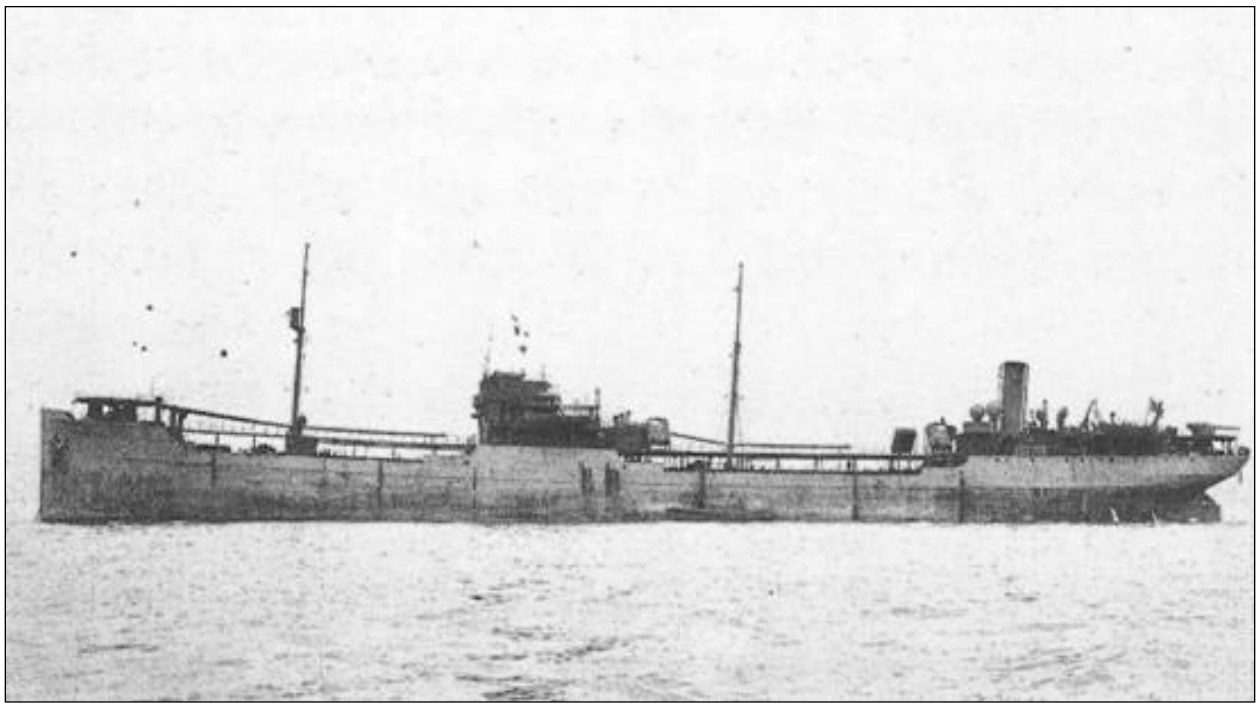
Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Gulfstate



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National Oceanic and
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Photo: Identification Photograph of *Gulfstate*
Source: SSHSA Collection, University of Baltimore Library

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Project Background

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

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

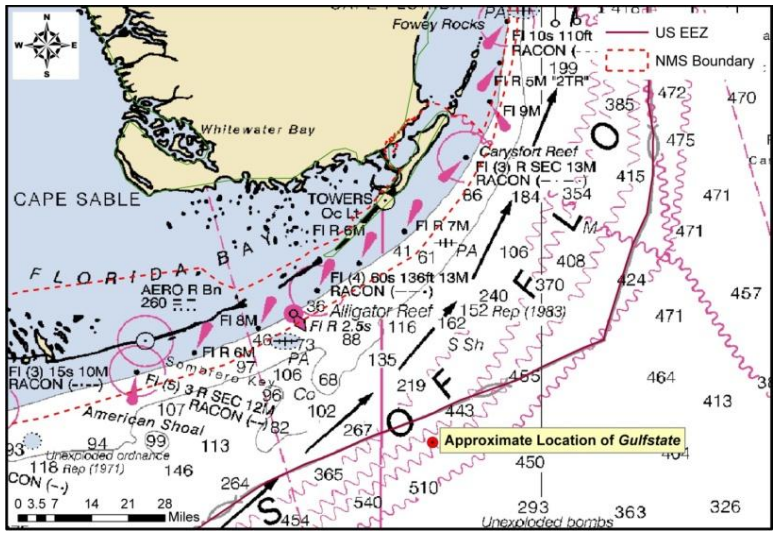
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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

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

Executive Summary: *Gulfstate*

The tanker *Gulfstate*, torpedoed and sunk during World War II off the Florida Keys in 1943, was identified as a potential pollution threat, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *Gulfstate*, 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.



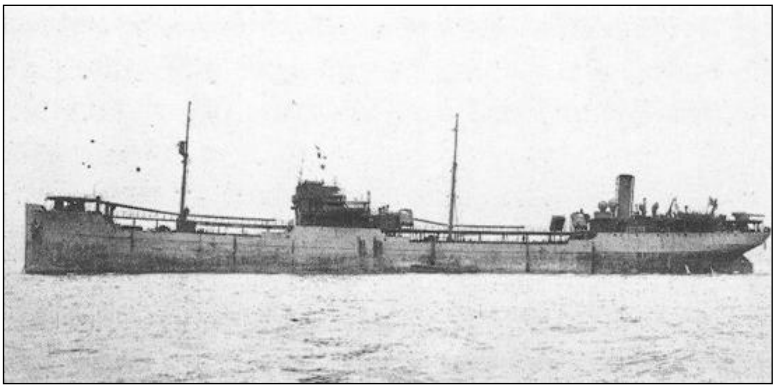
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Gulfstate* scores High with 20 points; for the Most Probable Discharge (10% of the Worse Case volume), *Gulfstate* also scores High with 17 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 that the location of this vessel is unknown, NOAA recommends that surveys of opportunity with state, federal, or academic entities 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 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	High	Med
	3B: Water Surface Resources	High	High
	3C: Shore Resources	High	Med
Socio-Economic Resources	4A: Water Column Resources	High	Med
	4B: Water Surface Resources	High	High
	4C: Shore Resources	High	High
Summary Risk Scores		20	17

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: *Gulfstate*

Official Number: 220675

Vessel Type: Tanker

Vessel Class: 7,000 gross ton (10,700 dwt) class tanker

Former Names: *Halway*

Year Built: 1920

Builder: Bethlehem Steel Company, Alameda, CA

Builder's Hull Number: 5271A

Flag: American

Owner at Loss: Gulf Oil Corporation

Controlled by: War Shipping Administration

Chartered to: War Shipping Administration

Operated by: War Shipping Administration

Homeport: Philadelphia, PA

Length: 435 feet

Beam: 56 feet

Depth: 33 feet

Gross Tonnage: 6,882

Net Tonnage: 4,230

Hull Material: Steel

Hull Fastenings: Riveted

Powered by: Oil-fired steam

Bunker Type: Heavy fuel oil (Bunker C)

Bunker Capacity (bbl): 7,059

Average Bunker Consumption (bbl) per 24 hours: 226

Liquid Cargo Capacity (bbl): 78,000

Dry Cargo Capacity: Unknown

Tank or Hold Description: Vessel had nine cargo tanks divided port and starboard by an oil-tight longitudinal bulkhead

Casualty Information

Port Departed: Galveston, TX

Destination Port: Portland, ME

Date Departed: March 29, 1943

Date Lost: April 3, 1943

Number of Days Sailing: ≈ 6

Cause of Sinking: Act of War (Torpedoes)

Latitude (DD): 24.43376

Longitude (DD): -80.29976

Nautical Miles to Shore: 25

Nautical Miles to NMS: 28

Nautical Miles to MPA: 4.72

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 2,940

Bottom Type: Sand/silt/clay

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

Wreck Orientation: Unknown

Vessel Armament: Vessel was armed with one 5"/51 gun, three .50cal machine guns, and two .30cal guns

Cargo Carried when Lost: 78,000 bbl of high-grade crude oil

Cargo Oil Carried (bbl): 78,000

Cargo Oil Type: High-grade crude oil

Probable Fuel Oil Remaining (bbl): ≤ 5,703

Fuel Type: Heavy fuel oil (Bunker C)

Total Oil Carried (bbl): 83,703

Dangerous Cargo or Munitions: Yes

Munitions Carried: Munitions for onboard weapons

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes

Reportedly Leaking: No

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

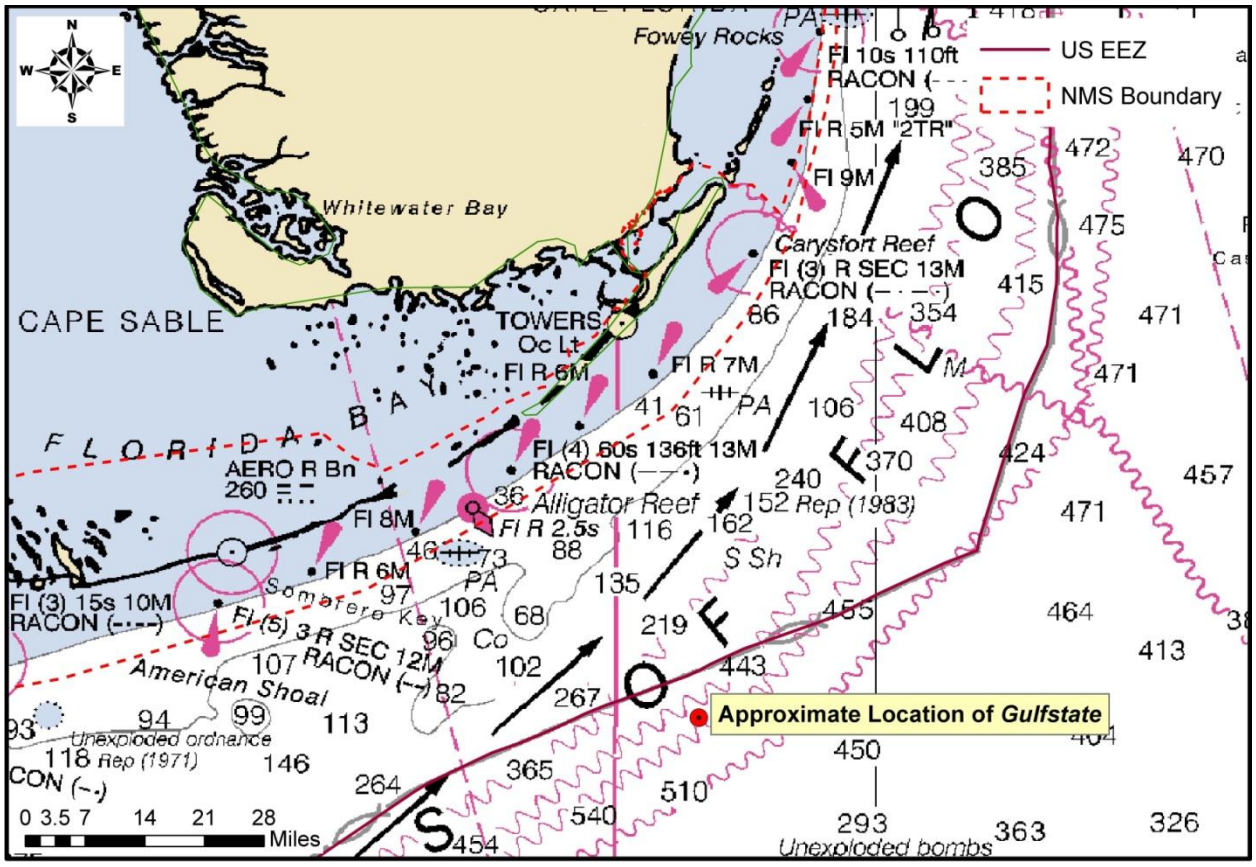


Chart Number: 411

Casualty Narrative

"At 09.03 hours on 3 Apr, 1943, the unescorted *Gulfstate* (Master James Frank Harrell, lost) was hit by two torpedoes from *U-155* about 50 miles southeast of Marathon Key, Florida while steaming a nonevasive course at 10.5 knots. The first torpedo struck on the port side directly under the bridge and ripped a large hole in the hull at the waterline, causing immediate flooding and setting the cargo on fire. The second torpedo struck at the engine room. The fire leapt 100 feet in the air and spread from the bridge to the after part of the vessel. The master ordered the engines secured and the ship abandoned, but the vessel sank bow first within four minutes. None of the lifeboats could be launched and all rafts were lost in the fire. Only a single doughnut raft managed to break free of the tanker. The eight officers, 34 crewmen and 19 armed guards (the ship was armed with one 5in, four .50cal and two .30cal guns) had to jump in the water and swim through 600 feet of burning oil surrounding the tanker. The survivors clung to floats and the single raft for seven hours before being discovered by a U.S. Navy blimp, which dropped two rubber life rafts. An U.S. Coast Guard seaplane picked up three of the most seriously wounded two hours later and took them to Miami. One hour later the remaining 15 survivors (five of them wounded) were picked up by the American patrol craft USS *YP-351*. Three of the wounded were later transferred to USS *Noa* (DD 343) for medical treatment. All survivors were landed at Key West. Eight officers, 26 crewmen and nine armed guards were lost."
-http://www.uboat.net:8080/allies/merchants/ships/2842.html

Under Captain James Frank Harrell, the *Gulfstate* was hit by torpedoes from *U-155* (Piening) while en route from Corpus Christi, TX to Portland, Maine via New York. The first torpedo struck under the bride on the port side. An explosion created a hole in at the waterline, which caused flooding. The cargo caught fire. The second torpedo struck the engine room. The fire was 100 feet in the air as it traveled from the bridge to the stern. The ship sank bow first in less than 4 minutes. The men jumped overboard and had to swim through 600 feet of burning oil surrounding the ship. 18 survivors and 43 dead.
-B.M. Browing Jr., "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 307.

M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 179. Sunk by *U-155*, hit by two torpedoes on the port side creating holes in the hull causing the ship to sink in 4 minutes. The torpedo hits also caused a fire onboard, burning much of the cargo.

General Notes

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

> DESCRIPTION
> 24 NO.1161; TANKER, 6882 GT; SUNK 4/3/42 BY SUBMARINE; POSITION ACCURACY 3-5 MILES. 67 12/30/50
>
> SURVEY REQUIREMENTS
> NOT DETERMINED
>
> Gross Tonnage also recorded as 7216, "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 307. The book records that Navy Records differ on the armament and indicate the vessel carried 78,000 bbl of oil.

Wreck Condition/Salvage History

Unknown; the wreck has never been discovered and rests in over 2,800 feet of water 4.9 miles beyond the U.S. EEZ.

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 wreck of *Gulfstate* has never been located so there are no site reports that would allow NOAA archaeologists to provide a condition based archaeological assessment of the shipwreck. Some additional analysis can be made based on the historic sinking reports of the ship that may be of utility to the Coast Guard. We know from archival research that the ship was struck by two torpedoes. The first torpedo struck on the port side amidships directly under the bridge (Fig. 1-1). This torpedo blast caused a large hole in the tanker below the waterline and set the ship on fire. The second torpedo struck aft of the engine room, opening another large hole and causing the fire to spread from the bridge to the after part of the vessel. Survivors of the attack reported having to swim through fire that extended 600 feet from the ship as burning oil escaped from the tanker.

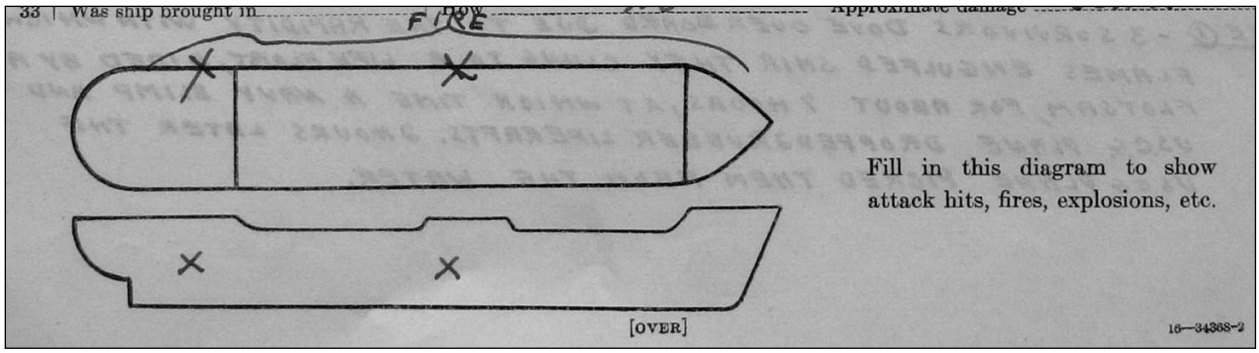


Figure 1-1: U.S. Coast Guard diagram of the location of torpedo impacts on *Gulfstate* (Image courtesy of National Archives, Washington, DC).

Based on the damage caused by the torpedoes and the fire that enveloped most of the ship, it is likely that most of the cargo tanks were destroyed or at least breached by the fire and may no longer contain oil. This may especially be the case as ongoing research also strongly suggests that vessels in great depths of water are generally found in an upright orientation. This orientation has often lead to loss of oil from vents and piping long before loss of structural integrity of hull plates from corrosion or other physical impacts. As it is believed that this vessel is in water greater than 2,900 feet, it is likely to have settled upright and may no longer contain oil.

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

may be eligible for listing on the National Register of Historic Places. The site is also considered a war grave and appropriate actions should be undertaken to minimize disturbance to the site.

Background Information References

Vessel Image Sources: SSHSA Collection, University of Baltimore Library

Construction Diagrams or Plans in RULET Database? No

Text References:

-AWOIS No. 34

-B.M. Browing Jr., "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 307

-M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 179

-http://www.uboat.net/allies/merchants/ships/2842.html

Vessel Risk Factors

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

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

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

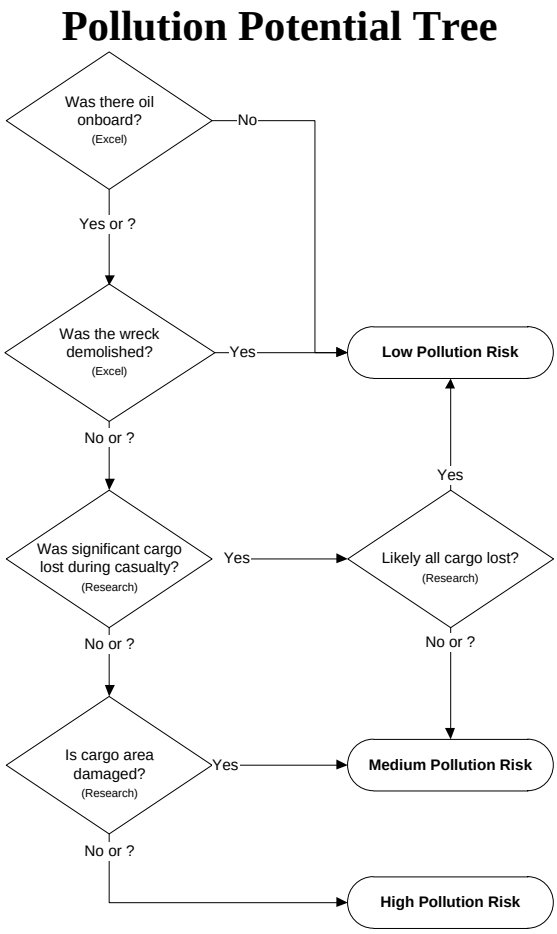


Figure 1-2: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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

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

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Gulfstate* 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 *Gulfstate i*s ranked as High Volume because it is thought to have a potential for up to 83,703 bbl, although some of that was lost at the time of the casualty. 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 *Gulfsate* as its location is unknown.

Risk Factor A2: Oil Type

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

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

The *Gulfstate* is classified as Medium Risk because the cargo is a high-grade 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:

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

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

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

This risk factor addresses any burning that is known to have occurred at the time of the vessel casualty and may have resulted in oil products being consumed or breaks in the hull or tanks that would have increased the potential for oil to escape from the shipwreck. The risk categories are:

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

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

Risk Factor C2: Reported Oil on the Water

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

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

The *Gulfstate* 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 *Gulfstate* is classified as Low Risk because there were two torpedo detonations and a fire at the time of casualty. 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 *Gulfstate* is classified as Unknown as the vessel sank very quickly; and whether additional structural breakup occurred is unknown as location is unknown. Data quality is high.

Factors That May Impact Potential Operations

Orientation (degrees)

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

The location of the *Gulfstate* 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 *Gulfstate* is believed to be greater than 2,940 feet due to 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 *Gulfstate* 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 *Gulfstate* had munitions for onboard weapons, one 5"/51 gun, three .50cal machine guns, and two .30cal guns. Data quality is high.

Vessel Pollution Potential Summary

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

Table 1-1: Summary matrix for the vessel risk factors for the *Gulfstate* 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 83,703 bbl, not known to be leaking	Med
	A2: Oil Type	Medium	Cargo is a high-grade crude oil, Group III oil type	
	B: Wreck Clearance	High	No	
	C1: Burning of the Ship	High	A significant fire was reported	
	C2: Oil on Water	High	Oil was reported on the water, amount is not known	
	D1: Nature of Casualty	High	Two torpedo detonations and fire	
	D2: Structural Breakup	High	Unknown	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking reports exist, assessment is believed to be very accurate	Not Scored
Operational Factors	Wreck Orientation	Low	Unknown, potential to be upright	Not Scored
	Depth	Low	Believed to be greater than 2,940 ft	
	Visual or Remote Sensing Confirmation of Site Condition	Low	No	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	One 5"/51 gun, three .50cal machine guns, and two .30cal guns	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	Yes	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

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

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Gulfstate* this would be about 86,000 bbl based on estimates of the maximum amount of oil remaining onboard the wreck at the time the models were run.

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

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

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

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

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

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	86 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	860 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	8,600 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	43,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	86,000 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 *Gulfstate* contained a maximum of 78,000 bbl of crude oil as cargo and 5,703 bbl of bunker fuel oil. Because the cargo is most likely the largest volume remaining, 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	~0.12-0.14 tarballs/m^2	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m^2	~12-14 tarballs/m^2	Ecological Impacts to Shoreline Habitats/Risk Factor 3C-1 and 2

Potential Impacts to the Water Column

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

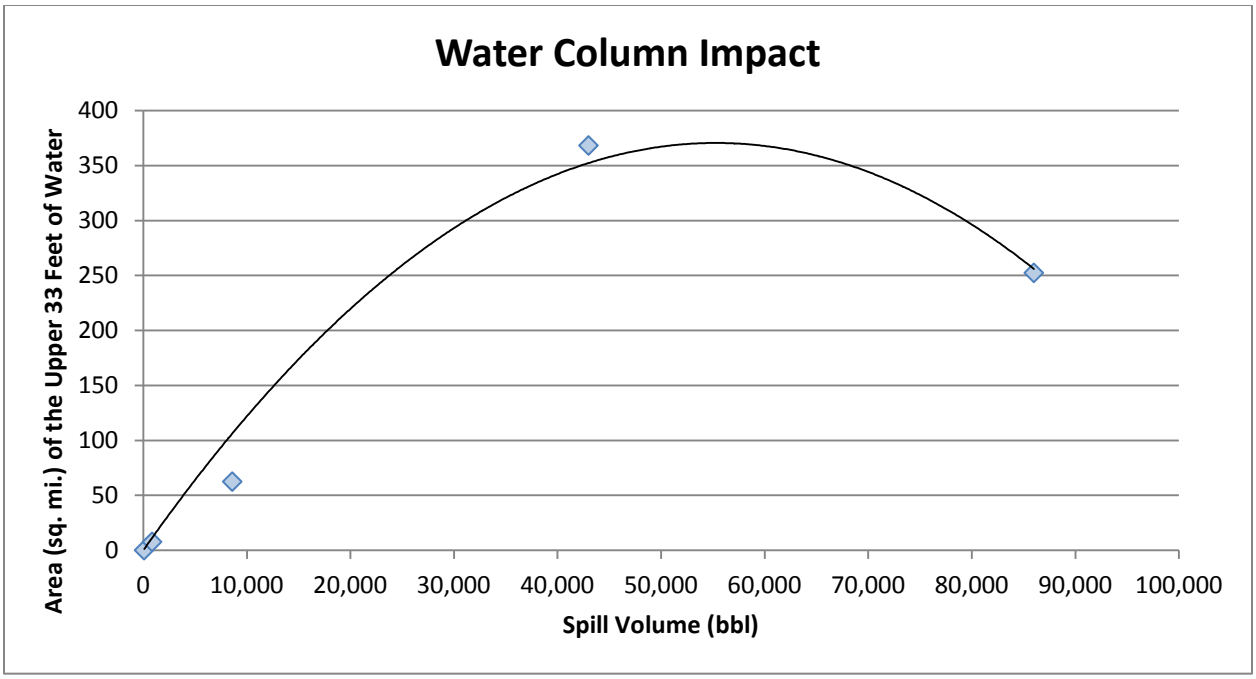


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted at or above the threshold of 1 ppb aromatics as a function of spill volume for the *Gulfstate*.

Potential Water Surface Slick

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

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

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	86	4,990 mi^2	4,900 mi^2
Episodic	860	15,800 mi^2	15,500 mi^2
Most Probable	8,600	54,000 mi^2	53,000 mi^2
Large	43,000	137,000 mi^2	135,000 mi^2
Worst Case Discharge	86,000	209,000 mi^2	207,000 mi^2

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

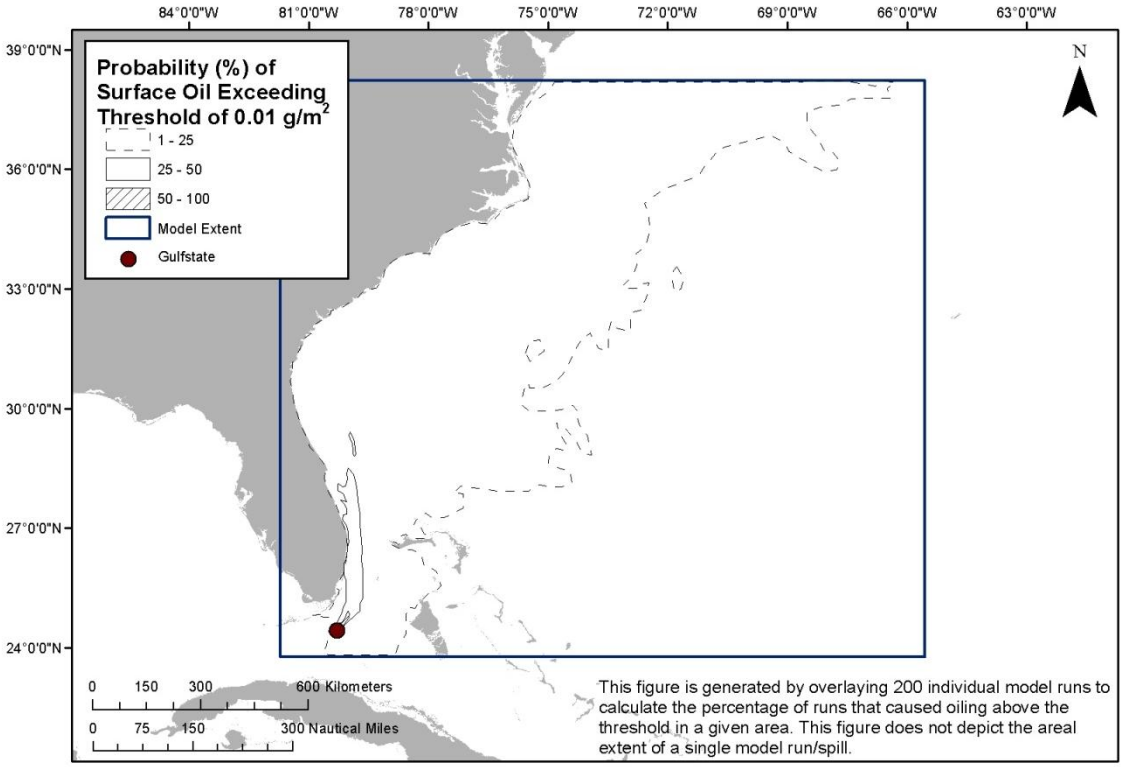


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 8,600 bbl of crude oil from the *Gulfstate* at the threshold for socio-economic resources at risk.

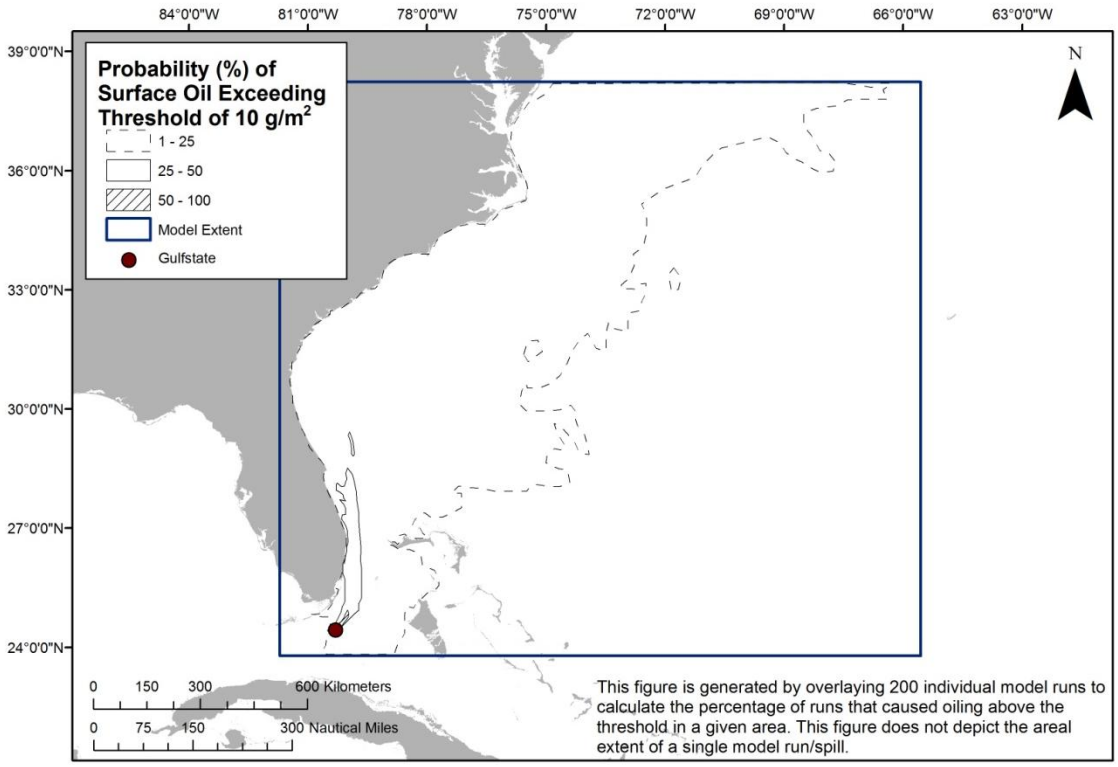


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 8,600 bbl of crude oil from the *Gulfstate* at the threshold for ecological resources at risk.

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.

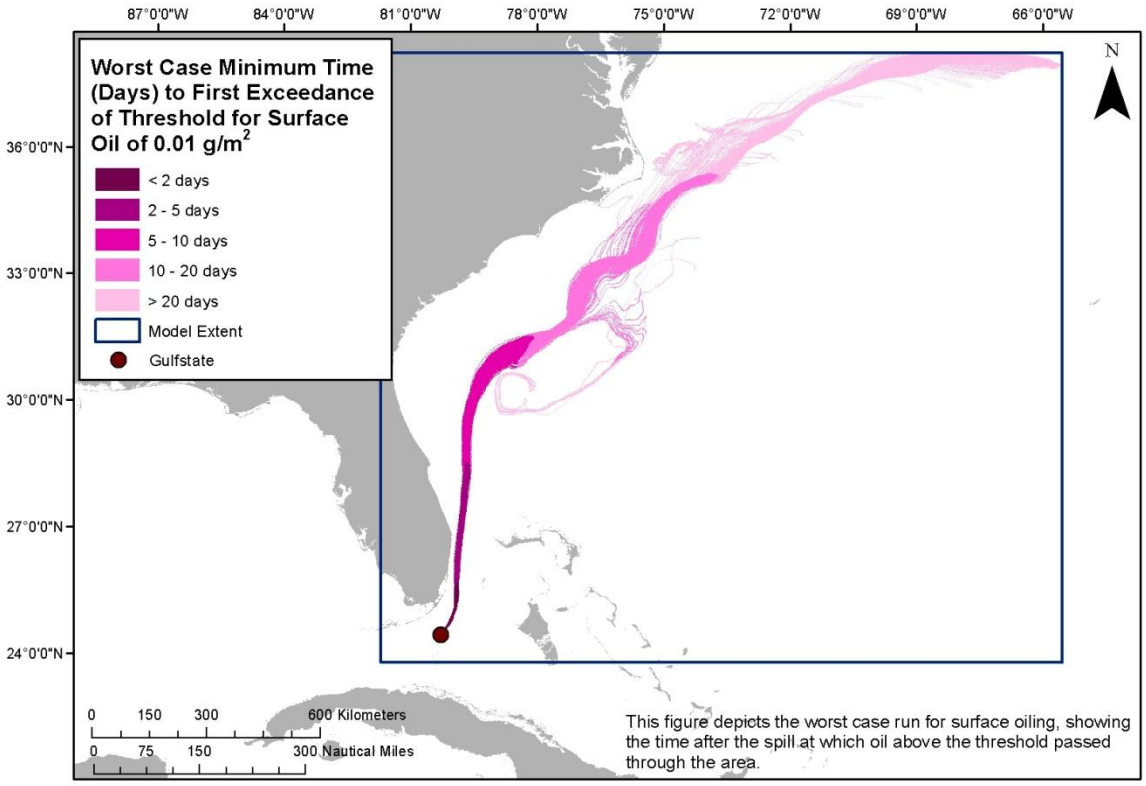


Figure 2-4: Water surface oiling from the Most Probable spill of 8,600 bbl of crude oil from the *Gulfstate* shown as the area over which the oil spreads at different time intervals.

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.

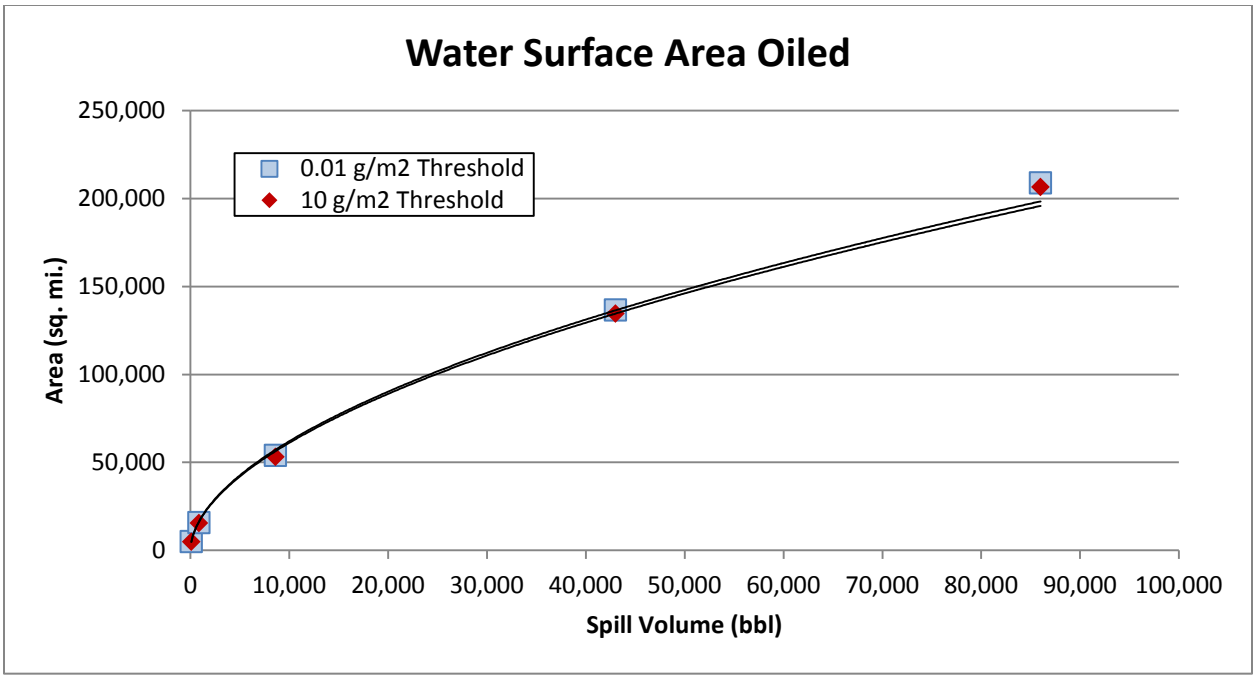


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Gulfstate*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2. The curves are so similar that they plot on top of each other.

Potential Shoreline Impacts

Based on these modeling results, shorelines from as far north as Outer Banks, North Carolina to as far south as the Florida Keys, 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 8,600 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. Estimated miles of shoreline oiling above the threshold of 1 g/m^2 by scenario type are shown in Table 2-4.

Table 2-4: Estimated shoreline oiling from leakage from the *Gulfstate*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	86	2	11	0	13
Episodic	860	3	42	4	49
Most Probable	8,600	4	54	13	71
Large	43,000	5	64	20	89
Worst Case Discharge	86,000	6	68	25	98

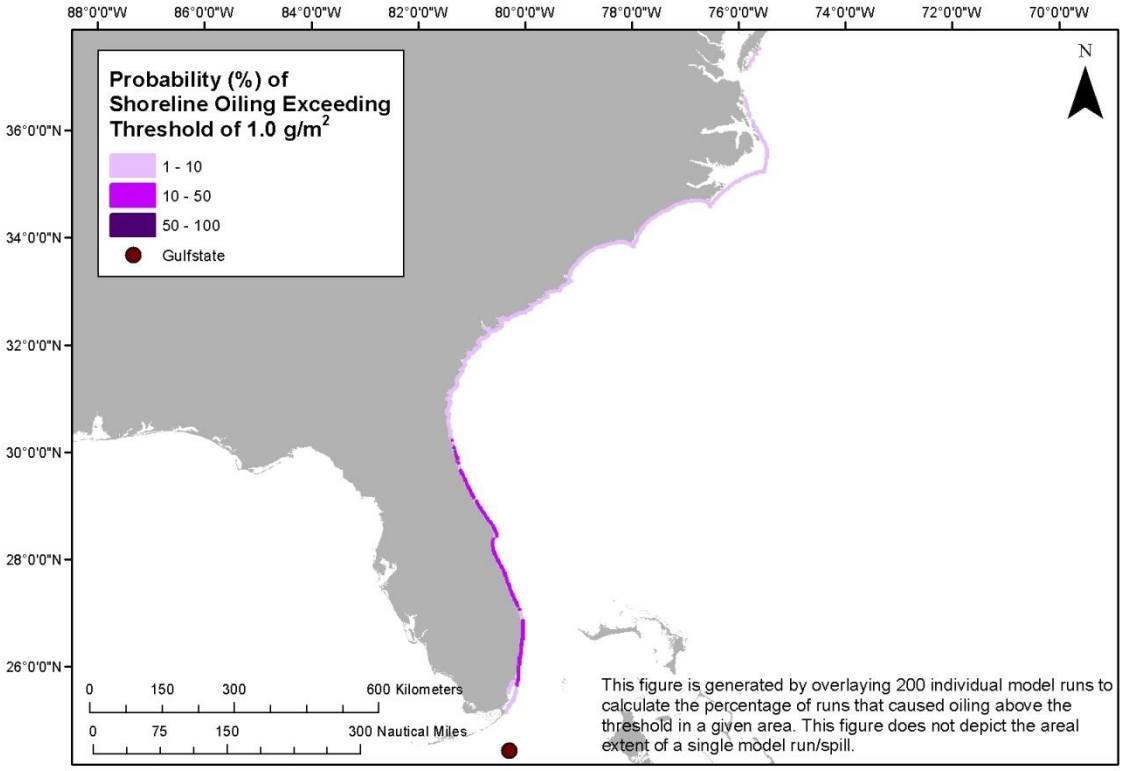


Figure 2-6: Probability of shoreline oiling (exceeding 1 g/m^2) from the Most Probable Discharge of 8,600 bbl of crude oil from the *Gulfstate*.

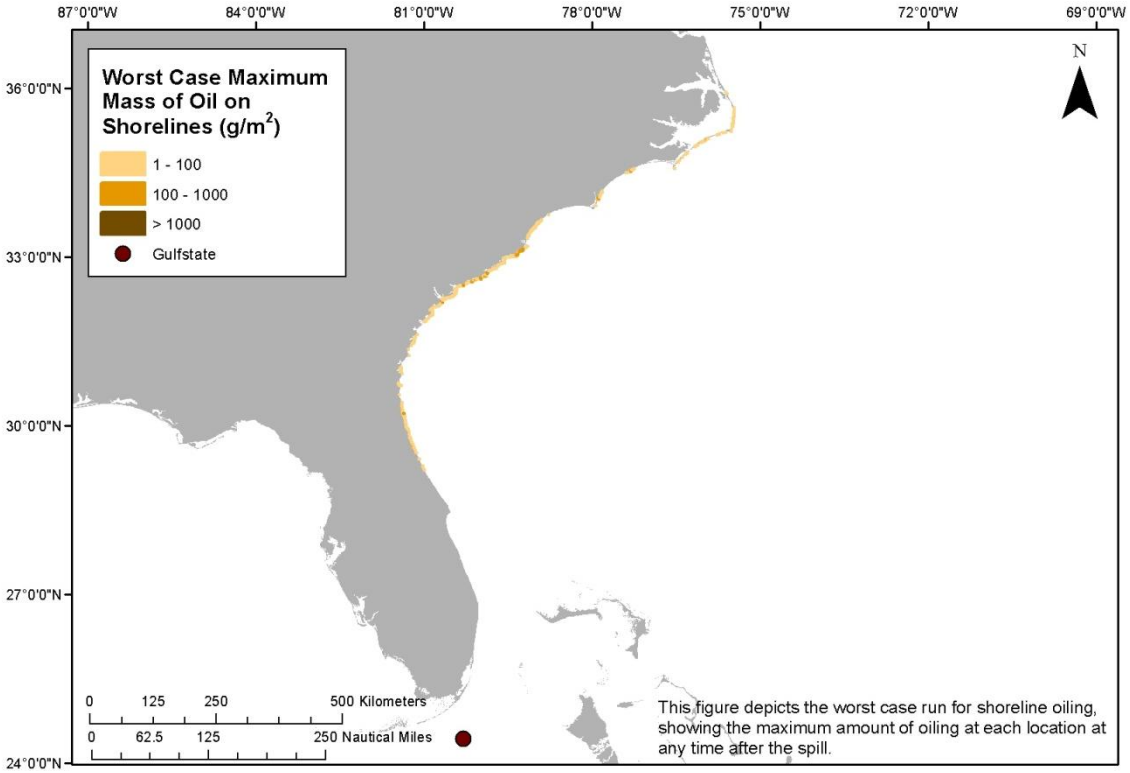


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 8,600 bbl of crude oil from the *Gulfstate* that resulted in the greatest shoreline oiling.

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.

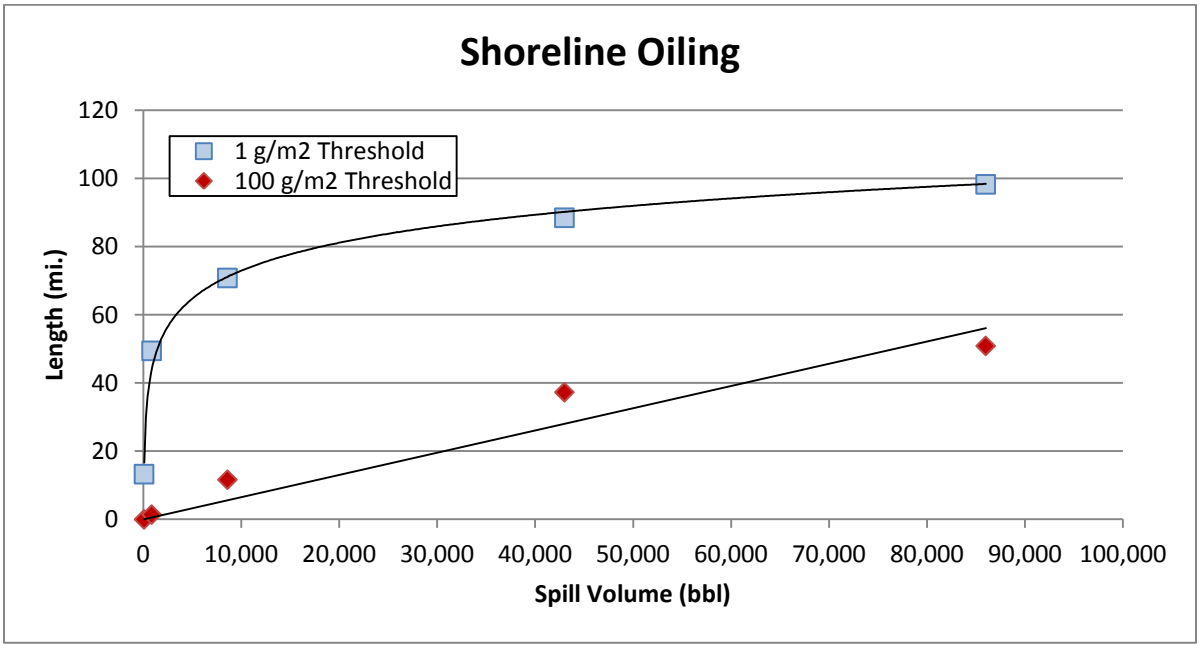


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Gulfstate*.

The worst case scenario for shoreline exposure along the potentially impacted area for the WCD volume (Table 2-5) and the Most Probable volume (Table 2-6) consists primarily of sand beaches. Salt marshes and tidal flats near tidal inlets are also at risk.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 86,000 bbl from the *Gulfstate*.

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	17 miles	2 miles
Sand beaches	252 miles	152 miles
Salt marshes and tidal flats	96 miles	4 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 8,600 bbl from the *Gulfstate*.

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	13 miles	2 miles
Sand beaches	212 miles	260 miles
Salt marshes and tidal flats	45 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Gulfstate* include numerous guilds of birds (Table 3-1), particularly those sensitive to surface oiling while rafting or plunge diving to feed, that are present in nearshore/offshore waters. In addition, this region is important for nesting loggerhead sea turtles, migrating marine mammals, and commercially important fish and invertebrates, including some sensitive hard-bottom habitats used by these species.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Seabirds	• Outer Continental Shelf (OCS) offshore of Cape Hatteras, NC: greatest diversity of seabirds in SE U.S.; greatest density of tropical seabirds in SE U.S. Species include: shearwaters, storm petrels, Bermuda petrels • Significant percentage of the global population of black-capped petrels (FE) may be present in *Sargassum* mats off Cape Hatteras and Gulf Stream off SE U.S. coast • Audubon's shearwaters (50-75% of population) concentrate along the Continental Shelf edge off of NC, to the VA border (~3,800 pairs)	OCS: Ranges by species but Mar-Nov peak Petrels off NC coast during summer through early fall and off SE U.S. coast in winter; Shearwaters off of NC: late summer
Pelagic Birds, Waterfowl, and Diving Birds	Coastal pelagic birds, waterfowl, diving birds • Outer Banks, inshore waters NC to VA: Key foraging area for gulls and terns; key migration corridor for loons and sea ducks; NC's largest population of northern gannet and red-breasted merganser • Southeastern U.S. inshore/offshore waters: 150K loons, >15K pelicans, thousands of waterfowl, 100s of thousands of cormorants and terns, millions of gulls • Important Bird Areas (IBAs) for SC include Cape Romain National Wildlife Refuge (NWR), Deveaux Bank, and Beaufort barrier islands; Feeding, and over-wintering grounds for substantial numbers of waterfowl and sea birds as well as nesting for thousands of brown pelicans • Altamaha River Delta, GA: Nesting for >5,000 brown pelicans • Canaveral National Seashore: Two of the largest brown pelican rookeries on the east coast; 10's of thousands of overwintering waterfowl	Winter use of shoals (Dec-Mar); Summer use of shoals likely farther north Terns, gulls in spring/summer; Loons, sea ducks in spring/fall; Waterfowl, gannets and red-breasted mergansers in winter

Sea Ducks	Sea ducks (includes mean/max distance of flocks to shore, 2009-2010 data)
	• Surf scoter - 2 nm/8 nm/Black scoter -2 nm/13 nm:
	  ○ Off NC: 0-41K surf scoters, 3.5-13K black scoters
	  ○ Off SC/GA: 0-100 surf scoters, 0-15K black scoters
	• Bufflehead, mergansers, goldeneyes (<1 nm/7-14 nm)
	  ○ Off NC: 12K
	  ○ Off SC/GA: 5K
		Sea ducks surveyed in winter (peak abundances); Migration from fall to spring (Oct-Apr)

Shorebirds and Colonial Nesting Birds	• Outer Banks, Cape Hatteras, and Cape Lookout: Globally important for coastal birds with 365+ species • Battery and Bald Head Islands, NC: Largest colonies of wading birds in NC; globally significant site with >10K nesting pairs of white ibis • Cape Romain NWR, SC: Largest wintering concentration of American oystercatchers on east coast; supports 45%- 70% of SC nesting gull-billed terns and black skimmers respectively; Western Hemispheric Shorebird Reserve Network (WHSRN) of international importance with up to 7,000 shorebirds per day • Deveaux Bank and Edisto ACE Basin NWR: Globally recognized IBAs supporting 1000s of nesting shorebirds including least tern (ST) and	Winter migration stop for plovers Colonial and beach nesters peak Apr-Aug Wading and shorebirds typically present year round

Species Group	Species Subgroup and Geography	Seasonal Presence
	Wilson's plover (ST); >900 foraging wood stork (FE) • Bay Point Island IBA: Shorebirds and wading birds year round; wintering populations averaging >5K shorebirds per day of dunlin, dowitcher, western sandpiper, 500 red knot, sanderling, least tern (ST), Wilson's plover (ST), and piping plover (FT) • Pinckney Island NWR: Important rookery for white ibis, egrets, and herons • GA coast supports significant populations of resident and migratory wading and shorebirds with wading birds most abundant in summer; beach nesting least tern (ST), Wilson's plover (ST), piping plover (FT) and American oystercatcher • Wassaw NWR and Altamaha River Delta: Heron and egret rookery; migrating/wintering site for piping plover (FT) and American oystercatcher; nesting habitat for gull-billed, royal, and sandwich terns as well as black skimmer and wood stork (FE) • St. Catherines Island and Cumberland Island NS: Two of the most important feeding/wintering sites along the Atlantic coast with thousands of shorebirds and wading birds including least tern (ST), Wilson's plover (ST), piping plover (FT), American oystercatcher, and wood stork (FE) • Northern FL: Globally recognized IBA (Nassau Sound) for breeding/roosting of threatened and endangered shorebirds; habitat supports numerous neotropical migrants in the spring and fall • Cape Canaveral-Merritt Island: Globally recognized IBA with around 8000 wading birds (>150 pairs of wood stork) and 14,000 neotropical migrants • Pelican Island NWR: Large colonial waterbird rookery • Southern FL, Biscayne Bay, and FL keys hammocks: Important stopovers for neotropical migrants in the spring and fall; rookery and roosting for Wilson's plover, least tern, white ibis, brown pelican, and magnificent frigatebird; FL Keys essential to survival of white-crowned pigeon (ST)	
Sea Turtles	Nesting (annual counts, by state, along shorelines at risk): NC nesting • 650+ Loggerhead (FT); <20 Green (FT); <10 Leatherback (FE) SC nesting • 4000+ Loggerhead (FT); <5 Green (FT); <5 Leatherback (FE) GA nesting • <2000+ Loggerhead (FT); <5 Green (FT); <15 Leatherback (FE) FL nesting (Nassau – St. Lucie County) • 65000+ Loggerhead (Conc. in Brevard/Palm Beach) • 13000+ Green (Conc. in Brevard/Palm Beach) • 1300+ Leatherback (Conc. in Martin/Palm Beach) Distribution: • Offshore hot spots not well known • Young associate with *Sargassum* mats off Cape Hatteras and FL • Bays and sounds are foraging grounds for juvenile green, loggerhead, and Kemp's ridley (FE)	Nesting season: Loggerhead/Green (NC-GA) Adults: May-Aug Hatching: Jul-Oct Loggerhead/Green (FL) Adults: Apr- Nov Hatching: May-Nov Leatherback Adults: Mar-Jul (NC-GA), Feb-Aug (FL) Hatching: May-Oct (NC-GA), Mar-Sep (FL) In water: Year round with Apr-Dec peak
Marine Mammals	*Baleen whales*: Primarily North Atlantic right whale (FE) with occasional humpback whale (FE) and minke whale • Right whales are critically endangered (<400 individuals left) coastal waters off SC/GA border are used as calving grounds *Inshore cetaceans:* Bottlenose dolphin frequently use coastal waters including rivers, bays, and sounds throughout potential spill area *Offshore cetaceans*: Risso's dolphin, striped dolphin, clymene dolphin,	Adults migrate from feeding grounds in North Atlantic to breeding grounds further south in the winter; Right whales with calf observed Nov-Mar Bottlenose dolphins present year round

Species Group	Species Subgroup and Geography	Seasonal Presence
	Atlantic spotted dolphin, spinner dolphin, short-finned pilot whale, pantropical spotted dolphin • Often associated with shelf edge features, convergence zones (fronts), and Sargassum mats (summer) *Pinnipeds and Sirenians*: • Juvenile harbor and hooded seals can sometimes occur as far south as N. FL during winter • West Indian manatees are present year round, concentrated along the FL coast with common summer sightings as far north as NC	Harbor and hooded seals present during the winter Manatees year round and coastal waters during summer
Fish and Inverts	Coastal ocean waters support many valuable fisheries and/or species of concern in the region: • *Benthic or bottom associated*: Snapper, grouper, black sea bass, butter fish, goose fish, shrimp (white, pink, brown, and rock), golden crab, queen conch, stone crab, spiny lobster • *Midwater*: Atlantic mackerel, Spanish mackerel, shortfin squid, bluefish, menhaden, cero, cobia • *Pelagic*: Bluefin tuna, yellowfin tuna, wahoo, dolphinfish, bigeye tuna, swordfish, marlin, sailfish • *Diadromous*: Alewife, blueback herring, American shad, hickory shad, Atlantic tomcod, American eel, Atlantic sturgeon (Fed. species of concern), shortnose sturgeon (FE), and striped bass • *Estuarine dependent*: Southern flounder, redfish, spotted seatrout, blue crab, Atlantic croaker, spot, weakfish, shrimp • *Estuarine resident*: Eastern oyster Important concentration/conservation areas are: • The Point (offshore of Cape Hatteras) – Essential Fish Habitat/Habitats Areas of Particular concern (EFH/HAPC) for coastal migratory pelagics and dolphin/wahoo • Primary nursery areas in NC bays – for estuarine dependent species • Large aggregations of sharks (i.e. lemon shark, bull shark) can be found by nearshore ledges in SE Florida during the winter. • *Sargassum* off Cape Hatteras, NC and Florida is important habitat for juvenile of some pelagic fish species (i.e., dolphinfish, jacks, triggerfish, and juvenile turtles) • Florida Keys National Marine Sanctuary includes much of the nearshore waters of the Keys • Striped croakers (NOAA species of concern) occupy nearshore hard bottom habitats from Sebastian Inlet north	Benthic and midwater species are present throughout the year Bluefin tunas present fall-spring with other pelagic fish present year round Anadromous fish migrate inshore to spawn in fresh water in spring American eel migrates offshore to spawn in winter Estuarine dependent fish migrate offshore in the fall/winter to spawn; juveniles and adults use estuaries during spring/summer
Benthic Habitats	Submerged aquatic vegetation is critical to numerous species and occurs inside bays and sounds with the greatest concentrations in FL coastal waters Scattered hard-bottom sites are located off NC and considered HAPC for reef-associated fishes (including areas listed above) Nearshore hard-bottom habitat off the coast of S. FL between Brevard and Miami-Dade counties	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Gulfstate* are generally available at each U.S. Coast Guard Sector. They can also be downloaded

at: http://response.restoration.noaa.gov/esi. These maps show detailed spatial information on the distribution of sensitive shoreline habitats, biological resources, and human-use resources. The tables on the back of the maps provide more detailed life-history information for each species and location. The ESI atlases should be consulted to assess the potential environmental resources at risk for specific spill scenarios. In addition, the Geographic Response Plans within the Area Contingency Plans prepared by the Area Committee for each U.S. Coast Guard Sector have detailed information on the nearshore and shoreline ecological resources at risk and should be consulted.

Ecological Risk Factors

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

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Gulfstate* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 86,000 bbl and a border around the Most Probable Discharge of 8,600 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 *Gulfstate* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 86,000 bbl because 69% 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 High Risk for degree of oiling because the mean volume of water contaminated was 252 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 8,600 bbl, the *Gulfstate* 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 63 mi^2 of the upper 33 feet of the water column.

Risk Factor 3B: Water Surface Impacts to EcoRAR

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

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

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

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

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

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

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

The *Gulfstate* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 92% 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 207,000 mi^2. The *Gulfstate* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 89% 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 53,200 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 *Gulfstate* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 80% 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 63 miles. The *Gulfstate* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 72% 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 13 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 86,000 bbl of crude oil from the *Gulfstate* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – High, because the large volume of water above the threshold includes areas with many sensitive species and habitats
- Water surface resources – High, because the oil can be transported over very long distances, putting many birds, sea turtles, and marine mammals potentially at risk. Oil could become concentrated in *Sargassum* mats, where many animals also concentrate. 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 shorelines are at risk of oiling by fresh slicks close to the releases site and weathered tarballs that could be transported long distances, potentially affecting many sensitive coastal resources or large areas

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 86,000 bbl** of crude oil from the *Gulfstate*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	69% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	High
3A-2: Water Column Degree EcoRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 252 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	92% 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 207,000 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	80% 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 63 mi	

For the Most Probable Discharge of 8,600 bbl, the ecological risk from potential releases of crude oil from the *Gulfstate* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Medium, because of the likely smaller volume of water column impacts
- Water surface resources – High, because the oil can be transported over very long distances, putting many birds, sea turtles, and marine mammals potentially at risk. Oil could become concentrated in *Sargassum* mats, where many animals also concentrate. 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 miles of shoreline are at risk

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 8,600 bbl** of crude oil from the *Gulfstate*.

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 63 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	89% 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 53,200 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	72% 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 13 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 *Gulfstate* include recreational beaches from Southern Maryland to southern Florida that are very highly utilized during summer, and are still in use during spring and fall for shore fishing. Three national seashores and two coastal national monuments would potentially be affected. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. The Gray's Reef National Marine Sanctuary off Georgia would also potentially be affected, along with a large number of coastal state parks.

A release could impact shipping lanes, which accommodate several ports with a total of over 14,000 annual port calls annually with a total of over 632 million tonnage.

Commercial fishing is economically important to the region. A release could impact fishing fleets from southern Virginia to southern Florida where regional commercial landings for 2010 exceed $212 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.

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

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

Resource Type	Resource Name	Economic Activities
	Boca Raton, FL Boynton Beach, FL Palm Beach, FL Pompano Beach, FL Coral Gables, FL	
National Marine Sanctuaries	Gray's Reef National Marine Sanctuary (GA) Florida Keys National Marine Sanctuary (FL)	Gray's Reef National Marine Sanctuary is one of the largest near shore live-bottom reefs in the southeastern U.S. The Sanctuary is popular with recreational anglers, boaters, and more experienced divers. The Florida Keys National Marine Sanctuary has the only barrier coral reef in North America. Visitors to the sanctuary take advantage of many recreational activities, including world-class diving, swimming, snorkeling, and fishing.
National Seashores	Cape Hatteras National Seashore, NC Cumberland Isl. National Seashore, GA Canaveral National Seashore, FL	National seashores provide recreation for local and tourist populations as well as preserve and protect the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area. Assateague Island is known for its feral horses. Cape Hatteras is known for its Bodie Island and Cape Hatteras Lighthouses. Popular recreation activities include windsurfing, birdwatching, fishing, shell collecting, and kayaking. The barrier island provides refuge for the endangered piping plover, seabeach amaranth, and sea turtles.
National Parks	Fort Pulaski National Monument, GA Fort Sumter, National Monument, SC Biscayne National Park, FL	Two coastal national historic monuments provide education in Civil War history. The Biscayne NP provides snorkeling in coral reefs among other recreational activities.
National Wildlife Refuges	Crocodile Lake NWR (FL) Arthur R. Marshall-Loxahatchee NWR (FL) Hobe Sound NWR (FL) Pelican Island NWR (FL) Archie Carr NWR (FL) Merritt Island NWR (FL) Wassaw NWR (GA) Harris Neck NWR (GA) Blackbeard NWR (GA) Wolf Island NWR (GA) Tybee NWR (SC) Savannah NWR (GA) Pickney Island NWR (SC) Ernest F. Hollings ACE Basin NWR (SC) Cape Romain NWR (SC) Waccamaw NWR (SC) Cedar Island NWR (NC) Pea Island NWR (NC) Currituck NWR (NC) Mackay Island NWR (NC) Back Bay NWR (VA) Fisherman Island NWR (VA) Eastern Shore of Virginia NWR (VA)	National wildlife refuges in five states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.

Resource Type	Resource Name	Economic Activities
	Wallops Island NWR (VA) Chincoteague NWR (VA)	
State Parks	Myrtle Beach SP, SC Huntington Beach SP, SC Edisto Beach SP, SC Hunting Island SP, SC Skidaway Island SP, GA Fort McAllister SP, GA Bulow Plantation Ruins SP, FL Washington Oaks Gardens SP, FL Amelia Island SP, FL Fort Clinch SP, FL Guana River SP, FL Anastastia SP, FL Faver-Dykes SP, FL Green Mound Archaeological SP, FL Bulow Creek SP, FL Tomoka SP, FL Sebastian Inlet SP, FL Fort Pierce Inlet SP, FL St. Lucie Inlet Preserve SP, FL John D. MacArthur Beach SP, FL Hugh Taylor Birch SP, FL John U. Lloyd Beach SP, FL Bill Baggs Cape Florida SP, FL John Pennkamp Coral Reef SP, FL Indian Key Historic SP, FL San Pedro Underwater Arch. SP, FL Bahia Honda SP, FL	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). Some of Florida's state parks offer unique opportunities for wildlife viewing and snorkeling. They provide income to the states. State parks in several states are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Commercial Fishing	A number of fishing fleets use potentially affected waters for commercial fishing.	
	Hampton Roads Area, VA	Total Landings (2010): $75.4M
	Chincoteague, VA	Total Landings (2010): $3.5M
	Ocean City, MD	Total Landings (2010): $8.8M
	Chincoteague, VA	Total Landings (2010): $3.5M
	Beaufort-Morehead City, NC	Total Landings (2010): $9.2M
	Belhaven-Washington, NC	Total Landings (2010): $3.7M
	Elizabeth City, NC	Total Landings (2010): $5.4M
	Engelhard-Swanquarter, NC	Total Landings (2010): $10.6M
	Oriental-Vandemere, NC	Total Landings (2010): $8.4M
	Sneads Ferry-Swansboro, NC	Total Landings (2010): $5.4M
	Wanchese-Stumpy Point, NC	Total Landings (2010): $22.0M
	Brunswick, GA	Total Landings (2010): $5.1M
	Cape Canaveral, FL	Total Landings (2010): $6.5M
	Charleston-Mt. Pleasant, SC	Total Landings (2010): $9.9M
	Darien-Bellville, GA	Total Landings (2010): $5.2M
	Fernandina Beach, FL	Total Landings (2010): $4.7M
	Georgetown, SC	Total Landings (2010): $6.0M
	Mayport, FL	Total Landings (2010): $11.0M
	Savannah, GA	Total Landings (2010): $5.0M
	Thunderbolt, GA	Total Landings (2010): $3.4M
Ports	There are a number of significant commercial ports along the Atlantic coast that could potentially be impacted by spillage and spill response activities. The port call numbers below are for large vessels only. There are many more, smaller vessels (under 400 GRT) that also use these ports.	

Resource Type	Resource Name	Economic Activities
	Hampton Roads, VA	3,021 port calls annually
	Baltimore, MD	2,100 port calls annually
	Morehead City, NC	85 port calls annually
	Wilmington, NC	550 port calls annually
	Brunswick, GA	304 port calls annually
	Charleston, SC	1,818 port calls annually
	Elba Is., GA	37 port calls annually
	Fernandina, FL	3 port calls annually
	Jacksonville, FL	1,641 port calls annually
	Port Canaveral, FL	38 port calls annually
	Savannah, GA	2,406 port calls annually
	Miami, FL	1,030 port calls annually
	Palm Beach, FL	126 port calls annually
	Port Everglades, FL	1,386 port calls annually

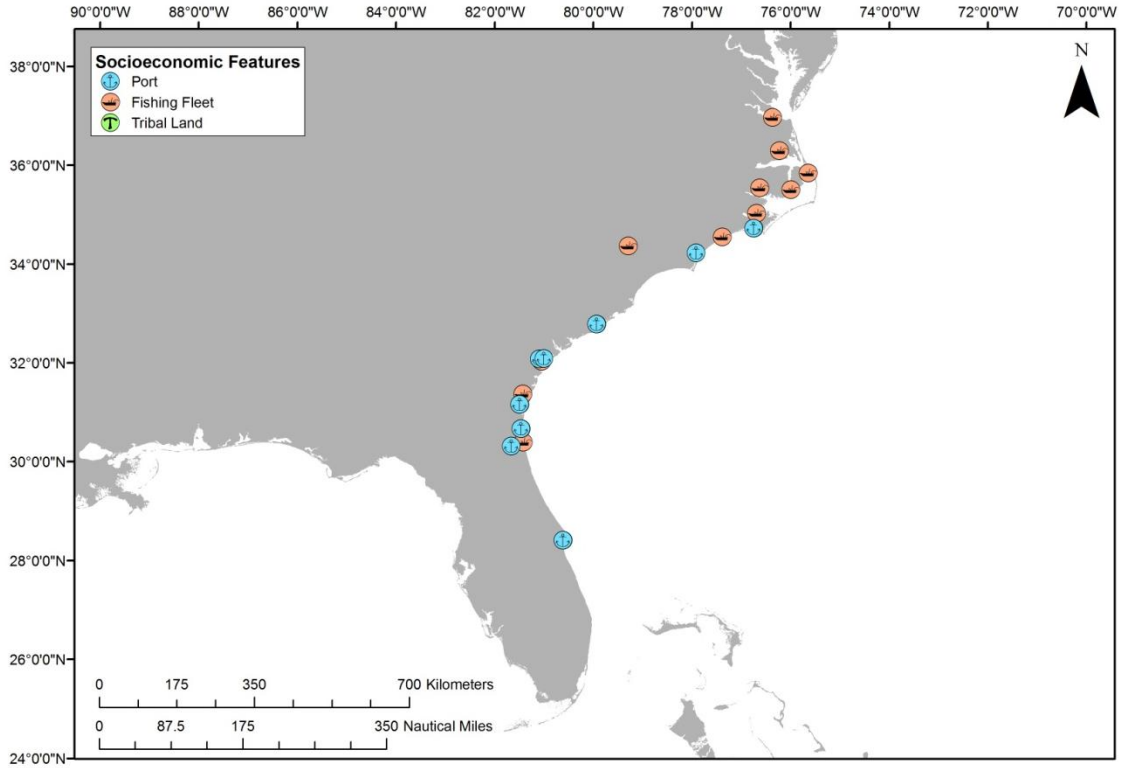


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Gulfstate*. (Note that there are no tribal lands at risk.)

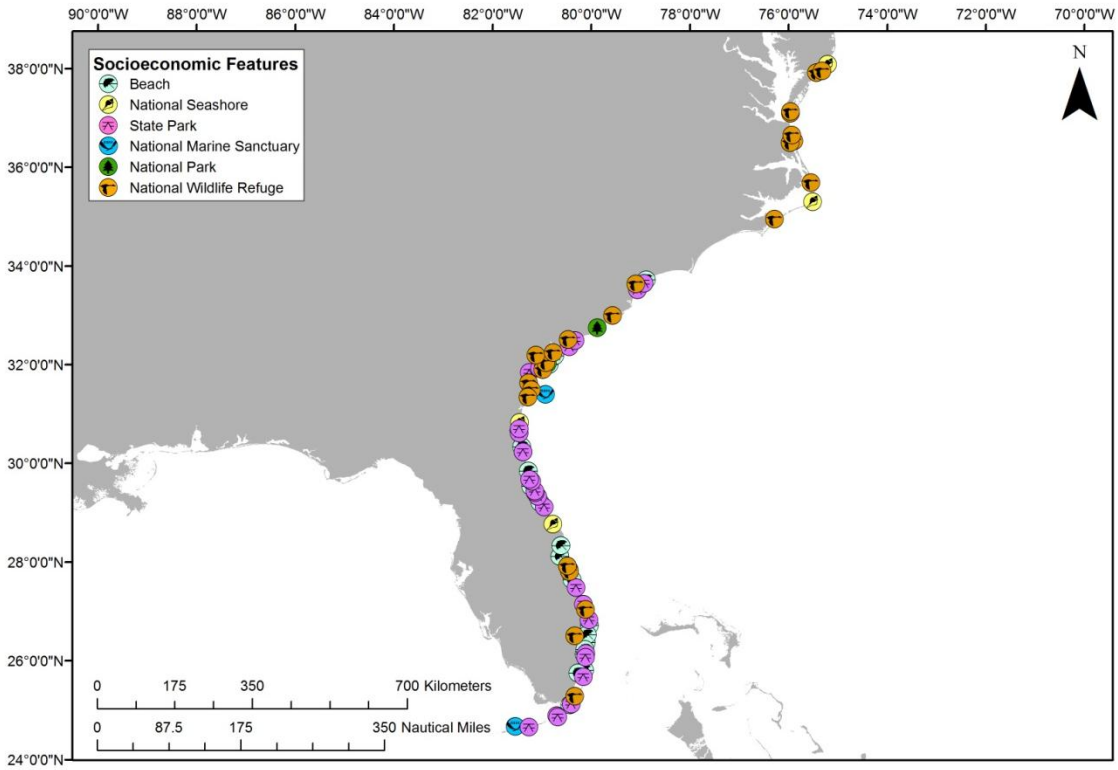


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Gulfstate*.

Socio-Economic Risk Factors

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, in the text classification for the *Gulfstate* shading indicates the degree of risk for the WCD release of 86,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 8,600 bbl.

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

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

The three risk scores for oiling are:

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

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

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

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

The *Gulfstate* is classified as High Risk for oiling probability and High Risk for degree of oiling for water column socio-economic resources for the WCD of 86,000 bbl because 69% 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 252 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 8,600 bbl, the *Gulfstate* 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 62 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 *Gulfstate* 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 209,000 mi^2. The *Gulfstate* 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 High Risk for degree of oiling because the mean area of water contaminated was 54,000 mi^2.

Risk Factor 4C: Shoreline Impacts to SRAR

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

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

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

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

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

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

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

The *Gulfstate* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 84% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is High Risk for degree of oiling because the mean length of weighted shoreline contaminated was 236 miles. The *Gulfstate* is classified as High Risk for both oiling probability for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 82% 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 181 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 86,000 bbl of crude oil from the *Gulfstate* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – High, because a significant area of water column would be impacted in important fishing grounds
- Water surface resources – High, because a large area of offshore surface water would be impacted including shipping lanes and a national marine sanctuary. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – High, because a significant length of high-value and sensitive shoreline would be impacted

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 86,000 bbl** of crude oil from the *Gulfstate*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	**High**	69% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**High**
4A-2: Water Column Degree SRAR Oiling	Low	Medium	**High**	The mean volume of water contaminated above 1 ppb was 252 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 209,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	84.5% 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 236 mi	

For the Most Probable Discharge of 8,600 bbl, the socio-economic risk from potential releases of crude oil from the *Gulfstate* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Medium, because a moderate area of water column would be impacted in important fishing grounds
- Water surface resources – High, because a large area of offshore surface water would be impacted including shipping lanes and a national marine sanctuary. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – High, because a significant length of high-value and sensitive shoreline would be impacted

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 8,600 bbl** of crude oil from the *Gulfstate*.

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	**Med**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 62 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 54,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	82% 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 181 mi	

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

The overall risk assessment for the *Gulfstate* 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, *Gulfstate* scores High with 20 points; for the Most Probable Discharge, *Gulfstate* also scores High with 17 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 *Gulfstate*. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

Gulfstate	**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 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 *Gulfstate*.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	Maximum of 83,703 bbl, not known to be leaking		**Med**
	A2: Oil Type	Med	Cargo is a high-grade crude oil, Group III oil type		
	B: Wreck Clearance	High	No		
	C1: Burning of the Ship	High	A significant fire was reported		
	C2: Oil on Water	High	Oil was reported on the water, amount is not known		
	D1: Nature of Casualty	High	Two torpedo detonations and fire		
	D2: Structural Breakup	High	Unknown		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking reports exist, assessment is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown, potential to be upright		**Not Scored**
	Depth	Low	Believed to be greater than 2,940 ft		
	Visual or Remote Sensing Confirmation of Site Condition	Low	No		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	One 5"/51 gun, three .50cal machine guns, and two .30cal guns		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	Yes		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Large volumes above thresholds with many sensitive species and habitats	**High**	**Med**
	3B: Water Surface Resources	High	Many birds, sea turtles, and marine mammals at risk from fresh slicks and long distance transport of tarballs	**High**	**High**
	3C: Shore Resources	High	Many coastal resources at risk from exposure to fresh slicks and long distance stranding of tarballs	**High**	**Med**
Socio-Economic Resources	4A: Water Column Resources	High	Significant area of water column would be impacted in important fishing grounds	**High**	**Med**
	4B: Water Surface Resources	High	Large area of offshore surface water would be impacted including shipping lanes and a national marine sanctuary	**High**	**High**
	4C: Shore Resources	High	Significant length of high-value and sensitive shoreline would be impacted	**High**	**High**
Summary Risk Scores				**20**	**17**