

# Screening Level Risk Assessment Package

## *George MacDonald*



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Photo: Identification Photograph of *George MacDonald*  
Source: <http://www.navsource.org/archives/09/19/19070.htm>



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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.

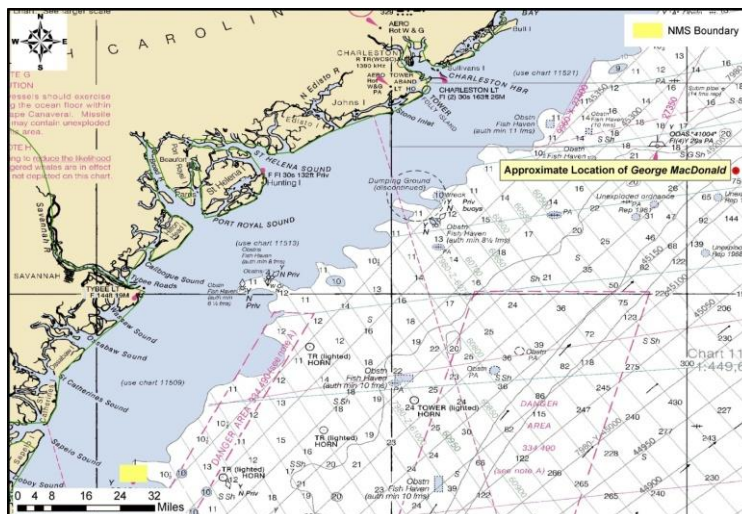
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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: *George MacDonald*

On June 27, 1960, The tanker *George MacDonald* suffered a catastrophic mechanical failure that caused the vessel to flood and sink off the coast of South Carolina. The fully laden vessel 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 *George MacDonald*, 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, *George MacDonald* scores High with 16 points; for the Most Probable Discharge (10% of the Worst Case volume), *George MacDonald* also scores High with 15 points. Given these scores, NOAA would typically recommend that this site be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action. However, given the variable level of data certainty, and that the location of this vessel is unknown, NOAA recommends that surveys of opportunity be used to attempt to locate this vessel and that general notations are made in the Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the general area where the vessel is believed lost.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	High	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
Archaeological Assessment	D2: Structural Breakup	Not Scored	
	Archaeological Assessment		
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
Ecological Resources	Historical Protection Eligibility	<div>WCD</div> <div>MP (10%)</div>	
Socio-Economic Resources	3A: Water Column Resources	Med	Low
	3B: Water Surface Resources	High	High
	3C: Shore Resources	Med	Med
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	High	High
	4C: Shore Resources	Med	Med
Summary Risk Scores		16	15

The determination of each risk factor is explained in the document. This summary table is found on page 39.

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

### Vessel Particulars

**Official Name:** *George MacDonald*

**Official Number:** 244028

**Vessel Type:** Tanker

**Vessel Class:** T3-S-A1 Type Tanker



**Former Names:** *Shabonee; Escalante* (AO-70)

**Year Built:** 1943

**Builder:** Bethlehem Steel Company, Sparrows Point, MD

**Builder's Hull Number:** 4380

**Flag:** American

**Owner at Loss:** Sinclair Refining Co., 600 Fifth Avenue, New York 20, NY

**Controlled by:** N/A

**Chartered to:** N/A

**Operated by:** Unknown

**Homeport:** Unknown

**Length:** 501 feet

**Beam:** 68 feet

**Depth:** 37 feet

**Gross Tonnage:** 10,164

**Net Tonnage:** 6,113

**Hull Material:** Steel

**Hull Fastenings:** Welded

**Powered by:** Oil-fired steam

**Bunker Type:** Heavy Fuel Oil (Bunker C)

**Bunker Capacity (bbl):** Unknown

**Average Bunker Consumption (bbl) per 24 hours:** Unknown

**Liquid Cargo Capacity (bbl):** 134,000

**Dry Cargo Capacity:** Unknown

**Tank or Hold Description:** Unknown

## Casualty Information

**Port Departed:** Houston, TX

**Destination Port:** New York

**Date Departed:** June 27, 1960

**Date Lost:** June 30, 1960

**Number of Days Sailing:**  $\approx$  4

**Cause of Sinking:** Foundering

**Latitude (DD):** 32.4167

**Longitude (DD):** -78.8333

**Nautical Miles to Shore:** 47.3

**Nautical Miles to NMS:** 133.8

**Nautical Miles to MPA:** 0

**Nautical Miles to Fisheries:** Unknown

**Approximate Water Depth (Ft):** 450

**Bottom Type:** Sand

**Is There a Wreck at This Location?** Unknown, wreck has not been located

**Wreck Orientation:** Unknown

**Vessel Armament:** None

**Cargo Carried when Lost:** 102,000 bbl of Bunker C fuel oil; All tanks were full (3'6" ullage) except #5 wing tanks which were empty, and #1 and #7 centers, which were slack

**Cargo Oil Carried (bbl):** 102,000

**Cargo Oil Type:** Heavy Fuel Oil (Bunker C)

**Probable Fuel Oil Remaining (bbl):** 3,360

**Fuel Type:** Heavy Fuel Oil (Bunker C)

**Total Oil Carried (bbl):** 105,360

**Dangerous Cargo or Munitions:** No

**Munitions Carried:** None

**Demolished after Sinking:** No

**Salvaged:** No

**Cargo Lost:** Yes, partially

**Reportedly Leaking:** No

**Historically Significant:** Unknown

**Gravesite:** No

**Salvage Owner:** Not known if any



## Wreck Location

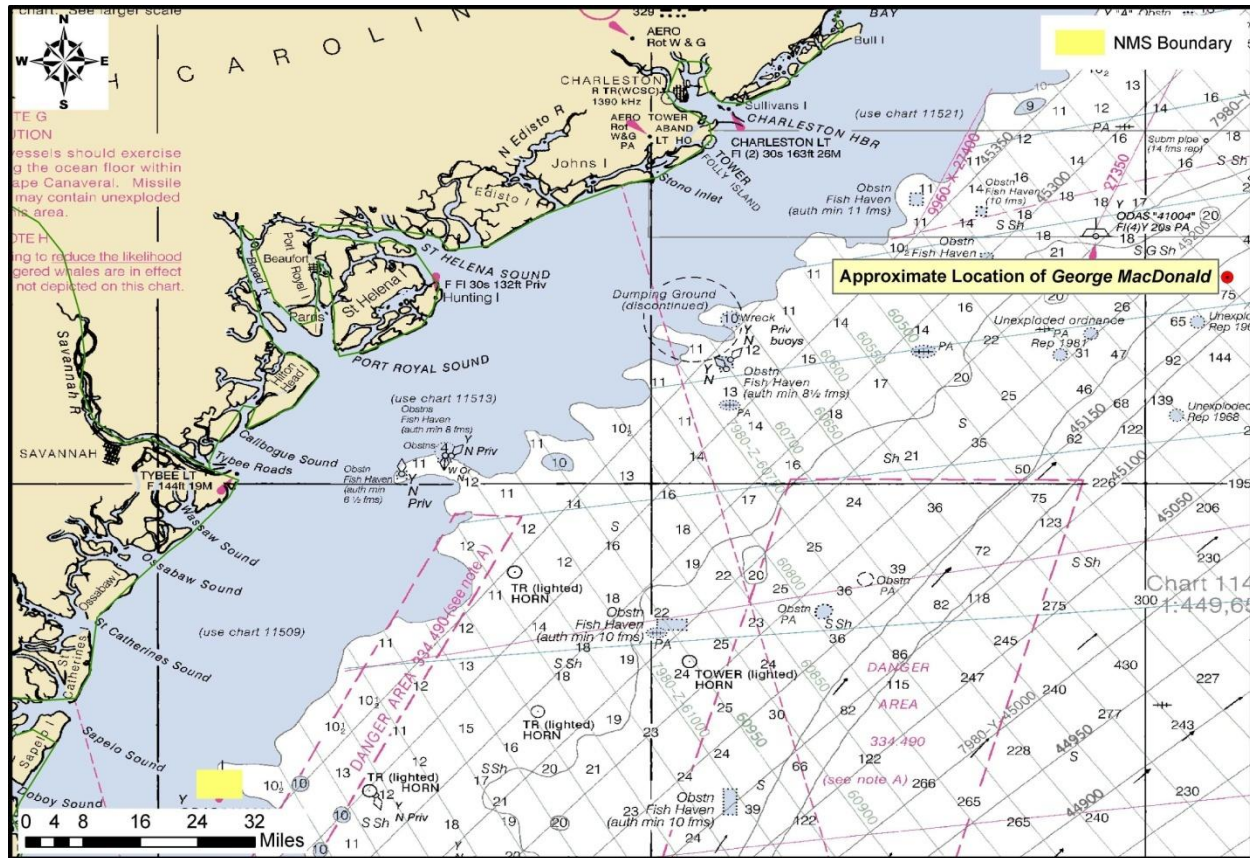


Chart Number: 11009

## Casualty Narrative

"At about 1900, 27 June 1960, the SS *George MacDonald*, a T-3 tank vessel, while approximately 165 miles east of Savannah, Georgia, suffered a ruptured water box on her main condenser which resulted in flooding of the after spaces and eventual foundering. All crew members were safely removed from the vessel before she went down...*George MacDonald* was en route from Houston, Texas to Brooklyn, New York with a cargo of Bunker C fuel oil. All tanks were full except number 5 wings which were empty and numbers 1 and 7 centers which were slack."

<http://www.uscg.mil/hq/cg5/docs/boards/geomcdonald.pdf>

## General Notes

In an attempt to save the vessel, the captain began to intentionally discharge some of the cargo, but realized it was not doing any good and resealed the tanks. The amount of oil that was pumped out is not known but is believed to be a small fraction of the total.

## Wreck Condition/Salvage History

Unknown, the wreck is not known to have been located and has not been salvaged.



## 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 *George MacDonald* was originally listed as a potential high priority shipwreck because of the amount of heavy oil the ship was carrying at the time of its loss and because of the nonviolent nature of the casualty. At the time of its loss, the tanker was carrying 102,000 bbl of Bunker C fuel oil as cargo and an additional 3,360 bbl of Bunker C fuel oil as bunkers. Given just these numbers, it would appear that *George MacDonald* should be considered a high priority shipwreck. The number of unknown factors associated with this shipwreck and the unknown final resting location, however, indicate that it is more likely a shipwreck to be aware of in the event of mystery spills and not one considered for in-water assessment.

Based on the nonviolent nature in which the ship sank, it is likely that the ship settled on the bottom in one contiguous piece. Because it sank in relatively deep water, it was not demolished as a hazard to navigation and has likely remained relatively structurally intact since 1960. This is not to say that the vessel is still full, as shipwrecks in similar depths surveyed in the Gulf of Mexico and elsewhere often display signs of damage caused by the ship's impact with the seafloor. This impact, as well as the amount of time the ship has been on the seafloor in Gulf Stream currents, may have caused welds to break, bulkheads to collapse, pockets of corrosion to form, and cargo loading hatches to become dislodged.

Although NOAA archaeologists cannot guarantee the presence or absence of oil on this wreck, and do not know the current condition of the wreck, it is likely that much of the oil has escaped from the wreck since it sank in 1960. This may particularly be the case considering that ongoing research strongly suggests that vessels in greater depths of water are generally found in an upright orientation. This orientation often leads to loss of oil from vents and piping long before loss of structural integrity of hull plates from

corrosion or other physical impacts. As that this vessel is believed to be in waters approximately 450 feet deep, it may be shallower than the threshold for which ships settle upright, but the slow sinking rate of the vessel and the fact that the lower holds were filled with water may have allowed the ship to remain on an even keel as it sank.

Should the vessel be located in a survey of opportunity or due to a mystery spill attributed to this vessel, it should be noted that this vessel could be of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) prior to any actions that could impact the integrity of the vessel. This vessel may be eligible for listing on the National Historic Register and a full National Historic Register assessment should be conducted prior to site disturbance.

## Background Information References

**Vessel Image Sources:** <http://www.navsource.org/archives/09/19/19070.htm>

**Construction Diagrams or Plans in RULET Database?** No, paper plans of this vessel type (without possible modifications) are available

### Text References:

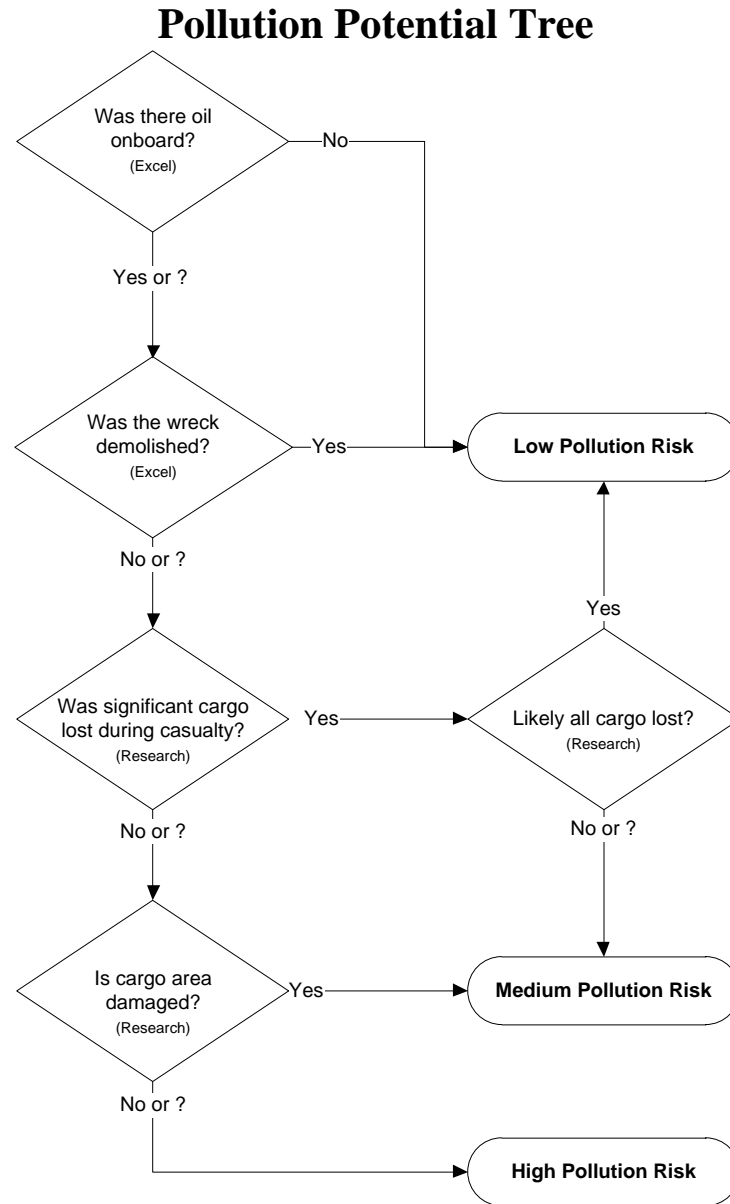
<http://www.uscg.mil/hq/cg5/docs/boards/geomcdonald.pdf>;  
<http://www.navsource.org/archives/09/19/19070.htm>

## Vessel Risk Factors

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

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

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



**Figure 1-1:** 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 *George MacDonald* 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 *George MacDonald* is ranked as High Volume because it was initially thought to have a potential for up to 115,000 bbl based on the cargo carried and an estimate of maximum bunker capacity, although some of that may have been lost at the time of the casualty due to intentional efforts to pump some of the cargo overboard. Additional research has also shown that the amount of bunker oil onboard at the time of loss was closer to 3,360 bbl, making the maximum potential oil carried closer to 105,360 bbl. 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 no reports of leakage from the *George MacDonald*.

#### **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<sup>1</sup>. (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)

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<sup>1</sup> 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]

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

***Was the wreck demolished?***

**Risk Factor B: Wreck Clearance**

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

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

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

***Was significant cargo or bunker lost during casualty?***

**Risk Factor C1: Burning of the Ship**

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

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

The *George MacDonald* is classified as High Risk because there was no report of fire 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 *George MacDonald* is classified as Medium Risk because the Captain of the vessel did pump some oil out of the vessel prior to the casualty. It wasn't working so the tanks were resealed. 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 *George MacDonald* is classified as High Risk because vessel foundered due to flooding from a ruptured water box on the main condenser. 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 *George MacDonald* is classified as Unknown as the disposition of the wreck after sinking and the location are unknown. Data quality is low.

**Factors That May Impact Potential Operations**

**Orientation (degrees)**

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

The location of the *George MacDonald* is unknown. Data quality is low.



### **Depth**

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

The depth for *George MacDonald* is believed to approximately 450 feet due to the last known location. Data quality is low.

### **Visual or Remote Sensing Confirmation of Site Condition**

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

The location of the *George MacDonald* is unknown. Data quality is low.

### **Other Hazardous (Non-Oil) Cargo on Board**

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

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

### **Munitions on Board**

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

The *George MacDonald* had no munitions on board. Data quality is high.

### **Vessel Pollution Potential Summary**

Table 1-1 summarizes the risk factor scores for the pollution potential and mitigating factors that would reduce the pollution potential for the *George MacDonald*.

**Table 1-1:** Summary matrix for the vessel risk factors for the *George MacDonald* are 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 105,360 bbl, not reported to be leaking	High
	A2: Oil Type	High	Cargo is heavy fuel oil, a Group IV oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	No fire was reported	
	C2: Oil on Water	High	Oil was reported on the water; amount is not known	
	D1: Nature of Casualty	High	Foundered due to flooding	
	D2: Structural Breakup	Low	Unknown whether the vessel broke up	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records of this ship exist, assessment is believed to be very accurate	Not Scored
Operational Factors	Wreck Orientation	Low	Unknown	Not Scored
	Depth	Low	≈ 450 feet	
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location unknown	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	No	
	Historical Protection Eligibility (NHPA/SMCA)	Low	Unknown	

## 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 onboard. For the *George MacDonald* this would be 102,000 bbl of cargo and up to 12,500 bbl of fuel oil. The models were run at 115,000 bbl, though later it was learned that there were 3,360 bbl of bunker fuel.

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

The **Most Probable** scenario is premised on the release of all the oil from one tank. In the absence of information on the number and condition of the cargo or fuel tanks for all the wrecks being assessed, this scenario is modeled using 10% of the WCD. The **Large** scenario is loss of 50% of the WCD. The five major types of releases are summarized in Table 2-1. The actual type of release that occurs 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 *George MacDonald*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
<b>Chronic</b> (0.1% of WCD)	115 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
<b>Episodic</b> (1% of WCD)	1,150 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
<b>Most Probable</b> (10% of WCD)	11,500 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
<b>Large</b> (50% of WCD)	57,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
<b>Worst Case</b>	115,500 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 *George MacDonald* contained a maximum of 115,500 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<sup>2</sup>, 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<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> 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.<sup>2</sup> Because oil often strands onshore as tarballs, Table 2-2b shows the number of tarballs per m<sup>2</sup> on the shoreline for these oil thickness thresholds, assuming that each tarball was a sphere that was 1 inch in diameter.

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

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

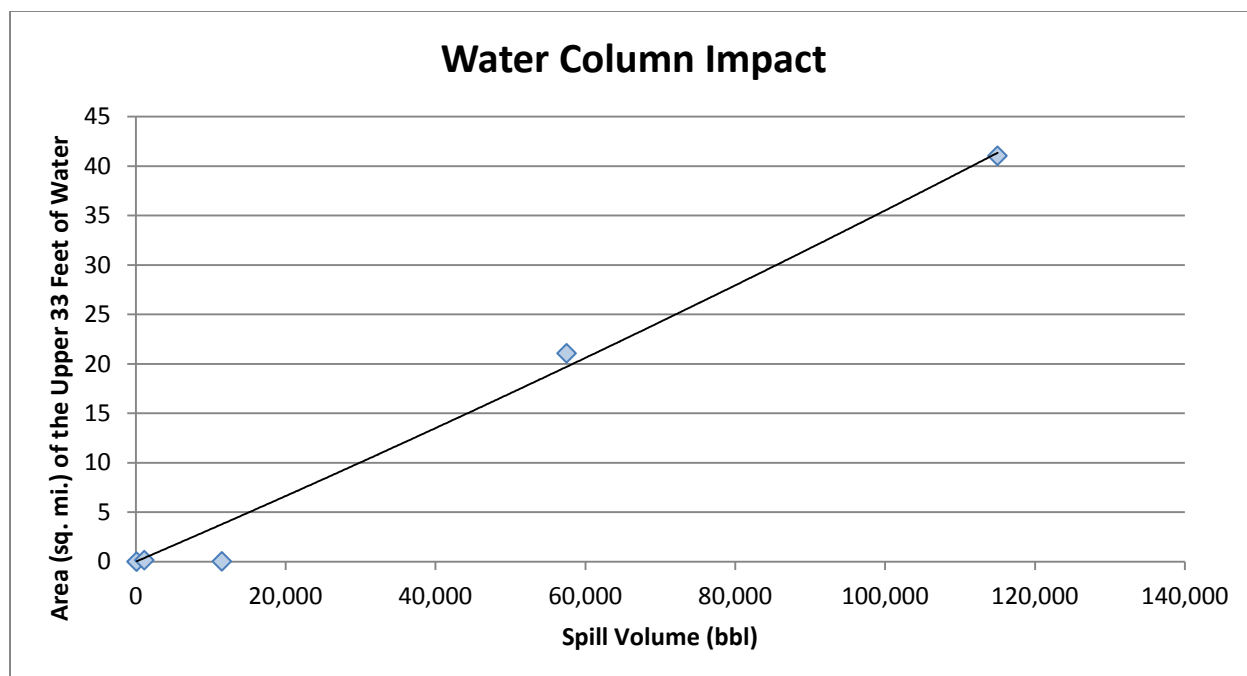
**Table 2-2b:** Oil thickness thresholds used in calculating miles of shoreline impacted. Refer to Sections 3 and 4 for explanations of the thresholds for ecological and socio-economic resource impacts.

Oil Description	Oil Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen/Tarballs	Dull Colors	0.001 mm	1 g/m <sup>2</sup>	~0.12-0.14 tarballs/m <sup>2</sup>	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m <sup>2</sup>	~12-14 tarballs/m <sup>2</sup>	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 *George MacDonald* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi<sup>2</sup> 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 (Fig. 2-1). Using this figure, the water column impacts can be estimated for any spill volume.

<sup>2</sup> 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. Interior, Washington, DC.



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

### Potential Water Surface Slick

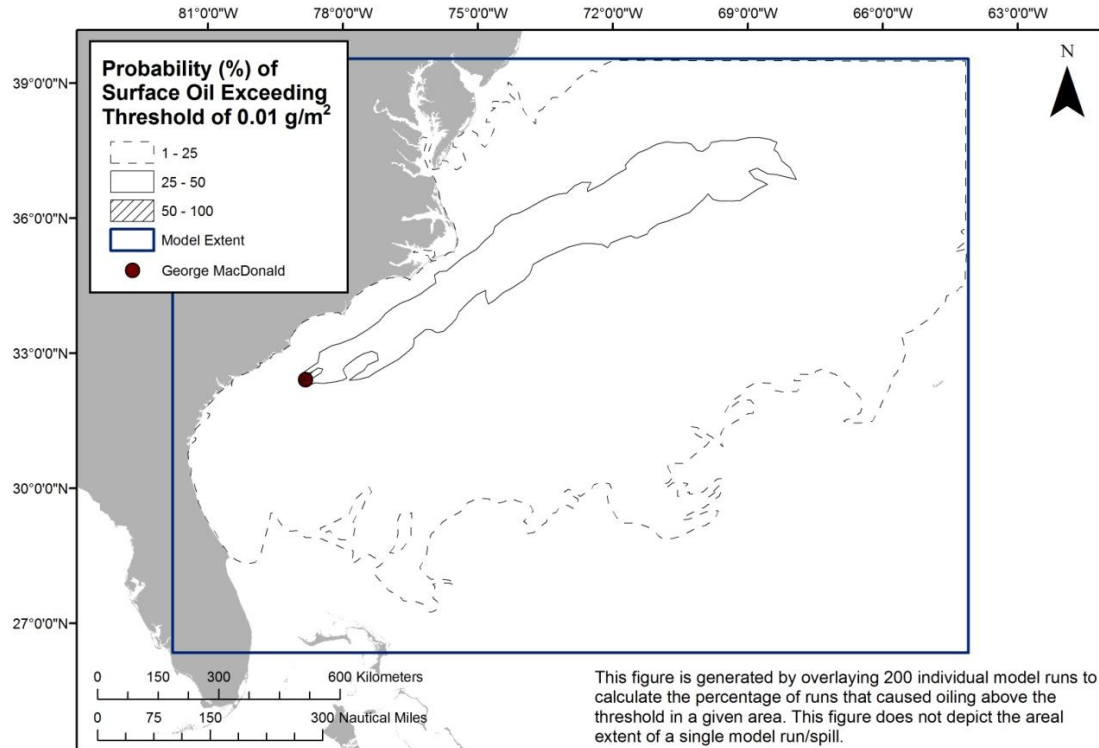
The slick size from an oil release from the *George MacDonald* is a function of the quantity released. The estimated water surface coverage by a fresh slick (the total water surface area “swept” by oil over time) for the various scenarios is shown in Table 2-3, as the mean result of the 200 model runs. 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  $975 \text{ g/m}^2$ , and is not able to spread any thinner. Thus, the results for the slick area swept are identical for the  $0.01 \text{ g/m}^2$  and  $10 \text{ g/m}^2$  thresholds. The slick will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers.

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

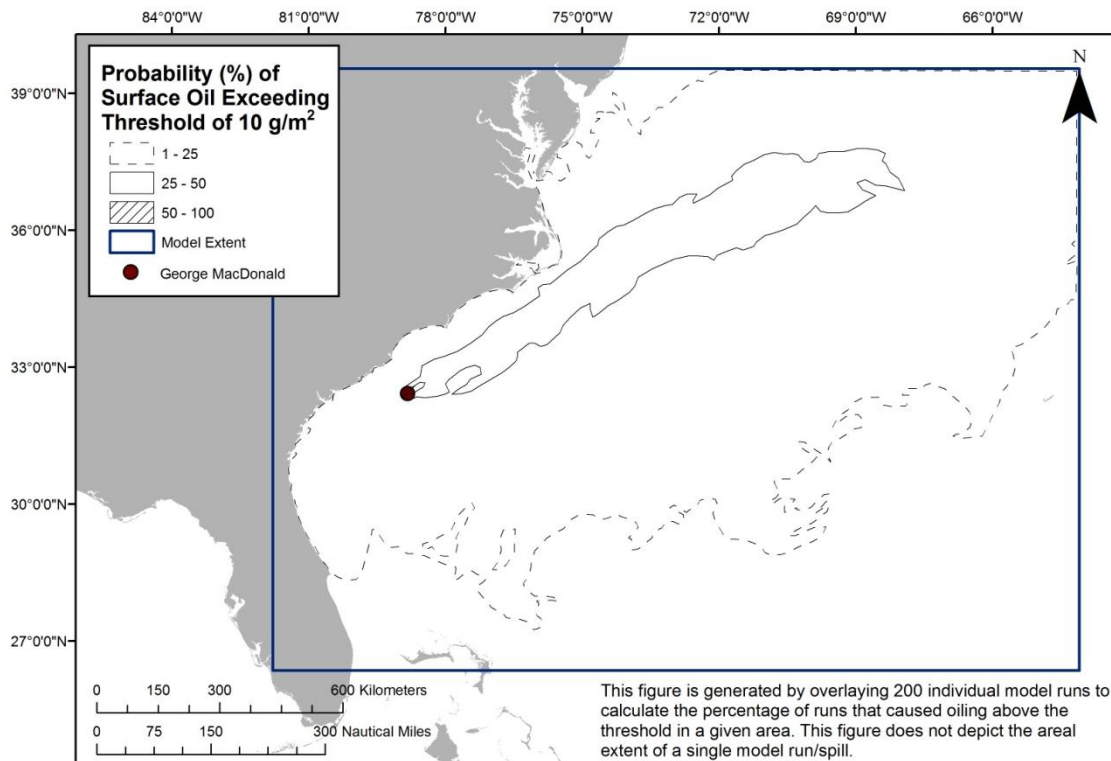
Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m <sup>2</sup>	10 g/m <sup>2</sup>
Chronic	115	1,820 mi <sup>2</sup>	1,820 mi <sup>2</sup>
Episodic	1,150	5,800 mi <sup>2</sup>	5,800 mi <sup>2</sup>
Most Probable	11,500	18,500 mi <sup>2</sup>	18,500 mi <sup>2</sup>
Large	57,500	42,900 mi <sup>2</sup>	42,900 mi <sup>2</sup>
Worst Case Discharge	115,000	61,800 mi <sup>2</sup>	61,800 mi <sup>2</sup>

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.



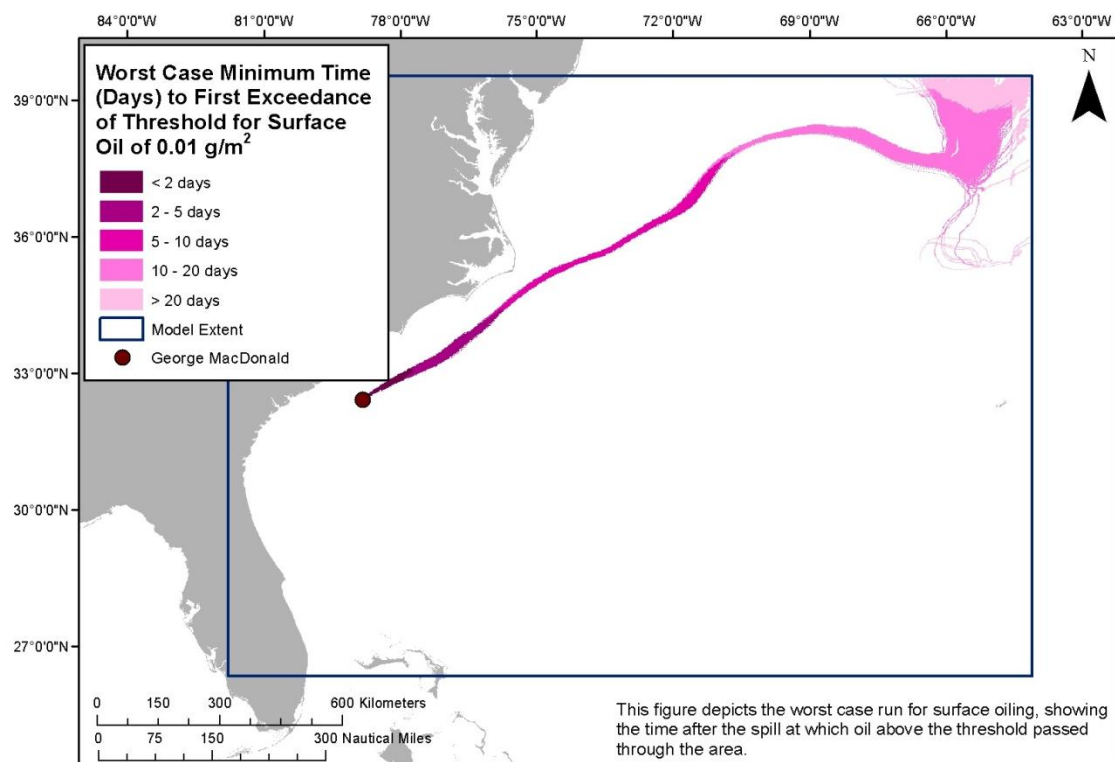


**Figure 2-2:** Probability of surface oil (exceeding 0.01 g/m<sup>2</sup>) from the Most Probable spill of 11,500 bbl of heavy fuel oil from the *George MacDonald* at the threshold for socio-economic resources at risk.



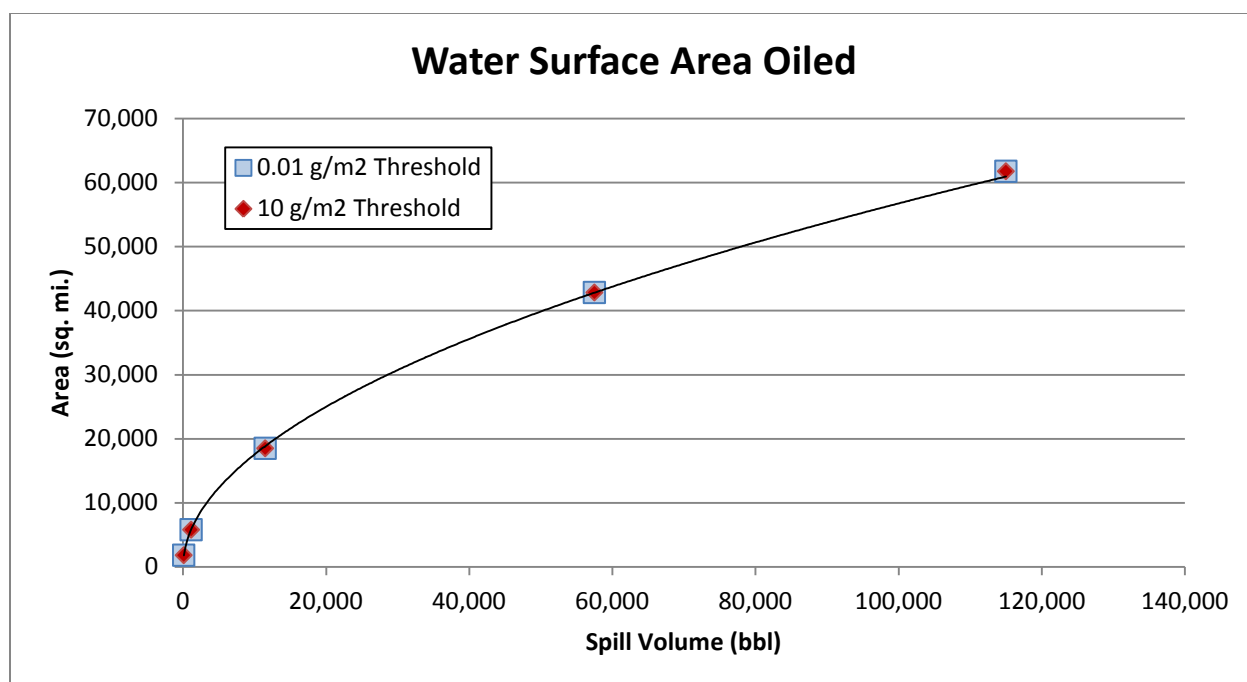
**Figure 2-3:** Probability of surface oil (exceeding 10 g/m<sup>2</sup>) from the Most Probable spill of 11,500 bbl of heavy fuel oil from the *George MacDonald* at the threshold for ecological resources at risk.

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



**Figure 2-4:** Water surface oiling from the Most Probable spill of 11,500 bbl of heavy fuel oil from the *George MacDonald* shown as the area over which the oil spreads at different time intervals.

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



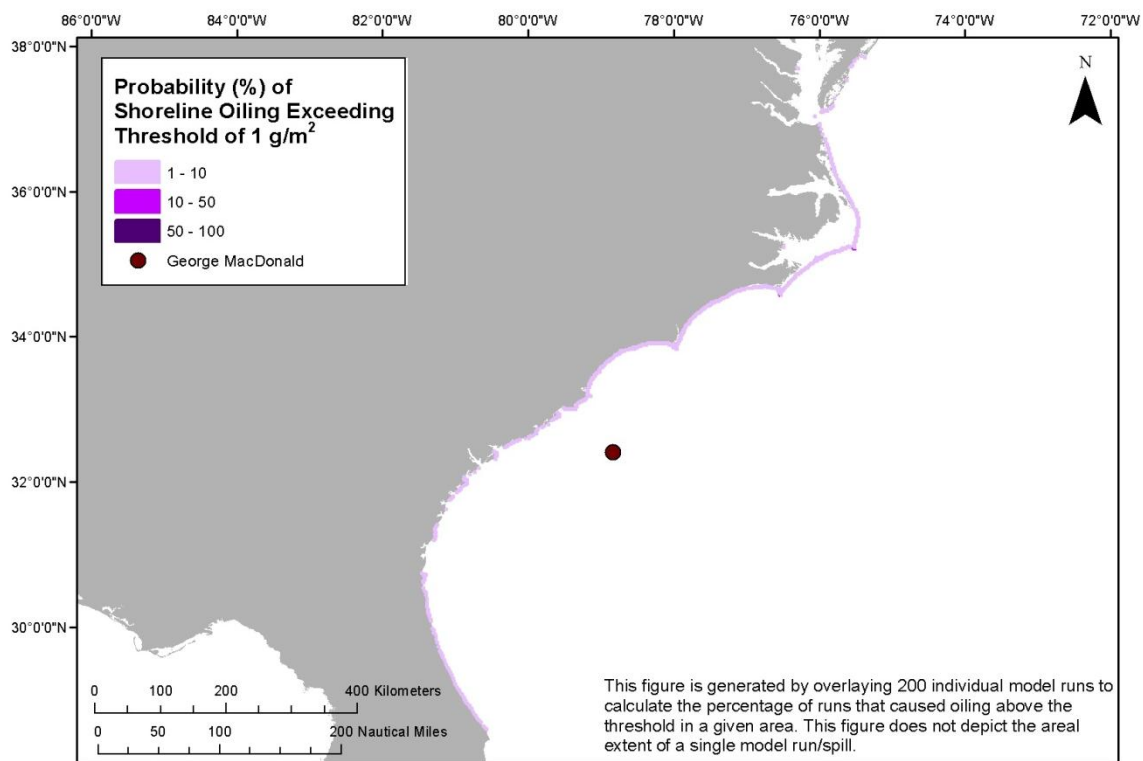
**Figure 2-5:** Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *George MacDonald*, showing both the ecological threshold of 10 g/m<sup>2</sup> and socio-economic threshold of 0.01 g/m<sup>2</sup>.

### Potential Shoreline Impacts

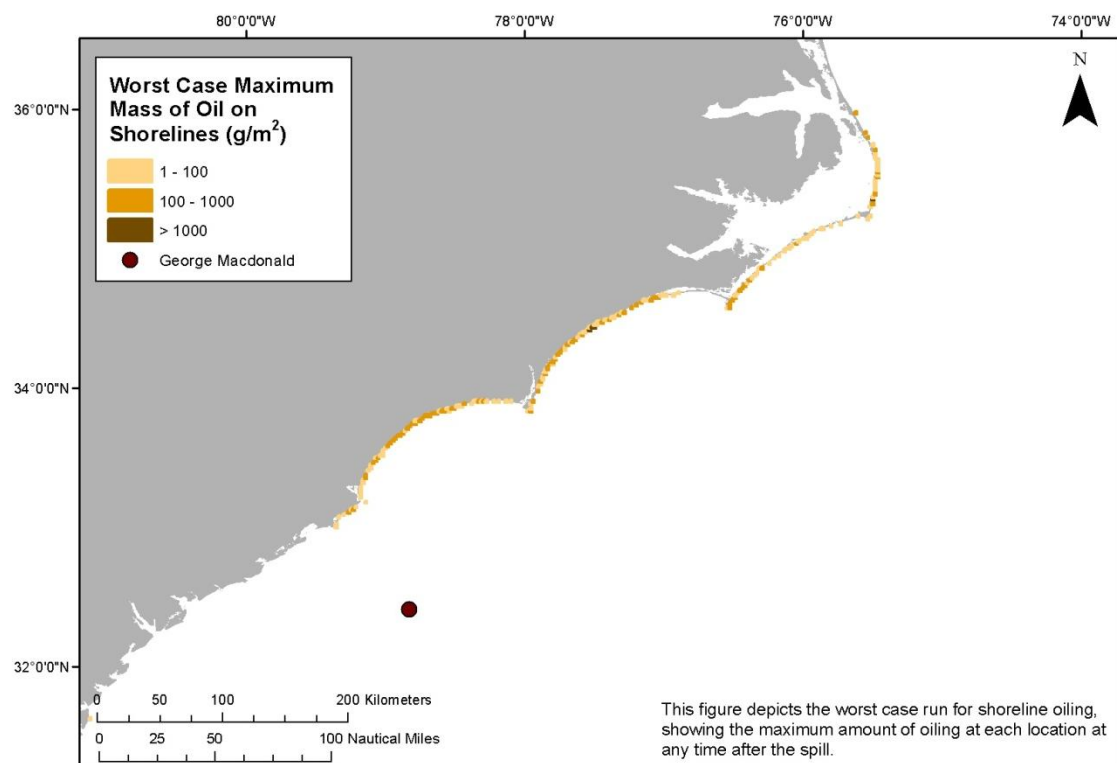
Based on these model results, shorelines from as far north as Maryland, to as far south as Cape Canaveral, Florida are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m<sup>2</sup>, for the Most Probable release of 11,500 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<sup>2</sup> by scenario type are shown in Table 2-4.

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m <sup>2</sup>			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	115	1	25	2	27
Episodic	1,150	2	42	8	52
Most Probable	11,500	2	42	14	58
Large	57,500	2	46	16	64
Worst Case Discharge	115,000	2	49	17	69

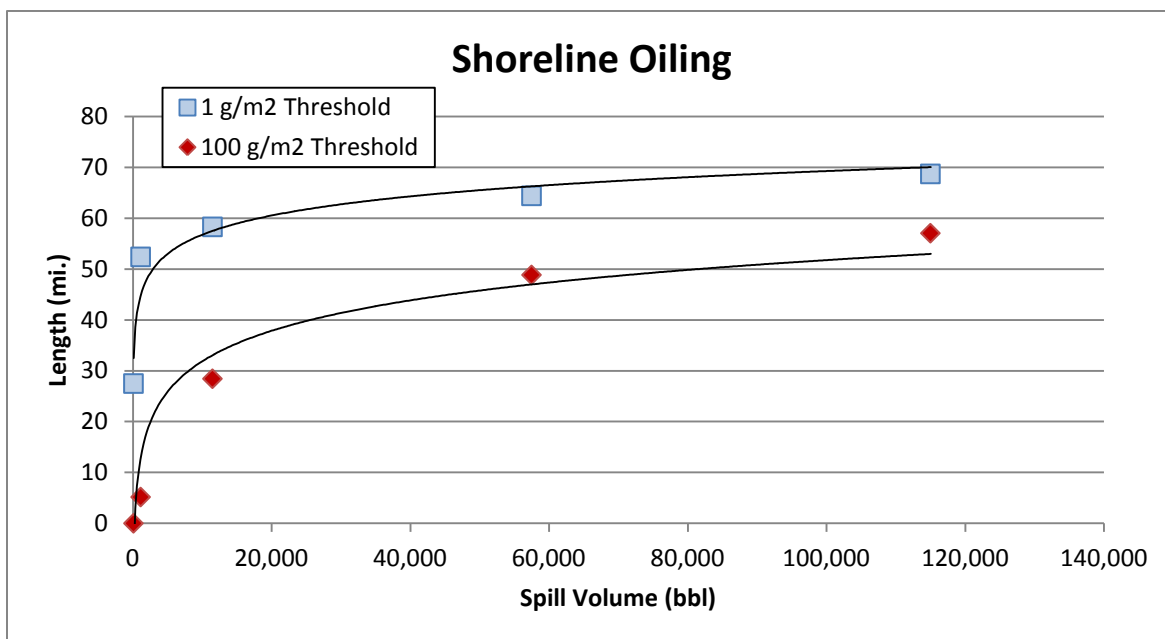


**Figure 2-6:** Probability of shoreline oiling (exceeding 1.0 g/m<sup>2</sup>) from the Most Probable Discharge of 11,500 bbl of a heavy fuel oil from the *George MacDonald*.



**Figure 2-7:** The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 11,500 bbl of a heavy fuel oil from the *George MacDonald* 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 shore length oiled using the five volume scenarios (Fig. 2-8). With 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 *George MacDonald*.

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

**Table 2-5:** Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 115,000 bbl from the *George MacDonald*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m <sup>2</sup>	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m <sup>2</sup>
Rocky and artificial shores/Gravel beaches	9 miles	1 mile
Sand beaches	169 miles	146 miles
Salt marshes and tidal flats	74 miles	37 miles

**Table 2-6:** Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 11,500 bbl from the *George MacDonald*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m <sup>2</sup>	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m <sup>2</sup>
Rocky and artificial shores/Gravel beaches	12 miles	0 miles
Sand beaches	164 miles	0 miles
Salt marshes and tidal flats	64 miles	0 miles

## SECTION 3: ECOLOGICAL RESOURCES AT RISK

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

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

Species Group	Species Subgroup and Geography	Seasonal Presence
<b>Seabirds</b>	Seabirds <ul style="list-style-type: none"> <li>Outer Continental Shelf (OCS) offshore of Cape Hatteras, NC: greatest diversity of seabirds in SE U.S.; greatest density of tropical seabirds in SE U.S. Species include: shearwaters, storm petrels, and Bermuda petrels</li> <li>Significant percentage of the global population of black-capped petrels (FE) may be present in <i>Sargassum</i> mats off Cape Hatteras and Gulf Stream off SE U.S. coast</li> <li>Audubon's shearwaters (50-75% of population) concentrate along the Continental Shelf edge off NC, extending northward to the VA border (~3800 pairs)</li> </ul>	OCS: Ranges by species but Mar-Nov peak  Petrels off NC/VA coast during the summer through early fall and off SE U.S. coast in winter  Shearwaters off of NC/VA: late summer
<b>Pelagic Birds, Waterfowl, and Diving Birds</b>	Coastal pelagic birds, waterfowl, diving birds <ul style="list-style-type: none"> <li>Mouth of Chesapeake Bay has high concentrations of species that are abundant over shoals (e.g. loons, pelicans, cormorants, sea ducks, gulls, terns, alcids); scoters are 10X more abundant than other species</li> <li>Outer Banks, inshore waters NC to VA: Key foraging area for gulls and terns; key migration corridor for loons and sea ducks; NC's largest population of northern gannet and red-breasted merganser</li> <li>Southeastern U.S. inshore/offshore waters: 150K loons, &gt;15K pelicans, thousands of waterfowl, 100s of thousands of cormorants and terns, millions of gulls</li> <li>Important Bird Areas (IBAs) for SC include Cape Romain NWR, Deveaux Bank, and Beaufort barrier islands: Feeding and over-wintering grounds for substantial numbers of waterfowl and sea birds as well as nesting for thousands of brown pelicans</li> <li>Altamaha River Delta, GA: Nesting for &gt;5K brown pelicans</li> </ul>	Winter use of shoals (Dec-Mar); Summer use of shoals likely farther north  Terns, gulls in spring/summer; Loons, sea ducks in spring/fall; Waterfowl, gannets, red-breasted mergansers in winter
<b>Sea Ducks</b>	Sea ducks (includes mean and max distance of flocks to shore, 2009-2010 data) <ul style="list-style-type: none"> <li>Surf scoter - 2 nm/8 nm/Black scoter - 2 nm/13 nm:               <ul style="list-style-type: none"> <li>Off NC: 0-41K surf scoter, 3.5-13K black scoter</li> <li>Off SC/GA: 0-100 surf scoter, 0-15K black scoter</li> </ul> </li> <li>Bufflehead, mergansers, goldeneyes (&lt;1 nm/7-14 nm)               <ul style="list-style-type: none"> <li>Off NC: 12K</li> <li>Off SC/GA: 5K</li> </ul> </li> </ul>	Sea ducks surveyed in winter (peak abundances); Migration from fall to spring (Oct-Apr)
<b>Shorebirds and Colonial Nesting Birds</b>	<ul style="list-style-type: none"> <li>VA Barrier Island/Lagoon System: Most important bird area in VA and one of most along Atl. Coast of No. America: piping plover (FT), Wilson's plover, American oystercatcher, gull-billed tern, least tern, black skimmer; internationally significant stopover point for whimbrel, short-billed dowitcher, and red knot</li> <li>Western Shore VA marshes: Extensive marshes support significant populations of many marsh nesting species</li> </ul>	Winter migration stop for plovers  Colonial and beach nesters peak Apr-Aug  Wading and shorebirds



Species Group	Species Subgroup and Geography	Seasonal Presence
	<ul style="list-style-type: none"> <li>Outer Banks, Cape Hatteras, and Cape Lookout: Globally important for coastal birds with 365+ species</li> <li>Battery and Bald Head Islands, NC: Largest colonies of wading birds in NC; globally significant site with &gt;10K nesting pairs of white ibises</li> <li>Cape Romain NWR, SC: Largest wintering concentration of American oystercatchers on east coast; supports 45% and 70% of SC nesting gull-billed terns and black skimmers, respectively; Western Hemispheric Shorebird Reserve Network of international importance with up to 7K shorebirds per day</li> <li>Deveaux Bank and Edisto ACE Basin NWR: Globally recognized IBAs supporting 1000s of nesting shorebirds including least terns (ST) and Wilson's plovers (ST); &gt;900 foraging wood storks (FE)</li> <li>Bay Point Island IBA: Shorebirds and wading birds year round; wintering populations averaging &gt;5K shorebirds per day of dunlins, dowitchers, western sandpipers, 500 red knots, sanderlings, least terns (ST), Wilson's plovers (ST), and piping plovers (FT)</li> <li>Pinckney Island NWR: Important rookery for white ibis, egrets, and herons</li> <li>GA coast supports significant populations of resident and migratory wading and shorebirds with wading birds most abundant in summer; beach nesting least terns (ST), Wilson's plovers (ST), piping plovers (FT) and American oystercatchers</li> <li>Wassaw NWR and Altamaha River Delta: Heron and egret rookery; migrating/wintering site for piping plovers (FT) and American oystercatchers; nesting habitat for gull-billed, royal, and sandwich terns as well as black skimmers and wood storks (FE)</li> <li>St. Catherines Island and Cumberland Island: Two of the most important feeding/wintering sites on Atlantic coast with thousands of shorebirds and wading birds including least terns (ST), Wilson's plovers (ST), piping plovers (FT), American oystercatchers, and wood storks (FE)</li> <li>Northern FL: Globally recognized IBA (Nassau Sound) for breeding/roosting of threatened and endangered shorebirds; habitat supports numerous neotropical migrants in the spring and fall</li> <li>Cape Canaveral-Merritt Island: Globally recognized IBA supports around 8K wading birds (&gt;150 pairs of wood storks) and 14K neotropical migrants</li> </ul>	typically present year round
<b>Sea Turtles</b>	<p>Nesting (annual counts, by state, along shorelines with most probable impacts)</p> <p>NC nesting</p> <ul style="list-style-type: none"> <li>650+ Loggerhead (FT)</li> <li>&lt;20 Green (FT)</li> <li>&lt;10 Leatherback (FE)</li> </ul> <p>SC nesting</p> <ul style="list-style-type: none"> <li>4000+ Loggerhead (FT)</li> <li>&lt;5 Green sea turtle (FT)</li> <li>&lt;5 Leatherback (FE)</li> </ul> <p>GA nesting</p> <ul style="list-style-type: none"> <li>&lt;2000+ Loggerhead (FT)</li> <li>&lt;5 Green (FT)</li> <li>&lt;15 Leatherback (FE)</li> </ul> <p>FL nesting (Nassau – Brevard County)</p> <ul style="list-style-type: none"> <li>29,000+ Loggerhead (88% in Brevard)</li> <li>6000+ Green (91% in Brevard)</li> <li>&lt;100 Leatherback (77% in Brevard)</li> </ul> <p>Distribution:</p>	<p>Nesting season:</p> <p>Loggerheads/Greens (NC-GA)</p> <p>Adults: May-Aug</p> <p>Hatching: Jul-Oct</p> <p>Loggerheads/Greens (FL)</p> <p>Adults: Apr- Oct</p> <p>Hatching: May-Nov</p> <p>Leatherbacks</p> <p>Adults: Mar-Jul (NC-GA) Feb-Aug (FL)</p> <p>Hatching: May-Oct (NC-GA) Mar-Sep (FL)</p> <p>In water:</p> <p>Year round with Apr-Dec peak</p>

Species Group	Species Subgroup and Geography	Seasonal Presence
	<ul style="list-style-type: none"> <li>Offshore hot spots not well known</li> <li>Young associate with <i>Sargassum</i> mats off Cape Hatteras</li> <li>Bays and sounds are foraging grounds for juvenile green, loggerhead, and Kemp's ridley (FE)</li> </ul>	
<b>Marine Mammals</b>	<p><i>Baleen whales</i>: Primarily North Atlantic right whale (FE) with occasional humpback whale (FE), and minke whales</p> <ul style="list-style-type: none"> <li>Right whales are critically endangered (&lt;400 individuals left) coastal waters in the potential spill area are used as calving grounds</li> </ul> <p><i>Inshore cetaceans</i>: Bottlenose dolphins frequently use coastal waters including creeks, bays, and sounds throughout area</p> <p><i>Offshore cetaceans</i>: Risso's dolphin, striped dolphin, clymene dolphin, Atlantic spotted dolphin, spinner dolphin, short-finned pilot whales, pantropical spotted dolphin</p> <ul style="list-style-type: none"> <li>Often associated with shelf edge features, convergence zones (fronts), and <i>Sargassum</i> mats (summer)</li> </ul> <p><i>Deep diving whales</i>: Sperm whale (FE), pygmy sperm whale, beaked whales (5 species present) forage in deep waters along the shelf</p> <p><i>Pinnipeds and Sirenians</i>:</p> <ul style="list-style-type: none"> <li>Juvenile harbor and hooded seals can sometimes occur as far south as N. FL during the winter</li> <li>West Indian manatees are present year round, concentrated along the FL coast with common summer sightings as far north as NC</li> </ul>	<p>Adults migrate from feeding grounds in North Atlantic to breeding grounds further south in the winter; Right whales with calf Nov-Mar</p> <p>Bottlenose dolphins present year round.</p> <p>Harbor and hooded seals present during the winter;</p> <p>Manatees year round and coastal waters during summer</p>
<b>Fish and Inverts</b>	<p>Coastal ocean waters support many valuable fisheries and/or species of concern in the region:</p> <ul style="list-style-type: none"> <li><i>Benthic or bottom associated</i>: Snapper, grouper, black sea bass, butter fish, goose fish, shrimp (white, pink, brown, and rock), golden crab, and other reef species</li> <li><i>Diadromous</i>: Alewife, blueback herring, American shad, hickory shad, Atlantic tomcod, American eel, Atlantic sturgeon (Fed. species of concern), shortnose sturgeon (FE), and striped bass</li> <li><i>Estuarine dependent</i>: Southern flounder, redfish, spotted seatrout, blue crab, Atlantic croaker, spot, weakfish, shrimp</li> <li><i>Estuarine resident</i>: Eastern oyster</li> </ul> <p>Important concentration/conservation areas are:</p> <ul style="list-style-type: none"> <li>Primary nursery areas in NC bays – for estuarine dependent species</li> <li>Grey's Reef National Marine Sanctuary, GA</li> <li>Numerous artificial reefs off SC, GA, and FL</li> <li><i>Sargassum</i> off Cape Hatteras, NC and Florida is important habitat for juvenile of some pelagic fish species (i.e. dolphinfish, jacks, triggerfish, and juvenile turtles)</li> <li>Striped croakers (NOAA species of concern) occupy nearshore hard bottom habitats from Sebastian Inlet north</li> </ul>	<p>Benthic and midwater species are present throughout the year</p> <p>Bluefin tunas present fall-spring with other pelagic fish present year round</p> <p>Anadromous fish migrate inshore to spawn in fresh water in the spring</p> <p>American eel migrates offshore to spawn in the winter</p> <p>Estuarine dependent fish migrate offshore in the fall/winter to spawn; Juveniles and adults use estuaries during the spring/summer</p>
<b>Benthic Habitats</b>	<p>Submerged aquatic vegetation is critical to numerous species and occurs inside of bays and sounds; greatest concentrations in FL coastal waters</p> <p>Scattered hard-bottom sites are located off NC and are considered Habitat Areas of Particular Concern (HAPC) for reef-associated fishes</p>	<p>Year round</p>

Species Group	Species Subgroup and Geography	Seasonal Presence
	Nearshore hard-bottom habitat off the coast of S. FL between Brevard and Miami-Dade counties	

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

## Ecological Risk Factors

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

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

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

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

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

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

As a reminder, the ecological impact thresholds are: 1 ppb aromatics for water column impacts; 10 g/m<sup>2</sup> for water surface impacts; and 100 g/m<sup>2</sup> 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 *George MacDonald* is provided, both as text and as shading of

the applicable degree of risk bullet, for the WCD release of 115,000 bbl and a border around the Most Probable Discharge of 11,500 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<sup>2</sup> 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<sup>2</sup> of the upper 33 feet of the water column at the threshold level
- **Medium Impact:** impact on 0.2 to 200 mi<sup>2</sup> of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi<sup>2</sup> of the upper 33 feet of the water column at the threshold level

The *George MacDonald* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 115,000 bbl because 100% of the model runs resulted in contamination of more than 0.2 mi<sup>2</sup> of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 41 mi<sup>2</sup> of the upper 33 feet of the water column. For the Most Probable Discharge of 11,500 bbl, the *George MacDonald* is classified as Low Risk for oiling probability for water column ecological resources because 2% of the model runs resulted in contamination of more than 0.2 mi<sup>2</sup> 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 <1 mi<sup>2</sup> 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<sup>2</sup> (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<sup>2</sup> 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<sup>2</sup> of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi<sup>2</sup> of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi<sup>2</sup> of water surface impact at the threshold level

The *George MacDonald* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 100% of the model runs resulted in at least 1,000 mi<sup>2</sup> of the water surface affected above the threshold of 10 g/m<sup>2</sup>. It is classified as High Risk for degree of oiling because the mean area of water contaminated was 61,800 mi<sup>2</sup>. The *George MacDonald* is classified as High Risk for oiling probability for the Most Probable Discharge because 100% of the model runs resulted in at least 1,000 mi<sup>2</sup> of the water surface affected above the threshold of 10 g/m<sup>2</sup>. It is also classified as High Risk for degree of oiling because the mean area of water contaminated was 18,500 mi<sup>2</sup>.

#### 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<sup>2</sup> (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<sup>2</sup> 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 *George MacDonald* is classified as Medium Risk for oiling probability for shoreline ecological resources for the WCD because 32% of the model runs resulted in shorelines affected above the threshold of 100 g/m<sup>2</sup>. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 80 miles. The *George MacDonald* is classified as Medium Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 29% of the model runs resulted in shorelines affected above the threshold of 100 g/m<sup>2</sup>. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 32 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 115,000 bbl of heavy fuel oil from the *George MacDonald* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Medium, because the area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – High, because of the very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk, sea turtle concentrations in *Sargassum* habitat, and the persistence of tarballs that can be transported long distances. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because most of the shoreline at risk is composed of sand beaches which are relatively easy to clean, although these beaches are used by many shorebirds and sea turtles for nesting and many shorebirds as wintering and migratory stopovers

**Table 3-2:** Ecological risk factor scores for the **Worst Case Discharge of 115,000 bbl** of heavy fuel oil from the *George MacDonald*.

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 <sup>2</sup> 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 41 mi <sup>2</sup> 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 <sup>2</sup> of water surface covered by at least 10 g/m <sup>2</sup>	High
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	High	The mean area of water contaminated above 10 g/m <sup>2</sup> was 61,800 mi <sup>2</sup>	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	32% of the model runs resulted in shoreline oiling of 100 g/m <sup>2</sup>	Med
3C-2: Shoreline Degree EcoRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 100 g/m <sup>2</sup> was 80 mi	



For the Most Probable Discharge of 11,500 bbl, the ecological risk from potential releases from the *George MacDonald* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because of the very small area of water column impacts
- Water surface resources – High, because of the very large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk, sea turtle concentrations in *Sargassum* habitat, and the persistence of tarballs that can be transported long distances. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because most of the shoreline at risk is composed of sand beaches which are relatively easy to clean, although these beaches are used by many shorebirds and sea turtles for nesting and many shorebirds as wintering and migratory stopovers

**Table 3-3: Ecological risk factor scores for the Most Probable Discharge of 11,500 bbl of heavy fuel oil from the *George MacDonald*.**

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	2% of the model runs resulted in at least 0.2 mi <sup>2</sup> 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 <1 mi <sup>2</sup> 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 <sup>2</sup> of water surface covered by at least 10 g/m <sup>2</sup>	High
3B-2: Water Surface Degree EcoRAR Oiling	Low	Medium	High	The mean area of water contaminated above 10 g/m <sup>2</sup> was 18,500 mi <sup>2</sup>	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	29% of the model runs resulted in shoreline oiling of 100 g/m <sup>2</sup>	Med
3C-2: Shoreline Degree EcoRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 100 g/m <sup>2</sup> was 32 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 *George MacDonald* include very highly utilized recreational beaches from Maryland to northeastern Florida during summer, and are still in use during spring and fall for shore fishing. Four national seashores, nineteen national wildlife refuges, and two coastal national monuments could potentially be affected. Many areas along the entire potential spill zone contain popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. The Gray's Reef National Marine Sanctuary off the Georgia coast could also potentially be affected, along with a large number of coastal state parks.

A release could impact shipping lanes to several ports that could be impacted by a release with a total of nearly 9,000 annual port calls annually with a total of over 382 million tonnage. Commercial fishing is economically important to the region. A release could impact fishing fleets from Maryland to Florida where regional commercial landings for 2010 exceeded \$137 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.

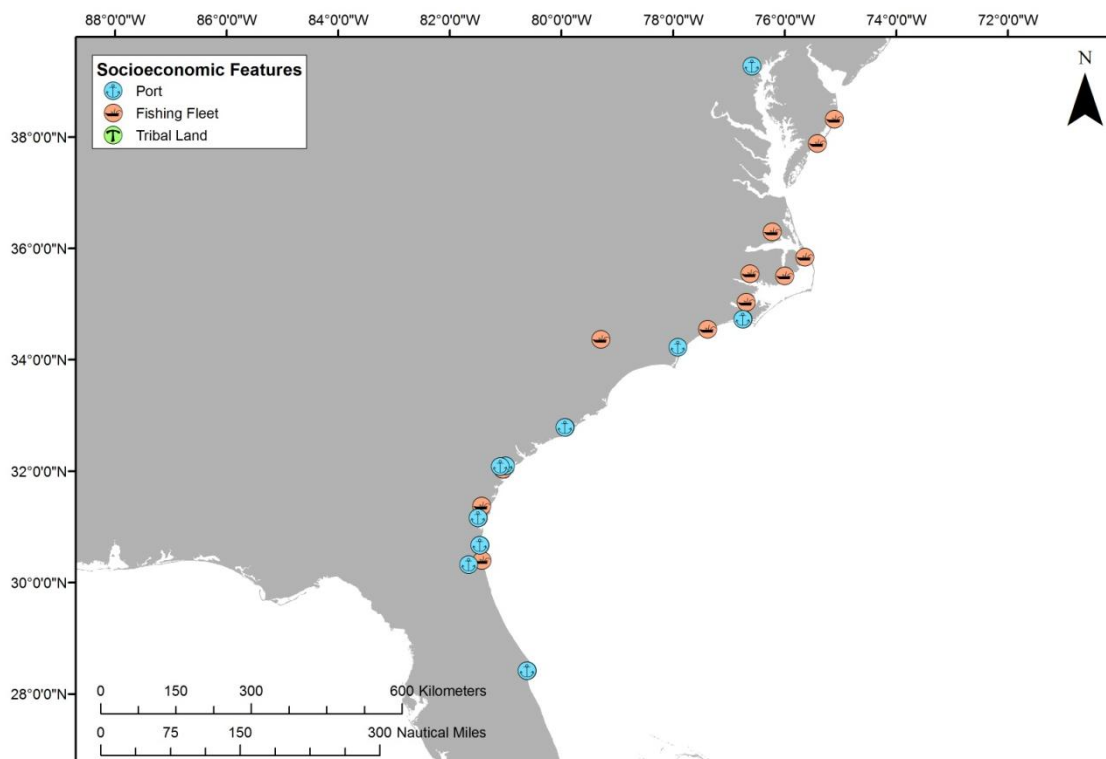
Spill response costs for a release of oil from the *George MacDonald* would be dependent on volume of oil released and specific areas impacted. The specific shoreline impacts and spread of the oil would determine the response required and the costs for that response.

**Table 4-1:** Socio-economic resources at risk from a release of oil from the *George MacDonald*.

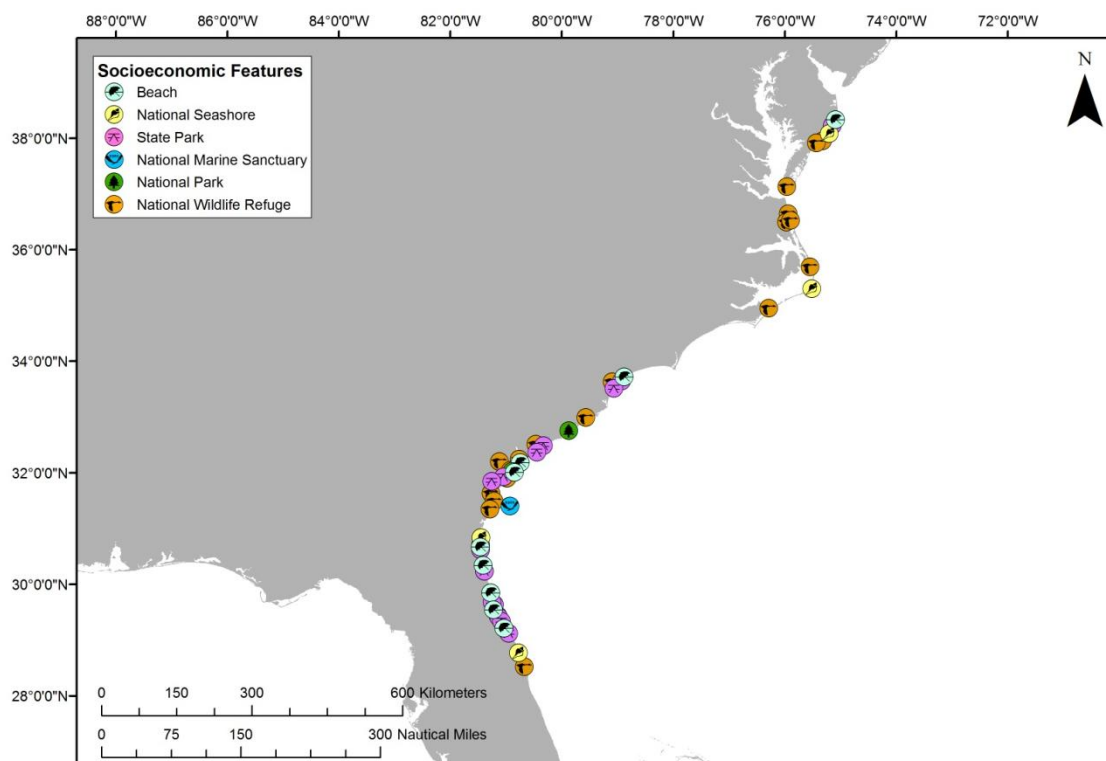
Resource Type	Resource Name	Economic Activities
<b>Tourist Beaches</b>	Ocean City, MD Myrtle Beach, SC Hilton Head Island, SC Tybee Island, GA Fernandina Beach, FL Atlantic Beach, FL St. Augustine Beach, FL Daytona Beach, FL Palm Coast, FL	Potentially affected beach resorts and beach-front communities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

Resource Type	Resource Name	Economic Activities
	MD/VA Cumberland Isl. National Seashore, GA Canaveral National Seashore, FL Chincoteague National Wildlife Refuge, VA	natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area. Assateague Island is known for its feral horses. Cape Hatteras is known for its Bodie Island and Cape Hatteras Lighthouses. Popular recreation activities include windsurfing, bird watching, fishing, shell collecting, and kayaking.
<b>National Parks</b>	Fort Pulaski National Monument, GA Fort Sumter, National Monument, SC	Two coastal national historic monuments provide education in Civil War history.
<b>National Wildlife Refuges</b>	Chincoteague NWR (VA) Wallops Island NWR (VA) Eastern Shore of Virginia NWR (VA) Back Bay NWR (VA) Mackay Island NWR (NC) Currituck NWR (NC) Pea Island NWR (NC) Cedar Island NWR (NC) Waccamaw NWR (SC) Cape Romain NWR (SC) Ernest F. Hollings ACE Basin NWR (SC) Pickney Island NWR (SC) Savannah NWR (SC) Tybee NWR (SC) Wassaw NWR (GA) Harris Neck NWR (GA) Blackbeard Island NWR (GA) Wolf Island NWR (GA) Merritt Island NWR (FL)	National wildlife refuges in five states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.
<b>State Parks</b>	Assateague SP, MD Myrtle Beach SP, SC Huntington Beach SP, SC Edisto Beach SP, SC Hunting Island SP, SC Skidaway Island SP, GA Fort McAllister SP, GA Bulow Plantation Ruins SP, FL Washington Oaks Gardens SP, FL Amelia Island SP, FL Fort Clinch SP, FL Guana River SP, FL Anastasia SP, FL Faver-Dykes SP, FL Green Mound Archaeological SP, FL Bulow Creek SP, FL Tomoka SP, FL	Coastal state parks are significant recreational resources for the public (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). They provide income to the states. State parks in several states are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
<b>Commercial Fishing</b>	A number of fishing fleets use potentially affected waters for commercial fishing.	
	Chincoteague, Virginia	Total Landings (2010): \$3.5M
	Ocean City, Maryland	Total Landings (2010): \$8.8M
	Chincoteague, Virginia	Total Landings (2010): \$3.5M
	Beaufort-Morehead City, NC	Total Landings (2010): \$9.2M
	Belhaven-Washington, NC	Total Landings (2010): \$3.7M
	Elizabeth City, NC	Total Landings (2010): \$5.4M
	Engelhard-Swanquarter, NC	Total Landings (2010): \$10.6M

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



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

## 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<sup>2</sup> for water surface impacts; and 1 g/m<sup>2</sup> for shoreline impacts.

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, in the text classification for the *George MacDonald*, shading indicates the degree of risk for a WCD release of 115,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 11,500 bbl.

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

This risk factor reflects the probability that at least 0.2 mi<sup>2</sup> 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<sup>2</sup> of the upper 33 feet of the water column at the threshold level
- **Medium Impact:** impact on 0.2 to 200 mi<sup>2</sup> of the upper 33 feet of the water column at the threshold level
- **High Impact:** impact on more than 200 mi<sup>2</sup> of the upper 33 feet of the water column at the threshold level

The *George MacDonald* 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 115,000 bbl because 100% of the model runs resulted in contamination of more than 0.2 mi<sup>2</sup> of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 41 mi<sup>2</sup> of the upper 33 feet of the water column. For the Most Probable Discharge of 11,500 bbl, the *George MacDonald* is classified as Low Risk for oiling probability for water column socio-economic resources because 2% of

the model runs resulted in contamination of more than 0.2 mi<sup>2</sup> 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 mi<sup>2</sup> 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<sup>2</sup> 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<sup>2</sup> (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<sup>2</sup> of water surface impact at the threshold level
- **Medium Impact:** 1,000 to 10,000 mi<sup>2</sup> of water surface impact at the threshold level
- **High Impact:** more than 10,000 mi<sup>2</sup> of water surface impact at the threshold level

The *George MacDonald* 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<sup>2</sup> of the water surface affected above the threshold of 0.01 g/m<sup>2</sup>, and the mean area of water contaminated was 61,800 mi<sup>2</sup>. The *George MacDonald* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 99% of the model runs resulted in at least 1,000 mi<sup>2</sup> of the water surface affected above the threshold of 0.01 g/m<sup>2</sup>. It is classified as High Risk for degree of oiling because the mean area of water contaminated was 18,500 mi<sup>2</sup>.

#### 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<sup>2</sup> (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 *George MacDonald* is classified as Medium Risk for oiling probability for shoreline socio-economic resources for the WCD because 35% of the model runs resulted in shorelines affected above the threshold of 1 g/m<sup>2</sup>. It is classified as High Risk for degree of oiling because the mean length of weighted shoreline contaminated was 168 miles. The *George MacDonald* is classified as Medium Risk for oiling probability and High Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 34% of the model runs resulted in shorelines affected above the threshold of 1 g/m<sup>2</sup>, and the mean length of weighted shoreline contaminated was 143 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 115,000 bbl of heavy fuel oil from the *George MacDonald* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Low, because of the low level of soluble fractions in the heavy fuel oil that would create a relatively small area of impact offshore
- Water surface resources – High, because the heavy fuel oil would spread over a large area, which would impact shipping lanes and other offshore activities. 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 relatively moderate amount of shoreline would be impacted with the persistent oil and tarballs and would be relatively easy to clean, although there are a large number of potentially vulnerable socio-economic resources located along the shoreline

**Table 4-2:** Socio-economic risk factor ranks for the **Worst Case Discharge of 115,000 bbl** of heavy fuel oil from the *George MacDonald*.

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 <sup>2</sup> 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 41 mi <sup>2</sup> 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 <sup>2</sup> of water surface covered by at least 0.01 g/m <sup>2</sup>	High
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m <sup>2</sup> was 61,800 mi <sup>2</sup>	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	35% of the model runs resulted in shoreline oiling of 1 g/m <sup>2</sup>	Med
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m <sup>2</sup> was 168 mi	

For the Most Probable Discharge of 11,500 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *George MacDonald* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Low, because of the low level of soluble fractions in the heavy fuel oil that would create a relatively small area of impact offshore
- Water surface resources – High, because the heavy fuel oil would spread over a large area, which would impact shipping lanes and other offshore activities. 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 relatively moderate amount of shoreline would be impacted with the persistent oil and tarballs and would be relatively easy to clean, although there are a large number of potentially vulnerable socio-economic resources located along the shoreline

**Table 4-3:** Socio-economic risk factor ranks for the **Most Probable Discharge of 11,500 bbl** of heavy fuel oil from the *George MacDonald*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	2% of the model runs resulted in at least 0.2 mi <sup>2</sup> 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 mi <sup>2</sup> of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	99.5% of the model runs resulted in at least 1,000 mi <sup>2</sup> of water surface covered by at least 0.01 g/m <sup>2</sup>	High
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m <sup>2</sup> was 18,500 mi <sup>2</sup>	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	34% of the model runs resulted in shoreline oiling of 1 g/m <sup>2</sup>	Med
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m <sup>2</sup> was 143 mi	

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

The overall risk assessment for the *George MacDonald* 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. As noted in Sections Three and Four, each of the ecological and socio-economic risk factors each has two components, probability and degree. Of those two, degree is given more weight in deciding the combined score for an individual factor, e.g., a high probability and medium degree score would result in a medium overall for that factor.

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

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

For the Worst Case Discharge, the *George MacDonald* scores High with 16 points; for the Most Probable Discharge, *George MacDonald* also scores High with 15 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team (RRT) 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 *George MacDonald*. The final determination rests with the U.S. Coast Guard.

<i>George MacDonald</i>	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

As noted in the Archaeological Assessment, this vessel may be of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) prior to any actions that could impact the integrity of the vessel.

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

Vessel Risk Factors		Data Quality Score	Comments	Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	High	Maximum of 105,360 bbl, not reported to be leaking	High	
	A2: Oil Type	High	Cargo is heavy fuel oil, a Group IV oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	No fire was reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Foundered due to flooding		
	D2: Structural Breakup	Low	Unknown whether the vessel broke up		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records of this ship exist, assessment is believed to be very accurate	Not Scored	
Operational Factors	Wreck Orientation	Low	Unknown	Not Scored	
	Depth	Low	≈ 450 feet		
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location unknown		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	No		
	Gravesite (Civilian/Military)	High	No		
	Historical Protection Eligibility (NHPA/SMCA)	Low	Unknown		
				WCD	Most Probable
Ecological Resources	3A: Water Column Resources	High	Heavy fuel oil has low water-soluble fractions that are quickly diluted in open water settings where most resources are highly mobile and able to avoid exposure	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 <i>Sargassum</i>	High	High
	3C: Shore Resources	High	Persistent tarballs strand on beaches and marshes, fouling habitats and animals	Med	Med
Socio-Economic Resources	4A: Water Column Resources	High	Relatively small area of water column impacted due to nature of heavy fuel oil	Low	Low
	4B: Water Surface Resources	High	A large area would be covered with tarballs and oil affecting shipping lanes and other offshore activities	High	High
	4C: Shore Resources	High	There are a large number of potentially vulnerable socio-economic resources located along the shoreline.	Med	Med
Summary Risk Scores				16	15