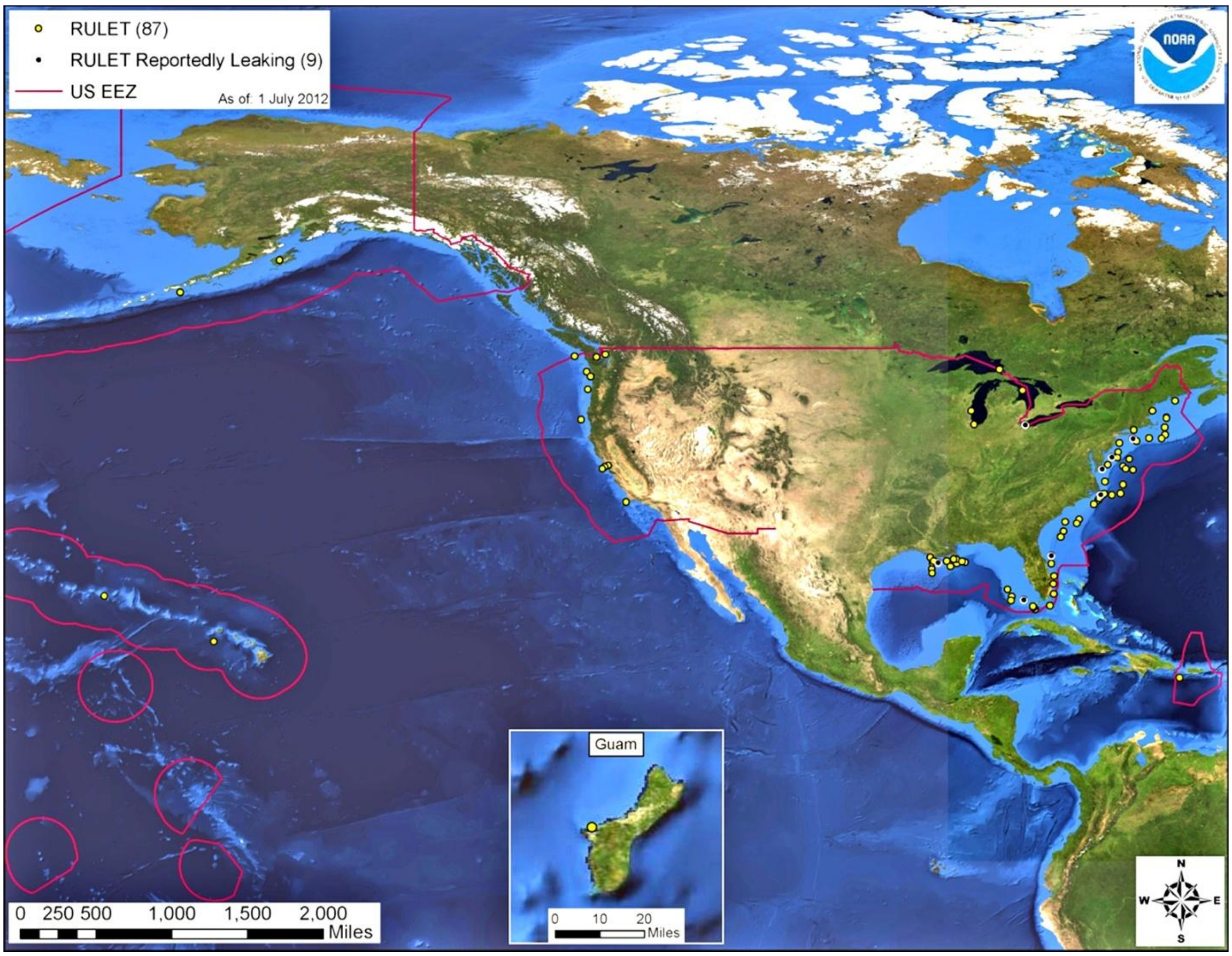
Department of Commerce
National Oceanic and Atmospheric Administration
Office of National Marine Sanctuaries
Office of Response and Restoration

Risk Assessment for Potentially Polluting Wrecks in U.S. Waters



March 2013

National Oceanic and
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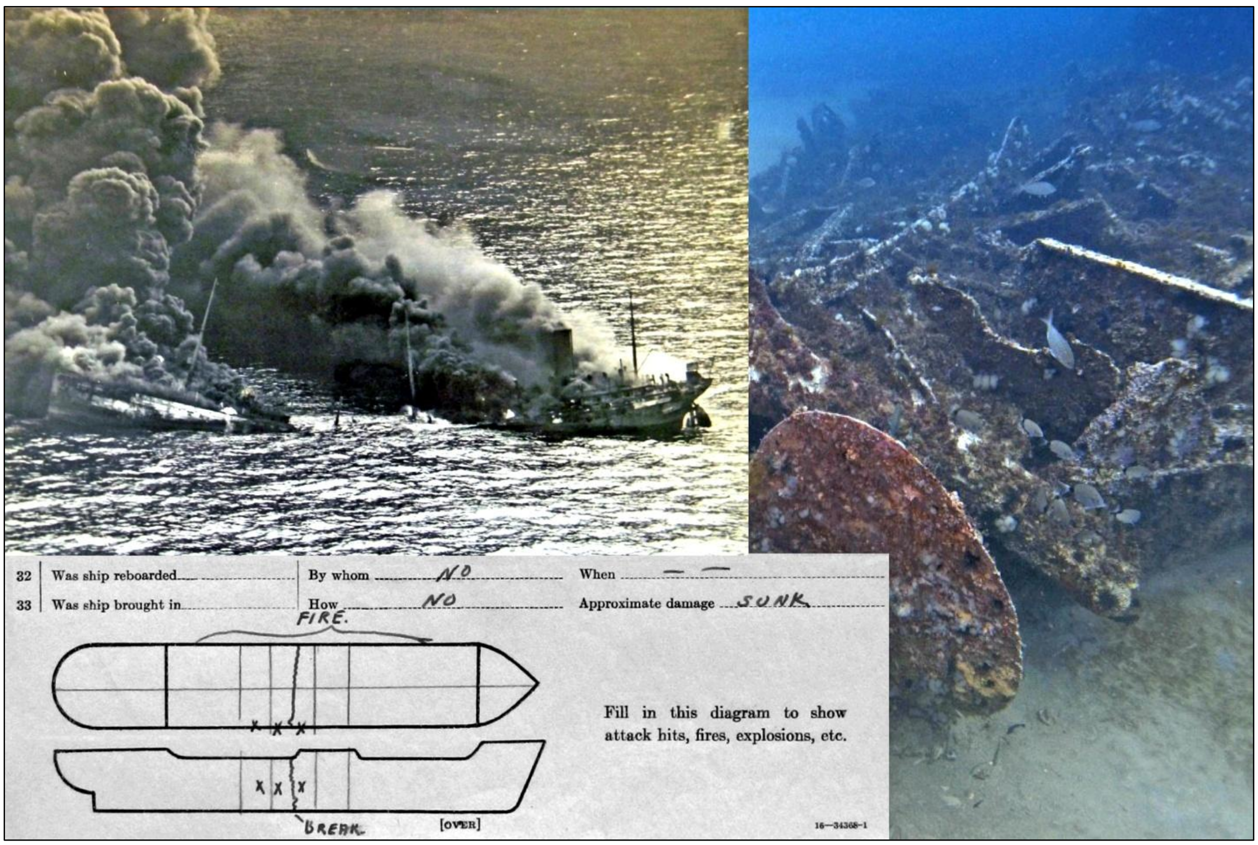

Images of tanker *Dixie Arrow* portraying types of information used to assess pollution risk and construct risk assessment packages. Top left: Historical photograph of *Dixie Arrow* sinking. Bottom left: Historical USCG sinking assessment of *Dixie Arrow* depicting torpedo impact locations. Right: Underwater site of the shipwreck in its current condition off the coast of Cape Hatteras, North Carolina.

RPI asa science. services. solutions. Environmental Research Consulting

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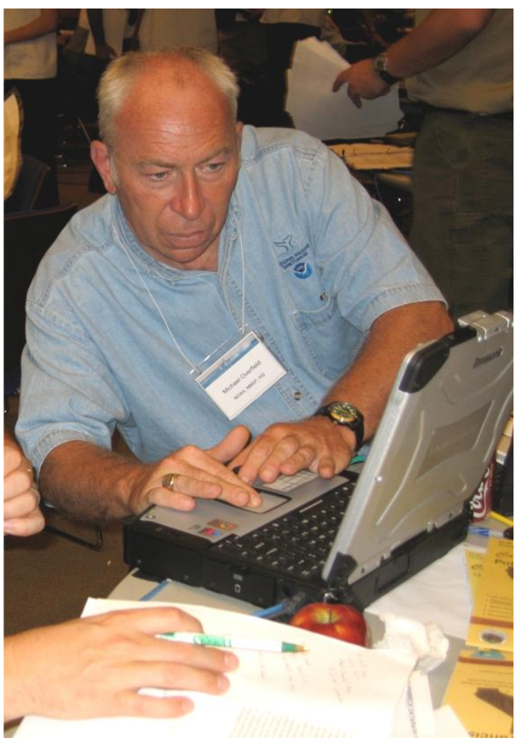
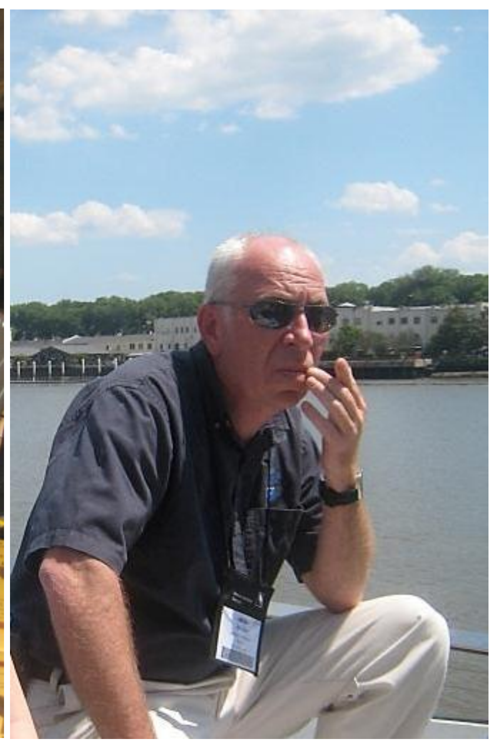
Dedication

This document is dedicated to the late Mike Overfield, an underwater archaeologist in the NOAA Office of National Marine Sanctuaries from 2003-2009. Without Mike's work on the Resources and UnderSea Threats (RUST) database, his innovative and creativity in getting things done, his ability to find the resources to meet challenges and overcome obstacles, and his dogged determination, NOAA's work on the potentially polluting wrecks issue would not have been accomplished. Mike's tireless efforts during a time of personal medical trial were a testament to his dedication to NOAA and public service. Mike had a selflessness that engaged others to understand and support his vision. His effectiveness in fostering dialogue among archaeologists, salvors, spill response organizations and policy makers has helped all better understand the complex nature of this issue and provided an effective model for the current level of engagement.





Executive Summary

Project Background

The past century of commerce and warfare has left a legacy of thousands of sunken vessels along the U.S. coast. The public has long been fascinated by shipwrecks because of their significance to history and culture. However, there is growing concern about their potential environmental impacts from eventual release of their cargo and fuel. Dozens of stories have been written about the problems associated with leaking World War II-era ships lost in both the Pacific and Atlantic Oceans. Although a few, such as the *Mississinewa* and the *Jacob Luckenbach*, are well-publicized oil pollution 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, often becoming the source of "mystery spills" until the source is identified.

Recent response efforts in the U.S. and elsewhere have led to interest from both government and the spill response and salvage industries to systematically identify, incorporate in regional and area contingency plans, investigate, and potentially offload the oil remaining onboard wrecks before they begin to leak. The Marine Technology Society published a special issue focused on underwater pollution threats (MTS, 2004), and the 2005 International Oil Spill Conference (IOSC) commissioned an issue paper (Michel et al., 2005) that furthered the discussion. Much of the interest is because proactive removal of oil contained within a wreck can be planned and managed more cost-effectively than an emergency spill response. Equally important, proactive removal of the oil would avoid environmental and socio-economic consequences associated with a discharge from the vessel. The scope and scale of the issue as previously framed by the IOSC and others were overwhelming for state and federal response personnel without narrowing of focus to vessels that are of highest risk.

Only a fraction of the estimated 20,000 shipwrecks in U.S. waters are likely to contain oil. Many older wrecks were coal-fired or sailing ships and never carried oil as fuel or cargo. More contemporary ships often came to a violent end, breaking apart in storms, collisions, or in battle. Many shallow wrecks were salvaged or were deemed hazards to navigation and intentionally destroyed. Others sank off the continental shelf and were never located. All have suffered from corrosion and the passage of time.

The National Oceanic and Atmospheric Administration (NOAA) maintains a large database of shipwrecks, dumpsites, navigational obstructions, underwater archaeological sites, and other underwater cultural resources. This internal database, Resources and Undersea Threats (RUST), includes approximately 20,000 shipwrecks in U.S. waters (Figure ES-1). Given these numbers of wrecks in U.S. waters, it is crucial that archival research and risk assessment conducted for this study focus on methods to determine which wrecks are most likely to contain harmful quantities of oil. 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. NOAA worked closely with the U.S. Coast Guard Office of Marine Environmental Response Policy in implementing this mandate. The Remediation of Underwater Legacy Environmental Threats (RULET) effort supported by these funds provides information that assists the U.S. Coast Guard and the Regional Response Teams (RRTs) as well as NOAA in prioritizing potential threats to coastal resources while at the same time assessing the historical and cultural significance of these nonrenewable cultural resources.

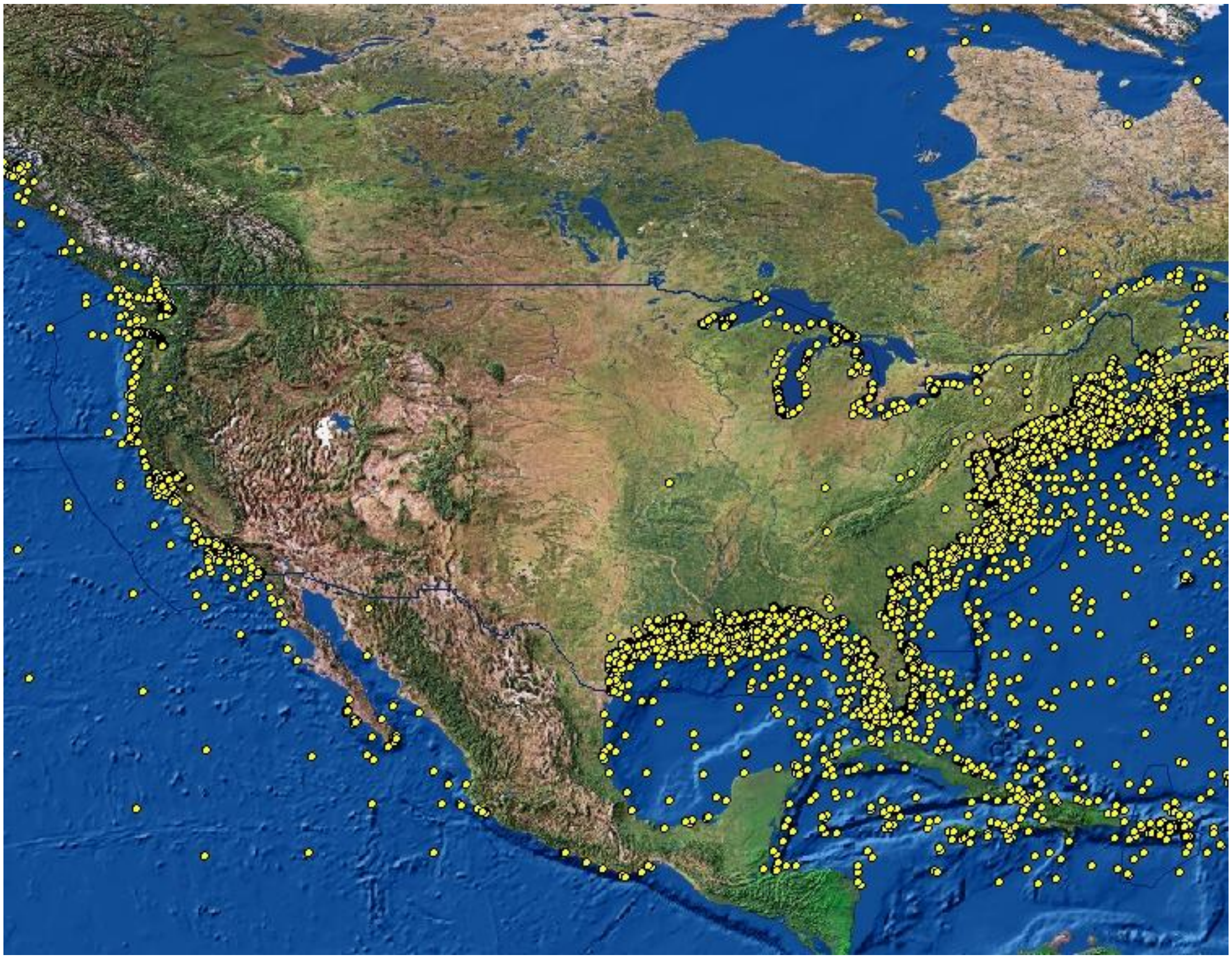


Figure ES-1: The NOAA Resources and UnderSea Threats (RUST) database has over 30,000 targets, including 20,000 vessels.

NOAA scientists and archaeologists analyzed data by searching a broad variety of historical sources on wrecks in U.S. waters using a tiered approach to develop a priority list of wrecks for further monitoring or assessment. They worked closely with the U.S. Coast Guard Salvage Engineering Response Team (SERT) to incorporate a salvage engineer's perspective into the historical information gathered by NOAA. In addition, NOAA worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct modeling of potential oil spills from the priority wrecks to identify the ecological and socio-economic resources at risk. This report summarizes this oil pollution threat assessment process and scores vessels based on a broad multi-disciplinary, weight-of-evidence approach that combines the historical evidence, archaeological interpretation, and salvage engineering with pollutant fate modeling, and ecological and socio-economic risk assessment.

Shipwrecks hold many secrets; key details such as logbooks and loading records literally went down with the ship. Most of these wrecks have not been directly surveyed by remote sensing technologies, divers, or remotely operated vehicles, thus detailed information on their physical status and remaining contents is unknown. This combination of historic and scientific assessment methods helps reduce those uncertainties and provides a sound basis for evaluating shipwrecks for further assessment and response. As more information becomes available, these evaluations may change.

Project Results and Summary

A separate database, RULET, was created for the subset of wrecks in RUST with the highest potential to cause pollution. NOAA used a tiered approach to develop an initial priority list of vessels for risk assessment. Initial screening criteria, based on available data for each wreck, included vessels sunk after 1891 (when U.S. vessels began conversion to fuel oil), vessels built of steel or other durable material, cargo vessels over 1,000 gross tons (smaller vessels would have limited cargo or bunker capacity), and any tank vessel. As a result of this initial screening, the RULET database narrowed down the 20,000 vessels to 573 wrecks within the U.S. Exclusive Economic Zone (U.S. EEZ) that could pose a substantial oil pollution threat. Additional research revealed that the actual number of wrecks posing a substantial pollution threat was much lower (107) due to the violent nature in which some ships sank and the structural reduction and demolition of those that were navigational hazards. The resources at risk assessments based on the pollution modeling further narrowed the list. NOAA developed a total of 87 risk assessment packages for consideration by U.S. Coast Guard Federal On-Scene Coordinators (FOSCs), RRTs, and Area Committees. Based on vessel contents, condition, environmental sensitivity, and other factors, NOAA has determined that 6 vessels are high priority for a Most Probable (10%) discharge, and 36 are high priority for a Worst Case Discharge (Table ES-1).

Table ES-1: Number of vessels in each priority category for the 87 priority wrecks for the Worst Case and Most Probable Discharge volumes.

Category Rank	No. Wrecks for Worst Case Discharge	No. Wrecks for Most Probable Discharge
High Priority	36	6
Medium Priority	40	36
Low Priority	11	45

Most of these wrecks have not been surveyed for pollution potential; in some cases, little is known about their current condition. It is possible that some vessels that were removed from the list may prove to be pollution hazards. For example, if archival research suggested a vessel had been salvaged or destroyed and would no longer have any structural integrity, it was removed from the list. However, it is necessary to use the best information available to focus limited resources on the highest priority threats.

To prioritize which vessels are candidates for further evaluation, NOAA used a series of vessel-related risk factors based on current knowledge and best professional judgment to assess physical integrity and pollution potential as well as other factors that may impact potential removal operations if such operations were undertaken. The pollution potential factors were: 1) total oil volume potentially onboard as cargo and bunker fuels; 2) oil type; 3) if the wreck was reported to have been cleared as a hazard to navigation or demolished; 4) if significant amount of oil was lost during the casualty; and 5) the nature of the casualty that would reduce the amount of oil onboard, such as multiple torpedoes or structural breakup. The factors that may impact potential operations were: 1) wreck orientation on the seafloor; 2) depth; 3) visual or remote sensing confirmation of the site conditions; 4) if other hazardous materials were onboard; 5) if munitions were onboard; and 6) if the wreck is of historic significance and will require appropriate actions to be taken under the National Historic Preservation Act and the Sunken Military Craft Act. Each factor was also assigned a data quality rating. At the end of the evaluation, each vessel was given an overall vessel risk score of High, Medium, or Low. After this third level of screening, 87 wrecks remained on the priority list (shown in Figure ES-2) as vessels scored low were screened out. Appendix A lists the 486 wrecks removed from the priority list and a short statement on the basis for removal.

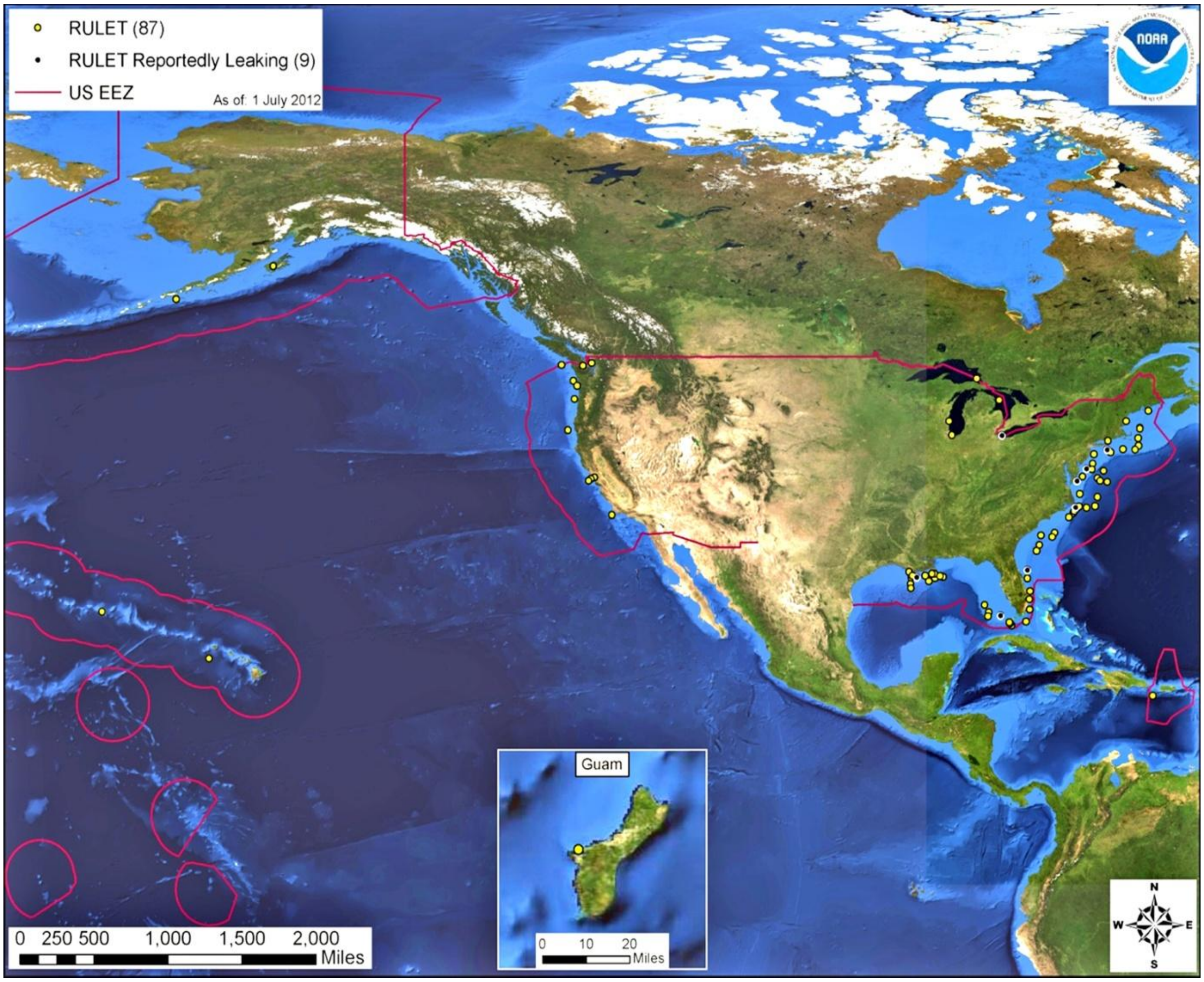


Figure ES-2: The locations of the 87 priority wrecks addressed in this report.

The next step was to use probabilistic computer models to assess the potential ecological and socio-economic impacts if there was an oil release. Because the amount of oil on board at the time of departure from port is unknown for most vessels, they were assumed to have full bunkers and cargo. In the few instances where fuel consumption rates were known before the environmental models were generated, the total bunker volumes were reduced to take into account the amount of fuel likely burned during the voyage. In most instances, however, this information was not known before the environmental models were generated, and the maximum bunker capacity was used to error on the conservative side. The models were run using five potential oil release scenarios (100, 50, 10, 1, and 0.1% of the known or estimated maximum total amount of oil onboard).

Of the 87 priority vessels, 47 (54%) have unknown or unconfirmed locations; "unconfirmed" locations includes vessels where divers have reported finding a ship but definitive identification of the shipwreck has not yet occurred. There are numerous instances of vessels being misidentified, particularly in areas where several vessels of similar size and age were lost. In these cases, the last known reported positions were used for modeling purposes. Wind and current records at and around the wreck site of interest were compiled into the oil spill models to help determine the potential range of distances and directions that these hypothetical oil spills might travel from the wreck site. These long-term wind and current records were sampled at random and model runs were performed for each of 200 selected spill dates and times. This set of random dates/times represents the potential environmental conditions that could occur during a release. The model results predicted the volumes of water that might be exposed, areas of water surface, and lengths and types of shoreline above effects thresholds for each modeled wreck.

Regression curves based on five different potential spill volumes for the modeled wreck were used to quantify the potential impacts to: 1) water column resources; 2) water surface resources, and 3) shoreline resources. It was not feasible to conduct individual computer model simulations of all 87 of the priority wrecks due to limited time and financial resources. Therefore, “clusters” of vessels within a reasonable proximity and with similar oil types were created. The wreck with the largest potential amount of oil onboard was selected for modeling of oil release volumes, and the results were used as surrogates for the other vessels in the cluster. To support contingency planning efforts, scores characterizing the scope and scale of potential ecological and socio-economic resource impacts are provided for two of the modeled volumes: the Worst Case Discharge (WCD; 100% of the oil volume) and the Most Probable Discharge (10% of the oil volume). Thus, each vessel had three scores for ecological impacts and three scores for socio-economic impacts, as illustrated in Table ES 2.

As shown in Table ES 2, to develop an overall risk score for each spill scenario for each wreck, the six component scores from the modeling were added with the score generated from the overall analysis of the pollution potential factors. Confidence in the data quality is also noted for each score. The total scores were used to assign a final priority to each wreck under both the Worst Case and Most Probable Discharge scenarios. Table ES-1 shows the distribution of the final risk scores, and Table ES-3 lists the 87 vessels and their final scores. Nine of these vessels were initially reported as leaking or known to have visible oil in overhead spaces that number changed over time with vessels being taken out of the database (e.g. a coal fired vessel with a vehicle and fuel drum deck cargo) and others added.

Most wrecks that have been identified in U.S. waters to date are thought to have little to no recoverable oil or represent relatively minor threats. However, a small number may contain hundreds of thousands of barrels (bbl) of oil and could become ecological and socio-economic threats. Selecting any of these vessels for proactive response will require further analysis including more detailed spill trajectory studies and monitoring or oil removal feasibility studies. While the salvage industry and oil spill response organizations have demonstrated great advancements in underwater oil removal technologies, in many cases the best alternative may not be removal of oil, but rather to monitor the wreck and plan for potential spills. The current risk assessment project will assist in better planning for both alternatives.

Under the National Contingency Plan, the U.S. Coast Guard, RRTs, and local Area Committees have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on review of available information and its role as a resource trustee, NOAA makes recommendations for each of the 87 wrecks in separate, detailed reports, ranging from inclusion of the wreck in the Area Contingency Plan (so that if a mystery spill is reported in the general area, the vessel could be investigated as a source) to implementation of an active monitoring plan, or consideration of the site for an in-water assessment. NOAA also recommends that outreach efforts be conducted with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area to gain awareness of localized spills in the general area where the vessel is believed lost. ***These are recommendations; the final determination of what type of action, if any, rests with the U.S. Coast Guard under authority from the National Contingency Plan and the Oil Pollution Act of 1990.*** As the risk assessments are incorporated into regional and area contingency plans, it is likely that local knowledge will bring forward other vessels that meet the criteria that the U.S. Coast Guard can apply the RULET methodology to as well.

Table ES 2: Example of summary scoring for a RULET wreck.

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 93,000 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Cargo is crude oil, a Group III oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	Significant fire reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Multiple torpedo detonations, explosion		
	D2: Structural Breakup	High	Vessel remains in one contiguous piece		
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports of this ship exist, assessment is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	High	Inverted (turtled)		**Not Scored**
	Depth	High	90 feet		
	Visual or Remote Sensing Confirmation of Site Condition	High	Location has been surveyed		
	Other Hazardous Materials Onboard	High	No		
	Munitions Onboard	High	Munitions for onboard weapons		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Nearshore habitats which are important spawning areas at greatest risk of impact	**Med**	**Med**
	3B: Water Surface Resources	High	Slicks could cover large areas with abundant wintering waterfowl, sea turtles concentrated in *Sargassum* mats where oil also tends to concentrate, and spawning habitat for many fish/shellfish	**High**	**Med**
	3C: Shore Resources	High	Shoreline resources include wetlands which are difficult to clean and under long-term decline, large bird nesting colonies, turtle nesting beaches, nursery areas for many fish and shellfish, and wintering habitat for listed bird species	**High**	**Med**
Socio-Economic Resources	4A: Water Column Resources	High	Moderate water column impact in important fishing grounds	**Low**	**Low**
	4B: Water Surface Resources	High	Relatively large impact in important shipping lanes and fishing areas	**High**	**Med**
	4C: Shore Resources	High	Moderate shoreline oiling would occur in areas with important resources	**Med**	**Med**
Summary Risk Scores				**16**	**13**

Table ES-3: Overall results of the assessment for Worst Case Discharge (WCD) and Most Probable Discharge (MP).

Vessel Name	Oil Type	WCD Volume (bbl)	WCD Final Score	MP Final Score
Gulfstate	Crude	86,000	20	17
Esso Gettysburg	Crude	132,000	18	16
Francis E. Powell	Light	93,000	18	14
R.W. Gallagher	Heavy	86,000	18	13
Lubrafol	Light	80,000	18	12
China Arrow	Heavy	93,000	18	10
Norness	Light	99,000	17	15
W.D. Anderson	Crude	146,000	17	15
W.L. Steed	Crude	78,000	17	13
Hamlet	Crude	77,000	17	13
Pan-Massachusetts	Light	116,000	17	12
George MacDonald	Heavy	115,000	16	15
Joseph M. Cudahy	Crude	90,000	16	15
William Rockefeller	Heavy	150,000	16	14
Coimbra	Light	29,000	16	13
Maiden Creek	Heavy	9,000	16	13
Doris Kellogg	Crude	60,000	16	13
Cities Service Toledo	Crude	93,000	16	13
Diamond Knot	Light	7,000	16	13
Drexel Victory	Heavy	12,000	16	12
Halo	Crude	71,000	15	14
Fernstream	Light	13,000	15	13
USNS Mission San Miguel	Light	15,000	15	13
John Straub	Heavy	13,000	15	13
Cornwallis	Heavy	10,000	15	12
Lancing	Light	77,000	15	12
Norlavore	Heavy	4,000	15	12
Paestum	Heavy	12,000	15	12
Juan Casiano	Heavy	7,000	15	12
Ohioan	Heavy	11,000	15	12
Jacob Luckenbach	Heavy	700	15	12
Puerto Rican	Heavy	21,000	15	12
Larry Doheny	Heavy	73,000	15	12
Regal Sword	Light	23,000	15	11
Gulfoil	Light	55,000	15	11
Cities Service No. 4	Light	12,000	15	10
Bloody Marsh	Heavy	118,000	14	14
Potrero Del Llano	Heavy	8,000	14	12
Argo	Crude	3,000	14	12
USS Neches (AO-5)	Light	68,000	14	12
Pan-Pennsylvania	Heavy	11,000	14	11
Allan Jackson	Crude	81,000	14	11
Buarque	Heavy	9,000	14	11
Marit II	Crude	84,000	14	11
Nordal	Heavy	8,000	14	11
Venore	Heavy	10,000	14	11

Note: Colors indicate final priority scoring. Red = High Priority; Yellow = Medium Priority; and Green = Low Priority

Table ES-3: Cont.

Vessel Name	Oil Type	WCD Volume (bbl)	WCD Final Score	MP Final Score
Prins Willem V	Light	3,000	14	11
Oregon	Light	9,000	14	9
C. O. Stillman	Light	144,000	14	8
Oneida	Heavy	5,000	13	12
Mormackite	Heavy	6,000	13	12
Managua	Heavy	5,000	13	12
Manzanillo	Heavy	5,000	13	12
Norlindo	Heavy	5,000	13	12
Cherokee	Heavy	10,000	13	11
Cayru	Heavy	14,000	13	11
Ljubica Matkovic	Heavy	7,000	13	11
Pacbaroness	Light	8,000	13	11
Camden	Heavy	8,420	13	11
Mobile Point	Light	4,000	13	11
India Arrow	Light	94,000	13	10
Sheherazade	Light	10,000	13	10
Empire Gem	Heavy	2,000	12	12
Marine Electric	Heavy	4,000	12	11
Northern Pacific	Heavy	8,000	12	11
Swiftscout	Heavy	4,000	12	11
Alcoa Puritan	Heavy	10,000	12	11
Gulfstag	Heavy	12,000	12	11
Robert E. Lee	Heavy	7,000	12	11
Virginia	Heavy	13,000	12	11
Gulfpenn	Heavy	14,000	12	10
Edmund Fitzgerald	Heavy	2,000	12	10
Monrovia	Heavy	2,000	12	10
Aleutian	Heavy	3,000	12	10
Panam	Light	7,000	12	9
Tokai Maru	Light	2,000	12	9
Taborfjell	Heavy	3,000	11	11
Empire Knight	Light	10,000	11	10
Stolt Dagali	Light	15,000	11	10
Munger T. Ball	Heavy	3,000	11	10
Coast Trader	Heavy	7,000	11	10
Santiago de Cuba	Heavy	3,000	11	9
Rawleigh Warner	Heavy	3,000	11	9
Bunker Hill	Heavy	2,000	11	9
Material Service	Light	3,000	10	10
Panky	Light	5,000	10	9
Vainqueur	Light	5,000	9	8

Note: Colors indicate final priority scoring. Red = High Priority; Yellow = Medium Priority; and Green = Low Priority

The distribution and final scores for the priority wrecks in each U.S. Coast Guard District have been plotted on maps and summarized in tables in Section 3. The maps and table for U.S. Coast Guard District 7 are shown in Figures ES-3 and ES-4 and Table ES-4, as examples.

U.S. Coast Guard District 7 – Florida

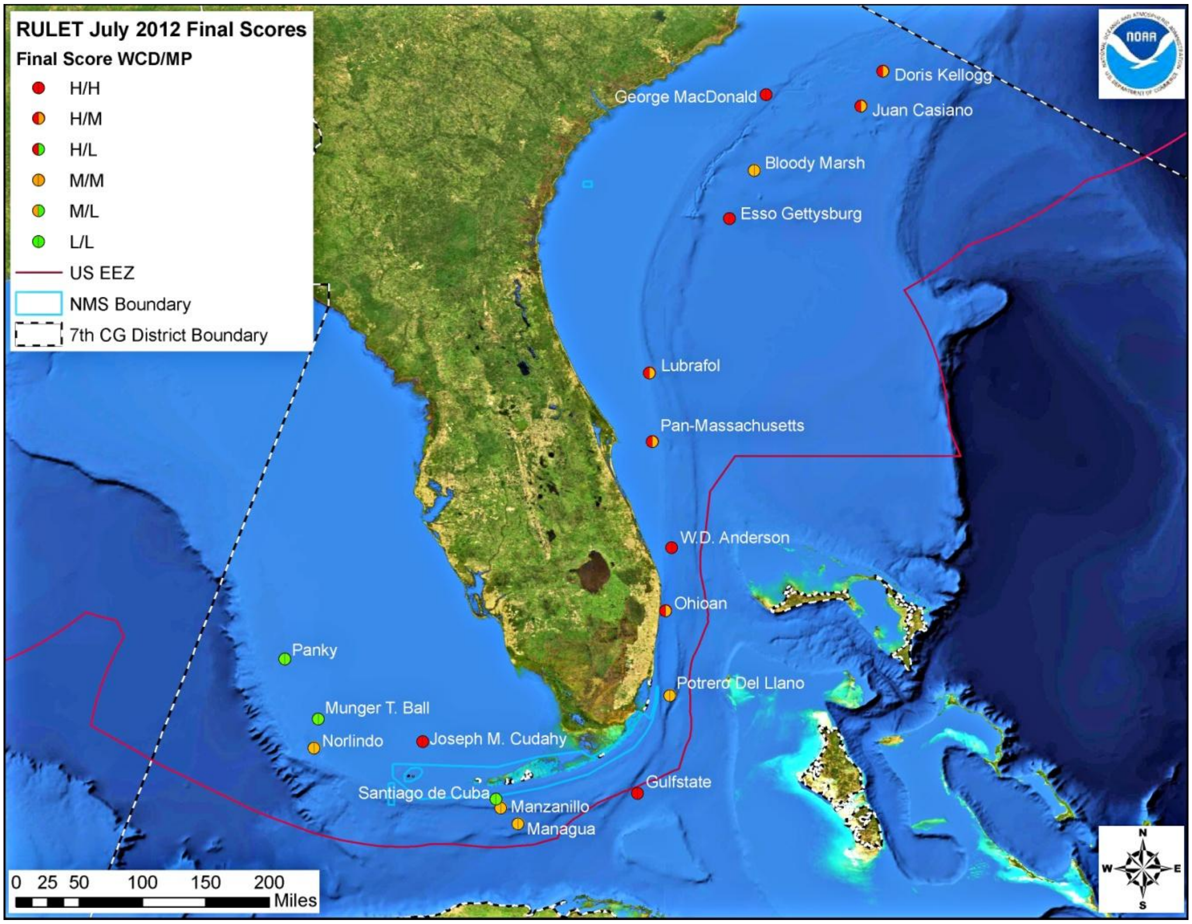


Figure ES-3: Map of the priority vessels in U.S. Coast Guard District 7 off Florida. All District maps are in Section 3.

U.S. Coast Guard District 7 – U.S. Caribbean Islands

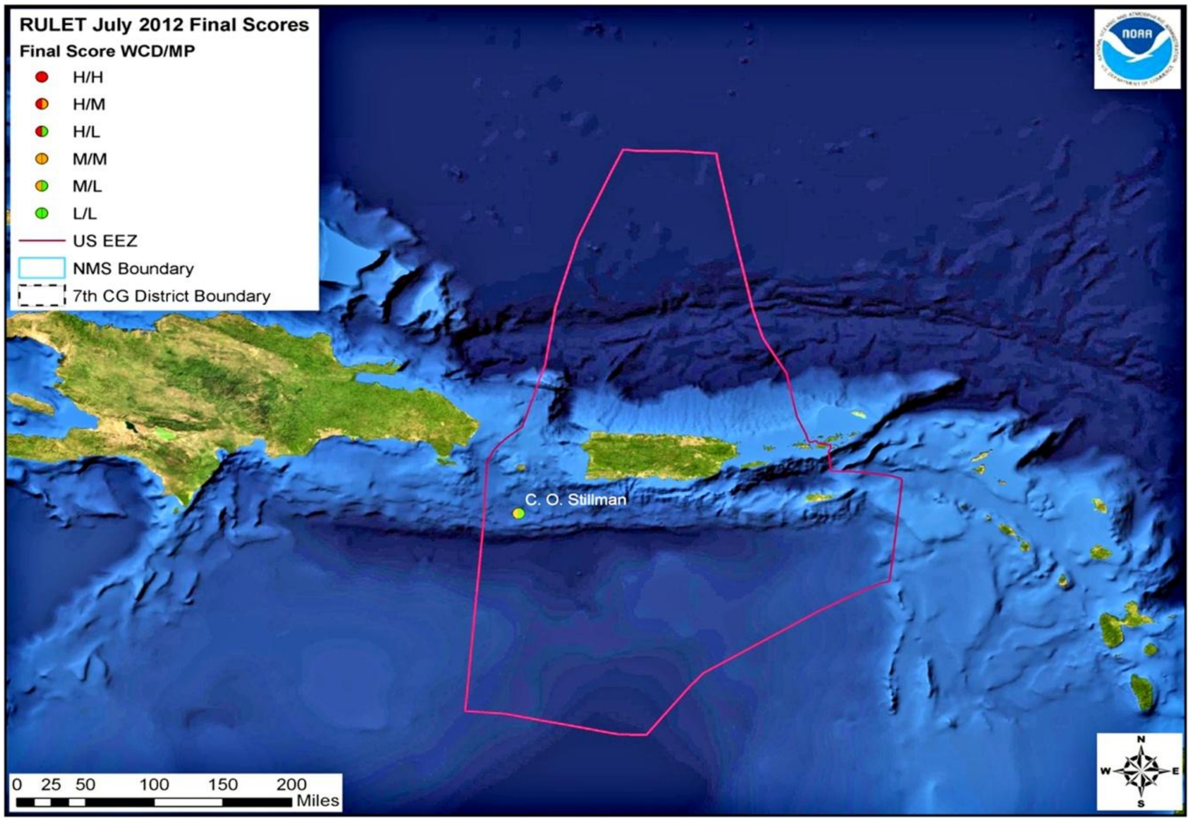


Figure ES-4: Map of the priority vessels in U.S. Coast Guard District 7 off the U.S. Caribbean islands. Maps for all Districts are in Section 3.

Table ES-4: Final scores for the priority vessels in U.S. Coast Guard District 7. Tables for all Districts are in Section 3.

Name	WCD Final Score	MP Final Score	USCG District
Gulfstate	20	17	7
Esso Gettysburg	18	16	7
*Lubrafol***	18	12	7
W.D. Anderson	17	15	7
Pan-Massachusetts	17	12	7*
George MacDonald	16	15	7
Joseph M. Cudahy	16	15	7
Doris Kellogg	16	13	7
*Juan Casiano***	15	12	7
Ohioan	15	12	7
Bloody Marsh	14	14	7
*Potrero Del Llano***	14	12	7
*Managua***	13	12	7
*Manzanillo***	13	12	7
Norlindo	13	12	7
Munger T. Ball	11	10	7
*Santiago de Cuba***	11	9	7
Panky	10	9	7*
*C.O. Stillman***	14	8	7

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

SECTION 1: INTRODUCTION

Background

The past century of commerce and warfare has left a legacy of thousands of sunken vessels along the U.S. coast. The public has long been fascinated by shipwrecks because of their significance to history and culture. However, there is growing concern in their potential environmental impacts from eventual release[1] of their cargo and fuel. Dozens of stories have been written about the problems associated with leaking World War II era ships lost in both the Pacific and Atlantic Oceans. Although a few, such as the *Mississinewa* and the *Jacob Luckenbach*, are well-publicized oil pollution 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, often becoming the source of “mystery spills” until the source is identified.

While proactive response to an oil-laden wreck is in most cases, more cost effective than an uncontrolled spill, only a fraction of the 20,000 shipwrecks in U.S. waters are likely to contain oil. Many older wrecks were coal-fired or sailing ships. More contemporary ships often came to a violent end, breaking apart in storms, collisions, or in battle. Many shallow wrecks were salvaged or were deemed hazards to navigation and were intentionally destroyed. Others sank off the continental shelf and were never located in the deep ocean. All have suffered from corrosion and the passage of time.

The National Oceanic and Atmospheric Administration (NOAA) maintains a large database of shipwrecks, dumpsites, navigational obstructions, underwater archaeological sites, and other underwater cultural resources. The Resources and Undersea Threats (RUST) database includes approximately 30,000 targets of which 20,000 are shipwrecks in U.S. waters. Given these numbers, it was crucial that the archival research and risk assessment conducted for this study focus on wrecks that are most likely to contain harmful quantities of oil. To narrow down the potential sites for inclusion into regional and area contingency plans, in 2010, Congress appropriated $1 million to develop a list of the most ecologically and economically significant potentially polluting wrecks in U.S. waters. NOAA worked closely with the U.S. Coast Guard Office of Marine Environmental Response Policy in implementing this mandate. The Remediation of Underwater Legacy Environmental Threats (RULET) project assists the U.S. Coast Guard and the Regional Response Teams (RRTs), as well as NOAA, in prioritizing potential threats to ecological and socio-economic resources while at the same time assessing the historical and cultural significance of these nonrenewable cultural resources.

NOAA scientists and archaeologists analyzed data from a broad variety of historical sources relating to wrecks in U.S. waters, using a tiered approach to develop a priority list of wrecks for further monitoring or assessment. NOAA’s team worked with the U.S. Coast Guard Salvage Engineering Response Team (SERT) to incorporate a salvage engineer’s perspective into the historical information. In addition, NOAA contracted with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to

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[1] In this report, the terms discharge and release are both used to describe the leaking of oil from a wreck; these terms do not imply a regulatory or legal determination.

conduct modeling of potential oil spills from the priority wrecks and assess the ecological and socio-economic resources at risk.

Goals and Organization of this Report

The intent of this report is to provide a current assessment of the threat of oil pollution from potentially polluting wrecks in U.S. waters, and to substantially update the position paper on potentially polluting wrecks that was done for the 2005 International Oil Spill Conference (Michel et al., 2005). Details of individual wrecks are supplied in a series of separate, detailed companion reports that are available via the web from NOAA and the U.S. Coast Guard.

Only wrecks within or likely to affect the U.S. EEZ and territorial waters are considered here. Two vessels in the Great Lakes and one off the coast of Florida, all just over the international boundaries, were the exceptions as they have significant potential for impact to U.S. resources. While NOAA focused on U.S. waters, this document may be useful for other countries concerned with potentially polluting wrecks in their waters. The report provides an understanding of the context, methods, and results of the multi-disciplinary risk assessment process that may be applicable for other jurisdictions facing similar issues. Like many other risk assessments of potentially polluting wrecks, NOAA's team often had to make assumptions regarding the status of the vessels in question. However, the broad and multi-disciplinary approach of this analysis allowed the team to develop pragmatic assessments that can be incorporated into area and regional spill response contingency plans by the U.S. Coast Guard. The intent of the risk assessment is to support U.S. Coast Guard Federal On-Scene Coordinator's (FOSCs), RRTs, and local Area Committees in their decision making about the need to initiate monitoring, assessment, or recovery work should it be necessary.

Section 1 provides a synopsis of recent assessment and recovery efforts of potentially polluting wrecks in U.S. waters, followed by some recent international examples. This report and ranking effort are focused on submerged wrecks. Although modern abandoned and derelict vessels along the shoreline and in shallow water are a significant issue, they are not addressed beyond a couple of examples. (In a parallel effort, the U.S. National Response Team is developing a Technical Assistance Document that is intended to provide best practices for dealing with derelict and abandoned vessels.) Section 1 also provides a summary and analysis of the risk factors for the separate detailed reports for the 87 priority wrecks.

Section 2 includes a detailed discussion of the iterative screening process used by the project team, explaining the identification of criteria and how the process was narrowed down with additional research. It also contains an assessment of the challenges and limitations of the accessible historical information. The risk assessments also include an evaluation of the expected archaeological site formation processes that help to provide understanding and context of how a ship becomes a shipwreck and what typically happens over time as a wreck deteriorates.

Section 3 analyzes consequences of potential spills using pollution trajectory models based on assumptions on the volume and oil type. Potential release volumes were based on available records, number of days underway, and information available about individual casualties, whether from collision, weather, or war. It was not feasible to model all 87 priority wrecks with the available time and financial resources, so vessels were clustered by oil type in oceanographically similar areas. Generally, the vessel within a cluster with the largest potential volume was modeled and regressions were used to derive information for the clustered vessels. Regardless of whether a vessel was individually modeled or is represented within a cluster, vessel-specific modeling that reflects current operational conditions would be necessary prior to on-site assessment or recovery activities. Modeling was only done for oil, not other hazardous cargos such as the mercury onboard the M/V *Empire Knight*. This report presents the risk assessment for potential releases of oil, pursuant to the specific Congressional directive. However, given operational and safety concerns, other hazards associated with an individual wreck are listed where known. Arguably, for some vessels with other hazardous cargos on board, the ecological and socio-economic impacts associated with those hazards may be more significant that those associated with potential oil pollution.

Ecological and socio-economic resources at risk information were based on modeling outputs and were provided for each vessel. Scores for each of the elements of the assessment were compiled, allowing the team to determine a High, Medium, or Low score for each vessel for both the Worst Case Discharge (maximum volume onboard) and the Most Probable Discharge (10% of this maximum volume).

Section 4 addresses U.S. developments in the understanding of this issue, a characterization of current state-of-the-art assessment and survey technologies, and recovery techniques. It also discusses monitoring, assessment, and response alternatives and operational issues that are important for decision makers to understand for reducing overall risk from potentially polluting wrecks.

Section 5 is a summary of legal issues, presented primarily from the U.S. national perspective, although some international authorities are also addressed.

Section 6 provides the overall recommendations and conclusions regarding next steps for monitoring, assessment, and response to the most significant potentially polluting wrecks, including those with known, unconfirmed, and unknown locations. This section provides a summary of NOAA's recommendations for assessment and potential pollution recovery, as well as identifying priorities for surveys of opportunity for monitoring and identification of vessels with unknown or unconfirmed locations.

Problem Definition/Framing the Issue

History of Concern for Potentially Polluting Wrecks

Recent response efforts in the U.S. and elsewhere have led to interest from both government and industry to systematically identify, investigate, and potentially offload the oil remaining onboard wrecks before they begin to leak. The Marine Technology Society published a special journal volume focused on underwater pollution threats (MTS, 2004), and the 2005 International Oil Spill Conference commissioned an issue paper (Michel et al., 2005) that furthered the discussion. Much of the interest is because proactive removal of oil contained within a wreck can potentially be planned and managed more cost-effectively than an emergency spill response. Equally important, proactive removal of the oil would avoid the environmental and socio-economic consequences associated with a discharge from the vessel.

Since these reports were published, several leaking or high-risk wrecks in the U.S. have been investigated and, when appropriate, remediated (see Section Case Histories – U.S.). Internationally, there have been a number of efforts to conduct risk assessments and undertake removal actions as well. New technologies have been developed, tested, and proven to be effective at both assessing the amount of oil remaining onboard and safely removing the oil, even at great depths. Therefore, with the technological limitations decreasing, the greatest remaining limitations are identification of priority threats and funding. It is through risk assessments, such as this study, that those vessels posing the greatest risk can be identified and prioritized.

Historical Context/Maritime Landscape/Battle of the Atlantic

Although many ships have wrecked in U.S. waters, most of these wrecks occurred before the use of oil as a fuel source or as a commonly carried cargo and do not present an oil pollution threat to the environment. As a result, the number of wrecks in U.S. waters that potentially contain oil is far less than the total number of vessels lost along the U.S. coast. The vast majority of potentially polluting shipwrecks lost in U.S. waters can be tracked to a four-year period between 1941 and 1945 when Japanese and German submarines sought to destroy tankers and freighters along the relatively undefended U.S. coasts.

After the Japanese attack on Pearl Harbor on December 7, 1941, the U.S. entered into World War II and declared war on Japan and Germany, setting in motion a widespread maritime conflict along the entire seaboard of North America. German U-boat raiders attacked merchant shipping off the East Coast with astonishing success, and the destruction that ensued came to be known as the "American turkey shoot," with nearly 200 merchant vessels sunk between January and April of 1942 (Cheatham, 1990).

> America is the largest enemy ship builder. The shipbuilding industry area lies in the eastern states and it, and the industries connected with it, relies considerably on oil fuel. The main American oil area lies on the Gulf of Mexico, and for this reason the larger part of the American tanker tonnage used in the coastal traffic is from the oil fields to the industrial area…
>
> From a report from Karl Doenitz, the Befehlshaber der U-Boote (supreme commander of the German Navy), to Hitler in July 1942 detailed his thoughts about how he saw the U-boat affecting the American home front.

Inaugurated by Germany's initial offensive, code named "Operation Paukenschlag," this "Atlantic Pearl Harbor" was the prelude to nearly five months of unchecked German commerce raiding (Gannon, 1990) on the East Coast. By the end of August 1942 alone, German submarines had attacked and sank 285 vessels in North American waters while losing only seven of their own and the Japanese had sunk a smaller number of vessels off the West Coast. Allied losses off Cape Hatteras, North Carolina were so numerous that the area known as the "Graveyard of the Atlantic" was being called a new name by the freighter and tanker crews: "Torpedo Junction" (Hickam, 1989).

As the merchant ships continued to be sunk, large amounts of oil and debris began to wash ashore, alerting coastal residents of the proximity of World War II to American soil. Despite the increasing loss of ships offshore, American cities kept their lights illuminated as they had during peacetime conditions, effectively silhouetting merchant vessels offshore and resulting in their demise.

Allied naval forces were amassed and ultimately forced withdrawal of the German and Japanese forces from U.S. waters. By the end of 1942, enemy attacks in U.S. waters slowed, and U.S. waters became safer to traverse without pressing concern of confrontation with enemy submarines. However, U-boats continued to harass and sink vessels off the Atlantic coast into the spring of 1945.

Although other ships have been lost in U.S. waters carrying oil and have been incorporated into this study, World War II resulted in the majority (53 of the 87) of the shipwrecks in the final list (Figure 1-1). Many of these shipwrecks have a place in our history and heritage as they represent the struggle to keep vital war supplies flowing domestically and overseas. They should be regarded not merely as potentially polluting shipwrecks, but as historical resources that may contain munitions, bunker fuel, and polluting cargos. Many of these shipwrecks are also gravesites. As such, in addressing potential threats to the environment, the World War II wrecks may raise a number of additional interests of history and culture that need to be considered in planning and execution of any assessment and recovery activities.

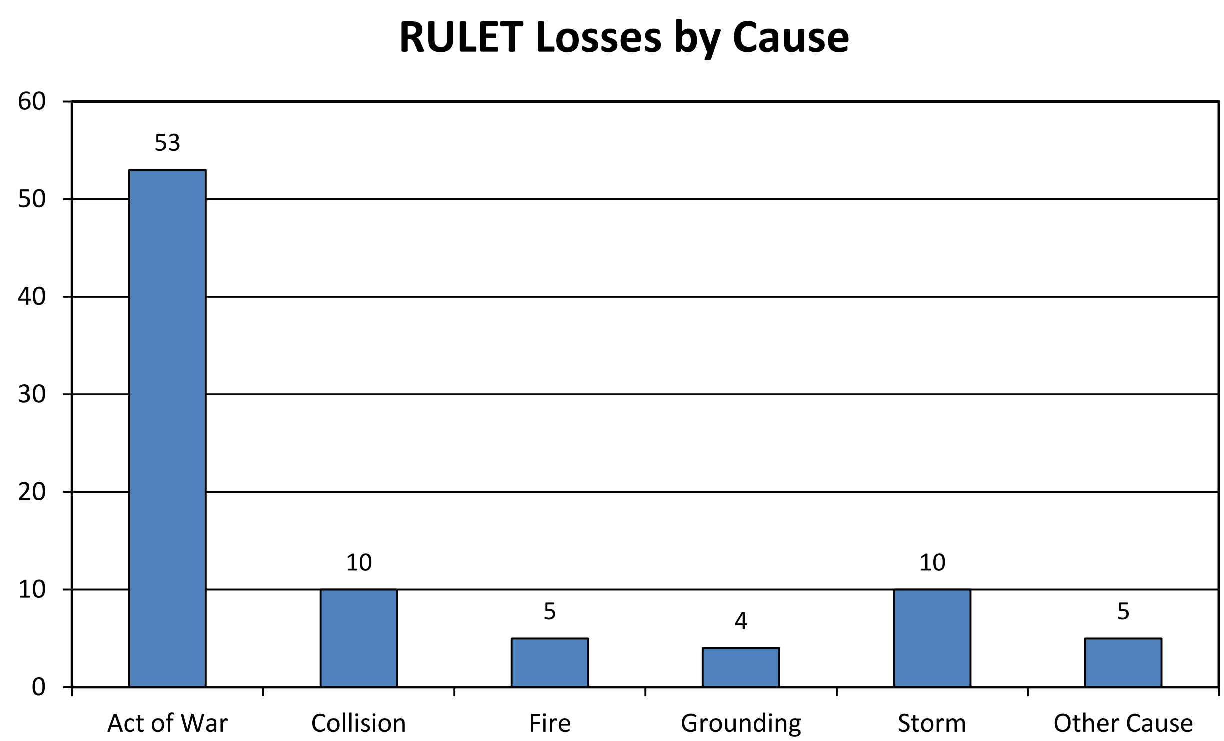


Figure 1-1: RULET losses by cause, highlighting the large number of vessels lost due to war-related causes during World War II.

Other Hazards from Wrecks

Non-petroleum Cargo

This assessment is focused on oil pollution, but oil is not the only pollution threat from shipwrecks. Many wrecks are known or suspected to contain significant quantities of toxic materials. The list of potential contaminants is large, as thousands of different chemicals and hazardous materials are shipped in bulk on ocean-going vessels. Much of the concern about hazardous cargos focuses on persistent substances, such as mercury, that are not soluble in seawater and not biodegradable, but are known to cause chemical contamination of the food chain. These contaminants may confound or complicate underwater salvage operations. For example, the M/V *Empire Knight*, a British freighter that struck an underwater ledge, split in two, and sunk in a blizzard off the Maine coast in December 1944, had 221 flasks of mercury in its war-time cargo. Because of the hazardous mercury cargo, the U.S. Coast Guard has declared a Permanent Safety Zone around this wreck site where dredging, diving, salvaging, anchoring, and fishing are prohibited. The U.S. Coast Guard has implemented a monitoring program for this site to evaluate potential impacts of the mercury in the surrounding environment.

More recently, the freighter *Pacbaroness* sank near the Channel Islands off the California coast in 1987 in over 1,400 feet of water with a cargo of 21,000 metric tons of finely powdered copper concentrate. The vessel was also carrying 8,080 bbl of fuel oil and 238 bbl of lubricating oil when it sank. Initial investigations indicated that approximately 476 bbl of oil spilled from the wreckage, and that some copper concentrate escaped into the water from breached cargo holds (Hyland, 1988).

Munitions

Warships and cargo vessels sunk in wartime may also contain munitions, including explosives and chemical warfare agents, which may pose a continued threat because of their chemical composition. Munitions can be found in major quantities in every ocean in the world, including many lakes, rivers, and inland waterways. Some were dumped intentionally to dispose of obsolete armaments after armed conflicts; others, when the vessels carrying them were lost. The number, types, and potential risks of munitions found at these dump sites or on vessels vary greatly, but are generally characterized as either conventional (high explosive filled), chemical, or radiological hazards. Underwater munitions are of concern as they can affect sensitive coastal and marine ecosystems, including waters containing subsistence and commercially harvested marine products, and create hazards for fishermen trawling or using other types of bottom gear. Discarded munitions are also a potential concern for mineral, oil, and gas exploration and extraction. However, this report does not specifically address underwater military munitions. The individual risk assessments for the high and medium risk vessels do note what types of munitions were known to be onboard at the time of loss. For the most part, these were small arms. Most of the vessels with significant munitions onboard were cleared by the military as hazards to navigation or because the military tried to destroy all wrecks that could help hide the magnetic or sonar signature of a U-boat.

Legal Issues

In addressing the concerns presented by a sunken vessel that is a potential threat to the marine environment, a number of legal issues may arise under U.S. and international law. The Oil Pollution Act of 1990 is the primary authority in the cleanup of oil-laden wrecks. However, there are also laws that protect heritage resources in discreet marine protected areas such as National Parks, National Monuments, and National Marine Sanctuaries; those laws and policies may also provide protections for historic shipwrecks outside of federal marine protected areas. These laws are summarized in Section 5. The overview in Section 5 also addresses domestic and international laws regulating the treatment of sovereign immune vessels, such as warships and other non-commercially operated government-owned vessels. The policies regarding these vessels may impact the manner in which cleanup operations may be conducted and the issues that arise because many wrecks are also gravesites. An overview of these laws and issues is set out to provide a legal context for the issue. It is not intended to be a comprehensive analysis or legal advice because such an analysis should be conducted on a case-by-case basis by the appropriate legal counsel in the agency with authority to implement particular statutes or agreements.

Case Histories – U.S.

Recent spills from sunken wrecks have heightened concerns about the potential environmental hazards posed by shipwrecks. Over the past decade a number of wrecks have been investigated, found intact, and been remediated, but other wrecks, long believed to be intact and potentially oil laden, were found to be empty. Recent wreck remediation projects in U.S. waters include examples from the Atlantic, Pacific, Alaska, and Oceania. In this section, short summaries of survey and removal actions for these recent case histories are provided. Most of these case histories involve long-sunken wrecks that were later investigated, but more recent sinkings and several stranded wrecks are also included as the technologies and issues are related. The case histories are listed by project year in Table 1-1.

Table 1-1: Domestic potentially polluting wreck remediation projects, listed by project year. HFO = heavy fuel oil.

Vessel Name (Year of Sinking)	Project Year	Location	Action	Quantity Removed (bbl)	Cargo/Bunker Type	Water Depth (ft)
Tenyo Maru, 1991	1991	Washington	Partial Removal	620	Diesel	540
Cleveco, 1942	1995	Ohio	Removal	8,095	HFO	72
Union Faith, 1969	1999	Louisiana	Partial Removal	400	HFO	125
Ehime Maru, 2001	2001	Hawaii	Partial Removal	665	Diesel	2,000
Jacob Luckenbach, 1953	2002	California	Partial Removal	2,380	HFO	178
Mississinewa, 1944	2003	Yap	Removal	42,860	Navy Special Oil, Diesel	130
Roy A. Jodrey, 1974	2003	New York	Partial Removal	143	HFO	200
Bow Mariner, 2004	2004	Virginia	Potential Removal	0	HFO, Diesel	265
Palo Alto, 2004	2006	California	Removal	12	HFO	Surface
Catala, 1965	2007	Washington	Removal	820	HFO	Surface
William Beaumont, 1971	2009	Texas	Removal	380	HFO	40
Ex- USS Chehalis, 1949	2010	Am. Samoa	Removal	1,430	Gasoline	160
Princess Kathleen, 1952	2010	Alaska	Removal	2,620	HFO	134
William McAllister, 1963	2011	New York	Removal	5	Diesel	160
Montebello, 1941	2011	California	Potential Removal	0	Crude/, HFO	900
Davy Crockett, 2011	2011	Washington	Removal	914	HFO	Surface

Tenyo Maru: On July 22, 1991, the Chinese freighter *Tuo Hai* collided with the Japanese fishing vessel *Tenyo Maru* approximately 25 miles northwest of Cape Flattery, off the northern coast of Washington State, and a short distance north of the United States-Canada border. The *Tenyo Maru* quickly sank in about 540 feet of water. As it sank, the vessel began releasing approximately 8,450 bbl of intermediate fuel oil and 2,330 bbl of diesel. The resulting slick was carried south and east by currents and winds and ultimately affected much of the Washington and a portion of the Oregon coast. The vessel leaked for several weeks. In August 1991, a remotely operated vehicle (ROV) was used to insert a hose through a porthole and recover approximately 620 bbl of diesel, but most of the fuel was believed to have been lost during or shortly after the sinking.

Cleveco: On December 3, 1942, the 260-ft tank barge *Cleveco* was being towed by the tug *Admiral* on Lake Erie in the Great Lakes when the tug and barge foundered in a severe storm. The *Cleveco,* loaded with about 28,600 bbl of No. 6 fuel oil, capsized and sank in 30 feet of water six miles north of Euclid, Ohio. The barge lost some of its cargo when it sank, and the barge became the source of periodic oil sheens, but no response actions were taken. In 1959, a deep-draft vessel struck the barge, causing an additional release. Because of the hazard to navigation, efforts were made in 1961 to raise and scrap the barge, but the barge could not be kept afloat, and the vessel capsized and sank again, this time in 72 feet of water. In 1994, the vessel began to leak again and an underwater survey found the barge intact and buried in silt, with oil remaining in ten of the twelve cargo tanks. A recovery operation in late summer of 1995 removed approximately 8,095 bbl of heavy fuel oil (Davin and Witte, 1997).

SS *Union Faith*: On April 6, 1969, the 503-ft Taiwanese freighter SS *Union Faith* collided with a tank barge being pushed by the towboat *Warren J. Doucet* in the Mississippi River near New Orleans, Louisiana. The *Union Faith* caught fire and later sank in the river. Twenty-five crewmembers, including all of the personnel on the bridge at the time of the collision, were killed and went down with the ship in approximately 125 feet of water. Salvage divers removed the masts and superstructure to reduce the hazard to navigation, but the wreck, containing 6,000 bbl of bunker fuel, was left and became buried in the river sediments. In 1999, after a number of oil releases along the New Orleans waterfront, *Union Faith* was identified as the probable source and the U.S. Coast Guard hired a contractor to locate and remediate the wreck. Approximately 400 bbl of fuel were removed (Long, 2001).

Ehime Maru: On February 9, 2001, the submarine USS *Greeneville* surfaced and collided with the Japanese fishery high school training ship *Ehime Maru* off of Oahu, Hawaii. The *Ehime Maru* sank quickly in 2,000 feet of water, killing nine crewmembers. The vessel had just refueled and was carrying at least 1,550 bbl of diesel. In October 2001 the *Ehime Maru* was lifted and moved to shallow water near Oahu were the remains of the victims were recovered. A full environmental response was staged including equipment for tapping into the tanks, but very little oil remained on board; 665 bbl were removed. The *Ehime Maru* was then scuttled in 6,000 feet of water. A light, non-recoverable sheen was released during the salvage operation (http://www.supsalv.org/pdf/March2002.pdf).

SS *Jacob Luckenbach*: The SS *Jacob Luckenbach* is an often-cited example of a potentially polluting wreck and a landmark in the development of underwater assessment and removal technologies. On July 14, 1953, the 469-ft freighter SS *Jacob Luckenbach* collided with the SS *Hawaiian Pilot*, and sank in 178 feet of water, approximately 17 miles west-southwest of San Francisco, CA, in the Gulf of the Farallones. In 2002, the decaying wreck of *Jacob Luckenbach* was identified as the source of mysterious, recurring oil spills that had occurred along the coast for nearly 30 years. Cumulatively these spills killed thousands of seabirds and other marine life along California's coast (*Luckenbach* Trustee Council, 2006). In 2002, the U.S. Coast Guard contracted a salvor to assess, locate, and remove the remaining oil from the hull. The assessment included development of a 3-D model of the vessel. Some oil remained in the tanks, but much of the oil had migrated extensively within the wreck via corroded vents and piping, and oil was found in over 30 compartments on the vessel. The U.S. Coast Guard led the response operation that removed approximately 2,380 bbl of oil remaining in the wreck. However, some of the compartments were inaccessible and some oil was left onboard. Thus, the *Jacob Luckenbach* is one of the wrecks assessed in this report.

USS *Mississinewa* (AO 59): The World War II U.S. Navy Fleet oiler USS *Mississinewa* was sunk on November 20, 1944 at Ulithi Atoll, Yap State, Federated States of Micronesia in the western Pacific Ocean. At its sinking, the 553-ft, 24,425-ton vessel had just taken aboard a full load of Navy Special Fuel Oil (NSFO), gasoline, and diesel fuel. For 57 years the *Mississinewa* remained undisturbed, capsized in 130 feet of water. In 2001 the wreck began leaking and, at the request of the Yap State Government, the U.S. Department of State, the U.S. Department of Interior, and the U.S. Coast Guard, the U.S. Navy assembled a team of experts to survey the *Mississinewa* wreck site and develop plans for later oil removal. Some small amounts of oil were recovered in 2002. In 2003, the U.S. Navy Supervisor of Salvage (SUPSALV) mounted an extensive operation that removed 42,860 bbl of NSFO and diesel fuel from the wreck (U.S. Navy, 2003).

M/V *Roy A. Jodrey*: On November 21, 1974, the 640-ft-long, iron ore freighter *Roy A. Jodrey* ran aground and sank in about 150-200 feet of water in the St. Lawrence River near Massena, New York. The vessel became a popular wreck dive, but was also the source of periodic sheens. In 2002, the U.S. Coast Guard established a safety zone around the vessel and prohibited wreck diving until the source could be remediated. A series of investigations found oil located in spaces throughout the vessel, and a recovery operation was initiated in 2003 that removed approximately 143 bbl of fuel oils. The safety zone was removed in 2007.

T/V *Bow Mariner*: On February 28, 2004, the 570-ft T/V *Bow Mariner*, a Singapore-flagged chemical tanker, suffered a series of explosions and quickly sank 50 miles off the coast of Virginia in approximately 265 feet of water. In addition to about 83,000 bbl of ethanol, the vessel had an estimated 4,500 bbl of intermediate fuel oil and 1,100 bbl of marine diesel oil, and a substantial oil slick was observed. On March 2, 2004, the NOAA Hydrographic Research Ship *Rude* conducted side-scan and multi-beam sonar surveys of the vessel and confirmed that the vessel was largely intact and upright on the sea floor. On March 24, 2004, twenty-five days after the *Bow Mariner* exploded and sank salvors began to survey the sunken wreck, including tapping into the hull. After two days of exploring the wreck with ROVs, the salvage crew concluded that the vessel was catastrophically damaged during the explosion and no accessible oil remained aboard in the fuel tanks (Csulak, 2010).

SS *Palo Alto*: In 2004 and 2005, oil-covered birds were observed near Seacliff State Beach in Aptos, California. Forensic chemistry was used to identify the SS *Palo Alto* as the source. The *Palo Alto* was a tanker built in 1919 as part of a World War I shipbuilding program using concrete instead of steel. The tanks, however, were built of steel. After the war, the *Palo Alto* was grounded on the beach in California and used for an amusement park and later became a fishing pier, but the bunker oil was never completely removed from the ship. After oil was found in the tanks, the U.S. Coast Guard and State of California implemented a survey and cleanup. Oil was confined to one forward port bunker tank. In 2006, salvors removed approximately 12 bbl of oil and 125 cubic yards of oily sand and residue from the decaying hull. Hundreds of dead birds and two dead harbor seals were also discovered trapped in the tank (http://www.dfg.ca.gov/ospr/).

SS *Catala*: The 229-ft SS *Catala*, a British-built coastal steam ship sold to the U.S., ran aground during a storm on January 1, 1965, near Ocean Shores, Washington. The upper portions of the passenger ship were cut off for scrap and over time the hull became buried in the sand. In 2006, erosion exposed the wreck and a beachcomber discovered an oily, thick sludge inside. In 2007, response efforts removed 820 bbl of heavy fuel oil, 8,570 bbl of oily water, and 2,585 tons of oil-contaminated sand (WDOE, 2007).

SS *William Beaumont*: On August 22, 2009, the U.S. Coast Guard was notified of oil sheen off Sabine Pass, Texas. Initially, a pipeline leak was suspected, but a sonar scan soon traced the spill to a shipwreck, and divers found oil bubbling from a capsized, mostly buried hull. Further investigation revealed the submerged vessel to be the wreck of the SS *William Beaumont*, a 417-ft liberty ship that sank in 1971. The vessel had sunk six miles off the East Texas-Louisiana shoreline in approximately 40 feet of water while being towed for scrap. The U.S. Coast Guard mobilized a commercial salvage team to the site, ultimately removing 380 bbl of heavy fuel oil.

Ex-USS *Chehalis*: On October 7, 1949, the 311-ft tanker ex-USS *Chehalis* exploded, capsized, and sank in 160 feet of water off the main fuel dock in Pago Pago, American Samoa. The *Chehalis* was carrying approximately 2,000 rounds of 3-inch ammunition, 16,000 rounds of 20 mm ammunition, and 9,520 bbl of aviation gasoline when it sank. The vessel was believed to be the source of periodic mystery spills in the harbor. An environmental assessment conducted by the American Samoa government in 2006 and 2007 found the vessel on its side, with both gasoline and bunker fuel onboard. In April 2009, SUPSALV, in collaboration with the U.S. Coast Guard, conducted preliminary site investigations to support planning for an oil removal project. In April 2010, more than 1,430 bbl of gasoline and fuel oil were removed from the vessel (U.S. Navy, 2010).

SS *Princess Kathleen*: On September 7, 1952, the 369-ft Canadian coastal passenger steamer SS *Princess Kathleen* grounded during bad weather on Pt. Lena, just north of Juneau, Alaska. Approximately 10 hours later during an incoming tide the vessel slipped off the rock and sank with an estimated 3,690 bbl of bunker C fuel oil in its tanks. After the sinking, periodic fuel releases and oil sheens had been noted in the vicinity. The vessel currently sits at an angle on its port side at a depth ranging from 52 feet at the bow to 134 feet at the stern. In the spring 2010, the State of Alaska and U.S. Coast Guard conducted an investigation to assess the pollution threat posed by the vessel, concluding that a removal operation was warranted. Divers removed oil from 14 fuel tanks and interior engineering spaces. An estimated 2,620 bbl of bunker oil and additional amounts of other oils and contaminated water were collected during the operations (ADEC, 2010).

William H. McAllister: On November 17, 1963, the tug *William H. McAllister* ran aground and sank in Lake Champlain between Vermont and New York. In 1997, oil sheens were discovered on the water above the *McAllister*, and concern was raised that the vessel may have been loaded with 333 bbl of diesel fuel. In September 2011, an ROV survey found the vessel landed upright in 160 feet of water. No fuel was found in the tanks, but about 5 bbl of oil were removed from overhead spaces in the wreck.

SS *Montebello*: On December 23, 1941, a Japanese submarine sank the SS *Montebello* off the central California coast, just south of the Monterey Bay National Marine Sanctuary. The vessel sits in federal waters, approximately six miles off the coast of Moonstone Beach in Cambria, 900 feet below the water's surface. Just prior to its sinking, the *Montebello* had loaded 73,571 bbl of Santa Maria crude oil and 2,477 bbl of bunker fuel at Port San Luis, California. No significant releases were observed when it sank. A series of submersible dives showed the ship remarkably intact and found that the torpedo missed the cargo tanks where the 71,000 bbl of crude oil were held. In 2009, a multi-agency Task Force was formed to investigate the vessel and funding was secured to conduct an underwater survey and collect samples from the tanks. After an extensive underwater survey in October 2011, the Task Force concluded that the wreck had no recoverable oil and had lost its cargo sometime over the past 70 years. (http://www.dfg.ca.gov/ospr/admin/Montebello/).

SS *Davy Crockett*: The SS *Davy Crockett* was a former World War II Liberty that was converted to a flat deck barge, and then stranded along the shore of the Columbia River in Washington State. In January 2011, the 431-ft ship was observed leaking due to improper and unpermitted salvage operations. Response efforts began immediately to contain oil and stabilize the vessel and, in mid-February 2011, the U.S. Coast Guard determined that the only way to remove the oil was to cut apart the vessel. Cleanup was completed in November 2011. Salvors removed 914 bbl of bunker fuel, 38,100 bbl of oily water, and 1.25 million pounds of oily debris. (http://www.ecy.wa.gov/programs/spills/incidents/DavyCrockett/DavyCrockett.html).

International Wreck Case Studies and Risk Assessment Approaches

Case Histories - International

A sampling of response efforts for submerged potentially polluting wrecks outside of the U.S. is shown in Table 1-2. In some cases, after an assessment and/or survey, oil was removed; in other cases authorities opted to monitor the wreck until a more comprehensive assessment or survey could be conducted, a more serious oil release occurred, or other legal, technical, or financial considerations could be addressed. Note that there are many other cases in which oil was successfully removed from a wreck that was grounded, damaged in a collision or allision (the act of a moving object striking a fixed object), or otherwise leaking oil but not fully submerged.

Table 1-2: International submerged potentially polluting wrecks, listed by project year. HFO = heavy fuel oil.

Vessel Name (Year of Sinking)	Project Year	Nation	Action	Quantity Removed (bbl)	Cargo/Bunker Type	Water Depth (ft)
TV *Mildred Anne Brovig* (1966)	1966	Germany	Removal	154,000	Crude	125
IJN *Mutsu* (1943)	1978	Japan	Removal	?	HFO	135
TV *Betelgeuse* (1979)	1979	Ireland	Removal	280,000	Crude	100
TV *Tanio* (1980)	1980	U.K./France	Removal	35,000	HFO	300
TV *Alessandro Primo*	1991	Italy	Removal	?	Chemicals, HFO	360
MV *Neuenfels* (1940)	1993	Norway	Monitor	0	HFO	80
MV *Eric Giese* (1940)	1993	Norway	Monitor	0	HFO	215
Blücher (1940)	1994	Norway	Partial Removal	7,000	HFO	300
RAF *Boardale* (1940)	1996	Norway	Monitor	0	IFO	220
TB *Irving Whale* (1970)	1996	Canada	Removal	21,700	Oil/PCBs	220
TV *Yuil No. 1* (1995)	1998	U.K./France	Removal	4,400	HFO	230
TV *Erika* (1999)	1999	U.K./France	Removal	77,700	HFO	425
HMS *Royal Oak* (1939)	2000	U.K.	Partial Removal	?	HFO	90
SS *Richard Montgomery* (1944)	2000	U.K.	Monitor	0	Munitions, HFO	25
TV *Ievoli Sun* (2000)	2001	France	Removal	28,000	Styrene, HFO	310
TV *Osung No. 3* (1997)	2001	S. Korea	Removal	140	HFO	230
MV *Castillo de Salas* (1986)	2001	Spain	Removal	2,800	HFO	15,000

Table 1-2: Cont.

Vessel Name (Year of Sinking)	Project Year	Nation	Action	Quantity Removed (bbl)	Cargo/Bunker Type	Water Depth (ft)
TV *Spabunker IV* (2003)	2003	Spain	Removal	7,000	Crude	200
TV *Prestige* (2002)	2004	Spain	Removal	91,000	HFO	12,000
TV *Solar* 1	2006	Philippines	Removal	63	Crude	2,100
MS *Sea Diamond*	2007	Greece	Removal	1,050	HFO	490
RMS *Niagara* (1940)	2007	New Zealand	Monitor	0	HFO	400
TV *Haven* (1991)	2008	Italy	Removal	residual	HFO	215
MV *Welheim* (1944)	2008	Norway	Survey & Removal	0	HFO	230
MV *Nordvard* (1940)	2008	Norway	Survey & Removal	0	HFO	130
MV *Don Pedro* (2007)	2008	Spain	Removal	1,400	HFO	150
MV *Ice Prince* (2007)	2009	U.K.	Removal	2,450	Marine Diesel	200
TV *Samho Brother*	2009	Taiwan	Removal	20,000	Benzene, HFO	240
SS *Skyttren* (1942)	2009	Sweden	Risk Assessment	0	HFO	245
Barge *Shovelmaster* (2009)	2009	Canada	Monitor	0	Diesel	475
TV *Hoyo Maru* (1944)	2009	Micronesia	Monitor	0	HFO	70
TV *Shinkoku Maru* (1944)	2009	Micronesia	Monitor	0	HFO	70
TV *Fujisan Maru* (1944)	2009	Micronesia	Monitor	0	HFO	130
MV *Rio de Janeiro Maru* (1944)	2009	Micronesia	Monitor	0	Diesel	145
TV *Nippo Maru* (1944)	2009	Micronesia	Monitor	0	Diesel	70
MV *Kiyosumi Maru* (1944)	2009	Micronesia	Monitor	0	Diesel	100
MV *Hanakawa Maru* (1944)	2009	Micronesia	Monitor	0	Diesel	100
MV *San Francisco Maru* (1944)	2009	Micronesia	Monitor	0	Diesel	210
PS *Queen of the North* (2006)	2010	Canada	Monitor	0	Diesel, Lube	1,400
MV *Asian Forest* (2009)	2010	India	Removal	?	HFO	105
U-864 (1945)	2011	Norway	Removal	0	Mercury	240
TV *Kyung Shin* (1988)	2011	S. Korea	Removal	?	HFO	320

International Risk Assessment Efforts

There are a number of risk assessment projects on potentially polluting wrecks underway outside the U.S., as summarized in Table 1-3. Like the current NOAA risk assessment project, international efforts have generally involved the development of a database of wrecks with varying types of data on each wreck as the basis of the initial assessment. The types of wrecks and associated data that have been included in the databases have differed based on the needs and focus of the authorities involved. For example, in the U.K., the Maritime Coastguard Agency's (MCA) database of post-1870 wrecks and obstructions has included significant information on munitions rather than strictly focusing on oil pollution risk potential. The Norwegian Coastal Administration (Kystverket) database includes vessels of 100 gross tons and larger, incorporating a much larger set of vessels than included in the current NOAA assessment. RULET contains wrecks that are post-1891 with steel, iron, or concrete hulls that are either tank vessels (tankers or tank barges) or are at least 200 feet long or 1,000 gross tons in size.

A comparison of the different international risk assessment methodologies and projects with the current (2012) NOAA RULET effort described in this report is shown in Table 1-4. International methodologies are further discussed in Appendix B.

Table 1-3: Synopsis of international wreck risk assessment projects.

Project Name or Location	Authorities Involved	General Approach
Scandinavia (Sweden, Denmark)	Swedish Maritime Administration National Environmental Research Institute (Denmark) Chalmers Univ. of Technology Alliance for Global Sustainability Swedish Coast Guard Swedish Navy Swedish Defense Research Agency Swedish National Heritage Board	• Analysis of legal situation of wrecks • Case study on SS *Skytteren* • Analysis of eco-toxicology of long-term leakage • Wreck database • Archaeological/engineering library research on wrecks • Risk model with five-point classes of probabilities of leakage and five ranks of consequences (human, economic, and ecological) • Oil trajectory modeling • International cooperation on assessments
DEEPP Mediterranean (France, Italy)	European Commission ICRAM CEDRE Italian Navy (Maridrografico) French Navy (SHOM)	• Wreck database (194 known wrecks) in the Mediterranean • Archaeological/engineering library research on wrecks • Sea bottom exploration • ROV investigation of selected wrecks • Risk matrix with hazards by oil type • International cooperation on assessments
Transport Canada (Eastern Canada)	Transport Canada Canadian Coast Guard Provincial Authorities	• Charting of 1,000s of wrecks off eastern Canada coast • Aerial surveillance for mystery spills • Establishment of contingency plans for spills, removal
Kystverket Norway	Norwegian Coastal Administration (Kystverket)	• Wreck database of ships sunk after 1914 over 50 m and over 100 tonnes (over 2,300 entries) • ROV survey on all wrecks classified as high risk (30 wrecks containing 100-300 tonnes oil) • Risk assessment by position, wreck type, fuel • Study on pollutants other than oil
SPREP (South Pacific)	Pacific Ocean Pollution Prevention Programme (PACPOL) International Maritime Organization (IMO) Canada-South Pacific Ocean Development Secretariat of the Pacific Regional Environment Programme (SPREP)	• Extensive mapping and identification of wrecks (particularly World War II-related) • Comprehensive database (3,000 wrecks) • Risk analysis (4% selected for further study) • International cooperation identifying wrecks
U.K. MCA (United Kingdom)	Maritime Coastguard Agency Ministry of Defense	• Wreck database (25,000 records) • Archaeological/engineering library research on wrecks • Risk analysis of munitions, spills • Risk matrix of pollution/safety severity and likelihood
National Maritime Research Institute (Japan)	National Maritime Research Institute Tokyo University of Marine Science and Technology	• Development of environmental risk assessment tool • Development of technologies to mitigate oil discharges

Table 1-4: Comparison of wreck risk assessment approaches.

Project	Database	Trajectory Modeling	Engineering and Archaeological Assessment	Risk Model or Matrix	Mapping	Other Hazards	Full Risk Assessment
NOAA 2012 RULET	Extensive data on vessels, potential impacts to resources at risk	Trajectory, fate, and effects modeling	Comprehensive	Yes	Yes	Limited data on munitions, chemicals	Yes, for 87 priority wrecks
Scandinavia	Extensive data on vessels	Some trajectory modeling	Limited	Yes	Yes	Limited data on other pollutants	One wreck; others in process
DEEPP	Location, type, size, owner, age	None	Limited (some surveys)	Yes	Yes	MARPOL chemicals	None
Transport Canada	Location, type, size, owner, age	None	No	None	Yes	None	None
Kystverket	Extensive data on vessels	None	Limited	None	Yes	Chemicals	Planned
SPREP	Location, type, size, owner, age	None	No	None	Yes	None	None
U.K. MCA	Extensive data on vessels	None	Limited	Yes	Yes	Munitions Chemicals	Planned
NMRI, Japan	No database	Trajectory and fate modeling planned	No	Yes	No	No	None

This NOAA RULET project differs significantly from the other wreck risk assessment projects with respect to the comprehensive approach taken. This project is the only one with comprehensive full risk assessment and prioritization conducted on a significant number of wrecks. The only other known project that included a full risk assessment is the Scandinavian project for which one risk assessment has been completed and others are in progress. This project is the only one to employ state-of-the-art trajectory, fate, and effects modeling for each wreck of concern to determine risks to ecological and socio-economic resources. The archaeological and engineering assessment conducted on the wrecks to determine condition and potential for spillage has also been more comprehensive than the more limited assessments conducted in other efforts.

SECTION 2: PRIORITIZING POTENTIALLY POLLUTING WRECKS IN U.S. WATERS

Initial Wreck Screening Process

NOAA's Resources and Undersea Threats (RUST) database includes approximately 20,000 shipwrecks in U.S. waters. Most are thought to have lost their cargos long ago, or contain minor amounts of oil. However, it is known from recent experience that some wrecks can contain hundreds or thousands of barrels of oil as illustrated in Tables 1-1 and 1-2. The sheer number of wrecks made it impossible within the scope and resources of the project to review and evaluate each vessel, prompting NOAA to use a tiered screening approach. The initial screening was conducted based on readily available information from a range of maritime resources to identify vessels with the greatest potential to be oil pollution threats. Initial screening factors focused on the vessels themselves, based on the vessels' age, location, construction material, propulsion, type, and size. After this initial screening, a separate database, called the Remediation of Underwater Legacy Environmental Threats (RULET), was generated consisting of 573 vessels. Each of the factors used to get to the initial screening result of 573 vessels is described below.

Initial Screening Factors

Vessel Age: Shipwrecks have occurred in U.S. waters since the first sailors explored these waters five centuries ago. Vessel technology and construction has evolved over time, and a ship's age is a good indication of both its propulsion (fuel) type and construction. The first oil tank steamer *Vaderland* was launched in 1873. The first oil-fired ships were built in the early 1890s and slowly became the standard for ocean-going vessels (The New York Times, 1891; Henry, 1907). Increased speed and efficiency of oil-powered ships led the designers of naval vessels to switch from coal to oil and, by World War I, most newly built naval vessels were oil fired (Dahl, 2001). However, these details were not always known with confidence (ships may have been repowered, for example). As an initial screen, NOAA excluded vessels built prior to 1891 from the database.

Vessel location: The RUST database includes some wrecks that were lost far offshore, or along the EEZ of neighboring countries. Some wreck locations are not known with certainty. As an initial screen, NOAA included only those wrecks within the U.S. EEZ, including the U.S. portions of the Great Lakes. Although this large boundary significantly increased the scope of the study and the uncertainty associated with some of the shipwrecks lost in very deep water, it was determined that this boundary would allow more environmental modeling to be conducted and would enable the U.S. Coast Guard to plan for potential spills anywhere within the U.S. EEZ.

Vessel Construction: Many older wrecks were built of wood. The first iron ships in the U.S. were built in the early to mid-1850s, but wooden construction was common until the early 20th century. Steel became common in the 20th century but, when steel became scarce during the First and Second World Wars, some merchant vessels were built of concrete. Modern day merchant vessels are almost all built of steel, but small craft are commonly constructed of wood, fiberglass, and/or aluminum. As an initial screen, only vessels built of durable materials (e.g., steel, iron, and concrete) were considered.

Propulsion Type: Until the mid-1800s, almost all ocean-going ships were sailing vessels and required no fuel oil. Sail power continued into the early 20th century. Steam ships became common mid to late 19th century, but coal was the preferred source of fuel until early in the 20th century. A few merchant vessels began using fuel oil to fire their boilers in the 1890s, but coal-fired merchant vessels were common until World War II. Modern vessels use various grades of fuel oil for propulsion. As an initial screen, all sailing vessels and coal-fired vessels were excluded from the database. Determining whether a vessel was converted from coal-fired to oil-fired was often difficult.

Vessel Type: Vessel type is a consideration in pollution type, as some vessels are designed to carry large amounts of oil as cargo or fuel. Until the 1880s, merchant ships were general-purpose vessels. Cargo was carried in general-purpose holds or on deck. Bulk liquids were carried in barrels. The first tank vessels appeared in the 1880s. From an oil-pollution perspective, oil tankers and tank barges (collectively tank vessels) pose the largest threat. Because of their overall size and strategic importance, U-boats frequently targeted tankers. Modern tankers are huge compared with tankers common during World War I and II, but tankers of that era still may have carried tens of thousands of barrels of oil as cargo. However, tank vessels often sailed with seawater ballast, thus they may not have been laden with oil when they sank. As an initial screen, all tank vessels were included in the database.

Vessel Size: Non-tank vessels also carried oil as fuel. Modern freighters, container ships, and cruise ships have grown in size over the past 50 years, and ultra-large crude carriers may carry up to 2,000,000 bbl of fuel oil. Most of the merchant vessels in the database are from World War II and earlier, and are considerably smaller. The average bunker (fuel) capacity of a World War II Liberty ship was about 12,054 bbl. Small coastal vessels, harbor craft, towing vessels, and fishing vessels also carried fuel oil in smaller quantities. These types of vessels vary in their fuel capacity; the largest of these (high-endurance fishing vessels and ocean-going tugs) may contain ten thousand barrels of fuel when fully laden, but usually these vessels carry much less (WDOE, 1991). As an initial screen, all non-tank vessels less than 200 feet in length or less than 1,000 gross tons were excluded from the database.

Based on these initial screening criteria, 573 wrecks located within U.S. waters were identified that could pose a substantial pollution threat. Those vessels were subject to secondary screening and additional research to further narrow the priority list.

Initial Screening Factors: Data Sources

The sources used to identify key vessel characteristics are numerous and often incomplete, requiring a synthesis of many different records and reports. Some of the major sources used to create the RULET database and to populate data fields are described below.

Lloyd's Register of British and Foreign Shipping is a shipping register that contains diagnostic information about many of the merchant vessels that are surveyed and classed by Lloyds. The information contained in these registers is often very detailed and provides the background information about a ship that is necessary to determine its length, size, and its method of propulsion. Some of the fields included in the register are name, official number, gross tonnage, net tonnage, date of build, builder, owner, homeport, length, breadth, depth, port of registry, engine type, boiler types, and location of machinery.

The *Record of American and Foreign Shipping* is a register published by the American Bureau of Shipping (ABS) and often referred to as the "American Lloyds." This register provides much of the same information as the *Lloyd's Register*, but for vessels inspected and classed by ABS. There is a large distinction between these registers for more recent ships, including many of the World War II era vessels in the RULET database. For these vessels, the *Record of American and Foreign Shipping* also lists bunker capacities, dimensions of the largest hold, and the number of tanks onboard.

The Annual List of Merchant Vessels of the United States, originally published by the U.S. Bureau of Navigation and currently published by the U.S. Coast Guard, is a list of merchant vessels sailing under the American Flag. Although this publication is not as detailed as the register books, it does provide information about American vessels that is sometimes not included in the other registers, such as a vessel's official number and crew size. The list also has some of the same fields as the register books including the name of vessel, gross tonnage, net tonnage, length, breadth, depth, location of build, and homeport.

Unfortunately, while these registers and record books are invaluable for populating data fields in a database and determining which ships met the initial screening criteria, they generally lack key information about the pollution potential of a ship. For example, with the exception of the *Record of American and Foreign Shipping*, none of the other registers or lists includes bunker capacities of vessels. This means that vessels inspected and classed by Lloyd's of London and not ABS do not have bunker capacities listed. Similarly, even though the *Record of American and Foreign Shipping* lists bunker capacities, it does not provide any insight into what type of cargo a ship was carrying at the time of its loss. To determine this type of information, additional archival research was necessary.

Secondary Wreck Screening Process

Archival and Historic Research

After the initial screening, RULET contained 573 shipwrecks that required additional research to determine their threat potential based on physical integrity. The additional screening relied heavily on archival research and original documents to gather additional details on the potential cargo and fuel onboard. Vessel casualty information and the structural reduction and demolition of those that were navigational hazards were areas of specific research focus. The archival research included identification of risk factors that both increased or mitigated the potential for pollution. For example, a tank vessel would be considered a higher risk because of the potential volume on board, but not all tankers were laden when sunk. The nature of the casualty could substantially reduce the potential for oil remaining on board; the more violent the sinking event, the lower the risk of remaining oil. A vessel that was struck by multiple torpedoes would be less likely to contain oil than one that sank due to foul weather.

Based on additional online research, NOAA was able to reduce the RULET database to 288 vessels as of September 2010, based on removing duplicate records for the same vessel and new information on vessel construction, size, and propulsion. Archival research was conducted on these wrecks to obtain additional information that could be used to populate data fields and provide information about how much oil a vessel carried or was capable of carrying at the time of its loss. Eventually, secondary screening reduced the database to 107 vessels.

Many primary source documents are located at: 1) the Archives I building in Washington, DC for reports of the U.S. Coast Guard; and 2) the National Archives II building located in College Park, MD for U.S. Navy reports about U-boat actions along the East Coast. National Archives I research focused on archive boxes from Record Group 26, Records of the U.S. Coast Guard, for information pertaining to vessels remaining in the database.

The boxed series within this record group that provided information for this study included: World War II Reports Concerning Merchant Vessels sinking, 1938-2002; War Casualty Section Survivor's Statements, 1941-1945; and War Casualty Section Casualty Reports, 1941-1946. These vessel casualty reports provided information regarding cargo carried, departure port and destination, location of torpedo impact, locations of fires, whether oil was released, and time it took the vessel to sink. This information provided a more accurate account of the sinking of the vessel and helped in hypothesizing the extent of the damage to the vessel at the time of the sinking. This information thus enabled a general assessment of what condition a wreck may be in if it had not been surveyed or discovered.

Research in Archives II focused on Record Group 32 (Records of the U.S. Shipping Board); Record Group 38 (Records of the Office of the Chief of Naval Operations, 1875-2006); Record Group 41 (Records of the Bureau of Marine Inspection and Navigation); Record Group 178 (Records of the U.S. Maritime Commission); and Record Group 428 (General Records of the Department of the Navy, 1947-[to present]). Although each of these Record Groups contained bits of information that could be included in the database, the most valuable information was located in Record Group 38. Boxes in Record Group 38 included Tenth Fleet Convoy & Routing Casualty Files; the Office of Naval Intelligence Security Classified Administrative Correspondence, 1942-1946 (declassification #NND813017); and the Records Relating to Naval Activity During World War II, World War II War Diaries. These record series provided the most information about vessel sinking events and war-related losses. The sinking reports contained in these series were invaluable for making inferences about the violent nature of a vessel's sinking and the likelihood that the vessel sank intact and could still retain a liquid cargo.

Record Group 178 held a series entitled Central Correspondence Files 901-2 Individual Ship, Files 1936-1950 that contained charter information about ships. These charter records exist for many of the vessels in the database and provided information about the bunker capacity of the vessel, the bulk cargo capacity, and even a description of the last two successive cargos the vessel carried. While this information does not indicate exactly how much fuel a vessel was carrying at the time of its loss, it does indicate how much fuel that vessel could have carried when fully laden. From Record Group 428, boxes in the series Office of Information Ship Files 1940-1958, proved helpful for obtaining newspaper articles written about torpedoed ships that provided additional descriptions and accounts of the loss of a vessel that were not recorded in the official sinking reports.

In addition to research conducted at the National Archives, historical articles from newspapers were examined. These newspapers often provided information that was not included in official sinking reports because they are tailored towards the general populace and are not intended to understand the movements of enemy combatants or determine the nature of a marine casualty. U.S. Coast Guard Marine Board of Investigation Reports and National Transportation Safety Board Marine Accident Reports also provided additional information about many wrecks that were not lost during World War II and were not part of the National Archive collections that were examined during this study.

From these sources and many additional secondary sources, information was obtained about the vessels lost within U.S. waters that were using oil for fuel or were transporting oil as cargo. This information, however, did not enable the reduction of the number of wrecks within the database, as it did not provide any information about the current condition of a vessel. Fortunately, extensive archaeological fieldwork and shipwreck surveys have been conducted that permitted the number of wrecks in the RULET database to be drastically reduced. Visual or remote sensing confirmation of the condition of a shipwreck by researchers in the field enabled the removal of wrecks that initially appeared to be high priority from initial research. Each element of the historical assessment was given a data quality ranking as to the veracity of the information.

Shipwreck Site Formation

One of the methods utilized to reduce the number of shipwrecks in the RULET database involved examining individual shipwrecks in terms of site formation processes, which is a study of how shipwrecks have been affected by environmental and cultural factors. This study involves interpreting some of the factors that reduce the structural integrity of a shipwreck and, therefore, its ability to retain oil. Site formation processes are commonly defined as how a ship transitions from a ship into a shipwreck site, or the reasons why a shipwreck on the ocean bottom often bears little resemblance to the vessel that plied the ocean. Originally proposed by archaeologist Keith Muckelroy, and building on models of site formation proposed by Michael Schiffer and others, these processes assess how cultural (that is, human-influenced or caused) and natural factors influenced the transition from the original entity (in this case, the floating ship, its cargo, crew and/or passengers, afloat and at the time of its sinking) and the shipwreck site as encountered in the current day.

In an archaeological context, these processes, whether they are cultural or natural as defined by Muckelroy (1978), are generally divided into two overarching concepts known as extracting filters and scrambling filters. Extracting filters are influenced by the buoyancy of artifacts and structural elements, by salvage of parts of a wreck or its cargo, post-sinking impacts by fishing gear, scouring and erosion, ongoing corrosion, and environmental variables influencing the preservation of certain types of materials and the lack of preservation of others. All of these are filters that entirely remove elements of the ship from a wreck site. Because most oils are lighter than water, they would also be “removed” from a wreck through tank openings. Scrambling filters, commonly storm surge, wave currents, or demolition of a wreck, are those which leave the elements of the ship on the site but that move them from their initial position or context (Muckelroy, 1978).

The theoretical and practical evolution of how archaeologists assess and define site formation processes has now evolved to not only assess the physical processes but also the human behaviors inherent in the cultural processes – questions such as contemporary assessment of what was or was not of value (cargoes), the recovery of human remains, and the nature of different forms and processes behind cultural removal of material from shipwrecks, including the different contexts of on-site and off-site ‘salvage.’

Although it would take a detailed study of each wreck site to determine the exact filters that have extracted or scrambled elements of a wreck (Figure 2-1), some generalizations can be made about relatively modern shipwrecks in U.S. waters. These generalizations help to explain why so few of the ships that once carried or burned petroleum products may still contain those products after they wrecked. Appendix A lists the vessels removed from RULET in part due to site formation processes.

Figure 2-1: Shipwreck site formation processes help explain why vessels, like the *Dixie Arrow* which initially carried approximately 86,136 bbl of crude oil, but was demolished during World War II, no longer remain intact and are no longer potentially polluting shipwrecks (Photo: NOAA). See Figure 2-5 for another example.

On the U.S. East Coast and in the Gulf of Mexico, the vast majority of potentially polluting shipwrecks were sunk by German U-boats during the first several months of 1942 (Figure 2-2). By examining historic records and the current condition of many shipwrecks lost in U.S. waters, it is evident that most World War II shipwrecks were lost in shallow coastal waters. This is to be expected, as wartime shipping routes required merchant marine and other vessels to travel close to the coast. Most of these ships were subsequently demolished as hazards to navigation or picked up as unidentified sonar contacts and depth charged. Similarly, many of these ships sank with their masts or stacks protruding from the surface of the water and were used as training targets for aircraft from the various Naval Air Stations. When combined with the initial torpedo damage already inflicted upon these ships, tanks were ruptured, decks were collapsed, and structural elements were reduced to rubble.

This post-sinking demolition was not limited to World War II wrecks. For example, the *Union Faith* and *Cleveco* case histories described in Section I also involved some structural modifications after sinking to reduce their potential as navigation hazards.

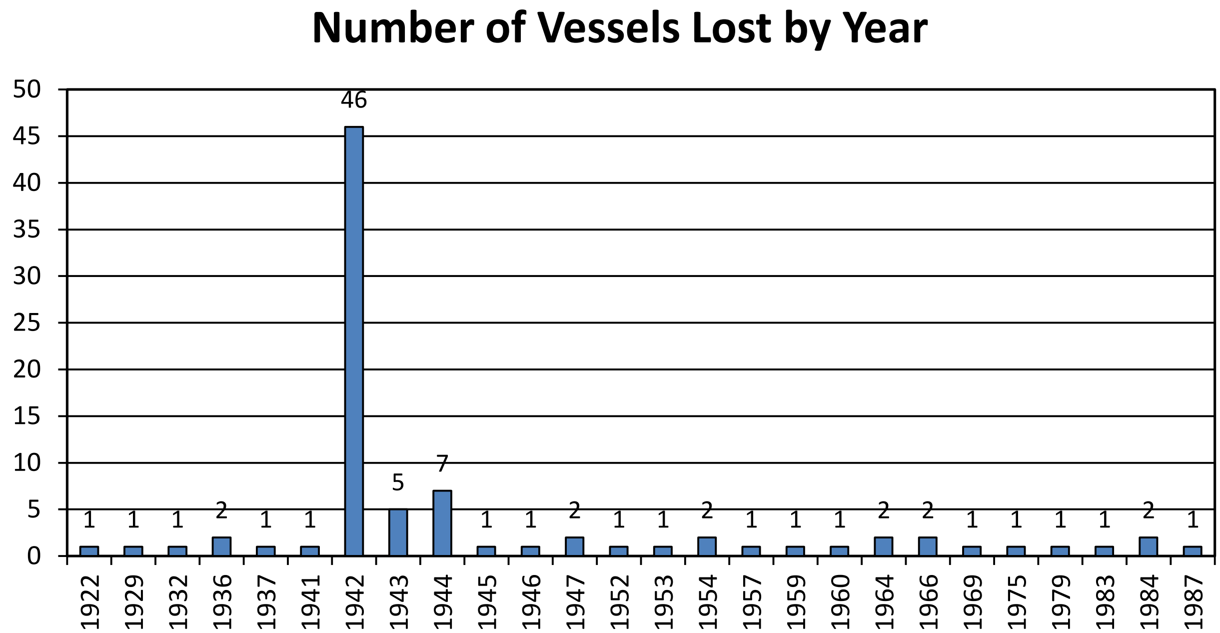


Figure 2-2: Number of vessels lost by year, highlighting vessels in RULET lost due to war-related causes in 1942.

On the other hand, the majority of potentially polluting shipwrecks on the U.S. West Coast and Alaska were lost due to grounding, a violent event typically resulting in the vessel's bottom being ripped out, waves and surf forcing the vessel parallel to shore, and the vessel being pounded to pieces between the waves and rocky coastline. Furthermore, many of wrecks were partially salvaged and or even dynamited to remove them as navigational hazards or environmental eyesores. Efforts were focused on removal of a physical hazard, not potential pollutants. However, in some cases, vessels retained enough integrity to retain trapped oil (e.g., the beached wrecks *Catala and Palo Alto* remediated in 2007 and 2006 respectively, and mentioned above).

By taking the violent losses of East Coast, Gulf Coast, and West Coast shipwrecks into account and examining their current condition, it becomes clear that many of them do not retain enough structural integrity to contain a liquid cargo or bunkers. The majority of wrecks that have been reported leaking or reported to contain trapped oil have come to rest either on one side or in an inverted position. Both are orientations that may have prevented the wrecks from being easily identified as hazards to navigation or as unidentified sonar contacts and demolished. These orientations also offer less resistance to ocean currents and better protect a hull from the forces of waves and currents that are commonly associated with a shipwreck resting on its keel, such as hogging, sagging, and splaying. It is important to recognize, however, that these are not all encompassing rules but merely generalizations that help explain the generally low number of shipwrecks identified as having the potential to pose a substantial threat to the environment.

Vessels in the database range from 120 to 729 feet in length and 36-114 years in age in 2012 (see Figure 2-3). Although the RULET screening criteria considered vessels of a range of hull materials including concrete, iron, and steel, all of the remaining high and medium risk vessels are constructed of steel. The majority of the wrecks, 54 (62%), are of riveted construction, 21 (24%) were welded, and 12 (13%) are of unknown construction. Construction type is reflective of when many of these vessels were built and often does not characterize changes in a vessel as it was converted from coal to oil or from cargo to a troop carrier, etc. The vessels remaining in RULET are mostly tankers (43 vessels, 49%) and freighters (37 vessels, 42%).

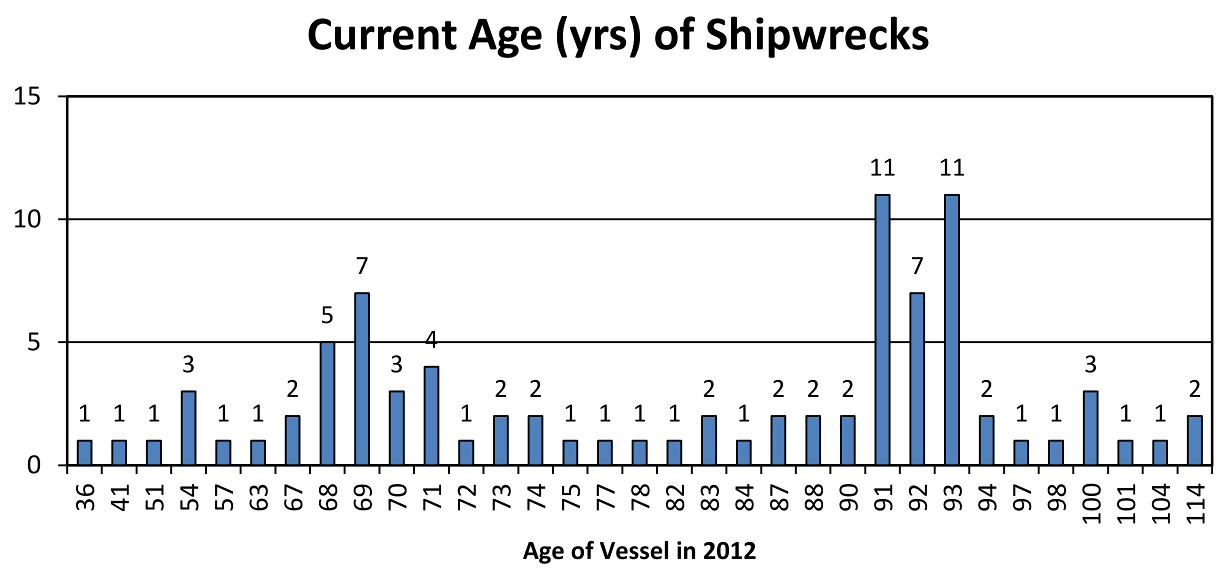


Figure 2-3: Age of the 87 priority shipwrecks (in years as of 2012) in the RULET database, depicting the advanced age of many of the vessels.

Corrosion and Age

There are generally two types of corrosion that impact shipwrecks: chemical and microbial. The hull of a wreck may appear intact, but may be suffering significant loss of structural integrity. Impacts from corrosion are generally difficult to assess visually, with the exception of manifestations such as rusticles like those seen in the iconic shots of the bow of the *Titanic*. Sampling of the hull material is typically required to gain an understanding of the physical integrity of a vessel. While testing of hull coupons[2] is possible, results are generally relative in that the thickness of a particular hull plate at the time of a casualty is unknown. While it may be possible to find records on the build specifications for a particular vessel, there were often variations in the quality of materials and in what may have been actually used, especially during times of war. Vessels that were in service for an extended period of time prior to casualty may have been significantly retrofitted from coal to oil or from one purpose to another. Records on changes to hull plate thickness from this type of work are limited. As Figure 2-4 illustrates, 42 of the 87 vessels for which risk assessments were prepared are 90 years of age or greater. Generally, older vessels will have thicker plating than new ones due to changes in steel manufacturing and rolling technology.

[2] Coupons are metal samples used for corrosion or other types of metallurgical analysis.

Understanding how corrosion processes affect the structural integrity of vessels is important for two reasons. If we understand how the corrosive processes work on shipwrecks of differing ages, depths, and environmental conditions, we may be able to develop approximate timelines for the eventual fate of a vessel. Second, the application of that information is important in understanding when a loss of structural integrity might occur for tanks or cargo holds containing fuel oils or other hazardous cargo materials. This type of information is useful for response personnel and agencies in understanding when direct intervention and removal of oil may be warranted.

A variety of issues can affect the rates of corrosion on potentially polluting wrecks in marine waters. Marine bacteria, bottom sediment types, storms and currents, and the sea itself all have a part in the slow degradation and conversions of metals to rust or metal oxides. Many vessels may have been structurally undermined due to explosions, fire, collisions causing stress, and the resultant tension or compression changes in the steel. Once submerged, these vessels have been continuously exposed to the corrosive effects of seawater (or fresh water for those in the Great Lakes). If sunk in an area where strong currents pass by the site, these currents can carry higher oxygen levels and speed the steel corrosion process. Impacts from storms and the bottom sediments in which a vessel lays also play their part in the site formation process, causing additional structural stresses and eventual failure of critical components within the vessels. There are also cathodic issues where non-sympathetic metals create an electrical-chemical effect that corrodes metal, much like the way a battery works. Iron oxide (rust) begins to occupy more physical volume than the iron or steel itself, distorting the metal and causing failure of metal components and fasteners. Leakage of oil and other chemicals from shipwrecks often occurs in the valves, piping, and other mechanical connections, where use of dissimilar metals is common. Corrosion is also strongly affected by the impact of cargo debris or nearby ore loading facilities such as copper containing minerals on wharf structures in Lake Michigan. Spillage of cargos from one shipwreck to another site is rare but has a very real impact. Long-term corrosion studies have shown the effects of proximity corrosion or a long-range form of galvanic corrosion coupled through the marine biota.

Based on comparisons of corrosion and environmental data from shallow and deep water sites, the Weins Number concept is proposed by a Department of Interior-led team as a means to predict long-term corrosion of iron-based alloys in sea water. The concept is a product of the corrosion studies conducted as a component of the National Park Service Submerged Resources Center’s USS *Arizona* Preservation project. The methodology, called Concretion Equivalent Corrosion Rate (CECR), involves the physical and chemical analysis of overlying concretion (hardened marine biofouling) and conversion of the data to corrosion rate of substrate metal. This technique has been used on the USS *Arizona*, the Japanese Midget Submarine thought to be *I-20A*, the Submarine *Explorer* and another Japanese Midget Submarine *I-16A* as well as the recent assessment of the SS *Montebello* (see coupons taken from the hull of the SS *Montebello* in Figure 2-4). Plotted as a function of reciprocal absolute temperature, Weins Numbers generate a linear plot from which the corrosion rates are calculated when temperature, oxygen concentration and concretion thickness are known. The utility of this approach is that a metal coupon is not required, only a sample of the concretion, which can be used to determine corrosion rate since loss.

Figure 2-4. Two of coupon samples from the SS *Montebello* prior to analysis.

Researchers from the Western Australian Museum are looking at how pH impacts corrosion rates in coral and coralline areas in the South Pacific. They have also noted that losses in concretion from physical impacts, such as localized dynamite fishing, can significantly increase corrosion rates and that wrecks with significant coral accretions seem to have increased localized turbulence and corrosion rates. Studies in the open ocean and at Chuk Lagoon suggest that corrosion rates fall logarithmically with water depths.

There are well-accepted methodologies for understanding corrosion in pipelines, wellheads, and marine infrastructure such as bridges and port structures. The understanding of how corrosion will impact degradation of potentially polluting wrecks is still very much under development. It will be some time before corrosion rates can be definitive for risk assessments without detailed metallurgical analysis of each individual shipwreck.

Interpreting Sinking Records

Casualty Information

In some cases, vessels sank in very deep water or unknown locations and have not been discovered. In these instances, it is only possible to approximate what condition such wrecks may be in through a subjective analysis of survivor reports and casualty narratives. Depending on the date, the nature of loss, and the number of survivors, historic casualty narratives contain differing amounts of information. This is also the case for many World War II era shipwrecks in the RULET database. Some ships sank very quickly and had few survivors, so the casualty reports are short and seemingly incomplete, whereas other vessels had multiple survivor accounts recorded. As with any type of eyewitness account, survivor accounts are very subjective and may vary widely for the same incident. However, they are a valuable source of information.

Because oil pollution was not a major consideration when many of these ships sank, whether cargo or bunker oil was lost at the time of the casualty can generally only be inferred from many of the reports. This is often the case when survivor reports reveal that a torpedo hit a tanker in at least one of the cargo tanks, or that a freighter or tanker was hit in the area of bunker tanks. Although many reports do not discuss the loss of cargo from these impacts, it can be inferred based on the torpedo impact location and the devastating amount of damage a torpedo would inflict.

There are sinking reports, newspaper articles, and U.S. Coast Guard Marine Investigation Reports that do document the release of oil from ships as they sank (see example in Figure 2-5). Multiple World War II survivor reports reveal how survivors could not escape a ship because of burning oil surrounding the ship, or how the survivors had to swim for hundreds of feet to get away from the oil escaping a doomed merchant vessel. One report by a survivor from a tanker lost in the Gulf of Mexico reported crude oil floating free from the tanker in a layer four inches thick three days after the vessel sank (Office of Naval Intelligence, 1942; Browning, 1996). Because uncontained oil slicks would not be four inches thick, it is assumed that this slick was contained within a debris field.

In other instances, airplanes patrolling the coastline during World War II also documented the loss of oil from sinking ships. These observations were reported to the Eastern Sea Frontier and were recorded in the Eastern Sea Frontier War Diaries and synthesized in the 1977 Massachusetts Institute of Technology study entitled Impact of Oil Spillage from World War II Tanker Sinkings (Eastern Sea Frontier, 1942; Campbell et al., 1977). Although these sinking reports are valuable for determining if there were petroleum products lost during the sinking event, they do not reveal the amount that was lost or how much has escaped in the years since the vessel sank. Photos taken by observers that are part of the official records can often document the presence of oil sheens or slicks as well, but again they can only provide limited information.

UNITED STATES COAST GUARD

REPORT ON U. S. MERCHANT TANKER WAR ACTION CASUALTY

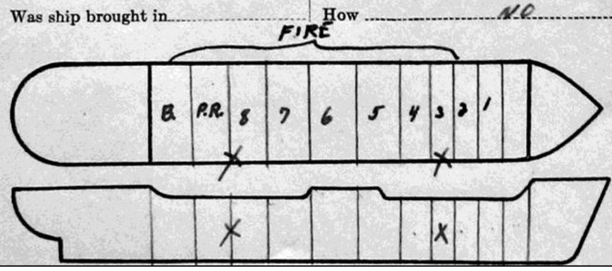
To: Commandant, U. S. Coast Guard, Washington, D. C.

Ships/S R. W. GALLAGHER — Service COASTWISE TANKER.

Owner STANDARD OIL Co. OF N.J. — Operator STANDARD OIL Co. OF N.J.

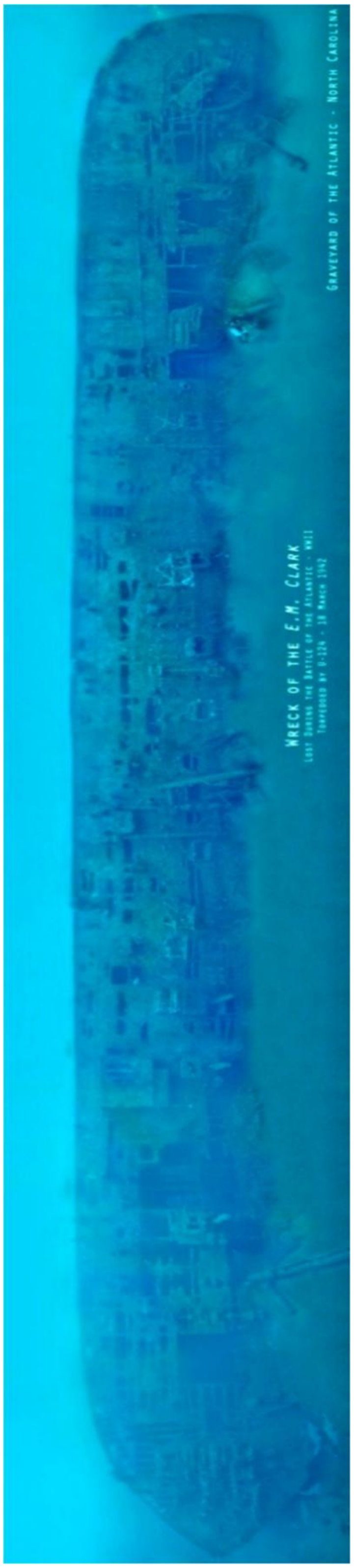
Information furnished by MASTER. + CREW — Date 6 DECEMBER, 1944

Line No.	QUESTIONS	ANSWERS	
1	Year built and propulsion	Built 1938	Propulsion STEAM
2	Tonnage	Gross 7989	Net 4738
3	Draft loaded (maximum allowed)	Fwd. 29'03" (M)	Aft
4	Draft when attacked	Fwd. 29'03" (M)	Aft
5	D. W. T. (Emergency Coastwise L. L.)	13 000	
6	Cargo 42's capacity and carried	Capacity 83,000 BBLS.	Carried 83000 BBLS.
7	Kind of cargo or tank ballast	BUNKER "C" FEUL OIL.	
8	Was ship gas-free? (Specify)	NO; LOADED.	
9	Voyage	From GALVESTON, TEXAS	To POINT EVERGLADES, FLORIDA.
10	Were routing orders followed	YES	
11	Any criticism of orders	NO	
12	Weather at time of attack	Weather CLEAR	Sea MODERATE
13	Was enemy sighted? When	NO	
14	Any friendly ships in sight	NO	
15	Were navigation lights on	NO	
16	Date and time of attack	Date 7-13-42	Time 0140
17	Position	Latitude 28°32' N	Longitude 90°59' W
18	Nature of attack (Give data)	TORPEDOED	
19	Number of hits	2	
20	Location of hits (Mark diagram)	1-AFT (⅔ PAR. BOD.); 1-FOR'D (⅓ PAR. BOD.)	
21	Effect of hits	SANK SHIP (VESSEL CAPSIZED AND SUNK)	
22	Was ship armed? What type	YES; 1-5"; 1-3"; 2-30 CAL.; 2-50 CAL.	
23	Was armament used? State result	NO	
24	Was oil sprayed over ship	YES	
25	Did cargo fire (Mark diagram)	YES	
26	Did tanks explode (Mark diagram)	NO	
27	Was deck ruptured	YES	
28	Did ship break in two	NO	
29	Was SOS sent	NO	
30	Ship's speed	Normal 12.0 — When attacked 12.5	When abandoned STOP
31	Time abandoned, sunk	Abandoned 0220 (40 min)	Sunk 0310 (1 hr, 30 min)
32	Was ship reboarded	By whom NO	When —
33	Was ship brought in	How NO	Approximate damage SUNK



Fill in this diagram to show attack hits, fires, explosions, etc.

Figure 2-5: Example of U.S. Coast Guard War Action Casualty Report for a tanker torpedoed during World War II.



Wreck Condition and Salvage

Although sinking reports help provide a better understanding of the potential condition of a shipwreck that has not been located, there is no substitute for visual assessments of shipwrecks or salvage reports of oil removal to definitively determine that a shipwreck no longer contains oil. Fortunately, advances in technology, archaeological surveys, and recreational divers with high-definition video cameras have made it far easier to examine the condition of shipwrecks on the seafloor in terms of structural integrity or ability to retain fuel in cargos or bunkers. These technologies and sources of data have allowed NOAA archaeologists to rule out hundreds of shipwrecks that once burned oil or carried it as cargo as potential sources of oil pollution.

By examining the current condition of shipwrecks, it is evident that most World War II-era shipwrecks that are commonly visited by divers were demolished as hazards to navigation or picked up as unidentified sonar contacts and depth charged or aerial bombed into veritable rubble fields. Other intact shipwrecks like *Montebello* off California and *E.M. Clark* off North Carolina (Figure 2-6) seem to have simply released their oil cargos through vents, cargo loading hatches, and piping over the past 70 years of resting on the seafloor, with no reports of sheening or oiling in the vicinity. Unfortunately, without in-water assessment and survey of each of these shipwrecks, they would appear to have the potential to be fully laden based on acoustic or visual surveys alone. Additionally, salvage reports of oil removal from shipwrecks or of the entire removal of a wreck from the seafloor enables that vessel to be removed from a potentially polluting shipwreck database. Because there are still shipwrecks that appear in various databases that were refloated and salvaged after they sank, these reports are invaluable for ensuring that any shipwreck added to the RULET database is still present on the seafloor. Likewise, reports of oil removal operations like that recently conducted on the passenger steamer *Princess Kathleen* and the Liberty ship *William Beaumont* ensure that these wrecks can safely be removed from the database.

Vessel Risk Factors

To develop scoring for the physical potential of a vessel to retain either bunkers or cargo based on the historical data, a vessel risk factor analysis was developed with guidance from the U.S. Coast Guard Salvage Engineering Response Team (SERT). This analysis allowed for comparison of all vessels including those in unknown locations and provided a quantitative means via a salvage engineer's perspective to address historical information (see Figure 2-7). SERT reviewed the general historical

Figure 2-6: Photomosaic of seemingly intact tanker *E.M.* Clark sunk by a German U-boat in 1942 off the coast of North Carolina (Photomosaic generated by Joe Hoyt, Source: NOAA) information available for the database as a whole and provided a stepwise analysis for an initial indication of Low/Medium/High risk values for each vessel. That stepwise analysis is detailed below and builds a picture of the cumulative risk for the physical characteristics of each wreck.

Pollution Potential Tree

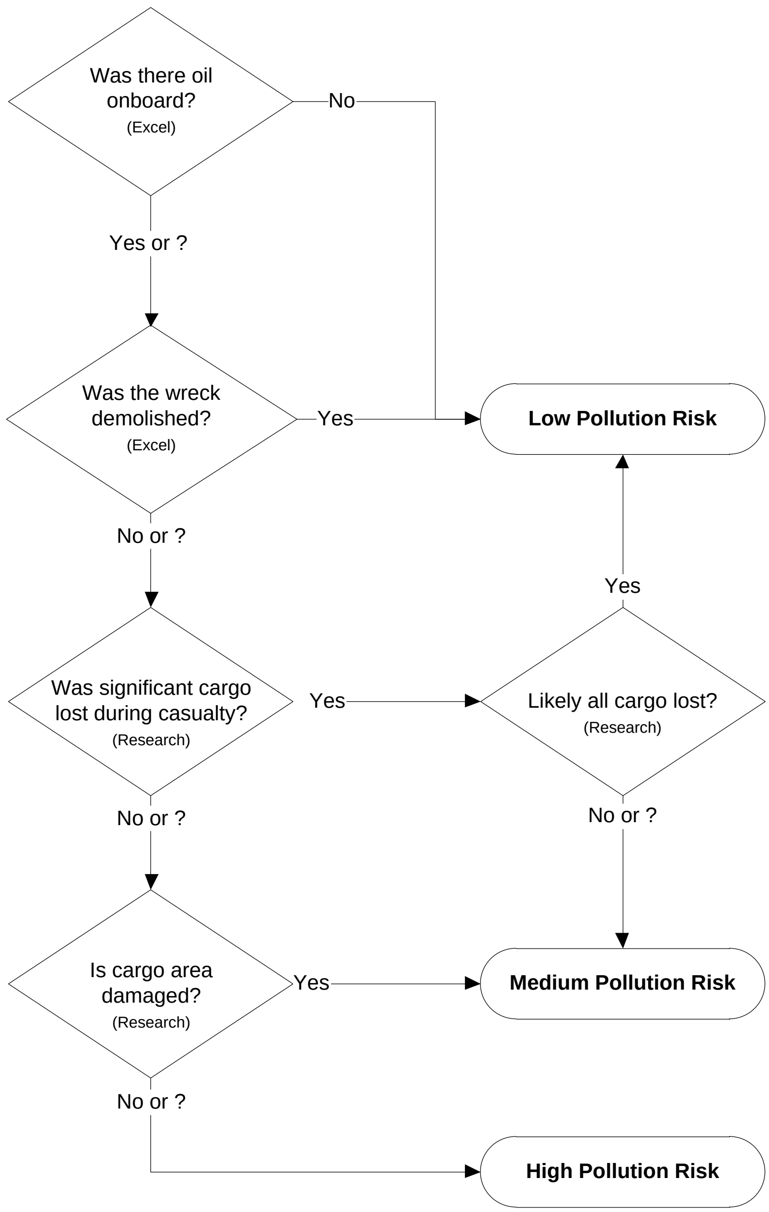


Figure 2-7: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed this Pollution Potential Decision Tree. Each diamond may represent more than one risk factor reflected in the following text.

The analysis is simple and straightforward and, in combination with the accompanying archeological assessment, provides a picture of each 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 data for each vessel.

In addition, where available, information related to operational considerations for any assessment or remediation activity was included but not scored. This includes information such as the depth or orientation of the vessel on the bottom. While important for what type of operational assessment could occur, depth and orientation generally do not have a direct bearing on pollution risk. In some instances, nuances from the archaeological assessment provided additional input that amended the final vessel score. 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 in Figure 2-7.

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, Moderate, and High for each risk factor is provided.

Pollution Potential Factors

Was there oil onboard? *(First diamond down in Figure 2-7)*

Risk Factor A1: Total Oil Volume

The oil volume classifications correspond to the U.S. Coast Guard spill classifications[3]:

- **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 barrels (≥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 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.

[3] As per USCG FOSC Guide. 10,000 gal = 238 bbl, but is shown as “240 bbl” in documents.

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[4]. (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)
- **Moderate 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)

Was the wreck demolished? *(Second diamond down in Figure 2-7)*

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

Was significant cargo or bunker lost during casualty? *(Third diamond down in Figure 2-7)*

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

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

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[4] 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 0.95 [API° ≤35.0 and >17.5]
Group IV - Specific gravity between 0.95 to and including 1.0 [API° ≤17.5 and >10.0], not included because not likely present on wrecks

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

Was the cargo area damaged*? (Fourth diamond down in Figure 2-7)*

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 how violent the sinking event was and the factors that would contribute to increase 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

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

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 higher likelihood of retaining an oil cargo in the non-vented and more structurally robust bottom of the hull.

Depth

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

Visual or Remote Sensing Confirmation of Site Condition

This factor takes into account the physical status of the 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.

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.

Munitions on Board

This factor addresses munitions cargo that may be on board the vessel and could potentially be released or detonated causing impacts to ecological and socio-economic resources at risk as well as responders.

National Historical Preservation Act, Sunken Military Craft Act and Gravesite Status

All of the vessels are reviewed to determine whether they are eligible for protection under the National Historical Preservation Act (NHPA) based on their age alone. This is the initial criteria for listing on the National Register and was the only criteria considered for this screening and the determination of which vessels need to be documented under Section 106 of the NHPA. In addition, each record was noted as to whether they are known to be civilian or military gravesites under the Sunken Military Craft Act (SMCA).

Vessel Pollution Potential Summary

For each vessel, physical integrity is summarized in a table (see Table 2-1) to provide an initial risk factor score that addresses the pollution potential and any mitigating factors that could reduce the pollution potential. The archaeological assessment and operational factors are included as well, but provide qualitative information for each vessel and are not scored.

During the research on the priority wrecks, it was determined that nine are leaking, as shown in Figure 2-8.

Table 2-1: Summary matrix for the vessel risk factors for the *Halo* 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)	Med	Maximum of 71,000 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Cargo is crude oil, a Group III oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	A significant fire was reported	
	C2: Oil on Water	High	Large amounts of oil were reported on the water	
	D1: Nature of Casualty	High	Multiple torpedo detonations	
	D2: Structural Breakup	High	The vessel remains in one contiguous piece	
Archaeological Assessment	Archaeological Assessment	High	Detailed sinking records and site reports of this ship exist, assessment is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Upright	**Not Scored**
	Depth	High	500 ft.	
	Visual or Remote Sensing Confirmation of Site Condition	High	Location has been surveyed	
	Other Hazardous Materials Onboard	High	No	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA and possibly SMCA	

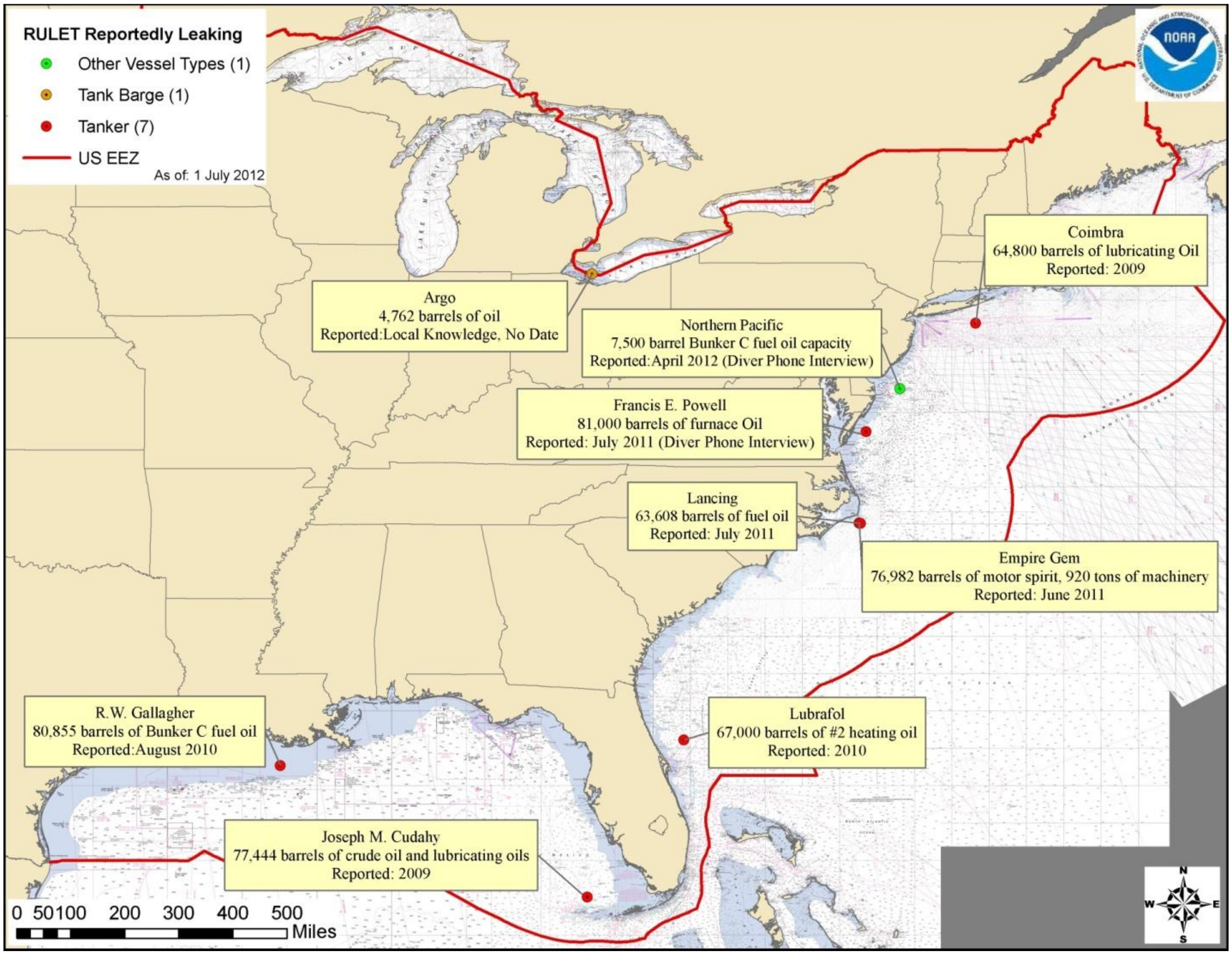

Figure 2-8: Nine of the wrecks in the RULET database that reportedly are leaking or have oil in the overheads.

SECTION 3: CONSEQUENCE ANALYSIS AND RESULTS: GETTING TO THE TRADEOFFS

Use of Worst Case Discharge and Most Probable Discharge

An estimate of the amount of oil that could remain on a ship is a critical input to environmental impact models. Unfortunately, because the wrecks in the RULET database are mostly historic vessels for which detailed cargo loading plans are not readily available, a combination of assumptions about oil volumes were made. The first conservative assumption that was to assume every shipwreck left in the database that could not be screened out still contained oil.

Although history has shown that many legacy wrecks are more likely to be empty than contain large quantities of oil, this study was designed to err on the conservative side. In most instances, there are reports of some amount of oil loss at the time of a vessel's sinking, so it is unlikely that any shipwreck will still contain the full amount of oil onboard prior to the casualty.

Combining information from historical sources previously listed, it was possible to determine the maximum amount of oil most RULET shipwrecks could carry or did carry at the time of their loss. Even though detailed cargo loading plans are not available, most of the U.S. Navy and U.S. Coast Guard sinking reports document how much cargo oil a tanker was reported to be carrying at the time it sank. Although these reports do not include how much bunker oil a vessel could carry, this information was obtained for many of the ships through information in charter contracts or the *Record of American and Foreign Shipping.* For the few remaining shipwrecks that bunker capacity information could not be found, the capacity information for similar sized vessels was used.

With this information, it was possible to estimate the maximum amount of oil that a ship could carry when it sank. These estimates were based on the amount of fuel the vessel would be expected to have aboard based on the number of days underway and the type of casualty. Casualty reports associated with World War I and II generally have notations as to the number of torpedo strikes, fire, explosions, or some initial loss of cargo. All of this information was used to estimate the volumes used for oil spill modeling. In addition, the oil spill modeling was done with a series of release volumes that allowed development of regression models. These models provide the ability to assess risks for smaller volume releases for each vessel should the estimated worst case volumes be incorrect, and for vessels in close geographic proximity carrying similar cargo or bunkers.

Based on discussion with the U.S. Coast Guard about what products are the most appropriate for contingency planning, both Worst Case Discharge, or a total loss of contents, and Most Probable Discharge, or a 10% loss of the Worst Case Discharge volume, the equivalent to the loss of an individual tank or smaller chronic losses from multiple tanks, were selected for detailed consequence analysis. To date, there are no documented cases of the complete loss of contents from a historic vessel in a single catastrophic event. Based on discussions with naval architects, salvage engineers, and responders, oil is more typically lost through a series of smaller spills over time. This generally equates to about a 10% loss from either one tank at a time or smaller chronic losses from several tanks. However, while a catastrophic discharge of the entire vessel contents is unlikely, it provides an important conservative benchmark for planning purposes. As with planning for other types of spill responses, the Most Probable Discharge is expected to be the most likely initial loss from a vessel. Although once a vessel starts to leak due to structural decline, it is unlikely it would only leak 10% overall. A 10% release provides a solid planning target and helps to place the threat from potentially polluting wrecks into context against other threats within an Area of Responsibility for any specific planning unit.

Environmental Impact Modeling

Introduction

Modeling can be a powerful tool for oil-spill impact quantification as part of environmental risk assessments, contingency planning, hind-cast impact analyses, and natural resource damage assessments. Models use knowledge of physical, chemical, and biological relationships along with environmental data to simulate pollutant transport, fate, and effects associated with a release of oil. Spill-related impacts are typically evaluated based on three factors: water surface oiling (area oiled, mass of oil on the surface), shoreline oiling (length/area oiled, shore types affected, mass of oil on shorelines), and water column contamination (volume of water exposed above effects threshold, dose). Deposition of oil-contaminated sediments is also a concern in some situations. Understanding the environmental tradeoffs of a proactive response versus a reactive one is feasible using models and subsequent resources at risk analysis.

Oil fate and effects modeling was conducted as part of the consequence analysis for potential oil spills from the wrecks identified in the screening analysis. The general approach was to use an existing, widely used and accepted oil-spill impact model, RPS ASA's Spill Impact Model Application Package (SIMAP), to project consequences associated with the priority wrecks identified in the screening analysis. Modeling was conducted using SIMAP's stochastic model to determine the range of distances and directions hypothetical oil spills are likely to travel from a wreck site, given historical wind and current speed and direction data for the area. Long-term wind and current records at, and around, the wreck site of interest were sampled at random and model runs performed for each of 200 selected spill dates and times. This set of random dates/times represents the potential environmental conditions that could occur during a release. Each model run was extended over 30 days.

The stochastic modeling outputs provide a statistical description of the potential likelihoods and magnitudes of oil-spill related impacts that would be expected from a given wreck; these results can be summarized by statistics such as mean and standard deviation. Using these results, we estimated the areas of water surface, lengths of shoreline, and volumes of water exposed above effects thresholds (oil thickness or concentrations) and developed regression models for each wreck fit to the resulting impacts as a function of spill volume, allowing impacts to be estimated for any potential release volume from the wreck, as well as for screening potential risks of spills from other nearby wrecks.

Model Description

SIMAP (described in detail in French McCay, 2003, 2004, 2009) is a computer modeling software application that estimates physical fates and biological effects of releases of oil. A geographical information system (GIS) database supplies values for water depth, sediment type, ecological habitat, and shoreline type throughout the modeled domain. An oil property database supplies physical and chemical parameters required by the model.

The model is designed to simulate fates of crude oils and petroleum products. Crude oil and petroleum products are complex mixtures of hydrocarbons; for modeling purposes, crude oils and petroleum products are represented by seven pseudo-components: three aromatic fractions considered toxic to organisms, three non-aromatic volatile and relatively insoluble fractions, and a nonvolatile insoluble (residual) fraction. Each has representative volatility and solubility characteristics for that component.

The three-dimensional physical fates model in SIMAP estimates distribution (as mass, areas and thicknesses of oil, and concentrations) of whole oil and oil components in the water column, on the water surface, on shorelines, and in sediments. Processes simulated include spreading, evaporation, slick transport, mixing, emulsification, entrainment of oil as droplets into the water, dissolution of soluble components, volatilization, adherence of oil droplets to suspended sediments, adsorption of soluble and semi-soluble aromatics to suspended sediments, sedimentation, stranding on shorelines, and degradation.

"Whole" oil (containing non-volatiles and volatile components not yet volatilized or dissolved from the oil) is simulated as floating slicks, emulsions and/or tar balls, or as dispersed oil droplets of varying diameter (some of which may resurface). Spreading (gravitational and by transport processes), emulsification, weathering (volatilization and dissolution loss), entrainment, resurfacing, and transport processes determine the thickness, dimensions, and locations of floating oil over time.

Surface slicks interact with shorelines, depositing and releasing material according to shoreline type. In the water column, horizontal and vertical transport by currents and turbulent (random) dispersion are simulated. A contaminant in the water column is partially adsorbed to particles and partially dissolved. Modeling of bottom sediment contamination is represents the mixing of bottom sediments through a simple bioturbation algorithm. Degradation of water column and sediment contaminant is estimated assuming a constant rate of "decay" in each environment.

The model algorithms in SIMAP (French McCay, 2002, 2003, 2004) have been developed over the past three decades to simulate fate and effects of oil spills under a variety of environmental conditions. SIMAP was derived from the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME, French et al., 1996), which was developed for the U.S. Department of the Interior as the basis of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) Natural Resource Damage Assessment regulations (as amended) for Type A. The SIMAP transport model has been validated with more than 20 case histories, including the *Exxon Valdez* and other large spills (French McCay, 2003, 2004; French McCay and Rowe, 2004), as well as test spills designed to verify the model's transport algorithms (French et al., 1997, 2007).

Vessels Modeled

The level of effort for this project did not allow for running individual models for all 107[5] of the wrecks identified in the screening analysis. However, environmental conditions are similar enough in several

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[5] Risk assessments were completed for only 87 vessels, 20 vessels with Low Worst Case and Most Probable scores were dropped.

locations that, although the release points would vary geographically, the results for a nearby wreck of the same oil type would be sufficiently similar as to provide insight into the potential impact scenarios. Thus, a set of model results for the oil type, release durations, and spill volumes was applied to nearby wrecks.

Following this approach, wrecks were grouped into clusters based on oil cargo types and geographic proximity. The environmental conditions and predominant wind and current directions were also considered in pooling locations. Of the 87 priority wrecks, 61 wrecks were located in close geographic proximity to at least one other wreck with the same oil cargo type, and thus were grouped into a total of 21 clusters. In general, the wreck with the largest volume of oil in each cluster was selected as the representative wreck for modeling. The clusters are summarized in Table 3-1; maps showing the clusters by U.S. Coast Guard District are shown in Figures 3-1 to 3-4. As an example, in Figure 3-2, there is a cluster of three vessels off Florida containing heavy fuel oil; the *Manzanillo* has the largest volume, so it was modeled, and regression equations were used to calculate the potential impacts for the potential release volumes of the other vessels in the cluster, namely *Managua* and *Santiago de Cuba*. In all, 47 wrecks were modeled directly, and 40 wrecks were represented by modeling for another vessel.

Table 3-1: Summary of modeled wrecks and associated clustered vessels. An additional 26 vessels were modeled, but were not associated with a cluster.

Modeled Wreck	Associated Clustered Vessel(s)
Cherokee	*Taborfjell*
Coimbra	*India Arrow*
Drexel Victory	*Camden*
Esso Gettysburg	*Doris Kellogg*
Francis E. Powell	*China Arrow*
George MacDonald	*Bloody Marsh*, *Juan Casiano*
Gulfoil	*Gulfpenn*, *Sheherazade*, *Vainqueur*
Hamlet	*Cities Service Toledo*, *Halo*
Lancing	*Panam*
Lubrafol	*Pan-Massachusetts*
Maiden Creek	*Pan-Pennsylvania*
Manzanillo	*Managua*, *Santiago de Cuba*
Marine Electric	*Cayru*, *Oneida*, *Northern Pacific*, *Swiftscout*
Marit II	*Allan Jackson*
Norlindo	*Munger T. Ball*
Norness	*Oregon*, *Regal Sword*
Ohioan	*Potrero del Llano*
Prins Willem V	*Material Service*
Puerto Rican	*Jacob Luckenbach*
R.W. Gallagher	*Alcoa Puritan*, *Gulfstag*, *Rawleigh Warner*, *Robert E. Lee*, *Virginia*
William Rockefeller	*Buarque*, *Empire Gem*, *Ljubica Matkovic*, *Mormackite*, *Nordal*, *Norlavore*, *Paestum*, *Venore*

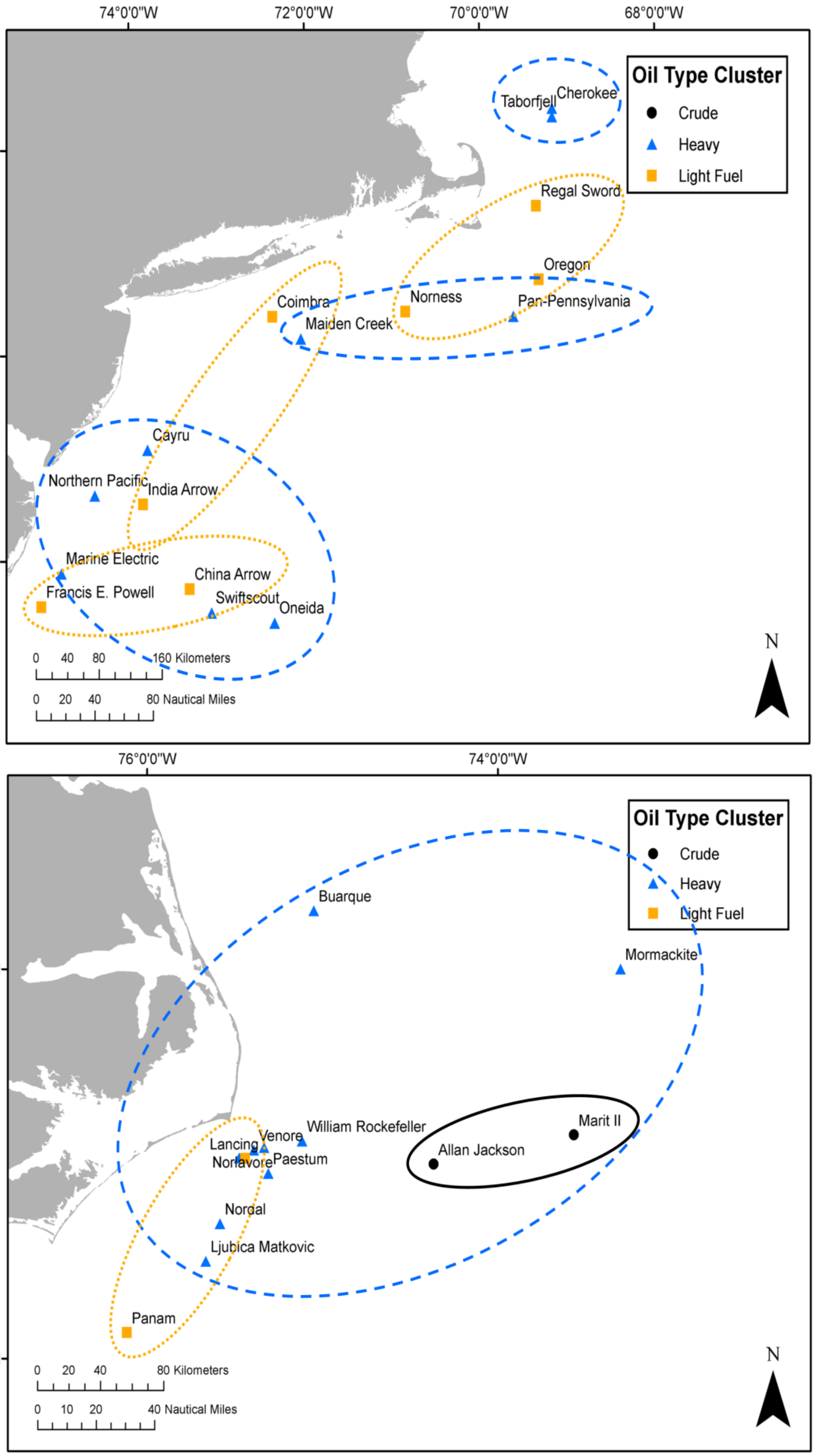

Figure 3-1: Map of the clusters for U.S. Coast Guard District 1 and District 5.

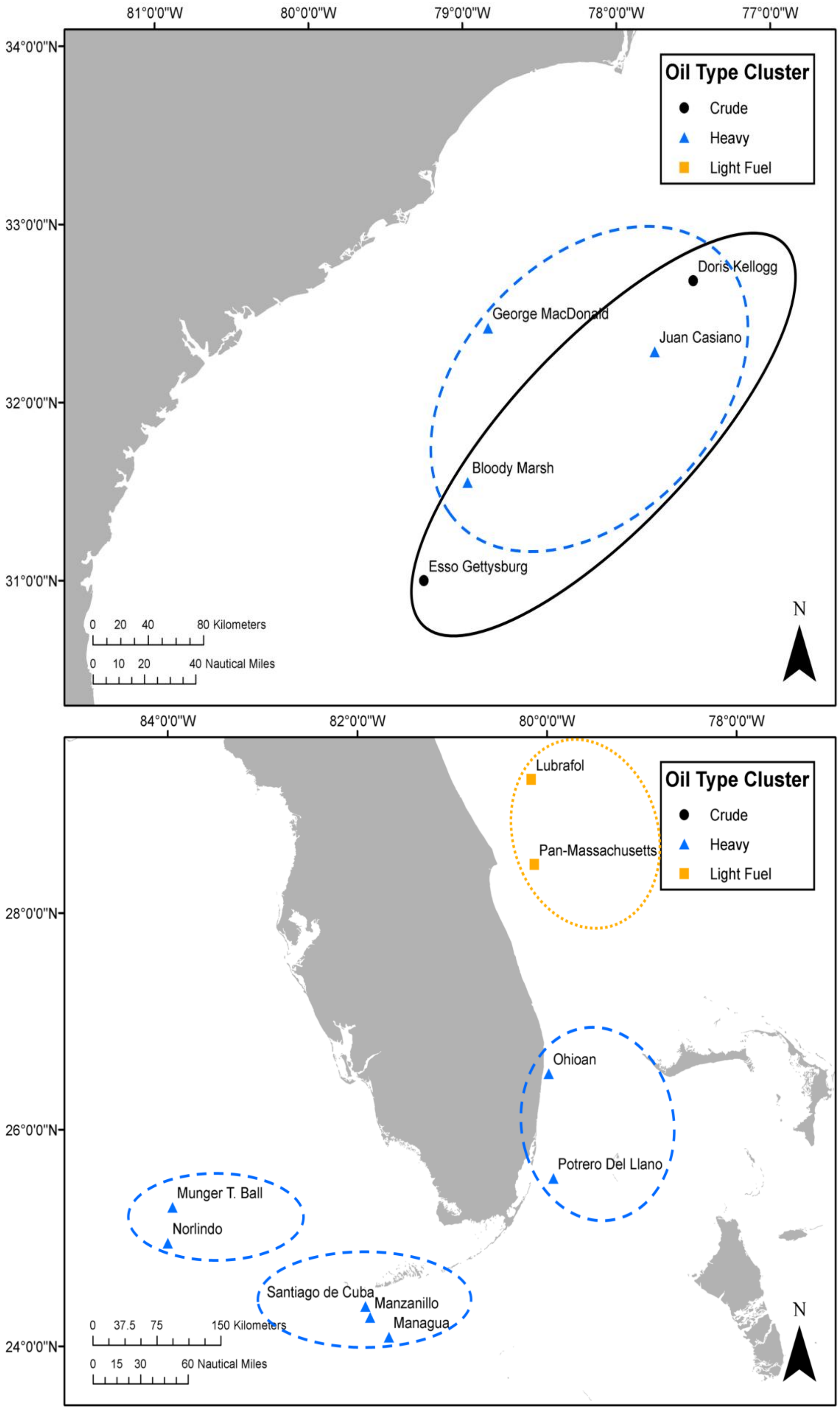

Figure 3-2: Map of the clusters for U.S. Coast Guard District 7.

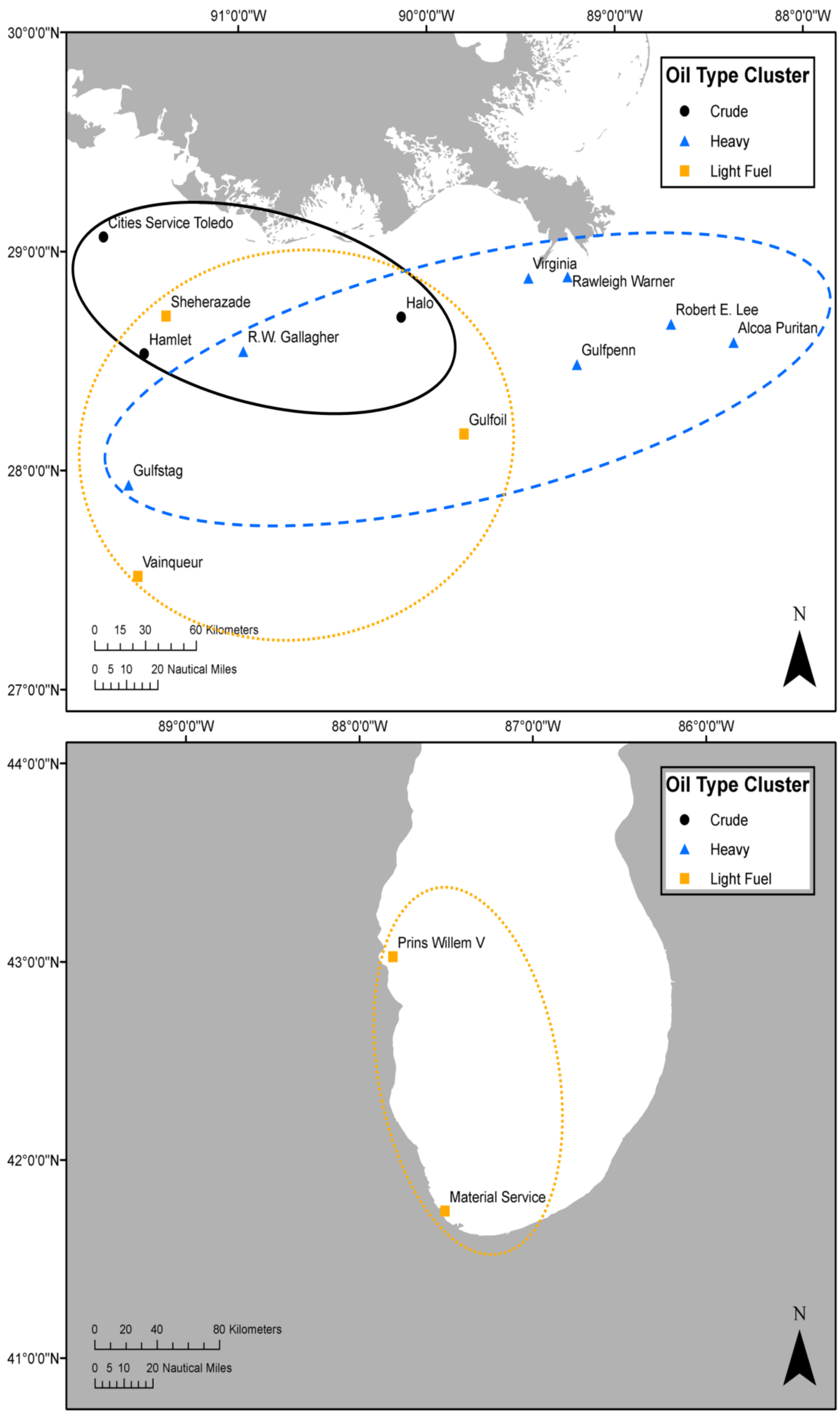

Figure 3-3: Map of the clusters for U.S. Coast Guard District 8 (top) and District 9 (bottom).

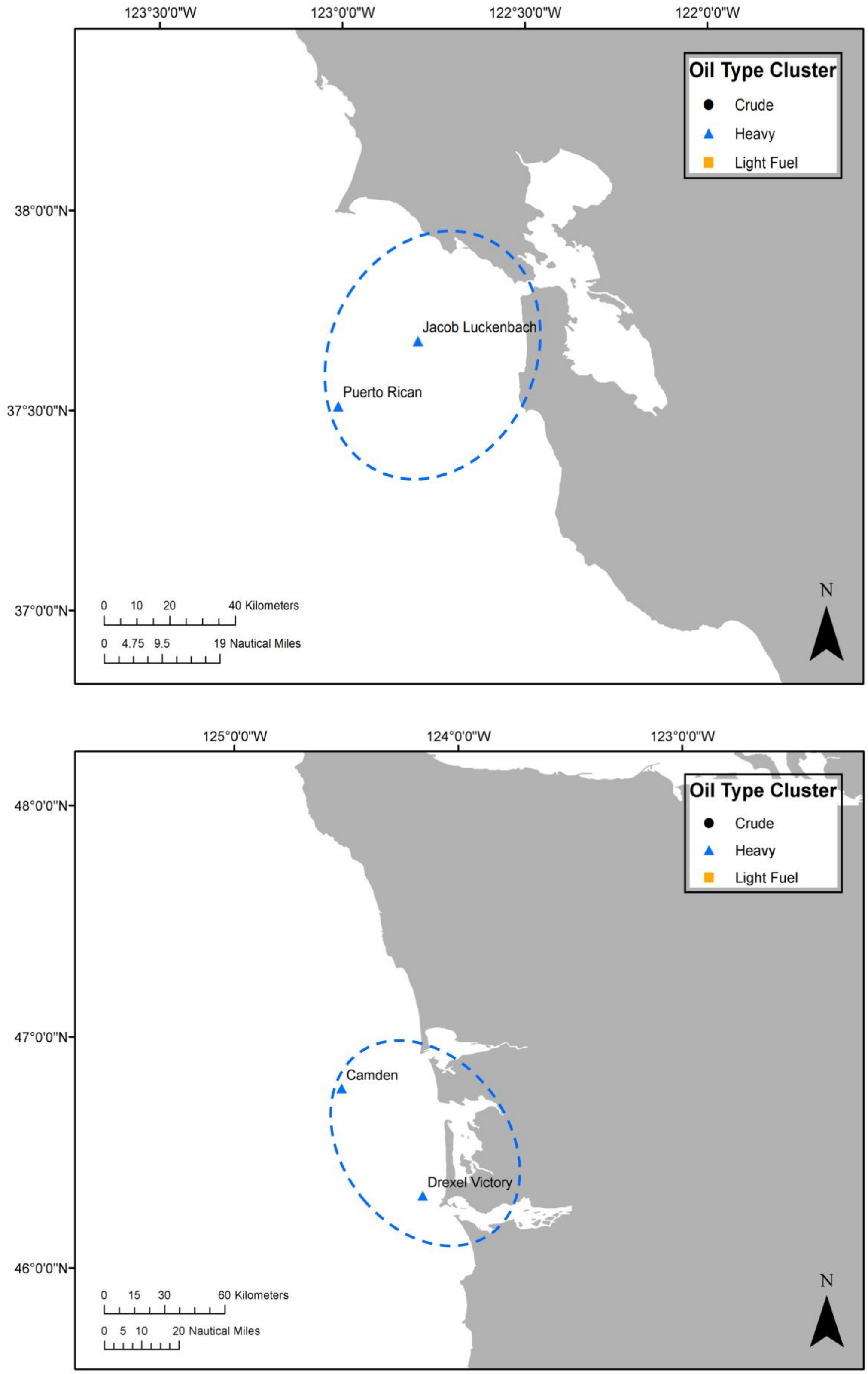

Figure 3-4: Map of the clusters for U.S. Coast Guard District 11 (top) and District 13 (bottom).

Model Inputs

Modeling inputs include habitat and depth mapping, winds, currents, other environmental conditions, chemical composition and properties of the oils likely to be spilled, and specifications of the release (amount, location, etc.). The input data for modeling impacts are available from government-run websites (e.g., winds, temperatures), government reports, published literature, and data libraries that RPS ASA has compiled over many years of performing similar modeling. General modeling inputs are discussed in the following sections. Additional detail regarding model inputs for each wreck can be found in Appendix C.

Winds: Wind data are typically obtained from NOAA National Data Buoy Center meteorological stations (e.g., coastal and offshore buoys). The model uses hourly wind speed and direction for the time of the spill and simulation. A long-term wind record (usually 10 years) is sampled at random to develop a probability distribution of environmental conditions that might occur at the time of a spill. The model can use multiple wind files, spatially interpolating between them to determine local wind speed and direction.

Currents: Currents have significant influence on the trajectory and oil fate, and they are critical data inputs. Dependent upon geographic location, wind-driven, tidal, and background currents are included in the modeling analysis. The tidal currents and background (other than tidal) currents are input to the model from a current file that is prepared for this purpose. Currents data sets used for modeling typically consist of long-term modeled simulations from global circulation models (e.g., HYCOM) and/or regional hydrodynamic models (e.g., ROMS, HYDROMAP, and BFHYDRO).

Temperature and Salinity: Temperature is an important variable, as volatilization, uptake rate into biota, and toxicity are all greatly enhanced at higher temperatures. Surface and bottom water temperatures vary by month in the model, based on data from French et al. (1996). The air immediately above the water is assumed to have the same temperature as the water surface, this being the best estimate of air temperature in contact with floating oil. Salinity is assumed to be the monthly mean value for the location of the spill site, based on data compiled in French et al. (1996). The salinity value assumed in the model runs has little influence on the fate of the oil, as salinity is used to calculate water density (along with temperature), which is used to calculate buoyancy, and none of the oils evaluated have densities near that of the water.

Other Environmental Inputs: Suspended sediment is assumed to be 10 milligrams per liter (mg/L), a typical value for coastal waters (Kullenberg, 1982). The settling velocity is 1 meter (m) per day. These default values have no significant effect on the model trajectory. Sedimentation of oil and polynuclear aromatic hydrocarbons (PAHs) becomes significant at about 100 mg/L suspended sediment concentration.

The horizontal diffusion (randomized mixing) coefficient is assumed to be 10 m^2/sec for floating oil and 1 m^2/sec for surface and deep waters. The vertical diffusion (randomized mixing) coefficient is assumed to be 0.0001 m^2/sec. These are reasonable values for coastal waters based on empirical data (Okubo and Ozmidov, 1970; Okubo, 1971) and modeling experience. These coefficients are for modeling small-scale transport that is not resolved by the hydrodynamics models providing current data. This smaller-scale transport is assumed to be random in direction, and the rates of movement are based on dye and similar studies made in oceanic waters.

Retention of oil on a shoreline depends on the shoreline type, width and angle of the shoreline, viscosity of the oil, tidal amplitude, and wave energy. In the NRDAM/CME (French et al., 1996), shore-holding capacity was based on observations from the *Amoco Cadiz* spill in France and the *Exxon Valdez* spill in Alaska (based on Gundlach, 1987) and later work summarized in French et al. (1996). This approach and data were used in the present study.

Habitats and Depths: For geographical reference, SIMAP uses a rectilinear grid to designate the location of the shoreline, water depth (bathymetry), and shore or habitat type. The grid is generated from a digital coastline using the ESRI ArcInfo-compatible Spatial Analyst program. The cells are then coded for depth and habitat type.

In general, the intertidal habitats are assigned based on the shore types in digital Environmental Sensitivity Index (ESI) maps distributed by NOAA Office of Response and Restoration, supplemented by other data sources where necessary. Open-water areas were defaulted to sand bottom, as open-water bottom type has no influence on the model results. Modeling results for countries adjacent to U.S. where habitat data were unavailable were defaulted to sandy beach shoreline habitats.

Depth data are typically obtained from bathymetric contours within the GEBCO Digital Atlas (GEBCO, 2003). Other bathymetric data sets are used as necessary (e.g., NOAA NOS Hydrographic Survey, NOAA Coastal Relief Model, and NOAA Great Lakes Environmental Research Laboratory Bathymetry).

Oil Types: There are thousands of oil types, with varying behaviors and environmental fates. To simplify the analysis, modeled wrecks were grouped into three general oil type categories, based on the predominant oil type thought to be onboard:

- Light fuel (e.g., marine diesel, fuel oil #2, fuel oil #4)
- Heavy fuel (e.g., Bunker C, Navy fuel oil)
- Crude oil

The oil’s content of volatile and semi-volatile aliphatics and aromatics (the aromatics also being soluble so as to cause toxicity in the water column) is defined and input to the model. Tables summarizing these properties are provided in Appendix C.

In general, light oils tend to rapidly spread to sheens and are easily dispersed into the water column by winds and waves, because of the low viscosities characteristic of these oils. The dispersed oil can be quite toxic to water column organisms. Light oils often have a high volatile content; so much of the oil mass may evaporate quickly.

Crude oils range from light to heavy (low to high density) with a broad range of viscosities as well. However, typically crude oils are more viscous, more persistent in the environment, float longer, and more likely to impact shorelines than light fuels. Many crude oils emulsify (take up water) under turbulent conditions to form mousse, which makes the oil more viscous and less likely to disperse. When crude oils are dispersed by high winds and waves, considerable toxicity can result in the water column.

Heavy fuel oil is the most viscous oil type considered. This property makes heavy fuel difficult to disperse and highly persistent. For the same spill volume, heavy fuel oil is more likely to strand on shorelines and oil wildlife at sea than the other oil types. Releases of heavy fuel oil that occur far offshore tend to break up into fields of tarballs that can cover large areas and persist over long time periods. Because the lighter, more toxic fractions of the oil are removed during the refining process, the resulting water column impacts are generally low for this oil type.

In the model, the representative heavy fuel oil used for this analysis spreads to a minimum thickness of 975 grams per square meter (g/m^2) (~1 millimeter), and the oil is not able to spread any thinner, owing to its high viscosity. As a result, water surface oiling results are identical for the 0.01 and 10 g/m^2 thresholds (discussed below). For the crude oil used for this analysis, the minimum spreading thickness is 8.52 g/m^2, so water surface oiling results are very similar for the 0.01 and 10 g/m^2 thresholds. The light fuel used in this analysis spreads to a minimum thickness of 8.56 g/m^2, but is of low viscosity, so water surface oiling results are higher for the 0.01 g/m^2 than the 10 g/m^2 threshold.

In some cases in this study, water column impacts decreased with increasing spill volume. This situation occurred when a relatively large percentage of the oil was predicted to settle to the sediments. When oil does not stay in the water and settles, there is less dissolution in water and, therefore, less water column impact. Sedimentation is proportional to both whole oil and sediment concentrations in the water, with more settling in shallower water. Thus, spill trajectories that head toward shallow water generally result in more sedimentation. For the smaller spill volumes from these wrecks, almost no oil goes to the sediments, but for large volumes in some runs a high percentage goes to the sediments (because of high whole water concentrations in the water combining with suspended sediments), so little water column impact occurs. This behavior leads to a situation where water column impacts increase with spill volume up to a certain level, and then decline above that spill volume where high sedimentation results.

Release Volumes: Releases of oil from the wrecks were assumed to occur at a depth of between 2 to 3 m above the seafloor. All releases were modeled as acute in nature (i.e., short-term rather than chronic or continuous discharges), with a release duration of 12 hours.

Five spill volumes were modeled for each wreck, consisting of the following:

- Worst Case Discharge (WCD), representing release of all of the cargo oil and bunkers onboard.
- Large release, assumed to be 50% of the WCD.
- Most Probable Discharge scenario, representing the release of all of the oil from one tank. In the absence of information on the number and condition of the fuel and/or cargo tanks for all the wrecks being assessed, this scenario is modeled using 10% of the WCD.
- Episodic release of 1% of the WCD.
- Chronic release of 0.1% of the WCD, representing a low chronic release, which would most likely occur due to corrosion of piping that allows oil to flow or bubble out at a slow, steady rate.

For the episodic and chronic releases, the scenario would essentially be repeated many times, potentially giving the same magnitude and type of impacts with each release. The use of five volumes facilitated the development of regression curves that allow for prediction of the area of water surface, shore length, and volume of water that could be exposed above the thresholds for a potential release volume from that wreck or nearby clustered vessels.

Analysis of Results

The modeling approach involves estimating the areas of water surface, lengths of shoreline, and volumes of water exposed above consequence thresholds for a series of oil spill volumes for each wreck. All of the impact thresholds are summarized in Table 3-2 and described below.

For water surface impacts, a threshold degree of oiling of 0.01 g/m^2 (as the amount of oil averaged over a modeled grid cell resolution ranging from 0.1 to 3.5 km^2, depending on location), which would appear as a barely visible sheen, oil patches of various amounts of oil, and/or scattered tarballs, was used as the threshold for impacts on socio-economic resources because fishing may be prohibited in areas with any visible oil to prevent contamination of fishing gear and catch. A threshold of 10 g/m^2 was used as the threshold for ecological impacts to the water surface, as this level of oiling has been observed to be enough to mortally impact birds and other wildlife associated with the water surface (French et al., 1996; French McCay, 2009).

For shoreline impacts, an average loading amount of 1 g/m^2 was used as the threshold for impacts on socio-economic resources because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity beaches. A threshold of 100 g/m^2 was used as the threshold for ecological impacts to shoreline habitats based a synthesis of the literature showing that shoreline life has been affected by this degree of oiling (French et al., 1996; French McCay, 2009).

Table 3-2: Impact thresholds used to estimate consequences.

Consequence	Impact Measure	Impact Threshold	Oil Appearance*	No. of 1 inch Tarballs	Rationale
Impact to ecological resources - water surface	Water surface area exposed to floating oil	10 g/m^2	Dark brown sheen	~5,000-6,000 tarballs per acre	This level of oiling has been observed to mortally impact birds and other wildlife
Impact to socio-economic resources - water surface	Water surface area exposed to floating oil	0.01 g/m^2	Colorless and silver sheen	~5-6 tarballs per acre	Fishing may be prohibited in areas with any visible oil to prevent contamination of fishing gear and catch
Impact to ecological resources - shoreline	Shore length exposed	100 g/m^2	Black oil	~12-14 tarballs/m^2	Based on a literature synthesis, this level of oiling affects shoreline life
Impact to socio-economic resources - shoreline	Shore length exposed	1 g/m^2	Dull brown sheen	~0.12-0.14 tarballs/m^2	This amount of oil would conservatively trigger the need for shoreline cleanup on amenity beaches
Water column impact	Water volume exposed to dissolved aromatic concentrations	1 ppb (i.e., 1 part per billion)	N/A	N/A	Screening threshold for potential impacts on sensitive marine organisms

* Oil appearance listed in the table is for a continuous area of oil of the same thickness. In reality, the degree of oiling in the model is based on the amount of oil averaged over a large area (dependent on the resolution of the model). For example, 0.01 g/m^2 of oil on the water surface could appear as a barely visible sheen, oil patches of various amounts of oil, and/or scattered tarballs.

Water column impacts for both ecological and socio-economic (e.g., commercial fishing) resources were quantified as the volume of water that had dissolved aromatic concentrations exceeding 1 part per billion (ppb). 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. Oil spills from sunken vessels would be released at low pressures; therefore, the oil droplet sizes would be large enough for the oil to rapidly float to the surface. As a result, impacts to water column resources would primarily be limited to the surface mixed layer, which is assumed to be 10 m deep in the model runs. Contamination in the water column changes rapidly in space and time, such that a dosage measure (i.e., the product of concentration and time) is a more appropriate index of impacts than simply peak concentration. Toxicity to aquatic organisms increases with time of exposure, such that organisms may be unaffected by brief exposures to the same concentration that is lethal at long times of exposure. Determining the dose to water column organisms was beyond the scope of this project, so a threshold of 1 ppb was used as a screening threshold for potential impacts on sensitive organisms.

The mean results from each scenario were used to develop regressions of exposures versus volume of oil spilled for each of the wrecks modeled. The regression models used were those that provided the best descriptive fit to the data, i.e., those that maximized the R-squared[6] value while providing a reasonable function of impact vs. spill volume. These regressions allow for prediction of the area of water surface, shore length, and volume of water that could be affected for any potential release volume from the wreck, or other nearby wrecks (i.e., the cluster vessels). Figure 3-5 shows the regression curve for the *William Rockefeller*, which was modeled for 5 release scenarios: 150,000, 75,000, 15,000, 1,500, and 150 bbl.

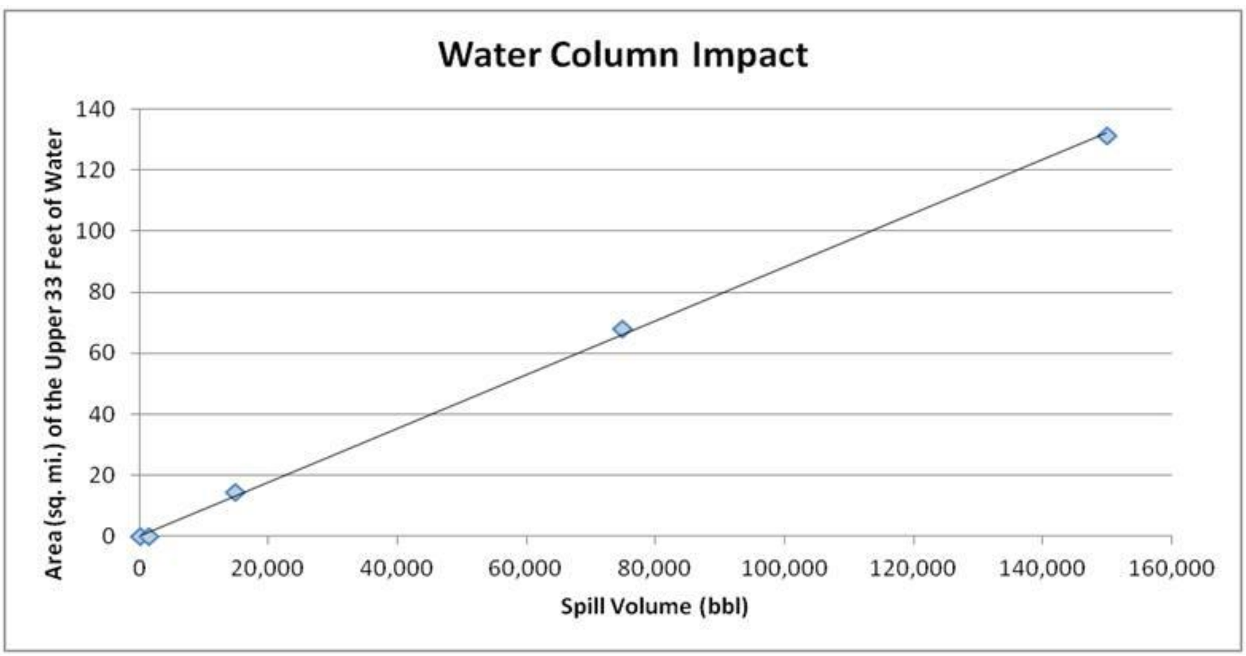

Figure 3-5: Regression model for the *William Rockefeller* with a Worst Case Discharge (WCD) of 150,000 bbl.

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6 R^2 is a statistical measure, also called the coefficient of determination, which indicates the degree to which the fitted curve (formula) accounts for the variability in the data. The higher the R^2 value, the better the "fit" of the regression formula to the data.

Model Limitations

Successful model simulation is dependent on the accuracy of the input data, most importantly spill volume, winds, currents, and assumed randomized diffusion rates. Because of the sheer number of vessels involved in this screening risk assessment and the large geographic extents required, the readily available data sources for currents and winds are often lower resolution and less site-specific than ideal. However, despite some uncertainty in each individual trajectory, when taken together, the results from the set of 200 runs are adequate for the purposes of a screening-level risk assessment.

These results provide a quantitative basis and statistical description of the potential likelihoods and magnitudes of oil-spill related impacts that would be expected, which can be used by decision-makers to evaluate the need for assessments to fully determine risk and any resultant oil removal or remediation operations and to prioritize wrecks within area contingency plans for such operations. The statistical analysis is important, such that uncertainty may be quantified and representative results are analyzed. Other uncertainties are also present, but not measured here, including specific details of current transport combined with weather at the time of a spill, variability in oil properties, other release durations than those examined here, and variability and seasonal variation in resources present (which can only be addressed in a general way in the screening analysis).

This analysis is meant to provide sufficient detail for a screening-level assessment based on potential risks as quantified by excedence of thresholds of concern. Detailed site-, vessel-, and seasonal-specific modeling would need to be conducted prior to any intervention on a specific wreck. The specifics of oil types and properties, release scenarios, response activities, local currents, and other environmental conditions all can influence the fate and effects of released oil and model results. Also, more site-specific analysis of exposures to specific resources at risk would be warranted, considering spatial and temporal variability in their distributions. In this screening analysis, we were not able to model all possible conditions and ramifications such that the details would be accurate in every situation. However, the general findings provide data to inform decisions regarding further evaluation of specific wrecks.

Risk Scoring and Ranking

Probability vs. Consequences

Assessing *risk* means evaluating both the *probability* of an event occurring and the *impacts* or *consequences* of that event, such that:

Risk = Probability x Consequences

In this risk assessment, there are essentially three steps to the overall risk analysis:

- **Vessel Risk:** Analysis of the probability that there will be an oil release from a wrecked vessel and the consequences of that release with regard to the volume of oil leakage.
- **Oiling Risk:** Analysis of the probability that there will be oil exposures to the water column, water surface, and shoreline over thresholds known to cause impacts to ecological and/or socioeconomic resources, and the magnitude or degree of that oil impact given that there is a hypothetical release of oil of a certain volume.

- **Ecological and Socio-economic Impact Risk:** Analysis of the probability that there will be oil exposures to the water column, water surface, and shoreline over thresholds known to cause impacts to ecological resources at risk (EcoRARs) and socio-economic resources at risk (SRARs), and the magnitude or degree of that oil impact given that there is a hypothetical release of oil of a certain volume.

Ecological Resources at Risk (Eco RAR)

Potential impacts to ecological resources at risk are assessed using the modeling results to identify the geographic area of oiling to water column, water surface, and shorelines resources. A literature review was conducted to identify the ecological resource at risk for each wreck location. The types of ecological resources evaluated in the risk analysis include those in Table 3-3.

Table 3-3: Descriptions of the ecological resources at risk considered in the consequence analysis for each wreck.

Ecological Group	Types of Ecological Resources Included	Sensitivity to Oiling
Seabirds	Seabirds (e.g., shearwaters, petrels, fulmars, albatrosses) are adapted to life on the open ocean. Some species come ashore only to breed and live far out to sea the rest of the year. Most form medium to large nesting colonies, mostly in isolated locations with direct access to the ocean. They feed by seizing prey while floating on the water surface or hovering above the water. A few species occasionally dive for food.	Seabirds are considered to be highly vulnerable to oil spill impacts because of their extreme reliance on open-water marine habitats. They spend most of their lives on the open ocean and roosting birds can become concentrated in offshore convergence zones, where offshore spills also tend to concentrate. A small amount of oiling on these birds can results in hypothermia and death.
Pelagic Birds, Waterfowl, and Diving Birds	Pelagic birds (alcids, murres, puffins), waterfowl (swans, geese, dabbling ducks), sea ducks (scoters, bufflehead, mergansers, goldeneyes) and coastal diving birds (pelicans, cormorants, terns, gulls) mostly feed by diving for food, either from the air or the water surface (dabbling ducks and frigatebirds are the main exceptions). They often form large flocks and spend much of the time floating on or swimming in the water. Many species form dense nesting colonies.	Pelagic seabirds are considered to be the most sensitive of all marine birds to spilled oil because they form large flocks in cold, offshore waters and spend much of their time on the water surface. A small amount of oiling on these birds can results in hypothermia and death. The sensitivity of waterfowl and sea ducks depends on their habitat preferences. The most sensitive species are those that occur in very large flocks during migration and in wintering areas using offshore and coastal marine waters.
Shorebirds and Colonial Nesting Birds	Shorebirds include plovers, turnstones, sandpipers, surfbirds, phalaropes, and oystercatchers. They utilize a wide variety of habitats, including sand beaches, rocky shores, marshes, and tidal flats. Colonial nesting birds include herons, egrets, ibis, spoonbills, stilts, avocets, and cranes. They form dense nesting colonies in sheltered wetland habitats.	Shorebirds have low to moderate vulnerability to direct oiling because they seldom enter the water. However, they can be affected by oil stranded on the shoreline and cleanup activities, particularly during nesting and the stress of long migrations. Wading birds have low vulnerability to oil from offshore wrecks because they mostly feed in sheltered areas. However, dense nesting colonies can be affected by spill response operations.

Table 3-3: Cont.

Ecological Group	Types of Ecological Resources Included	Sensitivity to Oiling
Sea Turtles	Sea turtles include: Federal Endangered: Green, Kemps' ridley, leatherback, and hawksbill; and Federal Threatened: Loggerhead and olive ridley. In the U.S., they nest on beaches on the East and Gulf coast from Alabama to North Carolina and Caribbean islands. They spend much of their life history at sea; females return to beaches to nest.	Oil effects on sea turtles include increased egg mortality and developmental defects; direct mortality due to oiling of hatchlings, juveniles, and adults; and negative impacts to the skin, blood, digestive and immune system, and salt glands. They lack avoidance behavior and feed indiscriminately in convergence zones where they (and oil) tend to concentrate.
Marine Mammals	Marine mammals include cetaceans (whales, dolphins), pinnipeds (seals, sea lions, and walruses), sea otters, and manatees. Pinnipeds form dense haul out colonies for breeding, molting, and resting.	The most sensitive marine mammals are those that rely on fur to keep warm, such as sea otters and fur seals. When their fur is oiled, they have to spend more energy to maintain normal temperatures, which may result in death by hypothermia and ingestion of oil during grooming. Little is known on how oil directly affects cetaceans; sublethal effects may be significant.
Fish and Invertebrates	The focus is on those species and habitats that are: Rare, threatened, endangered, and special concern species; Commercial and recreational species; Other sensitive or important species; Areas of high concentration; and Areas where sensitive life-history stages or activities occur.	Early life history stages (eggs, larvae, and juveniles) are at risk from oil spills because they have more limited mobility, thus less ability to avoid oil. They also have lower tolerances to oil exposures. Adults can avoid oil, inhabit deeper water, or are able to tolerate a wider range of environmental condition.
Benthic Habitats	Benthic habitats of concern include submerged aquatic vegetation, which is important to numerous species for spawning and rearing habitat, and hard-bottom habitats that are often considered habitats of particular concern for reef-associated species.	These habitats themselves would be sensitive mostly to spills in nearshore, shallow habitats. They are mostly of concern because of the concentrations of other sensitive fish and shellfish that concentrate in these habitats.

Socio-economic Resources at Risk (SRAR)

In addition to ecological resource impacts, spills from sunken wrecks have the potential to cause significant social and economic impacts. Socio-economic resources at risk for each wreck depend on the wreck location. The types of resources that were evaluated in the risk analysis include those in Table 3-4.

Table 3-4: Descriptions of the socio-economic resources at risk considered in the consequence analysis for each wreck.

SRAR Type	Economic Activities	Sensitivity to Oiling
Shore Communities/ Tourist Beaches	Beach resorts and beach-front residential communities provide year-round and seasonal residents and visitors with recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks). They also provide substantial incomes for local communities and state/local tax income. Depending on the location and climate, many of these recreational activities may be limited to or concentrated into certain seasons.	Shore communities and tourist beaches are extremely sensitive to oiling. Even if the degree of oiling is not enough to cause ecological or human impacts, the perception of unsightly oiling and tainting of beaches, as well as the presence of cleanup crews or closures, can cause millions of dollars of damage and lost income and property value to property owners and commercial interests associated with the beaches and shorefront communities.

Table 3-4: Cont.

SRAR Type	Economic Activities	Sensitivity to Oiling
Ports/Shipping Lanes	A significant amount of commerce takes place in our nation's ports. Port traffic in and out of our ports includes oil and chemical tankers, container ships, bulk carriers, vehicle carriers, tank barges, dry cargo barges, military vessels, passenger vessels, etc., and forms an important part of local, regional, and national commerce.	Impediments to shipping lanes and traffic in and out of ports can cause significant delays and involve considerable costs. Total or partial blockage of ports or re-routing of ship traffic due to significant oil on the water surface and/or the presence of response operations can affect commerce on a local or regional basis.
Tribal Lands	Coastal tribal lands and reservations and adjacent or nearby water and shoreline resources used by tribes are present in many parts of the nation, particularly in Washington and Alaska. Tribal populations use coastal and water resources for cultural heritage activities and rites in addition to residential and commercial purposes.	Native tribes, tribal lands, and reservations are particularly sensitive to impacts from oil, not only with respect to economic damage, but also to cultural impacts. Oiling of native lands can result in cultural heritage impacts that are immeasurable.
State Parks	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. Depending on location and climate, many of these recreational activities may be limited to or concentrated into certain months.	Like shore communities and beaches, state parks are very sensitive to oiling. Even if the degree of oiling is not enough to cause ecological or human impacts, the perception of unsightly oiling and tainting of beaches, as well as the presence of cleanup crews or closures can cause millions of dollars of damage and lost income to states administering the parks.
Subsistence Fishing	Subsistence fishing takes place in many localities in the nation and is of particular concern in waters and shorelines near and in tribal lands. In some cases, protein from fish and shellfish are the only or most significant source of protein for these sensitive human populations.	In addition to commercial and recreational fishing impacts, there can also be impacts to subsistence fishing resources with oiling of the water column, water surface, and shoreline. Actual and perceived tainting of fish and shellfish (e.g., shrimp, shoreline clams) can occur at relatively low levels of oiling. Mortality and significant impacts to fish and shellfish stocks occur at higher degrees of oiling, but populations that rely on subsistence fishing are usually particularly vulnerable as there are few substitute food resources.
Commercial Fishing	Commercial fishing is an important part of the economy and food supply for many regions. Shore communities and smaller ports often have significant fishing fleets. Includes aquaculture facilities.	Commercial fishing is particularly vulnerable to oiling impacts to the water column both because of actual mortality and organism life cycle impacts (reduction in eggs, larvae, reproduction) that can affect the amount of fish available in the short term and longer term, but also because of tainting or perceptions of tainting of fish catches. Public consumers are very sensitive to perceptions of potential tainting even when the fish are deemed safe by authorities. The public will shun fish (and shellfish) caught in areas known to have experienced a recent oil spill. This can cause significant loss of income for commercial fishermen. Commercial fishing activities can also be affected by the presence of oil on the water surface that can adhere to nets, vessels, and other fishing equipment, as well as by closures related to spill response operations.

Table 3-4: Cont.

SRAR Type	Economic Activities	Sensitivity to Oiling
Federal Protected Areas **National Wildlife Refuges** **National Marine Sanctuaries** **National Parks** **National Seashores** **National Lakeshores**	National wildlife refuges are federally managed and protected lands that provide refuges and conservation areas for sensitive species and habitats. Some refuges are accessible to the public for wildlife viewing and nature study. National marine sanctuaries are federally managed and protected areas that conserve unique and sensitive marine habitats and species. These sanctuaries also provide opportunities for snorkeling, diving, and nature study. National parks and recreation areas provide unique opportunities for recreational activities while preserving our nation's natural and historic treasures. National seashores and lakeshores provide recreation while preserving and protecting the nation's natural shoreline treasures.	Federally protected and managed areas, including national wildlife refuges, national marine sanctuaries, national parks, national seashores, and national lakeshores are highly sensitive to oiling on the shoreline, water surface, and in the case of marine sanctuaries, in the water column, because of the oil's effect on the very habitats and species that the protected areas are meant to preserve. In addition, these national treasures may provide income to the federal government through visitor fees and rentals. Local economic resources (e.g., food, lodging, rentals, and equipment) are often dependent on visitors.
Power Plant Intakes	Coastal power plants are important sources of electricity for areas in the vicinities of the plants, as well as for entire regions and power grids.	Power plants (coal, nuclear, hydroelectric, and oil) are sensitive to oil in intake water. When there is a potential for oiling of the water in the vicinity of intakes, the plants may need to shut down temporarily. If oil enters the intakes, it can cause considerable damage and necessitate longer-term shutdowns, which can have significant impacts on power supplies and costs.
Wind Farms	While there are no offshore wind farms currently constructed or operating in U.S. waters, there are permits for construction of at least one facility and plans for several other facilities in the North and Mid-Atlantic region.	Oiling of the structures of wind farms could cause moderate damage. The facilities do not in and of themselves have water intakes that could be impacted. The oiling of the structures would nevertheless require cleanup and possible damages.
Offshore Oil Exploration and Production	Offshore oil exploration and production facilities (platforms, rigs) and related vessel traffic (offshore supply vessels) are an extremely important part of our nation's energy production and economy, particularly in the Gulf of Mexico, Alaska, and California.	Impediments to offshore oil activities due to the presence of oil on the water surface and response operations, as well as oiling of facilities and vessels, can cause delays in production activities and cause economic damages. These facilities are moderately sensitive to oiling.

Ultimately, the overall risk assessment is aimed at determining whether there is a consequential impact to EcoRARs and SRARs. This requires addressing three main questions. Assuming that a spill occurs:

- What is the magnitude of exposure to the water column, water surface, and shoreline and to what degree does this exposure exceed thresholds known to cause impacts to ecological and/or socioeconomic resources; and
- Are there ecological and socio-economic resources in the area that are potentially at risk for exposure to oil above thresholds known to cause impacts; and
- How sensitive are these resources to oil exposure above the threshold levels effects (i.e., what is the degree of adverse impact)?

The EcoRAR and SRAR risk assessment process involves evaluating for both the Worst Case Discharge and the Most Probable Discharge risk to three categories:

- **Water Column:** Impacts to the water column and to ecological and socio-economic resources in the water column;
- **Water Surface:** Impacts to the water surface and ecological and socio-economic resources on the water surface; and
- **Shoreline:** Impacts to the shoreline and ecological and socio-economic resources on the shoreline.

For each of these three categories, in turn, risk is classified with regard to:
- The **probability of oiling** over a certain threshold (i.e., the likelihood that there will be exposure to specific 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).

The EcoRAR and SRAR risk scoring involves a three-step process:
- Analysis of the modeling data to determine *oiling probability risk scores* for water column, water surface, and shoreline oiling, and *degree of oiling risk scores* for water column, water surface, and shoreline oiling;
- Expert EcoRAR and SRAR impact analysis with regards to the presence of these resources (i.e., the probability that there might be an impact) and the sensitivity of these resources, if present, to the degree of oiling predicted in the modeling; and
- Final EcoRAR and SRAR risk scoring combining the modeling data scoring and the expert RAR evaluations.

A three-point scale of Low, Medium, and High were used to distinguish levels of probability and of impact. The colors of green, yellow, and red were used to depict Low, Medium, and High, respectively.

Water Column Impacts

The water column risk factor reflects the probability that at least 0.2 mi^2 of the upper 33 feet of the water column (approximately 5.18 million cubic meters) would be contaminated with a high enough concentration of oil to cause socio-economic impacts. For this study, the threshold for water column impacts 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 *probability of oiling* are:

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

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 Worst Case Discharge or Most Probable 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**

Water Surface Impacts

The water surface impact 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 EcoRARs 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. For SRARs, the threshold is lower at 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, such as closure of fisheries. *The thresholds for EcoRAR and SRAR impacts differ.* This means that there might be impacts to SRARs while there might not be any impacts or lower impacts to EcoRARs.

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 Worst Case Discharge or Most Probable 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**

Shoreline Impacts

For the EcoRAR risk analysis for shoreline impact, shoreline sensitivity has been factored into the modeling results and analysis. 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.

Likewise for the SRAR risk analysis for shoreline impact, shoreline sensitivity has also been factored into the modeling results and analysis. 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.*

For EcoRARs, the shoreline impact 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).

For SRARs, the shoreline impact 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). Note that this is lower than the threshold for EcoRARs. This means that there might be impacts to SRARs while there might not be any impacts or lower impacts to EcoRARs. The three risk scores for oiling are:

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

The degree of oiling of the shoreline reflects the total length of shoreline that would be affected in the event of a Worst Case Discharge or Most Probable 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**

Summaries of Risk Factor Scores

For each wreck, there are four tables of risk factors presented:

- EcoRAR risk factor scores for Worst Case Discharge
- EcoRAR risk factor scores for Most Probable Discharge
- SRAR risk factor scores for Worst Case Discharge
- SRAR risk factor scores for Most Probable Discharge

Table 3-5 shows the format of the resources at risk summary table presented for each of the 87 priority wrecks. For each table, the probability and degree of oiling are highlighted in color (red, yellow, or green for risk scores of high, medium, or low) with a brief explanation of the risk scores as they relate to the modeling results.

Table 3-5: Sample risk factor score summary table for ecological and socio-economic resources at risk.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
Water Column Probability EcoRAR or SRAR Oiling	Low	Medium	High	X% 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	Depends on Risk Scores and EcoRAR and SRAR Evaluation
Water Column Degree EcoRAR or SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was X mi^2 of the upper 33 feet of the water column	

Table 3-5: Cont.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
Water Surface Probability EcoRAR or SRAR Oiling	Low	Medium	High	X% of the model runs resulted in at least 1,000 mi² of water surface covered by at least 10 g/m² for EcoRAR impacts and at least 1 g/m² for SRAR impacts	Depends on Risk Scores and EcoRAR and SRAR Evaluation
Water Surface Degree EcoRAR or SRAR Oiling	Low	Medium	High	Mean area of water contaminated was X mi² above 10 g/m² for EcoRAR impacts and above 1 g/m² for SRAR impacts	
Shoreline Probability EcoRAR or SRAR Oiling	Low	Medium	High	X% of the model runs resulted in shoreline oiling of at least 100 g/m² for EcoRAR impacts and at least 10 g/m² for SRAR impacts	Depends on Risk Scores and EcoRAR and SRAR Evaluation
Shoreline Degree EcoRAR or SRAR Oiling	Low	Medium	High	Length of shoreline contaminated was X mi by at least 100 g/m² for EcoRAR impacts and at least 10 g/m² for SRAR impacts	

Final Resources at Risk Score Determination

The *Final Score* is based on evaluating the EcoRARs and SRARs in the vicinity of predicted oiling and determining through expert evaluation whether the degree and probability of oiling as modeled would represent a high, medium, or low risk.

This process basically entails comparing the probability and degree of oiling risk with the presence of EcoRARs and SRARs in the water column, on the water surface, and at the shoreline, and their potential sensitivities to these degrees of oiling. For example, if there was significant oiling of shorelines in areas with low ecological sensitivity or low socio-economic value, the risk would not be as high as when there were highly sensitive or valuable resources on the potentially affected shorelines. In other cases, extremely high sensitivity or socio-economic value of EcoRARs or SRARs might indicate a higher risk even though the degree of oiling is medium.

The overall risk assessment for each of the 87 priority wrecks 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 site formation processes have worked each vessel
- Ecological resources at risk
- Socio-economic resources at risk
- Other complicating factors (war graves, other hazardous cargo, etc.)

To make the scoring more uniform and replicable between wrecks, a value was assigned to each of the seven criteria for the two release scenarios (Worst Case Discharge and Most Probable Discharge). The criteria are pollution potential, ecological resources at risk (shoreline, water surface and water column) and socioeconomic resources (shoreline, water surface and water column). This assessment has a total of seven criteria with three possible scores for each criterion (L, M, and 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 range in scores assigned to the overall category rank and number of wrecks in each category by release scenario are shown in Table 3-6. The breaks between the categories were selected based on review of the seven scores for all vessels. To reach a score of 12 (making it a Medium Priority), a vessel had at least five out of the seven scores as Medium, or at least one High and three Medium scores. To reach a score of 15 (making it a High Priority), a vessel had at least six scores as Medium and one High, or at least two High and two Medium scores. These breaks seemed to appropriately reflect relative degrees of priority. The list of 87 wrecks and their final category rank for both release scenarios is shown in Table 3-6.

Table 3-6: Summary statistics for the final category ranks of Low, Medium, and High priority for the 87 wrecks.

Category Rank	Range of Scores	No. Wrecks for Worst Case Discharge	No. of Wrecks for Most Probable Discharge
High Priority	15-21	36	6
Medium Priority	12-14	40	36
Low Priority	7-11	11	45

Challenges and Limitations of Risk Assessment

Conducting an environmental risk assessment on a single potential pollution source presents many challenges based on the availability and accuracy of data, the interpretations of those data, definitions of and acceptability of risk, and the ultimate application(s) of the assessment. Conducting a risk assessment for a large number of potential pollution sources for the purpose of comparative analyses and prioritization increases the complexity and challenges immensely.

For the risk assessment of potentially polluting wrecks, there are a large number of data inputs that may limit the "accuracy" of the risk assessment, including data on the location and condition of the wreck, and the type and amount of oil remaining. In the current risk assessment, the overall quality of the data for each wreck, including availability, accuracy, and reliability, is noted. Gathering of accurate data on historical wrecks is extremely challenging. Because all modeling of potential impacts of potential oil releases assumes that there is oil of a particular type on board the vessel at a particular location, any inaccuracies in these data will reduce the reliability of the impact modeling results.

Another important limitation of risk assessments in general is that they necessarily deal with probability of events occurring in the future. There is no guarantee that any one wreck will (or will not) release oil at some point in the near or distant future. This type of prediction is similar to that made by meteorologists who give probabilities of rain based on current conditions. A 10% chance of rain does not mean that it will not rain on that day, nor does a 90% chance of rain mean that it is guaranteed to rain. With meteorology, there are extensive historical datasets on which to rely for predictions. With wrecks, there is a much smaller set of data or past experience on which to make determinations of likelihood of oil leakage.

The probability aspects of risk in general, and grasping the meaning of low-probability, high-consequence events and the converse, are difficult to apply to planning and decision-making. The acceptability of risk of impacts to valuable and sensitive ecological and socio-economic resources is an important consideration in the decision-making process. If the risk is deemed "unacceptable" because of the irreplaceability or high value of particular resources, a more aggressive approach may be in order. If the risk is deemed "reasonably acceptable," a more conservative approach may be desirable.

The modeling results presented in this risk assessment are based not only on assumptions of wreck location, oil content, and oil type, but also on the large variations in types of releases (volume, periodicity, and frequency) and the conditions under which they may occur. As with any oil spill, the degree of water surface, water column, and shoreline impact from the release of oil from a sunken wreck will depend on the conditions at the time of the oil release and its aftermath. There are infinite variations in combinations of wind direction and velocity, currents, weather, and seasonal patterns in environmental and socio-economic resource presence and sensitivity that will determine the ultimate outcome of a release. The modeling results in this risk assessment were analyzed with regard to “worst case” outcome for impacts based on random variations in the timing of the release, which translates to variations in currents and winds. The release of oil from a particular wreck, assuming that it does occur may not follow the trajectory (path) and behavior described in the specific scenarios herein. There is no guarantee that certain resources will (or will not) be impacted. There is no guarantee that the amount of oil assumed to have been released in the scenarios will be released in an actual event.

The modeling results and the risk assessment in general point only to the magnitude of “risk” – that is, the likelihood and degree of potential impact – based on the information currently available. The intent was to provide sufficient information so that when the risk assessments are reviewed against local and regional priorities, the U.S. Coast Guard, the RRTs, and affected local Area Committees can make informed decisions about whether additional actions may be necessary for specific wrecks. Those actions could include monitoring, an assessment, or a proactive removal of oil. Again, for wrecks deemed to present a relatively high risk, more detailed modeling of potential scenarios would be necessary prior to any assessment or response actions.

Distributions of RULET Wrecks by U.S. Coast Guard District

While the distribution of vessel casualties around the U.S. is pretty consistent, (as illustrated in ES-1) there are some distinct patterns that have emerged in the RULET project. The majority of the casualties are from the Battle of Atlantic in 1942, during World War II. Most are found along the Atlantic Seaboard and the Gulf of Mexico and were casualties of the “Great American Turkey Shoot” by German U-boats. This reflects where the majority of goods and material were being moved during this period.

Table 3-7 lists all the vessels and their final scores for the Worst Case Discharge and the Most Probable Discharge volumes. Figure 3-6 shows the distribution of the scores for the 87 priority wrecks for the two release scenarios. Figure 3-7 shows the number of wrecks with known vs. unknown location by U.S. Coast Guard District. Figure 3-8 shows the distribution of the 87 wrecks by the three levels of priority by U.S. Coast Guard District, for the two release scenarios. Districts 5 and 7 have the most priority wrecks for both release scenarios, reflecting the intensity of World War II casualties in the Battle of the Atlantic. For the Most Probable Discharge scenario, most of the high priority wrecks are located in District 7.

Table 3-7: Overall results of the assessment for Worst Case Discharge (WCD) and Most Probable Discharge. The volume listed is the modeled volume.

Vessel Name	Oil Type	WCD Volume (bbl)	WCD Final Score	MP Final Score
Gulfstate	Crude	86,000	20	17
Esso Gettysburg	Crude	132,000	18	16
Francis E. Powell	Light	93,000	18	14
R.W. Gallagher	Heavy	86,000	18	13
Lubrafol	Light	80,000	18	12
China Arrow	Heavy	93,000	18	10
Norness	Light	99,000	17	15
W.D. Anderson	Crude	146,000	17	15
W.L. Steed	Crude	78,000	17	13
Hamlet	Crude	77,000	17	13
Pan-Massachusetts	Light	116,000	17	12
George MacDonald	Heavy	115,000	16	15
Joseph M. Cudahy	Crude	90,000	16	15
William Rockefeller	Heavy	150,000	16	14
Coimbra	Light	29,000	16	13
Maiden Creek	Heavy	9,000	16	13
Doris Kellogg	Crude	60,000	16	13
Cities Service Toledo	Crude	93,000	16	13
Diamond Knot	Light	7,000	16	13
Drexel Victory	Heavy	12,000	16	12
Halo	Crude	71,000	15	14
Fernstream	Light	13,000	15	13
USNS Mission San Miguel	Light	15,000	15	13
John Straub	Heavy	13,000	15	13
Cornwallis	Heavy	10,000	15	12
Lancing	Light	77,000	15	12
Norlavore	Heavy	4,000	15	12
Paestum	Heavy	12,000	15	12
Juan Casiano	Heavy	7,000	15	12
Ohioan	Heavy	11,000	15	12
Jacob Luckenbach	Heavy	700	15	12
Puerto Rican	Heavy	21,000	15	12
Larry Doheny	Heavy	73,000	15	12
Regal Sword	Light	23,000	15	11
Gulfoil	Light	55,000	15	11
Cities Service No. 4	Light	12,000	15	10
Bloody Marsh	Heavy	118,000	14	14
Potrero Del Llano	Heavy	8,000	14	12
Argo	Crude	3,000	14	12
USS Neches (AO-5)	Light	68,000	14	12
Pan-Pennsylvania	Heavy	11,000	14	11
Allan Jackson	Crude	81,000	14	11
Buarque	Heavy	9,000	14	11
Marit II	Crude	84,000	14	11
Nordal	Heavy	8,000	14	11
Venore	Heavy	10,000	14	11

Table 3-7. Cont.

Vessel Name	Oil Type	WCD Volume (bbl)	WCD Final Score	MP Final Score
Prins Willem V	Light	3,000	14	11
Oregon	Light	9,000	14	9
C.O. Stillman	Light	144,000	14	8
Oneida	Heavy	5,000	13	12
Mormackite	Heavy	6,000	13	12
Managua	Heavy	5,000	13	12
Manzanillo	Heavy	5,000	13	12
Norlindo	Heavy	5,000	13	12
Cherokee	Heavy	10,000	13	11
Cayru	Heavy	14,000	13	11
Ljubica Matkovic	Heavy	7,000	13	11
Pacbaroness	Light	8,000	13	11
Camden	Heavy	8,420	13	11
Mobile Point	Light	4,000	13	11
India Arrow	Light	94,000	13	10
Sheherazade	Light	10,000	13	10
Empire Gem	Heavy	2,000	12	12
Marine Electric	Heavy	4,000	12	11
Northern Pacific	Heavy	8,000	12	11
Swiftscout	Heavy	4,000	12	11
Alcoa Puritan	Heavy	10,000	12	11
Gulfstag	Heavy	12,000	12	11
Robert E. Lee	Heavy	7,000	12	11
Virginia	Heavy	13,000	12	11
Gulfpenn	Heavy	14,000	12	10
Edmund Fitzgerald	Heavy	2,000	12	10
Monrovia	Heavy	2,000	12	10
Aleutian	Heavy	3,000	12	10
Panam	Light	7,000	12	9
Tokai Maru	Light	2,000	12	9
Taborfjell	Heavy	3,000	11	11
Empire Knight	Light	10,000	11	10
Stolt Dagali	Light	15,000	11	10
Munger T. Ball	Heavy	3,000	11	10
Coast Trader	Heavy	7,000	11	10
Santiago de Cuba	Heavy	3,000	11	9
Rawleigh Warner	Heavy	3,000	11	9
Bunker Hill	Heavy	2,000	11	9
Material Service	Light	3,000	10	10
Panky	Light	5,000	10	9
Vainqueur	Light	5,000	9	8

Note: Colors indicate final priority ranking. Red = High Priority; Yellow = Medium Priority; and Green = Low Priority

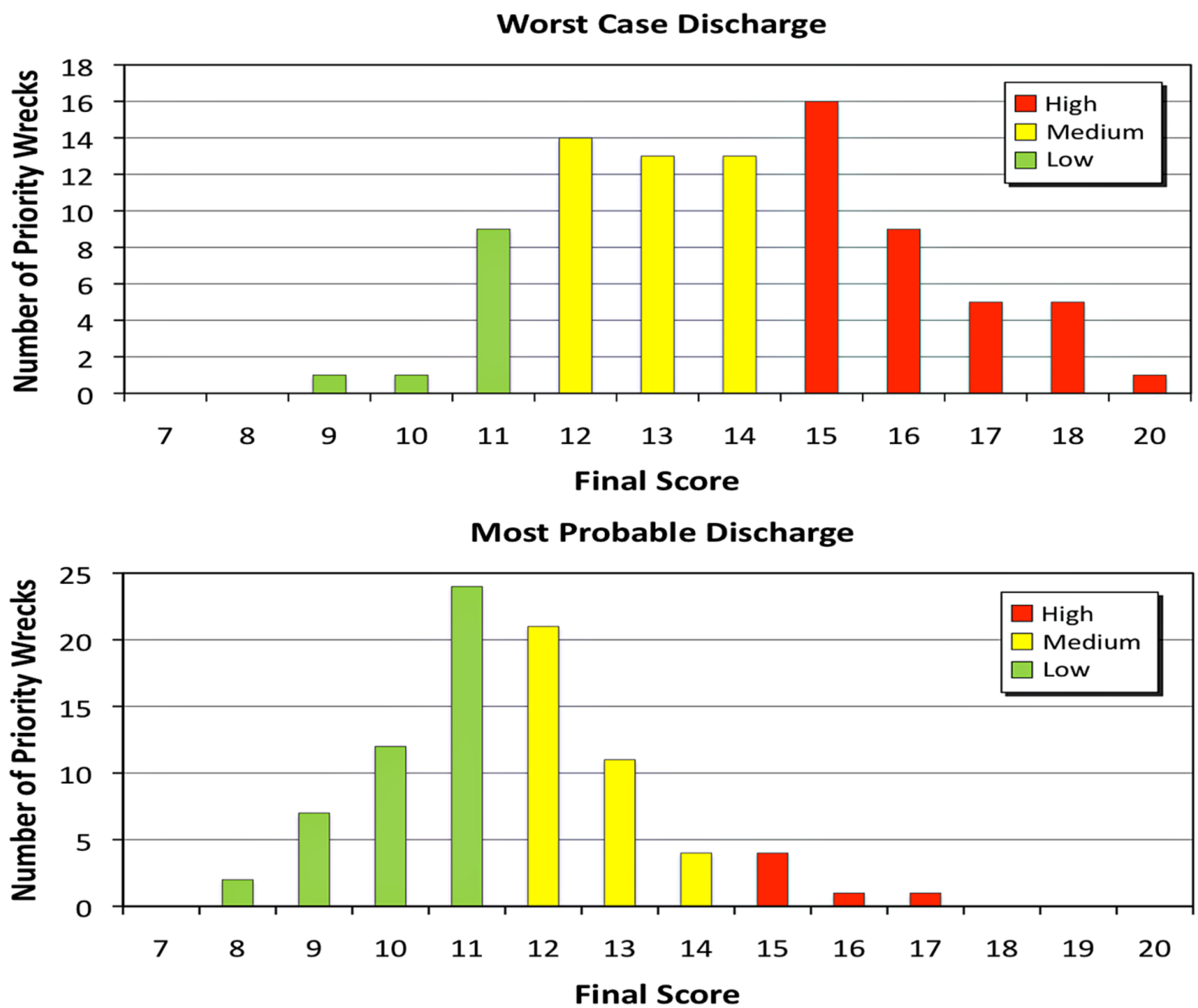


Figure 3-6: Distribution of the final scores for the 87 priority wrecks, for both WCD (top) and Most Probable Discharge (bottom).

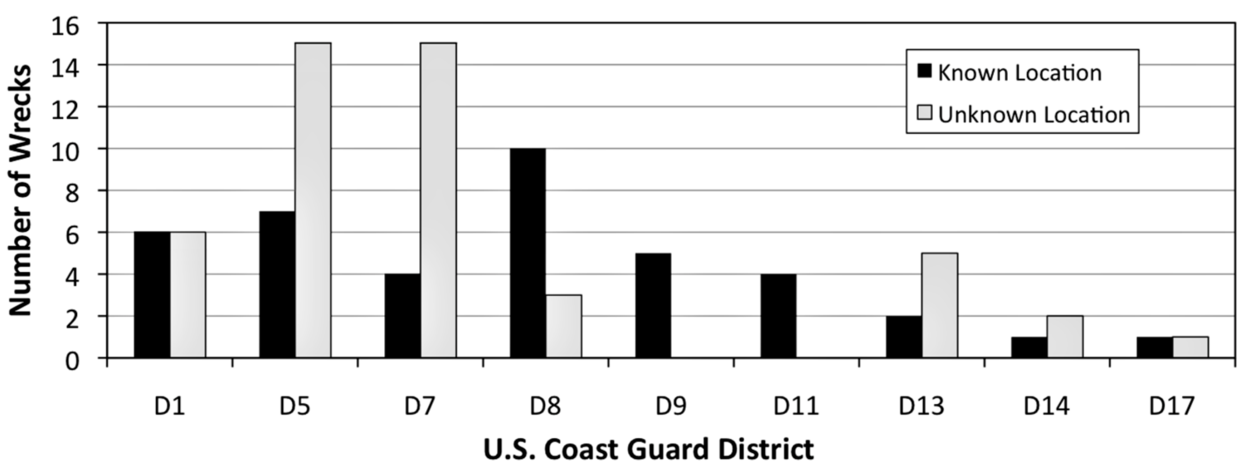
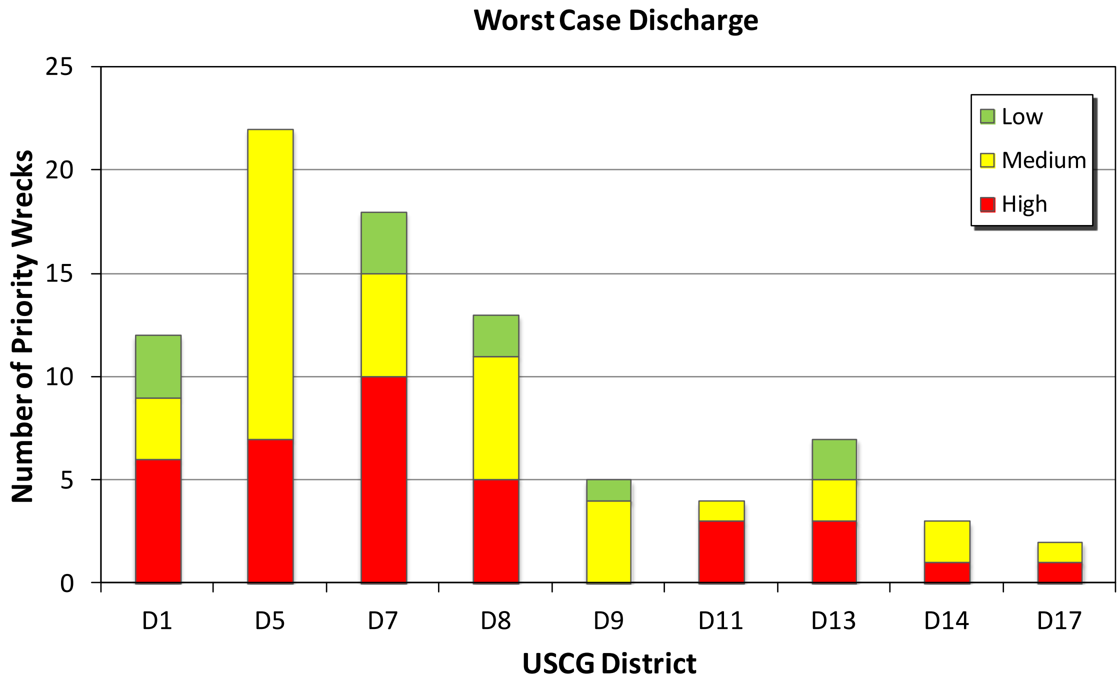


Figure 3-7: Number of priority wrecks with known vs. unknown location by U.S. Coast Guard District.



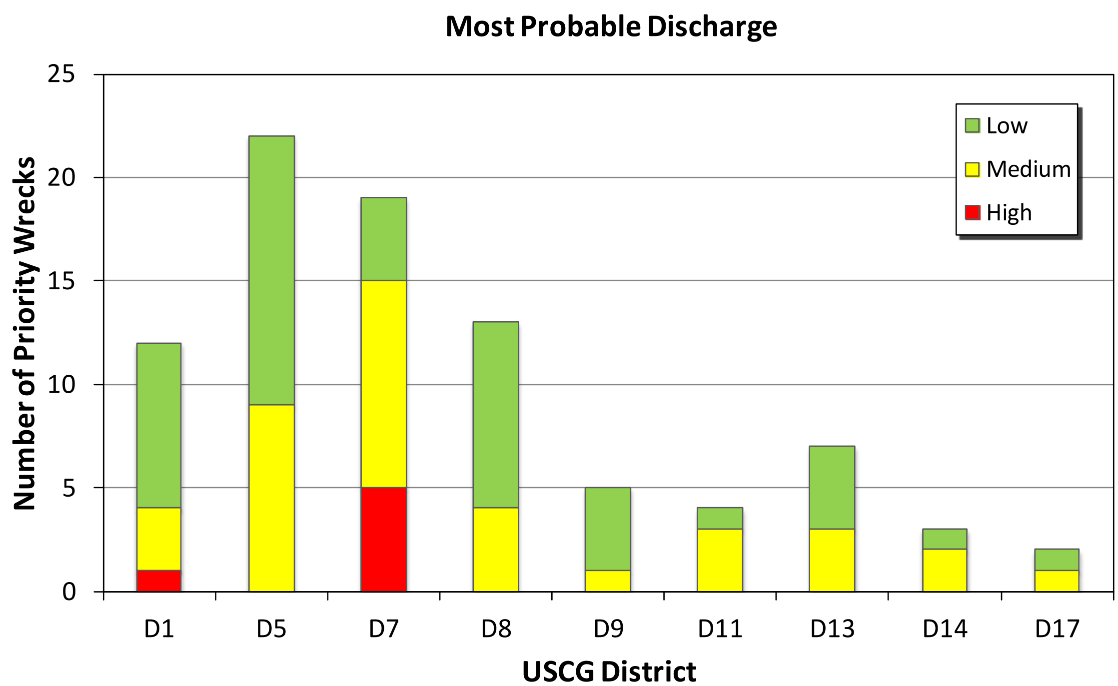
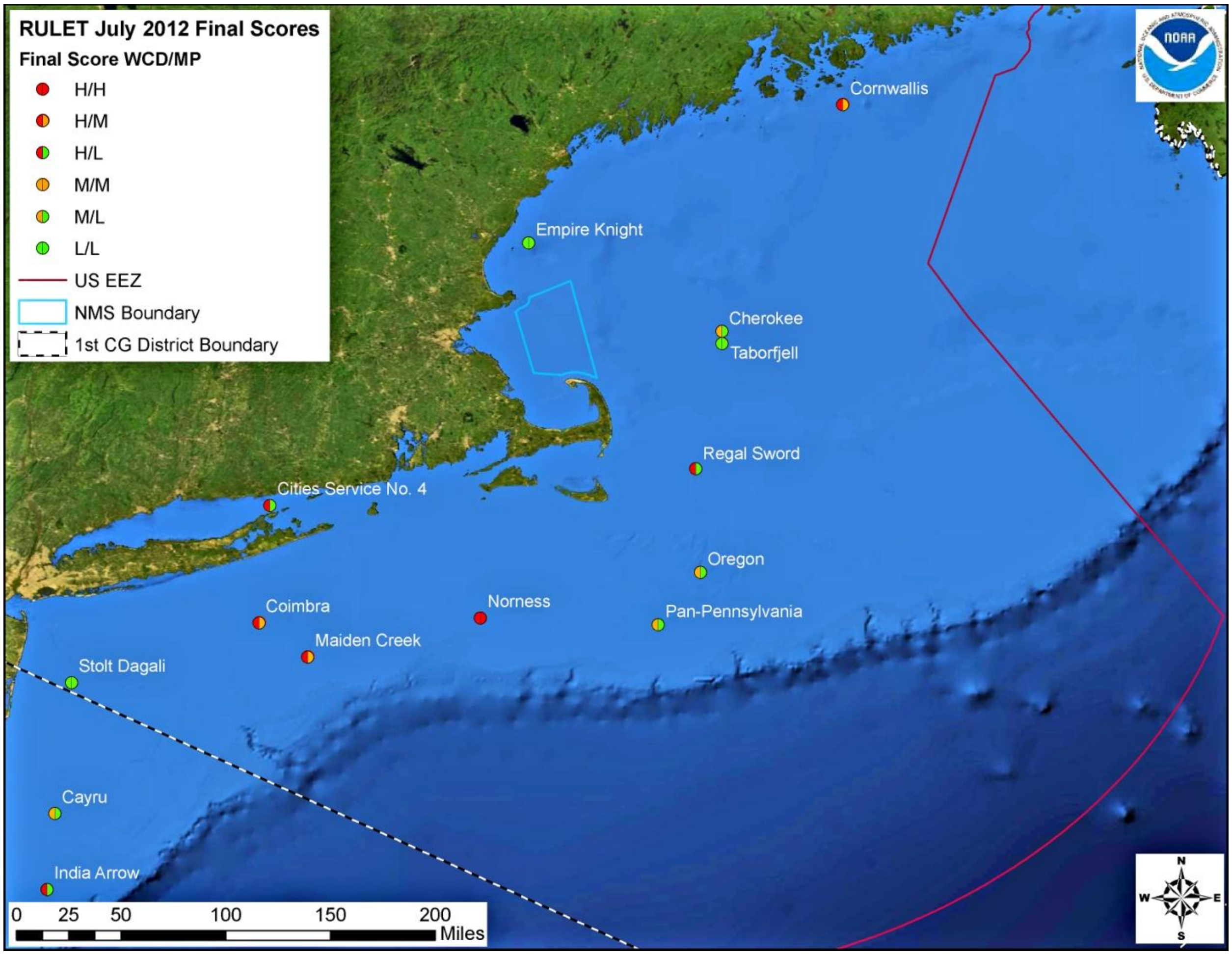


Figure 3-8: Distribution of the 87 priority wrecks by U.S. Coast Guard District, showing the number by priority ranks of Low, Medium, and High for the two release scenarios.

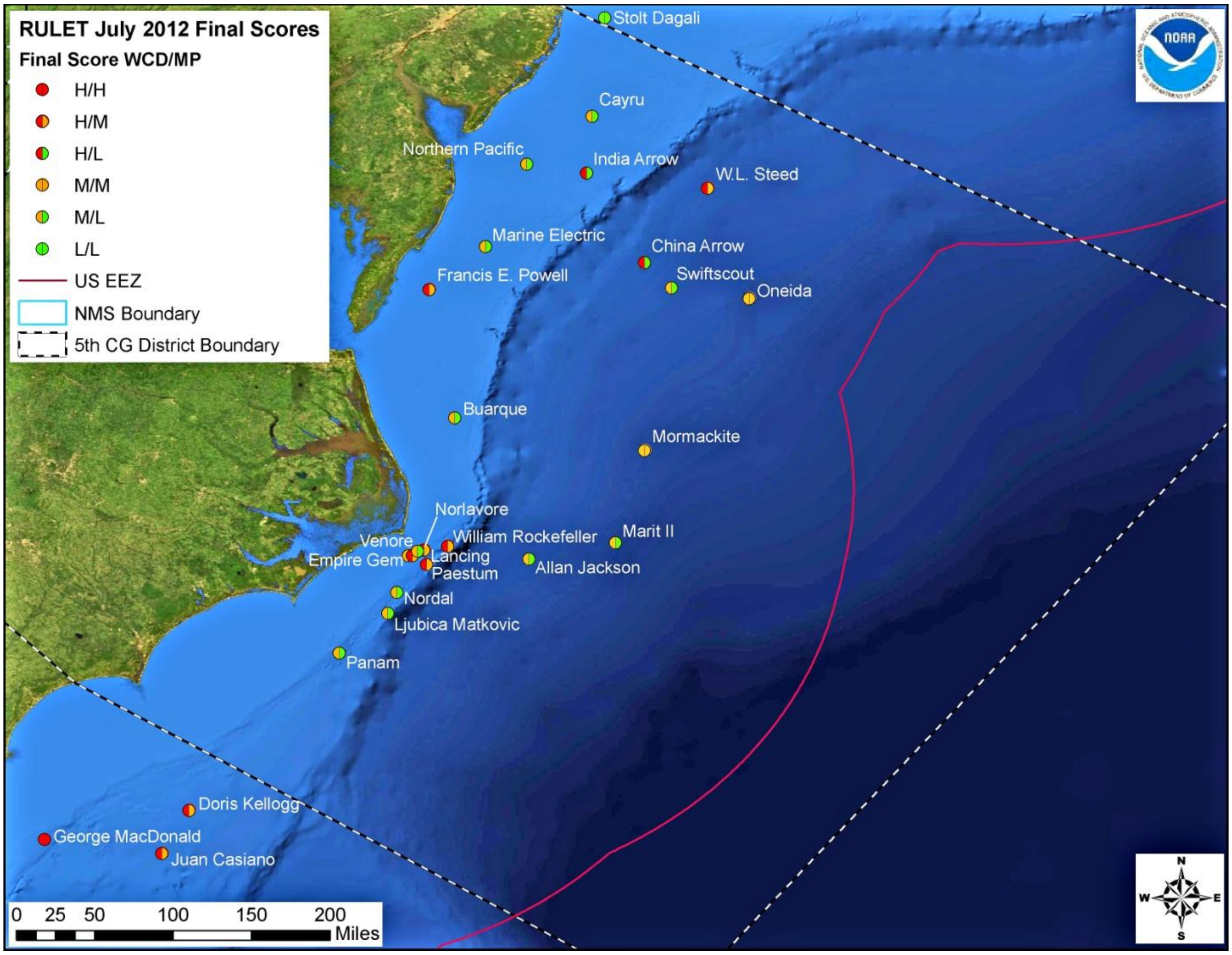
U.S. Coast Guard District 1



Name	WCD Final Score	MP Final Score	USCG District
*Norness***	17	15	1
*Coimbra***	16	13	1
Maiden Creek	16	13	1
*Cornwallis***	15	12	1
*Regal Sword***	15	11	1*
Cities Service No. 4	15	10	1
Pan-Pennsylvania	14	11	1*
Oregon	14	9	1
Cherokee	13	11	1
*Taborfjell***	11	11	1
*Empire Knight***	11	10	1
*Stolt Dagali***	11	10	1

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

U.S. Coast Guard District 5

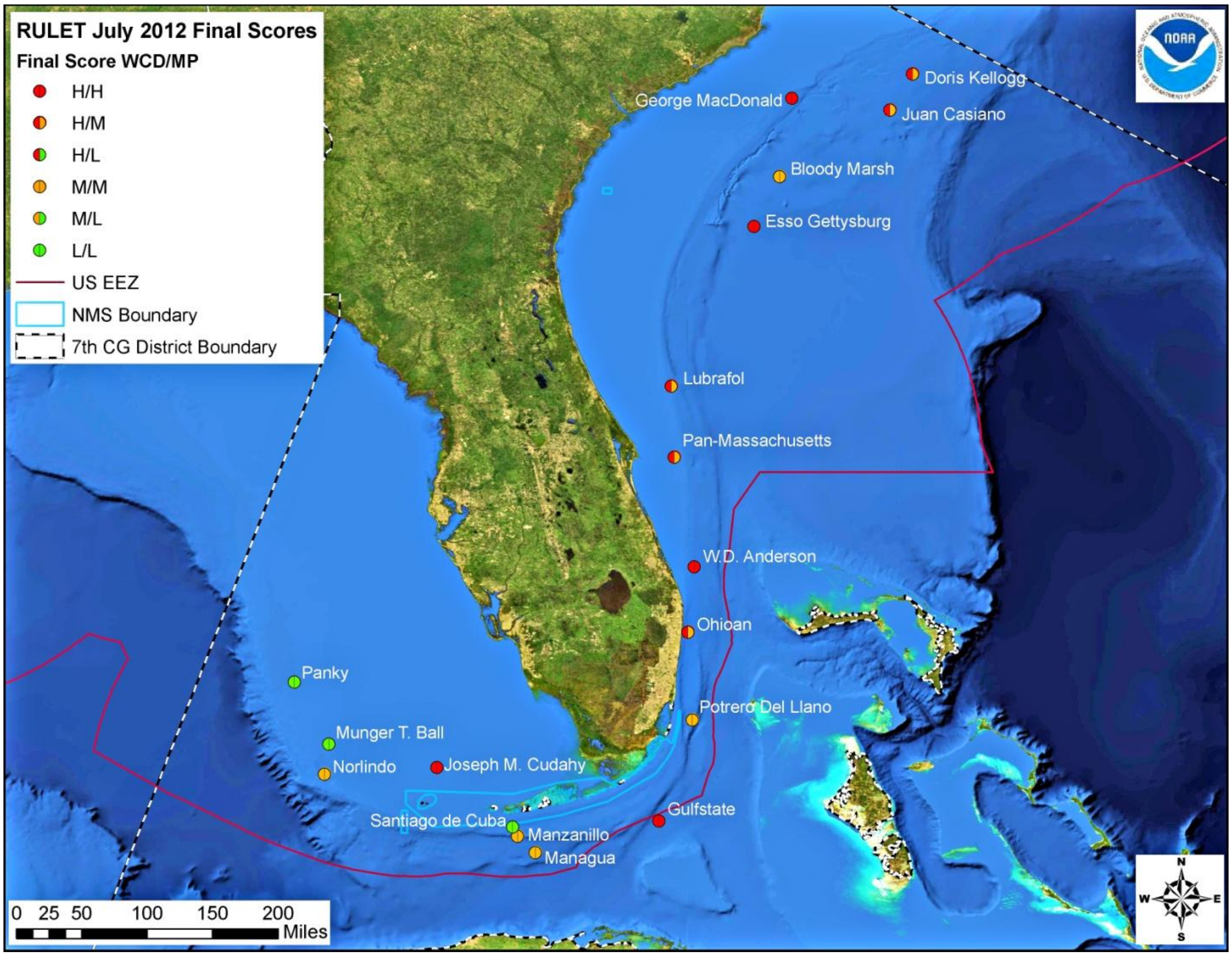


Name	WCD Final Score	MP Final Score	USCG District
Francis E. Powell	18	14	5
China Arrow	18	10	5
W.L. Steed	17	13	5
William Rockefeller	16	14	5
*Lancing***	15	12	5
Norlavore	15	12	5
*Paestum***	15	12	5
Allan Jackson	14	11	5
*Buarque***	14	11	5*
*Marit II***	14	11	5
*Nordal***	14	11	5*
Venore	14	11	5
Oneida	13	12	5
Mormackite	13	12	5
*Cayru***	13	11	5
*Ljubica Matkovic***	13	11	5
India Arrow	13	10	5

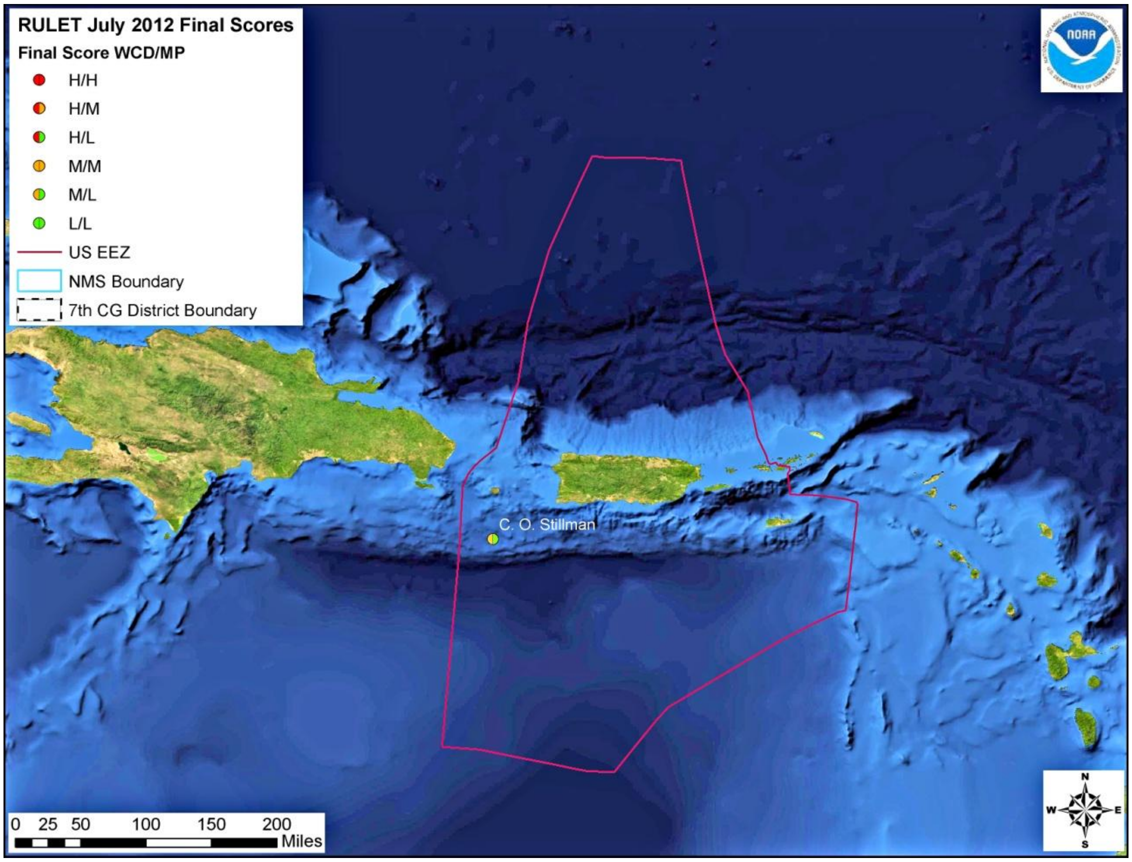
Name	WCD Final Score	MP Final Score	USCG District
*Empire Gem***	12	12	5
Marine Electric	12	11	5
Northern Pacific	12	11	5
Swiftscout	12	11	5
*Panam***	12	9	5*

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

U.S. Coast Guard District 7 – Florida



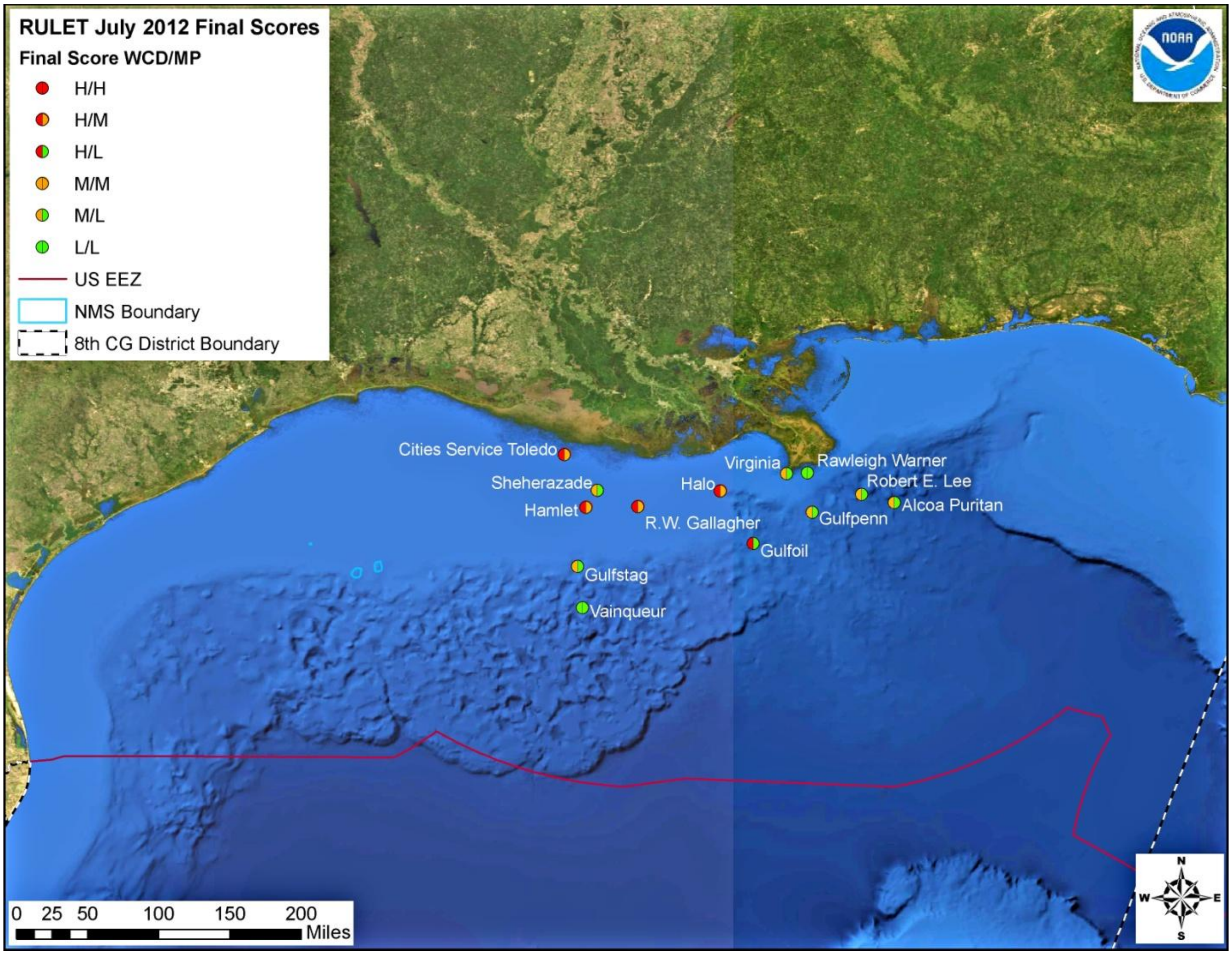
U.S. Coast Guard District 7 – U.S. Caribbean Islands



Name	WCD Final Score	MP Final Score	USCG District
Gulfstate	20	17	7
Esso Gettysburg	18	16	7
*Lubrafol***	18	12	7
W.D. Anderson	17	15	7
Pan-Massachusetts	17	12	7*
George MacDonald	16	15	7
Joseph M. Cudahy	16	15	7
Doris Kellogg	16	13	7
*Juan Casiano***	15	12	7
Ohioan	15	12	7
Bloody Marsh	14	14	7
*Potrero Del Llano***	14	12	7
*Managua***	13	12	7
*Manzanillo***	13	12	7
Norlindo	13	12	7
Munger T. Ball	11	10	7
*Santiago de Cuba***	11	9	7
*Panky***	10	9	7*
*C.O. Stillman***	14	8	7

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged. *Gulfstate* is in Bahamian waters but would impact U.S. resources.

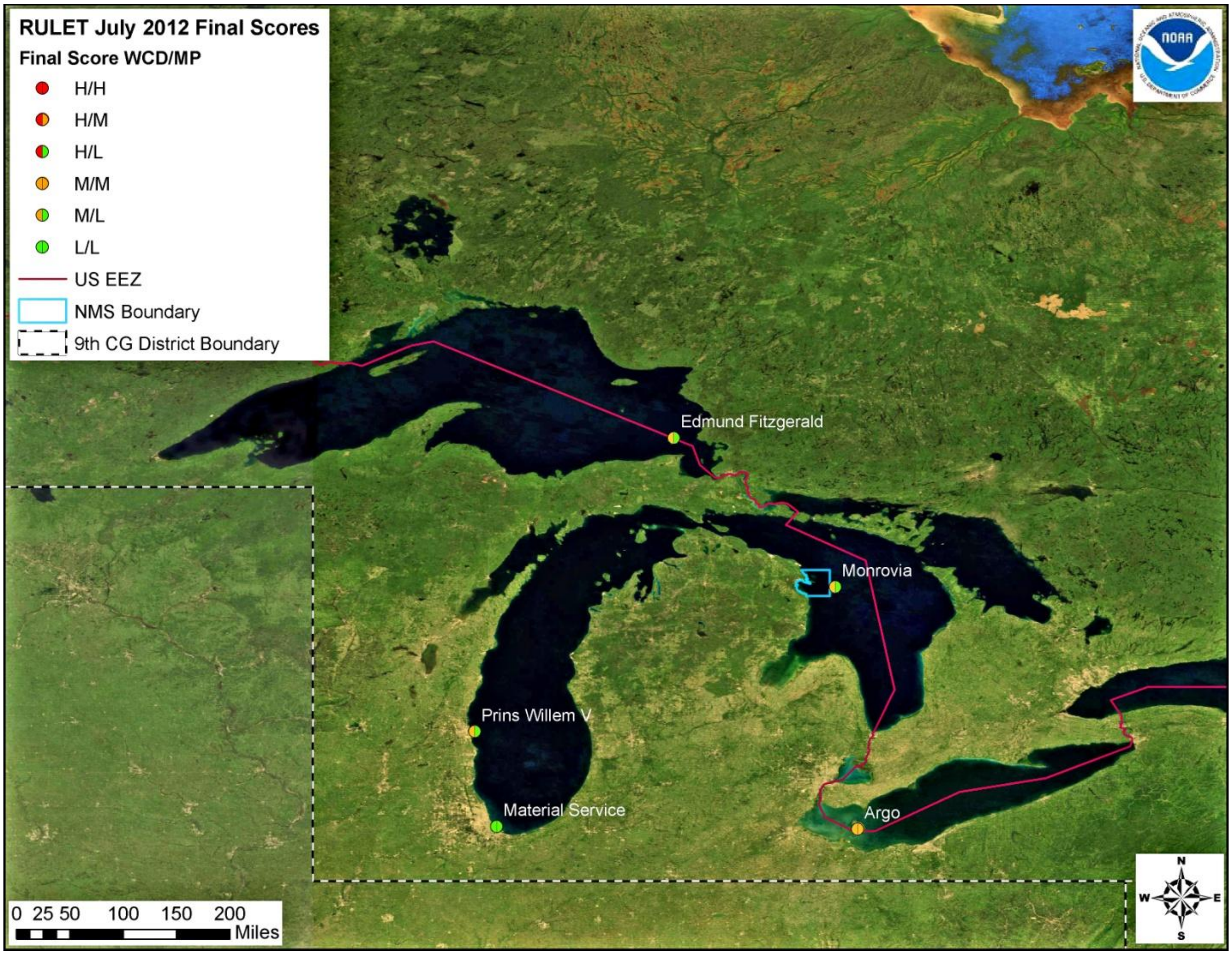
U.S. Coast Guard District 8



Name	WCD Final Score	MP Final Score	USCG District
R.W. Gallagher	18	13	8
*Hamlet***	17	13	8
Cities Service Toledo	16	13	8
Halo	15	14	8
Gulfoil	15	11	8
*Sheherazade***	13	10	8
Alcoa Puritan	12	11	8
Gulfstag	12	11	8
Robert E. Lee	12	11	8
Virginia	12	11	8
Gulfpenn	12	10	8
Rawleigh Warner	11	9	8
*Vainqueur***	9	8	8

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

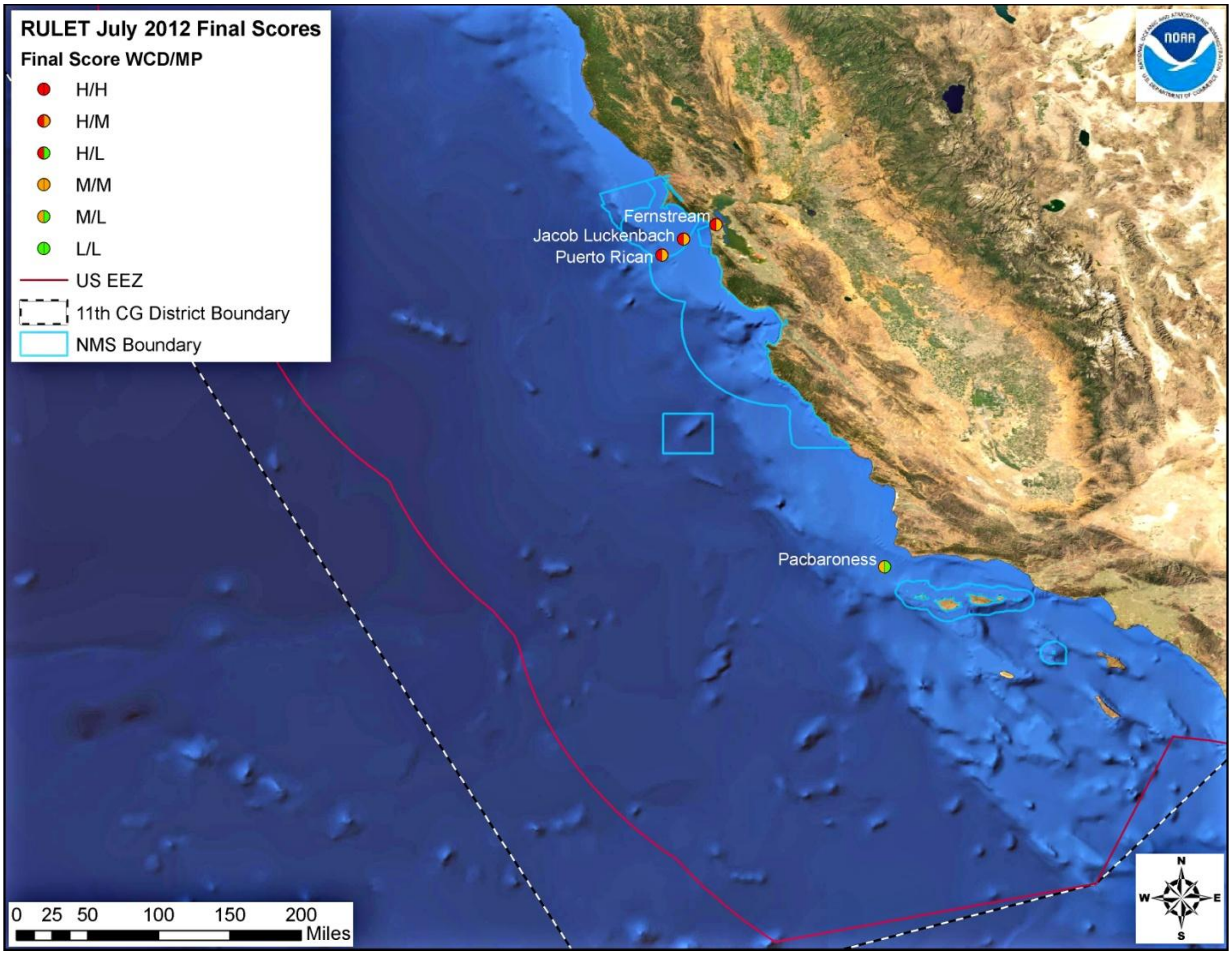
U.S. Coast Guard District 9



Name	WCD Final Score	MP Final Score	USCG District
Argo	14	12	9
*Prins Willem V***	14	11	9
Edmund Fitzgerald	12	10	9
*Monrovia***	12	10	9
Material Service	11	11	9

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged. *Argo* and *Edmund Fitzgerald* are both in Canadian waters but would impact U.S. resources.

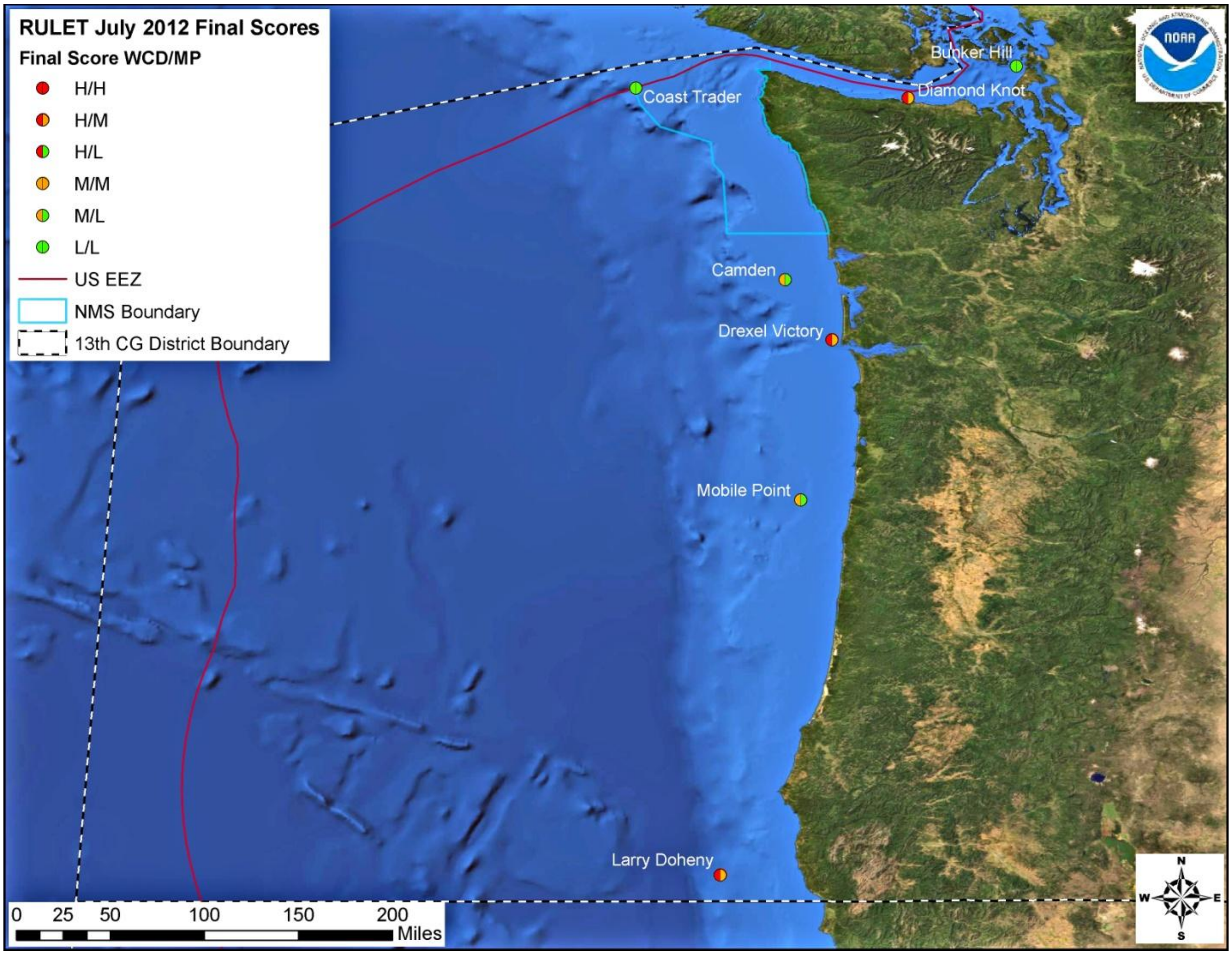
U.S. Coast Guard District 11



Name	WCD Final Score	MP Final Score	USCG District
*Fernstream***	15	13	11
Jacob Luckenbach	15	12	11
Puerto Rican	15	12	11
*Pacbaroness***	13	11	11

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; ** denotes foreign flagged.

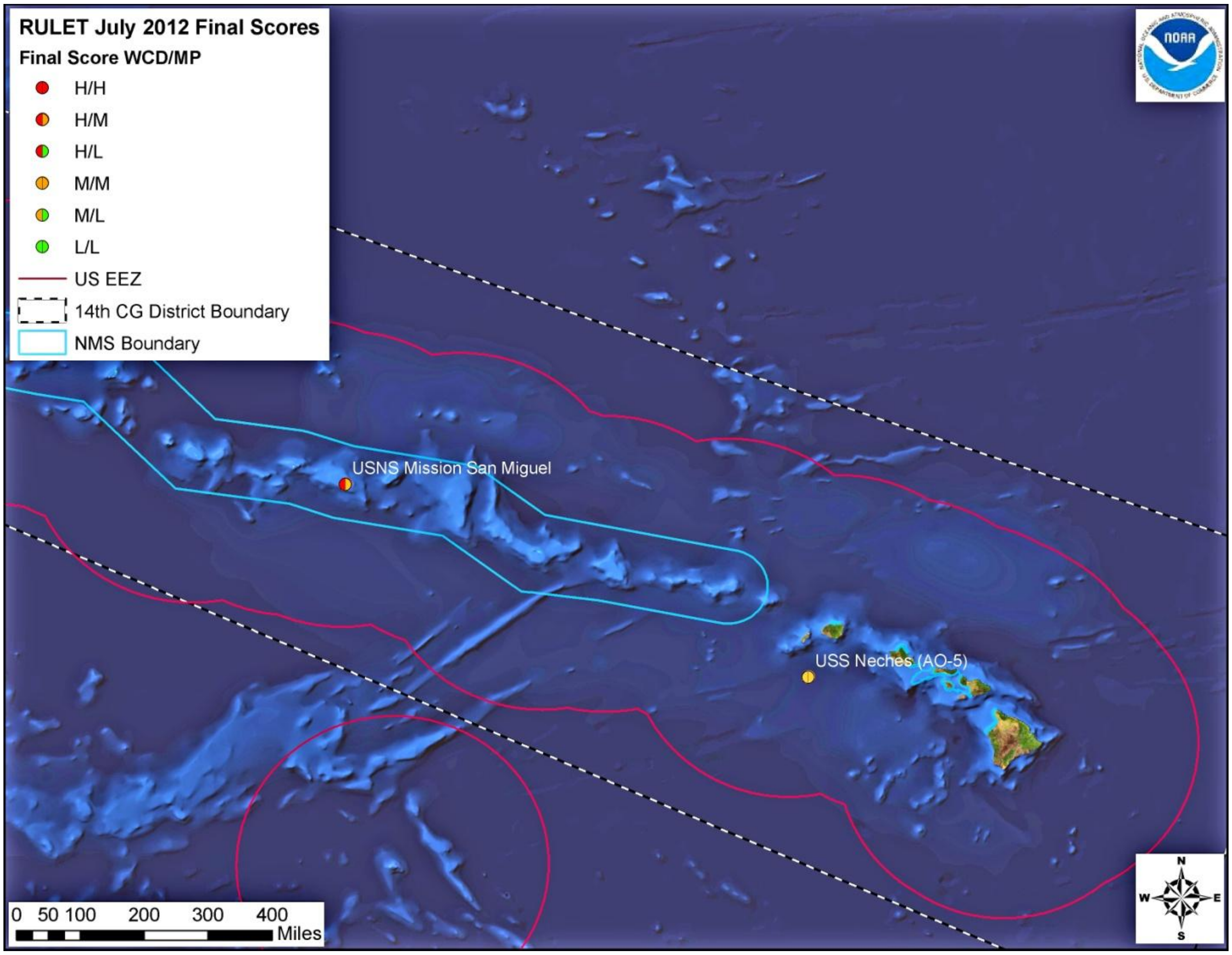
U.S. Coast Guard District 13



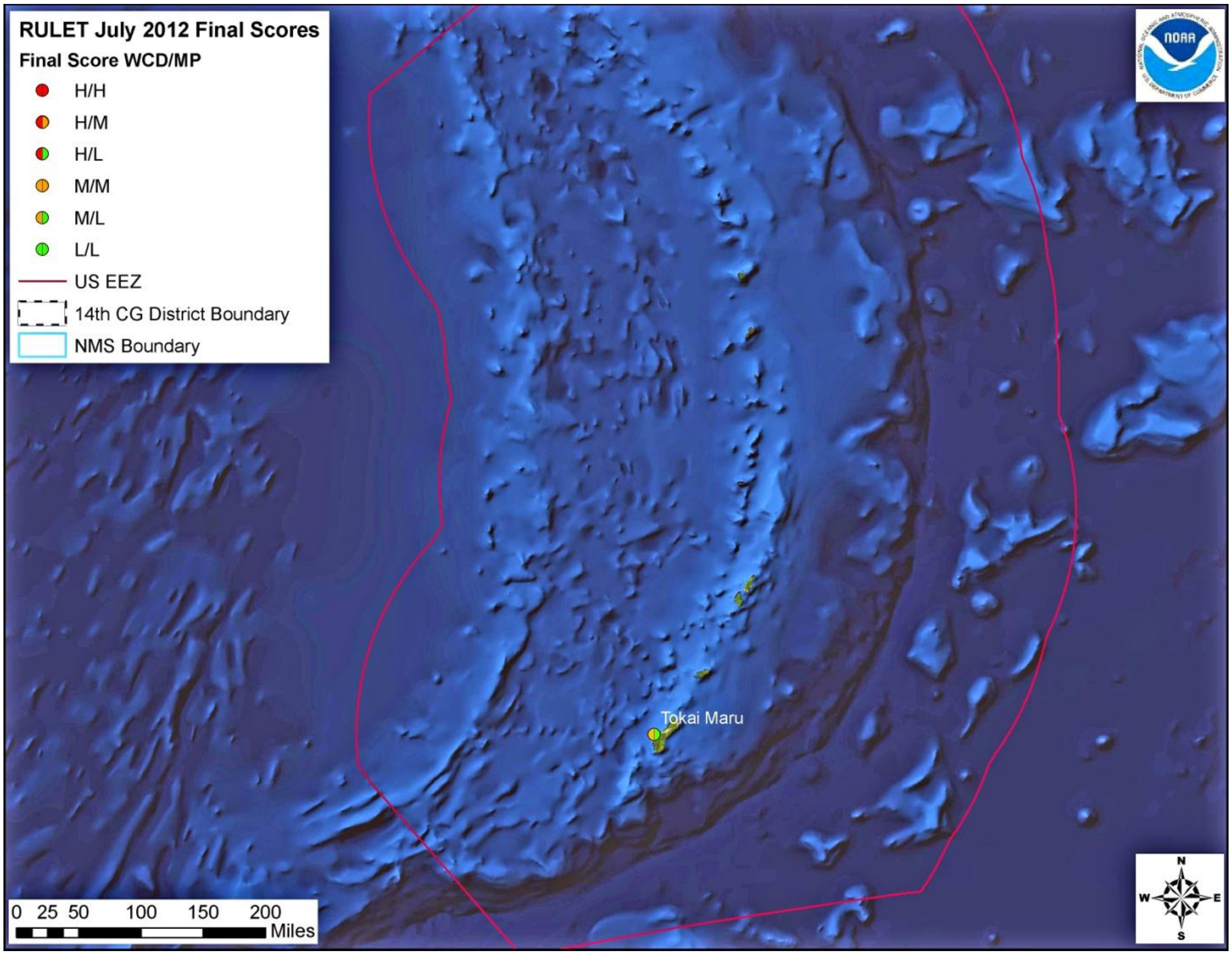
Name	WCD Final Score	MP Final Score	USCG District
Diamond Knot	16	13	13
Drexel Victory	16	12	13
Larry Doheny	15	12	13
Camden	13	11	13
Mobile Point	13	11	13
Coast Trader	11	10	13
Bunker Hill	11	9	13

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

U.S. Coast Guard District 14 - Hawaii



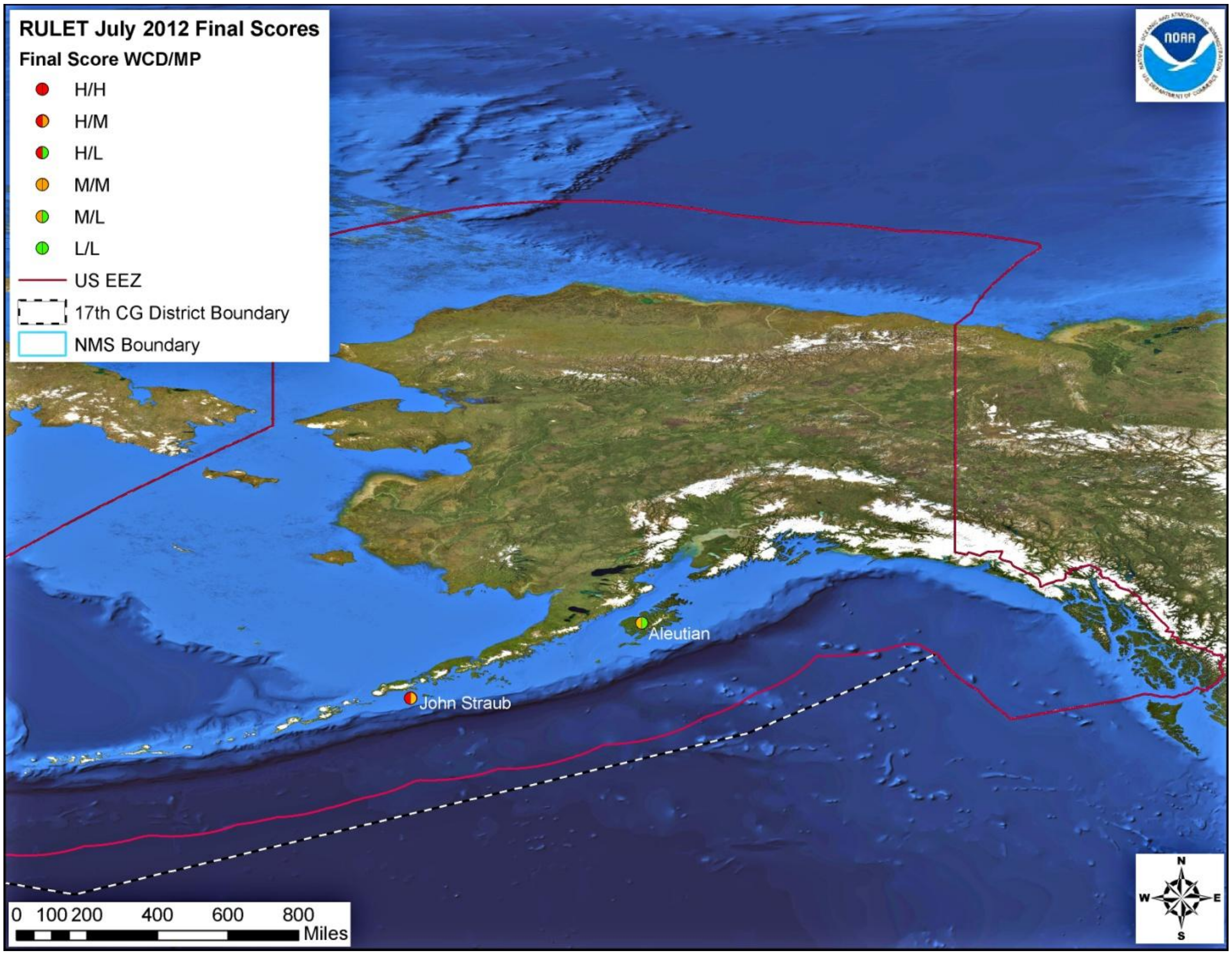
U.S. Coast Guard District 14 - Guam



Name	WCD Final Score	MP Final Score	USCG District
USNS *Mission San Miguel*	15	13	14
USS *Neches (AO-5)*	14	12	14
*Tokai Maru***	12	9	14

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

U.S. Coast Guard District 17



Name	WCD Final Score	MP Final Score	USCG District
John Straub	15	13	17
Aleutian	12	10	17

Note: Blue denotes WWII casualties; tan denotes confirmed location; * denotes unconfirmed location; remaining are unknown locations; ** denotes foreign flagged.

SECTION 4: CONSIDERATIONS FOR REDUCING THE RISKS OF POTENTIALLY POLLUTING WRECKS IN THE UNITED STATES

The response options for addressing potentially polluting wrecks are shown in Table 4-1. There are benefits as well as costs and consequences to consider in the decision-making process. Decision-makers can decide to leave the wreck alone and monitor it for any leakage or other changes or to move forward with an assessment and removal of pollutants. Depending on the frequency and nature of the monitoring protocol, there will be varying costs associated with the monitoring option. If a spill or leak is discovered during monitoring, a decision must be made as to whether an oil removal operation should (or should not) be conducted. This decision can also be made from the outset prior to commencing monitoring operations if the wreck is deemed to be of medium or high risk.

Table 4-1: Response options for potentially polluting wrecks.

Description	Benefits	Costs/Consequences
Leave As Is and Respond to Spills Leave the wreck as is and respond to any spills or discharges that may occur; Conduct emergency oil removal or lightering operation to stem oil flow if large spill occurs.	No costs for surveys or removal operations; Spills might not occur.	If spill does occur, response costs and damages may be higher than for proactive response; Impacts of spills; Higher cost for emergency removal operations; Threat remains; May be repeated spillage.
Research and Prepare Vessel-Specific Spill Contingency Plans Increase awareness of wreck's potential for spillage, and prepares appropriate contingency plans and assures readiness for response, if needed.	No costs for surveys or removal operations; Spills might not occur, but if spill does occur, better response and fewer damages with prepared response.	Some costs for planning and readiness; Threat remains; May be repeated spillage.
Monitor Wreck Monitor for leakage or any changes to condition of the wreck through over-flights, soundings or remote sensing.	Better timing on spill response; Can be upgraded to higher step as needed based on monitoring results.	Costs for monitoring; Threat remains; May be repeated spillage.
Site Surveys Conduct in-situ assessment of wreck to determine actual condition and/or confirm presence of oil with ROVs, remote sensing, diving, hot tapping. Verify site formation conditions; look for leakage, document oil locations and amounts, document corrosion.	Better able to make determination on risk; if oil removal operation required will be well prepared	Costs for surveys, oil sampling, and preparedness for potential spill during operations; Will be well-prepared for removal operation if needed; Costs may be lower for pre-planned operation than for emergency response; Threat remains; May be repeated spillage
Prepare Oil Removal/Salvage Plan Prepare contingency and salvage plans for oil removal operations for a possible future operation or emergency oil removal.	Will be well-prepared for removal operation if needed.	Costs for planning; Situation may change by plan implementation; Threat remains; May be repeated spillage.
Implement Oil Removal/Salvage Plan Prepare contingency and salvage plans for oil removal operations and implement the plans.	Threat removed or significantly reduced.	Costs for removal operation and preparedness for potential spillage during operations; Lower response costs and damages due to on-site preparedness vs. uncontrolled, episodic releases. Costs of future natural resource damages may be averted.

In considering the benefits and logistics of an oil removal operation, a decision can made not to conduct the operation at that time, leaving further decisions to be made if and when leakage occurs at a future time. Any responses to leaks and spills will result in costs for response, as well as any costs and damages from the impacts of the spilled oil. If a decision is made to conduct an oil removal operation, there are, of course, costs associated with that operation. If, in the course of conducting the removal, an unintended spill occurs, there may be costs associated with responding to that spill, along with any costs and damages associated with the impacts of the spilled oil. (Note that the costs of responding to a spill during a removal operation are generally lower in comparison to the same-sized spill if it occurred at another time, due to the pre-positioning of response equipment and personnel and the rapidity of a response possible due to pre-planning.)

Factors Affecting Planning for Assessment and Removal Operations

Underwater response operations present unique challenges. Extensive research may be necessary to locate ship drawings and other construction details, and detailed modeling of the wreck orientation is now the generally accepted practice to assist planning, particularly for ROV operations. Details about construction can be critical, and when coupled with environmental factors can contribute to increased corrosion. The primary purpose of three-dimensional modeling is to assist with response planning although modeling is also useful for briefing personnel and media about the assessment and potential removal activities. There are a number of general factors that affect the complexity of the operations that which need to be incorporated in the development of oil assessment and removal plans including:

- Oil type and properties (primarily viscosity)
- Oil volume
- Water depth
- Visibility
- Bottom currents
- Sea state (e.g., protected waters, open sea)
- Weather
- Resources at Risk (e.g., proximity to coral reefs and other sensitive locations)
- Distance to shore, from mobilization, and logistical support
- Vessel configuration (e.g., tank locations, accessibility, vents and piping systems, tank baffles and frame webbing)
- Vessel construction/engineering (e.g., plate thickness, riveting, welding)
- Vessel age (dates of construction, retrofits and casualty)
- Wreck condition (e.g., broken sections, corrosion, encrustation)
- Wreck orientation (e.g., upright, upside down)
- Safety factors (e.g., presence of munitions, hazardous materials, derelict fishing gear)
- Other cargo (non-hazardous cargo may still block access to tanks and void spaces)
- Historical/cultural concerns (e.g., historical significance, war grave)

While these factors can and should be considered in the operations planning process, there is always a considerable degree of risk-based contingency planning that needs to be incorporated as well. Planners and operations personnel need to consider each of the factors listed above and evaluate and plan for potential changes that could occur during the operations, including new information that is obtained once the operation is underway, as outlined in Table 4-2. An effective assessment and/or recovery plan should include contingencies and risk analyses that account for these factors.

Table 4-2: Planning for risk factors.

Risk Factor	Potential Issues	Pre-Planning
Oil Viscosity	Oil may be more viscous and weathered than anticipated requiring different pumping mechanisms, heating, chemical enhancement, or other methods. Heavier, more viscous oils are more difficult to pump at ambient temperatures.	Historical reviews of vessel records provide initial descriptions of oil type(s). Research on behavior of oil at depth, under pressure, and potential degree of weathering essential. Plan for potentially increased viscosity.
Oil Volume	There may be considerably more or considerably less oil than anticipated causing needs for prolonged operations, more or different equipment, and more storage capacity.	Archaeological/historical reviews of vessel records provide initial estimates of oil volume based on vessel configuration, records of loading, distance traveled, etc. Consideration that there may be more oil should be included in planning.
Water Depth	Survey and charting information needs to be confirmed.	Pre-operation surveys and charting to best estimate depths for diving safety, calculation of pressures, temperatures, etc.
Visibility	Visibility in the water column and at depth can be problematic from both a safety and an operational perspective.	Operations should be set up to address the potential for low visibility conditions during operations providing redundancy if necessary.
Bottom Currents	Significant bottom currents can rapidly tire divers and can make it difficult for ROVs to hold station—significantly impacting safety and operations.	Equipment and personnel should be equipped to work in environments with strong or changing currents. This may necessitate some additional safety equipment, etc.
Sea State/Weather	Weather and sea state are the most variable factors that can create challenges or complicate operations. Logistics and operations are considerably less complicated and safer in calmer seas and weather. High seas, storms, and high winds can cause safety and operations efficiency problems and may require step-down or delay in operations.	To the extent possible, operations should be planned for time periods generally associated with calmer weather and seas (e.g., not during hurricane season, summer rather than winter), but plans for inclement weather, storms, and high sea state, should be included in plans, if only to plan for step-down or delay in operations.
Resources at Risk	Proximity of operations (wreck location and/or operations and logistical support activity) to coral reefs, marine sanctuaries, or other highly sensitive locations creates the potential for unanticipated impacts.	Proximity of operations (wreck location and/or operations and logistical support activity) to coral reefs, marine sanctuaries, or other highly sensitive locations should be considered in preparing plans for oil removal operations and for possible oil leakage. Permits or consultation requirements may exist for some federally protected areas.
Distance to Shore, from Mobilization, Logistical Support	The need for more logistical or other support may arise during operations.	While distance to shore and support is unlikely to change, the possibility of requiring additional or different support and the distances (and time) involved should be incorporated into planning.
Vessel Configuration	Anomalies in configuration or misinformation on locations of tanks or other vessel sections can complicate operations, especially in vessels that have been modified or re-powered.	Historical and structural engineering reviews of vessel records provide significant information about vessel configuration, particularly with regard to tank (oil) locations. Surveys and vessel plans should be consulted for confirmation. Possibilities of deviation from information should be considered to the extent possible. In some cases, the best proxy will be plans from a sister ship.

Table 4-2: Cont.

Risk Factor	Potential Issues	Pre-Planning
Vessel Construction/ Engineering	The actual construction and engineering of the vessel with regard to such things as plate thickness, riveting, and welding may deviate from original plans, particularly for World War II-era vessels that were built in short order. Poorly constructed rivets and welding, in particular, can cause problems during operations.	Archaeological/structural engineering reviews of vessel records provide significant information about vessel configuration, particularly with regard to tank (oil) locations. Surveys and vessel plans should be consulted for confirmation. Possibilities of deviation from information should be considered to the extent possible.
Wreck Orientation	The orientation of the wreck (upright, upside down, on port side, on starboard side) or of portions of the wreck if it is broken are extremely important in planning the strategy for accessing tanks and oil pockets.	Previous surveys and archaeological/historical records may provide information about wreck orientation, but these records may be incomplete, outdated, or incorrect. Possible variations in vessel orientation should be incorporated into planning.
Wreck Condition	The wreck may be in worse condition (more damaged, greater degree of corrosion) than anticipated complicating operations. There may also be less damage than anticipated meaning that there may be more oil on board than anticipated.	Previous surveys and archaeological/historical records (e.g., degree of damage during casualty) may provide information about wreck condition with regard to broken sections and corrosion, but these records may be incomplete, outdated, or incorrect. Possibilities of greater damage and greater corrosion than records, surveys, and corrosion models might predict should be incorporated into planning.
Safety Factors	The presence of munitions, unexploded ordnance, and hazardous materials can create safety issues for response personnel and the public.	Information on potential (or confirmed) safety hazards may be available from archaeological/historical records and previous surveys. If no hazards are reported or on record, potential should be considered based on vessel type and mission. Safety plans and contingency plans should take these potential risks into account.
Historical/Cultural Concerns	With the goal of the operations to remove oil from the wreck, the fact that the wreck is a heritage site, on, or eligible to be on the National Register of Historic Places, and/or war grave, or the presence of non-combatant human remains creates particular needs for sensitive and respectful treatment of the wreck and any human remains or artifacts that may be found.	Information on potential (or confirmed) designation of the wreck as a heritage site or war grave, or the potential (or confirmed) presence of human remains may be available and should be incorporated into planning. In the U.S. this will at a minimum require compliance with the National Historic Preservation Act (Sections 106 and 110) and potentially the Sunken Military Craft Act, the National Marine Sanctuaries Act, and the Antiquities Act. The absence of an official designation still requires planning for potential unanticipated discoveries of human remains during operations.

Each oil removal operation from a wreck brings unique challenges. There is no one method or strategy for conducting an operation. There are no particular “rules of thumb” with regard to whether a project is feasible or not. Much like emergency oil spill response or firefighting, most operations require custom solutions that can be addressed in pre-planning to some extent, but may require adjustments and adaptations during actual operations. In all cases, creative approaches will need to be applied in the course of operations based on the types of risk factors in Table 4-2, as well as unpredictable site conditions that arise. All these risk factors need to be thoroughly considered in the feasibility analysis of a particular oil removal operation.

Wreck Assessment and Oil Removal

Each operation increases the capabilities and knowledge of the salvage response community and officials involved in the process. There have been considerable advances in various technologies, such as hot tapping, remotely operated vehicles, oil detection technologies, and diving techniques over the last two decades. There will undoubtedly be more advances in the future. But, as with spill response, the availability of certain technologies is not the most important factor in determining success for a particular operation or for a larger oil removal program in general. The experience and training of responders, the strategic and, at times, creative application of available technologies, as well as the ability to invent custom solutions under the unique circumstances and challenges presented by a particular operation are the best predictors of positive outcome for a project.

Tools and Technologies

Assessment of the wreck through surveying techniques or inspection is critical to determining the pollution threat and to the development of an effective oil removal plan if necessary. While archaeological and historical library research on the wreck can provide important information, an on-site inspection can confirm, correct, or possibly refute information in the records. If a survey has been conducted in the past, there may still be significant changes and new information that can be invaluable to current planning. If the wreck location is not precisely known, or there is confusion over the name of the wreck at a location, the first challenge may be finding the wreck and confirming the wreck's identity. Obviously, this is important in being able to match a vessel to historical records, available schematics and plans, etc.

Ideally, the wreck inspection will confirm the identity of the wreck and document the site conditions and orientation of the wreck. The inspection process can also be used to map out more precisely the wreck location, debris field, bottom profiles, and sediment conditions, as well as sample the oil, concretions, and metals (if needed) for further corrosion analysis. Initially, non-intrusive assessments may not be able to determine whether there is oil on board or not. The *Montebello* had several ROV and submarine assessments that determined the vessel had significant structural integrity that, when combined with no known release of pollutants, suggested the vessel still contained most of her original cargo and bunkers. However, a more rigorous assessment determined that there was no recoverable oil remaining onboard. More extensive inspections will usually be needed to determine the amount and locations of oil, and determine the feasibility and safety of oil removal.

Wreck inspection can be conducted in a number of ways, including through the use of remote sensing technologies, ROVs, autonomous underwater vehicles (AUVs), and divers. Often surveys are conducted in multiple phases. For example, the first phase might involve the use of ROVs to evaluate oil leakage, determine the general condition of the wreck, and collect environmental data and concretion samples for corrosion rate determinations. Sonic hull thickness gauges have progressed to the point they can be useful in ROV deployment. The second phase might include a more detailed assessment of the hull plating, sampling of metals and oil tanks, and assessment of the wreck for determination of landing plates and pump locations for the future oil removal operations. It might also include an assessment of the location and quantification of oil using various methods.

The location of oil in tanks and in other spaces in the wreck is essential to an effective removal operation. If oil has already leaked out of some of the tanks or if the tanks were not completely full at the time of the casualty, there may be significant stratification of the oil into lighter and heavier ends, as well as salt water, especially in colder temperatures. Location of the oil-water interface and stratified oil is also crucial in planning removal strategies. Finally, if the wreck is of historical, cultural, and/or archaeological interest, a survey and inventory of the entire wreck site should be completed before any potentially destructive activities are conducted (see National Historic Preservation Act Sections 106 and 110 in Section 5).

Diving

The most direct means of obtaining information on a wreck is to send divers to inspect, take photographs, take samples, and apply various sensing technologies. Diving can be employed to provide invaluable reconnaissance data on the wreck, as well as to conduct actual oil removal operations if necessary.

Diving, even when conducted by highly trained professionals, presents challenges and safety risks; therefore, the experience and safety regimen of the diving contractor should be carefully considered. Most commercial diving will be conducted following the Association of Diving Contractors, Intl. *Consensus Standards*, and the *U.S. Navy Diving Manual* regarding limits for air and mixed-gas diving. In some cases federal agency standards will apply to diving operations, particularly at the data gathering and evaluation stages, as these activities can be considered scientific diving and consequently fall under the Occupational Safety and Health Administration (OSHA) scientific diving exemption if done by agency divers. If contract divers are used, OSHA regulations apply. The Association of Diving Contractors *Consensus Standards* are voluntary unless contractually required. The surface supplied method provides surface control of the diver through voice and visual control, as well as control of gas supplies. The limits of surface-supplied compressed air diving is approximately 180 feet with limitations on the amount of time that can be spent at the deeper depths of that limit. The use of mixed-gas (Trimix), helium-oxygen (Heliox), and other gas mixtures such as Nitrox can extend surface supplied diving to 300 feet and beyond, and extend safe time limits for shallower depths. Advances in safety techniques for saturation diving (the preferred method for extended diving operations at depths greater than 190-300 feet) have greatly reduced the risks and improved the outcomes of such diving operations.

Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs)

While diving continues to serve a vital function in assessment and oil removal operations for shallow sunken wrecks, there has been a general trend in the industry to increasingly rely on remotely operated vehicles and autonomous underwater vehicles to decrease the risk to divers and to allow for lengthier operations under the water surface.

ROVs are unmanned vehicles that can be submerged and directed to the wreck to perform a variety of functions while being directed and operated by personnel at the surface. ROVs can be used at any depth but are particularly advantageous at depths beyond 1,000 feet. ROVs can be equipped to perform a large variety of applications, such as three-dimensional photography and imaging, single dimension photo and videography of the wreck, applying remote-sensing technologies, shuttling supplies or samples, and operating equipment, such as that used for hot tapping to remove oil or sealing leakage points.

The technologies for ROVs have greatly advanced in recent years. The oil removal operations conducted on the wreck of the *Prestige* at depths of over 11,000 feet, as well as the complex operations conducted during the well capping of the Macondo MC252 blowout at a depth of 5,000 feet, have demonstrated the capabilities of ROVs at considerable depth.

A more recent addition to the technologies available for wreck inspections and oil removal operations are submersible AUVs. These vehicles are similar to ROVs except that they are not tethered to surface equipment on a work platform like ROVs. Like with ROVs, AUV technology allows responders to go to the site of the wreck and transport and operate equipment without being exposed to the risks of diving and for longer periods of time and without the risks of umbilicals becoming snagged and entangled on a wreck. There are a limited number of prototypes of AUVs that have been used in other operations such as undersea exploration and in some wreck assessment operations. The ability to operate without tethering increases the maneuvering flexibility. AUVs can perform systematic remote sensing at virtually any depth, which greatly reduces survey costs particularly in deeper areas. Sonic, magnetic, and photo and video imagery can be combined with multi-parameter environmental sampling for a very cost-effective solution for wreck location and environmental variables determination.

Sonar Technology

With a submerged wreck, remote sensing greatly enhances the ability to examine the wreck from the surface or from a submerged location using divers, ROVs, or AUVs. Remote sensing can be used to determine the orientation and condition of the wreck in relationship to a differential GPS grid and to provide a "visualization" of the layout of the wreck and debris field for planning of operations, as well as for real-time tracking of locations between the wreck and a dynamically positioned support platform during operations.

Sonar technology is one method of remote sensing that has been applied to conduct non-destructive mapping of wreck sites from a surface vessel. The four main types of underwater imaging used in the assessment of wrecks and wreck sites are:

- **Echo sounder**: The most basic type of underwater imaging uses one transducer to transmit and receive sound waves. This technology is generally used to determine water depth and basic bathymetry. With its single beam, an echo sounder can only map one location at a time.
- **Multibeam sonar**: Multibeam sonar can map more than one location on the ocean floor with each ping and can produce significantly higher resolution images than echo sounding. Multibeam sonar images a strip of points or swath perpendicular to the ship's path. This technology is frequently used to map underwater locations, including wrecks. It can produce an image of the wreck, which aids in determining location, condition (e.g., broken in pieces), and orientation, as well as bathymetry in the vicinity of the wreck. Multibeam sonar devices can be operated from an AUV or ROV for more effective imagery in some cases. Figure 4-1 is an example of a multibeam survey of the SS *Montebello*.
- **Sidescan sonar**: Sidescan sonar uses a towed transducer (towfish) to send sound wave pulses. This type of sonar allows for viewing of different angles of objects, such as wrecks, on the ocean floor and produces more accurate three-dimensional imagery, such as in Figure 4-2.
- **High-resolution multibeam sonar with visualization**: Another technology involves high-resolution multibeam sonar surveying and visualization. The specialized multibeam sonar system

generates extremely detailed three-dimensional (3-D) point cloud models of shipwreck sites and renders them in a visualization program that allows three dimensional viewing and manipulation, such as depicted in Figure 4-3. The system can be pole-mounted for shallow water surveys or ROV mounted for deepwater surveys. A pole-mounted configuration limits the survey to approximately 197 feet water depth, while an ROV mounted survey is limited by the operational characteristics of the ROV. The surveys can be tailored to survey a wreck from multiple angles, enabling a wreck to be visualized from multiple directions, including the inside of the wreck. It may not be possible to investigate the internal portions of very intact shipwrecks with undamaged hulls and bulkheads.

Ultrasonic Thickness (UT) Hull Gauging

UT hull gauging is applied to measure steel plate thickness on a wreck. Deployed by an ROV or a diver, the UT sensor sends a short pulse of high frequency sound through the hull plate. The time taken for an echo to be received from the interior surface is measured and used to determine the thickness of the material, once concretions have been removed. This non-destructive sensor technique can be used to determine the overall integrity of the vessels side shell and external cargo tank walls.

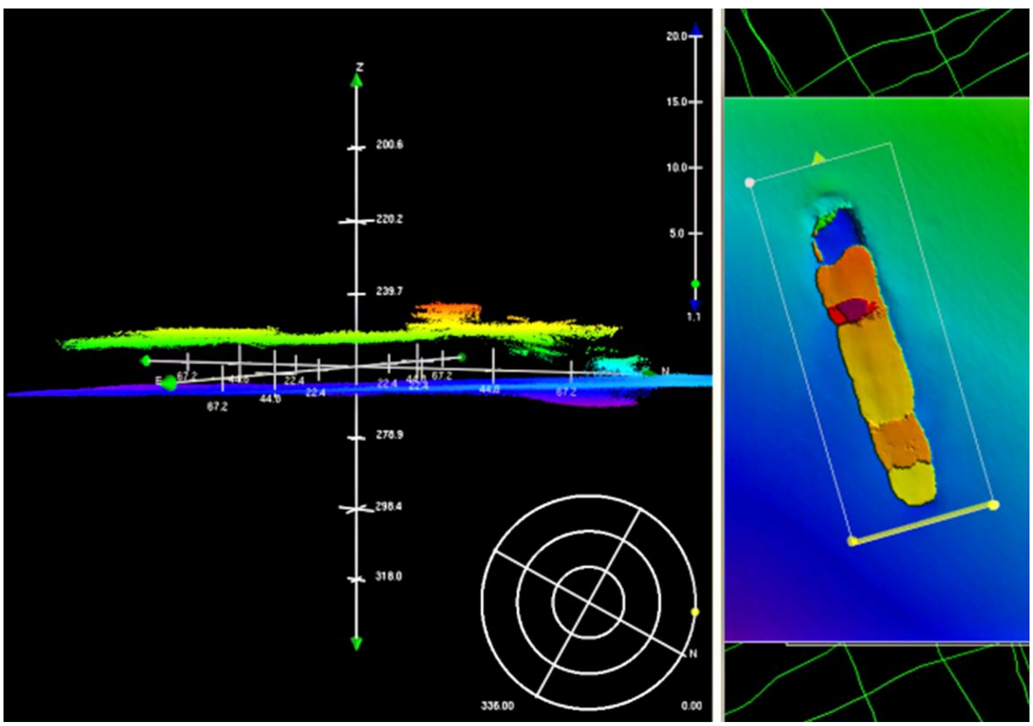


Figure 4-1: Multibeam survey of SS *Montebello* (Source: SS *Montebello* U.S. Coast Guard FOSC Report).

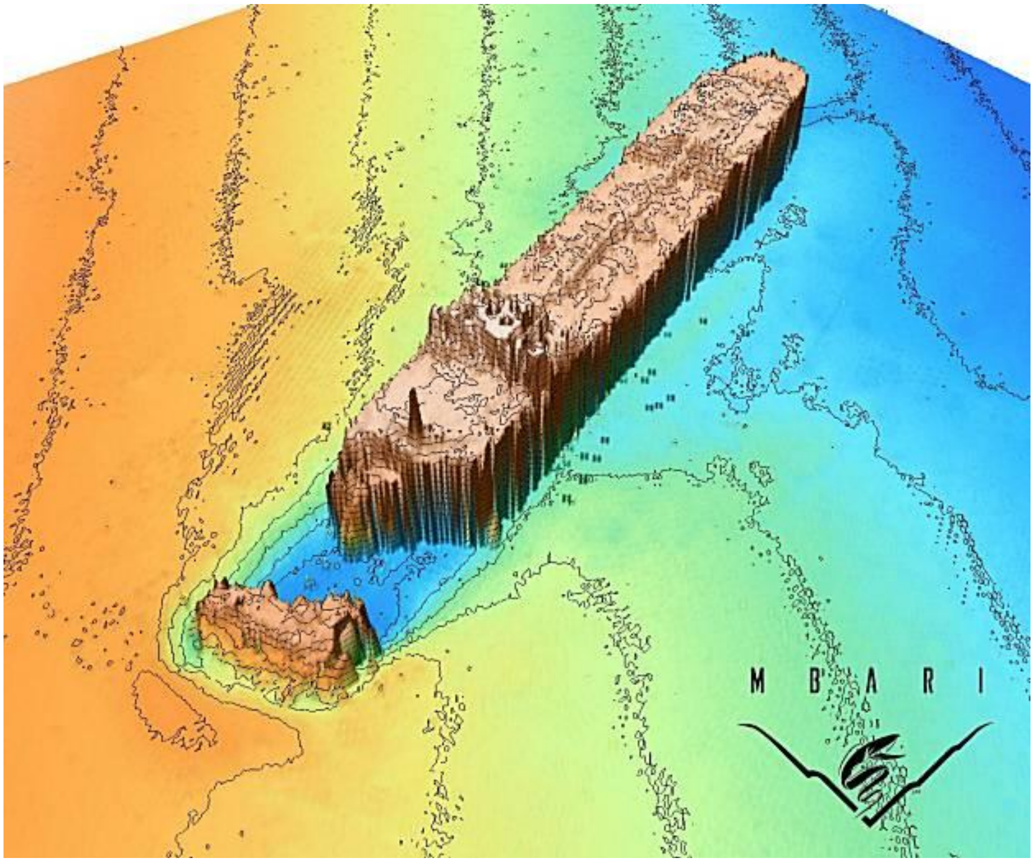


Figure 4-2: Multibeam sonar image of SS *Montebello* (Source: Monterey Bay Aquarium Research Institute).

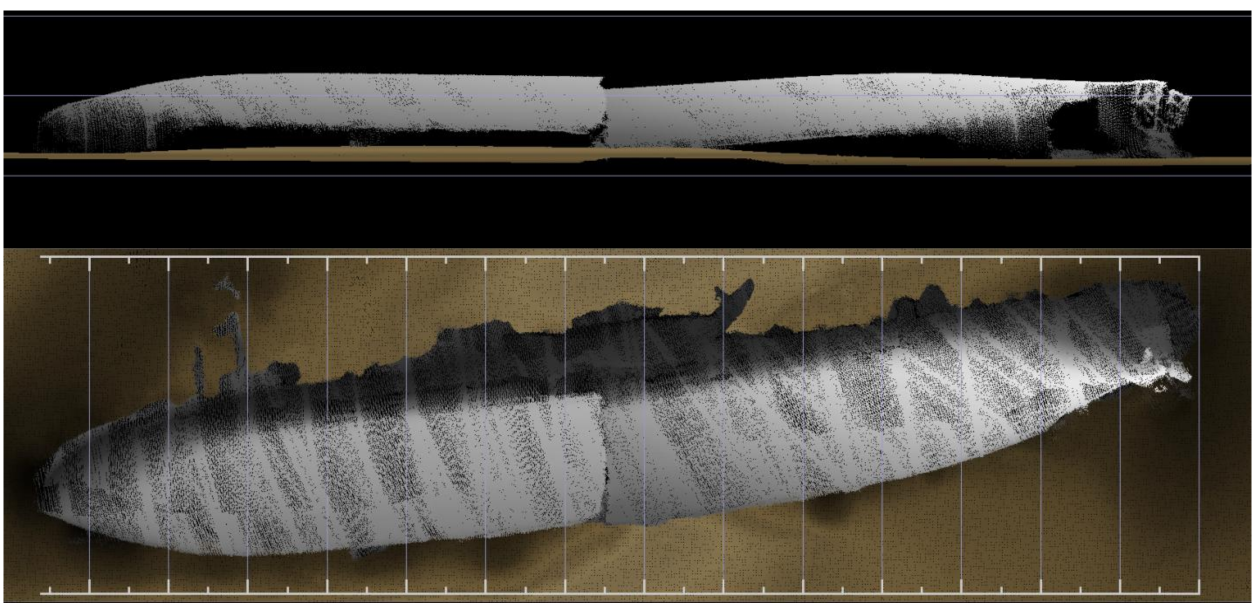


Figure 4-3: High-resolution multibeam survey with visualization software of inverted tanker torpedoed off the coast of North Carolina in 1942 (Image generated by ADUS and courtesy of NOAA).

Neutron Backscatter

Non-destructive oil sensing is an extremely valuable strategy for determining the location of oil in tanks of a wreck, as well as estimating the volume, and possibly oil properties, while minimizing unnecessary disturbance of the wreck, such as illustrated in Figure 4-4.

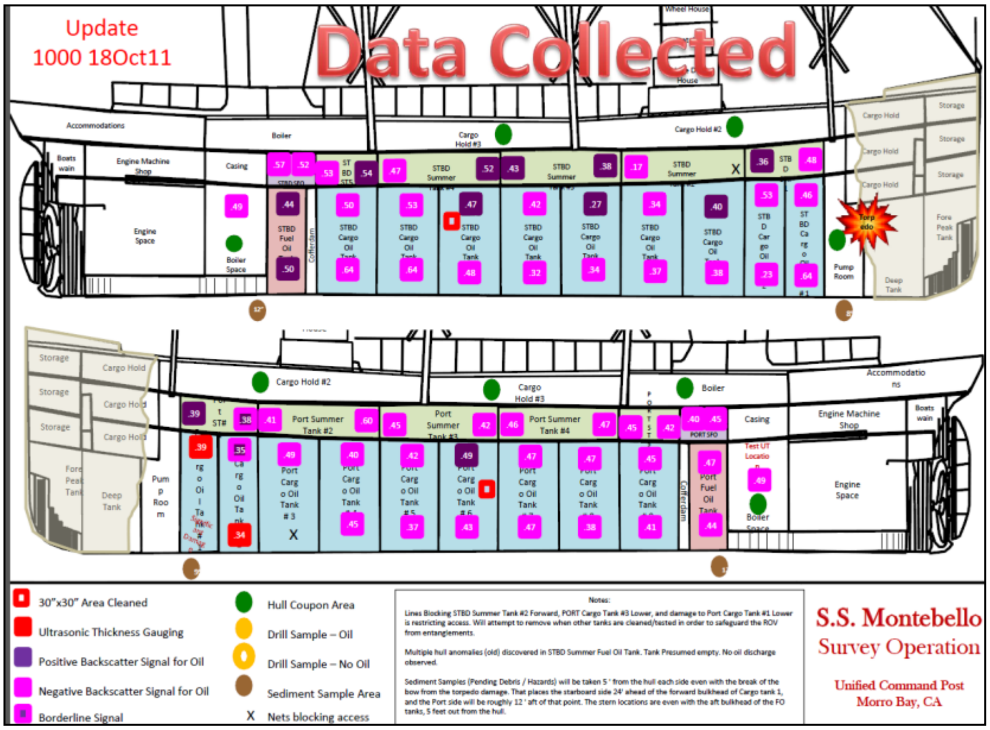


Figure 4-4: SS *Montebello* UT and neutron backscatter hull gauging locations. (Source: SS *Montebello* U.S. Coast Guard FOSC Report).

Neutron backscatter is a state-of-the-art non-destructive oil sensing technology that provides an assessment of the contents of the space behind a bulkhead, side shell, or external cargo tank wall. A neutron backscatter survey is performed by using a source of high-energy "fast" neutrons and a detector that is sensitive to low-energy "slow" neutrons. The neutron source is held against the side of the vessel once concretions have been removed and moved up and down over the surface by a diver and or an ROV. Fast neutrons from the source penetrate the vessel walls and interact with the medium inside. If the medium is hydrogenous, neutrons are slowed by collisions with the hydrogen nuclei. The slow neutrons are reflected back out of the vessel and are detected by the sensor. The detector essentially functions to measure the hydrogen concentration of the material adjacent to the detector. When the detector moves across a liquid/vapor interface a large change in detector response is observed. At interfaces between liquids of different hydrogen richness (such as oil and water), a smaller change in detector response is observed. The higher the concentration of hydrogen nuclei, the greater the magnitude of the sensor's response will be. Water has higher hydrogen richness than oil.

For oil detection on a wreck, the system requires calibration with hull thickness, which can be achieved by UT hull gauging. The suspected oil type also needs to be calibrated to interpret the results. For accurate results, there needs to be proper detector placement, survey area accessibility, good hull surface conditions, line of sight visibility, and certain sub-sea conditions. Rust, concretions and any encrusting marine life need to be removed so that the device can attach to a clean surface. When conditions are right, using neutron backscatter allows for the location of oil on a wreck and the limits the need for more time consuming, complex and costly hull tapping operations for taking samples.

Oil Removal Technologies

Hot Tapping

The hot tap is an oil recovery device that can be used in shallow water up to approximately 200 feet. It is generally diver-operated, though some hot tap systems can be deployed with ROVs at greater depths. The system creates a through-hull fitting into a ship's hull that allows recovery of oil (or other fluids) without spillage. The hot tap system installs an interface on the ship's hull (e.g., a base plate or flange). A short pipe and valve is then attached, A hole saw/drill is mounted outboard the valve. The valve is opened allowing penetration of the hull by the hole saw. After the hole is cut and saw withdrawn, the valve is closed, a pump system can then be mounted in place of the hole saw and be used to pump the pollutants to a receiving tank (e.g., a storage barge) on the surface.

Viscosity Lowering Techniques to Aid in Pumping

For highly viscous oils, viscosity-lower techniques are required for effective pumping. The most commonly applied method is heating. This can be accomplished through direct heating of the individual oil tanks by using the ship's tank heating coils and injection of hot water or steam. In many cases, however, the ship's heating coils are too corroded for use. Other methods of heating are the localized application of steam near the pump inlet or complete tank heating. Either approach requires portable boilers on a surface work platform that can deliver steam to the wreck through hoses.

The use of heat exchanges has been successfully demonstrated. This technique is often used in combinations with the setup of circulations cells, where the oil is pumped from the vessel through the heat exchanger back into a different location within the tanks, re-circulating the heated oil and mixing it with the vessel's contents in order to move the heat throughout the tank. Once the oil is demonstrably heated, the valve manifold is redirected to send oil to the surface for collection. Another method is to inject and mix in lighter oils, such as diesel, though this often requires mixing energy to reach throughout the tank and may possibly result in spillage of oil. Heating a tank significantly increases the chance that oil will be released in any places there the tank or its attached vents and piping have been compromised. Depending upon the wrecks orientation, plugging vents and piping may be necessary before heating can be done.

Pumping

Low-viscosity oils can be removed from a wreck using a vacuum pump and long suction hoses handled by divers or surface crews through the use of an ROV. A large variety of vacuum pumps are available ranging from simple diaphragm pumps to high-volume rotary vacuum pumps. High viscosity oils and debris can cause clogging of the suction hose.

Submersible hydraulic pumps are commonly used in salvage operations. Centrifugal pumps have the advantage of being lighter weight with higher flow rates than positive placement pumps. These pumps are not suited for operations with heavy oils. They also produce highly emulsified recovered product, which limits its usefulness for resale. Pumping of heavier oils with a viscosity over 100,000 centistokes has been accomplished using positive-displacement pumps fitted with annular water injection rings that lubricate discharge hoses to prevent clogging.

Alternative to Removal: Solidifiers

A potential solution would be the use of solidifiers, which would actually increase the viscosity to such an extent that the oil would behave as a rubbery semi-solid, reducing the risk of a liquid release. Because the solidifiers are dry substances that need to be mixed with the oil by sufficient mixing energy, there is concern of incomplete mixing, which would make the technique largely ineffective and may result in liquid oil remaining and eventually leaking from the tank.

Environmental Compliance Issues

A range of environmental compliance issues may be triggered depending on the location of the wreck, regardless of whether it is in state or federal waters. Some states may have additional requirements that come into play. All of these items should be well articulated for a region within the Area Contingency Plans, consultations required by many of these statutes should be periodically reviewed to ensure that they are up to date and reflect changes in approved technologies, listings of endangered species etc. The individual risk assessments will also note when additional issues may be applicable. Each assessment and oil recovery plan should address all the environmental and historical compliance issues. Emergency consultation requirements include the development of mitigating actions and best management practices that will limit impact to the affected resources. Please see Section 5 for additional discussions of legal issues.

- National Environmental Policy Act (NEPA)[7]
- Oil Pollution Act (OPA)
- National Contingency Plan (SWA/OPA)
- Clean Water Act (CWA)
- Wreck Act and Rivers and Harbors Act of 1899
- Abandoned Barge Act
- Sunken Military Craft Act (SMCA)
- Sovereign Immunity
- National Historic Preservation Act (NHPA) “Programmatic Agreement”
- Archaeological Resources Protection Act (ARPA)
- Abandoned Shipwreck Act
- National Marine Sanctuaries Act (NMSA)
- National Park Service Organic Act
- Marine Mammal Protection Act (MMPA)
- Endangered Species Act (ESA)
- Migratory Bird Treaty Act (MBTA)

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[7] Unlike emergency response activities, NEPA reviews will be necessary for proactive assessment and removal activities. The pending USCG Commandant Instruction #M16000.14, on Marine Environmental Protection will provide further guidance on NEPA issues in both emergency response and planning based scenarios.

- Magnuson Stevens Act (MSA) Essential Fish Habitat (EFH)

Contracting Issues

There may be several different contracts applied to different phases of an operation, especially a complex one that involves oil removal, diving, and pollution contractors. Generally, a professional salvor would conduct the wreck survey and oil extraction operations. Vessel removal is very unlikely for the majority of vessels identified in the RULET assessment due to cost, complexity, and historical significance. An oil spill response organization (OSRO) would typically be involved in spill preparedness, pollution abatement, and providing transport, storage, and disposal of removed oil in support of the overall assessment and oil removal operation for wreck.

There are eight basic types of contract strategies that may be applicable to oil removal operations, although several of these may not be appropriate for historic vessels or typically used by the U.S. Coast Guard:

- Basic Ordering Agreement (BOA) with Time and Materials Contingency;
- Pre-Negotiated Indefinite-Quantity Contracts with Time and Materials or Fixed- Fee delivery orders;
- Open Solicitation through Request for Quote (RFQ), Request for Proposal (RFP), or Tender with Time and Materials Contingency;
- Open Solicitation through Request for Quote (RFQ), Request for Proposal (RFP), or Tender with Fixed-Fee Contingency;
- Lloyd's Open Form (LOF);
- BIMCO[8]/ISU[9] International Wreck Removal and Marine Services Agreement (WRECKHIRE) 2010 (Daily Hire);
- BIMCO/ISU International Wreck Removal and Marine Services Agreement (WRECKSTAGE) 2010 (Lump Sum – Stage Payments); and
- BIMCO/ISU International Wreck Removal and Marine Services Agreement (WRECKFIXED) 2010 (Fixed Price – No Cure, No Pay).

A BOA may be applied by having the U.S. Coast Guard FOSC or Captain of The Port contract directly with oil removal, diving, and/or pollution control contractors as per previously arranged rates on a time and materials basis. While a BOA may be the most rapid process, it does not allow for a competitive bidding process, and it may not result in the employment of the best capabilities or the most effective response. Use of a BOA limits the possibility for evaluating a variety of approaches to the oil removal project and allows officials to inadvertently overlook candidates that may present particularly innovative, effectual, or cost-effective strategies. This form of contracting may be most appropriate for emergency operations to stem the sudden release of oil from a wreck, but may be suboptimal for a more complex planned removal operation.

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[8] The Baltic and International Maritime Council (BIMCO) is a shipping association whose main objective is to facilitate the commercial operations of its membership by means of developing standard contracts and clauses, and providing quality information, advice, and education. BIMCO is accredited as a Non-Governmental Organization (NGO) with all relevant United Nations agencies and other regulatory entities.

[9] International Salvage Union

Similar to a BOA but broader in scope and reach, pre-negotiated Indefinite Quantity Contracts are in anticipation of future actions, as yet unknown. They are competitively bid standing contracts. Delivery orders on pre-negotiated Indefinite Quantity Contracts can be executed very quickly with competitive labor and material rates. SUPSALV maintains a number of contracts to allow for worldwide pollution response and salvage very quickly. Delivery orders can be either Fixed-Fee or Time and Materials.

Open solicitation with competitive bidding for a specific individual response allows officials and decision-makers to consider a greater diversity of technical and strategic approaches and allows for the evaluation of the relative strengths, benefits, and costs of different proposals. The decision-makers can evaluate the degree to which the proposals address the complexities of the removal project, including the manner in which the risks for various contingencies have been addressed in the plans. The trade-off with using a competitive bidding and award process is that it is labor intensive and takes much more time to public into place. If a wreck isn't actively leaking, this should not be a constraint.

The proposal and ensuing contract can be executed with Time and Materials contingency, i.e., hourly/daily rates for personnel, equipment, logistics, etc., times the amount of time and resources required until the job is completed, or it can be executed with a Fixed-Fee contingency, i.e., a total fee that covers the costs of personnel, equipment, and logistics for the project regardless of actual time or resources that may eventually be required. There is some overlap in the two contract forms. Some Fixed-Fee contracts have contingencies for additional resources in the event of certain unexpected contingencies, and some Time and Materials contracts have certain limitations on time and resource allocations. In either case, there are likely to be issues regarding the actual time and resources involved in the operations compared with that proposed in the original RFQ. Underbidding on a Time and Materials contract by under estimating time involved followed by requirements for significantly more resources, or opting for the least expensive, but possibly not most effective strategy, can unintentionally increase costs in the long run. Acceptance of an underbid on a Fixed-Fee contract can also result in resources running out before the end of a complex operation, causing significant problems for both the contractor and officials. Realistic estimates on time and materials with a risk-based analysis of potential additional complications that might require more resources may be the best approach to controlling costs, as well as achieving an effective outcome.

A Lloyd's Open Form, formally Lloyd's Standard Form of Salvage Agreement, but more commonly referred to as LOF, is a standard legal document for a proposed marine salvage operation. The LOF is a common internationally used form of salvage agreement. The two-page contract is published by Lloyd's of London, and it is called "open" because no amount of money is stipulated for the salvage job. The compensation to be paid is determined later in London by a professional arbitrator. The fundamental premise of the agreement is "*no cure – no pay*." The arbitrator follows the English law of civil salvage in determining the salvage award. The value of the ship, its cargo, and freight at risk are taken into account when the arbitrator decides what the award should be, together with the extent of the dangers and the difficulty in effecting the salvage. This type of contract is generally used only for a recent wreck for which the vessel and its cargo need to be salvaged. It is unlikely to be applied in the case of a removal operation for a submerged historic wreck, though it may have applications for a recent wreck. In addition, a wreck may not be salvaged without the consent of the sovereign nation if that wreck is a public vessel from World War II or otherwise.

The Baltic and International Maritime Council (BIMCO)/International Salvage Union (ISU) standard marine services contract is among the most frequently used forms of salvage contract worldwide. There are three types of agreements: WRECKHIRE 2010 (Daily Hire), WRECKSTAGE 2010 (Lump Sum – Stage Payments) and WRECKFIXED 2010 (Fixed Price – No Cure, No Pay). WRECKHIRE 2010 contains provisions to encourage the swift conclusion of operations and resolve on-site disputes more quickly. It provides for a bonus-incentive scheme to limit the duration of the operation and decrease the daily rate if the operation goes beyond a specified period. WRECKSTAGE 2010 is a lump sum contract, with the payments in stages and the possibility of an additional payment in the event of delays in the work. WRECKFIXED 2010 is a lump sum agreement that is also no cure, no pay, providing the salvor with the incentive to get the work done as quickly as possible.

The International Convention on Salvage of 1989, known as the London Salvage Convention, replaced a convention on the law of salvage adopted in Brussels in 1910 and its "no cure, no pay" principle under which a salvor was only rewarded for services if the operation was successful. The 1989 Convention built upon the 1910 Convention in order to make provision for an enhanced salvage award taking into account the skill and efforts of the salvors in preventing or minimizing damage to the environment. (See Section 5 and summary of the London Salvage Convention.)

Attention to the manner of contracting and developing the best relationship between the contractors and officials is a crucial part of assuring the most cost-effective solution to oil removal projects. These factors are unrelated to the actual complexity of the operation with regard to risk factors, but can have significant impacts on overall project costs.

Cost Considerations

Introduction

The costs of oil removal from a wreck include:

- Planning and permitting costs;
- Spill response preparedness (necessary because of the risk of spillage during the removal operations);
- Spill response, if needed (lower costs than usual spill response due to on-site preparedness);
- Oil removal equipment and personnel;
- Federal/state oversight and supervisory equipment and personnel;
- Waste disposal; and
- Logistical support for personnel.

As with a spill response operation, the costs of oil removal operations will depend on a large number of factors pertaining to the technical details and complexity of the operation, as well as factors in the operating environment and the wreck itself. Each oil removal operation will represent a unique situation with unique challenges. There are, however, certain general rules of thumb that can be drawn from past removal operations. These cost factors are summarized in Table 4-3.

Table 4-3: Assessing cost factors of oil removal operations circa 2012.

Operation Complexity	Waters	Depth (ft.)	Oil Viscosity	Water Temp.	Wreck Condition	Vessel Factors	Mobilize Distance	Cost Range
Simple	Protected	65	Low	Higher	Good	Lesser age Optimal construction Less damage Heavy plating Low location sensitivity	Local	$1-5M
Moderate	Weather or sea issues	65 - 164	Medium	Medium	Moderate	Moderate age Good construction Moderate damage Heavy plating Moderate location sensitivity	Regional	$2-7M
Complex	Open	164 - 820	High	Lower	Poor	Great age More structural damage High location sensitivity	Distant	$5-20+M
Highly Complex	Open	> 820	High	Very Low	Very Poor	Greatest age Poor construction Highest damage Lesser plating Highest location sensitivity	Distant	$20-100+M
⟷ **Interrelated Factors**								

Costs tend to increase with complexity of operations, which is correlated with increased water depth, increased sea state, higher, oil viscosity, decreasing water temperature (which also increases viscosity and lowers water temperature), poor wreck condition, and greater mobilization/logistics distances.

The wreck location can have a significant effect on costs. Greater mobilization distances for logistics and equipment can increase costs. Work in offshore locations with high sea states requires more substantial and expensive moorings and work platforms. At the same time, the costs for work in more sheltered waters, while involving less expensive equipment overall, may also be affected by local vessel traffic, fishing areas, and may have more sensitive resources at risk. Local or national laws may affect the selection and use of foreign salvors, labor, equipment, and vessels, which can have a significant effect on costs. Because of the unique features and circumstances of each wreck there is often the need for custom engineering, such as the manufacturing of specific drill bits. The need to manufacture custom equipment can increase costs.

Cost Trends

Much like with oil spill response, planners often want to estimate the costs based on a simple factor, particularly the volume of oil involved. And much like with oil spill response, there is no reliable and universal per-barrel cost that can easily be applied. In fact, the cost of removal per barrel of oil removed tends to decrease with the number of barrels removed, as shown in Figure 4-5.

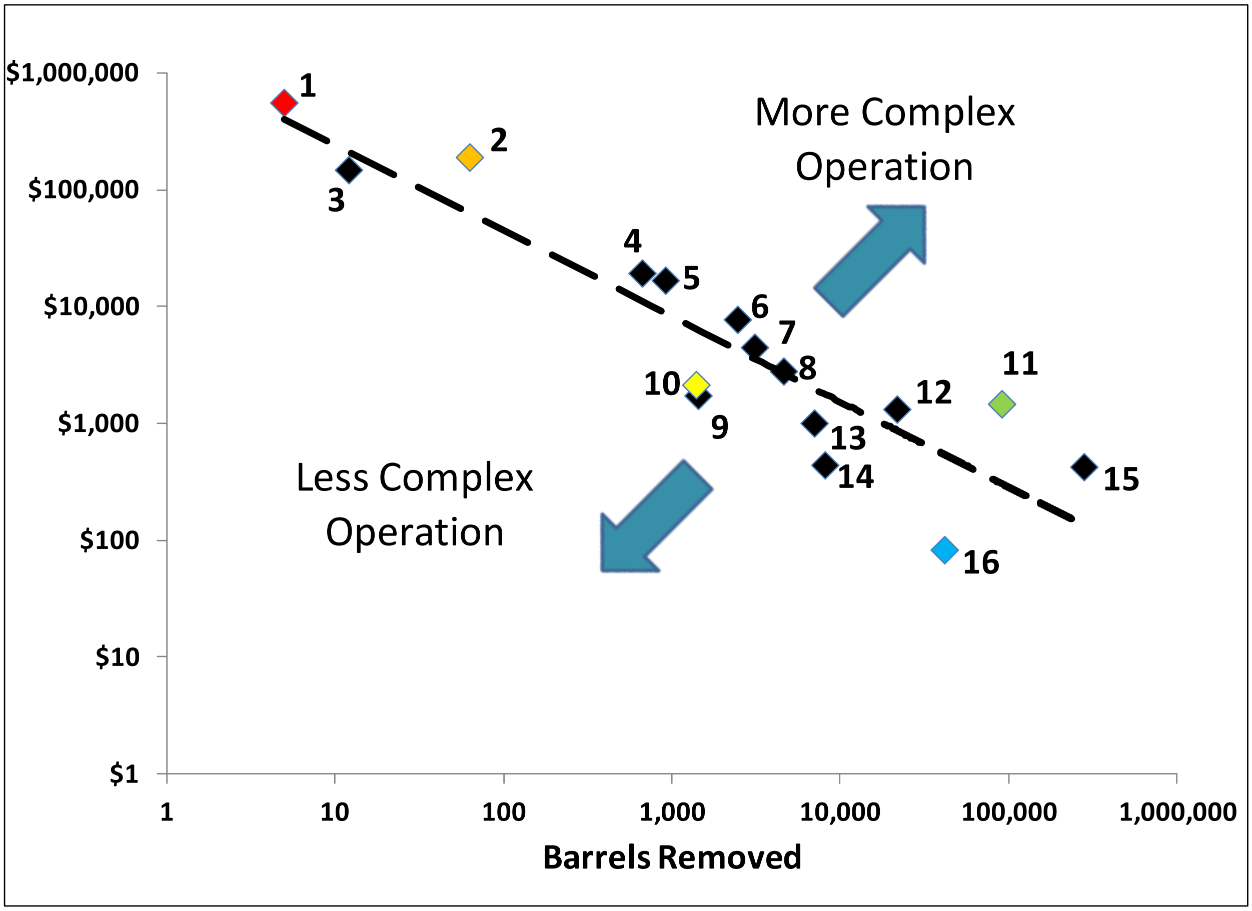

Figure 4-5: Cost of removal operations per barrel oil removed. The most expensive costs per-bbl of oil removed operations are on the left with the *Mwaalil Saat* (in red). The *Prestige* (in blue) was extremely complex. The USS *Mississinewa* (in green) and the *ex*-USS *Chehalis* operation (in yellow) cost less than the trend per bbl, due in part to the use of government resources.

There is an economy of scale in most operations. Just setting up the equipment, personnel, and logistics for even a small operation involving a relatively small removal can be as costly overall as a larger operation with more oil removed. This is a rough evaluation of a dozen recent cases. (With more data points, the results may be somewhat different.)

The cases that are more complex for one reason or another tend to be above the line, less complex below. Again, there are many factors involved in determining the final cost of an operation. In general, good pre-planning helps to reduce costs, but as with a medical surgery, it is difficult sometimes to know exactly what will happen until the operation is underway. The most expensive per-barrel of oil removed operations of the sampling of operations represented in the graph are on the left with the *Mwaalil Saat* (shown in red in Figure 4-5), which included removal of the entire vessel, and the *Solar I* operations (shown in orange), which only netted 5 and 63 bbl of oil respectively, but cost $2.78M and $190,000 per bbl. The T/V *Prestige* presented unique challenges with regard to depth was a complex operation that cost $1,600 per bbl (shown in green). The USS *Mississinewa* operation (shown in blue), on the other hand, cost $83 per bbl removed, despite the extreme remoteness of the location. The ex-USS *Chehalis* (shown in yellow) operation cost less than the trend per bbl. For both of these operations, U.S. government personnel and assets made the overall costs lower. In the case of the *Mississinewa* operation (outlined in green), Navy SUPSALV provided personnel, a diving support platform, two tug and barge pairs, oil removal and pollution response equipment such as hot taps, among other material. In general, more complex operations will cost more, on average, per barrel removed. Sample removal operation costs are shown in Table 4-4.

Table 4-4: Sample of oil removal operation costs.

Vessel	Year	Location	Factors in Case	Oil Removed (bbl)	Total Cost	Per Bbl Cost	Figure 4-5 Number
Montebello	2011	California	Crude Oil >850 ft. World War II loss, 50-year old wreck	Assessment Only	$3.4M	Assessment Only	--
Davy Crockett	2011	Washington	HFO Shallow (not submerged) Removal of entire vessel	914	$15.5M	$17,000	5
ExUSS *Chehalis*	2010	Amer. Samoa	Diesel/aviation gas 120 ft. depth 61-year old wreck	1,430	$2.5M	$1,750	10
Princess Kathleen	2010	Alaska	HFO, Hydrogen sulfide 134 ft. depth Poor vessel condition (rivets)	2,620	$14.0M	$5,344	7
Don Pedro	2008	Spain	HFO 150 ft. depth	1,400	$3.0M	$2,143	9
Solar I	2006	Philippines	Crude 2,100 ft. depth; Recent wreck	63	$12.0M	$190,480	2
Palo Alto	2006	U.S.	Waste oil Not completely submerged 73-year old wreck Concrete construction	12	$1.8M	$150,000	3
Mwaalil Saat	2005	Mariana Islands	Waste oil Not completely submerged Recent wreck	5	$13.9M[10]	$2.78M	1
Prestige	2004	Spain	HFO 12,000 ft. depth Recent wreck; broken in two	91,000	$132.6M	$1,460	11

[10] Includes wreck removal

Table 4-4: Cont.

Vessel	Year	Location	Factors in Case	Oil Removed (bbl)	Total Cost	Per Bbl Cost	Figure 4-5 Number
USS *Mississinewa*	2003	Micronesia	HFO Shallow depth Accessible tanks; Low complexity	42,000[11]	$3.5M	$83	16
Jacob Luckenbach	2002	California	HFO 175 ft. depth; 49-year old wreck Highly sensitive location	2,450	$19.2M	$7,836	6
Ehime Maru	2001	Hawaii	Diesel 2,000 ft. depth Recent wreck Poor vessel condition Removal of 9 bodies	665	$13.0M	$19,550	4
Osung No. 3/Yuil No. 1	1998	Korea I	HFO 230 ft. depth, Recent wreck Sensitive aquaculture nearby	4,600	$13.0M	$2,826	8
Irving Whale	1996	Canada	PCBs 220 ft. depth; 26-year old wreck	21,700	$29.0M	$1,366	12
T/B *Cleveco*	1995	Lake Erie	HFO 70 ft. depth; 50-year old wreck	8,100	$3.6M	$444	14
KMS Blücher	1994	Norway	HFO 300 ft. depth; 54-year old wreck, combat loss WWII	7,000	$7.1M	$1,014	13
Betelgeuse	1979	Ireland	Crude 100 ft. depth Explosion/fire damage Recent wreck	280,000	$120.0M[12]	$430	15

Trade-Offs

Important considerations in determining a course of action for a potentially polluting wreck are the resources at risk and the costs involved in an oil removal operation or other alternatives. The costs of an assessment or a removal action need to be compared with the benefits of such a response, i.e., the mitigation of potential environmental and socio-economic damages, as well as spill response costs that would be saved if the threat were removed. It is important to consider that, for many wrecks, the most likely discharge scenario is one of chronic or episodic discharges that may result in multiple or continuous responses and ongoing and cumulative natural resource damages.

[11] The removal cost estimate is for oil only, not oily water (7%).
[12] Includes wreck removal

A pro-active oil removal project for a wreck should involve an evaluation of the costs and damages associated with the operation versus a leave-alone approach. It is important to remember that the costs of monitoring for a leave-wreck-as-is approach will be ongoing, as will the costs and damages associated with any major oil release or chronic and episodic spills that may occur over time. Decision-makers should bear in mind that there may be repeated spill responses that have to be factored into the analysis. An example of this is the case of the *Jacob Luckenbach* in which there were several spills that occurred over the course of 10 years, with millions of dollars in cleanup costs and over 51,000 birds of more than 50 species oiled. In other cases, the complexity of the oil removal operations and consequent costs of the operations may exceed the costs of continuous spill response and preparedness, as well as potential ecological and socio-economic damages that might occur.

If there is a high probability of spillage, as determined by an analysis of vessel wreck factors and site surveys, the cost of a removal operation can then reasonably be compared with the costs of spill response, as well as the ecological and socio-economic damages that might occur from one or more spills that might occur from the wreck. The actual costs involved on either side of the comparison between oil removal operation and spill response will depend on the specifics of the case. Beyond the fiscal costs of a response, there are often significant and less tangible costs with a loss of trust between state and federal response agencies and coastal communities. This shift can come from fear about the safety of seafood, concerns about socio-economic impacts, and concerns about health risks from response alternatives. Another element to consider under the leaving a wreck "as is" option, is that corrosion increases and wreck integrity degrades over time making it more vulnerable to any additional physical impacts such as hung-up fishing nets, stray anchors or aggressive wreck divers. Future oil removal costs are likely to increase significantly as complexity of removal and potential for incidental spills increases.

For a particular wreck, the most comprehensive method for comparing the costs of oil removal from a wreck versus spill response is to simulate or model the potential spillage and evaluating the costs and damages of the spill, as well as the potential costs for responding to the spill. This type of analysis could be an extension of the modeling conducted for the individual wrecks in the current project, albeit with more specific details on costs and impacts of specific spill scenarios.

SECTION 5: LEGAL CONSIDERATIONS FOR POTENTIALLY POLLUTING WRECKS

Legal Issues

Purpose and Scope

There are a number of legal questions that may arise under U.S. and international law in addressing the concerns presented by a sunken vessel that is a potential threat to the marine environment. The purpose of this section is to identify those U.S. and international laws and identify potential legal issues that are of particular interest to federal response agencies but not to provide a comprehensive legal assessment. The Oil Pollution Act (OPA) is the primary authority in the cleanup of polluting vessels, while other laws may be applicable and other issues that may arise in certain cases when implementing OPA. A discussion of the treatment of historically significant wrecks under U.S. historic preservation laws in general and under U.S. laws establishing and regulating federal marine protected areas, such as National Parks and National Marine Sanctuaries for historic shipwrecks in those marine protected areas is also included. A survey of the domestic and international laws regulating the treatment of sovereign immune vessels, such as warships and other non-commercially operated government owned vessels are important as many of these vessels are the final resting places and OPA funding is not always available for government vessels. This legal context is not intended to be a comprehensive analysis or legal advice because such an analysis should be conducted on a case-by-case basis by the appropriate legal counsel in the agency with authority to implement the particular statute or agreement at issue. Within the RULET assessments, thirteen different flag states are represented with 56 American flagged vessels. The second most common flag state is Panama with seven vessels. In addition, a number of vessels are associated with World War I, World War II, and Korean War activities for the United States, the United Kingdom, or Japan.

Domestic Laws

U.S. Marine Environmental Laws Addressing Potentially Polluting Vessels

OPA, the principal statute governing oil spills in U.S. waters, was added as an amendment to the Clean Water Act in 1990 in the wake of the March 1989 *Exxon Valdez* oil spill. The statute establishes liability for injury to, destruction of, loss of, or loss of the use of the public's natural resources and designates Federal, State, and tribal natural resource trustees to recover natural resource damages as the result of oil spills. These damages include: the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of the damaged resources; the reasonable cost of assessing those damages; and the diminution in values of those natural resources pending restoration. Cultural resources are not yet addressed in OPA. OPA also contains limitations on liability for damages to natural resources resulting from oil pollution by the parties responsible, and it establishes a fund for the payment of compensation for such damages when the responsible party is unable or unwilling to do so. OPA also increased the penalties for regulatory noncompliance; broadened the response and enforcement authorities of the Federal government; and preserved State authority to establish law governing oil spill prevention and response.

The Clean Water Act provides the President with the authority, delegable to a U.S. Coast Guard FOSC, to ensure effective and immediate removal of a discharge, and mitigation or prevention of a substantial threat of discharge, of oil or other hazardous substance in U.S. navigable waters and out through the U.S. EEZ.[13] Under this authority, the FOSC has the discretion to (1) remove or arrange for the removal of a discharge, and mitigate or prevent a substantial threat of a discharge at any time; (2) direct or monitor all actions to remove a discharge; and (3) remove, and if necessary, destroy a vessel discharging or threatening to discharge by whatever means are available.[14] When a discharge or substantial threat of a discharge is determined to be of such a size and character so that it poses a substantial threat to the public health or welfare of the United States, the U.S. Coast Guard, through its appointed FOSC, directs actions to remove the discharge or to mitigate or prevent the threat of the discharge.[15] If the discharge does not pose a substantial threat to the public health or welfare of the United States, then the FOSC is not required to direct all the removal or mitigation actions and can instead allow the responsible party to volunteer and perform the removal or mitigation actions.[16] Those actions, however, must be approved of by the FOSC in order to ensure that the removal or mitigation is effective and immediate.[17]

If the vessels in the RULET database are determined by the FOSC to be a “substantial threat” then funding from the Oil Spill Liability Trust Fund (OSLTF) under OPA would be available for assessment and recovery activities. In general, the OSLTF cannot be used for monitoring activities associated with potentially polluting wrecks.

U.S. Law Regarding Wrecked Vessels and Barges

Both the Wreck Act and the Abandoned Barge Act regulate the removal of sunken vessels that pose a threat to navigation. Whereas OPA establishes liability for the discharge or potential discharge of oil from a ship or potentially polluting wreck, these two wreck removal statutes provide the authority to require the removal of sunken vessels. Typically these authorities are more relevant for derelict and abandoned vessels rather than the vessels in the RULET database.

Wreck Act and the Rivers and Harbors Act of 1899

Under Section 15 of the Rivers and Harbors Act of 1899,[18] known as the Wreck Act, the owner or operator of a sunken vessel is responsible for immediately marking that vessel with a buoy or beacon during the day and a lighted lantern at night. The markings must remain until the vessel is removed. The owner or operator is also required to "diligently" commence "immediate" removal of the sunken

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[13] 33 U.S.C. § 1321 (c)(1)(A) (2011).
[14] *Id.* § 1321(c)(1); The President’s authority under § 1321 (c) has been delegated to the Coast Guard for the “coastal zone” and the EPA for discharges in the “inland zone.” *See* Executive Order 12777 § 3, 56 Fed. Reg. 54757 (Oct. 22, 1991). “Inland zone” and “coastal zone” are defined in the National Contingency Plan (NCP). “Inland zone” is defined as “the environmental inland of the coastal zone excluding the Great Lakes and specified ports and harbors on inland rivers” and “coastal zone” is defined as “all United States waters subject to the tide, United States waters of the Great Lakes, specified ports and harbors on inland rivers, waters of the contiguous zone, other waters of the high seas subject to the NCP, and the land surface or land substrata, ground waters, and ambient air proximal to those waters.” *See* 40 C.F.R. § 300.5 (2011).
[15] *Id.* § 1321(c)(2)(A).
[16] 40 C.F.R. § 300.305(d) (2007).
[17] *Id.*
[18] 33 U.S.C. §§ 409-415 (2011).

vessel. If the vessel is not removed within thirty days it will be considered abandoned under this Act[19] and the U.S. Army Corps of Engineers (USACE), may take action to remove the vessel from the navigable channel.[20] The determination of whether a wreck poses an obstacle to navigation rests initially with the USACE and a reviewing court will only overturn the determination if the decision is found to be arbitrary and capricious.

If the government determines that the existence of the submerged or wrecked vessel in the navigable waters of the United States is creating an emergency situation, the vessel owner, lessee, or operator will be given twenty-four hours to begin removal of the vessel using the most expeditious method available. If the vessel is not removed or steps are not taken in an expeditious manner to secure the vessel's removal, the government may intercede to remove or destroy the vessel to alleviate the situation. The vessel owner, lessee, or operator will then be liable to the United States for all costs associated with the government's action. If the owner fails or refuses to reimburse the government within 30 days after notification, the vessel may be sold with the proceeds going to the U.S. Treasury.[21]

Abandoned Barge Act

Separate authority exists to remove sunken barges that are abandoned in the navigable waters of the United States under the Abandoned Barge Act of 1992.[22] Whereas the primary focus of the Wreck Act is on hazards to navigation, the Abandoned Barge Act was primarily enacted out of the concern that abandoned barges were essentially being used as dump sites for hazardous wastes. In order to prevent so-called "midnight dumping" and to make the abandoned barge owner liable for removal costs, the Abandoned Barge Act made it illegal to abandon barges greater than 100 gross tons in the navigable waters of the United States. Specifically, if barges are sunk, moored, stranded, or wrecked for longer than thirty days in violation of the Abandoned Barge Act, the owner or operator is liable for up to $1,000 per day of the violation. The government is authorized to remove the barge, after public notice in either a notice to mariners or an official journal in the county in which the barge is located, at the owner's expense.

U.S. Laws Protecting Historically Significant Vessels

In almost all cases, the historic significance of a particular wreck will not prevent cleanup efforts but may add additional process or requirements to address the underlying concern.[23] The additional requirements vary depending on the historic preservation laws applicable to a particular wreck site. Three factors to consider in determining what, if any other historic preservation laws apply are—the location of the wreck site, the owner of the vessel and, in the case of public vessels, whether or not it was a warship or on government, non-commercial service at the time of its sinking.

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[19] Abandonment under the Rivers and Harbors Act to address a hazard to navigation is not necessarily abandonment under the Abandoned Shipwreck Act, which addresses title and ownership.
[20] *Id.* § 414.
[21] *Id.* § 415(a)-(c).
[22] 46 U.S.C. §§ 4701-05 (2011).
[23] The USS *Arizona* being an example where measures to address the threat to the marine environment from leaving bunker fuel have been much less aggressive for a number of reasons including its historical significance and its protection and management as the resting place for those who lost their life on board (e.g., a grave site).

Federal Archaeology Program

The Federal Archaeological Program was developed by the National Park Service to implement various historic preservation laws in the terrestrial environment and is adhered to by federal agencies, such as the Bureau of Ocean Energy Management (BOEM), NOAA, and the U.S. Navy, when carrying out activities in the marine environment. The Antiquities Act of 1906 provided the legal foundation for the Federal Archaeological Program, but it is Section 106 of the National Historic Preservation Act of 1966 (NHPA) that is of primary interest in addressing federal activities directed at a potentially polluting wreck that may also be of some historical significance. Using the fifty year "rule of thumb," if the wrecked vessel is at least fifty years old, it may be considered a "historic property" under the NHPA.

The primary purpose of the NHPA is preservation through various Federal procedures and requirements. In their respective land management programs, federal agencies are to identify historic properties, such as prehistoric or historic districts, sites, buildings, structures or objects subject to their jurisdiction and control and determine whether they are eligible for inclusion in the National Register of Historic Places.[24] In carrying out their respective federal authorities and missions, the NHPA requires all federal agencies to consider the effects of their "undertakings" on historic properties or resources that are either eligible for listing or are listed on the National Register of Historic Places.[25] The NHPA requires consultation with State Historic Preservation Office for undertakings on federal lands, waters, and submerged lands, and for projects using federal dollars. The purpose of the consultation is to avoid adverse effects of the federal undertaking to the historic property, generally by avoiding, minimizing, or mitigating the adverse effects of the federal undertaking. There may also be state and local laws that apply in regard to a wreck, particularly if it is an abandoned shipwreck of historical significance.

The regulations for Section 106 allow an agency to fulfill its "Section 106 responsibilities for a particular program, a large or complex project, or class of undertakings . . . through a Programmatic Agreement."[26] In 1997, several federal departments and agencies[27] entered into the Programmatic Agreement on Protection of Historic Properties During Emergency Response Under the National Oil and Hazardous Substance Pollution Contingency Plan, to create a more streamlined alternative to the Section 106 review process while continuing to ensure that historic properties are properly considered during an emergency

[24] In order to be eligible for inclusion the historic property must be at least fifty years in age and must meet at least one of four categories: (a) associated with events that have made a significant contribution to the broad patterns of our history; (b) associated with the lives of persons significant in our past; (c) embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or (d) that have yielded, or may be likely to yield, information important to prehistory or history.
[25] 16 U.S.C. § 470(f) (2011).
[26] 36 C.F.R. § 800.13(e) (2004).
[27] The signatories to the Programmatic Agreement include the Advisory Council on Historic Preservation; National Conference on State Historic Preservation Officers; U.S. Environmental Protection Agency; U.S. Department of the Interior; U.S. Department of Transportation, Coast Guard; National Park Service; U.S. Department of Commerce, National Oceanic and Atmospheric Administration; U.S. Department of Energy; U.S Department of Defense; and U.S. Department of Agriculture. The Programmatic Agreement was signed by the director of specific offices in several of these agencies—for example, from the Department of the Interior, the Director of the Office of Environmental Policy and Compliance sign the Programmatic Agreement. As such, it is unclear whether the Programmatic Agreement applies exclusively to DOI's Office of Environmental Policy and Compliance or whether the Programmatic Agreement applies to all of DOI, including BOEM.

response to a hazardous substance release or spill.[28] The Programmatic Agreement called for the development of Area Contingency Plans, which required FOSCs to consult with State Historic Preservation Officers, Federal land-managing agencies, and other interested parties as part of the pre-incident planning process. These Area Contingency Plans ideally include a list of historic properties located within a particular area; a list of geographic areas where historic properties are unlikely to be affected in the event of spill in that location; a list of parties to be notified in the event of spill; and emergency response strategies for historic resources in that area.

As all but two of the vessels that had risk assessments developed for this study are over 50 years old, over half are greater than 75 years old, and seven are over 100 years old, many of these vessels are eligible for protection as significant historical and cultural resources.

Abandoned Shipwreck Act and State Historic Preservation Laws

Historically significant vessels located in state "submerged lands"—generally extending out three nautical miles[29] from the "coastline" or low-water line—may be subject to the Abandoned Shipwreck Act of 1987[30] and implementing state laws. Under the Abandoned Shipwreck Act, the federal government claimed title to all wrecks meeting the Act's qualifications and then transfers that title to the respective state or territorial government.[31] It is then left to the respective state or territorial government to determine how to legislate to protect those wrecks. Under the Abandoned Shipwreck Act the threshold consideration is whether a vessel is abandoned. The criteria for the transfer of title for abandoned vessels under the Act is: (1) the wreck is embedded in state submerged lands; (2) the wreck is in a protected coralline formation; or (3) the wreck is listed in the National Register of Historic Places or determined to be eligible for inclusion on that list.[32] Laws protecting historically significant vessels located within state submerged lands may vary greatly.[33] In addition to the Abandoned Shipwreck Act and related state laws, there may be federal laws that apply to certain wrecks because of where the wreck is located.

Antiquities Act and Federally Protected Marine Areas

The geographic scope of the Antiquities Act includes sites in the marine environment that are in or on federally owned or controlled submerged lands, such as national parks and sanctuaries, or the federally controlled outer continental shelf.[34] The Antiquities Act has three main components: (1) it provides the authority for the President to proclaim the establishment of national monuments on lands owned or controlled by the federal government; (2) it makes it unlawful for any person to appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity on lands owned

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[28] *See infra* Appendix D.
[29] For the Texas and the Gulf side of Florida, state submerged lands extend out to nine nautical miles from the low-water mark.
[30] 39 U.S.C. §§ 2101-06 (2011).
[31] *Id.* §§ 2101(a), 2105(c).
[32] *Id.* § 2105(a).
[33] *See infra* Appendix X for summary of laws of several coastal states.
[34] *See* DOJ Office of Legal Counsel Opinion (September 15, 2000) (finding that the Antiquities Act authority can be used to establish a National Monument in the marine environment off the coast of Hawaii extending out fifty nautical miles beyond the territorial sea and contiguous zone onto the continental shelf). Because the national monument provision can be used to establish national monuments on the continental shelf, the permitting provision may also apply to the continental shelf.

or controlled by the United States; and (3) it authorizes, through the issuance of permits, the examination of ruins, the excavation of archeological sites, and the gathering of objects of antiquity on lands owned or controlled by the United States.[35]

Section two of the Antiquities Act, which allows the President to establish national monuments, affords protection to historically significant wrecks located within areas given National Monument status.[36] Any activities conducted within the National Monument must be approved by the agency administrating the National Monument. It is through this process that the historically significant wrecks located within the Channel Islands National Monument[37] and Papāhanaumokuākea Hawaiian Islands National Monument are protected. Therefore, if a potentially polluting wreck is located within a National Monument, a permit from the agency administering the National Monument may be required before response activities can be conducted at the wreck site. A permit may also be required for potentially polluting wrecks located outside a National Monument but on federally owned or controlled land, such as in a national park, national marine sanctuary, or national seashore if the particular wreck is considered an object of antiquity as established in Section one of the Antiquities Act.[38]

National Marine Sanctuaries Act

Historically significant vessels located within a National Maritime Sanctuary are also afforded protection through the National Marine Sanctuary Act and the guidelines established in each sanctuary's management plan. Originally enacted as Title III of the Marine Protection, Research and Sanctuaries Act of 1972, the National Marine Sanctuaries Act (NMSA)[39] authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities as national marine sanctuaries. Day-to-day management of national marine sanctuaries has been delegated by the Secretary of Commerce to NOAA's Office of National Marine Sanctuaries. The primary objective of the NMSA is to protect marine resources, such as coral reefs, sunken historical vessels, or unique habitats.

The NMSA provides several tools for protecting designated national marine sanctuaries. For example, the NMSA provides the program with the authority to issue regulations for each sanctuary and the system as a whole. These regulations can, among other things, specify the types of activities that can and cannot occur within the sanctuary.[40] The NMSA requires the program to prepare and periodically update management plans that guide day-to-day activities at each sanctuary.[41] The NMSA authorizes NOAA and the program to assess civil penalties[42] (up to $140,000 per day per violation) for violations of the NMSA

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[35] 16 U.S.C. §§ 431-33 (2011).
[36] *Id.* § 431.
[37] This site is now managed as Channel Islands National Park, and the marine portion is overlapped by the Channel Islands National Marine Sanctuary.
[38] *Id.* § 432.
[39] 16 U.S.C. §§ 1431 to 1445c-1 (2011).
[40] 16 U.S.C. § 1439.
[41] 16 U.S.C. § 1434(a), (e).
[42] The $100,000 statutory maximum civil monetary penalty under the National Marine Sanctuaries Act (NMSA), 16 U.S.C. § 1437(d)(1), has been adjusted for inflation pursuant to the Federal Civil Penalties Inflation Adjustment Act

or its implementing regulations and allows for the assessment of damages for the destruction, loss, or injury to sanctuary resources the sum of which is to equal "the amount of response cost and damages resulting from the destruction, loss, or injury" plus interest.[43]

The NMSA requires federal agencies whose actions are "likely to destroy, cause the loss of, or injure a sanctuary resource," to consult with the National Marine Sanctuaries Office before taking the action. The Sanctuaries Office is, in these cases, required to recommend reasonable and prudent alternatives to protect sanctuary resources and may have site-specific regulations about disturbance of the seabed, or discharge and deposit of materials that could occur during assessment and recovery activities.[44] Thus, potentially polluting historic wrecks in national marine sanctuaries are subject to the NMSA as well as OPA and the NHPA. Assessment and recovery activities, therefore, requires consultation and coordination among all the interested parties prior to any on-water actions unless they are occurring in an emergency context. To a large extent that consultation and coordination has been addressed in the Section 106 NHPA Programmatic Agreement discussed above.[45] If the potentially polluting wreck is a warship or other kind of public vessel, that vessel may be subject to sovereign immunity and additional consultation and permitting may be required. At least five vessels that had risk assessments developed are considered public vessels, with likely sovereign immunity. Although for some that determination will take some untangling such as the Panamanian flagged vessel, *Norness*. It was chartered to the United States Maritime Commission and operated by the British Ministry of War under the Lend-Lease Act. All ocean vessels under the flag or control of the United States were seconded to the War Shipping Administration during World War II under Executive Order 9054, February 7, 1942. Whether all those vessels would be considered public vessels, will have to be determined on a case by case as to whether the War Shipping Administration or another federal agency controlled the vessel at the time of the casualty as many were chartered out if not needed.

Public Vessels and Sovereign Immunity under U.S. Law

Warships and vessels owned and operated by the U.S. Government or foreign governments and used only for government noncommercial service are subject to sovereign immunity. Therefore, the policies regulating sovereign immune vessels should be considered when carrying out the obligations created under OPA. Under domestic law, the doctrine of sovereign immunity can be traced back to early English common law where the sovereign was immune from suits by his or her subjects unless the sovereign consented to the suit. There is also a principle in public international law that the government of one state or nation is generally immune from arrest and from being subject to enforcement of the laws of another state without its consent. This immunity of the sovereign extends to the property of the respective sovereign governments, including sovereign or public vessels. In the U.S., this doctrine was upheld by the Supreme Court in the landmark case *Schooner Exchange v. McFaddon*.[46]

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of 1990 (Publ. No. 101-410), as amended by the Debt Collection Improvement Act of 1996 (Publ. No. 104-134), which requires each agency to issue regulations to adjust all civil monetary penalties established by law and assessed or enforced by the agency. As of March 16, 2011, the statutory maximum civil monetary penalty was at $140,000.

[43] 16 U.S.C. §§ 1436, 1437, 1443.

[44] 16 U.S.C. § 1434(d).

[45] *See supra* XXX.

[46] 11 U.S. 116 (1812).

The consent of the foreign flag state is generally sought before salvage, recovery, or intrusive activities are conducted.

Public Vessels and Waiver of Sovereign Immunity

U.S. publically owned vessels are not subject to arrest, and legal actions may not be commenced against the United States or its agencies by private parties with respect to such vessels unless such legal actions are in accordance with an express waiver of sovereign immunity by the U.S. Government. Certain legal actions by private parties in U.S. courts against other U.S. or foreign vessels entitled to sovereign immunity may also be precluded as a matter of international or domestic law. In 1916, Congress created one such waiver when it enacted the Shipping Act. Under the Shipping Act, a private shipowner was allowed to recover damages from the United States for damage caused to that private shipowner's vessel by a vessel owned by the United States and employed as a merchant vessel at the time the damage occurred.[47]

It was unclear in the Shipping Act whether the waiver of sovereign immunity allowed a private shipowner to seize or arrest a U.S. owned vessel in an admiralty proceeding. When the Supreme Court ruled in *Lake Monroe* that this waiver did allow the seizure or arrest of a U.S. owned vessel,[48] Congress passed the Suits in Admiralty Act in 1920 in order to avoid the embarrassment and expense of having a U.S. owned vessel seized or arrested.[49] Under the Act "a civil action in admiralty *in personam* may be brought against the United States or a federally-owned corporation." However, that waiver of sovereign immunity extended only to actions that would have existed had the vessel been privately owned or operated. Additionally, Congress did not extend that waiver of sovereign immunity to enforcement by foreign states: "This [Act] does not affect the right of the United States to claim immunity of a vessel or cargo from foreign jurisdiction."[50]

Because the government did not want this waiver to extend to the seizure or arrest of U.S. owned or operated vessels, the Act exempted from arrest or seizure any "vessel owned by, possessed by, or operated by or for the United States or a federally-owned corporation." Claimants could, however, pursue actions related to other *in rem* liabilities so long as those actions would have been available had a private party caused the damage.[51] Because sovereign immunity was waived for actions already existing in admiralty law, the Suits in Admiralty Act entitled the United States "to the exemptions from and limitations of liability provided by law to an owner, charterer, operator, or agency of a vessel" that also already existed in admiralty law.[52]

At the time of its passage, the Suits in Admiralty Act applied only to government owned or controlled merchant vessels.[53] Those vessels did not have to be actively employed as a merchant vessel in order for

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[47] *See* Canadian Aviator v. United States, 324 U.S 215, 219 (1945).
[48] *See* Lake Monroe, 250 U.S. 246 (1919).
[49] *Canadian Aviator*, 324 U.S at 219 (1945).
[50] 46 U.S.C. § 30915(d) (2011).
[51] E. Transp. Co. v. United States, 272 U.S. 675, 692-93 (1927).
[52] 46 U.S.C. § 30910 (2011).
[53] *Canadian Aviator*, 324 U.S at 220-21 (1945). In 1960, Congress eliminated the phrase "[p]rovided that such vessels is employed as a merchant vessel" from the Suits in Admiralty Act. However, the Supreme Court, in *United*

an action to be filed under the Act; all that was required was that "the vessel belong[ed] to th[e merchant] class as distinguished from one employed in government service."[54] Therefore, the Suits in Admiralty Act provided for an action against the United States for damaged caused by active government owned or controlled merchant vessels and damage caused by the wrecks of former merchant vessels.[55] Although Congress had contemplated extending the waiver of sovereign immunity to public vessels in addition to merchant vessels, there was some fear that inclusion of public vessels would delay passage of the Act.[56]

In 1925, Congress enacted the Public Vessels Act thus extending the waiver of sovereign immunity to public vessels. Under the Public Vessels Act, the United States allowed for the filing of a "civil action *in personam* in admiralty . . . against the United States for . . . damages caused by a public vessel of the United States."[57] Like the Suits in Admiralty Act, the Public Vessels Act retained the United States' sovereign immunity from arrest and seizure, but provided for a waiver of sovereign immunity from actions based on other *in rem* principles.[58] Similarly, the purpose of the Public Vessels Act was to impose the same kind of liability on the United States that admiralty law imposed on private ship owners; therefore, the act did not create new rights of action against the United States but instead waived the United States immunity from those actions existing under admiralty law. This waiver of liability was also extended to foreign nationals but only if "it appears to the satisfaction of the court in which the action is brought that the government of that country, in similar circumstances, allows nationals of the United States to sue in its courts."[59] Waiver from suit was not restricted to cases in which the "public vessel was the 'physical instrument' by which the 'physical damage' was done."[60] For example, the United States would be liable for damage caused by the negligence of a crewmember on a public vessel that caused damage to cargo so long as the principles of admiralty law would have imposed liability had private actors been involved. As in the Suits in Admiralty Act, under the Public Vessels Act "the United States is entitled to the exemptions from and limitations of liability provided by law to an owner, charterer, operator, or agency of a vessel."[61]

Although the Public Vessels Act does not define "public vessels," Congress intended the Public Vessels Act to be the public counterpart to the Suits in Admiralty Act. Therefore, any vessels owned or operated by the United States that did not belong to the merchant class were public vessels.[62] Under the Public

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States v. United Continental Tuna Corp., held that Congress still intended the Suits in Admiralty Act to apply only to merchant vessels, and that Congress had eliminated the term "employed as a merchant vessel" to ensure that all vessels employed as merchant vessels, regardless of the nature of the cargo, fell within the scope of the Suits in Admiralty Act. 425 U.S. 164, 174 (1976).

[54] *E. Transp. Co.*, 272 U.S. at 692.

[55] *Id.*

[56] *Canadian Aviator*, 324 U.S. at 220-21.

[57] 46 U.S.C. § 31102 (2006).

[58] *Canadian Aviator*, 324 U.S at 226-27.

[59] 46 U.S.C. § 31111 (2006).

[60] *Canadian Aviator*, 324 U.S at 222 (1945).

[61] 46 U.S.C. § 31106 (2006).

[62] Note that if a vessel is determined to be a public vessel, "jurisdiction may be either in admiralty under the Public Vessels Act or under the Tucker Act, depending on the nature of the claim." United States v. United Cont'l Tuna Corp, 425 U.S. 164, 180 (1976). A claim against the United States is brought under the Tucker Act, if the action is based on an express or implied contract or for damages not arising in tort; additionally, a Tucker Act claim has a limit of $10,000. 28 U.S.C. §§ 1346(a)(2), 1491 (2011).

Vessels Act, courts have found that government ownership of a vessel and government use of that vessel for a public purpose is enough to establish the vessel as a public vessel.[63] Government owned vessels that are operated by private individuals for a public purpose have also been considered public vessels.[64]

OPA's Retention of Sovereign Immunity

Unlike the Public Vessels Act, which provides for a waiver of the United States' sovereign immunity for damage caused by the public vessels of the United States, OPA does not waive sovereign immunity for damage caused by oil discharged, or the substantial threat of oil being discharged, from public vessels.[65] OPA lists three types of discharge that are excluded from the liability regime established in OPA: "any discharge—(1) permitted by a permit issued under Federal, State, or local law; (2) from a public vessel; or (3) from an onshore facility which is subject to the Trans-Alaska Pipeline Authorization Act."[66] In order to avoid confusion, OPA defines "public vessel" as "a vessel owned or bareboat chartered and operated by the United States, or by a State or political subdivision thereof, or by a foreign nation, except when the vessel is engaged in commerce."[67] It is important to point out that the definition of public vessel does not include vessels that are time chartered by the United States or vessels owned (or chartered) and operated by the United States for commercial purposes. Therefore, discharge from one of these types of vessels is not excluded from OPA's liability regime and may constitute a waiver of sovereign immunity in these specific circumstances. In such a case, the claimant can be a citizen of the United States or a citizen of a foreign state so long as that foreign claimant "has not been otherwise compensated for the removal costs or damages" and the "recovery is authorized by a treaty or executive agreement between the United States and the claimant's country, or the Secretary of State, in consultation with the Attorney General and other appropriate officials, has certified that the claimant's country provides a comparable remedy for United States claimants."[68]

Wrecked Public Vessels and Sovereign Immunity under International Law (Customary International Law and Treaties or Conventions)

Framework under the Law of the Sea Convention

The Law of the Sea Convention (LOSC)[69] sets forth a comprehensive legal framework with respect to uses of the ocean, balancing the rights and duties of States in conducting activities in, on, over, and under the oceans. The Convention also includes provisions pertaining to the protection of the marine

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[63] *E.g.* Petition of United States, 376 F.2d 505 (3d Cir. 1966).
[64] *See* Int'l Marine Carriers v. Oil Spill Liab. Trust Fund, 903 F. Supp. 1097, 1104 (S.D. Tex. 1994) (holding that a vessel chartered to International Marine Carriers by the Navy was a public vessel); Nelsen v. Research Corp. of Univ. Haw., 752 F. Supp. 350, 353(D. Haw. 1990) ("A vessels owned by the government and used for a public purpose by a private party according to the government's direction is a 'public vessel.'").
[65] Gatlin Oil Co. v. United States, 169 F.3d 207, 213 (4th Cir.) ("An express waiver of [sovereign] immunity from interest is not found in the Oil Pollution Act"); Int'l Marine Carriers v. Oil Spill Liab. Trust Fund, 903 F. Supp. 1097, 1102 (S.D. Tex 1994) ("Nothing in OPA section 2712, 2713, or 2715 can be construed as a waiver of sovereign immunity").
[66] 33 U.S.C. § 2702(c) (2011).
[67] 33 U.S.C. § 2701(29) (2011).
[68] 33 U.S.C. § 2707(a)(1) (2011).
[69] Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 (entered into force Nov. 1, 1994).

environment, natural resources, and objects of an archaeological and historical nature found at sea. The principle of sovereign immunity, derived from the longstanding international principles of sovereignty and comity of nations, is preserved in the LOSC in several different provisions.

Article 29 of the LOSC defines "warship" as "a ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list or its equivalent, and manned by a crew which is under regular armed forces discipline," and Articles 32 and 95 retains the status of warships as sovereign immune vessels.[70] In addition to warships, in accordance with Articles 31, 32, 96, and 236 of the LOSC, vessels owned or operated by a State and used only on government noncommercial service are also entitled to sovereign immunity.[71] While these sovereign vessels are immune from taxes, boarding, search, arrest, and enforcement of the foreign coastal State's laws, the flag State is responsible for any loss or damage to the coastal State resulting from non-compliance with coastal State law concerning passage through the territorial sea.[72]

Protection and Preservation of Marine Environment (Part XII)

Part XII recognizes the general obligation to protect and preserve the marine environment and the authority to take action to reduce or control pollution, including the development of contingency plans.[73] Under Article 194(1) nations are to jointly or individually take measures consistent with the Convention to prevent, reduce, and control pollution of the marine environment from any source. For this purpose, they are to use the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavor to harmonize their policies in this connection. The measures are to be designed to minimize to the fullest possible extent pollution from vessels, including prevention of unintentional discharges. Art. 194(3)(b).

Prevention of Transboundary Pollution

Under Article 194 (2), nations also have a duty to "take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention." Accordingly, it would be appropriate to consider this duty and potential liability in considering assessment of risk and relative priorities in preventative measures.

Warships and Other Public Vessels Subject to Sovereign Immunity

However, Article 236, exempts "any warship, naval auxiliary, other vessels or aircraft owned or operated by a State and used, for the time being, only on government non-commercial services" from the provisions of the LOSC related to the protection and preservation of the marine environment.[74]

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[70] *Id.* art. 29, 32. Public vessels on commercial service are treated the same as private vessels. There is no waiver of immunity and, therefore, they may be subject to arrest and enforcement.
[71] *Id.* Art. 31-32, 96, 236.
[72] *Id.* Art. 31.
[73] *Id.* Arts. 192-93,199.
[74] *Id.* Art. 236.

Precedent under international law indicates that there are only three ways through which ownership of a warship or state vessel can be transferred: (1) if the vessel is captured or surrendered during battle (prior to sinking); (2) by an international agreement; and (3) by an express act of abandonment, gift, or sale in accordance with relevant principles of international law and the law of the flag State governing the abandonment of government property. Once hostilities have ceased, protagonists do not acquire any title to vessels through the act of sinking them. Likewise, title to the vessel is not lost by the mere passage of time. Once hostilities have ceased, no person or State may salvage or attempt to salvage sunken State vessels, wherever located, without the express permission of the sovereign Flag State. Sunken State vessels that contain crew remains are entitled to special respect and must not be disturbed without the explicit permission of the Flag State.[75]

The articles of the LOSC establishing sovereign immunity must also be considered in conjunction with the general duty states have under the Convention "to protect objects of an archaeological and historical nature found at sea" and the duty to "co-operate for [that] purpose."[76]

Other Conventions or Treaties Regarding the Salvage and/or Preservation of Wrecks

Conventions to which the United States is Not Party

These Conventions, while not applicable to the United States, do address the topic of wrecked vessels and are included for information.

The London Salvage Convention

The International Convention on Salvage of 1989,[77] known as the London Salvage Convention, replaced a convention on the law of salvage adopted in Brussels in 1910 and its "'no cure, no pay" principle under which a salvor was only rewarded for services if the operation was successful. The 1989 Convention built upon the 1910 Convention in order to make provision for an enhanced salvage award taking into account the skill and efforts of the salvors in preventing or minimizing damage to the environment.

The London Salvage Convention recognizes the right of a coastal State to take measures against potentially polluting wrecks. Article nine of the Convention states that "[n]othing in this Convention shall affect the right of the coastal State concerned to take measures in accordance with generally recognized principles of international law to protect its coastline or related interests from pollution or the threat of pollution following upon a maritime casualty or acts relating to such a casualty which may reasonably be

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[75] This paragraph has largely been taken from Rand R. Pixa, *In Defense of Perpetual Title to Sovereign Wrecks*, DEPARTMENT NAVY, NAVAL HISTORY & HERITAGE COMMAND UNDERWATER ARCHAEOLOGY BRANCH, http://www.history.navy.mil/branches/org12-7m.htm (last visited July 12, 2012).
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[76] Convention on the Law of the Sea, *supra* note 59, Art. 303.
[77] International Convention on Salvage, Apr. 28, 1989, 1953 U.N.T.S. 165 (entered into force July, 14, 1996).

expected to result in major harmful consequences, including the right of a coastal State to give directions in relation to salvage operations."[78]

Consistent with other international law, the London Salvage Convention does not, however, apply to sovereign immune vessels. Article four of the Convention states that "this Convention shall not apply to warships or other non-commercial vessels owned or operated by a State and entitled, at the time of salvage operations, to sovereign immunity under generally recognized principles of international law unless that State decides otherwise."[79] Again, it is left up to each State to decide whether to consent in a particular case or through waiver of sovereign immunity under legislation. As discussed below, in the 2001 Presidential Statement on Warships, the United States and a number of other nations have articulated their policy on how they retain title to all of their sunken warships and require consent of the flag State. Therefore, the general rule under Article 4 of the London Salvage Convention has been expressly reiterated by the United States, United Kingdom, and Japan (as well as other States also retaining title to their warships). Those warships and other public vessels on non-commercial service are not subject to the provisions of the Salvage Convention and those countries could potentially allow their sunken warships to remain on the bottom of the ocean free from any legal physical interference. Conventions to which the United States is not Party.

Nairobi Wreck Removal Convention

The International Convention on the Removal of Wrecks, [80] known as the Nairobi Wreck Removal Convention, was adopted under the auspices the International Maritime Organization (IMO) in 2007 and will enter into force twelve months from the day that ten states have either agreed to be bound by the Convention; as of March 31, 2013, only six states have done so..[81] Under the Nairobi Wreck Removal Convention, a coastal State has the right to remove a wreck located in that coastal State's EEZ that poses a hazard to the coastal State or to require the shipowner to remove the wreck at his own expense; hazard being defined as "any condition or threat that: (a) poses a danger or impediment to navigation; or (b) may reasonably be expected to result in major harmful consequences to the marine environment, or damage to the coastline or related interests of one or more states."[82] Under the Nairobi Wreck Removal Convention the coastal State's power of removal only applies when both the coastal State and the vessel's flag State are parties to the Convention. And like many other maritime conventions, the Nairobi Wreck Removal Convention does not apply to "any warship or other ship owned or operated by a state and used, for the time being, only on Government non-commercial service" unless the flag State decides otherwise.[83]

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[78] *Id.* Art.9.
[79] *Id.* Art. 4.
[80] International Convention on the Removal of Wrecks (Nairobi Wreck Convention), May 18, 2007, INT'L MAR. ORG. (IMO) (June 30, 2012), http://www.imo.org/About/Conventions/StatusOfConventions/Documents/Status%20-%202012.pdf.
[81] *Status of* Conventions, IMO (March 31, 2013), http://www.imo.org/About/Conventions/StatusOfConventions/Pages/Default.aspx.
[82] Nairobi Wreck Convention, *supra* note 56, art. 1(5).
[83] *Id.* art. 4(2).

UNESCO Convention on the Protection of the Underwater Cultural Heritage

The 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001 UNESCO Convention)[84] entered into force on January 2, 2009. The goal of the Convention is to protect underwater cultural heritage, which is defined as "all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years such as . . . vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context."[85] Because the Convention applies only to underwater cultural heritage more than one hundred years old, it would not pertain to wrecks from World War I until at least 2014 and World War II wrecks until at least 2039. Sunken warships and other non-commercially operated government vessels clearly fall within the definition of underwater cultural heritage. In order to ensure that the protection offered under the 2001 UNESCO Convention is consistent with sovereign immunity, Article 2(8) states that "[c]onsistent with State practice and international law, including the Law of the Sea Convention, nothing in this Convention shall be interpreted as modifying the rules of international law and State practice pertaining to sovereign immunities, nor any State's rights with respect to its State vessels and aircraft" with State vessels and aircraft being defined as "warships, and other vessels or aircraft that were owned or operated by a State and used, at the time of sinking, only for government non-commercial purposes, that are identified as such and that meet the definition of underwater cultural heritage."[86] A coastal State has exclusive jurisdiction over any heritage in the territorial sea, including "State vessels," although the coastal State is encouraged to cooperate with the flag State.[87] The coastal State's jurisdiction over activities directed at UCH under the 2001 UNESCO Convention in the territorial sea, and to a lesser extent in the contiguous zone, is consistent with a coastal State's jurisdiction under the Law of the Sea Convention. This coastal State jurisdiction is kept in check by the 2001 UNESCO Convention not extending those rights to underwater cultural heritage located on the coastal state's continental shelf or EEZ seaward of the 24 nm contiguous zone. [88] Under Article 10.7 of the Convention, the consent of the flag State is expressly required before activities directed at underwater cultural heritage located on a coastal State's continental shelf or in the EEZ can be undertaken[89] except that portion of the continental shelf that is within the contiguous zone.[90]

At the time of writing this report, there are 42 parties to the Convention.[91] Of the foreign states that NOAA has currently identified as having potentially polluting vessels located off the U.S. coast, only Cuba, Mexico, and Panama are parties to the 2001 UNESCO Convention. While the 2001 UNESCO Convention does not apply to potentially polluting wrecks in waters subject to U.S. jurisdiction and control because the United States is not a party, the rules contained in an Annex to the Convention and other provisions may be helpful in particular cases. Although the United States is not a party to the

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[84] UNESCO Convention on the Protection of the Underwater Cultural Heritage, Nov. 2, 2001, 41 I.L.M. 40 [hereinafter 2001 UNESCO Convention]..
[85] *Id.* Art. 1(a).
[86] *Id.* Art. 2(8).
[87] *Id.* Art. 7.
[88] *See id.* Arts. 9-10.
[89] *Id.* Art. 10.7.
[90] *Id.* Art. 8.
[91] *The Convention on the Protection of the Underwater Cultural Heritage*, UNITED NATIONS TREATY COLLECTION, (last visited July 12, 2012).

Convention, as a matter of practice and policy, the United States,[92] like the United Kingdom and other non-parties, follow the Annex Rules or similar rules. At the time of its adoption, the United States cited several concerns that prevented it from supporting the Convention as a whole. Primary among these were (1) concerns that the Convention could create new rights for coastal states in a manner that could alter the delicate balance of rights and interests set up under the LOSC, and (2) concerns that the provisions of the Convention in regard to State vessels and aircraft are inadequate because they do not provide a regime under which the flag State must consent before its vessels can be the subject of recovery.[93]

Practice of Nations in Regard to Wrecked Public Vessels and Sovereign Immunity[94]

From ancient times, the presence of an armed ship of a foreign sovereign in the waters of another State raised concern and would be tolerated only under limited circumstances. Such a ship might be driven into the territorial waters of another State by *force majeure* and would be considered innocent if it were to engage in no conduct inimical to the prerogatives of the sovereign whose waters were visited, leaving as reasonably soon as conditions permitted. Or it could carry the ambassadors of one sovereign to another, therefore being cloaked in the historic privileges afforded to such emissaries so long as its mission was limited to the ambassadors' diplomacy. And naturally, the sovereign ship as the representative of a foreign sovereign could enter the waters of another State by invitation, restricted in its activities by the terms of the continuing forbearance of the visited State. Under any of the foregoing circumstances, the innocence of the visiting ship was the prerequisite for its continuing presence within the territorial waters of the visited State. On the other hand, if the warship of a foreign sovereign entered another sovereign's territory for other than the aforementioned purposes, violated the conditions of an otherwise innocent visit, or overstayed its welcome, the violation could be considered an act of war.

Modern international law reflects the special status conferred on sovereign vessels. The LOSC[95] handled the compromise between the unequivocal sovereignty of a warship and the rights of a coastal State by limiting coastal sovereign rights through the right of innocent passage.[96] The right of innocent passage is limited and designed to ensure such passage is truly innocent.[97] Article 30 of the LOSC specifies the mechanism to remedy breach of specified innocence: "If any warship does not comply with the laws and regulations of the coastal State concerning passage through the territorial sea and disregards any request for compliance therewith which is made to it, the coastal State may require it to leave the territorial sea

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[92] Agencies that have stated they will comply with the Annex Rules include the NOAA Office of National Marine Sanctuaries.

[93] Additional insight on the practical application of the convention to historical and cultural resources: *See* Ole Varmer et al., *United States: Responses to the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage*, 5 J. Mar. Archaeology 129 (2010)Ole Varmer, Jefferson Gray, David Alberg, United States: Responses to the 2001 UNESCO, and Convention on the Protection of the Underwater Cultural Heritage Published online: 14 December 2010 http://www.springerlink.com/content/311g661401ru1177/

[94] This section has largely been taken from Rand R. Pixa, *In Defense of Perpetual Title to Sovereign Wrecks*, Department Navy, Naval History & Heritage Command Underwater Archaeology Branch, http://www.history.navy.mil/branches/org12-7m.htm (last visited July 12, 2012).

[95] Although the United States is not a party to the LOSC, there are several provisions of the Convention that are now customary international law—a process that included customary acceptance of those provisions by countries such as the United States.

[96] Convention on the Law of the Sea, *supra* note 59, art. 17.

[97] *Id.* arts. 19-20.

immediately." But ships owned or operated by a State and used only on government non-commercial service shall, on the high seas, have complete immunity from the jurisdiction of any State other than the flag State.[98]

Laws and Practice of Foreign Nations in Regard to Salvage or Recovery of Their Sovereign Wrecks

The preamble in the Federal Register Notice of President Clinton's 2001 Presidential Statement on Warships includes the policies of France, Germany, Japan, Russia, Spain, and the United Kingdom with respect to their sunken warships. The policies of the United Kingdom, Spain, Germany, and Japan are of particular relevance here as those states have sunken state craft in U.S. territorial waters.

The United Kingdom

The United Kingdom has stated its policy as "[u]nder international law, warships, naval auxiliaries, and other vessels or aircraft owned or operated by a State and used only on government non-commercial service ('State vessels and aircraft') enjoy sovereign immunity. State vessels and aircraft continue to enjoy sovereign immunity after sinking, unless they were captured by another State prior to sinking or the flag State has expressly relinquished its rights. The flag State's rights are not lost merely by the passage of time. Further, many sunken State vessels and aircraft are maritime graves, which should be respected. No intrusive action may be taken in relation to the United Kingdom's sovereign immune State vessels or aircraft without the express consent of the United Kingdom."[99]

CASE STUDY: HMS *Royal Oak*

The United Kingdom's treatment of HMS *Royal Oak* serves as an illustrative case study. On October 14, 1939, only six weeks after the start of World War II, the German submarine *U-47* moved undetected into the Royal Navy's impenetrable home fleet base of Scapa Flow, near the Scottish island of Orkney. *U-47* fired three torpedoes at *Royal Oak*, and the "unsinkable" pride of the Royal Navy sank within fifteen minutes with over 3,000 tons of oil on board. Four hundred and fifty eight of the 833 officers and crew died in the attack. Since its sinking, *Royal Oak* has leaked oil at a steady but slow rate. In 1996, some of that oil was starting to soil beaches of Orkney, thus threatening the local environment and nearby salmon and oyster fisheries. Despite the looming environmental threat, the Ministry of Defense and the people of Orkney were reluctant to disturb *Royal Oak* because it represented Britain's largest official war grave. Over the next several years, there were several attempts to capture the leaking oil in the most minimally evasive way possible. Eventually, the Ministry of Defense was forced to hire a private company at a cost of several million dollars to "hot tap" *Royal Oak* by drilling holes into the vessel's oil tanks and pumping the oil to the surface. As of 2010, the hot tapping project was able to remove over 1,600 tons of the remaining oil on board the vessel and *Royal Oak* is believed to be no longer leaking. It is clear from the United Kingdom's strategy with *Royal Oak* that the protection of its sunken war graves is of great importance, and that the United Kingdom would want the protection of its sunken war graves to be a substantial factor in the treatment of any of its sunken warships located within the U.S. EEZ.

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[98] *Id.* art. 96.
[99] Department of State, Public Notice 4614, Office of Ocean Affairs; Protection of Sunken Warships, Military Aircraft and Other Sunken Government Property, 69 Fed. Reg. 5647, 5647-48 (Feb. 5, 2004).

Japan

Japan's policy on its sunken warships was stated as "[a]ccording to international law, sunken State vessels, such as warship and vessels on government service, regardless of location or of the time elapsed remain the property of the State owning them at the time of their sinking unless it explicitly and formally relinquishes its ownership. Such sunken vessels should be respected as maritime graves. They should not be salvaged without the express consent of the Japanese Government."[100] In an exchange of diplomatic notes signed jointly at the Department of Commerce on February 12, 2004, Japan and the United States agreed that the U.S. owns the historic sunken Japanese midget submarine located in deep water off the entrance of Pearl Harbor. In partnership with the National Park Service, NOAA is playing a key role in the protection and management of the Japanese midget submarine pursuant to U.S. policy on sunken vessels and historic preservation laws. The International Section of the NOAA Office of General Counsel has played an instrumental role in the development of the U.S.-Japanese agreement on the Japanese midget submarine as well as the agreement's implementing management plan because of the office's expertise in international and domestic law regarding historic shipwrecks. Consistent with the U.S.-Japanese Agreement and the U.S. Federal Archaeological Program, there are currently no plans to salvage the Japanese midget submarine. Instead, the preferred approach in the Agreement and in the federal cooperative management plan is for preservation in place.[101]

Other Nations

Germany: Under international law, warships and other vessels or aircraft owned or operated by a State and used only on government non-commercial service ("State vessels and aircraft") continue to enjoy sovereign immunity after sinking, wherever they are located. The Federal Republic of Germany also retains ownership of any German State vessel or aircraft owned by it or the German Reich at the time of its sinking. Further, many sunken warships and aircraft are maritime graves, which have to be respected. No intrusive action may be taken in relation to German State vessels or aircraft without the express consent of the German Government.[102]

Russian Federation: Under international law of the sea all the sunken warships and government aircraft remain the property of their flag State. The Government of the Russian Federation retains ownership of any Russian sunken warship, including the warships of the Russian Empire and the Soviet Union, regardless of the time they sank. These craft are considered places of special governmental protection and cannot be salvaged without special permission of the Government of the Russian Federation.[103]

Spain: The Embassy of Spain presents its compliments to the Department of State and has the honor to address the matter of Spanish laws and policy regarding the remains of sunken vessels that were lost while in the service of the Kingdom of Spain and/or were transporting property of the Kingdom of Spain. In accordance with Spanish and international law, Spain has not abandoned or otherwise relinquished its

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[100] *Id.* at 5647.
[101] See *Heritage: Japanese Midget Submarine*, NOAA Office General Counsel, http://www.gc.noaa.gov/gcil_japanese_mini-sub.html (last visited July 12, 2012) for more information including copies of the agreement.
[102] 69 Fed. Reg. 5647, 5647-48.
[103] *Id.*

ownership or other interests with respect to such vessels and/or its contents, except by specific action pertaining to particular vessels or property taken by Royal Decree or Act of Parliament in accordance with Spanish law. Many such vessels also are the resting place of military and/or civilian casualties.

The Embassy of Spain accordingly wishes to give notice that salvage or other disturbance of sunken vessels or their contents in which Spain has such interests is not authorized and may not be conducted without express consent by an authorized representative of the Kingdom of Spain.[104]

United States Law and Practice in Regard to Salvage or Recovery of U.S. Sovereign Wrecks[105]

Contemporary U.S. judicial history of the treatment of the sovereign wrecks of the United States begins with *Hatteras, Inc. v. U.S.S.* Hatteras,[106] in which the claim of the salvor was denied. Hatteras, Inc. argued that the United States' neglect of the wreck for over one hundred years after its 1863 sinking amounted to abandonment. The Court stated "[I]t is well settled that title to property of the United States cannot be divested by negligence, delay, laches, mistake or unauthorized actions by subordinate officials[,]" explaining further that U.S. government property may only be disposed of in the manner prescribed by Congress.[107]

In *U.S. v. Steinmetz,*[108] the so-called Alabama-bell case, the purchaser in due course of the bell was deprived of possession by the United States' superior right in title. By his account Richard Steinnetz, an antique dealer, acquired the bell at a London gun show in 1979; it had reportedly been recovered from the 1864 wreck of CSS *Alabama* in 1936 by a diver who placed it in a bar in trade for drinking privileges. The bell came to the attention of Navy officials in 1990 when Steinmetz put it up for auction. After Steinmetz refused to turn the bell over to the Navy, the Government filed an action against him for its return. The court determined that the United States was the successor sovereign to the Confederacy and had acquired all right and title to the property of the Confederate States of America including *Alabama* and the bell, finding that it had not been abandoned.[109]

The next landmark case was that confirming the Kingdom of Spain's ownership of *Juno* and *LaGalga*.[110] The two ships were lost on the Virginia coast in 1750 and 1802, respectively, and lay undisturbed until they were reportedly found by Sea Hunt, Inc. in the late 1990s. Sea Hunt claimed a salvage award or, in

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[104] *Id.*

[105] This section has largely been taken from Rand R. Pixa, *In Defense of Perpetual Title to Sovereign Wrecks*, Department Navy, Naval History & Heritage Command Underwater Archaeology Branch, http://www.history.navy.mil/branches/org12-7m.htm (last visited July 12, 2012).

[106] 1984 AMC 1094 (S.D. Tex. 1981), *aff'd without op.*, 698 F.2d 1215 (5th Cir. 1983), *cert. denied*, 464 U.S. 815 (1983).

[107] *Id.*

[108] 763 F. Supp. 1293 (D.N.J. 1991), *aff'd*, 973 f.2D 212 (3d Cir. 1992), *cert. denied*, 113 S.Ct. 1578 (1993)

[109] CSS *Alabama*, which rests in French waters, is managed by France's Association CSS *Alabama* under the auspices of the French Ministry of Culture pursuant to a 1995 agreement with the United States Government recognizing United States title to the wreck and providing for curatorial collaboration and cultural exchanges. United States ownership was recognized by the government of the Republic of France in the Verbal Note No. 2826 (Oct. 18, 1991).

[110] Sea Hunt v. Unidentified Shipwrecked Vessel, 221 F.3d 634 (4th Cir. 2000), *cert. den.,* 121 S.Ct. 1079 (2001).

the alternative, asked the U.S. District Court for the Eastern District of Virginia to award it title to the vessels under the law of finds. Assuming the identities of the ships to be those claimed by Sea Hunt, the court ruled that both vessels were sovereign vessels, and that they had not been abandoned absent an express renunciation of ownership by the Kingdom of Spain. The court further held that because Spain had expressly rejected salvage, Sea Hunt was not entitled to a salvage award.[111]

A more recent case is the protracted litigation involving a World War II "Devastator" TBD-1, which clarified the rights of the United States in the context of unwanted salvage.[112] Notwithstanding the Navy's repeated, express rejection of salvage of a historic aircraft in 800 feet of water off Florida, the would-be salvor twice brought components of the aircraft into the District Court seeking to invoke the jurisdiction of the Court, seeking a salvage award and claiming that Government officials had induced the undertaking. It was finally determined on appeal that the United States remained the owner and that a salvage award was not warranted because the U.S. had provided ample notice that it objected to salvage of the aircraft. The stakes were high in this case because not only was the aircraft the last of its kind, but it also had a distinguished history in the Battles of Midway and Coral Sea. Because of the risks attendant to any recovery attempt from the deep and rapidly moving water at the wreck site, the Navy preferred in-situ preservation over any attempt to move the wreck. Conversely, the salvor perceived the exceptional value associated with this unique wreck.

These cases and President Clinton's 2001 Presidential Statement on Warships were a catalyst for the 2004 Sunken Military Craft Act that in large part codified the law in these cases as well as the underlying practices and policies.

President's Statement on Warships (2001)

In January 2001, the White House issued the Presidential Statement on United States Policy on the Protection of Sunken State Craft (Presidential Statement on Warships). In it, President Clinton announced the United States' policy in regard to its sunken State craft as "the United States retains title indefinitely to its sunken State craft unless title has been abandoned or transferred in the manner Congress authorized or directed."[113] In regard to the sunken craft of foreign States, the President announced his intention to abide by the same policy thus recognizing the foreign State's retention of title to those vessels. Additionally, the President stated that "the United States [would] use its authority to protect and preserve sunken State craft of the United States and other nations, whether located in the waters of the United States, a foreign nation, or in international waters" and that any activity on these wrecks must occur with

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[111] The case of *Juno* and *LaGalga* is interesting also in two other respects. First, procedurally, the Court barred the U.S. Justice Department from representing Spain at that government's request pursuant to the 1902 Treaty of Friendship between the two countries. This case is included among expressions of U.S. Government policy as a consequence of the Government's interest and support throughout the proceedings, manifested through the rare move to represent a foreign sovereign. Second, the case represented the first time the Kingdom of Spain had asserted title to any wreck lost during the Spanish colonial period. Previously the government of Spain had been reluctant to do so, presumably as a result of the sensitivity of its former colonies and the frequent claim that the King's ships were the means of "looting" Latin America.

[112] International Aircraft Recovery, LLC v. Unidentified, Wrecked, and Abandoned Aircraft, 218 F.3d 1255 (11th Cir. 2000).

[113] 69 Fed. Reg. 5647, 5648 (Feb. 5, 2004).

"the express permission of the sovereign, and should only be conducted in accordance with professional scientific standards and with the utmost respect for human remains."[114]

CASE STUDY: USS *Mississinewa*
On November 20, 1944, a torpedo sank the U.S. Navy Fleet Oiler USS *Mississinewa* then located in the Ulithi Atoll in the Federated States of Micronesia.[115] Sixty three of the vessel's crew of 264 died in attack.[116] The force of the explosion ripped the bow of the vessel from the rest of the hull; the vessel eventually settled upside down on the ocean floor at a depth of 130 feet. At the time of the attack, *Mississinewa* was carrying a full load of Navy Special Fuel Oil, gasoline and diesel—totaling approximately 42,860 bbl of oil. In 2001, *Mississinewa* was rediscovered by sport divers, and shortly thereafter, a typhoon passed through the area and caused the vessel to start leaking.[117] Because of the area's pristine conditions, the Navy decided it was imperative that quick action be taken in this case.[118] The Navy dispatched a response team to survey the overall conditions of the vessel—temporary patches were placed at the leak spots and some of the oil was removed.[119] Later that year, another, more substantial, leak was reported.[120] A second Navy response team was sent down to survey the vessel and in 2003, pursuant to the response team's recommendation, 99% of the oil onboard the vessel was removed by hot tapping the vessel's cargo and bunker tanks.[121] Because *Mississinewa* is also the war grave of 63 of the vessel's crewmembers, the oil removal activity was directed at only those areas of the vessel that were unmanned at the time of the sinking to ensure that no human remains were disturbed in the process.[122] This was accomplished by hot tapping the oil and fuel bunker either directly through the skin of the vessel or through previously emptied tanks.[123] Because *Mississinewa* was resting upside down with its oil and fuel bunkers easily accessible and because the vessel was located in relatively shallow, warm, and protected waters, the removal operation was successfully conducted at relatively small cost of less than $3.5 million—compared to the nearly $20 million spent on SS *Jacob Luckenbach* oil removal operation.[124] Although the Navy considers the *Mississinewa* operation to be a unique case because it was conducted under "best-case scenario conditions,"[125] the treatment of *Mississinewa* shows that the U.S. places great importance on protecting human health and the marine environment in a manner that also respects its war graves by avoiding the disturbance of areas where human remains may be located.

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[114] *Id.*
[115] U.S. Navy Supervisor of Salvage & Diving Naval Sea Sys. Command, S0300-B6_RPT-10, U.S. Navy Salvage Report: USS Mississinewa (AO 59) Oil Removal Operations Ulithi Atoll 1-1 (2003).
[116] *Id.* at 1-6.
[117] *Id.* at 1-1; Richard Buckingham, *The Pollution Threat Posed by Sunken Naval Wrecks: A Realistic Perspective and a Responsible Approach*, Marine Tech. Soc. J., Fall 2004, at 17.
[118] *See* Buckingham, *supra* note 127, at 3.
[119] U.S. NAVY, *supra* note 125, at 1-1.
[120] *Id.*
[121] *Id.* at 1-1, 3-1,
[122] *Id.* at 1-6.
[123] *Id.*
[124] Buckingham, *supra* note 127, at 18.
[125]*Id.*

Sunken Military Craft Act[126]

On October 28, 2004, President George W. Bush signed the National Defense Authorization Act for Fiscal Year 2005. Title XIV of the Act, generally referred to as the Sunken Military Craft Act (SMCA),[127] preserves the sovereign status of sunken U.S. military vessels and aircraft by codifying both their protected sovereign status and permanent U.S. ownership, regardless of the passage of time. The purpose of the SMCA is to protect sunken military vessels and aircraft and the remains of their crews from unauthorized disturbance. The SMCA protects sunken U.S. military ships and aircraft wherever they are located, as well as the graves of their lost military personnel, sensitive archaeological artifacts, and historical information. Its scope is broad, protecting sunken U.S. craft worldwide and sunken foreign craft in U.S. waters, including internal waters, territorial sea, and contiguous zone (up to twenty-four nautical miles off the U.S. coast).

The principal premise of the SMCA is that "Right, title, and interest of the United States in and to any United States sunken military craft--- (1) shall not be extinguished except by an express divestiture of title by the United Sates; and (2) shall not be extinguished by the passage of time, regardless of when the sunken military craft sank."[128] This is the doctrine of perpetual sovereign title enunciated by case law extending from the U.S. Constitution's Property Clause.[129] The principle is founded on the view that the sovereign should not be deprived of its property through application of subordinate law other than as prescribed. Prior application had refined the rule to mean that only Congress might act to give authority to abandon or dispose of the vessels and aircraft of the United States.[130]

The statute defines "sunken military craft" as all or any portion of "any sunken warship, naval auxiliary, or other vessel that was owned or operated by a government on military noncommercial service when it sank,]" along with sunken military aircraft and spacecraft, and their associated contents,[131] and reaches across the craft's debris field.[132] All activity or attempts to engage in activity "directed at a sunken military craft that disturbs, removes, or injures any sunken military craft," except as authorized or subject to a permit, is prohibited.[133] Those who violate the prohibition are subject to civil penalties of up to $100,000 per day of violation and liable for damage to and specified consequential damages arising from the prohibited activities, including mitigation of damage resulting from disturbance.[134] Violators may also be subject to otherwise applicable criminal law sanctions.[135] Activities otherwise prohibited may be

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[126] This section has largely been taken from Rand R. Pixa, *In Defense of Perpetual Title to Sovereign Wrecks*, Department Navy, Naval History & Heritage Command Underwater Archaeology Branch, http://www.history.navy.mil/branches/org12-7m.htm (last visited July 12, 2012).
[127] Sunken Military Craft Act of 2005, Pub. L. No. 108-375, Stat. 2094-2098 (codified at 10 U.S.C. § 113 note (2011)).
[128] *Id.* § 1401.
[129] U.S. Const. art. 4, § 3, cl. 2 ("The Congress shall have Power to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States; and nothing in this Constitution shall be so construed as to Prejudice any Claims of the United States, or of any particular State.").
[130] *See*, *USS* Hatteras, *supra* note X.
[131] Sunken Military Craft Act § 1408 (3).
[132] *Id.* § 1408 (1) (B).
[133] *Id.* § 1402
[134] *Id.* § 1405
[135] *Id.* § 1406

carried on only as provided by a permit issued by the “Secretary concerned.”[136] The Maritime Administration is the successor agency to the Maritime Commission (1936-1950), and the War Shipping Administration (1942-1946). The War Shipping Administration oversaw the American merchant marine during WWII. The Maritime Commission was in charge of the war's shipbuilding program. Therefore we believe that these vessels fall under the definition of a "sunken military craft," as in Section 1408 (3) (A) SUNKEN MILITARY CRAFT- The term `sunken military craft' means all or any portion of-- (A) any sunken warship, naval auxiliary, or other vessel <u>that was owned or operated by a government on military noncommercial service when it sank</u>.

These vessels were owned by the Maritime Commission (US government) and were operated by the War Shipping Administration (US government) and in wartime were on military non-commercial service. The general prohibitions against disturbance are applicable across the board to all craft covered by the Act, but <u>the authorization to disturb is limited to the "secretary concerned." “</u>Secretary concerned" is defined as a secretary of a military department, except in the case of Coast Guard craft. Given that the Maritime Commission is under the Department of Transportation, there may be an issue with how the Maritime Commission will engage under this authority[137]

Significantly, the SMCA excludes sunken military craft from the operation of the two tenets of maritime law frequently used to assert claims to sunken wrecks. The law of finds has long been favored as a means to win the award of title to the historic shipwrecks premised on abandonment. Absent a showing of abandonment, recourse could be had under the law of salvage, which frequently results in an award of a large portion of the recovered materials. The plaintiff who sought to recover the Navy's TBD-1 “Devastator”[138] asserted both causes, albeit unsuccessfully. To preclude recourse to those remedies, the SMCA prescribes that “[t]he law of finds shall not apply to --- (1) any United Sates sunken military craft, wherever located; or (2) any foreign sunken military craft located in United States waters.”[139] It further states that “[n]o salvage rights or awards shall be granted with respect to --- (1) any United States sunken military craft without the express permission of the United States; or (2) any foreign sunken military craft located in United States waters without the express permission of the relevant foreign state.”[140] The provisions extend the jurisdiction of the United States to the maximum degree possible, consistent with the notion that sovereign vessels carry their sovereign status with them and that a coastal state can regulate activities within its waters. Note however that the exercise of jurisdiction in the latter case is without prejudice to sovereign ownership rights in foreign vessels.

The law also strengthens common interests in sunken military craft with foreign sovereigns through extension of the SMCA's general prohibition to foreign sunken military craft and other provisions. The Secretary of the Navy may carry out permitting at the request of and on behalf of a foreign state.[141] Additionally, “the Secretary of State, in consultation with the Secretary of Defense, is encouraged to negotiate and conclude bilateral and multilateral agreements with foreign countries with regard to sunken

[136] *Id.* § 1403
[137] Personal Communication from Barbara Voulgaris, Maritime Commission Counsel
[138] *See* International Aircraft Recovery, LLC, 218 F.3d.
[139] *Id.* § 1406 (c)
[140] *Id.* § 1407 (d)
[141] *Id.* § 1403 (d)

military craft....”[142] These are important provisions. While the SMCA extends the protection of the Act to United States sunken military craft wherever those craft are located,[143] the cooperation of foreign coastal and port states will be necessary to provide practical protection for U.S. sunken state craft outside U.S. waters. Reciprocity will further those interests.

The SMCA is consistent with notions of sovereign prerogative. The law of finds may be applied to private vessels whose owners’ inaction for an extended period evidences intentional or neglectful abandonment.[144] Traditional salvage principles also may be apposite to the recovery of commercial vessels and cargo for policy reasons favoring the return of “choses in action”[145] to the stream of commerce and encouraging the recovery of marine property in peril. But the same inaction of a State with respect to a sovereign vessel may represent a conscious decision on the part of the sovereign owner to avoid risk of environmental damage, a national policy regarding the sanctity of the watery graves of its sailors, or a conscious decision to await technological improvement of recovery techniques. While private owners of sunken vessels may disappear after the passage of a few years, the continued existence of a sovereign owner or successor sovereign is presumptive.

The SMCA therefore preserves the deliberateness of consideration with respect to preservation of sunken military craft. Application of the law of finds to sunken military craft might compel a sovereign owner to make poorly ordered recovery sequence decisions simply to avoid losing its property. Applicability of salvage law might have the same coercive effect on a government's decision making, or might divest the sovereign of valuable or historic property simply to pay a salvage award. A higher level of deliberation and freedom from decision-making externalities should work to the overall benefit of maritime historic preservation since officials should be free to establish priorities consistent with the availability of funds and adequate to complete curation professionally. Presumably, better decisions in the overall public interest would derive free from commercial motives. Critics of the policies underpinning the SMCA might argue that reservation of recovery decisions to sovereigns impedes recovery overall, but since available permitting procedures[146] facilitate public-private partnerships; recoveries that inure to the public benefit should not be impaired. On the other hand, the law of finds or salvage as applied to sovereign wrecks merely subsidizes private recoveries at public expense, with no guarantee that the public may view or study that sovereign property in the future.

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[142] *Id.* § 1407

[143] Although not so stated explicitly, Congressional intent may be inferred from the absence of language of geographic limitation generally with respect to United States sunken military craft, noting the explicit inapplicability of the law of finds to "any United States sunken military craft, wherever located[,]" in contrast to exclusion of that body of law from applicability to "any foreign sunken military craft located in United States waters[,]" and inapplicability of the law of salvage to "any foreign sunken military craft located in United States waters without the express permission of the relevant foreign state." *Id.* § 1406 (c)-(d). Since Congress limited the geographic applicability of certain provisions, the SMCA's otherwise unlimited prescriptions with respect to other matters, consistent with the basic tenets of international law with regard to portable sovereign immunity, evidence that more expansive intent.

[144] *See, e.g.*, Deep Sea Research, Inc. v. The Brother Jonathan, 102 F.3d 379, 387-88 (9th Cir. 1996), aff'd in part, vacated in part on other grounds, and remanded, 118 S.Ct. 1464 (1998).

[145] “Personal property that one person owns but another person possesses, the owner being able to regain possession through a lawsuit.” BLACK’S LAW DICTIONARY (9th ed. 2009).

[146] *See, e.g.*, 32 C.F.R. 767.

The principle of perpetual sovereign title to sovereign wrecks may well turn out to be one of the most important tools for historic preservation available at this time when almost all of the world's wrecks have become accessible. Reinforcement and codification of the principle is vitally important. In sum, sovereign immunity precludes a litigant from asserting an otherwise meritorious cause of action against a sovereign or a party with sovereign attributes unless the sovereign consents to suit. The most recent decision regarding foreign sovereign immunity, admiralty jurisdiction and the law of salvage being the 11th Circuit Court's 2011 decision that recognized that Spain owned the shipwreck that was subject to salvage and that the scope of sovereign immunity extended to cargo which may have been privately owned.[147] While this was primarily a decision under the Foreign Sovereign Immunity Act, the court also relied, at least in part, on the SMCA, the President's Statement on Warships, and underlying principle of sovereign immunity.

Respect for perpetual title and sovereign rights in sunken sovereign vessels is deeply embedded and broadly respected in international law: One example is the SPREP "Regional Strategy to Address Marine Pollution from World War II Wrecks,"[148] containing broad recognition of the applicable international law principles.

Internationally, there is currently no multi-lateral legal instrument governing the ownership of sunken warships or military aircraft. However, there is a well-developed body of customary international law governing the treatment of sunken warships and military aircraft, and there are a number of international laws in regard to wrecks, the prevention of pollution, salvage, and historic preservation, including the Law of the Sea Convention, which provides the legal framework for all of these activities.

Fifty-three casualties in RULET are associated with World War I, World War II, or the Korean War; this includes six that were military vessels in either World War I or World War II representing the United States, the United Kingdom, and Japan. At least seventeen vessels were used by the U.S. government or other federal entities as well as corresponding entities of the United Kingdom.

[147] Odyssey Marine Explorations, Inc. v. Unidentified Shipwrecked Vessel, 657 F.3d 1159 (11th Cir. 2011).
[148] http://www.sprep.org/att/IRC/eCOPIES/Pacific_Region/104.pdf

SECTION 6: CONCLUSIONS AND RECOMMENDATIONS

There are thousands of shipwrecks in U.S. waters. Some unknown portion of those vessels is likely to contain oil, both as fuel and cargo, and may eventually result in pollution to the marine environment. As noted in earlier sections, the vast majority of significant potentially polluting wrecks date from the World War II era and have succumbed to varying rates of corrosion over the passage of time. The issue of potentially polluting wrecks has arisen in the popular media and in the response community, but many challenges remain, including finding the human and financial resources necessary to comprehensively address the problem. Additional research and surveys will likely identify wrecks that are also potential threats that have not yet been discovered or had their identities confirmed. For those that have been discovered and identified, there is still the question as to which of those shipwrecks are most likely to still contain substantial amounts of oil. The 2005 International Oil Spill Conference Issue Paper on Potentially Polluting Wrecks in Marine Waters (Michel et al., 2005) summarized this issue as follows:

> *Uncertainty appears to be the most immediate problem. Despite all that is known about potentially polluting wrecks, disturbing gaps remain in our ability to definitively articulate the environmental threat beyond a nagging sense that the issue warrants earnest attention. We find ourselves at a crossroads. Do we invest time and resources into sufficiently characterizing the pollution threat in order to support decisions on mitigating actions? Or, do we gamble on the capacity of the marine environment and its inhabitants, as well as our respective economies, to withstand any eventual release of oil pollution these wrecks may produce?*

In 2010, Congress took a substantial step in addressing the public concern on this issue when it decided to invest time and resources in addressing that uncertainty, and directed NOAA to conduct an assessment of shipwrecks that could impact coastal and Great Lakes States. Congress' action resulted in substantial research and analysis based on available data and information as presented in this report. Although there are approximately 20,000 shipwrecks in U.S. waters, most of these are unlikely to be substantial pollution threats to the marine environment. However, there are approximately 573 wrecks that are large enough to have contained large amounts of fuel, and about 87 of these are known or suspected to still have enough structural integrity to contain oil. Nine of these are reportedly leaking or have oil in the overheads. As we've noted in this report, only 6 of those 87 vessels are of high priority for a most probable or 10% discharge. There are 37 vessels that are high priority for a worst case discharge. A companion series of screening reports list available information, environmental modeling results, and a scheme for prioritizing these vessels. These reports will be given to the U.S. Coast Guard FOSCs, RRTs, and local Area Committees for incorporation into Area and Regional Contingency Plans.

The objective of this project was to filter an overwhelming list of potentially polluting wrecks, leaving a shorter list of 87 high and medium priority wrecks that can realistically be used for regional and area contingency planning. The status of these priority vessels may change as more local knowledge is applied, and new vessels will likely come to light. The methodologies used here can easily be applied as appropriate to new vessels that meet the criteria and even to smaller vessels should the U.S. Coast Guard, RRT, or Area Committee want to use the methodology to assess those risks as well. The criteria and methodologies could be used and adapted by other countries to meet their challenges with potentially polluting wrecks.

One of the most difficult issues to address in analyzing potentially polluting wrecks is how best to address the threat from vessels with unconfirmed or unknown locations. For many of these vessels, the last known information is based on historic records of the casualty–and estimates on location based on those records. Vessels lost in deeper waters are more likely to be unknown as they are out of reach for recreational and technical divers and may not have been identified in oceanographic survey work. However, wrecks along the coast are not always known and well identified either. Of the 87 vessels NOAA developed risk assessments for, 47 or 54% of the vessels have unknown or unconfirmed locations. In some instances, there may be reports of a vessel at a location, but only one source and not enough information to confirm the identity of the vessel. The locations used for modeling and contingency planning purposes are based on the last known reports for each vessel and are a good starting point for monitoring for mystery spills in those respective regions and for remote sensing surveys of opportunity. Additional surveys are needed to identify the unconfirmed or unknown locations, as well as discover new wrecks that may be sources of potential pollution.

Wrecks within RULET are all submerged, ranging in depth from 30 to approximately 15,500 feet. The issue of derelict and abandoned vessels that are emergent or partially emergent in and on state submerged lands and waters may be just as, if not more, significant for the coastal states and our national interests. While these emergent or partially emergent vessels are not addressed in this discussion, the National Response Team is currently developing a Technical Assistance Document and best practices for these kinds of vessels.

The majority of higher risk wrecks identified in RULET are located in U.S. Coast Guard Districts 5 and 7. They have the most priority wrecks for both release scenarios (see Figures ES-1 and 3-8) reflecting the intensity of World War II casualties in the Battle of the Atlantic. **For the Most Probable Discharge scenario, the high priority wrecks are located in Districts 1 and 7.**

The findings presented here are preliminary and are intended to provide input for Area Contingency Plans. Those vessels considered to be potentially high-risk based on the best available data and modeling results would be candidates for further investigation, including on-site surveys, to validate assumptions about vessel condition, oil content, oil type, and other factors that would weigh into an informed wreck-specific response decision. Small wrecks were excluded from the analysis, but these may be locally significant sources of pollution. There are likely still significant potentially polluting wrecks that have not been discovered or evaluated during the NOAA assessment. There are some just being brought to public attention such as *U-550*, which was reported as this document was going to peer review. Historical information used in our analysis is often incomplete with records based on subjective witness statements often made during or just after times of great stress. Information was certainly lost in the fog of time and warfare. A ship’s cargo or bunkers may have been reported incorrectly, or confused with another vessel or voyage. However, we believe that the combination of the historical data, archaeological information, salvage engineering, and environmental modeling information here provides a strong basis for future actions and decision-making and allows U.S. Coast Guard FOSCs, RRTs, and local Area Committees to evaluate the local and regional risks that may be associated with these vessels in the context of other pollution threats within their areas of responsibility. These findings should be somewhat reassuring in light of earlier global analyses such as that of the 2005 International Oil Spill Conference report (Michel et al., 2005) which estimated the total spill risks assuming that most vessels would have between 70-80 percent of their total fuel volume on board, and thus suggested that a much higher number of vessels were putting coastal and marine economies and environments at risk.

While there are vessels that are of concern (at a minimum the six vessels that scored High for both Worst Case Discharge and Most Probable Discharge), the scope of the problem is much more manageable than initially feared. This comprehensive national analysis is not one that becomes obsolete as soon as it is printed. There are components that may need to be updated, but the general risk assessment principles hold over time, as they are based on the best available information. If more were known about how corrosion processes work at different depths, that knowledge could provide more of a temporal component to these analyses. At present, that assessment must be done on a case-by-case basis.

From a national perspective, our coastlines are not littered with "ticking time bombs" of oil, although there are definitely vessels of concern in our waters that should be assessed and monitored. With this assessment we can put reliable bounds on the potential oil pollution threats and start to plan accordingly. The distribution of vessels is skewed heavily to World War II casualties in the Battle of the Atlantic. While the Great Lakes are known for their heavy toll on maritime commerce, coal was used more frequently as a fuel and the larger casualties in the Lakes were coal fired.

Given that the Oil Spill Liability Trust Fund under OPA does not provide a funding source for monitoring activities without a direct connection to a response action, other funding sources and more creative solutions are necessary. It is possible that existing maritime domain awareness surveillance and monitoring activities could be used more proactively to monitor last known locations of high and medium priority wrecks. Domestic satellite surveillance activities for weather forecasting were used with a fair degree of effectiveness in the recent *Deepwater Horizon* incident; whether they can be as effective for smaller volume spills is unclear. Commercial satellites are routinely used in the Gulf of Mexico, but are prohibitively expensive for the U.S. Coast Guard to access for this purpose. It would be beneficial for the U.S. Coast Guard to include a scenario involving a discharge from one of the priority wrecks for one of the National Preparedness for Response Exercise Program (NPREP) exercises, to raise awareness and identify appropriate response resources and the availability of those resources for such an event.

This report focuses on vessels within the U.S. EEZ. There are clearly large numbers of sunken wrecks in waters adjacent to the U.S.–where a spill could directly affect U.S. waters, three were discussed in this report,[149] and there may be others in territorial waters. There are also vessels in distant waters that garner interest and concern, especially the World War II wrecks in Oceania. The U.S. government will have to decide what if any actions it may take regarding those sovereign vessels. At some point, a risk assessment similar to RULET would be helpful in addressing the scope and scale of that issue.

[149] *Edmund Fitzgerald* (Canada), *Argo* (Canada) and *Gulfstate* (off Florida) are just over the U.S. EEZ in each case, but the impacts from those vessels would impact U.S. waters.

Each of the 87 companion screening reports contains an overall score and preliminary, vessel-specific recommendations for further action, ranging from awareness within the local response community, to monitoring, to further assessment and planning for underwater remediation. Table 6-1 is a summary of these recommendations as applied to the 87 priority wrecks. In most cases the vessel's position, condition and orientation are only generally known. ROV or other underwater surveys will generally be necessary to determine the vessel's structural integrity and potential for oil remaining onboard.

Table 6-1: Summary of recommendations from all RULET risk assessments.

Vessel Scores	Possible NOAA Recommendations	Number of Vessels Receiving Recommendation
High (+*1 Medium*)	Wreck should be considered for further assessment to determine the vessel condition, amount of oil onboard, and feasibility of oil removal action	**17**
High & Medium (*Unknown Loc.*)	Use surveys of opportunity to attempt to locate this vessel and gather more information on the vessel condition	**46**
High & Medium	Conduct active monitoring to look for releases or changes in rates of releases	**22**
All	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	**87**
All	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	**87**

Wrecks are of great interest to commercial and recreational divers and fishermen, and outreach efforts with these user groups is important to garner local knowledge, especially for wrecks that are routinely visited. The U.S. Coast Guard should consider engaging individuals in their local communities as "citizen scientists" to help with monitoring general conditions and keeping an eye out for sheening. Regional academic institutions with marine and coastal research programs may also be interested in participating in surveys of opportunity or even baseline monitoring. Many vessels are also historically significant and may be war graves. State historic preservation offices (SHPOs) will need to be consulted. All of these groups may be concerned with damage to the vessel that would reduce its value as historic artifact, dive attraction, or artificial reef. However, oil removal actions are generally designed to minimize disturbance to the vessel so they retain their integrity as fishing areas or dive sites as well as gravesites or memorials.

In addressing the concerns presented by a sunken vessel that is a potential threat to the marine environment, a number of legal issues may arise under U.S. and international law that may complicate a response carried out under OPA. There may be issues in regard to compliance with other environmental and historic preservation laws as well as concerns in regard to public vessels, sovereign immunity, and respect for gravesites. While these matters will need to be addressed on a case-by-case basis, the overview of these laws and issues contained within this report may be helpful to FOSCs, RRTs, and Area

Committees in their planning efforts. It is expected that pending regulations from the Navy will make it clearer how the Sunken Military Craft Act will interact with OPA requirements.

In addition to the vessel-specific recommendation, the following general recommendations apply to future activities:

- Continue to update the RULET wrecks database as new information becomes available.
- Track case histories of underwater interventions and share lessons learned and best practices.
- Improve technology for wreck assessment and oil removal, working with the response and salvage community to test and utilize non-invasive technologies.
- Consider using potentially polluting wrecks in development of response exercise scenarios such as the National Response Preparation Exercises (NPREP).
- Coordinate with other international efforts to track and respond to sunken wrecks.
- Support research on corrosion and degradation of sunken wrecks.
- Improve guidelines for responding to pollution from wrecks, and from abandoned and derelict vessels.
- Consider whether the NHPA programmatic agreement needs to be updated to reflect new challenges in spill response including potentially polluting wrecks and derelict and abandoned vessels.
- Inform and advise salvors and responders about appropriate documentation and protection of cultural resources associated with potentially polluting wrecks.
- Work with the National Register and the National Park Service to develop a multi-property nomination for the Battle of the Atlantic that encompasses the vessels lost in the Gulf of Mexico and Atlantic Ocean. This process should establish the criteria for which vessels and types of vessels involved in World War II are appropriate for protection and potential designation as National Register sites.
- Consider adequacy of existing funding mechanisms for assessment and oil removal activities from shipwrecks.
- Enhance general planning and preparedness activities, and a better ability to address any spill response emergencies that may arise.

Prior to the final publication of this report, NOAA conducted briefings with many of the U.S. Coast Guard District staff on the study results. Following the briefing with U.S. Coast Guard District 7, they developed a flow chart for how they would address the potentially polluting wrecks in their region. Figure 6-1 is a more generic version of this flow chart, included here to assist other District staff in this process.

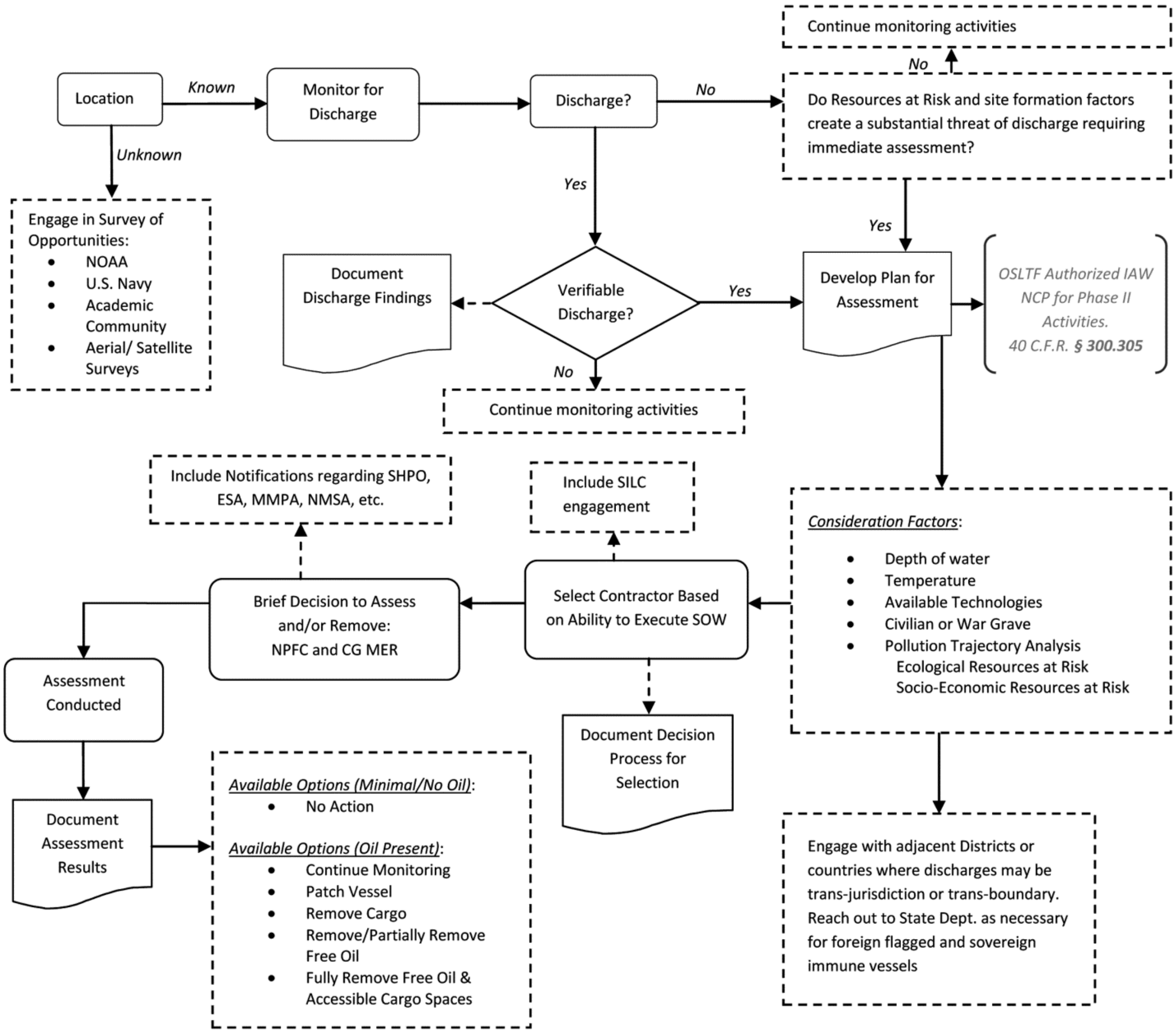

Figure 6-1. Decision flow chart that could be used to determine whether to monitor, assess, and/or remove oil from potentially polluting wrecks in U.S. Coast Guard Districts.

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APPENDIX A: WRECKS REMOVED FROM THE FIRST PRIORITY LIST

Initial screening of NOAA's wreck data, based on the vessel's age, type and size, identified 573 wrecks in the U.S. Exclusive Economic Zone (U.S. EEZ) that could pose a substantial oil pollution threat. This initial priority list included vessels sunk after 1891 (when U.S. vessels began being converted to use fuel oil), vessels built of steel or other durable material, cargo vessels over 1,000 gross tons (smaller vessels would have limited cargo or bunker capacity), and any tank vessel. After detailed archival research to fill in as much missing information as possible, the priority list was further shortened to 87 wrecks. This Appendix A lists the 486 wrecks that were removed from the priority list and a short statement on the basis for removal.

Name	Type	Rationale for Removal	USCG District
A.H. Olwine	Barge	Vessel was a wooden barge that did not carry a polluting cargo	1
Adventurer	Fishing Vessel	Vessel was a small fishing boat that was lost after a fire reached its fuel tanks	1
Agusta Snow	4 masted schooner	Sail powered, not a potentially polluting wreck	1
Alexander Macomb	Freighter	Wreck is entirely broken up into a mass of hull plates	1
Annapolis	Barge	Vessel was a barge carrying a cargo of coal when it was sunk in a collision with a U.S. Navy submarine	1
Annie Conant	Lighter	Small lighter not carrying polluting cargo	1
Argo Merchant	Tanker	Vessel spilled its entire cargo and was confirmed empty	1
Arundo	Freighter	Vessel was coal powered and did not carry a polluting cargo	1
Austin W.	Fishing Vessel	Vessel was a 67 foot fishing vessel lost in 1962 and does not meet the initial screening criteria for RULET	1
Bidevind	Freighter	Vessel has collapsed in on itself and is only a pile of hull plates	1
Bur	Freighter	Vessel was a coal powered freighter and did not carry a polluting cargo	1
Cape Fear	Concrete Ship	Vessel was coal powered	1
Charles S. Haight	Freighter	Vessel ruptured its fuel tanks after running aground and was salvaged multiple times	1
Chelsea	Unknown	Vessel broke in half and spilled its entire cargo of 6,000 bbl of No.2 fuel oil, the oil was washed offshore and dispersed and the wreck was demolished as a hazard to navigation	1
Choapa	Freighter	Vessel was a coal powered freighter and did not carry a polluting cargo	1
City of Columbia	Freighter	Vessel was coal powered and wrecked in 1896	1
City of Hartford	Freighter	Vessel was actually named Capital City when lost and was a coal powered freighter that did not carry a polluting cargo	1
Corvallis	Freighter	Vessel was a wooden freighter that was purchased from the U.S. Navy for the purpose of lighting it on fire and blowing it up for the movie *The Half-Way Girl*	1

Name	Type	Rationale for Removal	USCG District
Dighton	Barge	Vessel was a barge carrying coal and did not have a method of propulsion	1
Dixie Sword	Freighter	Vessel was demolished after sinking in shallow water and the debris is now entirely covered by sand	1
Druid Hill	Barge	Vessel was a wooden barge that did not carry a polluting cargo	1
Eagle Boat No. 42	Military Vessel	Vessel was scrapped before being scuttled as junk	1
El Estero	Unknown	Vessel was scrapped before being sunk at sea in bombing exercises	1
Empire Night	Freighter	Entry is a duplicate of Empire Knight which is still in RULET database	1
Ethel C	Freighter	Vessel was coal powered and only carried a cargo of scrap iron	1
Evans	Barge	Vessel was a small work barge that did not carry a polluting cargo	1
Fort Mercer	Tanker	Only the bow of this tanker sank and it was only carrying a cargo of kerosene, the vessel was sunk by incendiary shells fired through the bottom of the hull and the kerosene is believed to no longer be in the wreck	1
Fort Victoria	Passenger Vessel	Vessel was destroyed with over 25 tons of dynamite after it sank, virtually nothing remains of the wreck	1
G-4	Barge	This barge was raised and salvaged before being towed to deep water and scuttled	1
Garrett	Barge	Vessel was a wooden barge that was not carrying a polluting cargo	1
Gluckauf	Tanker	Vessel was the first modern prototype of an oil tanker and ran aground in 1893 and was entirely destroyed	1
Hartwelson	Freighter	Vessel was coal powered and only carried a cargo of coal	1
Henry Endicott	Barge	This wooden converted schooner barge does not have a mode of propulsion and was only carrying paving stones when lost	1
Herman Winter	Freighter	Vessel was coal powered and did not carry a polluting cargo	1
Ioannis P. Goulandris	Freighter	Vessel was coal powered and only carrying a cargo of coal	1
James Longstreet	Freighter	Vessel was used as a target ship for missile tests and is entirely destroyed, no tank structures remain intact	1
James M. Hudson	Barge	This barge was originally a schooner and did not carry a polluting cargo	1
Joel Cook	Barge	Vessel was a small work barge and did not carry a polluting cargo	1
King Phillip	Passenger Vessel	This small wooden passenger vessel sank at the dock and was raised and scuttled in deep water	1
L & W.B.C. CO.	Barge	Vessel was a wooden barge that carried coal	1
Lieutenant Sam Mengel	Barge	Vessel was a 1-deck wooden work barge and did not carry a polluting cargo	1
Lightburne	Tanker	Wreck sank in 30 feet of water and was entirely demolished as a hazard to navigation	1
Manokin	Barge	Vessel was a wooden barge and did not carry a polluting cargo	1
Marie Hooper	Barge	Vessel was a wooden barge and did not carry a polluting cargo	1

Name	Type	Rationale for Removal	USCG District
Mattawin	Freighter	Vessel was diesel powered and sank over 200 miles from shore in over 12,000 feet of water and possibly beyond the U.S. EEZ, preliminary environmental models show very limited environmental impacts	1
McGowen	Barge	Vessel was a small work barge and did not carry a polluting cargo	1
Moritz	Freighter	This wooden vessel was scrapped, set on fire, and scuttled	1
Newport	Barge	Vessel was a wooden barge and did not carry a polluting cargo	1
Orleans	Barge	Vessel was a wooden barge and did not carry a polluting cargo	1
Osceola	Barge	Vessel was a wooden barge and did not carry a polluting cargo	1
PinThis	Tanker	All tank structures are open to the sea	1
Pinthus	Tanker	This entry is a duplicate of Pinthis	1
Poling Bros. Number 2	Wooden Work Boat	Vessel was a wooden work boat that was 116 feet long and 159 tons, it does not meet the initial screening criteria for RULET	1
Port Nicholson	Freighter	Vessel was coal powered and did not carry a polluting cargo	1
Pottstown	Barge	Vessel was formerly a wooden schooner that was converted into a barge, the vessel does not meet the initial screening criteria for RULET and was carrying a cargo of coal	1
R.P. Resor	Tanker	The Coast Guard surveyed this wreck in 1967 and determined that no more oil remained in the wreck	1
R.R. Douglas	Three Masted Schooner	Vessel was actually named Rebecca R. Douglas and was a small 3 masted sailing schooner and did not carry a polluting cargo	1
Reliable	Barge	This small vessel was a work barge and did not carry a polluting cargo	1
Romance	Passenger Vessel	Vessel was coal powered and did not carry a polluting cargo	1
Sam Mengel	Barge	This entry is a duplicate of Lieutenant Sam Mengel	1
Sam Mengel	Barge	This entry is a triplicate of Lieutenant Sam Mengel	1
Sammerstad	Freighter	Entry is a duplicate of Sommerstad	1
Sommerstad	Freighter	Vessel has entirely collapsed and no tank structures remain, it may have also been coal powered	1
Stephano	Passenger Vessel	Vessel was coal powered	1
Stephen R. Jones	Collier	Vessel was coal powered and was demolished by the U.S. Navy after running aground	1
Strathdene	Freighter	Vessel was coal powered and did not carry a polluting cargo	1
Suffolk	Freighter	Vessel was coal powered and carried a cargo of coal	1
Union Faith	Unknown	The oil was removed from this vessel in 1999	1
USS San Diego	Military Vessel	Vessel was coal powered	1
Veneyard Sound	Lightship	Vessel was coal powered and much smaller than the initial screening criteria for RULET	1
William H. Machen	Freighter	Vessel was coal powered	1
Yankee	Freighter	Vessel was coal powered and carrying a cargo of coal	1

Name	Type	Rationale for Removal	USCG District
A.R. Heidritter	Schooner	Vessel is actually the Anna R. Heidritter which was a wooden 4 masted schooner that carried a cargo of logs	5
Advance II	Research Vessel	Vessel was a Coast Guard research vessel that was sunk as an artificial reef off North Carolina	5
Almirante	Freighter	Vessel was coal powered and did not carry a polluting cargo, the wreck was entirely demolished after sinking	5
American Oil Barge	Tank Barge	Vessel sank in very shallow water and was entirely demolished as a hazard to navigation	5
Amy Dora	Unknown	Vessel was lost in 1889 and does not meet initial screening criteria for RULET	5
Anastasia	Barge	Small wooden barge	5
Ario	Tanker	Wreck was entirely demolished during World War II	5
Ashkhabad	Freighter	Wreck was entirely demolished during World War II	5
Astra	Freighter	Vessel was coal powered and only carrying ballast water	5
Atlas	Tanker	Wreck was entirely demolished during World War II	5
Australia	Tanker	Wreck was entirely demolished during World War II	5
Barnstable	Barge	Vessel was a converted schooner that did not carry a polluting cargo	5
Bear Ridge	Barge	Small wooden barge that does not meet the initial screening criteria for RULET	5
Birch Lake	Barge	Vessel was a small wooden transport barge that burned and sank and that does not meet the initial screening criteria for RULET	5
Blink	Freighter	Vessel was coal powered and only carried a cargo of phosphate	5
British Splendour	Tanker	Wreck was entirely demolished during World War II	5
Byron D. Benson	Tanker	Wreck is entirely broken up into a debris field of hull plates	5
Caribsea	Freighter	Wreck was demolished during World War II and no tank structures remain intact	5
Carolina	Freighter	Vessel was a coal powered freighter carrying passengers and sugar	5
Cassimir	Freighter	Vessel has collapsed into a rubble field and does not have intact tank structures	5
Chaparra	Freighter	Wreck is a scattered debris field without any intact tank structures	5
Chenango	Freighter	Vessel was coal powered and only carried a cargo of ore	5
Chilore	Freighter	wreck was entirely demolished during World War II	5
Ciltvaira	Freighter	Vessel was coal powered and only carried a cargo of newsprint	5
City of Athens	Passenger Ship	Wreck was entirely demolished after sinking in a shipping channel	5
City of Atlanta	Freighter	Vessel was coal powered and was entirely demolished during World War II	5
City of Orleans	Barge	Vessel was a small work barge that did not carry a polluting cargo	5
Desert Light	Freighter	Vessel was coal powered and did not carry a polluting cargo	5
Dixie Arrow	Tanker	Wreck was entirely demolished during World War II	5
Dongan Hills	Freighter	After being sold for scrap for 1 dollar in 1967, the vessel was abandoned and began leaking oil in 1974. After the leak was discovered, the Coast Guard had the vessel demolished	5

Name	Type	Rationale for Removal	USCG District
E.M. Clark	Tanker	Vessel has been surveyed by NOAA multiple times and Woods Hole Oceanographic Institute (WHOI) has generated 3d video of the wreck, none of these surveys have given NOAA archaeologists reason to believe any oil remains in the wreck	5
Eidsvold	Freighter	Vessel was a coal powered freighter that did not carry a polluting cargo	5
Empire Thrush	Freighter	Wreck was entirely demolished during World War II	5
Equipoise	Freighter	Vessel was coal powered and only carried a cargo of ore	5
ESSO Nashville	Tanker	Wreck has entirely collapsed and no tank structures remain intact	5
F.W. Abrams	Tanker	Wreck was entirely demolished during World War II	5
Fall River	Barge	Vessel was a wooden barge that did not carry a polluting cargo, the barge was abandoned at sea	5
Gary	Barge	Vessel was a small work barge that was not carrying a polluting cargo	5
Gordan S Cook	Barge	Vessel was actually named Gordon C. Cooke and was a steel barge that sank while carrying a cargo of gypsum rock	5
Gulftrade	Tanker	The Coast Guard inspected this vessel in 1967 and discovered that it no longer contained any oil	5
Gypsum Prince	Freighter	Vessel was entirely demolished during World War II	5
Hampshire	Barge	Vessel was a small wooden barge that did not carry a polluting cargo	5
Harpathian	Freighter	Vessel was coal powered and was not carrying a cargo when lost	5
Hauppauge	Schooner	This wooden schooner was towed to shore and salvaged, it is not a shipwreck	Salvaged
Henrik Lund	Freighter	Vessel was coal powered and did not carry a polluting cargo	5
Henry Rush	Barge	Actually named Harry Rush, this vessel was a small wooden barge that did not carry a polluting cargo	5
Hustler	Tug Boat	Vessel was a small harbor tug that does not meet the initial screening criteria for RULET	5
Hvoslef	Freighter	The wreck was demolished and is entirely broken apart, no tank structures remain intact	5
John D. gill	Tanker	Vessel was entirely demolished during World War II	5
John Morgan	Freighter	Vessel was entirely demolished during World War II	5
Jones Port	Barge	Vessel was a small work barge and did not carry a polluting cargo	5
Joseph E. Hooper	Barge	Vessel was a small wooden schooner converted to a barge that did not carry a polluting cargo	5
Kassandra Louloudis	Freighter	Vessel was coal powered and did not carry a polluting cargo	5
Kennebec	Freighter	Vessel was coal powered and was demolished after sinking	5
Keshena	Tug Boat	Wreck was entirely demolished during World War II	5
Kingston Ceylonite	Military Vessel	Vessel was entirely demolished during World War II	5
Kyzickes	Tanker	Vessel entirely broke apart after running aground and was used for aerial bombing practice, no intact tank structures remain	5
L.B. Shaw	Barge	Vessel was a wooden barge and did not carry a polluting cargo	5

Name	Type	Rationale for Removal	USCG District
Lemeul Burrows	Freighter	Vessel was entirely demolished during World War II	5
Liberator	Freighter	Vessel was entirely demolished during World War II	5
Lillian	Freighter	This wreck was entirely broken up and lies broken apart in a scattered debris field extending over 500 feet, no tank structures remain intact	5
Madrugada	Four masted schooner	Vessel was a wooden 4 masted schooner that was not carrying a polluting cargo	5
Malchace	Freighter	This wreck has entirely collapsed and no tank structures remain intact	5
Manuela	Freighter	Wreck has entirely collapsed and no tank structures remain intact	5
Maurice Tracy	Freighter	Vessel was coal powered and carrying a cargo of coal when lost	5
Merida	Freighter	Vessel was entirely destroyed by dynamite	5
Mirlo	Tanker	This tanker was blown apart by a mine during World War I and the cargo of gasoline burned extensively, wreck is believed to have been entirely demolished after sinking in shallow water	5
Moldanger	Freighter	This freighter sank over 200 miles from shore in extremely deep water and possibly beyond the U.S. EEZ, preliminary environmental models show very limited environmental impacts	5
Naeco	Tanker	Vessel has entirely collapsed and all tank structures are open to the sea	5
New Orleans	Freighter	Vessel was coal powered and carried a cargo of sulphur	5
Northeastern	Tanker	All tank structures on this vessel have collapsed and are open to the sea	5
Northern 35	Barge	This small wooden barge was raised in 1927 and is no longer a shipwreck	5
Norvana	Freighter	Vessel was entirely demolished during World War II	5
Norwood	Sailing Ship	Vessel was a full rigged sailing vessel that was carrying salt when lost	5
Ocean Venture	Freighter	Vessel was coal powered and carried a cargo of foodstuffs	5
Oklahoma	Freighter	Vessel is entirely broken apart into a rubble field and no tank structures remain intact	5
Olinda	Freighter	Vessel was coal powered and carried a cargo of foodstuffs	5
Olympic	Tanker	Vessel disappeared without a trace during World War II and no accurate location is known	5
Pacific	Barge	Vessel was a small work barge and did not carry a polluting cargo	5
Papoose	Tanker	This tanker was sailing in ballast and divers who have visited the site have reported that all tanks are open to the sea and no oil remains in the wreck	5
Persephone	Tanker	The bow of the vessel was salvaged and the stern was entirely destroyed by the Coast Guard because it was a hazard to navigation	5
Phoenix	Tanker	This tanker was sailing in ballast and was scuttled and scrapped in the Delaware River after extensive burning	5
Portland	Freighter	This freighter sank in shallow water off North Carolina and was entirely demolished, no tank structures remain intact	5

Name	Type	Rationale for Removal	USCG District
Proteus	Passenger Vessel	This passenger vessel was coal powered	5
Rio Blanco	Freighter	Vessel was coal powered and carried a cargo of iron ore	5
Rio Tercero	Freighter	Vessel was coal powered and only carrying a general cargo	5
Russell 21	Tank Barge	This tank barge was not sunk in 1945 in a marine casualty like AWOIS states, but was abandoned due to disrepair in 1956	5
Saetia	Freighter	Vessel was coal powered and not carrying a polluting cargo	5
San Delfino	Tanker	All tank structures on this vessel have collapsed and are open to the sea	5
San Gil	Freighter	Vessel has entirely collapsed and no tank structures remain, the vessel carried a cargo of bananas	5
San Jose	Freighter	Vessel was coal powered and only carried a cargo of fruit and lumber	5
San Saba	Freighter	Vessel was entirely demolished and only carried a general cargo	5
Santore	Freighter	Vessel was entirely demolished during World War II and no tank structures remain intact	5
Schurz	Gun Boat	Vessel was coal powered	5
Sergo Zakariadze	Unknown	Vessel was refloated and towed to deep water where it was scuttled after responders determined there was no more fuel onboard	5
T.J. Hooper	Barge	Vessel was a schooner that was converted to a barge, it did not carry a polluting cargo	5
Tamaulipas	Tanker	Video footage of this tanker available online shows all tanks open to the sea and no longer capable of retaining oil	5
Tarpon	Submarine	Vessel was scrapped and sank while under tow to a junk yard	5
Tenas	Barge	Vessel was a wooden barge that did not carry a polluting cargo	5
Theodore Parker	Unknown	Vessel was scrapped and sunk as an artificial reef off North Carolina	5
Thistleroy	Freighter	Vessel was coal powered and carrying a cargo of cotton when it sank in 1911	5
Thomas Tracy	Freighter	Vessel was coal powered and did not carry a polluting cargo	5
Tiger	Tanker	Vessel was entirely demolished during World War II	5
Trepca	Freighter	Vessel was coal powered and did not carrying a polluting cargo	5
Ulysses	Passenger Vessel	Vessel was coal powered and did not carry a polluting cargo	5
USS *Jacob Jones*	Military Vessel	Vessel was entirely destroyed during World War II	5
Valchem	Unknown	Vessel did not sink in a collision and was scrapped two years later	Salvaged
Varanger	Tanker	The Coast Guard surveyed this vessel in 1967 and determined it did not contain any oil	5
W.E. Hutton	Tanker	NOAA divers have visited this wreck and video footage of the wreck available online shows all tanks open to the sea and no longer capable of retaining oil	5
Washingtonian	Freighter	Vessel has entirely collapsed and no tank structures remain intact	5

Name	Type	Rationale for Removal	USCG District
Webster	Freighter	This Liberty Ship was scrapped and sunk as an artificial reef off Virginia	5
York	Freighter	Duplicate of Norvana (York was a former name)	5
Alicia	Steamship	Ship was a coal powered steamship lost in 1905	7
Amazone	Freighter	Wreck is entirely broken up into a mass of hull plates	7
Artemis	Schooner	Vessel was a sailing schooner that sank over 200 miles from Tampa, it did not have a cargo when lost	7
Baja California	Freighter	Wreck was demolished during World War II and no longer has intact tank structures	7
Belmont	Barge	Vessel was a 103 foot work barge that does not meet the initial screening criteria for RULET	7
Benwood	Freighter	Vessel was coal powered and was entirely demolished, it is now an artificial reef in Florida Keys National Marine Sanctuary	7
Black Bart	Unknown	Vessel was scrapped and sunk as an artificial reef in 1979	7
Cities Service Empire	Tanker	Divers who have visited this site report that all tanks are open to the sea and that the ship no longer contains oil	7
City of St. Helens	Schooner	Vessel was a wooden schooner that did not carry a polluting cargo, the vessel was lost due to a fire	7
Croy N. Cris	Barge	Vessel was a 130 foot barge that was sunk in 1986 as an artificial reef	7
Dorothy Marine II	Sailboat	Vessel was a 102 foot sailboat that ran aground in 1986 and was broken apart by pounding waves	7
Edward Luckenbach	Freighter	Wreck was entirely demolished during World War II	7
Edward Luckenback	Freighter	Entry is a duplicate of Edward Luckenbach	7
Esparta	Freighter	Wreck was entirely demolished and no discernible elements of the wreck remain	7
Fred T. Berry	Unknown	Vessel was scrapped and sunk as an artificial reef during explosives training exercises	7
Gulf State	Tanker	This entry is a duplicate of Gulfstate which is still in RULET	7
Gulfamerica	Tanker	Vessel sank in very shallow water and was entirely demolished as a hazard to navigation, the rubble field is almost unrecognizable as a shipwreck	7
Gundor	Freighter	This entry is a duplicate of Gunvor	7
Gunvor	Freighter	This wreck was entirely demolished as a hazard to navigation and only consists of large chunks of metal, no tank structures are intact	7
Halsey	Tanker	Vessel was entirely demolished and no intact tank structures remain	7
Hebe	Freighter	Vessel was coal powered and did not carry a polluting cargo	7
Hector	Military Vessel	This navy collier sank carrying a full load of coal and was salvaged after it sank	7
Holliswood	Schooner	Vessel was a wooden schooner that was carrying lumber when it was lost	7
Korsholm	Freighter	Vessel was entirely demolished during World War II	7

Name	Type	Rationale for Removal	USCG District
Lugana	Freighter	Vessel was actually named Lugano and was coal powered and not carrying a polluting cargo, it is now part of Biscayne National Park	7
Mary B. Baird	Schooner	Vessel was a wooden schooner carrying a cargo of coal	7
Ocean Eagle	Tanker	The vessel discharged much of its oil cargo onto the beaches of Puerto Rico, 23,800 bbl of crude were then pumped out by USS Preserver, the wreck was then refloated, towed to deep water, and scuttled	7
Ocean Venus	Freighter	Vessel was coal powered and carried a cargo of general goods	7
Raritan	Freighter	This wreck is entirely broken apart and no tank structures are left intact	7
Renegade IV	Freighter	Vessel was actually named Republic when it sank in 1942, the vessel was salvaged and entirely demolished by the U.S. Navy after sinking	7
Republic	Freighter	This entry is a duplicate of Renegade IV	7
S.C. Loveland	Barge	Vessel was actually named Samuel C. Loveland, Jr. and was a barge that carried a cargo of sugar	7
Sonora	Schooner	This small diesel powered schooner sank over 90 miles outside the U.S. EEZ due to an engine fire and it does not meet the initial screening criteria for RULET	7
U-2513	Submarine	Vessel was scrapped and sunk by the U.S. Navy during a shooting drill	7
Umtata	Freighter	Vessel was coal powered and carried a cargo of mineral ore	7
USS Kendrick	Military Vessel	Vessel was scrapped and sunk as an artificial reef during a training exercise	7
USS Saufley (DD-455)	Military Vessel	Vessel was scrapped and sunk during a bombing test	7
USS Sturtevant	Military Vessel	Vessel was entirely demolished and no tank structures remain intact	7
USS YDS 68	Barge	This 110 foot lifting barge used for raising downed aircraft was not carrying a polluting cargo	7
Vamar	Freighter	Vessel was coal powered and only 598 gross tons, it is now a state underwater preserve in Florida	7
Vessel	Freighter	This entry is an AWOIS duplicate of Moira	7
Vessel	Freighter	This entry is an AWOIS duplicate of Manzanillo	7
Vessel	Freighter	This entry is also an AWOIS duplicate of Manzanillo with an incorrect rounding of the decimal degrees coordinates	7
White Eagle	Freighter	Vessel was entirely destroyed after running aground	7
Wilkes-Barre	Unknown	Vessel was scrapped and sunk as an artificial reef during explosives training	7
ABC 757	Barge	Work barge lost in the Mississippi River	8
ANACONDA	Barge	Duplicate of Anaconda	8
Anaconda	Barge	Small wooden barge	8
Barge ACBL303x	Barge	Freight barge inspected by the Coast Guard and deemed safe enough to leave unsalvaged	8

Name	Type	Rationale for Removal	USCG District
Barge FP-21	Barge	Freeport sulphur barge was carrying a cargo of sulphur and does not meet initial screening criteria for RULET	8
Benjamin Brewster	Tanker	The vessel sank in shallow water where it burned for 9 days before being broken up and salvaged	8
Big Mac	Barge	Vessel was a fuel barge that was salvaged immediately after sinking	8
Chippewa	Freighter	Vessel was scrapped and sunk in 1990 as an artificial reef	8
David McKelvy	Tanker	Vessel burned for days and was towed to shore and beached before it was declared a total loss and scrapped	8
Empire Mica	Unknown	Vessel is entirely broken apart and no tank structures remain intact	8
Galveston USA	Dredge	This small Army Corps of Engineers dredge was pushed ashore in a hurricane in 1943 and broke apart, the vessel is smaller than the minimum criteria for RULET	8
Gulf Oil	Tanker	This entry is a duplicate of Gulf Oil which is still in RULET	8
Gulf Penn	Tanker	This entry is a duplicate of Gulfpenn which is still in RULET	8
Gulf Stag	Tanker	This entry is a duplicate of Gulfstag which is still in RULET	8
H.O.S. Geco Apollo	Offshore Supply Vessel	Vessel is a 296 gross ton offshore supply vessel that was lost in 1991, the vessel does not meet the initial screening criteria for RULET	8
Heredia	Freighter	Vessel was demolished during World War II and only remains as a scattered debris field	8
Kodiak II	Tug Boat	This small towing vessel did not meet the initial criteria for RULET and was lost in over 4,000 feet of water in the Gulf of Mexico	8
Marvina	Freighter	This 150 foot long lumber carrier does not meet the initial screening criteria for RULET	8
Noorderkroon	Narcotics Boat	Vessel does not meet the initial screening criteria for RULET, it was a drug smuggling boat that was set on fire and scuttled	8
R.M. Parker, Jr.	Tanker	Divers who have visited this site report that all tanks are open to the sea and that the ship no longer contains oil	8
Torny	Freighter	This entry is a duplicate of Torny	8
Torny	Freighter	Vessel was coal powered and did not carry a polluting cargo	8
Utila Princess	Unknown	Vessel did not actually wreck and is not a shipwreck	8
William Beaumont	Freighter	T remaining oil was removed from this shipwreck in 2009	8
Cleveco	Tank Barge	Oil was removed from this tank barge in 1995	9
F.H. Prince	Dredge	This wooden dredge burned twice before having its engines and boilers salvaged	9
Grecian	Freighter	Vessel was coal powered and did not carry a polluting cargo	9
Sacremento	Unknown	Vessel ran aground on a reef and was thought to be a total loss, it was refloated however and returned to service before being abandoned at the Davidson Shipyard in 1939 where the remains still exist	9
Steelvendor	Freighter	This small diesel powered freighter sank in over 700 feet of water in Lake Superior and only had a bunker capacity of 599 bbl	9
A.C. Dutton	Barge	Vessel was a lumber barge that did not carry a polluting cargo	11

Name	Type	Rationale for Removal	USCG District
Alden Anderson	Freighter	Vessel was smaller than the initial screening criteria for RULET and was gutted by a fire before sinking	11
Alice	Schooner	Sail powered, not a potentially polluting wreck	11
Aurora	Schooner	Vessel was a small wooden schooner	11
Babinda	Unknown	Vessel was a small wooden vessel and does not meet the initial screening criteria for RULET	11
C-7742	Fishing Vessel	Vessel was a small salmon trawler that was entirely destroyed after running aground	11
Centennial	Barge	Vessel was a wooden barge not carrying a polluting cargo	11
Charles B. Kennedy	Barge	Vessel was a wooden schooner converted into a barge	11
Chickasaw	Freighter	Wreck was entirely destroyed and broken apart along the shoreline	11
City of Peking	Freighter	Vessel was coal powered and was scrapped around 1911, it is not a shipwreck	11
City of Sydney	Barge	Vessel was converted into a fishing barge and sank while under tow, it did not carry a polluting cargo	11
Coos Bay	Schooner	Vessel was a wooden schooner carrying a cargo of lumber, vessel broke to pieces on rocks off California	11
D. Wintemore	Freighter	Duplicate of Dorothy Wintermore	11
Daisy Matthews	Schooner	Vessel was a wooden schooner and did not carry a polluting cargo	11
Discovery	Freighter	Vessel was only 78 feet long and 117 gross tons, it does not meet the initial screening criteria for RULET	11
Dominator	Freighter	Vessel entirely broke apart after running aground	11
Dorothy Wintermote	Freighter	Vessel was a freighter smaller than the initial screening criteria for RULET and only carrying general goods and lumber	11
Dunkerque	Five masted schooner	Vessel was a five masted wooden schooner that did not carry a polluting cargo	11
E. A. Bryan	Freighter	Vessel was part of the Port Chicago disaster and was vaporized by the explosion of the 4,600 tons of ammunition the vessel carried	11
Eureka	Schooner	Vessel was a wooden schooner and did not carry a polluting cargo	11
Flavel	Schooner	This wooden schooner does not meet the initial screening criteria for RULET and was entirely destroyed after running aground	11
Frank H. Buck	Tanker	After releasing 64,300 bbl of oil, the vessel was partially salvaged and then dynamited as a hazard to navigation, no tank structures remain intact	11
Gregory	Unknown	This shipwreck was entirely demolished by the U.S. Navy	11
Harvard	Passenger Vessel	Vessel ran aground and was broken to pieces by waves against the shoreline	11
Henry Bergh	Freighter	Vessel is entirely broken apart on the rocks it ran aground upon	11
Hogan	Unknown	Vessel was scrapped and sunk in bombing tests	11
Ioannis G. Kulukundis	Freighter	Vessel broke apart on the shoreline then was entirely demolished with dynamite	11

Name	Type	Rationale for Removal	USCG District
Irene	Barge	This former wooden schooner was converted to a fishing barge and was entirely destroyed after washing ashore	11
Isaac Reed	Barge	This barge had no method of propulsion and was not carrying a polluting cargo	11
Johanna Smith	Freighter	This wooden vessel sank after burning and was dynamited as a hazard to navigation	11
John C. Butler	Unknown	Vessel was scrapped and then sunk by the U.S. Navy during explosives testing	11
La Janelle	Freighter	Vessel was salvaged, gutted, and turned into a breakwater	11
LST 803	Military Vessel	Vessel was scrapped and sunk by the U.S. Navy during target practice	11
Lyman A. Stewart	Tanker	Vessel was dynamited and entirely destroyed in 1938, no tank structures remain intact	11
Melrose	Freighter	Vessel did not carry or burn oil	11
Merced	Freighter	Vessel is actually the Spanish sailing vessel Nuestra Senora de la Merced (or La Merced for short) which sank off the coast of Virginia in 1750	11
Montebello	Tanker	This tanker was determined to no longer present a pollution threat to the environment in 2011	11
Moray	Unknown (Submarine?)	Vessel was scrapped and then scuttled by the U.S. Navy	11
Munleon	Freighter	Vessel entirely broke apart after running aground off Point Reyes, CA	11
Nippon Maru	Freighter	Vessel entirely broke apart and was demolished after running aground	11
Norlina	Freighter	Vessel was coal powered and did not carry a polluting cargo	11
Noyo	Schooner	This small steam schooner entirely broke apart after running aground	11
Ohioan	Freighter	Vessel which sank in 1936 was entirely broken up in 1938 and salvaged multiple times, no tank structures remain intact as documented by the National Park Service	11
Olympic II	Barge	Vessel was a sailing vessel that was converted into a floating fishing barge before it sank	11
Orteric	Freighter	Vessel entirely broke apart after running aground	11
Pacific Enterprise	Freighter	Vessel entirely broke apart after running aground and only small pieces of the wreck remain	11
Palawan	Unknown	Vessel was stripped and sunk as an artificial reef	11
Palo Alto	Concrete Ship	Vessel was converted into a breakwater and the oil was removed from it in 2006	11
Point Loma	Three Masted Schooner	Vessel was a wooden three masted schooner that was 142 feet long and 296 gross tons, it does not meet the initial screening criteria for RULET and did not carry a polluting cargo	11
Queen Christina	Freighter	Vessel was coal powered and did not carry a polluting cargo	11
Quinault Victory	Freighter	Vessel was part of the Port Chicago disaster and was vaporized by the explosion	11

Name	Type	Rationale for Removal	USCG District
Redline	Tanker	This small 388 gross ton tanker was entirely destroyed after suffering an explosion while still at the dock	11
Rhine Maru	Freighter	2/3 of this wreck were salvaged and the rest was entirely destroyed by pounding surf, no intact tank structures remain	11
Richfield	Tanker	The gasoline was pumped out of this tanker after it ran aground and the wreck was entirely broken apart on the rocks	11
Riverside	Freighter	Vessel was coal powered and only carried a cargo of lumber	11
Roanoke	Freighter	Vessel was coal powered and did not carry a polluting cargo	11
Roderick Dhu	Barge	This barge was entirely empty at the time of its loss	11
S-37	Submarine	Vessel was scrapped and lost in a storm while it was being towed to sea for target practice	11
San Joaquin	Freighter	This very small freighter does not meet the initial screening criteria for RULET	11
Sierra	Freighter	Vessel was coal powered and did not carry a polluting cargo	11
Simla	Wooden Bark	Vessel was wooden and did not meet the initial screening criteria for RULET	11
Star of Scotland	Barge	Vessel was converted to an anchored fishing barge before it sank and was dynamited	11
Thomas P. Emigh	Barge	Vessel was a wooden barge that did not carry a polluting cargo	11
Tortuga	Unknown	The oil was removed from this vessel by the U.S. Navy	11
Umpqua	Barge	Vessel was a lumber barge that was taken to deep water and scuttled	11
USS *Benevolence*	Military Vessel	Vessel was entirely demolished with dynamite	11
USS *Burns*	Military Vessel	Vessel was scrapped and sunk by the U.S. Navy during a shooting drill	11
USS *Burrfish*	Military Vessel	Vessel was scrapped and sunk by the U.S. Navy during a shooting drill	11
USS *Chauncey*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
USS *Delphy*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
USS *Fuller*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
USS *Independence (CVL-22)*	Military Vessel	The oil was removed from this vessel before it was scuttled, the wreck is of concern for the radioactive material sunk onboard the ship	11
USS *Macon*	Military Airship	Vessel is an airship that is entirely broken apart on the seabed and does not meet the initial screening criteria for RULET	11
USS *McCulloch*	Military Vessel	This small military vessel was a composite iron and wooden vessel of 869 gross tons and does not meet the initial screening criteria for RULET	11
USS *Milwaukee*	Military Vessel	Vessel was a coal powered cruiser	11

Name	Type	Rationale for Removal	USCG District
USS *Milwaukee*	Military Vessel	This entry is a duplicate of USS Milwaukee	11
USS *Moody*	Military Vessel	Vessel was scrapped and sunk for the movie *Hell Below*	11
USS *Nicholas*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
USS *Ramsden*	Military Vessel	Vessel was scrapped and sunk during a bombing test	11
USS *S.P. Lee*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
USS *Sabalo*	Military Vessel	Vessel was scrapped and scuttled as part of a fleet reduction	11
USS *Savage*	Military Vessel	Vessel was scrapped and sunk during a bombing test	11
USS *Woodbury*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
USS *Young*	Military Vessel	Nothing defining remains amongst the broken apart wreck, the wreck is entirely demolished and scattered across the seabed	11
Washtenaw	Freighter	Vessel was coal powered	11
Wellesley	Wooden Vessel	This small wooden vessel does not meet the initial screening criteria for RULET	11
Whittier	Freighter	Vessel was entirely destroyed after running aground	11
William C. Ralston	Freighter	Vessel does not contain oil but it is of concern for the chemical weapons that were placed on the ship before it was scuttled	11
Wilmington	Wooden Vessel	This small wooden vessel does not meet the initial screening criteria for RULET	11
YO-219	Yard Oiler	Vessel was scrapped and sunk as a target during explosives testing	11
Admiral Benson	Freighter	Entirely broken up along the coastline	13
Alaska Reefer	Freighter	This wooden refrigerated vessel does not meet the initial screening criteria for RULET and was gutted by multiple fires	13
Alvarado	Freighter	Entirely broken up along the coastline	13
Betty M.	Fishing Vessel	Vessel was a 191 foot fishing vessel that was lost in 1976 while carrying 900 tons of tuna, the oil was removed by the Coast Guard and a salvage company after it sank	13
C.A. Smith	Wooden Vessel	This wooden vessel does not meet the initial screening criteria for RULET and was only carrying 1.5 million feet of lumber	13
George L. Olsen	Schooner	This wooden wreck is a beach wreck located in Oregon and often buried by sand	13
George Olsen	Schooner	This entry is a duplicate of George L. Olsen	13
J.A. Chanslor	Tanker	Vessel was sailing in ballast and entirely broke apart after running aground in 1919	13
John Aspin	Barge	This small barge was not carrying a polluting cargo when it sank	13
John C. Kirkpatrick	Schooner	This small wooden schooner was destroyed by a fire	13

Name	Type	Rationale for Removal	USCG District
Lamut	Freighter	Vessel was coal powered and entirely broken apart on a rocky coastline	13
LST 784	Military Vessel	Vessel was scrapped and sunk by the U.S. Navy during target practice	13
LST 904	Military Vessel	Vessel was scrapped and sunk by the U.S. Navy during target practice	13
Multnomah	Passenger Vessel	Vessel was a wooden stern-wheeled steamship and does not meet the initial screening criteria for RULET	13
Rosecrans	Tanker	The crew of this vessel pumped the oil overboard to lighten the ship, but it was still entirely destroyed after it ran aground and was pounded to pieces by waves and surf	13
Santa Clara	Wooden Ship	This wooden vessel was beached and burned and does not meet the initial screening criteria for RULET	13
Willapa	Schooner	This small schooner only carried a cargo of lumber and does not meet the initial screening criteria for RULET	13
Anangel Liberty	Freighter	Vessel was refloated after grounding off Hawaii	14
Macaw	Military Vessel	Vessel was entirely demolished after it sank in a shipping channel off Midway	14
USN *Neches*	Military Vessel (Oiler)	Vessel is a duplicate of USS Neches which is still in RULET	14
USS *Arizona*	Military Vessel	This site is managed by the National Park Service and therefore it wasn't necessary to include in the RULET database and WORP project	14
USS *Hammann*	Military Vessel	Vessel was blown apart by its own depth charges as it sank	14
Admiral Evans	Freighter	Vessel was refloated and salvaged	17
Alaska Roughneck	Tug Boat	This small tugboat was smaller than the minimum criteria for RULET	17
Aleutian Enterprise	Fish Processing Plant	Vessel was 195 gross tons and 120 feet long and does not meet the initial screening criteria for RULET, the vessel was also lost in very deep water off Alaska	17
Aleutian Monarch	Fish Processing Plant	Vessel was gutted by fire before being towed to deep water by the Coast Guard and scuttled	17
Coldbrook	Freighter	Vessel is on land in Alaska after an earthquake lifted the island it was aground on four feet out of the water	17
Crown City	Freighter	Vessel entirely broke apart after running aground	17
Dellwood	Military Vessel	Vessel entirely broke apart after running aground in the Aleutian Chain	17
Lee Wang Zin	Freighter	Vessel spilled most of its bunker oil after running aground and was towed to deep water and scuttled by a salvage company with approval by the Coast Guard	17
Lulu	Barge	This work barge sank at the dock in Alaska and is still visible nearly ashore in satellite images	17
Mapele	Freighter	Vessel was entirely destroyed after running aground	17
Mount McKinley	Freighter	Vessel was entirely destroyed after running aground	17

Name	Type	Rationale for Removal	USCG District
North Wind	Freighter	Vessel was entirely destroyed after running aground	17
Oduna	Freighter	Photographs of this vessel show that it is entirely gutted and no tank structures remain intact	17
Pavlin Vinogradov	Freighter	Vessel was coal powered and did not carry a polluting cargo	17
Port Orford	Schooner	This small wooden steam schooner was carrying a cargo of lumber and was entirely destroyed after running aground	17
Princess Kathleen	Passenger Vessel	The oil remaining in this vessel was removed in 2010	17
Princess Mary	Barge	Vessel was converted into a barge and sank while carrying a cargo of ore	17
Princess Sophia	Passenger Vessel	Vessel is entirely broken apart and no tank structures remain intact	17
Scotia	Freighter	Vessel was partially salvaged after running aground and then entirely broken apart against the coastline	17
State of California	Passenger Vessel	Vessel was coal powered	17
Timlat	Freighter	Vessel was coal powered and did not carry a polluting cargo	17
Turksib	Freighter	Vessel ran aground in Alaska and was immediately salvaged	17
UMTB American Barge 283	Tank Barge	Vessel was sunk in 600 feet of water with potentially 20,000 bbl of diesel onboard. Vessel released its load of diesel after the Coast Guard shot holes in it to sink it upon receiving authorization from the Regional Response Team.	17
USS *Worden*	Military Vessel	Vessel was entirely broken apart after running aground	17
Western Salvor	Barge	Barge ran aground and broke apart of Alaska, releasing its cargo of lumber and 107 bbl of diesel fuel	17
Yukon	Passenger Freighter	Vessel was entirely destroyed after running aground	17
Adriatic C	Fishing Vessel	Vessel was a small fishing vessel lost in deep water	American Samoa
Ex-USS *Chehalis*	Tanker	The remaining oil was removed from this shipwreck in 2010	American Samoa
Akigawa Maru	Freighter	Vessel was sunk by a U.S. Submarine in Japanese waters during World War II	Outside EEZ
Amakusa Maru No. 1	Tanker	Vessel was a water tanker that was torpedoed by a U.S. Submarine well beyond the U.S. EEZ during World War II	Outside EEZ
Archangelos	Freighter	Vessel was lost off Mexico over 700 miles from U.S. waters	Outside EEZ
Athena	Freighter	Vessel was lost over 400 miles outside the U.S. EEZ and 600 miles from Alaska	Outside EEZ
Beaverhill	Freighter	Vessel was a coal burning freighter that had its cargo removed before being refloated and towed to sea and scuttled	Outside EEZ
Bolshoy Tschantar	Freighter	Vessel was a coal powered freighter carrying a general cargo	Outside EEZ

Name	Type	Rationale for Removal	USCG District
C Olsen USA	Freighter	Vessel was lost well beyond the U.S. EEZ over 1,000 miles from the coast of California	Outside EEZ
Caddo	Freighter	Vessel sank over 900 miles outside the U.S. EEZ in the middle of the Atlantic Ocean	Outside EEZ
East Star	Freighter	Vessel was 145 feet long and 643 gross tons, it sank 73 miles NE of Bermuda in 1962, the captain accused Cubans of filling his fuel tanks with water so the vessel had no power. It foundered in a storm after spending 9 days adrift	Outside EEZ
Eclipse	Freighter	Vessel only carrying coal and was lost well beyond the U.S. EEZ and over 1,000 miles from Hawaii	Outside EEZ
Edward A. Savoy	Freighter	Vessel was renamed Estoril before it sank and it was lost over 275 miles outside the U.S. EEZ in the middle of the Atlantic Ocean	Outside EEZ
El Sinore	Unknown	Vessel sank well beyond the U.S. EEZ off Manzanillo, Mexico	Outside EEZ
Empire Story	Freighter	Vessel was a coal powered freighter that was lost in Canadian Waters	Outside EEZ
Fairhaven	Unknown	Vessel sank well beyond the U.S. EEZ off the coast of Manzanillo, Mexico	Outside EEZ
Faja de Oro	Unknown	Vessel sank off the coast of Cuba over 40 miles outside the U.S. EEZ in over 9,500 feet of water	Outside EEZ
Foss 130	Tug Boat	This small tugboat was smaller than the minimum criteria for RULET and was lost over 700 miles from shore	Outside EEZ
George Calvert	Freighter	Vessel sank over 75 miles outside the U.S. EEZ and 50 miles east of Cuba while carrying a general cargo	Outside EEZ
Gezina Brovig	Tanker	Vessel sank over 100 miles beyond the U.S. EEZ north of Puerto Rico in over 14,000 feet of water	Outside EEZ
Gladstone	Freighter	Vessel was lost over 60 miles outside of the U.S. EEZ in 1979 in approximately 14,000 feet of water	Outside EEZ
Grammatiki	Unknown	Vessel was lost well beyond the U.S. EEZ and over 2,000 miles from Hawaii	Outside EEZ
Guam Pioneer	Freighter	Vessel sank over 55 miles outside of the U.S. EEZ and 350 miles from the coast of California	Outside EEZ
Halcyon	Freighter	Vessel was lost well beyond the U.S. EEZ in the middle of the Atlantic Ocean past Bermuda	Outside EEZ
Hampton Roads	Freighter	Vessel sank over 100 miles outside of the U.S. EEZ in extremely deep water and only carried a cargo of phosphate rock	Outside EEZ
J.A. Johnson	Unknown	Vessel was lost well beyond the U.S. EEZ and over 1,000 miles from the coast of California	Outside EEZ
J.V. Conolly	Passenger Vessel	Vessel was actually named Joseph V. Connolly when it sank, it was converted into a ship to return war casualties to America and burst into flames in the middle of the Atlantic and finally sank 550 miles outside the U.S. EEZ while under tow	Outside EEZ
John A. Johnson	Freighter	Vessel was torpedoed by a Japanese submarine in the middle of the Pacific and over 800 miles from the U.S. EEZ	Outside EEZ

Name	Type	Rationale for Removal	USCG District
Jupiter	Unknown	Vessel was lost well beyond the U.S. EEZ off the coast of Mexico	Outside EEZ
Lahaina	Freighter	Vessel sank beyond the U.S. EEZ and over 500 miles from Hawaii while carrying a cargo of molasses and scrap iron	Outside EEZ
Lewis Cass	Unknown	Vessel sank well beyond the U.S. EEZ in Mexican Waters	Outside EEZ
Lyng	Unknown	Vessel was lost well beyond the U.S. EEZ in Canadian Waters	Outside EEZ
Lysefjord	Freighter	Vessel was coal powered and only carrying a cargo of lumber and machinery	Outside EEZ
Major General Henry Gibbins	Freighter	Vessel sank over 80 miles outside the U.S. EEZ and over 300 miles from shore in the Gulf Of Mexico	Outside EEZ
Malahat	Five masted schooner	This wooden 5 masted schooner sank in Canadian Waters and was not carrying a polluting cargo	Outside EEZ
Mariscos Express I	Freighter	Vessel was 131 feet long and 148 gross tons, it does not meet the initial screening criteria for RULET and sank in over 6,000 feet of water in the Gulf of Mexico	Outside EEZ
Mentor	Freighter	Vessel was coal powered and did not carry a polluting cargo	Outside EEZ
Moira	Freighter	This wreck is well beyond the U.S. EEZ in Mexican Waters	Outside EEZ
Ogontz	Freighter	Vessel sank over 100 miles outside of the U.S. EEZ in the Gulf of Mexico while carrying a cargo of nitrate	Outside EEZ
R.P. Rithet	Barge	Vessel was converted into the barge Baramba and was lost without machinery or a polluting cargo	Outside EEZ
Rufus King	Unknown	Vessel was lost off Queensland, Australia and the bow was refloated and towed to Papua New Guinea where the cargo was salvaged	Outside EEZ
San Blas	Freighter	Vessel was lost well beyond the U.S. EEZ in Mexican Waters and was sailing in ballast	Outside EEZ
San Nicola	Freighter	Vessel sank over 130 miles outside of the U.S. EEZ and around 788 miles NW of Honolulu while carrying a cargo of scrap iron	Outside EEZ
Seabulk Islander	Freighter	Vessel sank well beyond the U.S. EEZ over 1,000 miles from Hawaii and California	Outside EEZ
Shinwa Maru	Unknown	Vessel sank well beyond the U.S. EEZ off the coast of Mexico	Outside EEZ
Southern Isle	Freighter	Vessel sank well beyond the U.S. EEZ over 400 miles east of South Carolina and it only carried a cargo of ore	Outside EEZ
Thirlby	Freighter	Vessel was coal powered and carried a cargo of corn	Outside EEZ
Touchet	Tanker	Vessel sank well beyond the U.S. EEZ in Mexican Waters	Outside EEZ
Transbalt	Freighter	Vessel sank over 700 miles outside the U.S. EEZ off the U.S. West Coast	Outside EEZ
USS *Gibson County*	Military Vessel	Vessel was scrapped then sunk by the U.S. Navy in target practice off the coast of Mexico	Outside EEZ

Name	Type	Rationale for Removal	USCG District
Uzbekistan	Freighter	Vessel was coal powered and the cargo was salvaged after it wrecked	Outside EEZ
Washington Mail	Freighter	Vessel was lost well beyond the U.S. EEZ over 1,000 miles from shore and only carried a cargo of flour and lumber	Outside EEZ
Westmoreland	Freighter	Vessel was lost well beyond the U.S. EEZ in the middle of the Atlantic Ocean past Bermuda	Outside EEZ
Albatross	Fishing Vessel	This fishing vessel was partially sunk in a hurricane but was raised by the Coast Guard and converted into a small tanker	Salvaged
Altair	Tanker	Vessel did not sink in a collision and was scrapped in 1943	Salvaged
ATC-133	Tank Barge	Vessel spilled 595 bbl of No. 6 fuel oil in the Delaware River before the leak was stopped, but it is not a shipwreck	Salvaged
Caribia	Unknown	Vessel was salvaged in 400-ton sections after it sank in a shipping channel in Guam	Salvaged
CBC-21	Barge	Barge was removed from the seabed in 1984	Salvaged
E. H. Blum	Freighter	Vessel struck an Allied mine in 1942 but was salvaged and repaired, wrecked off Fenwick Island in 1942 but was salvaged and repaired, renamed York in 1963, Binky in 1970, and was finally scrapped in 1971	Salvaged
E. J. Bullock	Tanker	Vessel was scrapped after its cargo of gasoline exploded	Salvaged
E-24	Tank Barge	Barge sank in 1985 carrying 20,000 bbl of crude oil, but it was refloated and salvaged in 1986 by DonJon Marine	Salvaged
Eaglesciff	Freighter	Vessel broke in two at the dock during Hurricane Alicia in 1983 and was scrapped	Salvaged
Elizabeth	Freighter	Wreck was salvaged after running ashore next to the Roney Plaza Hotel in Florida	Salvaged
Ellin	Freighter	This Greek steamer was refloated after running aground near Currituck, NC	Salvaged
Elna	Military Vessel	Vessel was salvaged during a Seabee's training exercise after it grounded in Alaska	Salvaged
Emidio	Tanker	Vessel was salvaged in 1950	Salvaged
Empire Kingfisher	Unknown	Vessel sank in Canadian Waters and was salvaged after sinking	Salvaged
Exminster	Unknown	Vessel was raised and scrapped in 1946	Salvaged
Exxon Houston	Tanker	Vessel was refloated and scrapped in 1989 after running aground	Salvaged
Exxon Valdez	Tanker	Vessel ran aground, was repaired and put back into active service	In Service
Fuji	Tanker	This tanker was empty and broke in half, the stern section which carried the fuel oil was towed to port and scrapped	Salvaged
Gravel Barge	Barge	Barge was salvaged by the Coast Guard after it sank	Salvaged
Gulfland	Tanker	The vessel burned and smoldered for 52 days before it was salvaged and towed back to port	Salvaged
J.A. Moffet	Freighter	Vessel was towed to shore and scrapped, it is not a shipwreck	Salvaged
J.H. Senior	Tanker	Vessel burst into flames after colliding with another vessel in a convoy over 650 miles from the U.S. EEZ, the vessel did not sink but was towed to Nova Scotia and scrapped	Salvaged

Name	Type	Rationale for Removal	USCG District
John Cadwalader	Passenger Ship	This converted wooden passenger ship was carrying ammunition and burned at the dock, was scrapped in 1948	Salvaged
John P. Gaines	Freighter	Vessel broke in half and washed ashore where it was salvaged and broken apart	Salvaged
Markay	Unknown	The oil and wreckage of this vessel were removed by U.S. Navy engineers	Salvaged
New Carissa	Freighter	The wreck was removed from the surf in 2008	Salvaged
Omi Charger	Tanker	Vessel was towed to port and the oil was removed, it is not a shipwreck	Salvaged
Omi Yukon	Tanker	Vessel was towed to Japan and scrapped, it is not a shipwreck	Salvaged
Oneida Victory	Freighter	Vessel did not sink in a collision but was towed to port and scrapped in 1949	Salvaged
Pine Ridge	Tanker	Vessel was sailing in ballast and broke in two, the stern section carrying the fuel tanks was towed to port	Salvaged
Quartette	Freighter	This entry is a duplicate of Quartette	Salvaged
Quartette	Freighter	Vessel grounded on Hermes Atoll and was salvaged	Salvaged
S.E. Graham	Tanker	Vessel burst into flames but did not sink, it was towed to port and scrapped, it is not a shipwreck	Salvaged
Tonkawa	Unknown	Vessel was raised and repaired, it is not a shipwreck	Salvaged
USS *Agerholm*	Military vessel	Vessel was scrapped and sunk as a target in compliance with environmental cleaning requirements	Salvaged
Victor H. Kelley	Unknown	Vessel did not actually sink and was scrapped in 1974	Salvaged
YFD-20	Floating Drydock	This floating drydock broke free of a tow and ran aground and was salvaged the next month	Salvaged

APPENDIX B: INTERNATIONAL RISK ASSESSMENT EFFORTS

There are a number of risk assessment projects on potentially polluting wrecks underway outside the U.S., as summarized in Table 1-3. Like the current NOAA risk assessment project, international efforts have generally involved the development of a database of wrecks with varying types of data on each wreck as the basis of the initial assessment. The types of wrecks and associated data that have been included in the databases have differed based on the needs and focus of the authorities involved. A comparison of the different international risk assessment methodologies and projects with the current (2012) NOAA RULET effort described in this report is shown in Table 1-4. This appendix provides more information on each of those efforts.

Mapping and Identification of Wrecks

Identification of wrecks and mapping their locations with incorporation into a database is generally the first step of risk assessment for potentially polluting wrecks. The most extensive mapping of wrecks has been conducted in the South Pacific, an area with thousands of shipwrecks from the World War II era. The South Pacific project, undertaken as a joint effort by Pacific Ocean Pollution Prevention Programme (PACPOL), International Maritime Organization (IMO), Canada-South Pacific Ocean Development, and the Secretariat of the Pacific Regional Environment Programme (SPREP), involved the identification and mapping of 3,000 wrecks, as shown in Figure B-1, along with a sample record.

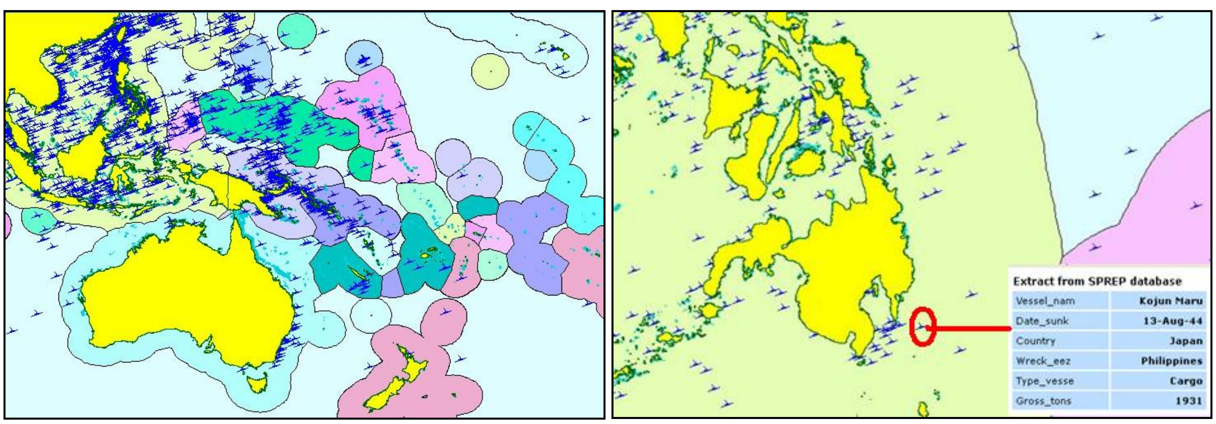

Figure B-1: Wreck locations in the South Pacific and a sample wreck database (Source: SPREP/PACPOL).

The largest database is that developed for the U.K. Maritime Coastguard Agency (MCA) with over 25,000 wrecks. The data include other obstructions, vessels that have previously been lifted or salvaged, and vessels of at least 100 tons, as shown in Figure B-2a. This would be similar to the initial information screened from the NOAA RUST database in the U.S. as discussed in Section 2 of this document. Figure B-2b shows all of the wrecks in the U.K.'s worldwide database of potentially polluting wrecks. It is referred to as the Potentially Polluting Wrecks Database 4; it is based on the U.K. Hydrographic Office wrecks database and shows only post-1870 wrecks. The blue dots are merchant vessels of all nations and the red dots are U.K. military wrecks.

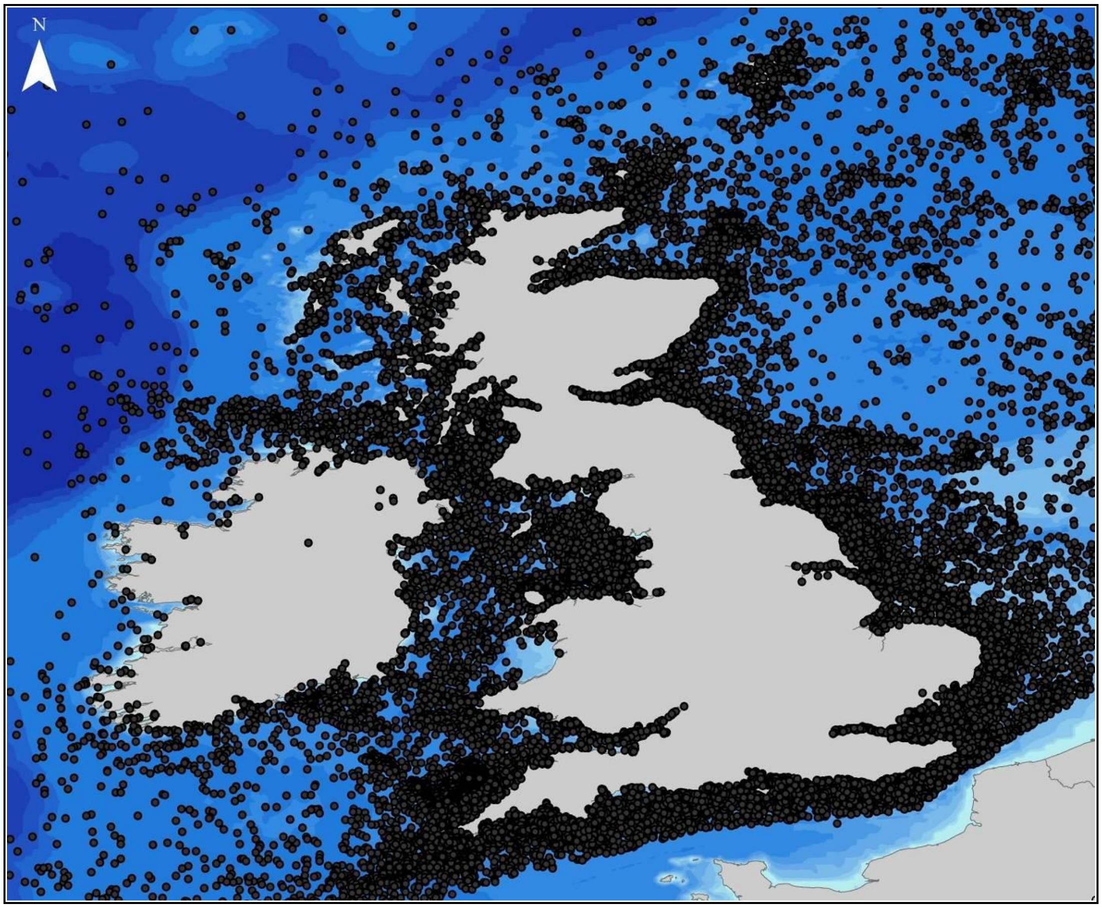

Figure B-2a: Potentially polluting wrecks in U.K. waters based on the U.K.'s Potentially Polluting Wrecks Database version 3 (Source: N. Goodwyn, ABP MER).

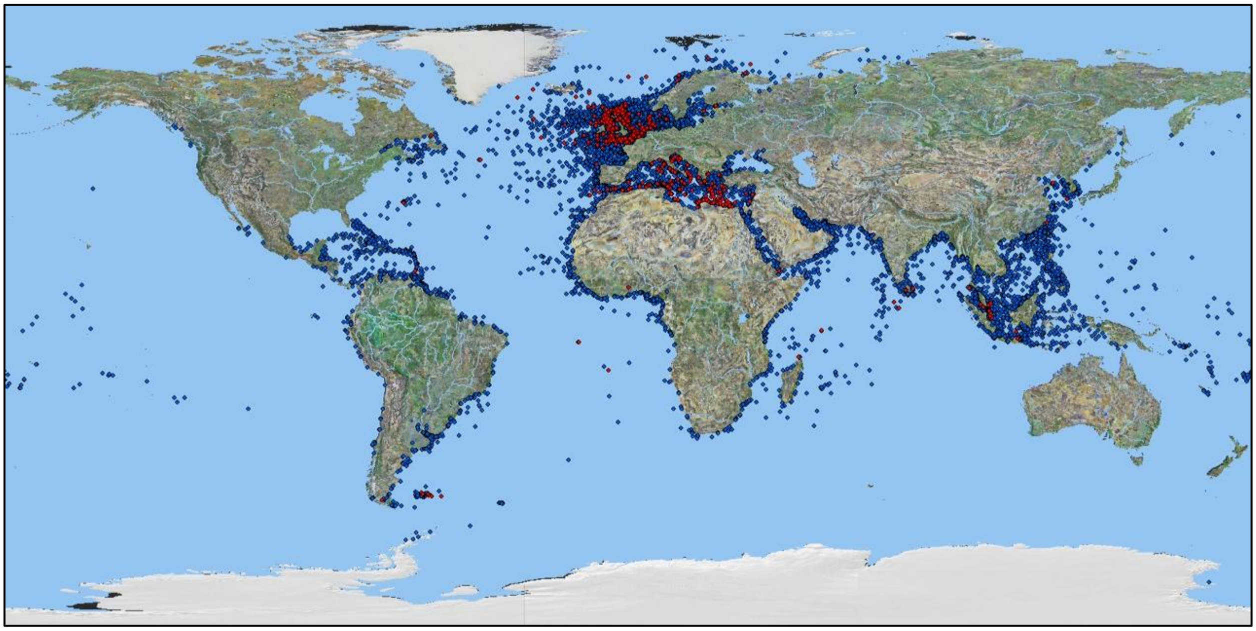

Figure B-2b: Wrecks in U.K.'s Potentially Polluting Wrecks Database version 4 (Source: M. Skelhorn, U.K. Ministry of Defense). The blue dots are merchant vessels of all nations and the red dots are U.K. military wrecks.

Risk Modeling

Risk models differ somewhat among the assessment projects with respect to approach. Example risk model from several different countries are described below.

The U.K. MCA project prioritizes risk into three categories, with a focus on munitions as well as oil pollutants:

- **High Risk:** The wreck poses a significant threat to human and natural resources with further action/mitigation required;
- **Medium Risk:** The wreck poses a minor threat to human and natural resources and should be monitored with a reassessment if conditions change; and
- **Low Risk:** The threat posed by the wreck is minimal with no further action required.

The U.K. MCA risk matrix is based on assessment of different criteria as shown in Table B-1.

Table B-1: U.K. MCA risk criteria.

Hazard Risk Components	Sector	No. of Assessment Criteria	Information Included
Severity			
(a) Severity of Pollution Risk	Pollution	3	Amount and type of cargo stored on wreck
(b) Severity of Safety Risk	Safety	1	Amount and type of explosives stored on wreck
Likelihood			
(c) Conditional Likelihood	Wreck Condition	6	Background information and condition of vessel
	Local Sea Area Process	4	Physical processes occurring in the area, e.g., hydrodynamics and sedimentology
(d) Impact Likelihood	Environmental & Heritage Sensitivity	3	Ecological information related to conservation and protection of species/habitats and designated wreck sites
	Economic	2	Economic considerations related to stakeholders and valuable resources

Another protocol for risk assessment has been developed by researchers at the National Environmental Research Institute in Denmark and the Chalmers University of Technology in Sweden. This protocol has only been applied to a limited number of vessels, though it is anticipated that after the Swedish Maritime Administration compiles a national shipwreck database, it will be used on a more widespread basis within Scandinavian waters.

The Scandinavian risk assessment project also has divided risk into three categories:

- **Unacceptable Risk:** The risk cannot be accepted under any circumstances;
- **As Low as Reasonably Possible (ALARP) Risk:** The risk can be accepted if it is economically and technically unfeasible to reduce it; and
- **Acceptable Risk:** The risk can be accepted.

The risk matrix for the Scandinavian project is shown in Figure B-3. Unacceptable Risk is colored orange, ALARP Risk is colored yellow, and Acceptable Risk is colored pale green.

Limitation

Combinations

Preventive

Probability						
5-Very High	$>10^{-1}$					
4-High	$10^{-3} – 10^{-1}$					
3-Moderate	$10^{-5} – 10^{-3}$					
2-Low	$10^{-7} – 10^{-5}$					
1-Very Low	$< 10^{-7}$					
		1 Minor	2 Small	3 Moderate	4 Severe	5 Catastrophic
Consequences	Human	Insignificant	Short duration	Permanent chronic	Single fatalities	Many fatalities
	Economic[150]	< $14,000	$14,000 - $140,000	$140,000 - $690,000	$690,000 - $1.4 M	> $1.4 M
	Ecological	Insignificant	Minor extent, short duration	Large extent, short duration	Very large extent or permanent	Very large extent and permanent

Figure B-3: Scandinavian risk assessment scoring.

The Development of European Guidelines for Potentially Polluting Shipwrecks (DEEPP) project developed a risk approach that involves 11 levels of risk based on pollutant volume, distance to coast or sensitive area, nature of product, and the age of the wreck. There are four classes of volumes and distance, as shown in Table B-2.

Table B-2: DEEPP risk classes for volume and distance.

Class	Volume	Distance
1	Less than 100 m^3 (approximately 630 bbl)	< 1 mile
2	100 to 500 m^3 (approximately 630 – 3,150 bbl)	1 – 10 miles
3	500 to 2,500 m^3 (approximately 3,150 – 15,700 bbl)	10 – 50 miles
4	> 2,500 m^3 (approximately > 15,700 bbl)	< 50 miles

The Risk Factor (RF) is calculated by the formula:

$$RF = \frac{class_{volume}}{class_{distance}}$$

There are thus 11 levels of risk factors, which are divided into five risk scale categories, as in Table B-3.

[150] Costs converted from Swedish krona to US dollars (as of 2012).

Table B-3: Calculation of risk factors for the Development of European Guidelines for Potentially Polluting Shipwrecks (DEEPP) Project.

Volume Class	Distance Class	Risk Factor (RF)	Risk Scale
Volume Class 1	Distance Class 1	1	Moderate to serious
	Distance Class 2	1/2	Minor to moderate
	Distance Class 3	1/3	Minor
	Distance Class 4	1/4	Minor
Volume Class 2	Distance Class 1	2	Serious
	Distance Class 2	1	Moderate to serious
	Distance Class 3	2/3	Moderate
	Distance Class 4	1/2	Minor to moderate
Volume Class 3	Distance Class 1	3	Serious
	Distance Class 2	3/2	Serious
	Distance Class 3	1	Moderate to serious
	Distance Class 4	3/4	Moderate
Volume Class 4	Distance Class 1	4	Serious
	Distance Class 2	2	Serious
	Distance Class 3	4/3	Moderate to serious
	Distance Class 4	1	Moderate to serious

The different scales of risk are defined as:

- Serious: Potentially very severe effects are expected; top priority cases that should receive immediate action plans and mitigation;
- Moderate: Wrecks that may have impacts for which special care and monitoring should be performed before making a decision to remove pollutants (and/or wreck) or leave in place based on accessibility of pollutants (depth, wreck position on sea bottom, wreck location, sea conditions, etc.); and
- Minor: Wrecks with limited damage potential due to the non-polluting character of the pollutant or the low Risk Factor. Authorities should compare cost-effectiveness ratio with other social priorities.

The two intermediate groups “minor to moderate” and “moderate to serious” take into account extreme values of the classes. For example, a risk factor of 1 corresponds to four scenarios: Volume Class 1/Distance Class 1, Volume Class 2/Distance Class 2, Volume Class 3/Distance Class 3, and Volume Class 4/Distance Class 4. A scenario of 3/3 means a volume of 1,000 to 2,500 m^3 (6,300 to 15,700 bbl) at a distance of 20 to 50 miles. The decision would not be the same for a wreck containing 15,000 bbl of pollutants at 21 miles offshore compared with 6,300 bbl 49 miles offshore. According to DEEPP, each case must be discussed by experts. The nature of the pollutants is then incorporated into the risk matrix as shown in Figure B-4.

Risk Factor (RF)				
4	serious	serious	serious	serious
3	serious	serious	serious	serious
2	serious	serious	serious	serious
3/2	serious	serious	serious	serious
4/3	moderate-serious	serious	serious	serious
1	moderate-serious	moderate-serious	serious	serious
3/4	moderate	moderate	serious	serious
2/3	moderate	moderate	moderate-serious	serious
1/2	minor-moderate	moderate	moderate-serious	moderate-serious
1/3	minor	minor-moderate	moderate	moderate-serious
1/4	minor	minor	minor-moderate	moderate
Hydrocarbons: fuels and cargo	Gasoline	Diesel Kerosene	Light Crude Oils	Heavy/Medium Crude Oils HFO/IFO
Liquid chemical transported in bulk (MARPOL classification)	OS Other Substance (No Harm)	Z Minor Hazard	Y Hazard	X Major Hazard

Figure B-4: DEEPP risk matrix.

The National Maritime Research Institute (NMRI) in Tokyo, Japan, has developed a risk model to assess the risk of oil discharges from sunken wrecks and for decision-making on countermeasures, as shown in Figure B-5. This model is theoretical and has not to date been applied to assessing risk for wrecks in Japan's waters. (Note that "diffusion/drift simulation" refers to trajectory and fate modeling of oil discharges.)

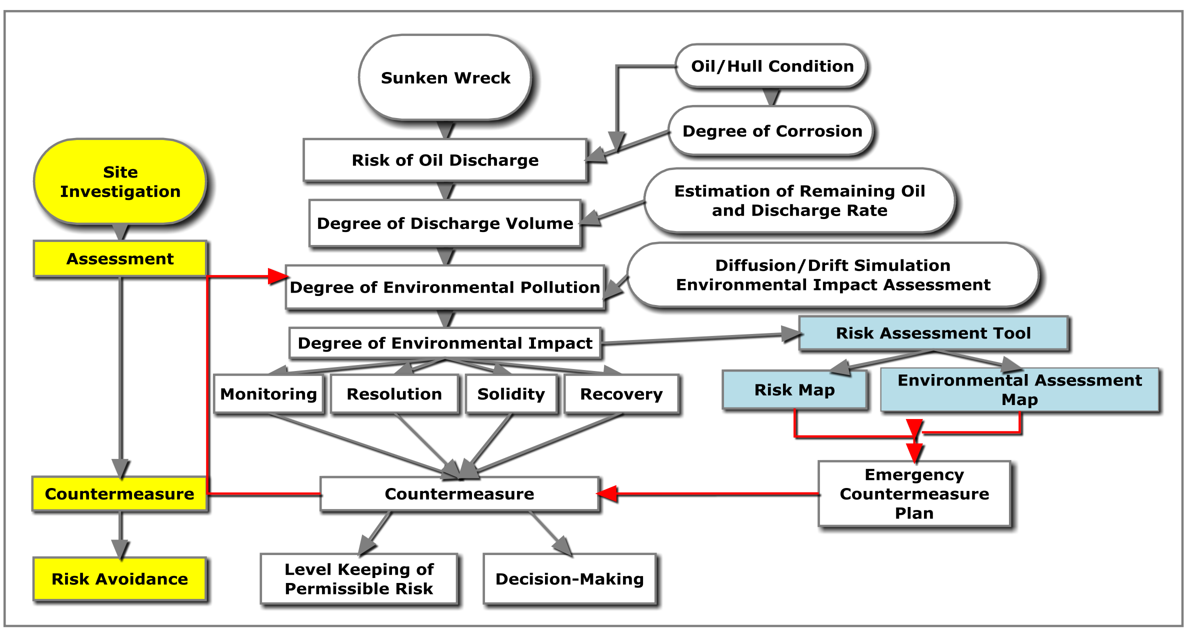

Figure B-5: National Maritime Research Institute (Japan) Risk Assessment Model (Source: S. Hara, NMRI).

APPENDIX C: SIMAP MODEL INPUT DATA DESCRIPTIONS

This appendix includes tabular data and references for the properties of the oils used in the SIMAP models (Tables C-1 to C-4) and the data inputs for the models that were run for each wreck (Table C-4).

Table C-1: Oil properties for Light Crude used in SIMAP simulations.

Property	Value	Reference
Density @ 25 deg. C (g/cm^3)	0.8518	Jokuty et al. (1999)*
Viscosity @ 25 deg. C (cp)	8.0	Jokuty et al. (1999)*
Surface Tension (dyne/cm)	25.9	Jokuty et al. (1999)*
Pour Point (deg. C)	-28.0	Jokuty et al. (1999)*
Adsorption Rate to Suspended Sediment	0.01008	Kolpack et al. (1977)
Adsorption Salinity Coef.(/ppt)	0.023	Kolpack et al. (1977)
Fraction monoaromatic hydrocarbons (MAHs)	0.01478	Jokuty et al. (1999)*
Fraction 2-ring aromatics	0.003161	Henry (1997)
Fraction 3-ring aromatics	0.005055	Henry (1997)
Fraction Non-Aromatics: boiling point < 180^{o}C	0.16522	Jokuty et al. (1999)*
Fraction Non-Aromatics: boiling point 180-264^{o}C	0.185839	Henry (1997)
Fraction Non-Aromatics: boiling point 264-380^{o}C	0.275945	Henry (1997)
Minimum Oil Thickness (mm)	0.01	McAuliffe (1987)
Maximum Mousse Water Content (%)	75.0	-
Mousse Water Content as Spilled (%)	0.0	-
Water content of oil (not in mousse, %)	0	-
Degradation Rate (/day), Surface & Shore	0.01	French et al. (1996)
Degradation Rate (/day), Hydrocarbons in Water	0.01	French et al. (1996)
Degradation Rate (/day), Oil in Sediment	0.001	French et al. (1996)
Degradation Rate (/day), Aromatics in Water	0.01	Mackay et al. (1992)
Degradation Rate (/day), Aromatics in Sediment	0.001	Mackay et al. (1992)

* Environment Canada's Oil Property Catalogue (Jokuty et al., 1999) provided total hydrocarbon data for volatile fractions of unweathered oil. The aromatic hydrocarbon fraction was subtracted from the total hydrocarbon fraction to obtain the aliphatic fraction of unweathered oil.

Table C-2: Oil properties for Heavy Fuel Oil used in SIMAP simulations.

Property	Value	Reference
Density @ 25 deg. C (g/cm^3)	0.9749	Jokuty et al. (1999)*
Viscosity @ 25 deg. C (cp)	3180.0	Jokuty et al. (1999)*
Surface Tension (dyne/cm)	27.0	Jokuty et al. (1999)*
Pour Point (deg. C)	7.0	Whiticar et al. (1994)
Adsorption Rate to Suspended Sediment	0.01008	Kolpack et al. (1977)
Adsorption Salinity Coef.(/ppt)	0.023	Kolpack et al. (1977)
Fraction monoaromatic hydrocarbons (MAHs)	0.001819	Jokuty et al. (1999)*
Fraction 2-ring aromatics	0.003794	Jokuty et al. (1999)*
Fraction 3-ring aromatics	0.015941	Jokuty et al. (1999)*
Fraction Non-Aromatics: boiling point < 180^{o}C	0.008181	Jokuty et al. (1999)*
Fraction Non-Aromatics: boiling point 180-264^{o}C	0.045206	Jokuty et al. (1999)*
Fraction Non-Aromatics: boiling point 264-380^{o}C	0.097059	Jokuty et al. (1999)*
Minimum Oil Thickness (mm)	1.0	McAuliffe (1987)
Maximum Mousse Water Content (%)	30.0	NOAA (2000)
Mousse Water Content as Spilled (%)	0.0	-
Water content of oil (not in mousse, %)	0.0	-
Degradation Rate (/day), Surface & Shore	0.01	French et al. (1996)
Degradation Rate (/day), Hydrocarbons in Water	0.01	French et al. (1996)
Degradation Rate (/day), Oil in Sediment	0.001	French et al. (1996)
Degradation Rate (/day), Aromatics in Water	0.01	Mackay et al. (1992)
Degradation Rate (/day), Aromatics in Sediment	0.001	Mackay et al. (1992)

* Environment Canada's Oil Property Catalogue (Jokuty et al., 1999) provided total hydrocarbon data for volatile fractions of unweathered oil. The aromatic hydrocarbon fraction was subtracted from the total hydrocarbon fraction to obtain the aliphatic fraction of unweathered oil.

TableC-3: Oil properties for Light Fuel Oil used in SIMAP simulations.

Property	Value	Reference
Density @ 25 deg. C (g/cm^3)	0.8558	Jokuty et al. (1999)*
Viscosity @ 25 deg. C (cp)	4.0	Jokuty et al. (1999)*
Surface Tension (dyne/cm)	25.6	Jokuty et al. (1999)*
Pour Point (deg. C)	-29.0	Jokuty et al. (1999)*
Adsorption Rate to Suspended Sediment	0.01008	Kolpack et al. (1977)
Adsorption Salinity Coef.(/ppt)	0.023	Kolpack et al. (1977)
Fraction monoaromatic hydrocarbons (MAHs)	0.009800	Wang et al. (1995)
Fraction 2-ring aromatics	0.017610	Reddy and Quinn (1996)
Fraction 3-ring aromatics	0.026855	Reddy and Quinn (1996)
Fraction Non-Aromatics: boiling point < 180^{o}C	0.039037	Jokuty et al. (1999)*
Fraction Non-Aromatics: boiling point 180-264^{o}C	0.408553	Jokuty et al. (1999)*
Fraction Non-Aromatics: boiling point 264-380^{o}C	0.488145	Jokuty et al. (1999)*
Minimum Oil Thickness (mm)	0.01	McAuliffe (1987)
Maximum Mousse Water Content (%)	0.0	-
Mousse Water Content as Spilled (%)	0.0	-
Water content of oil (not in mousse, %)	0.0	Kolpack et al. (1977)
Degradation Rate (/day), Surface & Shore	0.01	French et al. (1996)
Degradation Rate (/day), Hydrocarbons in Water	0.01	French et al. (1996)
Degradation Rate (/day), Oil in Sediment	0.001	French et al. (1996)
Degradation Rate (/day), Aromatics in Water	0.01	Mackay et al. (1992)
Degradation Rate (/day), Aromatics in Sediment	0.001	Mackay et al. (1992)

* Environment Canada's Oil Property Catalogue (Jokuty et al., 1999) provided total hydrocarbon data for volatile fractions of unweathered oil. The aromatic hydrocarbon fraction was subtracted from the total hydrocarbon fraction to obtain the aliphatic fraction of unweathered oil.

Table C-4: Summary of data inputs used for SIMAP modeling.

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
Aleutian	None	Heavy	6,000	57.42698 N, 153.8448 W	HYDROMAP (Isaji et al., 2002) simulations for tidal flows in Uyak Bay; NEP ROMS oceanographic model for outside of Bay (1997-2003)	National Data Buoy Center (NDBC) NDBC Station 46077 (2005-2011, redated to match currents record)	Interpolated NOAA Electronic Navigation Chart data for Uyak Bay; GEBCO Atlas data for outside of Bay	Environmental Sensitivity Index (ESI) Atlas	0.0133
Argo	None	Crude	3,000	41.705 N, 82.624 W	No Currents Used	NDBC Station SBIO1 (1998-2009); NDBC Station 45005 (1998-2009)	Contours created from NOAA/GLERL bathymetry data	NOAA shore classification; Great Lakes Coastal Wetlands Consortium wetland data	0.2117
Bunker Hill	None	Heavy	2,000	48.41763 N, 122.742 W	HYDROMAP (Isaji et al., 2002) simulations for depth-averaged tidal currents; Parallel Ocean Program (Maltrud et al., 1998) used to obtain seasonally averaged offshore currents (1992-2003)	NDBC Station SISW1 (1992-2003)	GEBCO Atlas	ESI Atlas for U.S. shorelines; GeoBC ShoreZone, shore unit, kelp bed, and eelgrass databases for Canadian shorelines	0.1975
C. O. Stillman	None	Light	144,000	17.55 N, 67.9167 W	HYCOM (2005-2011)	NDBC Station MGPI4 (2005-2011)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	1.759
Cherokee	Taborfjell	Heavy	10,000	42.4167 N, 69.1667 W	HYDROMAP (Isaji et al., 2002) simulations for tidal flows in the Bay of Fundy; HYCOM outside of the Bay (2003-2010)	NDBC Station 44005 (2003-2010)	GEBCO Atlas	ESI Atlas data for NJ, NY, CT, RI, MA, and NH; For ME, Maine Environmental Vulnerability Index (EVI) data; For Nova Scotia and New Brunswick, wetlands data from Nova Scotia Department of Natural Resources and New Brunswick Department of Natural Resources, respectively; other Canadian shoreline habitats filled in where possible by aerial interpretation using Google Earth, remaining fringing habitats set to rocky shore as a default	1.493
Cities Service No. 4	None	Light	12,000	41.2134 N, 72.3579 W	BFHYDRO (Muin and Spaulding, 1997a,b) simulations of tidal flows	NDBC Station 44039 (2004-2010); NDBC Station 44017 (2004-2010)	GEBCO Atlas	ESI Atlas	0.1528

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
Coast Trader	None	Heavy	7,000	48.24978 N, 125.668 W	HYDROMAP (Isaji et al., 2002) simulations for depth-averaged tidal currents; Parallel Ocean Program (Maltrud et al., 1998) used to obtain seasonally averaged offshore currents (1992-2003)	NDBC Station TTIW1 (1992-2003)	GEBCO Atlas	ESI Atlas for U.S. shorelines; GeoBC ShoreZone, shore unit, kelp bed, and eelgrass databases for Canadian shorelines	0.3075
Coimbra	India Arrow	Light	29,000	40.38677 N, 72.3579 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44025 (1992-2000)	GEBCO Atlas	ESI Atlas	1.723
Cornwallis	None	Heavy	10,000	43.9833 N, 68.3333 W	HYDROMAP (Isaji et al., 2002) simulations for tidal flows in the Bay of Fundy; HYCOM outside of the Bay (2003-2010)	NDBC Station 44005 (2003-2010); NDBC Station MISM1 (2003-2010)	GEBCO Atlas	ESI Atlas data for NJ, NY, CT, RI, MA, and NH; For ME, Maine Environmental Vulnerability Index (EVI) data; For Nova Scotia and New Brunswick, wetlands data from Nova Scotia Department of Natural Resources and New Brunswick Department of Natural Resources, respectively; other Canadian shoreline habitats filled in where possible by aerial interpretation using Google Earth, remaining fringing habitats set to rocky shore as a default	1.493
Diamond Knot	None	Light	7,000	48.1716 N, 123.576 W	HYDROMAP (Isaji et al., 2002) simulations for depth-averaged tidal currents; Parallel Ocean Program (Maltrud et al., 1998) used to obtain seasonally averaged offshore currents (1992-2003)	NDBC Station SISW1 (1992-2003); NDBC Station TTIW1 (1992-2003)	GEBCO Atlas	ESI Atlas for U.S. shorelines; GeoBC ShoreZone, shore unit, kelp bed, and eelgrass databases for Canadian shorelines	0.1975
Drexel Victory	Camden	Heavy	12,000	46.31232 N, 124.1596 W	HYDROMAP (Isaji et al., 2002) simulations for depth-averaged tidal currents; Parallel Ocean Program (Maltrud et al., 1998) used to obtain seasonally averaged offshore currents (1992-2003)	NDBC Station 46029 (1992-2003)	GEBCO Atlas	ESI Atlas for U.S. shorelines; GeoBC ShoreZone, shore unit, kelp bed, and eelgrass databases for Canadian shorelines	0.3075

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
Edmund Fitzgerald	None	Heavy	2,000	46.9985 N, 85.11 W	No Currents Used	NDBC Station STDM4 (1998-2009); NDBC Station PTIM4 (2004-2009); NDBC Station 45001 (1998-2009)	Lake Superior Decision Support Project bathymetric model	Shoreline geomorphology from Army Corps of Engineers/ Environment Canada (available via Great Lakes GIS); Coastal wetlands data from Great Lakes Coastal Wetlands Consortium	0.5801
Empire Knight	None	Light	10,000	43.0287 N, 70.5054 W	HYDROMAP (Isaji et al., 2002) simulations for tidal flows in the Bay of Fundy; HYCOM outside of the Bay (2003-2010)	NDBC Station IOSN3 (2003-2010)	GEBCO Atlas	ESI Atlas data for NJ, NY, CT, RI, MA, and NH; For ME, Maine Environmental Vulnerability Index (EVI) data; For Nova Scotia and New Brunswick, wetlands data from Nova Scotia Department of Natural Resources and New Brunswick Department of Natural Resources, respectively; other Canadian shoreline habitats filled in where possible by aerial interpretation using Google Earth, remaining fringing habitats set to rocky shore as a default	1.493
Esso Gettysburg	Doris Kellogg	Crude	132,000	31.00023 N, 79.2498 W	HYCOM (2003-2010)	NDBC Station 41004 (2003-2010)	GEBCO Atlas	ESI Atlas	3.472
Fernstream	None	Light	13,000	37.82006 N, 122.46 W	BFHYDRO (Muin and Spaulding, 1997a,b) simulations of tidal flows, refined to match NOAA tide and current station data	San Francisco Bay Ports Data for 9414750, Alameda Port; 9414750, San Francisco (Golden Gate) Port; and 9414863, Richmond Port (1996-2001)	NOAA NOS Hydrographic Survey Data	ESI Atlas	0.0394
Francis E. Powell	China Arrow	Light	93,000	37.4844 N, 75.2858 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44009 (1992-2000); NDBC Station 44014 (1992-2000)	GEBCO Atlas	ESI Atlas	1.723
George MacDonald	Bloody Marsh, Juan Casiano	Heavy	115,000	32.4167 N, 78.8333 W	HYCOM (2003-2010)	NDBC Station 41009 (1995-2008, redated to match currents record)	GEBCO Atlas	ESI Atlas	3.472
Gulfoil	Sheherazade, Vainqueur	Light	55,000	28.16692 N, 89.8 W	Hindcasts using the CUPOM model (Kantha et al., 1999) (1993-1999)	NDBC Station BURL1 (1993-1999); NDBC Station 42001 (1998-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	3.265

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
Gulfstate	None	Crude	86,000	24.43376 N, 80.2998 W	HYCOM (2003-2010)	NDBC Station SMKF1 (2000-2007, redated to match currents record)	GEBCO Atlas	ESI Atlas	2.959
Hamlet	Cities Service Toledo, Halo	Crude	77,000	28.53333 N, 91.5 W	Hindcasts using the CUPOM model (Kantha et al., 1999) (1993-1999)	NDBC Station BURL1 (1993-1999); NDBC Station 42001 (1998-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	3.265
John Straub	None	Heavy	13,000	54.33333 N, 163.333 W	NEP ROMS oceanographic model (1997-2003)	National Climatic Data Center weather observations for Cold Bay Airport (1997-2003)	GEBCO Atlas	ESI Atlas	1.552
Joseph M. Cudahy	None	Crude	90,000	25.0228 N, 82.7563 W	Blend of CUPOM and HYCOM models (1993-1999)	NDBC Station DRYF1 (1993-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	1.433
Lancing	Panam	Light	77,000	35.0297 N, 75.4417 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station DSLN7 (1992-2000); NDBC Station FPSN7 (1992-2000); NDBC Station 44014 (1992-2000)	NOAA NOS Hydrographic Survey Data; Missing data filled with ETOP01 Gridded Global Relief	ESI Atlas	1.804
Larry Doheny	None	Heavy	73,000	42.2 N, 125.02 W	NEP ROMS oceanographic model (1997-2003)	NDBC Station 46027 (1997-2003)	GEBCO Atlas	ESI Atlas for U.S. shorelines; GeoBC ShoreZone, shore unit, kelp bed, and eelgrass databases for Canadian shorelines	1.905
Lubrafol	Pan-Massachusetts	Light	80,000	29.23359 N, 80.1664 W	HYCOM (2003-2010)	NDBC Station 41009 (1995-2008, redated to match currents record)	GEBCO Atlas	ESI Atlas	3.472
Maiden Creek	Pan-Pennsylvania	Heavy	9,000	40.16677 N, 72.0328 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44025 (1992-2000)	GEBCO Atlas	ESI Atlas	1.723
Manzanillo	Managua, Santiago de Cuba	Heavy	5,000	24.26667 N, 81.8667 W	Blend of CUPOM and HYCOM models (1993-1999)	NDBC Station DRYF1 (1993-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	1.433

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
Marine Electric	Cayru, Oneida, Northern Pacific, Swiftscout	Heavy	4,000	37.8797 N, 74.7667 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44009 (1992-2000); NDBC Station 44014 (1992-2000)	GEBCO Atlas	ESI Atlas	1.723
Marit II	Allan Jackson	Crude	84,000	35.15019 N, 73.5662 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station DSLN7 (1992-2000); NDBC Station FPSN7 (1992-2000); NDBC Station 44014 (1992-2000)	GEBCO Atlas	ESI Atlas	1.352
Mobile Point	None	Light	4,000	45.0832 N, 124.401 W	NEP ROMS oceanographic model (1997-2003)	NDBC Station 46029 (1997-2003)	GEBCO Atlas	ESI Atlas for U.S. shorelines; GeoBC ShoreZone, shore unit, kelp bed, and eelgrass databases for Canadian shorelines	1.905
Monrovia	None	Heavy	2,000	44.9837 N, 82.923 W	No Currents Used	NDBC Station APNM4 (2005-2011); NDBC Station 45008 (2005-2011); NDBC Station 45003 (2005-2011)	Contours created from NOAA/GLERL bathymetry data	ESI Atlas for U.S. shoreline; NOAA shore classification; Great Lakes Coastal Wetlands Consortium wetlands data	0.2478
Norlindo	Munger T. Ball	Heavy	5,000	24.9504 N, 83.9999 W	Blend of CUPOM and HYCOM models (1993-1999)	NDBC Station DRYF1 (1993-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	1.433
Norness	Oregon, Regal Sword	Light	99,000	40.4363 N, 70.8395 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44025 (1992-2000); NDBC Station 44008 (1993-2000)	GEBCO Atlas	ESI Atlas	1.723
Ohioan	Potrero del Llano	Heavy	11,000	26.517 N, 79.9831 W	HYCOM (2003-2010)	NDBC Station 41009 (1995-2008, redated to match currents record)	GEBCO Atlas	ESI Atlas	2.959
Pacbaroness	None	Light	8,000	34.35 N, 120.75 W	Mean offshore currents compiled for January, March, May, July, September, and November using data from the California Cooperative Oceanic Fisheries Investigations Atlas No. 4 (State of California Marine Research Committee, 1966)	NDBC Station 40611 (1998-2009); NDBC Station 46053 (1998-2009)	GEBCO Atlas	ESI Atlas	0.5539

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
Panky	None	Light	5,000	25.96702 N, -84.3332 W	Blend of CUPOM and HYCOM models (1993-1999)	NDBC Station DRYF1 (1993-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	1.433
Prins Willem V	Material Service	Light	3,000	43.02473 N, 87.807 W	No Currents Used	NDBC Station 45007 (1998-2009); NDBC Station SGNW3 (1998-2009)	NOAA National Geophysical Data Center, Great Lakes Bathymetry	ESI Atlas; National Wetlands Inventory	0.1954
Puerto Rican	Jacob Luckenbach	Heavy	21,000	37.51 N, 123.012 W	Mean offshore currents compiled for January, March, May, July, September, and November using data from the California Cooperative Oceanic Fisheries Investigations Atlas No. 4 (State of California Marine Research Committee, 1966)	NDBC Station 46026 (1998-2009)	NOAA NOS Hydrographic Survey Data	ESI Atlas	0.1230
R.W. Gallagher	Alcoa Puritan, Gulfpenn, Gulfstag, Rawleigh Warner, Robert E. Lee, Virginia	Heavy	86,000	28.54191 N, 90.9734 W	Hindcasts using the CUPOM model (Kantha et al., 1999) (1993-1999)	NDBC Station BURL1 (1993-1999); NDBC Station 42001 (1998-1999)	GEBCO Atlas	ESI Atlas for U.S. shorelines; Sandy beach shore type assumed for non-U.S. shorelines	3.265
Stolt Dagali	Russell 21	Light	15,000	39.98916 N, 73.6657 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44025 (1992-2000)	GEBCO Atlas	ESI Atlas	1.723
Tokai Maru	None	Light	2,000	13.461 N, 144.651 E	HYDROMAP (Isaji et al., 2002) simulations for tidal flows in Apra Harbor; HYCOM for outside of Harbor (2003-2011)	NDBC Station 52009 (1990-1994, redated to match currents record)	Pacific Islands Benthic Habitat Mapping Center data for islands and some surrounding area; ETOP01 Global Gridded Relief for elsewhere	ESI Atlas	0.0047(Apra Harbor area); 0.4991(Guam outer coast)

Modeled Wreck	Associated Clustered Vessel(s)	Fuel Category	WCD Volume (bbl)	Wreck Location	Currents Data Source (years represented)	Wind Data Source (years represented)	Depth Data Source	Shore Type/Habitat Data Source	Habitat Grid Resolution (grid cell area, km^2)
USNS Mission San Miguel	None	Light	15,000	25.37167 N, 170.568 W	HYCOM (2007-2010)	NDBC Station 51001 (2007-2010)	NOAA NCCOS data for islands, reefs, and atolls; Pacific Islands Benthic Habitat Mapping Center data for islands and some surrounding area; ETOP02 Global Gridded Relief for elsewhere	NOAA Center for Coastal Monitoring and Assessment data	1.377
USS Neches (AO-5)	None	Light	68,000	21.01667 N, 160.10001 W	HYCOM (2007-2011)	NDBC Station 51003 (2007-2011); NDBC Station 51001 (2006-2010, redated to match currents record)	GEBCO Atlas	ESI Atlas	2.002
W.D. Anderson	None	Crude	146,000	27.2396 N, 79.9106 W	HYCOM (2003-2010)	NDBC Station 41009 (1995-2008, redated to match currents record)	GEBCO Atlas	ESI Atlas	3.472
W.L. Steed	None	Crude	78,000	38.4167 N, 72.7167 W	Hindcast simulation of the Princeton Ocean Model (Xu and Oey, 2011) (1993-2000)	NDBC Station 44009 (1992-2000)	GEBCO Atlas	ESI Atlas	1.723
William Rockefeller	Buarque, Empire Gem, Ljubica Matkovic, Mormackite, Nordal, Norvalore, Paestum, Venore	Heavy	150,000	35.11685 N, 75.1162 W	Hindcast simulation of the Princeton Ocean Model (Xu an d Oey, 2011) (1993-2000)	NDBC Station DSLN7 (1992-2000); NDBC Station FPSN7 (1992-2000); NDBC Station 44014 (1992-2000)	NOAA NOS Hydrographic Survey Data; Missing data filled with ETOP01 Gridded Global Relief	ESI Atlas	1.804

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APPENDIX D: PROGRAMMATIC AGREEMENT ON PROTECTION OF HISTORIC PROPERTIES

Programmatic Agreement on Protection of Historic Properties During Emergency Response Under the National Oil and Hazardous Substances Pollution Contingency Plan

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I. Purpose
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IV. Responsibility for Historic Properties Consideration
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VII. Regional PAs
VIII. Authority, Effective Date, Withdrawal, Amendment

Appendix I: Categorical Exclusion List—Releases or Spills Categorically Excluded from Additional National Historic Preservation Act Section 106 Compliance

Appendix II: Secretary of the Interior's Standards for Archeology and Historic Preservation

I. **PURPOSE**

A. The signatory Federal Departments and Agencies enter into this Programmatic Agreement (PA) to ensure that historic properties are taken into account in their planning for and conduct of the emergency response under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). 40 CFR Section Part 300. The National Conference of State Historic Preservation Officers (NCSHPO) is also a signatory, on behalf of State Historic Preservation Officers (SHPOs), to facilitate Federal agency ability to develop and execute a uniform nationwide approach for considering and treating historic properties before and during emergency response. In the event an individual SHPO is unable to respond, the Agency or Department may contact the NCSHPO or the Advisory Council on Historic Preservation (ACHP) to consider alternatives and receive assistance. The signatories agree that their Departments/Agencies will follow this PA or, to meet regional needs, develop regional PAs that are not inconsistent with this PA and the National Historic Preservation Act of 1966, as amended (NHPA), P.L. 89-665, 16 U.S.C. Section 470 *et seq.*, and the regulations promulgated thereto.

B. The NCP does not provide specific guidance for taking historic properties into account during emergency response to an actual or threatened release of a hazardous substance, pollutant or contaminant or the discharge of oil or other pollutants (hereinafter, a release or spill). Also, emergency provisions contained in the regulations implementing Section 106 of the NHPA do not directly address requirements for such emergency responses. Accordingly, for the purpose of this PA, an "emergency" shall be deemed to exist whenever circumstances dictate that a response action to a release or spill must be taken so expeditiously that normal consideration of the Section 106 process is not reasonably practicable.

C. The purpose of this PA is to provide an alternative process to ensure appropriate consideration of historic properties within the meaning of the NHPA during emergency response to a release or spill. This PA does not address the consultation procedures under Section 106 of the NHPA once that phase of the response action has ended.

D. In carrying out duties under the NCP, including the priorities of protecting public health and safety, the Federal On-Scene Coordinator (OSC) may have to make emergency response decisions that adversely affect historic properties. By following this PA, however, the Federal OSC will be making an informed decision that takes historic property information into account prior to authorizing actions that might affect such property.

E. The responsibility of the Federal OSC in protecting public health and safety is paramount. That mission is a difficult one involving problems that cannot be anticipated and calling for judgment on the part of the Federal OSC. Nothing in this PA changes the national response priorities, nor does it change the effect of existing law.

F. 36 CFR Section 800.13 provides, *inter alia*, that:

An Agency Official may elect to fulfill an agency's Section 106 responsibilities for a particular program, a large or complex project, or a class of undertakings...through a Programmatic Agreement.

36 CFR Section 800.13(e) provides that:

An approved Programmatic Agreement satisfies the Agency's Section 106 responsibilities for all individual undertakings carried out in accordance with the agreement until it expires or is terminated.

During such time as the ACHP and the NCSHPO are signatories, compliance with this PA by a Federal OSC will be deemed to constitute compliance with Section 106 of the NHPA during pre-incident planning and emergency response activities.

II. LEGAL AUTHORITIES PROTECTING HISTORIC PROPERTIES

A. National Historic Preservation Act

1. In 1966, Congress instituted a policy to preserve the Nation's cultural and historic heritage by enacting the NHPA. The NHPA implementing regulations most pertinent to actual or threatened releases of hazardous substances, pollutants or contaminants or oil spills are those of: 1) the ACHP, an independent Federal agency that administers Section 106 of the NHPA through procedures specified in 36 CFR Part 800, "Protection of Historic Properties," and 2) the Department of the Interior (DOI) regulations at 36 CFR Part 60, National Register of Historic Places.
2. Section 106 of the NHPA provides that Federal agencies are to take into account the effects of "Federal or federally assisted undertakings" on historic properties that are listed in or eligible for inclusion in the National Register of Historic Places. It further affords the ACHP an opportunity to comment on the undertaking.[(1)]

B. This PA does not address other Federal laws defining and protecting historic properties, such as:

1. The Archaeological Resources Protection Act (ARPA), 16 U.S.C. Section 470aa *et seq.*, which provides for the protection of archeological sites and other resources. ARPA establishes criminal and civil penalties for actual or attempted illegal excavation or removal of or damage to archeological resources; illegal trafficking in archeological resources; and knowingly causing another to commit an ARPA violation;
2. The Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. Section 3001 *et seq.*, which provides for the protection of Native American human remains and other defined classes of cultural items. NAGPRA also establishes criminal penalties for illegal trafficking in these cultural items. 18 U.S.C. Section 1170;
3. The Antiquities Act of 1906, 16 U.S.C. Section 433 *et seq.*, which establishes criminal penalties for non-permitted appropriation, excavation, injury, or destruction of any historic or prehistoric ruin or monument, or any object of antiquity, situated on lands owned or controlled by the Federal Government; and
4. The National Marine Sanctuaries Act (also known as Title III of the Marine Protection, Research and Sanctuaries Act, 16 U.S.C. Section 1431, *et seq.*, which establishes civil penalties for destruction of, loss of, or injury to a sanctuary resource, including historic properties. In addition to fines, parties can also be held responsible for response costs; damages including replacement cost, restoration cost, or acquisition of an equivalent sanctuary resource, and lost-use value of that resource and interest.

C. Many States also have laws defining and protecting historic properties. Regional PAs may consider State laws relevant to the historic properties in the region, to the extent they are not inconsistent with Federal law.

III. DEFINITION OF "HISTORIC PROPERTY"

A. The term "historic property" is defined in the NHPA as: "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register"; such term includes artifacts, records, and remains which are related to such district, site, building, structure, or object. 16 U.S.C. Section 470(w)(5).

B. Criteria for listing a property in the National Register of Historic Places are found at 36 CFR Part 60. The statutory definition of historic properties and the established criteria determine whether a historic property needs to be considered during emergency response. A historic property need not be formally listed on the National Register to receive NHPA protection, it need only meet the National Register criteria (i.e., be eligible for listing in the National Register). Section VI.C.2, below, discusses determining the National Register eligibility of historic properties during emergency response.

IV. RESPONSIBILITY FOR HISTORIC PROPERTIES CONSIDERATION

A. For the purpose of this PA, the Federal OSC, as the Federal official designated to coordinate and direct response actions, is responsible for ensuring that historic properties are appropriately considered in planning and during emergency response.

B. Planning Support/Coordination

1. The NCP, at 40 CFR Section 300.210(c), provides that Area Contingency Plans (ACPs) are to be developed under the direction of a Federal OSC. The Federal OSC shall ensure that ACPs include the information on consideration of historic properties and are developed in consultation with the parties specified in Section V of this agreement.
2. Federal agencies with expertise in protection of historic properties available to assist the Federal OSC during preparedness planning include the Department of the Interior,(2) the ACHP, and other Federal land-managing agencies for properties on their lands. The primary source of information on historic

properties in an area, particularly properties not on Federal lands, is the SHPO, who is the official appointed by the Governor as part of the State's participation in NHPA programs. Other parties that may assist are listed in V.A. of this PA.

3. The National Program Center (NPC) of the National Park Service, consistent with its authority and responsibilities, will provide coordination of appropriate expertise to Area Committees and Regional Response Teams (RRTs) for pre-incident planning activities through the United States Coast Guard (Coast Guard) and the United States Environmental Protection Agency (EPA). The NPC will coordinate through the Commandant of the Coast Guard and the Office of Emergency and Remedial Response of EPA.
4. Prior to finalizing or subsequently revising ACPs, the Federal OSC will provide a draft of sections addressing historic properties identification and protection to the parties identified in Section V.A. of this PA. Each party shall have 30 calendar days from receipt to review the draft and provide comments to the Federal OSC. Should any reviewing party file a timely objection to the draft or any portion thereof, the Federal OSC will consult with the objecting party to resolve the objection. If the objection cannot be resolved, the Federal OSC will provide documentation of the dispute to the ACHP and request their comments. The ACHP comments will be taken into account by the Federal OSC in finalizing or revising ACPs.

C. Emergency Response Support/Coordination

1. To ensure historic properties are considered during emergency response, the Federal OSC must have access to reliable and timely expertise and support in order to make timely and informed decisions about historic properties.
2. A Federal OSC may obtain historic properties expertise and support m any one of several ways. These include implementing an agreement with State or Federal agencies that have historic properties specialists on staff (*see* IV.B.2), executing a contract with experts identified in ACPs or hiring historic properties specialists on staff. Historic properties specialists made available under contract or hired must:
    a. Meet the qualifications listed in the *Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation*, 48 *Federal Register* 44738-39 (September 29, 1983); *see* Appendix II; and
    b. Be available to assist the Federal OSC whenever needed.

V. **PRE-INCIDENT PLANNING**

A. As part of pre-incident planning activities, Federal OSCs (or the OSC's management) shall consult with the SHPO, Federal land-managing agencies, appropriate Indian tribes and appropriate Native Hawaiian organizations, as defined in Section 301 of the NHPA, and the other interested parties identified during pre-incident planning, as described in Section IV.B of this PA, to:

1. Identify historic properties.
    a. Identify: 1) historic properties that have been listed in or determined eligible for inclusion in the National Register of Historic Places that might be affected by response to a release or spill; and 2) unsurveyed areas where there is a high potential for the presence of historic properties.
    b. Identify exclusions. These may be specific geographic areas or types of areas where, should a release or spill occur, historic properties are unlikely to be affected. This includes the specifics listed in Appendix I and any additional exclusions agreed on by the signatories to this or a regional PA. Incidents in areas covered by exclusions would not require

consideration for protection of historic properties, except as provided in Section VI.A.1.[3]

2. Develop a list of parties that are to be notified in the event of an incident in a non-excluded area. This list should include the SHPO for the State in which the incident occurred, Federal and Indian tribal land owners or land managers and Hawaiian Native organizations in the area where the incident occurred, if any.
3. Develop emergency response strategies that can be reasonably anticipated to protect historic properties. The Federal OSC shall ensure that response strategies, including personnel and equipment needed, are developed to protect or help protect historic properties at risk. This includes consideration of the sensitivity of historic properties to emergency response measures proposed in ACPs or other response plans, including chemical countermeasures and *in situ* burning.

B. The Federal OSC shall ensure that historic properties protection strategies can be carried out by:

1. Identifying who will be responsible for providing expertise on historic properties matters to the Federal OSC during emergency response. Depending on the size and complexity of the incident, a Federal OSC historic properties specialist or a historic properties technical advisory group convened by the specialist may be the most effective mechanism;
2. Providing information on availability of appropriate training for historic property specialists to participate in emergency response, ~g., Hazardous Waste Operations and Emergency Response (HAZWOPER) training, familiarity with all relevant contingency plans and response management systems, etc.; and
3. Working with the parties listed in Section V.A. to obtain information for response personnel on laws protecting and activities that may potentially affect historic properties.

VI. FEDERAL LEAD EMERGENCY RESPONSE

A. The Federal OSC shall determine whether the exclusions described in Section V.A.l.b. apply.

1. If the incident affects only excluded areas, no further actions are necessary under this PA, unless:
    a. Previously unidentified historic properties are discovered during emergency response; or
    b. The SHPO (or appropriate Federal, Indian, or Hawaiian Native organizations) notifies the Federal OSC that a categorically excluded release or spill may have the potential to affect a significant historic property.
2. If the area where a release or spill occurs has not been excluded, in the cases specified in Section VI.A. l .a or b, if the Federal OSC is unsure whether an exclusion applies, or if the specifics of the incident change so that it no longer fits into one of the exclusions, the remaining steps in this Section shall be followed.

B. Activate the agreed-upon mechanism for addressing historic properties, including notification of the parties identified pursuant to Section V.A.2., and consultation with these parties concerning the identification of historic properties that may be affected, assessing the potential effects of the emergency response, and developing and implementing emergency response activities. These requirements for notification and consultation shall be satisfied if the Federal OSC makes reasonable and timely efforts to notify and consult the parties listed in this Section. Thereafter there shall be additional consultation to the extent practicable.

C. Verify identification of historic properties.

1. Consult with the SHPO, land owners and/or land managers, appropriate Indian tribes and Native Hawaiian organizations, and other interested parties identified in pre-incident planning to verify the location of historic properties identified during the planning process and determine if other historic properties exist in areas identified in V .A. l .a.2. that might be affected by the incident or the emergency response.
2. If newly discovered or unanticipated potential historic properties are encountered during emergency response actions, the Federal OSC shall either: 1) consult with the SHPO (or appropriate Federal, Indian, or Hawaiian Native organizations) to determine if the properties are eligible for inclusion in the National Register, or 2) treat the properties as eligible.

D. Assess potential effects of emergency response strategies on historic properties. Such assessment shall be done in consultation with the parties listed in Section V A.
   1. The potential adverse effects of releases or spills and of emergency response on historic properties may include, but are not limited to:
      a. Physical destruction, damage, or alteration of all or part of the historic property;
      b. Isolation of the property from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register; and
      c. Introduction of visual, audible, or atmospheric conditions that are out of character with the property or alter its setting.
   2. Emergency response actions that may have adverse effects on historic properties include, but are not limited to:
      a. The placement of physical barriers to deter the spread of released or spilled substances and the excavation of trenches to stop the spread of the released or spilled substances; and
      b. Establishing camps for personnel, constructing materials storage and staging yards, excavating borrow pits for fill materials, and constructing alignments for road access.
   3. Direct physical contact of historic properties with released or spilled substances may result in one or more of the following: 1) inability to radiocarbon date the contaminated resources; 2) acceleration of deterioration of an object or structure; or 3) prevention of identification of historic properties in the field. As a result, important scientific, historic, and cultural information may be lost.

E. Make and implement decisions about appropriate actions. The Federal OSC shall take into account professional comments received from the parties listed in Section V.A. in making decisions that might affect historic properties.
   1. Emergency response strategies delineated in plans may need to be reviewed based on information available at the time of an actual incident. The purpose of this review is to evaluate whether implementation of the strategies in the plan might, for the emergency response action that is underway, adversely affect historic properties and, if so, how such effects might be avoided or reduced.
   2. Make arrangements for suspected artifact theft to be reported to the SHPO, law enforcement officials, and the land owner/manager.
   3. Arrange for disposition of records and collected materials.
   4. Ensure the confidentiality of historic property site location information, consistent with applicable laws, so as to minimize opportunities for vandalism or theft.

F. Whenever the Federal OSC determines the requirements of this Section cannot be satisfied concurrently with the paramount requirement of protecting public health and safety, the determination shall be documented in a writing including the name and title of the person who made the determination; the date of determination; and a brief description of the competing values between public health and safety and carrying on the provisions of this Section. Notwithstanding such a determination, if conditions subsequently permit, the Federal OSC shall endeavor to comply with the requirements of this Section to the extent reasonably practicable.

VII. **REGIONAL PAs**

A. Regional PAs may be developed as provided in I.A. as an alternative to this national PA. Regional PAs are to include the provisions of this PA and may include appropriate additional provisions responsive to regional concerns.

B. A regional PA should be signed by appropriate regional-level Federal officials, State agencies, tribal officials and the ACHP.

C. Either this PA or a PA developed at a regional level may be adopted by the RRT and incorporated or referenced in Regional Contingency Plans (RCPs), 36 CFR Section 300.210(b), and ACPs in the region.

VIII. **AUTHORITY, EFFECTIVE DATE, WITHDRAWAL, AMENDMENT**

A. The signatories below are authorized to sign the PA on behalf of their respective Department, Agency or organization. This PA may be signed in counterparts.

B. In order to allow sufficient time for pre-incident planning and other preparedness activities, this PA shall not be become effective with respect to a signatory Department or Agency until ninety (90) days after it has been signed on the Department's or Agency's behalf.

C. Any signatory may withdraw from this PA by sending, through an official authorized to act in this matter, written notice to all current signatories at least thirty (30) days in advance of the effective date of withdrawal. The requirements contained in this PA will remain in full force and effect with respect to remaining signatories.

D. Nothing herein prevents the signatories from agreeing to amend this PA.

SIGNATORIES

Advisory Council on Historic Preservation
Chairman
June 4, 1997

National Conference of State Historic Preservation Officers
President
May 13, 1997

U.S. Environmental Protection Agency
Acting Deputy Director, Office of Emergency and Remedial Response
May 23, 1997

U.S. Department of the Interior
Director, Office of Environmental Policy and Compliance
June 4, 1997

U.S. Department of Transportation, Coast Guard
Assistant Commandant for Marine Safety and Environmental Protection
May 13, 1997

National Park Service
Acting Deputy Director
August 7, 1997

U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Assistant Administrator for Ocean Services and Coastal Zone Management
July 3, 1997

U.S. Department of Energy
Deputy Director
November 7, 1997

U.S. Department of Defense
Deputy Under Secretary of Defense (Environmental Security)
November 3, 1997

U.S. Department of Agriculture
Under Secretary of Defense for Natural Resources and Environment
August 28, 1998

ENDNOTES

1) Section 106 of the NHPA provides, *inter alia,* as follows:

Effect of Federal undertakings upon property listed in National Register; comments by Advisory Council on Historic Preservation

The head of any Federal agency having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking in any State and the head of any Federal department or independent agency having authority to license any undertaking shall, prior to approval of the expenditure of any Federal funds on the undertaking or prior to the issuance of any license, as the case may be, take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. The head of any such Federal agency shall afford the Advisory Council on Historic Preservation ... a reasonable opportunity to comment with regard to such undertaking.

16 U.S.C. Section 470f.

2) 40 CFR Section 300 175(b)(9) reads, in pertinent part, as follows:

DOI may be contacted through Regional Environmental Officers (REOs), who are the designated members of RRTs....[B]ureaus and offices have relevant expertise as follows:
...(viii) National Park Service: General biological, natural, and cultural resource managers to evaluate, measure, monitor and contain threats to park system lands and resources; archaeological and historical expertise in protection, preservation, evaluation, impact mitigation, and restoration of cultural resources....

3) Response to spills or releases that involve non-excluded areas should be considered to have the potential to adversely affect historic properties that are listed in or eligible for inclusion in the National Register.

APPENDIX I. CATEGORICAL EXCLUSION LIST

Releases or Spills Categorically Excluded from Additional National Historic Preservation Act Section 106 Compliance

Releases/Spills onto (which stay on):

- Gravel pads
- Roads (gravel or paved, not including the undeveloped right-of-way)
- Parking areas (graded or paved)
- Dock staging areas less than 50 years old
- Gravel causeways
- Artificial gravel islands
- Drilling mats, pads, and/or berms
- Airport runways (improved gravel strips and/or paved runways)

Releases/Spills into (that stay in):

- Lined pits; *e.g.*, drilling mud pits and reserve pits
- Water bodies where the release/spill will not: 1) reach land/submerged land; and 2) include
- emergency response activities with land/submerged land-disturbing components
- Borrow pits
- Concrete containment areas

Releases/Spills of:

- Gases (*e.g.*, chlorine gas)

IMPORTANT NOTE TO FEDERAL OSC:

1) IF YOU ARE NOT SURE WHETHER A RELEASE OR SPILL FITS INTO ONE OF THE CATEGORIES LISTED ABOVE;

2) IF AT ANY TIME, THE SPECIFICS OF A RELEASE OR SPILL CHANGE SO IT NO LONGER FITS INTO ONE OF THE CATEGORIES LISTED ABOVE;

3) IF THE SPILL IS GREATER THAN 100,000 GALLONS; AND/OR

4) IF THE STATE HISTORIC PRESERVATION OFFICER NOTIFIES YOU THAT A CATEGORICALLY EXCLUDED RELEASE OR SPILL MAY HAVE THE POTENTIAL TO AFFECT A HISTORIC PROPERTY

YOU OR YOUR REPRESENTATIVE MUST FOLLOW THE SECTION VI OF THIS PA.

APPENDIX II. SECRETARY OF THE INTERIOR'S STANDARDS for Archeology and Historic Preservation

48 *Federal Register* 44738-39 (September 29, 1983)

Professional Qualifications Standards

The following requirements are those used by the National Park Service and have been previously published in the Code of Federal Regulations 36 CFR Part 61. The qualifications define minimum education and experience required to perform identification, evaluation, registration, and treatment activities. In some cases, additional areas or levels of expertise may be needed depending on the complexity of the task and the nature of the historic properties involved. In the following definitions, a year of full-time professional experience need not consist of a continuous year of full-time work but may be made up of discontinuous periods of full-time or part-time work adding up to the equivalent of a year of full-time experience.

- **History**

  The minimum professional qualifications in history are a graduate degree in history or closely related field; or a bachelor's degree in history or closely related field plus one of the following:

  1. At least two years of full time experience in research, writing, teaching, interpretation, or the demonstrable professional activity with an academic institution, historic organization or agency, museum, or other professional institution; or
  2. Substantial contribution through research and publication to the body of scholarly knowledge in the field of history.

- **Archeology**

  The minimum professional qualifications in archeology are a graduate degree in archeology, anthropology, or closely related field plus:

  1. At least one year of full-time professional experience or equivalent specialized training in archeological research, administration or management;
  2. At least four months of supervised field and analytic experience in general North American archeology; and
  3. Demonstrated ability to carry research to completion.

  In addition to these minimum qualifications, a professional in prehistoric archeology shall have at least one year of full-time professional experience at a supervisory level in the study of archeological resources of the prehistoric period. A professional in historic archeology shall have at least one year of full-time professional experience at a supervisory level in the study of archeological resources of the historic period.

- **Architectural History**

  The minimum professional qualifications in architectural history are a graduate degree in architectural history, art history, historic preservation, or closely related field, with course work in

American architectural history; or a bachelor's degree in architectural history, art history, historic preservation or closely related field plus one of the following:

1. At least two year of full-time experience in research, writing, or teaching in American architectural history or restoration architecture with an academic institution, historical organization or agency, museum. or other professional institution; or
2. Substantial contribution through research and publication to the body of scholarly knowledge in the field of American architectural history.

- **Architecture**

The minimum professional qualifications in architecture are a professional degree in architecture plus at least two years of full-time experience in architecture; or State license to practice architecture.

- **Historic Architecture**

The minimum professional qualifications historic in architecture are a professional degree in architecture or a State license to practice architecture, plus one of the following:

1. At least one year of graduate study in architectural preservation, American architectural history, preservation planning, or closely related field; or
2. At least one year of full-time professional experience on historic preservation projects.

Such graduate study or experience shall include detailed investigations of historic structures, preparation of historic structure research reports, and preparation of plans and specifications for preservation projects.