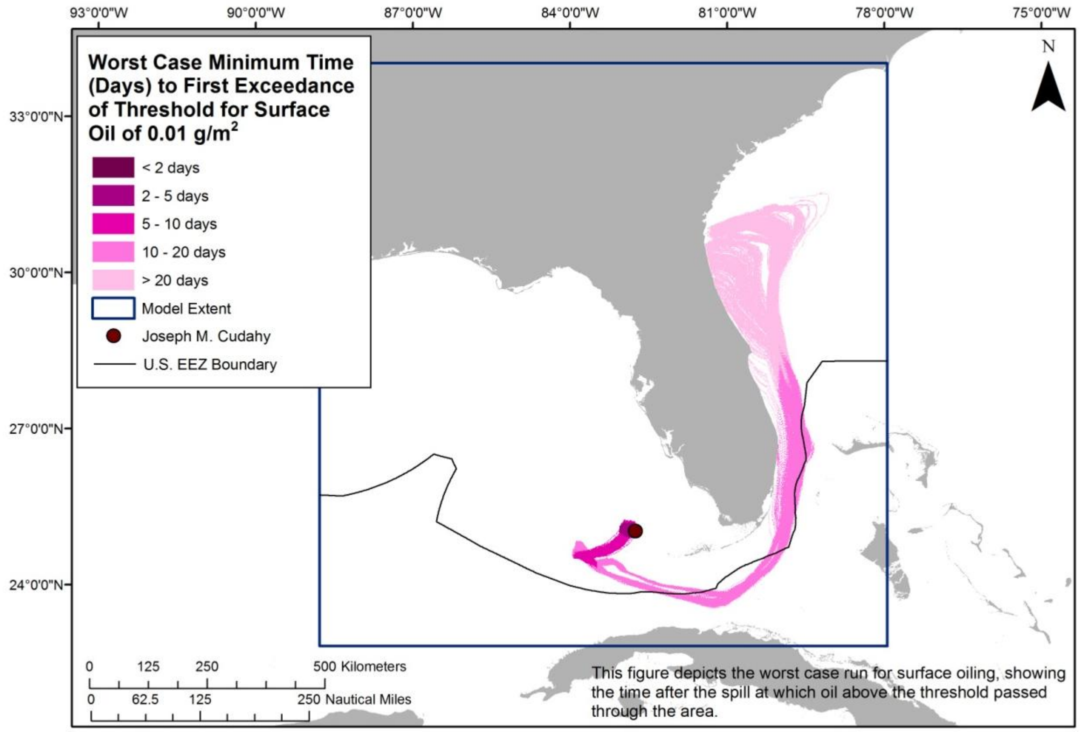

Figure 2-4: Water surface oiling from the Most Probable spill of 9,000 bbl of crude oil from the *Joseph M. Cudahy* shown as the area over which the oil spreads at different time intervals.

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 scale of potential 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.

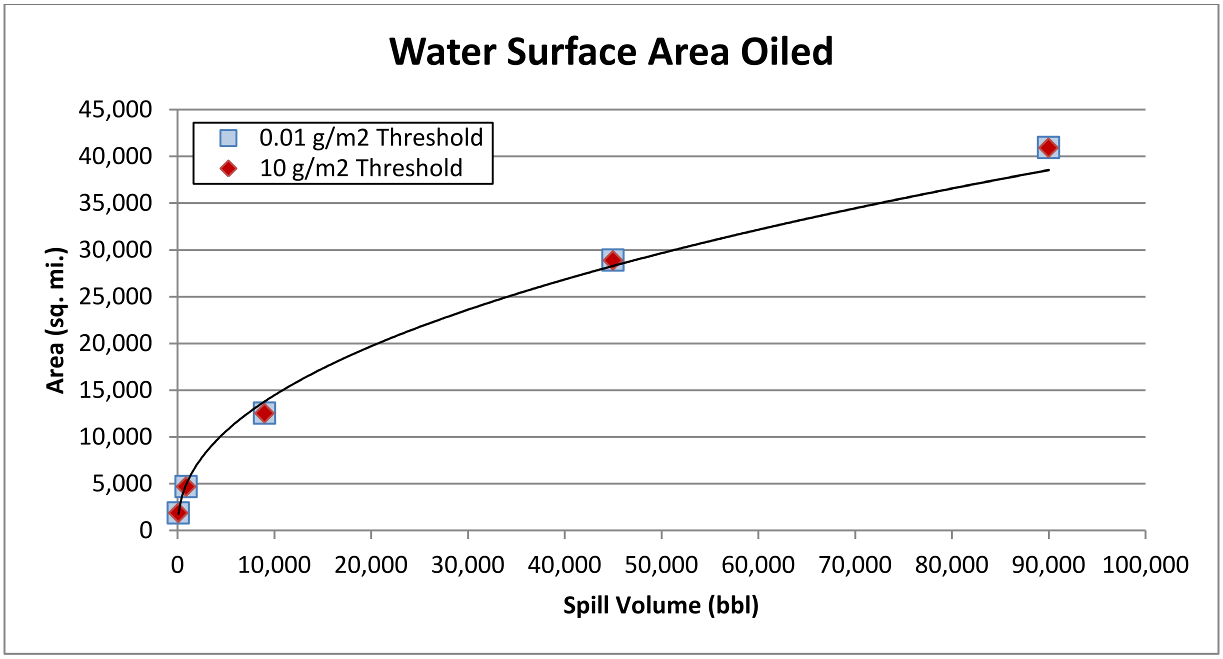

Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Joseph M. Cudahy*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2. They are so similar that they plot on top of each other.

Potential Shoreline Impacts

Based on these modeling results, shorelines from St. Augustine to the Florida Keys in Florida and the northwestern coast of Cuba 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 9,000 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 *Joseph M. Cudahy*. (U.S., Cuba, and Bahamas).

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	90	10	6	1	18
Episodic	900	12	25	10	48
Most Probable	9,000	13	30	25	67
Large	45,000	16	32	28	76
Worst Case Discharge	90,000	17	35	30	81

Table 2-4b: Estimated shoreline oiling from leakage from the *Joseph M. Cudahy*. (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	90	10	5	1	16
Episodic	900	12	16	10	39
Most Probable	9,000	13	19	25	57
Large	45,000	16	22	28	65
Worst Case Discharge	90,000	17	24	30	70

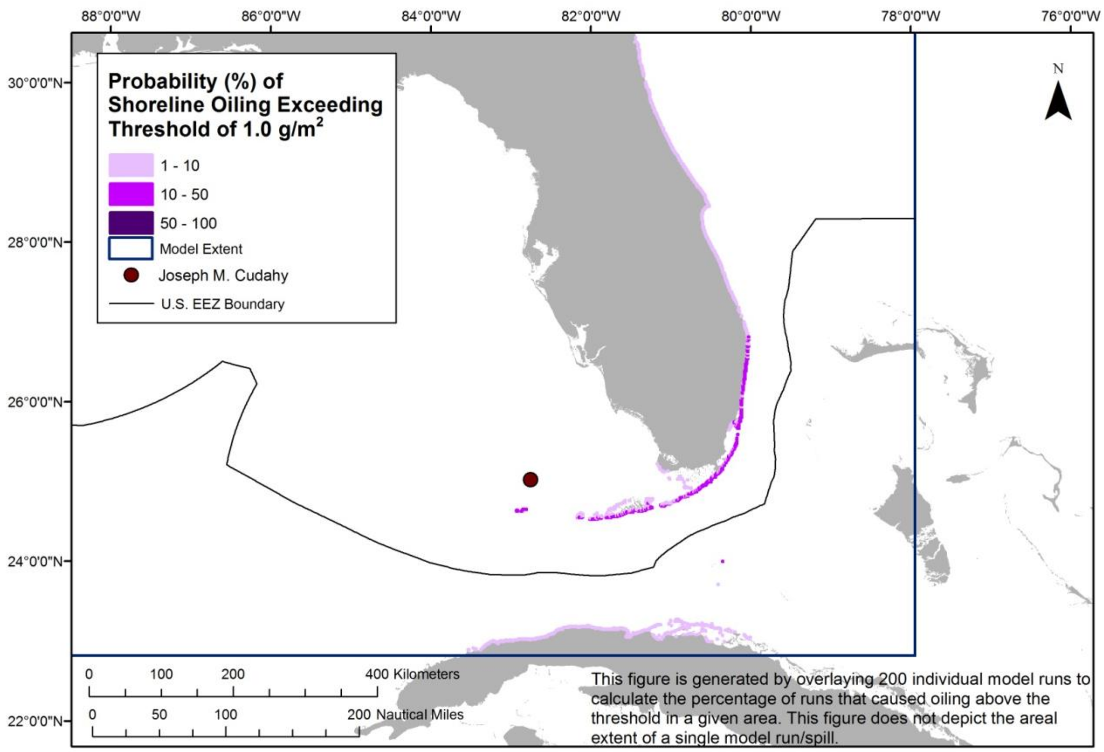

Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m²) from the Most Probable Discharge of 9,000 bbl of crude oil from the *Joseph M. Cudahy*.

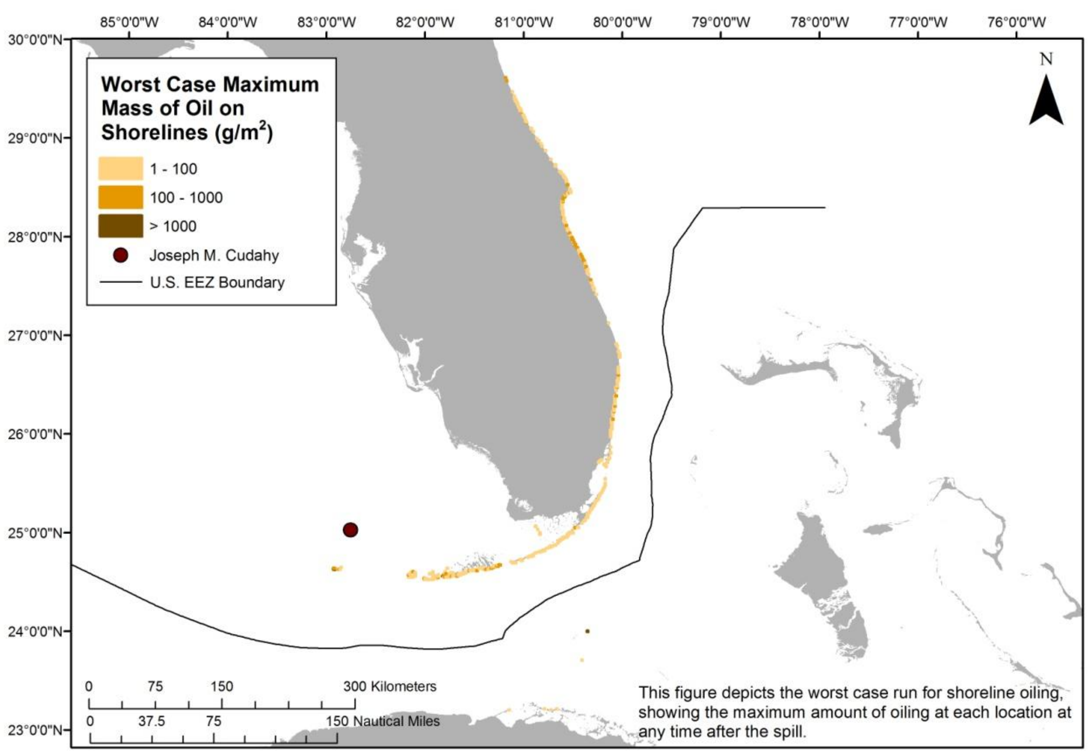

Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 9,000 bbl of crude oil from the *Joseph M. Cudahy* that resulted in the greatest shoreline oiling.

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.

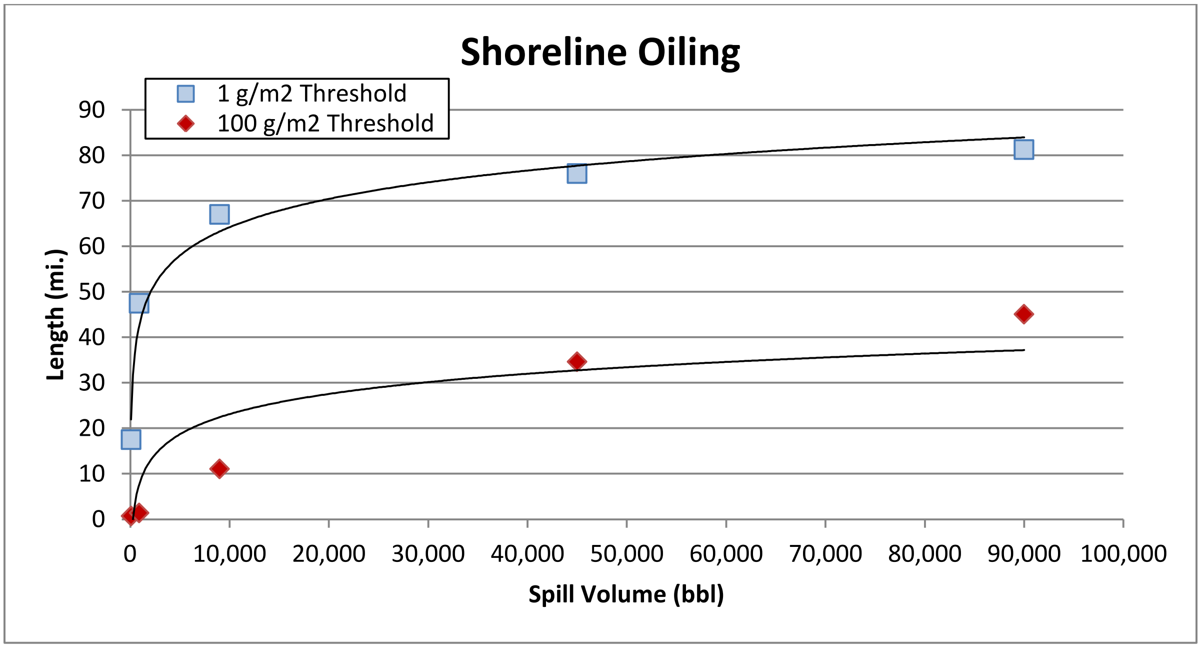

Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Joseph M. Cudahy*.

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. Salt marshes and tidal flats near tidal inlets are also at risk.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 90,000 bbl from the *Joseph M. Cudahy*.

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	57 miles	7 miles
Sand beaches	160 miles	106 miles
Salt marshes and tidal flats	101 miles	19 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 9,000 bbl from the *Joseph M. Cudahy*.

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	38 miles	2 miles
Sand beaches	123 miles	8 miles
Salt marshes and tidal flats	80 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Joseph M. Cudahy* (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 hard-bottom and seagrass habitats are important foraging and resting grounds for endangered sea turtles and nursery grounds for finfish and invertebrate fisheries.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Birds	Pelagic birds, shorebirds, wading birds and raptors can be found throughout the area of potential impact. Hotspots are listed below. *North/Central Florida*: • Nassau Sound: important breeding/roosting habitat for threatened and endangered shorebirds; also habitat for numerous neotropical migrants in spring and fall • Canaveral National Seashore contains two of the largest brown pelican (SSC) rookeries on the east coast and tens of thousands of overwintering waterfowl • Cape Canaveral/Merritt Island: habitat for ~8,000 wading birds including >150 pairs of wood storks (FE), 14,000 neotropical migrants, and overwintering habitat for shorebirds, including roseate terns (FT) and piping plovers (FT) • Pelican Island NWR contains a large colonial waterbird rookery, including >500 brown pelicans, 100 snowy egrets (SSC), 250 wood storks *Southern FL, Biscayne Bay, and FL keys hammocks* • Important stopovers for neotropical migrants in spring and fall • Rookery and roosting for Wilson's plovers, least terns (ST), white ibis (SSC), brown pelicans, 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 (1608 nests), great blue heron (1-200 nests) • Nesting great white herons (2-300 nests), little blue heron (175 nests; SSC), great blue heron (265 nests), and white-crowned pigeons (2,000 nests), reddish egrets, least tern (ST) • Wintering piping plovers, royal tern, sandwich tern, least tern • 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 frigatebird (300), masked boobies (50), brown pelican (20) • Neotropical migrant species (tropicbirds, boobies, noddies) in spring and fall *Cape Sable and surrounding area*	Colonial and beach nesters peak Apr-Aug Wading and shorebirds typically present year round Neotropical migrants present spring and fall Overwintering shorebirds Aug-May *Nesting*: Brown pelicans nest Nov-Sep Wood storks nest Nov-May Piping plovers present Jul-Mar Great blue herons nest Nov-Jul Reddish egrets nest Dec-Jun Brown noddies nest Mar-Oct Frigatebirds nest Feb-Apr Royal terns nest May-Aug Masked boobies nest Apr-May

Species Group	Species Subgroup and Geography	Seasonal Presence
	• Least tern, white-crowned pigeon, wood stork nesting in Whitewater Bay	
Reptiles	Atlantic shoreline of Florida is one of two major loggerhead nesting regions in the world and also supports significant green and leatherback nesting • >60,000 loggerheads (FT), >15,000 greens (FE) and 1,600 leatherbacks (FE) nest on Florida's Atlantic coast • Highest densities of loggerheads (198-232 nests/km) and greens (57-65 nests/km) along shoreline from Brevard to Palm Beach counties • Martin County has highest density of leatherback nesting (18 nests/km) • Hawksbill (FE) nesting documented at the Breakers in West Palm and on Boca Raton beach but is rare *Distribution* • Loggerheads and greens use nearshore hard-bottom habitats in south Florida as foraging and resting areas • Kemp's ridleys forage in areas along the SW coast of Florida • Central/west Florida Bay important habitat for loggerheads, juvenile greens and Kemp's ridleys • Hawksbills 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) • Offshore Hobe Sound NWR concentration area for loggerheads turtles during the fall • Foraging populations of all 5 species can be found in coastal waters of Cuba; however, Cuban nesting grounds are not in the predicted area of impact Crocodiles (FE) can be found in saltwater wetlands in South Florida and Cuba Atlantic salt marsh snake (FT) inhabits estuarine mangrove and saltmarsh habitats in Merritt Island NWR	Loggerheads nest Apr-Sep, hatch May-Nov Greens nest May-Sep, hatch Jun-Oct Leatherbacks nest Feb-Aug, hatch Mar-Sep Hawksbills nest Apr-Nov Kemp's ridleys more common Mar-Dec
Marine Mammals	*Baleen whales*: Primarily North Atlantic right whale (FE) with occasional humpback whale (FE), and minke whale; Right whales are critically endangered (<400 individuals left); calving grounds are in north Florida coastal waters *Inshore:* Bottlenose dolphins frequently use coastal waters including rivers, bays, and sounds throughout potential spill area *Offshore*: Risso's dolphin, striped dolphin, clymene dolphin, Atlantic spotted dolphin, spinner dolphin, short-finned pilot whale, pantropical spotted dolphin, • Often associated with shelf edge features, convergence zones, and *sargassum* mats (summer) West Indian manatees are present year round in coastal water in high concentrations south of Palm Bay	Right whales present in the winter Bottlenose dolphins and other cetaceans present year round Manatees calve year round but peak in spring
Terrestrial Mammals	• Southeastern beach mouse (FT) occurs primarily on beaches in Volusia and Brevard counties • Key deer (FE) present on 27 islands in Key Deer NWR • Lower Keys Marsh Rabbit (FE) present in the Saddlebunch keys	Year round
Fish & 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 nearby mangroves and seagrasses as nursery and/or foraging grounds. • Reef/structure/hardbottom associated: snappers, groupers, grunts, porgies, hogfish, jacks, barracuda, spiny lobster, stone crab	Nurse sharks mate Jun-Jul, parturition occurs Nov-Dec Snapper spawn during

Species Group	Species Subgroup and Geography	Seasonal Presence

	• Inshore: snook, red drum, tarpon, spotted seatrout, cobia, bonefish, queen conch
	• Pelagic/offshore: mackerels, tunas, wahoo, dolphinfish, sailfish, marlins
	
	Important concentration/conservation areas:
	• Smalltooth sawfish (FE) are most common throughout the keys and the west coast of Florida. Estuarine areas are important juvenile habitat for these species and have been designated critical habitat
	• Shallow waters are important mating, pupping and nursery grounds for lemon, nurse and bull sharks
	  ○ Nurse sharks aggregate to mate in the Dry Tortugas and Marquesas and pup in shallow waters of Florida Bay
	• Tortugas Ecological Reserve contains important reef fish spawning habitat
	  ○ 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)
	• Florida Keys National Marine Sanctuary includes much of the nearshore waters of the Keys
	• Queen conch aggregate at various sites throughout the keys reef tract. Higher abundances and densities are found in the lower keys
	• Tortugas waters support a valuable pink shrimp fishery
		the summer
		
		Grouper spawn during the winter
		
		Lobster spawn Apr-Sep
		
		Maximum conch aggregation densities in May and Oct
		
		Lemon sharks pup May-Jun
		
		Bull sharks pup Jun-Jul

Benthic Habitats	Benthic habitats include abundant seagrass and hardbottom sites • Hardbottom habitats are common in the neritic zone from Vero Beach south • 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 into Florida Bay. Johnson's seagrass (FE, SE) can be found near Jupiter Inlet and in northern Biscayne Bay Large mangrove forests are important habitats for juvenile fish	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 *Joseph M. Cudahy* 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 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).

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Joseph M. Cudahy* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 90,000 bbl and a border around the applicable degree of risk bullet for the Most Probable Discharge of 9,000 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 *Joseph M. Cudahy* is classified as Medium Risk for oiling probability for water column ecological resources for the WCD of 90,000 bbl because 10% 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 also classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 7 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 9,000 bbl, the *Joseph M. Cudahy* is classified as High Risk for oiling probability for water column ecological resources because 76% 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 10 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 *Joseph M. Cudahy* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 100% 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 High Risk for degree of oiling because the mean area of water contaminated was 40,930 mi^2. The *Joseph M. Cudahy* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 100% 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 High Risk for degree of oiling because the mean area of water contaminated was 12,540 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 oil impacts.

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 *Joseph M. Cudahy* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 77% 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 76 miles. The *Joseph M. Cudahy* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 74% 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 16 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 90,000 bbl of crude oil from the *Joseph M. Cudahy* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Low, because the area of potential water column impacts is relatively small, though these areas are important spawning habitats
- Water surface resources – High, because of the large area of water swept by the oil and the very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk, sea turtle concentrations in *Sargassum* habitat, and the persistence of tarballs that can be transported long distances. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – High, because the shoreline at risk includes highly sensitive mangroves and sand beaches that are used by many shorebirds, wading birds, and sea turtles for nesting

Table 3-2: Ecological risk scores for the **Worst Case Discharge of 90,000 bbl** of crude oil from the *Joseph M. Cudahy*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	**Medium**	High	10% 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 7 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	High
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	**High**	The mean area of water contaminated above 10 g/m^2 was 40,930 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	**High**	77% of the model runs resulted in shoreline oiling of 100 g/m^2	High
3C-2: Shoreline Degree EcoRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 100 g/m^2 was 76 mi	

For the Most Probable Discharge of 9,000 bbl, the ecological risk from potential releases from the *Joseph M. Cudahy* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because the area of potential water column impacts is relatively small, though these areas are important spawning habitats
- Water surface resources – High, because of the large area of water swept by the oil and the very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk, sea turtle concentrations in *Sargassum* habitat, and the persistence of tarballs that can be transported long distances. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because most of the shoreline at risk is composed of sand beaches which are relatively easy to clean, shorebirds, wading birds, and sea turtles for nesting

Table 3-3: Ecological risk scores for the **Probable Discharge of 9,000 bbl** of crude oil from the *Joseph M. Cudahy*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	**High**	76% 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 10 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	High
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	**High**	The mean area of water contaminated above 10 g/m^2 was 12,540 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	**High**	74% 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 16 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 *Joseph M. Cudahy* include very highly utilized recreational beaches from eastern Florida to the Florida Keys during summer, but also 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.

There are shipping lanes to several ports that could be impacted by a release 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. 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 and should be consulted.

Spill response costs for a release of oil from the *Joseph M. Cudahy* 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 *Joseph M. Cudahy*.

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 to the sanctuary 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. There are many more, smaller vessels (under 400 GRT) that also use these ports.	

Resource Type	Resource Name	Economic Activities
	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

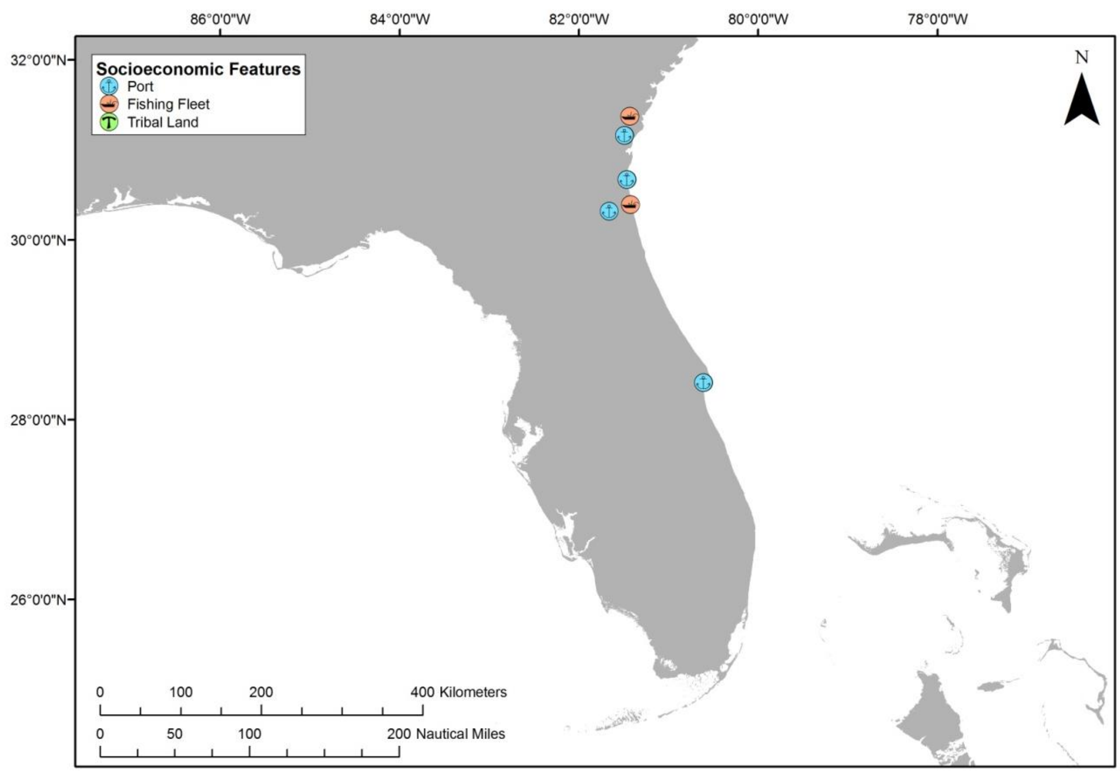

Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Joseph M. Cudahy*. (Note that there are no tribal lands at risk.)

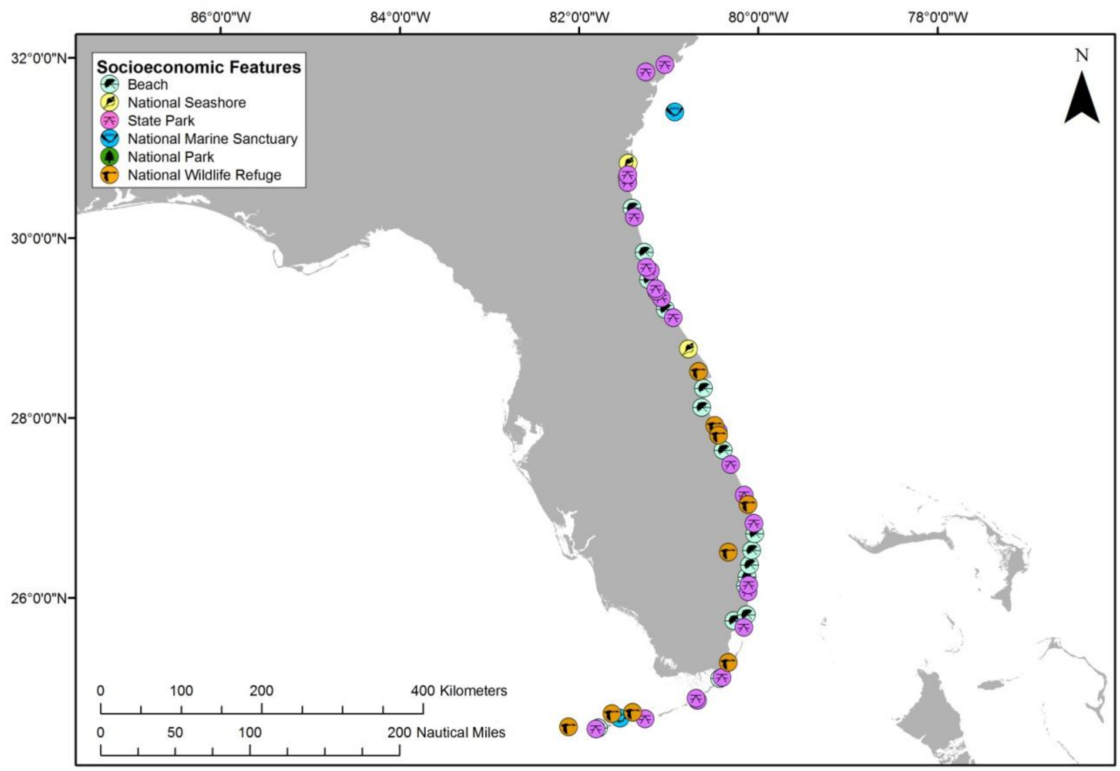

Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Joseph M. Cudahy*.

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).

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 *Joseph M. Cudahy* shading indicates the degree of risk for the WCD release of 90,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 9,000 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 *Joseph M. Cudahy* is classified as Medium Risk for both oiling probability and degree of oiling for water column socio-economic resources for the WCD of 90,000 bbl because 10% 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 7 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 9,000 bbl, the *Joseph M. Cudahy* is classified as High Risk for oiling probability for water column socio-economic resources because 76% 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 10 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 *Joseph M. Cudahy* is classified as High Risk for both oiling probability and for degree of oiling for water surface socio-economic resources for the WCD because 100% 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 41,000 mi^2. The *Joseph M. Cudahy* is classified as High Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the Most Probable Discharge because 100% 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 12,600 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 *Joseph M. Cudahy* is classified as High Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the WCD because 80% 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 153 miles. The *Joseph M. Cudahy* is classified as High Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 80% 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 128 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 90,000 bbl of crude oil from the *Joseph M. Cudahy* 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 – High, because a large 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 sheens, 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 90,000 bbl** of crude oil from the *Joseph M. Cudahy*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	**Medium**	High	10% 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 7 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	High
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	**High**	The mean area of water contaminated above 0.01 g/m^2 was 41,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	80% 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 153 mi	

For the Most Probable Discharge of 9,000 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *Joseph M. Cudahy* 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 – High, because a large 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 sheens, 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 9,000 bbl** of crude oil from the *Joseph M. Cudahy*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	**High**	76% 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 10 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	High
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	**High**	The mean area of water contaminated above 0.01 g/m^2 was 12,560 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	80% 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 128 mi	

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

The overall risk assessment for the *Joseph M. Cudahy* 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, *Joseph M. Cudahy* scores High with 16 points; for the Most Probable Discharge, *Joseph M. Cudahy* also scores High with 15 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 *Joseph M. Cudahy*. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

Joseph M. Cudahy	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 *Joseph M. Cudahy*.

Vessel Risk Factors		Data Quality Score	Comments	Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 90,000 bbl, reported to be leaking	**Med**	
	A2: Oil Type	Medium	Bunker C or combination of Bunker C and fuel or lubricating oil (possibly crude instead of fuel oil)		
	B: Wreck Clearance	High	Not cleared		
	C1: Burning of the Ship	High	Burned for two days		
	C2: Oil on Water	High	Water around ship burned, therefore oil in the water		
	D1: Nature of Casualty	High	Hit by two torpedoes, explosion		
	D2: Structural Breakup	High	In two sections		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports exist, assessment is believed to be very accurate	**Not Scored**	
Operational Factors	Wreck Orientation	High	120-degree list	**Not Scored**	
	Depth	High	145 feet		
	Visual or Remote Sensing Confirmation of Site Condition	High	Recreational dive site, recreational fishing site		
	Other Hazardous Materials Onboard	High	No		
	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	Potential impact areas are not large but include sensitive spawning habitats	**Low**	**Low**
	3B: Water Surface Resources	High	Surface oil sweeps through large areas which include bird, sea turtle, and marine mammal concentration areas	**High**	**High**
	3C: Shore Resources	High	Impacted shorelines include sensitive mangroves and sand beaches important for bird and turtle nesting	**High**	**Med**
Socio-Economic Resources	4A: Water Column Resources	High	A relatively small area of water column would be impacted in important fishing grounds.	**Low**	**Low**
	4B: Water Surface Resources	High	A large area of water surface would be impacted in offshore shipping lane areas.	**High**	**High**
	4C: Shore Resources	High	A relatively large area of shoreline would be impacted in areas with high-value shoreline resources	**High**	**High**
Summary Risk Scores				**16**	**15**