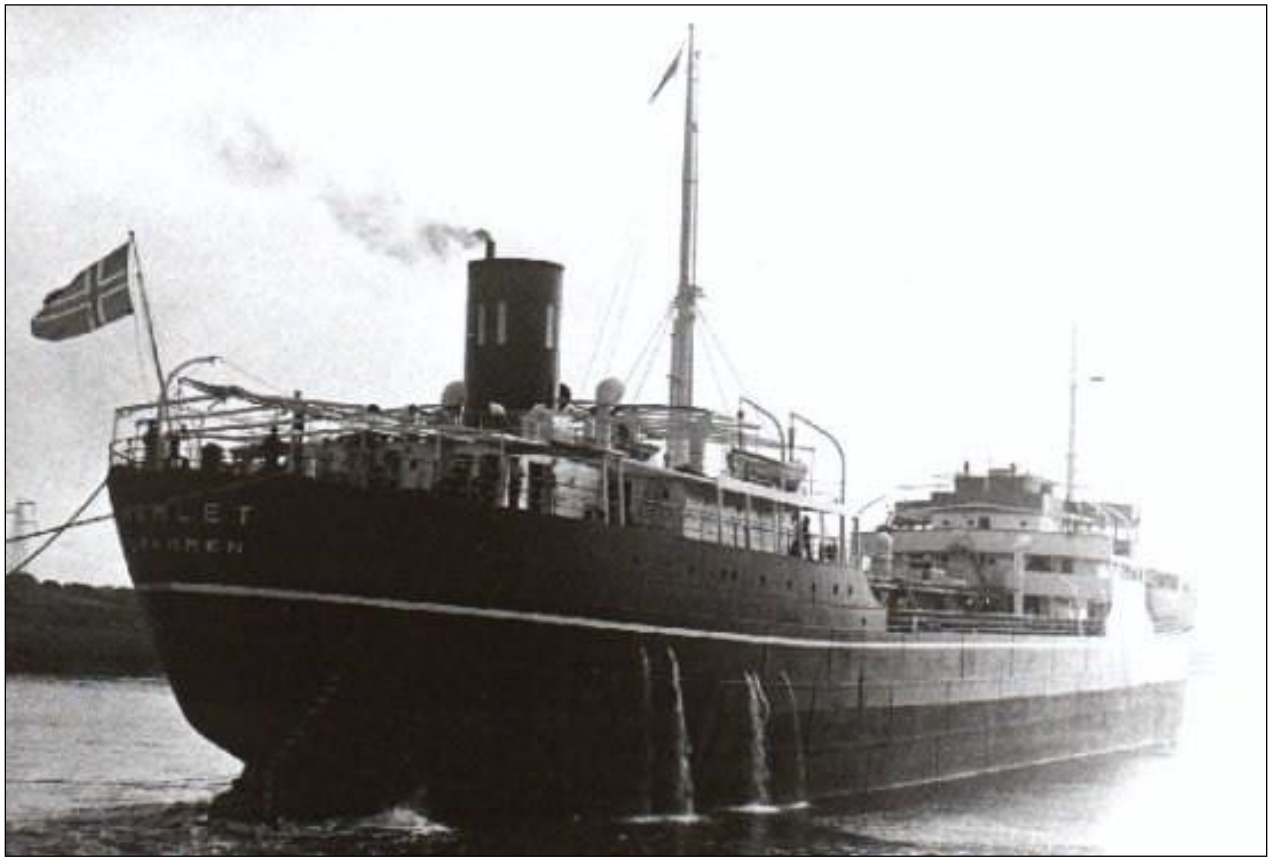
Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Hamlet



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National Oceanic and
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Photo: Photograph of *Hamlet*
Source: http://www.uboat.net/allies/merchants/ships/1712.html

Table of Contents

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.

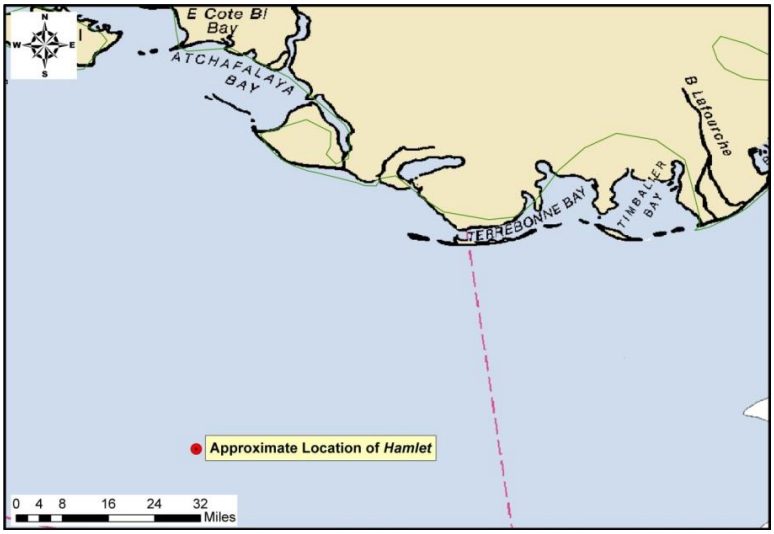
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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: *Hamlet*

The tanker *Hamlet*, torpedoed and sunk during World War II off the coast of Louisiana in 1942, was identified as posing potential pollution threats, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *Hamlet*, 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.



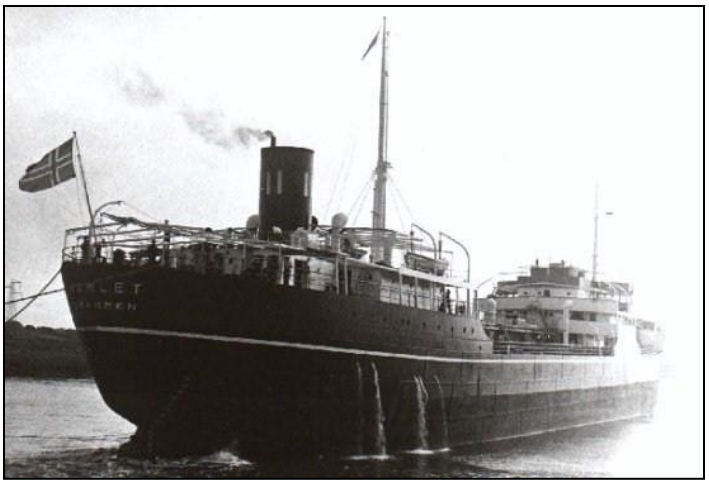
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Hamlet* scores High with 17 points; for the Most Probable Discharge (10% of the Worse Case volume), *Hamlet* scores Medium with 13 points. Given these scores, NOAA would typically recommend that this site be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action. However, given the moderate/low level of data certainty, and that the location of this vessel is unknown, NOAA recommends that surveys of opportunity be used to attempt to locate this vessel and that general notations are made in the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the general area where the vessel is believed lost.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	Med	Med
	3B: Water Surface Resources	High	Med
	3C: Shore Resources	High	Med
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	High	Med
	4C: Shore Resources	High	Med
Summary Risk Scores		17	13

The determination of each risk factor is explained in the document. This summary table is found on page 40.

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

Vessel Particulars



Official Name: *Hamlet*

Official Number: Unknown

Vessel Type: Tanker

Vessel Class: Unknown

Former Names: Eidsvold; Abu

Year Built: 1934

Builder: Gotaverken A/B, Gothenburg

Builder's Hull Number: Unknown

Flag: Norwegian

Owner at Loss: Bruusgaard Kiesteruds Skibs A/S (Bruusgaard Kiosterud & Co. managers)

Controlled by: Unknown

Chartered to: Unknown

Operated by: Unknown

Homeport: Drammen, Norway

Length: 408 feet **Beam:** 55 feet **Depth:** 33 feet

Gross Tonnage: 6,578 **Net Tonnage:** 3,994

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: Beaumont, TX

Destination Port: Liverpool, United Kingdom

Date Departed: May 25, 1942

Date Lost: May 27, 1942

Number of Days Sailing: ≈ 3

Cause of Sinking: Act of War (Torpedoes)

Latitude (DD): 28.5333

Longitude (DD): -91.5

Nautical Miles to Shore: 45

Nautical Miles to NMS: 130

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 140

Bottom Type: Unknown

Is There a Wreck at This Location? Unknown, wreck does not seem to have been located despite sinking in relatively shallow water

Wreck Orientation: Unknown

Vessel Armament: Vessel was armed but the types and number of weapons carried is currently unknown

Cargo Carried when Lost: 64,139 bbl of crude oil

Cargo Oil Carried (bbl): 64,139

Cargo Oil Type: Unknown Type of Crude

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

Fuel Type: Medium Fuel Oil (Diesel)

Total Oil Carried (bbl): ≤ 76,139

Dangerous Cargo or Munitions: Yes

Munitions Carried: Munitions for onboard weapons

Demolished after Sinking: Unknown

Salvaged: Unknown

Cargo Lost: Yes, partially

Reportedly Leaking: No

Historically Significant: Yes

Gravesite: No

Salvage Owner: Not known if any

Wreck Location

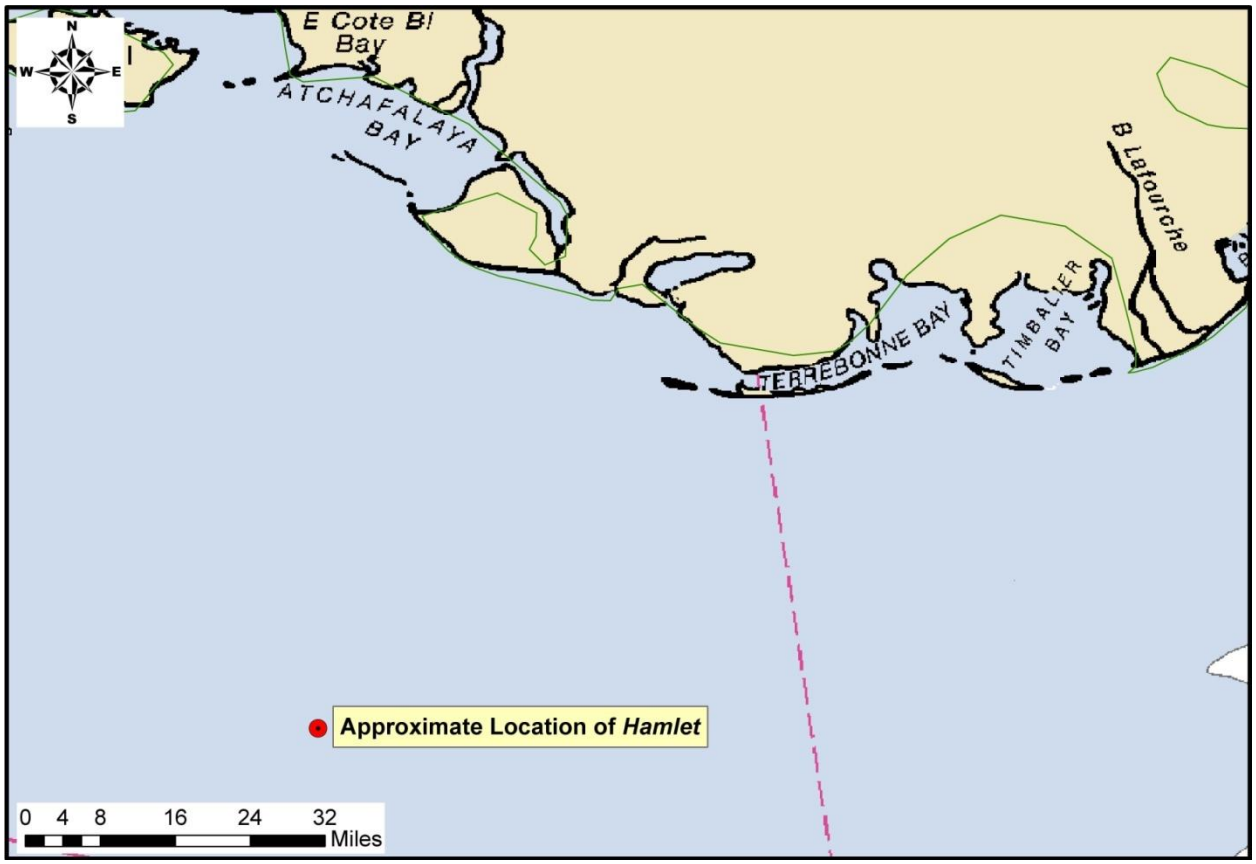


Chart Number: 411

Casualty Narrative

"At 11.03 hours on 27 May 1942, the unescorted *Hamlet* (Master Nils A. Ambjørnsen) was hit by one torpedo from *U-753*. The torpedo struck in the front part of the #10 tank. The engines were stopped and the guns manned, while the lifeboats were made ready for lowering. But the tanker did not sink and they tried to bring her to port. The radio antenna had been destroyed, so they had to rig up an emergency antenna, but before the work could be finished another torpedo hit at 11.28 hours. The ship now started to sink quickly and all crew members abandoned ship in the lifeboats. The men observed *U-753* on the surface at this time. At 11.42 hours, a third torpedo struck between #13 and #15 tank, causing her to sink down to the poop deck. The boats stayed alongside the ship until daylight two hours later to make sure no more men were in the water, whereupon course was set for closest land. The poop of the tanker could still be seen in a 45° angle above the water. Three hours later, some fishing vessels took the lifeboats in tow and arrived Morgan City, Louisiana in the late evening."
-http://www.uboat.net:8080/allies/merchants/ships/1712.html

The *Hamlet* was sunk by a small sub with no deck guns that was seen in the Gulf for the first time at the time of the attack. It fired three torpedoes, one of which was a flaming incendiary projectile. The first was fired at 4:10 am, and destroyed the crew's quarters and radio antennae. The radio operator was unable to

call for help. The second shot was the incendiary torpedo "which spattered liquid fire" and set the vessel on fire. The last torpedo struck the stern. The ship then sank.

---"RAIDING SUBS SINK SIX MORE SHIPS OFF U. S." Chicago Daily Tribune (1872-1963); Jun 1, 1942; ProQuest Historical Newspapers Chicago Tribune (1849 - 1986) pg. 1

---"9 LOST IN SINKING OF 4 MORE SHIPS" New York Times (1857-Current file); Jun 1, 1942; ProQuest Historical Newspapers The New York Times (1851 - 2005) pg. 6

Sunk by *U-753*, commanded by Alfred von Mannstein. The first torpedo struck close to the bow and started a small fire. The second torpedo missed, but a huge tower of flame erupted. After firing one more torpedo, the vessels stern hit the bottom of the sea and the bow stuck up out of the water. The u-boat then left the burning wreck.

---M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 71.

General Notes

No notes available for this site.

Wreck Condition/Salvage History

Unknown; despite sinking in relatively shallow water, the wreck does not seem to have been discovered. It is possible that the wreck was demolished as a hazard to navigation or used as a bombing target since it sank with part of its superstructure sticking out of the water.

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 *Hamlet* was sunk by German Submarine *U-753* off the coast of Louisiana on May 27, 1942. At the time of its loss, the ship was carrying 64,139 bbl of crude oil and had an unknown bunker capacity of marine diesel fuel oil. As the ship travelled from Beaumont, Texas destined for ports in the United Kingdom, it was struck by three torpedoes. The first torpedo struck on the starboard side forward, the second struck amidships on the starboard side, setting the ship on fire, and the third struck the stern on the port side. The damage inflicted by the torpedoes could not be assessed because the vessel began sinking immediately in approximately 120 feet of water with the stern left visible above the water.

Based on the damage caused by the torpedoes along the length of the tanker, it is likely that many of the cargo tanks were damaged or breached by the torpedo blasts and may no longer contain oil. This may also be the case since the vessel sank in relatively shallow water with its stern remaining visible and may have been demolished as a hazard to navigation or used as a training target for aerial bombs dropped by Allied aircraft. Since the shipwreck has never been located or surveyed, however, a condition-based assessment of the wreck cannot be made.

If the wreckage of *Hamlet* is ever located and the U.S. Coast Guard decides to assess the wreck, it should first contact archaeologists with the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) for more information as well as to ensure compliance with archaeological standards for assessing a historic resource. It should also be noted that this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) and possibly the Sunken Military Craft Act (SMCA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Register of Historic Places.

Background Information References

Vessel Image Sources: http://www.uboat.net/allies/merchants/ships/1712.html

Construction Diagrams or Plans in RULET Database? No

Text References:
http://www.uboat.net:8080/allies/merchants/ships/1712.html
Global Wrecks database NSS_ID 549449
U.S. Coast Guard database ID 5878
NIMA database WK_No. 36003

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Hamlet* based on the information available. These factors are reflected in the pollution potential risk assessment development by the U.S. Coast Guard Salvage Engineering Response Team (SERT) as a means to apply a salvage engineer's perspective to the historical information gathered by NOAA. This

analysis reflected in Figure 1-1 is simple and straightforward and, in combination with the accompanying archaeological assessment, provides a picture of the wreck that is as complete as possible based on current knowledge and best professional judgment. 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.

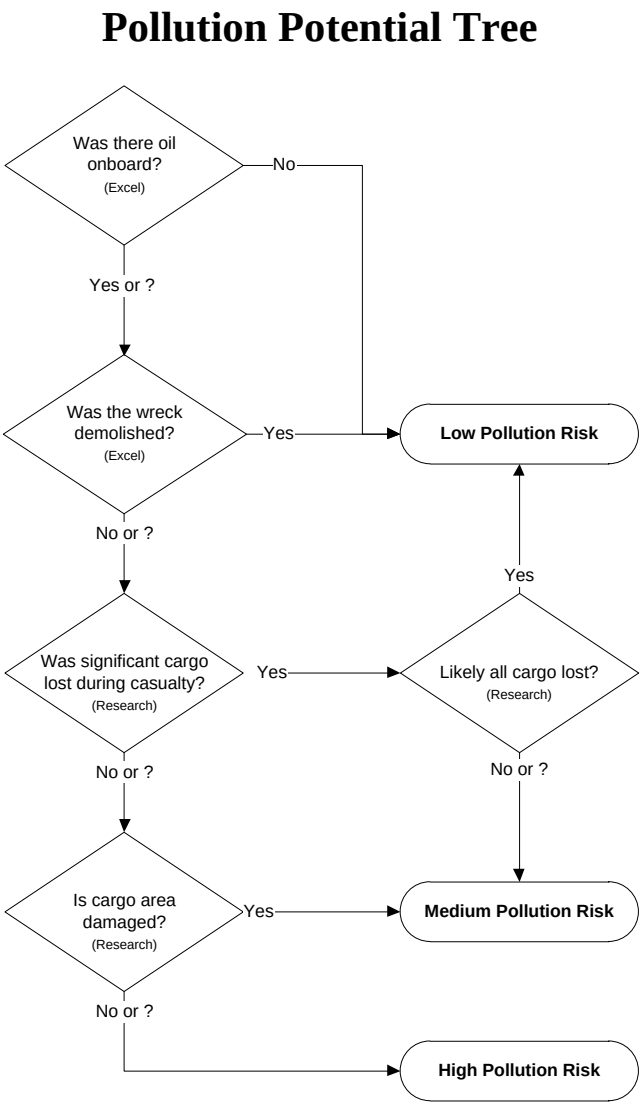


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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

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

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

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Hamlet* 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 *Hamlet i*s ranked as High Volume because it is thought to have a potential for up to 76,774 bbl, although some of that was lost at the time of the casualty due to the explosions. 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 no reports of leakage from the *Hamlet*.

Risk Factor A2: Oil Type

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

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

- **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 *Hamlet* is classified as Medium Risk because the cargo is crude oil, a Group III 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
- **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 *Hamlet* is classified as Unknown Risk because it is not known whether or not the wreck was cleared or demolished after its loss. Data quality is low.

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

Group III - Specific gravity between 0.85 and less than .95 [API° ≤35.0 and >17.5]
Group IV - Specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0]

Risk Factor C2: Reported Oil on the Water

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

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

The *Hamlet* is classified as Medium Risk because the 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 *Hamlet* is classified as Low Risk because there were multiple 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 *Hamlet* is classified as Unknown Risk because it is not known whether additional structural breakup occurred since the final sinking location is unknown. Data quality is low.

Factors That May Impact Potential Operations

Orientation (degrees)

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

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

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 *Hamlet* is believed to be approximately 140 feet based on the last known location. Data quality is low.

Visual or Remote Sensing Confirmation of Site Condition

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

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

Other Hazardous (Non-Oil) Cargo on Board

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

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 *Hamlet* had munitions for onboard weapons, but the types of weapons carried by the vessel are not known. 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 *Hamlet.* Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *Hamlet* 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 76,139 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Cargo is crude oil, a Group III oil type	
	B: Wreck Clearance	Low	Unknown wreck clearance	
	C1: Burning of the Ship	High	No fire was reported	
	C2: Oil on Water	High	Oil was reported on the water; amount is not known	
	D1: Nature of Casualty	High	Multiple torpedo detonations, explosion	
	D2: Structural Breakup	Low	Unknown structural breakup	
Archaeological Assessment	Archaeological Assessment	Medium	Detailed sinking records of this ship exist, but no site reports exist, assessment is believed to be moderately accurate	**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown	**Not Scored**
	Depth	Low	~ 140 feet	
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location unknown	
	Other Hazardous Materials Onboard	Medium	No	
	Munitions Onboard	High	Munitions for onboard weapons	
	Gravesite (Civilian/Military)	High	No	
	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 are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. For the *Hamlet*, with 64,139 bbl of crude oil as cargo and 12,000 bbl of medium fuel oil or diesel, this would be rounded up to 77,000 bbl based on current estimates of the maximum amount of oil remaining onboard the wreck.

The likeliest scenario of oil release from most sunken wrecks, including the *Hamlet*, 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. The **Large** scenario is loss of 50% of the WCD. The five major types of releases are summarized in Table 2-1. The actual type of release that occurs depends on the condition of the vessel, time factors, and disturbances to the wreck. Note that episodic and chronic release scenarios represent a small release that is repeated many times, potentially repeating the same magnitude and type of impact(s) with each release. The actual impacts would depend on the environmental factors such as real-time and forecast winds and currents during each release and the types/quantities of ecological and socio-economic resources present.

The model results here are based on running the RPS ASA Spill Impact Model Application Package (SIMAP) two hundred times for each of the five spill volumes shown in Table 2-1. The model randomly selects the date of the release, and corresponding environmental, wind, and ocean current information from a long-term wind and current database. When a spill occurs, the trajectory, fate, and effects of the oil will depend on environmental variables, such as the wind and current directions over the course of the oil release, as well as seasonal effects. The magnitude and nature of potential impacts to resources will also generally have a strong seasonal component (e.g., timing of bird migrations, turtle nesting periods, fishing seasons, and tourism seasons).

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

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	77 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	770 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	7,700 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	38,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	77,000 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 *Hamlet* contained a maximum of 64,139 bbl of crude oil (a Group III oil) as cargo and 12,000 bbl of medium fuel oil or diesel (a Group II oil). Because the bulk of the oil likely remaining on board is crude oil, the oil spill model was run using crude oil.

Oil Thickness Thresholds

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

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

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

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

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

Oil Description	Oil Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen/Tarballs	Dull Colors	0.001 mm	1 g/m^2	~0.12 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 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 *Hamlet* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi^2 that has been contaminated by 1 part per billion (ppb) oil to a depth of 33 feet. At 1 ppb, there are likely to be impacts to sensitive organisms in the water column and potential tainting of seafood, so this concentration is used as a screening threshold for both the ecological and socio-economic risk factors for water column resource impacts. To assist planners in understanding the scale of potential 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. Note that the water column impact decreases for the worst case discharge spill volume, because a significant amount of oil is removed from the water column due to sedimentation in the modeling results. Increased sedimentation will increase impacts to benthic habitats.

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

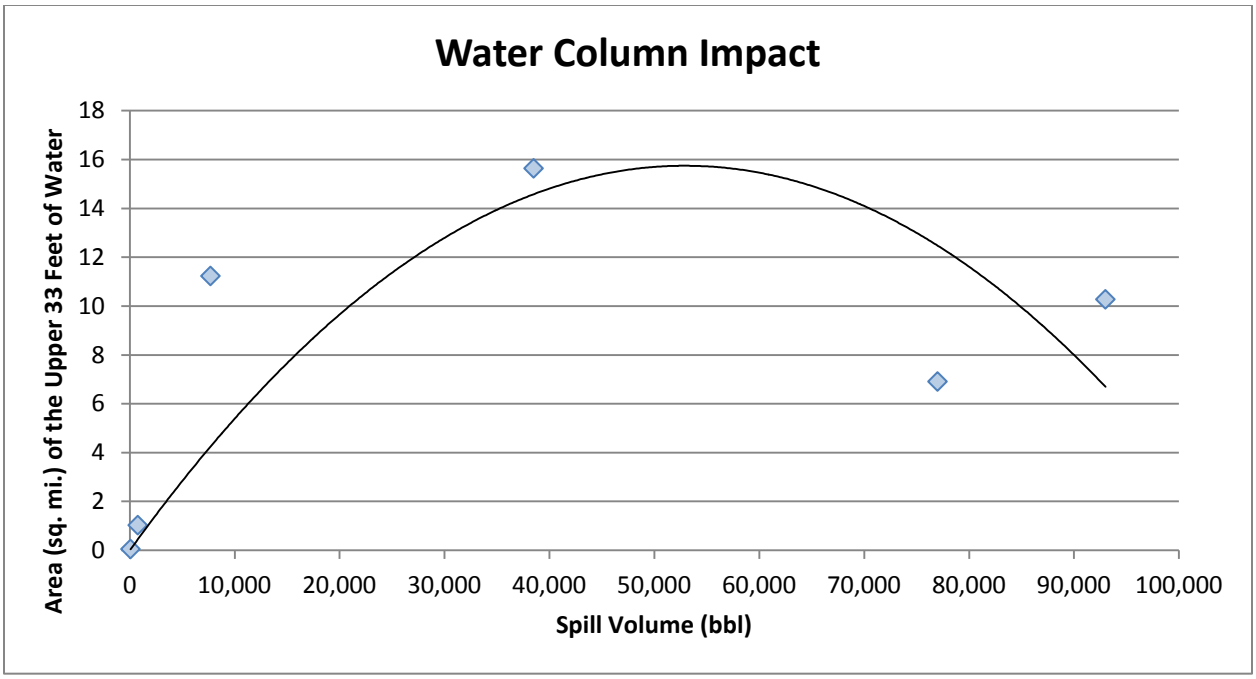


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Hamlet*.

Potential Water Surface Slick

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

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

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	77	1,020 mi^2	1,020 mi^2
Episodic	770	2,590 mi^2	2,580 mi^2
Most Probable	7,700	7,080 mi^2	7,060 mi^2
Large	38,500	18,500 mi^2	18,500 mi^2
Worst Case Discharge	77,000	28,400 mi^2	28,400 mi^2

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

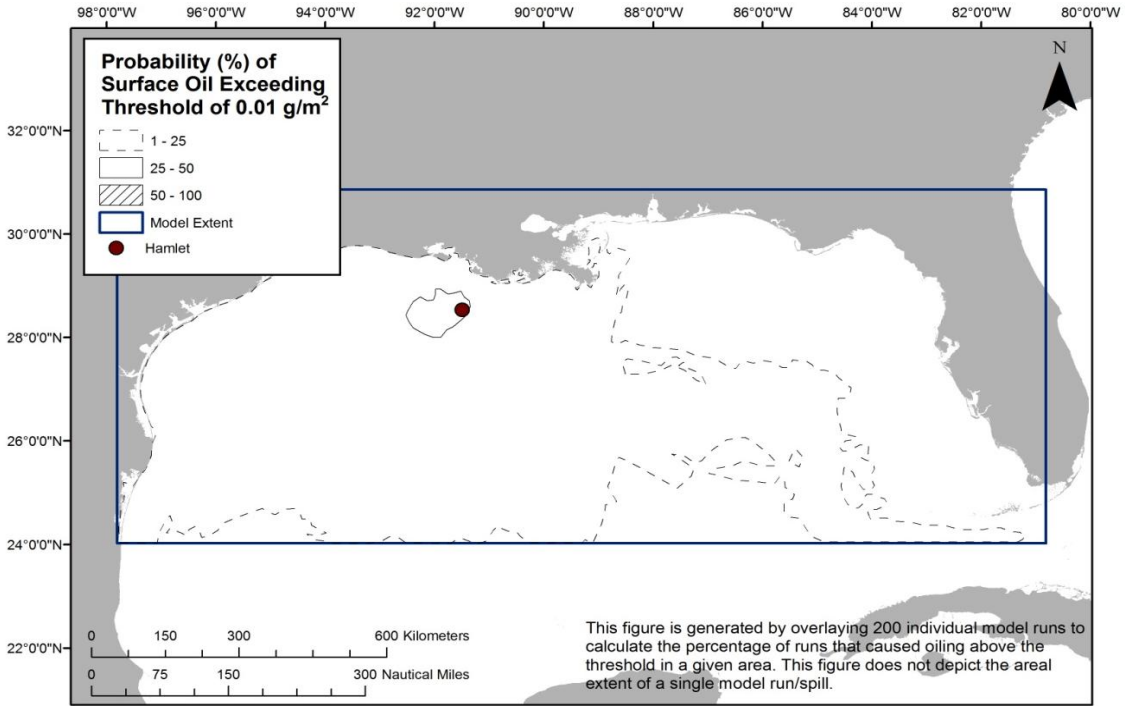


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 7,700 bbl of a crude oil from the *Hamlet* at the threshold for socio-economic resources at risk.

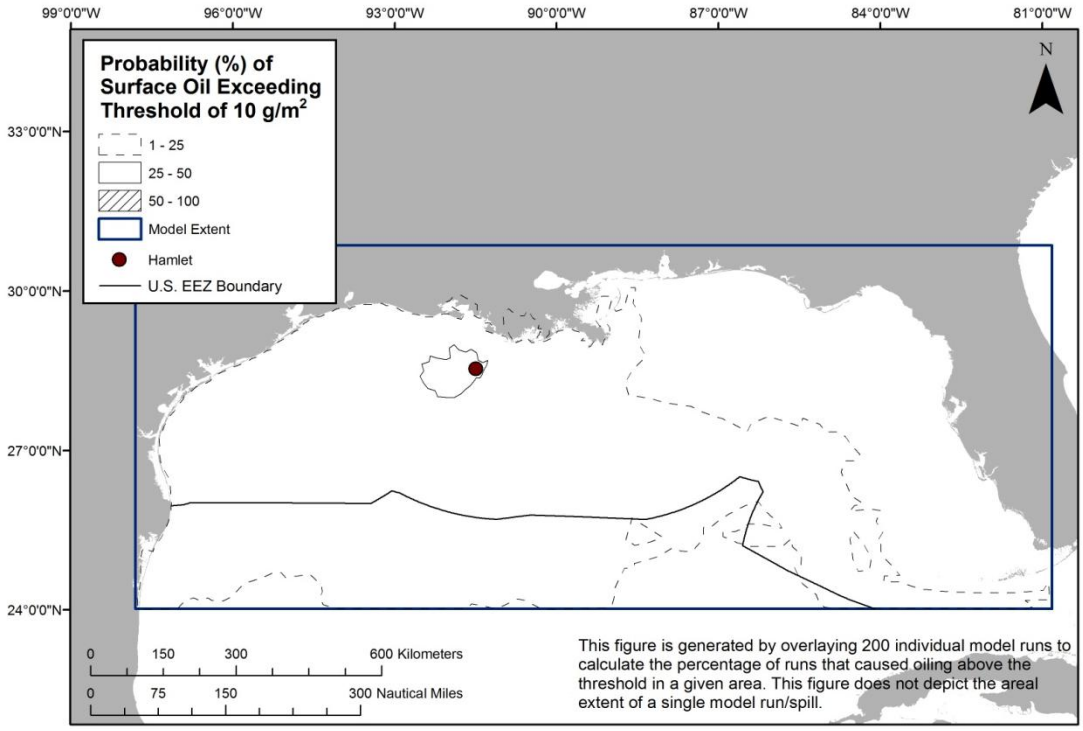


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 7,700 bbl of a crude oil from the *Hamlet* at the threshold for ecological resources at risk.

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

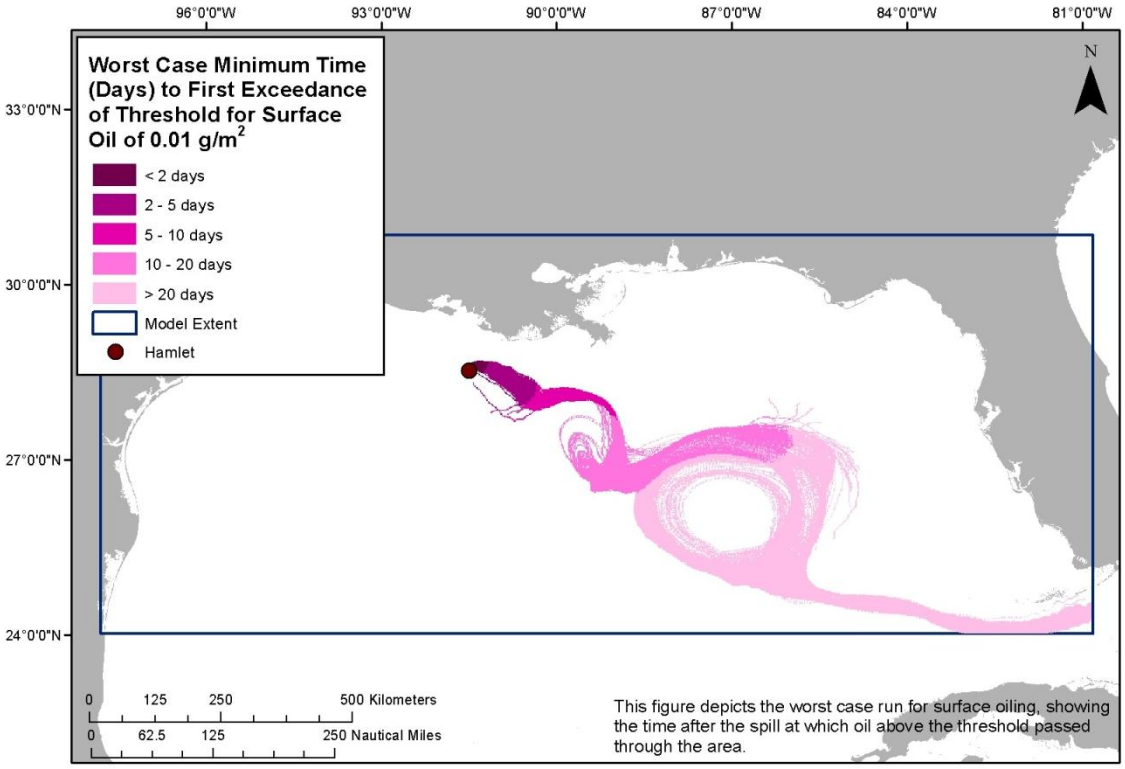


Figure 2-4: Water surface oiling from the Most Probable spill of 7,700 bbl of a crude oil from the *Hamlet* shown as the area over which the oil spreads at different time intervals.

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

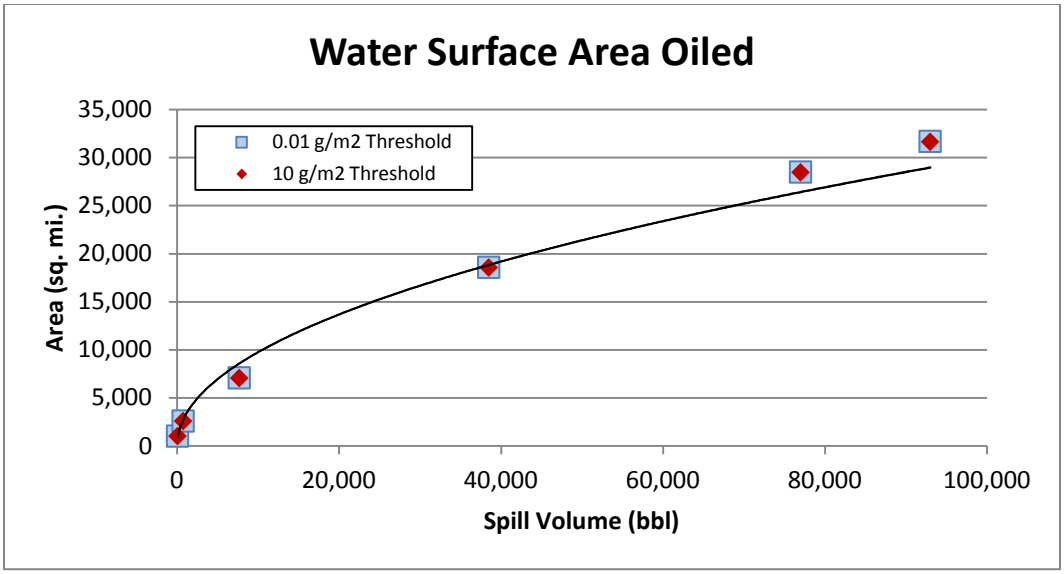


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Hamlet*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2. The curves are so similar that they plot on top of each other.

Potential Shoreline Impacts

Based on these modeling results, shorelines from the Chandeleur Islands in Louisiana west and south to below Brownsville, Texas into Mexico are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m^2, for the Most Probable release of 7,700 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. Estimated miles of shoreline oiling above the threshold of 1 g/m^2 by scenario type are shown in Table 2-4.

Table 2-4a: Estimated shoreline oiling from leakage from the *Hamlet*. (U.S. and Mexico).

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	77	8	8	2	18
Episodic	770	9	16	7	32
Medium	7,700	11	18	11	39
Large	38,500	14	21	15	50
Worst Case Discharge	77,000	16	24	20	59

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	77	8	7	2	16
Episodic	770	9	13	7	28
Medium	7,700	11	14	11	36
Large	38,500	14	18	15	46
Worst Case Discharge	77,000	16	20	20	55

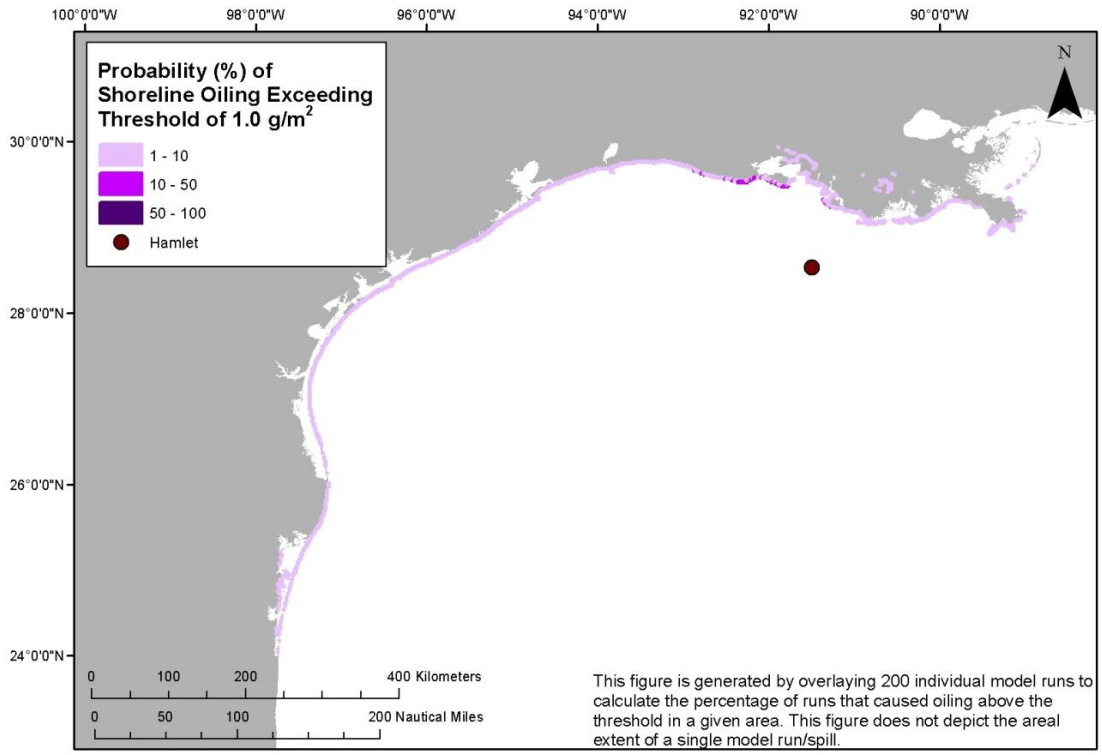


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 7,700 bbl of a crude oil from the *Hamlet*.

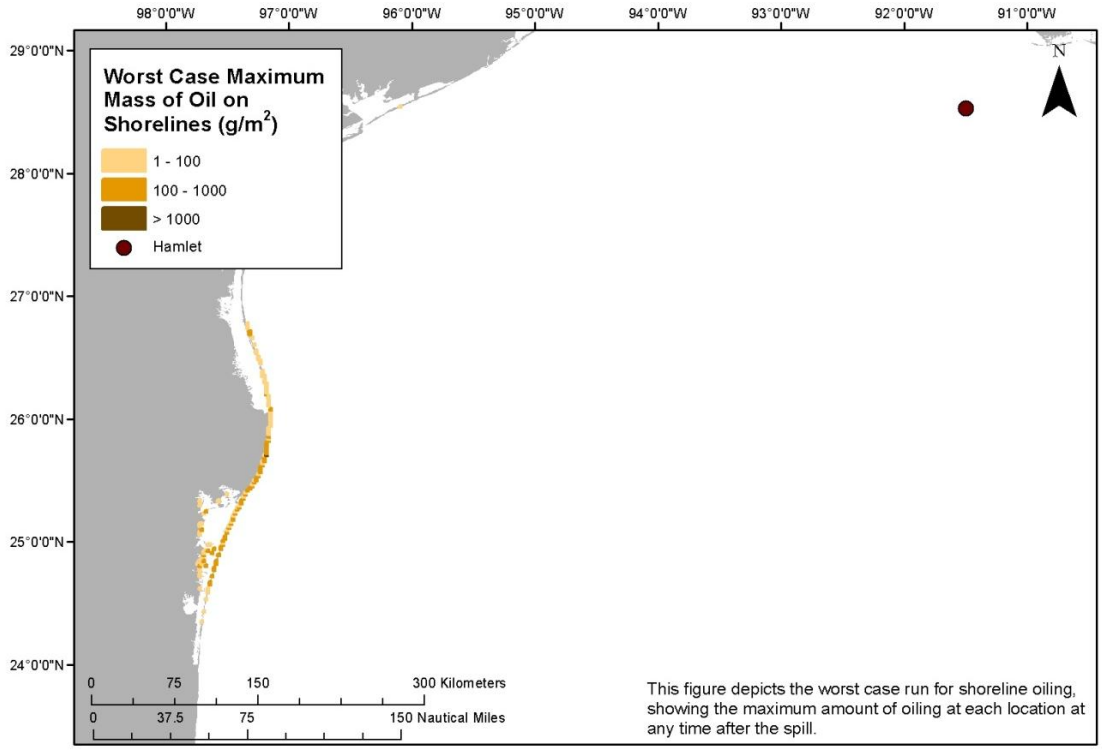


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 7,700 bbl of a crude oil from the *Hamlet* that resulted in the greatest shoreline oiling.

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

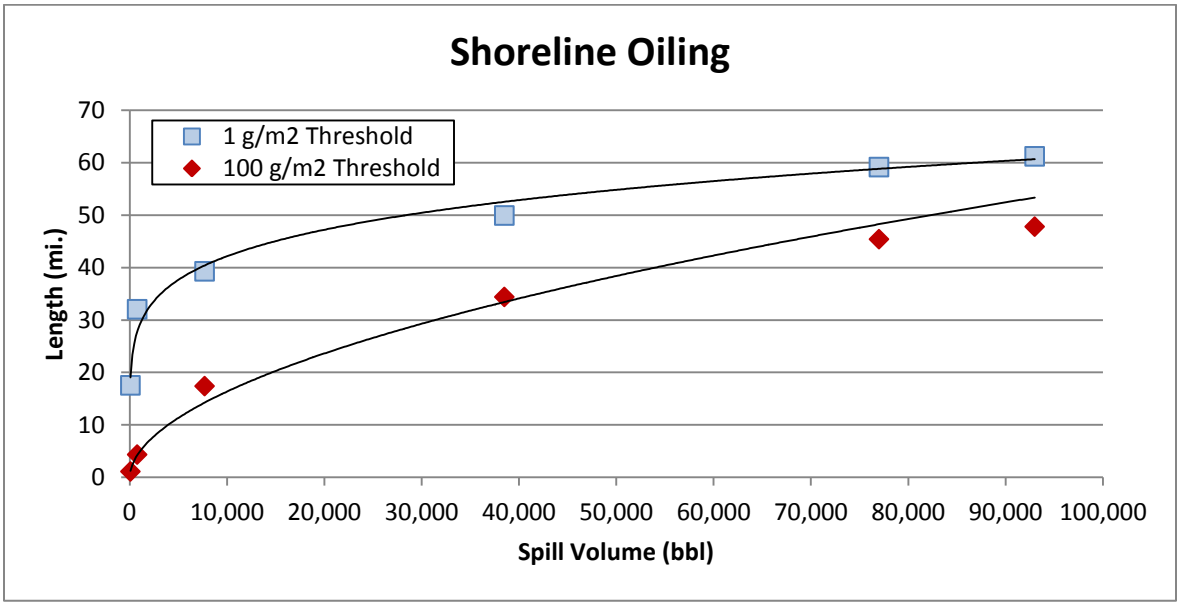


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Hamlet*.

The worst case scenario for shoreline exposure along the potentially impacted area for the WCD volume (Table 2-5) and the Most Probable volume (Table 2-6) consists primarily of sand beaches and gravel (shell) 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 77,000 bbl from the *Hamlet*.

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	72 miles	56 miles
Sand beaches	92 miles	46 miles
Salt marshes and tidal flats	22 miles	4 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 7,700 bbl from the *Hamlet*.

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	9 miles	0 miles
Sand beaches	154 miles	51 miles
Salt marshes and tidal flats	1 mile	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Hamlet* (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. Coastal marshes and barrier islands support large number of nesting shorebirds and wading birds and provide foraging grounds for overwintering shorebirds and waterfowl and migrating shorebirds and passerines. Kemp's ridley sea turtles use coastal waters heavily to travel between nesting beaches in South Texas and Mexico and foraging grounds near the Mississippi River Delta. In addition, nearshore waters of the Gulf support highly productive coastal fisheries for both finfish and invertebrates.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Coastal Birds	• Louisiana coastal islands and bays are important habitat for wintering waterfowl, supporting densities of up to 900 birds per square mile • Raptors (American kestrel, northern harriers, red-tailed hawk, turkey vulture, Cooper's hawk, osprey, bald eagle) can all be present in the coastal marshes • Half of North American population of mottled duck inhabits Louisiana	Ospreys present during winter Mottled duck nests Mar-Sep
Bird Nesting and Migratory Hotspots	*Mississippi Delta (Pass a Loutre State WMA, Delta NWR)* **bp = breeding pairs, otherwise numbers are individual bird counts* • Nesting habitat for mottled duck (445), secretive marsh birds, wading birds, brown pelican (2-3,000 bp) • High densities of king rails in the marsh • Habitat for 100,000 wintering waterfowl, including canvasback (9,000), northern pintail (48,000), gadwall (36,000) • Wintering habitat for western sandpiper, least sandpiper, and dunlin *Barataria-Terrebonne Bays* • Grand Isle State Park is important migratory bird stopover • Snowy plover stopover site • High abundances of overwintering blue and green-winged teal, American wigeon, ring-necked duck, lesser scaup, mallard, gadwall, and geese • Piping plovers overwintering on Elmer's Island, W Grand Terre, and Fourchon east (~50 total) • Nesting: Short-billed dowitcher (1,800), Wilson's plover (176 bp), black skimmer (899), gull-billed tern (>100), Forster's tern (600-900 bp), least tern (321 bp), little blue heron (2,690 bp), white ibis (2,500), roseate spoonbill (125 bp) *Isle Dernieres & Timbalier Islands* • Raccoon Island - high abundance of brown pelican, Wilson's plover, royal and sandwich tern, great, snowy and reddish egret, great blue and tricolored heron • Important wintering habitat: piping plover (50-100), snowy plover (<100), other shorebirds • Stopover for long-billed curlew, red knot, other shorebirds • Nesting: black skimmer (500 bp), sandwich tern (2600 bp), least tern (50 bp), brown pelican (6600 bp), Wilson's plover (150 bp) *Atchafalaya Delta* • Very important for wintering waterfowl, wading birds, and black skimmer	Piping plover present Aug-May Wilson's plover nests May-Aug Short-billed dowitcher present in winter Roseate spoonbill nests Mar-Jul Mottled duck nests Mar-Sep Egrets nest Feb-Jul Ibises nest Apr-Aug Herons nest Mar-Aug Gulls nest Apr-Jul Skimmers nest May-Sep Terns nest Apr-Sep Migrating shorebirds present spring and fall Wintering waterfowl present Oct-Mar

Species Group	Species Subgroup and Geography	Seasonal Presence
	• Marsh and scrub habitats important for rails, cranes, gulls, shorebirds, and terns *Chenier plain* • Shell Keys Isl.: stopover for white pelicans (1,807), brown pelicans, terns, gulls • > 400k overwintering ducks and geese • Mottled duck (1,000-2,000) present • Nesting: Forster's tern (800 bp), gull-billed tern (200 bp), black skimmer (400 bp), roseate spoonbill (200 bp) • Piping plover (30), long-billed dowitcher (6,000) habitat present *Bolivar Flats* • 100,000s of birds • Resting and feeding location for migrating shorebirds (American avocet, American golden-plover, semipalmated plover, Wilson's plover, piping plover, snowy plover) • Resident mottled duck • Breeding roseate spoonbills (50) *Jigsaw Island* • Nesting: American oystercatcher (5 bp), black skimmer (10 bp), laughing gull (50 bp), Caspian tern (6 bp), royal tern (600 bp), sandwich tern (300 bp), tricolored heron *North Deer Island* • 20-40k pairs of 17 bird species nest here; Can have 20k pairs of white ibis and 1,000 pairs of brown pelican, 2-3,000 pairs of laughing gull *Mustang Bayou Isl.* – wading birds, black skimmer, gull-billed and royal tern nesting *East Matagorda (Dressing Point)* • Nesting laughing gull (>2,000), royal tern (>1,000), sandwich tern (1,000), reddish egret (20-30), tricolored heron (500), snowy egret (200), great egret (200), great blue herons, white ibis (historically thousands, currently <100), roseate spoonbill (200), white-faced ibis (hundreds), brown pelican (200) *Sundown Island (West Matagorda)* – 18 species of colonial nesting birds, including one of the largest colonies of reddish egret in Texas (15,000 bp) • Nesting laughing gull (3,000 bp), royal tern (4,000 bp), sandwich tern (600 bp), tricolored heron (200 bp), brown pelican (2,000 bp), black skimmer, gull-billed tern, Caspian tern, reddish egret, little blue/great blue heron, snowy egret, great egret, cattle egret, white ibis, roseate spoonbill *Aransas NWR/Blackjack peninsula* • Whooping crane (276; FE, SE) critical wintering habitat • Important stopover area *Deadman Island (Long Reef)* • Nesting royal tern (400-500), sandwich tern (100-200), egrets, herons, American oystercatcher, black skimmer, Caspian and gull-billed terns, ring-billed gull *Green Island* • One of the largest aggregation of breeding reddish egret (1,400 bp) and roseate spoonbill (260 bp) in the world; Herons, egrets, ibises present	

Species Group	Species Subgroup and Geography	Seasonal Presence
	Laguna Vista spoils - Nesting • Gull-billed tern, royal tern, sandwich tern (1,000s), reddish egret, black skimmer *Pelagic distribution* Convergence zones (thermoclines and warm core eddies) are areas of high biodiversity and abundance. Bird assemblages change seasonally: • Early summer - terns, storm-petrels and gulls common; jaegers and shearwaters less common; tropicbirds, sulids, and frigatebirds rare • Mid-summer - black terns are extremely common; band-rumped storm petrel, magnificent frigatebird, Audubon's shearwater, sooty tern present • Late summer - high abundances of terns • Fall - laughing gull, royal tern, Pomarine jaeger common • Fall/winter - skuas present • Winter - herring and laughing gulls common	
Sea Turtles	*Nesting* • Kemp's ridley (FE, SE) nest in high concentrations on North Padre Island (~ 100 nests/yr) and in low concentrations (<25 nests/yr) from Galveston Bay to the extent of the modeled impact in northern Mexico ○ Densities of nesting Kemp's ridley sea turtles increase greatly (100s-1,000s per year) just south of the model extent; their major nesting ground is at Rancho Nuevo, Mexico • Loggerheads (FT, ST) nest in coastal Texas in low numbers • Greens (FT, ST) nest on beaches north to North Padre Island in low numbers • Hawksbills (FE, SE) and leatherbacks (FE, SE) nesting can occur on Padre Island National Seashore but is extremely rare *Distribution* • Coastal Louisiana is a major foraging ground for Kemp's ridley • South Texas and northern Mexico inshore waters are important foraging grounds for juvenile green sea turtles • Shelf waters are important adult habitat for loggerheads	Loggerheads nest May-Oct Kemp's ridleys and Greens nest Mar-Jul, hatch Apr-Sep Leatherbacks and Hawksbills nest during summer
Reptiles	Rockefeller State WR/Game Preserve has highest alligator nesting density in U.S. Diamondback terrapins can be found along the gulf shoreline in the area of impact	
Marine Mammals	Bottlenose dolphins (35-45,000) - Common in coastal waters including rivers, bays, and sounds throughout potential spill area. High concentrations in coastal Louisiana, especially around inlets and passes Manatees can be present in low abundance in inland waters in spring-fall	
Terrestrial Mammals	Northern river otter, mink, nutria and muskrat can all be present in marsh habitats	
Fish	*Inshore distributions* • Marsh habitats are extremely productive and support high biodiversity and abundance of resident estuarine fish • Estuarine areas are important nursery grounds for many commercial species, including red, mutton, gray, lane, dog and yellowtail snapper, goliath, red, gag and yellowfin grouper • Coastal nursery areas for blacktip sharks, spinner sharks, Atlantic sharpnose sharks, bull sharks, sandbar sharks in the region • Passes are often sites of fish spawning • Alabama shad spawn in rivers from Atchafalaya east in area of impact *Common in state waters* • Gulf sturgeon (FT), bull shark, blacktip shark, spinner shark, silky shark,	Shark species pup spring-summer Bluefin tuna spawn in spring Estuarine dependent fish migrate offshore in the fall/winter to spawn; juveniles and adults use estuaries during the spring/summer

Species Group	Species Subgroup and Geography	Seasonal Presence
	sharpnose shark, red snapper, mullet, lane snapper, red drum, gray snapper, vermillion snapper, king and Spanish mackerel, gag grouper, spotted seatrout, cobia, greater amberjack, black drum, hardheaded catfish, tarpon *Offshore distributions* • Surface oriented fish present include hammerhead sharks, tiger sharks, silky sharks, mako sharks, manta rays, eagle rays, cownose rays, tunas, billfish, molas • Whale shark hotspot near mouth of the Mississippi • Bluefin tuna spawn in areas offshore of coastal Texas & Louisiana • *Sargassum* is important habitat for juvenile of some pelagic fish species (i.e., dolphinfish, jacks, triggerfish, and juvenile turtles)	Bluefin tuna spawn Apr-May
Invertebrates	Significant shrimp fisheries occur for white shrimp, brown shrimp, blue crabs, gulf stone crabs and oysters in coastal areas • Spawning occurs offshore, larval and juvenile development occurs in estuarine waters • Female blue crabs move to deeper waters to spawn	Spawning: Brown shrimp Mar-Jul White shrimp Apr-Nov Blue crab peaks Aug-Sep Oysters late spring and early fall
Benthic habitats	Submerged aquatic vegetation (SAV) is critical to numerous species and can be found in bays and sounds south of Galveston Bay. Larger and more contiguous beds occur on the inland side of the Chandeleur Islands and south of Matagorda Bay	Year round

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

Ecological Risk Factors

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Hamlet* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 77,000 bbl and a border around the Most Probable Discharge of 7,700 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 *Hamlet* is classified as Low Risk for oiling probability for water column ecological resources for the WCD of 77,000 bbl because 8% 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 7 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 7,700 bbl, the *Hamlet* is classified as High Risk for oiling probability for water column ecological resources because 88% 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 11 mi^2 of the upper 33 feet of the water column. These results reflect the higher rate of oil/sediment interaction for a large release of crude oil, which results in less dissolved components in the water column, compared to smaller crude oil releases.

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 *Hamlet* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 100% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as High Risk for degree of oiling because the mean area of water contaminated was 28,400 mi^2. The *Hamlet* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 100% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 7,060 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 *Hamlet* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 68% 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 84 miles. The *Hamlet* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 57% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 29 miles.

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

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 77,000 bbl of crude oil from the *Hamlet* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Medium, because of the importance of coastal and estuarine waters as spawning and rearing habitat for commercially important fish and shellfish and the increased risk to those associated with benthic habitats because of the high rate of sedimentation at large spill volumes
- Water surface resources – High, because of the very large number of wintering, nesting, and migratory birds that use open ocean, coastal, and estuarine habitats at risk, sea turtle concentrations in *Sargassum* habitat, and the persistence of tarballs that can be transported long distances. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – High, because many sensitive shoreline resources include wetlands which are difficult to clean and under long-term decline, large bird nesting colonies, turtle nesting beaches, nursery areas for many fish and shellfish, and wintering habitat for listed bird species

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 77,000 bbl** of crude oil from the *Hamlet*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	8% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Med**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 7 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**High**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 28,400 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	68% of the model runs resulted in shoreline oiling of 100 g/m^2	**High**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 84 mi	

For the Most Probable Discharge of 7,700 bbl, the ecological risk from potential releases of crude oil from the *Hamlet* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Medium, because of the importance of coastal and estuarine waters as spawning and rearing habitat for commercially important fish and shellfish
- 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, tarballs, and streamers
- Shoreline resources – Medium, because fewer salt marshes are at risk

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 7,700 bbl** of crude oil from the *Hamlet*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	88% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Med**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 11 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 7,060 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	57% of the model runs resulted in shoreline oiling of 100 g/m^2	**Med**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 29 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 *Hamlet* include very highly utilized recreational beaches in Louisiana and Texas year-round, but also during spring and fall for shore fishing. 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. There are two national seashores and a number of state parks with heavily utilized beaches.

A release could impact shipping lanes that run through the area of impact to ports and offshore lightering areas in Mississippi, Louisiana, and Texas with a total of 26,000 vessel port calls and over 1.5 billion tonnage annually. Commercial fishing is economically important to the region, as well as to the nation. Regional commercial landings for 2010 exceeded $508 million.

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 *Hamlet* 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 *Hamlet*.

Resource Type	Resource Name	Economic Activities
National Seashores	Padre Island National Seashore, TX Gulf Island National Seashore, LA	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.
National Wildlife Refuges	Delta NWR (LA) Shell Keys NWR (LA) Sabine NWR (TX) Texas Point NWR (TX) McFaddin NWR (TX) Anahuac NWR (TX) Brazoria NWR (TX) San Bernard NWR (TX) Big Boggy NWR (TX) Aransas NWR (TX)	National wildlife refuges in two states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.
State Parks	Grand Isle SP, LA Cypremort Point SP, LA Sea Rim SP, TX	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining,

Resource Type	Resource Name	Economic Activities
	Galveston Island SP, TX Matagorda Island SP, TX Goose Island SP, TX Mustang Island SP, TX Point Isabel Lighthouse State Historic Park, TX Boca Chica SP, TX	camping, and amusement parks). They provide income to the states. State parks in Louisiana and Texas are potentially impacted.
Commercial Fishing	A number of fishing fleets use the western Gulf of Mexico area and surrounding waters for commercial fishing purposes.	
	Aransas Pass-Rockport	Total Landings (2010): $8.6M
	Brownsville-Port Isabel	Total Landings (2010): $52.5M
	Cameron	Total Landings (2010): $11.5M
	Delacroix-Yscloskey	Total Landings (2010): $11.7M
	Delcambre	Total Landings (2010): $20.7M
	Dulac-Chauvin	Total Landings (2010): $45.1M
	Empire-Venice	Total Landings (2010): $53.7M
	Freeport	Total Landings (2010): $9.2M
	Galveston	Total Landings (2010): $28.0M
	Golden Meadow-Leeville	Total Landings (2010): $21.9M
	Grand Isle	Total Landings (2010): $14.2M
	Gulfport-Biloxi	Total Landings (2010): $13.0M
	Intracoastal City	Total Landings (2010): $26.4M
	Lafitte-Barataria	Total Landings (2010): $20.4M
	Morgan City-Berwick	Total Landings (2010): $5.7M
	Palacios	Total Landings (2010): $31.9M
	Pascagoula-Moss Point	Total Landings (2010): $8.9M
	Port Arthur	Total Landings (2010): $47.4M
Ports	There are a number of significant commercial ports in the western Gulf of Mexico 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.	
	Port Arthur, TX	1,183 port calls annually
	Freeport, TX	777 port calls annually
	Galveston, TX	699 port calls annually
	Houston, TX	6,698 port calls annually
	Texas City, TX	1,167 port calls annually
	Corpus Christi, TX	1,037 port calls annually
	Lake Charles, LA	683 port calls annually
	Galveston Lightering Area, TX	591 port calls annually
	Pascagoula, MS	562 port calls annually
	Nederland Terminal, TX	389 port calls annually
	New Orleans, LA	5,544 port calls annually
	Loop Terminal, LA	295 port calls annually
	Southwest Pass Lightering Area, LA	249 port calls annually
	Gulfport, MS	197 port calls annually
	Ingleside, TX	193 port calls annually
	Point Comfort, TX	184 port calls annually
	South Sabine Point Lightering Area, TX	118 port calls annually
	Brownsville, TX	74 port calls annually
	Beaumont, TX	64 port calls annually
	Freeport Lightering Area, TX	30 port calls annually
	Corpus Christi Lightering Area, TX	26 port calls annually
	Sabine Pass, TX	235 port calls annually

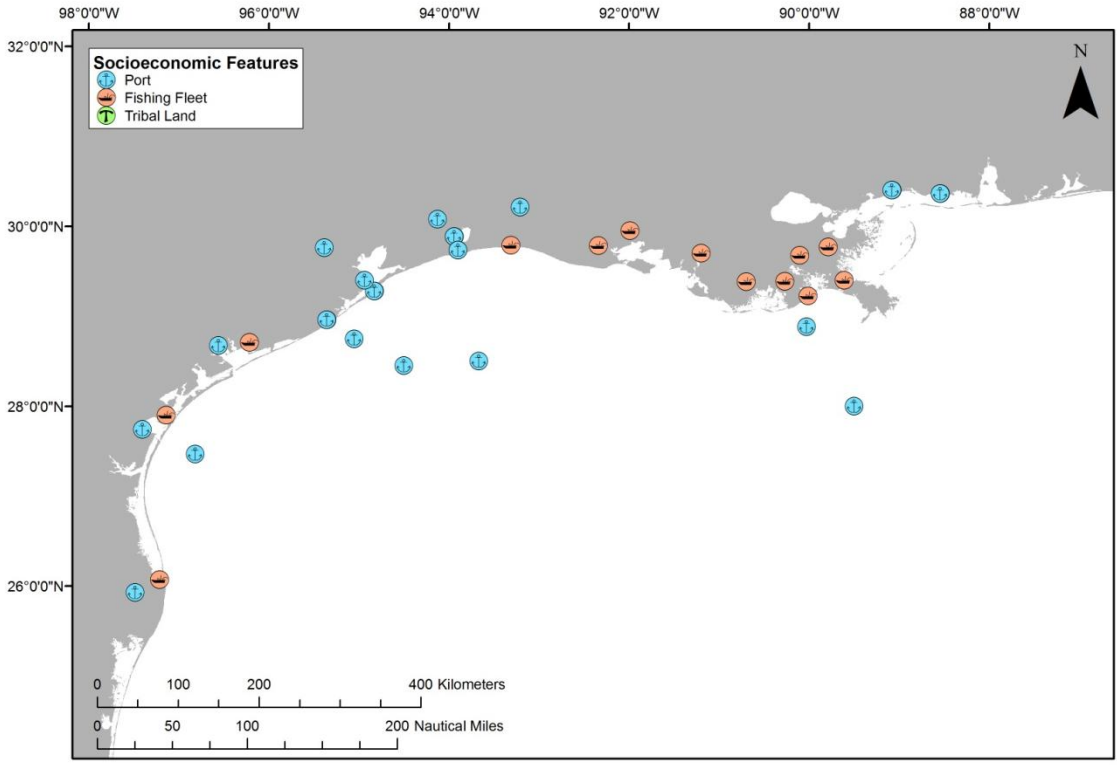


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Hamlet*. (Note that there are no tribal lands at risk.)

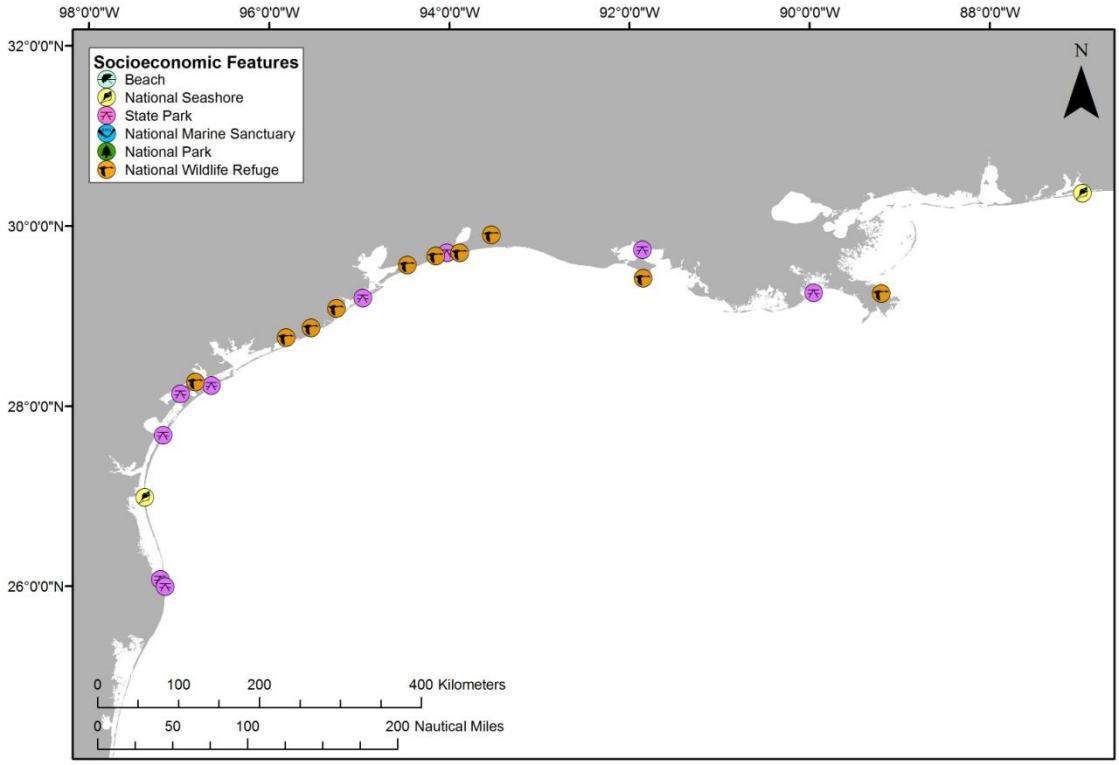


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Hamlet*.

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).

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 *Hamlet* is classified as Low Risk for oiling probability and Medium Risk degree of oiling for water column socio-economic resources for the WCD of 77,000 bbl because 8% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 7 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 7,700 bbl, the *Hamlet* is classified as High Risk for oiling probability for water column socio-economic resources because 88% 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 11 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 *Hamlet* is classified as High Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the WCD because 100% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2, and the mean area of water contaminated was 29,000 mi^2. The *Hamlet* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 100% of the model runs resulted in at least 1,000 mi^2

of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 7,100 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 *Hamlet* is classified as High Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the WCD because 70% 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 118 miles. The *Hamlet* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 67% 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 83 miles.

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

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 77,000 bbl of crude oil from the *Hamlet* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Low, because there is only a low probability of a relatively small amount of the water column being impacted in important fishing grounds
- Water surface resources – High, because there is a high probability of a large area of surface water being impacted in important shipping lanes and fishing areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – High, because there is a high probability of a large impact to shorelines with many sensitive resources

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 77,000 bbl** of crude oil from the *Hamlet*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	8% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 7 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	**High**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m^2 was 29,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	70% 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 118 mi	

For the Most Probable Discharge of 7,700 bbl, the socio-economic risk from potential releases of crude oil from the *Hamlet* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because a relatively small amount of the water column would be impacted in important fishing grounds
- Water surface resources – Medium, because there is a high probability of a large area of surface water being impacted in important shipping lanes and fishing areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because there is a high probability of a moderate impact to shorelines with many sensitive resources

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 7,700 bbl** of crude oil from the *Hamlet*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	88% 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 11 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	**Med**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m^2 was 7,100 mi^2	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	67% 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 83 mi	

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

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

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

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

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

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

For the Worst Case Discharge, *Hamlet* scores High with 17 points; for the Most Probable Discharge, *Hamlet* scores Medium with 13 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 *Hamlet*. The final determination rests with the U.S. Coast Guard.

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

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

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 76,139 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Cargo is crude oil, a Group III oil type		
	B: Wreck Clearance	Low	Unknown wreck clearance		
	C1: Burning of the Ship	High	No fire was reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Multiple torpedo detonations, explosion		
	D2: Structural Breakup	Low	Unknown structural breakup		
Archaeological Assessment	Archaeological Assessment	Medium	Detailed sinking records of this ship exist, but no site reports exist, assessment is believed to be moderately accurate		**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown		**Not Scored**
	Depth	Low	~ 140 feet		
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location unknown		
	Other Hazardous Materials Onboard	Medium	No		
	Munitions Onboard	High	Munitions for onboard weapons		
	Gravesite (Civilian/Military)	High	No		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA		
				WCD	**Most Probable**
Ecological Risks	3A: Water Column Resources	High	Nearshore habitats which are important spawning areas at greatest risk of impact	**Med**	**Med**
	3B: Water Surface Resources	High	Large areas with abundant wintering waterfowl, sea turtles concentrated in *Sargassum* where oil also tends to concentrate, and spawning habitat for many fish/shellfish	**High**	**Med**
	3C: Shore Resources	High	Shoreline resources include wetlands which are difficult to clean and under long-term decline, large bird nesting colonies, turtle nesting beaches, nursery areas for fish and shellfish, and wintering areas for many bird species	**High**	**Med**
Socio-Economic Resources	4A: Water Column Resources	High	Relatively small amount of the water column being impacted in important fishing grounds	**Low**	**Low**
	4B: Water Surface Resources	High	Large to moderate area of impact in important shipping lanes and fishing areas	**High**	**Med**
	4C: Shore Resources	High	High probability of a large impact to shorelines with many sensitive resources	**High**	**Med**
Summary Risk Scores				**17**	**13**