Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Coimbra

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National Oceanic and
Atmospheric Administration

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Photo: U.S. Coast Guard Identification Photograph of *Coimbra*
Courtesy of National Archives, Washington, D.C.

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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.

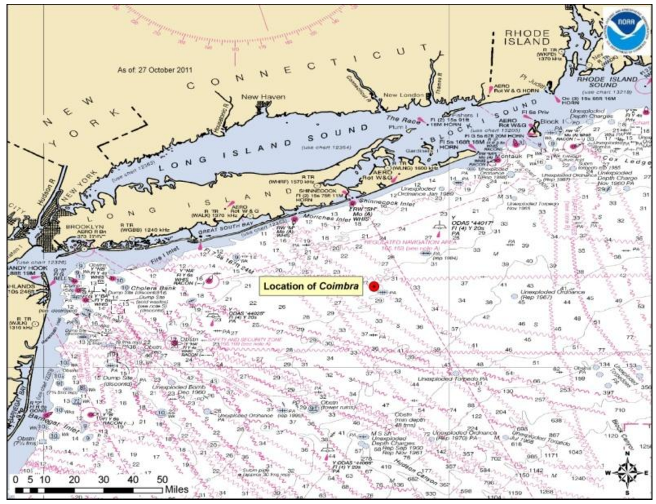
In order to narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to identify the most ecologically and economically significant potentially polluting wrecks in U.S. waters. This project supports the U.S. Coast Guard and the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



The tanker *Coimbra*, torpedoed and sunk during World War II off the coast of Long Island 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 *Coimbra*, 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.

The *Coimbra* is a particularly well-studied and visited wreck. In 1967, the U.S. Coast Guard's Sunken Tanker Project Report determined that residual traces of the lubricating oil cargo remained in the tanks that were accessible to the divers. They wre not able to assess the condition or contents of any of the tanks that were sunken into the mud. In 1975, the Polytechnic Institute of New York estimated the remaining contents of the un-assessed tanks at 28,500 bbl; this volume does not account for remaining bunkers. In 2009, recreational divers reported more oil than usual on the site. In 2009, at the request of the U.S. Coast Guard, NOAA obtained an accurate location and high-resolution sonar data of the wreck. During the survey, no oil was reported on the site.

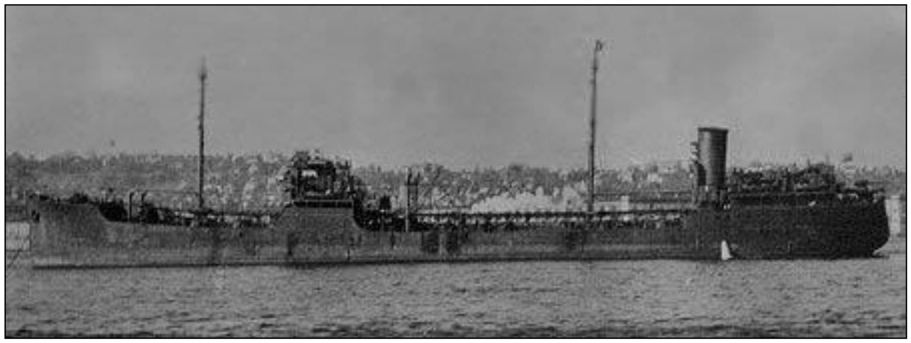
Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational 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	Med	Low
	3B: Water Surface Resources	Med	Low
	3C: Shore Resources	Med	Low
Socio-Economic Resources	4A: Water Column Resources	High	High
	4B: Water Surface Resources	High	High
	4C: Shore Resources	Med	Low
Summary Risk Scores		16	12

The determination of each risk factor is explained in the document. This summary table is found on page 45.

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, *Coimbra* scores High with 16 points; for the Most Probable Discharge (10% of the Worse Case volume), *Coimbra* scores Medium with 12 points. Given these scores, NOAA recommends that this site be noted in 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. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would help gain awareness of changes in the site.

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

Vessel Particulars



Official Name: *Coimbra*

Official Number: 165498

Vessel Type: Tanker

Vessel Class: N/A

Former Names: N/A

Year Built: 1937

Builder: Howaldts-Werke A.G., Kiel **Builder's Hull Number:** 756

Flag: British

Owner at Loss: Socony-Vacuum Transportation Co. Ld.

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

Operated by: Unknown

Homeport: London

Length: 422 feet **Beam:** 60 feet **Depth:** 32 feet

Gross Tonnage: 6,768 **Net Tonnage:** 3976

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

Bunker Type: Heavy Fuel Oil (Bunker C) **Bunker Capacity (bbl):** Unknown

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): Unknown **Dry Cargo Capacity:** Unknown

Tank or Hold Description: Unknown, but *Coimbra's* sister ship had eight main cargo tanks and four summer tanks

Casualty Information

Port Departed: New York

Destination Port: Unknown

Date Departed: January 14, 1942

Date Lost: January 15, 1942

Number of Days Sailing: 1

Cause of Sinking: Act of War (torpedoes)

Latitude (DD): 40.4014

Longitude (DD): -72.3706

Nautical Miles to Shore: 28.02

Nautical Miles to NMS: 154.11

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 170

Bottom Type: Sand

Is There a Wreck at This Location? Yes, wreck has been positively located and identified

Wreck Orientation: Broken into three parts and resting on its starboard side, the bow is inverted

Vessel Armament: One B.L. 4” gun; one Holman Projector; two Hotchkiss .303 guns; four Lewis .303 machine guns; one Ross rifle .303; two Walther 7.65 mm pistols

Cargo Carried when Lost: Lubricating oil

Cargo Oil Carried (bbl): Approximately 64,800

Cargo Oil Type: Unknown

Probable Fuel Oil Remaining (bbl): Unknown, <10,000

Fuel Type: Heavy Fuel Oil (Bunker C)

Total Oil Carried (bbl): <75,000

Dangerous Cargo or Munitions: Yes

Munitions Carried: 53 rounds 4” cordite charges; 40 rounds 4” high-explosive shells; 5 rounds 4” practice shells; 48 rounds 4” percussion tubes; 32 bombs for Holman Projector; 4,600 rounds for machine guns; 40 rounds for pistols

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes, partially

Reportedly Leaking: Yes

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

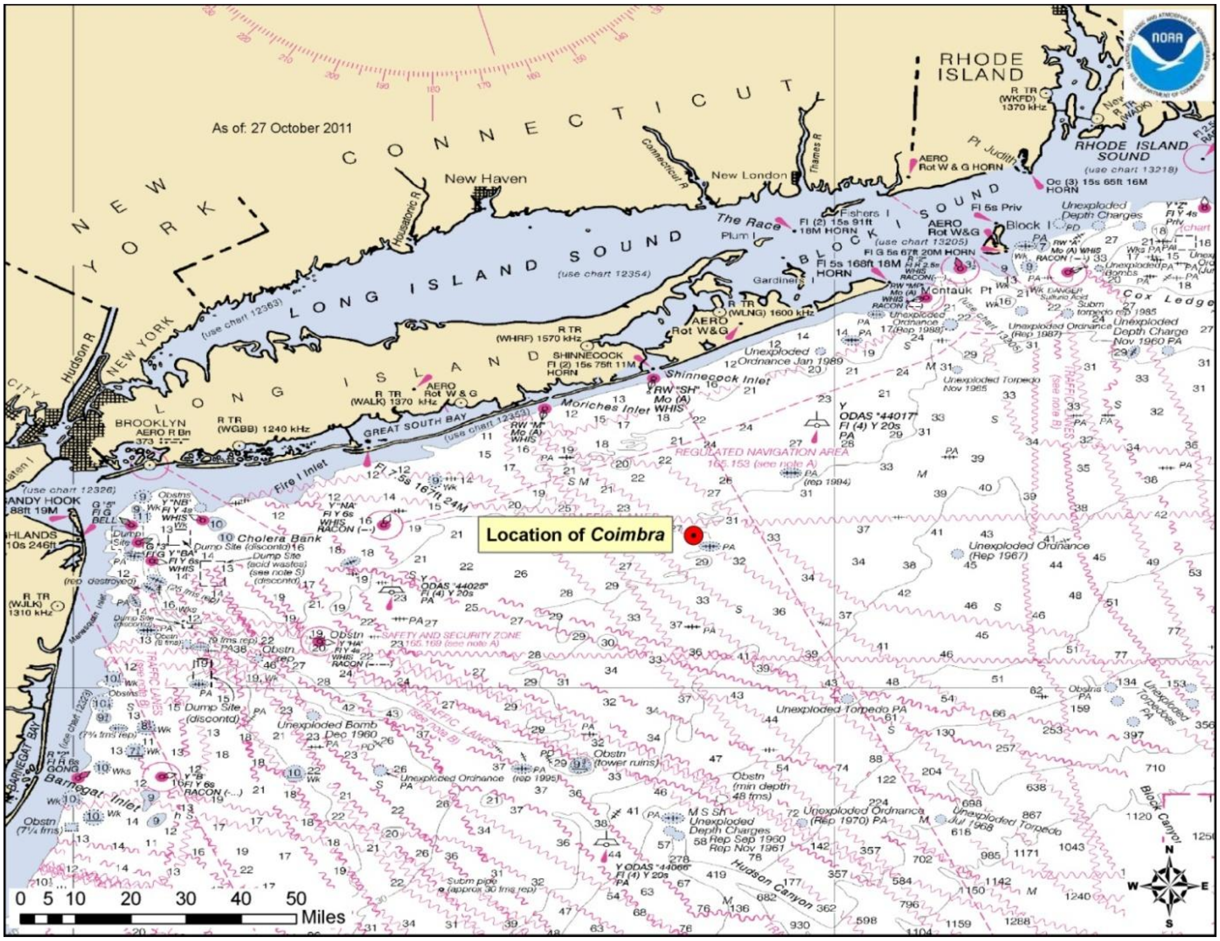
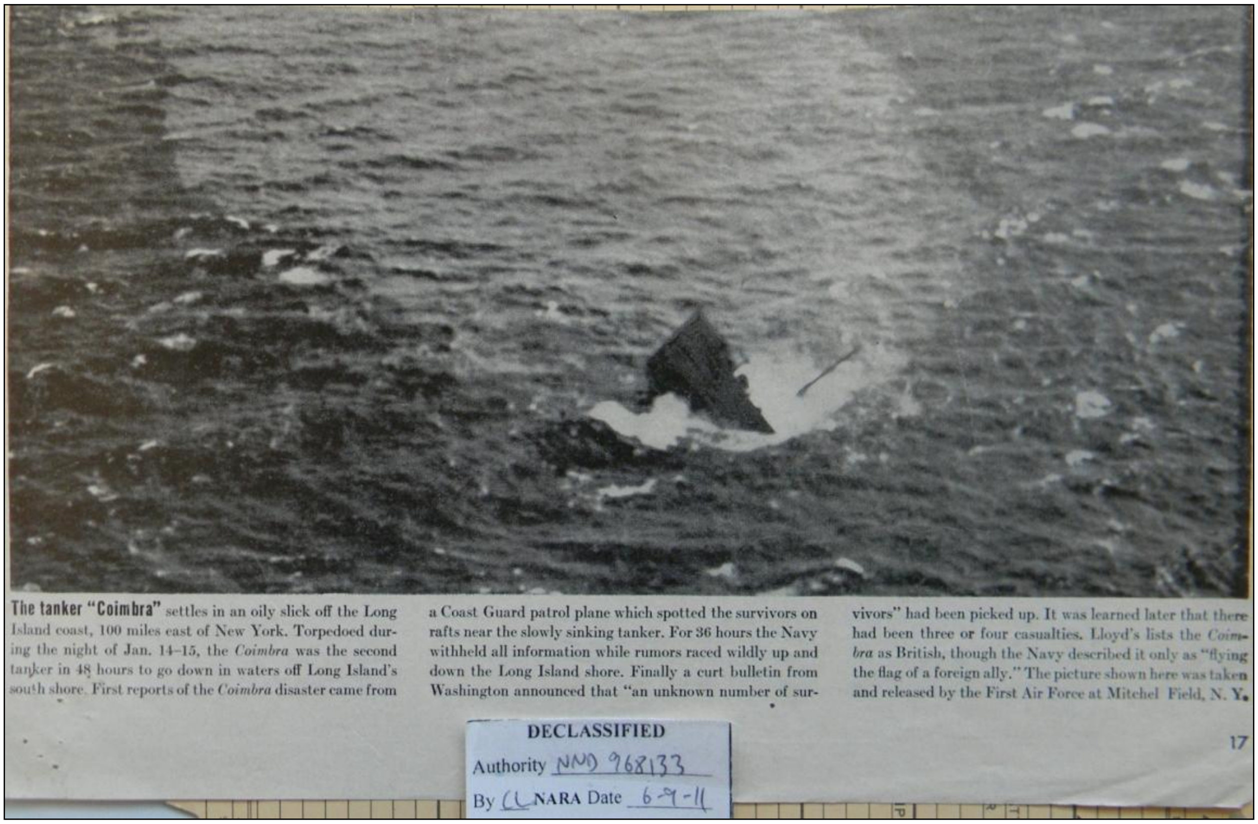


Chart Number: 12300

Casualty Narrative

"At 09.41 hours on 15 Jan, 1942, the unescorted *Coimbra* (Master John Patrick Barnard) was hit by one G7e torpedo from *U-123*, which had spotted the lights of the tanker astern while the U-boat was proceeding eastbound following the southern shore of Long Island. The torpedo struck on the starboard side just aft of the superstructure. A huge towering explosion lit up the night sky and the cargo of oil quickly caught fire and spread across the water. Residents from the Hamptons on Long Island could see the fire at sea 27 miles away and alerted the authorities. At 09.59 hours, a coup de grâce hit the tanker underneath the funnel and her stern settled fast, striking the sea floor after five minutes. Like his previous victim, the *Norness*, the bow of the *Coimbra* was sticking out of the water. Hardegen commented: These are some pretty buoys we are leaving for the Yankees in the harbor approaches as replacement for the lightships. The tanker later sank completely. The master, 29 crew members, and six gunners were lost. Ten survivors, six of them wounded were rescued from the rough seas. Two crew members were picked up by *USS Rowan* (DD 405) and landed at Argentia, Newfoundland. The remaining survivors were rescued by another American destroyer and landed at St. Johns."
--http://www.uboat.net:8080/allies/merchants/ships/1251.htm

Figure 1-1 shows a photograph of the sinking of the *Coimbra* taken by the First Air Force at Mitchell Field, NY.



The tanker "Coimbra" settles in an oily slick off the Long Island coast, 100 miles east of New York. Torpedoed during the night of Jan. 14–15, the *Coimbra* was the second tanker in 48 hours to go down in waters off Long Island's south shore. First reports of the *Coimbra* disaster came from a Coast Guard patrol plane which spotted the survivors on rafts near the slowly sinking tanker. For 36 hours the Navy withheld all information while rumors raced wildly up and down the Long Island shore. Finally a curt bulletin from Washington announced that "an unknown number of survivors" had been picked up. It was learned later that there had been three or four casualties. Lloyd's lists the *Coimbra* as British, though the Navy described it only as "flying the flag of a foreign ally." The picture shown here was taken and released by the First Air Force at Mitchel Field, N. Y.

DECLASSIFIED
Authority NND 968133
By CL NARA Date 6-9-11

17

Figure 1-1: LIFE Magazine article depicting the sinking of the tanker *Coimbra* (Source: National Archives, College Park, MD, Declassification Number NND968133.

General Notes

NOAA Automated Wreck and Obstruction Information System (AWOIS) Data:

HISTORY
NM4/42
NM49/42

DESCRIPTION-
NO.310; TANKER, 6768 GT, SUNK 1/15/42 BY SUBMARINE; POS. ACCURACY 1-3 MILES; POS. LAT. 40-20-00N, LONG. 72-20-00W. NO.199; TKR 3976 NT, SUNK 1/15/42 AT LAT. 40-22N, LONG. 72-20W.

**** POLYTECNIC INSTITUTE OF NY--PROPOSAL FOR RECOVERY OF OIL, 1975; REPORTS WK. IN 3 SECTIONS, STERN HEELED AT 80 DEG, MIDSHIPS SECTION INCLINED AT 75 DEG TO PORT AND PARTIALLY BURIED, ...VESSEL 6798 GT, 433 FT L, 33 FT D, BUILT 1937, OWNED BY SOCONY-VACUM COMPANY LTD.

**** USCG, SUNKEN TANKER PROJECT REPORT, 1967--LOCATED AT POS.40-23-12N 72-21-30W, DIVERS OBSERVE VESSEL IN 3 SECTIONS AT 182 FT DEPTH, METAL IN EXCELLENT CONDITION W/LITTLE DETERIORATION (CG POS. NOT CONSIDERED

RELIABLE DUE TO LARGE DIFFERENCES BETWEEN CG AND OTHER SOURCES OF PO. FOR OTHER WKS. IN REPORT. 1967 POS MAY BE BASED ON EARLIER AND LESS ACCURATE LORAN-C CHAR . LORAN C RATES PROVIDED BY MR. RICHARD TARACKA, GREENWICH, CT. POLICE DEPARTMENT, TEL NO 203-622-8020; 9960-X 262040, 9960-Y 43576.3. (ENTERED MSM 4/90).

TANKER, 6770 TONS; 433 FT. L, 60 FT. W, TORPEDOED 1/15/42 IN 180 FT. TANKER, 6786 TONS; TORPEDOED 1/15/42, IN 180 FT; PORT AND CENTER TANKS BELOW OCEAN FLOOR; DIVER INVEST.IN 1967 POS 40-22N, 72-20W. BUILT BY HOWALDJ SWERKE CO.OF GERMANY IN 1937; TANKER OWNED BY THE SOCONY VACUME OIL CO. LTD.; 423 FT. LONG, 60 FT. BEAM, DISPLACED 6768 GROSS TONS; HIT AMIDSHIPS BY A TORPEDO FROM THE U-123 ON JANUARY 15, 1942; FUEL CARGO EXPLODED INTO FLAMES AND SHIP WAS RIPPEDINTO THREE SECTIONS BEFORE SINKING; LOCATED 56 MILES SOUTHEAST OF JONES INLET IN 180 FT.; LORAN C RATES: 9960-26203.6, 9960-Y 43576.6. (ENTERED MSM 6/9).

The Coimbra was resurveyed in November 2009 by the NOAA Office of Coast Survey ftp://ftp.ngdc.noaa.gov/pub/coast/F00001-F02000/F00584/DR/F00584.pdf

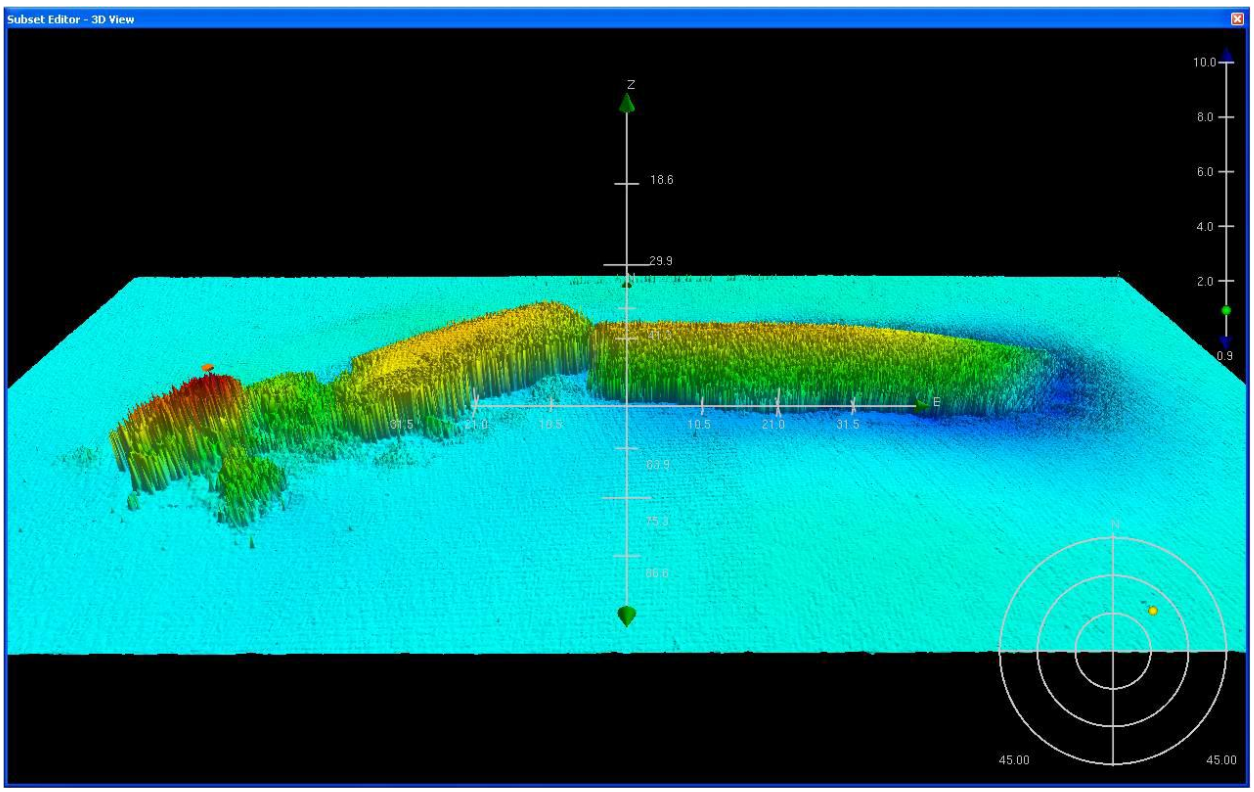


Figure1-2: High-resolution multibeam bathymetry of the *Coimbra* wreck taken by the NOAA Ship *Thomas Jefferson*, 11/10/2009.

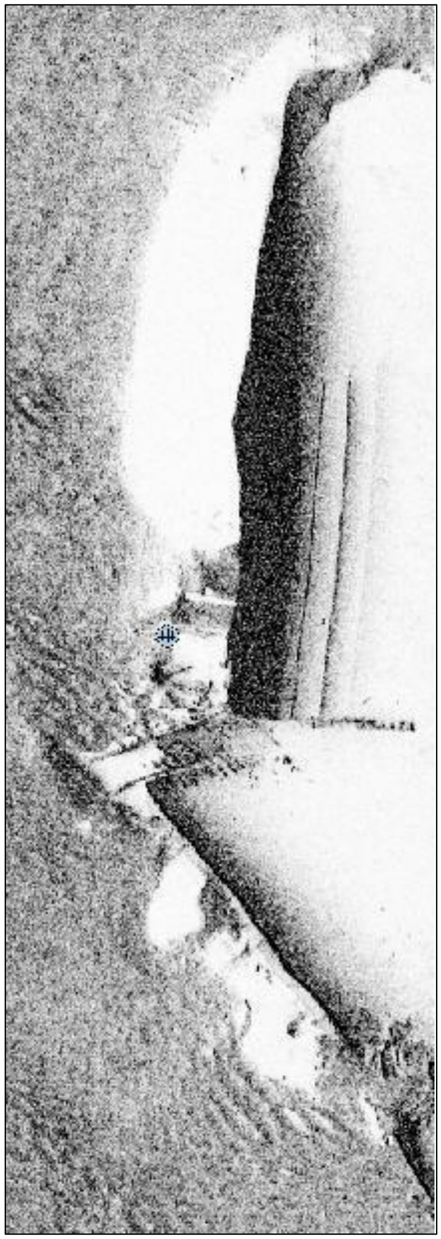


Figure1-3: Side scan sonar imagery of the *Coimbra* wreck taken by the NOAA Ship *Thomas Jefferson*, 11/10/2009.

Wreck Condition/Salvage History

From Brad Sheard's book Beyond Sportdiving—

> "The *Coimbra* lies on her starboard side under 180 feet of water. Her hull is broken at each of the torpedo impact points, forming three fairly intact sections. The shortest of the three pieces is the extreme stern, whose deck lies heeled over approximately 80 degrees to starboard. Part of the superstructure is still in place, including the stern gun that Lieutenant Hardegen made a note of in his war diary. Just forward of the stern section lies the midships piece of the wreck, intact to a point approximately 40 to 50 feet aft of the center island bridge. It lies inclined somewhat farther to starboard at an angle of about 100 degrees. Forward of this second break in the hull, the remainder of the ship runs intact all the way to her bow, which is now somewhat crumpled and twisted, and heeled over so far that it lies nearly upside down on the sandy bottom.

It is difficult to ascertain the condition of her internal tanks. In the extreme stern, her hull is but an empty shell. All the internal appointments of the crew's quarters have slid to the lower, starboard side of the wreck. Here, amidst a pile of rubble, divers have found her galley implements, including a few unbroken pieces of china bearing a small, blue flag emblazoned with a single letter "S". This apparently represents the initials of her owners, the Socony-Vacuum Company, Ltd. There were no oil tanks in this part of the ship.

At both of the torpedo impact points, the oil tanks are open to the sea and empty. Between the hull breaks, little can be concluded about the presence or absence of oil inside. The exterior of the hull is in excellent condition, with no apparent breaches. Along the sand, several of her tank inspection hatches can be seen, bent and distorted by the weight of the ship's hull. While open to the sea, the hatches now lie at the bottom of the tank since the ship lies on her starboard side. This effectively blocks the escape route for the lighter-than-water oil.

For now, the old tanker lies quietly on the ocean bottom, visited frequently by fishermen and occasionally by curious divers. Her location is clearly marked, however, by the thin slick of lubricating oil continuously oozing from her hull. No one knows exactly how much oil remains in her holds, or how long her heavy, steel hull will resist the relentless deterioration of the sea water in which she lies. Tragically, the *Coimbra* may someday make the headlines once again."

Archeological 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

Coimbra is a shipwreck that has received much attention by environmentalists, U.S. Coast Guard, and various academic institutes since it was torpedoed by the German submarine *U-123* on January 15, 1942. The wreck has been described as an environmental disaster waiting to happen and estimates of remaining cargo oil left onboard the wreck have been as high as 35,000 bbl (1,470,000 gallons) of lubricating oil, not including bunkers. The more commonly accepted and used estimate still remains as high as 28,500 bbl (1,197,000 gallons) of lubricating oil in eight cargo tanks, not including bunkers. The problem with these estimates, however, is that the studies they are based on are not easily accessible and were written as early as 1975. After more than three additional decades of leaking, it is unlikely that this amount of oil remains in the wreck. The estimate of 28,500 bbl of oil in eight intact cargo tanks appears to originate from a 1975 study written by the Polytechnic Institute of New York and referenced in a *New York Times* article written on November 30, 1975. Unfortunately, this study has not been located, so one is left to speculate as to which eight tanks the article refers.

Since the 1967 U.S. Coast Guard "Sunken Tanker Project Report" reported that the starboard tanks in the middle section were empty except for slight traces of oil and divers report the stern section where the bunker tanks were located is empty, the only tanks the study could reference would be the port side tanks the U.S. Coast Guard could not access in 1967, or the inverted tanks in the bow section. Since 1967, there is evidence to suggest the middle and aft sections of the wreck have rolled over. In fact, diver reports suggest that this transition likely occurred between 1987 when diver and author Dan Berg reported the wreck was listing to port (in an article written in his book *Wreck Valley Vol. II*, 1990) and 1991 when diver and author Brad Sheard reported the wreck was lying on its starboard side in his book *Beyond Sportdiving*. Today, divers report the decking on the wreck corroded away and the tank hatches from the middle section open to the sea, meaning the portside tanks are also likely empty or only contain residual oil since much of the oil would have escaped as the vessel rolled from its port side to its starboard side. Given these factors, it is likely that the article written by the Polytechnic Institute of New York refers to the tanks in the inverted bow section of the wreck.

It is not known, however, if the eight tanks referenced meant the four main bow cargo tanks divided into port and starboard tanks by the oil tight centerline bulkhead, or if it meant the four main bow cargo tanks and the four bow summer tanks or a combination of the two. Given that each main tank could hold around 3,571 bbl (150,000 gallons) of oil, any of the above scenarios would give about the same approximation of remaining oil as the Polytechnic Institute of New York came up with in 1975. It seems improbable, however, that this could be an accurate estimate given the violent nature in which the vessel sank. The captain of *U-123*, Reinhard Hardegen reported in his war diary that the tanker *Coimbra's* bridge was on fire (a structure located over main cargo tanks three and four, and over port and starboard summer tanks number two). As *Coimbra* sank, the vessel's stern struck the bottom, leaving the burning bow remaining above water from the foremast to the stem (the foremast was located above main cargo tanks one and two and above port and starboard summer tanks number one). The vessel's bow remained like this well after daylight before it finally lost buoyancy and sank.

Given the circumstances of the sinking and the violent nature of the torpedo attack, it is unlikely that any of the tanks on *Coimbra* escaped without some form of damage and some release of oil, so the exact amount of remaining oil cannot be determined with any degree of certainty.

Should the vessel be assessed, 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 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: National Archives, Washington, DC; National Archives, College Park, MD

Construction Diagrams or Plans in RULET Database? No

Text References:

-Office of the Chief of Naval Operations
1942 Tenth Fleet ASW Analysis & Stat. Section Series XIII. Report and Analyses of U. S. and Allied Merchant Shipping Losses 1941-1945 MS-19 - Nymphe, Records of the Office of the Chief of Naval Operations, Box 239, Record Group 38, National Archives at College Park, MD.

-United States Coast Guard
WWII Reports Concerning Merchant Vessels Sinking, 1938-2002 FOREIGN Ciltvairia to Denewood, Records of the United States Coast Guard, Entry P-2, Box 60, Record Group 26, National Archives Building, Washington, DC.

Office of Operations Intelligence and Security Division Merchant Vessels Information Files, 1939-52 Cockerel to Comatuga, Records of the United States Coast Guard, MLR A1 180, Box 36, Record Group 26, National Archives Building, Washington, DC.

-United States Coast Guard
1967 Sunken Tanker Project Report.
http://www.uscg.mil/history/docs/USCG_1967_Sunken_Tanker_Project_Report.pdf

-New York Times
1975 Oil Threat from Hulk off Fire I. is Studied. New York Times, Nov. 30, 1975.

-http://www.uboat.net/allies/merchants/1251.htm

-AWOIS database
-Coast Survey 2009 field report
ftp://ftp.ngdc.noaa.gov/pub/coast/F00001-F02000/F00584/DR/F00584.pdf
-NIMA database
-Global Wrecks
-http://njscuba.net/sites/site_coimbra.html

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Coimbra* 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 archeological 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 archeological assessment may provide additional input that will amend the score for Section 1. Where available, additional information that may have bearing on operational considerations for any assessment or remediation activities is provided.

Each risk factor is characterized as High, Medium, or Low Risk or a category-appropriate equivalent such as No, Unknown, Yes, or Yes Partially. The risk categories correlate to the decision points reflected in Figure 1-2.

Pollution Potential Tree

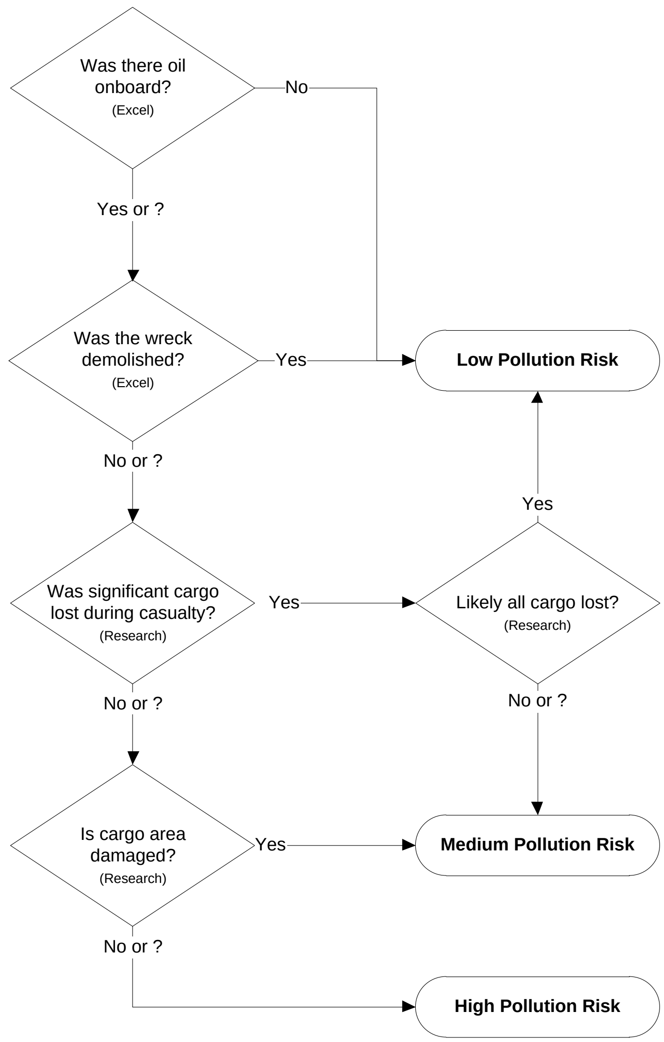


Figure 1-2: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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 *Coimbra* 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 *Coimbra* is ranked as High Volume because, the best estimates of remaining oil suggests there are potentially 28,500 bbl of oil remaining onboard. Data quality is low because this estimate has not been confirmed through detailed analysis of the vessel or of oil remaining in the intact tanks and cannot accurately determine how much oil has been released through frequently reported leaks.

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 multiple reports of leakage from the *Coimbra*.

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:

[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)."

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

The *Coimbra* is classified as Medium Risk because the cargo is lubricating oil, a Group II oil type. Data quality is high.

Was the wreck demolished?

Risk Factor B: Wreck Clearance

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

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

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

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

This risk factor addresses any burning that is known to have occurred at the time of the vessel casualty and may have resulted in oil products being consumed or breaks in the hull or tanks that would have 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 *Coimbra* is classified as Medium Risk because the oil caught fire and burned for a short period of time. Data quality is high.

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]

Risk Factor C2: Reported Oil on the Water

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

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

The *Coimbra* is classified as Medium Risk because the oil was reported to have spread across the water as it burned. Data quality is medium.

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 *Coimbra* is classified as Low Risk because there were two torpedo detonations and the vessel is broken into three sections. 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 *Coimbra* is classified as Medium Risk because it is broken into three pieces and the tanks around the breaks are open to the sea. 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 *Coimbra* is broken into three parts and resting on its starboard side, the bow is inverted. 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 *Coimbra* is 170 feet deep. 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.

Parts of the *Coimbra* are known to be intact and structurally sound. Recent remote sensing work by the NOAA Ship *Thomas Jefferson* confirms this information. 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 *Coimbra* had munitions for onboard weapons, one B.L. 4" gun; one Holman Projector; two Hotchkiss .303 guns; four Lewis .303 machineguns; one Ross rifle .303; two Walther 7.65 mm pistols. 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 *Coimbra*. Operational factors are listed but do not have a risk score.

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

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	28,500 bbl, reported to be leaking	**Med**
	A2: Oil Type	High	Cargo is lubricating oil, a Group III oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	Fire was reported	
	C2: Oil on Water	High	Oil was reported on the water; amount is not known	
	D1: Nature of Casualty	High	Two torpedo detonations	
	D2: Structural Breakup	High	The vessel is broken into three sections	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site assessments of this ship exist, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Stern and amidships sections resting on starboard side, bow is inverted	**Not Scored**
	Depth	High	170 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	Location is a popular technical diving and sport fishing site; NOAA conducted a survey in 2009 to locate the wreck and update the NOAA charts	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	Munitions for onboard weapons	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and SMCA	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

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

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Coimbra* this would be about 29,000 bbl based on current estimates of the amount of oil remaining onboard the wreck.

The likeliest scenario of oil release from most sunken wrecks, including the *Coimbra*, 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 *Coimbra*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	29 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	290 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	2,900 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	14,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	29,000 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 *Coimbra* contained a maximum of 28,500 bbl of lubricating oil (a Group II oil) as cargo and bunker fuel oil (a Group IV oil). Because the bulk of the oil likely remaining on board is lubricating oil, the oil spill model was run using light fuel oil.

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

For oil stranded onshore, a thickness of 1 g/m^2 was used as the threshold for socio-economic impacts because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity beaches. A thickness of 100 g/m^2 was used as the threshold for ecological impacts based on a synthesis of the literature showing that shoreline life has been affected by this degree of oiling.[2] Because oil often strands onshore as tarballs, Table 2-2b shows the number of tarballs per m^2 on the shoreline for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter.

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

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

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

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

Potential Impacts to the Water Column

Impacts to the water column from an oil release from the *Coimbra* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi^2 that has been contaminated by 1 part per billion (ppb) oil to a depth of 33 feet. At 1 ppb, there are likely to be impacts to sensitive organisms in the water column and potential tainting of seafood, so this concentration is used as a screening threshold for both the ecological and socio-economic risk factors for water column resource impacts. To assist planners 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. Office of Environmental Policy and Compliance, U.S. Dept. of the Interior, Washington, DC.

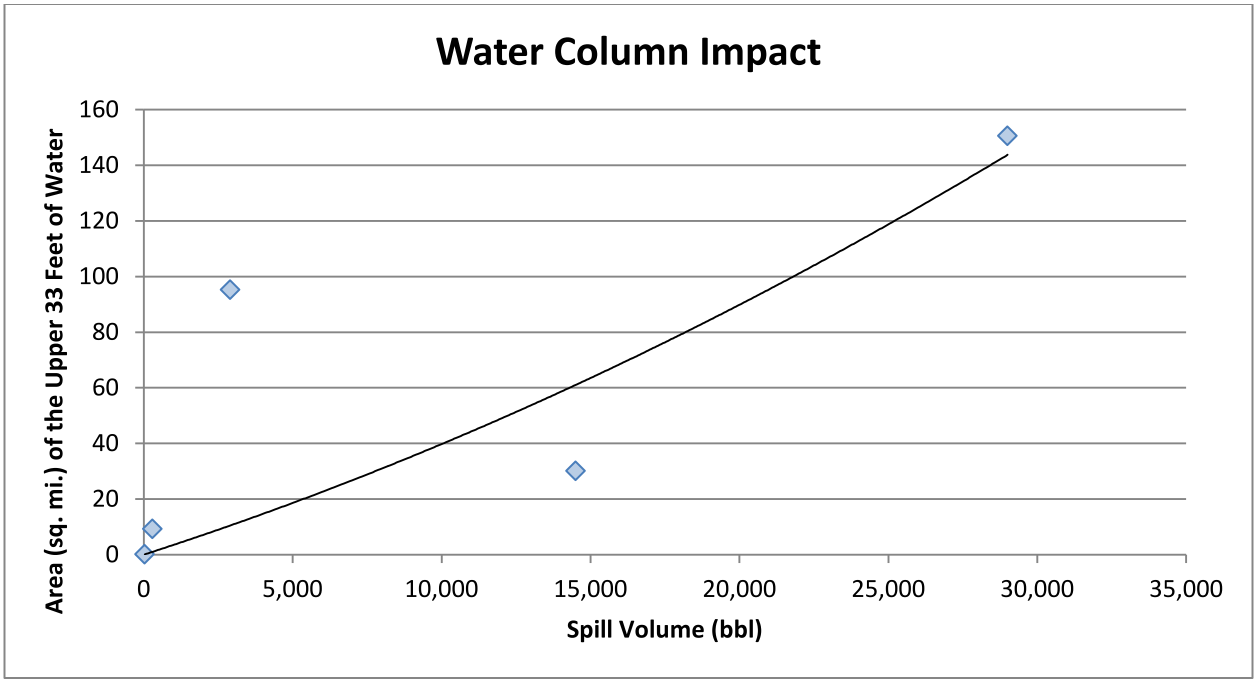


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Coimbra*.

Potential Water Surface Slick

The slick size from an oil release from the *Coimbra* 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. 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 *Coimbra*.

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m²	10 g/m²
Chronic	29	629 mi²	46 mi²
Episodic	290	2,340 mi²	200 mi²
Most Probable	2,900	7,490 mi²	970 mi²
Large	14,500	17,100 mi²	2,690 mi²
Worst Case Discharge	29,000	24,000 mi²	4,400 mi²

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

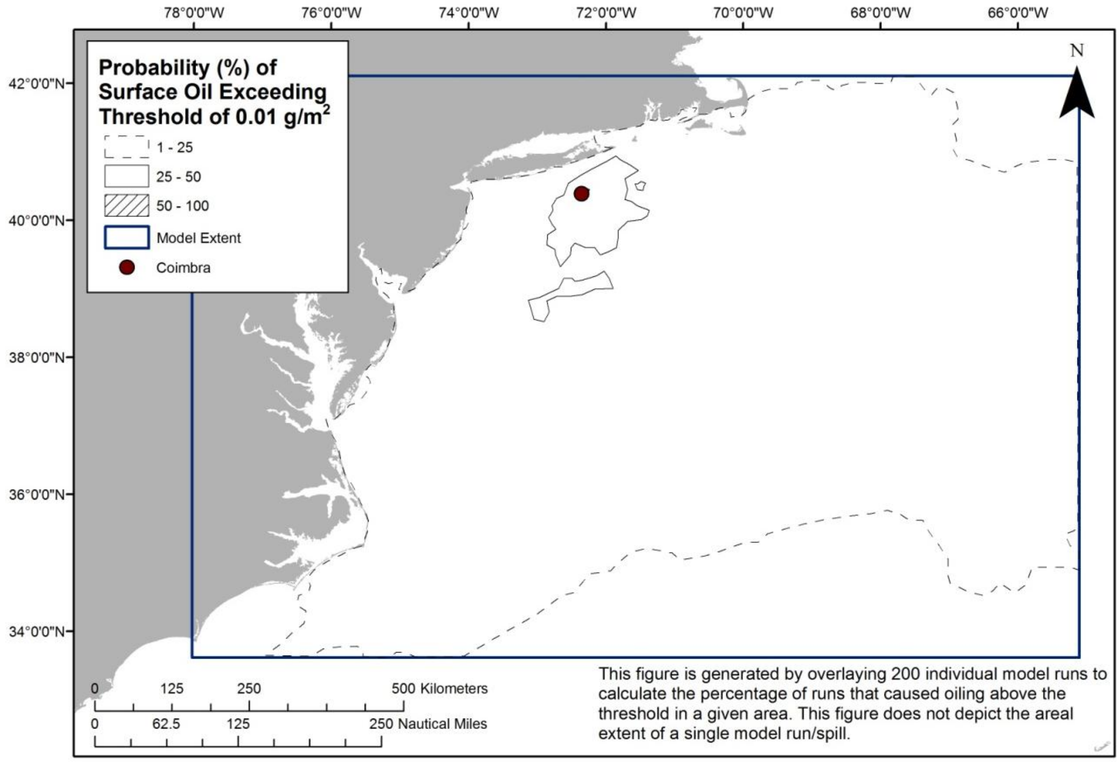


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 2,900 bbl of light fuel oil from the *Coimbra* at the threshold for socio-economic resources at risk.

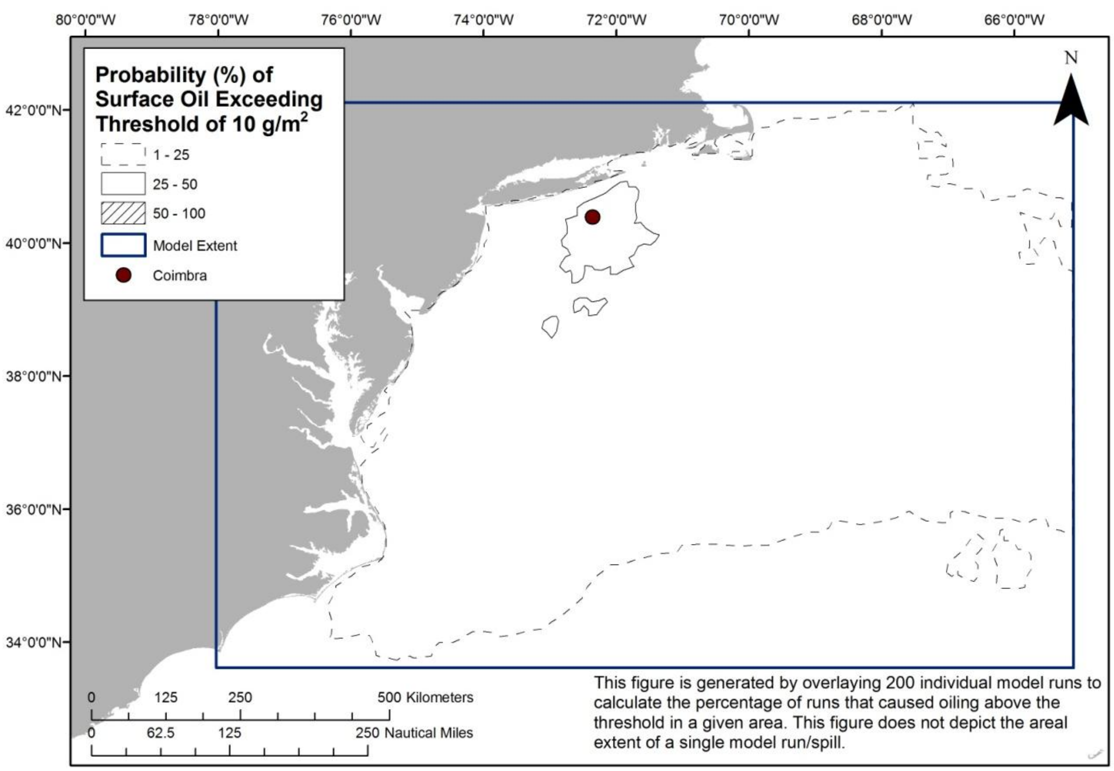


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 2,900 bbl of light fuel oil from the *Coimbra* at the threshold for ecological resources at risk.

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.

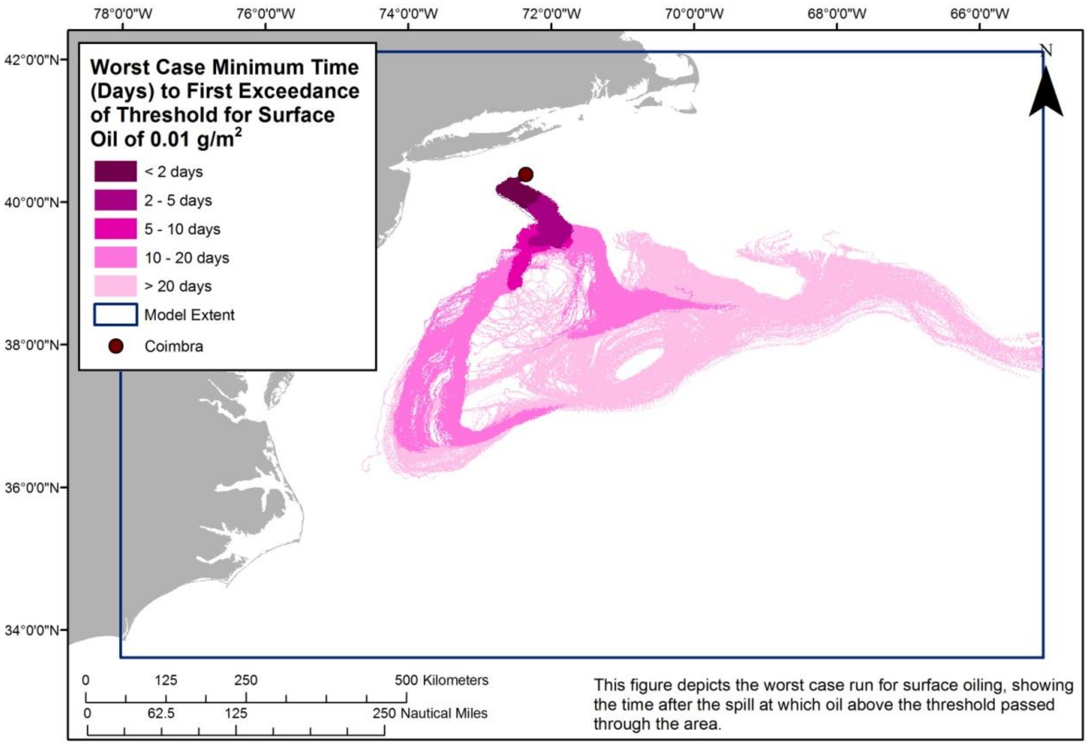


Figure 2-4: Water surface oiling from the Most Probable spill of 2,900 bbl of light fuel oil from the *Coimbra* shown as the area over which the oil spreads at different time intervals.

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.

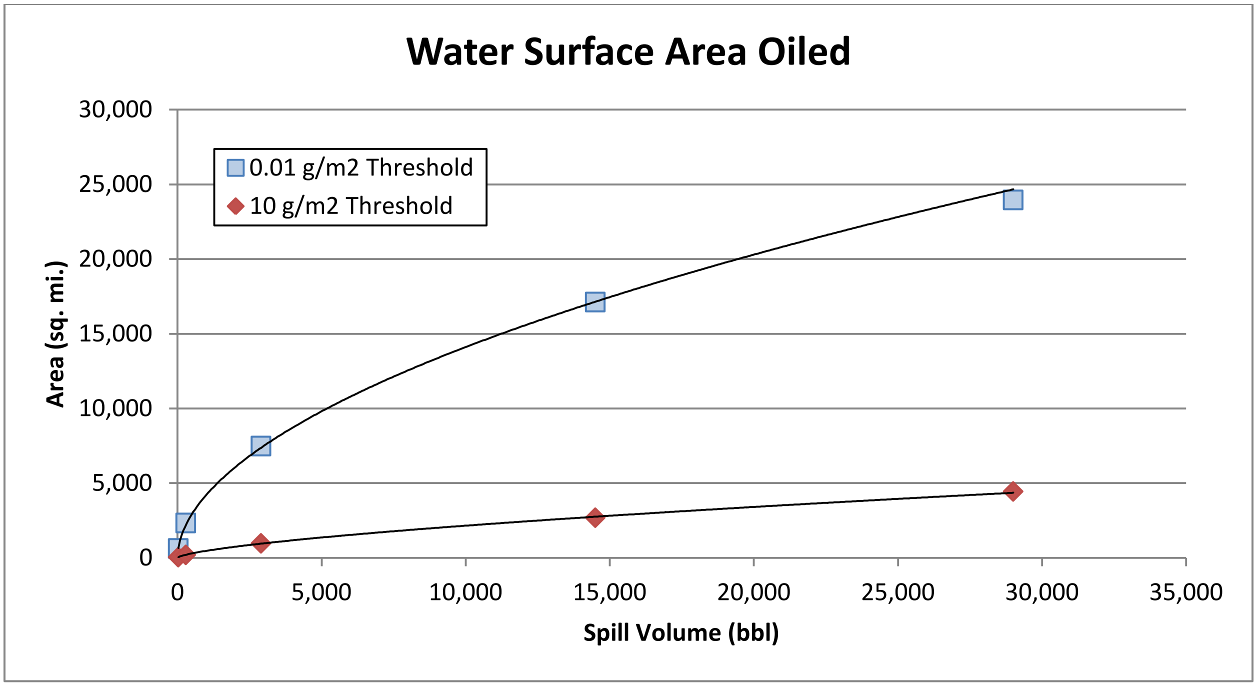


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Coimbra*, showing both the ecological threshold of 10 g/m² and socio-economic threshold of 0.01 g/m².

Potential Shoreline Impacts

Based on these modeling results, shorelines from as far north as Cape Cod, to as far south as Cape Lookout, North Carolina, 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 2,900 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 2-4: Estimated shoreline oiling from leakage from the *Coimbra*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m²			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	29	0	0	0	0
Episodic	290	1	0	0	1
Most Probable	2,900	3	1	0	5
Large	14,500	7	8	1	16
Worst Case Discharge	29,000	9	12	2	22

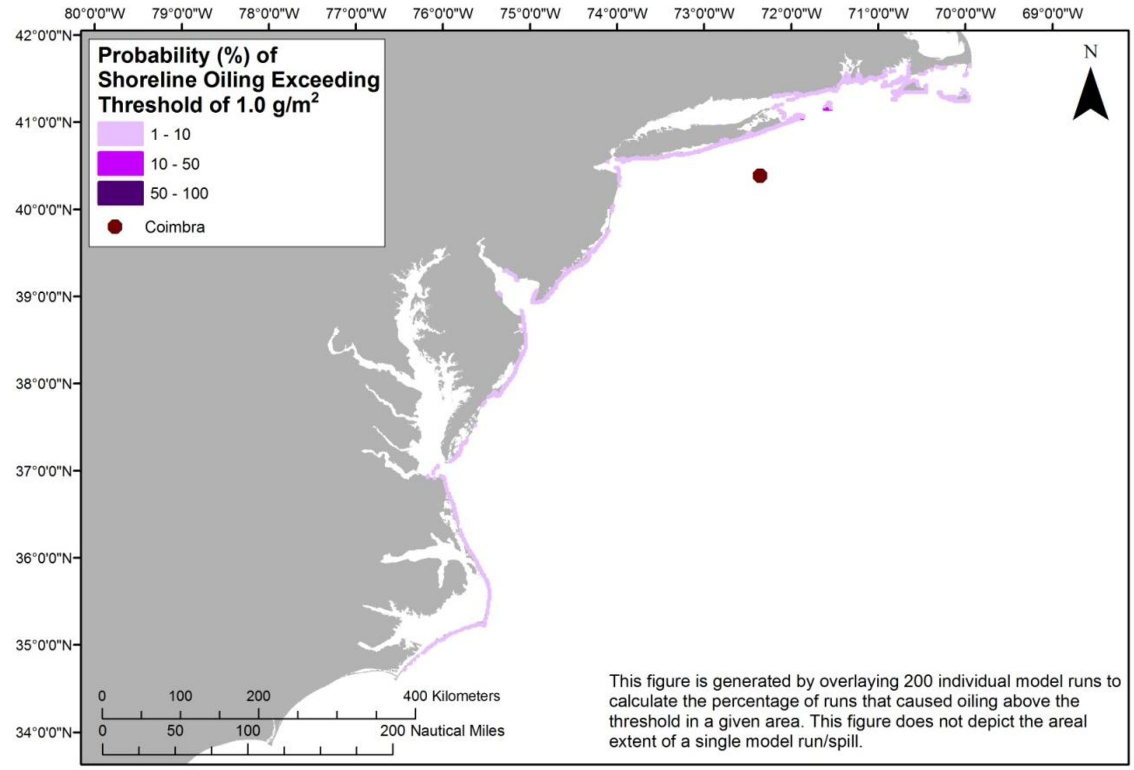


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m²) from the Most Probable Discharge of 2,900 bbl of light fuel oil from the *Coimbra*.

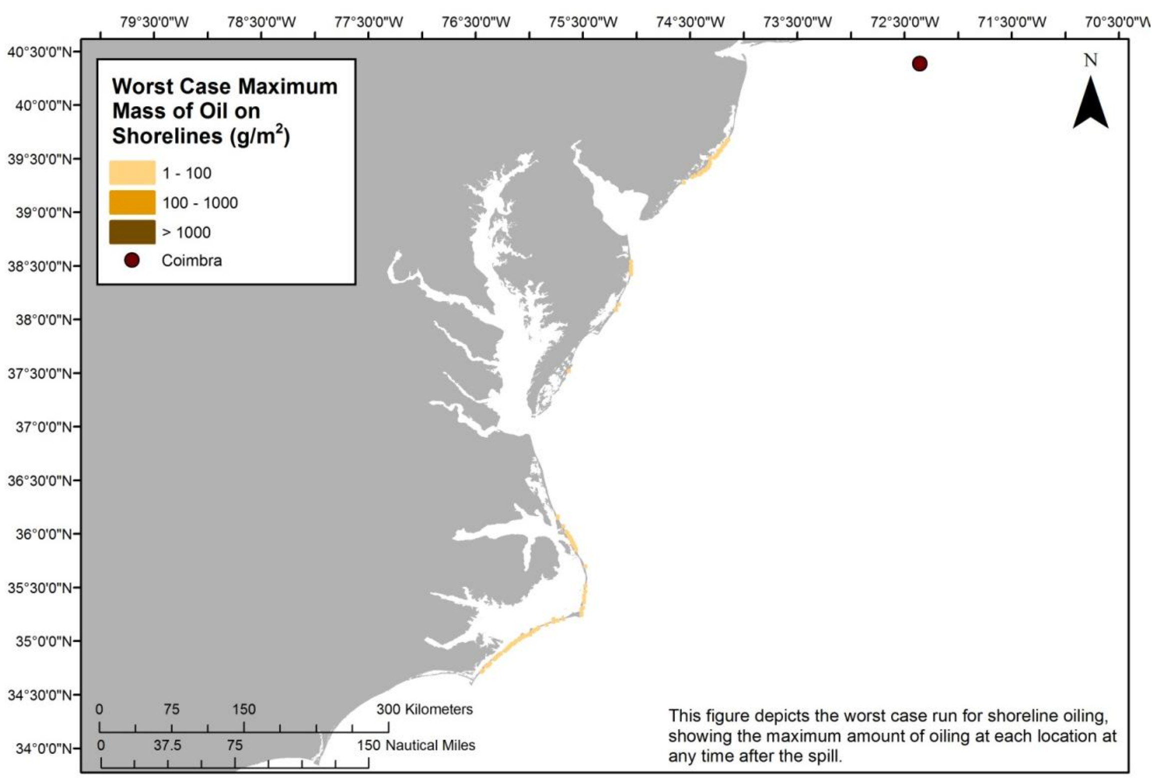


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 2,900 bbl of light fuel oil from the *Coimbra* that resulted in the greatest shoreline oiling.

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.

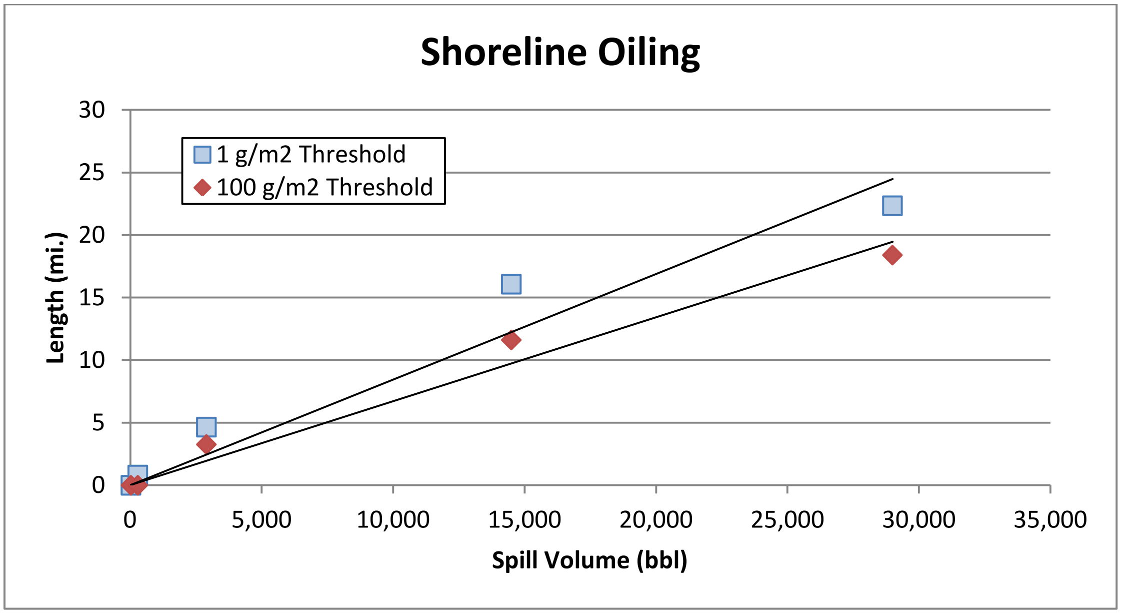


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Coimbra*.

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 29,000 bbl from the *Coimbra*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m^2	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m^2
Rocky and artificial shores/Gravel beaches	21 miles	9 miles
Sand beaches	80 miles	52 miles
Salt marshes and tidal flats	12 miles	2 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 2,900 bbl from the *Coimbra*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m^2	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m^2
Rocky and artificial shores/Gravel beaches	0 miles	0 miles
Sand beaches	20 miles	0 miles
Salt marshes and tidal flats	0 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Coimbra* (Table 3-1) include numerous guilds of birds, particularly those sensitive to surface oiling while rafting or plunge diving to feed and are present in nearshore/offshore waters. As can be noted in the table, large numbers of birds winter in both coastal and offshore waters, and many of the beaches are very important shorebird habitat. In addition, this region is important for commercially important fish and invertebrates.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Pelagic Birds and Sea Ducks	• North and Mid-Atlantic inshore/offshore waters: 150K loons (RI is critical wintering habitat for a significant number of loons); 2K grebes; 1,000s of petrels; millions of shearwaters, storm-petrels, gulls; 300K boobies; 6K pelicans; 100,000s of cormorants, phalaropes, and terns; 10,000s of alcids; 1,000s of raptors, jaegers, and skimmers; 1.3 million sea ducks • Mouths of DE Bay and Chesapeake Bay, and Nantucket Island have high concentrations of species that are abundant over shoals (e.g., loons, pelicans, cormorants, sea ducks, gulls, terns, alcids); shoals off of Nantucket Island are largest on East Coast and concentrate millions of birds (very important for scoters and other sea ducks); shoals also occur off of Long Island • Audubon's shearwaters (50-75% of population) concentrate along the edge of the Continental Shelf off the coast of NC extending northward to the VA border (~3,800 pairs) • Northern gannet are abundant Fall-Spring throughout the coastal zone (often >3 km from shore) • Pelagic/waterbird bird use of RI waters is most diverse and abundant Fall through Spring, but 10,000s of birds have been observed feeding some summers	Terns, gulls present in spring/summer; Loons, sea ducks present in spring/fall Most surveys in winter but use of shoals and offshore waters varies by species group and occurs throughout the year; summer shoal use more common on northern shoals Shearwaters off of NC/VA: late summer

Sea Ducks	Sea ducks (mean and max distance of flocks to shore, 2009-2010 data)
	• Scoters (black, surf, and white-winged; 2 nm/8-13 nm)
	  ○ Cape Cod/Nantucket: 51-55K
	  ○ Nantucket Shoals: 9-36K
	  ○ LI Sound: 6-22K
	  ○ Off LI south coast: 8-19K
	  ○ Off NJ coast: 1K
	  ○ DE Bay: 12-14K
	  ○ Off MD/DE: 18-111K
	  ○ Chesapeake Bay: 34-73K
	  ○ Off Pamlico Sound: 4-43K
	• Long-tailed duck (2 nm/25 nm)
	  ○ Cape Cod/Nantucket: 31K
	  ○ Nantucket Shoals: 71-128K
	  ○ LI Sound: 3-7K
	  ○ Off LI south coast: 1-38K
	  ○ Off NJ coast: 1-6K
	  ○ Off MD/DE: 2K
	  ○ Chesapeake Bay: 17-31K
	• Common eider (<1 nm/19 nm)
	  ○ Cape Cod/Nantucket: 92-201K
	  ○ Nantucket Shoals: 2-6K
		Sea ducks surveyed in Winter (peak abundances). Migration from Oct-Apr

Species Group	Species Subgroup and Geography	Seasonal Presence
	○ LI Sound: 21-41K ○ Off LI south coast: 3.5K • Bufflehead, mergansers, goldeneyes (<1 nm/7-14 nm) ○ Cape Cod/Nantucket: 11K ○ LI Sound: 7K ○ Off NJ Coast: 9K ○ Off MD/DE: 3K ○ Ches. Bay: 14K ○ Off NC: 12K • Benthic community composition and water depth important for determining preferred foraging sites (not well known in all areas, some studies have been conducted) • RI: Most critical wintering areas for harlequin ducks occur north of spill area, but rocky coasts in MA and RI also important	
Shorebirds and Colonial Nesting Birds	Shorebirds and colonial nesting birds are abundant on small islands, beaches, and marshes throughout the region • VA Barrier Island/Lagoon System: most important bird area in VA and one of most along Atlantic Coast (of global/hemispheric importance): piping plover (FT), Wilson's plover, American oystercatcher, gull-billed tern, least tern, black skimmer (many of these species are state listed or of special concern in several states); most significant breeding population in state of waders; marsh nesters have center of abundance here; internationally significant stopover point for whimbrel, short-billed dowitcher, and red knot • Assateague Island, MD: globally important bird area due to 60+ pairs of nesting piping plovers; largest colony of nesting least terns in MD; important for migratory shorebirds • DE/NJ sides of DE Bay: extremely important migratory stopover point for several species of shorebirds (tied to horseshoe crab spawning): ruddy turnstone, short-billed dowitcher, red knot, etc. Delaware Bay is globally/hemispherically important as a migratory stopover site; red knots have decreased over 90% since 1990 and this is the most important stopover location for them. • NJ: Edwin B. Forsythe NWR and Sandy Hook: essential nesting and foraging habitat for imperiled beach nesters (piping plover, American oystercatcher, black skimmer, least tern). • Barrier islands on south shore of Long Island and islands/marshes on bay side: beach nesters (e.g., piping plovers), nesting wading birds, raptors, migrating shorebirds, wintering waterfowl etc. • Great Gull Island (LIS): one of the most important tern nesting sites in the world (1,600 pairs of roseate terns (FE), 10K common terns); Bird Island (and possibly Ram Island), MA is the other important site for roseate tern; together they make up 80% of the nesting population. • CT: Hammonasset Beach State Park: nesting saltmarsh sharp-tailed sparrow and migratory stopover point • RI and MA: Numerous important sites for beach and salt marsh habitats, including many NWRs that support breeding (e.g., least tern and piping plover) and migratory stopover points. • Cape Cod is a nationally significant migratory stopover site for numerous species; e.g., Monomoy NWR and South Beach are the most important habitats in New England for nesting piping plover, American oystercatchers, and major late-summer concentrations of shorebirds and roseate terns	Colonial and beach nesters peak Apr-Aug Migration typically Spring/fall, but varies by species and location and ranges from Feb-Jun/Aug-Dec
Raptors and Passerines	Lower Delmarva (Cape Charles area of VA): 20-80K raptors and over 10 million migrating passerines	Fall

Species Group	Species Subgroup and Geography	Seasonal Presence
Sea Turtles	Estuaries are summer foraging grounds for adult and juvenile green (FE) and loggerhead (FT) sea turtles, especially Chesapeake Bay and Long Island Sound. Leatherback (FE), loggerhead, Kemp's ridley (FE) present offshore. Greens occur in VA, NJ, and DE but are rare further north. *Nesting:* Loggerheads nest on sand beaches south of Delaware. Kemp's ridley, green, and leatherback turtles may nest occasionally on the NC Outer Banks	Adults and juveniles present spring/summer Loggerheads Nest: Mar-Nov Hatch: May-Dec
Marine Mammals	*Baleen whales*: North Atlantic right whale (FE), humpback whale (FE), fin whale (FE) and minke whales are more common offshore but can move inshore to feed on forage fish and zooplankton. • Right whales are critically endangered (300-400 individuals remaining) and use this area as a migratory pathway • *Inshore cetaceans:* Atlantic white-sided, bottlenose dolphin, harbor porpoise and killer whales use coastal waters out to the shelf break. *Offshore cetaceans*: Northern bottlenose whale, pilot whales, Risso's dolphin, striped dolphin, common dolphin, Atlantic spotted dolphin, spinner dolphin • Often associated with shelf edge features and convergence zones *Deep diving whales:* Sperm whale (FE), beaked whales (5 spp present) forage in deep waters and canyons in the region. *Pinnipeds*: Gray seals and harbor seals are common during the winter, using Block Island as a haulout. Stray hooded seals and other sea lions can occur	Baleen whales migrate through the area spring and fall; males and juveniles may stay year round Dolphins more common in southern part of study area, during summer Harbor porpoises calve May-Aug Sperm whales present spring–summer
Fish & Invertebrates	Coastal ocean waters support many valuable fisheries and/or species of concern in the region: • Benthic: American lobster, sea scallop, scup, summer flounder, winter flounder, black sea bass, Atlantic rock crab, goosefish, Atlantic surf clam, butterfish, • Midwater: Atlantic mackerel, Atlantic herring, longfin squid, shortfin squid, striped bass, bluefish, menhaden, spiny dogfish sharks, spot, weakfish • Pelagic: bluefin tuna, yellowfin tuna, wahoo, dolphinfish, bigeye tuna, swordfish • Diadromous: alewife, blueback herring, American shad, Hickory shad, American eel, Atlantic sturgeon (Fed. species of concern) Pelagic species can be more concentrated around the shelf break and at oceanographic fronts in the region Estuaries are important nursery grounds for many of these species, and support many fisheries-blue crab, shrimp, horseshoe crab, Eastern oyster Important concentration/conservation areas are: • Nantucket Lightship closed area (S of Nantucket) • Great South Channel – boulder and cobble substrate thought to be nursery area for cod • EFH for highly migratory species occurs in the area, including swordfish, bluefin tuna, yellowfin tuna, bigeye tuna, shark species • Juvenile and adult bluefin tuna aggregate in the area in the winter Norfolk Canyon, Veatch Canyon, Oceanographer Canyon, and Lydonia Canyon are gear-restricted because they are important habitat for golden tilefish and monkfish	Generally spawn during the warmer months (except winter flounder) Juveniles of many species use estuaries, seagrass, and hard-bottom habitats as nursery areas Many coastal fish migrate seasonally either across the shelf or east-west (winter flounder)
Benthic Habitats	Submerged aquatic vegetation (mostly eelgrass) is critical to numerous species and occurs inside of bays and sounds throughout the region	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Coimbra* 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 based on a 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).

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

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Coimbra* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 29,000 bbl and $\boxed{\text{a border}}$ around the Most Probable Discharge of 2,900 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 *Coimbra* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 29,000 bbl because 58% 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 151 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 2,900 bbl, the *Coimbra* is classified as High Risk for oiling probability for water column ecological resources because 100% 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 95 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 *Coimbra* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 91% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 4,440 mi^2. The *Coimbra* is classified as Medium Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 37% 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 Low Risk for degree of oiling because the mean area of water contaminated was 970 mi^2.

Risk Factor 3C: Shoreline Impacts to EcoRAR

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

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

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

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

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

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

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

The *Coimbra* is classified as Medium Risk for oiling probability for shoreline ecological resources for the WCD because 46% 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 28 miles. The *Coimbra* is classified as Medium Risk for oiling probability for shoreline ecological resources for the Most Probable Discharge because 18% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Low Risk for degree of oiling because the mean weighted length of shoreline contaminated was 6 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 29,000 bbl of lubricating oil from the *Coimbra* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Medium, because the area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – Medium, because although there can be very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk, light fuel oils on the surface will not be continuous but rather be in the form of sheens that pose lesser risks to birds, sea turtles, and marine mammals
- Shoreline resources – Medium, because most of the shoreline at risk is composed of sand and gravel beaches where light fuel oils are not expected to persist, although these beaches are used by many shorebirds and sea turtles for nesting and many shorebirds as wintering and migratory stopovers

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 29,000 bbl** of lubricating oil from the *Coimbra*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	**High**	58% 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	**Med**
3A-2: Water Column Degree EcoRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 151 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	91% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 10 g/m^2 was 4,440 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	**Medium**	High	46% 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 28 mi	

For the Most Probable Discharge of 2,900 bbl, the ecological risk from potential releases from the *Coimbra* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because the area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – Low, because although there can be very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk, light fuel oils on the surface will not be continuous but rather be in the form of sheens that pose lesser risks to birds, sea turtles, and marine mammals
- Shoreline resources – Low, because of the small amount of potential shoreline oiling

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 2,900 bbl** of lubricating oil from the *Coimbra*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	100% 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 95 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	37% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	Low
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	High	The mean area of water contaminated above 10 g/m^2 was 970 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	18% of the model runs resulted in shoreline oiling of 100 g/m^2	Low
3C-2: Shoreline Degree EcoRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 100 g/m^2 was 6 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 *Coimbra* include very highly utilized recreational beaches from North Carolina to Massachusetts during summer, but also during spring and fall for shore fishing. Hotspots for chartered fishing vessels and recreational fishing party vessels include along the New Jersey shore, off the mouth of Delaware Bay, and off the outer banks of North Carolina. 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.

A release could impact shipping lanes that run through the area of impact from New York east of Cape Cod, and into Narragansett Bay. Coastal waters off Rhode Island and southern Massachusetts are popular sailing locations. A proposed offshore wind farm site is located in Nantucket Sound.

Commercial fishing is economically important to the region. Regional commercial landings for 2010 exceeded $600 million. Cape May-Wildwood, NJ and Hampton Roads, VA were the 6th and 7th nationally ranked commercial fishing ports by value in 2010. The most important species by dollar value present in and around the Mid-Atlantic are sea scallops, surf clams, ocean quahogs, menhaden, striped bass, and blue crab.

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 *Coimbra* 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 *Coimbra*.

Resource Type	Resource Name	Economic Activities
Tourist Beaches	Ocean City, MD Rehoboth Beach, DE Dewey Beach, DE Indian Beach, DE Bethany Beach, DE Middlesex Beach, DE Fenwick Island, DE Cape May, NJ Wildwood, NJ Avalon, NJ	Potentially affected beach resorts and beach-front communities in Massachusetts, Rhode Island, New York, New Jersey, Delaware, and North Carolina 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 east coast of New Jersey, northeastern Delaware, the southern coast of Long Island, New York, the southern coast of Rhode Island, and the southwestern shore of Massachusetts and

Resource Type	Resource Name	Economic Activities
	Atlantic City, NJ Ocean City, NJ Absecon Beach, NJ Ludlam Beach, NJ Seven Mile Beach, NJ Margate City, NJ Peck Beach, NJ Ventnor City, NJ Brigantine Beach, NJ Beach Haven, NJ Spray Beach, NJ Brant Beach, NJ Long Beach, NJ Point Pleasant Beach, v Seaside Park, NJ Ortley Beach, NJ Ocean Beach, NJ Normandy Beach, v Ocean Beach, NY Fire Island Pines, NY Southampton, NY East Hampton, NY Westhampton Beach, NY Montauk, NY Block Island, RI East Matunuck State Beach, RI Roger W. Wheeler State Beach, RI Scarborough State Beach, RI Newport, RI Martha's Vineyard, MA	Martha's Vineyard, Massachusetts, are lined with economically valuable beach resorts and residential communities. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
National Seashores	Cape Hatteras National Seashore, NC Assateague Island National Seashore, MD and VA Fire Island National Seashore, NY	National seashores provide recreation for local and tourist populations as well as preserve and protect the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area. Assateague Island is known for its feral horses. Cape Hatteras is known for its Bodie Island and Cape Hatteras Lighthouses. Popular recreation activities include windsurfing, birdwatching, fishing, shell collecting, and kayaking. The barrier island provides refuge for the endangered piping plover, seabeach amaranth, and sea turtles. Fire Island, a barrier island south of Long Island, has the historic William Floyd House and Fire Island Lighthouse.
National Wildlife Refuges	Prime Hook NWR (DE) Bombay Hook NWR (DE) Cape May NWR (NJ) Edwin B. Forsythe NWR (NJ) Seatuck NWR (NY) Wertheim NWR (NY) Amagansett NWR (NY) Block Island NWR (RI) Ninigret NWR (RI) Trustom Pond NWR (RI) Sachuest Point NWR (RI)	National wildlife refuges in seven states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.

Resource Type	Resource Name	Economic Activities
	Nomans Land Island NWR (MA) Mashpee NWR (MA) Nantucket Island NWR (MA) Monomoy NWR (MA) Fisherman Island NWR (VA) Eastern Shore of Virginia NWR (VA) Wallops Island NWR (VA) Chincoteague NWR (VA) Back Bay NWR (VA) Mackay Island NWR (NC) Currituck NWR (NC) Pea Island NWR (NC) Cedar Island NWR (NC)	
State Parks	Assateague State Park, Maryland Delaware Seashore State Park, DE Cape Henlopen State Park, DE Cape May Point State Park, NJ Corson's Inlet State Park, NJ Barnegat Lighthouse State Park, NJ Island Beach State Park, NJ Robert Moses State Park, NY Shadmoor State Park, NY Camp Hero State Park, NY Montauk State Park, NY Salty Brine State Park, RI Fishermen's Memorial State Park, RI Beavertail State Park, RI Wetherill State Park, RI Brenton Point State Park, RI Fort Adams State Park, RI Horseneck Beach State Park, MA Demarest Lloyd State Park, MA Fort Phoenix State Park, MA Nasketucket Bay State Park, MA	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). They provide income to the states. State parks in Massachusetts, Rhode Island, New York, New Jersey, Delaware, and Maryland are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Tribal Lands	Shinnecock Indian Reservation, NY	Shinnecock Indian Reservation, New York, is home to over 500 tribal members. (Note this reservation has been recognized by New York State but not by the U.S. Bureau of Indian Affairs)
	Narragansett Indian Reservation, RI	Narragansett Indian Reservation, Rhode Island, is home to 2,400 tribal members.
	Wampanoag Indian Reservation, MA	Wampanoag Indian Reservation, Massachusetts, is home to over 2,000 tribal members.
Commercial Fishing	A number of fishing fleets use the New York Bight area and surrounding waters for commercial fishing purposes.	
	Atlantic City, NJ	Total Landings (2010): $17.3M
	Belford, NJ	Total Landings (2010): $2.2M
	Cape May-Wildwood, NJ	Total Landings (2010): $81M
	Chincoteague, Virginia	Total Landings (2010): $3.5M
	Montauk, NY	Total Landings (2010): $17.7M
	New London, Connecticut	Total Landings (2010): $10.6M
	Newport, RI	Total Landings (2010): $6.9M
	Ocean City, Maryland	Total Landings (2010): $8.8M
	Point Pleasant, NJ	Total Landings (2010): $22.8M

Resource Type	Resource Name	Economic Activities
	Stonington, Connecticut	Total Landings (2010): $18.5M
Ports	There are a number of significant commercial ports in the Northeast 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.	
	Camden, NJ	249 port calls annually
	Claymont, DE	19 port calls annually
	Delaware City, DE	211 port calls annually
	Gloucester, NJ	180 port calls annually
	New York/New Jersey	5,414 port calls annually
	Newport, RI	95 port calls annually
	Philadelphia, PA	914 port calls annually
	Providence, RI	128 port calls annually
	Salem, NJ	52 port calls annually
	Wilmington, DE	443 port calls annually
Other Resources	Cape Wind Offshore Wind Farm (proposed), MA	Rated to produce up to 468 MW of wind power with average expected production of 170 MW which is almost 75% of the 230 MW average demand for Cape Cod, Martha's Vineyard, and Nantucket.

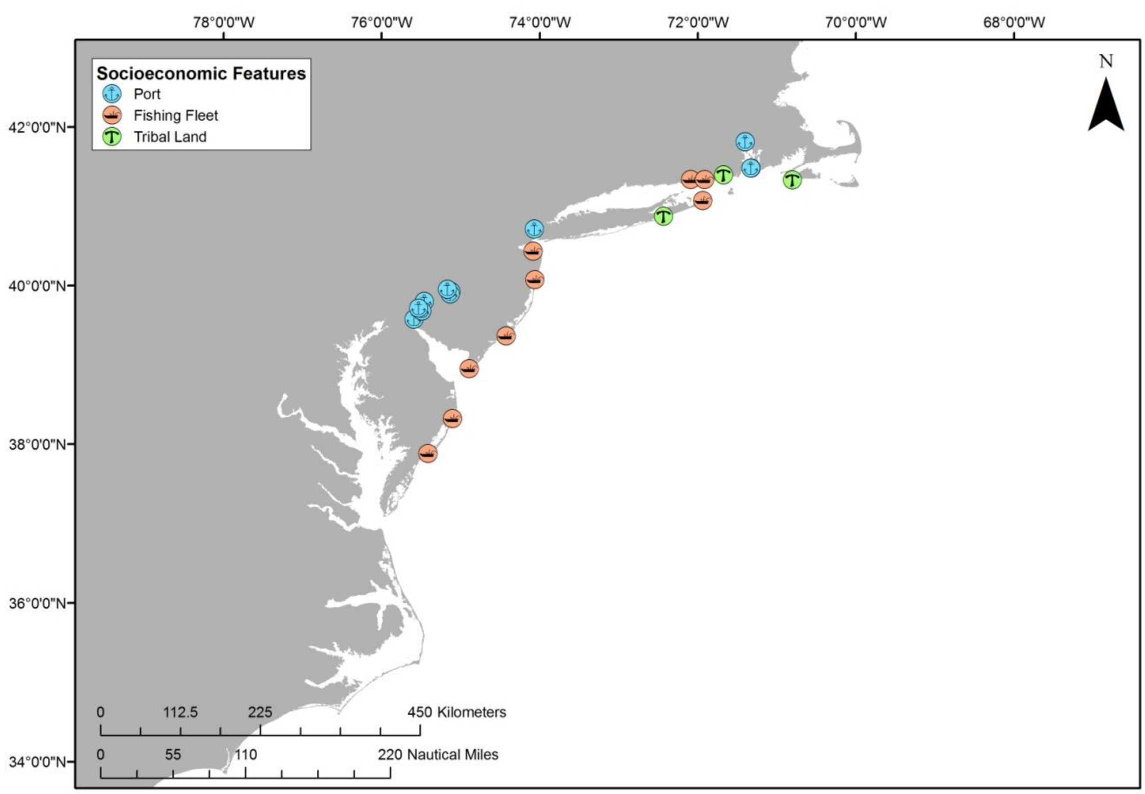


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Coimbra*.

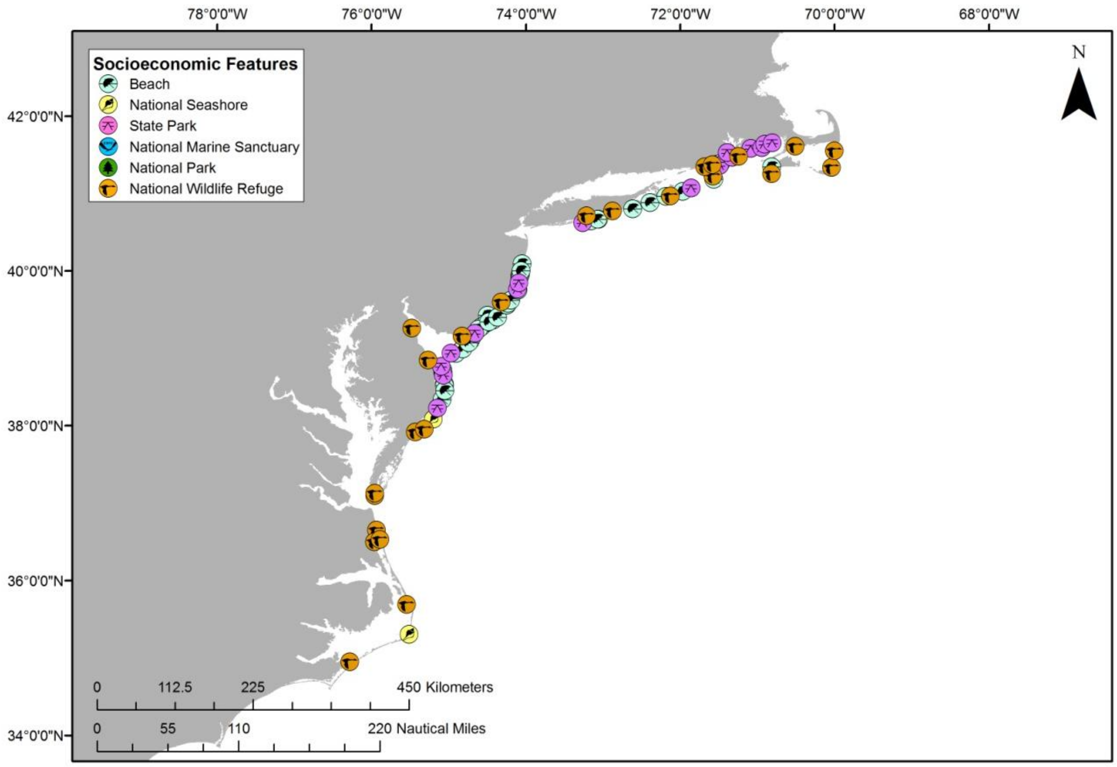


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Coimbra*.

Socio-Economic Risk Factors

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

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

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

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

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

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

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

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 *Coimbra* is classified as High Risk for both oiling probability and for degree of oiling for water column socio-economic resources for the WCD of 29,000 bbl because 92% 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 321 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 2,900 bbl, the *Coimbra* is classified as Medium Risk for oiling probability for water column socio-economic resources because 100% 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 was classified as Medium Risk for degree of oiling because the mean volume of water contaminated 131 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 *Coimbra* is classified as High Risk for both oiling probability and 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 28,600 mi^2. The *Coimbra* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 96% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 9,000 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 *Coimbra* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 50% 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 length of weighted shoreline contaminated was 65 miles. The *Coimbra* is classified as Medium Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the Most Probable Discharge because 28% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2, and the mean length of weighted shoreline contaminated was 16 miles.

Using the definitions of the socio-economic risk factors as described above, Table 4-2 shows the risk ranking as well as the value of the metric generated from the oil spill modeling data that was used to assign the risk ranking for the WCD; Table 4-3 shows the same information for the Most Probable Discharge.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 29,000 bbl of lubricating oil from the *Coimbra* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – High, because a relatively large water column area would be impacted in important fishing grounds
- Water surface resources – High, because a large offshore area would be affected in an area of important shipping lanes. 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 a moderate amount of shoreline would be impacted with the persistent oil and tarballs and would be relatively easy to clean, although there are a large number of potentially vulnerable socio-economic resources located along the shoreline

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 29,000 bbl** of lubricating oil from the *Coimbra*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	**High**	92% 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	High
4A-2: Water Column Degree SRAR Oiling	Low	Medium	**High**	The mean volume of water contaminated above 1 ppb was 321 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 28,600 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	50% of the model runs resulted in shoreline oiling of 1 g/m^2	Medium
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 65 mi	

For the Most Probable Discharge of 2,900 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *Coimbra* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – High, because a relatively large water column area would be impacted in important fishing grounds
- Water surface resources – High, because a large offshore area would be affected in an area of important shipping lanes. 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 – Low, because a small amount of shoreline would be impacted with the persistent oil and tarballs and would be relatively easy to clean, although there are a large number of potentially vulnerable socio-economic resources located along the shoreline

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 2,900 bbl** of lubricating oil from the *Coimbra*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	**High**	100% 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	High
4A-2: Water Column Degree SRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 131 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 0.01g/m^2 was 9,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	**Medium**	High	28% of the model runs resulted in shoreline oiling of 1 g/m^2	Low
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 16 mi	

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

The overall risk assessment for the *Coimbra* 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 particular vessel
- Ecological resources at risk
- Socio-economic resources at risk
- Other complicating factors (war graves, other hazardous cargo, etc.)

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

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

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

For the Worst Case Discharge, the *Coimbra* scores High with 16 points; for the Most Probable Discharge, the *Coimbra* scores Medium with 12 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Coimbra*. The final determination rests with the U.S. Coast Guard.

Coimbra	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
	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 *Coimbra*.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	28,500 bbl, reported to be leaking		**Med**
	A2: Oil Type	High	Cargo is lubricating oil, a Group III oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	Fire was reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Two torpedo detonations		
	D2: Structural Breakup	High	The vessel is broken into three sections		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site assessments of this ship exist, assessment is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	High	Stern and amidships sections resting on starboard side, bow is inverted		**Not Scored**
	Depth	High	170		
	Visual or Remote Sensing Confirmation of Site Condition	High	Location is a popular technical diving and sport fishing site		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	Munitions for onboard weapons		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and SMCA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources	**Med**	**Low**
	3B: Water Surface Resources	High	Seasonally very high concentrations of marine birds in coastal and shelf waters but light sheens pose lesser risks	**Med**	**Low**
	3C: Shore Resources	High	Mostly sand/gravel beaches at risk, where a light fuel oil is not likely to persist	**Med**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	A relatively large water column area would be impacted in important fishing grounds	**High**	**High**
	4B: Water Surface Resources	High	A large offshore area would be affected in an area of important shipping lanes	**High**	**High**
	4C: Shore Resources	High	A moderate length shoreline would be impacted, although there are a large number of potentially vulnerable socio-economic resources	**Med**	**Low**
Summary Risk Scores				**16**	**12**