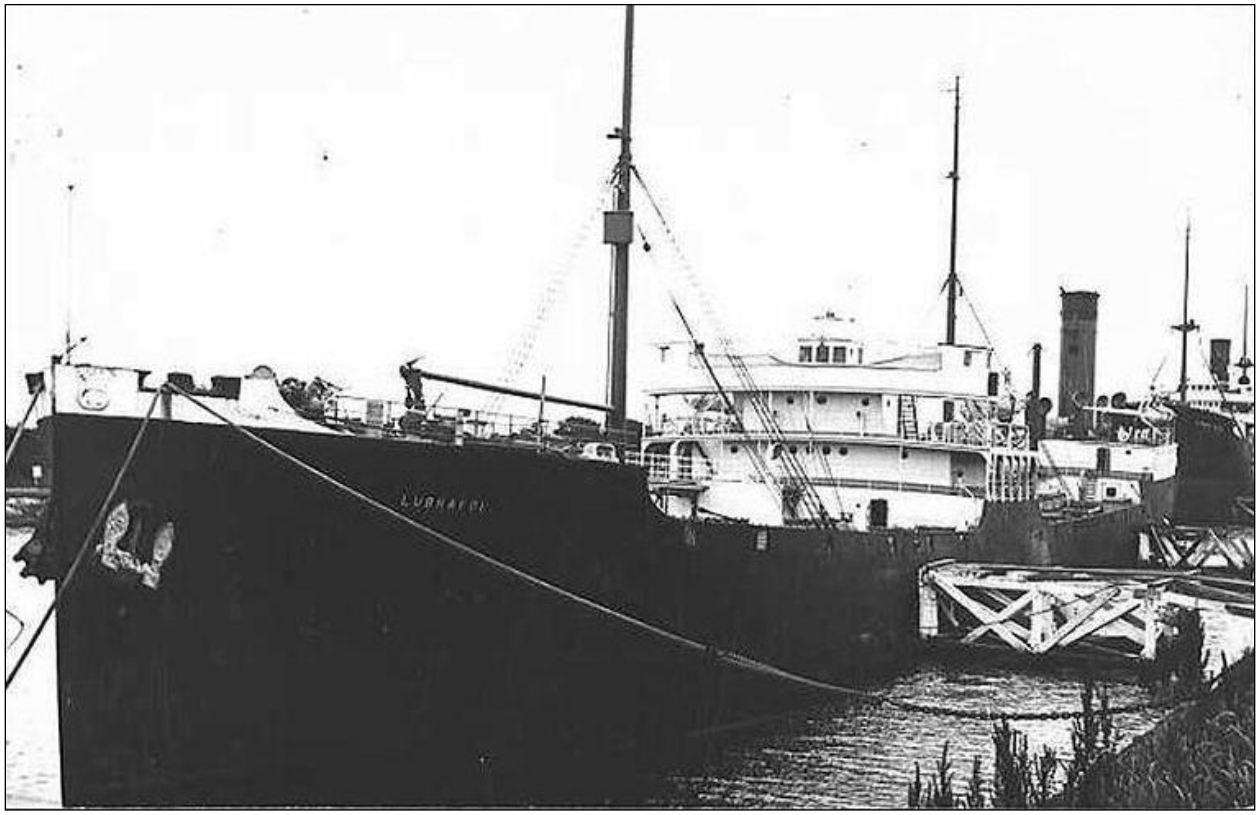
Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Lubrafol



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National Oceanic and
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Photo: Identification Photograph of *Lubrafol*
Source: http://www.photoship.co.uk/JAlbum%20Ships/Old%20Ships%20L/slides/*Lubrafol*-01.html

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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.

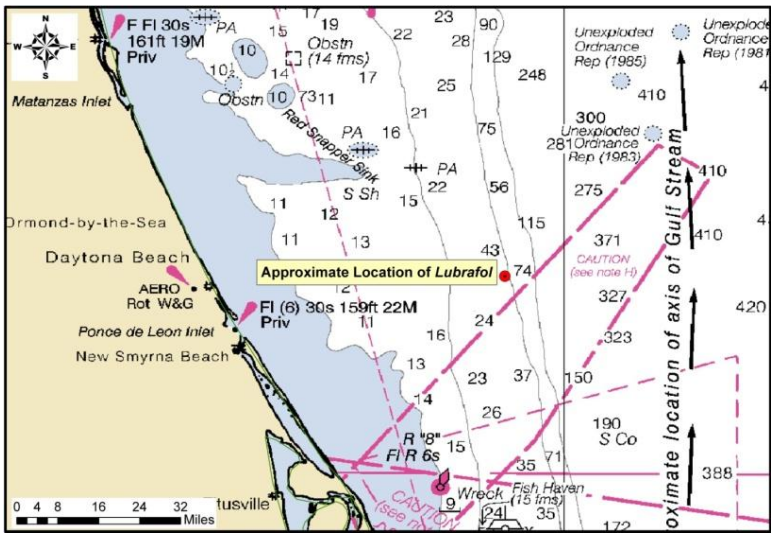
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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: *Lubrafol*

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



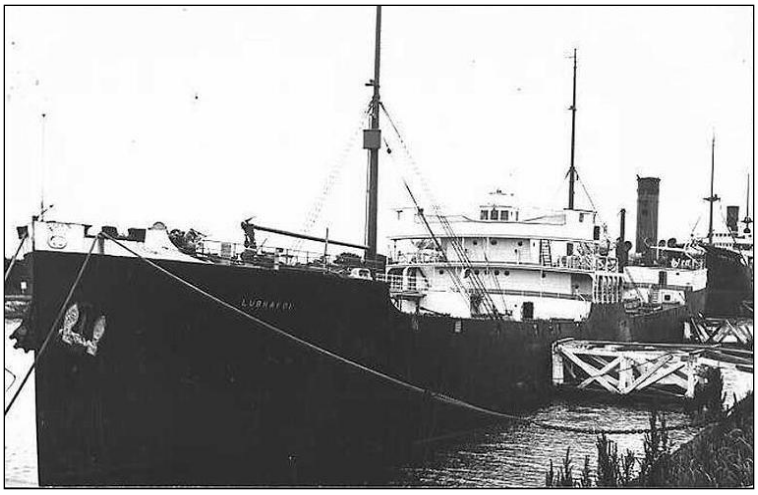
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Lubrafol* scores High with 18 points; for the Most Probable Discharge (10% of the Worse Case volume), *Lubrafol* scores Medium with 12 points. Given these scores, and higher level of data certainty, NOAA recommends that this site be reflected within the Area Contingency Plans and be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action, as well as the context of other oil pollution threats within the region. 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 be helpful to gain awareness of changes in the site.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	High	Low
	3B: Water Surface Resources	High	Med
	3C: Shore Resources	Med	Low
Socio-Economic Resources	4A: Water Column Resources	Med	Low
	4B: Water Surface Resources	High	High
	4C: Shore Resources	High	Med
Summary Risk Scores		18	12

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

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

Vessel Particulars



Official Name: *Lubrafol*

Official Number: Unknown

Vessel Type: Tanker

Vessel Class: N/A

Former Names: Scottish Highlands

Year Built: 1924

Builder: Armstrong Whitworth & Co. Ltd. Newcastle

Builder's Hull Number: Unknown

Flag: Panamanian

Owner at Loss: Gulf Oil Corporation

Controlled by: Unknown

Chartered to: Unknown

Operated by: Unknown

Homeport: Panama City, Panama

Length: 440 feet

Beam: 57 feet

Depth: 34 feet

Gross Tonnage: 7138

Net Tonnage: 3988

Hull Material: Steel

Hull Fastenings: Riveted

Powered by: Oil Engines

Bunker Type: Medium Fuel Oil (Marine Diesel)

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

Casualty Information

Port Departed: Aruba

Destination Port: New York

Date Departed: May 2, 1942

Date Lost: May 9, 1942

Number of Days Sailing: ≈ 8

Cause of Sinking: Act of War (torpedoes)

Latitude (DD): 29.23359

Longitude (DD): -80.16642

Nautical Miles to Shore: 42.9

Nautical Miles to NMS: 134

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 180

Bottom Type: Sand-silt/clay

Is There a Wreck at This Location? The accuracy of the listed coordinates is not known but the wreck has been located

Wreck Orientation: Inverted (Turtled)

Vessel Armament: One 5-inch gun and two .30 caliber Lewis machine guns

Cargo Carried when Lost: 67,000 bbl of #2 fuel oil

Cargo Oil Carried (bbl): 67,000

Cargo Oil Type: Medium Fuel Oil

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

Fuel Type: Medium Fuel Oil (Diesel)

Total Oil Carried (bbl): ≤ 77,000

Dangerous Cargo or Munitions: Yes

Munitions Carried: Munitions for onboard weapons

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes, partially

Reportedly Leaking: No (see wreck condition notes)

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

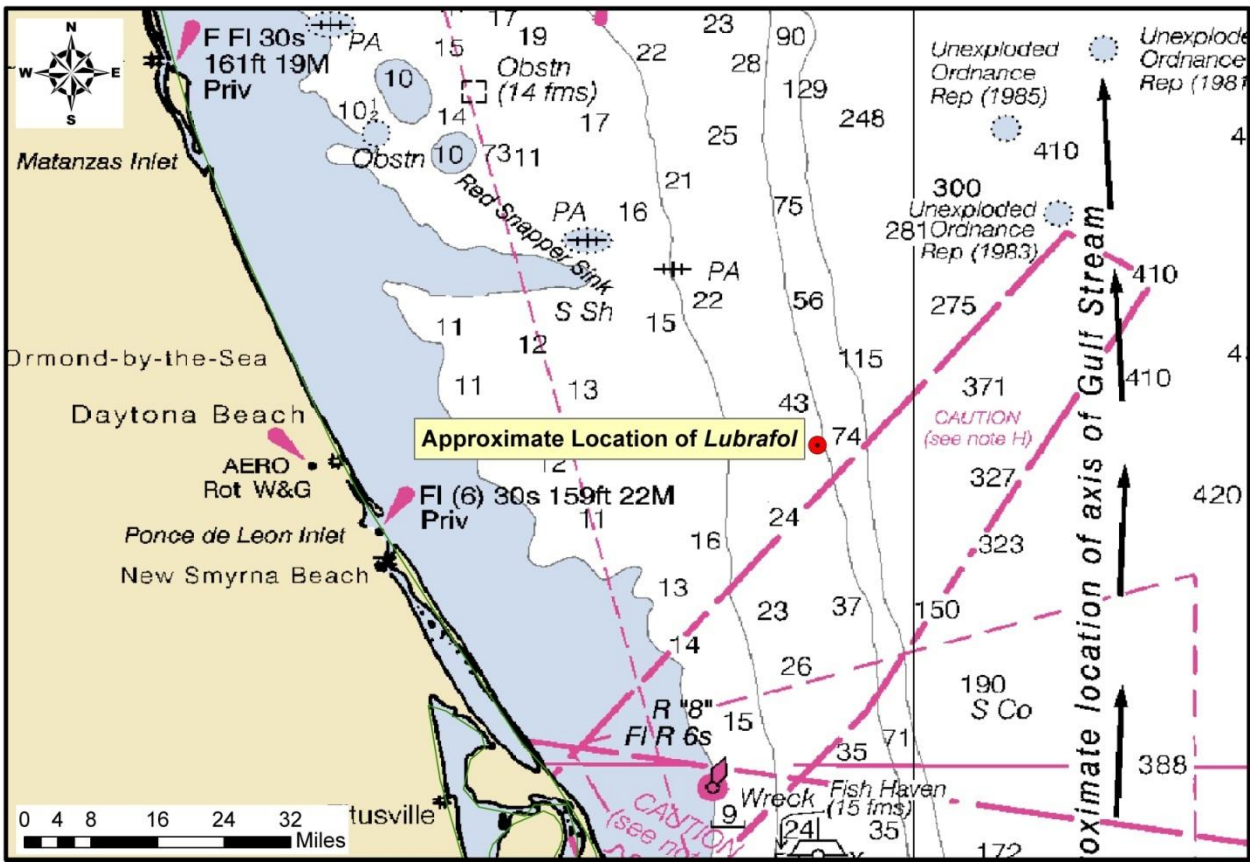


Chart Number: 11009

Casualty Narrative

"At 10.02 hours on 9 May 1942, the unescorted *Lubrafol* (Master E. Van Schoenberg) was torpedoed by *U-564* about 3.5 miles off Hillsboro Inlet, Florida. A torpedo hit on the starboard side amidships at #5 tank, which burst into flames immediately and seconds later the #1 tank also caught fire. The explosion stopped the engines, destroyed the radio antenna and the foremast toppled on the bridge, killing two men. The survivors among the 38 crew members and six armed guards abandoned ship in three lifeboats, but one of them caught fire and the men had to jump overboard and were lost. The remaining two boats with 31 survivors, seven of them injured, were towed free from the burning tanker by two U.S. Coast Guard boats and landed at Boynton Beach, Florida. The vessels also recovered seven bodies.

The burning *Lubrafol* drifted until 11 May and then sank in shallow waters in 26°41N/80°01W. The burnt out wreck was broken up in 1954."
-- http://www.uboat.net:8080/allies/merchants/ships/1620.html

See Figure 1-1 taken of the burning tanker on 9 May 1942.

Figure 1-1: The burning tanker *Lubrafol* on 9 May 1942, the day she was torpedoed. (Courtesy of: National Archives, College Park, MD)

General Notes

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

DESCRIPTION-

NO.496; TANKER 7138 GT; SUNK 5/9/42 BY SUBMARINE; POSITION ACCURACY 1 MILE; LOCATED 6/22/43, REPORTED AS SOUND CONTACT THRU GSF LTR, 6/22/43.NO.466; TANKER, 4588 NT, SUNK 5/9/42. POS. ESTABLISHED BY SOUND CONTACT.

SURVEY REQUIREMENTS INFORMATION ASSIGNED:
OPR-G174-MI-84 TKR; TORPEDOED MAY 9, 1942; IN 300 FT; 7138 TONS.

Wreck Condition/Salvage History

"On Saturday we motored out to the wreck of the *LUBRAFOL*, a Panamanian tanker torpedoed in World War II. She now rests in 180fsw, 38 miles east of Ponce Inlet.

There was a very gentle northward push, which was pretty much irrelevant since 8 out of 9 divers were scootering. The thermocline started at 30fsw with a hazy water layer. On the bottom, most Uwatecs hit 64 degrees, but were still dropping on ascent; one diver's computer registered 55 degrees. The brisk temperatures influenced the profiles quite a bit, with most divers opting to bug out early at around 25-30

minutes max. We had a bit of green water, with perhaps 50 foot of visibility on the bottom. The wreck was stacked up with lots of red snapper, as well as the flocks of AJs. Also observed were some nice warsaws and a few fat gag. Once on the bottom, one of the divers who is also an FBI agent and is apparently very dedicated to the job, deftly spotted a couple of illegal aliens -- two adult lionfish (*P. volitans*). I moved in and got some nice close-up footage of the exotic species before moving off to explore the rest of the wreck. The tanker is lying hard over on her starboard side, 95% turtled. As you move aft, the wreck is less turtled and more lying on her starboard side. The sides of the bow are separated like a peeled banana, with the hawse pipes and chain disarticulated from the hull. The masts and forward gun tubs lie off in the sand. Amidships, the hull is torn with a large boiler spilling out from the interior. A large stern deck gun can be found on the stern, resting in the sand, with the barrel pointing aft. The entire wreck is fairly bare of encrustation, with just a thin coating of rust and crud; browns were the dominant hue, randomly punctuated with a white sprig of Oculina coral.

The interior can be penetrated easily, but I would exercise extreme caution: Joe and I popped into one of the forward holds, and when I cast my HID up I realized the entire upper portions of the hold had trapped an unknown quantity of jelled oil. I was confused at first, as the light was simply sucked up by the black substance. Upon closer examination, I could see bubbles trapped in the goo. I did not tempt to see how solidified it was. I signaled Joe that we should get the hell out, though he didn't understand my signals until I explained back on the boat. I could just imagine how bumping into that muck would really ruin your day."
- http://uwex.us/061603.htm

Archaeological Assessment

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

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

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

Assessment

The tanker *Lubrafol* has been listed as a higher priority shipwreck because it is one of the shipwrecks in U.S. Coast Guard District 7 that NOAA has confirmed contains oil. On July 26, 2011, Technical SCUBA diver Michael Barnette reported to NOAA Scientific Support Coordinators that, "The *LUBRAFOL* off Ponce is purging even more [than *Joseph M. Cudahy*] - beyond a sheen and including nasty globs of black oil as recent as last year [2010]. I got some nasty goo on my shotline and dive ladder. There is a good bit trapped in the tanks, and you can go inside and see it congealed and trapped by the hull." Although NOAA archaeologists have never examined this shipwreck and cannot provide an accurate estimate of how much oil could be inside the shipwreck, they can provide the U.S. Coast Guard with some information about the vessel that can help assist them in determining if they would like to conduct an in water assessment of the tanker.

When the tanker was torpedoed on May 9, 1942, it was carrying a cargo of 67,000 bbl of #2 fuel oil and likely had a bunker capacity of about 10,000 bbl of marine diesel oil. The ship was struck by one torpedo in the number five tank amidships, which ruptured the ship's deck and sprayed oil over the ship. This tank immediately burst into flames and, almost simultaneously, the number one tank caught on fire. As the crew abandoned ship, the entire tanker became engulfed in flames and burning oil began spreading across the water. On May 11, two days later, the vessel was observed still afloat and still burning. By May 12, however, the vessel had finally disappeared in approximately 180 feet of water. When the vessel finally sank, it came to rest upside down, effectively blocking the escape of oil through vents and pipes and trapping it in the structurally robust underside of the tanker.

Based on the sinking report, photographs of the burning ship, and the description of the site, it is likely that large quantities of the initial oil cargo burned off in the attack or have escaped in small leaks since 1942. This is one of the few shipwrecks that NOAA has been able to verify still contains oil, however, and the account of oil inside the wreck by Michael Barnette certainly makes it sound like a relatively large quantity of recoverable oil may exist.

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 Historic Register. 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:
http://www.photoship.co.uk/JAlbum%20Ships/Old%20Ships%20L/slides/*Lubrafol*-01.html;
National Archives

Construction Diagrams or Plans in RULET Database? No

Text References:
http://www.uboat.net:8080/allies/merchants/ships/1620.html;
http://uwex.us/061603.htm
AWOIS database;

NIMA database;
Global Wrecks database

-Global Wrecks

-http://njscuba.net/sites/site_*Lubrafol*.html

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Lubrafol* based on the information available. These factors are reflected in the pollution potential risk assessment development by the U.S. Coast Guard Salvage Engineering Response Team (SERT) as a means to apply a salvage engineer's perspective to the historical information gathered by NOAA. This analysis reflected in Figure 1-2 is simple and straightforward and, in combination with the accompanying archaeological assessment, provides a picture of the wreck that is as complete as possible based on current knowledge and best professional judgment. This assessment *does not* take into consideration operational constraints such as depth or unknown location, but rather attempts to provide a replicable and objective screening of the historical date for each vessel. SERT reviewed the general historical information available for the database as a whole and provided a stepwise analysis for an initial indication of Low/Medium/High values for each vessel.

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

Each risk factor is characterized as 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.

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.

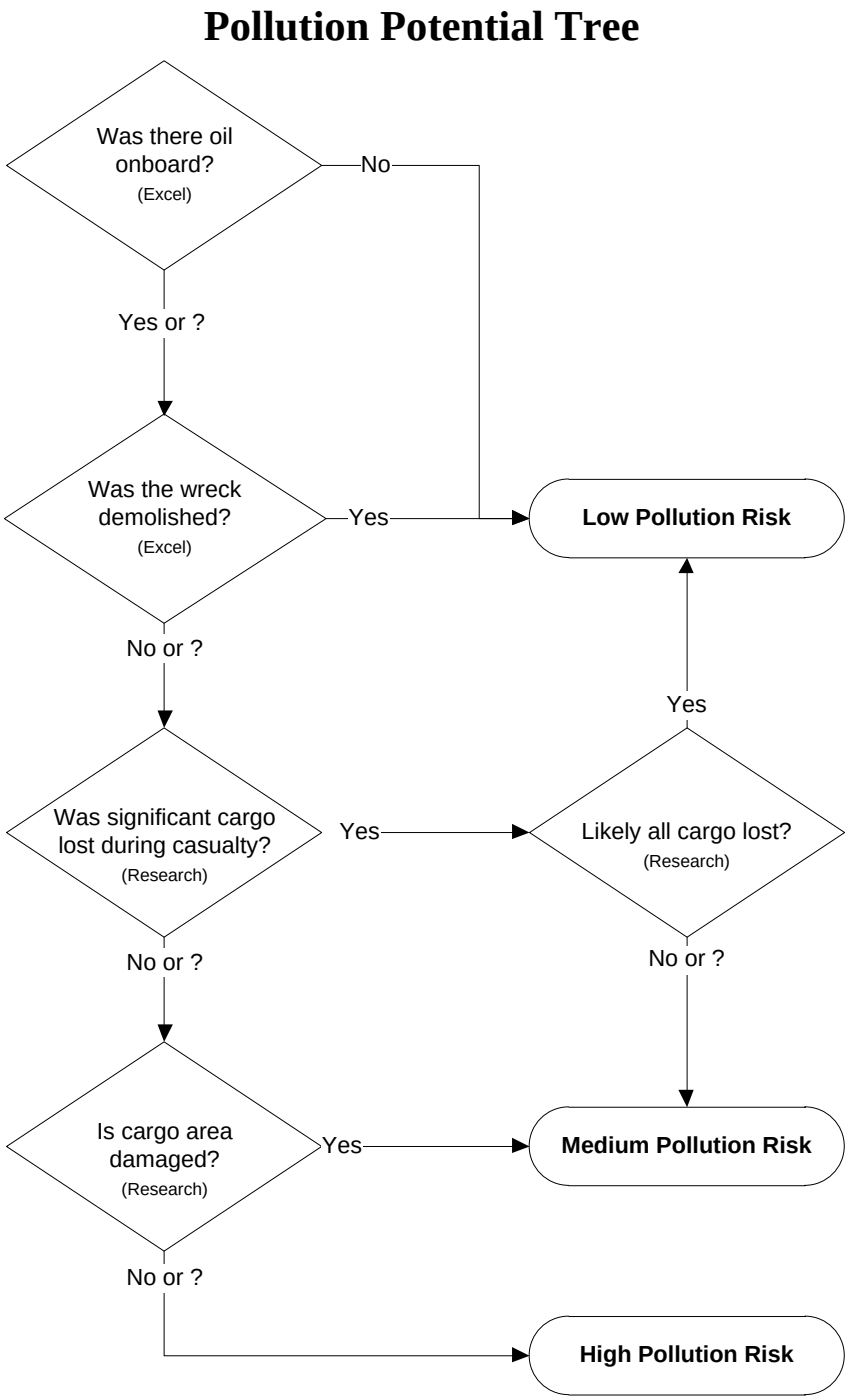


Figure 1-2: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Lubrafol* 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 *Lubrafol i*s ranked as High Volume because it is thought to have a potential for up to 77,000 bbl, although some of that was lost at the time of the casualty due to the explosion and breakup of the vessel. Data quality is medium.

The risk factor for volume also incorporates any reports or anecdotal evidence of actual leakage from the vessel or reports from divers of oil in the overheads, as opposed to potential leakage. This reflects the history of the vessel's leakage. There are reports of leakage from *Lubrafol* in 2010.

Risk Factor A2: Oil Type

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

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

The *Lubrafol* is classified as Medium Risk because the cargo is medium fuel 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 wreck was reported to have been entirely destroyed after the casualty

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

- **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 *Lubrafol* 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 *Lubrafol* is classified as Low Risk because it burned for over a day. Data quality is high.

Risk Factor C2: Reported Oil on the Water

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

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

The *Lubrafol* is classified as Medium Risk because oil was reported to have spread across the water as the vessel went down. Data quality is high.

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

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

- **Low Risk:** Multiple torpedo detonations, multiple mines, severe explosion

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

The *Lubrafol* is classified as Low Risk because there were two torpedo detonations. 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 *Lubrafol* is classified as High Risk because it is contiguous. 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 orientation of the *Lubrafol* is upside down. Data quality is high.

Depth

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

The depth for *Lubrafol* is 180 feet. Data quality is high.

Visual or Remote Sensing Confirmation of Site Condition

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

The location of the *Lubrafol* is technical dive site. 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 *Lubrafol* had munitions for onboard weapons, one 5-inch gun and two .30 caliber Lewis machine guns. 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 *Lubrafol*. Operational factors are listed but do not have a risk score.

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

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 77,000 bbl, reported to be leaking	**Med**
	A2: Oil Type	High	#2 Fuel Oil	
	B: Wreck Clearance	High	Not cleared	
	C1: Burning of the Ship	High	Burned for two days	
	C2: Oil on Water	High	Oil on the water at time of casualty	
	D1: Nature of Casualty	High	Hit by two torpedoes, explosion, fire	
	D2: Structural Breakup	High	In one piece	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records of this wreck exist as well as dive reports, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Vessel is upside down	**Not Scored**
	Depth	High	Vessel is 180 feet deep	
	Visual or Remote Sensing Confirmation of Site Condition	High	Technical dive site	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	Small arms, 5-inch gun and two .30 caliber Lewis machine guns	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

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

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most of the discharges would tend to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Lubrafol* this would be about 67,000 bbl of medium fuel oil (similar to diesel) and up to 10,000 bbl of bunker fuel based on current estimates of the amount of oil remaining onboard the wreck; the WCD volume of 80,000 bbl was used in the models because the bunker fuel was thought to be 12,500 bbl at the time the models were run.

The most-likely scenario of oil release from most sunken wrecks, including the *Lubrafol*, 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 cause 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. Another “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 would depend on the condition of the vessel, time factors, and disturbances to the wreck. Note that, for the episodic and chronic releases, the scenario would essentially be repeated many times, potentially giving the same magnitude and type of impacts with each release. Again, the actual impacts would depend on the trajectory factors during each release and the types/amount 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 so 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 resource impacts 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 *Lubrafol*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	80 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	800 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	8,000 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	40,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	80,000 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 *Lubrafol* contains a maximum of 67,000 bbl of medium fuel oil, which is similar to diesel (a Group II oil) as cargo and <10,000 bbl of bunker fuel oil (a Group IV oil). Because the bulk of the oil potentially remaining on board is the cargo 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.

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.

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 *Lubrafol* 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 square miles (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 scaling the potential impact 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, April, 1996; Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, PB96-501788.

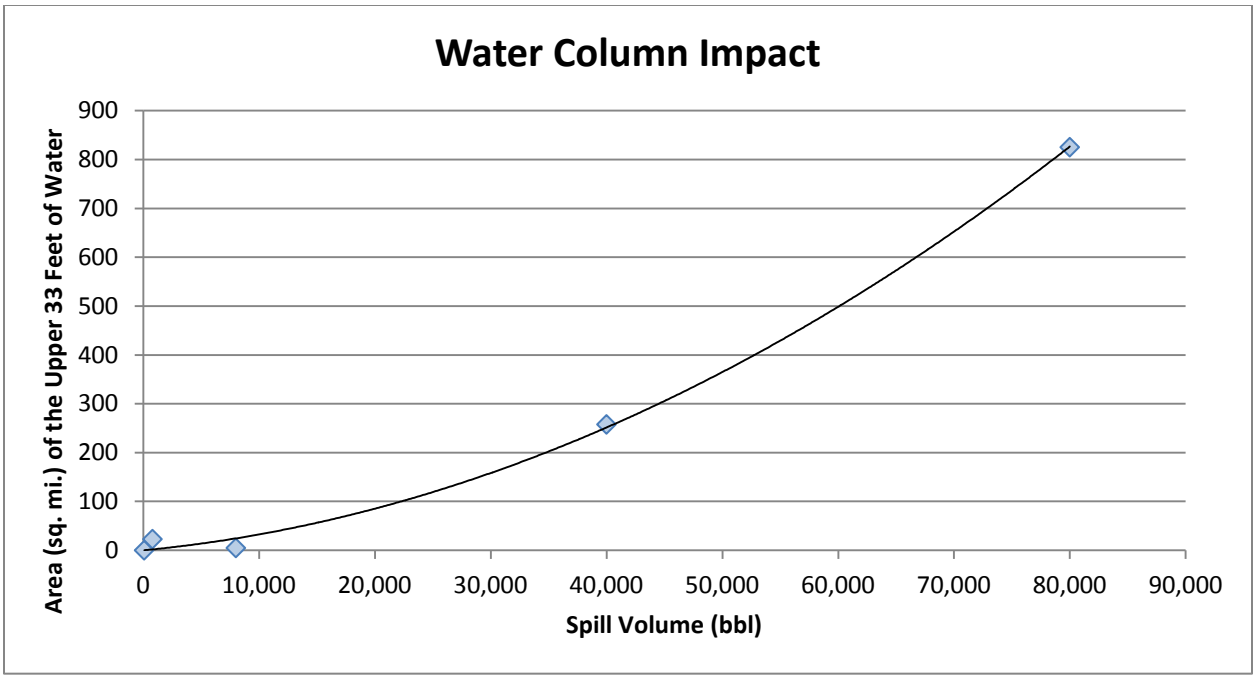


Figure 2-1: Regression curve for estimating the volume of water column impacted as a function of spill volume for the *Lubrafol*.

Potential Water Surface Slick

The slick size from an oil release from the *Lubrafol* will be determined by the volume of leakage. 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 and streamers; light fuel oils do not readily emulsify or form tarballs.

Table 2-3: Estimated slick coverage on water for oil release scenarios from the *Lubrafol*.

Scenario Type	Oil Volume (bbl)	Estimated Fresh Slick Coverage Mean of All Models	
		0.01 g/m²	10 g/m²
Chronic	80	1,900 mi²	390 mi²
Episodic	800	6,000 mi²	1,500 mi²
Most Probable	8,000	16,700 mi²	5,500 mi²
Large	40,000	33,400 mi²	13,300 mi²
Worst Case Discharge	80,000	45,000 mi²	19,300 mi²

The location, size, shape, and spread of the oil slick(s) from an oil release from the *Lubrafol* 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.

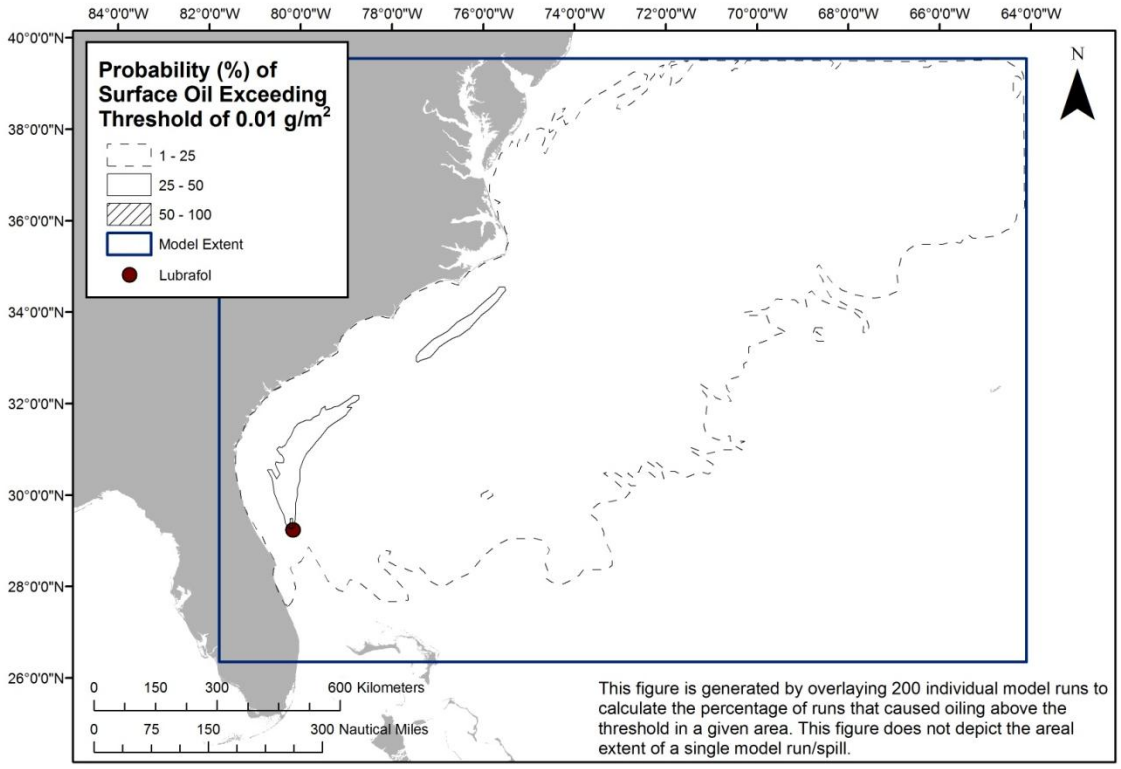


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 8,000 bbl of light fuel oil from the *Lubrafol* at the threshold for socio-economic resources at risk.

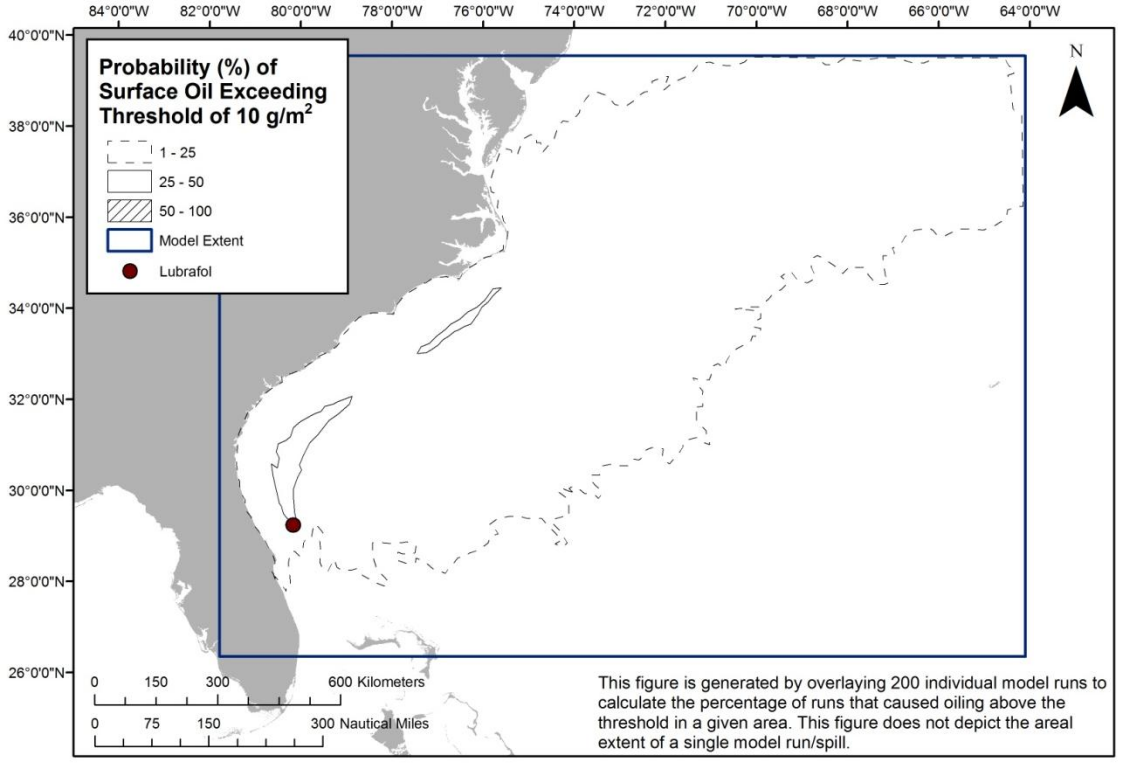


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 8,000 bbl of light fuel oil from the *Lubrafol* at the threshold for ecological resources at risk.

The behavior of light fuel oils to spread into thin sheens is demonstrated by the comparison of Figures 2-2 and 2-3, which show the probability of surface oil at different thicknesses. At the socio-economic threshold of a barely visible sheen (0.01 g/m^2), the overlay of all 200 models generates a map showing the probability of 1-25% oil in each model grid that covers a very large area. At the ecological threshold of a heavy sheen with dark colors (10 g/m^2), the 1-25% probability area of oil presence is much smaller.

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.

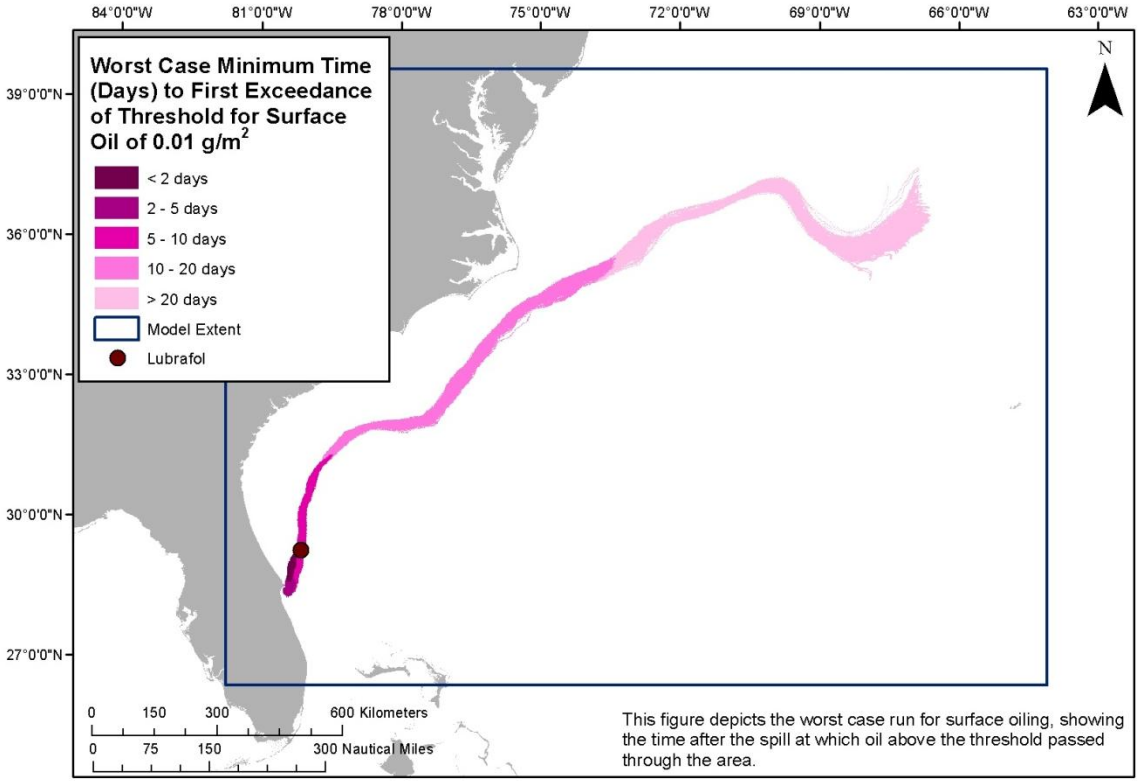


Figure 2-4: Water surface oiling from the Most Probable of 8,000 bbl of light fuel oil from the *Lubrafol* shown as the area over which the oil spreads at different time intervals.

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 scaling the potential impact 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.

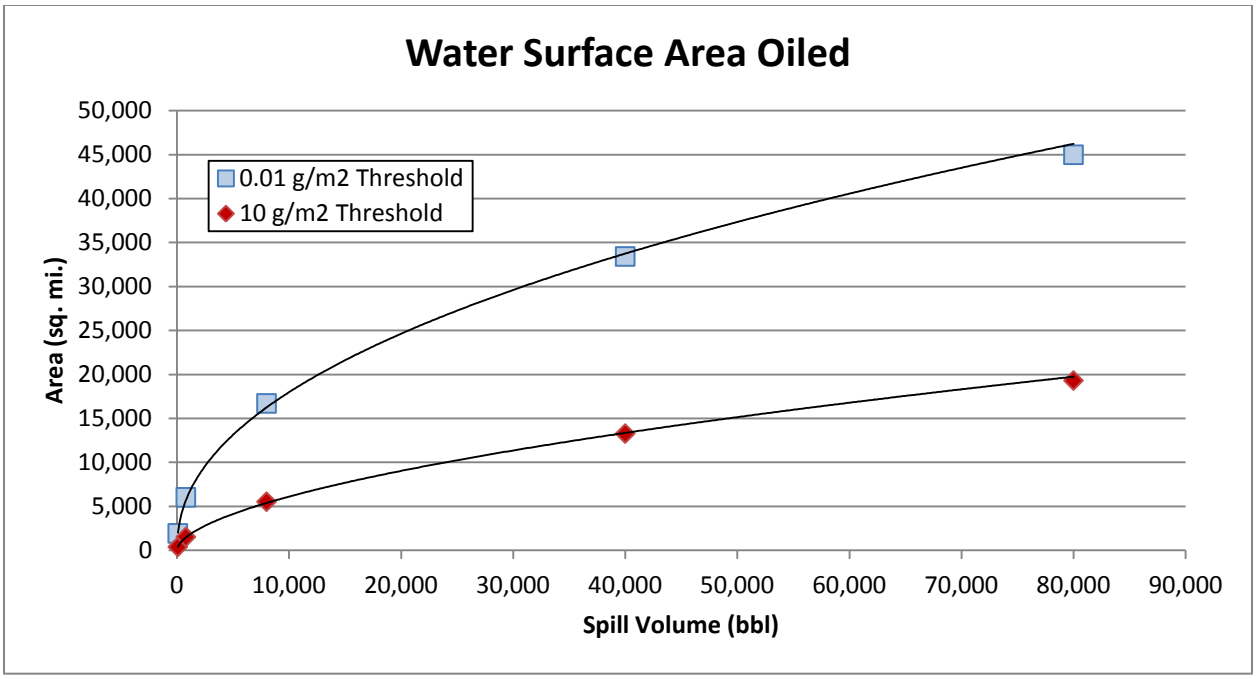


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Lubrafol*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2.

Potential Shoreline Impacts

Shorelines from as far north as the North Carolina/Virginia border, to as far south as Cape Canaveral, Florida, are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the socio-economic threshold of 1 g/m^2, for the Most Probable release of 8,000 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. For this single model run, shoreline oiling occurred from the mouth of the Wilmington River to Cape Lookout, North Carolina. 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 *Lubrafol*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	80	0	0	0	0
Episodic	800	1	1	0	2
Medium	8,000	0	7	1	8
Large	40,000	1	20	5	26
Worst Case Discharge	80,000	1	29	8	38

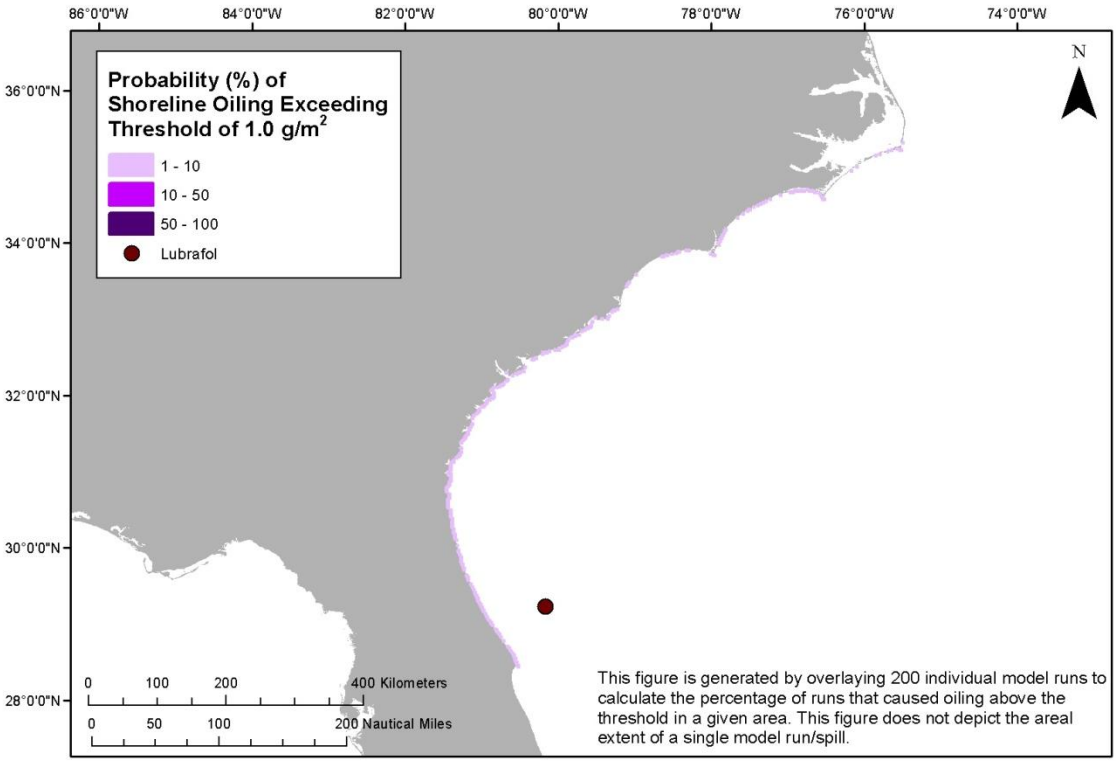


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 8,000 bbl of light fuel oil from the *Lubrafol*.

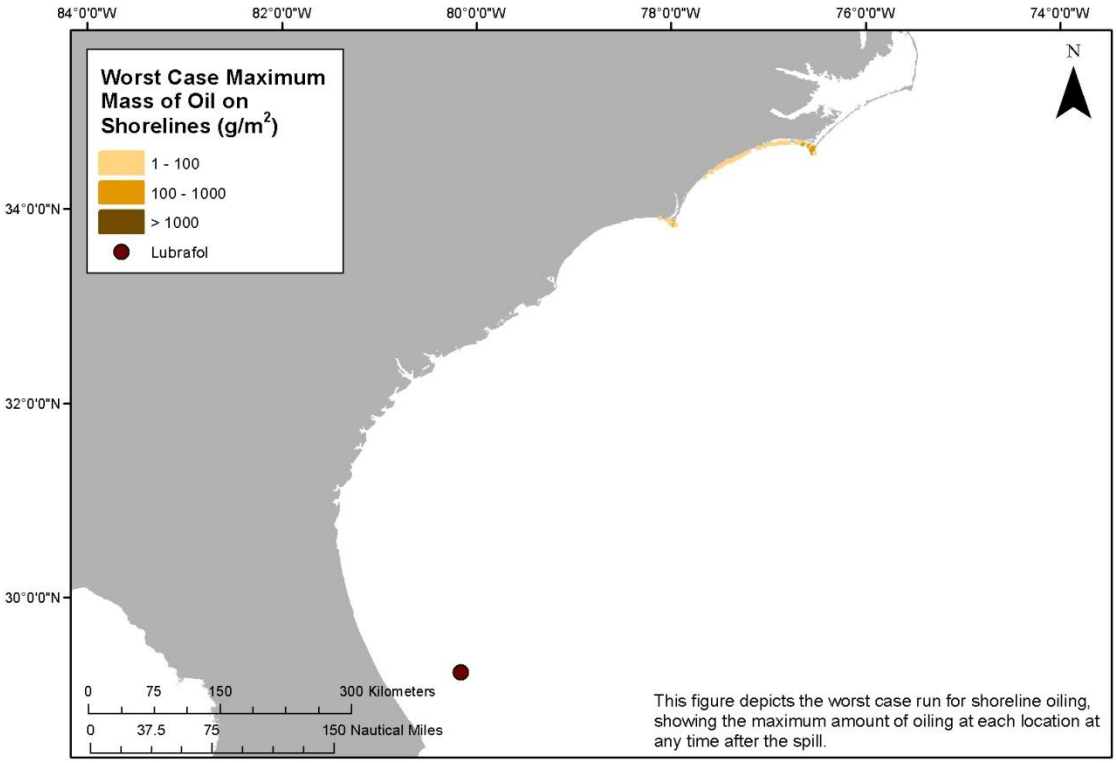


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 8,000 bbl of light fuel oil from the *Lubrafol* that resulted in the maximum extent of shoreline oiling.

The actual shore length affected by a release will be determined by the volume of leakage. 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.

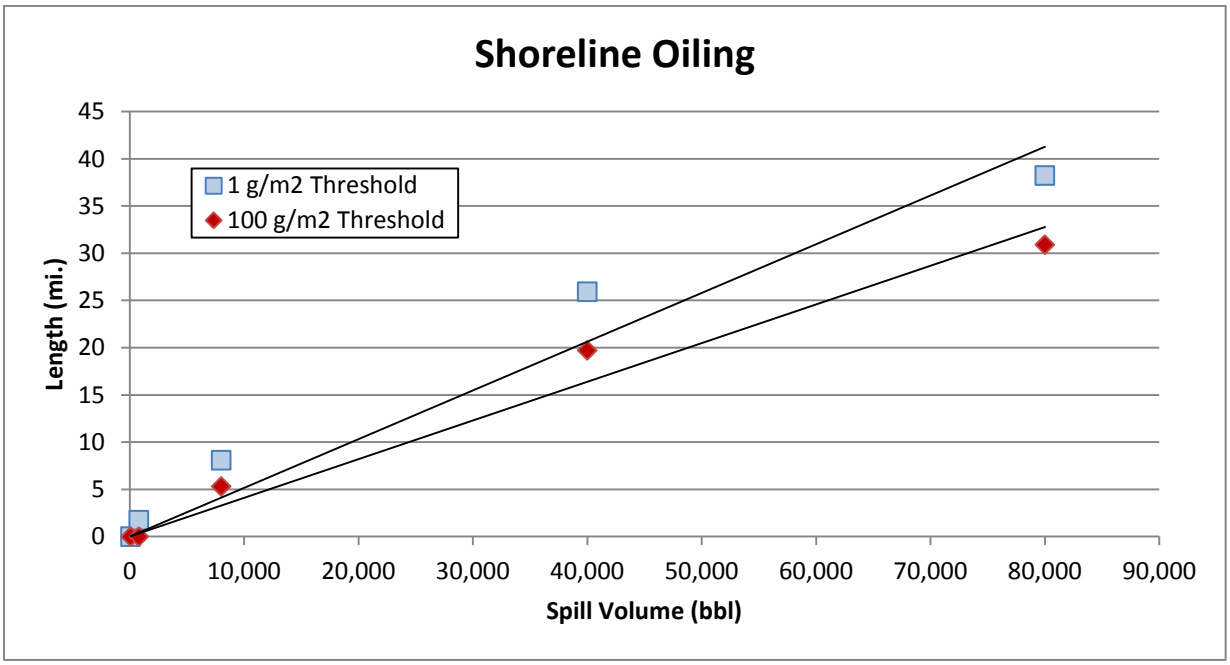


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Lubrafol*.

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 80,000 bbl from the *Lubrafol*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	2 miles	1 mile
Sand beaches	100 miles	79 miles
Salt marshes and tidal flats	19 miles	1 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 8,000 bbl from the *Lubrafol*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	0 miles	0 miles
Sand beaches	35 miles	6 miles
Salt marshes and tidal flats	3 miles	1 mile

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Lubrafol* (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 offshore habitats, birds are attracted to convergence zones, which is also where oil tends to be concentrated. The potentially affected region is important for commercially important fish and invertebrates.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Seabirds	• Outer Continental Shelf offshore Cape Hatteras, NC: greatest diversity of seabirds in SE U.S.; greatest density of tropical seabirds in SE U.S. Species include: shearwaters, storm petrels, Bermuda petrel • Significant percentage of the global population of black-capped petrel (FE) may be present in *Sargassum* mats off Cape Hatteras and Gulf Stream off SE U.S. coast • Audubon's shearwater (50-75% of population) concentrate along the Continental Shelf edge off NC, extending northward to the VA border (~3800 pairs)	OCS: Ranges by species but Mar-Nov peak Petrels off NC/VA coast during the summer through early fall and off SE U.S. coast in winter Shearwaters off of NC/VA: late summer
Pelagic Birds, Waterfowl, and Diving Birds	Coastal pelagic birds, waterfowl, diving birds • Mouth of Chesapeake Bay has high concentrations of species that are abundant over shoals (e.g., loons, pelicans, cormorants, sea ducks, gulls, terns, alcids); scoters are 10X more abundant than other species • Outer Banks, inshore waters NC to VA: Key foraging area for gulls and terns; key migration corridor for loons and sea ducks; NC's largest population of northern gannet and red-breasted merganser • Southeastern U.S. inshore/offshore waters: 150K loons, >15K pelicans, thousands of waterfowl, 100s of thousands of cormorants and terns, millions of gulls • Important Bird Areas (IBAs) for SC include Cape Romain NWR, Deveaux Bank, and Beaufort barrier islands: Feeding, and over-wintering grounds for substantial numbers of waterfowl and sea birds as well as nesting for thousands of brown pelicans • Altamaha River Delta, GA: Nesting for >5K brown pelicans • Canaveral National Seashore: Two of the largest brown pelican rookeries on the east coast; 10's of thousands of overwintering waterfowl	Winter use of shoals (Dec-Mar); summer use of shoals likely farther north Spring/summer, for terns, gulls; spring/fall for loons, sea ducks; winter for waterfowl, gannets and red-breasted mergansers

Sea Ducks	Sea ducks (includes mean and max distance of flocks to shore, 2009-2010 data)
	• Surf scoter at 2 nm/8 nm: NC = 0-41,000; SC/GA = 0-100
	• Black scoter at 2 nm/13 nm: NC = 3,500-13,000; SC/GA = 0-15,000
	• Bufflehead, mergansers, goldeneyes (<1 nm/7-14 nm)
	  ○ NC = 12,000;
	  ○ SC/GA = 5000
		Sea ducks surveyed in winter (peak abundances); Migration from fall to spring (Oct-Apr)

Species Group	Species Subgroup and Geography	Seasonal Presence
Shorebirds and Colonial Nesting Birds	• Assateague Island, MD: globally important bird area due to 60+ pairs of nesting piping plovers • VA Barrier Island/Lagoon System: Most important bird area in VA and one of most along U.S. Atlantic coast: piping plover (FT), Wilson's plover, American oystercatcher, gull-billed tern, least tern, black skimmer; internationally significant stopover point for whimbrel, short-billed dowitcher, and red knot • Western Shore VA marshes: Extensive marshes support significant populations of many marsh nesting species • Outer Banks, Cape Hatteras NS, and Cape Lookout: Globally important for coastal birds with 365+ species • Battery and Bald Head Islands, NC: Largest colonies of wading birds in NC; globally significant site with >10K nesting pairs of white ibis • Cape Romain NWR, SC: Largest wintering concentration of American oystercatcher on east coast; supports 45%- 70% of SC nesting gull-billed tern and black skimmer respectively; Western Hemispheric Shorebird Reserve Network (WHSRN) of international importance with up to 7K shorebirds per day • Deveaux Bank and Edisto ACE Basin NWR: Globally recognized IBAs supporting 1000s of nesting shorebirds including least tern (ST) and Wilson's plover (ST); >900 foraging wood stork (FE) • Bay Point Island IBA: Shorebirds and wading birds year round; wintering populations averaging >5K shorebirds per day of dunlin, dowitcher, western sandpiper, 500 red knot, sanderling, least tern (ST), Wilson's plover (ST), and piping plover (FT) • Pinckney Island NWR: Important rookery for white ibis, egrets, and herons • GA coast supports significant populations of resident and migratory wading and shorebirds with wading birds most abundant in summer; beach nesting least tern (ST), Wilson's plover (ST), piping plover (FT) and American oystercatcher • Wassaw NWR and Altamaha River Delta: Heron and egret rookery; migrating/wintering site for piping plover (FT) and American oystercatchers; nesting habitat for gull-billed, royal, and sandwich terns as well as black skimmer and wood stork (FE) • St. Catherines Island and Cumberland Island NS: Two of the most important feeding/wintering sites along the Atlantic coast with thousands of shorebirds and wading birds including least tern (ST), Wilson's plovers (ST), piping plover (FT), American oystercatcher, and wood stork (FE) • Northern FL: Globally recognized IBA (Nassau Sound) for breeding/roosting of threatened and endangered shorebirds; habitat supports numerous neotropical migrants in spring and fall • Cape Canaveral-Merritt Island: Globally recognized IBA supports around 8K wading birds (>150 pairs of wood stork) and 14K neotropical migrants • Pelican Island NWR: Large colonial waterbird rookery	Winter migration stop for plovers Colonial and beach nesters peak Apr-Aug Wading and shorebirds typically present year round
Sea Turtles	Nesting (annual counts, by state, along shorelines with most probable impacts): NC nesting • 650+ Loggerhead (FT) • <20 Green (FT) • <10 Leatherback (FE) SC nesting • 4000+ Loggerhead (FT) • <5 Green (FT)	Nesting season: Loggerheads/Greens (NC-GA) Adults: May-Aug Hatching: Jul-Oct Loggerheads/Greens (FL) Adults: Apr-Oct Hatching: May-Nov

Species Group	Species Subgroup and Geography	Seasonal Presence
	• <5 Leatherback (FE) GA nesting • <2000+ Loggerhead (FT) • <5 Green (FT) • <15 Leatherback (FE) FL nesting (Nassau – Brevard) • 26000+ Loggerhead (87% in Brevard) • 7950 Green (95% in Brevard) • 165 Leatherback (61% in St. Lucie) Distribution: • Offshore hot spots not well known • Young associate with *Sargassum* mats off Cape Hatteras • Bays and sounds are foraging grounds for juvenile green, loggerhead, and Kemp's ridley (FE)	Leatherbacks Adults: Mar-Jul (NC-GA) Feb-Aug (FL) Hatching: May-Oct (NC-GA) Mar-Sep (FL) In water: Year round with Apr-Dec peak
Marine Mammals	*Baleen whales*: Primarily North Atlantic right whale (FE) with occasional humpback whale (FE), and minke whale • Right whales are critically endangered (<400 individuals left) coastal waters in the potential spill area are used as calving grounds *Inshore cetaceans:* Bottlenose dolphin frequently use coastal waters including creeks, bays, and sounds throughout potential spill area *Offshore cetaceans*: Risso's dolphin, striped dolphin, clymene dolphin, Atlantic spotted dolphin, spinner dolphin, short-finned pilot whale, pantropical spotted dolphin • Often associated with shelf edge features, convergence zones (fronts), and Sargassum mats (summer) *Deep diving whales:* Sperm whale (FE), pygmy sperm whale, beaked whales (5 species present) forage in deep waters along the shelf *Pinnipeds and Sirenians*: • Juvenile harbor and hooded seals can sometimes occur as far south as N. FL during the winter • West Indian manatees are present year round in the potential spill area; concentrated along the FL coast with common summer sightings as far north as NC	Adults migrate from feeding grounds in North Atlantic to breeding grounds further south in the winter; Right whales with calf Nov-Mar Bottlenose dolphins present year round Harbor and hooded seals present during the winter; Manatees year round and coastal waters during summer
Fish and Inverts	Coastal ocean waters support many valuable fisheries and/or species of concern in the region: • *Benthic or bottom associated*: Snapper, grouper, black sea bass, butter fish, goose fish, shrimp (white, pink, brown, and rock), golden crab • *Midwater*: Atlantic mackerel, Spanish mackerel, shortfin squid, bluefish, menhaden, cero, cobia • *Pelagic*: Bluefin tuna, yellowfin tuna, wahoo, dolphinfish, bigeye tuna, swordfish, marlin, sailfish • *Diadromous*: Alewife, blueback herring, American shad, hickory shad, Atlantic tomcod, American eel, Atlantic sturgeon (Fed. species of concern), shortnose sturgeon (FE), and striped bass • *Estuarine dependent*: Southern flounder, redfish, spotted seatrout, blue crab, atlantic croaker, spot, weakfish, shrimp • *Estuarine resident*: Eastern oyster Important concentration/conservation areas are:	Benthic and midwater species are present throughout the year Bluefin tunas present fall-spring with other pelagic fish present year round Anadromous fish migrate inshore to spawn in fresh water in the spring American eel migrates offshore to spawn in the winter

Species Group	Species Subgroup and Geography	Seasonal Presence
	• Pelagic species can be more concentrated around the shelf break and at oceanographic fronts in the region • The Point (offshore of Cape Hatteras) – Essential Fish Habitat/Habitats Areas of Particular concern (EFH/HAPC) for coastal migratory pelagics and dolphin/wahoo • Ten Fathom Ledge – South of Cape Lookout • Big Rock- SE of Cape Lookout • Primary nursery areas in NC bays – for estuarine dependent species • Charleston Bump Complex EFH • Grey's Reef National Marine Sanctuary, GA • Numerous artificial reefs off SC, GA, and FL • Large aggregations of sharks (i.e. lemon shark, bull shark) can be found by nearshore ledges in SE Florida during the winter. • Sargassum off Cape Hatteras, NC and Florida is important habitat for juvenile of some pelagic fish species (i.e. dolphinfish, jacks, triggerfish, and juvenile turtles) • Striped croaker (NOAA species of concern) occupy nearshore hard-bottom habitats from Sebastian Inlet north	Estuarine dependent fish migrate offshore in the fall/winter to spawn; Juveniles and adults use estuaries during the spring/summer
Benthic Habitats	Submerged aquatic vegetation is critical to numerous species and occurs inside of bays and sounds throughout the region with the greatest concentrations in FL coastal waters Scattered hard-bottom sites are located off NC and are considered HAPC for reef-associated fishes (including the areas listed above)	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Lubrafol* 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 to be any 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 for which there are significant impacts have less impact than this case, and half have more.

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

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

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Lubrafol* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 80,000 bbl and a border around the Most Probable Discharge of 8,000 bbl.

Risk Factor 3A: Water Column Impacts to EcoRAR

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

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

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

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

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

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

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

The *Lubrafol* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 80,000 bbl because 99% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It also classified as High Risk for degree of oiling because the mean volume of water contaminated was 825 mi^2 of the upper 33 feet of the water column. Light fuel oils are readily entrained into the water column, thus potentially affecting the water column under surface slicks. For the Most Probable Discharge of 8,000 bbl, the *Lubrafol* is classified as Low Risk for oiling probability for water column ecological resources because 3% 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 5 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 *Lubrafol* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 95% 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 High Risk for degree of oiling because the mean area of water contaminated was 19,300 mi^2. The *Lubrafol* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 87% 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 5,500 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 *Lubrafol* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 54% 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 38 miles. The *Lubrafol* is classified as Medium Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 17% 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 80,000 bbl of light fuel oil from the *Lubrafol* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – High, because a large area of water column is potentially affected and would occur in areas of the seasonal use of shelf habitats for spawning by commercially important fish and shellfish
- Water surface resources – High, because of the large area sweep by floating oil and importance of this area for pelagic and coastal birds and sea turtles. 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 and streamers
- Shoreline resources – Medium, because of the lower likelihood of significant amounts of light fuel oil to strand onshore and most of the potentially impacted shorelines are sand beaches where light fuel oil would not be as persistent as heavier oils

Table 3-2: Ecological risk scores for the **Worst Case Discharge of 80,000 bbl** of light fuel oil from the *Lubrafol*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	99% 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**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 825 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	95% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**High**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 19,300 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	54% 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 38 mi	

For the Most Probable Discharge of 8,000 bbl, the ecological risk from potential releases of light fuel oil from the *Lubrafol* is summarized as listed below and indicated in the far-right column in Table 3-3:

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

Table 3-3: Ecological risk scores for the **Most Probable Discharge of 8,000 bbl** of light fuel oil from the *Lubrafol*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	3% 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 5 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	87% 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 5,500 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	17% 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 *Lubrafol* include very highly utilized recreational beaches from North Carolina to northeastern Florida during summer, but also during spring and fall for shore fishing. Three national seashores and two coastal national monuments would potentially be affected. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. The Gray's Reef National Marine Sanctuary off Georgia would also potentially be affected, along with a large number of coastal state parks.

There are shipping lanes to several ports that could be impacted by a release with a total of nearly 9,000 annual port calls annually with a total of over 382 million tonnage. Commercial fishing is economically important to the region. Regional commercial landings for 2010 exceed $212 million with fishing fleets from southern Virginia to Florida potentially impacted by a release.

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

Spill response costs for a release of oil from the *Lubrafol* 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 *Lubrafol*.

Resource Type	Resource Name	Economic Activities
Tourist Beaches	Myrtle Beach, SC Hilton Head Island, SC Tybee Island, GA Fernandina Beach, FL Atlantic Beach, FL St. Augustine Beach, FL Daytona Beach, FL Palm Coast, FL	Potentially affected beach resorts and beach-front communities in Virginia, Maryland, North Carolina, South Carolina, Georgia, and northeastern Florida provide recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks) with substantial income for local communities and state tax income. Much of the coast is lined with economically-valuable beach resorts and residential communities. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
National Marine Sanctuary	Gray's Reef National Marine Sanctuary (GA)	Gray's Reef National Marine Sanctuary is one of the largest near shore live-bottom reefs in the southeastern U.S. The Sanctuary is popular with recreational anglers, boaters, and more experienced divers.

Resource Type	Resource Name	Economic Activities
National Seashores	Cape Hatteras National Seashore, NC Cumberland Isl. National Seashore, GA Canaveral National Seashore, FL	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.
National Parks	Fort Pulaski National Monument, GA Fort Sumter, National Monument, SC	Two coastal national historic monuments provide education in Civil War history.
National Wildlife Refuges	Mackay Island NWR (NC) Currituck NWR (NC) Pea Island NWR (NC) Cedar Island NWR (NC) Waccamaw NWR (SC) Cape Romain NWR (SC) Ernest F. Hollings ACE Basin NWR (SC) Pickney Island NWR (SC) Savannah NWR (SC) Tybee NWR (SC) Wassaw NWR (GA) Harris Neck NWR (GA) Blackbeard Island NWR (GA) Wolf Island NWR (GA) Merritt Island NWR (FL)	National wildlife refuges in four states may be impacted. These federally-managed and protected lands provide refuges and conservation areas for sensitive species and habitats.
State Parks	Myrtle Beach SP, SC Huntington Beach SP, SC Edisto Beach SP, SC Hunting Island SP, SC Skidaway Island SP, GA Fort McAllister SP, GA Bulow Plantation Ruins SP, FL Washington Oaks Gardens SP, FL Amelia Island SP, FL Fort Clinch SP, FL Guana River SP, FL Anastastia SP, FL Faver-Dykes SP, FL Green Mound Archaeological SP, FL Bulow Creek SP, FL Tomoka SP, FL	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 several states are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Commercial Fishing	A number of fishing fleets use potentially affected waters for commercial fishing.	
	Hampton Roads Area, VA	Total Landings (2010): $75.4M
	Chincoteague, VA	Total Landings (2010): $3.5M
	Ocean City, MD	Total Landings (2010): $8.8M
	Chincoteague, VA	Total Landings (2010): $3.5M
	Beaufort-Morehead City, NC	Total Landings (2010): $9.2M
	Belhaven-Washington, NC	Total Landings (2010): $3.7M
	Elizabeth City, NC	Total Landings (2010): $5.4M

Resource Type	Resource Name	Economic Activities
	Engelhard-Swanquarter, NC	Total Landings (2010): $10.6M
	Oriental-Vandemere, NC	Total Landings (2010): $8.4M
	Sneads Ferry-Swansboro, NC	Total Landings (2010): $5.4M
	Wanchese-Stumpy Point, NC	Total Landings (2010): $22.0M
	Brunswick, GA	Total Landings (2010): $5.1M
	Cape Canaveral, FL	Total Landings (2010): $6.5M
	Charleston-Mt. Pleasant, SC	Total Landings (2010): $9.9M
	Darien-Bellville, GA	Total Landings (2010): $5.2M
	Fernandina Beach, FL	Total Landings (2010): $4.7M
	Georgetown, SC	Total Landings (2010): $6.0M
	Mayport, FL	Total Landings (2010): $11.0M
	Savannah, GA	Total Landings (2010): $5.0M
	Thunderbolt, GA	Total Landings (2010): $3.4M
Ports	There are a number of significant commercial ports along the Atlantic coast that could potentially be impacted by spillage and spill response activities. The port call numbers below are for large vessels only. There are many more, smaller vessels (under 400 GRT) that also use these ports.	
	Baltimore, MD	2,100 port calls annually
	Morehead City, NC	85 port calls annually
	Wilmington, NC	550 port calls annually
	Brunswick, GA	304 port calls annually
	Charleston, SC	1,818 port calls annually
	Elba Is., GA	37 port calls annually
	Fernandina, FL	3 port calls annually
	Jacksonville, FL	1,641 port calls annually
	Port Canaveral, FL	38 port calls annually
	Savannah, GA	2,406 port calls annually

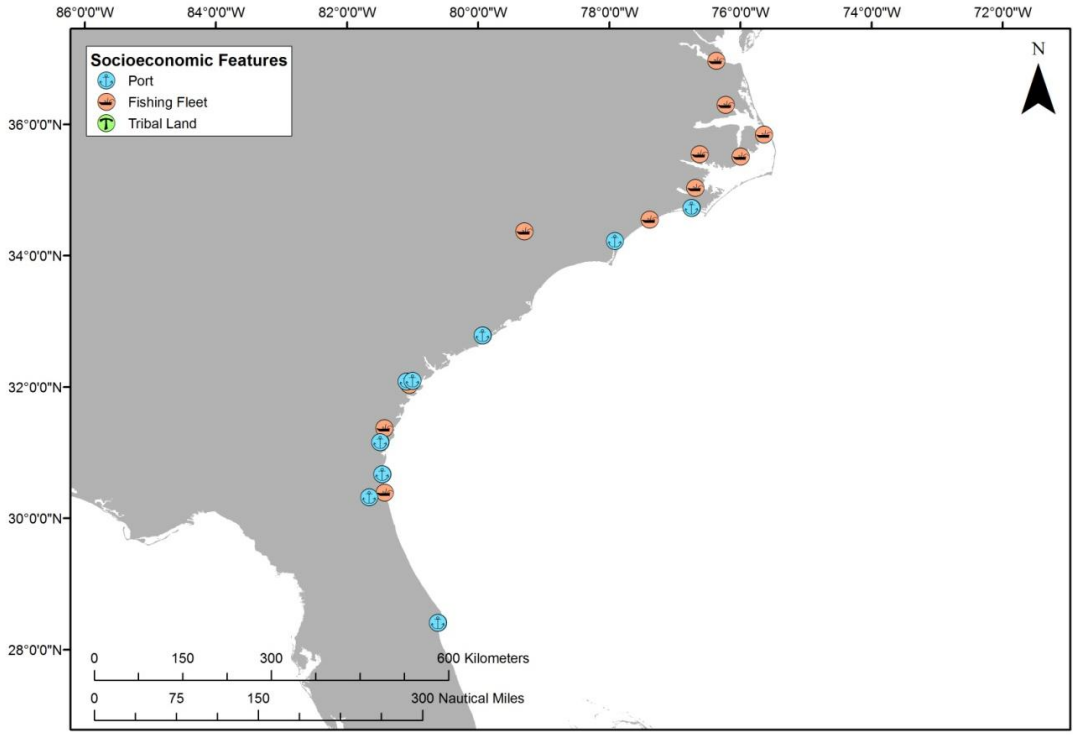


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Lubrafol*. (Note that there are no tribal lands affected.)

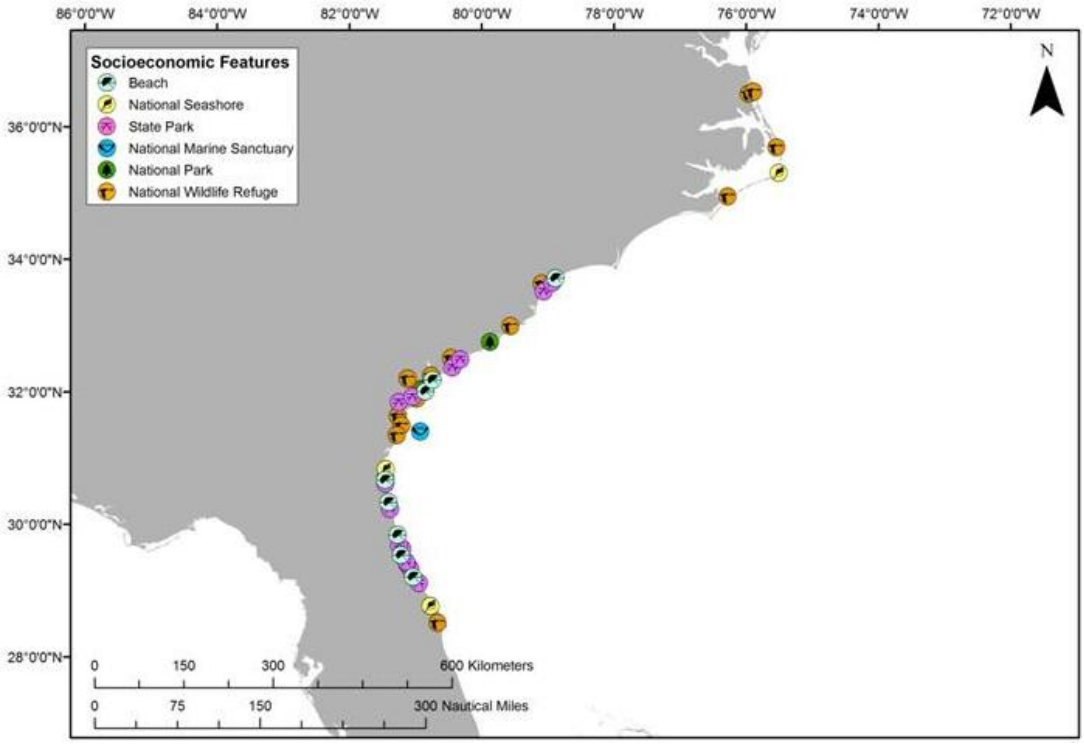


Figure 4-2: Beaches, coastal state parks, and federally protected areas at risk from a release from the *Lubrafol*.

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 is to be any 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 for which there are significant impacts have less impact than this case, and half have more.

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

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

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

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, the classification for the *Lubrafol* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 80,000 bbl and a border around the Most Probable Discharge of 8,000 bbl.

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

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

The three risk scores for oiling are:

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

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

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

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

The *Lubrafol* is classified as High Risk for both oiling probability and degree of oiling for water column socio-economic resources for the WCD of 80,000 bbl because 98% 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 825 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 8,000 bbl, the *Lubrafol* is classified as Low Risk for oiling probability for water column socio-economic resources because 3% 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 5 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 *Lubrafol* is classified as High Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the WCD because 97% 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 45,000 mi^2. The *Lubrafol* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 92% 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 High Risk for degree of oiling because the mean area of water contaminated was 16,700 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 *Lubrafol* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 57% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is classified as Medium risk for degree of oiling because the mean length of weighted shoreline contaminated was 97 miles. The *Lubrafol* is classified as Medium Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 30% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2, and the mean length of weighted shoreline contaminated was 22 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 80,000 bbl of light fuel oil from the *Lubrafol* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Medium, because a moderate area of water column would be impacted in fishing grounds
- Water surface resources – High, because a relatively large area of offshore surface water would be impacted including important shipping lanes and a national marine sanctuary. 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 and streamers
- Shoreline resources – High, because a relatively large length of shoreline would be impacted in areas with high-value and sensitive resources

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 80,000 bbl** of light fuel oil from the *Lubrafol*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	98% 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
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 825 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	97% 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 45,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	57% of the model runs resulted in shoreline oiling of 1 g/m^2	High
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 97 mi	

For the Most Probable Discharge of 8,000 bbl, the socio-economic risk from potential releases of light fuel oil from the *Lubrafol* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Low, because a moderate area of water column would be impacted in fishing grounds
- Water surface resources – High, because a relatively large area of offshore surface water would be impacted including important shipping lanes and a national marine sanctuary. 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 and streamers
- Shoreline resources – Medium, because a moderate to small length of shoreline would be impacted in areas with high-value and sensitive resources

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 8,000 bbl** of light fuel oil from the *Lubrafol*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	3% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 5 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	92% 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 16,700 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	30% of the model runs resulted in shoreline oiling of 1 g/m^2	Med
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 22 mi	

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

The overall risk assessment for the *Lubrafol* 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, *Lubrafol* scores High with 18 points; for the Most Probable Discharge, *Lubrafol* 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 *Lubrafol*. The final determination rests with the U.S. Coast Guard.

Lubrafol	**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 Lubrafol.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 77,000 bbl, known to be leaking		**Med**
	A2: Oil Type	High	#2 fuel oil		
	B: Wreck Clearance	High	Not cleared		
	C1: Burning of the Ship	High	Burned for two days		
	C2: Oil on Water	High	Oil on the water at time of casualty		
	D1: Nature of Casualty	High	Hit by two torpedoes, explosion, fire		
	D2: Structural Breakup	High	In one piece		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records of this wreck exist as well as dive reports, assessment is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	High	Vessel is upside down		**Not Scored**
	Depth	High	Vessel is 180 feet deep		
	Visual or Remote Sensing Confirmation of Site Condition	High	Technical dive site		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	Small arms, 5-inch gun and two .30 caliber Lewis machine guns		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Large spills of light fuel oil can have significant impacts to water column resources; smaller spills are less persistent in open water	**High**	**Low**
	3B: Water Surface Resources	High	Under the WCD, slicks spread over large surface areas; smaller spills are less persistent; even light sheens can become concentrated in convergences with *Sargassum* mats which host many species	**High**	**Med**
	3C: Shore Resources	High	Mostly expect to have light oiling by light fuel oil on outer sand beaches	**Med**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	Moderate area of water column would be impacted in fishing grounds	**Med**	**Low**
	4B: Water Surface Resources	High	Relatively large area of offshore surface water would be impacted including important shipping lanes and a national marine sanctuary	**High**	**High**
	4C: Shore Resources	High	Relatively large length of shoreline affected in areas with high-value and sensitive resources	**High**	**Med**
Summary Risk Scores				**18**	**12**