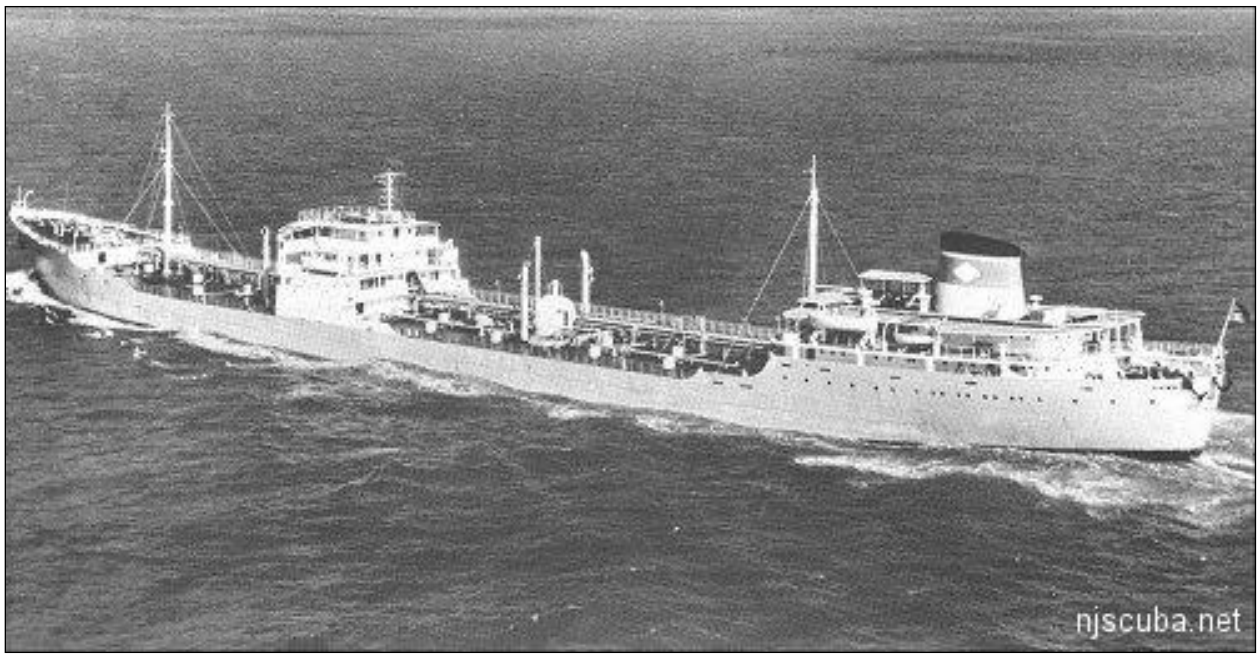
Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Stolt Dagali



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National Oceanic and
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Photo: Photograph of *Stolt Dagali*
Source: http://njscuba.net/sites/site_stolt_dagali.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.

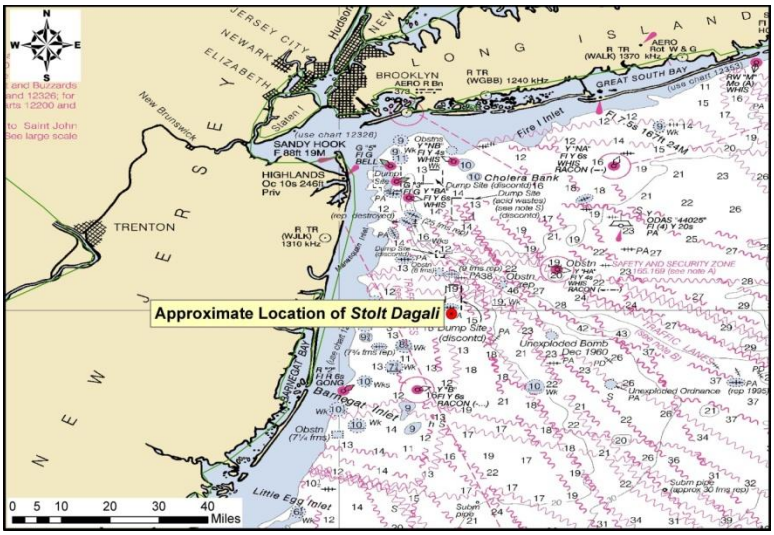
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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: *Stolt Dagali*

The tanker *Stolt Dagali*, which collided with another vessel and sunk off the coast of New Jersey in 1964, 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 *Stolt Dagali*, 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.



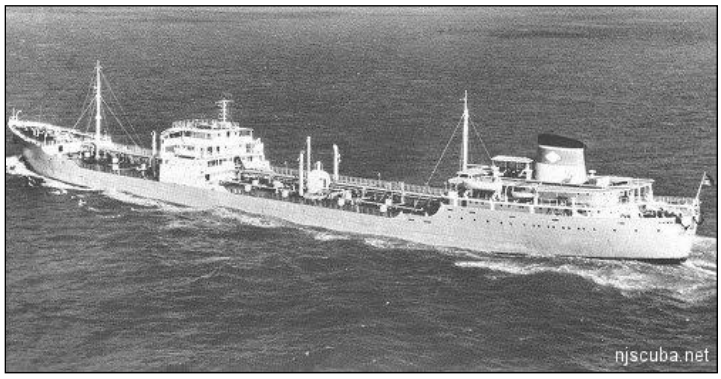
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Stolt Dagali* scores Low with 11 points; for the Most Probable Discharge (10% of the Worse Case volume), *Stolt Dagali* also scores Low with 10 points. Given these low scores, and the higher level of data certainty about the vessel, NOAA recommends that this site be noted in the Area Contingency Plans as necessary to answer future questions about the pollution risks associated with this particular vessel, and 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 any significant changes or further deterioration of the site.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
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	Med	Low
	3C: Shore Resources	Low	Low
Socio-Economic Resources	4A: Water Column Resources	Med	Med
	4B: Water Surface Resources	Med	Med
	4C: Shore Resources	Low	Low
Summary Risk Scores		11	10

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

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

Vessel Particulars



Official Name: *Stolt Dagali*

Official Number: Unknown

Vessel Type: Tanker

Vessel Class: M-class tanker

Former Names: Unknown

Year Built: 1955

Builder: Burmeister & Wain, Copenhagen, Denmark

Builder's Hull Number: Unknown

Flag: Norwegian

Owner at Loss: A/S Ocean Company (John P. Pedersen & Son, Mgrs.)

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

Operated by: Unknown

Homeport: Oslo, Norway

Length: 582 feet **Beam:** 70 feet **Depth:** 30 feet

Gross Tonnage: 12,723 **Net Tonnage:** Unknown

Hull Material: Steel **Hull Fastenings:** Unknown **Powered by:** Oil engines

Bunker Type: Marine diesel **Bunker Capacity (bbl):** Unknown

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): Unknown **Dry Cargo Capacity:** Unknown

Tank or Hold Description: Unknown

Casualty Information

Port Departed: Philadelphia, PA

Destination Port: Newark, NJ

Date Departed: Unknown

Date Lost: November 26, 1964

Number of Days Sailing: Unknown

Cause of Sinking: Collision

Latitude (DD): 39.98916

Longitude (DD): -73.66573

Nautical Miles to Shore: 23

Nautical Miles to NMS: 231

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 130

Bottom Type: gravel-sand

Is There a Wreck at This Location? The exact accuracy of the listed coordinates is not known, but the location of the wreck is known by local scuba divers and probably the U.S. Coast Guard

Wreck Orientation: Resting on its starboard side

Vessel Armament: None

Cargo Carried when Lost: Vegetable and coconut oil, fats, molasses, and solvents

Cargo Oil Carried (bbl): Unknown

Cargo Oil Type: Vegetable and coconut oil

Probable Fuel Oil Remaining (bbl): Unknown

Fuel Type: Marine diesel

Total Oil Carried (bbl): Unknown

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: No

Salvaged: Yes, bow section was saved

Cargo Lost: No

Reportedly Leaking: No

Historically Significant: Unknown

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

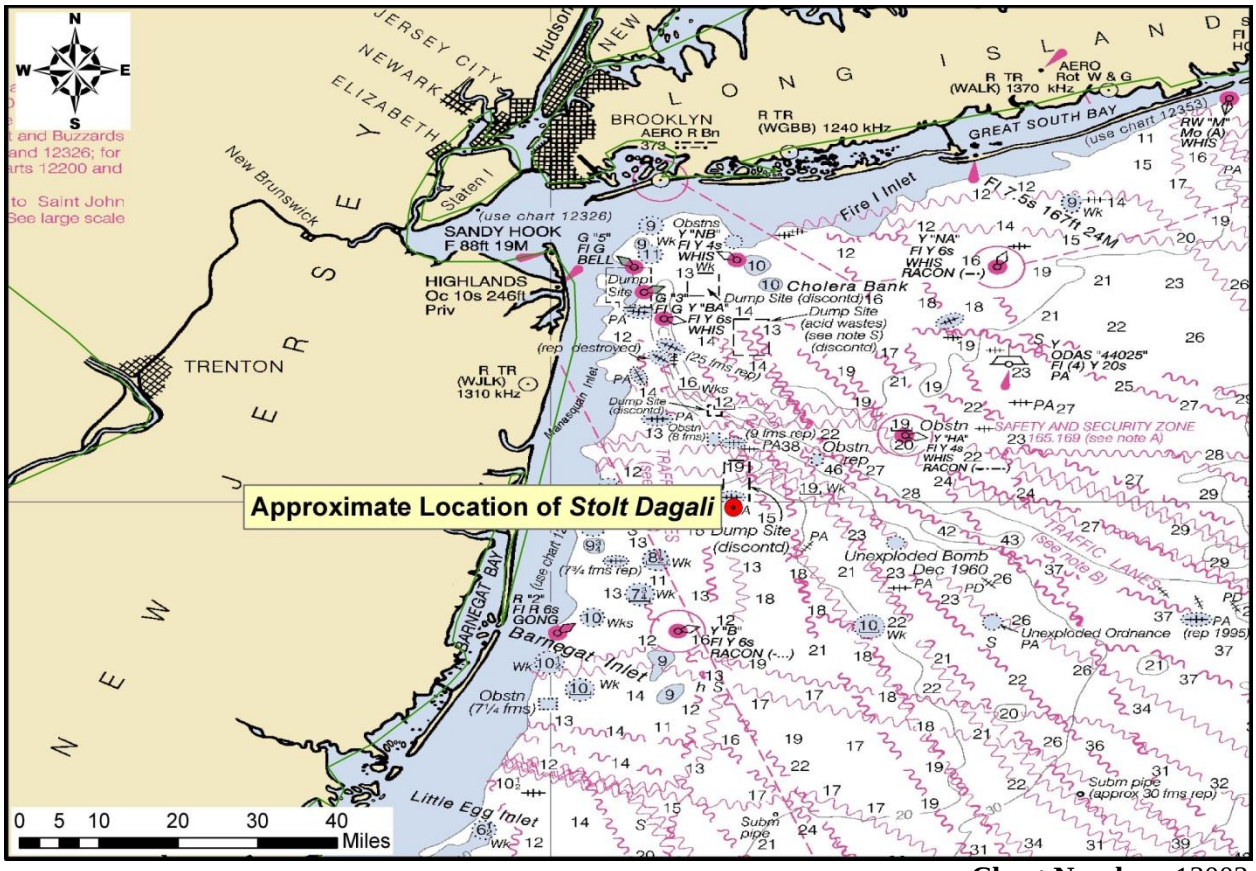


Chart Number: 13003

Casualty Narrative

"On November 26, 1964 (Thanksgiving Day), while carrying a cargo of vegetable, coconut oil and fats from Philadelphia to Newark, N.J., the *Stolt Dagali* entered a dense fog bank. The watch officers in the 629 foot, Israel luxury liner *S.S. Shalom*, which was outbound for a Caribbean cruise, had also entered the same fog bank and called Captain Freudenberg to the bridge. The *Shalom*'s radar was cluttered with static, but the watch officer identified a vessel 1.6 miles off the starboard bow. Captain Freudenberg reduced the ships speed and sounded her fog horns. Reports taken from the *Shalom*'s log go on to tell of how the bridge personnel saw the masthead light and red side light of the vessel in front of them. These lights were " well open ", which indicated that the *Dagali* was at a right angle to the *Shalom*. The *Shalom* was steered hard to starboard in an unsuccessful effort to steer clear of the *Stolt*'s stern. The turbine steam powered *Shalom*'s bow crashed into and sliced neatly through the *Stolt Dagali*'s port side at a 45 degree angle sheering off her stern. The *Stolt Dagali*'s 140 foot stern sank immediately taking 19 crew members to the bottom with her. Most of the men killed were sleeping in her stern section at the time of the collision which is where the crews quarters were located. At 2:25 AM, the U.S. Coast Guard gets the following radio message "*Shalom* reports collision, unknown vessel, thick fog," At 2:44 AM, "S.O.S. This is *Stolt Dagali*. Collided with unknown ship. Sinking, repeat, sinking". The *Shalom* had suffered a forty foot gash in her bow, but due to her water tight compartments she remained afloat and in the area to aid in rescue efforts. The U.S. Coast Guard sent seven cutters, a few patrol boats and seven helicopters from

Floyd Bennett station, to the scene. At 3:05 AM, Moriches Coast Guard gets the message " My whole stern has disappeared". The *Shalom* launched a motor launch after having heard cries from the water, they plucked five men from the frigid sea. At 4:25 AM message " Coast Guard helicopter and plane circling around us but has not sighted us." At 5:28 AM the U.S. Coast Guard cutter *Point Glover*, arrives at the scene. The lucky men who were on the bow of the *Stolt* including Captain Kristian Bendiksen and nine others were rescued. The next day 19 additional men were saved by helicopters lowering horsecollar rings and baskets to haul up the survivors from a nearly swamped lifeboat. Another dramatic rescue was of a crewmen who had woke up to find himself submerged in 50 degree water while wearing only his underwear. By the time a Coast Guard helicopter found him and hauled him up he was so cold that his fingers became frozen to the side of the rescue basket. Captain Bendiksen reported that the U.S. Coast Guard action during this day was the " best thing I saw in my life ".

The *Shalom*, owned by the Zim line was not fatally wounded but did suffer a gash on her starboard side which caused her Number 1 hold to fill with sea water. After staying on location to render assistance during the rescue operation the *Shalom* requested and received permission from the U.S. Coast Guard to leave the scene, and she slowly motored back to New York under her own power.

The *Stolt Dagali*'s bow section, which stayed afloat due to her watertight compartments, was towed to the port of New York by two Moran tugs escorted by Coast Guard Cutters. The *Stolt*'s bow was anchored in Gravesend Bay so her remaining cargo could be removed. This reduced the wrecks draft to 27 feet and allowed tugs to tow her into the ship yards without the bow section bottoming out in shallow water. She was eventually salvaged, re-fitted with a completely new stern section and re-sailed."
- http://www.aquaexplorers.com/StoltDagali.htm

General Notes

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

DESCRIPTION
LORAN C RATES PROVIDED BY MR. RICHARD TARACKA, GREENWICH, CT. POLICE DEPARTMENT, TEL. NO. 203-622-8020; IDENTIFIED AS *STOLT DAGALI*; 9960-X 26768.0, 9960-Y 43410.0; LAT. 39-59-20.57N, LONG. 73-39-58.16W (COMPUTED FROM LORAN RATES). (ENTERED 5/90 MSM) 213 583 FT., 19150 TON TANKER IDENTIFIED AS *STOLT DAGALI*; SUNK IN A DENSE FOG BANK WHILE CARRYING A CARGO OF VEGETABLE AND COCONUT OIL FROM PHILADELPHIA TO NEWARK; ON NOVEMBER 26, 1964, THE LUXURY LINER, SHALOM, COLLIDED WITH THE *STOLT DAGALI*'S PORT SIDE AND SHEERED OFF HER STERN; THE BOW WAS TOWED INTO PORT AND PARTIALLY SALVAGED; 190 FT. PIECE OF STERN RESTS ON ITS STARBOARD SIDE 36 MILES OUT OF DEBS INLET IN 130 FT. OF WATER; RISES TO WITHIN 36 MILES OF SURFACE; LORAN C RATES: 9960-X 26787.6, 9960-Y 43484.3. (ENTERED MSM 6/90)

Wreck Condition/Salvage History

"Today, a 140 foot piece of the *Stolt Dagali*'s stern rests on its starboard side 36 miles out of Debs Inlet, Long Island, and 18 miles from Manasquan Inlet, New Jersey, in area known as Wreck Valley. Her remains lie in 130 feet of water, but rise to within 65 feet of the surface. Divers who want to experience the magnificence of the *Stolt Dagali* first hand can utilize a number of charter boats running out of either the Jersey coast or as far as Long Island, New York. New Jersey's prime dive season starts in May and

runs through September. During this time, divers will want to wear a full wet suit, hood, boots and gloves, especially while descending on an offshore wreck. For the more hardy dry suited divers, our season is extended from April straight through November, weather permitting. Equipment needed would be the same as for any cold water deep wreck dive. Depth gauge, bottom timer, dive computers, two knives, lights, tether line and an adequate air supply. Many divers choose to mount double tank systems, while others add a pony bottle to their single tank. Once in the water divers will find that the visibility at this site is usually excellent. Average horizontal visibility is around 40 feet. Bear in mind that this is only an average, actual visibility ranges from two feet to over 90 feet, depending on weather and wind. By the time divers descend to the wreck they will already have witnessed the huge array of aquatic life in the area. Everything from schooling bait fish, bergals, black fish, angler fish, ling and shark can be found around the *Stolt Dagali*.

It seems that the *Stolt Dagali* did not die when she sank over 26 years ago, she has continued her life as one of the East coast's most popular shipwrecks. The *Stolt* has everything a diver could want, good visibility, fish, lobsters, artifacts and a fascinating history. The *Stolt Dagali* is one of the more popular Jersey shipwrecks because divers of all experience levels enjoy exploring her remains. Novice divers can swim around the exterior or take photographs outside the wreck while the more experienced penetrate deep into her interior in search of artifacts. Remember that wreck penetration requires specialized training and equipment. Lobstering is also a popular dive plan for this wreck, and most bugs are taken down by the sand. One way to find these tasty crustaceans is to look for their antennas sticking out from under wreckage. The next trick is to catch them. One swift thrust landing your hand on the lobster's body, just behind the claws, will do the trick. Next, just wiggle him out and insert him tail first into a mesh bag. Putting the lobster in tail first will help prevent him from escaping. Lobsters swim backwards, so once you let go the bug swims deeper into the bag and not out of it.

For further information about dive charters to the *Stolt Dagali* contact any of the New Jersey or Long Island N.Y. dive shops. Boats run to this wreck almost every week of the summer. This magnificent wreck is usually surrounded with clear water, and provides an artificial reef for all types of aquatic life and divers to enjoy."
-http://www.aquaexplorers.com/StoltDagali.htm

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

No archaeological assessment was prepared for *Stolt Dagali*. This shipwreck is not a historical shipwreck, and records relating to the loss of the vessel were not part of the National Archives record groups examined by NOAA archaeologists. It is possible that the local U.S. Coast Guard District or Sector has access to more records about this wreck than are available at the National Archives.

From video footage of the wreck readily accessible online, it appears that the wreck is already suffering from severe site degradation and it seems unlikely that the wreck could still contain large quantities of diesel oil. However, this has not been confirmed since NOAA archaeologists have never directly surveyed the site and cannot guarantee that it is empty.

Background Information References

Vessel Image Sources: http://njscuba.net/sites/site_stolt_dagali.html

Construction Diagrams or Plans in RULET Database? No

Text References:

-AWOIS database

-http://www.ecophotoexplorers.com/stolt.asp
-http://njscuba.net/sites/site_stolt_dagali.html
-http://www.aquaexplorers.com/StoltDagali.htm

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Stolt Dagali* 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.

Pollution Potential Tree

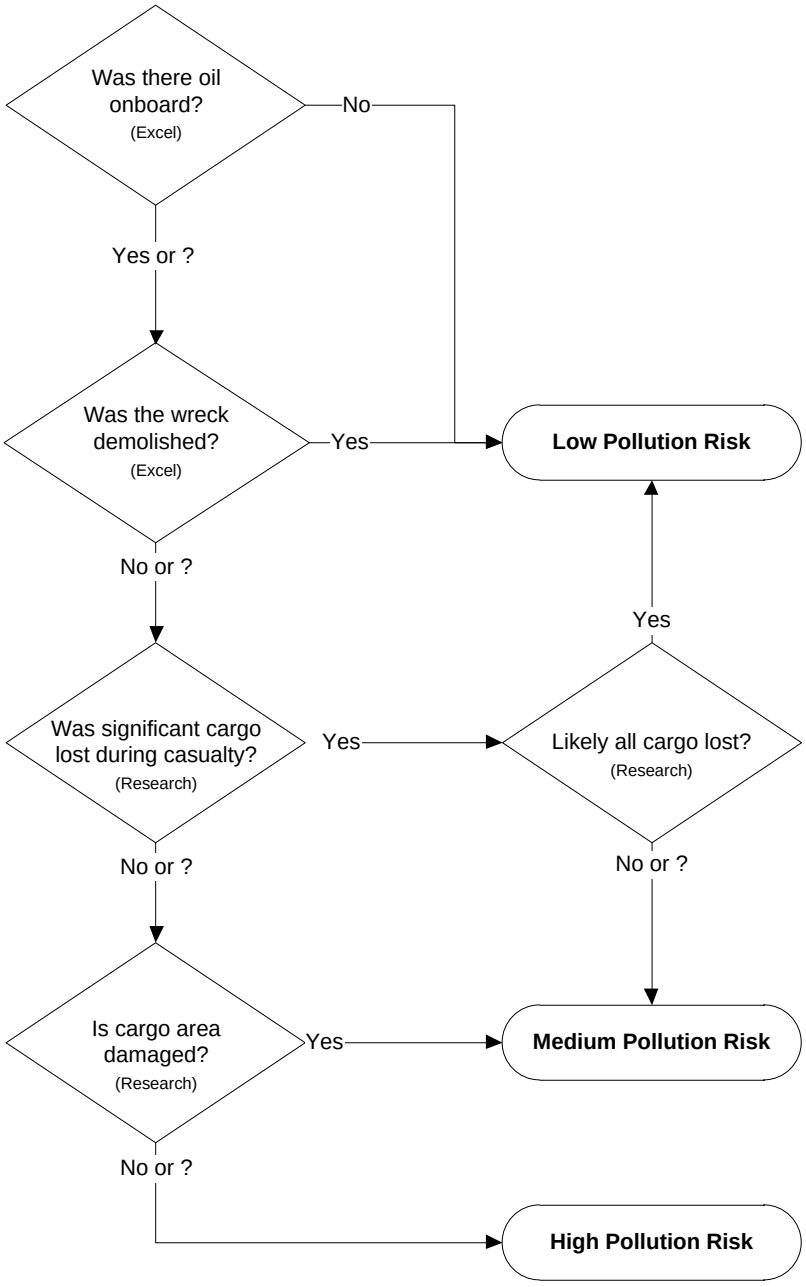


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

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.

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 *Stolt Dagali* 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 *Stolt Dagali i*s ranked as High Volume because it is thought to have a potential for up to 15,000 bbl, although some of that may have been lost at the time of the casualty or after the vessel sank. Data quality is low because the exact bunker capacity of the ship is not known, and the volume was estimated based on the gross tonnage of the vessel.

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 *Stolt Dagali*.

Risk Factor A2: Oil Type

The oil type(s) on board the wreck are classified only with regard to persistence, using the U.S. Coast

Guard oil grouping[1]. (Toxicity is dealt with in the impact risk for the Resources at Risk classifications.) The three oil classifications are:

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

The *Stolt Dagali* is classified as Medium Risk because the bunker oil is marine diesel, a Group II 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 *Stolt Dagali* 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 *Stolt Dagali* is classified as High Risk because there was no report of fire at the time of casualty. Data quality is high.

[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]

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 *Stolt Dagali* is classified as High Risk because there are no known reports of oil spreading out 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 *Stolt Dagali* is classified as High Risk because the stern sank after it was sheared off in a collision. 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 *Stolt Dagali* is classified as Medium Risk because it broke into two pieces at the time of casualty and only the stern sank. Data quality is high.

Factors That May Impact Potential Operations

Orientation (degrees)

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

The stern of the *Stolt Dagali* is resting on its starboard side. Data quality is high.

Depth

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

The *Stolt Dagali* is 130 feet deep. Data quality is high.

Visual or Remote Sensing Confirmation of Site Condition

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

Divers report that the wreck is resting on its side and relatively intact. Data quality is high.

Other Hazardous (Non-Oil) Cargo on Board

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

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

Munitions on Board

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

The *Stolt Dagali* was not carrying munitions. 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 *Stolt Dagali.* Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *Stolt Dagali* 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)	Low	Maximum of 15,000 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Bunker oil is diesel fuel oil, a Group II 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 known to have been reported on the water	
	D1: Nature of Casualty	High	Collision	
	D2: Structural Breakup	High	The vessel broke in two at the time of sinking	
Archaeological Assessment	Archaeological Assessment	Low	Wreck is not a historic wreck, no archaeological assessment was prepared	**Not Scored**
Operational Factors	Wreck Orientation	High	Resting on its starboard side	**Not Scored**
	Depth	High	130 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	Location is a popular dive site	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	No	

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 *Stolt Dagali* this would be about 15,000 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 *Stolt Dagali*, 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 *Stolt Dagali*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	15 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	150 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	1,500 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	7,500 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	15,000 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 *Stolt Dagali* contained a maximum of 15,000 bbl of marine diesel (a Group II oil) as bunker fuel. Therefore, the oil spill model was run using light 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 *Stolt Dagali* 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.

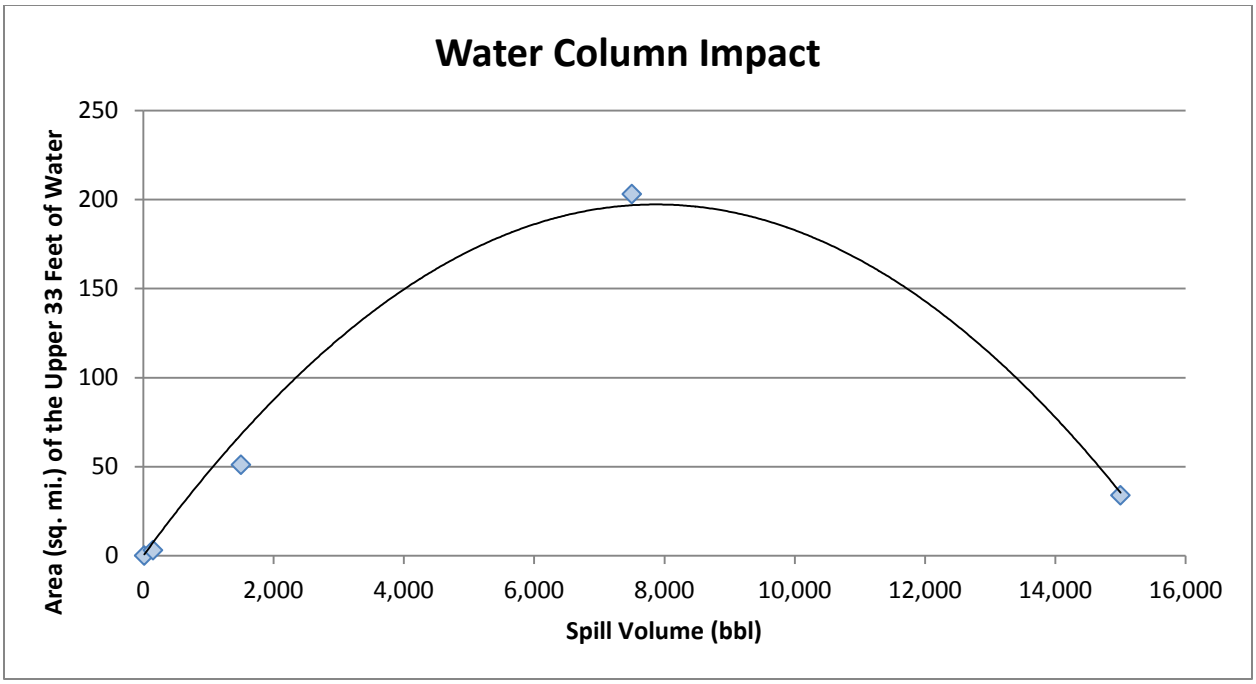


Figure 2-1: Regression curve for estimating the volume of water column impacted at or above 1 ppb aromatics as a function of spill volume for the *Stolt Dagali*.

Potential Water Surface Slick

The slick size from an oil release from the *Stolt Dagali* is a function of the quantity released be determined by the volume of leakage. 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 due to the subsurface release of the oil. Surface expression is likely to be in the form of sheens, tarballs, and streamers.

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

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m²	10 g/m²
Chronic	15	300 mi²	33 mi²
Episodic	150	1,300 mi²	130 mi²
Most Probable	1,500	4,200 mi²	560 mi²
Large	7,500	9,400 mi²	1,600 mi²
Worst Case Discharge	15,000	13,000 mi²	2,500 mi²

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

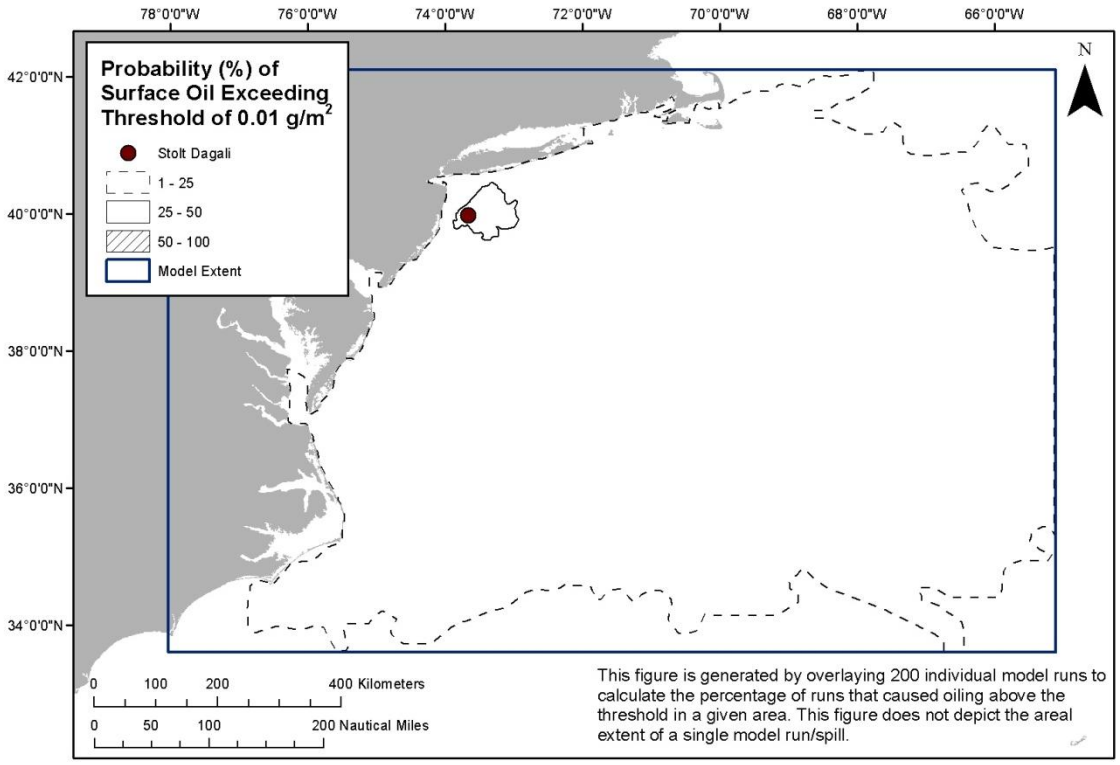


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 1,500 bbl of light fuel oil from the *Stolt Dagali* at the threshold for socio-economic resources at risk.

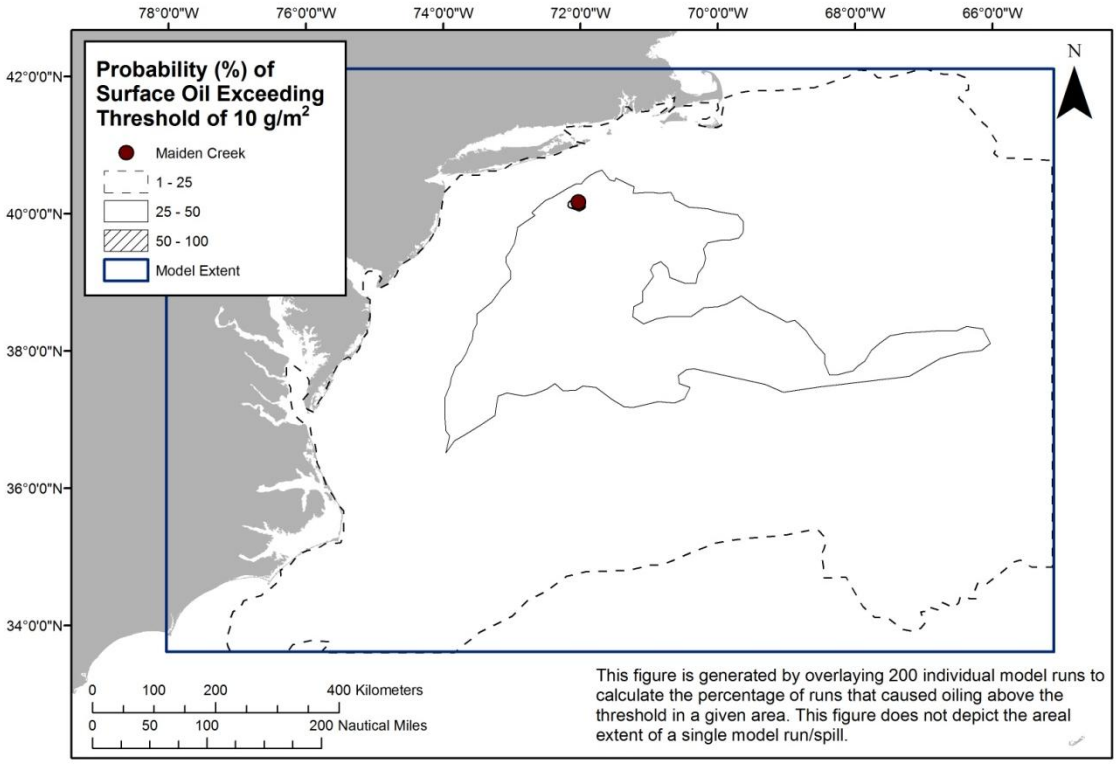


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 1,500 bbl of light fuel oil from the *Stolt Dagali* at the threshold for ecological resources at risk.

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.

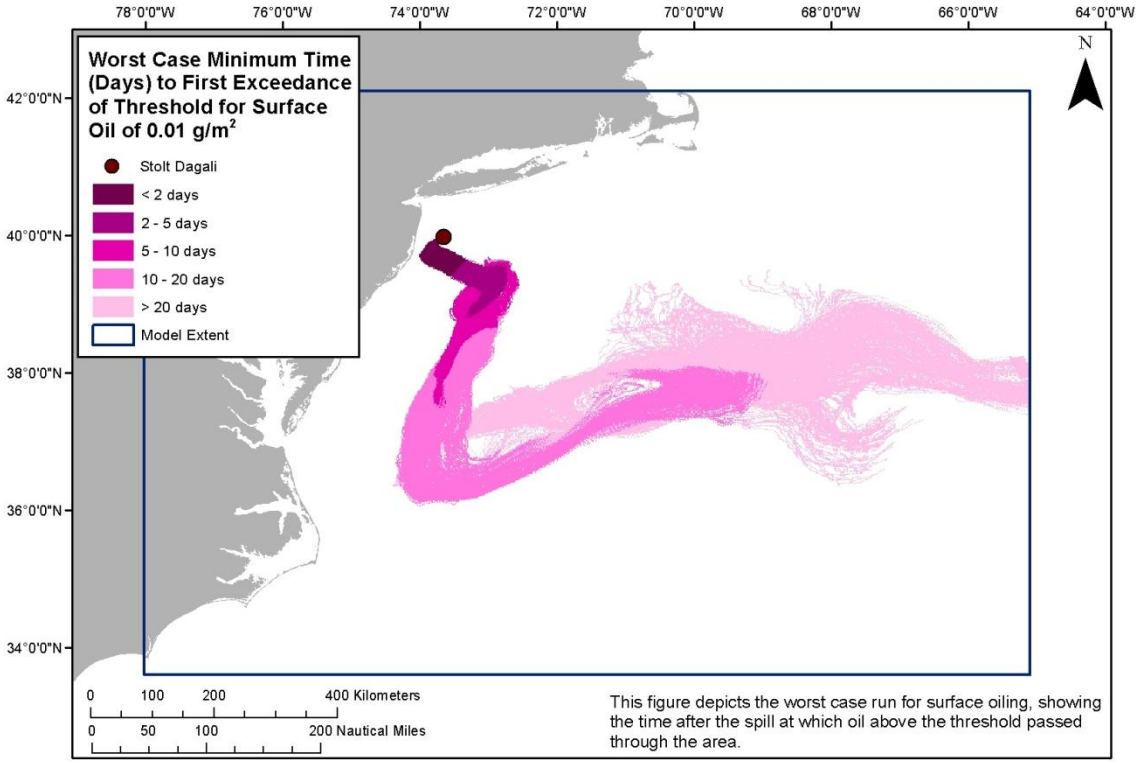


Figure 2-4: Water surface oiling from the Most Probable spill of 1,500 bbl of light fuel oil from the *Stolt Dagali* shown as the area over which the oil spreads at different time intervals.

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.

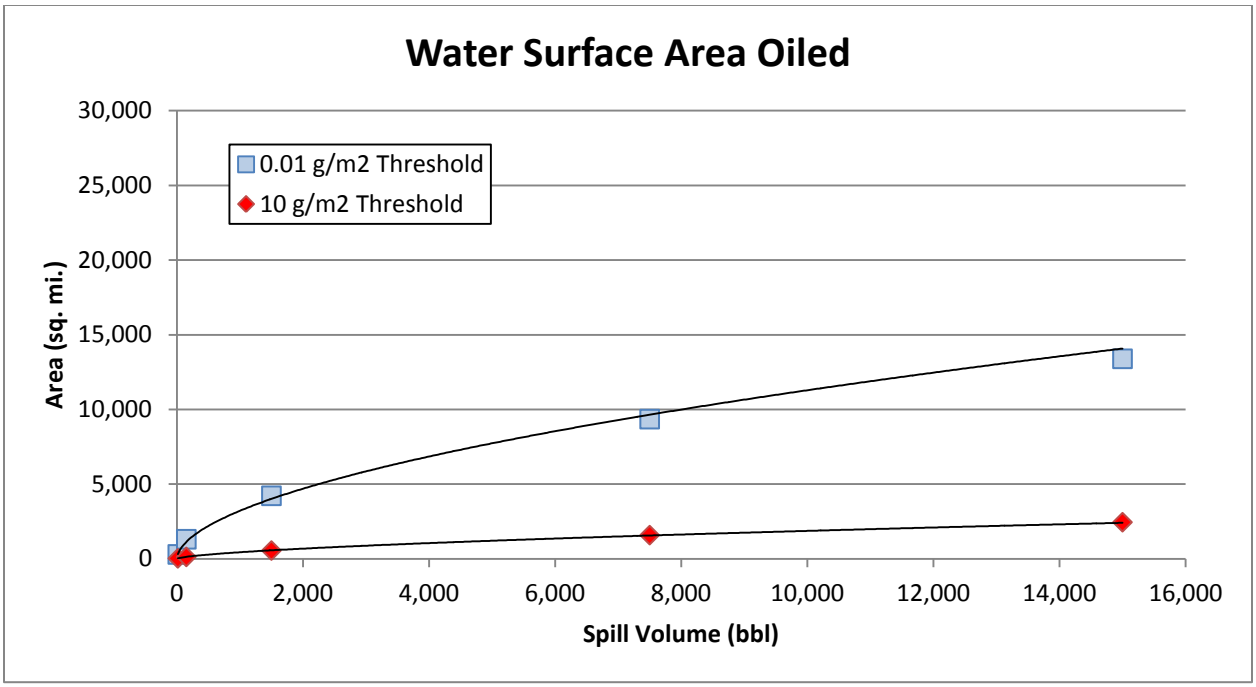


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Stolt Dagali*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2.

Potential Shoreline Impacts

Based on the modeling results, shorelines from as far north as Cape Cod, to as far south as the Outer Banks, North Carolina, 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 1,500 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^2 by scenario type are shown in Table 2-4.

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	15	0	0	0	0
Episodic	150	0	0	0	0
Most Probable	1,500	0	1	0	2
Large	7,500	1	4	1	6
Worst Case Discharge	15,000	1	8	1	10

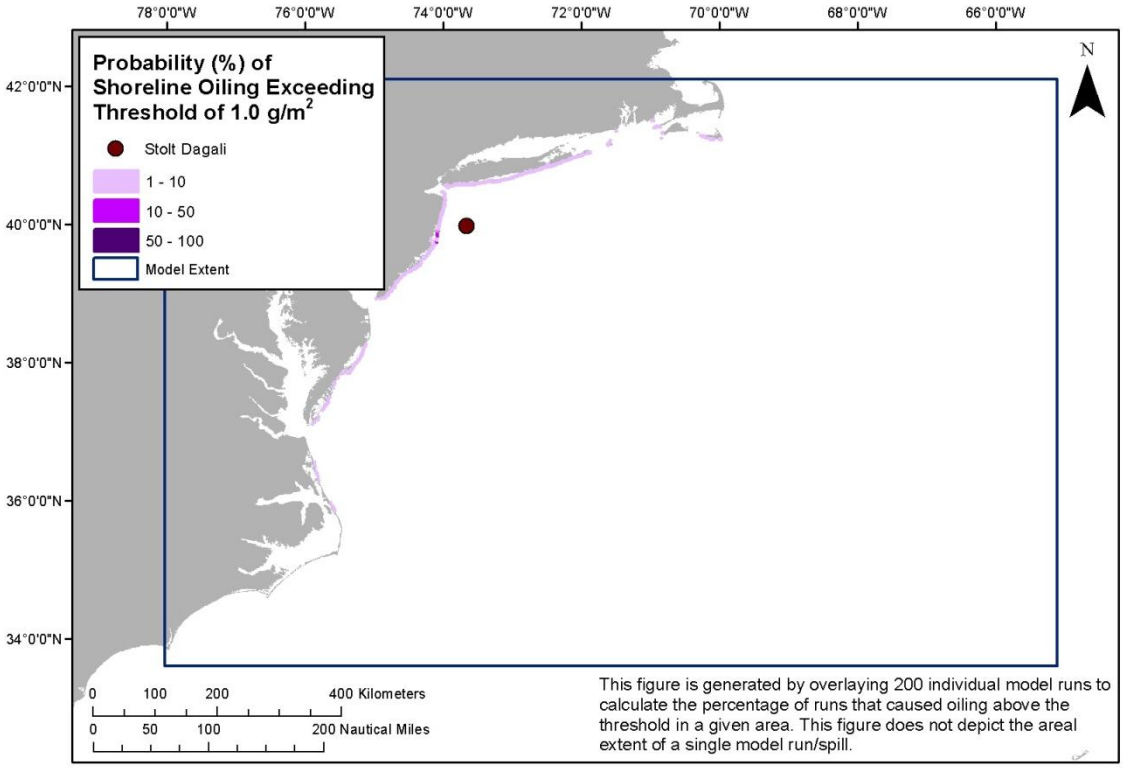


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 1,500 bbl of light fuel oil from the *Stolt Dagali*.

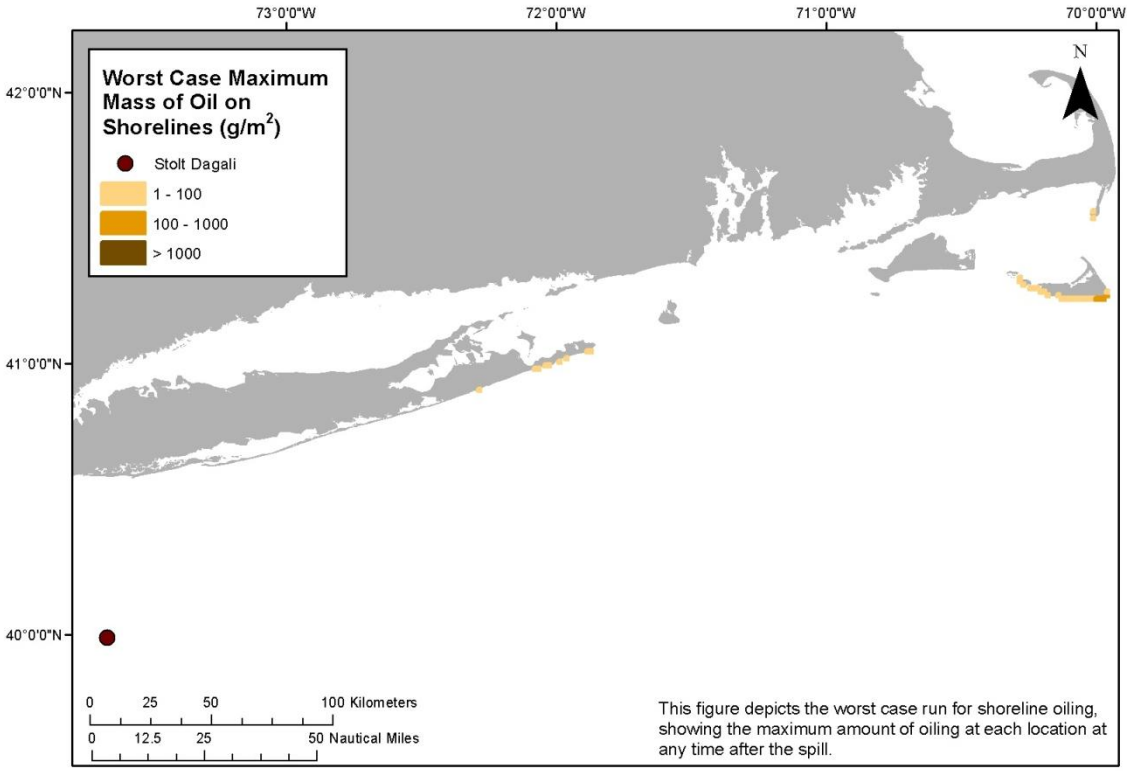


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 1,500 bbl of light fuel oil from the *Stolt Dagali* that resulted in the greatest shoreline oiling.

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.

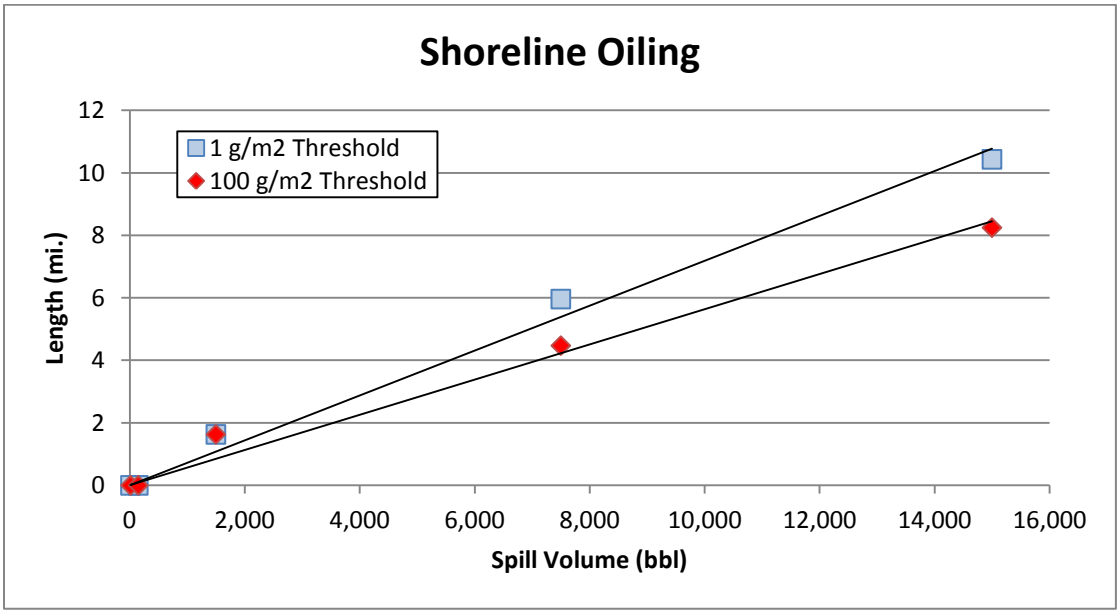


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Stolt Dagali*.

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 gravel beaches and mand-made shorelines.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 15,000 bbl from the *Stolt Dagali*.

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	53 miles	41 miles
Sand beaches	6 miles	2 miles
Salt marshes and tidal flats	0 miles	0 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 1,500 bbl from the *Stolt Dagali*.

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	3 miles	2 miles
Sand beaches	0 miles	0 miles
Salt marshes and tidal flats	0 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Stolt Dagali* 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 sensitive hard-bottom habitats used by these species.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Pelagic Birds and Waterfowl	• North and Mid-Atlantic inshore/offshore waters: 150,000 loons (RI is critical wintering habitat for a significant number of loons); 2,000 grebes; 1,000s of petrels; millions of shearwaters, storm-petrels, gulls; 300,000 boobies; 6,000 pelicans; 100,000s of cormorants, phalaropes, and terns; 10,000s of alcids; 1,000s of raptors, jaegers, and skimmers • Pelagic/waterbird bird use of RI waters is most diverse and abundant fall through spring, but 10,000s of birds have been observed feeding some summers • RI: Critical wintering areas for harlequin duck, hosting 11-23% of southern New England population • Mouths of DE Bay and Chesapeake Bay have high concentrations of species that are abundant over shoals (e.g., loons, pelicans, cormorants, gulls, terns, alcids) • Audubon's shearwater (50-75% of population) concentrate along the Continental Shelf edge off NC extending northward to the VA border (~3,800 pairs) • Northern gannet are abundant fall-spring throughout the coastal zone (often >3 km from shore) • Outer Banks, Inshore ocean NC to VA: key foraging area for gulls and terns; key migration corridor for loons; NC's largest population of northern gannet and red-breasted merganser	Terns, gulls present spring/summer; Loons present spring/fall; Harlequin duck present during winter Northern gannet, red-breasted merganser present in winter Most surveys in winter but use of shoals and offshore waters varies by species group and occurs throughout the year; Summer shoal use more common on northern shoals; Shearwaters off NC/VA in late summer

Sea Ducks	Sea ducks (includes mean and max distance of flocks to shore, 2009-2010 data)
	• Scoters (black, surf, and white-winged; 2 nm/8-13 nm)
	  ○ Off LI south coast: 8-19K
	  ○ Off NJ coast: 1K
	  ○ Off MD/DE: 18-111K
	• Long-tailed duck (2 nm/25 nm)
	  ○ Off LI south coast: 1-38K
	  ○ Off NJ coast: 1-6K
	  ○ Off MD/DE: 2K
	• Common eider (<1 nm/19 nm)
	  ○ Off LI south coast: 3.5K
	• Bufflehead, mergansers, goldeneyes (<1 nm/7-14 nm)
	  ○ Off NJ Coast: 9K
	  ○ Off MD/DE: 3K
	• RI: Most critical wintering areas for harlequin duck occur north of spill area, but rocky coasts in MA and RI also important
		Sea ducks surveyed in winter (peak abundances); Migration from Oct-Apr

Shorebirds and Colonial Nesting Birds	Shorebirds and colonial nesting birds are abundant on small islands, beaches, and marshes throughout the region • Outer Banks and Cape Hatteras: regionally important for coastal birds with	Colonial and beach nesters peak Apr-Aug

Species Group	Species Subgroup and Geography	Seasonal Presence
	365+ species including piping plover, willet, black skimmer, American oystercatcher • VA Barrier Island/Lagoon System: most important bird area in VA and one of the most along Atlantic Coast (of global/hemispheric importance): piping plover (FT), Wilson's plover, American oystercatcher, gull-billed tern, least tern, black skimmer; most significant breeding population of waders in state; marsh nesters have center of abundance here; internationally significant stopover point for whimbrel, short-billed dowitcher, and red knot • Assateague Island, MD: globally important bird area due to 60+ pairs of nesting piping plovers; largest colony of nesting least tern in MD; important for migratory shorebirds • Edwin B. Forsythe National Wildlife Refuge and Sandy Hook, NJ: essential nesting/foraging habitat for imperiled beach nesters: piping plover, American oystercatcher, black skimmer, least tern • Barrier islands on south shore of Long Island and islands/marshes on bay side: beach nesters (e.g., piping plover), nesting wading birds, raptors, migrating shorebirds, wintering waterfowl, etc.	Migration typically spring/fall, but varies by species and location and ranges from Feb-June/Aug-Dec
Raptors and Passerines	Lower Delmarva (Cape Charles area of VA): 20-80K raptors and over 10 million migrating passerines	Fall
Sea Turtles	Estuaries are summer foraging grounds for adult and juvenile green (FE) and loggerhead (FT) sea turtles, especially Chesapeake Bay and Long Island Sound Leatherback (FE), loggerhead, Kemp's ridley (FE) present offshore from Spring/Summer in the area of most probable impact. Greens occur in VA, NJ, and DE but are rare further north Nesting (annual counts along shorelines with most probable impacts). Mostly occurs in North Carolina but loggerheads can nest as far north as Delaware: • 650+ Loggerhead (FT) • < 20 Green (FT) • < 10 Leatherback (FE) Distribution: Offshore hot spots not well known Bays and sounds are foraging grounds for juvenile green, loggerhead, and Kemp's ridley (FE)	Adults and juveniles present spring/summer Loggerheads Nest: Mar-Nov Hatch: May-Dec
Marine Mammals	*Baleen whales*: North Atlantic right whale (FE), humpback whale (FE), fin whale (FE), sei whale (FE), and minke whale are more common offshore but can move inshore to feed on forage fish and zooplankton • Right whales are critically endangered (300-400 individuals remaining) and use this area as a migratory pathway *Inshore cetaceans:* Atlantic white-sided, bottlenose dolphin, harbor porpoise, common dolphins and killer whales use coastal waters out to the shelf break *Offshore cetaceans*: Northern bottlenose whale, pilot whales, Risso's dolphin, striped dolphin, common dolphin, Atlantic spotted dolphin, spinner dolphin • Often associated with shelf edge features and convergence zones *Pinnipeds*: 100s of gray seal and harbor seal are common during winter, with Block Island serving as an important haul out location. They can also occur as far south as NC. Harp, hooded, and gray seals have been observed but are rare	Baleen whales migrate through the area spring and fall; Males and juveniles may stay year round Dolphins more common in southern area, during summer Harbor porpoises calve May-Aug Sperm whales present spring-summer Harbor seals present during winter
Fish and Invertebrates	Coastal ocean waters support many valuable fisheries and/or species of concern in the region:	Benthic and midwater species are present

Species Group	Species Subgroup and Geography	Seasonal Presence
	• *Benthic or bottom associated*: Sea scallop, scup, black sea bass, butterfish, winter flounder, goosefish, scamp, horseshoe crab, tilefish • *Midwater*: Atlantic mackerel, Spanish mackerel, shortfin squid, bluefish, menhaden, spiny dogfish, smooth dogfish • *Pelagic*: Bluefin tuna, yellowfin tuna, wahoo, dolphinfish, bigeye tuna, swordfish • *Diadromous*: Alewife, blueback herring, American shad, hickory shad, Atlantic tomcod, American eel, Atlantic sturgeon (Fed. species of concern), shortnose sturgeon (FE), striped bass Important concentration/conservation areas are: • Pelagic species can be more concentrated around the shelf break and at oceanographic fronts in the region • EFH for highly migratory species occurs in the area, including swordfish, bluefin tuna, yellowfin tuna, many shark species • Juvenile and adult bluefin tuna aggregate in the area in the winter	throughout the year; Generally spawning during the warmer months (except winter flounder) Anadromous fish migrate inshore to spawn in fresh water in spring American eel migrates offshore to spawn in winter Bluefin tunas present fall-spring
Benthic Habitats	Submerged aquatic vegetation (mostly eelgrass) is critical to numerous species and occurs inside of bays and sounds throughout the region	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas from a leak from the *Stolt Dagali* 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 *Stolt Dagali* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 15,000 bbl and a border around the Most Probable Discharge of 1,500 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^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 *Stolt Dagali* is classified as Medium Risk for oiling probability for water column ecological resources for the WCD of 15,000 bbl because 24% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 34 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 1,500 bbl, the *Stolt Dagali* is classified as High Risk for oiling probability for water column ecological resources because 99% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 51 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 *Stolt Dagali* is classified as High Risk for oiling probability for water surface ecological resources for the WCD because 68% 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 2,500 mi^2. The *Stolt Dagali* is classified as Medium Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 15% 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 Low Risk for degree of oiling because the mean area of water contaminated was 560 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 *Stolt Dagali* is classified as Medium Risk for oiling probability for shoreline ecological resources for the WCD because 44% 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. The *Stolt Dagali* is classified as Low Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 2% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Low Risk for degree of oiling because the mean weighted length of shoreline contaminated was 2 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 15,000 bbl of light fuel oil from the *Stolt Dagali* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Low, because the area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – Medium, because of the seasonally large number of wintering, nesting, and migratory birds that use ocean, coastal, and estuarine habitats at risk and winter concentrations of seals. 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 and streamers
- Shoreline resources – Low, because of the lower likelihood of significant amounts of light fuel oil to strand onshore and most of the potentially impacted shorelines are sand/gravel beaches where a light fuel oil would not be persistent

Table 3-2: Ecological risk factor scores for the **Worst Case Discharge of 15,000 bbl** of light fuel oil from the *Stolt Dagali*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	**Medium**	High	24% 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 34 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	Low	Medium	**High**	68% 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 2,500 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	**Medium**	High	44% of the model runs resulted in shoreline oiling of 100 g/m^2	**Low**
3C-2: Shoreline Degree EcoRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 100 g/m^2 was 10 mi	

For the Most Probable Discharge of 1,500 bbl, the ecological risk from potential releases of light fuel oil from the *Stolt Dagali* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because the area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – Low, because the area affected is small and mostly far enough offshore that fewer marine birds are 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 and streamers
- Shoreline resources – Low, because very few miles of shoreline are at risk

Table 3-3: Ecological risk factor scores for the **Most Probable Discharge of 1,500 bbl** of light fuel oil from the *Stolt Dagali*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	99% 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 51 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	15% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Low**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 560 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	2% of the model runs resulted in shoreline oiling of 100 g/m^2	**Low**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 2 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 *Stolt Degali* include very highly utilized recreational beaches from North Carolina to Massachusetts during summer, but also during spring and fall for shore fishing. Hotspots for chartered fishing vessels and recreational fishing party vessels include along the New Jersey shore, off the mouth of Delaware Bay, and off the outer banks of North Carolina. 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 release could impact shipping lanes that run through the area of impact from New York east of Cape Cod, and into Narragansett Bay. Coastal waters off Rhode Island and southern Massachusetts are popular sailing locations. A proposed offshore wind farm site is located in Nantucket Sound. Commercial fishing is economically important to the region. Regional commercial landings for 2010 exceeded $600 million. Cape May-Wildwood, NJ and Hampton Roads, VA were the 6th and 7th nationally ranked commercial fishing ports by value in 2010. The most important species by dollar value present in and around the Mid-Atlantic are sea scallops, surf clams, ocean quahogs, menhaden, striped bass, and blue crab.

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 *Stolt Degali* 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 *Stolt Dagali*.

Resource Type	Resource Name	Economic Activities
Tourist Beaches	Ocean City, MD Rehoboth Beach, DE Dewey Beach, DE Indian Beach, DE Bethany Beach, DE Middlesex Beach, DE Fenwick Island, DE Cape May, NJ Wildwood, NJ Avalon, NJ Atlantic City, NJ Ocean City, NJ Absecon Beach, NJ	Potentially affected beach resorts and beach-front communities in Massachusetts, Rhode Island, New York, New Jersey, Delaware, and North Carolina 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 east coast of New Jersey, northeastern Delaware, the southern coast of Long Island, New York, the southern coast of Rhode Island, and the southwestern shore of Massachusetts and Martha's Vineyard, Massachusetts, are lined with economically-valuable beach resorts and residential communities.

Resource Type	Resource Name	Economic Activities
	Ludlam Beach, NJ Seven Mile Beach, NJ Margate City, NJ Peck Beach, NJ Ventnor City, NJ Brigantine Beach, NJ Beach Haven, NJ Spray Beach, NJ Brant Beach, NJ Long Beach, NJ Point Pleasant Beach, v Seaside Park, NJ Ortley Beach, NJ Ocean Beach, NJ Normandy Beach, v Ocean Beach, NY Fire Island Pines, NY Southampton, NY East Hampton, NY Westhampton Beach, NY Montauk, NY Block Island, RI East Matunuck State Beach, RI Roger W. Wheeler State Beach, RI Scarborough State Beach, RI Newport, RI Martha's Vineyard, MA	Many of these recreational activities are limited to or concentrated into the late spring through the early fall months.
National Seashores	Cape Hatteras National Seashore, NC Assateague Island National Seashore, MD and VA Fire Island National Seashore, NY	National seashores provide recreation for local and tourist populations while preserving and protecting the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area. Assateague Island is known for its feral horses. Cape Hatteras is known for its Bodie Island and Cape Hatteras Lighthouses. Popular recreation activities include windsurfing, birdwatching, fishing, shell collecting, and kayaking. The barrier island provides refuge for the endangered piping plover, seabeach amaranth, and sea turtles. Fire Island, a barrier island south of Long Island, has the historic William Floyd House and Fire Island Lighthouse.
National Wildlife Refuges	Prime Hook NWR (DE) Bombay Hook NWR (DE) Cape May NWR (NJ) Edwin B. Forsythe NWR (NJ) Seatuck NWR (NY) Wertheim NWR (NY) Amagansett NWR (NY) Block Island NWR (RI) Ninigret NWR (RI) Trustom Pond NWR (RI) Sachuest Point NWR (RI) Nomans Land Island NWR (MA) Mashpee NWR (MA) Nantucket Island NWR (MA)	National wildlife refuges in seven states may be impacted. These federally-managed and protected lands provide refuges and conservation areas for sensitive species and habitats.

Resource Type	Resource Name	Economic Activities
	Monomoy NWR (MA) Fisherman Island NWR (VA) Eastern Shore of Virginia NWR (VA) Wallops Island NWR (VA) Chincoteague NWR (VA) Back Bay NWR (VA) Mackay Island NWR (NC) Currituck NWR (NC) Pea Island NWR (NC) Cedar Island NWR (NC)	
State Parks	Assateague State Park, Maryland Delaware Seashore State Park, DE Cape Henlopen State Park, DE Cape May Point State Park, NJ Corson's Inlet State Park, NJ Barnegat Lighthouse State Park, NJ Island Beach State Park, NJ Robert Moses State Park, NY Shadmoor State Park, NY Camp Hero State Park, NY Montauk State Park, NY Salty Brine State Park, RI Fishermen's Memorial State Park, RI Beavertail State Park, RI Wetherill State Park, RI Brenton Point State Park, RI Fort Adams State Park, RI Horseneck Beach State Park, MA Demarest Lloyd State Park, MA Fort Phoenix State Park, MA Nasketucket Bay State Park, MA	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 Massachusetts, Rhode Island, New York, New Jersey, Delaware, and Maryland are potentially impacted. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Tribal Lands	Shinnecock Indian Reservation, NY	Shinnecock Indian Reservation, New York, is home to over 500 tribal members. (Note this reservation has been recognized by New York State but not by the U.S. Bureau of Indian Affairs)
	Narragansett Indian Reservation, RI	Narragansett Indian Reservation, Rhode Island, is home to 2,400 tribal members.
	Wampanoag Indian Reservation, MA	Wampanoag Indian Reservation, Massachusetts, is home to over 2,000 tribal members.
Commercial Fishing	A number of fishing fleets use the New York Bight area and surrounding waters for commercial fishing purposes.	
	Atlantic City, NJ	Total Landings (2010): $17.3M
	Belford, NJ	Total Landings (2010): $2.2M
	Cape May-Wildwood, NJ	Total Landings (2010): $81M
	Chincoteague, Virginia	Total Landings (2010): $3.5M
	Montauk, NY	Total Landings (2010): $17.7M
	New London, Connecticut	Total Landings (2010): $10.6M
	Newport, RI	Total Landings (2010): $6.9M
	Ocean City, Maryland	Total Landings (2010): $8.8M
	Point Pleasant, NJ	Total Landings (2010): $22.8M
	Stonington, Connecticut	Total Landings (2010): $18.5M
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.	

Resource Type	Resource Name	Economic Activities
	Camden, NJ	249 port calls annually
	Claymont, DE	19 port calls annually
	Delaware City, DE	211 port calls annually
	Gloucester, NJ	180 port calls annually
	New York/New Jersey	5,414 port calls annually
	Newport, RI	95 port calls annually
	Philadelphia, PA	914 port calls annually
	Providence, RI	128 port calls annually
	Salem, NJ	52 port calls annually
	Wilmington, DE	443 port calls annually
Other Resources	Cape Wind Offshore Wind Farm (proposed), MA	Rated to produce up to 468 megawatts of wind power with average expected production will be 170 megawatts which is almost 75% of the 230 megawatt average electricity demand for Cape Cod and the Islands of Martha's Vineyard and Nantucket.

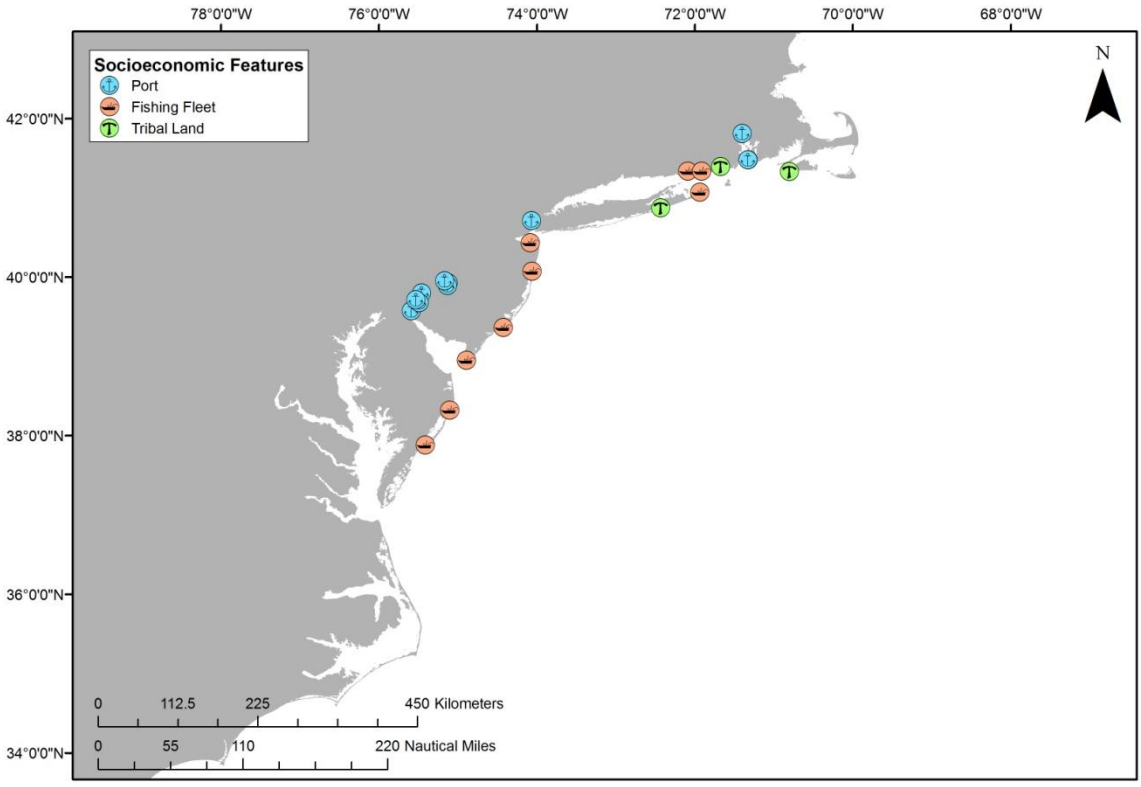


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Stolt Dagali*.

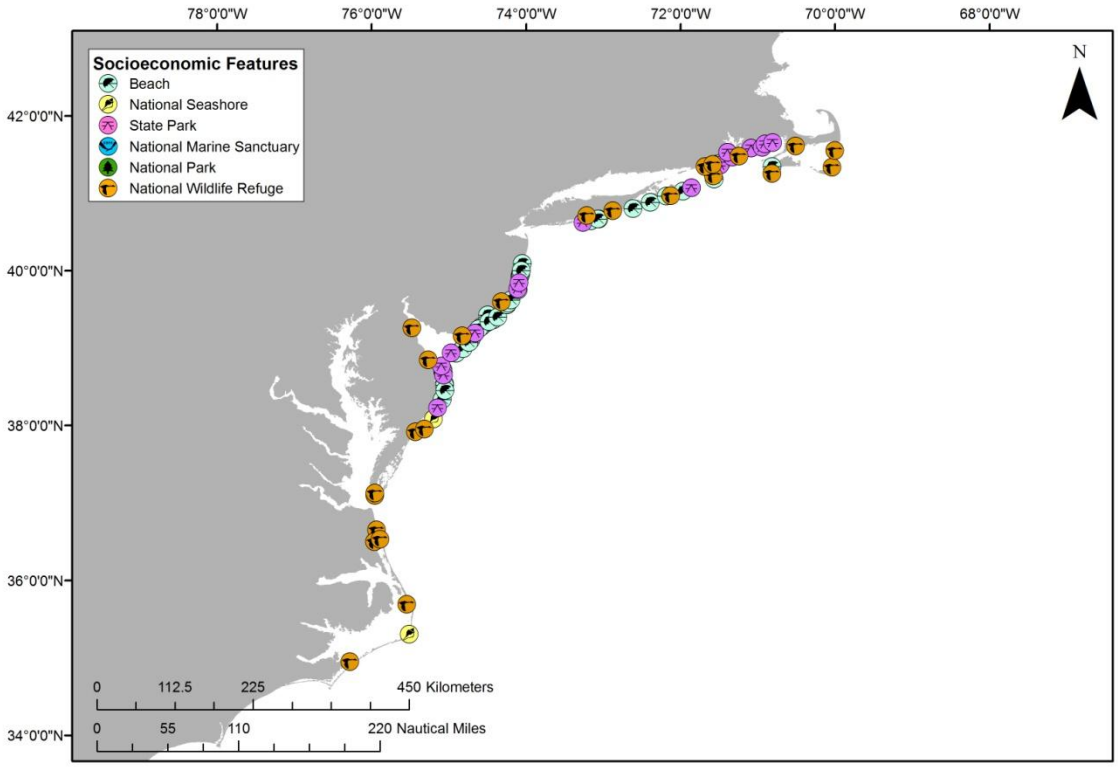


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Stolt Dagali*.

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, in the text classification for the *Stolt Dagali* shading indicates the degree of risk for the WCD release of 15,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 1,500 bbl.

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

This risk factor reflects the probability that at least 0.2 mi^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 *Stolt Dagali* is classified as Medium Risk for both oiling probability and degree of oiling for water column socio-economic resources for the WCD of 15,000 bbl because 24% 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 34 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 1,500 bbl, the *Stolt Dagali* is classified as High Risk for oiling

probability for water column socio-economic resources because 99% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 51 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 *Stolt Dagali* is classified as High Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the WCD because 86% 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 13,000 mi^2. The *Stolt Dagali* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 68.5% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2 It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 4,200 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 *Stolt Dagali* is classified as Medium Risk for oiling probability for shoreline socio-economic resources for the WCD because 48% 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 28 miles. The *Stolt Dagali* is classified as Low Risk for both oiling probability and degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 4% 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 4 miles.

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

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 15,000 bbl of light fuel from the *Stolt Dagali* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Medium, because a moderate water column area would be impacted in important fishing grounds
- Water surface resources – Medium, because a large offshore area would be affected in an area of important shipping lanes. 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 and streamers
- Shoreline resources – Low, because a moderate amount of shoreline would be impacted by a light fuel, though it would not be persistent, and 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 15,000 bbl** of light fuel oil from the *Stolt Dagali*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	**Medium**	High	24% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Med**
4A-2: Water Column Degree SRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 34 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	**High**	86% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	**Med**
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	**High**	The mean area of water contaminated above 0.01 g/m^2 was 13,000 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	**Medium**	High	48% of the model runs resulted in shoreline oiling of 1 g/m^2	**Low**
4C-2: Shoreline Degree SRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 1 g/m^2 was 28 mi	

For the Most Probable Discharge of 1,500 bbl, the socio-economic risk from potential releases of light fuel from the *Stolt Dagali* is summarized below and indicated in the far-right column in Table 4-3:

- Water column resources – Medium, because a moderate water column area would be impacted in important fishing grounds
- Water surface resources – Medium, because a moderate area of important shipping lanes would be affected by non-persistent oiling. 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 and streamers
- Shoreline resources – Low, because of the minor amount of shoreline oiling likely

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 1,500 bbl** of light fuel oil from the *Stolt Dagali*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	99.5% 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	Med
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 51 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	68.5% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	Med
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m^2 was 4,221 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	4% of the model runs resulted in shoreline oiling of 1 g/m^2	Low
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 4 mi	

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

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

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

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

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

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

For the Worst Case Discharge, *Stolt Dagali* scores Low with 11 points; for the Most Probable Discharge, *Stolt Dagali* also scores Low with 10 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 *Stolt Dagali*. The final determination of what type of action, if any, rests with the U.S. Coast Guard.

Stolt Dagali	**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

Should additional information become available that would suggest a greater level of concern, then an active monitoring program could be implemented or an assessment undertaken.

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

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Low	Maximum of 15,000 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Bunker oil is diesel fuel oil, a Group II 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 known to have been reported on the water		
	D1: Nature of Casualty	High	Collision		
	D2: Structural Breakup	High	The vessel broke in two at the time of sinking		
Archaeological Assessment	Archaeological Assessment	Low	Wreck is not a historic wreck, no archaeological assessment was prepared		**Not Scored**
Operational Factors	Wreck Orientation	High	Resting on its starboard side		**Not Scored**
	Depth	High	130 ft		
	Visual or Remote Sensing Confirmation of Site Condition	High	Location is a popular dive site		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	No		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	No		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Exposures above thresholds occur offshore where there are no known concentrations of sensitive resources	**Low**	**Low**
	3B: Water Surface Resources	High	Large releases could affect many migratory and wintering birds; smaller releases have limited areas above threshold	**Med**	**Low**
	3C: Shore Resources	High	Limited shoreline oiling, and light oils are not persistent	**Low**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	A moderate water column area would be impacted in important fishing grounds.	**Med**	**Med**
	4B: Water Surface Resources	High	A moderate offshore area of important shipping lanes with non-persistent oil.	**Med**	**Med**
	4C: Shore Resources	High	Light oils are not expected to persist on shorelines, although there are many important socio-economic resources present along the shoreline	**Low**	**Low**
Summary Risk Scores				**11**	**10**