Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Pacbaroness

Bulk carrier *Pacbaroness* sinking stern first after collision with the car carrier *Atlantic Wing* off Point Conception in 1987.

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National Oceanic and
Atmospheric Administration

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Photo: Photograph of *Pacbaroness* sinking off California
Source: http://channelislands.noaa.gov/shipwreck/dbase/pacbaroness_2.html

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Project Background

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

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

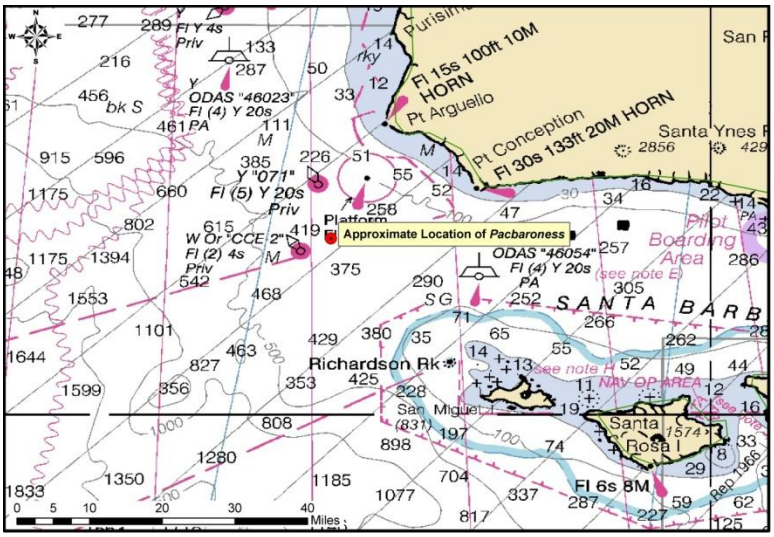
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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

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

Executive Summary: *Pacbaroness*

The freighter *Pacbaroness*, sunk after a collision off Pt. Conception, California in 1987, was identified as a potential pollution threat, thus a screening-level risk assessment was conducted. The different sections of this document summarize what is known about the *Pacbaroness*, the results of environmental impact modeling composed of different release scenarios, the ecological and socio-economic resources that would be at risk in the event of releases, the screening-level risk scoring results and overall risk assessment, and recommendations for assessment, monitoring, or remediation.



Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Pacbaroness* scores Medium with 13 points; for the Most Probable Discharge (10% of the Worse Case volume), *Pacbaroness* scores Low with 11 points. Given these scores, and the higher level of data certainty, NOAA recommends that this site be noted in Area Contingency Plans and considered for an assessment if the resources at risk are underrepresented in this assessment. At a minimum, an active monitoring program should be implemented. Outreach efforts with the technical dive community and commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the site.

Vessel Risk Factors		Risk Score	
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	
	A2: Oil Type		
	B: Wreck Clearance		
	C1: Burning of the Ship		
	C2: Oil on Water		
	D1: Nature of Casualty		
	D2: Structural Breakup		
Archaeological Assessment	Archaeological Assessment	Not Scored	
Operational Factors	Wreck Orientation	Not Scored	
	Depth		
	Confirmation of Site Condition		
	Other Hazardous Materials		
	Munitions Onboard		
	Gravesite (Civilian/Military)		
	Historical Protection Eligibility		
		WCD	MP (10%)
Ecological Resources	3A: Water Column Resources	Med	Low
	3B: Water Surface Resources	Low	Low
	3C: Shore Resources	Low	Low
Socio-Economic Resources	4A: Water Column Resources	Med	Med
	4B: Water Surface Resources	High	High
	4C: Shore Resources	Med	Low
Summary Risk Scores		13	11

The determination of each risk factor is explained in the document. This summary table is found on page 38.

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

Vessel Particulars

Bulk carrier *Pacbaroness* sinking stern first after collision with the car carrier *Atlantic Wing* off Point Conception in 1987.

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Official Name: *Pacbaroness*

Official Number: 5444

Vessel Type: Freighter

Vessel Class: Unknown

Former Names: Unknown

Year Built: 1976

Builder: Namura Shipbuilding Co., Osaka, Japan

Builder's Hull Number: Unknown

Flag: Liberian

Owner at Loss: Trans Pacific Shipping Company

Controlled by: N/A

Chartered to: Unknown

Operated by: Unknown

Homeport: Monrovia

Length: 531 feet

Beam: 82 feet

Depth: 45 feet

Gross Tonnage: 14,412

Net Tonnage: 9,480

Hull Material: Steel

Hull Fastenings: Unknown

Powered by: Oil Engines

Bunker Type: Medium Fuel Oil (IFO 180 & Marine Diesel)

Bunker Capacity (bbl): 9,200

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): 0

Dry Cargo Capacity: Unknown

Tank or Hold Description: Vessel had five cargo holds

Casualty Information

Port Departed: Long Beach, CA

Destination Port: Unknown

Date Departed: September 21, 1987

Date Lost: September 21, 1987

Number of Days Sailing: 1

Cause of Sinking: Collision with the car-carrier *Atlantic Wing*

Latitude (DD): 34.35

Longitude (DD): -120.75

Nautical Miles to Shore: 13

Nautical Miles to NMS: 12

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 1,460

Bottom Type: Continental Margin

Is There a Wreck at This Location? Yes, the wreck has been positively located and identified

Wreck Orientation: Broken in half and mostly resting on an even keel

Vessel Armament: None

Cargo Carried when Lost: 21,000 metric tons of finely powdered copper concentrate

Cargo Oil Carried (bbl): None

Cargo Oil Type: N/A

Probable Fuel Oil Remaining (bbl): 7,842

Fuel Type: Medium Fuel Oil (IFO 180 & Diesel)

Total Oil Carried (bbl): 7,842

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes

Reportedly Leaking: No

Historically Significant: No

Gravesite: No

Salvage Owner: Not known if any

Wreck Location

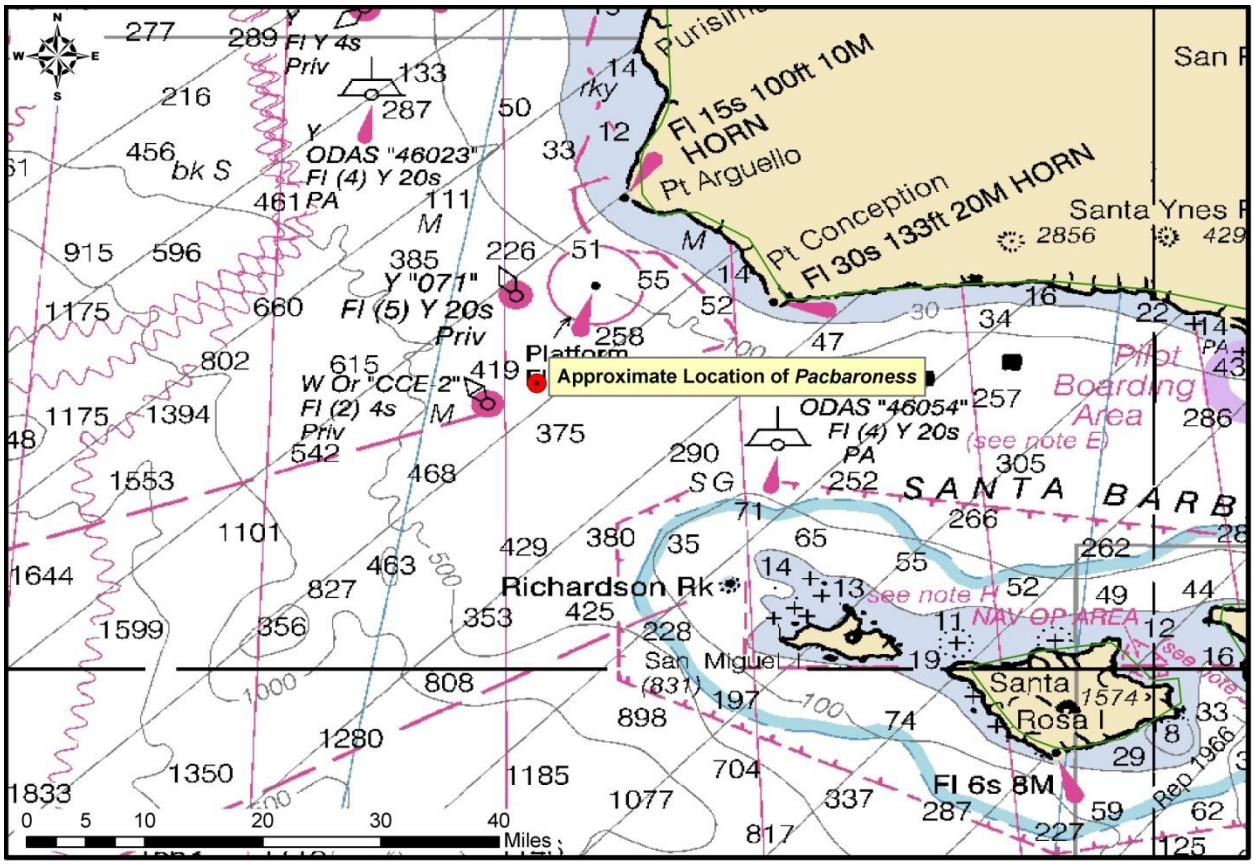

Chart Number: 18020

Casualty Narrative

"On September 21, 1987 at 0600, the Liberian bulk carrier *Pac Baroness* and the Panamanian freighter *Atlantic Wing* collided in foggy, high sea conditions, twelve miles southwest of Point Conception, California. The *Pac Baroness* was carrying 21,000 metric tons of dry bulk copper concentrate consisting of 30% copper, 30% iron, 30% other oxides and approximately 9,200 bbl of bunker fuel (IFO-180 and marine diesel fuel) as well as quantities of lube oil and hydraulic oil. The *Atlantic Wing* was carrying automobiles and was bound for Long Beach. The *Pac Baroness* sustained damage to the number 4 and 5 cargo holds and the Atlantic Wing suffered a 25 foot by 10 foot gash in her bow. The Chief Engineer on board the *Pac Baroness* activated the vessel's bilge pumps and a tug attached a towline to the vessel to prevent the *Pac Baroness* from drifting toward the shoreline. By 1607, the *Pac Baroness* was still taking on water and was close to sinking. The *Pac Baroness* sank at 1618 on September 21, resulting in a release of approximately 9,200 bbl of oil and quantities of copper ore over the next 20 days. The currents at the time of the incident were to the northwest at 3-4 knots; winds in the area were from the N-NW at 10 knots. The seasonal Davidson Current flows north along isobaths at about 0.25 knots. The Clean Seas Co-op was originally conducting cleanup on behalf of the owners of the *Pac Baroness*. On September 24, Clean Seas notified the U.S. Coast Guard's Federal On Scene Coordinator (FOSC) that they would no longer be continuing operations due to disagreements over their contract with the owners. The FOSC declared the incident a Federal response and opened the 311(k) fund. The U.S. Coast Guard began

negotiations to contract Clean Seas as part of the Federal response. By September 28, Clean Seas had resumed working for the owners of the *Pac Baroness*, with the agreement that the owners would finance the Clean Seas response inclusive of the period from September 24 to September 28. U.S. Coast Guard district 11."
-http://www.incidentnews.gov/incident/6499

Figure 1-1 shows a diagram of the cargo holds on the *Pacbaroness*.

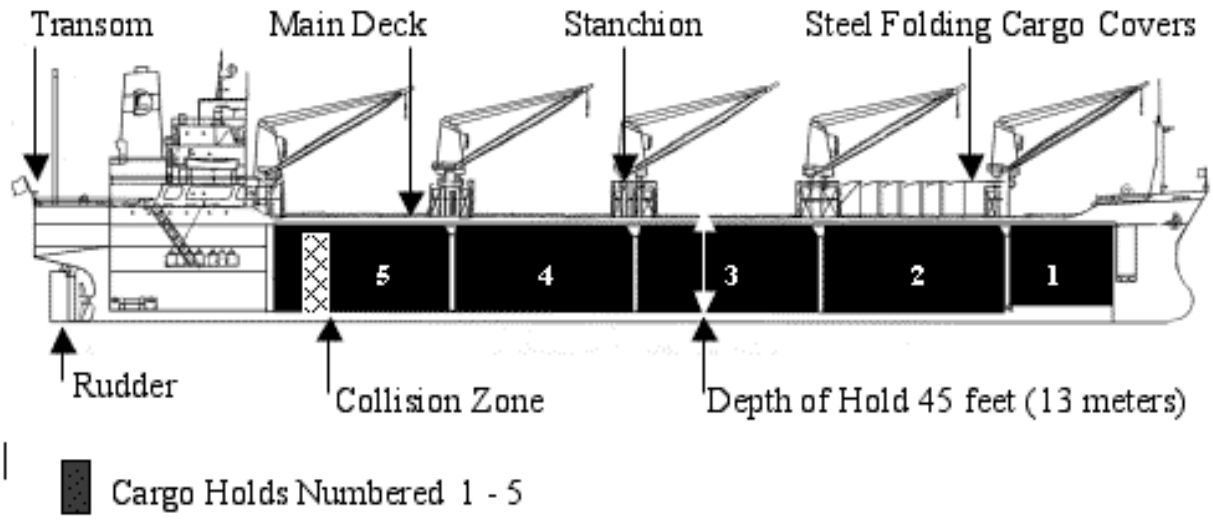

Figure 1-1: Diagram depicting cargo holds of *Pacbaroness* and collision impact area (Source: http://channelislands.noaa.gov/shipwreck/dbase/pacbaroness_2.html).

General Notes

No notes available in database.

Wreck Condition/Salvage History

"The ROV *Maxrover* was launched from the research vessel *Independence*. Upon arriving on the ocean floor the sonar equipped ROV revealed an image of a large structure dead ahead. The sonar also rendered images of cable hazards draped from the ship's structure disappearing into the sediment. The *Maxrover* was carefully maneuvered around the cables as the powerful lights illuminated the steel hull of the *Pacbaroness'* stern. The ship's rudder was partially buried in the sediment and there was no sign of the large propeller, which was now completely buried. It was confirmed that the stern section had separated from the remainder of the ship, breaking at the collision point. The ROV cameras also revealed that the *Pacbaroness* was not a "dead zone" as some suspected, but supported a diverse marine life community. During the first dive near the ocean floor observations included sablefish, Dover sole, Thorny-head rockfish, Blackgill, urchins, nudibranchs, and Brittle stars.

The following day a 10-hour ROV circumnavigation of the site confirmed the *Pacbaroness* is in three separate sections. The stern is separated most likely at the collision impact zone in the No. 5 cargo hold and is angled away from the main wreckage. Because of the 40-degree downward angle of the stern section into the ocean floor, what appeared on the side scan image to be an elongated structure protruding

beyond the stern was recorded to be the rudder. The bow is also headed in a slightly different direction from the midships section of the shipwreck where the cargo holds are located. During the exploration near the No. 3 & 4 cargo holds it was discovered that the height from the main deck level of the shipwreck to the ocean floor sediment was actually the same level. Had the shipwreck been sitting upright ton its keel with no sediment buildup, it would be approximately 45-feet (13 meters) from the main deck to the ocean floor. The main deck location was confirmed during this phase of the assessment by locating one of the starboard stanchions located in its original outward position on the main deck. This discovery revealed that bottom sediment has been building up around the shipwreck site and possibly encapsulating the spilled cargo near the vessel. An attempt to penetrate the shipwreck's interior to verify if the steel folding cargo covers were breached after sinking was aborted since further visual and sonar inspection revealed cable hazards preventing safe navigation for the *Maxrover*.

The ROV moved into position to inspect the portside bow, the lights revealed that the painted letters of the ship's name curved inward into the steel hull. It was apparent the bow had suffered severe damage when impacting the ocean floor, causing rippling damage "like an accordion." The final goal was to return to the stern transom and record the hull surface where the ship's name was painted. Videography and still photographs documented the current levels of marine growth covering the letters where compared to the images recorded in 1988 of the same region when the transom was clean of marine growth. With the exception of penetrating the cargo hold region, the expedition was successful, providing the Sanctuary Quest science team with some answers to the long-awaited question of whether life exists at the shipwreck *Pacbaroness*. Upon recovery of the *Maxrover*, sediment sample collection continued throughout the next twelve hours.

The samples were sent to a Seattle lab to be analyzed for copper and polynuclear aromatic hydrocarbons (PAHs). Samples collected around the *Pacbaroness* and a nearby control site are also being evaluated to investigate potential impacts on macroinfauna. Results of the sediment testing are expected in 2003." -http://channelislands.noaa.gov/cr/pdf/*Pacbaroness*.pdf

Archaeological Assessment

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

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

In some cases where little additional historic information has been uncovered about the loss of a vessel, archaeological assessments cannot be made with any degree of certainty and were not prepared. For

vessels with full archaeological assessments, NOAA archaeologists and contracted archivists have taken photographs of primary source documents from the National Archives that can be made available for future research or on-site activities.

Assessment

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

Background Information References

Vessel Image Sources: http://channelislands.noaa.gov/shipwreck/dbase/*Pacbaroness*_2.html

Construction Diagrams or Plans in RULET Database? No, but a general hold diagram is available from http://channelislands.noaa.gov/shipwreck/dbase/*Pacbaroness*_2.html

Text References:
http://channelislands.noaa.gov/cr/pdf/*Pacbaroness*.pdf
http://www.incidentnews.gov/incident/6499
http://collections.nhm.org/collection.html?code=mmspac
http://channelislands.noaa.gov/shipwreck/dbase/*Pacbaroness*.html

Vessel Risk Factors

In this section, the risk factors that are associated with the vessel are defined and then applied to the *Pacbaroness* based on the information available. These factors are reflected in the pollution potential risk assessment development by the U.S. Coast Guard Salvage Engineering Response Team (SERT) as a means to apply a salvage engineer's perspective to the historical information gathered by NOAA. This analysis reflected in Figure 1-2 is simple and straightforward and, in combination with the accompanying archaeological assessment, provides a picture of the wreck that is as complete as possible based on current knowledge and best professional judgment. This assessment ***does not*** take into consideration operational constraints such as depth or unknown location, but rather attempts to provide a replicable and objective screening of the historical date for each vessel. SERT reviewed the general historical information available for the database as a whole and provided a stepwise analysis for an initial indication of Low/Medium/High values for each vessel.

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

Each risk factor is characterized as High, Medium, or Low Risk or a category-appropriate equivalent such as No, Unknown, Yes, or Yes Partially. The risk categories correlate to the decision points reflected in Figure 1-2.

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.

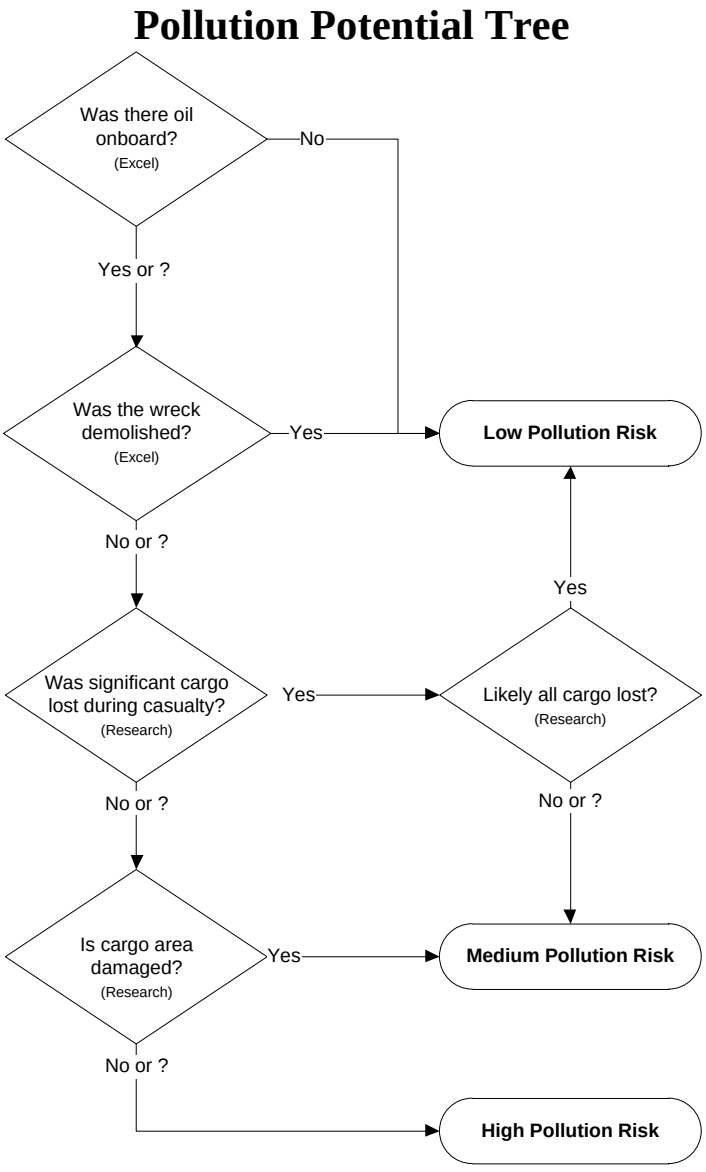

Figure 1-2: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Pacbaroness* is provided, both as text and as shading of the applicable degree of risk bullet.

Pollution Potential Factors

Risk Factor A1: Total Oil Volume

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

- **Low Volume: Minor Spill** <240 bbl (10,000 gallons)
- **Medium Volume: Medium Spill** ≥240 – 2,400 bbl (100,000 gallons)
- **High Volume: Major Spill** ≥2,400 bbl (≥100,000 gallons)

The oil volume risk classifications refer to the volume of the most-likely Worst Case Discharge from the vessel and are based on the amount of oil believed or confirmed to be on the vessel.

The *Pacbaroness i*s ranked as High Volume because it is thought to have a potential for up to 7,842 bbl (based on the amount believed to be onboard at time of the sinking), although some of that may have been lost at the time of the casualty or after the vessel sank. Data quality is medium.

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

Risk Factor A2: Oil Type

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

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

The *Pacbaroness* is classified as Medium Risk because the bunker fuel is diesel oil, a Group II oil type. Data quality is high.

Was the wreck demolished?

Risk Factor B: Wreck Clearance

This risk factor addresses whether or not the vessel was historically reported to have been demolished as a hazard to navigation or by other means such as depth charges or aerial bombs. This risk factor is based on

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

historic records and does not take into account what a wreck site currently looks like. The risk categories are defined as:

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

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

Was significant cargo or bunker lost during casualty?

Risk Factor C1: Burning of the Ship

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

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

The *Pacbaroness* is classified as High Risk because there was no report of fire at the time of casualty. Data quality is high.

Risk Factor C2: Reported Oil on the Water

This risk factor addresses reports of oil on the water at the time of the vessel casualty. The amount is relative and based on the number of available reports of the casualty. Seldom are the reports from trained observers so this is very subjective information. The risk categories are defined as:

- **Low Risk:** Large amounts of oil reported on the water by multiple sources
- **Medium Risk:** Moderate to little oil reported on the water during or after the sinking event
- **High Risk:** No oil reported on the water
- **Unknown:** It is not known whether or not there was oil on the water at the time of the casualty

The *Pacbaroness* is classified as Medium Risk because the oil was reported to have spread across the water as the vessel went down and for days afterward. Data quality is high.

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

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

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

The *Pacbaroness* is classified as High Risk because it sank as a result of a collision. Data quality is high.

Risk Factor D2: Structural Breakup

This risk factor takes into account how many pieces the vessel broke into during the sinking event or since sinking. This factor addresses how likely it is that multiple components of a ship were broken apart including tanks, valves, and pipes. Experience has shown that even vessels broken in three large sections can still have significant pollutants on board if the sections still have some structural integrity. The risk categories are:

- **Low Risk:** The vessel is broken into more than three pieces
- **Medium Risk:** The vessel is broken into two-three pieces
- **High Risk:** The vessel is not broken and remains as one contiguous piece
- **Unknown:** It is currently not known whether or not the vessel broke apart at the time of loss or after sinking

The *Pacbaroness* is classified as Medium Risk because it is broken into three sections. Data quality is high.

Factors That May Impact Potential Operations

Orientation (degrees)

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

The *Pacbaroness* is resting upright on the bottom. Data quality is high.

Depth

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

The *Pacbaroness* is 1,460 feet deep. Data quality is high.

Visual or Remote Sensing Confirmation of Site Condition

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

The location of the *Pacbaroness* is known and has been surveyed. Data quality is high.

Other Hazardous (Non-Oil) Cargo on Board
This factor addresses hazardous cargo other than oil that may be on board the vessel and could potentially be released, causing impacts to ecological and socio-economic resources at risk.

The *Pacbaroness* carried a cargo of powdered copper concentrate. Data quality is high.

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

The *Pacbaroness* did not carry any munitions. Data quality is high.

Vessel Risk Factors Summary

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

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

Vessel Risk Factors		Data Quality Score	Comments	Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 7,842 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Bunker oil is diesel oil, a Group II oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	No fire was reported	
	C2: Oil on Water	High	Oil was reported on the water; amount is not known	
	D1: Nature of Casualty	High	Collision	
	D2: Structural Breakup	High	The vessel is broken into three sections	
Archaeological Assessment	Archaeological Assessment	Low	The best assessment still comes from the U.S. Coast Guard Incident Investigation Report so a detailed assessment was not prepared	**Not Scored**
Operational Factors	Wreck Orientation	High	Resting upright on the bottom	**Not Scored**
	Depth	High	1,460 feet	
	Visual or Remote Sensing Confirmation of Site Condition	High	Site has been surveyed	
	Other Hazardous Materials Onboard	High	Copper concentrate	
	Munitions Onboard	High	No	
	Gravesite (Civilian/Military)	High	No	
	Historical Protection Eligibility (NHPA/SMCA)	High	No	

SECTION 2: ENVIRONMENTAL IMPACT MODELING

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

Release Scenarios Used in the Modeling

The potential volume of leakage at any point in time will tend to follow a probability distribution. Most discharges are likely to be relatively small, though there could be multiple such discharges. There is a lower probability of larger discharges, though these scenarios would cause the greatest damage. A **Worst Case Discharge** (WCD) would involve the release of all of the cargo oil and bunkers present on the vessel. In the case of the *Pacbaroness* this would be about 8,000 bbl (rounded up from 7,842 bbl) based on estimates of the maximum amount of oil remaining onboard the wreck.

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

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

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

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

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

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	8 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	80 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	800 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	4,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	8,000 bbl	One-time release	Over several hours or days	Least likely	Tier 3

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

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

Oil Type for Release

The *Pacbaroness* contained a maximum of 7,842 bbl of a medium fuel oil (IFO 180 and diesel) (a Group II oil). Because the bulk of the oil likely remaining on board is a mixture of both oils, the oil spill model was run using light fuel oil.

Oil Thickness Thresholds

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

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

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

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

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

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

Potential Impacts to the Water Column

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

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

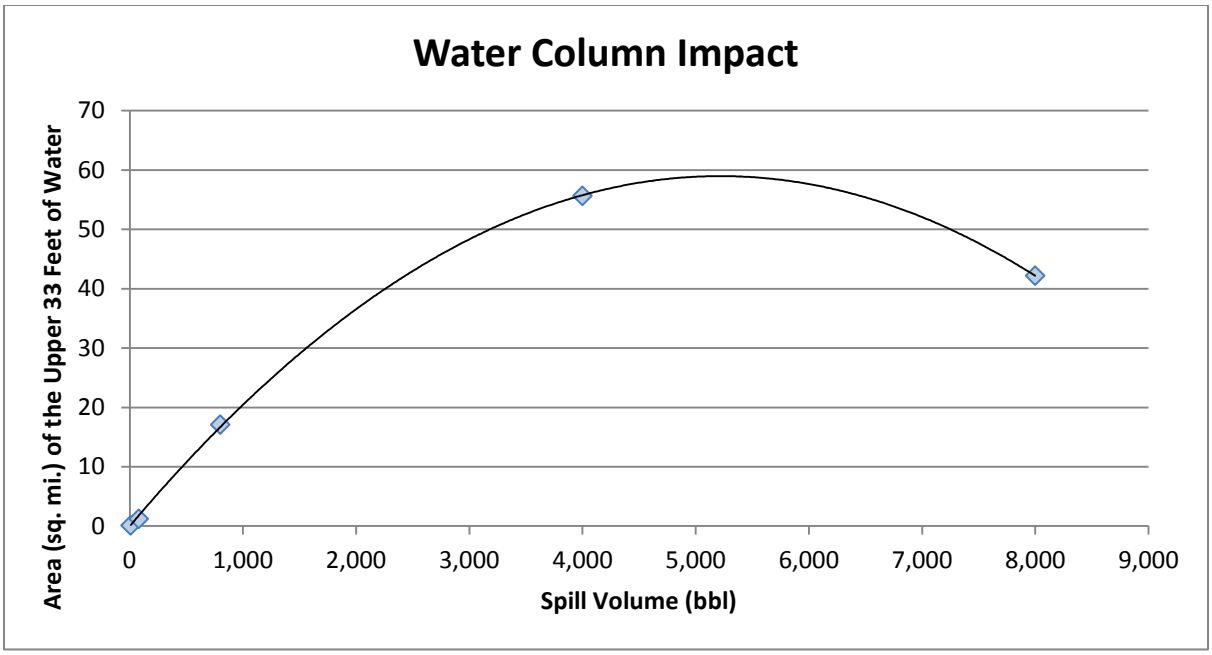

Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Pacbaroness*.

because a significant amount of oil is removed from the water column due to sedimentation in the modeling results. Increased sedimentation will increase impacts to benthic habitats.

Potential Water Surface Slick

The slick size from an oil release from the *Pacbaroness* is a function of the quantity released. The estimated water surface coverage by a fresh slick (the total water surface area "swept" by oil over time) for the various scenarios is shown in Table 2-3, as the mean result of the 200 model runs. Note that this is an estimate of total water surface affected over a 30-day period. The slick will not be continuous but rather be broken and patchy due to the subsurface release of the oil. Surface expression is likely to be in the form of sheens and streamers.

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

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

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m²	10 g/m²
Chronic	8	207 mi²	0 mi²
Episodic	80	860 mi²	0 mi²
Most Probable	800	3,100 mi²	4 mi²
Large	4,000	8,500 mi²	8 mi²
Worst Case Discharge	8,000	13,500 mi²	13 mi²

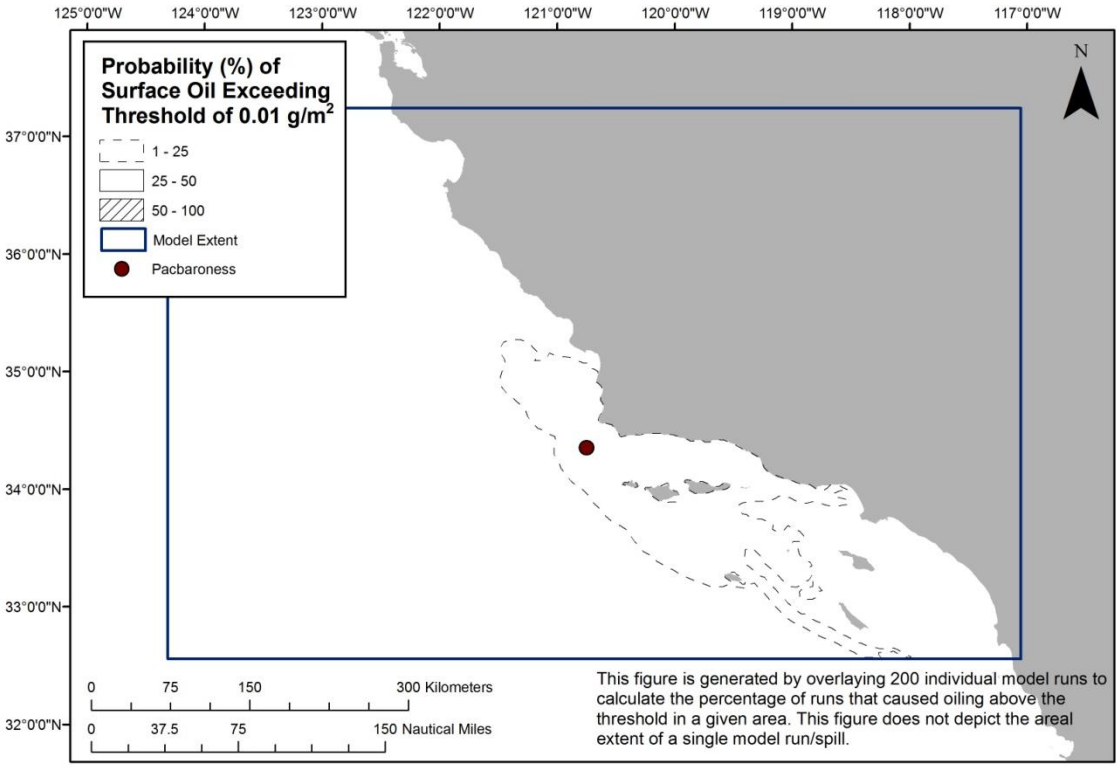

Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 800 bbl of light fuel oil from the *Pacbaroness* at the threshold for socio-economic resources at risk.

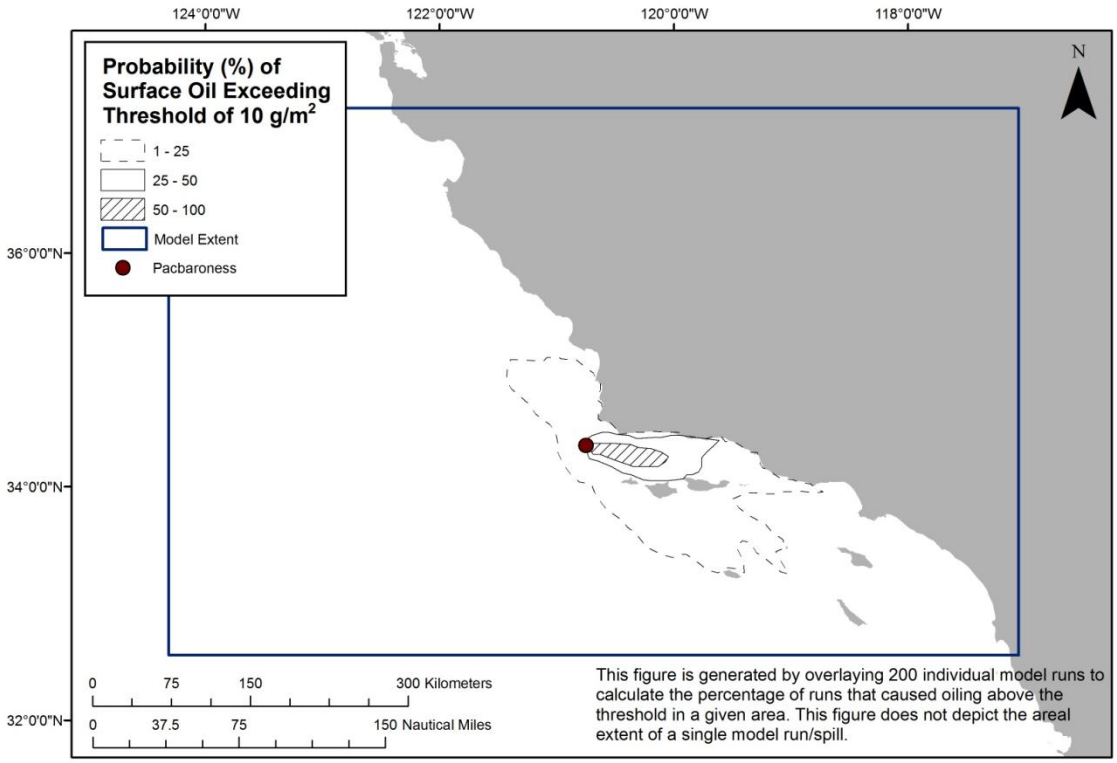

Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 800 bbl of light fuel oil from the *Pacbaroness* at the threshold for ecological resources at risk.

The behavior of light fuel oils to spread into thin sheens is demonstrated by the comparison of Figures 2-2 and 2-3, which show the probability of surface oil at different thicknesses. At the socio-economic threshold of a barely visible sheen (0.01 g/m^2), the overlay of all 200 models generates a map showing the probability of 1-25% oil in each model grid that covers a large area. At the ecological threshold of a heavy sheen with dark colors (10 g/m^2), the 1-25% probability area of oil presence is much smaller.

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

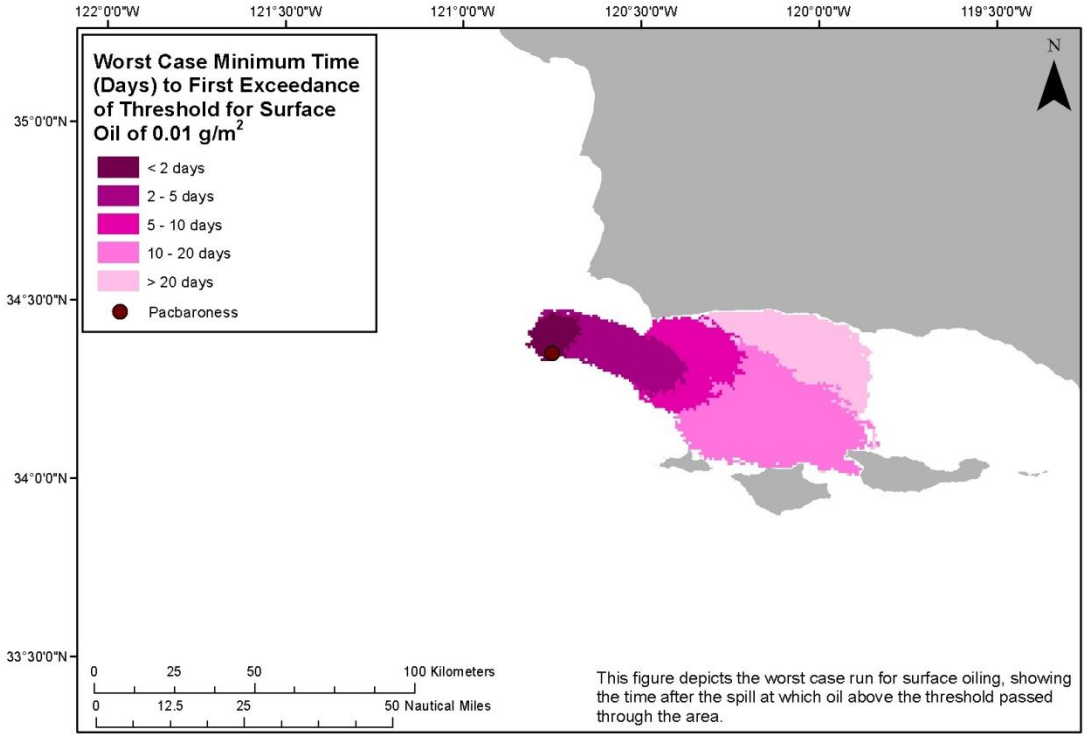

Figure 2-4: Water surface oiling from the Most Probable of 800 bbl of light fuel oil from the *Pacbaroness* shown as the area over which the oil spreads at different time intervals.

The actual area affected by a release will be determined by the volume of leakage, whether it is from one or more tanks at a time. To assist planners in understanding the scale of potential impacts for different leakage volumes, a regression curve was generated for the water surface area oiled using the five volume scenarios, which is shown in Figure 2-5. Using this figure, the area of water surface with a barely visible sheen can be estimated for any spill volume. Note that there are different scales for each threshold (on the right for the 10 g/m^2 curve and on the left for the 0.01 g/m^2 curve).

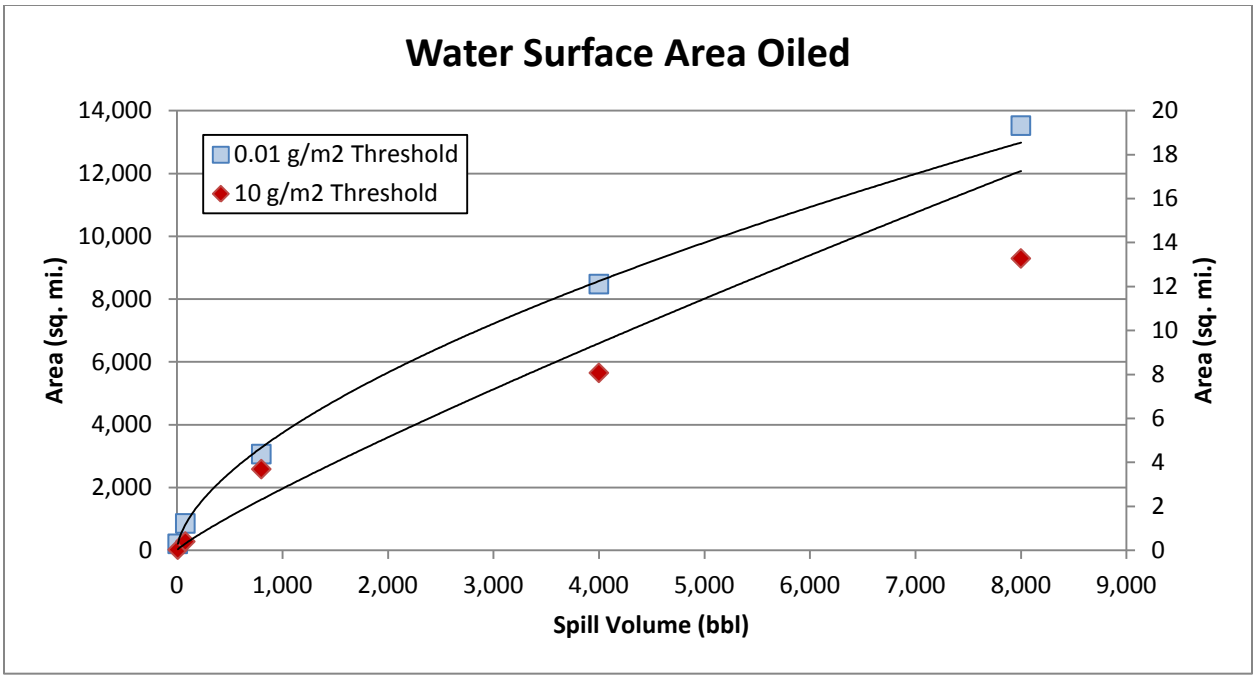

Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Pacbaroness*, showing both the ecological threshold of 10 g/m^2 (use the scale on the right side of the plot) and socio-economic threshold of 0.01 g/m^2 (use the scale on the left side of the plot).

Potential Shoreline Impacts

Based on these modeling results, shorelines of Santa Barbara County and the north and western shores of the Channel Islands are at risk. Figure 2-6 shows the probability of oil stranding on the shoreline at concentrations that exceed the threshold of 1 g/m^2, for the Most Probable release of 800 bbl. However, the specific areas that would be oiled will depend on the currents and winds at the time of the oil release(s), as well as on the amount of oil released. Figure 2-7 shows the single oil spill scenario that resulted in the maximum extent of shoreline oiling for the Most Probable volume. Estimated miles of shoreline oiling above the threshold of 1 g/m^2 by scenario type are shown in Table 2-4.

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

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	8	0	0	0	0
Episodic	80	1	0	0	1
Most Probable	800	4	0	0	4
Large	4,000	7	1	0	7
Worst Case Discharge	8,000	7	2	0	9

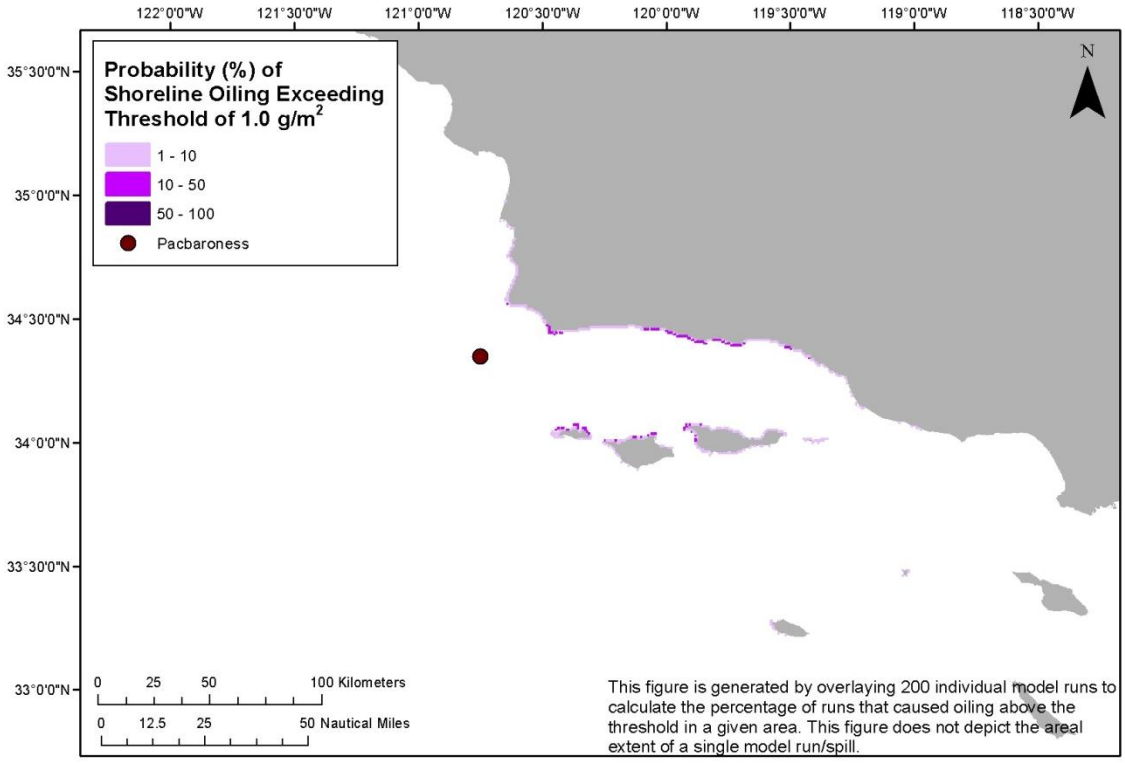

Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 800 bbl of light fuel oil from the *Pacbaroness*.

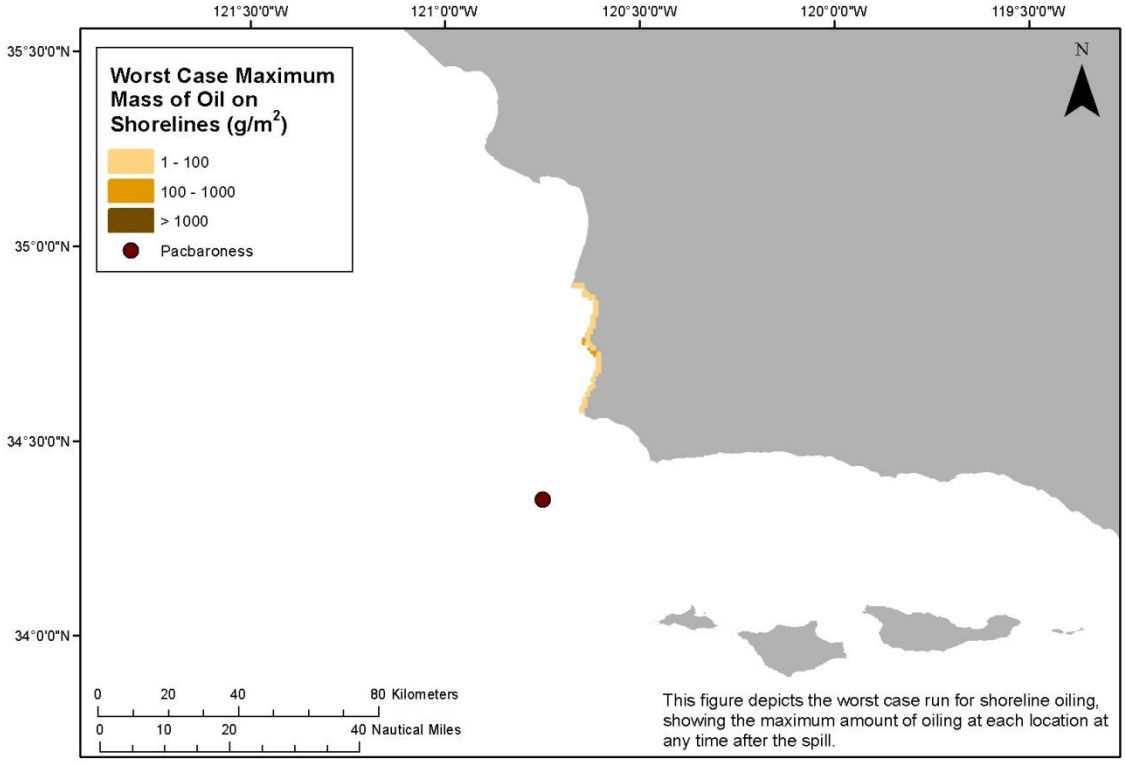

Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 800 bbl of light fuel oil from the *Pacbaroness* that resulted in the greatest shoreline oiling.

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

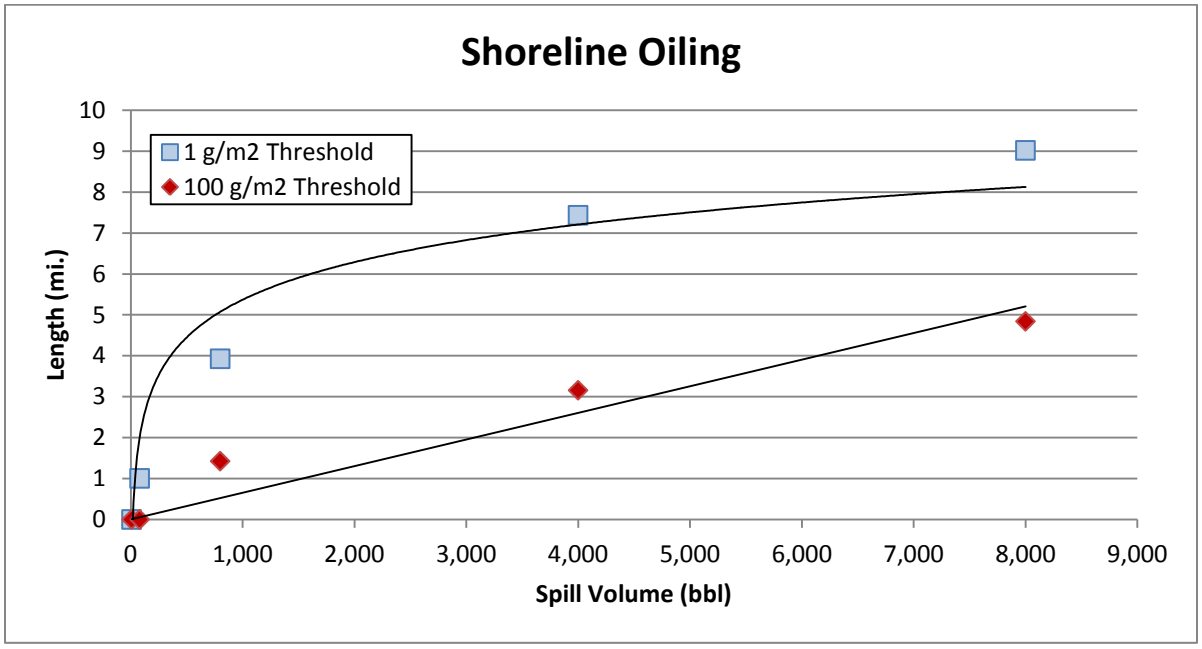

Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Pacbaroness*.

The worst case scenario for shoreline exposure along the potentially impacted area for the WCD volume (Table 2-5) consists primarily of rocky shores and sand beaches.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 8,000 bbl from the *Pacbaroness*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	18 miles	9 miles
Sand beaches	8 miles	2 miles
Salt marshes and tidal flats	0 miles	0 miles

Table 2-6: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 800 bbl from the *Pacbaroness*.

Shoreline/Habitat Type	Lighter Oiling Oil Thickness <1 mm Oil Thickness >1 g/m²	Heavier Oiling Oil Thickness >1 mm Oil Thickness >100 g/m²
Rocky and artificial shores/Gravel beaches	7 miles	2 miles
Sand beaches	6 miles	0 miles
Salt marshes and tidal flats	0 miles	0 miles

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Pacbaroness* (Table 3-1) include some of the largest concentrations of pinnipeds in the world. In addition, numerous birds, fish, and invertebrate species use the intertidal regions as foraging or nesting sites. Marine productivity is high in the area and supports a large diversity and abundance of marine mammals, fish, and invertebrates.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Birds	General • Stopover sites for birds on the Pacific flyway during both north (April through May) and south (September through December) migrations • Channel Islands provide nesting sites for many species of shorebirds and seabirds • High densities of brown pelican in Santa Barbara channels • High avian diversity in area of impact • Pelagic birds (kittiwake, shearwater, petrel, fulmar), waterfowl (surf scoter) and diving birds present in coastal waters (loons, cormorants, western grebe) San Miguel • Nesting: ashy storm-petrel (~900), Xantus's murrelet (ST,150) black oystercatcher (40), Brandt's cormorant (3,000), Cassin's auklet (10,000), Double crested cormorant (193), Leach's storm-petrel (114), pelagic cormorant (~550), pigeon guillemot (800-1,000), western gull (3,000), western snowy plover (30-35), brown pelican (200-600), rhinoceros auklet (0-15) • Raptors (peregrine falcon, bald eagle (SE), osprey) also present Santa Rosa • Nesting: Brandt's cormorant (3,900), pelagic cormorant (800), western gull (140), pigeon guillemot (300), brown pelican (14), black oystercatcher (10), western snowy plover (13), double-crested cormorant (27) • Raptors, shorebirds, surf scoter present but not nesting Santa Cruz (western end only): • Nesting: Cassin's auklet (132), Xantus's murrelet (75), ashy storm-petrel (10), Brandt's cormorant (2,300), pelagic cormorant (150), black oystercatcher (40), western snowy plover (10), western gull (450), brown pelican (410), pigeon guillemot (1,000), • Peregrine falcon, willet, gulls, sanderling, western grebe, surf scoter, Xantus' murrelet, western snowy plover, brown pelican, double-crested cormorant, Cassin's auklet present but not nesting Mainland • Vandenberg AFB: Western snowy plover and California least tern nesting in high concentrations; brown pelican, California least tern, pelagic cormorant, western gull, pigeon guillemot in low abundances • Point Conception nesting: Western snowy plover, western gull, pigeon guillemot, black oystercatcher • Government Point to Santa Barbara: high concentrations of wintering shorebirds and wading birds, med-low concentrations of western snowy	Migration stopovers Apr-May and Sep-Dec Transient shorebird abundance peaks Jun-Jul Pelagic birds, waterfowl and diving birds overwintering (Sep-May) *Nesting*: Cormorants: Mar-Jun Petrels: Jan-Sep Alcids: spring-fall Oystercatcher: Mar-Sep Gulls: Feb-Sep Pelican: Dec-Aug Western snowy plover: Mar-Sep

Species Group	Species Subgroup and Geography	Seasonal Presence
	plovers nesting	
Sea Turtles	Green (FT), leatherback (FE), loggerhead (FT), and olive ridley (FT) can all occur but are not common	Leatherback: Mar-Jul
Pinnipeds and sea otters	San Miguel • Point Bennett is one of the largest concentrations of pinnipeds in the world (>30,000 sea lions alone) • California sea lion (50,000) , northern elephant seal (15,000), harbor seal (1200), and northern fur seal (1,000s) rookeries and haul-outs present on the island • Guadalupe fur seal (FT, ST) present but rare • Historical Steller sea lion (FT) rookery • Sea otters (FT) present Santa Rosa & Santa Cruz • Northern elephant seal (3-4,000) present on Santa Rosa • California sea lions in higher concentration on Santa Cruz (700) than Santa Rosa (30) • Harbor seal in higher concentration on Santa Rosa (500-1,000) than Santa Cruz (<500) Mainland • Point Conception – harbor seal and northern elephant seal rookery • Point Arguello – harbor seal and California sea lion haul-out • Concentrations much lower than the Channel Islands • Southern sea otters present	Sea otters present Dec-May Northern elephant seal pups Dec-Mar, molts Apr-Jul *Pupping*: Harbor seal: Mar-Jun California sea lion: May-Jul Guadalupe fur seal: Jun-Aug
Cetaceans	Species commonly found in Santa Barbara Channel: • Bottlenose dolphin, gray whale, killer whale, minke whale, blue whale (FE), fin whale (FE) and humpback whale, Pacific white-sided dolphin, Risso's dolphin, Dall's porpoise, northern right-whale dolphin, short-beaked common dolphin • Very high concentrations of whales north of Santa Rosa from Apr-Nov	Cetaceans more abundant in spring/summer Gray whale more common Jan-Mar
Fish and Inverts	Channel Islands have higher fish diversity and invertebrate (crabs, rock shrimp, abalones) concentrations than mainland areas Coastal streams • Tidewater goby (FE) nest in sand burrows in coastal streams (Canada del Cojo, Jalama Creek) • Steelhead (FT/ST) spawn in coastal streams Intertidal • California grunion spawn on sand beaches throughout the area • Surf smelt spawn in the upper intertidal zone of coarse sand/gravel beaches; eggs adhere to the substrate • Rocky intertidal areas are habitat for monkeyface prickleback, some species of rockfish, and larval fish • California spiny lobster nearshore and south of Pt. Conception • Pismo clam and black abalone in intertidal areas north of Pt. Arguello • Black abalone (FE) present in nearshore environments of Channel Islands and mainland	Goby nests year round Steelhead spawn Nov-Apr, juveniles migrate out of coastal streams mid Jun California grunion spawn Mar-Aug
Benthic Habitats	Large kelp beds (*Macrocystis pyrifera* and *Nereocystis lutkeana)* are found along the shoreline from Pt. Conception to Rocky Point and east of Government Point	Year round

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

Ecological Risk Factors

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

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each ecological risk factor is provided. Also, the classification for the *Pacbaroness* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 8,000 bbl and a border around the Most Probable Discharge of 800 bbl.

Risk Factor 3A: Water Column Impacts to EcoRAR

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

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

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

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

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

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

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

The *Pacbaroness* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 8,000 bbl because 56% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 42 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 800 bbl, the *Pacbaroness* is classified as High Risk for oiling probability for water column ecological resources because 100% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 17 mi^2 of the upper 33 feet of the water column.

Risk Factor 3B: Water Surface Impacts to EcoRAR

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

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

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

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

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

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

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

The *Pacbaroness* is classified as Low Risk for oiling probability for water surface ecological resources for the WCD because 1% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is classified as Low Risk for degree of oiling because the mean area of water contaminated was 13 mi^2. The *Pacbaroness* is classified as Low Risk for oiling probability for water surface ecological resources for the Most Probable Discharge because 0% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 10 g/m^2. It is also classified as Low Risk for degree of oiling because the mean area of water contaminated was 4 mi^2.

Risk Factor 3C: Shoreline Impacts to EcoRAR

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

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

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

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

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

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

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

The *Pacbaroness* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 66% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Low Risk for degree of oiling because the mean weighted length of shoreline contaminated was 9 miles. The *Pacbaroness* is classified as Medium Risk for oiling probability for shoreline ecological resources for the Most Probable Discharge because 18% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Low Risk for degree of oiling because the mean weighted length of shoreline contaminated was 3 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 8,000 bbl of light fuel oil from the *Pacbaroness* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Medium, because the moderate-sized area of highest exposure occurs in open shelf waters without any known concentrations of sensitive upper water column resources
- Water surface resources – Low, because of the small area swept by surface oil. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens and streamers
- Shoreline resources – Low, because most of the potentially shoreline impacted consists of exposed rocky shores where light fuels oil will not persist, and the average shoreline oiling was less than 10 miles

Table 3-2: Ecological risk scores for the **Worst Case Discharge of 8,000 bbl** of light fuel oil for the *Pacbaroness*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	56% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Med
3A-2: Water Column Degree EcoRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 42 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	Medium	High	1% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	Low
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	Medium	High	The mean area of water contaminated above 10 g/m^2 was 13 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	**High**	66% of the model runs resulted in shoreline oiling of 100 g/m^2	Low
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	Medium	High	The length of shoreline contaminated by at least 100 g/m^2 was 9 mi	

For the Most Probable Discharge of 800 bbl, the ecological risk from potential releases of light fuel oil from the *Pacbaroness* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because of the likely smaller volume of water column impacts and limited sensitive water column resources in the offshore area of most likely impact
- Water surface resources – Low, because of the very small area swept by surface oil. It should be noted that oil on the surface will not be continuous but rather be broken and patchy and in the form of sheens and streamers
- Shoreline resources – Low, because the average shoreline oiling was less than 3 miles and only exposed rocky shores where a light fuel oil would not persist

Table 3-3: Ecological risk scores for the **Most Probable Discharge of 800 bbl** of light fuel oil for the *Pacbaroness*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	100% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 17 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	0% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Low**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 4 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	18% of the model runs resulted in shoreline oiling of 100 g/m^2	**Low**
3C-2: Shoreline Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 100 g/m^2 was 3 mi	

SECTION 4: SOCIO-ECONOMIC RESOURCES AT RISK

In addition to natural resource impacts, spills from sunken wrecks have the potential to cause significant social and economic impacts. Socio-economic resources potentially at risk from oiling are listed in Table 4-1 and shown in Figures 4-1 and 4-2. The potential economic impacts include disruption of coastal economic activities such as commercial and recreational fishing, boating, vacationing, commercial shipping, and other activities that may become claims following a spill.

Socio-economic resources in the areas potentially affected by a release from the *Pacbaroness* include very highly utilized recreational beaches and beach communities along the California coast. Many areas along the entire potential spill zone are widely popular seaside resorts and support recreational activities such as boating, diving, sightseeing, sailing, fishing, and wildlife viewing. There are a number of state beaches and parks, as well as a national park and national recreation area in the area of potential impact.

Shipping lanes run through the area of impact into the vital commercial ports of Los Angeles/Long Beach, the third-busiest port in the nation, and the smaller ports of Port Hueneme, and El Segundo. Over 5,000 vessel port calls and 318.5 million tonnage was reported for 2010.

Commercial fishing is economically important to the region. Regional commercial landings for 2010 exceed $83 million.

The Iipay Nation of Santa Ysabel located in Santa Ynez is in the potential impact area. The Santa Isabel Band of Diegueno Mission Indians is a federally-recognized tribe of Kumeyaay Indians with a population of about 250.

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

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

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

Resource Type	Resource Name	Economic Activities
Beach Communities	Santa Barbara Gaviota Goleta Isla Vista Summerland Carpinteria Ventura Oxnard	Potentially affected beach resorts and beach-front communities along the California coast provide recreational activities (e.g., swimming, boating, recreational fishing, wildlife viewing, nature study, sports, dining, camping, and amusement parks) with substantial income for local communities and state

Resource Type	Resource Name	Economic Activities
		tax income. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
National Parks	Channel Islands National Park Santa Monica Mountains National Recreation Area	National parks and recreation areas provide recreation for local and tourist populations as well as preserve and protect the nation's natural shoreline treasures. National seashores are coastal areas federally designated as being of natural and recreational significance as a preserved area.
State Parks	Gaviota State Parl Refugio State Beach El Capitan State Beach Carpinteria State Beach Emma Wood State Beach San Buenaventura State Beach McGrath State Beach Mandalay State Beach Oxnard State Beach Silver Strand State Beach Port Hueneme State Beach	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 state. Many of these recreational activities are limited to or concentrated into the late spring into early fall months.
Tribal Lands	Santa Ynez Indian Reservation	The Santa Isabel Band of Diegueno Mission Indians is a federally recognized tribe of Kumeyaay Indians with a population of about 250.
Commercial Fishing	A number of fishing fleets use surrounding waters for commercial fishing purposes.	
	Port Hueneme-Oxnard-Ventura	Total Landings (2010): $37.4M
	Santa Barbara	Total Landings (2010): $8.2M
	Los Angeles	Total Landings (2010): $37.8M
Ports	There are a number of significant commercial ports in this part of California that could potentially be impacted by spillage and spill response activities. The port call numbers below are for large vessels only. There are many more, smaller vessels (under 400 GRT) that also use these ports.	
	Los Angeles/Long Beach	4,469 port calls annually
	Port Hueneme	276 port calls annually
	El Segundo	257 port calls annually

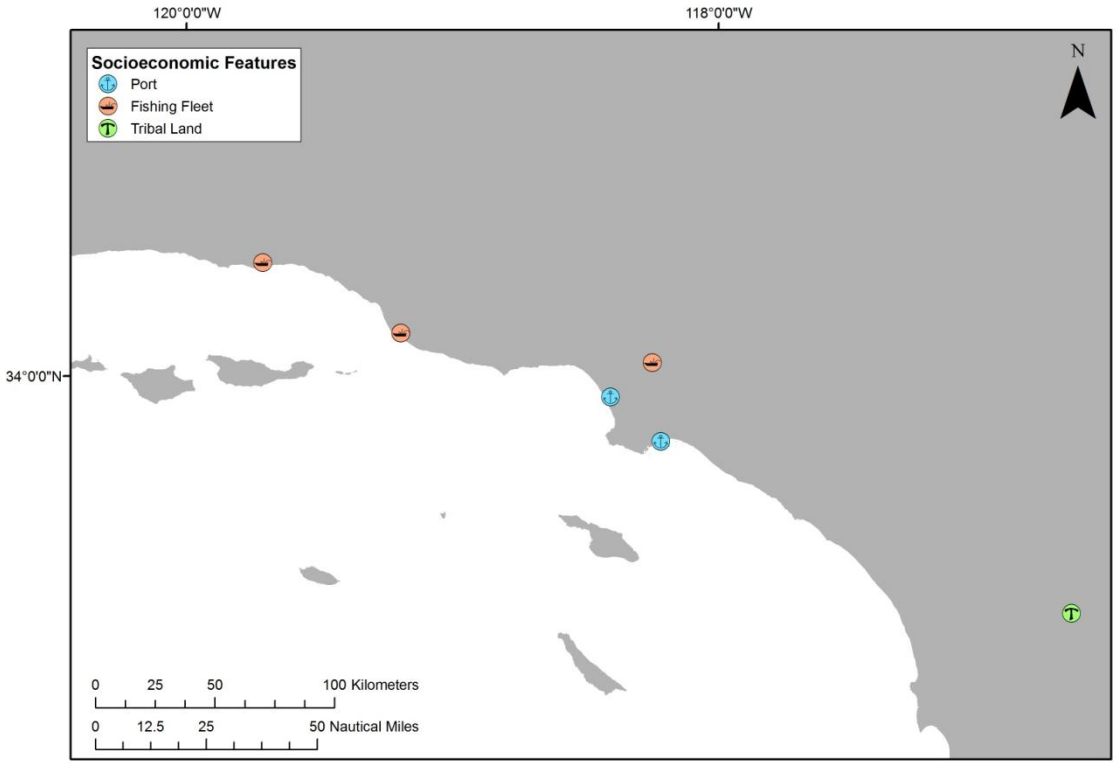

Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Pacbaroness*.

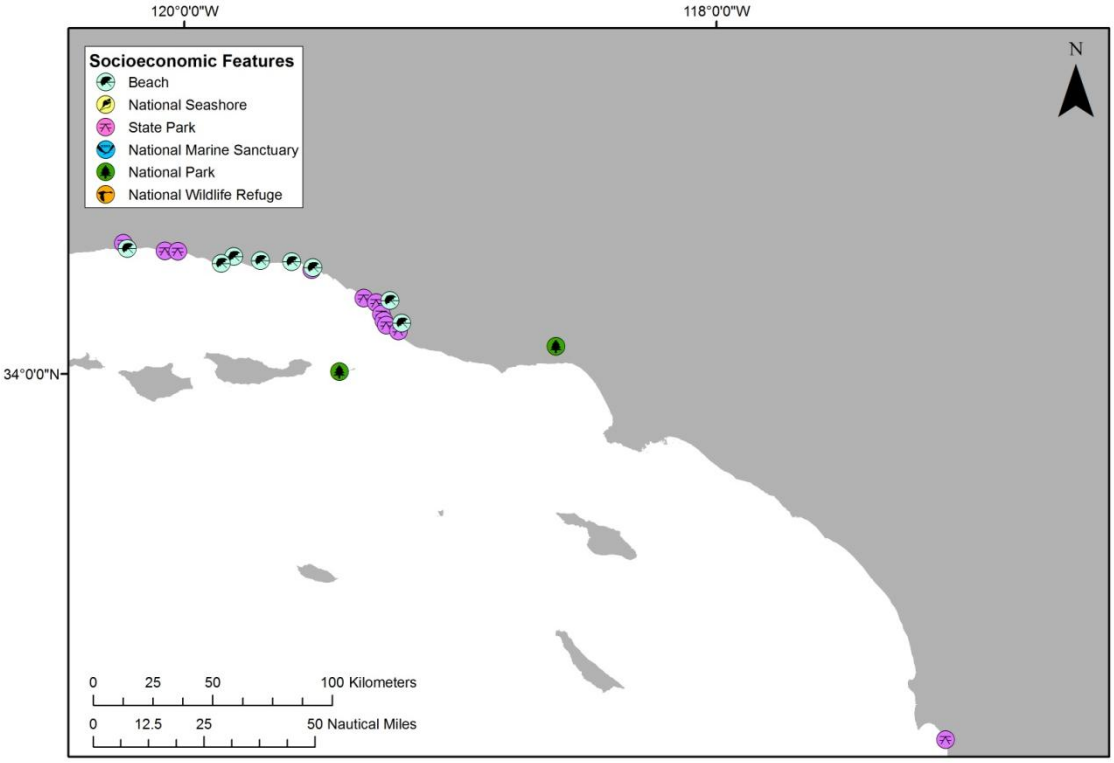

Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Pacbaroness*.

Socio-Economic Risk Factors

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

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

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

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

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

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

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

In the following sections, the definition of low, medium, and high for each socio-economic risk factor is provided. Also, in the text classification for the *Pacbaroness* shading indicates the degree of risk, for the WCD release of 8,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 800 bbl.

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

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

The three risk scores for oiling are:

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

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

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

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

The *Pacbaroness* is classified as High Risk for oiling probability and Medium Risk for degree of oiling for water column socio-economic resources for the WCD of 8,000 bbl because 56% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 42 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 800 bbl, the *Pacbaroness* is classified as High Risk for oiling probability for water column socio-economic resources because 100% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Medium Risk for degree of oiling because the mean volume of water contaminated was 17 mi^2 of the upper 33 feet of the water column.

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

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

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

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

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

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

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

The *Pacbaroness* is classified as High Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the WCD because 99% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2, and the mean area of water contaminated was 13,500 mi^2. The *Pacbaroness* is classified as High Risk for oiling probability for water surface socio-economic resources for the Most Probable Discharge because 94% of the model runs resulted in at least 1,000 mi^2 of the water surface affected above the threshold of 0.01 g/m^2. It is classified as Medium Risk for degree of oiling because the mean area of water contaminated was 3,100 mi^2.

Risk Factor 4C: Shoreline Impacts to SRAR

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

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

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

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

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

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

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

The *Pacbaroness* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 79% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean length of weighted shoreline contaminated was 20 miles. The *Pacbaroness* is classified as High Risk for oiling probability and Low Risk for degree of oiling for shoreline socio-economic resources for the Most Probable Discharge as 60% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2, and the mean length of weighted shoreline contaminated was 8 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 8,000 bbl of light fuel oil from the *Pacbaroness* is summarized as listed below and indicated in the far-right column in Table 4-2:

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

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 8,000 bbl** of light fuel oil from the *Pacbaroness*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	**Low**	**Medium**	**High**	56% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Med**
4A-2: Water Column Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 42 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	**Low**	**Medium**	**High**	99% of the model runs resulted in at least 1,000 $mi^2$of water surface covered by at least 0.01 g/m^2	**High**
4B-2: Water Surface Degree SRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 0.01 g/m^2 was 13,520 mi^2	
4C-1: Shoreline Probability SRAR Oiling	**Low**	**Medium**	**High**	79% of the model runs resulted in shoreline oiling of 1 g/m^2	**Med**
4C-2: Shoreline Degree SRAR Oiling	**Low**	**Medium**	**High**	The length of shoreline contaminated by at least 1 g/m^2 was 20 mi	

For the Most Probable Discharge of 800 bbl, the socio-economic risk from potential releases of light fuel oil from the *Pacbaroness* is summarized below and indicated in the far-right column in Table 4-3:

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

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 800 bbl** of light fuel oil from the *Pacbaroness*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	100% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Med
4A-2: Water Column Degree SRAR Oiling	Low	**Medium**	High	The mean volume of water contaminated above 1 ppb was 17 mi^2 of the upper 33 feet The mean volume of water contaminated of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	94% of the model runs resulted in at least 1,000 $mi^2$of water surface covered by at least 0.01 g/m^2	High
4B-2: Water Surface Degree SRAR Oiling	Low	**Medium**	High	The mean area of water contaminated above 0.01g/m^2 was 3,060 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	60% of the model runs resulted in shoreline oiling of 1 g/m^2	Low
4C-2: Shoreline Degree SRAR Oiling	Low	Medium	High	The length of shoreline contaminated by at least 1 g/m^2 was 8 mi	

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

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

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

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

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

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

For the Worst Case Discharge, the *Pacbaroness* scores Medium with 13 points; for the Most Probable Discharge, the *Pacbaroness* scores Low with 11 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Pacbaroness*. The final determination rests with the U.S. Coast Guard.

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

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

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Medium	Maximum of 7,842 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Bunker fuel is diesel, a Group II oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	No fire was reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Collision		
	D2: Structural Breakup	High	The vessel is broken into three sections		
Archaeological Assessment	Archaeological Assessment	Low	The best assessment still comes from the U.S. Coast Guard Incident Investigation Report so a detailed assessment was not prepared		**Not Scored**
Operational Factors	Wreck Orientation	High	Resting upright on the bottom		**Not Scored**
	Visual or Remote Sensing Confirmation of Site Condition	High	1,460 feet		
	Other Hazardous Materials Onboard	High	Site has been surveyed		
	Munitions Onboard	High	Copper concentrate		
	Gravesite (Civilian/Military)	High	No		
	Historical Protection Eligibility (NHPA/SMCA)	High	No		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Mobile resources in the areas of potential impacts	**Med**	**Low**
	3B: Water Surface Resources	High	Light fuel oils are rapidly entrained into the water column, esp. in high-energy ocean settings, reducing risks even where there are many marine birds and mammals present	**Low**	**Low**
	3C: Shore Resources	High	Mostly expect to have light oiling by a light fuel oil on rocky shores and sand beaches with little persistence, though sensitive intertidal resources at risk	**Low**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	Moderate impact on the water column in important fishing grounds	**Med**	**Med**
	4B: Water Surface Resources	High	Large area of surface water would be impacted in an area with significant shipping activities, offshore oil exploration, and fishing	**High**	**High**
	4C: Shore Resources	High	Moderate length of shoreline would be impacted in areas with high-value and sensitive resources	**Med**	**Low**
Summary Risk Scores				**13**	**11**