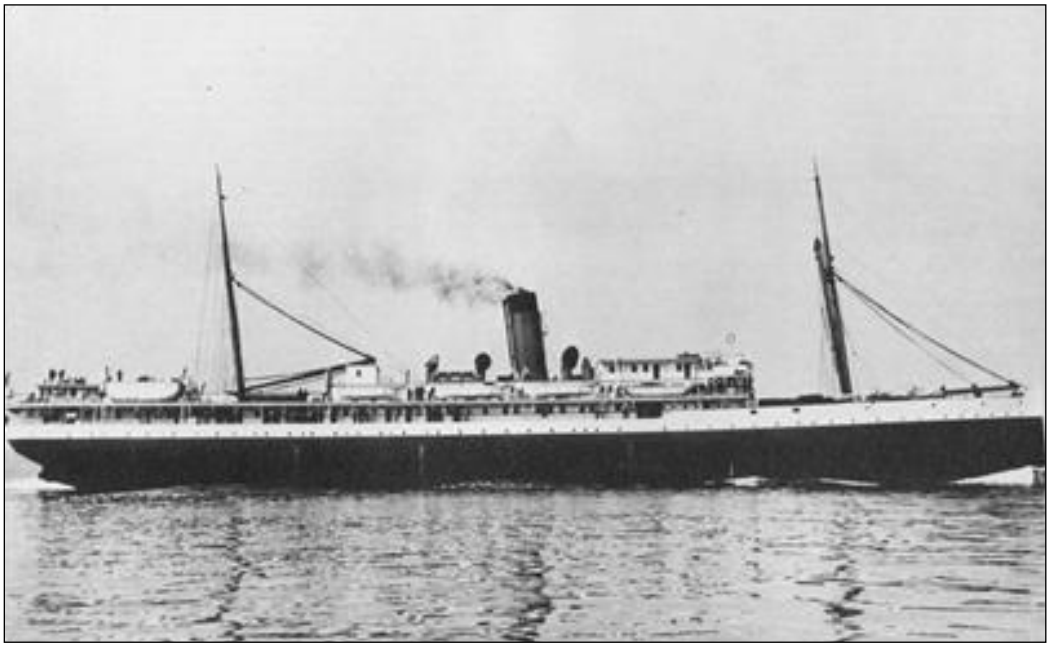
Office of National Marine Sanctuaries
Office of Response and Restoration

Screening Level Risk Assessment Package

Aleutian



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National Oceanic and
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Photo: Photograph of *Aleutian*
Source: http://www.lostshipwrecks.com/archives/archival_docs/blueprints/xaleutian_underway.jpg

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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.

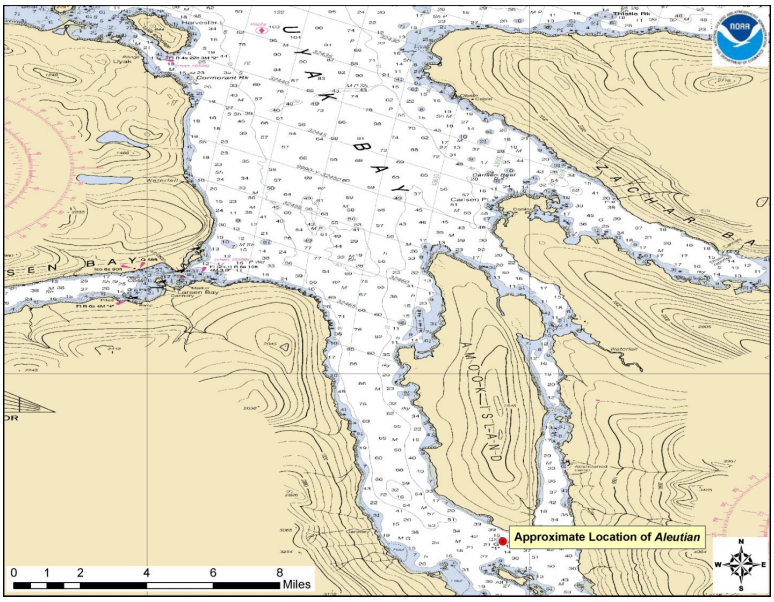
The potential polluting shipwrecks were identified through searching a broad variety of historical sources. NOAA then worked with Research Planning, Inc., RPS ASA, and Environmental Research Consulting to conduct the modeling forecasts, and the ecological and environmental resources at risk assessments.

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: *Aleutian*

The passenger vessel *Aleutian*, sunk after grounding in Uyak Bay, Kodiak Island, Alaska in 1929, 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 *Aleutian*, 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.



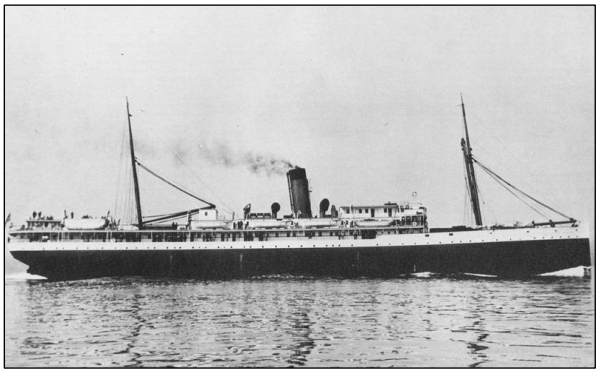
Based on this screening-level assessment, each vessel was assigned a summary score calculated using the seven risk criteria described in this report. For the Worst Case Discharge, *Aleutian* scores Medium with 12 points; for the Most Probable Discharge (10% of the Worse Case volume), *Aleutian* scores Low with 10 points. Given these scores, NOAA recommends that surveys of opportunity be used to attempt to gather more information on the vessel condition. Also, it should be noted in Area Contingency Plans so that if a mystery spill is reported in the general area, this vessel could be investigated as a source, and the vessel be considered for an assessment if the resources at risk are underrepresented in this assessment. Outreach efforts with the technical and recreational dive community as well as commercial and recreational fishermen who frequent the area would be helpful to gain awareness of localized spills in the 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	Med	Med
	3C: Shore Resources	Med	Low
Socio-Economic Resources	4A: Water Column Resources	Low	Low
	4B: Water Surface Resources	Low	Low
	4C: Shore Resources	Med	Med
Summary Risk Scores		12	10

The determination of each risk factor is explained in the document. This summary table is found on page 41.

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

Vessel Particulars



Official Name: *Aleutian*

Official Number: 96435

Vessel Type: Passenger Vessel

Vessel Class: Unknown

Former Names: *Havana*; *Panama*

Year Built: 1898

Builder: William Cramp & Sons Shipbuilding, Philadelphia, PA

Builder's Hull Number: 294

Flag: American

Owner at Loss: Alaska Steamship Company

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

Operated by: Unknown

Homeport: New York, NY

Length: 360 feet **Beam:** 50 feet **Depth:** 20 feet

Gross Tonnage: 5,638 **Net Tonnage:** 3,476

Hull Material: Steel **Hull Fastenings:** Riveted **Powered by:** Oil-fired steam

Bunker Type: Heavy fuel oil (Bunker C) **Bunker Capacity (bbl):** 7,000

Average Bunker Consumption (bbl) per 24 hours: Unknown

Liquid Cargo Capacity (bbl): Unknown

Dry Cargo Capacity: Unknown

Tank or Hold Description: Vessel had four fuel tanks capable of holding 7,000 bbl of oil

Casualty Information

Port Departed: Zacher Bay, Kodiak Island

Destination Port: Uyak Bay

Date Departed: May 26, 1929

Date Lost: May 26, 1929

Number of Days Sailing: 1

Cause of Sinking: Grounding (Rock Pinnacle)

Latitude (DD): 57.4223

Longitude (DD): -153.8314

Nautical Miles to Shore: 0

Nautical Miles to NMS: 1,136

Nautical Miles to MPA: 0

Nautical Miles to Fisheries: Unknown

Approximate Water Depth (Ft): 220

Bottom Type: Unknown

Is There a Wreck at This Location? The exact accuracy of the listed location is not known, but it is the location of the rock pinnacle that *Aleutian* ran aground on. The location of the wreck is also known by recreational divers in the area and archaeologists in Alaska.

Wreck Orientation: Sitting on an even keel

Vessel Armament: None

Cargo Carried when Lost: Mail and 115 tons of freight

Cargo Oil Carried (bbl): 0

Cargo Oil Type: N/A

Probable Fuel Oil Remaining (bbl): ≤ 7,000

Fuel Type: Heavy fuel oil (Bunker C)

Total Oil Carried (bbl): ≤ 7,000

Dangerous Cargo or Munitions: No

Munitions Carried: None

Demolished after Sinking: No

Salvaged: No

Cargo Lost: Yes

Reportedly Leaking: No (but oil is reported in the overheads)

Historically Significant: Yes

Gravesite: Yes

Salvage Owner: Not known if any

Wreck Location

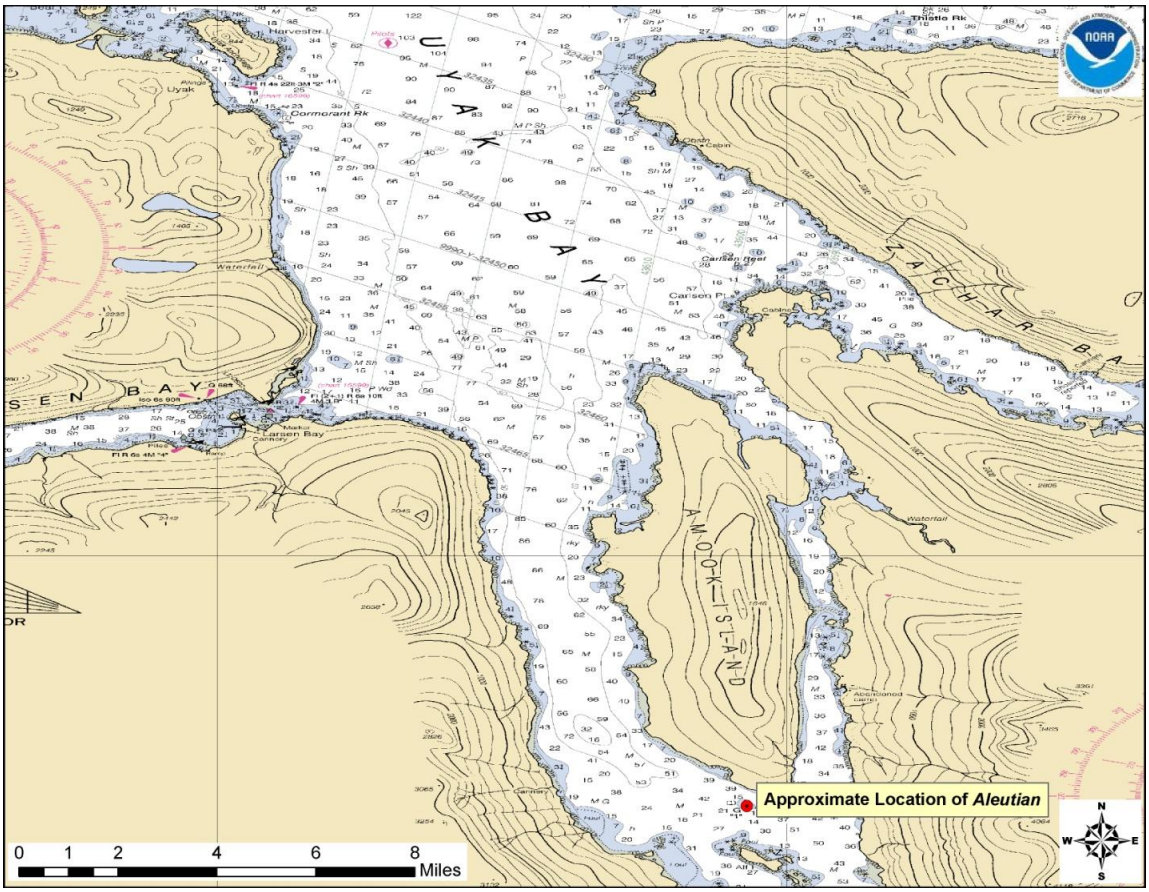


Chart Number: 16597

Casualty Narrative

"Seward Daily Gateway May 27, 1929
STEAMER *ALEUTIAN* SINKS UYAK BAY; ONE LIFE LOST
STEAMER SANK IN SEVEN MINUTES AFTER CRASHING INTO ROCK SUNDAY MORNING AT 5:30 A.M.—LIFE BOATS LAUNCHED IN RECORD TIME—NUMBER HAULED IN FROM WATER—MISS MILLER OF LATOUCHE NARROWLY ESCAPED: CLAD IN NIGHT DRESS AND COAT SHE WAS FORCED TO JUMP FROM RAIL—JANITOR WENT BACK TO STATEROOM TO SAVE A CHARM AND WAS NEVER SEEN SINCE
ALEUTIAN VALUED MILLION DOLLARS

Coast and Geodetic Survey steamer Surveyor, at anchor in Zacher Bay when received news of the disaster—rushed immediately to the scene and picked up survivors—administered medical attention to several, gave them hot food—due to arrive in Seward this afternoon. The graveyard of the Pacific, the North Pacific Ocean, claimed one more vessel yesterday when the SS *Aleutian* of the Alaska Steamship Company, making a special trip Westward from the local terminal port, struck a rock in mid-channel of Uyak Bay, sinking at 5:30 a.m. Captain Gus Nord, veteran skipper of the company, commanded the *Aleutian*. Only one life was lost, according to the meager reports which brought practically no details excepting the statement the steamer had sunk and the passengers and crew were aboard the Coast and Geodetic Survey vessel Surveyor, *Captain R.R. Lukens* and would arrive in Seward this afternoon. The

first message from Captain Lukens was to the effect he would bring his ship into port this morning. The second wire stated heavy weather would probably delay him and the arrival was set for this afternoon.

LATER DETAILS

The SS *Aleutian* struck a rock in mid-channel at the south end of Amook Island in Uyak Bay and was so badly damaged that she filled immediately, slid off into deep water, disappearing entirely in seven minutes. As she sank her stern rose high in the air and from her port holes, due to the air pressure within, towels, clothing, etc. shot out with great force. The spectacular and efficient work of officers and crew in landing the lifeboats prevented a great loss of life, it is reported, as the ship listed badly. Every boat was filled without the slightest confusion. All the people in the water were picked up by the small boats; also by a gas boat of some big game hunters nearby, the latter taking the women and four other passengers to their camp at Larson Bay from which point the disaster was broadcast.

SURVEYOR RUSHES SCENE

The Coast and Geodetic Survey vessel Surveyor, *Capt. R.R. Lukens*, was anchored in Zacher Bay and upon receipt of the wireless message rushed, full steam, to the scene and upon its arrival met the cannery tender *Raven* towing the lifeboats. All hands were taken aboard the Surveyor then proceeded to Larson Bay where the balance of the survivors were taken on board and sailed for Seward. The last report from Captain Lukens was to the effect he would bring his ship into port at 5:30 this afternoon.

JANITOR WAS LOST

The only life lost was that of Manuel Dorras, janitor. He was aroused in plenty of time but returned to his quarters to get a lucky charm—a stone—which he always carried. He never returned. One of the passengers, Miss Miller, of Latouche, barely escaped with only her night gown on and a coat hurriedly thrown over her shoulders, she had to jump from the rail into the water and was hauled into a small boat just as the ship went down.

A NARROW ESCAPE

On one of the life boats a painter became fouled but the quick work of Pilot Stimson in cutting it saved the boatload of people from being dragged down with the stricken *Aleutian*.

REMARKABLE WORK

Throughout the disaster, the discipline and coolness of the officers of the *Aleutian* is reported to have been extraordinarily remarkable. The work of getting the life boats away in less than seven minutes will forever stand, it was said, as a credit to American shipping. The *Aleutian* sank in deep water, her hull so badly shredded that it is doubtful she will ever be raised. The *Aleutian*'s crew numbered 114. Postmaster Charles Sheldon, of the Seward post office, reports there were seven pouches of mail matter lost. Claims may be put in for mail left at the post office up to last Friday night. Mr. Sheldon states all airmail was held in the local office.

SISTERSHIP TO YUKON

The *Aleutian* was built in Philadelphia in 1898 for the Ward Steamship lines and later sold to the U.S. Panama Railroad for $600,000 and renamed the Panama. The vessel was purchased by the Alaska Steamship Co. in 1927 and re-christened the *Aleutian*, a popular Alaskan name. The *Aleutian* was the sistership of the A.S.S. Co. steamer *Yukon*, which was likewise obtained from the Panama Railroad, having been operated under the name *Colon*.

FIVE PASSENGERS
Passengers out of Seward on the SS *Aleutian* numbered five, three of whom were Seward residents and two for Uganik. J.H. Flickinger, local agent for the A.S.S. Co., accompanied by Mrs. Flickinger, and Mrs. Charles C. Weybrecht, were aboard, the other two being John A. Johnson and Gus Wyman for Uganik. It is thought the latter two men had already been taken to their destination. A later report said Miss Miller of Latouche was also aboard.

MANY HAD TICKETS
According to the local office of the company about 50 reservations for the southbound voyage of the SS *Aleutian* had been sold. Practically all of these have been refunded and tickets purchased at the Pacific Steamship Co. office for transportation south on the Admiral Evans, now in port from the Westward, and which will depart for the south soon after the arrival this evening of the regular passenger train from the Interior."
-http://www.lostshipwrecks.com/archives/archival_docs/news_old/artcle_sdg_19290527.htm

General Notes

"Anchorage Daily Times May 28, 1929
BRAVERY AND EFFICIENCY OF LINER *ALEUTIAN* CREW AVERTED BIG DEATH TOLL
SURVIVORS OF DISASTER TO ALASKA LINE VESSEL REACH SEWARD ON U.S.S.
SURVEYOR AND SAIL SOUTH ON STEAMER ADMIRAL EVANS
LUKENS PRAISES NORD
MASTER OF SURVEYOR SAYS WORK OF LIFE-SAVING AT SEA MOST EFFICIENT EVER RECORDED

The liner *Aleutian*, the most palatial vessel in the service of the Alaska Steamship Co. sank in mid-channel at the south end of Amook Island in Uyak Bay seven minutes after striking a rock. Manual Dorris, janitor of the ship, was the only victim of the disaster. He lost his life when he went back to the sinking ship to obtain a lucky charm and was never seen again.

The vessel was so badly damaged that it filled quickly as it slid off the rock into deep water and completely disappeared. The efficient work of the officers and crew in launching the lifeboats prevented a great loss of life. The ship listed badly but the boats were launched and filled with people without confusion. As it sank the stern was thrown high in the air and the air pressure within the vessel caused towels, clothing, etc. to be shot through the portholes with great force.
All the people in the water were picked up by small boats and a gas-boat under charter to a nearby big game hunter took the women and four passengers to the cannery at Larson bay, from where news of the disaster was broadcast. The coast and geodetic survey vessel *Surveyor* was at anchor in Zachar bay and upon receipt of the news rushed immediately at full speed for the scene.

Upon its arrival it met the cannery tender *Raven* towing the lifeboats. All were taken aboard the *Surveyor* and given hot food and medical attention. Several sustained minor injuries. Picking up the remainder of the survivors at Larsen bay, the *Surveyor* left for Seward. Miss Miller of Latouche barely escaped when she jumped from the rail of the *Aleutian* clad only in a night dress and coat. She was hauled from the water just as the vessel went down. As the lifeboats were being launched painter became fouled in one of

them and only quick thinking on the part of Pilot Stimson in cutting away saved the same boat loaded with people. Captain Gus Nord of the *Aleutian* and the crew of 111 and the four passengers aboard the *Surveyor*, arrived in Seward to board the *Admiral Evans*, which was on the other side of the large island at the time of the sinking of the *Aleutian*. The coolness and efficiency of the officers and crew was demonstrated in their remarkable work of getting the boats away in less than seven minutes, and their work will stand as a credit to American shipping. The *Aleutian* is in deep water with its hull so badly shredded that raising it probably never will be possible. The Surveyor arrived here at 5:30 o'clock yesterday afternoon and the passengers and crew of the *Aleutian* sailed southward at 9 o'clock last night aboard the *Admiral Evans*. Captain Nord, master of the *Aleutian*, said: "Like Lindbergh, I have nothing to say, except that a fine vessel is lost. The boat is gone and that is all there is to it."
Captain Lukens, master of the *Surveyor*, speaking of Nord and his men, said: "It was the most efficient act of life-saving at sea I have ever heard of."

As the *Surveyor* docked, the victims started coming ashore, some with blankets thrown across their shoulders and the majority dressed as they were when they left the *Aleutian*. Captain S.K. Gill of the Admiral Evans extended every courtesy to the shipwrecked passengers and crew, and with the co-operation of the local quartermaster's department of the signal corps, which loaned cots and blankets, the *Aleutian* crew was made comfortable for the trip south. J.H. Flickinger, local agent for the Alaska Steamship Co., outfitted the crew with needed clothing, etc. A recheck showed 155 persons were aboard the *Aleutian* and that 115 of the crew land here. The others, aside from the passengers, were left at Larsen bay. The 110 tons of cargo lost consisted mostly of cannery supplies and three carloads of copper ore taken aboard at Cordova. The ship sank at 5:29 o'clock in the morning, not 5:30, Captain Lukens said. The ship apparently struck a pinnacle rock which could be located only by means of a drag line. He said the last time Uyak bay was charted was in 1917. Mrs. Charles Weybrecht of Seward, widow of Colonel Weybrecht, sustained minor injuries to her limbs as she slid to the rail of the *Aleutian* as it listed."
-http://www.lostshipwrecks.com/archives/archival_docs/news_old/artcle_adt_19290528.htm

Wreck Condition/Salvage History

"The sunken *ALEUTIAN* rests upright on the bottom in 220 feet of water. Depending on the state of tide, the top of the ship's superstructure rises to within 165 feet of the surface, and the tops of her twin masts are covered to a depth of 110 feet. Significant portions of superstructure—including the bridge, social hall, smoking room, and first class staterooms—are collapsed in a confusing tangle of debris. The lifeboat davits sit empty, the capstans and other deck equipment silent. Giant ling cod and black rockfish guard the staterooms and crew quarters.

Everyday artifacts of shipboard life lie everywhere: portholes, door hardware, light fixtures, and china emblazoned with the Alaska Steamship Company logo. White porcelain sinks from the *ALEUTIAN*'s staterooms reflect white under the glow of a diver's powerful light. Iron deck beams and rusting cargo hatch coamings drop away into the inky blackness of unexplored passages. Ghostly white metridium sea anemones blanket the masts, bow and stern of the ship where the powerful tidal currents of Uyak Bay sweep nutrient-rich water in an endless cycle of influx and outflow.

The *ALEUTIAN* is disintegrating under the unstoppable forces of time and saltwater corrosion, but the ship is remarkably intact and recognizable, considering the violence of her sinking and the decades she

has lain underwater. Her resting place is an unforgiving environment that can be visited only by experienced deep-wreck scuba divers with the training and equipment necessary to conduct their dives safely and responsibly."
-http://www.dive*Aleutian*.com/frozen.htm

"The S.S. *ALEUTIAN* sits upright in water that is 220 feet deep. Both the fore and aft masts are still standing, and both are blanketed in enormous white metridium anemones. There are two permanent moorings on the wreck, one at the extreme aft of the lifeboat deck, and one on the forward lifeboat davit on the starboard side.

Depending upon the state of the tide, you will often see the ghostly outline of one of the masts rising from the murk as you descend past 80 feet. The tops of the masts are about 110 feet deep. As you continue down the mooring line, the mast will fade away into the gloom and the ambient light will grow increasingly dim. You will arrive at the mooring point at a depth of around 165 to 175 feet.

After checking your gas and your equipment, you can begin your tour of this ghostly vessel that lay undiscovered and unexplored for more than 70 years. Schools of cod and rockfish school around the wreck, and will swim up to investigate the strange visitor to their silent underwater world. If your tour takes you to the bow or stern of the *ALEUTIAN*, you will encounter dense colonies of white anemones that thrive in the nutrient-rich tidal currents of Uyak Bay.

With a maximum depth of 190 feet, most dive profiles will give you between 15 and 20 minutes of bottom time before you begin your ascent. There is surface-supplied oxygen for use during decompression beginning at 20 feet, and most divers using an air computer choose to breathe the 100% oxygen as a safety factor, while continuing to decompress according to the air schedule."
-http://www.diveAleutian.com/Aleutian.htm

Mr. Steve Lloyd has stated that upon a revisit to the site in July of 2012 he documented additional degradation in the physical integrity of the wreck since he'd last been on the site in 2004. He states he has been on the site 50 times over a 10-year period. He has extensive video from that visit, and he put together a 10 minute video on the history and recent. The video shows oil in the overhead bulkheads and significant deck and hull degradation. He also has plans and schematics for the vessel (pers. comm. 12/2012).

The state of Alaska and Mr. Lloyd are parties to a 2005 settlement that requires an environmental risk assessment of the site prior to any additional commercial activities at the site.

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

Because records relating to the loss of this vessel were not part of the National Archives record groups examined by NOAA archaeologists there is little additional historic documentation on the sinking of *Aleutian* that can be provided on top of the casualty narrative included in this packet and readily accessible online.

We do know from sinking reports available online that there was some oil reported on the water at the time the vessel was lost, and we know from diver reports that some oil is still trapped by the ceilings in the cabins and hallways of the shipwreck. Unfortunately, based on the descriptions available, it is not possible to determine with any degree of accuracy how much oil remains inside the wreck. The best information we have been able to obtain comes from a local diver named Steve Lloyd who has concerns about the oil on the wreck and was willing to provide NOAA with the following information.

"In late 2007 I applied to Alaska Sea Grant for funding to conduct a preliminary oil survey of the *Aleutian*. Our proposal was not selected for funding, and I did not reapply. The attached Sea Grant proposal will give you an overview of the ship's history, its sinking, and what we believe to be some of the environmental risks of the site. I will provide additional information below.

> I'm sure you are familiar with the S.S. *Jacob Luckenbach* off San Francisco and the S.S. *Princess Kathleen* near Juneau. In 2002, divers removed approximately 100,000 gallons of bunker oil from the Luckenbach wreck. In 2010, a reported 123,575 gallons of oil and other petroleum products were recovered from the Kathleen wreck.
>
> I dived on both those wrecks several times prior to their remediation. Based on my observations underwater, the *Aleutian* poses at least as great a risk for a sudden, uncontrolled release of bunker oil as did either of those shipwrecks.
>
> The attached report on the *Luckenbach* may interest you, if you don't have it already.

My research on the *Aleutian* has not turned up a set of deck plans. The Alaska Steamship Co. archives at the University of Alaska Fairbanks has plans for some of their ships, but not the *Aleutian*. Likewise for the ship plans collection at the Puget Sound Maritime Historical Society in Seattle. The closest I have been able to come are the attached images of the *Aleutian*'s sister ship, the S.S. *Yukon*. The two vessels were constructed just a year apart at the same yard, according to the same design. Although there were some superficial differences relating to the way both ships were remodeled when moved from Cuba to Pacific Northwest service in the 1920s, their mechanical details should be nearly identical.

The blueprints included here are from the Alaska State Library archives in Juneau. Their file reference (or finding aid number) is "PCA 44-14 246". According to the *Yukon* plans, the *Aleutian* had four fuel tanks with a total capacity of 7,000 bbl (or 294,000 gallons) of bunker oil for use by the ship's boilers.

Both the *Aleutian* and the *Yukon* also carried lubricating oil, although the location and capacity of these oil tanks is not shown on the plan.

I have information about the quantity of lubricating oil used by the *Aleutian*: 2,275 gallons in 1927; 3,419 gallons in 1928; and 994 gallons in 1929 from the beginning of the year until her sinking on May 26 of that year. By comparison, the *Yukon* consumed approximately 85 gallons of lubricating oil for every 1,000 nautical miles traveled. Based on these figures, I estimate the *Aleutian* may have carried 500 to 1,000 gallons of lubricating oil in addition to her bunker fuel.

I have a note that the *Yukon* carried "30,000 gallons of fish oil in a separate tank". I'm not sure if that means there was an extra tank for carrying oil as cargo—distinct from oil used by the vessel—or if the term "fish oil" refers to the ship's supply of lubricating oil (although 30,000 gallons seems like far more than would need to be carried, based on a consumption rate of just 85 gallons per 1,000 miles of travel).

In my opinion, and based on what I've seen on the wreck, the biggest concern for possible oil release on the *Aleutian* relates to the bunker fuel that remains on board. I've learned that the total amount of bunker oil used by the *Aleutian* was 35,650 bbl in 1927; 54,229 bbl in 1928; and 15,745 bbl in 1929 from the first of that year until her next-to-last voyage. I say "next-to-last" because I know these figures do not include fuel consumed on her final voyage, since no bridge or engine room logs were saved before the ship went down.

Although daily fuel usage statistics for the *Aleutian* are not available, my research uncovered a record of average daily fuel use by her sister ship, the *Yukon*.

Between 1927 and 1929, the *Yukon* consumed an average of 335 bbl (14,070 gallons) of oil every 24 hours while underway at sea, and 71 bbl (2,982 gallons) every 24 hours while at port, loading and unloading.

It is unknown has much fuel was aboard the *Aleutian* when she sank, but we can make some reasonable estimates.

The average quantity of fuel used by *Yukon* during 1927, '28 and '29 was .961 barrel (or 40.36 gallons) of oil for each nautical mile of travel. Let's assume the *Aleutian* used an equivalent amount, and that her tanks were filled when she left Seattle. The distance from Seattle to Seward via the outside route is 1,234 nautical miles. Seward to Uyak Bay on Kodiak Island is 228 miles. That's a total of 1,462 nautical miles which would have burned approximately 1,405 bbl (59,009 gallons) of fuel, not counting any fuel used while at port.

By those calculations, the *Aleutian* may have had as much as 5,595 bbl (234,990 gallons) of bunker fuel on board when she went down. That is as much as the total fuel recovered from the *Jacob Luckenbach* and *Princess Kathleen* wrecks, combined.

Hours after the sinking, the *Aleutian*'s captain reported a "sheen" of oil on the surface. He does not say how extensive the oil was, and there is no information about whether oil continued to be released in the days and weeks after the *Aleutian* went down.

During our exploratory dives on the *Aleutian* between 2002 and 2004, the greatest concentration of leaking oil was encountered inside the pantry on the starboard side, just aft of the dining room. This compartment is directly above the No. 3 cargo hold, which in turn is directly above the starboard fuel oil tank. The pantry floor has a small hatch, with a ladder that provided access to the cool storage rooms in the No. 3 hold. My theory is that oil has leaked from the *Aleutian*'s two main tanks—with a capacity of 2,750 bbl each—and pooled at the ceiling of the No. 3 hold. From there, it has found its way through the hatch in the pantry floor, and pooled along the ceiling of the pantry and (probably) the adjacent galley amidships.

Originally, the *Aleutian* had public rooms on the two decks immediately above the pantry, galley and dining room. These are visible on the attached deck plans, labeled "Writing Room" on the Upper Deck and "Social Hall" and "Observation Room" on the Boat Deck. Above the Observation Room were the wheelhouse and chart room, which are not shown on the attached public deck plan, since these areas were restricted to crew members.

In the eight decades since the *Aleutian* sank, the three uppermost levels of the ship's superstructure have collapsed. The floor of the wheelhouse (which is the ceiling of the Observation Room) has collapsed and compacted into what was the Writing Room. The floor of the Writing Room (which is the ceiling of the pantry and dining room) was still intact when I last dived the wreck in 2004. My distinct impression is that this portion of the structure will be the next area to give way as the wreck continues to collapse and compact. When it does, the oil pooled in the overhead of the pantry/galley areas will be released. When the structural collapse progresses to the point that the No. 3 cargo hold overhead bulkhead is compromised, the oil that has accumulated there will release as well.

As I've pointed out, there is no way to know for sure how much oil the *Aleutian* carried when she sank. However, the details of the ship's construction as shown on the attached plan and elevation

views, coupled with my underwater observations about the compromised structure of that portion of the vessel situated above the fuel oil tanks, suggest that an oil release of unknown quantity and severity is a probable event.

The *Jacob Luckenbach* oil was removed 50 years after the ship sank. The *Princess Kathleen* had been underwater 57 years when its oil was extracted. The *Aleutian* has been on the bottom for 83 years."

Should the vessel be assessed, it should be noted that this vessel is of historic significance and will require appropriate actions be taken under the National Historic Preservation Act (NHPA) prior to any actions that could impact the integrity of the vessel. This vessel is also on the National Register of Historic Places. The site is also considered a gravesite and appropriate actions should be undertaken to minimize disturbance to the site. Steve Lloyd completed several dives during the summer of 2012 and collected high resolution video and photographs of the site and is more than willing to provide this information to the U.S. Coast Guard beyond what is mentioned above. He can be reached at (907) 441-2815, SteveL@wavebooks.com.

Background Information References

Vessel Image Sources:
http://www.lostshipwrecks.com/archives/archival_docs/blueprints/x*Aleutian*_underway.jpg

Construction Diagrams or Plans in RULET Database? No

Text References:

-http://www.dive*Aleutian*.com/museum/gallery/drawing.php
-http://www.lostshipwrecks.com/archives/archival_docs/archival_docs.htm

Vessel Risk Factors

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

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

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

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.

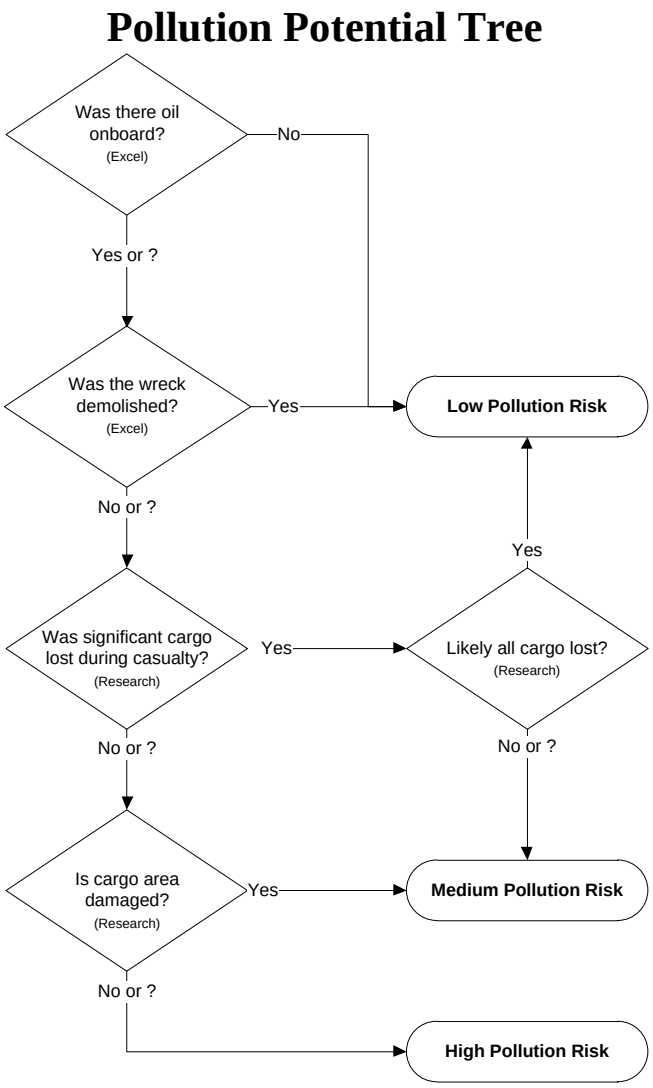


Figure 1-1: U.S. Coast Guard Salvage Engineering Response Team (SERT) developed the above Pollution Potential Decision Tree.

- **Low Data Quality:** Significant issues exist with missing data on wreck that precludes making preliminary risk assessment, and/or the data quality is suspect. Significant additional research needed.

In the following sections, the definition of low, medium, and high for each risk factor is provided. Also, the classification for the *Aleutian* 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 *Aleutian i*s ranked as High Volume because it is thought to have a potential for up to 5,595 bbl (based on calculations made by a local diver), although some of that was lost at the time of the casualty. 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 *Aleutian*, but local divers report that oil can be seen in the overheads of the hallways and cabins.

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 *Aleutian* is classified as High Risk because the bunker oil is heavy fuel oil, a Group IV oil type. Data quality is high.

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

Was the wreck demolished?

Risk Factor B: Wreck Clearance

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

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

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

Is the cargo area damaged?

Risk Factor D1: Nature of the Casualty

This risk factor addresses the means by which the vessel sank. The risk associated with each type of casualty is determined by 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 *Aleutian* is classified as Medium Risk because it struck a rock pinnacle and sank. 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 *Aleutian* is classified as High Risk because it is not broken into sections and remains as one contiguous piece. 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 *Aleutian* 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 *Aleutian* is 220 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 *Aleutian* is a popular technical dive site. Data quality is high.

Other Hazardous (Non-Oil) Cargo on Board

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

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

Munitions on Board

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

The *Aleutian* did not carry munitions. Data quality is high.

Vessel Pollution Potential Summary

Table 1-1 summarizes the risk factor scores for the pollution potential and mitigating factors that would reduce the pollution potential for the *Aleutian.* Operational factors are listed but do not have a risk score.

Table 1-1: Summary matrix for the vessel risk factors for the *Aleutian* 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 5,595 bbl, not reported to be leaking	**Med**
	A2: Oil Type	High	Bunker oil is heavy fuel oil, a Group IV oil type	
	B: Wreck Clearance	High	Vessel not reported as cleared	
	C1: Burning of the Ship	High	No fire was reported	
	C2: Oil on Water	High	Oil was reported on the water; amount is not known	
	D1: Nature of Casualty	High	Ran aground on a rock pinnacle	
	D2: Structural Breakup	High	The vessel remains as one contiguous piece	
Archaeological Assessment	Archaeological Assessment	High	An accurate archaeological analysis could not be generated, but information provided to NOAA archaeologists by local divers is believed to be very accurate	**Not Scored**
Operational Factors	Wreck Orientation	High	Upright	**Not Scored**
	Depth	High	220 ft	
	Visual or Remote Sensing Confirmation of Site Condition	High	The site is a popular technical dive site	
	Other Hazardous Materials Onboard	High	None	
	Munitions Onboard	High	None	
	Gravesite (Civilian/Military)	High	Yes	
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA	

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 *Aleutian* this would be about 6,000 bbl (rounded up from 5,595 bbl) based on current estimates of the amount of oil remaining onboard the wreck.

The likeliest scenario of oil release from most sunken wrecks, including the *Aleutian*, 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 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 *Aleutian*.

Scenario Type	Release per Episode	Time Period	Release Rate	Relative Likelihood	Response Tier
Chronic (0.1% of WCD)	6 bbl	Fairly regular intervals or constant	100 bbl over several days	More likely	Tier 1
Episodic (1% of WCD)	60 bbl	Irregular intervals	Over several hours or days	Most Probable	Tier 1-2
Most Probable (10% of WCD)	600 bbl	One-time release	Over several hours or days	Most Probable	Tier 2
Large (50% of WCD)	3,000 bbl	One-time release	Over several hours or days	Less likely	Tier 2-3
Worst Case	6,000 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 *Aleutian* contained a maximum of 5,595 bbl of heavy fuel oil as bunker fuel (a Group IV oil). Thus, the oil spill model was run using heavy fuel oil.

Oil Thickness Thresholds

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

For oil stranded onshore, a thickness of 1 g/m^2 was used as the threshold for socio-economic impacts because that amount of oil would conservatively trigger the need for shoreline cleanup on amenity

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

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

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

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

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

Potential Impacts to the Water Column

Impacts to the water column from an oil release from the *Aleutian* 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.

[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.

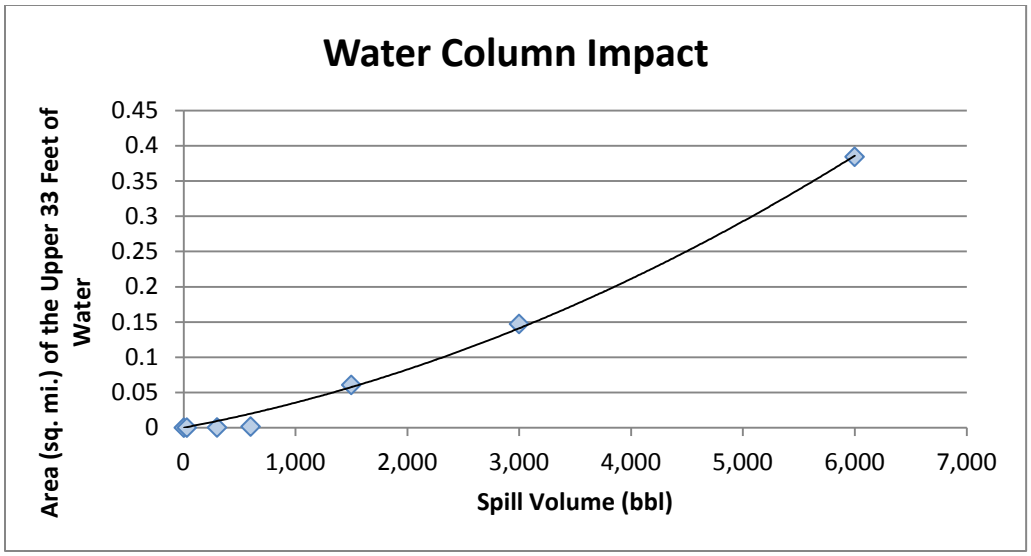


Figure 2-1: Regression curve for estimating the volume of water column at or above 1 ppb aromatics impacted as a function of spill volume for the *Aleutian*.

Potential Water Surface Slick

The slick size from an oil release from the *Aleutian* will be determined by the volume of leakage is a function of the quantity released. The estimated water surface coverage by a fresh slick (the total water surface area "swept" by oil over time) for the various scenarios is shown in Table 2-3, as the mean result of the 200 model runs. Note that this is an estimate of total water surface affected over a 30-day period. In the model, the representative heavy fuel oil used for this analysis spreads to a minimum thickness of approximately 975 g/m^2, and is not able to spread any thinner. As a result, water surface oiling results are identical for the 0.01 and 10 g/m^2 thresholds. The slick will not be continuous but patchy due to the subsurface release. Surface expression is likely to be in the form of sheens, tarballs, and streamers.

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

Scenario Type	Oil Volume (bbl)	Estimated Slick Area Swept Mean of All Models	
		0.01 g/m^2	10 g/m^2
Chronic	6[3]	0 mi^2	0 mi^2
Episodic	60[3]	0 mi^2	0 mi^2
Most Probable	600	7 mi^2	7 mi^2
Large	3,000	52 mi^2	52 mi^2
Worst Case Discharge	6,000	147 mi^2	147 mi^2

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

[3] The volume of this vessel was revised after environmental modeling was completed; as a result, models were not run for the release volumes of 6 and 60 bbl. The results presented for these two volumes are estimated based on the regression analysis of the five volumes that were modeled (6,000, 3,000, 600, 30, and 3 bbl).

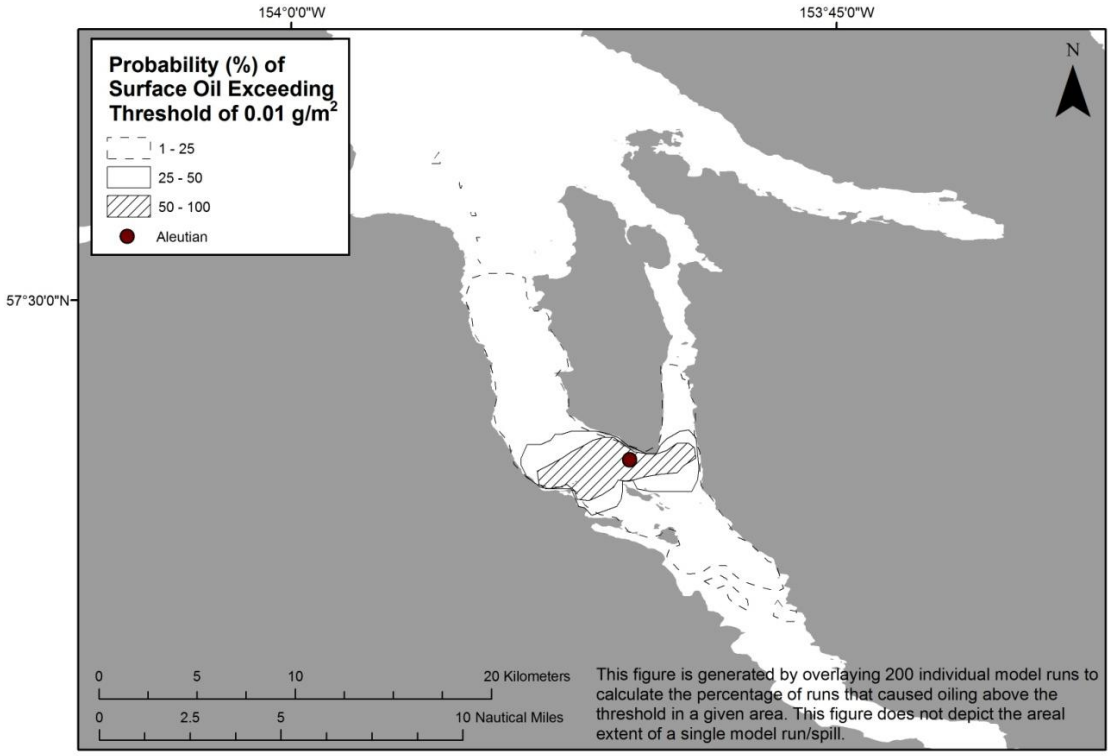


Figure 2-2: Probability of surface oil (exceeding 0.01 g/m^2) from the Most Probable spill of 600 bbl of heavy fuel oil from the *Aleutian* at the threshold for socio-economic resources at risk.

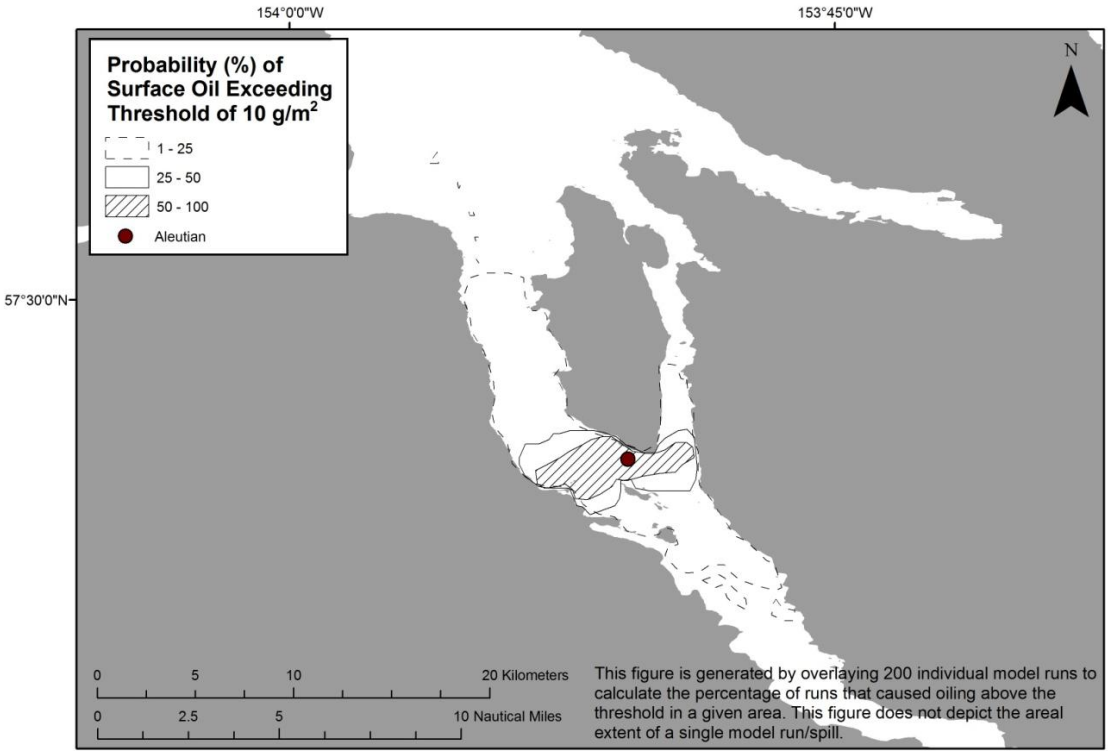


Figure 2-3: Probability of surface oil (exceeding 10 g/m^2) from the Most Probable spill of 600 bbl of heavy fuel oil from the *Aleutian* at the threshold for ecological resources at risk.

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

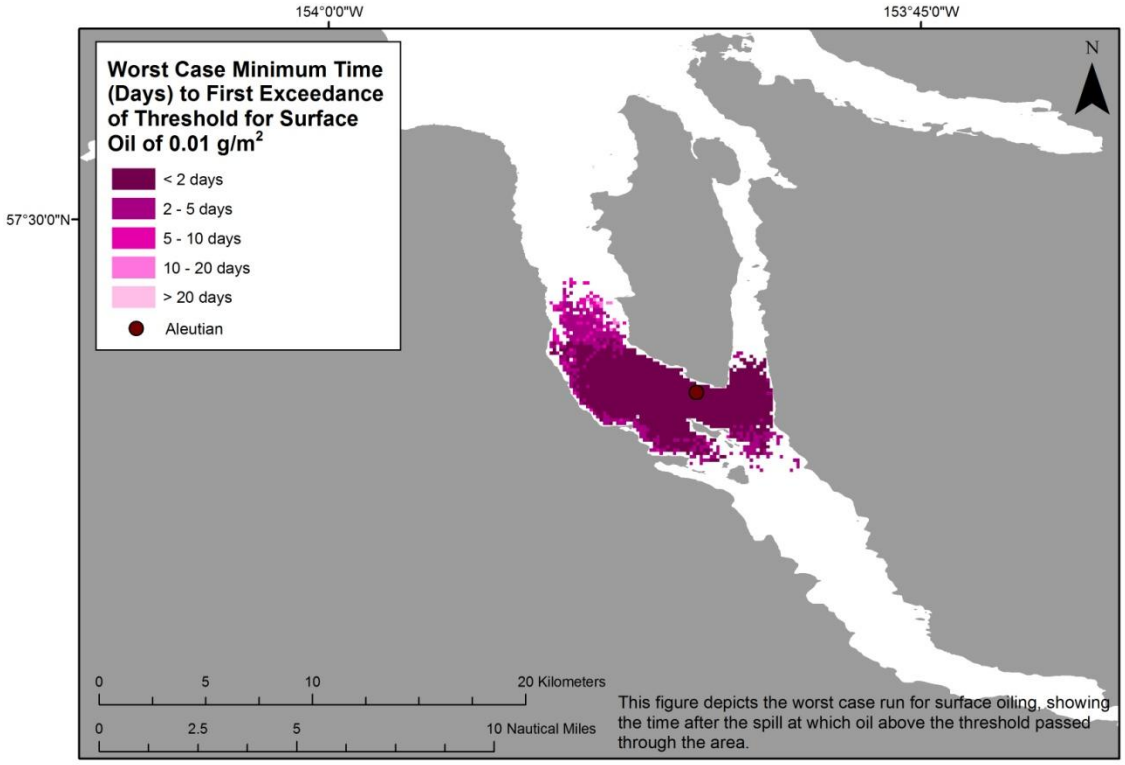


Figure 2-4: Water surface oiling from the Most Probable spill of 600 bbl of heavy fuel oil from the *Aleutian* shown as the area over which the oil spreads at different time intervals.

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

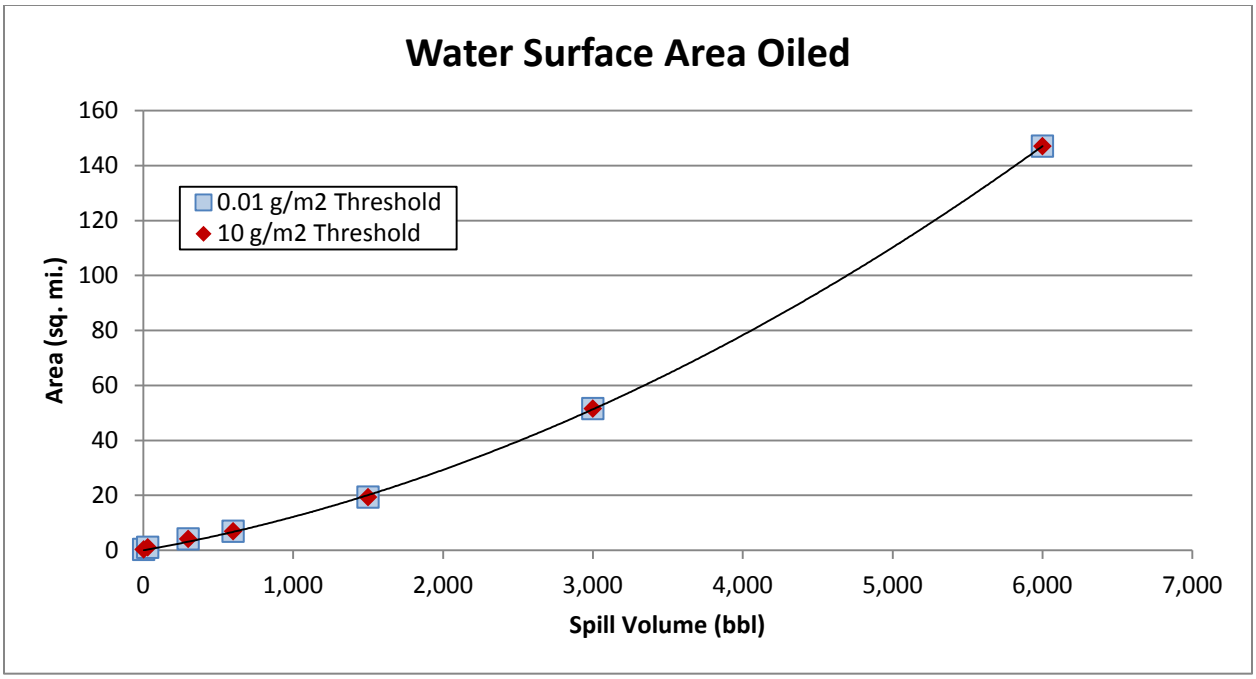


Figure 2-5: Regression curve for estimating the amount of water surface oiling as a function of spill volume for the *Aleutian*, showing both the ecological threshold of 10 g/m^2 and socio-economic threshold of 0.01 g/m^2. The curves are so similar that they plot on top of each other.

Potential Shoreline Impacts

Based on these modeling results, shorelines along Uyak Bay 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 600 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 *Aleutian*.

Scenario Type	Volume (bbl)	Estimated Miles of Shoreline Oiling Above 1 g/m^2			
		Rock/Gravel/Artificial	Sand	Wetland/Mudflat	Total
Chronic	6[4]	1	0	0	1
Episodic	60[4]	2	0	0	2
Most Probable	600	3	0	0	3
Large	3,000	7	0	0	7
Worst Case Discharge	6,000	10	0	0	10

[4] The volume of this vessel was revised after environmental modeling was completed; as a result, models were not run for the release volumes of 6 and 60 bbl. The results presented for these two volumes are estimated based on the regression analysis of the five volumes that were modeled (6,000, 3,000, 600, 30, and 3 bbl).

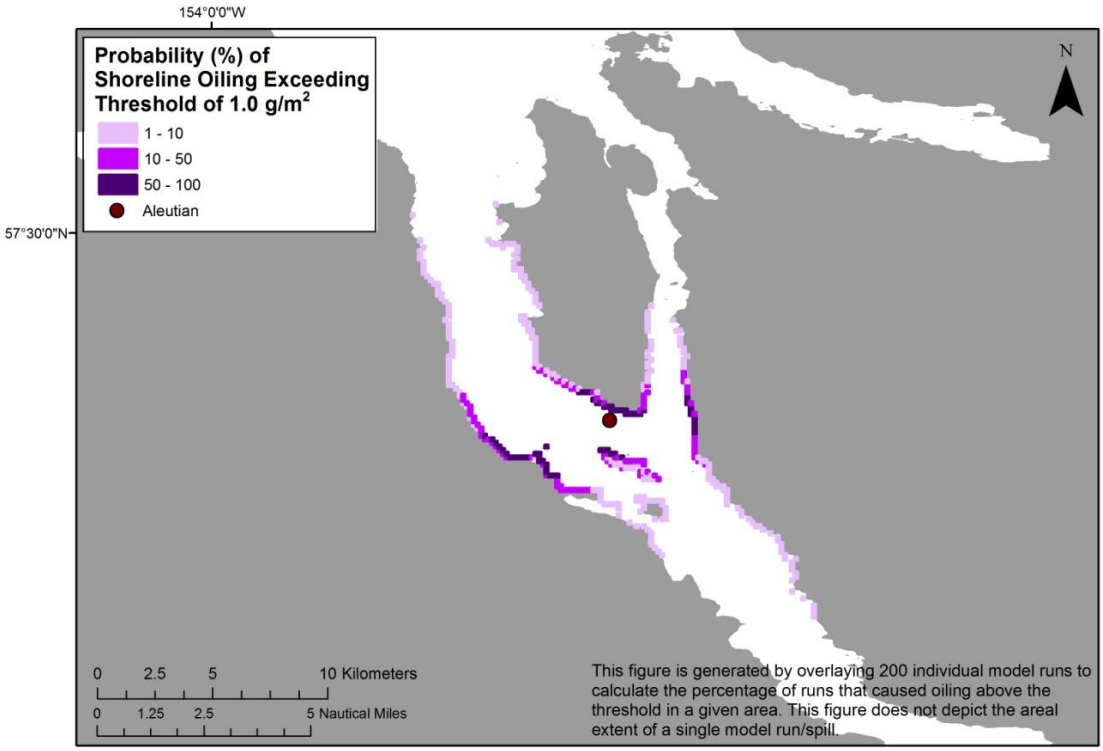


Figure 2-6: Probability of shoreline oiling (exceeding 1.0 g/m^2) from the Most Probable Discharge of 600 bbl of heavy fuel oil from the *Aleutian*.

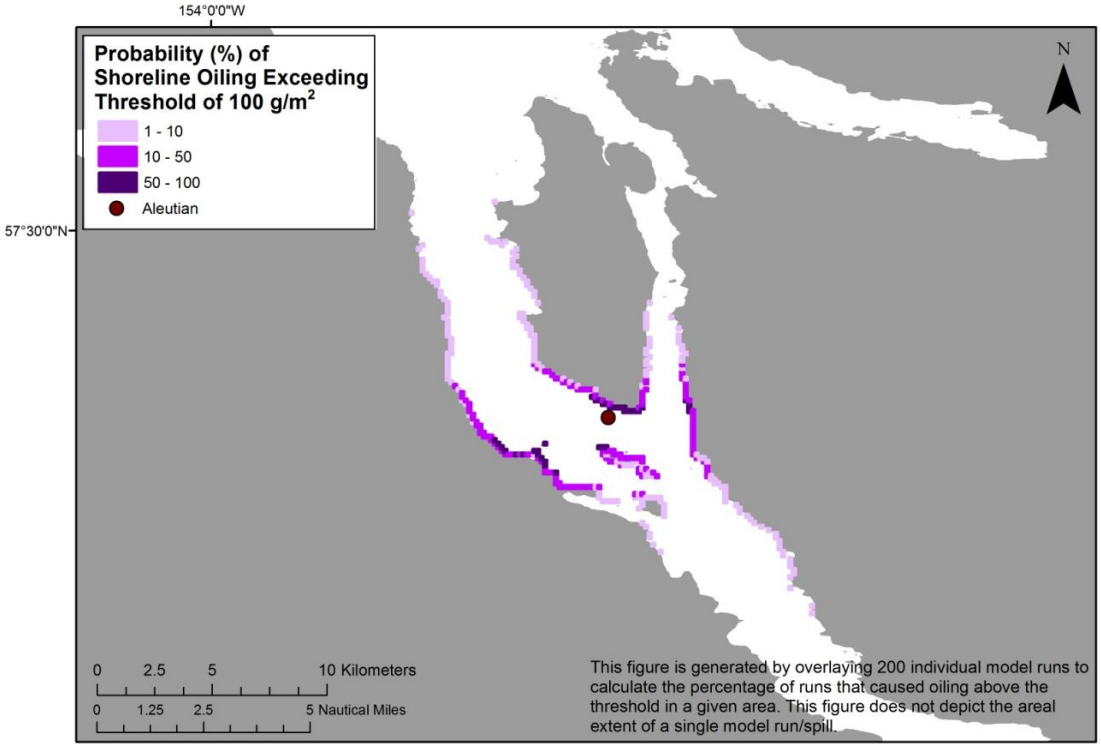


Figure 2-7: The extent and degree of shoreline oiling from the single model run of the Most Probable Discharge of 600 bbl of heavy fuel oil from the *Aleutian* that resulted in the greatest shoreline oiling.

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.

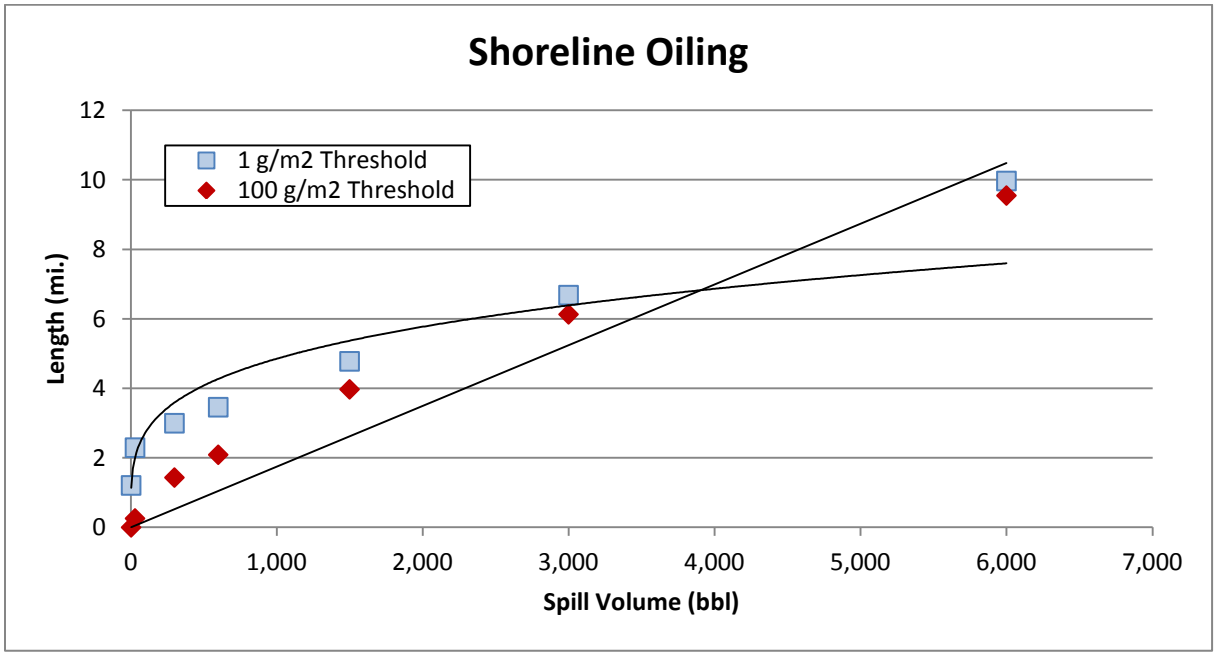


Figure 2-8: Regression curve for estimating the amount of shoreline oiling at different thresholds as a function of spill volume for the *Aleutian*.

The worst case scenario for shoreline exposure along the potentially impacted area for the WCD volume (Table 2-5) and the Most Probable volume (Table 2-6) consists of sheltered rocky shores and gravel beaches.

Table 2-5: Worst case scenario shoreline impact by habitat type and oil thickness for a leakage of 6,000 bbl from the *Aleutian*.

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	15 miles	14 miles
Sand beaches	0 miles	0 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 600 bbl from the *Aleutian*.

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

SECTION 3: ECOLOGICAL RESOURCES AT RISK

Ecological resources at risk from a catastrophic release of oil from the *Aleutian* (Table 3-1) include nesting colonial shorebirds and overwintering sea ducks foraging in inshore waters. Sea otters, harbor seals and sea lions commonly forage in the area of impact. Commercial and recreational fisheries for salmon, groundfish and forage fish can also be found in the region.

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

Species Group	Species Subgroup and Geography	Seasonal Presence
Birds	Colonial nesting birds include black-legged kittiwake, glaucous-winged gull, horned and tufted puffins, and pelagic and red-faced cormorants • 3 colonies present in area of impact: 1 large (>1,000) and 2 smaller (<1,000) • Bald eagle nests common in forested areas along the shorelines • Marbled murrelet (FT) nests in nearshore areas and forages in inshore waters Wintering migrants include 12 species of sea duck: common eider, king eider, Steller's eider, black scoter, white-winged scoter, surf scoter, Barrow's goldeneye, common goldeneye, bufflehead, long-tailed duck, harlequin duck, common merganser, and red-breasted merganser • Areas of high concentration present in Uyak Bay • Harlequin duck, Barrow's goldeneye, black scoter, common eider, and common and red-breasted mergansers nest in the region • Other water birds abundant in winter include pelagic cormorant, common murre, glaucous-winged gull, greater scaup, mallard, and black oystercatcher	Colonial seabirds nest spring-fall Waterfowl and sea ducks present in high concentrations in winter Sea ducks nesting during summer Bald eagle nests spring-summer
Mammals	Kodiak brown bear commonly forage in inshore waters in summer months *Pinnipeds and otters* • Steller sea lion (FE) haul-out is present along Shelikof strait; Uyak Sound is part of the Shelikof Strait foraging area critical habitat (for ~212 individuals) • Harbor seal common in area of impact • Sea otter (FT) common in inshore waters • Northern elephant seal and northern fur seal could also occur in the area of impact, but are not common *Cetaceans* • Dall's porpoise, harbor porpoise common in area of impact • Gray, fin (FE), and humpback (FE) whales can be found foraging in Shelikof Strait during migration periods	Bears present spring-fall, hibernate Nov-Mar Harbor seals pup Jun-Aug Gray whales Apr-May Humpbacks summer
Fish and Invertebrates	*Anadromous* • Chinook, sockeye, coho, pink, chum salmon and some char species occur in the area • Juveniles use inshore areas as nursery habitat once they emigrate from freshwater streams *Intertidal* • Pacific herring aggregate and spawn in nearshore areas • Sand lance spawn on coarse sand/gravel beaches *Demersal* • Tanner crab, dungeness crab, giant Pacific octopus, and red sea cucumber are	Juvenile anadromous fish move downstream in the spring Herring spawn in the spring-summer Sand lance spawn late Aug-Oct

Species Group	Species Subgroup and Geography	Seasonal Presence
	commercially harvested in Uyak Bay • Black rockfish and Pacific cod make up the bulk of the commercial fishery • Nearshore demersal fish community is dominated by Pacific cod, pricklebacks, gunnels, greenlings, and sculpins	
Benthic Habitats	Rockweed, kelp common along rocky shorelines Very small amount of eelgrass present in the area of impact	Year round

The Environmental Sensitivity Index (ESI) atlases for the potentially impacted coastal areas in the U.S. from a leak from the *Aleutian* 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 *Aleutian* is provided, both as text and as shading of the applicable degree of risk bullet, for the WCD release of 6,000 bbl and a border around the Most Probable release of 600 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 *Aleutian* is classified as High Risk for oiling probability for water column ecological resources for the WCD of 6,000 bbl because 98% 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 0.4 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 600 bbl, the *Aleutian* is classified as Low Risk for oiling probability for water column ecological resources because 0% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated was 0 mi^2 of the upper 33 feet of the water column.

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 *Aleutian* is classified as Low Risk for oiling probability for water surface ecological resources for the WCD 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 classified as Low Risk for degree of oiling because the mean area of water contaminated was 147 mi^2. The *Aleutian* 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 classified as Low Risk for degree of oiling because the mean area of water contaminated was 7 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 *Aleutian* is classified as High Risk for oiling probability for shoreline ecological resources for the WCD because 100% of the model runs resulted in shorelines affected above the threshold of 100 g/m^2. It is classified as Medium Risk for degree of oiling because the mean weighted length of shoreline contaminated was 19 miles. The *Aleutian* is classified as High Risk for oiling probability to shoreline ecological resources for the Most Probable Discharge because 100% 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 4 miles.

Considering the modeled risk scores and the ecological resources at risk, the ecological risk from potential releases of the WCD of 6,000 bbl of heavy fuel oil from the *Aleutian* is summarized as listed below and indicated in the far-right column in Table 3-2:

- Water column resources – Medium, because of the use of nearshore waters as aggregation, spawning, and nursery habitat for salmon, herring, and sand lance, among other species
- Water surface resources – Medium, because of nesting colonies with up to thousands of birds are in the area of impact, the bay is important wintering/migratory area of many sea ducks, and the area is used by marine mammals, including sea otters who are highly sensitive to oil exposure
- Shoreline resources – Medium, because oil persistence and effects are higher along sheltered, rocky shores, which are also foraging habitat for many birds and adjacent to herring spawning habitat

Table 3-2: Ecological risk scores for the **Worst Case Discharge of 6,000 bbl** of heavy fuel oil from the *Aleutian*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	Low	Medium	High	98% 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 0.4 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	Med
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	Medium	High	The mean area of water contaminated above 10 g/m^2 was 147 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	Low	Medium	High	100% of the model runs resulted in shoreline oiling of 100 g/m^2	Med
3C-2: Shoreline Degree EcoRAR Oiling	Low	**Medium**	High	The length of shoreline contaminated by at least 100 g/m^2 was 19 mi	

For the Most Probable Discharge of 600 bbl, the ecological risk from potential releases of heavy fuel oil from the *Aleutian* is summarized as listed below and indicated in the far-right column in Table 3-3:

- Water column resources – Low, because of the likely smaller volume of water column impacts
- Water surface resources – Medium, because of nesting colonies with up to thousands of birds are in the area of impact, the bay is important wintering/migratory area of many sea ducks, and the area is used by marine mammals, including sea otters who are highly sensitive to oil exposure
- Shoreline resources – Low, because of the limited extent of shoreline impact

Table 3-3: Ecological Risk Score for the **Most Probable Discharge of 600 bbl** of heavy fuel oil from the *Aleutian*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
3A-1: Water Column Probability EcoRAR Oiling	**Low**	**Medium**	**High**	0% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	**Low**
3A-2: Water Column Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean volume of water contaminated above 1 ppb was 0 mi^2 of the upper 33 feet of the water column	
3B-1: Water Surface Probability EcoRAR Oiling	**Low**	**Medium**	**High**	0% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 10 g/m^2	**Med**
3B-2: Water Surface Degree EcoRAR Oiling	**Low**	**Medium**	**High**	The mean area of water contaminated above 10 g/m^2 was 7 mi^2	
3C-1: Shoreline Probability EcoRAR Oiling	**Low**	**Medium**	**High**	100% 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 4 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 *Aleutian* include the native village of Larsen Bay and the Kodiak National Wildlife Refuge.

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 *Aleutian* 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 *Aleutian*.

Resource Type	Resource Name	Economic Activities
Tribal Land	Larsen Bay Native Village/Tribal Council	This area of Kodiak Island includes the Larsen Bay Native Village, which has a population of 89.
National Wildlife Refuge	Kodiak NWR	There is one national wildlife refuge in this part of Kodiak Island.

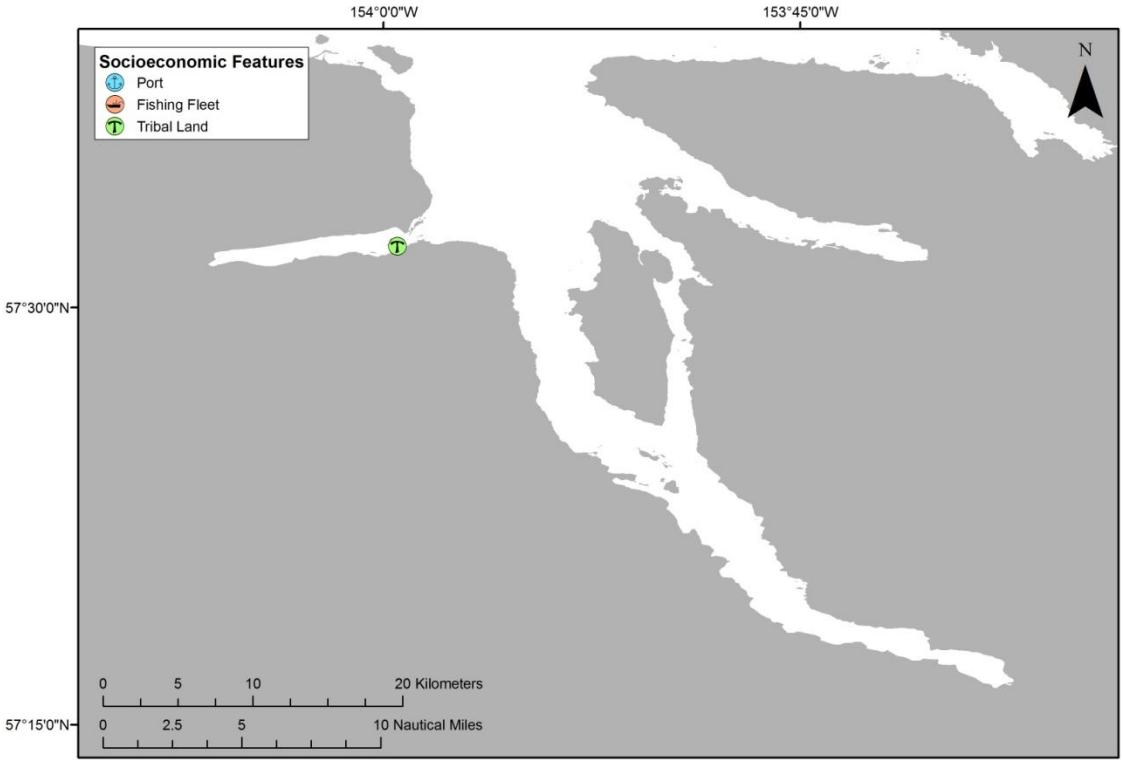


Figure 4-1: Tribal lands, ports, and commercial fishing fleets at risk from a release from the *Aleutian*.

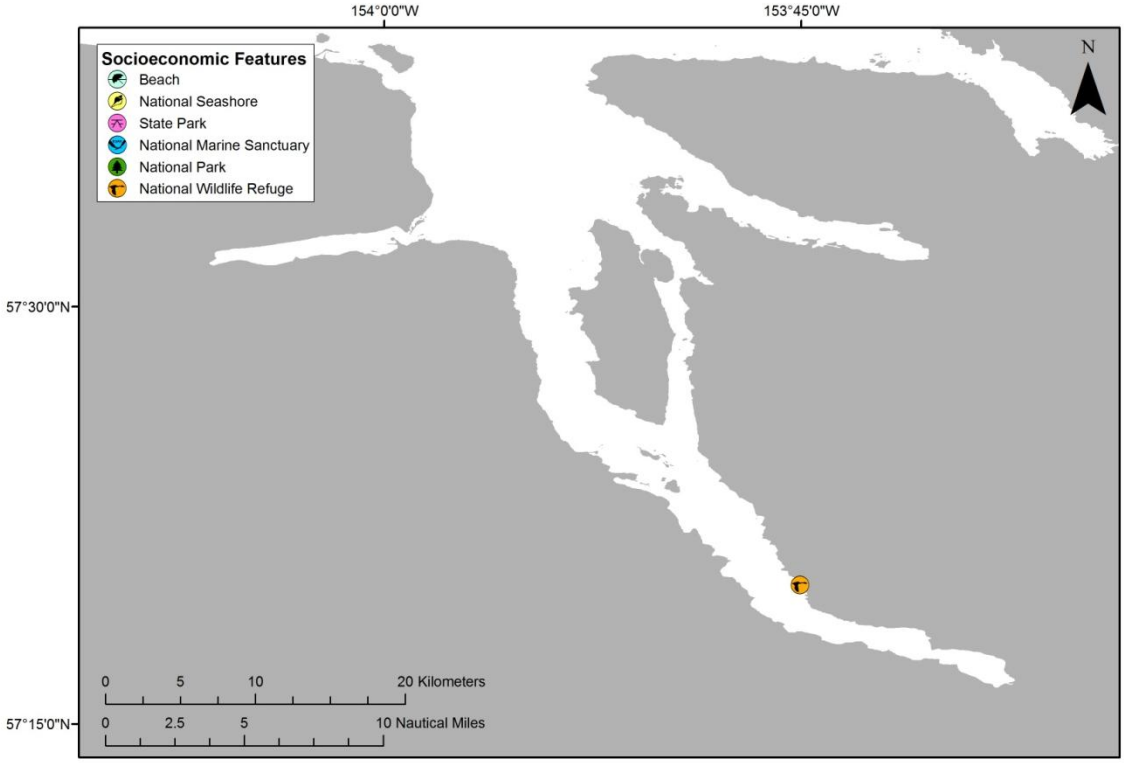


Figure 4-2: Beaches, coastal state parks, and Federal protected areas at risk from a release from the *Aleutian*.

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 is to be any 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 for which there are 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).

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 *Aleutian*, shading indicates the degree of risk for a WCD release of 6,000 bbl and a border indicates degree of risk for the Most Probable Discharge of 600 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 *Aleutian* 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 6,000 bbl because 98% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics, and the mean volume of water contaminated was 0.4 mi^2 of the upper 33 feet of the water column. For the Most Probable Discharge of 600 bbl, the *Aleutian* is classified as Low Risk for oiling probability for water column socio-economic resources because 0% of the model runs resulted in contamination of more than 0.2 mi^2 of the upper 33 feet of the water column above the threshold of 1 ppb aromatics. It is classified as Low Risk for degree of oiling because the mean volume of water contaminated 0 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 *Aleutian* is classified as Low Risk for both oiling probability and degree of oiling for water surface socio-economic resources for the WCD because 0% 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 147 mi^2. The *Aleutian* is classified as Low Risk for oiling probability for water surface socio-economic

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 0.01 g/m^2. It is classified as Low Risk for degree of oiling because the mean area of water contaminated was 7 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 *Aleutian* is classified as High Risk for oiling probability for shoreline socio-economic resources for the WCD because 100% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2. It is classified as Medium Risk for degree of oiling because the mean length of weighted shoreline contaminated was 20 miles. The *Aleutian* 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 100% of the model runs resulted in shorelines affected above the threshold of 1 g/m^2, and the mean length of weighted shoreline contaminated was 7 miles.

Considering the modeled risk scores and the socio-economic resources at risk, the socio-economic risk from potential releases of the WCD of 6,000 bbl of heavy fuel oil from the *Aleutian* is summarized as listed below and indicated in the far-right column in Table 4-2:

- Water column resources – Low, because of the very small area of impact
- Water surface resources – Low, because of the low probability of water surface oiling
- Shoreline resources – Medium, because although a relatively small length of shoreline might be impacted, it is in a high-value Alaskan native area

Table 4-2: Socio-economic risk factor ranks for the **Worst Case Discharge of 6,000 bbl** of heavy fuel oil from the *Aleutian*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	98% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 0.4 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	0% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	Low
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m^2 was 147 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	100% 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 600 bbl, the socio-economic risk from potential releases of heavy fuel oil from the *Aleutian* is summarized below and indicated in the far-right column in Table 4-3:

- Water column resources – Low, because no impacts above threshold are likely
- Water surface resources – Low, because of the low probability of water surface oiling
- Shoreline resources – Medium, because although a relatively small length of shoreline might be impacted, it is in a high-value Alaskan native area

Table 4-3: Socio-economic risk factor ranks for the **Most Probable Discharge of 600 bbl** of heavy fuel oil from the *Aleutian*.

Risk Factor	Risk Score			Explanation of Risk Score	Final Score
4A-1: Water Column Probability SRAR Oiling	Low	Medium	High	0% of the model runs resulted in at least 0.2 mi^2 of the upper 33 feet of the water column contaminated above 1 ppb aromatics	Low
4A-2: Water Column Degree SRAR Oiling	Low	Medium	High	The mean volume of water contaminated above 1 ppb was 0 mi^2 of the upper 33 feet of the water column	
4B-1: Water Surface Probability SRAR Oiling	Low	Medium	High	0% of the model runs resulted in at least 1,000 mi^2 of water surface covered by at least 0.01 g/m^2	Low
4B-2: Water Surface Degree SRAR Oiling	Low	Medium	High	The mean area of water contaminated above 0.01 g/m^2 was 7 mi^2	
4C-1: Shoreline Probability SRAR Oiling	Low	Medium	High	100% 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 7 mi	

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

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

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

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

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

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

For the Worst Case Discharge, the *Aleutian* scores Medium with 12 points; for the Most Probable Discharge, the *Aleutian* scores Low with 10 points. Under the National Contingency Plan, the U.S. Coast Guard and the Regional Response Team have the primary authority and responsibility to plan, prepare for, and respond to oil spills in U.S. waters. Based on the technical review of available information, NOAA proposes the following recommendations for the *Aleutian*. The final determination rests with the U.S. Coast Guard.

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

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

Vessel Risk Factors		Data Quality Score	Comments		Risk Score
Pollution Potential Factors	A1: Oil Volume (total bbl)	Med	5,595 bbl, not reported to be leaking		**Med**
	A2: Oil Type	High	Bunker oil is heavy fuel oil, a Group IV oil type		
	B: Wreck Clearance	High	Vessel not reported as cleared		
	C1: Burning of the Ship	High	No fire was reported		
	C2: Oil on Water	High	Oil was reported on the water; amount is not known		
	D1: Nature of Casualty	High	Ran aground on a rock pinnacle		
	D2: Structural Breakup	High	The vessel remains as one contiguous piece		
Archaeological Assessment	Archaeological Assessment	High	An accurate archaeological analysis could not be generated, but information provided to NOAA archaeologists by local divers is believed to be very accurate		**Not Scored**
Operational Factors	Wreck Orientation	High	Upright		**Not Scored**
	Depth	High	220 feet deep		
	Visual or Remote Sensing Confirmation of Site Condition	High	The site is a popular technical dive site		
	Other Hazardous Materials Onboard	High	None		
	Munitions Onboard	High	None		
	Gravesite (Civilian/Military)	High	Yes		
	Historical Protection Eligibility (NHPA/SMCA)	High	NHPA		
				WCD	**Most Probable**
Ecological Resources	3A: Water Column Resources	High	Nearshore waters are aggregation, spawning, and nursery habitat for important fish species	**Med**	**Low**
	3B: Water Surface Resources	High	Impact area includes 3 nesting bird colonies, wintering habitat for sea ducks, and use by marine mammals	**Med**	**Med**
	3C: Shore Resources	High	At risk shorelines are bird foraging areas and adjacent to herring spawning sites	**Med**	**Low**
Socio-Economic Resources	4A: Water Column Resources	High	Only a very small area of water column would be impacted	**Low**	**Low**
	4B: Water Surface Resources	High	Low probability that there would be water surface impacts	**Low**	**Low**
	4C: Shore Resources	High	Although a relatively small length of shoreline might be impacted, it is in a high-value Alaskan native area	**Med**	**Med**
Summary Risk Scores				**12**	**10**