Screening Level Risk Assessment Package

R.W. Gallagher
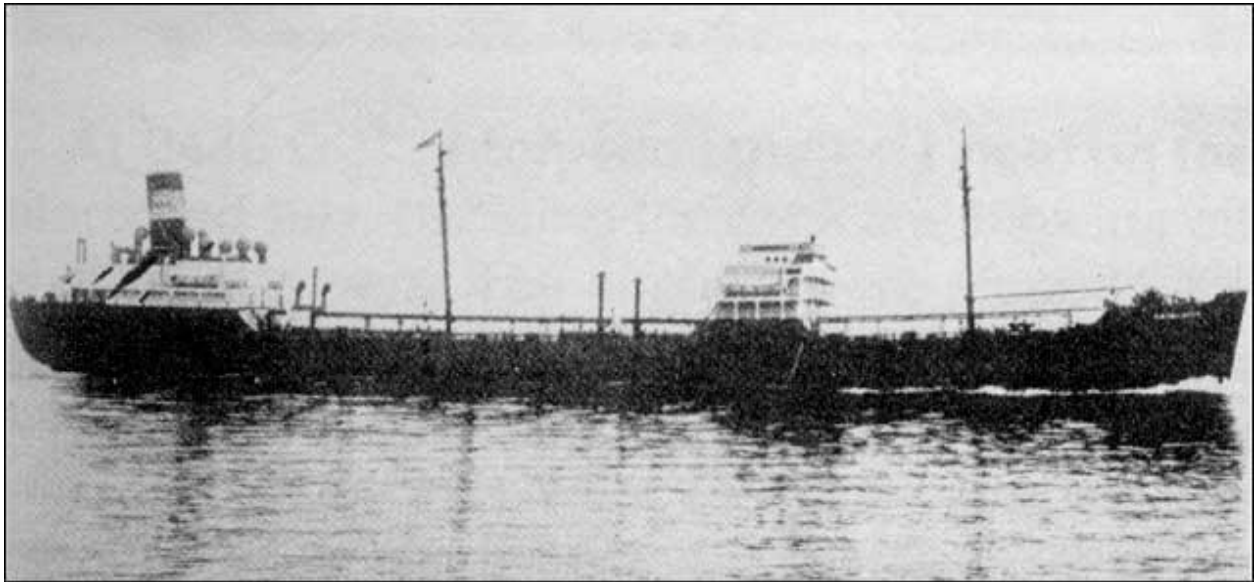
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Project Background

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: *R.W. Gallagher*

The tanker *R.W. Gallagher*, torpedoed and sunk during World War II off the coast of Louisiana in 1942, was identified as a potential pollution threat, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *R.W. Gallagher*, 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.
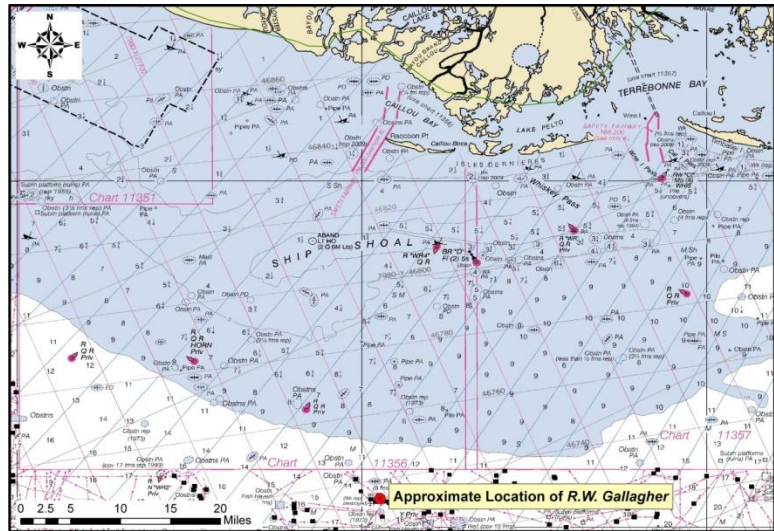
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *R.W. Gallagher* scores High with 18 points; for the Most Probable Discharge (10% of the Worse Case volume), *R.W. Gallagher* scores Medium with 13 points. Given these scores, and higher level of data certainty, NOAA recommends that this site be reflected within the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source. It should be considered for further assessment to determine the vessel condition, amount of oil onboard and feasibility of oil removal action. At a minimum, an active monitoring program should be implemented. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of changes in the site.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	**Med**	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	**Not Scored**	
Operational Factors	Wreck Orientation	**Not Scored**	
	Depth		
	Visual or Remote Sensing Confirmation of Site Condition		
	Other Hazardous Materials Onboard		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility (NHPA/SMCA)		
		WCD	**MP (10%)**
Ecological Resources	3A: Water Column Resources	Med	Low
	3B: Water Surface Resources	High	Med
	3C: Shore Resources	High	Med
Socio-Economic Resources	4A: Water Column Resources	Med	Low
	4B: Water Surface Resources	High	High
	4C: Shore Resources	High	Med
Summary Risk Scores		**18**	**13**

The determination of each risk factor is explained in the document. This summary table is found on page 42.

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

Vessel Particulars

Official Name: *R.W. Gallagher*

Official Number: 237760

Vessel Type: Tanker

Vessel Class: 7,989 gross ton class tanker

Former Names: N/A

Year Built: 1938
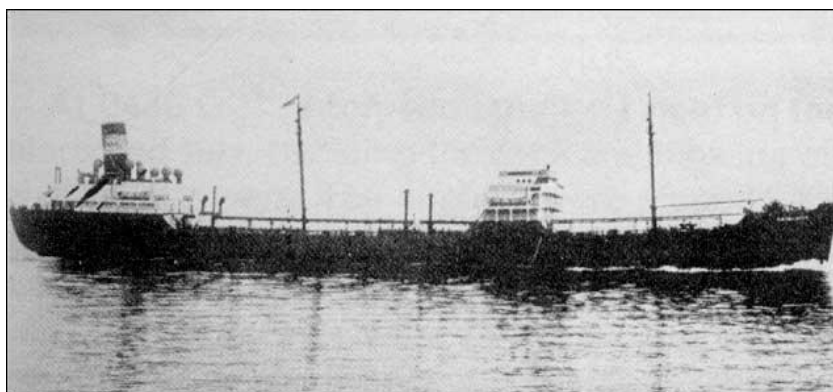
Builder: Bethlehem Steel Company, Sparrows Point, MD

Builder's Hull Number: 4307

Flag: American

Owner at Loss: Standard Oil Company of New Jersey

Controlled by: Unknown

Chartered to: Unknown

Operated by: Unknown

Homeport: Wilmington, DE

Length: 463 feet   **Beam:** 64 feet   **Depth:** 35 feet

Gross Tonnage: 7,989   **Net Tonnage:** 4,738

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

Bunker Type: Heavy Fuel Oil (Bunker C)   **Bunker Capacity (bbl):** 4,551

Average Bunker Consumption (bbl) per 24 hours: 185

Liquid Cargo Capacity (bbl): 106,715   **Dry Cargo Capacity:** Unknown

Tank or Hold Description: Vessel had 8 cargo tanks divided port, center, and starboard by two oil-tight longitudinal bulkheads, the internal structure and bulkheads were welded

Casualty Information

Port Departed: Galveston, TX

Destination Port: Port Everglades, FL

Date Departed: July 12, 1942

Date Lost: July 13, 1942

Number of Days Sailing: ≈ 2

Cause of Sinking: Act of War (Torpedoes)

Latitude (DD): 28.5419

Longitude (DD): -90.9734

Nautical Miles to Shore: 30

Nautical Miles to NMS: 160

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 90

Bottom Type: Sand/mud

Is There a Wreck at This Location? These coordinates may be wrong but the location of the wreck is known

Wreck Orientation: Inverted (Turtled)

Vessel Armament: One 5-inch gun, one 3-inch gun, two .50 caliber guns, and two .30 caliber guns

Cargo Carried when Lost: 83,000 bbl of Bunker C fuel oil in all except one or two wing tanks

Cargo Oil Carried (bbl): 83,000

Cargo Oil Type: Heavy Fuel Oil

Probable Fuel Oil Remaining (bbl): ≤4,500

Fuel Type: Heavy Fuel Oil (Bunker C)

Total Oil Carried (bbl): ≤ 87,500

Dangerous Cargo or Munitions: Yes

Munitions Carried: Munitions for onboard weapons

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes, partially

Reportedly Leaking: Yes, last observed October 2010

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any
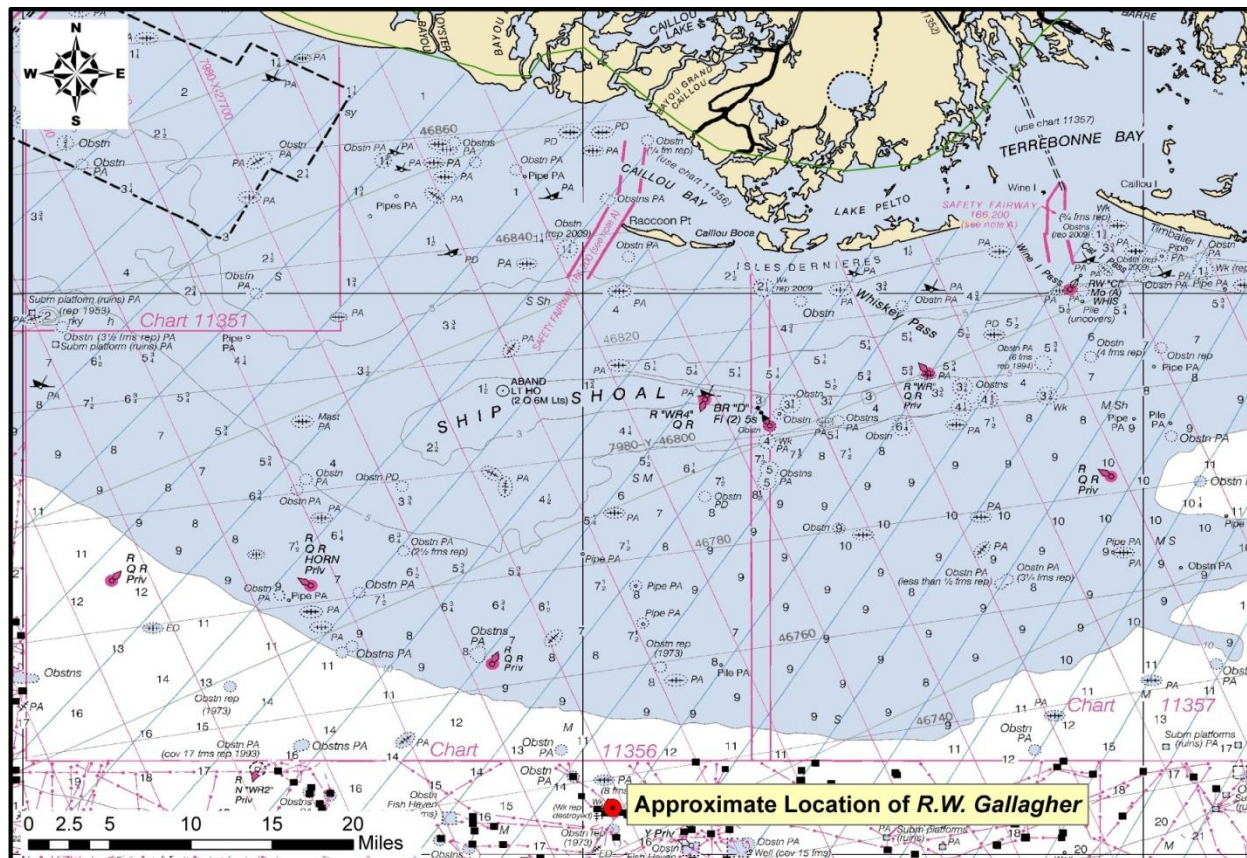
Wreck Location

Chart Number: 11340

Casualty Narrative

"At 07.35 hours on 13 Jul, 1942, the unescorted *R.W. Gallagher* (Master Aage Petersen) was hit on the starboard side by two torpedoes from *U*-67 about 80 miles from Southwest Pass, Mississippi (sic). The first torpedo struck at the #3 tank just forward of amidships and the second hit abaft the midships house between the #8 tank and the pump room. The explosions buckled parts of the ship and started a fire that quickly spread the length of the vessel and into the water. The tanker immediately took a 30° list to starboard, capsized at 09.00 hours and sank at 11.30 hours.

With the steam whistle jammed, the eight officers, 32 crewmen and twelve armed guards (the ship was armed with one 5in, one 3in, two .50cal and two .30cal guns) abandoned ship in one lifeboat, one raft and by jumping into the water because the fire had destroyed the other boats and rafts. The master was the last man that jumped overboard after he waited for 40 minutes on the bow. Two officers, four crewmen and two armed guards were lost.

The survivors were picked up within one hour by the U.S. Coast Guard cutter USS *Boutwell* (WPC 130) and three of the most seriously wounded were taken by a U.S. Coast Guard plane from Biloxi Air Station to Lake Pontchartrain, transferred to the U.S. Coast Guard boat USS *CG-6264* and taken to the Marine hospital in New Orleans. Two crewmen died ashore from severe burns after reaching the hospital."

-http://www.uboat.net:8080/allies/merchants/ships/1930.html

Traveling from Baytown, TX to Port Everglades, FL under Captain Aage Petersen. 80 miles from Southwest Pass, Mississippi (sic) the *U-67* (Muller-Stockheim) fired a torpedo that struck the starboard side of the #3 tank just forward of amidships. The second struck five seconds later abaft the midships house between the #8 tank and the pump room. The explosion buckled parts of the ship and started a fire that spread the length of the vessel and into the water. 8 lives were lost.
-B.M. Browing Jr., "U.S. Merchant Vessel War Casualties of World War II", (Naval Institute Press, 1996), 184-185.
-"Ships of the Esso Fleet…"

Attacked by *U-67* under Muller Stockheim with two torpedoes, which caused a "high explosion pillar bridge and front mast burn immediately." He recorded that the tanker began to blow its sirens as it sank, sagging steeply to starboard. As they left the sinking ship, they heard several more explosions and high flames.
-M. Wiggins "Torpedoes in the Gulf: Galveston and the U-Boats 1942-1943" Texas A&M University Press, College Station (1995), 103-105.

General Notes

NOAA Automated Wreck and Obstruction Information System (AWOIS) Data:
    HISTORY
    NM11/4 REPORTED AT 28-32-30N, 90-58-24W AND NO LONGER A HAZARD TO
    NAVIGATION

    DESCRIPTION
    24 NO.696; TANKER, 7989 GT; SUNK 7/13/42 BY SUBMARINE; LOCATED 1950 (SOURCE
    UNK), POS. ACCURACY 1 MILE, POS.28-32N, 90-59-20W. 27 NO.628; TANKER, 4738 NT.

    SURVEY REQUIREMENTS
    INFORMATION

    20 TKR, 7989 TONS, TORPEDOED 7/13/42, IN 90 FT. WITH 83,000 BARRELS OF BUNKER C
    OIL ON BOARD, AT 28-32-30N, 90-59-18W.

The book "Ships of the Esso Fleet in World War II" records that there were 80,855 bbl of fuel onboard.

The ship was named for the Chairman of the Board of Standard Oil Co. and was launched on Jan 22 1938. The ship had a 64 ft beam and weighed 13,000 tons. It was outfitted with motors capable of 3,500 horsepower that could reach 13 knots. The ship was made fireproof and outfitted specifically for tropical climates.

-"LARGE TANKER LAUNCHED" Special to THE NEW YORK TIMES. New York Times (1857-Current file); Jan 23, 1938; ProQuest Historical Newspapers The New York Times (1851 - 2005) pg. 29

-"Gallagher Heads Standard Oil, N. J." Christian Science Monitor (1908-Current file); Jan 9, 1943; ProQuest Historical Newspapers Christian Science Monitor (1908 pg. 14)

Wreck Condition/Salvage History

"SITE DESCRIPTION
Dimensions for the shipwreck based on the sonar data are listed as "at least" 450 feet in length, 75 wide, and 28 feet above the seafloor (Cochrane 1996).

Munson dived on the vessel, and in a personal communication to the Minerals Management Service (MMS), reports that the wreck is bottom up with a single screw.

Information archived by the Navy includes a document (Serial No. 19284) dated 1/18/1944 from Paul W. Kraemer, Lieutenant, U.S. Naval Reserves. This document titled, "*R.W. Gallagher* (Tk), Wreck No. 628, Determination of depth of water above the wreck", reports that the shipwreck site was identified in 90 feet of water. Significant oil slicks were present for several hundred yards north of the Wreck Buoy. Divers investigated the wreck in order to attach marker buoys. They determined that the wreck was "turned over on her beam ends and well buried in the soft bottom". Soundings were then performed to verify that at least 50-feet of clearance was available for navigation over the wreck. It was determined that a minimum of 59-feet of clearance was present.

Literature references identified a number of wrecks within 15 miles of the wreck in the Ship Shoal area. Of these, the *R.W. Gallagher*, *Heredia*, and *Hamlet* all have similar dimensions and are similar vessel types that were all torpedoed in this portion of the Ship Shoal area. The identify of each wreck has been provided to the MMS by Avery Munson of New Iberia, LA who apparently has dived on each wreck site. No maps, dimensions, or other materials are currently available to confirm or dispute Munson's identifications.

We drove the wreck, and it in fact has a single screw, and a big torpedo hole in its starboard side. The wreck is still full of oil, as evidenced by the dive team as they surfaced. The wreck is burping plenty of oily mess, and the slick on the surface is quite impressive. We encountered a small amount of current on this wreck, numerous squalls and thunderstorms moved through, and water temp was 85 all the way to the bottom. Visibility was 60 feet along the keel, couldn't see your hand in front of your face at the bottom."
-http://www.spreeexpeditions.com/trip_reports/2010/aug13-27.asp

Archaeological Assessment

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

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

shipwrecks. It also addresses questions of historical significance and the relevant historic preservation laws and regulations that will govern on-site assessments.

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

Assessment

The tanker *R.W. Gallagher* was sunk by German Submarine *U-67* off the coast of Louisiana on July 13, 1942. At the time of its loss, the tanker was carrying 83,000 bbl of Bunker C fuel oil as a cargo, and had a bunker capacity of an additional 4,551 bbl of Bunker C fuel oil. Although it is likely that the amount of oil was reduced due to the violent nature in which the vessel sank, archaeologists from the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) were able to document some oil escaping from the shipwreck during the fall of 2010.

When the ship sank, it was torpedoed twice (Fig. 1-1), which ruptured the vessel's deck and sprayed burning oil across the deck and into the water surrounding the tanker. Fire quickly spread out over the entire vessel until it was burning from stem to stern. Although this fire likely mitigated some of the oil onboard the tanker, the ship rolled over and sank an hour and a half after the initial attack, effectively putting out the flames and trapping an unknown amount of oil in the structurally robust underside of the tanker. In August 2010, archaeologists from BOEM and BSEE documented some of this oil escaping from the inverted hull of the tanker and leaving a visible sheen on the surface.
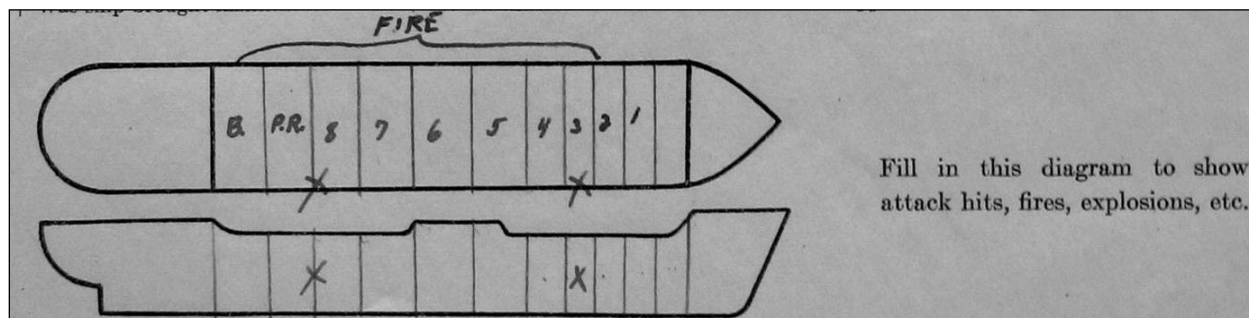
Figure 1-1: U.S. Coast Guard diagram of the location of torpedo impacts and fire aboard *R.W. Gallagher* (Image courtesy of National Archives, Washington, DC).

Although the amount of oil remaining onboard the tanker is not known, the inverted orientation of the ship has trapped some oil. This vessel was also one of the few tankers lost in American Waters during World War II that had eight cargo tanks split port, center, and starboard by two oil-tight longitudinal bulkheads, which created 24 separate oil-tight tanks that could contain oil.

Since NOAA archaeologists have never examined the site, additional condition based assessments cannot be made. If the U.S. Coast Guard decides to assess the wreck, it should first contact archaeologists with

the BOEM and BSEE for more information as well as to ensure compliance with archaeological standards for assessing a historic resource.

It should also be noted that this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) and possibly the Sunken Military Craft Act (SMCA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Register of Historic Places and is considered a war grave and appropriate actions should be undertaken to minimize disturbance to the site.

Background Information References

Vessel Image Sources: http://www.spreeexpeditions.com/trip_reports/2010/aug13-27.asp

Construction Diagrams or Plans in RULET Database? No

Text References:
http://www.uboat.net:8080/allies/merchants/ships/1930.html
http://www.spreeexpeditions.com/trip_reports/2010/aug13-27.asp
AWOIS database No. 248
NIMA database WK_No 36162
Global Wrecks database NSS_ID 550403
Coast Guard No. 5877
"Ships of the Esso Fleet in World War II" (1946) published by Standard Oil Company (New Jersey), 356-359

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *R.W. Gallagher* 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.

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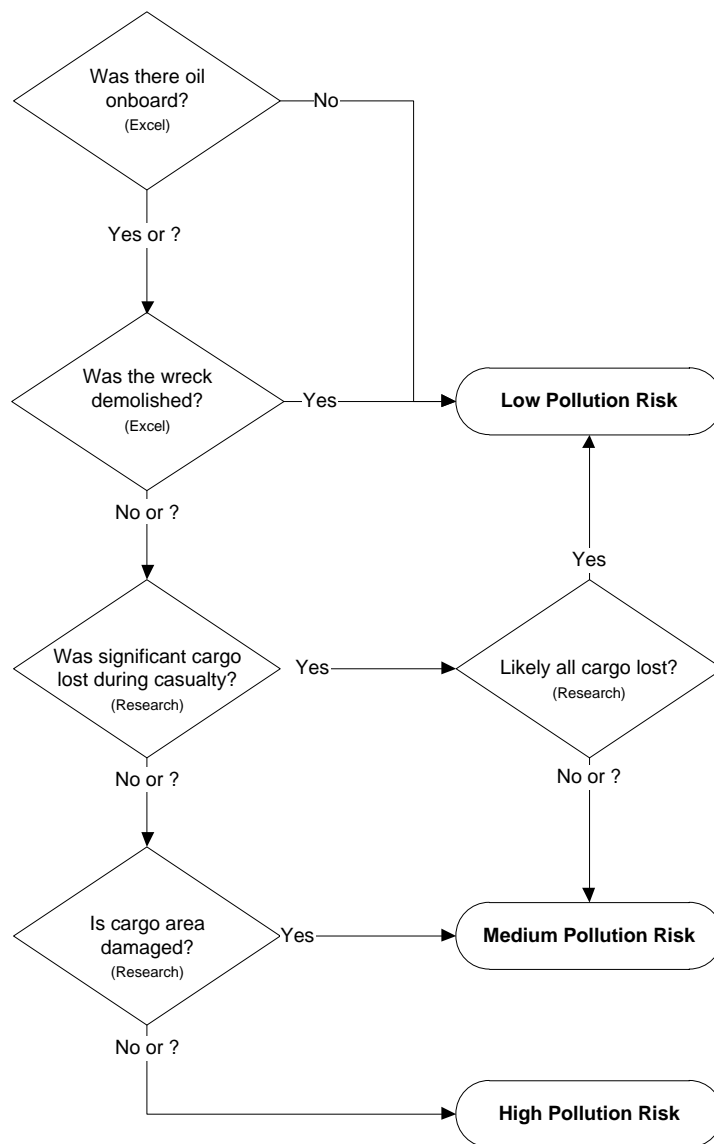
Figure 1-2: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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

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

- **Low Data Quality:** Significant issues exist with missing data on wreck that precludes making preliminary risk assessment, and/or the data quality is suspect. Significant additional research needed.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *R.W. Gallagher* 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 *R.W. Gallagher i*s ranked as High Volume because it is thought to have a potential for 87,500 bbl, although some of that was lost at the time of the casualty due to fire and leaking of oil. Data quality is high.

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

Risk Factor A2: Oil Type
The oil type(s) on board the wreck are classified only with regard to persistence, using the U.S. Coast Guard oil grouping[1]. (Toxicity is dealt with in the impact risk for the Resources at Risk classifications.) The three oil classifications are:
- **Low Risk: Group I Oils** – non-persistent oil (e.g., gasoline)
- **Medium Risk: Group II – III Oils** – medium persistent oil (e.g., diesel, No. 2 fuel, light crude, medium crude)
- **High Risk: Group IV** – high persistent oil (e.g., heavy crude oil, No. 6 fuel oil, Bunker C)

The *R.W. Gallagher* is classified as High Risk because the cargo is heavy fuel oil, a Group IV oil type. Data quality is high.

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

Was the wreck demolished?

Risk Factor B: Wreck Clearance

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

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

The *R.W. Gallagher* is classified as High Risk because the wreck was not demolished as a hazard to navigation. Data quality is high.

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

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

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

The *R.W. Gallagher* is classified as Medium Risk because fire burned for a few hours at the time of 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 *R.W. Gallagher* 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 *R.W. Gallagher* is classified as Low Risk because there were two torpedo detonations, although the vessel is whole and inverted on the bottom. 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 *R.W. Gallagher* is classified as High Risk because it is not broken and remains as one contiguous albeit inverted piece. 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 *R.W. Gallagher* is inverted. Data quality is high.

Depth

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

The depth for *R.W. Gallagher* is 90 feet. Data quality is high.

Visual or Remote Sensing Confirmation of Site Condition

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

The location of the *R.W. Gallagher* was visually surveyed by BOEM in 2010. Data quality is high.

Other Hazardous (Non-Oil) Cargo on Board

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

There are no reports of hazardous materials onboard. Data quality is high.

Munitions on Board

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

The *R.W. Gallagher* had munitions for onboard weapons. Data quality is medium.

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 *R.W. Gallagher*. Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *R.W. Gallagher* 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)	High	Maximum of 87,500 bbl, known to be leaking in 2010	**Med**
	A2: Oil Type	High	Bunker C cargo and fuel oil, Group IV oil types	
	B: Wreck Clearance	High	Not cleared	
	C1: Burning of the Ship	High	For a few hours	
	C2: Oil on Water	High	Yes	
	D1: Nature of Casualty	High	Two torpedoes	
	D2: Structural Breakup	High	No	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports exist, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Inverted	**Not Scored**
	Depth	High	90 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	2010 visual assessment BOEM	
	Other Hazardous Materials Onboard	High	None	
	Munitions Onboard	Medium	Small arms	
	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 *R.W. Gallagher* 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 *R.W. Gallagher*, 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 *R.W. Gallagher*.

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 *R.W. Gallagher* contained a maximum of 86,000 bbl of heavy fuel oil as cargo and bunker fuel oil (both Group IV oils). Thus, the oil spill model was run using heavy fuel oil.

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

For oil stranded onshore, a thickness of 1 g/m^2 was used as the threshold for socio-economic impacts because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity

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

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

Oil Description	Sheen Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen	Barely Visible	0.00001 mm	0.01 g/m2	~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/m2	~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/m2	~0.12-0.14 tarballs/m2	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m2	~12-14 tarballs/m2	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 *R.W. Gallagher* 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 mi2 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.

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[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.
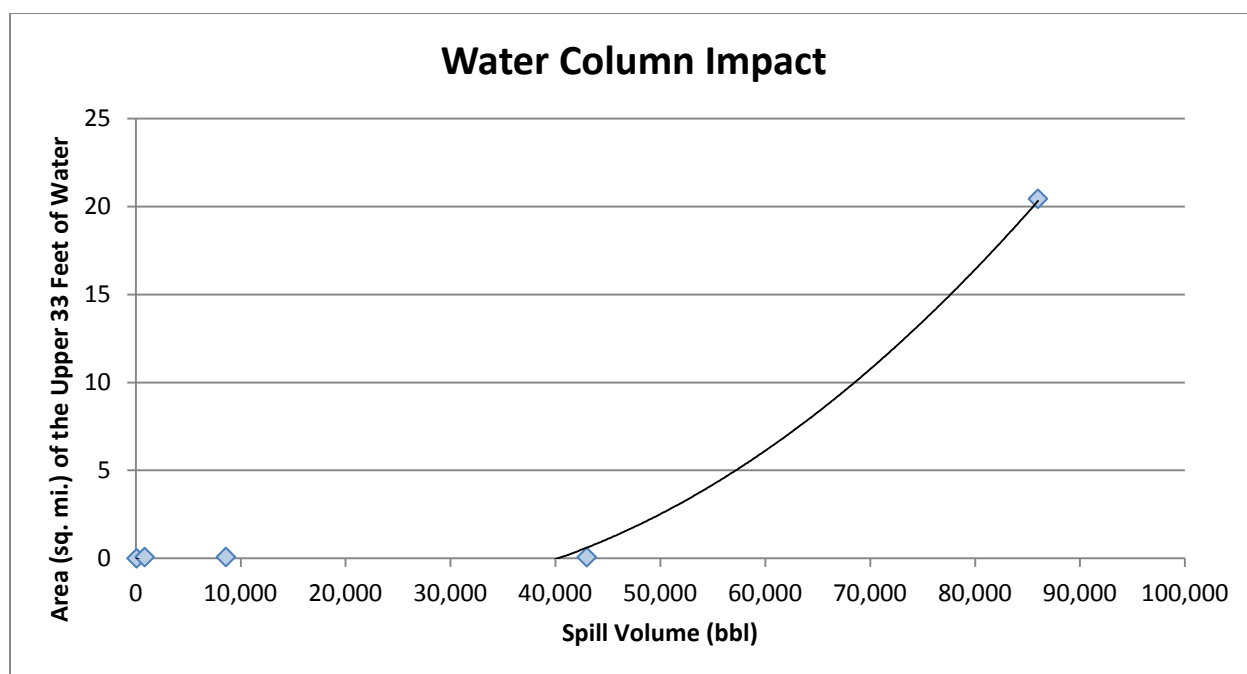
Water Column Impact

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

Potential Water Surface Slick

The slick size from an oil release from the *R.W. Gallagher* 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 *R.W. Gallagher*.

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	86	400 mi²	400 mi²
Episodic	860	1,290 mi²	1,290 mi²
Most Probable	8,600	4,280 mi²	4,280 mi²
Large	43,000	10,600 mi²	10,600 mi²
Worst Case Discharge	86,000	16,000 mi²	16,000 mi²

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 heavy fuel oil from the *R.W. Gallagher* at the threshold for socio-economic resources at risk.
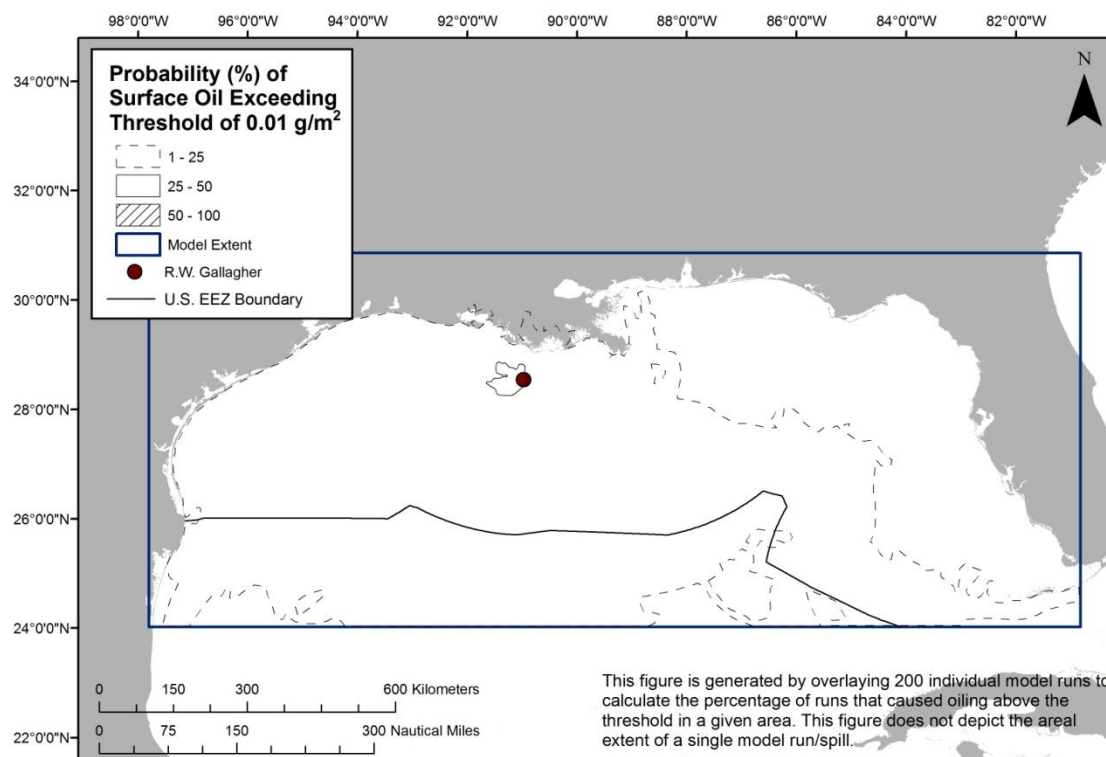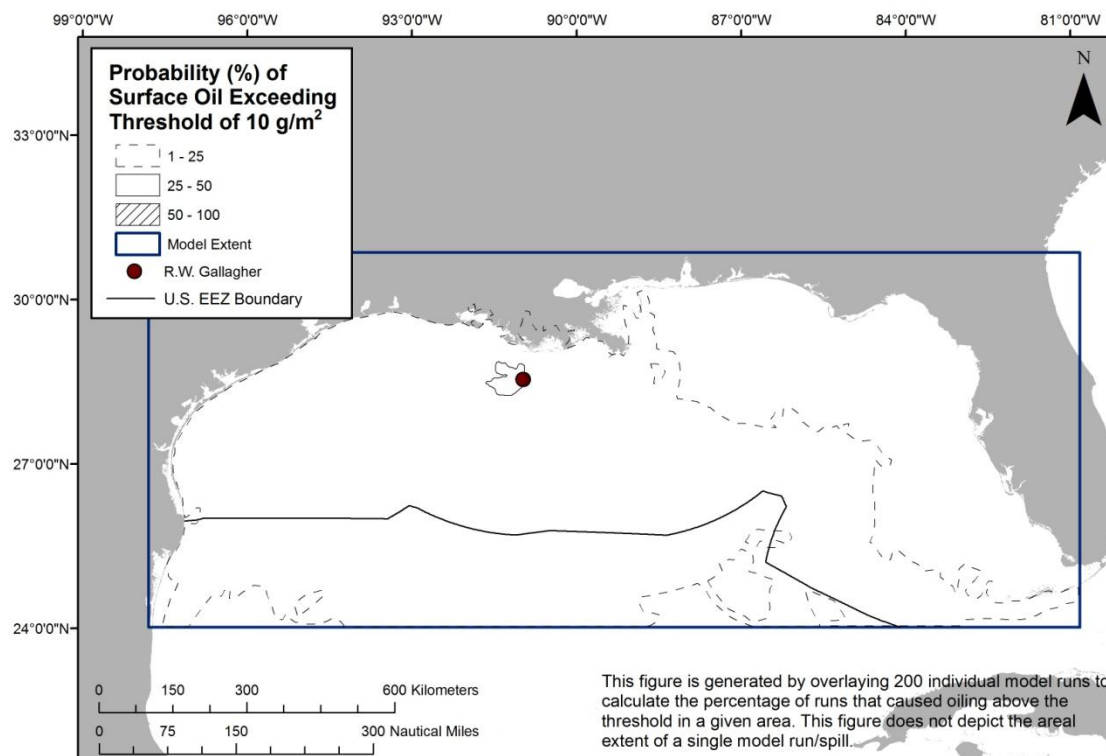

Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 8,600 bbl of heavy fuel oil from the *R.W. Gallagher* at the threshold for ecological resources at risk.

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.
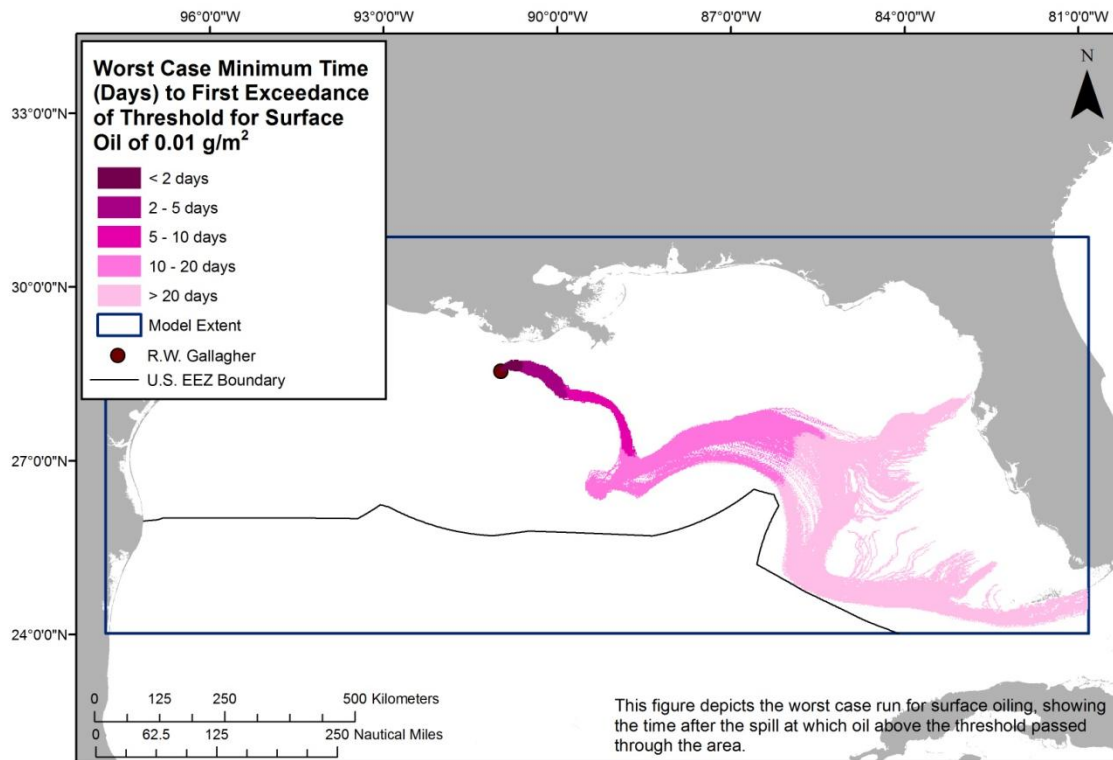
Figure 2-4: Water surface oiling from the Most Probable of 8,600 bbl of heavy fuel oil from the *R.W. Gallagher* shown as the area over which the oil spreads at different time intervals.

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 or tarballs can be estimated for any spill volume.

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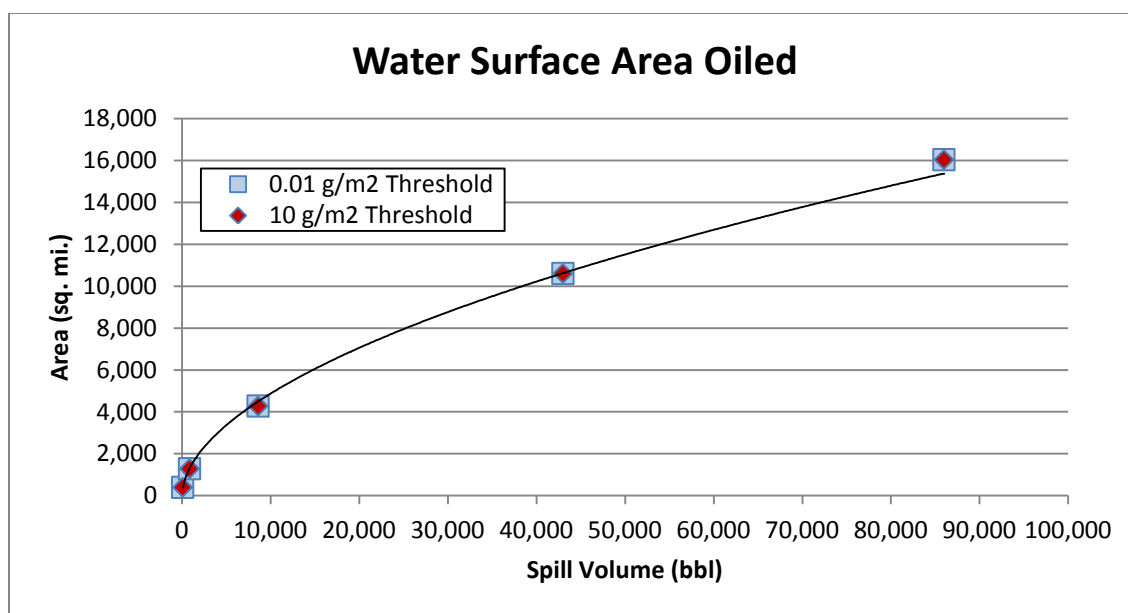
Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *R.W. Gallagher*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2. The curves are so similar that they plot on top of each other.

Potential Shoreline Impacts

Based on these modeling results, shorelines at risk of oiling extend from the Chandeleur Islands to south of the Rio Grande, into Mexico. 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 2-4a: Estimated shoreline oiling from leakage from the *R.W. Gallagher*. (U.S. and Mexico).

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	86	9	8	4	21
Episodic	860	9	12	10	31
Most Probable	8,600	10	13	13	35
Large	43,000	13	15	17	45
Worst Case Discharge	86,000	15	17	22	53

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	86	9	7	4	20
Episodic	860	9	11	10	30
Most Probable	8,600	10	12	13	34
Large	43,000	13	13	17	43
Worst Case Discharge	86,000	15	15	22	52

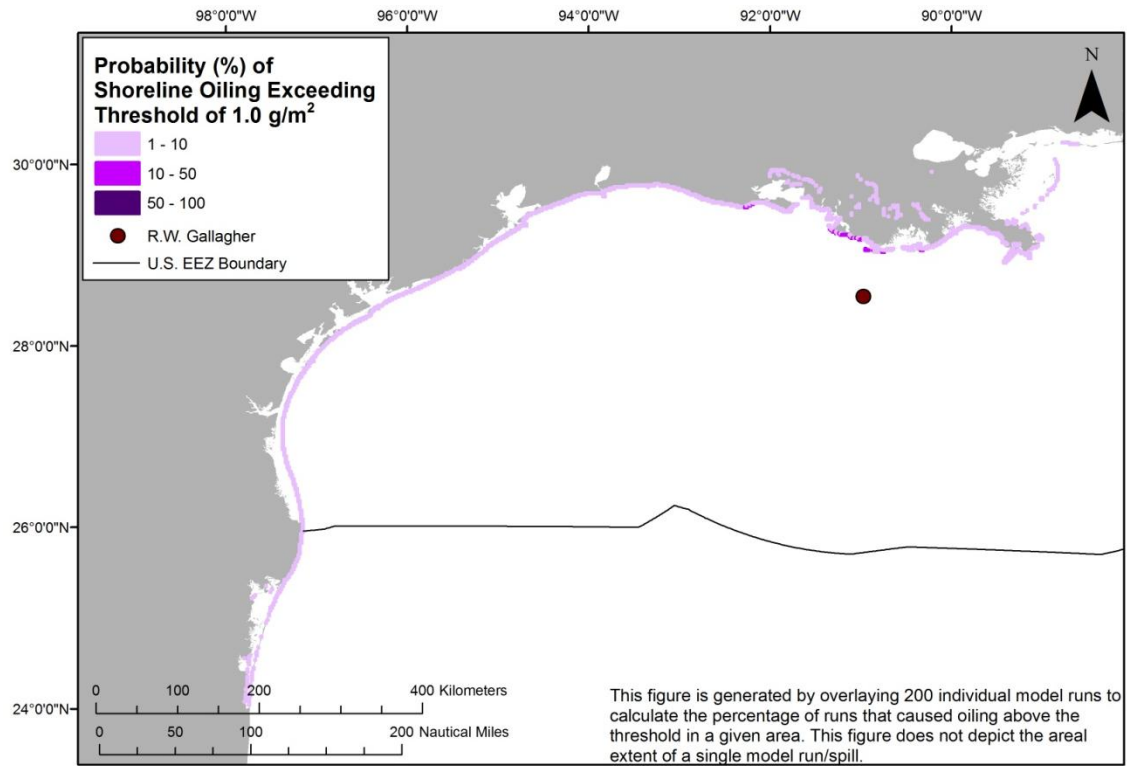**Figure 2-6:** Probability of shoreline oiling (exceeding 1 g/m^2) from the Most Probable Discharge of 8,600 bbl of heavy fuel oil from the *R.W. Gallagher* that resulted in the greatest shoreline oiling.
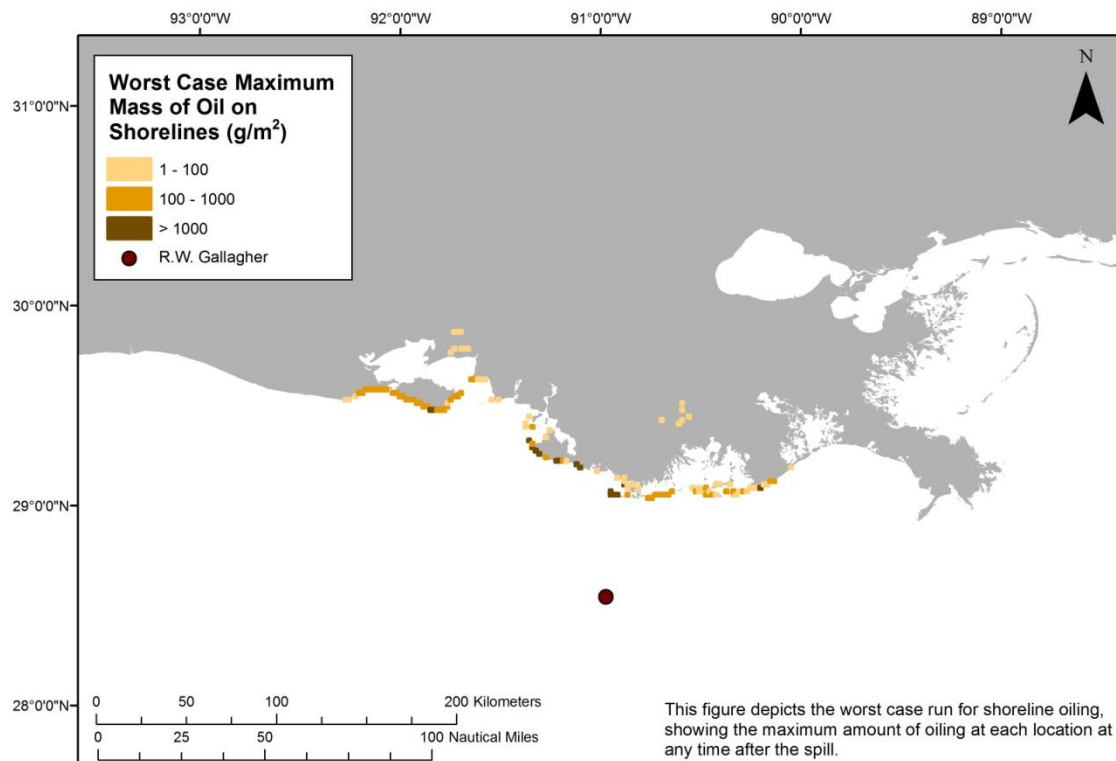

Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 8,600 bbl of heavy fuel oil from the *R.W. Gallagher* that resulted in the greatest shoreline oiling.

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.
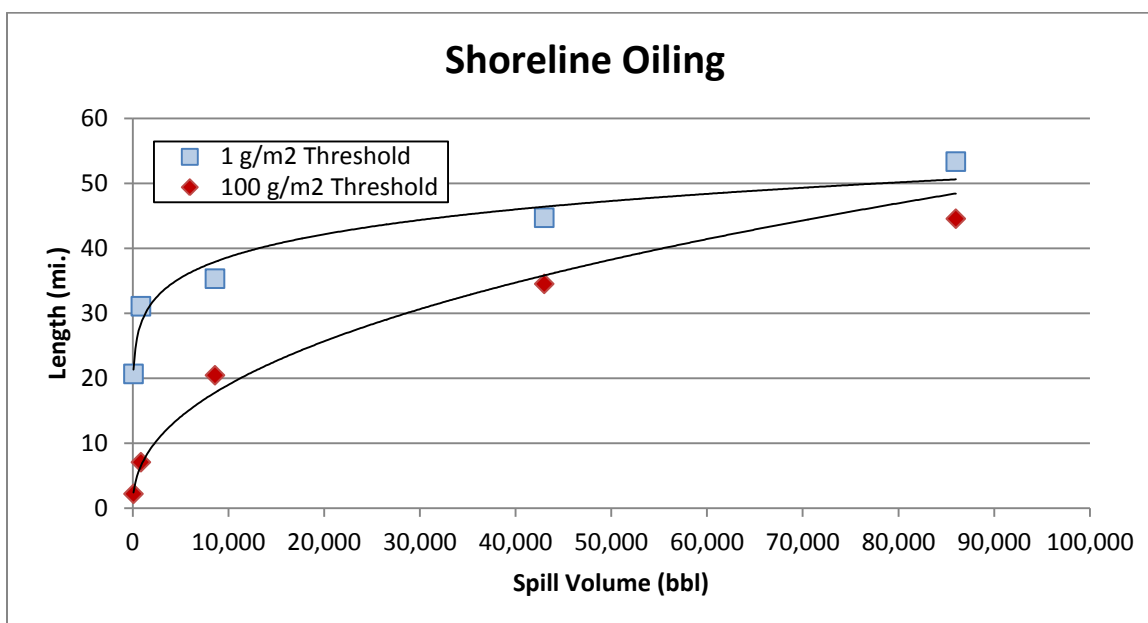

Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *R.W. Gallagher.*

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 marshes and sand beaches, although artificial shorelines and gravel (shell) beaches 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 *R.W. Gallagher.*

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	4 miles	4 miles
Sand beaches	15 miles	15 miles
Salt marshes and tidal flats	73 miles	55 miles

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

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	18 miles	11 miles
Sand beaches	13 miles	8 miles
Salt marshes and tidal flats	82 miles	7 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *R.W. Gallagher* (Table 3-1) include numerous guilds of birds, particularly those sensitive to surface oiling while rafting or plunge diving to feed and are present in nearshore/offshore waters. Coastal marshes and barrier islands support large number of nesting shorebirds and wading birds and provide foraging grounds for overwintering shorebirds and waterfowl and migrating shorebirds and passerines. In addition, nearshore waters of the Gulf support highly productive coastal fisheries for both finfish and invertebrates. Kemp's ridley sea turtles use coastal waters heavily to travel between nesting beaches in South Texas and Mexico and foraging grounds near the Mississippi River Delta.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Coastal birds	- Louisiana bays are important habitat for wintering waterfowl, supporting densities of up to 900 birds per square mile - Raptors (American kestrel, northern harriers, red-tailed hawk, turkey vulture, Cooper's hawk, osprey, bald eagle) can all be present in the coastal marshes - Half of North American population of mottled duck inhabits Louisiana	Ospreys present during winter Mottled duck nests Mar-Sep
Nesting and migratory hotspots	*Chandeleur Islands* **bp = breeding pairs, otherwise numbers are individual bird counts* - Critical habitat for wintering piping plover (FT) - Most abundant nesters: brown pelican (1,642 bp), laughing gull, Caspian tern, black skimmer (575 bp), royal tern (1-9,000 bp), sandwich tern (<33,000 bp) - Redhead and lesser scaup are common - Stopover for migratory birds *Mississippi Delta (Pass a Loutre State WMA, Delta NWR)* - Nesting habitat for mottled duck (445), secretive marsh birds, wading birds and brown pelican (2-3,000 bp) - High densities of king rails in the marsh - Habitat for 100,000 wintering waterfowl, including canvasback (9,000), northern pintail (48,000), gadwall (36,000) - Wintering habitat for western sandpiper, least sandpiper and dunlin *Barataria-Terrebonne Bays* - Grand Isle State Park is important migratory bird and snowy plover stopover - High abundances of overwintering blue and green-winged teal, American wigeon, ring-necked duck, lesser scaup, mallard, gadwall, and geese - Piping plovers overwintering on Elmer's Island, W Grand Terre, and Fourchon east (~50 total) - Nesting: Short-billed dowitcher (1,800), Wilson's plover (176 bp), black skimmer (899), gull-billed tern (>100), Forster's tern (600-900 bp), least tern (321 bp), little blue heron (2,690 bp, 7 colonies), white ibis (2,500), roseate spoonbill (125 bp) *Isle Dernieres and Timbalier Islands* - Raccoon Island has extremely high abundance of brown pelican, Wilson's plover, royal and sandwich tern, great, snowy and reddish egret, great blue and tricolored heron	Piping plover present Aug-May Wilson's plover nests May-Aug Short-billed dowitcher present in winter Roseate spoonbill nests Mar-Jul Mottled duck nests Mar-Sep Egrets nest Feb-Jul Ibises nest Apr-Aug Herons nest Mar-Aug Gulls nest Apr-Jul Skimmers nest May-Sep; Terns nest Apr-Sep Migrating shorebirds present spring and fall Wintering waterfowl present Oct-Mar

Species Group	Species Subgroup and Geography	Seasonal Presence
	• Important wintering piping plover (50-100), snowy plover (<100) habitat • Stopover for long-billed curlew, red knot, and other shorebirds • Emergency stopover for passerines • Nesting: black skimmer (500 bp), sandwich tern (2,600 bp), least tern (50 bp), brown pelican (6,600 bp), Wilson's plover (150 bp) *Atchafalaya Delta* • Very important for wintering waterfowl, wading birds, and black skimmer • Marsh and scrub habitats important for rails, cranes, gulls, shorebirds, terns *Chenier Plain* • Shell Keys Isl. stopover for white pelicans (1,807), brown pelicans, terns, gulls • > 400k overwintering ducks and geese • Mottled duck (1,000-2,000) present • Nesting: Forster's tern (800 bp), gull-billed tern (200 bp), black skimmer (400 bp), roseate spoonbill (200 bp) • Piping plover (30), long-billed dowitcher (6,000) habitat present *Bolivar Flats* • 100,000s of birds • Resting and feeding location for migrating shorebirds (American avocet, American golden-plover, semipalmated plover, Wilson's plover, piping plover, snowy plover). • Resident mottled duck • Breeding roseate spoonbills (50) *Jigsaw Island* • Nesting: American oystercatcher (5 bp), black skimmer (10 bp), laughing gull (50 bp), Caspian tern (6 bp), royal terns (600 bp), sandwich tern (300 bp), tricolored heron *Mustang Bayou Island* – wading birds, black skimmer, gull-billed/royal terns nesting *Sundown Island (West Matagorda)* – 18 species of colonial nesting birds, including one of the largest colonies of reddish egret in Texas (15,000 bp) • Nesting laughing gull (3,000 bp), royal tern (4,000 bp), sandwich tern (600 bp), tricolored heron (200 bp), brown pelican (2,000 bp), black skimmers?, gull-billed tern, Caspian tern, reddish egret, little blue heron, snowy egret, great blue heron, great egret, cattle egret, white ibis, roseate spoonbill (these are all in lesser concentrations than above) *Laguna Vista spoils* • Nesting gull-billed tern, royal tern, sandwich tern (1,000s), reddish egret, black skimmer *Pelagic distribution* Convergence zones (thermoclines and warm core eddies) are areas of high biodiversity and abundance. Bird assemblages change seasonally • Early summer - terns, storm-petrels and gulls common; jaegers and shearwaters less common; tropicbirds, sulids and frigatebirds rare • Mid-summer - black terns extremely common; band-rumped storm petrel, magnificent frigatebird, Audubon's shearwater, sooty tern present • Late summer - high abundances of terns • Fall - laughing gull, royal tern, Pomarine jaeger common	

Species Group	Species Subgroup and Geography	Seasonal Presence
	• Fall/winter - skuas present • Winter - herring and laughing gulls common	
Sea Turtles	*Nesting* • Kemp's ridley (FE, SE) high nest counts on North Padre Island (~100 nests/yr) and low (<25 nests/yr) from Galveston Bay to northern Mexico • Densities of nesting Kemp's ridley sea turtles increase greatly (100s-1,000s per year) just south of the model extent; their major nesting ground is at Rancho Nuevo, Mexico • Loggerheads (FT, ST) nest on the Chandeleur Islands and coastal Texas in low abundance • Greens (FT, ST) nest on beaches north to North Padre Island in low numbers • Hawksbill (FE, SE) and leatherback (FE, SE) nesting can occur on Padre Island National Seashore but is extremely rare *Distribution* • Coastal Louisiana is a major foraging ground for Kemp's ridley • *Sargassum* is important habitat for juvenile sea turtles • South Texas and northern Mexico inshore waters are important foraging grounds for juvenile green sea turtles • Shelf waters are important adult habitat for loggerheads	Loggerheads nest May-Oct Kemp's ridley and Green nest Mar-Jul, hatch Apr-Sep Leatherbacks and hawksbills nest during the summer
Reptiles	Rockefeller State Wildlife Refuge/Game Preserve has highest alligator nesting density in U.S. Diamondback terrapins can be found along the gulf shoreline in the area of impact	
Marine Mammals	Bottlenose dolphins (35-45k): Common in coastal waters including rivers, bays, and sounds throughout potential spill area. High concentrations in coastal Louisiana, especially around inlets and passes Whales and dolphins are often associated with shelf edge features, convergence zones, and *Sargassum* mats Manatees can be present in low abundance in inland waters	Manatees present spring-fall
Terrestrial mammals	Northern river otter, mink, nutria and muskrat can all be present in marsh habitats	
Fish	*Inshore distributions* • Marsh habitats are extremely productive and support high biodiversity and abundance of resident estuarine fish • Estuarine areas important nursery grounds for many commercial species: red, mutton, gray, lane, dog, yellowtail snapper, goliath, red, gag, yellowfin grouper • Coastal nursery areas for blacktip sharks, spinner sharks, Atlantic sharpnose sharks, bull sharks, sandbar sharks in the region • Passes are often sites of fish spawning *Common in state waters* • Gulf sturgeon (FT), bull shark, blacktip shark, spinner shark, silky shark, sharpnose shark, red snapper, mullet, lane snapper, red drum, gray snapper, vermillion snapper, king and Spanish mackerel, gag grouper, spotted seatrout, cobia, greater amberjack, black drum, hardheaded catfish, tarpon *Offshore distributions* • Surface-oriented fish include hammerhead sharks, tiger sharks, silky sharks, mako sharks, manta rays, eagle rays, cownose ray, tunas, billfish, molas • Whale shark hotspot near mouth of the Mississippi • Bluefin tuna spawn in areas offshore of coastal Texas and Louisiana	Shark species pup spring-summer Bluefin tuna are present to spawn in the spring Estuarine dependent fish migrate offshore in the fall/winter to spawn; juveniles and adults use estuaries during the spring/summer Bluefin tuna spawn offshore Apr-May

Species Group	Species Subgroup and Geography	Seasonal Presence
	• *Sargassum* is important habitat for juvenile of some pelagic fish species (i.e., dolphinfish, jacks, and triggerfish	
Invertebrates	Significant shrimp fisheries occur for white shrimp, brown shrimp, blue crabs, gulf stone crabs and oysters in coastal areas • Spawning occurs offshore, larval and juvenile development occurs in estuarine waters • Female blue crabs move to deeper waters to spawn	Spawning: Brown shrimp Mar-Jul; White shrimp Apr-Nov; Blue crab peaks Aug-Sep; Oysters in late spring and early fall
Benthic habitats	Submerged aquatic vegetation is critical to numerous species and can be found in bays and sounds south of Galveston Bay. Larger and more contiguous beds occur on the inland side of the Chandeleur Islands and south of Matagorda Bay	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *R.W. Gallagher* 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 *R.W. Gallagher* 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 *R.W. Gallagher* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 86,000 bbl because 100% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 20 mi^2 of the

upper 33 feet of the water column. For the Most Probable Discharge of 8,600 bbl, the *R.W. Gallagher* is classified as Low Risk for oiling probability for water column ecological resources because 4% 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 Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 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 *R.W. Gallagher* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 98% 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 16,000 mi^2. The *R.W. Gallagher* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 98% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 4,280 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 *R.W. Gallagher* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 69% 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 91 miles. The *R.W. Gallagher* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 62% 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 37 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 heavy fuel oil from the *R.W. Gallagher* is summarized as listed below and indicated in the far-right column in Table 3-2:

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

Table 3-2: Ecological risk scores for the **Worst Case Discharge of 86,000 bbl** of heavy fuel oil from the *R.W. Gallagher*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	100% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Med
3A-2: Water Column Degree EcoRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 20 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	High	100% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	High
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	High	The mean area of water contaminated above 10 g/m^2 was 16,000 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	69% 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 91 mi	

For the Most Probable Discharge of 8,600 bbl, the ecological risk from potential releases of heavy fuel oil from the *R.W. Gallagher* is summarized below and indicated in the far-right column in Table 3-3:

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

Table 3-3: Ecological risk scores for the **Most Probable Discharge of 8,600 bbl** of heavy fuel oil from the *R.W. Gallagher*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	4% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	98% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 10 g/m^2 was 4,280 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	**High**	62% 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 37 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 *R.W. Gallagher* include very highly utilized recreational beaches in Louisiana and Texas year-round, but also during spring and fall for shore fishing. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. There are two national seashores and a number of state parks with heavily utilized beaches.

Shipping lanes run through the area of impact to ports and offshore lightering areas in Mississippi, Louisiana, and Texas with a total of 26,000 vessel port calls and over 1.5 billion tonnage annually.

Commercial fishing is economically important to the region, as well as to the nation. Regional commercial landings for 2010 exceeded $508 million.

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

Spill response costs for a release of oil from the *R.W. Gallagher* 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 *R.W. Gallagher*.

Resource Type	Resource Name	Economic Activities
National Seashores	Padre Island National Seashore, TX Gulf Island National Seashore, LA	National seashores provide recreation for local and tourist populations as well as preserve and protect the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area.
National Wildlife Refuges	Delta NWR (LA) Shell Keys NWR (LA) Sabine NWR (TX) Texas Point NWR (TX) McFaddin NWR (TX) Anahuac NWR (TX) Brazoria NWR (TX) San Bernard NWR (TX) Big Boggy NWR (TX) Aransas NWR (TX)	National wildlife refuges in two states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.

Resource Type	Resource Name	Economic Activities
State Parks	Grand Isle SP, LA Cypremort Point SP, LA Sea Rim SP, TX Galveston Island SP, TX Matagorda Island SP, TX Goose Island SP, TX Mustang Island SP, TX Point Isabel Lighthouse State Historic Park, TX Boca Chica SP, TX	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). They provide income to the states. State parks in Louisiana and Texas are potentially impacted.
Commercial Fishing	A number of fishing fleets use the western Gulf of Mexico area and surrounding waters for commercial fishing purposes.	
	Aransas Pass-Rockport	Total Landings (2010): $8.6M
	Brownsville-Port Isabel	Total Landings (2010): $52.5M
	Cameron	Total Landings (2010): $11.5M
	Delacroix-Yscloskey	Total Landings (2010): $11.7M
	Delcambre	Total Landings (2010): $20.7M
	Dulac-Chauvin	Total Landings (2010): $45.1M
	Empire-Venice	Total Landings (2010): $53.7M
	Freeport	Total Landings (2010): $9.2M
	Galveston	Total Landings (2010): $28.0M
	Golden Meadow-Leeville	Total Landings (2010): $21.9M
	Grand Isle	Total Landings (2010): $14.2M
	Gulfport-Biloxi	Total Landings (2010): $13.0M
	Intracoastal City	Total Landings (2010): $26.4M
	Lafitte-Barataria	Total Landings (2010): $20.4M
	Morgan City-Berwick	Total Landings (2010): $5.7M
	Palacios	Total Landings (2010): $31.9M
	Pascagoula-Moss Point	Total Landings (2010): $8.9M
	Port Arthur	Total Landings (2010): $47.4M
Ports	There are a number of significant commercial ports in the western Gulf of Mexico that could potentially be impacted by spillage and spill response activities. The port call numbers below are for large vessels only. There are many more, smaller vessels (under 400 GRT) that also use these ports.	
	Port Arthur, TX	1,183 port calls annually
	Freeport, TX	777 port calls annually
	Galveston, TX	699 port calls annually
	Houston, TX	6,698 port calls annually
	Texas City, TX	1,167 port calls annually
	Corpus Christi, TX	1,037 port calls annually
	Lake Charles, LA	683 port calls annually
	Galveston Lightering Area, TX	591 port calls annually
	Pascagoula, MS	562 port calls annually
	Nederland Terminal, TX	389 port calls annually
	New Orleans, LA	5,544 port calls annually
	Loop Terminal, LA	295 port calls annually
	Southwest Pass Lightering Area, LA	249 port calls annually

| Resource Type	Resource Name	Economic Activities
	Gulfport, MS	197 port calls annually
	Ingleside, TX	193 port calls annually
	Point Comfort, TX	184 port calls annually
	South Sabine Point Lightering Area, TX	118 port calls annually
	Brownsville, TX	74 port calls annually
	Beaumont, TX	64 port calls annually
	Freeport Lightering Area, TX	30 port calls annually
	Corpus Christi Lightering Area, TX	26 port calls annually
	Sabine Pass, TX	235 port calls annually
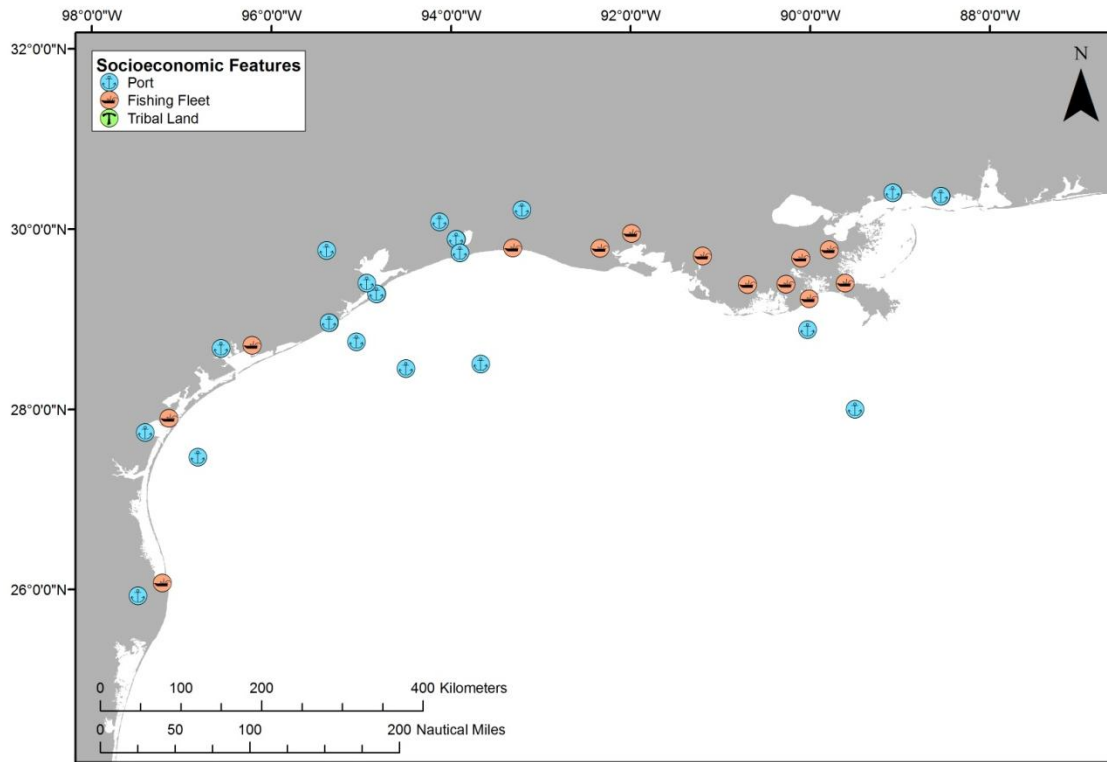
Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *R.W. Gallagher*. (Note that there are no tribal lands at risk.)
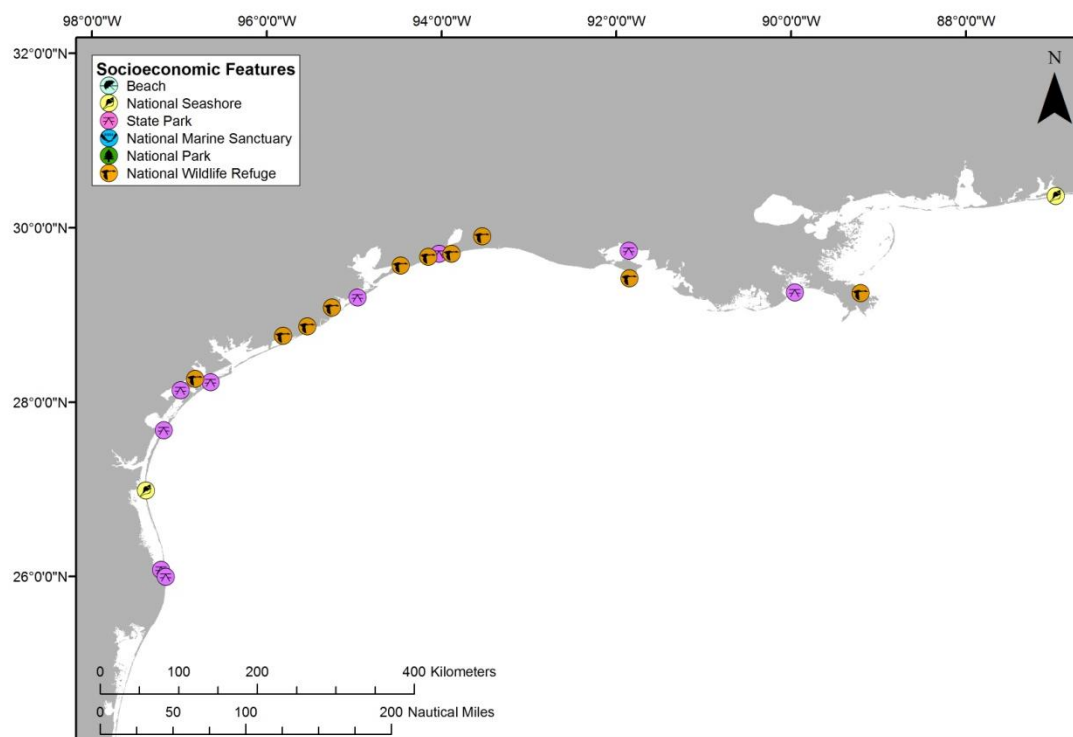
Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *R.W. Gallagher*.

Socio-Economic Risk Factors

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

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, the classification for the *R.W. Gallagher* shading indicates the degree of risk, for the WCD release of 86,000 bbl and a border around 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 *R.W. Gallagher* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for water column socio-economic resources for the WCD of 86,000 bbl because 100% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 20 mi^2 of the upper 33 feet. The *R.W. Gallagher* is classified as Low Risk for oiling probability for water column socio-economic resources because 10% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 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 *R.W. Gallagher* 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 16,000 mi^2. The *R.W. Gallagher* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 98% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 4,280 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 *R.W. Gallagher* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 70% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is classified as Medium Risk for degree of oiling because the mean length of weighted shoreline contaminated was 98 miles. The *R.W. Gallagher* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 68% 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 68 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 heavy fuel oil from the *R.W. Gallagher* is summarized as listed below and indicated in the far-right column in Table 4-2:

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

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 86,000 bbl** of heavy fuel oil from the *R.W. Gallagher.*

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	100% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Med
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 20 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 16,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	70% of the model runs resulted in shoreline oiling of 1 g/m^2	High
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 98 mi	

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

- Water column resources – Low, because there would be a very low impact to the water column in important fishing grounds
- Water surface resources – High, because a large area of surface water would be impacted in important shipping and fishing areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because a moderate length of shoreline would be impacted in areas with high-value resources

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 8,600 bbl** of heavy fuel oil from the *R.W. Gallagher*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	Medium	High	5% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
4A-2: Water Column Degree SRAR Oiling	**Low**	Medium	High	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	97.5% 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 4,300 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	**High**	68% of the model runs resulted in shoreline oiling of 1 g/m^2	**Med**
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 68 mi	

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

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

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

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

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

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

For the Worst Case Discharge, *R.W. Gallagher* scores High with 18 points; for the Most Probable Discharge, *R.W. Gallagher* scores Medium with 13 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *R. W. Gallagher*. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

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

Table 5-1: Summary of risk factors for the *R.W. Gallagher.*

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	High	Maximum of 87,500 bbl, known to be leaking in 2010	**Med**
	A2: Oil Type	High	Bunker C cargo and fuel oil, Group IV oil type	
	B: Wreck Clearance	High	Not cleared	
	C1: Burning of the Ship	High	For a few hours	
	C2: Oil on Water	High	Yes	
	D1: Nature of Casualty	High	Two torpedoes	
	D2: Structural Breakup	High	No	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports exist, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Inverted	**Not Scored**
	Depth	High	90 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	2010 visual assessment BOEM	
	Other Hazardous Materials Onboard	High	None	
	Munitions Onboard	Medium	Small arms	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	Yes	

				WCD	Most Probable
Ecological Resources	3A: Water Column Resources	High	Relatively small areas of impact mostly offshore	**Med**	**Low**
	3B: Water Surface Resources	High	Heavy fuel oil forms persistent tarballs that can travel long distances posing risks to the many birds and sea turtles in the area, esp. when concentrated in convergence zones and *Sargassum*	**High**	**Med**
	3C: Shore Resources	High	Persistent tarballs strand on beaches and marshes, fouling habitats and animals	**High**	**Med**
Socio-Economic Resources	4A: Water Column Resources	High	Moderate to low impact to the water column in important fishing grounds	**Med**	**Low**
	4B: Water Surface Resources	High	Large area of surface water would be impacted in important shipping and fishing areas	**High**	**High**
	4C: Shore Resources	High	Moderate length of shoreline would be impacted in areas with high-value resources	**High**	**Med**
Summary Risk Scores				18	13

As noted in the archaeological assessment, this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) and possibly the Sunken Military Craft Act (SMCA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Register of Historic Places and is considered a war grave and appropriate actions should be undertaken to minimize disturbance to the site. Archaeologists with the BOEM and BSEE should also be consulted to ensure compliance with archaeological standards for assessing a historic resource.