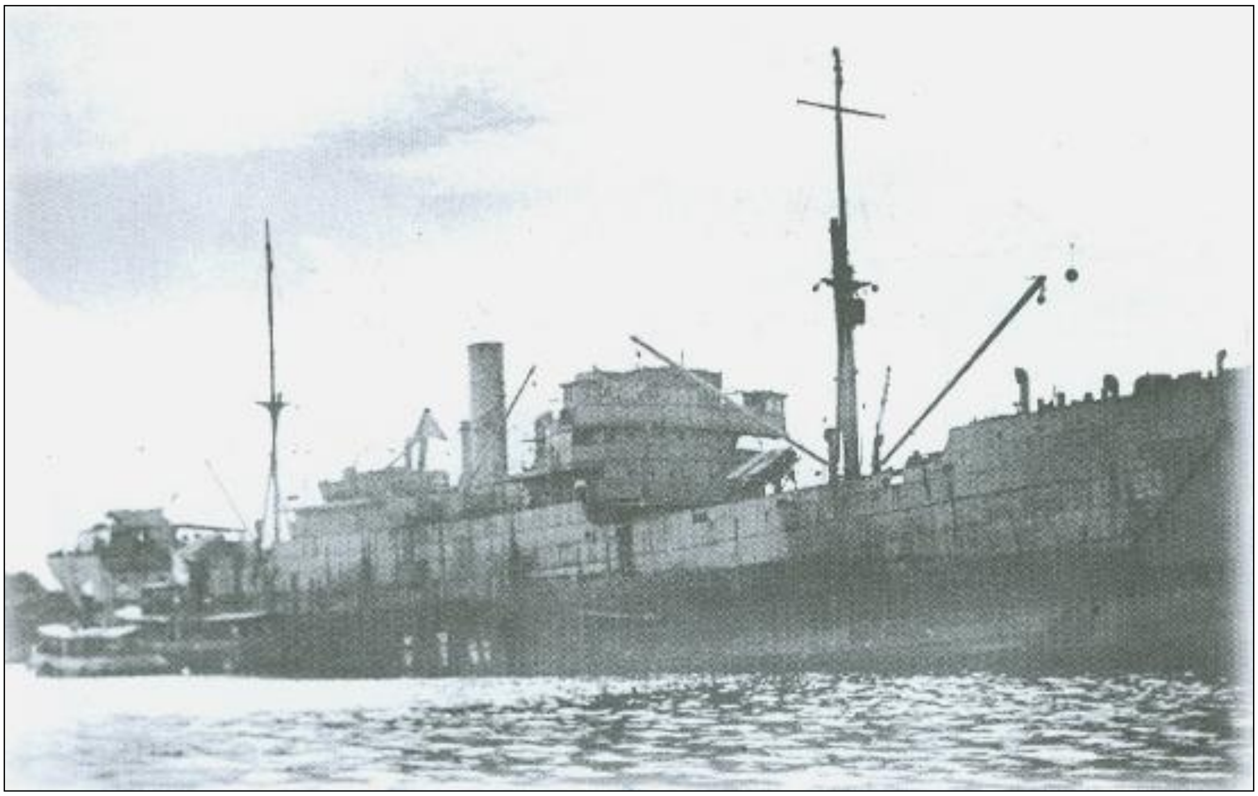
rOffice of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Cornwallis



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National Oceanic and
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Photo: Photograph of *Cornwallis*
Source: http://www.uboat.net/allies/merchants/ships/3382.html

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Project Background

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

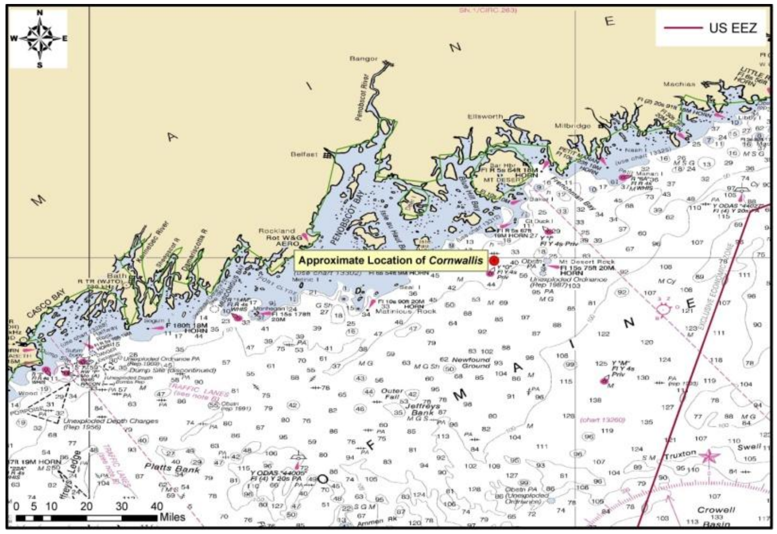
In order to narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to identify the most ecologically and economically significant potentially polluting wrecks in U.S. waters. This project supports the U.S. Coast Guard and the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

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

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

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

Executive Summary: *Cornwallis*



The freighter *Cornwallis*, torpedoed and sunk during World War II off the coast of Maine in 1944, 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 *Cornwallis*, 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.

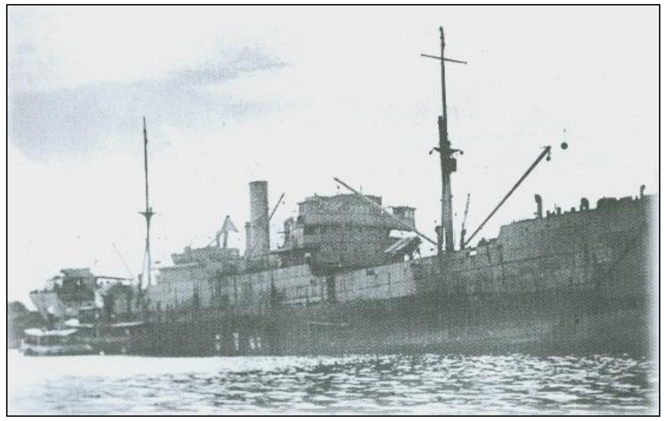
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Cornwallis* scores High with 15 points; for the Most Probable Discharge (10% of the Worse Case volume), *Cornwallis* scores Low with 11 points. Given these scores, NOAA would typically recommend that this site be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action. However, given that the location of this vessel is unknown, NOAA recommends that surveys of opportunity with state, federal, or academic entities be used to attempt to locate this vessel and that general notations are made in Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the general area where the vessel is believed lost.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	Low	Low
	3B: Water Surface Resources	High	Med
	3C: Shore Resources	Med	Med
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	High	Med
	4C: Shore Resources	High	Med
Summary Risk Scores		15	11

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: *Cornwallis*

Official Number: Unknown

Vessel Type: Freighter

Vessel Class: Unknown

Former Names: *Canadian Transporter*

Year Built: 1921

Builder: J. Coughlan & Sons, Ltd., Vancouver BC

Builder's Hull Number: 20

Flag: Canadian

Owner at Loss: Canadian National Steamship Company of Montreal, Canada

Controlled by: Unknown **Chartered to:** Unknown

Operated by: Canadian National Steamship Company of Montreal, Canada

Homeport: Vancouver, B.C.

Length: 400 feet **Beam:** 52 feet **Depth:** 28 feet

Gross Tonnage: 5,458 **Net Tonnage:** 3,352

Hull Material: Steel **Hull Fastenings:** Riveted **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): 0 **Dry Cargo Capacity:** Unknown

Tank or Hold Description: Unknown

Casualty Information

Port Departed: Barbados

Destination Port: St. John, New Brunswick, Canada

Date Departed: November 20, 1944

Date Lost: December 3, 1944

Number of Days Sailing: ≈ 14

Cause of Sinking: Act of War (Torpedo)

Latitude (DD): 43.9833

Longitude (DD): -68.3333

Nautical Miles to Shore: 7

Nautical Miles to NMS: 135

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 300

Bottom Type: Sand/silt/clay

Is There a Wreck at This Location? Unknown, the wreck does not appear to have ever been located or surveyed

Wreck Orientation: Unknown

Vessel Armament: Vessel was armed with one 4-inch gun, one 12-pounder, 2 Oerlichons, and two machine guns

Cargo Carried when Lost: Bagged sugar and molasses in bbl

Cargo Oil Carried (bbl): 0

Cargo Oil Type: N/A

Probable Fuel Oil Remaining (bbl): ≤ 10,000

Fuel Type: Heavy fuel oil (Bunker C)

Total Oil Carried (bbl): ≤10,000

Dangerous Cargo or Munitions: Yes

Munitions Carried: Munitions for onboard weapons

Demolished after Sinking: Unknown

Salvaged: No

Cargo Lost: Yes

Reportedly Leaking: No

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

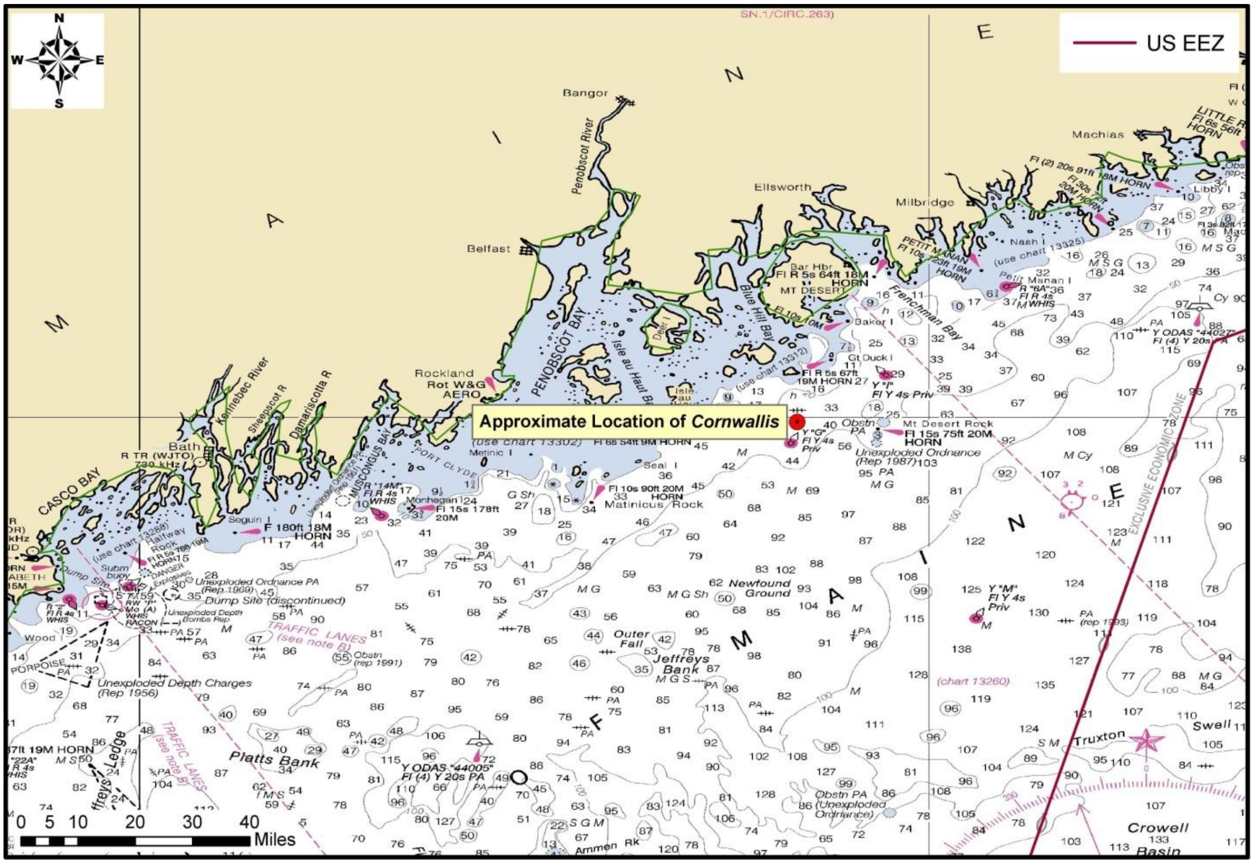


Chart Number: 13003

Casualty Narrative

"At 10.00 hours on 3 Dec, 1944, the unescorted *Cornwallis* (Master Emerson Horace Robinson) was torpedoed and sunk by a Gnat from *U-1230* 10 miles southwest of Mount Desert Rock in the Gulf of Maine. The master, 35 crew members and seven gunners were lost. Five survivors were picked up by the fishing vessel *Notre Dame* and landed at Rockland, Maine."
http://www.uboat.net:8080/allies/merchants/ships/3382.html

General Notes

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

DESCRIPTION

24 NO.206; CARGO, 5458 GT, SUNK 12/3/44 BY SUBMARINE; POSITION ACCURACY 1-3 MILES; REPORTED THRU SR ON 12/3/44.
27 NO.825; CARGO, 5458 GT, SUNK 12/3/44. POSITION IS APPROXIMATE
SURVEY REQUIREMENTS
NOT DETERMINED

Wreck Condition/Salvage History

Unknown; the wreck does not appear to have ever been located or surveyed. It should be noted, however, that a portion of this ship was blasted off by a torpedo in a harbor in Barbados in 1942 and is now part of a snorkel and scuba park in Barbados. Many of the snorkeling and scuba diving websites in Barbados make it sound like the entire ship is still in the harbor, but this is not the case. Only a small part of the ship remains in Barbados and the entire ship was indeed torpedoed and lost off the coast of Maine in 1944.

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

Little historic documentation on the sinking of the Canadian freighter *Cornwallis* has been located and no site reports exist that would allow NOAA archaeologists to provide much additional archaeological assessment about the shipwreck on top of the casualty narrative included in this packet. We do know from archival research that the ship was struck on the starboard side near the number one hold by one torpedo. The blast of this torpedo blew the hatch cover off the number one cargo hold and caused the ship to sink by the bow within ten minutes. Survivors of the attack reported that no fires broke out on the ship before it sank. After the ship sank, a local fishing crew aboard the vessel *Iva M* reported, “We are about 8 miles west northwest of Mount Desert. There are a lot of bodies and bbl floating around here.” Although no oil was reported in the water, rescue efforts were postponed due to darkness and poor weather conditions that may have prevented oil from being observed.

Based on the location of the torpedo damage, the vessel’s bunker tanks probably were not damaged by the initial blast. Since the vessel was travelling from Barbados to St. John, New Brunswick, Canada, however, it is likely that much of the ship’s bunkers had already been consumed by the time the ship was lost. Since the shipwreck has never been discovered, it is not possible to determine with any degree of accuracy what the current condition of the wreck is and how likely the vessel is to contain oil. Since this attack occurred towards the end of WWII, at a time when U-boat attacks in American waters were rare, the wreck may not have been depth charged and destroyed as an unidentified sonar contact and could presumably remain relatively structurally intact. Alternatively, the force of the ship striking the seafloor, the amount of time the ship has remained submerged, and local fishing activity may have resulted in severe structural damages to the ship.

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

Background Information References

Vessel Image Sources: http://www.uboat.net/allies/merchants/ships/3382.html

Construction Diagrams or Plans in RULET Database? No

Text References:

-Office of the Chief of Naval Operations
1942 Tenth Fleet ASW Analysis & Stat. Section Series XIII. Report and Analyses of U. S. and Allied Merchant Shipping Losses 1941-1945 Columbia - Dekabrist, Records of the Office of the Chief of Naval Operations, Box 220, Record Group 38, National Archives at College Park, MD.

http://www.uboat.net/allies/merchants/ships/3382.html

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Cornwallis* 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 <u>*does not*</u> 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 either 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.

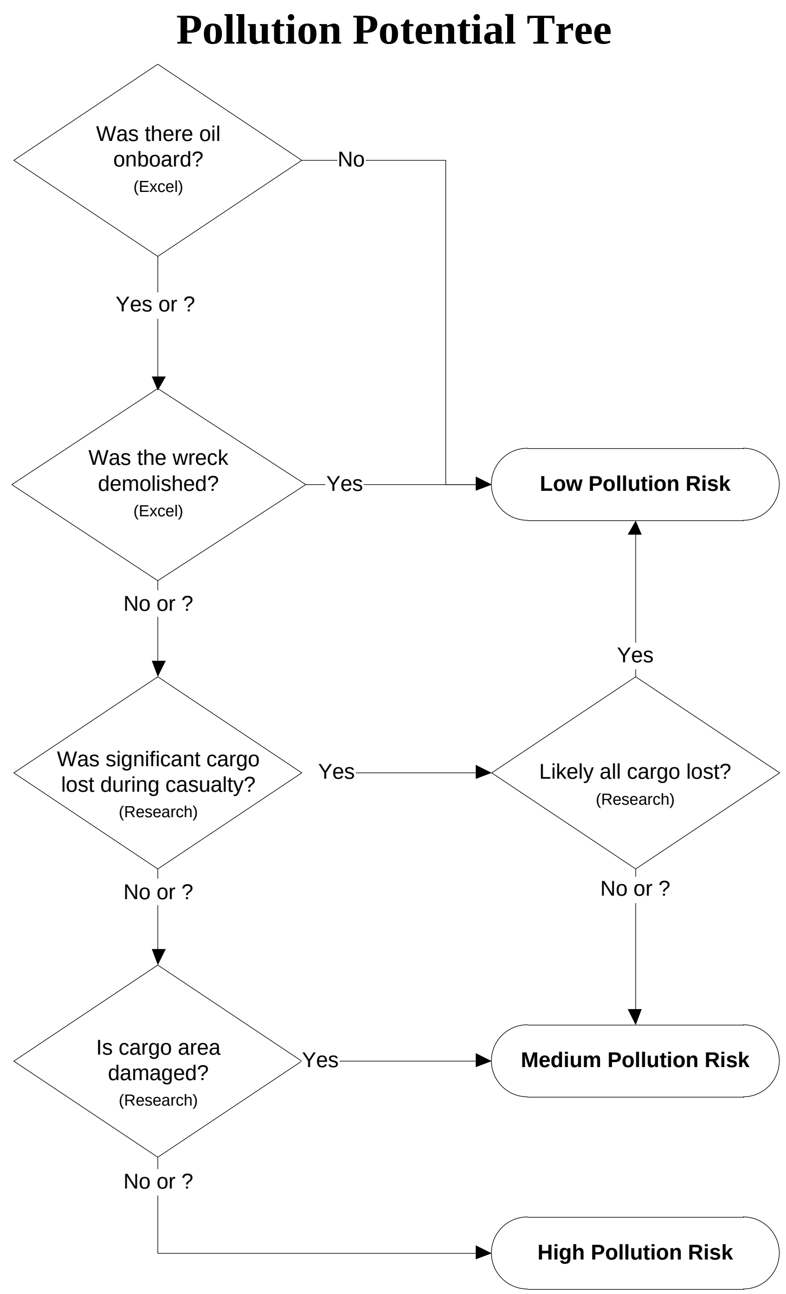


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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 *Cornwallis* 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 *Cornwallis i*s ranked as High Volume because it is thought to have a potential for up to 10,000 bbl, although some of that may have been lost at the time of the casualty due to the explosion or since the vessel sank. Data quality is medium.

The risk factor for volume also incorporates any reports or anecdotal evidence of actual leakage from the vessel or reports from divers of oil in the overheads, as opposed to potential leakage. This reflects the history of the vessel's leakage. There are no reports of leakage from the *Cornwallis*.

Risk Factor A2: Oil Type

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

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

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

The *Cornwallis* is classified as High Risk because the bunker oil 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 *Cornwallis* 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 *Cornwallis* 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 *Cornwallis* is classified as High Risk because no oil was reported to have spread across the water as the vessel went down. Data quality is high.

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

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

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

The *Cornwallis* is classified as Medium Risk because there was only one torpedo detonation. 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 *Cornwallis* is classified as Unknown Risk because it is not known if the vessel broke apart after sinking since the location is unknown. Data quality is low.

Factors That May Impact Potential Operations

Orientation (degrees)

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

The location of the *Cornwallis* 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 *Cornwallis* is believed to be around 300 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 *Cornwallis* 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 *Cornwallis* had munitions for onboard weapons, one 4-inch gun, one 12-pounder, two Oerlichons, and two machine guns. Data quality is high.

Vessel Risk Factors Summary

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

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

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 10,000 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Bunker oil 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	No oil was reported on the water	
	D1: Nature of Casualty	High	One torpedo impact	
	D2: Structural Breakup	Low	Unknown structural breakup	
Archaeological Assessment	Archaeological Assessment	Medium	Limited additional historical information has been located, and no site reports exist, assessment is believed to have low accuracy	**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown, wreck not located	**Not Ranked**
	Depth	Low	Approximately 300 feet	
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location not known	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	Weapons for onboard weapons	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

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

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Cornwallis* this would be about 10,000 bbl based on current estimates of the maximum amount of oil remaining onboard the wreck.

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

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

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

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

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

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	10 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	100 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	1,000 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	5,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	10,000 bbl	One-time release	Over several hours or days	Least likely	Tier 3

The modeling results represent 200 simulations for each spill volume with variations in spill trajectory based on winds and currents. The spectrum of the simulations gives a perspective on the variations in likely impact scenarios. Some resources will be impacted in nearly all cases; some resources may not be impacted unless the spill trajectory happens to go in that direction based on winds and currents at the time of the release and in its aftermath.

For the large and WCD scenarios, the duration of the release was assumed to be 12 hours, envisioning a storm scenario where the wreck is damaged or broken up, and the model simulations were run for a period of 30 days. The releases were assumed to be from a depth between 2-3 meters above the sea floor, using the information known about the wreck location and depth. It is important to acknowledge that these scenarios are only for this screening-level assessment. Detailed site/vessel/and seasonally specific modeling would need to be conducted prior to any intervention on a specific wreck.

Oil Type for Release

The *Cornwallis* contained a maximum of 10,000 bbl of heavy fuel oil (a Group IV oil) as bunker fuel oil. Thus, the oil spill model was run using heavy fuel oil.

Oil Thickness Thresholds

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

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

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

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

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

Oil Description	Oil Appearance	Approximate Sheen Thickness		No. of 1 inch Tarballs	Threshold/Risk Factor
Oil Sheen/Tarballs	Dull Colors	0.001 mm	1 g/m^2	~0.12-0.14 tarballs/m^2	Socio-economic Impacts to Shoreline Users/Risk Factor 4C-1 and 2
Oil Slick/Tarballs	Brown to Black	0.1 mm	100 g/m^2	~12-14 tarballs/m^2	Ecological Impacts to Shoreline Habitats/Risk Factor 3C-1 and 2

Potential Impacts to the Water Column

Impacts to the water column from an oil release from the *Cornwallis* will be determined by the volume of leakage. Because oil from sunken vessels will be released at low pressures, the droplet sizes will be large enough for the oil to float to the surface. Therefore, impacts to water column resources will result from the natural dispersion of the floating oil slicks on the surface, which is limited to about the top 33 feet. The metric used for ranking impacts to the water column is the area of water surface in mi^2 that has been contaminated by 1 part per billion (ppb) oil to a depth of 33 feet. At 1 ppb, there are likely to be impacts to sensitive organisms in the water column and potential tainting of seafood, so this concentration is used as a screening threshold for both the ecological and socio-economic risk factors for water column resource impacts. To assist planners in understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water column volume oiled using the five volume scenarios, which is shown in Figure 2-1. Using this figure, the water column impacts can be estimated for any spill volume. Note that the water column impact decreases for the worst case discharge spill volume, because a significant amount of oil is removed from the water column due to sedimentation in the modeling results. Increased sedimentation will increase impacts to benthic habitats.

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

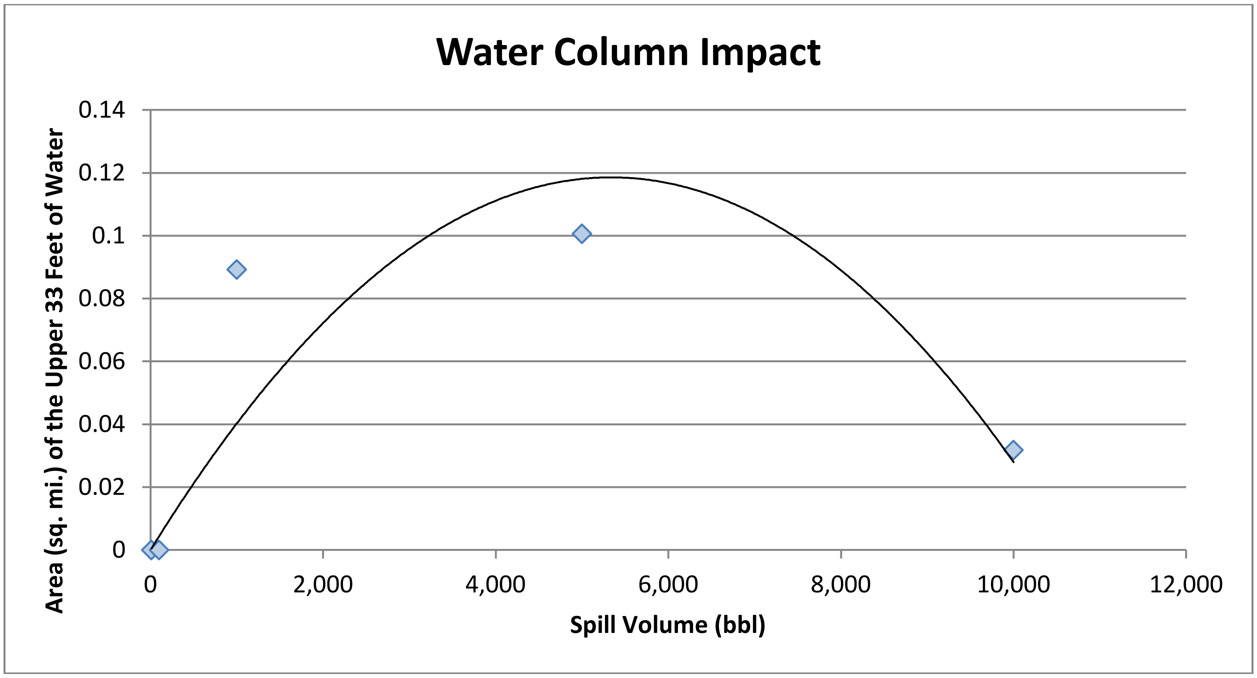


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Cornwallis*.

Potential Water Surface Slick

The slick size from an oil release from the *Cornwallis* 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. The slick will not be continuous but rather be broken and patchy. Surface expression is likely to be in the form of sheens, tarballs, and streamers.

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

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	10	160 mi^2	160 mi^2
Episodic	100	520 mi^2	520 mi^2
Most Probable	1,000	1,700 mi^2	1,700 mi^2
Large	5,000	4,200 mi^2	4,200 mi^2
Worst Case Discharge	10,000	6,200 mi^2	6,200 mi^2

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

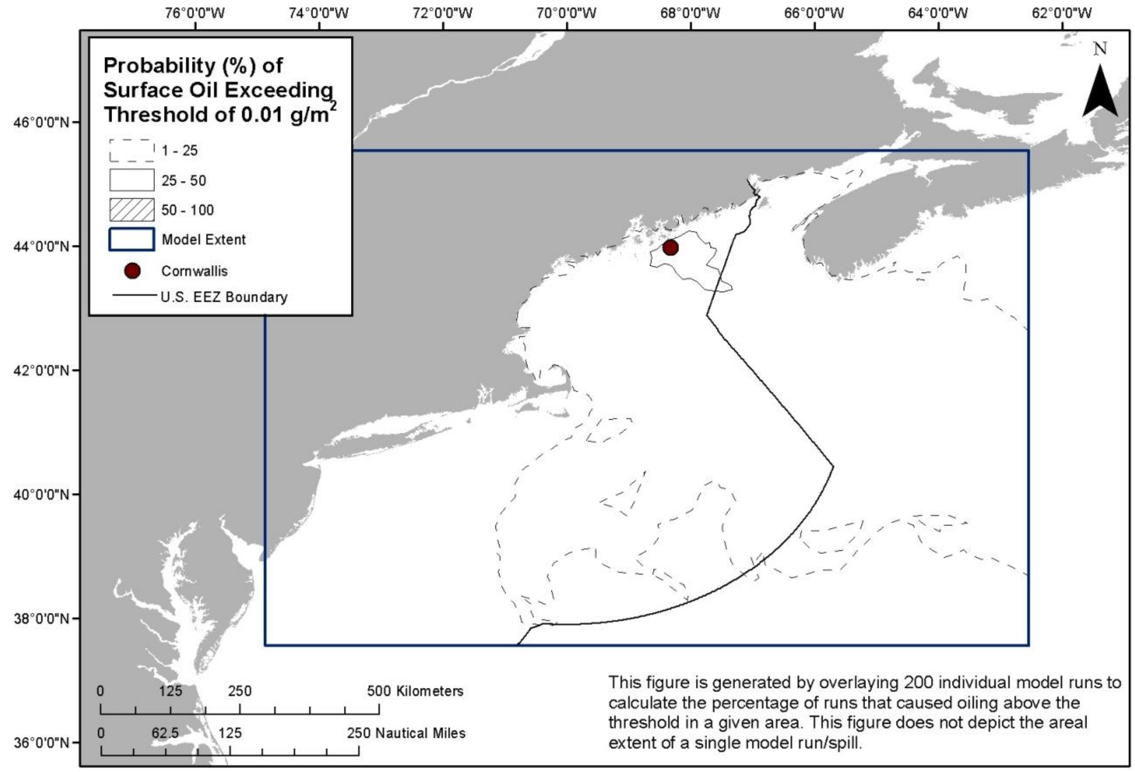


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 1,000 bbl of heavy fuel oil from the *Cornwallis* at the threshold for socio-economic resources at risk.

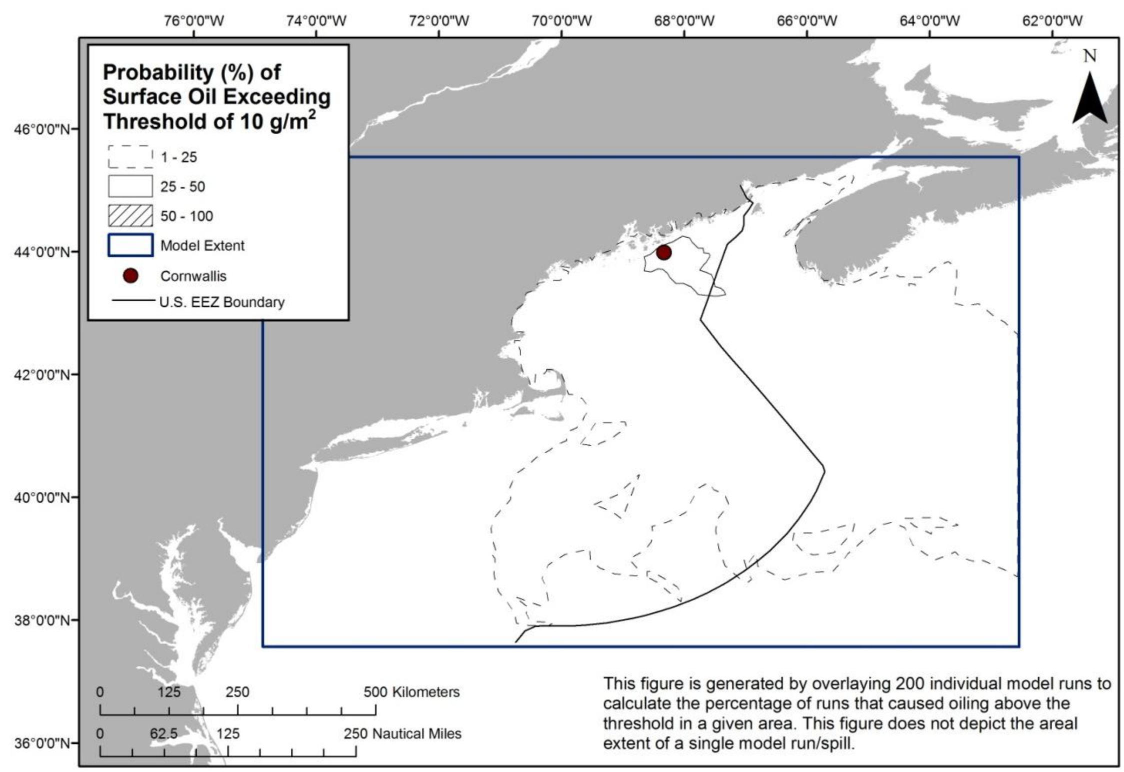


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 1,000 bbl of heavy fuel oil from the *Cornwallis* at the threshold for ecological resources at risk.

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.

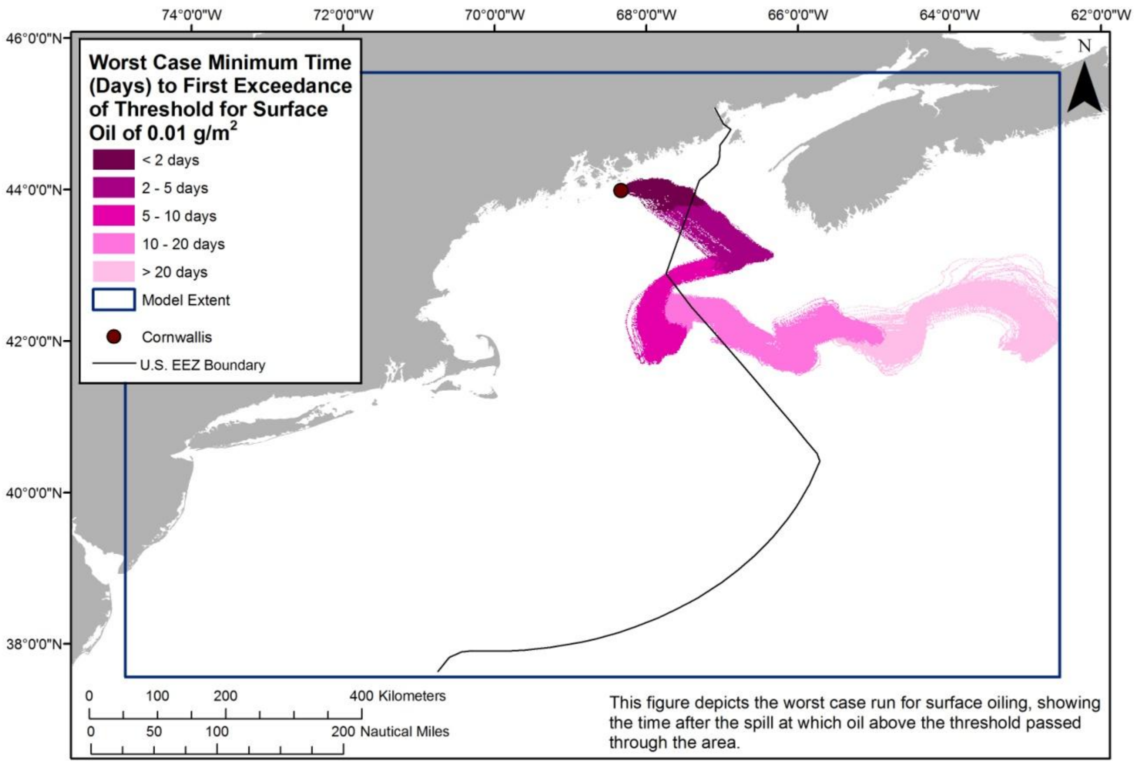


Figure 2-4: Water surface oiling from the Most Probable spill of 1,000 bbl of heavy fuel oil from the *Cornwallis* shown as the area over which the oil spreads at different time intervals.

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.

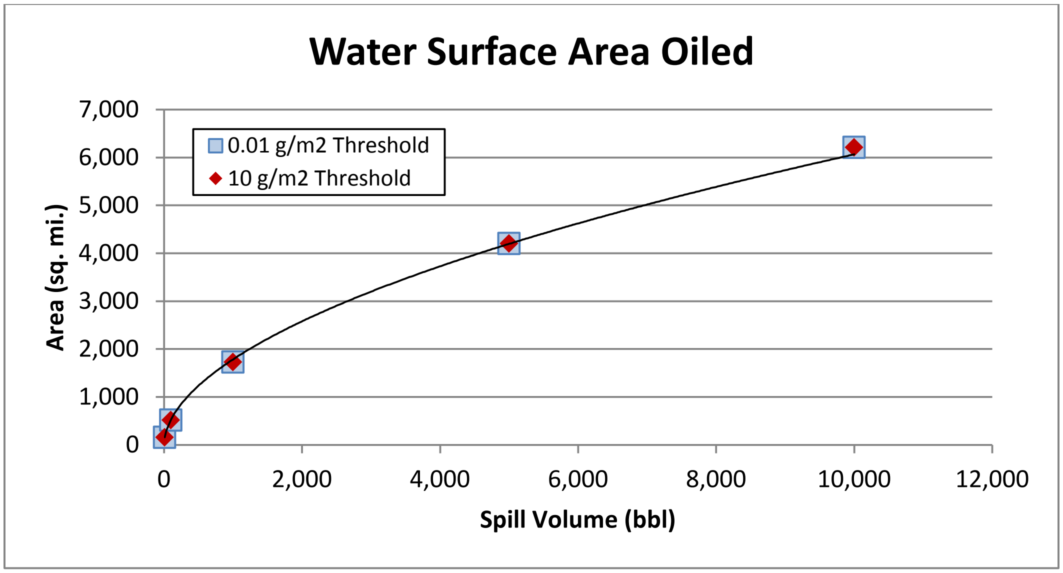


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Cornwallis*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2.

Potential Shoreline Impacts

Based on these modeling results, shorelines from as far north as the both sides of lower Bay of Fundy, Canada to as far south as the north end of Cape Cod, Massachusetts, are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m^2, for the Most Probable release of 1,000 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. Estimated miles of shoreline oiling above the threshold of 1 g/m^2 by scenario type are shown in Table 2-4.

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	10	4	0	0	5
Episodic	100	10	2	0	12
Most Probable	1,000	15	5	1	21
Large	5,000	22	7	4	34
Worst Case Discharge	10,000	27	9	6	42

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	10	1	1	0	2
Episodic	100	3	2	0	5
Medium	1,000	4	6	1	11
Large	5,000	6	9	4	19
Worst Case Discharge	10,000	8	12	5	24

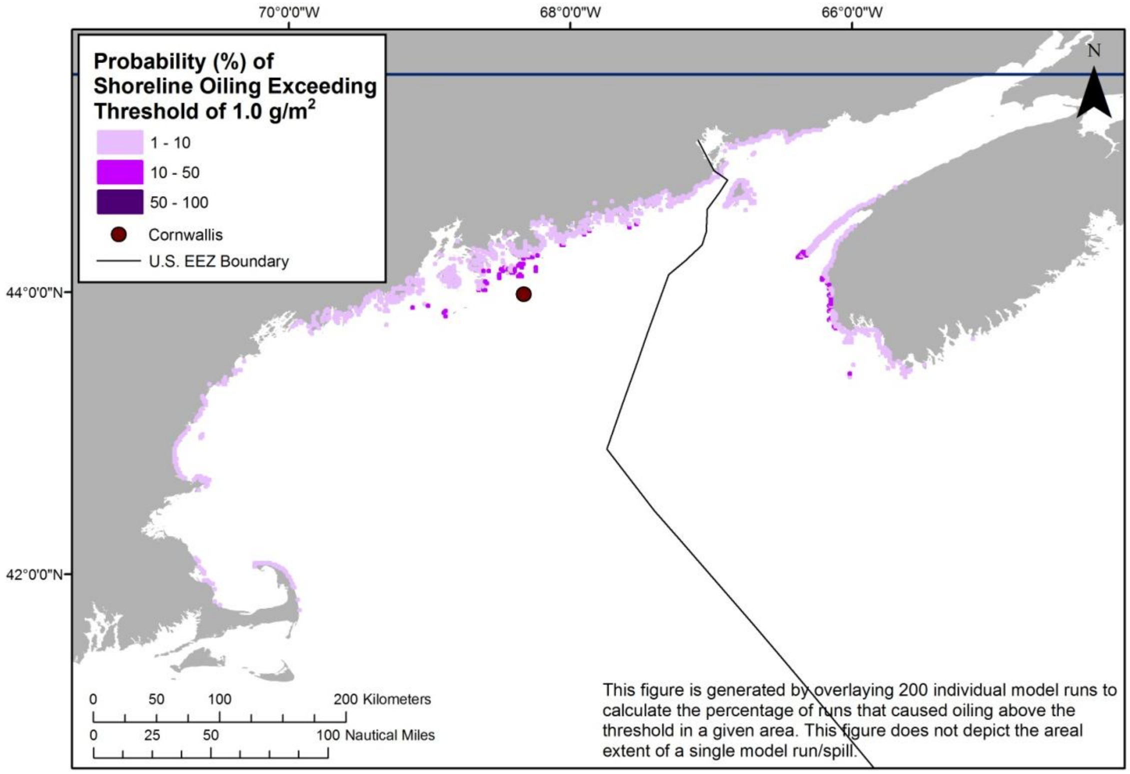


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 1,000 bbl of heavy fuel oil from the *Cornwallis*.

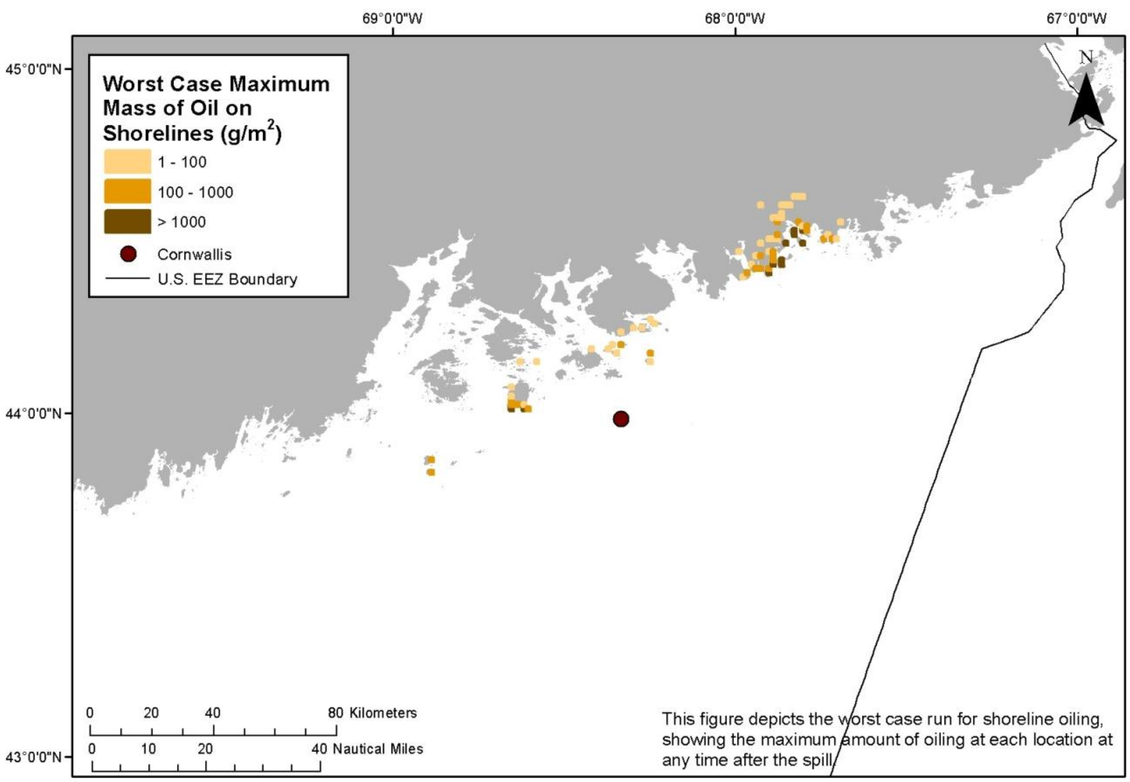


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 1,000 bbl of heavy fuel oil from the *Cornwallis* that resulted in the greatest shoreline oiling.

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

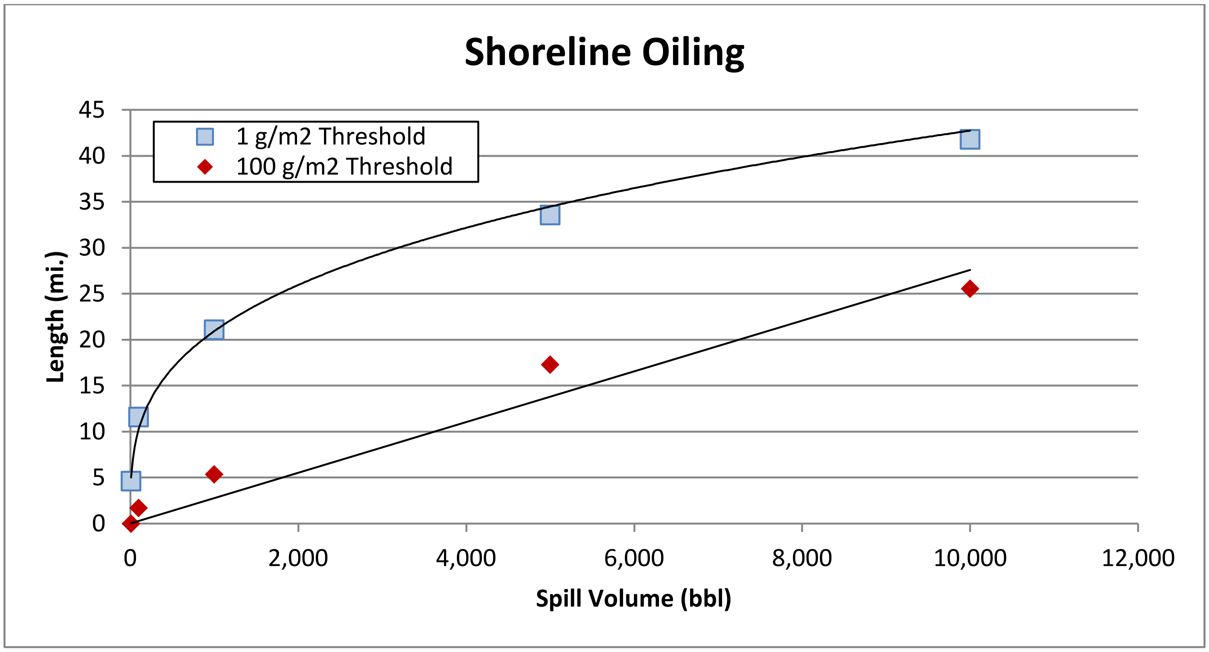


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Cornwallis*.

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 rocky shores and gravel beaches. Sand beaches, salt marshes, and tidal flats are also at risk.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 10,000 bbl from the *Cornwallis*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	78 miles	27 miles
Sand beaches	8 miles	5 miles
Salt marshes and tidal flats	24 miles	5 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 1,000 bbl from the *Cornwallis*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	2 miles	1 mile
Sand beaches	6 miles	1 mile
Salt marshes and tidal flats	11 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Cornwallis* (Table 3-1) include numerous guilds of birds and marine mammals. The islands of coastal Maine support an incredible diversity and abundance of nesting seabirds, migrating shorebirds and passerines and overwintering waterfowl. Shorelines in this region are important haul-out and pupping sites for seals. Coastal waters are summer foraging habitat for several species of large whales. Nearshore regions also support productive commercial fisheries for fish and invertebrate species.

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

Species Group	Species Subgroup and Geography	Seasonal Presence

Birds	*Important areas*
	• Bay of Fundy mudflats are critical red knot stopover points
	• Digby Neck, NE Coastal Maine, Grand Manan Island, and Cape Cod region are important for migratory birds
	• Coastal Maine is important breeding habitat for Arctic terns (ST)
	• Over 365 of Maine's coastal islands have recent records of seabird nesting
	• Rocky islands of Maine, Nova Scotia, and New Brunswick are important wintering habitat for harlequin ducks (ST)
	• Nearshore waters of Maine, Nova Scotia, and New Brunswick are important habitat for razorbill (ST) and Atlantic puffin (ST)
	• Shoreline from Casco Bay south is critical to least tern (FE, SE) and piping plover (FT, SE) nesting
	• Sable Island important for migratory shorebirds, plovers, yellowlegs, sanderlings, red knots, sandpiper
	• High concentrations of eiders around Gloucester
	
	Massachusetts nesting sites (numbers are in pairs unless otherwise noted)
	• Plymouth area: gulls, double-crested cormorant, least tern
	• Boston Harbor Islands: American black duck, common eider, black-crowned night heron, glossy ibis, great egret, herring gull, great black-backed gull, double-crested cormorants
	
	Maine nesting sites
	• Stratton Island: common tern (960), roseate tern, least tern (59), American oystercatcher (2)
	• Outer Green Island: common tern (1,067)
	• Jenny Island: common tern (753)
	• Eastern Egg Rock: Atlantic puffin (123), roseate tern (90), common tern (829 pairs), laughing gull (2,051), arctic tern
	• Maine Coastal Islands National Wildlife Refuge (NWR): seabirds, waterfowl, wading birds, bald eagles, eiders, Arctic terns nesting, including razorbill (4 colonies) and Atlantic puffin (4 colonies):
	  o Petit Manan Island has 8 spp. of nesting seabirds, including Leach's storm-petrel and black guillemot
	  o Seal Island NWR: Atlantic puffin (546), arctic tern (1,201), common tern (1,836), razorbill, black guillemot, Leach's storm-petrel, occasionally roseate tern, common eider, gulls, cormorants
	  o Matinicus Rock: most diverse nesting colony on the U.S. Atlantic coast and
		Nesting:
		Arctic tern nests May-Jun
		
		Razorbill present Mar-Sep; nests May-Jun
		
		Atlantic puffin nests Apr-Aug
		
		Least tern, roseate tern, common tern, piping plover present and nesting May-Aug
		
		Double-crested cormorant nests Apr-Jul
		
		Generally, seabird nesting season Apr-Aug
		
		Wintering:
		Harlequin duck, common eider present Oct-Mar
		
		Migratory:
		Red knot present Jun-Jul
		
		Shorebird migration August
		
		Most summer residents leave by Sep
		
		Fall waterfowl migration Sep-Oct

Species Group	Species Subgroup and Geography	Seasonal Presence
	only colony of manx shearwater; nesting species include arctic tern (859), manx shearwater (4), puffins, razorbill, black guillemot, Leach's storm-petrel, common and roseate tern, laughing gull, common eider o Pond Island NWR: common tern, occasionally roseate and arctic tern, common eider *Canada nesting sites* • Grand Manan Archipelago: common eider, herring gull, black guillemot, great black-backed gull (common), common tern (1 colony), double-crested cormorant (3 colonies), razorbill and common murre (1 colony each), Leach's storm-petrel (5 colonies) • Sable Island, Canada: Leach's storm petrel, mallard, northern pintail, red-breasted merganser, black duck, spotted sandpiper, least sandpiper, herring and great black-backed gull, common and Arctic tern	
Pinnipeds	Harbor seals and gray seals are common. Harp seals and hooded seals are transitory. Additional arctic species have been sighted but are not common *U.S. (Massachusetts and Maine)*: • High concentrations of harbor seals can be found in Plymouth harbor and the islands off Cohassett • 30-40,000 harbor seals in coastal Maine and Isle of Shoals population • Approx. 1,500-2,000 gray seals pup at Green Island, ME and Seal Island, ME • Harbor and Gray seals in high abundance in Jericho and Blue Hill Bay, ME *Canada*: Gray seals are more common in Canadian than U.S. waters. • Resident seal colonies on Grand Manan, Brier Island, and Sable Island • Sable Island is an important pupping site for gray seals • Seals common along SW shore of Nova Scotia • Walruses can be found as far south as Sable Island	Harp seals present Jan-May Harbor seals pup May-Jun Gray seals pup Dec-Feb
Cetaceans	*Common to Gulf of Maine/Bay of Fundy*: North Atlantic right whale (FE), fin whale (FE), minke whale, humpback whale (FE), Atlantic white-sided dolphin, harbor porpoise • Cape Cod Bay is critical right whale foraging habitat • Harbor porpoise more common in Bay of Fundy during the summer and move towards Cape Cod in winter *Also present*: blue whale (FE), sei whale, pygmy sperm whale, sperm whale (FE), northern bottlenose whale, beaked whale, beluga, killer whale, long-finned pilot whale, white-beaked dolphin, bottlenose dolphin, common dolphin, striped dolphin	Right, humpback, fin present in summer Atlantic white-sided dolphin calve Jun-Jul Harbor porpoise calve May-Jun
Fish	Coastal streams/estuaries • Shortnose sturgeon (FE) spawn in Sheepscot, Kennebec, Androscoggin, and Penobscot Rivers, and Merrymeeting Bay • Atlantic salmon (FE) spawn in streams in Maine, North of Casco Bay • Atlantic sturgeon (FT) spawn in Kennebec and Penobscot Rivers • Alewife and American shad in all streams • Juvenile anadromous fish use nearshore waters as nursery habitat • American shad concentrate in North Gulf of Maine in fall Marine • Nearshore waters support high concentrations of anadromous fish • Offshore ledges and banks support highly productive fisheries, including Atlantic halibut, Atlantic cod, winter flounder, witch flounder, American plaice, hake, monkfish	American shad spawn May-Nov Alewife common offshore in the fall, spawn Mar-May Shortnose sturgeon Spawn Apr-May

Species Group	Species Subgroup and Geography	Seasonal Presence
Invertebrates	Atlantic surf clam, softshell clam, bay scallop, northern quahog and blue mussels are all present in bays and nearshore environments. American lobster, rock crabs, northern shrimp and sea scallop beds all found in nearshore areas. Areas of high concentration areas are listed below: • Blue mussels around Manomet Point • Sea scallops offshore of Indian Brook conservation area • Softshell clam beds common in bays of Maine • American lobsters migrate inshore in the summer; rocky intertidal areas may be important nursery habitat	Northern shrimp spawn Nov-May Mussels spawn in spring
Benthic Habitats	Submerged aquatic vegetation (mostly eelgrass) is critical to numerous species and occurs inside of bays and sounds throughout the region; Plymouth Bay and Casco Bay have large beds Rockweed can be found along rocky shores from Maine north and is important habitat for juvenile fish, invertebrates, and birds	Year round

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

Ecological Risk Factors

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

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Cornwallis* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 10,000 bbl and a border around the Most Probable Discharge of 1,000 bbl.

Risk Factor 3A: Water Column Impacts to EcoRAR

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

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

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

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

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

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

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

The *Cornwallis* is classified as Low Risk for oiling probability for water column ecological resources for the WCD of 10,000 bbl because 4% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 1,000 bbl, the *Cornwallis* is classified as Low Risk for oiling probability for water column ecological resources because 3% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 mi^2 of the upper 33 feet of the water column.

Risk Factor 3B: Water Surface Impacts to EcoRAR

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

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

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

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

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

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

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

The *Cornwallis* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 95% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 6,210 mi^2. The *Cornwallis* is classified as High Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 67% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 1,730 mi^2.

Risk Factor 3C: Shoreline Impacts to EcoRAR

The impacts to different types of shorelines vary based on their type and the organisms that live on them. In this risk analysis, shorelines have been weighted by their degree of sensitivity to oiling. Wetlands are the most sensitive (weighted as “3” in the impact modeling), rocky and gravel shores are moderately sensitive (weighted as "2"), and sand beaches (weighted as "1") are the least sensitive to ecological impacts of oil.

Risk Factor 3C-1: Shoreline Probability of Oiling of EcoRAR

This risk factor reflects the probability that the shoreline would be coated by enough oil to cause impacts to shoreline organisms. The threshold for shoreline oiling impacts to ecological resources at risk is 100 g/m^2 (i.e., 100 grams of oil per square meter of shoreline). The three risk scores for oiling are:

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

Risk Factor 3C-2: Shoreline Degree of Oiling of EcoRAR

The degree of oiling of the shoreline reflects the length of shorelines oiled by at least 100 g/m^2 in the event of a discharge from the vessel. The three categories of impact are:

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

The *Cornwallis* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 67% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 47 miles. The *Cornwallis* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 58% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 10 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 10,000 bbl of heavy fuel oil from the *Cornwallis* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Low, because the largest volume of water column above thresholds for the 200 model runs was 1 mi^2
- Water surface resources – High, because of the seasonally very large number of marine mammals and wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because of the many marine mammal haulouts and bird nesting areas associated with shorelines potentially at risk; also the likely impacted area includes complex shoreline with difficult access

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 10,000 bbl** of heavy fuel oil from the *Cornwallis*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	4% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	95% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**High**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 6,210 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	67% of the model runs resulted in shoreline oiling of 100 g/m^2	**Med**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 47 mi	

For the Most Probable Discharge of 1,000 bbl, the ecological risk from potential releases of heavy fuel oil from the *Cornwallis* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because of the likely smaller volume of water column impacts
- Water surface resources – Medium, because the area affected is smaller, but there are still a large number of birds and marine mammals at risk. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, although fewer miles of shoreline are at risk, there are many marine mammal haulouts and bird nesting areas associated with these shorelines

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 1,000 bbl** of heavy fuel oil from the *Cornwallis*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	3% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0.1 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	67% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 1,730 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	58% of the model runs resulted in shoreline oiling of 100 g/m^2	**Med**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 10 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 *Cornwallis* include very highly utilized recreational beaches from Cape Cod, Massachusetts, up to northern Maine during summer, but also during spring and fall for shore fishing. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. A national park would also potentially be impacted.

A release could impact shipping lanes that run through the area of impact into the ports of Boston, MA, Portsmouth, NH, Portland, ME, and Searsport, ME, totaling over 1,080 vessel calls and 57 million tonnage annually. Commercial fishing is economically important to the region. There are fishing fleets coming out of several coastal towns and cities with annual catches totaling $184.3 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 *Cornwallis* 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 *Cornwallis*.

Resource Type	Resource Name	Economic Activities
Tourist Beaches	Nantucket Island, MA Martha's Vineyard, MA Provincetown, MA Sagamore Beach, MA White Horse Beach, MA Priscilla Beach, MA Wellfleet, MA Truro, MA Duxbury, MA Chatham, MA Vinalhaven, ME Frenchboro, ME Cranberry Isles, ME Bar Harbor, ME Winter Harbor, ME Jonesport, ME Bar Harbor, ME Cutler, ME	Potentially affected beach resorts and beach-front communities in Massachusetts, New Hampshire, and Maine provide recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks) with substantial income for local communities and state tax income. Much of the coast is lined with economically valuable beach resorts and residential communities. Many of these recreational activities are limited to or concentrated into the late spring through the early fall months.

Resource Type	Resource Name	Economic Activities
	Scituate, MA Duxbury, MA Marshfield, MA Marblehead, MA Manchester-by-the-Sea, MA Newburyport, MA Gloucester, MA Wingaersheek Beach, MA Ipswich, MA Essex, MA	
National Parks	Acadia National Park	National parks also provide recreation for local and tourist populations while preserving and protecting the nation's natural treasures.
National Wildlife Refuges	Massasoit NWR (MA) Thacher Island NWR (MA) Parker River NWR (MA) Great Bay NWR (NH) Rachel Carson NWR (ME) Pond Island NWR (ME) Franklin Island NWR (ME) Seal Island NWR (ME) Petit Manan NWR (ME) Cross Island NWR (ME)	National wildlife refuges in three states may be impacted. These federally managed and protected lands provide refuges and conservation areas for sensitive species and habitats.
State Parks	Birch Point SP, ME Camden Hills SP, ME Warren Island SP, ME Lamoine SP, ME Roque Bluffs SP, ME Quoddy Head SP, ME	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 of Maine are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Commercial Fishing	A number of fishing fleets use the area and surrounding waters for commercial fishing purposes.	
	Provincetown-Chatham, MA	Total Landings (2010): $19.9M
	Gloucester, MA	Total Landings (2010): $56.6M
	Portland, ME	Total Landings (2010): $18.8M
	Rockland, ME	Total Landings (2010): $10.6M
	Stonington, ME	Total Landings (2010): $45.3M
	Boston, MA	Total Landings (2010): $15.1M
	Jonesport, ME	Total Landings (2010): $18.0M
Ports	There are a number of significant commercial ports in the Northeast 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.	
	Boston, MA	584 port calls annually
	Portland, ME	317 port calls annually
	Searsport, ME	100 port calls annually
	Portsmouth, NH	83 port calls annually

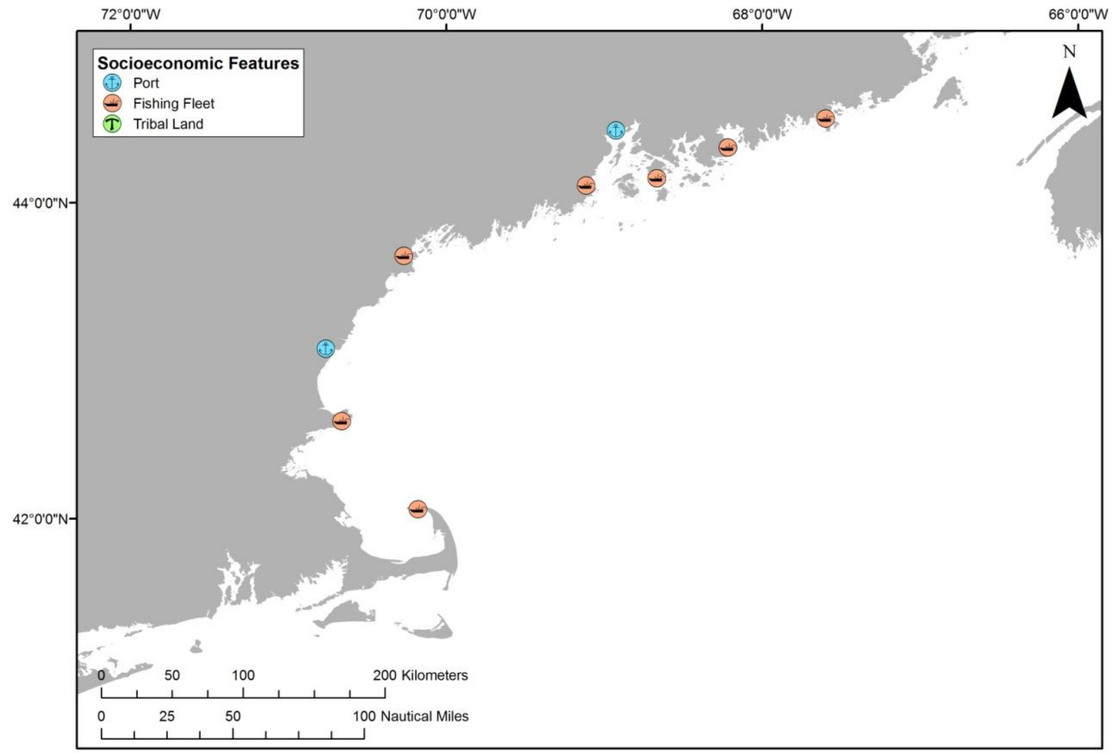


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Cornwallis*. (Note that there are no tribal lands at risk.)

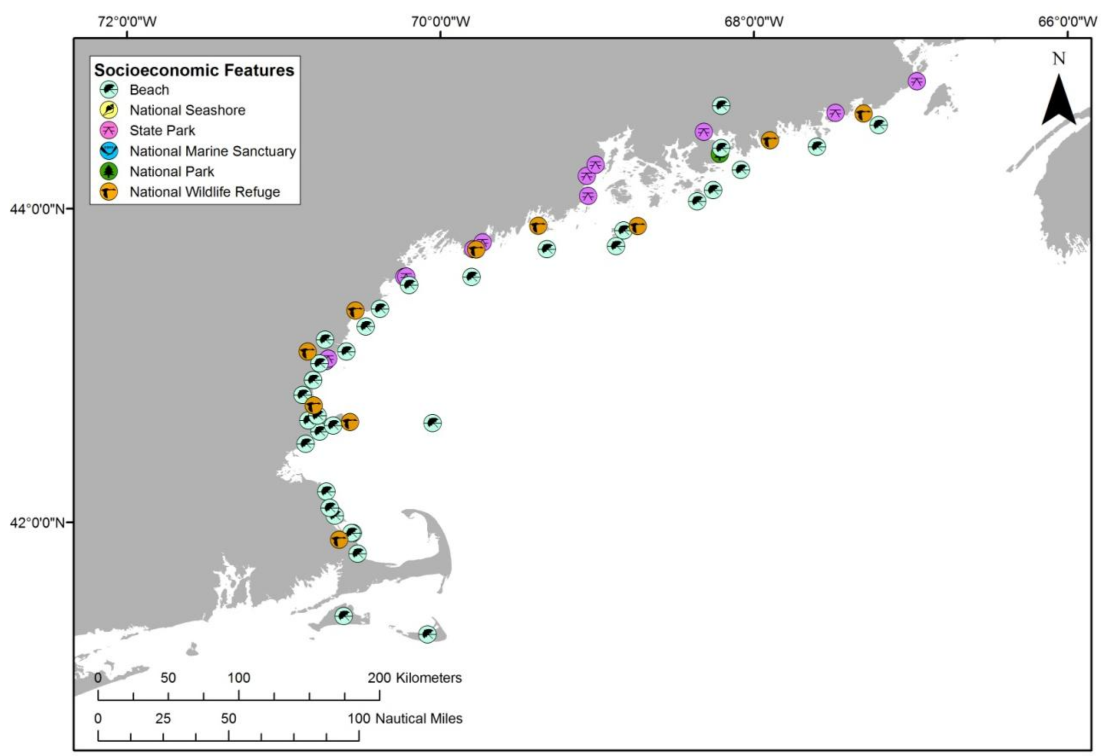


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Cornwallis*.

Socio-Economic Risk Factors

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

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, the classification for the *Cornwallis* shading indicates the degree of risk for the WCD release of 10,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 1,000 bbl.

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

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

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

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

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

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

The *Cornwallis* is classified as Low Risk for both oiling probability and degree of oiling for water column socio-economic resources for the WCD of 10,000 bbl because 5% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 0 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 1,000 bbl, the *Cornwallis* is classified as Low Risk for oiling probability for water column socio-economic resources because 3% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0.1 mi^2 of the upper 33 feet of the water column.

Risk Factor 4B-1: Water Surface Probability of Oiling of SRAR

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

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

The threshold level for water surface impacts to socio-economic resources at risk is 0.01 g/m^2 (i.e., 0.01 grams of floating oil per square meter of water surface). At this concentration and above, one would expect impacts to socio-economic resources on the water surface.

Risk Factor 4B-2: Water Surface Degree of Oiling of SRAR

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

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

The *Cornwallis* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for water surface socio-economic resources for the WCD because 95% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2, and the mean area of water contaminated was 6,210 mi^2. The *Cornwallis* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 67% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 1,730 mi^2.

Risk Factor 4C: Shoreline Impacts to SRAR

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

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

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

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

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

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

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

The *Cornwallis* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 70% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is classified as Medium Risk for degree of oiling because the mean length of weighted shoreline contaminated was 87 miles. The *Cornwallis* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 68% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2, and the mean length of weighted shoreline contaminated was 45 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 10,000 bbl of heavy fuel oil from the *Cornwallis* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Low, because there would be virtually no water column impact
- Water surface resources – High, because a significant offshore water surface area would be impacted near shipping lanes and fishing areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – High, because a significant length of shoreline would be impacted in areas with high-value and sensitive resources

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 10,000 bbl** of heavy fuel oil from the *Cornwallis*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	5% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	95% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	**High**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m^2 was 6,210 mi^2	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	70% of the model runs resulted in shoreline oiling of 1 g/m^2	**High**
4C-2: Shoreline Degree SRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 1 g/m^2 was 87 mi	

For the Most Probable Discharge of 1,000 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *Cornwallis* is summarized as listed below and indicated in the far-right column in Table 4-3:

- Water column resources – Low, because there would be virtually no water column impact.
- Water surface resources – Medium, because a moderate offshore water surface area would be impacted near shipping lanes and fishing areas. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens, tarballs, and streamers
- Shoreline resources – Medium, because a moderate length of shoreline would be impacted in areas with high-value and sensitive resources

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 1,000 bbl** of heavy fuel oil from the *Cornwallis*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	3% of the model runs resulted in at least 0.2 mi² of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0.1 mi² of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	67% of the model runs resulted in at least 1,000 mi² of water surface covered by at least 0.01 g/m²	**Med**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m² was 1,730 mi²	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	68% of the model runs resulted in shoreline oiling of 1 g/m²	**Med**
4C-2: Shoreline Degree SRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 1 g/m² was 45 mi	

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

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

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

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

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

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

For the Worst Case Discharge, *Cornwallis* scores High with 15 points; for the Most Probable Discharge, *Cornwallis* scores Low with 11 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Cornwallis*. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

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

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

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 10,000 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Bunker oil 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	No oil was reported on the water		
	D1: Nature of Casualty	High	One torpedo impact		
	D2: Structural Breakup	High	Unknown structural breakup		
Archaeological Assessment	Archaeological Assessment	Low	Limited additional historical information has been located, and no site reports exist, assessment is believed to have low accuracy		**Not Scored**
Operational Factors	Wreck Orientation	Low	Unknown, wreck not located		**Not Scored**
	Depth	Low	Approximately 300 feet		
	Visual or Remote Sensing Confirmation of Site Condition	Low	Location not known		
	Other Hazardous Materials Onboard	Medium	No		
	Munitions Onboard	High	Weapons for onboard weapons		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Small volume of open, deep water affected	**Low**	**Low**
	3B: Water Surface Resources	High	Seasonally high concentrations of birds and marine mammals at risk	**High**	**Med**
	3C: Shore Resources	High	Complex shoreline with difficult access; many sensitive resources in seasonally high concentrations	**Med**	**Med**
Socio-Economic Resources	4A: Water Column Resources	High	Virtually no water column impact	**Low**	**Low**
	4B: Water Surface Resources	High	Significant impacts near shipping lanes and fishing areas	**High**	**Med**
	4C: Shore Resources	High	Significant length of shoreline would be impacted in areas with high-value and sensitive resources	**High**	**Med**
Summary Risk Scores				**15**	**11**